Exhibit 2

1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

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4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 DECEMBER 16, 2009
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 75, P.M. SESSION

16

17 APPEARANCES:

18

19 For the Plaintiffs: MR. W.A. DREW EDMONDSON
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THE COURT: As I say, we're looking at some of these issues. And we'll rule on those as we are more comfortable. Number one, the federal common law issue is a significant one. Because, frankly, in looking over the break at the Supreme Court's language, it is very inclusive.

I don't think, as I sit here right now, that the Supreme Court ought to have used that broad language, frankly. I don't think it's a good idea for the -- for Congress to displace the common law. And the common law is a valuable thing for all of us. And to the extent that Congress steps in and displaces, I think it does -- in many cases, unless it's well thought out, it does a great disservice to us as citizens.

But the language that the Supreme Court -- this is Justice Powell in '81 -- used is extremely broad. And if that's how I come down, I'm going to highlight it and suggest that perhaps it ought not be read that broadly, but, frankly, I'm afraid that's above my pay grade. So we'll see how we come down on that.

I know there have been courts that have taken issue with what they consider to be overbroad decisions of the United States Supreme Court, and

limited the application of that language. I think it's, frankly, perilous and, arguably, violates one's oath of office if one was to do that.

I don't think it's the wise course or the wise law here. But as I sit here after reviewing the law briefly over the break, we're doing more work looking into whether or not some circuit has limited that language in the nearly 30 years since it was stated. But at this juncture, it doesn't appear -- I take it both sides have done complete research on that. I know Mr. Jorgensen has.

Mr. Bullock.

MR. BULLOCK: I know that we did our extensive briefs previously, and the court has talked --

THE COURT: I don't want any more briefing.

MR. BULLOCK: Judge, I'm not trying to argue that.

THE COURT: Frankly, I'm a little put out with the -- as I've said already today, with some of the representations with regard to the cases. You all are officers of the court. It, frankly, takes us more time if the cases -- the holdings of cases have been misrepresented. And I'm not pointing the finger at any one person, but I'm saying you're

MR. PAGE: Your Honor, if I may. I believe The witness and Mr. Green had pointed out parts of this report that are specific criticisms of Dr. Olsen and Dr. Engel and also the modeling of the lake.

In his report, he does not discuss the overall chemical, physical or biological processes of fate and transport, nor does he discuss or define what fate and transport evaluation should contain or how it should proceed.

Mr. Green's question had to do with a general explanation of fate and transport. The sections that he pointed you to related to critiques of specific expert reports provided by the State.

THE COURT: I understand, but necessarily if he's going to critique the State's fate and transport analysis, he has to have an understanding of that. The objection is overruled. Go ahead.

MR. GREEN: Thank you, sir.

Q. (By Mr. Green) So the question was with respect to these terms fate and transport and mass balance, what is your understanding of them and how are they related?

A. Fate and transport is a term of art that's common in our field. And it refers to all of the physical,

chemical and biological processes that affect a pollutant as that pollutant moves from its original source to its final destination, and how those processes interact and how they affect the movement and the ultimate disposition of the pollutant.

Mass balance is a tool. Mass balance is used in the context of fate and transport in order to help evaluating fate and transport. Mass balance is, more specifically, a statement of conservation of mass, that mass can be neither created nor destroyed so that fate and transport calculations and analyses are essentially tracking mass. They're conforming to conservation of mass. They quantify sources, they quantify syncs. And mass balance is all about balancing sources and syncs as you are looking at the fate and transport within the environment.

Q. Doctor, has the EPA issued any guidance concerning fate and transport analysis?

A. Yes, they have.

Q. What form has that guidance taken?

A. EPA has a rather substantial guidance document on conducting ecological risk assessments. And within that document, they provide pretty specific guidance on how to conduct a fate and transport

chemical and biological processes that affect a pollutant as that pollutant moves from its original source to its final destination, and how those processes interact and how they affect the movement and the ultimate disposition of the pollutant.

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A. Yes, they have.

Q. What form has that guidance taken?

A. EPA has a rather substantial guidance document on conducting ecological risk assessments. And within that document, they provide pretty specific guidance on how to conduct a fate and transport

analysis.
Q. And if one wanted to look for that guidance, where would they find it?
A. That guidance is available on EPA's website.
Q. Let me show you what we've marked as Tyson Demonstrative 208, and ask you to take a look at that, sir.
MR. PAGE: Your Honor, for the record, I want to reurge that these processes that are provided and discussed, these overall processes concerning chemical, physical and biological processes that are on Tyson Demonstrative 2008 (sic) are not found. Those discussions are not found in this expert's report. This is new analysis, and it should not be allowed.
MR. GREEN: Your Honor --
MR. PAGE: Nor is the EPA website found in his report, that citation.
THE COURT: Mr. Green.
MR. GREEN: To begin with, the doctor, in writing his report and in describing the problems that occurred to him in which he has evaluated in connection with the analysis of Drs. Fisher, Olsen and Engel, all partake of this analysis and these processes.

here affect the fate and transport of phosphorus in the environment and necessary for me to consider as I evaluated the fate and transport of phosphorus.

Q. And do you agree, sir, with the EPA's categorization here that these are the sort of chemical, biological and physical processes that one would look at in assessing fate and transport?

A. They are.

Q. Let's -- let's focus, then, if we can, on the first component or segment of this demonstrative which consists of the chemical processes that might affect contaminants.

Can you tell us, sir, how these chemical processes relate to a fate and transport investigation?

A. Certainly. As a chemical is moving through the environment, obviously it's affected by chemistry. And this summarizes the five principal processes that affect a chemical. A chemical can be degraded in the environment, so it actually disappears. It can be ionized, so it goes from a neutral substance to an ion. It can precipitate, which means that it goes from being dissolved to being solid. It can adsorb, which means that it becomes associated with the surface of a solid particle. And it can be

complex, which means that it can combine with other compounds to form large complexes in the environment. And all of those processes affect where the chemical goes and whether the chemical persists.

Q. Let me take you, then, to the next category on this demonstrative, sir, the physical processes that might affect contaminants. And could you help us to understand how these physical processes relate to a fate and transport investigation.

A. Well, volatilization is essentially the movement of a pollutant between water and air. And so as you're moving through the environment, you can exchange -- at least for certain pollutants, you can exchange between the water and the air, and that would obviously affect where they go.

Erosion is the erosion of sediment off the bottom. And so to the extent that a pollutant is associated with particles, it's subject to erosion.

Deposition is the opposite of erosion so that if it's particulate in nature, it can settle to the bottom.

Weathering of parent material is pretty much what it sounds like, like weathering of rocks, for example.

And water transport is simply movement associated with the movement of the water.

Q. Let us move, then, to the final category on this demonstrative, the biological processes that might affect contaminants. How do they relate to a fate and transport analysis, Doctor?

A. They, again, are obviously significant in controlling where a chemical goes and how it persists. Bioaccumulation is the uptake of a chemical by biological organisms. Biodegradation is the degradation typically by microorganisms.

Biological transformation is the conversion by an organism from one form to another form. Food chain transfer is a transfer up the food web to higher trophic levels. And excretion is the elimination of a pollutant by an organism or a plant back into the environment.

Q. Sir, in conducting a fate and transport study, does one have to look at all of these processes as part of the analysis?

A. It depends, obviously, on the pollutant you're looking at. They don't all apply to every pollutant, but those that do, you have to consider.

Q. Now, Doctor, we all know in this courtroom that this case is focusing principally on phosphorus in

the Illinois River Watershed.

Can you describe for us how various of these processes may be relevant to studying phosphorus movement in a system such as the IRW.

A. Sure. In terms of the chemical processes, phosphorus really doesn't -- isn't exposed to any chemical degradation, but there is ionization in the sense that phosphorus can exist in -- as an ionized form as a phosphate in the environment.

Precipitation exists because phosphorus or phosphate will precipitate with other chemicals, most significantly with calcium, iron and aluminum.

Adsorption is very important. Phosphorus will adsorb onto the surface of particles, principally smaller particles in the environment, clay-size, silt-size particles. Those that have iron hydroxide or aluminum hydroxide coatings, which are very common, phosphorus will readily adsorb onto those surfaces. And phosphorus can complex with other large compounds in the environment.

So with the exception of degradation, all of those processes apply.

With regard to the physical processes, phosphorus isn't subject to volatilization because a portion of its particulate, it is subject to erosion

and deposition.

Weathering of parent material is important because rocks contain phosphorus, so any weathering of rock material would liberate phosphorus. And obviously it's carried by water, and so water transport is important.

In terms of the biological processes, bioaccumulation is important because it's taken up by algae, which is what we're principally looking at here, but also by other organisms.

It doesn't biodegrade, but it is biotransformed from one form to another. There are some food chain transfers as one organism meets another, and phosphorus is excreted by organisms back into the environment.

Q. Dr. Connolly, in assessing fate and transport and mass balance as well, to what extent, if any, is it necessary, sir, to examine alternative sources of a constituent such as phosphorus in a system like the Illinois River Watershed?

A. It's absolutely critical. In fact, it's typically the first thing that you do in a study.

Q. When assessing the movement of a constituent in a system -- again, I'm always making reference here to the Illinois River Watershed -- where should fate and transport be assessed, sir?

sit in the back of the courtroom, listen to the testimony of other experts and then comment on the opinions of the experts that have already testified.

Now, if you want to do that relative to this witness, you can certainly do that.

MR. PAGE: Your Honor --

THE COURT: Now, where have I denied you that opportunity, Mr. Page?

MR. PAGE: During direct examination, there were opportunities where I --

THE COURT: Well, you have to specifically refer to something. If you can prove to me that I denied you the opportunity that I'm about to give Mr. Green, I'll give you the opportunity to bring them on in rebuttal. Otherwise, the objection is overruled.

Go ahead, Mr. Green.

MR. GREEN: Thank you, sir.

Q. (By Mr. Green) Doctor, you've undoubtedly lost track of the question I asked. Let me ask you again, and let me represent that Dr. Engel testified that once phosphorus begins to move off a field and to head downhill, it will necessarily continue on until it reaches the river and ultimately Lake

Tenkiller.

And I want to ask you whether you agree with that assessment.

A. Not at all.

Q. Can you explain for us here why you do not agree with that?

A. Because of all the fate and transport processes we just discussed, phosphorus is not immune to them. In fact, phosphorus is a very reactive element. A lot of these processes occur along the way. And the fact that phosphorus interacts with things along the way is one of the reasons, for example, they build buffer strips in order to treat water as it's moving downhill, because that buffer strip will necessarily affect the amount of phosphorus moving through it.

Q. What about different soils where phosphorus may be deposited, would that also impact the fate and transport?

A. Certainly, because the nature of the soils affects the speciation of the phosphorus, what forms the phosphorus is in, whether the phosphorus is in a dissolved form or becomes in a particulate form either by precipitating or adsorbing, what organisms might exist in the soil and what reactions might be going on, converting organic matter to inorganic

matter. So there's a tremendous amount of site specificity to the fate of any applied phosphorus.

Q. Let me ask you, what is a quantitative analysis? When scientists use that term, what is that in reference to?

A. Quantitative is just what it sounds like; it has to do with numbers. And so a quantitative analysis is an analysis that is consistent with mass balance, and so it is attempting to quantitatively account for the changes that are occurring.

So in the context of what we're talking about here, a quantitative analysis attempts to calculate mathematically, or approximately mathematically, what's going on, and so you can explain when you see different values in the environment why they're different and how they might be related.

Q. How does a quantitative analysis differ from a qualitative analysis?

A. Well, qualitative analysis is as it says, it's looking at the quality of something, not the quantity of something, so it's not numerical. So it's more looking at patterns than anything else.

So, for example, a qualitative analysis might simply be to look at, at this location I have

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So, for example, a qualitative analysis might simply be to look at, at this location I have

phosphorus, zinc, copper and so on, and at this location I have phosphorus, zinc, copper and so on, and so I say, okay, qualitatively they look similar or one is higher and one is lower. But there's no attempt to quantitatively relate what we're seeing at the two locations, which is what is the subject of a quantitative analysis.

Q. To what extent, if any, is it important to undertake a quantitative analysis rather than a qualitative analysis of the movement of a constituent through a system such as the IRW?

A. It's extremely important in order to be able to connect the dots, in other words.

Q. Can one do a fate and transport study based only on a qualitative analysis?

A. No.

Q. In reviewing the reports of the State's experts which you saw and in reviewing the testimony of the various experts, did you see any traditional -- in your mind, any traditional fate and transport analysis of the type that you've been describing which assesses the movement of constituents in poultry litter from fields to the rivers or streams and on to the lake?

A. No.

Q. Doctor, a slide was put up in an argument to the

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A. No.

Q. Doctor, a slide was put up in an argument to the

you agree with Dr. Fisher's assertion.

Let me -- let's take the first clause of that answer, sir. "Because the wastes were all similar and the in behavior of that waste under the influence of rainfall and gravity is all similar or the same, the waste is fungible." Do you agree with that proposition?

A. No. I think that's a pretty naive proposition.

Q. Can you flesh that out for us, why you believe that?

A. Because of the site-specific factors that will affect the extent to which the waste or poultry litter, however we want to refer to it, moves after it's applied.

I mean, there are so many site-specific factors that control whether you will get runoff and to the extent that you'll get runoff that it seems silly to me to make a statement such as what I'm seeing here.

Q. And the second clause is that there's no reason to do a site-specific analysis of fate and transport in the Illinois River Watershed.

Do you agree or disagree with that proposition that was uttered by Dr. Fisher in this courtroom?

A. I completely disagree.

Q. And why do you disagree?

A. Because fate and transport is, by its very nature,

site specific. And it is different from one field to another. And it's different depending upon what is between the field and the stream.

THE COURT: Under that analysis, how far do you take it? It's a million-acre watershed. Would you do a million fate and transport analyses for every acre? An acre is a pretty big place. Would you do three of them per acre?

THE WITNESS: I think what you have to do is divide the watershed up -- and this is what's typically done -- into areas that have similar characteristics, and then you --

THE COURT: Even within those similar characteristics, under your argument, there may be a pond interfering with the flow of water even though this area is similar to this area next to it. How many would you take within a million-acre watershed?

THE WITNESS: I think what you would have to do -- and I'm not -- when I'm saying a site-specific analysis here, what I'm saying is you have to take into account the conditions. Now, given --

THE COURT: How many fate and transport analyses would you take within a million-acre watershed?

THE WITNESS: I would not venture a guess until I did a lot more work in trying to make that decision.

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 76 - AM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

DECEMBER 17, 2009

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

1 I N D E X

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5 *WITNESSES ON BEHALF OF THE PLAINTIFF*

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7 **JOHN CONNOLLY, PH.D.**

8 Continued Direct Examination by Mr. Green 8874

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CONTINUED DIRECT EXAMINATION

BY MR. GREEN:

Q. I would like to start this morning by returning to the question that the court asked at the close of court yesterday afternoon. I think that -- I think I understand the point that the court was perhaps concerned about and so let me ask you a few questions, Dr. Connolly, and see if I can bring some clarification to this issue. I want to ask a question which is going to call for an analysis at the macro level, if you will.

If you wanted to investigate in the entire Illinois River Watershed which source or sources was or were the principle contributor of phosphorus to the waters of the watershed, could that be done using a traditional fate and transport study?

A. Yes, it could.

Q. Okay. Now, would you have to do -- would you have to undertake a million fate and transport studies to correspond to the million acres in this watershed or perhaps even more than one study per acre? Would you need to do fate and transport studies in that number, sir?

A. No.

Q. Okay. So how would you go about determining

whether or not a source, or combination of sources, were the dominant contributors of phosphorus to this watershed at the macro level?

A. At the macro level, you want to do things that are estimations, sort of averaging. And so what you would do would be to break the watershed up into various categories, so categories based on land use, soil type, and slope.

When you do that, perhaps you break the watershed up into 30 or so categories. And then within each category, you would do a site-specific study at one or two representative locations in order to provide data that you could use to calibrate a model of the watershed that you would then apply to get an estimate of the contribution of the various sources.

Q. Okay. Now, was that done in this case as far as you can tell from your review of all the testimony and the reports that you examined?

A. I see nothing in everything that I've examined where such an analysis was done. The most that I've seen is samples taken at the edge of a field as the closest thing to such a study.

Q. Okay. Now, I want to descend from the macro and come all the way down to a scale which I think is

whether or not a source, or combination of sources, were the dominant contributors of phosphorus to this watershed at the macro level?

A. At the macro level, you want to do things that are estimations, sort of averaging. And so what you would do would be to break the watershed up into various categories, so categories based on land use, soil type, and slope.

When you do that, perhaps you break the watershed up into 30 or so categories. And then within each category, you would do a site-specific study at one or two representative locations in order to provide data that you could use to calibrate a model of the watershed that you would then apply to get an estimate of the contribution of the various sources.

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A. I see nothing in everything that I've examined where such an analysis was done. The most that I've seen is samples taken at the edge of a field as the closest thing to such a study.

Q. Okay. Now, I want to descend from the macro and come all the way down to a scale which I think is

some more appropriate for the issues that we're discussing in this case and I want to ask you this question.

If you wanted to determine whether phosphorus moves off the fields -- a field or the fields of any particular grower who is affiliated with any of the integrators in this case, would it be appropriate to undertake a fate and transport study?

A. Yes.

Q. Okay. Now, at that level, far below the macro level, how would you undertake a fate and transport study to answer that question?

MR. PAGE: Objection, Your Honor; new opinion.

MR. GREEN: I think, Your Honor, this is just responding to your question, number one; and number two, it's not a new opinion at all. His analysis throughout his opinion is all about the proper method of conducting a fate and transport study. So we are simply asking him how one would go about doing that at the micro level, for lack of a better way of putting it.

THE COURT: Now, going back to this issue that was raised here at the end of the day yesterday, obviously at the time the expert report was

prepared on January 30th, the witness had the opportunity to read the plaintiff's experts' reports; correct?

MR. GREEN: Yes, sir.

THE COURT: And he did not opine with regard to this particular matter as to how he would undertake a fate and transport study?

MR. GREEN: Can we put that question first to the witness?

THE COURT: That's fine.

MR. GREEN: Okay.

Q. *(BY MR. GREEN)* Doctor, in your report, do you address this subject?

A. I do address this subject by discussing what you have to consider to do a fate and transport study, an appropriate fate and transport study.

MR. PAGE: Your Honor, may I be heard?

THE COURT: Yes, sir.

MR. PAGE: Dr. Connolly's report takes specific criticisms of specific fate and transport analysis by the state's witnesses. It does not overall in his report describe what he would have done if he would have done this study, which essentially is the testimony being elicited today.

THE COURT: I think it's implicit. If

you look at summary of findings 1.2(7), he talks about how the water quality modeling conducted by the plaintiff's consultants is flawed. The objection's overruled.

Go ahead.

Q. *(BY MR. GREEN)* Well, Doctor, the question that I want you to have in mind is, if you were now tasked with looking at the field of a particular grower or perhaps several fields belonging to that grower who was under contract to one of these integrators, how would you go about conducting a fate and transport study to determine whether phosphorus contained in land-applied poultry litter is migrating off that field and reaching the surface waters of the watershed?

A. First thing that I would do would be to determine just how many fields this grower had. If the grower simply had a few fields, then I would conduct a study for each one of the fields. If the grower had, you know, ten fields or twenty fields, I would take a subset of those fields, trying to cover the range of characteristics of those fields that are important -- again, land use, soil type, slope -- and conduct studies for that subset.

The way I would set up such a study would be

to first characterize the field, just based upon topography, so that I understood in a rainfall event where runoff would occur off of this field, which you can do based upon the topography of the field. I would then track the application of fertilizer to that field so that I knew when it was applied, how much was applied, then wait for a rainfall event.

When the rainfall event occurred, I would monitor the rainfall event itself, how much rain was occurring for how long and at what intensity. I would sample at the exit points of the field that I had previously determined, and if, in fact, that rainfall generated runoff, I would sample the runoff at the edge of the field.

In order to understand the fate of that, one of the things that is typically done would be to tag the water by, for example, putting some dye in it. So you could put dye in the water that's running off the field so you can track that.

Based, again, upon a reconnaissance study before, you can have a pretty good idea of here are the exit points of water from the field and based upon topography this is likely where that water will go and where it will ultimately intersect a tributary.

And using the dye to understand when that

water is reaching that tributary, you could sample that tributary at that point -- or where the intersection is of that tributary, knowing that you are now sampling the water coming off the field because the dye has told you that is, in fact, that water. That would allow you then to see what happens between the edge of the field and where the water running off that field actually intersects a tributary.

Then within the tributary, all right, you would attempt to sample along the tributary, but there it gets much more complicated.

MR. PAGE: Your Honor, none of this discussion about dyes and intersections of samples is in his report. This is all brand-new analysis.

THE COURT: Okay. It's part and parcel of the question, how would one go about a fate and transport study if looking at a particular grower. The objection was made and it was overruled. It's the same objection. Overruled again.

Go ahead.

Q. *(BY MR. GREEN)* Can you pick up where you were, Doctor?

A. Yes. It becomes much more complicated now once you reach the tributary because now you can

certainly track things down a tributary, but now you have to begin to take account of additional water coming in from other lands and potentially other sources coming in. And so it becomes a much more intensive study in order to try to take account of all the other sources and the additional water that would be coming in as water moved down the tributary.

Q. Okay. And can you just give us a very brief explanation of how you would undertake that further accountability exercise, if you will?

A. You'd have to measure flow so that you have some sense of the flow at the point where the water running off the field hits the tributary, you'd have to measure flow downstream so you could account for the increase in flow from other sources, and you would have to have some sense of where that water was coming from and how it might contribute phosphorus.

Q. Okay. Doctor, let me step back and ask you some general questions here and then we'll proceed to more specific issues.

I want to show you a demonstrative; it's Tyson Demonstrative No. 19.

MR. GREEN: If you could bring that up, please.

Q. *(BY MR. GREEN)* That's a demonstrative,

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Q. *(BY MR. GREEN)* That's a demonstrative,

certainly track things down a tributary, but now you have to begin to take account of additional water coming in from other lands and potentially other sources coming in. And so it becomes a much more intensive study in order to try to take account of all the other sources and the additional water that would be coming in as water moved down the tributary.

Q. Okay. And can you just give us a very brief explanation of how you would undertake that further accountability exercise, if you will?

A. You'd have to measure flow so that you have some sense of the flow at the point where the water running off the field hits the tributary, you'd have to measure flow downstream so you could account for the increase in flow from other sources, and you would have to have some sense of where that water was coming from and how it might contribute phosphorus.

Q. Okay. Doctor, let me step back and ask you some general questions here and then we'll proceed to more specific issues.

I want to show you a demonstrative; it's Tyson Demonstrative No. 19.

MR. GREEN: If you could bring that up, please.

Q. *(BY MR. GREEN)* That's a demonstrative,

Doctor. Do you see that in front of you?

A. Yes, I do.

Q. Now, that's been exhibited in this courtroom before during this trial.

With respect to these sources that are indicated here, sir, do you agree that each of the potential sources indicated on this demonstrative are capable of contributing phosphorus to the watershed?

A. Yes, they all are.

Q. Okay. I want to ask you about a couple of these that are pictured here.

I want to direct your attention first to deforestation and ask you, how can deforestation contribute phosphorus loadings to surface waters in the watershed?

A. Phosphorus -- I'm sorry -- forests are relatively good conservers of soil just by the nature of the root system of the trees and the underbrush typically in a forest.

Deforestation removes that root system and the underbrush, makes the soil much more susceptible to runoff, and so it's well known that deforestation results in increased erosion of soil and there's phosphorus in the soil that's being eroded.

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Deforestation removes that root system and the underbrush, makes the soil much more susceptible to runoff, and so it's well known that deforestation results in increased erosion of soil and there's phosphorus in the soil that's being eroded.

Q. When you prepared your report, did you come

across information which led you to conclude that the IRW, the watershed, has suffered substantial deforestation over the past several decades?

A. It has in large point -- in large part because of the growth in population that has occurred in the watershed. This is a relatively rapidly growing part of the country.

Q. Now, let me turn your attention to urbanization, which is another one of these potential sources of phosphorus loading.

How does that impact phosphorus loading in the watershed, Doctor, urbanization?

A. It does so in several ways.

MR. PAGE: Your Honor, I object. If this is a question directed to the Illinois River Watershed, this witness has done no study as to urban effects on this watershed. If it's directed just to general watersheds in general, then I have no objection. But I believe the question is ambiguous in that regard.

MR. GREEN: Urbanization is discussed specifically in his report. If the question should be rephrased as to urbanization generally, I'm happy to rephrase it.

THE COURT: Okay. Apparently, we're

1 going to need to go through, as we go through the
2 opinions, and be able to reference the portions here
3 of the report.
4 What portion of the report addresses impact
5 of urbanization and phosphorus loading on the
6 watershed?
7 MR. GREEN: If you'll bear with me one
8 minute, Your Honor.
9 THE COURT: Yes, sir.
10 MR. GREEN: If Your Honor has the
11 report, page 2-3, there is a discussion of the many
12 contributors of phosphorus to the Illinois River and
13 Lake Tenkiller, second paragraph.
14 THE COURT: I see it. Overruled.
15 Go ahead.
16 MR. GREEN: All right. Thank you, sir.
17 Q. *(BY MR. GREEN)* Would you now, Doctor, be
18 kind to tell me how urbanization can impact phosphorus
19 loading to the watershed?
20 A. It does so in several ways. The first is the
21 construction phase, so urbanization obviously involves
22 a tremendous amount of construction. That
23 construction in and of itself disturbs soil, provides
24 for greater erosion of soil than would occur in the
25 absence of the construction phase.

Urbanization converts soil land to impervious sources, so we're building roads and parking lots and buildings. So whereas water would run into the ground, it will now run into an impervious surface. In urban areas, we collect that water in storm sewers, direct those storm sewers to the receiving water. So we've now taken water that would normally not make its way to the receiving water and we're channeling it to the receiving water.

Because of the activities in the urban areas, there's phosphorus on the impervious surfaces, so we're providing a direct conduit to transfer that phosphorus to the receiving water.

And in addition, because we're now providing a direct pathway for water to get to the receiving water without being lost through infiltration in the ground, you change the hydrograph of the river so that its response to high-flow events is different. And, in fact, we generate greater responses to high-flow events because we're bringing more of the water into the river during -- during the high-flow events.

That increased flow results in increased velocities, which results in increased erosion of the stream bottom and the stream banks, and that also contributes then to phosphorus loading and transport.

Q. How well-recognized is the impact of urbanization on water quality?

A. It's very well-recognized. EPA has been studying urbanization for decades. In fact, EPA has a large program called -- called the National Urban Runoff Program. That program's been around since the late '70s, early '80s. EPA has compiled a tremendous database on urban runoff pollutants from urban runoff. That database is continually updated and is the source of information that is generally used in assessing urban runoff impacts on waterbodies.

Q. And what about the location of urban areas, particularly with reference to the watershed we're talking about; does that have any impact on water quality?

A. Well, it does. Because, I mean, if the urban area is at the downstream end of the watershed, obviously it's only affecting that limited portion of the watershed.

Here, a lot of the urbanization is in the upper reaches of the watershed, so the sources of phosphorus due to urbanization are reaching this watershed at its upper reaches, and therefore, can impact the watershed from nearly its beginning and throughout it.

Q. All right. Let's shift focus just a bit and talk about wastewater-treatment plants.

Are they, in your view, Doctor, relevant to water quality in terms of phosphorus loading in the watershed?

A. Very much so. Wastewater-treatment plants are carrying the phosphorus from most of the humans in the watershed, at least those that are tied into the sanitary sewer system, and there's a considerable amount of phosphorus associated with that. It's delivered directly to the waterbody, so the discharge from the wastewater-treatment plant is to a tributary to the river and it discharges continuously.

Q. What about the form of that phosphorus?

A. Most of the phosphorus that comes out of a wastewater-treatment plant is dissolved phosphorus, and much of the dissolved phosphorus out of a wastewater-treatment plant is what is termed "soluble-reactive phosphorus," which is the phosphorus that's readily taken up by algae.

Q. Let's look at another one of these potential sources on the demonstrative, and let me ask you something quickly about cattle.

What contribution, if any, do cattle make to phosphorus loading in the watershed, Doctor?

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Q. Let's look at another one of these potential sources on the demonstrative, and let me ask you something quickly about cattle.

What contribution, if any, do cattle make to phosphorus loading in the watershed, Doctor?

A. Well, cattle manure has a fairly high phosphorus content. Cattle tend to loaf in streams or in the riparian areas of streams so that they defecate proximate to a stream so that there is very little travel distance, in some cases none at all, because the defecation occurs right in the stream.

In addition, because cattle tend to congregate in these areas, they tend to tramp down the ground which reduces the ability of rainwater to infiltrate in those areas, and so it assists in runoff and moving the phosphorus in the cattle manure directly into a receiving water.

Q. Now, have you examined phosphorus levels in runoff from fields that contained cattle manure?

A. I've looked at the data collected by the plaintiffs that's purported to represent runoff from fields inhabited by cattle.

Q. Okay. And did you, sir, in the course of your work for this case, prepare a chart to illustrate that analysis?

A. I did.

Q. Okay.

MR. GREEN: Leave this off the screen for a minute.

Q. *(BY MR. GREEN)* You have in your notebook

Defendants' Joint Exhibit 6109. Do you see that, Doctor?

A. Yes, I do.

Q. Okay. First of all, was this chart contained in your report?

A. Yes.

Q. And what does this chart show us, sir?

A. This chart shows the phosphorus concentration in all of the edge-of-field samples collected by the plaintiffs, both from fields that were purported to have had poultry litter applied and to fields that were inhabited by cattle.

Q. And is there a name for this kind of a chart?

A. This is a -- what we call a "probability plot." And it's simply a way to array every data point on one plot so that we can see all of the values. They're arranged from lowest value on left to highest value on the right.

Q. All right.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6109.

THE COURT: Any objection?

MR. PAGE: No objection, Your Honor.

THE COURT: Defendants' 6109 is admitted.

MR. GREEN: May we put that on the screen, please?

THE COURT: You may, sir.

Q. *(BY MR. GREEN)* All right. Now, Doctor, let's talk about -- I see mostly triangles and then there are a couple of diamonds. Can you explain, you know, what this information is so that we all understand it?

A. The triangles are -- each one is a measurement from an edge-of-field sample purported to be from a poultry-applied litter field. The diamonds are the measurements of phosphorus in the edge-of-field samples from the cattle-impacted fields.

Q. Okay. And this is all plaintiff's sampling data; is that right?

A. Yes, it is.

Q. All right. And so once you do your probability plot and you have it arranged as it is here on this exhibit, what is it telling you, Doctor?

A. Well, it tells me two things. One, if we just look at the triangles, you can see there's a huge range in concentration. You can see that whereas there are many triangles -- and, in fact, in the legend at the upper left the first number in the

parenthesis is the number of samples -- so you can see that there were 86 samples from edge-of-field associated with poultry -- or purported to be associated with poultry. There are only two samples from fields to which cattle were associated.

So the first thing I take away from this was that, you know, there's clearly a biased sampling program here that was focused on poultry-applied fields to pretty much the exclusion almost of cattle -- cattle fields.

But perhaps the more important thing here is if you look at this and if you go up at the 50 percent value that you see on the horizontal axis, that represents then the median value. So half the values are greater than the value that crosses that 50 percent and half are less. And so you can see the median value of phosphorus in the edge-of-field samples purported to be associated with poultry is approximately one milligram per liter.

You can see that two samples, the diamonds, from the two cattle fields both are about the same value, so that the two cattle fields that were sampled had an edge-of-field phosphorus concentration of approximately 1 milligram per liter which corresponds to the median value of the edge-of-field samples

associated with poultry.

Q. So, Doctor, in your view, is there any real or meaningful difference in the phosphorus levels between the poultry edge-of-field samples and these cattle edge-of-field samples?

A. There is not. In fact, one of the -- one of the ways in which you would look at that, at least the way a statistician would look at that, would be given this larger data set for poultry, you could ask the question, are those two cattle samples different?

And because they are right in the middle of the distribution of the poultry, you would conclude they are not different. And so there is -- you cannot see any difference between these two data sets in terms of phosphorus concentration.

Q. Okay. Let me continue with our discussion of some of these potential sources, and let me ask you the question about commercial fertilizer.

To what extent, sir, can commercial fertilizer impact phosphorus loadings and water quality in the IRW?

A. Commercial phosphorus is applied, you know, in a similar manner to other fertilizers. It can be a significant source because the phosphorus in commercial fertilizer is essentially inorganic

phosphorus and so it's easily solubilized and can easily run off a field if there's runoff during a rain event.

Q. We've touched on a number of these contributors of phosphorus to the watershed, or potential contributors.

Are there differences in the -- are differences in the source of where phosphorus is coming from relevant to mass balance and fate and transport considerations, Doctor?

A. Yes. Because you really have to understand all the fate and transport processes that might impact the phosphorus between the location where it's applied and the receiving water.

Q. In your review of Dr. Engel's report and his testimony, and for that matter, perhaps even Dr. Fisher or Dr. Olsen, did you find any evidence that any of them extended their analysis beyond the edge-of-field?

A. I saw no analysis of the transport or fate of things beyond the edge-of-field.

Q. I want to switch bases here just a couple of degrees and talk about the different types of phosphorus, if I may, Doctor.

When we talk about phosphorus in the

environment, are we talking about the element phosphorus, elemental P?

A. No. Elemental P doesn't exist in the environment. It's a -- phosphorus is a very reactive compound, and elemental P actually is created in a laboratory and is used for things like fireworks.

In the environment, phosphorus reacts with oxygen so phosphorus is always present in the environment combined with oxygen. The free element phosphorus is not found naturally in the environment.

Q. Okay. Does elemental phosphorus have any implications for hazardous substance categorization?

A. Yes. Elemental phosphorus, because of its highly reactive nature, is a CERCLA hazardous substance.

Q. Now, Doctor, have you studied the types of phosphorus compounds that can exist in the environment?

A. Yes.

Q. And does phosphorus appear in different forms in the environment?

A. Yes, it does.

Q. Now, in connection with your report, Doctor, did you prepare a chart which shows the types of phosphorus compounds that do exist in the environment?

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A. Yes.

MR. GREEN: All right. Let me, if I may, ask that Demonstrative Exhibit DJX6070 be put up.

Q. *(BY MR. GREEN)* Now, Doctor, is this a chart that you prepared?

A. It is.

Q. And did this chart appear, sir, in your report?

A. Yes.

Q. Okay. What were you attempting to depict or illustrate using this chart with respect to the different types of phosphorus?

A. I was trying to illustrate the broad categorization of phosphorus that's typically done by scientists looking at phosphorus in the environment.

Q. Okay. Can you give us a little explanation of how one would read this chart and understand the arrows and so forth?

A. Certainly. Broadly, you can divide phosphorus into four categories, and that's what the four boxes represent.

The first row, the two boxes in the first row, you can see the left label "organic." So we divide organic phosphorus into two categories. And if you look at the bottom, you see the left is

1 particulate, the right is dissolved. So organic
2 phosphorus we separate into particulate organic
3 phosphorus and dissolved organic phosphorus.
4 You can see there's an arrow going from the
5 particulate organic phosphorus to the dissolved
6 organic phosphorus, and that's because typically
7 through biological processes, through microbial
8 degradation of organic matter, organic phosphorus is
9 first solubilized so -- microorganisms secrete enzymes
10 that actually can solubilize organic matter, changing
11 it from a particulate form to a dissolved form. So
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20 "mineralization" or "hydrolysis." This is, again,
21 part of microbial degradation where microorganisms in
22 order to use organic matter, right, are breaking down
23 the organic matter, and as part of the breakdown of
24 the organic matter, they liberate inorganic phosphorus
25 in a dissolved form. That form of phosphorus is

available for algal growth.

The particulate inorganic phosphorus that you see in the lower right interacts in several ways with the dissolved inorganic phosphorus. And you can see the arrow from the dissolved inorganic phosphorus to the particulate inorganic phosphorus, and it's labeled "adsorption" and "precipitation."

So there are several processes here by which dissolved inorganic phosphorus can become dissolved particulate phosphorus. Precipitation is where the dissolved inorganic phosphorus is reacting with another chemical in the environment and becoming a solid. Principally that occurs in association with iron, aluminum, or calcium, and so they'll form iron phosphates, aluminum phosphates, calcium phosphates that precipitate out.

The adsorption is the association of the dissolved inorganic phosphorus with the surface of solid particles, and so that process is reversible, and so you can adsorb onto the surface and desorb off. That principally occurs with smaller particles, it happens to a great extent with clay-type particles, and it happens to particles that are coated with iron hydroxides and aluminum hydroxides. Many particles have these kind of coatings -- aluminum or iron

hydroxide coatings -- and phosphorus will adsorb onto those surfaces. And then as you see the arrow back, it can desorb or it can dissolve.

Now, the dissolving is if, for example, we have an iron phosphate particulate, that can dissolve back into solution and form the dissolved inorganic phosphorus.

Q. Thank you. I just feel like I've been through a full chemistry course.

Doctor, when phosphorus compounds change from one form to another, is there a name for that?

A. What -- transformation is the general categorization for that.

Q. Okay. Now, using this chart, what is the significance, if any, sir, of the different types of phosphorus for your analysis in this case?

A. Well, the significance comes from the fact that there's only a portion of the phosphorus that can be taken up by algae, and so you really have to understand the form of the phosphorus associated with the various sources, as well as the ability and the rates for transformation among the forms in order to understand how much phosphorus is available to grow algae.

Q. Okay.

THE COURT: Now, is that generally the soluble-reactive phosphorus then?

THE WITNESS: Yes. And soluble-reactive phosphorus does not actually fit exactly in one of these boxes. Soluble-reactive phosphorus is mostly dissolved inorganic phosphorus. It does include, though, a small amount of dissolved organic phosphorus, and that comes from the way the test is conducted.

In order to measure what's called "soluble-reactive phosphorus," you take a sample and you filter it and then you add a little bit of acid to that. The little bit of acid that you add can actually break down a little bit of the organic matter, and so some of that organic matter that gets broken down gets measured. Because the way we measure phosphorus is an attempt to convert it all to phosphate and then measure the amount of phosphate.

Soluble-reactive, you're measuring what phosphate is there existing and what little bit of organic might have been converted by the acid.

When we're looking at organic phosphorus, or particulate organic, or dissolved organic, and trying to measure it, it includes a digestion step. You add this really aggressive acid to essentially digest all

the phosphorus and convert it all to phosphate, and at the end of the day you measure phosphate.

So all measurements of phosphorus are measurements of phosphate, and in the laboratory they're doing all sorts of things to convert all the forms to phosphate to make the measurement.

THE COURT: All right. But all of that phosphate is not available for algae growth?

THE WITNESS: No.

THE COURT: But primarily that which is available for algae growth is dissolved reactive phosphorus?

THE WITNESS: Yes, yes.

THE COURT: Okay. Now, with regard to the orthophosphate, that's primarily what you're talking about that's in this adsorption/precipitation step?

THE WITNESS: It is. It's on the dissolved side. So the algae can only take up dissolved orthophosphate. And so to the extent that some of it is on particles, the algae can see if it desorbs off the particle.

THE COURT: So is dissolved reactive phosphorus a subset of orthophosphate?

THE WITNESS: No. It includes all of

the dissolved orthophosphate. So any orthophosphate that's dissolved is included in soluble-reactive phosphate.

THE COURT: All right. Go ahead.

MR. GREEN: Thank you, sir.

Q. *(BY MR. GREEN)* Now, Doctor, when scientists measure total phosphorus in water, which types of phosphorus are included in that measure?

A. All of the types.

Q. And so when a scientist hears a measurement of total phosphorus, is that a measurement of what phosphorus is available to feed algae?

A. No.

Q. And I think you probably in your colloquy with the judge may have answered this, but let me -- indulge me to see if -- to make sure that we have an answer.

When we talk about the measurement of total dissolved phosphorus, is all of that available to support algae growth?

A. No.

Q. Okay.

A. The dissolved organic phosphorus is largely unavailable to the algae.

Q. All right, Doctor. There has been

environment, are we talking about the element phosphorus, elemental P?

A. No. Elemental P doesn't exist in the environment. It's a -- phosphorus is a very reactive compound, and elemental P actually is created in a laboratory and is used for things like fireworks.

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Q. Okay. Does elemental phosphorus have any implications for hazardous substance categorization?

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A. Yes.

Q. And does phosphorus appear in different forms in the environment?

A. Yes, it does.

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Q. Okay.

substantial testimony in this case regarding point sources and nonpoint-source pollution. You are familiar with those terms; correct?

A. Yes.

Q. Are point sources typically associated with any particular form of phosphorus?

A. Yes. The dominant point source is wastewater-treatment plant, and that phosphorus is principally dissolved phosphorus and most of that is soluble-reactive phosphorus.

Q. And how would that contrast with the kind of phosphorus, you know, typically in nonpoint sources? Is there a difference?

A. There's a -- there's a difference and it's really important in two ways. There is -- there's a difference because some of the phosphorus coming from nonpoint sources at its origin is particulate. But along the pathway, as phosphorus is moving from a source in a nonpoint, it's encountering a lot of solids, right? In a runoff event, right, we're generating a huge load of solid material, soil that's being eroded.

Phosphorus, even if it started out off a field as dissolved phosphorus, when it sees the high concentrations of solids that are associated with

runoff will react and absorb and become associated with those solids. So that nonpoint sources in and of themselves will be a combination of dissolved particulate running off the field and along the way from the field to the receiving water will encounter a lot more eroding soil, and that soil will absorb some of that phosphorus.

So for nonpoint sources it's typical that by the time you get to the receiving water, a significant fraction of that phosphorus is associated with particulate matter.

Q. Okay. We'll return to that subject a little later.

In the course of your work on this case and in preparing your materials, sir, did you have occasion to analyze the plaintiff's wastewater-treatment plant effluent sampling data to determine whether or not that point-source discharge in the watershed is dominated by dissolved phosphorus?

A. Yes.

Q. And did you, sir, create a graph to demonstrate the results of your analysis?

A. Yes.

Q. All right. You have in your notebook Defendants' Joint Exhibit 6088. Would you turn to

that for a moment, please?

A. I have it.

Q. Okay. Now, was this graph contained in your expert report?

A. Yes.

Q. And the data from this graph comes from where, Doctor?

A. It's data collected by the plaintiffs.

MR. GREEN: All right. I move the admission of Defendants' Joint Exhibit 6088, Your Honor.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: Defendants' 6088 is admitted.

MR. GREEN: May we put it --

THE COURT: Before we -- yes, you may put it up.

Before you go on, there is no question, though, Doctor, that by bringing in lots of phosphate into the watershed for inclusion into poultry feed going through the poultry's internal processes and deposited into poultry litter, it does increase in some amount the amount of dissolved -- or soluble-reactive phosphorus available for algae growth

in a watershed with a relatively high gradient, you're going to have these low-gradient portions where the water doesn't move very fast; right?

THE WITNESS: Yes, you will. So I'm sort of speaking in general. You know, there are, I'm sure, some tributaries in this system that are low gradient, and even under a high-flow event, water will move slow enough to allow some algae growth.

But in terms of the larger Illinois River, which is what I was referring to, there really is very little time during a high-flow event to allow algae to grow.

THE COURT: Of course, there's been testimony here that things change on a weekly basis. Because from a high-flow event, you may have relatively low flow the next week?

THE WITNESS: Yes.

THE COURT: We've been talking about -- I think on this record, one of the algae experts has even told us the flow speed at which algae tends to break up and move downstream, but a week later when the flow is less it starts building up again.

It's a very dynamic process; right?

THE WITNESS: Yes. Yes, it is.

THE COURT: All right. Do you opine

here as to what percentage of the overall soluble-reactive phosphorus you believe is contributed to by the integrators bringing phosphates into the watershed?

THE WITNESS: No. I've not done a calculation to say what fraction of the phosphorus.

What I focused on, because I did not have the opportunity to do the kind of calculation that I think we talked about earlier, to figure out how much of that phosphorus is coming from the growers, was to categorize it in terms of the influence of nonpoint sources in general, poultry litter being some component of the nonpoint sources.

The nonpoint sources dominate. I mean, you know, 75, 80 percent of the phosphorus that's moving to Lake Tenkiller is coming from nonpoint sources.

What I focused on was the impact of that phosphorus load on water quality vis-a-vis the impact of point sources on water quality. A lot of that has to do with the dynamics of the system, the opportunity for growth, the ultimate fate of the phosphorus as it moves through the system.

It was through that analysis, trying to contrast the relationships between the point and nonpoint sources that has led me to conclude that the

algae growth that we see is in large part controlled by the point sources in the system rather than the nonpoint sources.

THE COURT: Now, you're on one of these EPA standing committees; correct?

THE WITNESS: Yes.

THE COURT: And in looking at our Clean Water Act issue, which I referred to, we were trying to become instant experts on the Clean Water Act and to what extent the amendments to the Clean Water Act have filled in the gaps in the federal common law. In doing so, we've looked here at some EPA publications where EPA basically admits that they've done a pretty good job controlling point source, but nonpoint source is the real problem in this country today.

Generally, would you agree with that?

THE WITNESS: Yes, it is. And a lot of that has to do with just the nature of the waterbodies and whether or not there's opportunities for nonpoint sources to have an impact.

For example, you know, EPA has conducted large-scale studies on big systems as part of it. So there's a huge study, for example, in Chesapeake Bay. And by the nature of Chesapeake Bay --

THE COURT: With the Delmarva poultry

production being one of the focuses of that study; correct?

THE WITNESS: Yes. But the nature of Chesapeake Bay is such that nonpoint sources can be more important there than perhaps in another case from what I've concluded in the Illinois River Watershed because of the differences in the nature of the systems and in how phosphorus is transported and the opportunities for nonpoint sources to impact water quality, which are substantially different here than they are in some other areas of the country.

THE COURT: Mr. Green.

MR. GREEN: Thank you, sir.

THE COURT: I mean, clearly this is far more rural than the eastern shore and the D.C. area; correct?

THE WITNESS: Yes, it is.

THE COURT: Route 50 to the shore has gotten fairly urbanized; right?

THE WITNESS: Yes, it has.

THE COURT: Go ahead.

MR. GREEN: I yearn for the eastern shore, Your Honor, where I will spend the holidays. Thank you.

Q. *(BY MR. GREEN)* All right. We have on the

1 screen Defendants' Joint Exhibit 6088. And would you
2 be kind enough, Doctor, to explain to us what is this
3 chart showing us, what's the analysis here, and how
4 does it inform your opinion, sir?
5 A. The plaintiffs took samples of wastewater
6 treatment effluent and analyzed the phosphorus in it
7 and analyzed it in the components we were just looking
8 at, and I've simply plotted their data.
9 In the upper plot on the horizontal axis, you
10 see it says "total phosphorus." So that's the total
11 phosphorus content measured in that wastewater
12 treatment sample. And the vertical axis is the
13 fraction of that total phosphorus that's dissolved.
14 So you see it says the dissolved phosphorus divided by
15 total phosphorus.
16 So every one of the samples is here. You can
17 see that a large number of the samples have similar
18 total phosphorus concentrations of a few tenths of a
19 milligram per liter, so on the order of 200 or 300
20 micrograms per liter. Two of the samples had much
21 higher phosphorus, about 3 milligrams per liter or
22 about 3,000 micrograms per liter.
23 But if you look and you count up the dots,
24 there are, I believe, ten samples here. Seven of the
25 ten samples have greater than 50 percent of the

phosphorus in the dissolved form, one sample is about 50 percent, the other's 40 percent, and one is about 25 percent.

So the majority of these samples, at least, say, seven out of ten, are showing that most of the phosphorus -- more than half of the phosphorus, and for at least six out of the ten more than 80 percent of the phosphorus, coming out of the wastewater-treatment plant is dissolved phosphorus.

The bottom plot here has the same horizontal axis, so we're looking at total phosphorus measured in the effluent. But now on the Y axis here, or the vertical axis, we're looking at the fraction of the dissolved phosphorus that's soluble-reactive phosphorus. So you see it says that soluble-reactive phosphorus is divided by dissolved phosphorus.

Here, we have a total of five measurements to use, and you can see they range from .6, or 60 percent, to .9, 90 percent. So 60 to 90 percent of the dissolved phosphorus coming out of the wastewater-treatment plants was measured as soluble-reactive phosphorus.

Q. Okay. And what are the implications of this analysis, these findings, Doctor?

A. That most of the phosphorus that comes out of

wastewater-treatment plants is in a form that can be used by algae.

Q. All right. Let me ask you this follow-up question, sir.

Did you analyze river water sampling data to investigate whether particular forms of phosphorus are related to higher flow conditions?

A. Yes.

Q. And why did you decide to undertake that particular analysis, sir?

A. To gain an understanding of the forms of the phosphorus that would occur under what we called "base flow conditions," which are nonrunoff conditions, and under runoff conditions, to understand whether, in fact, the forms of the phosphorus were different under those two conditions.

Q. Okay. And what sampling data did you actually examine?

A. I examined the data collected by the United States Geological Survey and data collected by the plaintiffs.

Q. Okay. And did you create a graph to demonstrate the results of your analysis?

A. I did.

Q. Okay. Turn to -- without us putting this

document or graph on the screen yet, turn to Defendants' Joint Exhibit 6099.

Do you have that in front of you, sir?

A. Yes, I do.

Q. Now, there are actually two documents there, one behind the other. The document below is Defendants' Joint Exhibit 6099 and the top document is 6099-revised.

So which of these was actually in your report?

A. The one that does not say "revised."

Q. Okay. And did you furnish the revised chart as part of your errata?

A. I did.

Q. And tell me -- or tell the court how the chart submitted with your report differs from the chart that was submitted with your errata.

A. The two charts are identical in the sense that they show exactly the same data plotted in exactly the same locations. The only difference is that in the revision, two of the samples, if I remember right, that were colored red were switched to blue, which effectively means that I changed them from being categorized as base flow samples to categorizing them as runoff samples.

Q. Okay. So the color of two dots changed --
A. Yes.
Q. -- between the original and the revised; is that right?
A. Yes.
Q. All right. Now, are you confident, with respect to the revised version of this chart, that it correctly reflects the underlying data that you analyzed?
A. I am.
Q. All right.
MR. GREEN: With that, Your Honor, I move the admission of Defendants' Joint Exhibit 6099-revised.
THE COURT: Any objection?
MR. PAGE: No objection, Your Honor.
THE COURT: Very well. 6099-revised is admitted.
Q. *(BY MR. GREEN)* And I should ask you, Doctor, whether the changes that you've described detract from your analysis in any way?
A. No. They had no impact on the analysis.
Q. Okay. So then let's get to the analysis, and perhaps you can help some of us to understand what this exhibit is depicting.

A. What's plotted on here is the fraction of the phosphorus that's particulate. So it's essentially particulate phosphorus divided by total phosphorus plotted in relation to the river flow at the time the sample was taken. And I've separated the data into the period prior to 19 -- I'm sorry -- prior to 2004 and post-2004.

I made that break because the wastewater-treatment plants were upgraded and the upgrades were largely completed by 2004. So 2004 represents a period of the different contributions from wastewater-treatment plants than the earlier period, and I wanted to see whether the relationships would look different in the two periods.

The red dots indicate base flow, blue dots indicate runoff, and the determination of whether a particular flow is base flow or runoff is determined using a statistical analysis that's fairly standard. It's approximate so I wouldn't put a lot of faith in the reds and the blues, but it's a method that's typically used to try to say at any time whether the water we're seeing is generated from base flow, which would mean that it's ultimately generated from groundwater, or it's generated from runoff, water coming across the surface.

And if you look at either one of these, you can see under the lower flows, which are largely base flows, that the amount of phosphorus that's particulate ranges anywhere from zero to maybe fifty percent. But the vast majority of the data are plotting between about, you know, five percent particulate to maybe twenty or thirty percent with an average maybe of fifteen percent particulate.

So under the lower flow conditions, much of the phosphorus in the river is dissolved phosphorus. As you move to the right, we're moving to higher and higher flows, and the large runoff events in this river occur at flows greater than about 10,000 cubic feet per second, which is the ten to the fourth that you see on the axes.

So if you look at the data that are greater than 10,000 CFS, which are the large runoff events, you see that both in the earlier period and the later period greater than 50 percent of the phosphorus is particulate.

So we're seeing a transition here from much more being dissolved under low flow, and as we get into runoff events and larger and larger runoff events, a greater and greater percentage of the phosphorus is in the particulate form.

Q. All right, sir. Looking at this chart and analysis that you performed, what conclusions do you draw regarding the type of phosphorus coming from point sources vis-a-vis nonpoint sources?

A. Well, the base flow conditions were dominated by the point sources, principally the wastewater-treatment plants, and this confirms the data measured in the effluents from the wastewater-treatment plants, it's largely dissolved, and that's confirmed by the data measured in the river. I should have indicated this is at Tahlequah.

When runoff events occur, we start to bring in more particulate phosphorus. The greater the runoff event, the greater the amount of particulate phosphorus we bring into the river.

Q. Okay. Now, the conclusions that you just described, which you took from the data in your investigation, was that all surprising to you, what you found?

A. No, no. In fact, when I generated this, this is exactly what I expected to find. I would have been surprised if I didn't find it.

Q. And are there any further implications to your analysis and your conclusion in regard to algae growth or algae propagation?

overland movement, migration of phosphorus, or possible migration.

When rain falls on a field, Doctor, does it always result in a runoff event to rivers and streams?

A. No.

Q. What is typically going to happen if there is a light to moderate rain, sir?

A. It would depend upon what's called "antecedent conditions," whether, you know, the soil was saturated, for example, before the rain occurred. But most of the time in a light rain you don't generate runoff.

Q. Okay. How hard then does it have to rain -- if this is a concept that scientists deal with, how hard does it have to rain to cause the transport of constituents, such as phosphorus or even other chemicals, to migrate over a field?

MR. PAGE: Objection, Your Honor; new analysis.

MR. GREEN: I don't believe it's a new analysis at all, Your Honor.

THE COURT: All right. Where do we discuss this?

And while he's looking, Doctor, one of the themes here has been with respect to the contention

caused that runoff, he discusses that report. And even on 2-8, there's a discussion about the movement of chemicals migrating across the land.

Your Honor, this question is not one I want to take a lot of time struggling over --

THE COURT: Right. Because I don't see on 2-11 that the subject matter is raised. The objection's sustained.

Go ahead.

MR. GREEN: All right, sir.

Q. *(BY MR. GREEN)* Let's again switch direction here just a bit, Doctor.

Having studied the available data, which you've already identified and described for us, have you formed a conclusion regarding whether there is a dominant source for bioavailable phosphorus in the Illinois River and Lake Tenkiller?

A. Yes. In terms -- and when I say "dominant source," I'm talking about dominant source in terms of what's controlling water quality.

Q. Yes. And what is that opinion?

A. That wastewater-treatment plants are the dominant source of phosphorus controlling water quality.

Q. Okay. Now, succinctly what do you base that

opinion on, and then we'll get to more specific questions about your analysis?

A. I base that opinion on looking at all of the data that's been collected in this system; looking at patterns within the system in terms of phosphorus concentration and the relationship of that concentration to sources; looking at all of the data with regard to algal growth, where algae grow, to what level they grow, how they grow, and under what conditions they grow; and the contributions of wastewater-treatment plants versus nonpoint sources at various times.

Q. Okay. And when you say "at various times," does that take into account the fact that wastewater-treatment plants are discharging their effluent, you know, around-the-clock, essentially every day of the year?

A. Yes, yes.

Q. All right. Now, sir, with respect to your analysis regarding this subject, did you review any literature or studies or data regarding wastewater-treatment plants in the watershed?

A. Yes, I did.

Q. And that included all of the plaintiff's sampling data; is that correct?

A. Yes.

Q. All right. Now, did you review specifically any data regarding wastewater-treatment plant discharges in the watershed?

A. Yes. I reviewed estimates that were made by the plaintiffs, and in addition, an analysis and report generated by Ron Jarman on behalf of the defendants.

Q. Okay. Now, do you recall whether or not Dr. Engel came up with an estimate of how many pounds of phosphorus per year are discharged into the rivers and streams in this watershed from wastewater-treatment plants?

A. Yes. My memory is that, at least for the more recent period, he estimated approximately 90,000 pounds per year of phosphorus from wastewater-treatment plants.

Q. Okay. And was that consistent in your view with the estimates made by Mr. Jarman?

A. Yes. They were very close.

Q. And did you then use an amount of phosphorus for your analysis, you know, in your report and so forth?

A. Yes.

Q. And what was that, if you recall?

A. About 37,000 kilograms per year, which is approximately 81,000 pounds per year.

Q. All right. Let me represent to you -- and you may well have reviewed this testimony -- that Dr. Engel testified in this case from that witness stand that during base flow conditions, one should expect subwatersheds impacted by wastewater-treatment plants to have high phosphorus levels.

Do you recall whether you saw or reviewed that testimony?

A. Yes, I did.

Q. Okay. Do you agree with Dr. Engel?

A. Yes, I do.

Q. Okay. Why do you agree with him, sir?

A. Based on my own analysis of the data, which clearly shows high phosphorus concentrations in the tributaries downstream of wastewater-treatment plants.

Q. Did you have occasion to analyze phosphorus levels in rivers and streams in relation to the location of wastewater-treatment plants in this watershed?

A. Yes.

Q. And how did you commence that analysis? Where did you start?

A. Actually, the place I started was sort of the

A. About 37,000 kilograms per year, which is approximately 81,000 pounds per year.

Q. All right. Let me represent to you -- and you may well have reviewed this testimony -- that Dr. Engel testified in this case from that witness stand that during base flow conditions, one should expect subwatersheds impacted by wastewater-treatment plants to have high phosphorus levels.

Do you recall whether you saw or reviewed that testimony?

A. Yes, I did.

Q. Okay. Do you agree with Dr. Engel?

A. Yes, I do.

Q. Okay. Why do you agree with him, sir?

A. Based on my own analysis of the data, which clearly shows high phosphorus concentrations in the tributaries downstream of wastewater-treatment plants.

Q. Did you have occasion to analyze phosphorus levels in rivers and streams in relation to the location of wastewater-treatment plants in this watershed?

A. Yes.

Q. And how did you commence that analysis? Where did you start?

A. Actually, the place I started was sort of the

10,000-foot or 50,000-foot view. I just threw all the data on a map and just looked at the concentrations of phosphorus and looked for patterns.

I mean, you know, one of the first things that you typically do in any of these studies is to sort of start with the big picture and say, okay, here's all the data, what do I see, what is the data telling me. So I started there, and those patterns that I saw said, ah-hah, it looks like wastewater-treatment plants are having a significant impact here.

Q. All right. Let's take a look at the charts that you made reference to, and they should be in your notebook and Mr. Page's and Your Honor's notebook at tabs 8 and 9. They are Defendants' Joint Exhibit 6089 and Defendants' Joint Exhibit 6090.

Are those the charts that you were making reference to?

A. They are.

Q. Okay. And just so we pin this down, these charts were included in your report?

A. Yes.

Q. And the data that's plotted on these charts comes from where, sir?

A. The data that's plotted on these charts comes

from the plaintiff's database, data generated by OWRB, data generated by ADEQ, and data generated by the United States Geological Survey.

Q. All right.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6089 and 6090.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6089 and 6090 are admitted.

Q. *(BY MR. GREEN)* All right. Let's put the first one up on the screen, if I may, and this is Defendants' Joint Exhibit 6089.

Would you be kind enough to tell us, you know, what this is showing us, sir?

A. Yes. What this is showing is phosphorus concentrations indicated by a color scheme at every location in the watershed, in the tributaries and in the Illinois River and in Lake Tenkiller, where phosphorus was measured, and we're looking at total phosphorus concentrations.

Different symbols indicate the different sources of the data and the different colors indicate concentration. The concentration scale goes from blue being the lowest concentrations on up to red being the highest concentrations.

Also shown on the map are the locations of the principle wastewater-treatment plants and they're indicated by yellow diamonds on this figure.

Q. And Exhibit 6089 is a pictorial of total phosphorus levels; correct?

A. Yes, yes.

Q. All right. Let me just move ahead and we'll come back to each of these separately to Defendants' Joint Exhibit 6090.

MR. GREEN: That could come up on the screen for a moment.

Q. *(BY MR. GREEN)* And what are we looking at here at 6090, sir?

A. We're looking at the identical presentation, with the exception that now we're looking at soluble-reactive phosphorus rather than total phosphorus.

I should point out one difference here. When we created this, we actually broke out the USGS samples so you see the stars there. That doesn't appear on the previous plot because those USGS data were incorporated in the plaintiff's data there, so they actually appear with the same symbol in the total phosphorus block, but otherwise they're identical.

Q. All right. Now, once you engaged in this

exercise and plotted all of this information, when you stepped back and looked at Exhibit 6089 and 6090, what did you conclude regarding the distribution of phosphorus concentrations in the watershed?

A. One thing to make clear, too, is these are averages, all right, so they're averages of the data collected at each of the stations.

The first thing that I concluded was there's a very large range of phosphorus concentrations here, so you see we have the whole rainbow of colors appearing.

The second thing that I noticed was that at the location of almost every wastewater-treatment plant in the system there's a transition. So if, for example, we look at the top right of the map, right, where it says "Tributary Off Osage Creek," you can see above the wastewater-treatment plant it's a blue color, then you cross the wastewater-treatment plant and all of a sudden it's red and then it's orange as we go downstream.

If you go to Spring Creek, you see the same pattern. It's blue upstream, you hit the wastewater-treatment plant and all of a sudden now we're seeing oranges and some reds. That pattern is pretty consistent.

It we go over to look at Sager Creek, you can see the same thing happening. If we go down to Muddy Fork, you see the same happening. It's pretty consistent that every time you cross a wastewater-treatment plant, there's a significant jump in concentration and then a persistence of high concentrations as you move downstream from the wastewater-treatment plant.

So that was the first "ah-hah" that I got looking at this map.

Q. Okay. And what happens if we -- which one are we just -- I lost my.

A. Total phosphorus.

Q. Total phosphorus. Okay. So let's go to 6090.

Did you see the same kind of spatial pattern there associated with wastewater-treatment plants?

A. I did. You can follow the patterns and they're really the same. You go from blues or greens typically above a wastewater-treatment plant and then reds and oranges downstream.

Q. Now, Doctor, to my very untrained eye on both of these exhibits, you do have some red squares that are indicating, you know, relatively high levels; right --

It we go over to look at Sager Creek, you can see the same thing happening. If we go down to Muddy Fork, you see the same happening. It's pretty consistent that every time you cross a wastewater-treatment plant, there's a significant jump in concentration and then a persistence of high concentrations as you move downstream from the wastewater-treatment plant.

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A. I did. You can follow the patterns and they're really the same. You go from blues or greens typically above a wastewater-treatment plant and then reds and oranges downstream.

Q. Now, Doctor, to my very untrained eye on both of these exhibits, you do have some red squares that are indicating, you know, relatively high levels; right --

A. Yes.

Q. -- that don't seem to be related, you know, to wastewater-treatment plants.

Does that detract from your conclusion in any way?

A. No. I mean, it certainly indicates that there are phosphorus sources that are not associated with wastewater-treatment plants and there are a number of potential sources for phosphorus. So at the individual locations where those high values are measured, clearly there must be a source of phosphorus proximate to that. But they all tend to be isolated, so you'll see a red dot and nothing around it.

So while there are some points here that are not associated with wastewater-treatment plants that are high, they're sort of random and there's no consistent pattern. The only consistent pattern I was able to discern from this was a pattern associated with wastewater-treatment plants.

Q. Okay. In light of that last answer, you know, the spatial relationships that you observed between wastewater-treatment plants and these high phosphorus levels, did you perform any further analysis of specific locations in the watershed?

A. I did. But if I could just back up --

Q. Sure.

A. -- and supplement my last answer.

Q. Please.

A. There's a significant difference between the total phosphorus and the soluble phosphorus maps in terms of these high concentrations that appear that are not associated with wastewater-treatment plants. And that is whereas there's a number of them on the total phosphorus plot, on the soluble-reactive phosphorus plot there are very few.

So the locations that had high total phosphorus that weren't associated with wastewater-treatment plants in general did not have high soluble-reactive phosphorus concentrations.

So I think that was -- that was also important to me in terms of, yes, there was some sources of phosphorus that weren't associated with wastewater-treatment plants obviously, but in most cases they weren't high sources of soluble-reactive phosphorus.

Q. Let me then return to where I was heading --

THE COURT: Before we do that, Mr. Green, let's break for our mid-morning.

MR. GREEN: Yes, sir.

(Short break)

treatment plants given the evident difference from the colors. So I looked at comparing data above and below several of the wastewater-treatment plants.

Q. Okay. And have you prepared a demonstrative exhibit showing this analysis?

A. Yes.

Q. All right. Would you turn to -- I believe it's tab 10 in the notebook, Tyson's Demonstrative 259.1?

MR. GREEN: Can we put that up, please?

Q. *(BY MR. GREEN)* Now, first question, Doctor, is, where does the data depicted on this demonstrative, 259.1, where's that data come from?

A. This is the same data we were just looking at on the other map, and so it's data generated by the plaintiff's, USGS, OWRB, and ADEQ.

Q. Now, just so the record is clear, when you say it's the data that's coming from the other map -- would you just page back a couple of tabs? -- are you referring to Exhibit 6089?

A. Yes, I am.

Q. Okay. So now, using this demonstrative, can you describe for us what further analysis you undertook?

A. I went to the -- a number of the locations

where wastewater-treatment plants were and then averaged the data for a distance upstream and for a similar distance downstream. Those are indicated by the circles.

So you'll see there are four wastewater-treatment plants, yellow diamonds, that are circled, and there are lines that come off of the circles representing the distance upstream and distance downstream that I used to average the data.

So for each one of these plants, whatever samples would fall within the limits of that line would be included in an analysis. I just simply then averaged the data over that distance to compare upstream to downstream of the wastewater-treatment plants.

Q. All right. Then let's move to the next demonstrative, which is 259.2, which relates to the wastewater-treatment plant at Sager Creek; is that correct?

A. Yes, it does.

Q. And what is the analysis that you undertook which is in effect represented by the pictorial here, Demonstrative 259.2?

A. This shows a zoom-in on the map we just looked at so that you can see the circle here around

the Siloam Springs wastewater-treatment plant and the distances upstream and downstream over which the data are averaged.

And then in the upper left, there's a bar plot because I wanted to compare the actual numbers. So the bar for upstream is the average of -- and if you look back at the map, you'll see there are four stations that fall up there, so it's the average of those four stations. And then for about the same distance downstream, you see there are two stations, and so it's the average of those two stations on the downstream.

So this shows in Sager Creek, upstream of the wastewater-treatment plant, the total phosphorus concentration is pretty low, on the order of less than a tenth of a milligram per liter, and downstream of the wastewater-treatment plant is approximately 1.5 milligrams per liter. So a pretty dramatic change in concentration.

Q. Okay. Let's go to your next demonstrative, which is 259.3. And is this depicting your analysis in regard to the Prairie Grove wastewater-treatment plant?

A. It is.

Q. Okay. Tell us how this represents the

analysis you conducted here. I'm talking now about Demonstrative 259.3.

A. Yes. So this is a similar presentation to the last one. It's a zoom-in on this portion of the watershed. The location of the Prairie Grove plant is circled, and then the lines show the distances upstream and downstream of which the data are taken and averaged. And then the bar plot is the comparisons of those averages.

So you can see upstream of the wastewater-treatment plant the concentration of phosphorus is perhaps a tenth of a milligram per liter, and downstream of the wastewater-treatment plant it's approximately 1.3 milligrams per liter. So, again, a dramatic change as you go from upstream to downstream.

Q. Let me direct you to the next demonstrative, Tyson 259.4, which pertains to the Rogers and Springdale wastewater-treatment plants on Osage and Spring Creeks; is that correct?

A. Yes.

Q. And so would you be kind enough to explain how this demonstrative illustrates the analysis that you undertook with respect to these two wastewater-treatment plants?

A. Yes. Again, it's the same presentation, the zoom-in to that part of the watershed, and then the lines indicating the distance over which we looked and averaged data.

Spring Creek is the Springdale plant. Rogers is the one on Osage Creek. And, again, comparing the averages upstream to downstream, on Osage Creek it was perhaps a little less than a tenth of a milligram per liter and about .6 or so downstream.

Spring Creek off the Springdale plant, again, it was perhaps a little less than a tenth of a milligram per liter upstream and close to 1.5 milligrams per liter downstream. So the same pattern that we're seeing at the other locations.

Q. All right. Now, Doctor, on the basis of this additional and further analysis which you've just described, what conclusion, if any, did you draw regarding the type and magnitude of wastewater-treatment plants as a source of phosphorus to the waters of the watershed?

A. This indicated to me that the wastewater-treatment plants were having a dominant impact on phosphorus concentrations in the tributaries to which they discharged.

Q. And does that carry over to an assessment of

what type of phosphorus as well?

A. Well, it does because of what we had looked at earlier, that most of that phosphorus will be dissolved phosphorus and much of that dissolved phosphorus will be soluble-reactive phosphorus.

Q. Did you undertake to perform any further or additional analysis to determine whether these wastewater-treatment plants that we've been looking at have an impact on the levels of soluble-reactive phosphorus in the river itself?

A. Yes. What I -- I'm sort of taking this in steps, so at this step looking at the approximate locations of the wastewater-treatment plants.

The next step was to look at the patterns in the Illinois River itself to see whether, in fact, there was evidence that these concentrations we're seeing downstream of the wastewater-treatment plants are having an evident impact on phosphorus levels, soluble-reactive phosphorus levels, within the Illinois River.

Q. Okay. And did you prepare any chart to represent that analysis, depict your analysis?

A. Yes.

Q. All right. Let me ask you to turn to Defendants' Joint Exhibit 6091, Doctor, and that

should be at tab 14 in your notebook.

Do you have that in front of you?

A. I do.

Q. Did this chart appear in your report?

A. Yes.

Q. And the data that's plotted on this chart, where did that come from, sir?

A. This is the same data that's plotted on the maps, so it includes data from the USGS, from OWRB, ADEQ, the plaintiffs. In addition, there's a very small amount of data from a U.S. EPA study that was conducted by a consulting firm named Parsons.

Q. Okay. So is this chart essentially using the same data that was depicted on the earlier charts, just representing that data in a different format? Is that what we're doing here?

A. Yes.

Q. All right, sir.

MR. GREEN: I move the admission, Your Honor, of Defendants' Joint Exhibit 6091.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6091 is admitted.

MR. GREEN: Now, if you'd be so kind to put that up on the screen for us.

Q. *(BY MR. GREEN)* Can you take us through this, sir, and help us to understand what your analysis is and what it's indicating?

A. What I did was to organize the data based on time period so you see three plots here. The top plot is for data collected between 1998 and 2000, the middle plot is for data collected between 2001 and 2003, and the bottom plot is for data collected from 2004 on.

And what I'm plotting here is the average soluble-reactive phosphorus concentration measured at various stations along the Illinois River and the uncertainty of those averages, which are indicated by the bars around each symbol. The point of this was to run through -- essentially follow a pathway -- we're following a pathway from the upper reaches of the Illinois River through the Illinois River to Tahlequah -- and looking at the changes that occur in soluble-reactive phosphorus.

I've indicated on the map where the major tributaries are as well as where Lake Frances is in order to get some sense of where we are because this is not plotted against river mile. If you look down at the bottom, you see what are essentially sampling location designations from the databases and we're

moving from upstream to downstream. So as we move from left to right, we're moving downstream in the river.

The different data sets have different spatial coverage. So on some periods there's data at some stations and not at others. But what I saw was a pattern that was consistent across all of the three time periods.

Starting upstream, if we look at the top panel, 1998 to 2000, we see that concentrations of soluble-reactive phosphorus in the river are about .05 milligrams per liter, 50 micrograms per liter. Then there's a large jump in concentrations, so it goes up to almost .2 milligrams per liter. Between those two stations you can see Osage Creek comes in. Then there's a slight increase to above Lake Frances, and then there's a continual decline in concentration as we move down to Tahlequah.

2001 to 2003 has less upstream data. In fact, there's only one point above Osage Creek but its concentration is very similar to what was measured in '98 to 2000. So in 2001 to 2003, it was also about .05.

The next station downstream has an average of about .15, so there's a significant increase there.

It's further downstream than the one we saw in '98 to 2000 but it's between Osage Creek. So the upstream sample's above Osage Creek, the downstream sample is below Osage Creek. We see an increase and then, you know, some variability but a general decline as we move downstream.

The bottom panel, which is 2004 to 2008, has much more data than the other periods. So we can see at the most upstream stations in the river very, very little soluble-reactive phosphorus. Some increase, and as we cross Muddy Fork, which is where Prairie Grove comes in, there's a little bit of an increase.

But then as we go from upstream of Osage Creek to downstream of Osage Creek, there's a large jump. We're going again from about .05 to the data point downstream of Osage Creek is .15.

So across three separate time periods, three independent data sets, we see the same pattern of an increase in phosphorus as we go downstream and a large jump in phosphorus as we go past Osage Creek. Then downstream of Osage Creek, things are variable but there's a general sense of a decline in concentration.

Q. Now, Doctor, given the pattern that you've now noted around Osage Creek, did you perform any closer analysis of that area?

A. I did.

Q. And did you prepare a chart showing that analysis?

A. Yes.

Q. And basically, what were you undertaking to do? What is the further analysis?

A. Well, the last analysis showed this consistent increase in the Illinois River from upstream of Osage Creek to downstream of Osage Creek. So then I did essentially the identical analysis, starting in the tributaries to Osage Creek down into the Illinois River, to try to see where the phosphorus that was clearly impacting the Illinois River was originating.

Q. Okay. Now, did you prepare a chart that illustrates the analysis that you undertook?

A. Yes.

Q. Could you turn to Defendants' Joint Exhibit 6093 behind tab 15 in your notebook there? Is that the chart that you prepared?

A. It is.

Q. And, sir, let me ask you this.

Where does that data come from, sir?

A. This is the same data that's depicted on the maps we saw earlier.

Q. Okay.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6093.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6093's admitted.

Q. *(BY MR. GREEN)* Okay. Just kind of a preliminary question here, Doctor. Is the type of analysis that, you know, is reflected on the preceding exhibit, which is Defendants' Joint Exhibit 6091, and the analysis depicted here on 6093, is this an example of a real gradient analysis?

A. Yes. This is exactly what a gradient analysis is. This is something that I would commonly use, and essentially what it is is following a pathway.

So in the earlier one, we were following a pathway down the Illinois River, and the one we're looking at now we're following a pathway through the tributaries and down the Illinois River.

Q. Okay.

A. And that's a gradient analysis is.

Q. Now, do you see in your review in any of the reports prepared by the state's experts or any of the testimony that you reviewed any evidence of a gradient

analysis, such as this, undertaken by any of those experts?

A. No. Because I saw no analysis that followed a pathway, and if you're not following a pathway, you're not doing a gradient analysis.

Q. All right, sir. With attention now to Exhibit 6093, can you walk us through this and explain to us how this depicts the analysis you undertook?

A. Yes. We're starting up in the tributaries and so the top panel shows Spring Creek. Spring Creek discharges into Osage Creek, and you can see the arrow indicating that, and then the pattern in Osage Creek, and then Osage Creek discharges to the Illinois River and the bottom panel is the Illinois River.

So if we start furthest upstream in Spring Creek and look at the concentrations in the creek, we can see a pattern where the concentrations jump dramatically, and that jump coincides with the location of the Springdale wastewater-treatment plant.

So concentrations go from perhaps .08 milligrams per liter to greater than .4 milligrams per liter between the Springdale wastewater-treatment plant, so clearly the Springdale wastewater-treatment plant is causing a large increase in soluble-reactive phosphorus.

As we move downstream in Spring Creek, some of that soluble-reactive phosphorus disappears, probably largely through algal uptake processes. Then when we're exiting Spring Creek, we're at a concentration of approximately .2 milligrams per liter.

If we look at Osage Creek, the most upstream location at Osage Creek has very low phosphorus concentration. We pass the Rogers wastewater-treatment plant and there's a significant jump in concentration, as up to close to .3 milligrams per liter. Again, there's a decline as we move down and that decline probably is because of algae. Here, I'm speaking about attached algae, periphyton on the bottom, that are probably taking up some of that soluble-reactive phosphorus.

And then we get --

MR. PAGE: Objection, Your Honor. I move to strike. That's speculation. The witness did not do any evaluation of the algae concentrations in these locations.

THE COURT: Mr. Green.

MR. GREEN: I think based on his experience, he's able to offer an assessment of where that phosphorus is likely going, Your Honor.

THE COURT: Overruled. Go ahead.

A. And just above where Spring Creek comes in, the concentration is about .2, and then you see Spring Creek comes in and you see no jump across the location where Spring Creek comes in.

You know, at first blush, someone might say, well, obviously that must mean Spring Creek's having no impact, but that's not true because the only reason there's no concentration change is if they look at the concentration in the water coming out of Spring Creek, it's .2 milligrams per liter and the water in Osage Creek upstream is .2 milligrams per liter.

So we are essentially mixing two waters that are at the same concentration, and so downstream we have more phosphorus because we have greater flow, but we have no change in concentration because we've mixed two waters that are about the same concentration.

As you proceed further down Osage Creek, we see a drop in soluble-reactive, again likely associated with the uptake of soluble-reactive phosphorus by periphyton, so that the water coming in to the Illinois River is somewhere perhaps .12, .13, or so milligrams per liter.

Then we go down and look at the Illinois River, and we can see -- because this is what we had

1 looked at earlier in the last plot -- that when we
2 cross Osage Creek, we see a jump. That jump is
3 occurring because the water upstream of Osage Creek is
4 carrying about .05. Osage Creek water is coming in at
5 a higher concentration, they mix, and we get an
6 increase in concentration in the Illinois River.
7 So what this analysis allowed me to do was to
8 interpret the previous plot that said, there's a big
9 increase in phosphorus in the Illinois River as you
10 cross Osage Creek, and this gradient or pathway
11 analysis allows me to conclude that that increase is
12 attributable to phosphorus that's coming in from the
13 Springdale and Rogers wastewater-treatment plants, or
14 I should say dominantly.
15 I mean, certainly there can be contributions
16 from other sources, so I'm not saying it's the only
17 source of phosphorus, but clearly it's the dominant
18 source of phosphorus.
19 THE COURT: How can the whole be greater
20 than the sum of its parts? I mean, you get the
21 concentration of about .12 coming in from Osage Creek,
22 and yet after it dumps into the Illinois River, you're
23 going up to over .15 in many cases.
24 THE WITNESS: Yeah, that's a great
25 point. And I think that's simply a reflection of the

uncertainty in the data and the averaging that I'm doing. So I'm not following a pathway at an exact time so I'm averaging data.

And so to the extent that the sample downstream in the Illinois River isn't exactly timed with the samples that are in the Osage Creek, that can account for some of that difference so that's why they don't work.

But Your Honor's exactly correct, this number -- the whole can't be greater than the sum of the parts, but I think it's sort of a consequence of all the averaging that's going on

MR. GREEN: Shall I continue, Your Honor?

THE COURT: Yes, sir.

Q. *(BY MR. GREEN)* Doctor, did you perform a similar analysis on soluble-reactive phosphorus data, sampling data, for years prior to 2004?

A. Yes. I wanted to use the earlier data as well to assure myself that the patterns that I'm seeing in the one period are robust, they're repeated in other periods.

Q. Okay. So let's turn now to Defendants' Joint Exhibit 6095, if you will, at tab 16 in your book.

Does this reflect your analysis of the

earlier sampling data?

A. It does.

Q. And was this chart in your expert report?

A. Yes.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6095.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6095's admitted.

Q. *(BY MR. GREEN)* Would you help us, sir, to understand the analysis you undertook and how it's depicted on this exhibit, sir?

A. This is the same data that had appeared earlier, and it's the same exact analysis as we looked at in the last chart, only using data from the period between 1989 and 2003, and again trying to trace through the pathway from Spring Creek to the Illinois River.

Q. Okay. What, if anything, does the data here on this chart tell you about the impact that wastewater-treatment plant discharges have had on soluble-reactive phosphorus concentrations in the rivers and streams in the watershed?

A. That, again, the wastewater-treatment plants coming into Spring Creek and Osage Creek are having a

dominant impact on the soluble-reactive concentrations.

And one thing I should point out here, based on Your Honor's last question, this is an example here of how matching data based on averaging can affect these patterns. And if you look at Osage Creek, you see the large jump to the right just downstream of Rogers and then a dramatic drop between that and the next station. Some of that is averaging data over different time periods.

So the patterns here are more important than the absolute values because again some of the averaging of data from slightly different periods. But the patterns here are the same as we saw before, that there's a large jump as you cross Springdale with a decline, a large jump as you cross the Rogers wastewater-treatment plant with a decline again. There's probably some mismatching here a little bit but the pattern's clear. And then when we get in from Osage Creek to the Illinois River, you can see the large jump in soluble-reactive phosphorus as we cross Osage Creek.

THE COURT: Now, you say "a dominant impact." Are you saying the dominant impact or one of the dominant impacts?

THE WITNESS: Based on the data that I have, it appears to be the dominant impact.

THE COURT: Go ahead.

Q. *(BY MR. GREEN)* Doctor, did you undertake any additional analysis to evaluate the significance of wastewater-treatment plants to phosphorus levels in the river comparing those phosphorus levels with the wastewater discharge levels?

A. Yes.

Q. And did you prepare a chart that summarizes that analysis?

A. Yes. Yes, I did.

Q. Okay. Let me ask you to turn to the next tab, which is tab 17 of -- now, sir, does that chart reflect your analysis?

A. It does.

Q. Now, this is another example of where there are basically two exhibits behind tab 17, Defendants' Joint Exhibit 6097 and 6097-revised.

Do you see that, sir?

A. Yes.

Q. Okay. Now --

A. Actually, the version I have only has the one chart in it. It has the revised; doesn't have the original.

witness' deposition on April 8th and 9th. This errata was prepared about a month later. I have not had a chance to cross-examine on this issue and how he made his changes.

MR. GREEN: Your Honor, I'm going to obviate any controversy here. I'm just going to use the original exhibit that was in the report, and I will ask the doctor to explain his analysis and whether he needs to embellish that by virtue of his observation that he made later about data.

THE COURT: Very well. Do you wish to seek admission of 6097?

MR. GREEN: Yes, yes.

THE COURT: Any objection?

MR. PAGE: No, Your Honor.

THE COURT: All right. 6097 is admitted.

MR. GREEN: Thank you.

Q. *(BY MR. GREEN)* Let's just look then at 6097 and see if you can help us to understand what the analysis is that you undertook, which is depicted in this exhibit, sir.

A. The analyses that I had done to this point showed a clear indication that the wastewater-treatment plants were a very important

source of phosphorus to the river.

And so I then conducted an analysis asking the question, can the wastewater-treatment plants in and of themselves account for all of the phosphorus that we see in the river under base flow conditions?

Now, unfortunately, I don't have any information on the variability of the loads from the wastewater-treatment plants, which clearly vary day to day, treatment plants have upsets, so there are times where they actually put out a lot less treated waste than they normally would, but all I have is some estimate of the average. So that's what I'm relying on.

And then in the river, I have much more information, in terms of under base flow conditions, what is the phosphorus load moving down the river? And so what I wanted to do was to say, how does the average load coming from a wastewater-treatment plant compare to what's in the river under base flow conditions? And so I made this plot and I did it at two stations. I did it at the station at Watts and the station at Tahlequah.

So I looked at all of the measurements of phosphorus, for example, at Watts in the river and then did a frequency plot, essentially looking at how

frequently is the phosphorus load in the river within particular ranges.

And so if you look at the bars, you can see that the top bar is the most frequent categorization. So about thirty percent of the time the phosphorus load into the river under base flow conditions is between -- and I apologize, this is a log scale so it's a little bit hard to interpret -- but if you count the ticks, it's 10, 20, 30 you see, so the left side of that bar is a little greater than 30, that's about 32, then 40 and 50.

So 30 percent of the time the load of phosphorus in the river at Watts is between 32 and 50 kilograms per day. So that's the way to interpret that.

Now, 20 percent of the time it's at some lower range, 20 percent of the time it was at some higher range, and then less frequently it was at either the lower values or higher values. So it gives you some sense of the distribution of concentrations and loads in the river.

And I compared that to the average coming out of the wastewater-treatment plants to see how well they correspond. The vertical bar is the average load from the wastewater-treatment plants. So at Watts,

the average load from the wastewater-treatment plants is about 50 kilograms per day. That corresponds to the most frequently seen load in the river at Watts. And, in fact, if you totaled up all the bars below that where the wastewater-treatment plant bar crosses, about 67 percent of the time the loads observed in the river were lower than that, about 33 percent of the time they were higher than that. But there's a pretty good correspondence between what the wastewater-treatment plants were putting out and we see what's in the river at Watts.

And then the same --

Q. Before you move to Tahlequah --

A. I'm sorry.

Q. -- I just want to see if you will agree with me that with respect to the revised exhibit, which has not been moved into evidence, that line representing the wastewater-treatment plant discharges is unaffected, did not move; right --

A. It did not move at all.

Q. -- between the two of them?

A. No.

Q. Okay. So if you would then move to Tahlequah, sir.

A. So Tahlequah is the same presentation. We're

looking at a frequency distribution of the total phosphorus loads measured at Tahlequah under base flow. So that you see the top bar there, you know, 30 percent of the time the load at Tahlequah is between about 35 and 65 or 70 kilograms per day. And you can see where the wastewater treatment bar plots, and it's about 100 kilograms per day coming from wastewater-treatment plants.

So it seems that the wastewater-treatment plant load can fairly well account for what we see in the river. Again, all I can do is sort of compare the pattern here because I don't have the variability of the wastewater-treatment plant, but certainly the wastewater-treatment plant at times was discharging higher or lower than what that bar shows.

But the close correspondence between the pattern in the river and the wastewater-treatment plant average condition confirms for me the pattern that I had been seeing in the last plots, that under base flow conditions the wastewater-treatment plants are the dominant source of phosphorus to the river.

Q. Now, just to kind of come and close the loop, that line representing the wastewater-treatment plant discharges at Tahlequah, where did that move on your revised graph, if you will, or chart?

A. It moved from approximately 100 kilograms per day to 95 kilograms per day.

Q. All right. Is that a significant deviation?

A. No.

Q. All right, Doctor. How much of the time is the Illinois River Watershed, if you were able to determine, essentially at base flow in contrast to high flow?

A. Well, obviously that varied based on the time of year. I did an analysis for the period May through September, which represents sort of the growing season. It's not an absolute measure of the growing season. Clearly, algae can grow before May 1st and they can grow after September 30th. But it's a pretty good and commonly used window of the principle growing period.

And during that period, based on an analysis of the hydrograph, the measurements of flow in the river, the river's under base flow approximately 80 percent of the time.

Q. Now, what would be the relevance, if any, of that observation to water quality conditions, both in the river and the lake, as it relates to algae growth?

A. Well, the algae are -- for eight out of ten days, the algae are seeing essentially base flow

A. It moved from approximately 100 kilograms per day to 95 kilograms per day.

Q. All right. Is that a significant deviation?

A. No.

Q. All right, Doctor. How much of the time is the Illinois River Watershed, if you were able to determine, essentially at base flow in contrast to high flow?

A. Well, obviously that varied based on the time of year. I did an analysis for the period May through September, which represents sort of the growing season. It's not an absolute measure of the growing season. Clearly, algae can grow before May 1st and they can grow after September 30th. But it's a pretty good and commonly used window of the principle growing period.

And during that period, based on an analysis of the hydrograph, the measurements of flow in the river, the river's under base flow approximately 80 percent of the time.

Q. Now, what would be the relevance, if any, of that observation to water quality conditions, both in the river and the lake, as it relates to algae growth?

A. Well, the algae are -- for eight out of ten days, the algae are seeing essentially base flow

conditions and they're seeing phosphorus associated with base flow conditions. And so that's likely, therefore, what's controlling the growth of phosphorus in the system.

Q. Growth of algae, you mean?

A. I apologize. Yes, the growth of algae.

Q. And what form of phosphorus are they seeing that 80 percent of the time?

A. It's dominantly dissolved phosphorus, as we saw earlier in the plot of how much of the phosphorus is dissolved versus river flow. Under base flow conditions, it's probably on average 80 to 85 percent dissolved, and from the wastewater-treatment plants being the source, most of that dissolved is soluble-reactive phosphorus.

Q. Okay. How robust, sir, do you consider your analysis regarding the impact of wastewater-treatment plants on water quality?

A. I consider it very robust because it looks at things in different and independent ways. I looked at the patterns in the entire watershed and saw an evident impact of wastewater-treatment plants. When I looked at data upstream to downstream of wastewater-treatment plants, it confirmed that individual plants were causing large increases in

concentration in the tributaries.

When I looked at the patterns in a gradient analysis within the Illinois River, I saw a large increase across Osage Creek that seemed to take the phosphorus from modest levels to very high levels, traced that back to the wastewater-treatment plants in those tributaries.

And then this other last analysis, which is really independent of that, that just says based upon our best estimate of the total amount of phosphorus that the treatment plants put into the river, how does that compare to the massive phosphorus that's actually in the river?

And that correspondence confirms for me the dominant source of the wastewater-treatment plants under base flow conditions, and the fact that base flow conditions are occurring eight out of ten days during the principle growing period for algae further reinforces the idea that the wastewater-treatment plants are providing the phosphorus to the algae, and then lastly, the idea that most of that phosphorus is in a form that algae can use.

Q. Let me shift direction here just a bit and talk about the potential for phosphorus to impact the Illinois River itself.

Is there any feature of that river, Doctor, that is relevant to the degree to which phosphorus will impact water quality in that river?

A. Yes. And that's the velocity of the river.

Q. Okay. Now, we need to understand how river velocity is relevant to your analysis. Can you help us with that?

A. It's relevant in two ways. As I indicated before, algae don't grow instantly, they take awhile to grow. So the rate at which algae grow, it requires, you know, a time period of perhaps a week to grow up algae to a point where someone might be concerned with those algae.

So in the river, right, the water would have to take at least a week or so to get downstream to allow algae to grow to a significant extent in the river. And now I'm talking about suspended algae.

The other thing that can happen in the river is the algae can grow on the rocks at the bottom of the river, and their time of travel doesn't matter because they're always seeing that phosphorus, it's always going by them and so they can grow.

The velocity, though, impacts the extent to which they can grow because essentially the shear stress of the water moving by, if the water velocity

is high enough, will slough off the algae off the rocks and prevent accumulation of algae, so that the water velocity can limit the amount of attached algae that you would actually grow in the river.

Q. Let me ask you this.

What are the implications of river velocity for particulate phosphorus in carrying particulate phosphorus downstream?

A. Particulate matter can settle in a river so long as the velocity is fairly low. Once the velocity gets high enough to create enough vertical turbulence in the river, even though particles are settling, they sort of just kind of bounce back up into the water.

When you get water velocities greater than -- so the river is flowing faster than perhaps 15 miles a day, which corresponds to about a foot per second, so if the velocity in the river is greater than about a foot per second, the particles can't settle. I mean, obviously you put a rock in there and it will settle. If you have large sand particles, they might settle. But the lighter particles that would be carrying phosphorus have no opportunity to settle if the river is flowing at greater than about one foot per second velocity.

Q. Now, did you undertake to perform any

analysis of water velocity in the watershed?

A. Yes.

Q. And did you prepare a chart, sir, that reflects that analysis?

A. Yes.

Q. Okay. If you would turn to the chart behind tab 18, which is Defendants' Joint Exhibit 6100.

Is that a chart which reflects your analysis?

A. Yes.

Q. Okay. And was this in your report, Doctor?

A. Yes.

Q. And where did the data come from that underlies -- I mean, I take it these are calculations; is that right?

A. Yes. They're calculations using, you know, basic fluid mechanics and surface -- surface water hydraulics information.

Q. Okay. And what's depicted here on Exhibit 6100?

A. For sections of the river in Oklahoma, what I've depicted on here is the average velocity of the river under typical summer conditions, conditions we typically see in May to September, as well as the travel time, the time it takes to go through various sections of the river.

Q. Okay. Then with that in mind, Your Honor, I move the admission of Defendants' Joint Exhibit 6100.

THE COURT: Any objection?

MR. PAGE: No objection, Your Honor.

THE COURT: Mr. Green, I am told I need to break at this point to allow the court staff to make the Christmas luncheon. We'll be back at 1:15.

MR. GREEN: 1:15. Yes, sir.

(Lunch recess was taken)

Q. Okay.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6093.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6093's admitted.

Q. *(BY MR. GREEN)* Okay. Just kind of a preliminary question here, Doctor. Is the type of analysis that, you know, is reflected on the preceding exhibit, which is Defendants' Joint Exhibit 6091, and the analysis depicted here on 6093, is this an example of a real gradient analysis?

A. Yes. This is exactly what a gradient analysis is. This is something that I would commonly use, and essentially what it is is following a pathway.

So in the earlier one, we were following a pathway down the Illinois River, and the one we're looking at now we're following a pathway through the tributaries and down the Illinois River.

Q. Okay.

A. And that's a gradient analysis is.

Q. Now, do you see in your review in any of the reports prepared by the state's experts or any of the testimony that you reviewed any evidence of a gradient

analysis, such as this, undertaken by any of those experts?

A. No. Because I saw no analysis that followed a pathway, and if you're not following a pathway, you're not doing a gradient analysis.

Q. All right, sir. With attention now to Exhibit 6093, can you walk us through this and explain to us how this depicts the analysis you undertook?

A. Yes. We're starting up in the tributaries and so the top panel shows Spring Creek. Spring Creek discharges into Osage Creek, and you can see the arrow indicating that, and then the pattern in Osage Creek, and then Osage Creek discharges to the Illinois River and the bottom panel is the Illinois River.

So if we start furthest upstream in Spring Creek and look at the concentrations in the creek, we can see a pattern where the concentrations jump dramatically, and that jump coincides with the location of the Springdale wastewater-treatment plant.

So concentrations go from perhaps .08 milligrams per liter to greater than .4 milligrams per liter between the Springdale wastewater-treatment plant, so clearly the Springdale wastewater-treatment plant is causing a large increase in soluble-reactive phosphorus.

1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

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4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

11

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13

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 DECEMBER 17, 2009
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 77, P.M. SESSION

16

17 APPEARANCES:

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PROCEEDINGS

DECEMBER 17, 2009:

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THE COURT: Mr. Jorgensen.

MR. JORGENSEN: It's good to see you, Your Honor. After your comments over the last couple of days, all of the defendants spent last night and this morning checking the things we've said to you to see if there were any errors, and I have a couple to report.

THE COURT: All right. Great.

MR. JORGENSEN: You asked me, I think two days ago, on the point from the Milwaukee I decision where the Supreme Court said federal common law cannot apply if state law applies. It's one or the other. You asked me, well, that would take -- if Oklahoma law applies, then if still the federal common law would apply in Arkansas. And I said yes. That's wrong.

The way that *Milwaukee* decision works is if state law can apply, be it Arkansas state law or, as Mr. Baker helpfully said in his response, that if federal common law doesn't apply, they'll try to extend Oklahoma common law under a choice of law principle into Arkansas.

If any state law applies, then the federal common law cannot apply. That's the holding of *Milwaukee I*.

So Arkansas obviously has a regulatory regime for poultry litter. Oklahoma has a regulatory regime for poultry litter. Both states have nuisance law. The fact that the State might lose under that law doesn't set aside the holding in *Milwaukee I*. Federal common law cannot apply in either state because this activity is governed by state law.

THE COURT: Are you conceding by that that Oklahoma nuisance law may apply across the state line?

MR. JORGENSEN: I'm not conceding that, Your Honor. But at a minimum, Arkansas nuisance law would apply, and that would set aside, under the holding of *Milwaukee I*, the federal common --

THE COURT: So Oklahoma then could exercise Arkansas law with respect to a nuisance that occurs in Oklahoma?

MR. JORGENSEN: No, no, in Arkansas, Your Honor.

THE COURT: Well, I understand. They're arguing that there's a nuisance that results here in

Oklahoma. So you're saying they could apply Arkansas law with respect to that nuisance that occurs here in Oklahoma? Arkansas law?

MR. JORGENSEN: I think, Your Honor, they could -- under a choice of law principles, one of the state laws would apply, one of the state common laws would apply.

And Mr. Baker's argument was Oklahoma's law would apply under a choice of law principle because the nuisance occurs here. If that's true, then federal common law cannot apply in --

THE COURT: All right. So then the court could obviously adjust its earlier ruling that Oklahoma nuisance law doesn't apply across state borders, if that's the case.

The law presumes if there's a right, there's got to be a remedy. That's one of the foundational principles. So you're saying that no federal common law can apply, that it's got to be Arkansas nuisance law and Oklahoma nuisance law. And, obviously, if the plaintiff can't apply Arkansas nuisance law to an alleged nuisance that occurs in Oklahoma, then the court had to have been wrong, and Oklahoma nuisance law could extend to activities in Arkansas that create the nuisance in

Oklahoma, correct?

MR. JORGENSEN: No, sir. I've thoroughly messed this up. So let me try again.

THE COURT: All right. But it seems to me that your argument leaves a void that has to be filled somewhere.

MR. JORGENSEN: You're exactly right. So what I meant to say before, and mean to say now, is that if there is a void, then federal common law could potentially apply if there's --

THE COURT: That's what I'm saying. That's why I asked you first whether federal common law might apply to activities that occur in Arkansas. Now we're coming full circle.

MR. JORGENSEN: Indeed.

THE COURT: But you just told me that that was incorrect.

MR. JORGENSEN: I don't believe it could, because I believe Arkansas regulates this conduct in Arkansas.

THE COURT: Then there's a void, is what I'm saying, in terms of nuisance. I mean, just focusing in on the law of nuisance. If federal common law can't apply, and if Arkansas nuisance common law can't apply to activities that occur in

Arkansas that create a nuisance in Oklahoma, then there's a void.

So the court must have been wrong in ruling that Oklahoma -- the Oklahoma nuisance law can't cross the state line, and then we apply Oklahoma state common law of nuisance -- presuming it can be applied at all. Right?

MR. JORGENSEN: I continue to do a bad job. I guess what I'm trying to say is Mr. Baker can't be right on both points, that federal common law applies in Arkansas and Oklahoma nuisance law applies in Arkansas. It would be one or the other.

THE COURT: I suspect that's right. It really is a -- maybe I've got it evaluated all wrong. I mean, that's what you are here to help me grapple with. But you see my problem with your argument?

MR. JORGENSEN: Yes.

THE COURT: It leaves a void. There can't be a void there, correct?

MR. JORGENSEN: I do believe that federal common law could exist to fill in the void, although that gets me to my other errors.

You asked me this morning when the nonpoint source regulations came into effect, and I told you

seven years after the *Sewerage* decision. It's six.

THE COURT: That was a leading question, so you just went along with my lead.

MR. JORGENSEN: And you have the citation for the Water Quality Act of 1987. It's Public Law No. 100-4, 101 Stat. 42, 1987. That's the one.

You were right in that the *Sewerage* decision was based on the amendments from 1972. The *Milwaukee II* case discussed those.

On that point, I'll just quickly point out the fact that the Supreme Court said in 1981 that all federal common law is preempted based on what existed at that point for nonpoint source regulation.

The fact that then there was more nonpoint source regulation later makes it more likely that federal common law has been displaced, not less.

If what existed in 1981 was enough, the fact that more federal law existed in 1987 only makes preemption more likely, not less likely.

And I know the court is aware on that point, with the mess up I made this morning, of the *Audubon* decision out of the Ninth Circuit where the Ninth Circuit applied the *Sewerage* case to nonpoint source pollution and said nonpoint source pollution

is completely preempted under the Supreme Court's language.

And then in dissent, one judge said essentially what this court said, I don't like that, I think this is too broad of language for what was before the Supreme Court at the time, but I lack the power to not follow it, and noted that the Supreme Court had repeated its holding since the *Sewerage* decision in *Ouellette*, the 479 U.S. 481. The court had looked back to the *Sewerage* decision and said the same language again. Here's the quote.

"Consequently, the court has held that federal legislation now occupies the field" -- meaning the field of water pollution -- "preempting all federal common law."

Thank you for your patience, sir.

THE COURT: The date of that latest decision?

MR. JORGENSEN: 1987.

THE COURT: What I'm going to have to do is obviously read these decisions, which I've not had the time to do.

MR. JORGENSEN: Yes, sir.

Did I give you the cite for *Audubon*, or should I actually just give you a copy?

THE COURT: Go ahead and give me a copy, if you would.

MR. JORGENSEN: Yes, sir.

MR. BULLOCK: Judge, do you wish to entertain further argument on these points?

THE COURT: Well, let me say that in the event that I am leaning the defendants' direction, because as I showed this morning or stated this morning, based upon what was related to me, it sounded like we would stay the course on the court's decision that was made, I believe, at the time of the motion to dismiss.

If I start leaning the other direction, I'll give you that heads-up, because obviously this is a very important issue in the context of this case. So I will afford you that opportunity.

I don't have a firm fix on the time line yet on where the Clean Water Act was with respect to all these decisions. I haven't read the Ninth Circuit decision. So I need to personally focus in on these.

MR. BULLOCK: I appreciate that. Thank you, Judge.

THE COURT: Yes, sir.

Mr. Green.

CONTINUED DIRECT EXAMINATION

BY MR. GREEN:

Q. So, Dr. Connolly, would you be kind enough -- let's just step back two or three paces here -- and refresh us on what analysis of yours is depicted on this exhibit, sir?

A. This is an analysis of the average velocities in the river under typical summer conditions for sections of the river in Oklahoma as well as the time of travel to go between various points within Oklahoma.

Q. And can you tell us just what -- what is charted here on the left-hand axis and what the red and blue represent --

A. Yes.

Q. -- the bars.

A. The red bars represent velocity. The blue bars represent travel time, the time it takes to get from one location to another. The velocities are on the vertical axis on the left. The travel time is on the vertical axis to the right.

And so we're starting at Watts. And to go from Watts to Chewey, the river is traveling at about 30 miles per day, and it takes about one and a half days to make that journey.

Then from Chewey to Tahlequah, the river is traveling faster. It's traveling at about 55 miles a day, and it takes only about half a day to get to Tahlequah.

Then from Tahlequah to Barren Fork, the river was traveling still fairly quickly, about 45 miles a day, and it takes about a tenth of a day to get there.

At that point, we reach the riverine section of Lake Tenkiller, and you can see how dramatically things slow down. The velocity between Barren Fork and LK-04 is now down to just a couple of -- down to about two miles per day or so, and it takes about five days to go from Barren Fork to LK-04, which is the first water quality sampling station that the plaintiffs have used in the lake, in the riverine section of the lake.

Q. Now, on the basis of this data, did you come to any conclusions, Doctor, regarding the movement of particulate phosphorus associated with runoff events or theoretical runoff events in the Illinois River?

A. Yes. Now, this represents average summer flow conditions, so it's lower than the flows that would exist in most runoff events. So in those events, actually the velocities would be higher.

But these velocities all the way down to Barren Fork are high enough to prevent particulate matter containing phosphorus from settling within those sections of the river.

As I indicated earlier, the threshold is roughly about 15 miles per day. Above that, the particles really will stay in the water column.

Q. When Dr. Fisher appeared here to testify, he said that it was difficult to find fine particulate sediments in the Illinois River system because they are carried by the water down to the lake where they're deposited on the lake bottom.

Let me ask you whether his assessment is consistent, sir, with your views and your analysis.

A. Yes. And I think this velocity analysis explains why it was difficult for him to find fine sediments.

Q. Now, you noted earlier -- we've talked for a short moment about how phosphorus can change forms. Do you recall that discussion?

A. Yes.

Q. Is there any relationship between river velocity and the ability of particulate phosphorus to become dissolved phosphorus?

A. It's not so much velocity as it is the travel

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time. So if you -- if we sum up the travel time from Watts to Barren Fork, it's about two days or so.

The turnover times for particulate phosphorus are much longer than that, so in order for particulate phosphorus to be converted to phosphorus available to algae, that requires times more like a week or more.

Typical conversion rates are on the order of about ten percent per day. And that's for relatively labile organic -- particulate organic phosphorus.

Q. What do you mean by "labile"?

A. Organic phosphorus that can be broken down by bacteria.

Q. Let's focus on the lake here for a moment. Did you review any data regarding how much phosphorus reaches Lake Tenkiller in a year?

A. Yes.

Q. And where did that data came from, Doctor, that you looked at?

A. That comes from the data collected by the USGS and by the plaintiffs.

Q. Now, Dr. Engel, again, testified that on average, 505,000 pounds per year of phosphorus

reached the lake. Is that assessment consistent with the estimates you reviewed?
A. It's slightly higher than the number I obtained, but fairly similar.
Q. Have you seen any data regarding how much phosphorus exit, departs the lake each year via the dam?
A. Yes.
Q. And what is that amount, sir?
A. That's approximately 30,000 kilograms per day.
Q. And so if there's a difference between that number and Dr. Engel's input number of 505,000 pounds per year, where is that difference going?
A. I apologize, because we keep switching between pounds and kilograms. If we do it on a kilogram basis, my estimate is 205,000 kilograms per year coming in, which is about 450,000 pounds versus Dr. Engel's 500,000 pounds.
So 205,000 come in. The estimate of 30,000 leaving means the difference is about 175,000 kilograms per year.
Q. Now, I don't want to spend my time citing to you testimony of all of the other experts, but I think it's worthwhile just to phrase this question.
Dr. Wells and Dr. Cooke both testified that

river water entering the lake plunges to a level below the epilimnion. Do you agree with that assessment?

A. Yes. The lake -- the river water coming in is typically colder than the water in the lake and, therefore, it dives down.

Q. What, if any, impact does this plunging effect have on phosphorus entering the lake and on the water quality in the lake?

A. It -- as the water dives, it carries the phosphorus with it. So the diving brings the phosphorus that's coming into the lake or a significant fraction of the phosphorus coming into the lake down below the epilimnion.

The epilimnion is the surface layer of the lake where algae can grow. And so it effectively is moving phosphorus out of the region that algae can grow into a region below where algae can grow.

Q. When you say it -- the plunging water carries, you know, the phosphorus down into the lake, are we talking about all types of phosphorus or essentially particulate phosphorus?

A. It carries everything that's in the water with it, so it carries dissolved phosphorus and particulate phosphorus.

Q. Is that then deposited on the bottom of Lake Tenkiller?
A. Certainly the particulate phosphorus is deposited on the bottom. The dissolved phosphorus, unless it's converted to a particulate form, is likely to flow out of the lake.
Q. The phosphorus that gets deposited, Doctor, on the lake bottom, can that return to the water column?
A. In part it can, yes.
Q. How would that work, if you can explain that?
A. Within the sediments, there's a process called digenesis that's going on. So the organic matter that deposits on the sediment is decomposed by bacteria.

As the bacteria decompose the organic matter, some of the phosphorus associated with that organic matter is released into the pore water in the sediment. So we have essentially orthophosphate in the pore water of the sediment.

That phosphorus can diffuse out of the sediments, although it cannot -- typically does not do so if there's oxygen in the bottom waters, because if there's oxygen if the bottom waters, we will typically have iron and manganese oxides in the

sediments, and they will adsorb any phosphorus trying to move up. So effectively are a barrier.

So the process occurs once the lake goes anoxic, so there's no oxygen in the water. The iron and manganese are reduced. And in their reduced form, they're soluble, so the barrier goes away and some of the phosphorus that's dissolved in the pore water can diffuse out into the bottom waters of the lake.

Q. If some of this phosphorus is returned to the water column, however slight the amount, is it still particulate phosphorus?

A. No. It's -- what's coming out of the bottom is essentially soluble reactive phosphorus. It's orthophosphorus.

Q. And did you perform any analysis to measure the degree to which this is happening in Lake Tenkiller?

A. Yes.

Q. And what did you do, Doctor?

A. The plaintiffs had measured phosphorus in the bottom waters of the lake over the course of the summer, so from when the lake first stratifies in late spring through the summer and into the fall.

And over that period, you can see an increase of soluble reactive phosphorus in the

bottom waters. And based upon the increase in concentration and the volume of water in the hypolimnion, you can calculate a mass of phosphorus, a soluble reactive phosphorus that has increased over the course of the summer.

Q. Is that the same as saying it's returned to the water column?

A. I'm sorry, yes. Returned to the hypolimnion, the bottom waters of the water column.

Q. Were you able to quantify that amount of phosphorus based on your analysis?

A. Yes. The analysis indicated that approximately 3,000 kilograms of phosphorus had returned to the water column from the sediments.

Q. Is that a significant amount, Doctor?

A. In terms of the full mass balance, it's a small component of the full mass balance. And whether it's significant or not depends upon its ultimate fate.

Q. Let's try to talk a bit about the effect of that. Can that phosphorus from the lake bottom support algae growth in the lake during the growing season when it reenters the water column?

A. No. During the --

MR. PAGE: Judge, I have to object as lack

of foundation of what analysis this witness has done to determine whether or not the SRP that's released from the sediments can affect the algae in the water column.

THE COURT: Any response?

MR. GREEN: Your Honor, bear with me one moment.

THE COURT: It's mainly a function of the growing season, I take it.

MR. GREEN: Let me just do this this way, Your Honor.

Your Honor, you have Figure 2-35 in the copy of your report.

Doctor, you have a copy of Figure 2-35 -- 2-35 in your report.

And if you have the full report, Mr. Page, you have that as well. And it's discussed --

If Your Honor can juggle --

Q. (By Mr. Green) First of all, did you review Dr. Wells' testimony that there's no exchange between the hypolimnion and the epilimnion?

A. Yes, I did.

Q. So you're aware of that. Now, let me show you with reference to your Figure 2-35, and the discussion on page 2-39 of your report, and can you

look at those two sources, if you will, and tell me whether or not you discussed in your report your views with respect to the amount of phosphorus that recycles into the water column and the impact of that?

A. Yes. The analysis that I did, which is described on page 2-39, was to look at separately the epilimnion of the lake and the hypolimnion of the lake and the soluble reactive phosphorus levels in both and the changes in those levels over the course of the year and use that information to demonstrate that the phosphorus coming out of the sediments was not to any significant extent during the summer, making its way to the hypolimnion and supporting algal growth.

Q. Now, on the --

THE COURT: Let me rule on the objection. Having looked at 2-39 and 2-40, the objection is overruled. Go ahead.

Q. (By Mr. Green) Then let me return to the question that got this process started, and that was whether or not the phosphorus from the lake bottom, can it support algae growth in the lake during the growing season when it reenters the water column?

A. No, because the very limited exchange that

occurs between the hypolimnion and the epilimnion, the soluble reactive phosphorus that's entering the hypolimnion is not transported to the epilimnion to any significant extent, and it's only if it were able to get into the epilimnion that it could support algal growth.

So until the lake turns over in the fall, that soluble reactive phosphorus is effectively locked in the hypolimnion.

Q. Would the residence time of water in the lake also have any impact on this process?

A. Well, it does to the extent that the soluble reactive phosphorus that has come out of the sediment, which is -- the term we've used is "regenerate." So the phosphorus that's been regenerated out of the sediment doesn't enter the lake as a whole until after overturn.

So in the fall, sometime in October or so, the lake will overturn, the phosphorus that's come out of the sediments will go into the full lake. And that's sort of at the end of the growing season, so it's really not having much impact.

But if that phosphorus is still around the next spring when the lake warms up, it could potentially provide a source of phosphorus to grow

algae.

But because of the residence time of the lake, much of that phosphorus washes out of the lake before the next growing season, and so is not available to support algae.

Q. Now, I admit to you that I jumped around a little bit in asking for your various components of analysis. I'm wondering whether I could ask you to kind of bring them together and summarize for the court and all of us your understanding of how point and nonpoint sources of phosphorus loading impact Lake Tenkiller.

A. During the summer period, May through September, 80 percent of the time, the river is flowing into the lake under what we characterize as base flow conditions, which are dominated by wastewater treatment plant phosphorus, most of which is available to the algae.

It runs through the river much too quickly to grow a lot of algae in the river; so coming into the lake, the algae concentrations are low.

You hit the lake, things slow down and now we're able to grow algae. And so in the upper parts of the lake, the riverine parts of the lake, we grow at sometimes fairly high concentrations of algae.

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You hit the lake, things slow down and now we're able to grow algae. And so in the upper parts of the lake, the riverine parts of the lake, we grow at sometimes fairly high concentrations of algae.

That's being supported by this very bioavailable phosphorus coming in from the wastewater treatment plants principally under base flow conditions 80 percent of the time.

Runoff events are contributing, and they're occurring the other 20 percent of the time. When they occur, they increase the velocity in the system. The travel time even into the riverine portion of the lake is much reduced so that they run through the riverine portion pretty quick, don't provide a lot of opportunity for algal growth.

Once the water, both under base flow and runoff events, enters the lake and moves past the riverine portion of the lake, it begins to dive down below the epilimnion and, as a result, in essence protects the lacustrine portion of the lake.

So we don't have high algal concentrations typically in the lacustrine portion of the lake because much of the phosphorus has entered below the epilimnion. Much of the phosphorus that comes in associated with nonpoint sources with a significant particular fraction winds up in the sediments.

So in total, the sort of simple way to describe this is that the high algal concentrations that we see in the upper portions of the lake are

largely being driven by the point sources. The nonpoint source phosphorus, to a great extent, is entering the bottom waters of the lake, and a large part of that is being stored in the sediment.

And so the opportunity for the nonpoint sources to impact the lake is actually through the recycle process. So if you can think about it, most of the time we're seeing base flow, we're seeing point source-dominated system, we're growing algae. We get runoff events. We bring in a lot more phosphorus. That phosphorus comes quickly through the system, enters the bottom waters, settles into the sediment, then has the opportunity to cause a problem if it recycles back.

In this system, it seems that the recycle is actually fairly low, and that that recycle does not contribute significantly to the algal growth the next year. As a result, the high chlorophyll levels that we see are being driven, to a great extent, by the point sources that are coming into the system rather than the nonpoint sources.

Q. Building on that explanation and analysis that you just articulated, and in light of all of your investigation and analytical work in this case, have you formed an opinion, Doctor, as to the impact that

phosphorus from land-applied poultry litter has on water quality in the watershed?

A. Yes. I've concluded that, for the most part, this is a point source-dominated problem. Nonpoint sources are not -- nonpoint sources are not controlling water quality to a great extent in this system.

Poultry litter application provides some fraction of those nonpoint sources. As we discussed earlier, poultry litter is one of many potential nonpoint sources into the system. And to the extent that nonpoint sources as a whole are not what's really driving the water quality here, certainly then poultry litter application, which represents only some fraction of nonpoint sources, cannot be controlling water quality in the system.

Q. So what would be your opinion, Doctor, if eliminating the use of poultry litter, what would that accomplish on improving water quality?

MR. PAGE: Objection, new opinion, Your Honor.

MR. GREEN: Your Honor, I don't believe it's a new opinion at all.

THE COURT: If you could point me to the portion in the report.

MR. GREEN: If you go to the summary of findings, Your Honor, at 1.2, and also look at the summary of detailed findings on 2.1, this opinion that I'm asking for is embraced within those findings. And particularly within summary of finding number 1 and certainly I think the follow on findings on 2 and 3.

And also if you turn over to 2.1, I think it's implicit in the further summary of detailed findings in those various bullet points.

And I think that because this is both my direct examination of this witness and also, for practical purposes, my rebuttal of the plaintiff's expert case as presented in this courtroom, and because there was considerable discussion among the plaintiff's experts about the impact, if any, of eliminating land application of poultry litter, that there's clearly a predicate, and it is permissible for me to ask this question and elicit this opinion.

THE COURT: I think this opinion is encompassed both in item 1 in the summary of findings and 1.2 as well as bullet point 5 in the summary of detailed findings, 2.1. The objection is overruled.

Q. (By Mr. Green) So, Doctor, where I was taking

you was to ask you what your opinion would be if the use of poultry litter in the watershed were eliminated, what impact would that have, sir, on water quality in the Illinois River Watershed?

A. Given the way that phosphorus is operating in the system and the sources of phosphorus that are driving water quality, eliminating poultry litter application would not have a significant impact on the water quality in the lake or in the Illinois River.

Q. Doctor, I want to turn now to seek your views on some of the analysis that was performed and testified to in this case by certain of plaintiff's consulting testifying experts.

I want to talk about what's come to be sometimes called the ratio analysis, Dr. Fisher's ratio analysis and Dr. Olsen's gradient analysis. You've seen those terms --

A. Yes.

Q. -- used in your review of your materials?

A. Yes.

Q. And have you had occasion to review not only their reports but the testimony that they gave with respect to this ratio analysis and this gradient analysis?

A. Yes.
Q. Now, let me just start right off by asking, do you agree with Dr. Fisher and Dr. Olsen's testimony that phosphorus from land-applied poultry litter can be tracked in the manner in which they testified to?
A. Not at all. I mean, they're attempting to track it using chemicals that are ubiquitous in the watershed, so I don't think it's possible.
Q. Are their theories, to the extent you understand them, consistent with traditional notions of fate and transport characteristics?
A. No, not at all. In fact, they're ignorant of fate and transport characteristics.
Q. Doctor, did you see any analysis in your review of their material that qualifies, in your opinion, as a traditional fate and transport analysis?
A. None at all.
Q. Do they assume -- and I'm just asking this, do each of these doctors, or one of them, assume that chemicals and constituents that are found in poultry litter move together through the environment?
MR. PAGE: Objection, leading.
THE COURT: Sustained. Rephrase.
Q. (By Mr. Green) What, if anything, do they conclude, Doctor, about whether constituents in

poultry litter move together in the environment?
A. They conclude that they must roughly move together in the environment because they simply rely on the fact that if poultry litter contains a number of chemicals, four or five chemicals, and they go somewhere else and find the same four or five chemicals that, therefore, it must be poultry litter.
Q. Is that a sufficient analysis, in your mind, to support the assumption that they move together in the environment?
A. No.
Q. Let me just fold into my question some of these chemicals or constituents that they dwell on.
What types of characteristics, sir, would you need to look at to understand how phosphorus, zinc, copper, potassium and arsenic move and persist in the environment?
A. You have to look at many, if not all, of the fate and transport processes that we had discussed yesterday. Each of these chemicals is subject to those processes, and they're subject to them in different and unique ways.
And so that depending upon the environment that they're applied in, you will get different

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And so that depending upon the environment that they're applied in, you will get different

reactions. As they move off a field and move through the soil environment and into a water environment and so forth downstream, they are subject to very many reactions and interactions and unique ways that will change their relative composition and their relative mobility and fate.

Q. And do they all have differences in their relative mobility?

A. Yes, very much so.

Q. Can you give us an example of how differences in sorption rates may be relevant to understanding the -- you know, the transport of the constituents as well as the fate that Dr. Olsen and Dr. Fisher examined?

A. Differences in sorption rates will control the extent to which the compound is traveling through the environment in a dissolved form versus associated with particles.

The transport of dissolved material and particulate material is very different in the environment. So to the extent that they have different sorption characteristics, and they do, they will travel differently because the dissolved material is traveling different than the particulate material.

The dissolved material is not subject to erosion and deposition, for example, whereas the solid material is. The dissolved material wouldn't be intercepted by the soil environment that it's traveling through, for example, but particulate material would.

So differences in sorption have potentially a large impact in how they move in the environment and their ultimate fate.

Q. Are there any generalizations that you can make, let's say, as between copper and zinc when you talk in terms of sorption rates?

A. Yeah. There are significant differences in terms of their extent of adsorption and the type of things they will adsorb to.

Zinc tends to partition to a greater extent than copper, but copper has a unique affinity for dissolved organic matter and will adsorb and complex with dissolved organic matter to an extent that zinc won't.

And so the presence of dissolved organic matter will significantly affect the sorption properties of copper. If won't affect the sorption properties of zinc to anywhere near that extent.

Q. Let me just ask you, what are cations and

anions?
A. Cations are positively charged chemicals. Anions are negatively charged chemicals.
Q. Would it be important, in your view, Doctor, to understand a chemical's charge in assessing fate and transport characteristics?
A. Yes. A chemical's charge controls, to a great extent, the type of reactions it would be subject to and other chemicals in the environment that it would interact with.
Q. And will phosphorus, you know, bind to some chemicals or bind better to some chemicals than others?
A. Certainly. Phosphate in the environment is negatively charged, so orthophosphate will exist as H2P04, which is a single negative charge, or HP04 which is two negative charges, or PO4 which is three negative charges. And it will interact with positively charged ions, and very significantly with iron, aluminum and calcium.
So it will form compounds with iron, aluminum and calcium because they're positively charged and the phosphate is negatively charged.
Q. How important is it, if at all, Doctor, to understand the tendency of a particular chemical to

bind to other chemicals, compounds or metals?
A. Well, it's very important because it really affects where they go and how far they go.
Q. And you mentioned -- you mentioned iron and aluminum a moment ago. Let me just pause with respect to those metals and ask you, in your analysis, if they are significant and why they are significant.
A. They're very significant, and they are so because they're so abundant. Iron and aluminum are two of the most common elements in the earth's crust. Soil particles can sometimes be as much as 10 percent iron and aluminum.
THE COURT: Am I wrong, in terms of the ions -- anions that you mentioned, the most prevalent is the orthophosphate, the H2P04?
THE WITNESS: Yes, that would be the most prevalent.
MR. GREEN: Should I continue, Your Honor?
THE COURT: Yes, please.
Q. (By Mr. Green) Let me just back up. I want to talk about the chemical's charge and assessing fate and transport. And I want to ask you: Given the differences in charges, what are the implications for whether or not phosphorus will or will not bind

to something that zinc, copper and arsenic might bind to? Do you follow my question?
A. Yes. If affects it very much because, again, zinc and copper and arsenic are positively charged, so they will interact with different things.
So, for example, zinc and copper will react with chloride present in the environment. So you'll form zinc chlorides and copper chlorides and sulfates in the environment. So you'll form zinc sulfates and copper sulfates. And that's very different than the kind of compounds that you would form with phosphorus.
Q. Dr. Fisher and Dr. Olsen testified regarding their sampling and the sampling of the limits of copper, zinc, arsenic and potassium found in poultry litter. Do you recall that discussion?
A. Yes, I do.
Q. Now, these chemicals that I just identified, do they have other sources in the environment?
A. They have a multitude of sources.
Q. Can you just tick off a few.
A. All of those chemicals are constituents of soil. So they will be everywhere in the watershed because they're part of the soil matrix typically. They're also pollutant sources. I mean, the metals,

zinc and copper, are mined and used in manufacture, and so they're present in the urban environment. They're significant constituents of urban runoff.

Arsenic is present in the environment. Naturally, it also, for example, is a constituent you'd find downstream of a combustion site. Like a coal-fired power plant, for example, puts out a fair amount of arsenic and particulate matter that would settle within the watershed.

Wastewater treatment plants are sources. Land application of sewage sludge would be sources. As I indicated, urban areas, so storm runoff from urban areas would be sources.

Q. How about other animal manure?

A. Certainly other animal manure would also contain these substances.

Q. Did you see in your review of the materials submitted by plaintiff's experts any what you deem to be meaningful consideration of the alternative sources of these chemicals that we've talked about?

A. None at all.

Q. Are you able to characterize the method by which Dr. Fisher and Olsen went about supporting their analysis?

A. Yeah. It seems to me that what they did was

start with -- I guess they would term it probably a hypothesis. The hypothesis being that poultry litter was responsible for water quality impacts in the Illinois River and Lake Tenkiller.

They then, though, used that hypothesis almost as a conclusion, and conducted analyses to support that hypothesis in a way that I would suggest is not consistent with the scientific method in that they didn't try to challenge that hypothesis in all the ways that you would normally challenge a hypothesis to evaluate it, looking at all of the possibilities that exist and attempt to try to challenge the hypothesis.

Typically the scientific method, when you form a hypothesis, you are conducting experiments, in essence, to try to disprove your hypothesis. And the more you're not able to disprove your hypothesis, the greater strength there is in your hypothesis.

Science very rarely proves a hypothesis. They typically gain confidence in it by their inability to disprove it.

Q. Let's look at some techniques which might qualify as disproving their hypothesis.

Did you prepare any analysis -- or did you

1 undertake any analysis of what I'm going to call
2 Dr. Fisher's ratio analysis approach?
3 A. Yes.
4 Q. And did you prepare some charts to illustrate
5 how you went about this, sir?
6 A. Yes.
7 Q. I'm going to ask you to turn to the exhibit
8 behind tab 19 in your notebook, which is Defendants'
9 Joint Exhibit 6096. Was this chart in your report,
10 sir?
11 A. Yes.
12 Q. And can you just briefly tell us where the data
13 is coming from which is depicted in this --
14 graphically or on this exhibit?
15 A. This is the plaintiff's data.
16 Q. All right, sir.
17 MR. GREEN: I move the admission,
18 Your Honor, of Defendants' Joint Exhibit 6096.
19 THE COURT: Any objection?
20 MR. PAGE: No objection.
21 THE COURT: 6096 is admitted.
22 Q. (By Mr. Green) Doctor, would you, with this
23 exhibit in front of you, lead us through the
24 analysis here that is reflected on Exhibit 6096.
25 What did you do, and how does this inform

your analysis?
A. What I was attempting to do here was to evaluate the idea that zinc, copper and arsenic can be used as tracers in the environment. And so I started with the edge of field. And what's shown here is the relative proportions in the edge-of-field samples for these three compounds. So you can see in edge-of-field samples, on a relative basis, 54 percent is copper, 40 percent is zinc, and 6 percent is arsenic.

I then compared that to the relative composition of these three same chemicals in rivers and streams under base flow conditions, rivers and streams under high flow conditions, and Lake Tenkiller.

And as I believe this demonstrates, the relative distribution in the environment does not look at all like the relative distribution in the edge-of-field samples. Whereas copper is the most common of these three in edge-of-field samples, zinc is by far and away the most common in the environment being -- and whether or not we're under base flow or high flow conditions in the rivers or whether we're looking in Lake Tenkiller.
Q. What does this tell you, if anything, about

whether or not poultry litter is the source of these constituents further downstream?
A. It provides no evidence that poultry litter is the source. And, in fact, if you are to accept the proposition that you could use these, it suggests that poultry litter is not the source.
Q. Now, to the extent we have different relative concentrations, if you will, or percentages of these constituents at the various high flow lake and base flow edge-of-field locations, did you evaluate, Doctor, whether the differences between these relationships are statistically significant?
A. I did, and they are. There's no single significance between the three environmental groups between rivers under base flow and high flow or Lake Tenkiller, but all three of those are statistically different from the edge-of-field samples.
Q. Okay. Let us then turn to the next exhibit behind tab 20 in your book, which is Defendants' Joint Exhibit 6105. Did you prepare that, Doctor?
A. I did.
Q. Was that in your report?
A. Yes.
Q. And the data that's reflected on this exhibit comes from where, sir?

A. This is from the plaintiff's data.
Q. And just very briefly, what are you showing here on this before we descend into further explanation?
A. This is similar to what we just looked at. We're looking at the relative composition of zinc, copper and arsenic in various samples, only whereas before we were looking at water samples, now we're looking at solid samples.
MR. GREEN: I move the admission of Defendants' Joint Exhibit 6105.
THE COURT: Any objection?
MR. PAGE: No objection.
THE COURT: Defendants' 6105 is admitted.
Q. (By Mr. Green) Doctor, can you take us through the analysis here that's reflected on this exhibit.
A. Yes. The upper left shows the relative composition of these three chemicals in poultry litter. And you can see that in poultry litter, zinc is slightly more dominant than the others; 54 zinc, 44 copper, 2 percent arsenic.
If you go to the upper right, there is litter-applied land. Litter-applied land looks a little bit different than poultry litter, but there is a fair similarity between litter-applied land

soil and poultry litter.

In the middle is alleged control soil samples, so these are samples that the plaintiffs took from fields that they believed have never received poultry litter application.

And then the lower left and the lower right are the sediment samples. As I indicate, on the lower left, it's from the streams. And then on the lower right is from the sediment.

And what you can see here is that the distribution in those sediments is different than the distribution of poultry litter or litter-applied land, but it's remarkably similar to the distribution in control soil.

Q. And what are the implications that flow from your analysis, sir?

A. That just looking at these distributions, you could not draw a conclusion that poultry litter is the source of these chemicals in the sediments.

Q. And did you again, as you did before, evaluate whether these differences in these relationships as depicted here are statistically significant?

A. I did. And lake sediment and stream sediment are not statistically different from control soil, but they are statistically different from

litter-applied land or poultry litter.
Q. Doctor, is it possible to look at these last two exhibits and explain away the discrepancy in these relationships by simply contending that copper is less mobile than the other chemicals?
A. Well, you could certainly posit that, but if you're going to posit that, I think you would have to make a demonstration that that difference, in fact, exists and can quantitatively account for the changes you see.
Q. In reviewing any of the plaintiff's experts, did you see them trying to undertake such an assessment as you just described?
A. I did not.
Q. Now, did you perform any other analysis, sir, of the State's sampling results for copper, zinc and arsenic in poultry litter and the State's edge-of-field samples?
A. Yes.
Q. Tell us what you did.
A. What I did was to compare poultry litter to edge-of-field samples because if this idea that you can look at the relationships among these chemicals and use them for tracers, that the first place to look is does that relationship hold even at edge of

field. Does what you see at edge of field look like poultry litter? And you shouldn't go -- that's the first step. And so I felt it important to look at the first step: Does this work between poultry litter and edge of field?

Q. And did you prepare a chart to demonstrate the analysis that you made of that subject, sir?

A. Yes.

Q. Let me ask you to look at Defendants' Joint Exhibit 6107 which is behind tab 21 in the notebook. And was this prepared by you, Doctor?

A. Yes.

Q. Was it included in your report?

A. Yes.

Q. And the data comes from where, sir?

A. This is the plaintiff's data.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6107.

THE COURT: Any objection?

MR. PAGE: No objection, Your Honor.

THE COURT: 6107 is admitted.

Q. (By Mr. Green) Doctor, is this another probability plot?

A. Yes, it is.

Q. I've just exhibited the extent of my

understanding. Would you be kind enough to explain to us what this shows, sir.

A. Again, a probability plot is just a convenient way to display the results for every sample. And, again, in a probability plot, they are arranged from left to right from lowest value to highest value.

And what's plotted here are ratios. Upper left is phosphorus to zinc. Upper right is phosphorus to copper. Lower left is phosphorus to arsenic, and lower right is zinc to copper.

And the comparison that I'm making here is between edge-of-field samples, which are indicated by triangles, and poultry litter samples, which are indicated by diamonds.

So if we start in the upper left and look at the ratio of phosphorus to zinc, you can see if you look at the diamonds that represent poultry litter, they're almost a flat line, which means that with almost no exception, poultry litter has a very consistent relationship between phosphorus and zinc. Almost every sample has about the same relationship. They're very tight, which is what it means to be flat. The greater the slope on here, the greater the variability and the difference.

When we go to edge-of-field samples, we see

for phosphorus to zinc that there is a much greater variability. So whereas in poultry litter the phosphorus to zinc ratio is probably sitting about 40s, I would guess the average of those data, edge-of-field samples have something -- there's one that I would call an outlier that's down about .5, but they're as low as maybe 4 or 5 and as high as 200. So much more variable than what we see in poultry litter.

If we look at the upper right and look at phosphorus to copper, again with a couple of exceptions, it's very tight for poultry litter. Again, most of the data, just sitting on a flat line. There's a couple of samples that fall off that at the end, but pretty tight.

When we look at edge of field, we see that most of the edge-of-field samples plot above the poultry litter. So edge-of-field samples have more phosphorus per unit copper than does poultry litter.

If we go to the lower left, we're looking at the ratio of phosphorus to arsenic. And you can see that poultry litter, the diamonds, plot significantly above edge of field.

So what that is saying, edge-of-field samples have a lot less phosphorus per unit arsenic

than does poultry litter.

If you look at the lower right at zinc to copper, you can see that zinc to copper in edge of field is much more variable than in poultry litter, and most of the data plot higher than poultry litter.

And what I conclude from this, to the extent that these edge-of-field samples are, in fact, measuring something coming off of a litter-applied field, that the relationship among these chemicals is changing so that even at the edge of field, they differ from poultry litter, which makes them poor tracers in the environment for poultry litter.

THE COURT: Is that surprising, given the interaction between copper and dissolved organics?

THE WITNESS: No. In fact, that's one of the reasons that it probably shifts the way it does.

THE COURT: All right. But in your view, it makes it a poor predictor?

THE WITNESS: Yes.

THE COURT: All right. Go ahead.

Q. (By Mr. Green) One way to look at this, and I think you've said it, but there's no match between poultry litter samples and edge-of-field samples; is

that the lesson we take from this?
A. Yes.
Q. Let me talk about a couple of these other tracers that were utilized by plaintiff's experts, Dr. Olsen. Dr. Olsen made use of potassium as a potential tracer. Do you recall that testimony?
A. I do.
Q. Do you, sir, have an opinion whether or not potassium is an effective tracer for poultry litter?
A. It is not.
Q. Why is that?
A. Potassium is ubiquitous. You see it everywhere. It has a multitude of sources. It's certainly an important constituent of soil. Potassium is the 20th most common element in the Earth's crust, so you pretty much find it wherever you look. So it's not a good candidate as a tracer.
Q. Let me follow up and say to you, represent to you that Dr. Olsen testified that it's unusual, unusual to see potassium in the environment, including in the waters across the entire country. Do you remember his testifying to that?
MR. PAGE: Objection, Your Honor, that misstates the testimony. The testimony of Dr. Olsen was that it's unusual to see these levels of

flow and high flow and Lake Tenkiller.

And you can see there's not a lot of difference, whether we're under base flow, high flow or in Lake Tenkiller, but these distributions or relative concentrations of these three major cations are different in the environment than they are at edge of field.

Q. What do you draw from this mismatch of these various cations in these samples?

A. That looking at these cations, you cannot see an impact from edge of field to rivers and streams or the lake.

Q. So these are not good tracers for poultry litter, is that my understanding?

A. Yes.

Q. All right. Doctor, let me turn to discuss for a while Dr. Olsen's gradient analysis. And I think we touched on a gradient analysis for a moment a while back, at least as to what constitutes a gradient analysis. But what is a proper gradient analysis?

A. A proper gradient analysis follows a known pathway. So earlier when we were looking at the Illinois River from upstream to downstream and looking at how concentrations change, that's a

gradient analysis.

When we look in the tributaries and follow the tributaries down to the Illinois River, that's a gradient analysis. It requires you to move along a pathway and look at the concentration changes as you move along the pathway.

MR. GREEN: If Your Honor would allow me to interrupt for a quick second, perhaps we should mark this drawing of the algae formula. If I could put an exhibit number on it or assign an exhibit number to it --

THE COURT: I don't think it's necessary, given it's in the record.

MR. GREEN: I agree, sir.

THE COURT: Once again, let me go back here to 6104 insofar as you testified that potassium is part -- 1.7 parts potassium in the formula for algae.

THE WITNESS: Yes.

THE COURT: Once again, at least part of this drop in total potassium may be attributable to algae uptake, correct?

THE WITNESS: Yes.

THE COURT: But your point is that although this doesn't eliminate the possibility of poultry

litter as being a source, it's not a good tracer.

THE WITNESS: Yes.

THE COURT: So this is not necessarily inconsistent with Fisher and Olsen's theory, it just doesn't -- you say it doesn't sufficiently support it.

THE WITNESS: Yes.

THE COURT: All right. Go ahead.

Q. (By Mr. Green) Back to Dr. Olsen's gradient analysis. Having reviewed his report and his testimony, do you have a view, sir, as to whether or not Dr. Olsen actually conducted a proper gradient analysis?

A. He did not, because he didn't follow actual pathways.

Q. Was there anything about the way he reported his sampling results and the interval between sampling results that would also impact that?

A. Yes. He was combining data from a whole suite of locations and a suite of times into one number. So he would, say, take all small tributaries no matter where they are in the watershed and just get one number from them. So a lot of disparate information that's been compiled together.

Q. Now, Dr. Olsen testified that he examined these

concentrations going downgradient. Do you recall reviewing that testimony?
A. Yes.
Q. Now, let me ask you this: The fact that we see elevated levels of soluble reactive phosphorus in the edge-of-field samples, do those elevated levels, Doctor, support the conclusion that what we're looking at here in this exhibit is evidence of any kind of gradient?
A. They do not because, again, we haven't established a pathway, and I mean -- let me use an example. If you go to Fort Knox, there's a lot of gold in Fort Knox. If you went across the street and there happened to be a bank across the street, you would probably have some gold in the bank.
The way that Dr. Olsen is looking at this, that analogy would be the same as saying, well, since there's so much gold in Fort Knox and there's some gold in this bank, gold must be flowing out of Fort Knox to this bank. But in order for you to conclude that, you really need to make sure there's a pathway that gold can get from Fort Knox to the bank. Because just simply the fact that there's more here than here, without having established a pathway to get from here to here, is insufficient

evidence of migration. You actually need to demonstrate that you've got a pathway.

Q. That was a proposition that Dr. Olsen could have tested for, correct?

A. Yes.

Q. Now, sir, I think it's -- I think this -- I think what you just testified to is probably an answer to this question as well, but let me just ask you.

Can you look at this exhibit, Demonstrative 245a, and conclude that the soluble reactive phosphorus measured in the receiving waters came from the fields where the edge-of-field samples were taken?

A. Not without knowing and being aware that there was a pathway to get from those edge of fields to those tributaries.

Q. Again, we see this phenomenon where the base flow readings, if you will, are higher than the high flow readings. Do you see that?

A. Yes.

Q. Do you attribute any significance to that?

A. Again, it's hard to say because the values are, you know, not all that different in the two cases. But again, it suggests some dilution under high flow

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 78 - AM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

DECEMBER 21, 2009

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

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2

3 Page

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

6

JOHN CONNOLLY, PH.D.

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Continued Direct Examination by Mr. Green 9051
8 Cross-Examinations by Mr. Page 9126

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Q. Behind tab 23.

A. I do.

Q. All right. Now, the question that I want to put to you is whether or not you performed any --

(Discussion held off the record)

Q. *(BY MR. GREEN)* Oh, I'm sorry. 245a.

MR. GREEN: Thank you. Thank you, Gordon.

Q. *(BY MR. GREEN)* Behind tab 25.

A. Yes, I have it.

Q. Okay. So the question then is, again, whether you performed any analysis of the data that is underlying this chart to determine whether Dr. Olsen's claim of a gradient from edge of fields to the lake has any flaws or defects from your perspective?

A. I did.

Q. Okay. And what did you do, sir?

A. First I did -- first thing I did was to replicate the plot to ensure myself that I had been using all of the data that Dr. Olsen used to generate the plot, and then I replotted the data taking out the two locations that were impacted by wastewater-treatment plants and replotted the data.

Q. All right. And did you have -- do you have a demonstrative that will illustrate your replotting of

that data?

A. Yes.

Q. All right. Would you turn then to the demonstrative that is behind tab 26 in your notebook, Tyson Demonstrative 257, sir? Do you have that?

A. Yes, I do.

Q. All right. Can you explain to us, what is this demonstrative showing us, Doctor?

A. This demonstrative shows for both total phosphorus and soluble-reactive phosphorus the same presentation that Dr. Olsen made, which is represented by the blue bars, and how the bars for small tributaries are affected if you pull out the samples that were associated with wastewater-treatment plants, and that's the red or the rust-colored bars. You can see that when you pull those out, the averages drop significantly to the point where there is no longer a gradient.

I should also point out that the values that I took out are listed at the bottom of each graph so that you can see, for example, for total phosphorus under base flow the value that was put -- pulled -- there were two values pulled out. One was a value of 1,866, the other was a value 1,251. So you can see how much higher they are than the rest of the data,

which is plotting at, you know, 100 for the high flow and about 60 for the low flow.

The high flow values are equally elevated so you can see the high flow value. The first one is 1,453, the second one is 827, again considerably higher than the rest of the data.

The same is true in the bottom plot for soluble-reactive phosphorus when you pull out the two tributaries that were impacted by wastewater-treatment plants. And, again, the values that were pulled out are listed on the bottom. So under base flow, they were 1,744 in the first station, 1,191 in the second station. So you can see, you know, how they compare to the red bars, which are both less than a hundred, so their order of magnitude greater.

And under high flow, the two values that were pulled out is 1,282 and 747. You can see, again, that they're about an order of magnitude higher than anything else.

Q. Does your replotting of this data on Demonstrative 257 tell you anything about whether or not small tributaries are responsible for any portion of the phosphorus in the IRW?

A. There's no evidence in this analysis that they are.

transported in the early years because you have a lot of unconsolidated material at the surface that can be moved and is typically from the shallow areas. Winds and things will move it down into the deeper parts of the lake.

So the expectation and what you typically see in a reservoir is in the early years you get the greatest sedimentation and the greatest rate of accumulation of sediment in the bottom.

Q. Dr. Connolly, did Dr. Fisher plot individual core data and trends over time as part of his effort to compare phosphorus levels in the lake to poultry production?

A. He did not.

Q. And how problematic was that or is that in your view, sir?

A. It obscured the individual trends among the cores resulting in a sort of scatter plot that didn't allow you to make an authoritative evaluation of changes over time.

Q. Okay. Now, if you separate that data and plot the individual core data in trends over time and you see a change in phosphorus concentration, does that necessarily mean a change in phosphorus load to Lake Tenkiller?

A. It does not.

Q. Why not?

A. You have to account for the type of sediment that you're looking at because the type of sediment affects the amount of phosphorus associated with the sediment even if the sediment load is the same. And so you can be confounded when you look at two samples. If the nature of the two sediments are different, they may very well have different phosphorus concentrations even though they saw the same phosphorus load.

Q. Okay. Now, before we adjourned for the weekend, I had talked to you about iron and aluminum and calcium compounds and the relationship between those and phosphorus.

Does that analysis bear on this issue at all?

A. Yes, it does.

Q. Can you help us to understand how that does?

A. Phosphorus is associated with iron, aluminum, and calcium in a couple of ways. One, it is a component of iron, aluminum, and calcium compounds; you get iron phosphates, calcium phosphates, and aluminum phosphates.

In addition, particles, particularly finer particles, generally have coatings of iron oxides or hydroxides and aluminum iron oxides and hydroxides.

A. It does not.

Q. Why not?

A. You have to account for the type of sediment that you're looking at because the type of sediment affects the amount of phosphorus associated with the sediment even if the sediment load is the same. And so you can be confounded when you look at two samples. If the nature of the two sediments are different, they may very well have different phosphorus concentrations even though they saw the same phosphorus load.

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A. Phosphorus is associated with iron, aluminum, and calcium in a couple of ways. One, it is a component of iron, aluminum, and calcium compounds; you get iron phosphates, calcium phosphates, and aluminum phosphates.

In addition, particles, particularly finer particles, generally have coatings of iron oxides or hydroxides and aluminum iron oxides and hydroxides.

Phosphorus has a high affinity for those aluminum and iron hydroxides. So the more aluminum and iron hydroxide associated with a sediment, the more phosphorus will adsorb onto that sediment.

Q. Now, Doctor, did you undertake to perform any analysis to explore that potential that you just identified?

A. Yes.

Q. Can you give us an analogy to something perhaps less scientific to help us understand the purpose of your analysis of iron and aluminum concentrations in the sediments?

A. What I was attempting to do was to take out differences in what you might call the stickiness of the particles. A simple analogy might be flypaper.

If I had a small piece of flypaper, nice and sticky flypaper, and a large piece of flypaper, nice and sticky, and I took a bucket of sand -- so I have one source; it's the bucket of sand -- and I just dump it over the two pieces of flypaper and then I just pick them up and shake them off, obviously the larger piece of flypaper is going to have more sand on it than the smaller piece of flypaper. Not because the larger piece of flypaper saw a greater source of sand -- it was the single bucket -- but simply because

it had more sticky surface than the small piece of flypaper.

That's the analogy here. You can think of the stickiness as the iron and aluminum compounds associated with the sediment. The more of that on the sediment, the more phosphorus it will grab even if it was seeing the same source of phosphorus.

Q. Now, are you familiar with the technique in the scientific investigation called "normalization"?

A. Yes.

Q. And what is normalization all about, Doctor?

A. Normalization is an attempt to take out the influence of the differences in stickiness, if we use that term, so that you can compare the data on an equal footing. So you can compare -- for example, if we look at the flypaper, not the total amount of sand on each piece of flypaper, but the amount of sand per unit area of the flypaper.

So in that case, you would normalize it by the area of flypaper in order to look at how much sand there is per square inch of flypaper, let's say, so you divide by the area of flypaper. And you'd find out in that case that both pieces of flypaper had the same amount of sand per unit area, and so you'd now know that they saw the same source of sand.

Q. Now, this system of normalization, is this an analytical technique that's discussed and supported in peer-reviewed literature?

A. Yes. It's a common method.

Q. So, Doctor, as a result of your analysis -- well, let me ask you this.

Did you undertake this normalization inquiry here?

A. Yes.

Q. And as a result of your analysis, Doctor, what did you determine regarding any correlation between phosphorus levels in sediment samples and iron and aluminum levels in those same samples?

A. That the phosphorus levels in sediment samples are largely determined by the amount of iron and aluminum in the sediment.

Q. Now, sir, did you -- oh, did you also have any -- undertake to assess whether or not those levels have changed since the mid 1980s?

A. Yes.

Q. Okay. And did you prepare a chart to illustrate your analysis?

A. Yes.

Q. Okay. If you would then turn to Defendants' Joint Exhibit 6074, Doctor, which is behind tab 29 in

your notebook. Tell me when you have that.

A. I have it.

Q. Okay. Did you prepare this chart?

A. Yes, I did.

Q. And does this chart appear in your report, Doctor?

A. It does.

MR. GREEN: All right. Your Honor, I move the admission of Defendants' Joint Exhibit 6074.

THE COURT: Any objection?

MR. PAGE: No objection, Your Honor.

THE COURT: Exhibit 6074 is admitted.

Q. *(BY MR. GREEN)* All right. Doctor, just tell us, you know, what we're looking at here and explain the analysis that you undertook, which is depicted on Exhibit 6074, please.

A. The purpose of this chart is to illustrate the impact of normalization and how normalization allows you to draw very different conclusions than you might draw in the absence of normalization.

So what I've done here is taken some stream sediment samples and some control soil samples and I've purposefully included stream sediment samples that cover a range of phosphorus concentrations. So that's the blue bars.

So you can see if we start at the left, SD-029 is a stream sediment sample. It has a total phosphorus concentration of a little over a hundred milligrams per kilogram.

At the other end of the spectrum, you see SD-0011, also a stream sediment sample, that has almost 800 milligrams of phosphorus per kilogram of sediment. And then you see one other stream sediment sample, SD-2301, and then control soils samples.

And so you can see there's a broad range in phosphorus concentrations. And if we look from the left to the right, we're going almost a factor of seven or so difference in concentration.

So looking at that by itself, you might think that SD-0011 at almost 800 milligrams per kilogram of phosphorus must have seen a lot more phosphorus loading than SD-029. And so the conclusion you might draw from that is, well, there's a lot more phosphorus contamination at that location, SD-0011, than there is at location SD-029, and that if you compare it to the control soils, you would say, well, clearly, that location is contaminated beyond what I would expect from control soils because it has a phosphorus concentration higher than the control soils.

But if you try to normalize for the

differences in aluminum content of the different samples; in other words, to account for the different stickiness or absorptive ability of the samples, you get the orange bars. So now this is phosphorus per unit of iron and aluminum in the samples, and now you can see that almost all of these samples have about the same value. There's a very small range in concentration.

And that very high sample, SD-0011, you can see if you compare it to the CL samples, CL-2 samples, which are control soil samples, you can see that that sample has no more phosphorus per unit iron and aluminum than control soils.

So, in other words, that sample is not contaminated with phosphorus beyond what you would get from control soils, it has a higher phosphorus content, because it had more iron and aluminum than the control soil samples, but it has the same amount of phosphorus per unit iron and aluminum.

So this allows you to evaluate whether differences in phosphorus really are indicating differences in the loading of phosphorus to the environment or simply just differences in the nature of the particles that have settled to the bottom.

Q. Did you then take your normalization

technique and expand that analysis to a broader population of samples?

A. Yes.

Q. And how far did you, you know, embrace the other samples?

A. I expanded the analysis to include every sediment sample, lake and stream; control soil samples; and poultry litter samples.

Q. And did you prepare a chart, Doctor, to illustrate this further analysis?

A. I did.

Q. All right. If you would then turn to Defendants' Joint Exhibit 6075, which is behind tab 30 in your notebook. Do you have that in front of you?

A. Yes.

Q. Does this chart appear in your report, Doctor?

A. Yes.

Q. And the data is coming from?

A. The plaintiff's data.

MR. GREEN: All right. Your Honor, I move the admission of Defendants' Joint Exhibit 6075.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6075 is admitted.

Q. *(BY MR. GREEN)* Doctor, help us, if you will, to understand what you're depicting here, your analysis, and the conclusions you draw from that analysis using Exhibit 6075, please.

A. For every one of the samples that we just discussed, I'm now plotting the phosphorus concentration in that sample in relation to the iron and aluminum concentration in that sample. The cloud of symbols that you see to the top are poultry litter, and then the lake sediment samples are green circles, the stream sediment samples are blue boxes, and then control soils are shown as crosses, either orange or blue, and they're separated into control soils that came from fields and control soils that came from forests.

And if for a moment we ignore the poultry litter samples and look at all the environmental samples, what you can see is that the phosphorus concentration on any one of those samples is largely determined by the amount of iron and aluminum in the sample.

So, for example, if we look at the samples with the lowest amount of phosphorus, and you can see some stream sediment samples there, some lake sediment samples there, and some of the forest control soils

there, you can see that at the lowest phosphorus concentrations, those are the samples with the lowest iron and aluminum.

If we go to the other end and look at the samples that have the highest phosphorus concentration, and now we're up to phosphorus concentrations in the range of a thousand to two thousand, you can see that the stream sediment samples and the lake sediment samples that have the highest phosphorus have the highest iron and aluminum. So that the biggest determinate of the phosphorus concentration associated with any of the environmental samples is the amount of iron and aluminum associated with those samples.

If we now look at the poultry litter samples that you see towards the top, poultry litter has more phosphorus than environmental samples so they plot higher, but they have much less iron and aluminum and so they don't conform to the relationship you see in the environment. They're sort of their own unique relationship.

Q. Doctor, do you recall that -- and I think it was Dr. Olsen who testified at trial that iron and aluminum are very common in the environment? Do you recall that testimony?

there, you can see that at the lowest phosphorus concentrations, those are the samples with the lowest iron and aluminum.

If we go to the other end and look at the samples that have the highest phosphorus concentration, and now we're up to phosphorus concentrations in the range of a thousand to two thousand, you can see that the stream sediment samples and the lake sediment samples that have the highest phosphorus have the highest iron and aluminum. So that the biggest determinate of the phosphorus concentration associated with any of the environmental samples is the amount of iron and aluminum associated with those samples.

If we now look at the poultry litter samples that you see towards the top, poultry litter has more phosphorus than environmental samples so they plot higher, but they have much less iron and aluminum and so they don't conform to the relationship you see in the environment. They're sort of their own unique relationship.

Q. Doctor, do you recall that -- and I think it was Dr. Olsen who testified at trial that iron and aluminum are very common in the environment? Do you recall that testimony?

A. Yes.
Q. Is that a proposition that you agree with?
A. Yes.
Q. Now, as far as you can tell, having reviewed the expert reports from plaintiffs in this case, did any of the state's experts attempt to normalize their data for iron and aluminum as you have?
A. They did not.
Q. All right. Now, Doctor, if you believe that phosphorus levels in the sediment vary because of variations in the levels of iron and aluminum in the sediment, as you've just kind of explained to us, is it possible that the variations in the phosphorus levels are caused by iron and aluminum in poultry litter?
A. No, that's not possible.
Q. If you were to mix control soil and poultry litter, what levels of iron and aluminum would result, sir?
A. If you -- if you look at the iron and aluminum content of poultry litter, you can see that --
Q. Are you back now at 6075?
A. Yeah, 6075.
Q. Okay, sir.

A. You can see that they range from less than a thousand milligrams per kilogram to maybe seven or eight thousand.

If you look at the environmental samples, all right, and look at the control soils, the control soils have, if you use forest soils, around 10,000 or so. If you use field soils, they're around 20,000 or so. So you'd be mixing material that has 20,000 or so milligrams per kilogram of iron and aluminum with material that has a few thousand, and so, in fact, you'd then generate something in between. So if you mixed them in equal proportions, you might generate something that's, say, seven or eight thousand.

Well, if you now look in the environment for something that has about seven or eight thousand milligrams per kilogram of iron and aluminum, which could if you deposit it be a mixture of poultry litter and control soil, you would see that those samples in the environment have very little phosphorus.

And so if you mixed control soil and poultry litter, you would generate samples with iron and aluminum concentrations that in the environment only have very low phosphorus concentrations. And so this is another example of how it's impossible for those sediment samples to be some mixture of poultry litter

and control soil.

Q. If you were going to plot that point on this graph that we've been talking about, you know, where would it be?

A. It would be, as I said, at iron and aluminum content that might be, say, you know, six or seven --

MR. PAGE: Your Honor, I have to object. This is new analysis.

THE COURT: Well, it's part of -- this figure was contained in the report?

MR. GREEN: Yes.

THE COURT: All right. Overruled.

A. As I indicated, if you mix them, perhaps you'd get an iron/aluminum content of about six, seven, or eight thousand. So that would plot on the iron and aluminum scale about where the lowest environmental samples plot. But because it has much more phosphorus if you mixed it, it would have more phosphorus than those samples, and so it would plot somewhere about halfway between -- or if you mixed them in equal proportions -- halfway between the phosphorus content of poultry litter and the phosphorus content of control soils and it would plot all about itself in a place in between poultry litter and control soils that didn't match any environmental

sample.

Q. *(BY MR. GREEN)* All right, Doctor. Let me move on here, sir.

Did you apply this normalization analysis to phosphorus levels in the sediments at the bottom of Lake Tenkiller over time?

A. Yes.

Q. And how did you do that? What did you do, Doctor?

A. I took the phosphorus concentrations in each sediment sample, normalized it by the iron and aluminum in that sample, plotted it against the date or age of that sample as determined by a corrected analysis of dating, and compared the change in that concentration over time.

Q. Okay. And did you prepare a chart, Doctor, to demonstrate that analysis and those relationships?

A. I did.

Q. Okay. Would you turn then to Defendants' Joint Exhibit 6078, which is behind tab 31 in your notebook?

A. I have it.

Q. Is this the chart you prepared?

A. Yes, it is.

Q. And does this appear in your report?

A. It does.

Q. And the data comes from?

A. The sediment data comes from the plaintiff's database. The poultry populations come from Dr. Fisher's report.

MR. GREEN: All right. Your Honor, I move the admission of Defendants' Joint Exhibit 6078.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6078 is admitted.

Q. *(BY MR. GREEN)* Okay, Doctor. Can you take us through this exhibit and explain to us what is depicted here in your analysis and the conclusions that you draw from it, sir?

A. In order to be able to plot poultry populations and phosphorus on the same charts, what I did was to divide the phosphorus concentrations or the poultry populations by the values in the period 1965 to '69, so that if you look at the bars in every one of these plots and go across, you'd see that in the period 1965 to '69 both the orange bars and blue bars plotted exactly the same height at a value of one.

So, in other words, I've taken the phosphorus concentration or the poultry populations, divided it by the value in '65 and '69 so that plots at one. And

then all of the other time periods are divided by, again, the values in 1965 to '69, which allows us to look at a relative change over time.

I've plotted separately the results for the four sediment cores -- LKSED-1, LKSED-2, LKSED-3, LKSED-4 -- removing as we go down here from the lacustrine portion to the lake up the riverine portion. So LKSED-1 is the core closest to the dam, and we move upstream to LKSED-4, which is in the riverine portion of the reservoir.

Q. All right. And what conclusion do you draw from having plotted this data and undertaken this analysis?

A. If we look at the blue bars, which represent phosphorus -- and, again, this is normalized by iron and aluminum that take out that variability -- and if we look at LKSED-1, you can see when we move forward in time there is a slight increase the bars for the blue bars go up somewhat. If we look at the bars in the more recent periods, you see that they plot at values maybe about 1.3 to 1.5.

So that means that in the recent past, last, you know, 15, 20 years, the phosphorus concentrations in the sediment are 30 to 50 percent higher than they were in the '60s. If you look at poultry populations,

the orange bars -- and they're the same in every one of these plots -- and you go forward and you see they continue to rise, so by the most recent period here, 2000 to 2004, they're up to close 3. So the poultry populations since the late '60s have, in essence, tripled.

The phosphorus concentrations have gone up much more modestly, less than 50 percent, and that's consistent for each one of these cores. So if we look at the blue bars in every one of these cores, you can see that they never get higher than about 1.5, and in most cases they're actually less than that. So there's been a modest increase in phosphorus concentrations in sediments that does not match the increase you see in poultry populations.

The other thing that's important in these charts is that if you focus on the period from about 1985 on forward and you go across with the blue bars, if you go -- I'm sorry -- if you go sediment sample by sediment sample, you see they're relatively flat.

So if you look at LKSED-1, really not much change; LKSED-2 from '85 on forward, not much change; LKSED-3, not much change, flat; and LKSED-4, not much change, flat, perhaps even a slight decline.

So there really hasn't been a change in

phosphorus concentrations in the sediments when you account for iron and aluminum since at least the mid to late '80s, despite the fact that poultry populations have continued to rise

THE COURT: Does one have to take into account, for lack of a better term, the saturation levels of possible aluminum and iron bonds in the sediments?

THE WITNESS: Potentially. The capacity, though, is much greater than the levels that we have here. The iron and aluminum content that we're looking at here at a maximum is about .03 or .035, so .03 or .035 grams of phosphorus per gram of iron and aluminum. So it's still relatively low. There's very little phosphorus due to iron and aluminum, and so the capacity of the sediments is much greater. That's a very good question. I mean, are we looking at capacity here? You just can't get anymore on. But that's not the case.

You can get much more phosphorus per unit of iron and aluminum than the levels that we see here because they're like 300 -- no, .03. Three percent is the maximum amount that you see here in terms of phosphorus per iron and aluminum and so that's below what would be the saturation.

THE COURT: Okay. Thank you. Mr. Green.

MR. GREEN: Thank you, sir.

Q. *(BY MR. GREEN)* So on the basis of this further analysis reflected on Defendants' Joint Exhibit 6078, let me ask you, Doctor, do you see any causal relationship between poultry production and phosphorus concentrations in the Lake Tenkiller sediments?

A. I do not.

Q. Let me now ask you a few questions about Dr. Olsen's leachate analysis, if I can.

Did you review his testimony and his report as it pertains to that subject, sir?

A. Yes.

Q. Okay. And just to kind of set the scene here, what did you understand Dr. Olsen to be exploring with this analysis?

A. He was exploring the potential to leach phosphorus and various metals from samples of poultry litter or samples of cow manure.

Q. And do you have a recollection as to how the procedure was conducted?

A. Yes. The procedure was to take a sample, mix it with water, essentially a synthetic water meant to

represent precipitation, you put it into a jar, and you agitate it for 18 hours. This is a standard EPA procedure.

After you agitate it for 18 hours, you separate the water from the solids and you measure the chemical concentrations in the water and use those values as some estimate of your ability to leach various constituents from the sample.

Q. If you know, the amount of water used in an experiment like that, is it equivalent to some other reference such as a 25-year storm or whatever scientists relate to?

A. For the leachate analysis, you really can't make that -- really can't equate it. Essentially, they use twenty parts of water to one per of solid.

Q. Did you consider the analysis undertaken by Dr. Olsen to be instructive as to what happens in the, you know, real world on real pastures in the Illinois River Watershed?

A. It is not representative.

Q. Is it proper to, in your view, sir, attempt a comparison between samples of cow manure on a field with samples of poultry litter that's gathered from inside a poultry house?

A. Not at all. The cow manure samples from the

MR. GREEN: Okay. Your Honor, I move the admission of Defendants' Joint Exhibit 6121.

THE COURT: Any objection?

MR. PAGE: No objection, Your Honor.

THE COURT: 6121 is admitted.

Q. *(BY MR. GREEN)* All right, Doctor. Would you tell us what we're looking at with respect to this Exhibit 6121, sir?

A. We're looking at maps of the watershed and then symbols indicating the locations at which benthic algal densities were measured. The top panel is the data collected in summer 2006. The bottom panel is the data collected in spring 2007.

The colors indicate the density of algae. If we use EPA's value of 15, then an orange or a red symbol would be a value that exceeds that. If you look at the top panel, summer of 2006, you see there are no orange or red values. As I indicated, the highest measurement in 2006 was 13.

If we look at the yellow values, the values between 10 and 15, you see there are very few of those. I think I count three of them. Two of the three you see are located on tributaries that have wastewater-treatment plants upstream of them.

If we look at the bottom panel, spring of

2007, there are some orange and red values so there are values greater than 15. Many of them are below wastewater-treatment plants.

So you can see an orange value on Spring Creek downstream of those Springdale wastewater-treatment plants. You can see a series of orange values on Sager Creek downstream of the Siloam Springs plant. And you can see a few other values that are sort of just at various places around.

There are two values on the Illinois River itself. You see a red dot sort of in the middle and an orange dot to the left, so there are two locations on the Illinois River that do show values.

For the most part, the values, though, on the Illinois River and for most of the tributaries are below the value of 15 and most of them are below the value of 10.

Q. Okay. With respect to the top chart, the summer of 2006, I just want to make sure that when you're talking about even the values in the 10 to 15 range, did you mean to say they were downstream of wastewater-treatment plants?

A. Yes, I did. I'm sorry if I didn't state that correctly.

MR. GREEN: If Your Honor please, I have

not the major contribution.

MR. PAGE: I'm sorry, Your Honor. I couldn't hear the last of the witness' statement.

Q. *(BY MR. GREEN)* Sorry.

A. Nonpoint sources provide some minor contribution, and poultry litter is some fraction of nonpoint sources. So it's some fraction of that minor contribution.

Q. Did you analyze any temporal trends for phosphorus concentrations in the Illinois River?

A. Yes.

Q. And what did you do?

A. I looked at the data prior to what would have been the upgrades to the wastewater-treatment plants, so about 2004, and compared it to the data post-2004 to see whether there were any changes in phosphorus levels in the river between those two periods.

Q. And, Doctor, did you prepare a chart or graph that reflects your analysis?

A. I did.

Q. All right. Let me ask you to turn your attention to Defendants' Joint Exhibit 6160, which is behind tab 33 in your report. Do you have that, Doctor?

A. Yes, I have it.

Q. Was Defendants' Joint Exhibit 6160 a part of your report?

A. Yes.

Q. And where did this data come from, sir?

A. This is a compilation of data from several sources, all at Tahlequah, the USGS and the state and the plaintiffs.

MR. GREEN: Your Honor, I move the admission of Defendants' Joint Exhibit 6160.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 6160 is admitted.

Q. *(BY MR. GREEN)* All right, Doctor. Would you tell us what this graph is depicting, what's plotted here, and how this informed your analysis, sir?

A. This is a plot of total concentration in the river at Tahlequah in relation to river flow, and the red symbols are the base flow samples, the blue samples are the runoff samples. The data, as I indicated, are organized into the period before 2004, so in this case 1997 to 2003; and in the right panel, the most recent data, from 2004 to 2008.

And what I did was to separately look at levels under the base flow conditions and the runoff conditions. You can see lines through the data.

Those are, in essence, regression lines through that data. So that in 1997 to 2003, you see a line that is through the base flow data and then a line that's through the runoff data.

In 2004 to 2008, there are solid lines that represent the regressions for those data and dash lines which are a repeat of the lines from the earlier period.

So if you look at base flow conditions, you can see that the new line, the solid line, is below the dashed line, which is the line from the earlier period. And, in fact, if you look closely, you can see that nearly all of the data in the 2004 to 2008 period under base flow conditions fall below the dashed line, which goes through the middle of the earlier period, so that most of the data in 2004 to 2008 are below what they were in the earlier period.

The dashed line of the runoff shows the runoff phosphorus values, and you can see at the high flows there's been a drop in total phosphorus concentration in the latter period relative to the earlier period.

Q. So am I reading this right, that the data is indicating that phosphorus levels passing the Tahlequah gauging station have fallen in the more

recent period?

MR. PAGE: Leading; objection.

THE COURT: Sustained.

Q. *(BY MR. GREEN)* Have they fallen, sir, in the more recent period?

A. Yes, they have fallen.

Q. Okay. Doctor, have you made any comparison between this data that we've been looking at and poultry populations?

A. Yes.

Q. And what did you conclude, sir?

A. That while poultry populations are increasing, the phosphorus levels in the river appear to be decreasing.

Q. All right, Doctor. Did you also have occasion to analyze water quality in Lake Tenkiller?

A. Yes.

Q. And in doing that, sir, did you take into account the entire lake as part of your analysis?

A. Yes.

Q. And as a result of that analysis, sir, have you come to any conclusions?

A. Yes.

Q. And what are those conclusions?

A. That the water quality conditions in the lake

vary significantly from the riverine portion to the lacustrine portion of the lake. The water quality conditions are lower in the riverine section. Chlorophyll levels in the riverine section are high enough to be at nuisance levels, but that declines and when you get to the lacustrine portion of the lake, average chlorophyll concentrations are not particularly elevated.

Q. Is the phosphorus from wastewater-treatment plants, Doctor, adequate to account for the algae growth that you see downstream from wastewater-treatment plants?

A. Yes.

Q. I want to talk a little bit about chlorophyll-a because we heard mention of chlorophyll-a.

Did you prepare a chart that shows chlorophyll-a and phosphorus levels across Lake Tenkiller?

A. Yes.

Q. All right, sir. If you would turn to Defendants' Joint Exhibit 6162, which is behind tab 34 in your report, and tell me when you have that.

A. I have it.

Q. Does this chart appear in your report, sir?

A. Yes, it does.

Q. And where's the data come from that you're plotting there?

A. This is the plaintiff's data.

Q. Okay.

MR. GREEN: Your Honor, I moved the admission of Defendants' Joint Exhibit 6162.

THE COURT: Any objection?

MR. PAGE: Your Honor, I'm not clear. This does show this lake data included 2008, and that's been excluded by the court for both sides. So to the extent this includes 2008 data, it should not be allowed.

THE COURT: Mr. Green.

Q. *(BY MR. GREEN)* Doctor, to what degree would these lines be impacted, if you're able to answer this question, if we removed data from 2008?

MR. PAGE: Your Honor, that's improper because he's now using an analysis based on the same exhibit.

THE COURT: Mr. Green, I understand that this does contain 2008 data?

MR. GREEN: It was in his report. May I -- why don't I ask the Doctor. May I?

THE COURT: Yes.

Q. Does the state identify -- if you can recall, does the state identify one or more sources for this impairment?

A. As I recall, they list, I think, nine possible sources for the impairment.

Q. And looking at that data, are there any conclusions that you draw from it, sir, with respect to dissolved oxygen levels?

A. Dissolved oxygen levels within the Illinois River Watershed largely are consistent with the state standards.

Q. Do you have any view whether or not phosphorus from poultry litter is causing algae growth in rivers or causing low dissolved oxygen levels?

A. Well --

MR. PAGE: Objection, Your Honor; compound.

MR. GREEN: I'll uncompound it.

Q. *(BY MR. GREEN)* Do you have any view, sir, whether phosphorus from poultry litter is causing algae growth in the rivers?

A. The algae growth in the rivers, as I indicated, is not at high levels. Point sources are probably the biggest contributor. I'm sure nonpoint-sources provide some contribution but it's

I mean, it's his consistent opinion and I can take you back to earlier portions of this report -- I think we've already looked at them -- that phosphorus which is stimulating the growth of algae, the soluble-reactive phosphorus, is principally coming from wastewater-treatment plants. I mean, that's -- I mean, that's a point earlier made in the report.

And I can --

THE COURT: Yes. Well, the next to the last bullet point in his summary of detailed findings, 2.1, together with that which is set forth in 4.4 or 4-4, the objection's overruled.

Go ahead.

Q. *(BY MR. GREEN)* Let me pick up, sir, we were talking now about the -- you know, the riverine portion of the lake, and I asked you whether you had an opinion as to the source of that phosphorus that impacts the riverine portion of the lake.

And you do have an opinion?

A. Yes.

Q. And that opinion is again?

A. That point sources are the dominant source of the phosphorus that's impacting the algae in the riverine portion of the lake.

Q. Okay. Dr. Connolly, can you explain to the

1 court what the trophic state index is and how it is
2 used in assessing the lake?
3 A. The trophic state index is a convenient,
4 mathematical way to translate measures of algae
5 populations to a numerical scale, and the numerical
6 scale is used to classify waterbodies; that is,
7 oligotrophic, mesotrophic, eutrophic, or
8 hypereutrophic.
9 Q. Are you, sir, familiar with Oklahoma's use of
10 the trophic state index in its BUMP report?
11 A. Yes.
12 Q. And did you review Oklahoma's assessment of
13 Lake Tenkiller and other lakes in Oklahoma in the BUMP
14 report?
15 A. Yes.
16 Q. And based on that review, sir, what did you
17 conclude about Lake Tenkiller?
18 A. That its trophic state is not unusual for the
19 state of Oklahoma, that there are many lakes within
20 the state that have a similar trophic state, and a
21 number of lakes that have a more eutrophic state
22 despite the absence of poultry litter.
23 Q. Okay, sir. Let me ask you to look at the
24 last exhibit, which I will draw your attention to in
25 the course of this examination, which is Defendants'

which is what we characterize as point sources.

Q. So it's the runoff from the land; correct?

A. It's the runoff from the land.

Q. Okay. And you've calculated the relative contributions, did you not, between point and nonpoint pollution; correct?

A. Contributions to?

Q. The IRW as for phosphorus.

A. The -- I'm confused by the question, to the IRW.

Q. Let me try to make it more clear.

Did you calculate the amount of nonpoint-source phosphorus loading to the IRW?

A. No.

Q. Didn't you testify on direct that based on the numbers that you received of about 220,000 kilograms per year and the evaluation of wastewater-treatment plant loading of about 37,000 kilograms per year, didn't you testify on direct that the nonpoint-source quotient or loading of phosphorus to the IRW was about 85 to 90 percent?

A. The numbers are -- that I have are 205,000 kilograms per year on average in total entering the lake. Wastewater-treatment plants discharge 37,000, I think that ratio is 18 percent, so the number would be

82 percent --

Q. Okay.

A. -- versus other than wastewater-treatment plants.

Q. So your calculation, sir -- thank you -- of nonpoint-source contribution of phosphorus to the IRW is 82 percent, correct, of all the phosphorus?

A. Yes, yes.

Q. Okay. Now, doesn't that amount of phosphorus that by definition -- that is, nonpoint-source phosphorus -- by definition runs off the land indicate to you, sir, that there is a transport pathway of phosphorus from the land to the rivers and streams of the IRW?

A. Yes.

Q. So you're not suggesting that phosphorus does not run off of fields and forests and urban areas of the IRW and enter the streams of the IRW, are you, sir?

A. I'd be pretty silly to do that.

Q. I agree. Now, sir, where does the water in the rivers and streams of the IRW and eventually making it to the Lake Tenkiller come from?

A. Precipitation.

Q. Okay. Rainfall or snow or ice?

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3

4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 DECEMBER 21, 2009
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 79, P.M. SESSION

16

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Q. (By Mr. Page) Dr. Connolly, do you believe that increased land application of manure is related to increased flow-adjusted trends in orthophosphorus and total phosphorus in the IRW?

I'm sorry. Did you not answer the question --

MR. PAGE: I'm sorry, Your Honor.

Your Honor, my counsel has informed me that with the objection, I never got an answer to my last question.

Q. (By Mr. Page) So could you answer the last question. Do you agree with the conclusion of the USGS that you just read here on page 46 of Exhibit 21?

A. I can't agree with it without looking at their analyses, because there are lots of biases that can be introduced in this kind of analysis, and even they indicate they were surprised by the result, which makes me wonder if there are some other explanation for this result. So without doing my own independent analysis of this data, I can't agree or disagree with this.

Q. Let me ask, then, the next question. Do you have an opinion as to whether or not manures -- land-applied manures and field-deposited manures

affect phosphorus concentrations, both orthophosphates and total phosphorus in IRW streams?
A. I see no analysis that would persuade me to answer that in the affirmative.
Q. Do you have an opinion as to whether increasing -- you know for a fact, sir, that there's been increasing amounts of poultry and poultry manures produced in the IRW, correct?
A. Yes.
Q. Do you have an opinion as to whether or not that increasing manure production had an effect of both the orthophosphate and total phosphorus in IRW streams? Yes or no.
A. I don't think I can answer that question yes or no.
Q. Do you believe that there is -- that the increased manures being produced in the basin have been related to -- by regression analysis to increase orthophosphates and total phosphorus in those streams?
MR. GREEN: Your Honor, I object. To what reference is counsel alluding to with regression analysis?
THE COURT: Overruled. Dr. Connolly is qualified to answer the question.

Q. Where is the Horseshoe Bend of Lake Tenkiller?
A. It's down at the riverine section of the lake.
Q. Does this show that the total phosphorus load at Horseshoe Bend for nonpoint source, average, is 83.5 percent?
A. Yes.
Q. Point source is how much, sir? 5.5 percent?
A. Yes, but that number is an error. But that's what it says.
Q. What should be the correct amount?
A. The analysis that they did for point sources is completely flawed in this work, and so I don't know what the right number should be, but it's not that number.
Q. So since your deposition, you've looked at this and you've determined now that it's a flawed analysis?
A. Yes, it is.
Q. Okay, sir. Looking for base flow, what does it show the total contribution for base flow is for phosphorus?
A. 16,518.
Q. Okay. And what is the point source versus nonpoint source versus background allocation based on this study?

A. This study shows 46.2 for nonpoint source, 44.1 for point source, and 9.7 for background.
Q. Do you agree with that analysis, sir?
A. No. Again, the point source analysis is completely flawed.
Q. Let's go to the third page of this document. And it's in the abstract for findings and conclusions. And I would like you to read that bottom paragraph. It's a little double i on this exhibit.
A. I'm sorry, which --
Q. The third page of the exhibit, sir.
A. Third page. Abstract?
Q. Under Abstract, where it says, "Findings and conclusions." Would you read that for me, sir.
A. "The mean annual concentrations of phosphorus, nitrogen, and chlorophyll a measured throughout Lake Tenkiller were indicative of eutrophic conditions. A gradient in trophic status was evident in the epilimnion strata of the lake, i.e., from eutrophic at the upper end to meso-eutrophic at the lower end. The entire lake was affected by eutrophication as evidenced by the presence of anoxic conditions in the hypolimnion during summer stratification."
Q. Do you agree, sir, that anoxic conditions are

some forest areas to see what the background concentration would be?
A. I did not.
Q. In fact, you took no samples as any part of your investigation in this case, correct?
A. I did not.
Q. Now, Doctor, would you consider the Illinois River Watershed a largely urban area?
A. I'm not sure how to answer that question.
Q. What's the percentage of land use, urban land use in the IRW?
A. I don't remember precisely. Something on the order of a little less than ten percent.
Q. Are these locations that are outside of wastewater treatment plant discharges, are those areas urban areas?
A. Some are, yes.
Q. Are most?
A. I'd have to go back and look. I don't remember for sure.
Q. Can we -- let's talk about some of your demonstrative exhibits. 259.1, do you have that, sir?
A. What tab would that be?
THE COURT: 10.

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7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
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10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 DECEMBER 22, 2009
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 80, A.M. SESSION

16

17 APPEARANCES:

18

19 For the Plaintiffs: MR. W.A. DREW EDMONDSON
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both established permitting procedures and regulations and provided remedies to the states. The states are capable of protecting their interest through the regulatory scheme and, therefore, no federal common law remedy was available to the states.

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again, recognized that the scope of the 1972 Clean Water Act amendments were broad. That the act applied to all point sources in virtually all bodies of waters, that it provided remedies for permit violations, and permitted citizen suits.

The court again noted that Congress intended to dominate the field of pollution regulation, and it concluded that the Federal Water Pollution Control Act preempted Vermont nuisance law to the extent that it sought to impose liability on the New York point source.

The case that gives the court some pause is the Ninth Circuit case which Mr. Jorgensen has referenced that dealt with the diversion of water from Mono Lake thereby reducing the lake's natural volume and consequently increasing the lake's salinity and ion concentration.

The plaintiff, National Audubon Society, brought a claim of water pollution under the federal common law of nuisance. The Ninth Circuit noted that the Supreme Court's statement that federal common law nuisance claims for water pollution are preempted by the Federal Water Pollution Control Act was unequivocal, and it affirmed the district court's ruling that the claim was preempted by the

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The court agreed that "nothing in the Clean Water Act demands that a state adopt a regulatory system for nonpoint sources."

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And in the Second Circuit case that Mr. Jorgensen referenced, *Connecticut v. American Electric Power Co.*, although it does not address the Clean Water Act, it addresses the Clean Air Act, and it does have a useful discussion of displacement.

The linchpin -- and there are at least eight factors here, but to cut to the chase here, the linchpin in that Second Circuit case is whether the legislation actually regulates the nuisance at issue, and whether there is a legislated remedy.

It is not clear here, and the defendants have not shown the court -- obviously this remains

an issue for ultimate determination by the court in findings and conclusions, but the defendants have not shown that the 1987 amendments to the Clean Water Act legislate a remedy or actually regulate the nonpoint source alleged nuisance at issue.

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That, I believe, leaves us with the nuisance claim based on state public law, the statutory claims and the integrator-specific motions. The integrator-specific motions essentially went to causation. I think I can rule on those here this morning as well. Correct?

MR. GEORGE: Your Honor, you are correct, they did go to causation.

THE COURT: With respect to the integrator-specific motions, those Rule 52(c) motions will also be denied. And we're taking a little closer look at -- what was it, Title 50, Section 4. Interestingly, it was not one of the issues addressed by Judge Eagan in the Eucha-Spavinaw case.

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REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

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JOHN CONNOLLY, PH.D.

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10 **STEPHEN THOMPSON**

11 Testimony by Videotaped Deposition 9453

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with this question here.

The patterns that you have plotted and charted here on Defendants' Joint Exhibit 6094, are they consistent with the same patterns that you described during your direct examination?

A. They are.

Q. Okay, sir. Just a couple of seconds more here.

MR. GREEN: Your Honor, indulge me just one moment.

THE COURT: Yes, sir.

(Discussion held off the record)

Q. *(BY MR. GREEN)* All right. I just have a couple of little follow-ons of things that Mr. Page asked you to look at.

Do you still have in front of you Demonstrative 326 that he showed you, which is the USGS report entitled: "Trends in Nutrient and Sediment Concentrations and Loads in Major River Basins of the South-Central United States, 1993-2004"?

A. Yes, I have it.

Q. And that was an extract -- those are some pages extracted out of Oklahoma Exhibit 0021.

Let me direct you to a page that Mr. Page asked you to look at, and that would be page 46, which

is maybe five pages into the demonstrative.

A. Yes.

Q. And he asked you to read portions of what is there recited. I want to direct you to the first paragraph on this page, which comes from page 46 of the report, where there's a reference to the WLS regression analysis. Do you see that?

A. Yes.

Q. And then would you go down and read the very last sentence of that first paragraph?

A. "Statistically significant results of the WLS regression analyses are presented in this section relative to phosphorus trends; however, the reader is cautioned against overinterpretation of the results."

Q. Now, when you see a report and there's an admonition such as that, that you're cautioned against overinterpretation of the results, what impact does that have on you in assessing the data in this report?

A. It says that you have to keep it very much in context and not overinterpret it in terms of its meaning and application outside the context of this particular study.

Q. Okay, sir. Now you can put that aside.

(Discussion held off the record)

MR. GREEN: One more question, Your

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EARL SMITH, JR.

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Direct Examination by Mr. Bassett 9462
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Would you briefly explain for the record what that is?

A. Well, it's a compact between Arkansas and Oklahoma. It required federal legislation to form the compact as well as state legislation to form the compact. It basically looks at the apportionment of the water in the compacted area of the states -- between the two states, apportions the flow in the subwatersheds. It also speaks to some of the water quality aspects of the area.

Q. And did that commission meet annually?

A. It does.

Q. All right. And did you have any involvement with the Compact Commission as part of your duties at the Arkansas Soil and Water Commission in the mid to late 1980s?

A. Yes. I've been a member of the engineering committee of that Compact since that time.

Q. And as a member of the engineering committee, did you attend all the meetings?

A. I did.

Q. All right. What purpose, Mr. Smith, did the engineering committee have with respect to the Compact Commission in the 1980s?

A. Well, the Compact has within its structure

several committees in which the commissioners can assign items to discuss and bring back to them, assign questions or assignments to work on and respond back to them. That was our main function, was to provide technical support and be able to answer different items that were assigned to us to report back to the commissioners.

Q. In respect to your involvement with the Compact Commission in the mid to late 1980s, do you know whether there was a particular nutrient that was a concern over others?

A. Well, back in the 1980s, that far back, nitrogen was the primary element of concern when you were looking, for example, at trying to decide on fertilizer rates that you were -- that you were spreading. That far back nitrogen was the primary element of concern.

Q. Okay, sir. Did you continue to serve on the engineering committee of the Compact Commission into the early 1990s?

A. I did.

Q. All right. And did the Compact Commission adopt any kind of nutrient-reduction goals that affected any part of the Illinois River Watershed during the time frame of the early 1990s?

A. In 1997, the Compact did adopt a nutrient-reduction goal.

Q. And what was the goal adopted by the Compact Commission?

A. The goal was to try to achieve a 40 percent reduction in phosphorus from the annual loading of the river.

Q. Okay. And that goal was adopted, as you said, in 1997?

A. That's my memory, yes, sir.

Q. Okay. Was this goal focused on any particular source or sources of phosphorus or was it just total loading?

A. We were concerned with total loading of the river and total loading on it.

Q. Okay. And was this a goal that was set for the IRW?

A. It was. And the basis for that goal was the Clean Lakes study on Lake Tenkiller that was done by EPA and Oklahoma state.

Q. Okay. Did Oklahoma officials approach Arkansas officials about the 40 percent goal reduction?

A. The genesis of that was Oklahoma requested that the commission adopt that goal.

Q. Did the Compact Commission include officials from both the states of Arkansas and Oklahoma?

A. It does. It's made up by appointees by the governor of the states with a federal chairman that's appointed by the President.

Q. All right. Has that goal that you just referenced ever been changed by the Compact Commission since it was first adopted?

A. No, sir. It's still in effect.

Q. All right. What role, Mr. Smith, if any, did your engineering committee play with regard to the 40 percent goal of the Compact Commission?

A. Well, once the goal was adopted, then one of the assignments that was made to the engineering committee was to -- how are we going to monitor progress toward making that goal? So one of our first points was to decide how we were going to portray that, how we are going to see if progress was made toward that goal.

So what the engineering committee did was ultimately we decided to select monitoring sites in Arkansas and Oklahoma. We chose four sites in Arkansas and we chose four sites in Oklahoma. We were to take -- we decided we would monitor those points, continue the sampling in the same manner that the

A. You know, I believe probably a year, year and a half, something like that. It was a lengthy period that we met.

Q. And what kind of work was your subgroup doing, Mr. Smith, in connection with your service on the task fours?

A. Well, there again, we were answering questions that were referred to us, the technical aspects of the monitoring, and things like monitoring, we were.

Q. Prior to the task force being formed, had any Nutrient Management Plans been drafted or did any such plans exist in the state of Arkansas?

A. Well, sure. Things like fertilizer recommendations and planning, things like that were being made, yes.

Q. Okay. Had some people gotten plans voluntarily?

A. They had.

Q. In the late '80s and the very early '90s, would these plans have been written as phosphorus-based plans?

A. No. Back then the governing parameter was nitrogen by and large.

Q. Were any of these old plans at that time in

existence in the Illinois River Watershed?

A. They were.

Q. Okay. Were any of the people who had those plans poultry-growers?

A. They were.

Q. In the late 1980s and early 1990s, were there any legal requirements in Arkansas for a poultry-grower or anyone else to obtain a nitrogen-based Nutrient Management Plan?

A. No.

Q. Were those plans then obtained voluntarily?

A. They were.

Q. Okay. Based on your personal knowledge and personal observations and your work at the agency, did the poultry companies or officials at those companies do anything that you interpreted as discouraging of growers obtaining these plans?

A. Not obtaining the plans, no, sir.

Q. Were they supportive?

A. They were supportive of it.

Q. At the time the task force in Arkansas was first assembled in the early 1990s, Mr. Smith, did any agency in either Arkansas or Oklahoma, to your knowledge, have regulatory authority over nonpoint sources?

A. Not to my knowledge.

Q. Okay. Had either state at that point in time enacted any legislation to attempt to regulate any nonpoint sources prior to the task force being formed?

A. Not to my knowledge.

Q. As a result of your involvement on the task force, Mr. Smith, was there any change in what the Arkansas Department of Environmental Quality did with regard to nonpoint sources in Arkansas?

A. Basically, I think the thrust -- one of the major outcomes of the task force was in our looks at liquid waste. It resulted in our Department of Environmental Quality's adoption of regulation No. 5 which does regulate -- or provide the basis for regulation of liquid animal manures. The task force did then look at dry litter and made some recommendations about how the management of dry litter could be made.

Q. Why did regulation focus on CAFOs and liquid manure operations at that time?

A. Well, that was the -- that was the one area in which regulatory authority existed.

Q. Okay. Were poultry farms part of any CAFO regulations in Arkansas at that time?

A. Some of the egg-laying operations, those that

disposed of their waste in a liquid manner, like laying operations, some of those did fall under those. The dry litter aspects, of course, did not.

Q. There were no dry litter regulations at that time, were there?

A. There were none, no.

Q. All right. Was there anything different that your agency, which was then called the Arkansas Soil and Water Commission, began doing after the task force work was completed?

A. Well, we -- at about that same time, we were fortunate in that the federal government did start making funds available through Section 319 of the Clean Water Act, and that's the section of the act that speaks to nonpoint pollution. That gave us a basis of resources that we could utilize to look at nonpoint pollution. So we started at that point doing nonpoint projects.

One of our priorities in this watershed was to make Nutrient Management Plans available to farmers. We, for example, contracted with some of the conservation districts in the state so that we could have some technicians to prepare Nutrient Management Plans for growers in that area.

Q. And when you say "this watershed," you're

talking about the IRW; is that correct, sir?

A. Yes, sir. The Illinois River Watershed.

Q. All right. Did your agency do anything to help provide resources for getting plans written or for teaching people how to use those plans?

A. Yeah. You know, basically -- and this has kind of been the thrust of our program -- we felt we could be most effective if we did kind of a three-pronged approach to that. We felt it was important to do some information, education-type things. We have just found that to be very helpful over different things.

We wanted to do some implementation in this arena of confined animal operations. For example, we looked at -- at providing Nutrient Management Plans. In some of the other areas, in the delta part of the state, for example, we were focusing on siltation-type measures to do that.

The other approach was to do demonstration projects to look at the effectiveness of best management practices that could be utilized, what sort of best management practices could we best utilize to help improve and abate some of the pollution -- nonpoint pollution aspects.

Q. Were the educational and informational and

implementation programs you developed all still voluntary programs at that time when it came to nonpoint sources?

A. Well, certainly there was no authority to do anything but voluntary programs.

Q. All right. Did the Arkansas Natural Resources Commission, your agency, elect to regulate dry poultry litter application in the IRW, or elsewhere, in the early 1990s following the completion of the work of the governor's task force?

A. Well, following the work of the task force, later on we did view that we wanted to move and to have some regulatory aspect. We didn't have any regulations at that point in time, but we did start to seek to achieve the authority to have those regulations.

Q. And what did you do to do that?

A. We advocated that the legislature pass legislation that would do that.

Q. And was this just for poultry litter or all nonpoint sources?

A. No, no. Our program has always been looking at the total aspect of nonpoint pollution. We felt if we were going to really look at the problem, we needed to approach it in all of its elements. So the program

has always focused on all of the elements of the things, on agricultural-type things, on urban runoffs, on forested area runoffs, things like county roads, runoff from county roads. All of those things, you know, have some impact on that. So we just felt that what we needed to do was look at the whole suite of nonpoint areas.

Q. And over what period of time did that take place, what years?

A. Well, from the early '90s on forward really.

Q. All right. We'll come back to the legislation in Arkansas in just a minute.

Back in the early 1990s, Mr. Smith, as far as you were aware, were voluntary programs, such as you have just described to His Honor, were those programs consistent with what other states were doing at that time?

A. I think so.

Q. Was the EPA involved in Governor Clinton's task force?

A. They attended the meetings.

Q. Did the EPA representative on the task force demand or request mandatory regulations at that time?

A. No.

MR. NANCE: Objection; calls for hearsay.

MR. BASSETT: Your Honor -- oh, excuse me. I don't want to interrupt.

THE COURT: Any response?

MR. BASSETT: Well, Mr. Smith was in the room. I don't know that that's hearsay. He was in the room and was a part of the discussion. Not offered really for the truth of the matter asserted. Just trying to show what -- what took place in that task force, the fact that the EPA had a representative in there, and was not pushing for mandatory regulations seems to be relevant.

THE COURT: I believe it is sought for the truth. Sustained.

MR. BASSETT: Very well, Your Honor.

Q. *(BY MR. BASSETT)* Did the voluntary program, Mr. Smith, that you have described in Arkansas for poultry litter management predate the regulatory requirements in both Arkansas and Oklahoma?

A. Oh, yes, it did.

Q. And I think you've already testified that the poultry-growers did participate -- or many of the poultry-growers did participate in the voluntary program?

A. They did.

Q. Okay. Did the poultry companies, Mr. Smith, or the officials with those companies, based on your observations and knowledge, present any obstacle to your agency in getting growers to participate in the voluntary program?

A. No. They encouraged their growers to participate in the voluntary program.

Q. Did the poultry companies provide education and information to their growers about the program?

A. They did.

Q. Okay. Now, you mentioned that aside from education and information, your agency also wanted to do some monitoring to get more data on nonpoint sources in places like the IRW; correct?

A. Uh-huh. That's correct.

Q. What kinds of monitoring was the Arkansas Soil and Water Commission doing, Mr. Smith, or involved in after the task force work was completed?

A. Well, we -- as -- we really did it in two arenas. One was the intensive monitoring that we did at the state line. For example, we've already talked about that.

The other part of that was to look to monitor individual best management practices to get a feel for

disposed of their waste in a liquid manner, like laying operations, some of those did fall under those. The dry litter aspects, of course, did not.

Q. There were no dry litter regulations at that time, were there?

A. There were none, no.

Q. All right. Was there anything different that your agency, which was then called the Arkansas Soil and Water Commission, began doing after the task force work was completed?

A. Well, we -- at about that same time, we were fortunate in that the federal government did start making funds available through Section 319 of the Clean Water Act, and that's the section of the act that speaks to nonpoint pollution. That gave us a basis of resources that we could utilize to look at nonpoint pollution. So we started at that point doing nonpoint projects.

One of our priorities in this watershed was to make Nutrient Management Plans available to farmers. We, for example, contracted with some of the conservation districts in the state so that we could have some technicians to prepare Nutrient Management Plans for growers in that area.

Q. And when you say "this watershed," you're

talking about the IRW; is that correct, sir?

A. Yes, sir. The Illinois River Watershed.

Q. All right. Did your agency do anything to help provide resources for getting plans written or for teaching people how to use those plans?

A. Yeah. You know, basically -- and this has kind of been the thrust of our program -- we felt we could be most effective if we did kind of a three-pronged approach to that. We felt it was important to do some information, education-type things. We have just found that to be very helpful over different things.

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has always focused on all of the elements of the things, on agricultural-type things, on urban runoffs, on forested area runoffs, things like county roads, runoff from county roads. All of those things, you know, have some impact on that. So we just felt that what we needed to do was look at the whole suite of nonpoint areas.

Q. And over what period of time did that take place, what years?

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The other part of that was to look to monitor individual best management practices to get a feel for

rather than issues, recommended practices, and grant programs?

A. Well, it has been our judgment for a long time that we needed to move into that arena, but we did start advocating early on that we needed -- that the state needed to adopt some regulations.

Q. And about what time period would that have been?

A. In the early -- in the early 2000s.

Q. Okay. Is it your understanding, Mr. Smith, that the statutes that were passed by the Arkansas Legislature established the policy objectives for the state?

A. They did.

Q. Do they lay out the framework for how litter use, among other things, should be managed in Arkansas?

A. It did. The legislation in 2003, for example, designated what was called surplus nutrient areas. Those were areas in which we could -- that regulations would apply.

The other pieces of the legislation, for example, required that -- legislation requires that in those nutrient surplus areas, that anyone that spreads nutrients on the land, that they do it in accordance

with a Nutrient Management Plan. It also requires certification of the people that draw up those Nutrient Management Plans as well as the people -- and requires a certification for people that spread the nutrients on the land.

And here again, I'd point out that we're not talking about just dry poultry litter; this is any nutrients. This is commercial fertilizer. It could be compost. It's any form of nutrients that's spread on the land, you're required to do that in accordance with a Nutrient Management Plan.

Q. And what year did the Arkansas Legislature pass those statutes?

A. 2003.

Q. All right. Was there an acreage criteria in the statutes?

A. The statute says that anything above two and a half acres is where the Nutrient Management Plans are required.

Q. And do you know why there was an acreage criteria in the statutes?

A. Well, the judgment was made if you go below that, then you're looking at such things as individual city lots, individual residential lots on there, to -- it was just the judgment that to prepare a

unique Nutrient Management Plan for that small an area, for that many different lots was just not feasible.

Q. Okay. Following the passage of the legislation, Mr. Smith, in 2003, were there also regulations that were subsequently enacted to fill in the details?

A. Well, certainly anytime that enabling legislation is passed, then the responsible agency then prepares rules and regulations to detail how you're going to administer that authority that's given to you. So we did, after the passage of that, start drafting our rules and regulations.

Q. And was that the work done by your agency?

A. It was.

Q. All right. And when were those regulations enacted?

A. 2005.

Q. All right. And were you involved in setting up those regulations, working on those regulations?

A. I was a part of the team that worked on that, yes.

Q. Okay. And did your agency retain anybody or any institution to help draft and prepare those regulations?

A. Yeah. With the details that we had to have with -- for example, in the preparation of Nutrient Management Plans, we had to develop phosphorus indices. For example, a decision was made to base those plans on the phosphorus index. That had to be developed.

At the same time, we felt that rather than wait until the growers -- focus on growers, the people receive the plans, rather than just continue to let them utilize and spread the -- spread the nutrients that they had in the past, we needed -- it would be well to have a protective rate to give people the options of either spreading the nutrients with their Nutrient Management Plan that they had or to do a protective rate.

So we contracted with the University of Arkansas to do both of those things, to give us a phosphorus index to be able to draft the plans themselves, and to provide a protective rate that people could utilize while they were waiting for their plans to be developed.

The idea there was you do two things. You give a measure of protection that wouldn't exist if they waited until the plans are developed, and it gave the individuals something to quantify that they could

utilize while their plans were being developed.

Q. Okay. What specific U of A scientists were involved in developing the phosphorus index that was incorporated into the Arkansas regulations?

A. At that time, I believe it would have been Phillip Moore and Tommy Daniels. Those two professors are what comes to my mind.

Q. All right. Now, Mr. Smith, I know you're not a soil scientist -- you are not a soil scientist, are you?

A. I am not, no. No, sir.

Q. Okay. But despite the fact that you're not a soil scientist, can you give us just generally your understanding of what a phosphorus index is and how it works generally?

MR. NANCE: Lack of foundation, Your Honor.

THE COURT: Sustained.

Q. *(BY MR. BASSETT)* You have been with the Arkansas Natural Resources Commission since 1985; correct?

A. I have, sir.

Q. And you worked, along with others in your agency, to develop these regulations; correct?

A. I did.

1 So go ahead?
2 Q. *(BY MR. BASSETT)* Let me just repeat the
3 question for you, Mr. Smith.
4 Can you give us -- give the judge your
5 understanding generally of what a phosphorus index is
6 and how it works?
7 A. Basically, the index is a risk-based
8 calculation on being able to reduce the risk of runoff
9 from a -- from a farm, for example, for whatever
10 you're drawing up a Nutrient Management Plan for. We
11 think it's more flexible and more useful --
12 MR. NANCE: Your Honor, this is opinion
13 testimony, and he's definitely not an expert on its
14 usefulness or its flexibility.
15 THE COURT: This is basically Arkansas
16 policy. I'll take it as that. Overruled.
17 Q. *(BY MR. BASSETT)* You may continue.
18 A. It allows you to look at -- at a suite of
19 things in developing a Nutrient Management Plan. You
20 start with the soil test phosphorus, you look at the
21 uniqueness of the individual's land, you look at his
22 soil types, you look at the topography of the land,
23 you look at the slopes of the land, you look at best
24 management practices that he might want to incorporate
25 in his plan -- or has incorporated in his plan. And

So go ahead?

Q. *(BY MR. BASSETT)* Let me just repeat the question for you, Mr. Smith.

Can you give us -- give the judge your understanding generally of what a phosphorus index is and how it works?

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MR. NANCE: Your Honor, this is opinion testimony, and he's definitely not an expert on its usefulness or its flexibility.

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Q. *(BY MR. BASSETT)* You may continue.

A. It allows you to look at -- at a suite of things in developing a Nutrient Management Plan. You start with the soil test phosphorus, you look at the uniqueness of the individual's land, you look at his soil types, you look at the topography of the land, you look at the slopes of the land, you look at best management practices that he might want to incorporate in his plan -- or has incorporated in his plan. And

1 looking at that whole suite of things, then you can
2 take those and compute a Nutrient Management Plan from
3 those. But it allows you looks at all of those areas,
4 and we think that's the strength of the -- of the
5 phosphorus index procedures.
6 Q. And is each field looked at individually and
7 uniquely?
8 A. Oh, certainly. It's -- it -- with
9 the -- with the complicated things that you look at
10 from that, it simply is not -- you're not able to do a
11 cookie-cutter approach. You have to look at the
12 uniqueness of each farm in itself. So it
13 takes -- that's why, for example, that we wanted the
14 people that draw those plans up to be certified.
15 There -- you got to bring some expertise to that.
16 Q. Is each field scored using the index?
17 A. It is.
18 Q. Okay. And then is a recommendation made
19 regarding nutrient use on that field taking all those
20 factors into consideration?
21 A. Yes, sir, it is.
22 Q. Okay. Do you know if Arkansas, Mr. Smith, is
23 the only state that manages litter
24 applications through the phosphorus index?
25 A. Oh, no. There are many, many states that

utilize the phosphorus index.

Q. Do you know how many states use the phosphorus index?

MR. NANCE: Your Honor, I don't believe this is relevant to any consideration before this court.

THE COURT: Overruled.

Q. *(BY MR. BASSETT)* Do you know how many states use the phosphorus index, Mr. Smith?

A. The number's up into the 40s. I've heard as high as 48 of the states utilize the phosphorus index.

Q. All right. Now --

MR. BASSETT: Just one moment, Your Honor.

THE COURT: Yes, sir.

MR. BASSETT: I'm not as organized as the rest of these good lawyers are here.

Q. *(BY MR. BASSETT)* Mr. Smith, the court has been very patient for a number of months now and has heard about something called the NRCS Code 590 from the USDA.

Do you know what the NRCS is and what Code 590 is?

A. Well, NRCS is the Natural Resources Conservation Service, an agency of the USDA.

Q. Do you know what the NRCS recommendations are to state agencies, such as yours in Arkansas, as far as guidance to states on how they can manage nutrient application?

A. As with most bureaucracies, guidance documents are prepared and sent down so that each -- that there will be some uniformity in the way the programs are carried out across the states, and 590 is one of those guidance documents that NRCS has prepared.

Q. Does the NRCS recognize different approaches to managing nutrient applications?

A. Yeah. They basically look at -- my recollection is that there are three areas in which they recognize the development of Nutrient Management Plans. One is the soil test phosphorus, one is the phosphorus index, and one is a phosphorus threshold. Each of those options are available through their documents in the preparation of Nutrient Management Plans.

Q. Just so for the record, is a phosphorus index one of the legitimate approaches or options a state can elect to use under NRCS recommendations?

A. It is.

Q. Okay. Do you know what approach the State of

fertilizer?

A. Yes, sir.

Q. And do you work with that in your office day in and day out?

A. Yes, sir.

Q. All right. And you help put together these regulations; is that true?

A. There again, I was part of the team that worked on that.

Q. And you are familiar with those regulations?

A. Yes, sir.

Q. And do you know what those regulations require a poultry-grower to do?

A. Within any of the surplus nutrient areas, a poultry-grower is required to obtain a Nutrient Management Plan in order to apply nutrients to the soil, to the land.

Q. Okay. Does the plan have to be written by a certified nutrient management specialist?

A. They do.

Q. Okay. And does the site have to be evaluated using the criteria in the Arkansas phosphorus index?

A. That's certainly part of the development of a Nutrient Management Plan.

Q. Were these regulations, Mr. Smith, set up

such time as the plans could be developed.

Q. All right. This may have already been covered --

MR. BASSETT: And, Your Honor, I apologize if this is repetitious. But I want to ask Mr. Smith --

Q. *(BY MR. BASSETT)* Or, Mr. Smith, I want to ask you -- of course there's been some discussion about the Arkansas litter laws having a protective rate -- but do you know anything about this protective rate? Obviously you do because you've already talked about it, but do you know something about the protective rate? Do you know what it is?

A. Well, certainly it was -- it was an option that we wanted to put in place to give until such time as plans develop.

Q. Who determined the protective rate?

A. We worked with the University of Arkansas in developing that protective rate.

Q. All right.

A. The numbers for the protective rate.

Q. And was the protective rate intended to be something used on an interim basis only?

A. Yes. It could only be used until 2007. So there's a specific time frame span in which that

protective rate could be utilized.

Q. Was the protective rate more or less restrictive than what had previously been allowed or than what was then allowed under a Nutrient Management Plan?

A. Well, until the time the legislation was adopted, there was -- there was no restriction at all on there other than voluntary-type measures. In general, I think the protective rate is probably more restrictive than the phosphorus index would be because it does not -- it doesn't take into account the other things that a phosphorus index can look at.

Q. The factors you talked about earlier?

A. Yes, sir.

Q. Can farmers or others still use a protective rate for litter applications?

A. No, sir. That option expired in 2007.

Q. Not to quibble here, but did it actually expire on December 31st, 2006?

A. Yes, sir. That's true.

Q. All right. Now, the Arkansas regulations have recently been revised, have they not?

A. Yes, sir. Just within the last few days.

Q. Do the revised regulations allow poultry litter to be applied at a protective rate?

A. No, they do not.

Q. All right. To your knowledge, did Arkansas seek input or comments from Oklahoma related to its poultry litter regulatory statutes or regulations?

A. Well, we had the -- since we meet via the Compact, we meet with Oklahoma annually on there, and our commissioners at that time, this period of time that you're speaking of, we would report annually to the Compact progress toward our -- we spoke about the legislation that was being passed, we spoke about the development of our rules and regulations, and reported to the Compact itself. That encompassed, of course, those Oklahoma individuals that were sitting on the Compact.

Q. Okay. And I don't want to be confusing about the dates. I'm really referencing now prior to the laws that were passed in 2003.

Do you know if copies, draft statutes, were provided to Oklahoma officials before the legislation was passed in 2003 in Arkansas?

A. I'm not sure. I suspect they were but I'm not sure.

Q. Okay. So do you know if draft copies were provided to any Oklahoma officials?

A. I couldn't tell you for sure.

Q. All right. To your knowledge, did any Oklahoma official identify any particular aspects of the proposed statutes or regulations in Arkansas that they found objectionable or unreasonable?

A. No, sir. I don't recall any.

Q. You testified that you have participated in meetings in which Oklahoma officials were there also; is that correct?

A. Yes, sir.

Q. Okay. In leading up to the passage of the laws in Arkansas in 2003, Mr. Smith, did you ever participate in or witness anything that you believe would have constituted intimidation of Oklahoma officials that would have made them nervous about providing comment on the Arkansas regulations?

A. No, sir.

Q. Okay. Did you ever try to intimidate an Oklahoma official?

A. I don't think a minor official can intimidate an Oklahoma official.

Q. You don't strike me as the intimidating sort either.

But did you ever witness anybody else, any other official, or anybody else at all, from Arkansas that tried to do that?

A. No, sir.

MR. BASSETT: Your Honor, if I might have a moment here, there's a couple of questions I had that I think Mr. Smith's already covered and I don't want to be repetitious.

THE COURT: Yes, sir.

Q. *(BY MR. BASSETT)* Mr. Smith, are you aware that -- and I'm sure you are since you're sitting in this courtroom -- aware that several poultry companies are being sued in this case by the State of Oklahoma?

A. I am.

Q. Those companies are represented by these lawyers over here. Let me just name them for you very briefly. Tyson Foods, Cobb-Vantress, Cargill, Simmons, Peterson, George's, and Cal-Maine. I think that's the lineup.

Is it your recollection that any of these poultry companies, or any officials connected to these poultry companies, were opposed to the regulations or somehow held up the process of developing and passing regulations back during the 2003, 2004, 2005 time period?

A. No. They were supportive of the legislation and the rules and regulations.

Q. Was there any resistance from any of the poultry-growers to those regulations?

A. Well, yes, there were, and that was evidenced in our public hearings. There were -- you know, certain individuals just felt that the government was straying into areas they didn't need to be moving into.

Q. All right. Mr. Smith, do you know anything about an agreement between Arkansas and Oklahoma called the Joint Statement of Principles from 2003?

A. Yes, sir, I do.

Q. Were you involved in any discussions surrounding the entry into that agreement?

A. Yes. I participated and I was at the meetings in which those discussions with Arkansas and Oklahoma took place.

Q. And what was the purpose of that agreement, Mr. Smith, as you understood it?

A. Well, it was -- when we were made aware that Oklahoma intended to adopt those rules and regulations, it was the consensus of the Arkansas agencies that that was a standard that was just not achievable.

Q. Now, let me stop you there for just a second.

When you're talking about those regulations,

are you talking about the numeric criteria for phosphorus in the scenic rivers in the IRW?

A. Yeah. The .037.

Q. Thank you. Now you may continue.

A. Yeah. In lieu of that, I guess the choices there was to either file suit, to do that, or enter into an agreement with Oklahoma regarding that, which we did. That document, for example, set forth some criteria that Arkansas would agree to do. It looked at -- for example, it mentions that the standard would be adopted by 2012 and sets forth some agreements between the two states.

Q. What is your understanding of what Arkansas agreed to do in this agreement?

A. Basically, we -- we agreed to look at reducing our point sources to one part per million and to go forward with looking at reducing nonpoint pollution abatement by doing things like the Nutrient Management Plans.

Q. Okay. So were the Arkansas litter management statutes also a part of this agreement?

A. Well, that became a part of it.

Q. Okay. To the best of your knowledge, Mr. Smith, has Arkansas fulfilled its duties under this agreement?

A. We really feel that we've -- that we've not only met the spirit of the agreement, but gone beyond it. A lot of our point sources are able to achieve below the one part. We felt that we have really been able to bring some resources to bear and have achieved a lot in the nonpoint arena.

Q. Has Arkansas done anything beyond what was discussed or required under this 2000 agreement to try to reduce phosphorus loads to streams and rivers in the IRW?

A. I think so.

Q. Tell us what.

A. Well, by bringing the point sources down below the one part, for example, with enacting the legislation that requires the Nutrient Management Plans and the certifications that we talked about, by not only addressing those type of things, but looking and putting resources in to do urban nonpoint projects, to look at adoption of best management practices in the arena of timber harvesting and things like that.

Q. And how about CREP grants?

A. Well, one other -- we were extremely happy to -- that we were successful in getting the CREP grant for the Illinois River Watershed, which will

the Walton Family Foundation contributed some money also. So it was a widespread effort, if you will, to garner that $6 million so that we could capture that $24 million in federal funding.

Q. All right. Let me ask you this, Mr. Smith. You touched on this already.

When did the -- officially on what date did the revisions to the Arkansas phosphorus index go into effect?

A. Just a few days ago, the first of the year.

Q. January 1st, 2010?

A. 2010, Yes, sir.

Q. Or 2010, whatever we're supposed to say. That would have been last Friday; correct?

A. Yes, sir.

Q. Do you have any understanding of what the revisions to the regulations do?

A. Well, they look at -- they allow us to get into the newest scientific work that the university has done and allow us to capture those type things, to revise our index to the state-of-the-art, if you will, as far as the science is going today.

Q. And did the scientists at the University of Arkansas work on this revision to the phosphorus -- Arkansas phosphorus index?

regulations, the laws in the state of Arkansas, and that has been well hashed out in this court, as Your Honor well knows.

As was pointed out by Mr. Tucker and others, the state really didn't ever get into anything that was going on on the other side of 16th Street to use Mr. Tucker's analogy. And we are here today and we're asking the court to take judicial notice of these regs and the new Arkansas PI because we simply think it would be useful and helpful to you as the trier of fact to know what the present and existing regulations are in the state of Arkansas, to know what the law is in the state of Arkansas.

THE COURT: Particularly given the fact that this is an action for an injunction, I can't ignore existing realities. It seems to me that to the extent that the new regulation effective January 1, 2010, is specifically referenced and adopted -- let me take a look once again at 2201.4B.

To the extent that it's part of the law of the state of Arkansas, I believe it has to be taken into consideration relative to any proposed injunctive relief being sought. The court will take judicial notice of the revised Arkansas phosphorus index, which is incorporated as part of Section 2201.4B of the

rules governing the Arkansas soil nutrient and poultry litter application and management program effective January 1, 2010.

But once again, I'm not going to allow this witness to testify about that index for a couple of reasons. Number one, violation of the 72-hour rule; and number 2, in trying to get the overall explanation from this witness, he admits he's not an expert in that regard.

MR. BASSETT: Yes, sir.

THE COURT: So go ahead.

MR. NANCE: Your Honor, I just -- I understand your ruling and I'm not going to quibble with it. I'm concerned about future expert testimony they may try to slip in based on this document that would be new opinion or we would be prejudiced because we haven't had a chance to have any discovery on or any expert from our side, as need be, to review. I just flag that as a future issue and --

THE COURT: Well, if that's a concern and if it comes in, in terms of expert testimony from the defense, then you've got the opportunity for a rebuttal witness.

So go ahead.

MR. NANCE: Thank you, Your Honor.

Arkansas is spending on plan writers and enforcement activity on the Arkansas side of the Illinois River Watershed?

A. Oh, hundreds of thousands of dollars is spent on plan-writing.

Q. You earlier mentioned in your testimony, Mr. Smith, a water quality criteria or standard for scenic rivers implemented by the State of Oklahoma, the 0.37 standard. You recall that testimony, do you not?

A. I do.

Q. Okay. Is that something that your agency, the Arkansas Natural Resources Commission, has set as a target to be met in Arkansas at any particular time?

A. We have not set it as a target because, as we discussed before, we believe it to be unachievable.

Q. All right. Do you know whether any of your counterparts in Oklahoma who you Interact with on these issues through the Compact Commission, or otherwise, share that same belief, that that standard is not achievable?

A. They never vocalized to me that --

MR. NANCE: Objection. It calls for speculation, particularly if they never vocalized it.

THE COURT: Sustained.

Q. *(BY MR. BASSETT)* All right. Mr. Smith, do you know whether a TMDL for the Illinois River Watershed has ever been considered by the State of Oklahoma?

A. It's been discussed several times in the past at our Compact meetings the fact that -- that Oklahoma, for example, their DEQ was considering developing a TMDL for the watershed.

Q. Okay. Has one been done in Oklahoma to your knowledge?

A. Not to my knowledge.

Q. Now, let me ask you -- or switch topics here -- not really switch topics but move to a different area.

Mr. Smith, are you aware that the Environmental Protection Agency has now very recently advised that it's doing a TMDL for the IRW?

A. Yes. We've been advised by the Dallas region that they -- that they have moved forward with starting their TMDL exercise on the Illinois River, both in Arkansas and in Oklahoma.

Q. That would be Region 6 of the EPA; is that right?

A. That's correct.

Q. Are you personally involved in that process, Mr. Smith?

A. Yes. In this particular exercise, it's somewhat unusual. But when the notice went out, the state asked to be involved early on in the writing in the production of this TMDL. So representatives from both our DEQ -- our Department of Environmental Quality -- and the Natural Resources Commission were asked to give some technical advisors to work with the contractor that they have selected to do that. So that's going to be my involvement in this exercise.

Q. All right. And has the EPA already selected a contractor?

A. They have. It's AQUA TERRA, I believe.

Q. All right. Have you met, Mr. Smith, with the EPA or anyone else about this current TMDL process?

A. The EPA did call a meeting in November --

MR. NANCE: Your Honor, I object. That's nonresponsive to the question.

THE COURT: Sustained. The question was, have you met with the EPA or anyone else about this current TMDL process.

Q. *(BY MR. BASSETT)* Have you been to a meeting, Mr. Smith?

A. Yes, I have.

right now is to get the word out that those are available. So we're involved in the information -- in that information exchange right now as well as providing administration help to the federal agencies in that project.

Q. Okay. And is the federal government involved in these 319 programs in any way?

A. Well, EPA is involved in the 319 programs, yes, sir, they are, heavily.

Q. All right. And how are they involved?

A. Well, for two ways. First of all, they're -- they're the funding vehicle for the projects themselves. As well as when we receive our allocation for funding in the year we know how much money there is, then we take that and we propose projects to utilize that funding, the funds that are made available. All of those proposals and applications go to Dallas for approval so each project that we fund through the 319 project has to be approved by Dallas.

Q. Okay. With regard to the studies of the watershed that are a part of the programs sponsored by your agency in the IRW, does your agency provide reports or results to the federal government or to the EPA on the results of those projects?

A. We do. We're required to submit an annual report to EPA on the results of those projects annually.

Q. Have there been any nonpoint source comprehensive management plans or strategies developed by your agency for the IRW?

A. Oh, yes, sir, there have.

Q. Such as?

A. Well, I mentioned the annual reports themselves, as well as our overall nonpoint management plan that's also a requirement by EPA.

Q. And why is that a requirement?

A. Well, recently in the last several years, EPA has informed us that a nine-element watershed plan is going to be required in order to continue to receive funds. So in each of the watersheds that we're having -- we're underway with development of what they call their nine-element watershed plan.

Q. Is it your understanding, Mr. Smith, that your agency, the Arkansas Natural Resources Commission, has legal authority and jurisdiction in Arkansas over agricultural nonpoint-source discharges in nutrient-sensitive watersheds?

A. We do.

Q. Okay. And in that role, what has been your

experience, as far as the EPA's interest and involvement with what your agency does, with regard to nonpoint sources in the IRW?

A. Well, they're certainly quite interested in that, and as I mentioned, we do report those things to them on an annual reports.

Q. Okay. To your knowledge, has the EPA or any other federal agency ever directed your agency, the Arkansas Natural Resources Commission, that land application of dry poultry litter constitutes a nuisance in the IRW?

A. No, sir.

Q. To your knowledge, has the EPA or any other federal agency ever taken action to eliminate or limit dry poultry litter applications in the IRW?

A. No, sir.

Q. Has the EPA or any other federal agency ever informed you or your agency that a Nutrient Management Plan that Arkansas has adopted or endorsed is violating either state or federal law in any environmental media?

A. No, sir.

MR. BASSETT: Your Honor, might I have just a moment?

(Discussion held off the record)

1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

3

4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 JANUARY 4, 2010
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 83, P.M. SESSION

16

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Animal Waste Task Force, was the approach of the poultry integrators that the way to handle pollution problems should be by some voluntary method?

A. Yes, sir, they were extremely supportive of the voluntary approach, not the regulatory approach.

Q. Now, I think you mentioned that during the '80s and '90s, there was no legal requirement for a Nutrient Management Plan in Arkansas.

A. That's correct.

Q. But that the integrators were supportive of their growers having such plans, right?

A. Voluntary plans, yes.

Q. Voluntary plans. Exactly.

And that, in fact, the integrators got information about those plans to their growers?

A. Yes, sir. I would even say encouraged their growers to secure those plans.

Q. If you know, why did they do that?

A. Sir?

Q. Why did the integrators encourage their growers to have plans?

A. Well, it's just a good practice to do that. It's a plan that does two things: It reduces the risk of runoff on their fields. It also makes them more efficient -- in a lot of ways, more efficient

with their applications. They -- it gives them a point where they don't overapply commercial fertilizer, for example. So it can really serve two purposes: A way of doing some protection of runoff itself while being -- making farmers a little more efficient in their operation.

Q. And from your experience in those days, were those the reasons that the integrators encouraged their growers to get voluntary plans?

A. Sure, plus just the overall need to start addressing the overall nonpoint problems.

Q. You testified that you were -- you considered yourself fortunate to be able to get 319 money to do various programs, right?

A. I think it was fortunate that the timing occurred when it did. At the -- right after the -- we'd had a lot of the Supreme Court -- the time frame when that was in place. At the same time, the Animal Waste Task Force was finishing up their deliberations. At the time, the Clean Lake Study was being done and being requested by Oklahoma to look at doing a pollution reduction standard.

It was just fortunate that those resources were made available for that time frame, is what I meant by that.

that?
A. Oh, no, sir.
Q. Mr. Smith, what legal jurisdiction does your agency have to enforce a TMDL against nonpoint sources, particularly nonpoint poultry sources, poultry waste sources in the state of Arkansas?
MR. HOPSON: Objection, Your Honor, calls for a legal conclusion.
THE COURT: Sustained.
MR. NANCE: I have nothing further, Your Honor.
THE COURT: Mr. Bassett.

REDIRECT EXAMINATION

BY MR. BASSETT:
Q. Good afternoon, Mr. Smith. You were asked just a few minutes ago by Mr. Nance, I believe he asked you if the Arkansas phosphorus index has stopped all pollution. Do you remember that question?
A. I do.
Q. It wasn't clear to me if Mr. Nance was asking about pollution from poultry litter or nonpoint sources or what. So are you aware of any specific instances of pollution, however you might define that, by any grower in the IRW that contracts with one of the defendants in this case?

A. No.
Q. Now, I want to also direct your attention -- I think you still have up there -- actually, let me --
MR. BASSETT: Your Honor, may I approach?
THE COURT: You may, sir.
Q. (By Mr. Bassett) Mr. Smith, I have asked you to pull out -- at the top, it says United States Department of Agriculture. Has to do with the CREP. Remember Mr. Nance asked you some questions?
Specifically, I wanted you to go to page A-6, page 6 of the appendix. And do you recall Mr. Nance asking you to read a couple of sentences from that middle paragraph where it starts off Table 1?
A. Yes.
Q. In fact, I think he had you read starting with the sentence that says, "Land use in the watershed is probably the best indicator." Remember that?
A. I do.
Q. All I want to ask you to do now is to read the one sentence right before that into the record.
A. That starts "However, detecting and determining the extent of impacts to the contributions of nutrients from nonpoint sources is difficult."
Q. Thank you.

from looking at these diagrams and the linear relationships that he portrayed on these diagrams that basically the different groups of samples that are shown on the diagrams -- I think the term he used was "blended seamlessly" with one another. And I interpreted that or understood that to mean that they were basically following the same line throughout the range of concentrations and across the different groups of samples that you see portrayed on these diagrams.

Q. Do you recall the conclusion that Dr. Fisher offered based upon his Figure 22, Oklahoma Exhibit 2502?

A. Yes.

Q. Would you repeat that, Dr. Fisher's conclusion?

A. His conclusion, as understood it, was that these groups of samples, geoprobes, wells and springs were impacted by poultry litter as a consequence of the fact -- or as a consequence, his conclusion, that they, "blended seamlessly" or followed the same pattern as the end-of-field samples that were portrayed on this diagram.

Q. You've said "end of field," and several times in this courtroom we've used the term "edge of field." Are those equivalent terms in your usage,

sir?
A. Yes.
Q. So edge-of-field samples and end of field are the same to you?
A. Yes.
Q. Now, that opinion of Dr. Fisher's that you just recited, do you agree with it?
A. No, I don't.
Q. Why not?
A. Because when you look at the individual groups of samples that you see here and you examine them individually, what you'll see is that they don't have the same pattern. The relationships that you get from looking at the individual groups are different from the relationship that you get from looking at the edge-of-field information that's portrayed on here.
Q. Did you prepare any sort of figures or data plots as part of your analysis that would illustrate your analysis and demonstrate what you've just described to the court?
A. Yes, I did.
Q. If you would, sir, if you would look in the materials that I provided you what was marked for identification as Defendants' Joint 1624. Can you

identify what Defendants' Joint 1624 is, sir?
A. Yes, this is a figure I prepared that illustrates the dissolved --
Q. I'm sorry, go ahead. I just didn't want you to explain too much about it. We just want to identify it for the record.
A. It was a figure that I prepared for my report.
Q. Is the -- is this Figure 1; is that right?
A. Yes, it is.
Q. I'm going to try to keep that straight as well. Was your Figure 1, Defendants' 1624, was it based upon Dr. Fisher's data?
A. Yes, it was.
Q. Was this figure prepared by you or under your direction?
A. Yes, it was.
MR. MCDANIEL: Your Honor, I offer for admission Defendants' Joint Exhibit 1624.
THE COURT: Any objection?
MR. GARREN: No objection.
THE COURT: Defendants' Joint Exhibit 1624 is admitted.
Q. (By Mr. McDaniel) She's displaying it on the screen, Mr. Larson. Would you explain the elements of your figure, your Figure 1, Exhibit 1624.

A. What I've done on Joint Exhibit 1624 was to take the group of samples that I call groundwater samples, which are the samples taken from the wells, so on Dr. Fisher's Figure 22 it would be equivalent to the group labeled "wells," and I've extracted those for the diagram that Dr. Fisher prepared comparing dissolved copper and dissolved phosphorus concentrations. I've extracted them onto this figure alone. So all you see on this figure is the groundwater samples from the wells.

And then I've plotted them in the same fashion that Dr. Fisher has; that is on -- using logarithmic scales, both on the ordinate going -- on the left, we plot the dissolved copper concentration and on the -- going to the -- from left to right, the dissolved phosphorus concentrations, both plotted on a logarithmic scale in the same fashion as Dr. Fisher used on Figure 22. Exhibit 2502.

Then after I extracted that group of data, these are the groundwater well samples, I then calculated the same linear fit or relationship -- or using the same methodology, calculated the linear relationship exhibited by that data and portrayed on the diagram in the small box the nature of that linear relationship and the correlation coefficient

of that area.
Q. Do the edge of -- cattle edge-of-field samples plot within the general range of concentration for the remaining edge-of-field samples?
A. Yes, they do. They're right in sort of the central part of that range.
Q. All right. Did you -- Mr. Larson, did you perform a similar analysis to look at the relationships between the concentrations of any other of Dr. Fisher's key constituents besides the dissolved copper and dissolved phosphorus?
A. Yes. I also looked at dissolved zinc and dissolved phosphorus.
Q. All right. Let's look at what's been marked for identification as Defendants' Joint 1628. When you find it, if you would identify that for the court, please.
A. I have it.
Q. Identify it, please.
A. Exhibit 1628 is a copy of a figure that I prepared for my report.
Q. Figure 5 from your report?
A. Yes.
Q. Is Figure 5 based upon Dr. Fisher's data?
A. Yes.

Q. Was it prepared by you or under your direction?
A. Yes, it was.
MR. MCDANIEL: Your Honor, defendants offer for admission Joint Exhibit 1628.
MR. GARREN: No objection.
THE COURT: 1628 is admitted.
Q. (By Mr. McDaniel) All right, sir. This figure looks rather similar to the last one. Can you explain what we're looking at here and how it differs from the last figure?
A. Well, as with the last figure, I followed the same procedure that I described earlier where I extracted the individual groups of samples, that is the groundwater wells, the geoprobes and the springs and the edge-of-field samples, and examined each of those groups individually. For each of those groups, I calculated the linear correlation relationship exhibited by those individual groups of samples. And the results of that evaluation I've then displayed on this chart.
Q. Whereas your prior -- Figure 4, the prior exhibit, you were looking at dissolved copper versus dissolved phosphorus. What are we looking at -- what relationships are we looking at here with your Figure 5, Exhibit 1628?

A. Here we're looking at the dissolved zinc versus the dissolved phosphorus.
Q. All right. From this analysis that you performed, Mr. Larson, and what's visible on your Figure 5, did you draw any conclusions?
A. Yes, I did.
Q. And what are they?
A. I concluded that the data for the groundwater wells, the geoprobes and the springs do not blend seamlessly with the edge-of-field data, and that's illustrated by the fact that when you looked at these statistical linear relationships, that those linear relationships are different from the relationship associated with the edge-of-field samples. And I've shown on this diagram the nature of the linear relationships that are calculated and also the degree of correlation exhibited by those linear relationships.
Q. All right, sir. Did you also plot on this Figure 5 the dissolved zinc versus dissolved phosphorus, the -- what's been referred to as the cattle edge-of-field samples?
A. Yes, I did.
Q. What symbol did you use on the legend?
A. Again, it's an orange symbol with a square

So what I did to try to illustrate that better was to prepare what we call histograms of those two sets of data to illustrate how the histograms show the difference that you tend to see with just viewing the dataset visually, how the histograms actually demonstrate the differences in the patterns of those two populations.

Q. Let's look at what's been marked for identification as Defendants' Joint 1629. Identify that for the court, please.

A. 1629 is a figure that I prepared for my report.

Q. Is this Figure 6 from your report?

A. Yes, it is.

Q. All right, sir. Is Figure 6, Defendants' Joint 1629, is it based upon Dr. Fisher's data?

A. Yes, it is.

Q. Was this figure prepared by you or under your direction?

A. Yes, it was.

MR. MCDANIEL: Your Honor, defendants offer Joint Exhibit 1629.

MR. GARREN: No objection.

THE COURT: 1629 is admitted.

Q. (By Mr. McDaniel) Mr. Larson, you refer to this as a histogram. Tell us what a histogram is.

A. In a sense, it's a discrete probability distribution. You may be familiar with normal probability distribution curves. Those are continuous distributions. Histograms are the -- what I'll call the discrete version of the continuous distributions.

Basically what you do is you look at a population of values or results, and then you subdivide that population into groups based on their magnitude. And then you basically count how many occurrences you get in each of your different groups and then you display that relative frequency of that count against the total number of items in your population plotted against the values associated with each group. And that creates what we call a histogram.

Q. I think we ended the day with you giving everybody a little bubble in their brain with that answer. We shouldn't assume that I understood all of that.

What's the point of the visual display?

A. Each histogram -- well, first of all, I construct histograms for both the groundwater well samples and for the edge-of-field samples. And these histograms illustrate the distribution of the

population of values. In this case, the values are the ratio of copper to phosphorus in the individual samples.

So each individual sample has a copper concentration and a phosphorus concentration. I take that ratio, and I get a value. I then take the collection of values and group them, in this case into generally logarithmic bins, we call them, or groups.

And so, for example, you'll see a group under the label 0.01. So what it says is that all the values that have ratios between 0.003, the value prior to that, and .01, are counted, and they're portrayed by the vertical red bar that you see above .01.

If you follow that bar over to the left, it intersects that vertical access roughly at about 15 percent. So what that means is that 15 percent of the ratios that you calculated were within that range of values from .003 to .01.

I then did that same thing for these logarithmic groups up to a value of 30. That gives me the distribution of the population of those so I can visually see both the central tendency of those numbers and the distribution about that central

tendency.
Q. How is this methodology typically employed in your profession, sir?
A. It's employed to look at both, as I said a moment ago, the central tendency; that is, where are most of the values located and how are they spread out about that central tendency. And when we compare two different groups of information, we can see whether they tend to have the same central tendency or whether they have a different set of central tendency.
Q. Is it a common analytical tool in your profession?
A. Yes.
Q. Now, you mentioned --
MR. MCDANIEL: I'll stop at the court's pleasure. We can keep going or -- it's up to you, sir, obviously.
THE COURT: How many more questions until you get to an appropriate stopping point?
MR. MCDANIEL: I'd say probably five minutes to finish with this figure, or less.
THE COURT: Go ahead.
MR. MCDANIEL: Thank you.
Q. (By Mr. McDaniel) What was your objective in

evaluating this groundwater data using this method?
A. I wanted to determine whether or not what I saw visually by looking at that diagram would also be portrayed if I looked at it with a more formalized methodology, the histogram calculation or histogram display. And so I wanted to see what those two populations looked like, that is the groundwater well samples on the one hand and the edge-of-field samples on the other hand, to look at where their central tendency was and whether their central tendencies were the same or different.
Q. You mentioned a few moments ago when we were looking at the linear plots that your terminology on your figure of groundwater samples -- you told us the other figures' groundwater samples meant the water well samples. Does that apply to this figure as well?
A. Yes, it does.
Q. Okay. All right, sir. This analysis that you did by preparing this histogram, looking at the ratio of dissolved copper to dissolved phosphorus for the water well samples, did you draw any conclusions from that analysis?
A. Yes, I did.
Q. What were they?

A. When you look at the ratio for the edge-of-field samples in terms of the ratio of copper to phosphorus in the individual samples, the central tendency of those ratios was almost an order of magnitude or more lower than the ratio of copper to phosphorus that were exhibited by the groundwater well samples that are shown in the blue.

You can see that, say, the peak or the high points in the blue which represent the groundwater well samples are somewhere in the range of .3 to 1 in terms of that ratio, whereas the sort of central tendency or the peak of the edge-of-field samples is in the range of .03 to .1, which is about an order of magnitude different between the ratios exhibited by the edge-of-field samples versus the groundwater well samples.

The conclusion I reached was that those ratios actually are different in terms of their central tendencies.

MR. MCDANIEL: That would be the stopping point, Your Honor.

THE COURT: We'll be in recess.

(Whereupon a recess was had.)

IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 84 - AM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

JANUARY 5, 2010

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

6

STEVEN LARSON

7

Continued Direct Examination by Mr. McDaniel 9731
8 Cross-Examination by Mr. Garren 9750

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BILLY R. CLAY, DVM.

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Direct Examination by Mr. Tucker 9802

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thousand pounds, then all you'd have to do would be to add things up, but all cows don't all weigh a thousand pounds. So you have to determine what the cow population and the cattle population consists of in order to make the next step which is how much manure which leads to how much phosphorus.

THE COURT: Overruled.

Q. *(BY MR. TUCKER)* With regard to heifers, if you cull -- if you cull a cow in eight years, what is the -- how do you replace the cow that you're culling?

A. Well, it really takes a portion of two heifers, if you will. You have to have a portion of a heifer that's approaching the calving age, which is two years, and then you have to have a heifer that is lightweight coming on. So that's the way it's done. They tend to have a heifer saved back each year that is going to contribute to that replacement.

Q. Did you determine the approximate number of cattle total in the watershed?

A. Yes.

Q. And what is that?

A. About 200,000 head.

Q. How did you use the census data to calculate those numbers -- or that number?

in the distributions of those results. The conclusion is that the distributions are different, significantly different.

Q. All right, sir. In the course of your testimony yesterday and what we've just gone through with the second histogram, you've described two different types of analyses you did by looking -- by plotting on a linear fashion the relationships between Dr. Fisher's constituents and the different media as one technique that you used and the second technique being using these histograms to look at the distribution of the relationships.

Based upon these two types of analyses, did you form an opinion as to whether or not Dr. Fisher had shown that groundwater samples were related to the edge-of-field samples?

A. Yes, I did.

Q. What is that opinion?

A. That these data do not demonstrate a relationship between the edge-of-field samples and the groundwater samples.

Q. Did you form any opinion as to whether or not Dr. Fisher's fingerprint ratio analysis can support any conclusion about the source of any constituents in the groundwater in the Illinois River Watershed?

Q. And I'm assuming that you consistently thanked your father for that early assignment which led you to the study of veterinary medicine?

A. Well, it was a contributor, no doubt. And yes, I did thank my father.

Q. Did you determine the size of the land mass of the Illinois River Basin?

A. Yes.

Q. How large is it?

A. About 1.1 million acres.

Q. Did you determine how much of the land in the basin is devoted to farming and agricultural production?

A. Yes.

Q. How did you go about doing that?

A. Using the agricultural census, which is a voluntary completion of the census forms from the USDA in which farmers will fill those out. And it -- they report how many acres they use that are involved in their farming operation.

Q. And did you say that's sponsored by the federal government?

A. Yes. It's the U.S. Department of Agriculture. They have a branch called the National Agricultural Statistic Service.

A. Please repeat that.

Q. I'll try to do something close to it.

Do you believe that that method of determining what percentage of the -- if you call them the boundary zip codes, where the land mass was inside or outside the watershed, was reliable for use for your purposes in determining generally the amount of agricultural uses of this million-some-odd-acre watershed?

A. Yes. In that I was interested in an estimate. I knew I could not get the precise number to begin with.

Q. How many agricultural-use acres did you calculate in the watershed as reported in the census?

A. 698,000 were tabulated.

Q. About what percent is that?

A. Well, it's approximately two-thirds of the watershed.

Q. Did the ag census capture all the acres devoted to farming?

A. No.

Q. How do you know that?

A. Well, I also did an assessment of the property owners that exist in the watershed in which I tabulated the number of property owners that owned

A. The ones I just mentioned would have the most information at the local level.

Q. Dr. Clay, what did you determine to be the predominant land use of the land that was devoted to farming?

A. It's for pasture for livestock, or at least forages for livestock.

Q. Did you using the census consider how that pasture or how that livestock land was actually used and broken down?

A. Well, I used the -- or I collected the data from the census that shows their allocation of those uses, yes.

Q. I'd like you to turn to -- and if you'd pull up please -- Tyson Demonstrative 262. Could you explain what Demonstrative 262 is, please, Dr. Clay?

A. Yes. This is the summary from the -- tabulated summary of the information collected from the census. They categorize it in the permanent pasture for cattle, and then they show hay and harvested forages, and then they show forages that are planted, typically annually, for grazing, and then woodland pastures.

Q. Let's start at the top, if you would. And I can see soybeans, corn, and wheat, but let's start at

permanent pasture cattle. And would you define or explain what the census means when they talk about permanent pasture cattle?

A. Well, in the category of asking the people filling out the census is that they identify permanent pasture, meaning this is -- this is designated for one use. In most cases, that is a perennial plant that's planted in the -- on that land and it is used for cattle.

Q. And the cattle would be expected to occupy that pasture year-round; is that right?

A. That's correct.

Q. Now, the second category is hay/harvested forage. Would you explain that category?

A. Yes. That's land that is devoted to the production of hay or to production of forages that could be harvested in various ways. Could be made into silage. Could be made into various other forms.

Q. Now, with the hay/harvested forage, we're contemplating there that hay will be harvested or baled; is that right? Or silage will be collected and baled?

A. Well, silage won't be baled but hay would be baled, yes. Generally, that's the case.

Q. Can you tell whether the hay that's harvested there will be fed to cattle on that property?

A. No.

Q. Can it tell you whether the cattle -- whether that hay will be sold and consumed within the basin or outside the basin?

MR. GARREN: Leading, Your Honor.

THE COURT: Overruled. It's "can it tell you." It's not leading.

Go ahead.

A. It cannot tell you where it will be used.

Q. *(BY MR. TUCKER)* Would the same be true for silage?

A. That is correct.

Q. Would you explain forage for grazing?

A. Yes. In that there are some stocker cattle in this area -- that's lighter-weight cattle or growing cattle -- and then there are a fair number of dairies, they plant pasture on an annual, basis and some of it is overseeded and others as well, so that planting is what would be forage for grazing.

Q. All right. Now, how is that different than permanent pasture?

A. Well, permanent pasture comes back from the base of the plant or the crown, if you will, every

year regardless of frost. These plants usually terminate their growth -- they have a growth cycle that ends within a year.

Q. Would you give some examples of what forage for grazing crops would be?

A. Small grains are typically used, wheat, oats, rye, barley, rye grass, sudangrass, millet, things of that nature.

Q. And the fourth category, woodland pastures, would you define that for us, please?

A. That is part of -- part of the property owner's land that they -- that is forested, yet they use it for pasture for cattle.

Q. In other words, the cows can get in between the trees to graze?

A. Correct.

Q. Of those categories -- permanent pasture, harvested, forage, and woodland pastures -- are woodland pastures susceptible to being fertilized by anything, chemical fertilizer or poultry litter or anything else?

A. Not very easily.

Q. Why is that?

A. Well, as it says, it's woodland pasture and generally you have to have equipment access in order

to apply fertilization. It could be done but it would be much more difficult. It would require hand application.

Q. Did you reach a conclusion as to whether the ag census fully explains and accounts for all agricultural use of land in the basin?

A. Well, no, it doesn't. But it makes an estimate.

Q. And how does it -- how does it miss the mark, if you believe it misses the mark?

A. Well, as pointed out earlier, I know that there's an additional 6,000 property owners there with acreage five or greater that do not report to the census so they do something with their land. And so --

Q. Do you know of any of those owners, particularly that have had cattle on their land, that fit in that category?

A. Well, through recent conversation, I learned of one.

Q. Who is that?

MR. GARREN: Objection; hearsay. Not established also whether we're talking about the IRW, Your Honor.

THE COURT: Sustained.

over the years, I was interested in cattle in particular, although I'm interested in all the livestock.

So I studied what Oklahoma's cattle production looks like, if you will, not once, but many times. I've looked at the Arkansas cattle production as well as other livestock production, not once, but many times. I have communicated with university personnel in both the University of Arkansas and Oklahoma State University pertaining to cattle production there. I've read numerous pamphlets, pieces of research, pieces of information pertaining to livestock production in general in those states.

I feel comfortable that I know what the business is in general.

Q. Are there any earth-shattering differences between cattle production that occurs in the Illinois River Basin and cattle production that occurs elsewhere in eastern Oklahoma?

A. No. And not -- I mean, it's just terrain. You know, there's places in western Oklahoma that would be different, different kinds of forages, but basically they're the same.

Q. All right. What did you find about the cattle production that occurs generally in the basin?

A. There are three types of -- or groups of cattle that you can expect to find there. You find a cow-calf operation, which is -- the sole purpose of that business is to produce a baby calf that raises up to weaning weight, which is about generally 210 days, approximately 500 pounds, and that is the item that is sold from that property and that's the sort of income.

The other beef cattle operation is called a stocker operation. That's a situation in which either on planted forages, or permanent pasture in many cases, folks will buy wean-age cattle with the objective of growing them to a level whereby they could be placed in feed yards, and that's generally from the 500-pound range up to about 800 pounds, and then sell them and send them on to the feed yard.

In that operation, that is their business. So they set a group of cattle in, raise them to that level, sell them, replace them with a new group of cattle, and so on and so on.

And then there is the dairy operation. There are -- there are dairies in both Arkansas and Oklahoma within the Illinois River Watershed. The dairy operation in this case is typically a forage-based operation, although they have to have feed imported, and their primary business of course is the production

of milk. Now, they do produce calves but the calves generally are not an important economic part of their business except for the heifers that they would save for replacement.

Q. Now, let's go back to the cow-calf.

You indicated that the cow-calf operation sells the calves off each year; right?

A. Yes, that's right.

Q. Does the cow-calf operator sell anything else off besides the calves?

A. Well, they have to sell the cull cows and/or the cull bulls.

Q. What are cull cows and cull bulls?

A. Well, the life of a beef cow is about eight years, and so they have to plan to replace that beef cow every eight years. So that means that on an annual basis, they'll be culling some percentage of the cows, typically at ten percent, if you will, cull on an annual basis. And so those culls will either go on pasture for -- so that they can put some weight on and hit a better market condition, or they'll be sold directly from the place and sent to the sale barn or wherever they're sold.

Q. And you say that the working span of a cow is about eight years?

thousand pounds, then all you'd have to do would be to add things up, but all cows don't all weigh a thousand pounds. So you have to determine what the cow population and the cattle population consists of in order to make the next step which is how much manure which leads to how much phosphorus.

THE COURT: Overruled.

Q. *(BY MR. TUCKER)* With regard to heifers, if you cull -- if you cull a cow in eight years, what is the -- how do you replace the cow that you're culling?

A. Well, it really takes a portion of two heifers, if you will. You have to have a portion of a heifer that's approaching the calving age, which is two years, and then you have to have a heifer that is lightweight coming on. So that's the way it's done. They tend to have a heifer saved back each year that is going to contribute to that replacement.

Q. Did you determine the approximate number of cattle total in the watershed?

A. Yes.

Q. And what is that?

A. About 200,000 head.

Q. How did you use the census data to calculate those numbers -- or that number?

Q. And I want to ask you about manure. That's all we're talking about right now.

Did you use those materials to determine the amount of manure that's produced by all the cattle in the basin each year?

A. Yes, yes. The cattle that I considered to be year-round survivors.

Q. And what did you calculate that to be?

A. The number?

Q. Yes.

A. I believe that was about 233,000 dry tons per year.

Q. What is the difference between a dry ton and a wet ton?

A. Well, of course a wet ton is as the weight is produced. In other words, when an animal excretes the manure, it is wet and drops right on the ground.

Q. And the dry ton would be after the water has evaporated or otherwise gone away?

A. Or by knowing the amount of dry matter that's typically in cattle manure, one can make an estimate of the dry weight, and that is what I did.

Q. Did we ask you to determine, the best you could, in your capacity as an expert the number of tons of poultry manure produced in the basin each

A. Yes.

Q. And using that, did you determine the amount of phosphorus in the cattle manure that's deposited in the basin each year?

A. I did.

Q. And what is that amount?

A. About 3100 tons.

Q. Did you make a determination of how much phosphorus is in the manure produced by poultry in the basin each year?

A. I did.

Q. How did you determine that?

A. In a similar fashion.

Q. Now, we've had jokes about the thousand-pound chicken. Is that -- is that -- and it seems kind of silly. But is that the way you have to calculate it in order to be talking about apples and apples?

A. Well, if you're going to use the guide books, it's based on a thousand pounds and that makes it simple, or relatively simple.

Q. So we gather together a thousand pounds of chicken and calculate it that way?

A. Correct.

Q. And based upon that, about how much phosphorus is in the manure produced by poultry in the

basin each year?

A. Also about 3100 tons, slightly more.

Q. Now, just to be clear, are tons of litter the same thing as tons of poultry manure?

A. No.

Q. Quickly if you might explain the difference just for the record.

A. Well, manure is that which is excreted from the bird directly onto the bedding, then the bedding and the manure together become the litter.

Q. And the same is true with regard to cattle manure, isn't it, that the tons of phosphorus in cattle manure is not the same as thinking of the -- of the chunk of cow manure on the pasture?

A. Restate that, if you would, sir.

Q. Well, in other words, a cow patty is not composed entirely of phosphorus obviously?

A. Oh, absolutely not, no. It's the water. The dry components are the solids, if you will, and the solids would have in it phosphorus.

Q. Did you determine how much of the phosphorus in the poultry manure produced in the basin is available to potentially be applied in the basin?

A. Yes.

Q. And what was that amount?

Q. Is it possible that some litter may have been exported that was not included in your export total?

A. Sure.

Q. Is there any way to tell what those numbers will be?

A. Probably not without a subpoena.

Q. Is there any certainty that 70,000 tons wet weight will continue to be exported?

A. No.

Q. Did you make a determination of the amount of phosphorus produced by other animals and deposited in the basin each year?

A. I did.

Q. How did you do that?

A. Following a similar method as before using -- using the census. But in the case of wildlife, I had to use other methods to do that, and much of that information I was able to acquire through recent TMDLs that have been filed.

Q. What does other animals consist of?

A. Well, it's swine, deer -- well, deer in the case of wildlife, horses, sheep, ducks, geese, wild turkeys.

Q. And the domestic animals, I gather, were reported in the census?

A. Yes.

Q. But wildlife is not?

A. That's right.

Q. So for that, what data do you use?

A. I relied on data from the wildlife services from both states.

Q. Taken together, what did you find insofar as the -- well, did you take that calculation on down and also determine the amount of phosphorus that those animals produced from their manure?

A. Yes.

Q. Using the same methods as you've described before?

A. Yes. In the case of the wildlife, though, as I said, I got the guidelines from the TMDLs.

Q. What did you find as to the total for other animals approximately?

A. About 950 tons of phosphorus.

Q. Okay.

MR. TUCKER: If we could pull up Demonstrative 263.

Q. *(BY MR. TUCKER)* Would you tell the court what that is intended to show?

A. This is a table from my report, and it shows the dry mass -- the summary of the dry mass or dry

A. Yes.

Q. But wildlife is not?

A. That's right.

Q. So for that, what data do you use?

A. I relied on data from the wildlife services from both states.

Q. Taken together, what did you find insofar as the -- well, did you take that calculation on down and also determine the amount of phosphorus that those animals produced from their manure?

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Q. What did you find as to the total for other animals approximately?

A. About 950 tons of phosphorus.

Q. Okay.

MR. TUCKER: If we could pull up Demonstrative 263.

Q. *(BY MR. TUCKER)* Would you tell the court what that is intended to show?

A. This is a table from my report, and it shows the dry mass -- the summary of the dry mass or dry

weight of the manure of all of the classes of animals that I made calculations on.

Q. Now, let me interrupt you at this point.

For beef cattle, you show 217,000 and for poultry you show 157,000. I thought you told us that the total amounts of manure were about the same?

A. I did. But this is -- this has the export taken out of it.

Q. So that is net of BMP's 70,000 tons?

A. It is net of BPM.

Q. All right. And then does this chart also demonstrate the amount of phosphorus contained in that manure?

A. Yes. It's shown in the fourth column -- well, actually fifth column from the left.

Q. And for other animals, would you identify in this sheet, just so we have it clear, which of the -- which of the lines relate to other animals?

A. Hogs and pigs, horses and ponies, whitetail deer, sheep and lambs, while turkeys, wild geese and ducks.

MR. TUCKER: Please pull up Demonstrative 265.

Q. *(BY MR. TUCKER)* Could you tell us what is that intended to illustrate, please, Dr. Clay?

A. This is a bar graph to illustrate the phosphorus production for all cattle, poultry, poultry after export compared to all other animals.

Q. And I see two columns for poultry. Is one -- one says "less exported" and one just says "poultry."

A. The one that says "poultry" is production, what phosphorus is produced on an annual basis of the poultry in the watershed. That is produced. It doesn't say what happens to it. Likewise with the cattle.

Q. So when you reduce it down to its base question here in this courtroom, which is phosphorus, it looks like, as far as production is concerned, that cattle and poultry is roughly equivalent?

A. Yes.

MR. TUCKER: Please pull up Demonstrative 266.

Q. *(BY MR. TUCKER)* And could you explain, just for illustrative purposes, what you intend to show with this?

A. Well, in this case, it shows the cattle again at 3136. It shows the poultry less exported. So that's poultry litter that is available for application to the watershed.

Q. Now, why do you say "available"?

A. Well, we don't know whether it is applied because something else could be done with it. It's available. I have no record of whether it's applied or not.

Q. As a part of your analysis, did you determine whether poultry-growers apply all their litter in their houses every year?

A. Well, poultry-growers certainly don't. Poultry-growers, if they have cattle in pasture, they may apply some.

MR. GARREN: Your Honor, I'm going to move -- I object to this. We don't have a foundation where he's getting his poultry information and --

THE COURT: Sustained. Let's take our recess for lunch.

(Lunch recess was taken)

1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

3

4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 JANUARY 5, 2010
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 85, P.M. SESSION

16

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PROCEEDINGS

JANUARY 5, 2010:

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THE COURT: Mr. Tucker.

MR. TUCKER: Thank you, Your Honor.

BILLY CLAY,

having been previously duly sworn, was called as a witness and testified as follows:

CONTINUED DIRECT EXAMINATION

BY MR. TUCKER:

Q. I'd like to direct your attention now to the topic of cattle behavior in the Illinois River basin. You told us something about cattle behavior generally earlier. Can you tell us what you observed with regard to cattle behavior in the basin.

A. Cattle in the basin function very similar to most other cattle with a few exceptions. And one of the exceptions is that when the trees were cleared so that they could produce pasture, they left the trees along the ravines and the streams. And as indicated earlier, when cattle are not feeding, grazing, they find shade and they find water.

Q. About how many hours a day do cattle spend grazing?

A. Eight to twelve, depending on the available amount of forage.
Q. You say when they're not grazing, they're staying where?
A. They're loafing. They're either on their way to the loafing area or they're in the loafing area or they're getting water.
Q. What is a loafing area?
A. That's a place where they spend their time lounging. Actually, the nature of a cow is that they have to spend time after grazing for what's called rumination. And that means that that which they had consumed, they actually regurgitate and chew again to add saliva to it and pulverize it so that the fermentation process can begin.
Q. That's chewing your cud?
A. That's chewing the cud.
Q. What exactly is a loafing area? I know it makes sense to you, but a loafing area I think of in terms of a smoking area; someone designates where cows go to loaf. I have a sense that's not true.
A. Well, the cows designate it. The owner doesn't necessarily designate it, although they could influence it, but the cows decide where the loafing area is. The loafing area tends to be, as I said,

close to where water is. Now, unless it's wintertime when the predominant food source for the animals is hay or provided feed; then they'll hang around that area an awful lot.

Q. How much does the average beef cattle defecate?

A. About 12 times a day and upwards of five pounds per defecation.

Q. Can you draw any conclusions for the court about generally where a cow defecates or where cattle defecate?

A. Where they spend their time. An exception is that usually they defecate when they consume water and they usually urinate when they consume water.

Q. About how many hours a day would cattle spend in loafing areas?

A. Well, the remainder of 8 to 12, so up to 16 potentially.

Q. You say that they tend to deposit where they are?

A. Yes.

Q. Would it be correct to assume that the majority of defecation takes place in the loafing areas?

A. That's correct.

Q. If cattle are loafing in riparian areas, are there any concerns in addition to potential

close to where water is. Now, unless it's wintertime when the predominant food source for the animals is hay or provided feed; then they'll hang around that area an awful lot.

Q. How much does the average beef cattle defecate?

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Q. You say that they tend to deposit where they are?

A. Yes.

Q. Would it be correct to assume that the majority of defecation takes place in the loafing areas?

A. That's correct.

Q. If cattle are loafing in riparian areas, are there any concerns in addition to potential

accumulations of manure?
A. Certainly it -- the presence can create erosion and/or compaction.
Q. Is it any different for dairy cattle?
A. The only difference is about a third of the time, dairy cattle are either waiting in line to be milked, being milked, or are just finished being milked and usually are eating some in an area near the barn.
Q. They would spend less time in so-called loafing areas?
A. Correct.
Q. Does the kind of pasture on which a cow grazes affect its water-seeking behaviors?
A. Yes, it does.
Q. Could you explain that to us, please.
A. Well, the -- one of the very important permanent pastures in the Illinois River Watershed is Fescue, and Fescue has long been known to harbor a fungus called an endophyte. The endophyte ingested by cattle causes the body temperature to elevate one to two degrees and, therefore, they tend to seek shade more readily as well as seek water more readily, and even more than that, they like to submerse their bodies, or at least as much of their

permanent pastures.
Q. Would you look at Defendants' Joint Exhibit 631, please, 0013.
A. Yes.
Q. Do you have some photographs that demonstrate cattle behavior?
A. Yes, I do.
Q. Were you present when these photographs were taken?
A. Yes, or I took them.
Q. The photographs that we have in your notebook, are you familiar with what those photographs are? We're going to go through them one at a time, but are you familiar with them in advance?
A. Yes.
Q. Are those photographs an accurate depiction of what was photographed?
A. Yes.
Q. Looking at Defendants' Joint Exhibit 631A, DJX0631-0013, that's all the numbers on the bottom of the page --
A. Yes.
Q. -- so I don't get numbers left out. Can you just tell us generally what that is?
A. This is a wintertime view of a pasture, and

it's overgrazed. It's a mixture of --
Q. Is it located in the Illinois River basin?
A. Yes. In fact, the trees in the background --
Q. Just answer my question.
A. Yes.
Q. And does this accurately depict what that scene was when you were there?
A. Yes.
MR. TUCKER: Move the admission of this exhibit, Your Honor.
THE COURT: Any objection?
MR. GARREN: Is it a one-page or two-page exhibit?
MR. TUCKER: I was going to do one page at a time.
MR. GARREN: I'm just asking. No objection to 13.
THE COURT: All right. DJX631-0013 is admitted.
Q. (By Mr. Tucker) Could you explain what we see in that picture.
A. Well, this is wintertime, and the predominant available food for the cattle in this case is a feeding station. And, in fact, it's just to the right not in the photograph, as a matter of fact,

where hay, round bales are kept in the feeding station, so the cattle consume there, and they spend a lot of their time right in that area. And this happened to be a rainy day, and so water is moving across the pasture.

Q. Where is it moving toward?

A. It's moving toward the stream, which is the Illinois River.

Q. The Illinois River is located where in that photograph?

A. The trees in the background represents -- represent the riparian area of the river itself, and this is along Highway 16 between Fayetteville and Lake Weddington.

Q. I know it's self-evident for all of us looking at the photograph, but just for the written part of the record, what are the black items that are shown there in the water and in the grass next to the water?

A. Well, it's the places where the cattle have defecated.

Q. Please look in your notebook, Dr. Clay, at DJX0631-0014.

A. Yes, I see that.

Q. Can you tell us what that is?

A. This is in the same general area. This is a feeding station, again, for growing cattle.

MR. TUCKER: Move the admission of 0014, DJX631-0014.

MR. GARREN: No objection.

THE COURT: The exhibit is admitted.

Q. (By Mr. Tucker) What does that photograph show us?

A. It shows growing cattle being fed. They're lined up with their heads in the trough. And, of course, it's the same rainy condition that exists there.

Q. Is there a water feature nearby?

A. Well, yes, the river is also further into the trees that you see there.

Q. Is it the second line of trees or the first line of trees?

A. Second line of trees.

Q. Would this be considered typical winter behavior for cattle in the watershed?

A. Yes.

Q. Please turn in your book to Exhibit -- Defendants' Joint Exhibit 632-0047.

A. Yes, I have it.

Q. Would you tell me what that is.

A. This is a photograph taken along the Muddy Fork of the Illinois River just north of Lincoln, Arkansas, and --
Q. What is the time of year?
A. Fall.
Q. And what does this -- does this accurately reflect what was shown at that time?
A. Yes, this is a near midday photograph --
MR. TUCKER: Move the admission of Defendants' Joint Exhibit 632-0047.
THE COURT: Any objection?
MR. GARREN: He didn't establish that he took the picture, I don't believe, Your Honor.
Q. (By Mr. Tucker) Were you present when that picture was taken?
A. I took this picture.
MR. GARREN: No objection.
THE COURT: The exhibit is admitted.
Q. (By Mr. Tucker) 0047. Tell us now so we can all see it, what do we see in that picture?
A. We see the treeline and the pasture in front of the treeline with cattle, many of them lounging under the trees on the bank of the creek.
Q. That is not an overgrazed pasture, it doesn't appear to be from here; is that correct?

A. I'm sorry?
Q. Is that an overgrazed pasture as well?
A. This one is moderately grazed.
Q. Where is the creek in this photograph?
A. Where the treeline is.
Q. I see a front treeline and a back treeline.
A. The creek meanders. You're seeing a part of it right in front of you, then it meanders to the back.
Q. Got it. Please turn to Defendants' Joint Exhibit 632-0055.
A. Yes.
Q. And were you present when that photograph was taken?
A. I took this photograph.
Q. Could you tell me just generally what the photograph is?
A. This is a photograph of Ballard Creek on Highway 59 on the Arkansas side.
MR. TUCKER: Move to admit 0055.
MR. GARREN: No objection.
THE COURT: The exhibit is admitted.
Q. (By Mr. Tucker) Tell us what that photograph shows that's important, please.
A. Well, it shows that the cattle have direct access to the stream. They use the stream as the

water source and they spend time in and around there. This photograph was taken, my recollection is, more in the morning, like midmorning or late morning. And the cattle -- in fact, the cow to the left had just defecated. I missed that on the shot. There's one in the background urinating.

Q. How can you tell that?

A. Her legs are spread, and her tail is raised.

Q. I notice the fence in this photograph. Are those cattle being fenced out of the stream?

A. No, they're being fenced out of the highway.

Q. We couldn't get to the stream from the highway, but the cows could get to the stream?

A. Well, that was their abode. That's where they live.

Q. Is that typical of cattle behavior in the basin?

A. Yes.

Q. If you would turn to Defendants' Exhibit 633A, Defendants' Joint Exhibit 00633-0045.

A. Yes.

Q. Were you present when that photo was taken?

A. Yes.

Q. Tell us very generally about that photograph, please.

A. This is a photograph taken of the Illinois River bank just south of Eagle Bluff. And it's showing where cattle have moved up and down --
Q. You've told us where it was. Hold on just one second, if you would.
MR. TUCKER: I would move to admit 0045, Your Honor.
THE COURT: Any objection?
MR. GARREN: No objection.
THE COURT: The exhibit is admitted.
Q. (By Mr. Tucker) Now that the picture is up, can you tell us what it shows, Dr. Clay.
A. It shows the bank of the river with a path whereby the cattle have moved up and down in that path, and a Mullen plant is right to the left.
Q. What is a Mullen plant?
A. It's an imported plant from Europe that was brought here for medicinal purposes. It escaped. It's called Verbascum.
Q. Turn to Defendants' Joint Exhibit 0633-0051. And were you present when that photo was taken?
A. Yes.
Q. Would you tell us very generally about that photo.
A. It is the -- yes. This is in the same general

area as the preceding photograph.

MR. TUCKER: So we move admission of 0051.

MR. GARREN: No objection.

THE COURT: The exhibit is admitted.

Q. (By Mr. Tucker) Tell me what that shows, if you would, please.

A. This shows cattle lounging along the bank of the stream in the shade, and this is the cattle that would have been moving back and forth on the trail we did show you in the photograph before.

Q. Are all these photographs representative of what you're testifying is typical cattle behavior in the Illinois River basin?

A. Yes, sir.

Q. You've testified for quite a while here today, Dr. Clay. Are there particular take-away points you would like the court to consider from your testimony?

A. Yes.

Q. What are those, please?

A. Well, there are many properties -- property owners in the Illinois River Watershed of five acres and greater, but only about 40 percent of those report to the census so that we know exactly or have an estimate of the livestock that exists there.

where? Is that cakeout just put into a storage shed?
A. No. It means that they don't remove the litter every year at the end of 12 months, for example.
Q. But it is ultimately removed and land applied commonly, correct?
A. Yes.
Q. So at some point, it gets to the ground as a fertilizer, correct?
A. But it won't be the same amount of litter on a relative basis, because it will have more manure in it.
Q. Well, every year, isn't it a fact that -- well, do you know how many times or how often they are cleaning out the barns, poultry barns?
A. Well, many of them clean out at the end of about 12 months. Some will not clean out for upwards of 16 to 18 months. And there are others that go even longer.
Q. Did you survey, scientifically count, those who do not clean out on an annual basis?
A. No.
Q. So this is a speculated estimate on your part, correct?
A. Not entirely. That comes from information

from -- the gentleman's name is Patrick Fisk with the Arkansas Department of Natural Resources, and he gave me a percentage number of which I applied to the watershed.

Q. Okay. You did nothing to scientifically validate the number that you say he gave you, did you?

A. No.

Q. Now let's talk about what these cattle do when they eat the grass. You agree, I believe, and I think you previously testified that you agree with what has been referred to as recycling; that the cattle, they eat the grass that's been fertilized with poultry waste, they then recycle that phosphorus back to the ground, correct?

A. Yes. Cattle do graze the grass that's available to them, and they defecate on the ground. So you could look at it from the point of view of recycling.

Q. In fact, the -- what the cattle can do is simply move it around a field, correct?

A. They can move it around the field, yes.

Q. Now, are you familiar with the Comprehensive Management For Nonpoint Source Pollution report on the Illinois River by the Arkansas Soil and Water

On Flint Creek, the lowest downstream site is RS-421, and the score was 37. And at RS-902, the score was 39.

Q. And so in terms of the categorical rankings relative to the beneficial use of fish and wildlife propagation, what do the IBI scores at these five sites tell you?

A. They tell me, according to that regulation, that the beneficial use of fish and wildlife propagation is supported at these five sites.

Q. Independent of any beneficial use analysis, do these IBI scores tell you anything, Mr. Chadwick?

A. Yes. As I just mentioned, I think they are very robust indices of fish community health. If you look at the individual parameters, they're all measures of community health essentially. So I think that you can look at that score and evaluate the fish communities as well.

THE COURT: How high do the possible scores on the index go? To 50?

THE WITNESS: No, 45.

THE COURT: Go ahead.

Q. (By Mr. Chadick) And this may be clear, but in terms of at these five sites, the categorical ranking, are these the highest categorical rankings,

not numerical rankings but the highest categorical rankings?
A. Yes. They have three categories, and all five of these sites ranked in the highest category.
Q. And in particular, again, independent of the beneficial use analysis, do you -- can you look at these scores, and does it tell you anything about the diversity or the health of the communities at these five sites?
A. Well, you can get that by all three of these parameters. You have the number of species, we have very robust populations there. You have a number of sensitive species. You can see over half the community is comprised of individuals that are sensitive to water quality changes. Then with the IBI, which is an index that measures community health, if you will, by looking at those, you can -- yes, I think you can form conclusions as to the health of the fish communities at these locations.
Q. What are your conclusions?
A. My conclusion is that these communities are good.
Q. Assuming Professor Stevenson's data regarding the TP levels in the IRW is correct, what, if anything, do these TP geometric means that are

by Dr. Stevenson.

MR. CHADICK: Next, please, pull up Demonstrative 307.

Q. (By Mr. Chadick) This is, Mr. Chadwick, slide 136 as used by the State in midtrial motions. As characterized here, what did Professor Stevenson comment on regarding fish biodiversity?

A. Dr. Stevenson stated that, "Then we could observe an effect on fish biodiversity that was related to indications of nutrient availability and of poultry house density."

Q. What is your opinion of fish biodiversity in IRW streams?

A. I feel the biodiversity as a whole in the fish communities in the 37 sites that I had data from Dr. Stevenson at are fairly good.

Q. Are they healthy?

A. The communities by and large, as a whole, yes, they are fairly healthy. The IBI scores are consistently above 37, 37 or above in most of the sites. The proportion of sensitive species to total species is very good in the IRW. So we have a lot of sensitive species around.

Q. Do you have an opinion of whether fish diversity in IRW streams appears to be impacted by

1 IN THE UNITED STATES DISTRICT COURT

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 JANUARY 6, 2010
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 86, A.M. SESSION

16

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average floodplain elevation, you get the cut thickness for that particular transect. And I indicate how the channel cuts varied, and I said -- don't know if I've said it yet, but the Echota Bend area, because a lot of that meander that was cutting into sediments, it was actually cutting into what we call a stream terrace deposit. It's quite a flat area. It's older sediments deposited there long ago. And the thickness of the cut there was 18 feet. The banks were quite a bit higher. So more sediment per linear surface area would have been removed for every foot the stream moved.

Q. We reach the average cut thickness, which is what?

A. 10.8 feet.

Q. Now that you have that, are you able to make a determination about the volume of sediment that's been moved from the bank of the river into the river?

A. Yes. One, two, three shows that. It shows the cut volume, sediment moved equals the average cut thickness times surface area, which is 10.8 feet, times 886 acres. A new term maybe for some of you: That's 9,568.8 acre feet. An acre foot or acre feet is one acre of surface area one foot thick. So --

Q. Once you have that number, what are you able to do?
A. Then I'll convert it to more common terms. I'll convert it to cubic yards. So that amount of acre feet, 9,568.8 -- I can't measure things as accurate as eight-tenths of a foot. I'm just not running this off because that's the exact number the computer gives me. We're not that accurate. That amounts to 15.5 million cubic yards of sediment moved from the banks of the main channel.
Q. Can you give us an example that we might understand of how much volume this is?
A. If you had 18 cubic yard dump trucks -- and those are pretty good-size trucks that can still go on the road. They're not mining trucks, they're regular dump trucks -- it would take 861,000 loads, full loads of those trucks to move that much sediment.
Q. Did you consider this a significant amount of sediment?
A. That's a significant amount to me.
Q. I think we're coming to the portion that everybody has been waiting for. That is the 3D portion. But before we get there, let's -- what is the purpose of using 3D technology to take your

THE COURT: Mr. Volpe.

MR. VOLPE: I've been told the 3D effect on the paper images can be better than the one on the screen, given the sharpness of the screen. You have a copy there in front of you, if you want to peruse it later.

THE COURT: With the 3D glasses, huh?

Oh, I see. Very good.

Q. (By Mr. Volpe) I was asking you, based on your study of -- the meander study and your study of the amount of sediments that were moved by the meander, whether you reached any conclusions regarding the Illinois River.

A. Yes. I found that the Illinois River was an active meandering body. It was doing significant amounts of movement. It was cutting and depositing sediments in the stream channel.

Q. Just to conclude this. Again, what was the amount of sediment that you found was moved by the river?

A. 15.5 million cubic yards.

Q. You were asked to do one more thing for us in this case, and that had to do with land development, correct?

A. That's right.

A. Yes. I found an area that was developed, and I described the limits of that area by digitizing using a polygon, a many-sided feature, to describe it. Some little farm homesteads might just be a square or rectangle, and big real estate developments with many roads and buildings would be a much more complicated larger polygon.

Q. Sir, let's look at Defendants' Joint Exhibit 3494.

A. 3494 is also an exhibit in my expert report.

Q. It was Figure 47 in your report?

A. It was.

Q. What was the title of this exhibit?

A. It's entitled "Land development study on the east side of the Illinois River basin."

MR. VOLPE: At this time, I move for admission of Defendants' Joint Exhibit 3494.

MR. BAKER: No objection.

THE COURT: 3494 is admitted.

Q. (By Mr. Volpe) Can you display it for us.

A. All right. This is Exhibit 3494.

Q. Walk us through what's going on here in this exhibit, starting with the existing development as of 1982, which is the leftmost image.

A. Okay. That image, you can see there's a lot of

gray tones in it. And what I did is, I took all of the developed areas that I could detect as of 1982 and I digitalized them and then color coded them in this gray color. So there are hundreds, if not thousands, of polygons in here coded gray, representing areas in which the land had been developed, home sites or commercial development, things of that nature, but not agriculture and so on existed in that area.

And I found, using my GIS, after I had mapped everything, that there were a total of 12,309 acres that fell within the developed category as of 1982.

Q. What percentage of the study area did that represent?

A. That represents 12.6 percent of my study area.

Q. Let's go to the next image, which is entitled "Development observed between 1982 through 1994."

A. This shows the same study area, but now I show in red the polygons indicating newly developed areas that had been developed between the period of time between 1982 and 1994. So this is strictly newly developed areas. It does not include any of the areas that were mapped from the 1982 period.

Q. How many acres have been developed during this

time period?
A. During this time period, there were a total of 9,491 newly developed areas, amounting to 9.8 percent of the full study area.
Q. And the middle image, "Development observed between 1994 through 2001"?
A. That image, the polygons are colored in blue, and they represent the new development since 1994 and up to 2001. And that totals 618 -- 6,818 acres, or 7 percent of the study area.
Q. That's new development?
A. New development only.
Q. All right, sir. Let's look at the fourth image which is entitled "Development observed between 2001 and 2006."
A. Okay. The polygons in that area are coded in green. And once again, they represent new development occurring since 2001 and as of the 2006 date of photography. And that shows that there were 9,594 acres of newly developed land, amounting to 9.9 percent of the study area.
Q. What does the last image in Joint Exhibit 3494 represent?
A. The last portion or rectangular feature on the far right, which is multicolored, I have turned on

all of the polygons for all of the dates. So I'm showing all of the areas that were developed in the period of time in which they were developed.

Q. What were the results of when you turned on the cumulative development?

A. The cumulative development amounted to 38,212 acres, or 39.3 percent of the study area that had been developed as of 2006.

Q. Let's get a closer look at that last image. Turn to Figure 49, would you.

A. All right. Figure 49 on the left shows the basin in the study area in brown. And then on the right, same thing is shown, but I've also added the developed polygons.

Q. Is this part of your expert report?

A. Yes, it is.

Q. This was based on data you compiled?

A. Yes.

MR. VOLPE: Your Honor, at this point, I'd move Defendants' Joint Exhibit 3676 into evidence.

MR. BAKER: No objection.

THE COURT: 3676 is admitted.

Q. (By Mr. Volpe) Now can you describe what's going on here in this image.

A. On the left, we see the basin with the stream

channels and the limits of the basin and the limits of the study area, and the Illinois River as well in blue.

On the right, I'm showing the same things, except that I've added in the polygons, indicating by color the period of time in which they were developed.

Q. All right, sir. Can we take a closer look at one of the areas of this image?

A. Yes. What we'll do is we'll start to zoom in on this northern portion of the area here, the area near Rogers, Arkansas. And so I'm showing a yellow zoom box. I'm eventually going to zoom in all the way so we'll just be looking at the area inside that yellow box.

Q. Still looking at an image from Exhibit 3676; is that right?

A. We are. I've not changed any of the polygons. I'm just magnifying them more so we can see them better.

Q. Can you pull this apart so we can see the image as it develops?

A. Yes. I'll zoom in, and I'll show on this example here my Figure 49. This shows the development that's taken place as of 1982, and it's

in gray, just like it was in gray in the other versions when I was showing a larger, more zoomed-out area.

Q. Let's layer on another year.

A. Okay. The next year that we're going to add to it in red will be 1994. So these are the additional areas that were developed between 1982 and by the date of photography in 1994.

Q. Is what we're seeing here the polygons that you're describing?

A. Yes.

Q. These are areas of development?

A. Yes.

Q. Let's look at the year 2001.

A. All right. I've turned the polygons on for 2001, and they're in blue. So now we have gray, red, and blue, blue representing the areas developed after 1994 and as of the date of photography in 2001.

Q. Okay. I think we have one more image.

A. Yes, we do. This is 2006, which I have mapped and color coded in green. Now we see four different periods of time with the most recent 2006.

Q. Okay, sir. Now let's look back at Exhibit 3494, which is the last image.

A. All right, here we are.
Q. All right, sir. Based on your land development study, what conclusions did you reach about the development on the Arkansas side of the Illinois River basin?
A. I found that there was fairly significant rapid development during the period of my study. And a lot of the land was converted from farmland to either residential or commercial with additional pavement and other features, building structures and so on.
MR. VOLPE: Your Honor, I have no further questions.
THE COURT: Mr. Sanders.
(Off-the-record discussion was had.)
MR. VOLPE: Let me just do a couple cleanup things here.
Q. (By Mr. Volpe) I wanted to ask you about the 1.5 million cubic yards that you described as the amount of sediment that was moved. Can we just pull that image up?
A. I think I said 15.5.
Q. 15.5 million cubic yards. That is sediment that's been moved since 1972; is that right?
A. That's right.

A. All right, here we are.
Q. All right, sir. Based on your land development study, what conclusions did you reach about the development on the Arkansas side of the Illinois River basin?
A. I found that there was fairly significant rapid development during the period of my study. And a lot of the land was converted from farmland to either residential or commercial with additional pavement and other features, building structures and so on.
MR. VOLPE: Your Honor, I have no further questions.
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(Off-the-record discussion was had.)
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A. I think I said 15.5.
Q. 15.5 million cubic yards. That is sediment that's been moved since 1972; is that right?
A. That's right.

Q. So it's 15.5 million cubic yards of sediment moved since 1972?
A. Correct, based on the mapping from essentially four dates of photography. And if I had -- if I could have mapped on every date, the number would have gone up because I didn't --
MR. BAKER: Objection, Your Honor. That's not contained within his expert report.
THE COURT: Sustained.
Q. (By Mr. Volpe) On the data that you had, what was the amount of sediment moved since 1972?
A. I believe it was, yeah, 15,000 -- 15.5 million cubic yards.
MR. VOLPE: Your Honor, just one second.
THE COURT: Yes. While he's doing that, the periods here on Joint Exhibit 3494 that you studied in terms of development in this seven-and-a-half-mile swath of land, the first period was about a 12-year period, '82 through '94; the second, a five-year period -- I'm sorry, six-year period; then the third a five-year period.
It would appear that if these figures are accurate, the land development in that area is increasing in shorter and shorter periods of time.
THE WITNESS: It certainly was until the

economy tanked. I don't know if it's still doing that.

THE COURT: Right. But you have the largest percentage of land development in the shortest period of time between 2001 and 2006 here.

THE WITNESS: Exactly.

THE COURT: Mr. Volpe.

MR. VOLPE: I may have neglected to move into evidence Defendants' Joint Exhibit 3656, and I just want to do so at this time.

THE COURT: Any objection? Where is that, Mr. Volpe?

MR. VOLPE: I'm pulling it, sir. It was Figure 26 from Mr. Grip's report. It is the --

THE WITNESS: I've got it here. This one.

THE COURT: Is that a multipage or single page?

MR. VOLPE: It's one page, but we used it multiple times.

THE COURT: That's simply a repetition of something that's been --

MR. VOLPE: It's the fifth slide, Your Honor, in the presentation.

THE COURT: It was admitted earlier, correct?

MR. HOPSON: I guess I should have asked those questions up front.
Q. (By Mr. Hopson) Have you looked at Dr. Taylor's report?
A. I have.
Q. Have you looked at Dr. Taylor's deposition?
A. Yes, I have.
Q. Have you looked at Dr. Taylor's testimony in this case?
A. Yes, indeed.
Q. Have you looked at other testimony in this case, including the testimony of company representatives and the growers who have testified?
A. I have.
Q. Okay. Based on what you've seen and the materials you reviewed, have you seen anything in this case in the IRW that suggests to you that the integrators are exploiting or exercising market power over the growers because of this vertically integrated structure?
A. I have not seen one shred of empirical evidence that supports that assertion or that hypothetical.
Q. Let me ask you this question. Does the fact that the industry is vertically integrated or vertically coordinated, standing alone, prove that

the integrators have market power over the growers?
A. No, it does not.
Q. If, in fact, the integrators had market power over the growers, would you have expected or not expected to see the trends that you demonstrated in Exhibit 3121?
A. On the contrary. If the integrators, as Dr. Taylor has asserted, are exercising oligopsonistic power -- first of all, he talks about monopsonistic power. That's impossible here, because you have a number of integrators. In a monopsonistic world, you can only have one buyer or one integrator.
But if you look at the actual exercise of such power, that would result in less supply to the marketplace. You can't --
Q. Let me stop you there. Why would the exercise of oligopsonistic power result in less supply?
A. Because when you exercise that power, you can only achieve that outcome by restricting the amount of pullets or broilers that are being processed under the following condition: If supply is perfectly inelastic, then you can do it, but there's no evidence, and no experts have shown, that supply at the grower level is perfectly inelastic.

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IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 87 - PM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

JANUARY 6, 2010

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

as a whole in the United States there is -- much of the income that's generated by the household is sourced with off-farm activities in contrast to actual farm activities.

Q. Let me ask you -- and I don't have a demonstrative -- but did you also in your report do an analysis of the percentage of off-farm income for poultry-growers as opposed to other farmers or persons engaged in agriculture?

A. Yes, I did.

Q. And what did that show?

A. What that shows is that if you look at poultry producers themselves, they're generating relatively more income on-farm than off-farm relative to all of agriculture.

Q. Let's go back and explore the issue of switching a little bit.

I want to ask you if the available evidence that you've had a chance to review and analyze indicates whether there is switching of growers between integrators going on in the Illinois River Watershed?

A. Yes. And here, a lot of it's anecdotal evidence. But also to the extent that the growers who have testified in this court, you'll see that each of

Q. And why is that, Doctor?

A. In large part, because of nutrient plan requirements that have come through regulations over the course of the last decade, those kinds of samples are required for those nutrient plans.

Q. Okay. So the people who are taking those samples are people who apply litter?

A. Generally speaking, yes.

Q. You mentioned a moment ago the size of the field. Why would the size of the field on which samples are taken be relevant to a statistical analysis of average STP levels?

A. Because if I'm taking a sample on a 300-acre farm, that sample is -- the attempt is to use that sample as being representative for 300 acres. Suppose I take another sample and it's only two acres. The weighting of those two particular samples should be dramatically different.

In this particular case, Dr. Johnson didn't have the data with regard to the size of the field so he couldn't make any adjustments associated with size. However, if you're going to serve the purpose for which he was doing his analysis and you want representativeness, you should know the size of the field from which the samples were drawn.

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

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1 IN THE UNITED STATES DISTRICT COURT

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16

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explanation provide you any -- cause you any concern?

MR. PAGE: Same objection, Your Honor.

THE COURT: Overruled.

Q. (By Mr. George) Please answer.

A. Well, it caused concern because basically Dr. Engel's model gave the same answers for the entire Illinois River Watershed as it gave when half the watershed was left out. I mean, common sense told me that this is a red flag. There's a serious flaw somewhere in that model.

Q. Now, Doctor, we've talked about the first errata. Was that the final answer, if you will, of Dr. Engel with respect to his modeling work?

A. No. No, there was another errata or -- this was in October. We were again provided with different numbers and new model files.

Q. Doctor, did you run a series of simulations using Dr. Engel's routing model?

A. Yes, I did.

Q. What was the purpose of those simulations?

A. The routing model relates the nonpoint source phosphorus loads computed by Dr. Engel's GLEAMS model plus wastewater treatment plant loads to his observed total phosphorus loads at the three outlet

stations at the bottom of the watershed.

And the purpose for me conducting -- I wanted to check the routing model. I wanted to confirm or determine whether or not it could actually pin down the loadings from the watershed and relate them to the loadings at the outlet stations.

Q. What approach did you use to confirm or test the routing model?

A. Well, I did some sensitivity analyses with the model, and that involved putting in different input loadings to determine how the model would respond.

Q. And without going into a lot of detail, because we'll come back to these in a moment, can you list for the court the specific tests or sensitivity analysis that you performed on the routing model?

A. Yes. I did four tests. The first test consisted of not changing the magnitudes of the input loads that Dr. Engel put into the routing model, but just reversing the time order. This model was applied to the period from 1998 through 2006, so I just took -- I took the load on the last day, made it first, and reversed everything and ran the time series backwards.

The second thing I did was I then modified

the changed -- I changed the loadings from the loadings that Dr. Engel put into the model, and I put my own loadings into the model. I increased the wastewater treatment plant loads by a very substantial amount. I then increased the nonpoint source loading component. And then finally, I decided to just use made-up numbers, put them in and see what would happen, and that was -- the numbers I chose to use were the S&P 500 Stock Index values for the period 1998 through 2006.

Q. Let's talk about each of these in order. Let's start with where you ran the model load -- with the loads backwards. What was the purpose of that analysis?

A. Dr. Engel explained that the one thing the routing model does is it redistributes -- it distributes loads and time to make sure that the -- not only that the right -- that the loads are the right magnitude make it to the bottom of the watershed, but they there at the right time.

So I thought this would be a test of the timing of the model. Basically it was a test to see whether the model could tell the difference between days on which it's not raining, on days which it is raining, because on days on which it's raining, you

can get nonpoint source runoff.
Q. Doctor, did you have an expectation as to whether the results would change, having reversed the loads?
A. Well, certainly, yes, I expected the results would change.
Q. Doctor, did you prepare for your report a chart showing the results of this first test or analysis?
A. Yes, I did.
Q. Do you have a binder with the exhibits?
MR. GEORGE: David, you have the exhibits, don't you?
MR. PAGE: Yes.
MR. GEORGE: Your Honor, you have a binder as well?
THE COURT: Yes.
Q. (By Mr. George) Could you turn to tab 2 in the binder and find Defendants' Joint Exhibit 2414.
A. Yes, I'm there.
Q. Can you identify for the record Defendants' Joint Exhibit 2414.
A. Yes. This is Figure 19 from my expert report.
Q. And did you prepare this exhibit?
A. Yes, I did.
Q. And can you identify the source of the

information of data that's shown on this exhibit.
A. Yes. Again, some more foundation. Dr. Engel applied his linked GLEAMS routing model system separately to each of three subwatersheds in the Illinois River Watershed. He -- these three panels here show results for each of these three subwatersheds. The top panel represents the results for the Illinois River subshed, the middle is Barren Fork, the bottom was Caney Creek.

In each of these plots, the X axis, the horizontal axis here, represents Dr. Engel's observed phosphorus loads at the bottom of the watershed at the USGS station at the bottoms of each of these three respective watersheds.

The vertical axis represents the predicted loads from the routing model.

MR. GEORGE: Your Honor, at this time, I move for the introduction of Defendants' Joint Exhibit 2414.

THE COURT: Any objection?

MR. PAGE: No objection, Your Honor.

THE COURT: 2414 is admitted.

Q. (By Mr. George) Doctor, with reference to this exhibit, could you please explain what that figure shows about the results of the first test.

A. Yes. The test I conducted was, one, I changed the order of the loads; and then, two, I attempted to calibrate -- recalibrate the model exactly the way Dr. Engel claims to have calibrated it and validated it in his expert report. And basically I did a regression analysis of predicted versus observed phosphorus loads, exactly as Dr. Engel had done it. And these plots here depict the results.

The lines in each plot represent the fitted regression line. The metric that I used to determine how -- the goodness of fit is the so-called R^2 -- it's the same the metric Dr. Engel used for his calibration validation. And the type is a bit small, but the R^2 is reported for each of fits for each of these three subwatersheds.

Q. How does your R^2 compare to the R^2 reported by Dr. Engel?

A. As good or better.

Q. What conclusion, if any, do you draw from this analysis, Doctor.

A. Simply put, Dr. Engel's routing model can't tell the difference between dry days and rainy days in the Illinois River Watershed.

Q. Let's talk about the test that you ran where you -- I think you said you increased the wastewater

treatment plant loads and the nonpoint source inputs, right?
A. Yes, I did.
Q. What was the purpose of that analysis?
A. Well, the purpose was to check the model to determine -- the question I was asked is this: Can that routing model -- can it actually pin down the loadings from the watershed and relate -- and make them fit, tightly constrain them to the observed loads at the bottom of the watershed.
And to test whether -- to test how tight the connection is between the loads Dr. Engel put in and his observed loads at the bottom of the watershed, I changed the loads that he put in and determined whether or not the model could still fit the loads at the bottom of the watershed.
Q. For your expert report, Doctor, did you prepare a chart illustrating the magnitude of the increases that you applied to these input values?
A. Yes, I did.
Q. Could you turn to tab 3 in your binder and find Defendants' Joint Exhibit 2415.
A. Yes, I'm there.
Q. And for the record, could you identify Defendants' Joint Exhibit 2415.

A. Yes. That's Figure 20 from my expert report.
Q. And what's the source of the information or data shown on Defendants' Joint Exhibit 2415?
A. The top panel contains the inputs that I used for wastewater treatment plants for the second of my four tests. The bottom panel contains the nonpoint source phosphorus loadings I used for the third of my four tests.
Q. Doctor, did you prepare Defendants' Joint Exhibit 2415?
A. Yes, I did.
MR. GEORGE: Your Honor, at this time, we'd offer into evidence Defendants' Exhibit 2415.
MR. PAGE: No objection.
THE COURT: 2415 is admitted.
Q. (By Mr. George) Doctor, what does this figure show about the magnitude of the increases in this particular test that you applied to the wastewater treatment plant loads and the nonpoint source loads?
A. Again, I'll note again that the model was run for 19- -- for each year from 1998 to 2006. So we see bars for each year. Let's look at the green bars. The green bars are there just for reference. They represent Dr. Engel's observed phosphorus loads

to Lake Tenkiller.

The red bar -- let's go to the top panel. For the top panel, the red bar represents the magnitudes of the wastewater treatment plant loads that Dr. Engel put into his routing model. And the blue bars represent the substantially increased wastewater treatment plant loads that I put into his model to conduct that test.

Q. Your Honor -- I'm sorry. Doctor, are these plots linear or log scale?

A. No, it should be noted that they're log scale. The loads that I put in are much, much larger than the loads Dr. Engel put in. That is apparent from looking at these plots.

Q. With respect to the bottom panel, can you describe the magnitude of the increases you applied to the nonpoint source loads in this test?

A. Yes. The convention is the same. The green, for reference, represents Dr. Engel's observed phosphorus loads at the bottom of the watershed. The red in this case on the bottom panel represents the nonpoint source loads from Dr. Engel's GLEAMS model, by the way, that he put into his routing model. And, again, the blue bars represent the nonpoint source loads that I put into his model.

Q. Doctor, after these loads were increased and the model was reran, did you compare the results to the results of Dr. Engel?
A. Yes. I did the same thing here. I -- with my loads, I attempted to recalibrate Dr. Engel's routing model.
Q. And how did those loads compare?
A. The -- the wastewater treatment plant load was -- the load that I put in was, I think, 345 times the load that Dr. Engel put into the model. The nonpoint source load was 15 times higher than his nonpoint source load.
Q. And how did the results of that test compare, observed versus predicted, with Dr. Engel's?
A. I was able to recalibrate Dr. Engel's routing model for both of these cases, and achieved R^2 values that were equal to or better than his.
Q. Doctor, what, if any, conclusions did you draw from this test?
A. Well, I guess, simply put, Dr. Engel's routing model can't tell the difference between the loads he put into the model and the wildly unrealistic loads that I put into the model.
Q. Let's talk about -- I think you referred to it as the S&P 500 test?

A. Yes.
Q. What was the purpose of that analysis?
A. Well, after seeing results from these first three tests, it became apparent to us that we could put in numbers over extremely wide ranges, and the model could still be calibrated to the observed data.

So I guess we decided to see how far we could push it, and we said -- I just -- I took made-up numbers that had nothing to do with phosphorus loads, we put them into the model, and that was the S&P 500 test.

Q. Doctor, when you did that, were you able to produce loads that matched the observed loads of the downstream?
A. Yes. Again, I was able to recalibrate that model and achieve calibrated -- results as good as Dr. Engel's original model.
Q. Doctor, did you provide in your expert report a chart setting out the results of this analysis?
A. Yes, I did.
Q. Could you turn in your binder to -- I believe it's tab 4, and find Defendants' Joint Exhibit 2416.
A. Yes.

Q. For the record, could you identify Defendants' Joint Exhibit 2416.
A. That's Figure 21 from my expert report.
Q. Doctor, did you prepare Defendants' Exhibit 2416?
A. Yes, I did.
Q. Can you identify the source of the information or data that is shown in this exhibit?
A. I ran this test only for the Illinois River subwatershed, which is the largest of the three. The top panel actually contains the same results. They contained Dr. Engel's results for his calibration and purported validation for his routing model. That's from his expert report. The bottom panel contains the results from the S&P test I conducted.
MR. GEORGE: Your Honor, at this time, we'd offer into evidence Defendants' Joint Exhibit 2416.
THE COURT: Any objection?
MR. PAGE: No objection.
THE COURT: Defendants' 2416 is admitted.
Q. (By Mr. George) Doctor, what conclusions, if any, did you draw from this analysis?
A. I guess the simplest way to state it is, Dr. Engel's routing model can't tell the difference

between phosphorus loads that are realistic and numbers that are completely made up.

Q. What is it, Doctor, about Dr. Engel's routing model that allows it to consistently produce similar results, despite changes in the inputs?

MR. PAGE: Objection, Your Honor. This witness said he recalibrated the model. It's not the same model. That question is misleading.

MR. GEORGE: Your Honor, I think that's material for cross-examination, if he wants to explore it.

THE COURT: Overruled.

Q. (By Mr. George) Can you answer the question, please?

A. Please repeat the question.

Q. Sure. What is it about Dr. Engel's routing model that allows it to consistently produce similar results, regardless of the changes in the inputs?

A. Well, there are two things. It's an empirical, statistical equation. It does not explicitly represent any of the physical, chemical and biological processes that actually influence the transport, fate, delivery, the journey, the pathway of phosphorus through the Illinois River stream and network. In a sense, it's a free-spinning wheel.

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Another reason is that in each case when Dr. Engel conducted his calibration and purported validation, he compared what he called his predicted loads to observed loads. I need to take a step back and set a foundation again.

The phrase "observed loads" is widely used, but it's -- strictly speaking, that's a misnomer. One doesn't observe loads. One observes flow, and one observes concentration. And when you multiply the two together, you get load.

So the X axis on all these plots we've looked at are Dr. Engel's observed loads at the outlet station at the bottom of the watershed, and they were computed by multiplying USGS flow times concentration.

What Dr. Engel did is his predicted loads on the vertical axis were not independently determined, because he also used the measured USGS flows at the bottom of the watershed to determine the predicted loads on the Y axis. So we have measured flow on the Y, measured flow on the X. And flow is a dominant influence on loads to Lake Tenkiller. So if you've got the same -- if you've got flow on the vertical and flow on the horizontal, then, in a sense, when you do these regressions,

you're almost regressing flow on itself, and you're almost guaranteed to get good results.

Q. Doctor, as a scientist with 36 years of experience with models, what do these tests that we've been discussing tell you about the integrity and reliability of Dr. Engel's models?

A. Well, in my opinion, the results from Dr. Engel's models are not scientifically defensible, they're not valid, and they're simply not reliable.

Q. Doctor, does that opinion you just expressed apply to both the GLEAMS application and the routing model?

A. Yes, it does, for reasons I set forth in my report.

Q. Did the corrections that Dr. Engel made to his work between his original report and his errata report confirm your opinion in any way?

A. Well, they actually did, because all the tests that we've been speaking about that I conducted were the basis for my own opinions, but Dr. Engel's errata represents the product of his own work. And he independently confirmed that his models give the same answer whether he includes the entire watershed or leaves half of it out. And that's completely

independent of anything I did.
Q. Dr. Engel testified on direct in this case that he omitted, I think, 23 hydrologic response units in the model runs to support his original report. You've reviewed that testimony, haven't you?
A. Yes, I did.
Q. As part of your work in this case, did you evaluate the size of each of Dr. Engel's HRUs?
A. Yes, I did.
Q. And what percentage of the total land area in the watershed did Dr. Engel omit from his original report?
A. Fifty-four percent.
Q. Now, Dr. Engel explained in his testimony from that stand how it was that his model could omit half the watershed and still generate the same answer. Have you reviewed that testimony?
A. Yes, I have.
Q. And I've reviewed it as well. Can you help us by explaining your understanding of what Dr. Engel is describing as the explanation for that.
A. Yes. The code was originally set up with a do loop index to go from one to nine to capture all the HRUs. It was set up first on Caney Creek. There are -- in Dr. Engel's GLEAMS model, there were 21

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A. Yes, I have.
Q. And I've reviewed it as well. Can you help us by explaining your understanding of what Dr. Engel is describing as the explanation for that.
A. Yes. The code was originally set up with a do loop index to go from one to nine to capture all the HRUs. It was set up first on Caney Creek. There are -- in Dr. Engel's GLEAMS model, there were 21

HRUs in the Illinois River subshed, 20 in Barren Fork, and 9 in Caney. Code was developed for Caney, copied over into the other folders. The do loop index wasn't changed. It remained at 9, so it captured all 9 in Caney, and only the first 9 of 20, 21 in Illinois, and the first 9 of 20 in Barren, so it left out 23.

So to answer your question, how could it give the same answer, well, the -- Dr. Engel had a calibration algorithm called the shuffled complex evolution algorithm. I'll call it SCE for short.

The SCE algorithm was given a model calibration target, and the model calibration target was where the loads -- Dr. Engel's observed loads to Lake Tenkiller at the bottom of the watershed.

And what the SEC algorithm did, it iterated through the GLEAMS model, it ran it over and over again, and it changed the values of seven model input parameters so as to ensure that the output of the GLEAMS model matched that target.

Q. Doctor, is that an appropriate adjustment, in your view?

A. Well, not -- well, not in this case, because what the parameter that that algorithm adjusted, the way it worked is that it adjusted primarily the rate

of application of animal waste phosphorus.

And basically what it did in this case, to give the same answer, is the algorithm added more load, it added all the load it needed to the parts of the watershed that Dr. Engel did include to compensate for the half that he left out. And that just simply is not scientifically defensible nor does it represent the reality of how animal waste is actually applied in the Illinois River Watershed.

Q. Doctor, you've mentioned a time or two calibration targets. What were the calibration targets for Dr. Engel's models?

A. The calibration targets were his observed phosphorus loads at the bottom of the watershed at the three outlet stations, and he used these targets for both his GLEAMS model and his routing model.

Q. Could you turn in your binder to tab 5 and find Tyson Demonstrative 248.

A. Yes, I'm there.

Q. Doctor, did you prepare this demonstrative exhibit?

A. Yes, I did.

Q. And can you describe generally what this exhibit is.

A. Yes. Let's work backwards from the locations

of application of animal waste phosphorus.

And basically what it did in this case, to give the same answer, is the algorithm added more load, it added all the load it needed to the parts of the watershed that Dr. Engel did include to compensate for the half that he left out. And that just simply is not scientifically defensible nor does it represent the reality of how animal waste is actually applied in the Illinois River Watershed.

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Q. Doctor, did you prepare this demonstrative exhibit?

A. Yes, I did.

Q. And can you describe generally what this exhibit is.

A. Yes. Let's work backwards from the locations

of the three USGS gauges at the bottom of the watershed. The watershed area above each -- there are three gauges, three subwatersheds, one above each of these gauges, and one is the Illinois, one is Barren Fork, and one is Caney Creek. What the graphic shows, it actually shows the stream and river networks within each of these subwatersheds.

Q. Doctor, using this demonstrative, can you explain the problems, in your view, with Dr. Engel's calibration approach?

A. Well, the calibration approach -- and I'm speaking specifically with GLEAMS here. The calibration targets that Dr. Engel used for his GLEAMS model simply do not correspond to what the GLEAMS model actually computed. That's the problem.

The GLEAMS model actually computes runoff of nonpoint source phosphorus to edges of fields. And those represent locations that are spatially distributed throughout the entire watershed. Some of them intersect these tributaries, some don't.

However, the calibration target that Dr. Engel used was the loadings to Lake Tenkiller. As I said, one, that's apples and oranges; that's not what GLEAMS is computing.

Number two, the locations at which GLEAMS is computing these loads to edges of field are spatially distributed throughout the watershed, and they are located in some cases up to a hundred miles away from the points in space where his calibration targets were computed. So that makes no sense.

Q. Is this calibration approach scientifically defensible, in your view?

A. Not in my opinion, no.

MR. GEORGE: Your Honor, this is sort of a transition point, if we'd like to take our midmorning break. It would be convenient for me, but I'd defer to you, obviously.

THE COURT: It would be convenient. And back here in the gallery, we have Mr. John Boozer, who's a student at the University of Oklahoma. Welcome. And, gentlemen, feel free to introduce yourselves to Mr. Boozer. If he has any questions, please make yourself available.

MR. GEORGE: Thank you, Your Honor.

THE COURT: We'll be in recess.

(Whereupon a recess was had.)

THE COURT: You may proceed.

MR. GEORGE: Thank you, Your Honor.

Q. (By Mr. George) Dr. Bierman, I want to go back

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MR. GEORGE: Thank you, Your Honor.

THE COURT: We'll be in recess.

(Whereupon a recess was had.)

THE COURT: You may proceed.

MR. GEORGE: Thank you, Your Honor.

Q. (By Mr. George) Dr. Bierman, I want to go back

for just a moment to Demonstrative 248, which is a map of the watershed. And I want to ask you, if you could, to get out of your chair and go to the screen. And I want to go back through and have you explain again because, frankly, I got a little lost, and maybe some others did, too, the issue with the spatial distribution of edge-of-field locations in reference to these algal stations. Okay? Could you do that, please.

A. So the context is the calibration of Dr. Engel's GLEAMS and routing models?

Q. Yes, sir.

A. Okay. First, what Dr. Engel's GLEAMS model actually computes are nonpoint source phosphorus loads to edges of fields. And those locations are distributed throughout the entire watershed. Some of them abut these tributaries, and some of them don't. But they're spatially distributed throughout the Illinois River, Barren Fork and Caney creek. So that's the first point.

The calibration targets -- this is an important point. The calibration targets that Dr. Engel used for both of his models are the same, the -- his observed phosphorus loads to Lake Tenkiller at the three outlet stations at the

bottoms of the watersheds.

So for the GLEAMS model, even though it computed runoff and nonpoint source phosphorus loads at the edges of fields that were spatially distributed throughout the entire watershed, he calibrated them by comparing them to loads at the very bottom. That's not what GLEAMS computed, number one. And number two, those locations are up to a hundred miles away from the locations where the GLEAMS model was actually computing its results.

So in my opinion, that's not a credible approach.

The -- should I proceed --

Q. One more question, Doctor. Did he have available data that is more close in proximity to some of these locations?

A. Well, yes. The plaintiffs collected almost 150 edge-of-field samples, and Dr. Engel did not use those samples to compare with the results of his GLEAMS model.

Q. Thank you. Could you retake the chair, please.

A. You asked me about the routing model?

Q. I'm sorry. Doctor, please explain the issue with respect to the routing model.

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So for the GLEAMS model, even though it computed runoff and nonpoint source phosphorus loads at the edges of fields that were spatially distributed throughout the entire watershed, he calibrated them by comparing them to loads at the very bottom. That's not what GLEAMS computed, number one. And number two, those locations are up to a hundred miles away from the locations where the GLEAMS model was actually computing its results.

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A. Well, yes. The plaintiffs collected almost 150 edge-of-field samples, and Dr. Engel did not use those samples to compare with the results of his GLEAMS model.

Q. Thank you. Could you retake the chair, please.

A. You asked me about the routing model?

Q. I'm sorry. Doctor, please explain the issue with respect to the routing model.

A. The routing model -- the inputs to the routing model are the nonpoint source phosphorus loadings from Dr. Engel's GLEAMS model plus wastewater treatment plant loadings that he determined separately, all outside the model.

He puts those into the routing model. And again, the calibration targets are the three -- are his observed phosphorus loads at the bottom of the watershed.

So the routing model makes the connection between the loads he computed at the edges of fields, again, distributed throughout the watershed, and these three stations at the base of the watershed.

And the issue there is that he ignores everything that happens in between the edges of those fields and these three stations. He does not explicitly represent any of the transport, fate or delivery processes in over 3,000 miles of the watershed.

And, furthermore, those weren't the only data available to him, because distributed throughout the watershed in the stream and river network, there are almost -- there are about 250 sampling stations, and there are over 3,000

measurements of total phosphorus available that he could have used and, in my opinion, should have used to calibrate the routing model, but he ignored them all and leap-frogged the whole system and went right down to the three stations at the base of the watershed.

Q. Thank you, Doctor. Let's turn now to Dr. Wells' work. You reviewed Dr. Wells' work as well; is that right?

A. Yes, I did.

Q. Dr. Wells testified on direct examination that his model runs on phosphorus loads at the three USGS stations. Did you review that testimony?

A. Yes. The end point for Dr. Engel's model is basically the starting point for Dr. Wells' model.

Q. What is the source of the phosphorus loading inputs that feed into Dr. Wells' lake model?

A. The loadings that Dr. Wells used to calibrate his model for Lake Tenkiller were provided by Dr. Engel.

Q. Did some of those loadings come from the output of Dr. Engel's model?

A. None of the loads that Dr. Engel provided to Dr. Wells for calibration of his model came from Dr. Engel's model.

A. Please state the question again.
Q. Sure. You reviewed Dr. Engel's testimony that once phosphorus begins to move off of a field, it will necessarily continue in motion and reach the reservoir at the bottom of a watershed. You reviewed that testimony?
A. Yes, I did.
Q. Do you agree with that assumption or statement?
A. No, I don't.
Q. Why not?
A. Well, I'll answer it in three parts. If there's a molecule of phosphorus in the middle of a field, and it begins moving toward the edge of field, it's not correct to assume that it will necessarily and inevitably make it there.

One reason is that there are many physical, chemical and biological processes that can impact the transport and fate of the journey. Another reason is that there might not be a pathway for it to make it there.

Another reason could be that as it gets near the edge of field, it might see a buffer strip and be unable to penetrate.

I should point out that buffer strips aren't the only best management practice. There's a

whole universe of Best Management Practices out there that have been developed by federal and state agencies to be put in place on land simply for the specific purpose of preventing that from happening.

The second part of my answer is -- let's jump head, let's suppose it makes it to the edge of field. It may or may not enter a stream and river network. For one reason, the edge of field may or may not intersect a stream. It might intersect a puddle, a lake, a ditch, a pond. It might intersect a road.

Finally, let's take the third step. If it does enter -- manage to enter the stream and river network -- and in this case, it would have to travel a hundred or so miles to make it to Lake Tenkiller -- again, there are many physical, chemical and biological processes that influence the fate, pathway and delivery, and impact the journey.

Q. Doctor, does Dr. Engel's routing equation actually model any of the fate and transport processes that you just described?

A. It does not explicitly model any of them.

Q. Are there computer models out there that actually account for and represent the fate and transport processes affecting a substance such as

A. Yes.
Q. What dataset did Dr. Engel use for land cover or land uses in the watershed?
A. He began with the National Land Cover Dataset, NLCD.
Q. Who maintains that dataset?
A. My understanding is it's the USDA.
Q. What generally does that dataset show?
A. Well, it's remotely sensed imagery, and it shows land, and it comes with a number of codes that represent different operational categories of land cover.
Q. If a modeler is using the National Land Cover Dataset, does the modeler have to make some interpretations of those codes?
A. Yes. The codes don't correspond directly to urban land, pastureland, forest, cropland. The user needs to determine first what are the characteristics of the site of the watershed for the particular site-specific application and then make judgments about how to use those codes to classify areas for the particular watershed model.
Q. Now, is the land cover -- I'm sorry, the National Land Cover Dataset a dataset that's commonly used in the watershed modeling community?

A. Yes.
Q. Have you reviewed Dr. Engel's land use classification inputs into his model to determine whether his judgments are accurate and realistic representations of the actual land uses?
A. Yes.
Q. How did you conduct that review or investigation?
A. Well, we -- I overlaid aerial infrared imagery, looked at overlays of imagery --
MR. PAGE: Your Honor, I'm going to object. This witness testified in his deposition that he actually did not do this work and that he actually has never done this work before. I think it's a lack of foundation and it's hearsay.
THE COURT: Response?
MR. GEORGE: Your Honor, Dr. Bierman has testified that -- first of all, that's material for cross-examination. But, secondly, Dr. Bierman has testified that he worked with a staff and he reviewed all of their work product, and the opinions and testimony he's providing today are his own.
THE COURT: Overruled.
Q. (By Mr. George) Doctor, could you continue describing how you conducted that investigation.

A. Yes. Aerial infrared imagery was overlaid with portions of Dr. Engel's land use classifications, and we noted a number of discrepancies in his classification of pastureland.

Q. Doctor, did you include any of those overlay figures in your report?

A. Yes, I did.

Q. Could you turn to -- let's talk about them in a group first -- tab 6, 7 and 8 in your binder, which for the record are Defendants' Joint Exhibits 2398, 2399, and 2400.

Could you identify those exhibits for the record, please.

A. Yes. Those are all figures from my expert report.

Q. And could you describe generally, without getting into the details of a specific exhibit, the source of the information that is shown in those exhibits.

A. Yes. They're overlays of Dr. Engel's classifications in his model, GLEAMS model input files that he derived from the NLCD data overlaid with aerial infrared imagery, and we attempted to check Dr. Engel's classifications to determine if they were accurate and correct.

Q. Doctor, are these three exhibits the product of the investigation and review that you just testified about?
A. We found many discrepancies. These are simply illustrative results.
MR. GEORGE: I move for the introduction of Defendants' Joint Exhibits 2398, 2399 and 2400.
THE COURT: Any objection?
MR. PAGE: Yes, Your Honor. The objection is on the same basis that I objected to his testimony. This witness did not do this work nor does he have experience in doing this type of aerial photo interpretation.
THE COURT: Overruled. Exhibits 2398, 2399, and 2400 are admitted.
Q. (By Mr. George) Now, Doctor, let's start with Exhibit 2398 which is behind tab No. 6.
A. Yes.
Q. Can you describe what is shown in Defendants' Exhibit 2398?
A. Yes. This is an example of how land which was actually forested land was classified by Dr. Engel as pasture in his GLEAMS model input files.
Q. And with reference to the images, could you point out some examples of that misclassification?

A. Yes. Let's look at the bottommost panel. And we have a legend there that says, "Engel classified forest as forest," and the arrows point to those dark red portions. The aerial infrared imagery reveals that, in fact, they are forest; and, in fact, Dr. Engel classified that area as forest.

However, if we move over, the arrow that says, "Engel classified forest as pasture," that's the same type of land. The aerial infrared imagery saw forest. The shaded overlay indicates that Dr. Engel classified that as pasture.

Q. Turn to Defendants' Exhibit 2399, which is behind tab No. 7. And could you describe what is shown in that exhibit.

A. This is the same type of format, except here it depicts examples of urban land that Dr. Engel classified as pasture.

Q. Finally, could we turn to Defendants' Exhibit 2400, which is behind tab No. 8.

A. Yes.

Q. And, Doctor, could you describe what is shown in this exhibit.

A. Again, the format is the same as the three previous pictures, but here this illustrates that what the infrared imagery saw as roads were actually

classified as pastureland in Dr. Engel's GLEAMS input files.

Q. Are the areas shown in the last three exhibits that we just discussed the only instances of miscalculation that you found in your investigation?

A. No. There were many other instances. We prepared these as simply illustrative examples.

Q. What is the impact, if any, of these misclassifications of lands as pastures on the reliability of Dr. Engel's modeling work?

A. Well, in watershed models, if you don't get the land use types right, you can't get the nonpoint source runoff right. And the reason is that if a rainfall event occurs and if runoff occurs, the amount of runoff one gets, the amount of phosphorus per unit area one gets really depends on the type of land cover that the precipitation hits. So if you want to get the loads right, you need to get the land right.

Now, with respect to pasture, Dr. Engel classified more land as pasture in his model than actually exists in the real world in the Illinois River Watershed.

So one consequence would be that his model would overestimate the nonpoint source load from

pasture. As another consequence --

MR. PAGE: Objection, Your Honor, this is speculation. The witness hasn't provided any foundation to support his opinion.

THE COURT: Overruled.

Q. (By Mr. George) Please continue, Doctor.

A. Another consequence is that inside Dr. Engel's model, animal waste phosphorus is being applied to a larger pasture area than it actually is applied in the real world in the Illinois River Watershed.

Q. Let's move to urban areas. Doctor, did you review the input values and assumptions that Dr. Engel used in his model to simulate runoff of phosphorus from lands that he classified as urban?

A. Yes, I did.

Q. Does GLEAMS have default values or coefficients designed to represent the physical processes that exist in urban areas?

A. No, because GLEAMS is an Ag model. It is not designed to represent urban areas.

Q. Based upon your review, did Dr. Engel model urban areas in a manner that's representative of urban areas?

A. He didn't accurately represent the characteristics of urban areas, in my opinion.

pasture. As another consequence --

MR. PAGE: Objection, Your Honor, this is speculation. The witness hasn't provided any foundation to support his opinion.

THE COURT: Overruled.

Q. (By Mr. George) Please continue, Doctor.

A. Another consequence is that inside Dr. Engel's model, animal waste phosphorus is being applied to a larger pasture area than it actually is applied in the real world in the Illinois River Watershed.

Q. Let's move to urban areas. Doctor, did you review the input values and assumptions that Dr. Engel used in his model to simulate runoff of phosphorus from lands that he classified as urban?

A. Yes, I did.

Q. Does GLEAMS have default values or coefficients designed to represent the physical processes that exist in urban areas?

A. No, because GLEAMS is an Ag model. It is not designed to represent urban areas.

Q. Based upon your review, did Dr. Engel model urban areas in a manner that's representative of urban areas?

A. He didn't accurately represent the characteristics of urban areas, in my opinion.

Q. Can you explain the basis for that statement?
A. Yes. The GLEAMS watershed model, for each land use type -- and urban land use is one of the land use types used by Dr. Engel -- the GLEAMS model requires that nutrient inputs be specified and that hydrology inputs be specified. Let's talk about the nutrient inputs first.

The nutrient parameter input file that Dr. Engel input to his GLEAMS model for urban land represented a crop type, by crop equals two, if anyone is taking notes that specifically. That corresponds to alfalfa hay and it's based on an example from the GLEAMS manual.

Let's turn to hydrology. The GLEAMS model requires that the user specify a curve number. Simply put, the curve number determines, if a precipitation event occurs, how much runoff occurs per unit area from the land surface, and that's what the curve numbers do. So the user needs to specify that.

Now, I investigated Dr. Engel's hydrology input files. The initial value he specified for the curve number for his hydrology file for urban land use was, in my opinion, reasonably representative of the impervious surfaces that exist in urban land

use.

However, the calibration process that Dr. Engel used varied a number of the model input parameters so as to achieve correspondence with the calibration targets.

For the hydrology calibration, one of the input parameters that was varied was the curve number. So after the calibration was completed, the curve number in Dr. Engel's calibrated model was very different than the initial curve number he specified. It was much lower. The initial values, I believe, were 85 to 89. He ended up at values below 50.

And in the GLEAMS manual, it's very clear that curve numbers that low correspond to the runoff characteristics of wooded areas.

Q. Are wooded areas, based upon your professional experience, an appropriate surrogate for urban areas in terms of curve numbers?

A. No, they're not. And basically inside Dr. Engel's model, the hydrology characteristics that were actually operating in his calibrated model represented wooded areas and not urban areas.

Q. Doctor, the last input value used by Dr. Engel that I want to discuss with you is the phosphorus in

which we could compute the volume of each box. And we investigated the amount of phosphorus, concentration in each of these boxes. And there's nothing difficult about this. It's just a tedious bookkeeping exercise where you just compute the mass in each box, and then at the end, you add up the mass in all the boxes.

Q. Did you, in fact, at the end sum up the total amount of phosphorus in the soils that Dr. Engel included in his model?

A. Yes, I did.

Q. How much phosphorus did he assume was in these soils in the watershed at all depths?

A. It was about 6.4 million tons.

Q. Can you explain what that 6.4 million tons represents.

A. That represents basically a snapshot in time corresponding to his calibrated GLEAMS model.

Q. Doctor, do you recall what annual value for poultry litter phosphorus, as Dr. Engel called it, he assumed in his GLEAMS model?

A. Yes. On page D-18 in Dr. Engel's expert report, he has a number of 4,642 tons of poultry P per year, and that was taken from Appendix B, the mass balance conducted by Meagan Smith. And that's

the number he puts forth as the phosphorus added each year due to poultry P.

Q. In your report, did you provide a comparison of the tons of phosphorus that Dr. Engel assumed was present in the soils in his model with this addition of 4,642 tons of phosphorus annually?

A. Yes, I did.

Q. Can you provide us with the results of this comparison?

A. The 4,642 tons of P that Dr. Engel assumed is added each year is approximately .07 percent of the total phosphorus that's already present in the soil in his GLEAMS model.

Q. You mentioned Meagan Smith's mass balance report. Did you review that report as well?

A. Yes, I did.

Q. Do you recall seeing her pie chart presenting the various different sources of phosphorus additions to the watershed that she identified?

A. Yes, I did.

Q. Let me ask you to turn to tab 9 and find Tyson Defendants' Demonstrative 230.

A. Yes, I have it.

Q. Did you prepare this demonstrative?

A. Yes.

evidence Defendants' Joint Exhibit 2418.

THE COURT: Any objection?

MR. PAGE: No objection.

THE COURT: 2418 is admitted.

Q. (By Mr. George) Doctor, I'm going to take a step back for a moment and ask you some general summary-type questions. Based upon your review of Dr. Engel's modeling work, do you have an opinion as to whether Dr. Engel's modeling results provide a realistic and reliable representation of phosphorus loading to Lake Tenkiller for either current, historical or future conditions?

A. Yes, I do.

Q. What is that opinion?

A. My opinion is that Dr. Engel's entire modeling framework is conceptually flawed. My opinion is that the methods that Dr. Engel used to apply that flawed conceptual framework to the IRW in this case are full of numerous errors and, likewise, are completely flawed.

My opinion also is that the results from Dr. Engel's model for his calibration and purported validation period and all of the results for any prediction scenarios he conducted, as well as his 100-year hindcast, are not scientifically

defensible, they're not valid, and they are unreliable.

Q. Doctor, based upon your review of the modeling work of Dr. Wells, do you have an opinion as to whether Dr. Wells' modeling results provide a realistic and reliable representation of water quality for the lake for either current, historical or future conditions?

A. Yes, I do.

Q. What is that opinion?

A. The water quality computed by Dr. Wells' model for his calibration period, those results are flawed due to the flawed and unreliable inputs for total phosphorus and soluble reactive phosphorus provided to Dr. Wells by Dr. Engel.

I'm also of the opinion that because -- let me restate. For all of Dr. Wells' forecast scenarios and predictions, as well as his 100-year hindcast, he used the flawed and unreliable outputs, predictions, from Dr. Engel's flawed models. Therefore, all of Dr. Wells' forecast results and hindcast results are similarly flawed and unreliable.

MR. GEORGE: Your Honor, this is a transition point for me, and we are at the noon

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IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 89 - PM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

JANUARY 7, 2010

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

Have you performed any scientific investigations prior to work in this case relating to urban runoff?

A. I've done some simple spreadsheet modeling of different land use areas, including urban.

Q. But you've never published any of your investigations, or any investigation, concerning urban runoff in a peer-reviewed paper?

A. Yes, that's correct.

Q. Now, Dr. Bierman, is it your opinion that GLEAMS cannot be used to model urban runoff?

A. My opinion is consistent with the developers of the model who stated that it was not designed for that intended purpose.

Q. I know you've told me what the model designed purpose was.

But my question is, based on your experience as a modeler, can the GLEAMS model be used to model urban runoff?

A. Are we speaking of the hydrology, or are we speaking of the nonpoint-source phosphorus runoff?

Q. Nonpoint-source phosphorus runoff.

A. I don't know if the GLEAMS model, which is designed to be an ag model, can in a scientifically defensible manner be modified to represent

nonpoint-source phosphorus runoff. But I do know that the way Dr. Engel used it to represent that runoff in this case was incorrect and was flawed.

Q. So just so the record's clear, you don't know whether or not GLEAMS can be used to model nonpoint source nutrient runoff; correct?

A. Whether one can do it is one thing. Whether one can do it and have it be done in a scientifically acceptable manner is another question.

Q. Dr. Bierman, we'll get through this a little bit faster if you just answer my question. We'll take it stepwise.

I first just want to know whether you have an opinion as to whether one can modify the GLEAMS model in order to model urban runoff?

A. I suppose. Yes, I suppose one could do that.

Q. Okay. Now, let's talk about what your concerns are with Dr. Engel.

A. Uh-huh.

Q. You mentioned that you were concerned about the crop selection for urban runoff?

A. I was concerned -- no, my concern was broader than that.

The GLEAMS model -- for each land use type it

requires two sets of inputs, one is hydrology and one is nutrients. The nutrient parameter input file that Dr. Engel used for his GLEAMS model was taken from an example in the GLEAMS manual and it represented a crop type of alfalfa hay.

Q. Okay. And what was wrong with that?

A. Because alfalfa hay doesn't grow in -- doesn't cover the urban land use area in the Illinois River Watershed.

Q. Okay. But those language or verbal descriptors aren't all of the variables that are part of the land use aspect of the GLEAMS model, are they, sir? I mean, there's all kinds of different curves and different inputs beyond just the name "alfalfa"; correct?

A. Yes. And that's precisely the point. This is not just a labeling issue. Because the nutrient input file, it's not just a label that says "alfalfa hay." It contains specifications for phosphorus concentrations, nitrogen concentrations, how phosphorus cycles, how nitrogen cycles, how phosphorus and nitrogen interact.

When one makes that designation for urban land, one invokes all of that nutrient cycling, and, sir, that simply doesn't occur in pavements and

highways in the Illinois River Watershed.

Q. But, the alfalfa -- you can adjust those subparameters, can you not? Those can be adjusted?

A. Dr. Engel did not do that in a nutrient parameter input file; he used it straight up.

Q. Oh, that's your testimony, sir, he did not make any adjustments in those parameters?

A. He did not adjust -- he used the nutrient parameter input file. The adjustments he made, sir, were in the hydrology file.

Q. Okay. Isn't the curve number also part of like, for example, soil moisture?

A. The curve number is very important for the hydrology, yes.

Q. Okay. Did you consider whether or not there were modifications in the hydrology concerning soil moisture content?

A. I didn't look at soil moisture consent. I looked at curve number, which is very -- far more important.

Q. Okay. Well, you can also modify the soil moisture content to make a difference also; is that correct, sir?

A. Yes, sir, you can.

Q. Did you do any tests; that is, rerun the

analysis.

Q. And did you actually perform a water quality model of the IRW, actually do a water quality model --

A. A watershed model?

Q. Yes, sir.

A. No, sir, I did not.

Q. Well, did you do an in-stream model?

A. No, sir, I did not.

Q. Did you do a lake model for the IRW?

A. No, sir. My assignment in this case was to review Dr. Engel's body of work, not to develop my own independent model.

Q. And did you do any independent investigation of transport or delivery of phosphorus from poultry litter fields in the IRW to Lake Tenkiller?

A. No.

Q. Did you or your team perform any sampling or other field investigations, other than a site visit, of the IRW?

A. No, we did not.

Q. Now I want to talk a little bit about your testimony concerning the land use land cover database.

A. Yes, sir.

Q. What database did Dr. Engel use?

A. My understanding is that he used the national

certainly not standard practice.

Q. Well, let's talk about your sensitivity. I think you called it a sensitivity test of the routing model?

A. That would be one way to refer to it, yes, sir.

Q. Yeah. Now, did you actually run these sensitivity tests or did someone from your staff do this work?

A. Both. I ran some and one of my staff ran them as well.

Q. All right, sir. Let's -- let's -- you mentioned that you calibrated Dr. Engel's model; is that correct, sir?

A. I recalibrated I think was the --

Q. You recalibrated. So you changed the model, did you not?

A. In my opinion, I didn't change the model; I recalibrated the model.

Q. When you recalibrated the model, you changed the routing coefficients, at least some of them, for that model, did you not?

A. I changed the coefficients, but in my opinion, that's not changing the model. Because in Dr. Engel's expert report on page D-21, he presents

what he represents as his routing model. The routing model, as represented in his expert report, it doesn't have specific numerical values attached to the coefficients A, B, C, or P accumulation.

Q. So it's your testimony, sir, that Dr. Engel -- if you changed the coefficients in Dr. Engel's routing model, it does not change the model?

A. It doesn't change the model; it changes the site-specific application of the model.

This is what's done every day in environmental modeling. You have a set of equations, these equations have coefficients, and the calibration process consists of applying that model to a site to data and determining the coefficients through calibration.

That's what Dr. Engel did in his expert report, and that is exactly what I did, sir, when I conducted my sensitivity analysis.

Q. Are you saying you don't know what the coefficients were -- when Dr. Engel calibrated his model, he identified the coefficients for that model, correct, that routing model?

A. When he calibrated the model, each time he calibrated it -- and we're speaking of three different

versions now -- each time he did that, he ended up with a set of coefficients.

Q. But the final version that supported his testimony in this case, he had specific coefficients for that routing model; correct?

A. Yes, sir, he did.

Q. And then he used independent data, a separate set of data, to check that model's calibration to validate it; correct?

A. That's incorrect.

Q. Okay. Well, he didn't change the cal -- he calibrated it and then used it for this case. He used the same coefficients then as he did his model predictions; is that correct?

A. Okay. I'm taking issue with a different part of your statement, sir.

Q. Okay.

A. Dr. Engel represented his work as calibration validation. Actually, when he calibrated -- his calibration and validation steps were completely separate for the hydrology portion of his GLEAMS model.

Q. Okay. Let me get on to the point here.

A. The running model --

Q. Let me get on to the point here, sir.

MR. MCDANIEL: Your Honor, excuse me. If Mr. Page could extend the witness the courtesy of allowing him to finish his answer.

THE COURT: Well, he began to -- the objection's sustained.

Go ahead and finish.

A. Okay. Let me cut back to the routing model, sir. Your question was about the routing model.

Before I answer the question you asked, I have to -- one of the premises in your question is not correct and I can't answer the question as asked. So I would have to point out Dr. Engel represented that he calibrated and validated his routing model.

Sir, the way you asked the question, you represented it to me as though a calibration step was conducted and then a separate validation step was conducted, but that's not what Dr. Engel did.

Q. Let me ask a different question.

A. Yes, sir.

Q. After Dr. Engel calibrated his model for testimony in this case, he didn't modify the coefficients in the routing model, he maintained them the same way; correct?

A. For use in his forecast scenarios, yes, sir, he did.

Q. Yes, he did. But when you did these sensitivity analyses, you changed those coefficients, did you not?

A. Yes. Because I recalibrated, and therefore, it was the same model with different coefficients. It was a different realization of the same model.

Q. Well, if you change the coefficients in a water quality model, that changes the results, does it not?

A. It doesn't change the model; it changes the numerical results. It's the same model.

MR. PAGE: May I approach, Your Honor?

THE COURT: You may.

Q. *(BY MR. PAGE)* Okay. Now, Dr. Bierman, I handed you what's marked as Demonstrative 361.

A. Yes, sir.

Q. Do you recognize that as being Dr. Engel's routing model?

A. Yes. This is how Dr. Engel represented what's on this demonstrative.

Q. Okay, sir. And so there's certain coefficients there. There's the A, B, and C coefficients; correct?

A. Yes, that's correct.

Q. And depending on what numbers you have in

recalibrated, the recalibration resulted in different values for the coefficients A, B, C, and P accumulation. Whether these are those specific coefficients, I'm not sure. But yes, sir, I changed the coefficients.

Q. And so isn't it --

A. Excuse me, sir.

Q. I'm sorry. Isn't it true, sir, that when you changed these coefficients, you created a different routing model?

A. I disagree with that opinion. It's the same model but the -- it's a different calibration of the same model. I guess we can get hung up on semantics here.

So the terms -- I will concede that my coefficients are different. I should also point out that Dr. Engel during his deposition stated that these coefficients have no physical meaning and there were no constraints on what values they could take when he calibrated the model.

Q. Dr. Bierman, isn't your routing model really different because Dr. Engel's routing model and his coefficients were created based on empirical observations in the IRW, and your routing model coefficients are based on a hypothetical increase of

100 times the phosphorus in GLEAMS?

MR. GEORGE: Objection, Your Honor. Asked and answered. We've been around the tree several times on whether Dr. Bierman believes this is a different routing model. I believe he made it clear on that.

THE COURT: I believe this is a different question. Overruled.

Go ahead.

A. Please repeat the question, sir. I lost track.

Q. *(BY MR. PAGE)* Isn't it different, because Dr. Engel's routing model, his coefficients, were created based on an empirical observations in the IRW and your routing model coefficients are based on a hypothetical increase of a hundred-fold phosphorus in GLEAMS?

A. I'm not sure I would -- I agree with your representation of the inputs. But certainly my inputs were different than his inputs and the coefficients were different -- my coefficients were different than his.

Q. And your inputs for phosphorus were substantially greater; correct?

A. Yes, sir, they were.

Q. But you assumed that the loading; that is, the observed loadings, would be the same when you did your recalibration?

A. I calibrated to the same -- I calibrated to Dr. Engel's observed loads which were the same calibration targets he used.

Q. Does it make sense to you, sir, that if you increase the nonpoint-source loading of 100 or 18 or how many times you did it, that you'd have the same phosphorus going into the lake? Does that make sense to you, sir?

A. That doesn't make sense and that's precisely the point. Because one could put loadings that were unrealistically high, one could put numbers into Dr. Engel's routing model, and still get the same results. Those fictitious loads would still correspond to what went in the lake.

Q. You only get the same results, Dr. Bierman, if you change the coefficients and retain more phosphorus in the river by changing those coefficients as you did; isn't that correct?

A. No, that's not correct.

Q. Well, let's just test that, sir.

MR. PAGE: May I approach?

A. Sir, I did test it. You asked me the

question, would things change. I tried -- I tried -- I did two analyses. I redid the reversed order analysis and I put the S & P 500 numbers back into Dr. Engel's routing model with the same equations and exactly the same coefficients and I got exactly the same results.

Q. *(BY MR. PAGE)* Okay. Well, in the nonpoint source example here, sir, that we're talking about, when you put in your change in inputs --

A. Yes.

Q. -- you made changes in the routing model, you said you recalibrated. Did you ever run those additional inputs, nonpoint source or wastewater-treatment plant, with the same coefficients; that is, the same model, that Dr. Engel had to see what the results would be?

A. Not for those, but I did for the S & P 500, sir. I got calibration results which were just as good as the calibration results in Dr. Engel's expert report. I also did so, sir, for the sensitivity analyses where I reversed the order of the loads from first day to last day, and I got the same results when I did that with the same coefficients and the same equation.

Q. Is it your testimony, sir, that you used the

same exact coefficients in the same routing model when you did the S & P loadings for Dr. Engel's model?

A. Not in my expert report, sir. You just asked me, though -- you asked me that if I put different loads into the model with the same equation and same coefficients, would I get the same results, would I expect different results? And I said, no, I tried that and I got exactly the same results.

Q. That's not part of your expert report?

A. No, sir. It was an answer to your question.

Q. So you never gave that opinion in your expert report? You never provided that analysis as part of your expert report?

A. That's correct, that is not in my expert report. I simply answered your question, sir. The reason I did that was because in the Daubert motion, I was surprised when Dr. Engel expressed --

Q. I think you've answered my question. Thank you, sir.

A. Thank you, sir.

MR. PAGE: May I approach, Your Honor?

THE COURT: You may.

Q. *(BY MR. PAGE)* Now, Dr. Bierman, I've provided you Demonstrative 363. What I've shown here is, we ran your routing model with your inputs but

question, would things change. I tried -- I tried -- I did two analyses. I redid the reversed order analysis and I put the S & P 500 numbers back into Dr. Engel's routing model with the same equations and exactly the same coefficients and I got exactly the same results.

Q. *(BY MR. PAGE)* Okay. Well, in the nonpoint source example here, sir, that we're talking about, when you put in your change in inputs --

A. Yes.

Q. -- you made changes in the routing model, you said you recalibrated. Did you ever run those additional inputs, nonpoint source or wastewater-treatment plant, with the same coefficients; that is, the same model, that Dr. Engel had to see what the results would be?

A. Not for those, but I did for the S & P 500, sir. I got calibration results which were just as good as the calibration results in Dr. Engel's expert report. I also did so, sir, for the sensitivity analyses where I reversed the order of the loads from first day to last day, and I got the same results when I did that with the same coefficients and the same equation.

Q. Is it your testimony, sir, that you used the

didn't hold the same observed amount.

A. Excuse me?

Q. Did not use the same observed numbers. We just ran the model with your routing model, used your inputs and ran the model, and the upper numbers are what we came up with.

Now, sir, does it surprise you --

MR. GEORGE: I'm sorry, Mr. Page. Your Honor, it's a little unclear to me, but I believe the demonstrative is apparently the work product of maybe Dr. Engel that has been done outside of the confines of his direct testimony, files that have not been produced in this case. There's simply no foundation.

This is not a demonstrative exhibit. It's not an impeachment. It's Mr. Page seeking to get in some analysis who's done by an expert who's not here to testify to.

THE COURT: Sustained. Now, let me ask, because all of this raises the distinct possibility that I need to hire a special master to compare these two and to make you all pay for it frankly, but do I understand that with regard to the S & P analysis that you did in reversing the times, that you did so in your report using the different coefficients and not the same coefficients as Dr. Engel did?

THE WITNESS: Yes, sir, that's what I did.

THE COURT: And why is that? I don't understand that. Why did you change the coefficients? And I understand your distinction between the model and the coefficients. But if you want to compare apples to apples, why didn't you keep the coefficients the same?

THE WITNESS: The objective was, to answer the question, could the model be recalibrated to connect Dr. Engel's loads from the watershed to the observed loads? So the purpose was to see if I could calibrate it with loads that made no sense.

THE COURT: And you did that because Dr. Engel was recalibrating; is that correct?

THE WITNESS: Well, when Dr. Engel developed his model initially, he calibrated to observed data.

THE COURT: Yes.

THE WITNESS: I simply repeated that same exact process. I --

THE COURT: Observed data at the three locations below?

THE WITNESS: Observed data at three locations.

Go ahead.

MR. GEORGE: Your Honor, may I request that the exhibit that the court has sustained the objection on be taken off the screen?

THE COURT: Oh, yes. Absolutely.

Do you remember the question?

THE WITNESS: No, sir, not at this point.

THE COURT: Okay. I guess you're going to have to rephrase by necessity.

MR. PAGE: I'll do my best, Your Honor.

(Discussion held off the record)

Q. *(BY MR. PAGE)* Dr. Bierman, isn't it true, though, when you multiply by the nonpoint source by a hundred times; that is, the input, and the wastewater-treatment plant by a similar amount, it was unrealistic then to use the one percent or the one -- the basis of one for wastewater-treatment plant observed loads when you did your analysis? That is, was it reasonable for you to assume that the observed loads would remain the same if you increased the phosphorus inputs a hundred-fold?

A. First of all, that's not exactly what I did; I didn't increase. I increased nonpoint source 15 times and wastewater-treatment plant 345 times. What

I did was completely consistent with the purpose of my test.

The purpose of my test was not to compute loads to Lake Tenkiller. My purpose was not to develop a new model. My purpose was to ask a very, very simple question. Could the model that Dr. Engel developed and applied and calibrated, could that model also be calibrated for loads that don't make sense?

And if it -- what I expected to see was that the model simply can't be calibrated to loads that made sense. But the model, given its conceptual construction and the way he set it up, it was able to be calibrated. And, sir, I did so in a way that was exactly consistent with how Dr. Engel explained he did his calibration in his deposition.

Q. If you had used Dr. Engel's routing model --

A. Yes, sir.

Q. -- and used the 345-time wastewater-treatment plant inputs --

A. Yes, sir.

Q. -- would you expect to see his model then show much greater loading into Lake Tenkiller?

A. I don't know because I didn't do that. But I did it for the S & P 500 --

Q. Just please just stick to the answer.

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

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VICTOR BIERMAN, PH.D.

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IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 90 - AM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

JANUARY 11, 2010

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

Demonstrative 360, please?

Q. *(BY MR. ELROD)* Okay. This is a little bit busy. What role does the chicken litter play in the economy of the IRW?

A. I think the main point of this slide here, the nutrient value flow in the IRW, is that really you have a substance, poultry litter, that is a source of nutrients. That source of nutrients, the value of that, is captured and enhanced through the production of forage and the production of hay. The value of the forage and the hay is enhanced and captured through the production of cattle by consuming that which is sold which provides income for farmers.

Q. All right. Let's examine these boxes before we get into this in any greater depth, and we're going to come back and revisit this chart in a few minutes.

The upper left-hand box says, "poultry provides 295,000 tons of litter"; correct?

A. That's correct.

Q. Where did you get that number?

A. That number was contributed by Billy Clay.

Q. All right. And if, in fact, the true number -- and I suppose God would only know -- is 354,000 tons of litter, does that affect your analysis or is it the same analysis?

A. The analysis would be the same; the outcome might be different.

Q. All right. Now, if we move to the -- well, would it be different in terms of your ultimate conclusions in this case?

A. Yes.

Q. All right. Numerically?

A. Numerically.

Q. All right. We'll talk about that.

Move to the right, please. That box says, "Required forage 2.26 tons per acre." What is forage?

A. Well, forage is the plant material that cattle consume directly off the land.

Q. By grazing?

A. By grazing.

Q. We'll talk about hay in a second; correct?

A. Correct.

Q. So where did you get the number 2.26 tons per acre being required for forage? We're going to get into the analysis of the number, but just --

A. Sure.

Q. -- what's the purpose of that number?

A. Well, in order -- in order to feed the number of animals that are in the watershed -- and they would be fed eight months of the out year on that pasture --

you'd have to have 2.26 tons per acre on the acres that are available uniformly across the watershed in order to provide the green material for those eight months to feed all those animals.

Q. Then the lower right-hand corner says, "Required hay 1.92 tons per acre"?

A. That's correct.

Q. What's the purpose of that box?

A. The 1.92 tons per acre is the amount of hay that would be required again to feed those animals over a four-month hay-feeding period.

Q. Okay. And then we move to the lower center box. Is that the number of cows that you are trying to feed in the watershed with your proposition?

A. That's correct.

Q. And where did you get that number?

A. Again, those numbers were provided by Billy Clay.

Q. All right, sir. And then the dollar sign is representative of economic impacts of moving these numbers around?

A. Right.

Q. All right, sir. Now, generally speaking, is poultry litter less expensive or more expensive than the nutrient equivalent of chemical fertilizers?

A. Normally, it would be less expensive.

Q. And how much phosphorus and nitrogen is in one ton of poultry litter on average for your analysis?

A. We used 60 pounds of phosphorus and 60 pounds of nitrogen per ton of litter.

Q. And where did you get that number?

A. I think the literature is widespread in that that's a fairly widespread determination.

Q. And did you include that information in your report?

A. Yes, we did.

Q. Are there some typographical errors in your report?

A. There are.

Q. Just a couple of them?

A. Pardon me?

Q. A couple of them?

A. Yes.

Q. I mean, it's not replete with them, is it?

A. No.

Q. All right. Would you tell the court and counsel the two that need to be corrected for your analysis?

MR. GARREN: Objection, Your Honor.

A. That's correct.

Q. Is there a symbiotic relationship between poultry, forage, and beef in the IRW?

A. Yes.

Q. What is that symbiosis?

A. Again, as I showed earlier, the poultry litter, it provides input nutrients for the forage and hay production that is fed to the livestock. And, again, the point there is to try to capture the value-added component and the increased income of each one of those activities.

Q. And then all of those go into your IMPLAN model; is that true?

A. Well, any changes that we have in that budget from a scenario where we have litter and a scenario where we don't have litter, any of those changes in output, that would be what would go into the IMPLAN model.

Q. Then you push the start button and it spits out information; is that fair?

A. That's correct.

Q. Is this a tried, true, and tested model?

A. I think IMPLAN -- the IMPLAN model itself is probably one of the most written about, used, and published models that we have in the United States.

Your Honor.

THE COURT: Sustained.

Q. *(BY MR. ELROD)* Do these prices typically come and go in terms of cost?

A. Yes.

Q. And in 2008, was it one of the highest-priced years in recent times?

A. It was. It was on trend to increase and will probably return that way.

Q. And Urea --

MR. GARREN: Objection, Your Honor. Ask that that be stricken as to what it probably will do. That was not responsive to the question. It would call again for speculation.

THE COURT: Sustained.

Q. *(BY MR. ELROD)* The price of Urea is dependent upon the price of what basic resource?

A. Natural gas.

Q. All right. And is DAP, that phosphorus, a mined phosphorus, m-i-n-e-d?

A. Diammonium phosphate is a -- comes from a mined product that is then chemically mixed.

Q. And so it's an extracted resource?

A. It's an extracted resource, correct.

Q. Are we about to run out of it?

MR. GARREN: Objection, Your Honor; foundation.

MR. ELROD: Your Honor, I think that's already in evidence. Somebody -- it may have been Gordon Johnson -- it was the cross-examination of somebody that -- Taylor, Dr. Taylor.

THE COURT: There was talk about that.

MR. ELROD: All right.

THE COURT: Overruled. Go ahead.

A. Yeah. I believe there is current estimates of a 15- to 25-year lifetime for the available phosphorus.

Q. *(BY MR. ELROD)* Now, what if I didn't want any phosphorus and only wanted to apply an equivalent amount of 60 pounds of nitrogen using chemical fertilizer?

A. Well, you could certainly purchase just the Urea and apply it.

Q. So if I just bought Urea, what would the equivalent amount, including transportation and spreading costs, be?

A. Well, at the prices that we had when we did the report at $800 a ton, for 920 pounds of nitrogen in that ton, the cost would be close to 90 cents a pound for that Urea. And if you had to put on 130.43

display.

A. Again, as you said, this is a summary of what we've just been through. If I look at 60 pounds of nitrogen and 60 pounds of phosphorus, if I owned the litter, I'm calling the cost $18.28. If I have to purchase the litter, the cost of that would be $30.28. And if I have to go and get chemical fertilizer and the cost to apply it, the cost of that same chemical mix would be $113.86.

Q. All right, Dr. Dicks. Let's return to 360, please, the nutrient value flow in the IRW, and let's kind of get down in the weeds of this thing a little bit.

You've already testified that you calculated -- the boxes in the right-hand corner are the forage and the hay necessary to maintain the cattle in the IRW at its current levels?

A. That's correct.

Q. So you have shown in this chart your opinion that's in your report, that the nutrients to produce forage would require 63.1 pounds of nitrogen per acre and 30.2 pounds of phosphorus per acre; is that correct?

A. That's correct.

Q. And for hay, it would be 45.8 pounds of

THE WITNESS: Again, you know, I think that's a typical strategy for EPA. Obviously, the most relevant form of pollution is the point source, it's the largest. But then they have always -- every problem we've had in the United States about pollution, whether it's air, water, whatever, since 1965 since we began down this road, was to first identity the point source, clean up the point source, then move to the nonpoint source.

THE COURT: Can't do it all at once?

THE WITNESS: You cannot do it at all once.

THE COURT: Go ahead.

MR. ELROD: Thank you, Judge.

Q. *(BY MR. ELROD)* Dr. Dicks, then did you look at the macroeconomic impacts on the agriculture community of the watershed under two polar scenarios?

A. Yes.

Q. And one polar scenario is what?

A. Well, one scenario would be that the farmers faced with the elimination of poultry litter and the elimination of these nutrients, which would mean they'd have an inability to produce enough forage to feed their cattle, would then go and purchase chemical fertilizers.

policy advisor for the federal government, USDA likely, either polar?

A. No.

Q. What is your view that would be the most likely scenario?

A. Well, given that we have producers in the watershed that are both high-cost and low-cost producers, immediately some people will cut back on their herds and some people won't. Over time, I think you'd start with, of course, most people believing that perhaps they could get away with the chemical substitution. When they tried it, they'll find out that their returns drop and they'll move away from that.

So I think what we've done is try to set up two scenarios here, where one would be -- the hundred percent replacement would be the more typical immediate response, but over time we'll be moving towards all the producers towards the zero replacement.

MR. ELROD: Now if you'd put up 371, please, April.

Q. *(BY MR. ELROD)* Does this display the polar extreme results of your IMPLAN analysis?

A. Yes, it does.

Q. All right. The top one is what would happen upon one hundred percent replacement of poultry litter with chemical fertilizer; is that true?

A. That's correct.

Q. All right. Moving from left to right, would you describe to the court what direct costs are at $25 million negative?

A. Well, those direct costs came from our use of an increase in chemical fertilizer; our reduction in revenues, profits, to the farmers; our increase in the use of cubes, cake, protein feed supplement; and the increase in operating interest that would be paid because of the increased cost of the chemical fertilizer.

Q. And indirect costs are a positive 600,000. What are indirect costs in the IMPLAN model and why is it positive here?

A. Well, the indirect costs are the goods and services that are used that are -- that are -- how do you say it? -- spun-off or created by trying to produce the things that went into the direct impacts.

It's positive here basically because you've now -- you're moving a lot of material, in terms of chemical fertilizer, and the volume of that material and the economic activity of that is greater than the

economic activity lost from the movement of poultry litter.

Q. And induced costs are a negative 6 million?

A. That's correct.

Q. What are induced costs?

A. In both the direct and indirect impacts, you have people that are making a living, that are gaining an income, and they use that income to purchase a market basket of goods, whether it's car insurance or their groceries, and that then is the economic activities that is involved in the induced impact.

Q. So does that negative $6 million induced represent the $25 million rippling through the economy?

A. That's correct. It's a net of both, John.

Q. All right, sir. Now, your total for 2006 dollars is $31 million?

A. That's correct.

Q. And then you extrapolate it to 2008 dollars; is that true?

A. Right. We use a deflator to get back to the 2008 value, which would be a minus 34 million.

Q. And the IMPLAN model, does it tell you that there are 501 jobs lost under that scenario?

A. That's correct.

Q. And just briefly, tell the court how it comes to that conclusion.

A. How it comes to the jobs lost conclusion?

Q. Yeah. How does the interworkings of the model spit out that conclusion?

A. So every industry just -- labor is an input to every industry. So every time an industry loses so much economic activity, so much output, it loses a proportionate number of jobs.

Q. All right. Now, the other polar scenario is that you do not replace lost nutrients from poultry litter with chemical fertilizer at all; correct?

A. That's correct.

Q. So there would be no nutrients available to be annually applied in the watershed at all under this scenario?

A. That's correct.

Q. All right, sir.

A. Well, sorry, John. No, that's not exactly correct. There are already -- in both circumstances, there are chemicals that are being applied, even in our -- even in our -- the amount of litter that's being applied does not provide enough nitrogen in the watershed. So you're still providing chemical nitrogen on top of the litter.

Q. Okay.

A. So all we've done is remove the litter. There's still chemical nitrogen at that rate being applied, no more.

Q. All right, sir. I'm sorry. Correct.

So under that scenario then, the direct cost is what?

A. The direct cost is simply the loss in cattle sales, loss of $43 million.

Q. And because of lower stocking rates?

A. Correct.

Q. Because you don't have enough to feed them?

A. That's correct.

Q. And the indirect costs of $31 million, describe what that's all about.

A. Well, everybody that is involved in providing inputs to raise those things, whether it's veterinarian services or the feed store, is going to have less sales because of the loss of those -- those cattle.

Q. And induced costs here are a negative 6 million again?

A. That's correct.

Q. And that's, again, the ripple effect of --

A. That's the ripple effect.

Q. -- those numbers going through the economy? And your total 2008 dollars lost under that scenario is 88 million?

A. That's correct.

Q. Jobs lost 1192?

A. Yes.

Q. All right, sir.

MR. ELROD: Your Honor, I'm going to move the introduction of two exhibits. First one is 6356, which is --

THE COURT: Any objection to 6356?

MR. GARREN: No, Your Honor.

THE COURT: 6356 is admitted.

MR. ELROD: And move the introduction of 6357.

THE COURT: Any objection?

MR. GARREN: No objection.

THE COURT: 6357 is admitted.

THE COURT: And I do have one follow-up in regard to His Honor's 20 percent removal of litter.

THE COURT: Yes, sir.

Q. *(BY MR. ELROD)* The numbers you have used, are they before or after removal of litter by BMP's, Inc. of 70,000 tons?

A. They're before removal of it. We do not

economic activity lost from the movement of poultry litter.

Q. And induced costs are a negative 6 million?

A. That's correct.

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1 I N D E X

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

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MICHAEL DICKS, PH.D.

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Direct Examination by Mr. Elrod 10440
8 Cross-Examination by Mr. Garren 10501

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1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

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4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 JANUARY 11, 2010
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 91, P.M. SESSION

16

17 APPEARANCES:

18

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23

24

25

That would be the first one.

Another project that I did that was pretty heavily focused on movement of chemicals or constituents to streams would be a project to look at the effectiveness of riparian buffers in agricultural lands, on pasture settings. And that project, I set up I think it was 23 treatment cells on pasture lands. Each was about a hundred feet long and about maybe 15 feet wide. And we would apply dairy cow manure to those plots, and they had -- they were in different slope classes and they had different sizes of riparian buffers installed, and then we would be build gutter systems to collect the runoff as overland flow and shallow groundwater interflow. So to collect that surface -- those two surface layers of runoff because those were the layers of hydrological flow that would contribute the constituent that we were concerned about into a stream. It was fecal coliform bacteria that we were focused on in that study. So there was a lot of that kind of effort there. I can talk about other examples, if you like.

Q. Doctor, let me ask you about one specifically that I don't think you have discussed yet. Have you been involved in the Tillamook Bay Watershed?

A. Yes.
Q. What type of work have you done in the Tillamook Bay?
A. I worked on the Tillamook system for about eight years, and that involved a variety of projects. We did several watershed assessments there. But a lot -- we did a characterization study. The bay has five rivers that flow into it. There are big concerns there about salmonid fisheries issues and about fecal indicator bacteria getting to the bay where the oyster beds are, people consume raw oysters, there is some health concerns about that.

They're also concerned about riparian vegetation integrity and water temperature that is associated with that and erosional issues and also nutrient issues. So a number of concerns.

We did a characterization study for a year where we sampled throughout different parts of the watershed and made an evaluation and assessment of what the chemistry was in each of the five rivers. And as those rivers came out of the forest at what we called the forest/ag interface, then as you moved down through the agricultural lands, then we had some urban lands and then the bay.

So we looked at data from the forest/ag interface to reflect what was happening up in the forest, and we looked at data just above the bay to see what the intervening impacts were from the ag lands and the urban lands.

So we did that characterization study. Then we did episodic projects where we sampled during storms. I can't remember how many storms we did, but it was a lot over about five or six years. We would go out and sample repeatedly during a storm and evaluate changes in the chemistry, the stream water during that storm. And the big focus of that part was on the fecal indicator bacteria.

We also did a demonstration project. I can talk about that one, if you'd like.

Q. In your Tillamook Bay Watershed assessment work, did -- you described your sampling efforts -- did you bracket suspected sources in your sampling?

A. That was another actually couple of projects that we did in Tillamook was a bracketing-type project.

In that, what we did -- I'll talk about two because that was really my major focus, two of the rivers. What we did was to sample from the forest/ag interface down into the bay and actually

into the bay itself at multiple intervals. Depending on the river, there were maybe 12 to 20 different locations along the river where we would sample. And we would sample during storm events. And we would sample at three locations in the middle of the river and on the right and left sides of the river so we could evaluate things coming in from the sides.

So we would collect these samples and then evaluate as you move downstream at what location did the concentration of bacteria jump up. Because if the concentration of bacteria jumps up at that location, especially if it happens repeatedly in lots of storms and during different samplings during the storm, then we would suspect that there's something in that landscape between those two points that's contributing bacteria.

So then we would identify all the land that would drain into that reach of river, and we would look at the land cover issues, we would tabulate the housing clusters to evaluate septic system issues, and then try to establish relationships between the various pieces of real estate draining into the slices and what the changes in fecal bacteria were. So that was a way to get at the sources of fecal

indicator bacteria.
Q. Doctor, in that assessment work, were you assessing potential nonpoint sources?
A. Yes. We had some point source -- we had three point sources in the watershed. That was primarily a nonpoint source project.
Q. Doctor, in your professional experience in assessing potential nonpoint sources, is it helpful to have the sort of localized sampling approach that you've described?
A. It's critical. Nonpoint source, by definition, is a local issue. It's a distributed pollutant. If you're not collecting information that's site-specific and narrowly focused, it's very, very difficult to figure out what's going on.
Q. I'm going to go back for just a moment. You described this project involving -- I think you described it as a demonstration project where there was some plot studies done. Do you recall that testimony?
A. Those were actually two projects, but yes.
Q. I'm interested in the study where you were actually evaluating in the field the movement of constituents off of a pasture.
A. Okay.

indicator bacteria.
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A. Those were actually two projects, but yes.
Q. I'm interested in the study where you were actually evaluating in the field the movement of constituents off of a pasture.
A. Okay.

A. That's correct.
Q. Did you review Dr. Stevenson's testimony?
A. Yes.
Q. Do you recall that Dr. Stevenson suggested that the phosphorus levels in the Illinois River Watershed in the receiving waters were elevated as compared to phosphorus levels elsewhere?
A. Yes, I remember that.
Q. Do you agree with that testimony?
A. No. I think that it all depends on where you look. There are certainly streams and rivers around the country that have higher phosphorus, and there are streams and rivers that have lower phosphorus. It's very site-specific. It depends on where you look.
Q. Could you provide the court with sort of an overview of how you went about your comparative analysis of phosphorus levels in the watershed to other available data.
A. In the watershed, my major comparison for that would be the comparison to Oklahoma statewide. I did some comparisons with the IRW to national datasets as well, but the Oklahoma one, what I did was to pull together the data from three data sources.

These were the sources that had large volumes of data on total phosphorus from different streams throughout Oklahoma. It was EPA STORET, Oklahoma Water Resources Board, and the U.S. Geological Survey. So I pulled together data from those agencies for the state, including the Oklahoma portion of the IRW.

Q. Did you look at any regional or national data on phosphorus concentrations?

A. Yes.

Q. And could you identify generally what information and data was available to you for that analysis?

A. There was data from EPA. There was data from USGS. There was a study done primarily in Oklahoma, there were over 500 samples. There were a few in Arkansas, but the vast majority in Oklahoma.

Q. Doctor, based upon the data that you have reviewed, have you formed an opinion as to whether or not phosphorus levels in the Illinois River Watershed streams and rivers are generally higher than phosphorus levels regionally or across the country?

A. Based on the analysis I did, there's no reason to think that those samples are different than what

we see other places. They're in the same range of what we find many places.
Q. Doctor, could you turn -- do you have a binder in front of you with some exhibits in it?
A. Yes.
Q. Okay.
MR. GEORGE: Your Honor, hopefully one has been provided to you and counsel has one.
Q. (By Mr. George) Could you turn to tab 1 in that notebook, please, and find Tyson Defendant Demonstrative 355.
A. Yes.
Q. Doctor, did you prepare this demonstrative exhibit?
A. Yes, it was prepared under my direction.
Q. And what data is set forth in this exhibit?
A. This would be the median total phosphorus concentration in streams at different locations and from different studies.
THE COURT: Before we go any further, Mr. George's question asked you whether or not you had an opinion regarding phosphorus levels being generally higher than phosphorus levels regionally or across the country. Just so I have an overview before we get into this, let's focus on this

1 particular ecoregion.
2 Are, in your opinion, phosphorus levels in
3 the IRW generally higher than phosphorus levels
4 within the ecoregion?
5 THE WITNESS: For the most part, I would
6 say that that's true.
7 THE COURT: They're higher --
8 THE WITNESS: They are higher than the
9 ecoregion --
10 THE COURT: That was a compound question.
11 I wanted it to be a little clarified. Go ahead.
12 MR. GEORGE: Thank you, Your Honor.
13 THE COURT: Go ahead.
14 Q. (By Mr. George) Dr. Sullivan -- and I'm glad
15 His Honor asked that question, because we were going
16 to walk through this exhibit which I think will
17 illustrate exactly that point.
18 Dr. Sullivan, can you walk us through Tyson
19 Defendant Demonstrative 355 and explain what it
20 shows in terms of the comparison between phosphorus
21 levels and streams and rivers in this watershed to
22 the other data that was available.
23 A. Okay, I'll do my best. It's a little bit of a
24 complicated plot. In the middle, we have the two
25 brown bars that are the median from Dr. Olsen's

master database. We've got a base flow bar, and we've got a bar to represent all flow. So that gives an idea from the thousands of samples that Dr. Olsen collected in the IRW what the levels were. Then the two to the right of that were from streams that were analyzed by Dr. Stevenson in his biological studies.

And he sampled, I think it was four or five -- I think it was four points in time. And the point in time would have been, say, the spring, for example, in a year like 2006. So he had about four points in time. And I reported his upper and his lower so we'd see what kind of range he picked up in terms of median phosphorus.

Q. What were his ranges?

A. From essentially 0.6 to 0.8.

Q. Doctor, with respect to Dr. Olsen's water quality data, what were the ranges of medians in terms of phosphorus concentration within that dataset for the Illinois River Watershed?

A. They were both about 0.6.

Q. And if you could continue explaining how those values relate to the other available data.

A. Okay. So those values compare to a nationwide survey. We can look at two nationwide surveys.

We've got the one on the far left, that's the USGS survey. And the median concentration there would be about double what we have in the IRW. Then we could go to -- so that would be the one for the U.S. Then we would go --

Q. Let me stop you there, Doctor. The value for the United States of .12 milligrams of liter for total phosphorus, is that what it sounds like, a nationwide survey of streams?

A. It's a nationwide survey of rivers, 250 rivers.

Q. Thank you.

A. So the minimum size was -- I believe it was a thousand square kilometers. That's quite a bit smaller than the IRW, but it's still a good-size system. So those are rivers.

Q. Just so we're clear, Doctor, how do the phosphorus levels reported by the State's experts for the Illinois River Watershed streams and rivers compare to the median value nationally for rivers?

A. The IRW is about half of the national level.

Q. Thank you. If you could continue with the discussion of the USGS and OWRB dataset.

A. Those data were 563 sites in Oklahoma. There were just four Arkansas sites. So it's principally an Oklahoma database. I think this points out an

important issue, is that the result that you get depends partially on what size stream you're looking at in many cases. That's not always the case, but oftentimes that's the case.

And so on the larger streams, fourth order and larger, it was actually fairly close to the USGS number. But then on the smaller streams, it was lower, and it would depend on how steep those streams were.

For perspective, the IRW where it flows into Lake Tenkiller is a seventh-order stream. So that's a bit bigger than the fourth and higher here.

Q. Doctor, if we could turn now to the Wadeable Streams Assessment information that's shown here. Did you have available a database from EPA in connection with this Wadeable Streams Assessment?

A. Yes.

Q. Is that, again, a national database?

A. Yes. It's another database that was selected with a statistical basis.

Q. I notice you have two different median values reported from that dataset for your comparisons here. Could you explain that?

A. Yes. I picked out the sites in Oklahoma and Arkansas. There were 57 of those, so it's quite a

few. But I do need to provide the caveat that the study was not designed such that the data from any one state would be statistically representative of that state. But, nevertheless, we have quite a few sites, so I think it's very illustrative.

Q. What were the median phosphorus concentrations in the 57 sites in this survey in Oklahoma and Arkansas?

A. They were about .05.

Q. How does that compare generally to the phosphorus concentrations reported by Dr. Olsen and Dr. Stevenson for the Illinois River Watershed?

A. Very similar.

Q. Now, I notice -- and I think this gets to His Honor's question. That the last bar on this exhibit is described as Ozark and Ouachita segment of the SA ecoregion. Do you see that?

A. Yes.

Q. What is the SA ecoregion?

A. That's the Southern Appalachian ecoregion. The thing we have to be careful of with ecoregions is that there are multiple schemes that are used. So the ecoregion scheme that was used for EPA's Wadeable Stream Assessment that was published in 2006 was what's called an Omernik Level 1 ecoregion.

So they're fairly large.

The ecoregion scheme that was used in the Wadeable Stream Assessment that was published by EPA in 2006 was what's called an Omernik, a person's name, Omernik, O-M-E-R-N-I-C-K, Jim Omernik. Omernik Level 1. So those are large.

The southern Appalachian ecoregion that they used includes the IRW, the Ozarks, and Ouachita, but it extends all the way up to Pennsylvania. So it's quite a large ecoregion.

Then there are level 2 and level 3 ecoregions as well. The level 3 ecoregion is a much finer scale. That would be -- the Ozark area would be a level 3.

Q. Is that the ecoregion in which the Illinois River Watershed is situated?

A. It's situated in both. It depends on what scale you're looking at. Then there are other regions, too, that are maintained by the Forest Service that are different from Omernik. But depending on which level you're looking at, the answer is yes.

Q. Doctor, with respect to the Ozark and the Ouachita segments of that ecoregion, what was the reported phosphorus concentration median value

within that dataset?
A. That was about .01.
Q. And do you agree that's lower than the phosphorus concentrations that are reported in the data by Dr. Olsen and Dr. Stevenson for the Illinois River Watershed?
A. Yes, I do.
Q. Okay. Doctor, did you evaluate the land uses within the watersheds that comprise the value of .011 phosphorus in the Ouachita and Ozark segments of the ecoregion?
A. Yes, I did.
Q. How did those land uses, in terms of development and pasture versus forest, compare to the Illinois River Watershed?
A. Well, the big difference is the amount of forest. The amount of forest is a really important variable in looking at phosphorus in streams, is how much forest is in your watershed. If the watershed is forested, you typically -- not always, but typically -- will have much lower levels of phosphorus in the water than if your watershed has other land uses that are more impacted by people and their animals: Urban areas, rural residential areas, agricultural areas of all types. So that's

not a surprise.

The level of forest in the watersheds that were sampled by EPA in this study, I think that the average was about 72 percent of the watersheds that were included in that Ozark/Ouachita were forested.

Q. How does that compare to the percentage of forestland in the Illinois River Watershed?

A. Illinois River Watershed forest is much lower, it's in the 40s; maybe 43, 45 percent, something like that.

Q. Does that difference in percent forest have any impact on your comparative analysis and the conclusions you draw from this reported value for the ecoregion of .011?

A. Well, it does. It's partially a function of how much forest you have, and it's also partially a function of the watershed area. The watersheds that were included in the EPA study tended to be very small. They were all quite a bit smaller than the IRW, but they tended to be a very small fraction of the size of the IRW.

Q. How does the watershed size impact the relationship one would expect to see with phosphorus concentrations?

A. Well, in larger watersheds, you're far more

likely to be picking up agricultural and urban lands as you move downslope. The typical situation in the United States is that if you're looking at your watersheds, the top sections -- if you're in a forested region or generally forested region, the top sections of your watershed are most likely to be forested and on steeper slopes. Then as you move downhill to lower elevations, you tend to get more flat terrain that's more suitable for agriculture.

So in the larger watersheds that pick up that additional real estate downslope, you're more likely to get more urban and agriculture development.

I want to point out something that's really important in this evaluation is that the IRW is in a lot of ways upside down in the sense --

MR. BULLOCK: I'm going to ask that the witness restrain himself to only ask questions -- answer the question asked rather than giving long soliloquies.

THE COURT: Sustained. Mr. George, go ahead.

Q. (By Mr. George) Dr. Sullivan, is there another aspect of difference between this watershed and the watersheds included in the ecoregion data that you

looked at that you believe is important and may explain some of the differences?

A. Yes. I think this business of the IRW being, to some extent, upside down and that the more typical pattern -- it's not universal, by any means, but the more typical pattern is in the watershed, you have your forested land at the top and steeper slopes, and as you move downhill, if you're going to have ag lands, you'll pick it up generally at the lower elevations that tend to be flatter. Same thing for the urban areas. That's the typical pattern that I'm used to seeing in lots of places around the country and lots of studies.

In the IRW, in contrast, most of the urban development is concentrated at the very top of the watershed. And so you have urban impacts influencing the headwaters of the system. And then as you start to move downstream, you're picking up more and more of the agricultural influences.

Actually, most of the forests are the furthest downstream. So you have -- whatever pollutants might be associated with human activity, you're seeing them at the top, in the beginning, which is the opposite of what we normally find.

Q. Doctor, when I look at Demonstrative 355, I

notice on the vertical axis that your analysis is based upon total phosphorus; is that right?
A. That's correct.
Q. Why did you use total phosphorus in your analysis?
A. For multiple reasons. I think the most important one is because the water quality standard that's scheduled to take effect in a couple of years in the IRW is based on total phosphorus, and that's what this lawsuit is about. So I mean, that was good justification.

But in addition to that, when I'm looking for data, there typically are more data available for total phosphorus because it's more commonly measured than other forms, like soluble reactive phosphorus or other forms of phosphorus.

Then the final issue is that, to some degree, the forms are interconvertible. I didn't do calculations to evaluate how long that would take or the way that might occur, but there are interconversions that can take place, so if you do total phosphorus, then you're capturing all of the phosphorus that's there.
Q. Doctor, did you also undertake any comparison of phosphorus concentrations in streams and rivers

in the Illinois River Watershed to phosphorus concentrations reported for streams and rivers throughout the state of Oklahoma?

A. Yes, I did.

Q. And what sources of data did you use in that analysis?

A. I used EPA STORET, Oklahoma Water Resources Board and U.S. Geological Survey.

Q. Doctor, in that analysis, that comparative analysis, did you compare individual samples or did you aggregate the data?

A. I aggregated the data.

Q. Why did you do that?

A. So that we could see the spatial patterns. I'm interested in what the phosphorus concentrations are like at different locations. And it's a much more robust analysis if you include a number of data points for each location.

There are many reasons why you might see a particularly high or particularly low value for any parameter, including phosphorus. So to best capture of what's going on at a particular location, you'd like to have multiple samples. And so that's why I aggregated them.

Q. That comparative analysis for the statewide

work in Oklahoma, did you compute something that's referred to as geomeans?
A. Yes, I did.
Q. What is a geomean?
A. It's also called a geometric mean. It's a measure of central tendency for the data. There are basically three measures of central tendency that are commonly used in environmental data. There's a fourth, but it's very seldom used. One is the mean or the average. There's the median, and the third is the geomean.
Q. Doctor, are you aware that the .037 criterion that you mentioned earlier is expressed as a geometric mean, or geomean?
A. Yes.
Q. Do you have an understanding as to whether, for that purposes of that standard, there is some time frames around the number of samples over a period of time to compute the geomean?
A. That's correct.
Q. What are those time constraints and requirements?
A. Five or more samples over a 30-day period.
Q. Doctor, did you limit your geometric mean analysis of the statewide phosphorus concentration

data to samples collected at a site within 30 days?
A. No, I did not.
Q. Why not?
A. Well, the main reason I didn't was because I wouldn't have had enough data points to do the spatial analysis that I was trying to do. And if I had had enough data points, I would be restricting them further by eliminating a lot of my data by that restriction. Again, when you have more data, it's a much more robust analysis of spatial patterns.
But the final reason was that it's really not necessary or useful for me to do that. Environmental studies are typically not conducted that way for looking at spatial patterns. I was not trying to evaluate regulatory compliance of any sort. I was trying to evaluate the spatial patterns and available data.
Q. You used a phrase that I'm not sure has been used in this case yet, but "spatial patterns." Could you, for the benefit of the record, describe what that is.
A. Spatial pattern analysis is something that I do quite a lot of in my field. And it's a way of looking at the data that we have, either we collect it ourselves or we obtain it from government

agencies or other groups, and trying to see how the concentrations -- typically what we look at, how those concentrations change across space. Are they going up as you move downhill? Are they going down? Are they high in one region? Low in another region? What are the patterns in the concentrations expressed as a measure of central tendency across space? And how are those patterns related to the things that we believe might influence those patterns, different kinds of land uses, different activities, different pollution sources or whatever?

Q. Doctor, did you include in your report maps plotting the geometric means for total phosphorus levels in streams and rivers across the state?

A. Yes.

Q. Could you turn in your notebook or binder to tab No. 2.

A. Yes.

Q. And could you identify for the record what's been marked as Defendants' Joint Exhibit 2221.

A. Yes. That's a map from my report.

Q. And was this figure prepared under your direction?

A. Yes, it was.

Q. Doctor, could you identify the source of the data that's represented on this figure?
A. Oklahoma Water Resources Board.
MR. GEORGE: Your Honor, I move for the admission of Joint Exhibit 2221.
MR. BULLOCK: No objection.
THE COURT: Defendants' 2221 is admitted.
Q. (By Mr. George) Doctor, could you explain how this figure was prepared and explain what it shows in connection with your spatial analysis.
A. Yes. The -- on the map of Oklahoma, there are small black dots at the base of each of these bars. And those dots represent the locations where samples were collected. And we plotted all the locations where there were five or more samples available to evaluate that were collected during the time period between 2000 and 2007, and then the data for each location would be represented as a geomean of those available data.
So each location has a bar. The location of the site is identified by the black dot. The height of the bar is proportional to the concentration. And the scale bar is down at the bottom middle. It shows you the height of a bar that would be 0.5 milligrams per liter of total

phosphorus. Then there's an inset map that blows up the IRW so you can see it a little bit better.
Q. Doctor, the Illinois River Watershed and the data from OWRB related to that watershed is shown on this map; is that right?
A. That's correct.
Q. Doctor, what does this analysis show about the levels of total phosphorus in streams and rivers in the Illinois River Watershed compared to levels of total phosphorus in other streams and rivers throughout the state of Oklahoma?
A. Well, it shows a number of things. One is, I neglected to point out in your earlier question, that the color of the bars has some meaning. If the bar is colored green, that means that the geomean concentration was below the .037 value. If the bar was orange, that was above the .037 value.
Q. Let me stop you there, Doctor. You're not suggesting, are you, that the .037 standard applies throughout the state of Oklahoma, are you?
A. No. The .037 is a scenic river standard. It's applicable in the IRW and some other places.
Q. Continue on with your answer, please.
A. So in terms of spatial patterns, we see several things. Most important to me in the context of this

case is that what we see for geomean concentrations in the IRW are not unusual compared to geomean concentrations elsewhere throughout the state. That would be the first thing.

The second thing is that where there is evidence that there are particularly high concentrations, they're not in the IRW but, rather, in the central part of the state. That would be the second conclusion. I can go into more detail if you'd like me to.

Q. Let me ask you to focus on the eastern third of the state of Oklahoma in this map, Dr. Sullivan. Based upon your review of the data, have you formed an opinion as to whether the waters in the eastern third of the state of Oklahoma demonstrate markedly higher phosphorus concentrations when compared to the rest of the state?

A. They do not.

Q. As part of your work in this case, did you evaluate levels of poultry production across Oklahoma?

A. Yes, I did.

Q. What did you learn as a result of that evaluation?

A. That the poultry densities are highest by a lot

in the eastern part of the state.
Q. Did you include a figure in your report that shows a representation of that data?
A. Yes, I did.
Q. Let me ask you to turn to tab 6, please.
A. Yes.
Q. And let me ask you to identify for the record what's been marked as Defendants' Joint Exhibit 2225.
A. That's a figure from my report.
Q. Okay. Was this report prepared under your direction?
A. Yes, it was.
Q. And what data is shown on this report?
A. Total poultry numbers by county throughout Oklahoma for the year 2002.
Q. What's the source of that data?
A. The Oklahoma 2002 Census of Agriculture.
MR. GEORGE: Your Honor, I move for admission of Defendants' Joint Exhibit 2225.
MR. BULLOCK: No objection.
THE COURT: Defendants' 2225 is admitted.
Q. (By Mr. George) Dr. Sullivan, does this map illustrate what you were just saying regarding poultry production being largely confined to the

eastern third of the state?
A. Yes, sir.
Q. Now, let's go back, if we can. And could you turn to tab 3. Find what's been marked as Defendants' Joint Exhibit 2222.
A. Yes.
Q. And could you identify that document for the record, please.
A. That's a figure from my report.
Q. Was this figure prepared under your direction?
A. Yes.
Q. And does it show some data represented on the figure?
A. Yes, it does.
Q. What's the source of that data?
A. EPA STORET.
Q. Doctor, does this figure follow the same format as Defendants' Exhibit 2221, just uses a different dataset?
A. That's correct.
MR. GEORGE: I move for the admission of Defendants' Joint Exhibit 2222.
MR. BULLOCK: No objection.
THE COURT: 2222 is admitted.
Q. (By Mr. George) Doctor, why do we have two maps

of the state of Oklahoma with these bars of phosphorus concentrations?
A. There are two different data sources.
Q. And the data source with respect to Defendants' Joint Exhibit 2222 is EPA STORET; is that right?
A. That's right.
Q. Doctor, what conclusions do you draw from your review of this data?
A. The same conclusions that I drew from the Oklahoma Water Resources Board data, that the concentrations of total phosphorus expressed as a geomean are not unusual in the IRW compared to the rest of the state. In fact, where we do see a pattern -- a spatial pattern of somewhat higher values, it's in the central part of the state.
Q. If you could turn back to tab 2, which is Defendants' Joint Exhibit 2221, and look at the inset of the Illinois River Watershed. Can you find that, please.
A. Yes, sir.
Q. I notice that there is one bar in this dataset that appears to be higher than the rest. Do you see that?
A. Yes.
Q. What's the location of the water quality

sampling site that is reflected by those higher concentrations of phosphorus?
A. It's on Sager Creek about three miles below the Siloam Springs wastewater treatment plant.
Q. Now if we could turn to tab 4, please. If you could find Defendants' Joint Exhibit 2223.
A. Yes.
Q. Could you identify that document for the record, please.
A. It's a figure from my report.
Q. And was this figure prepared under your direction?
A. Yes, it was.
Q. Does this figure involve the same formatting of data statewide that we've seen in the prior two exhibits?
A. Yes.
Q. Doctor, what's the source of the data shown on this figure?
A. U.S. Geological Survey.
MR. GEORGE: I'd move for the introduction of Defendants' Joint Exhibit 2223.
MR. BULLOCK: No objection.
THE COURT: 2223 is admitted.
Q. (By Mr. George) I note on this map we have

fewer bars than some of the ones we've seen previously. Do you have an explanation for that?
A. There's just fewer data available in terms of number of locations with the USGS data than the other two data sources.
Q. Doctor, do you draw any conclusions from this dataset regarding how phosphorus levels in the watershed compare to phosphorus concentrations statewide?
A. I wouldn't draw conclusions in a spatial analysis from this dataset. There simply are not enough data points represented to do that. But I would say that they're not inconsistent with what we've seen elsewhere.
Q. Last map, Doctor. If you could turn to tab 5 in your binder and find Defendants' Joint Exhibit 2234.
A. Yes.
Q. Can you identify for the record this exhibit.
A. It's a figure from my report.
Q. Was it prepared under your direction?
A. Yes.
Q. And, Doctor, can you identify the source of the data that is shown in Defendants' Joint Exhibit 2234.

A. This is a combination of all the data shown on the three previous figures with data from EPA STORET, Oklahoma Water Resources Board and USGS.

Q. Why, Doctor, did you combine all of that data into one map?

A. I think it's, again, the more data you have, the better you can resolve your spatial patterns and see what's going on spatially across the area of interest. There's no reason why they have to be separated simply because they're different datasets. I thought it was useful to look at them separately, but then a combined map is -- I think is even more illustrative simply because you've got more data.

MR. GEORGE: I move for the introduction of Defendants' Joint Exhibit 2234.

THE COURT: Any objection?

MR. BULLOCK: No objection.

THE COURT: 2234 is admitted.

Doctor, in terms of comparison and -- wouldn't a more helpful comparison have been those waterbodies within this Ozark subecoregion? Oklahoma has quite a variety of different hydrological systems.

THE WITNESS: Yes.

below these wastewater treatment plants?
A. Yes, I did.
Q. And what were those opinions or conclusions?
A. At all three sites, the concentration of total phosphorus in the stream water, all three sites above the wastewater treatment plants were all relatively low. They were in the vicinity of the .037 benchmark standard value.
And in all three cases, the samples collected below the wastewater treatment plant were substantially higher than that .037 standard.
Q. Based upon those observations, did you draw any conclusions about the impact of wastewater treatment plants on phosphorus concentrations?
A. Well, this indicates to me that these plants are important sources of phosphorus to the stream. And beyond that, that the quantity of phosphorus is actually quite high for two of them. The Siloam Springs one is over three milligrams per liter. That's an extremely high value of phosphorus.
Q. Doctor, these three facilities, do I understand that they actually have pipes that discharge into the river?
A. Correct.
Q. Is there any facility, wastewater treatment

plant or sewage treatment facility in the watershed that is not designed to be a discharging facility?
A. One that I'm aware of, yes.
Q. Which one is that?
A. It's at Watts.
Q. What type of sewage treatment system is present in Watts?
A. It's a total retention lagoon system.
Q. Total retention, does that mean, Doctor, that all of the wastewater and all of the phosphorus in that wastewater from the city of Watts stays in that lagoon?
A. No. The wastewater is periodically, after partial treatment, land-applied on a plot that's adjacent to the plant. It's sprayed on the plot.
Q. Are you familiar with the location of the Watts sewage lagoon and this application area that you just described?
A. Yes.
Q. And is it in close proximity to the Illinois River?
A. Yes, it is.
Q. Now, Doctor, as part of your work in this case, did you retrieve any aerial imagery of the Watts lagoons and the application area?

MR. GEORGE: I actually was trying to follow up on the questions the court asked, because I think they are important. And that was the purpose of the question, Your Honor.

THE COURT: I'm going to sustain. I probably went farther than I ought to have.

MR. GEORGE: No, I wanted to address Your Honor's questions, if I could, but I appreciate the court's ruling.

THE COURT: No, I appreciate it.

Q. (By Mr. George) Doctor, let's turn to another comparative analysis that you did in your work in this case. Did you conduct an evaluation of phosphorus levels in Lake Tenkiller as opposed to phosphorus levels in the streams and rivers?

A. I compared -- not quite -- a comparison with the lakes rather than streams and rivers.

Q. I'm sorry. Let me clean up my question. Doctor, did you conduct an evaluation of the phosphorus levels in Lake Tenkiller as opposed to the phosphorus levels in the rivers and streams? Did I ask the same question?

A. Yes.

Q. Let me try it again. Doctor, did you compare water quality data for Lake Tenkiller to water

quality data for any other lakes or reservoirs?
A. Yes, I did.
Q. Did you focus on other lakes in the state of Oklahoma?
A. No.
Q. Okay. Why not?
A. I wanted to follow up on some of the comparisons that I had done in those larger regional comparisons. And Dr. Connolly was focused on a comparison with the rest of Oklahoma, and I didn't want to duplicate the work he was doing.
Q. Did you have available some data on other reservoirs in what's referred to as the central states region?
A. Yes.
Q. And for the benefit of the record, what geographic area is comprised in the central states region, just generally?
A. Well, for the reservoirs, those actually were not focused on the central states together. They were focused on the state of Missouri.
Q. Okay. What data did you have available on reservoirs from the state of Missouri?
A. Data in a publication by Jones, et al. in 2004.
Q. Doctor, is this the same Jack Jones who there's

been some testimony about being a consultant for the State of Oklahoma in this case?
A. I've heard that, but I don't know that for a fact.
Q. Okay. You had this dataset on reservoirs from Missouri. Did you compare that to any water quality data for Lake Tenkiller?
A. Yes, I did.
Q. And, Doctor, did you compare it to water quality data from all of the sampling stations in Lake Tenkiller?
A. No.
Q. Why not?
A. Well, the data represented in the Jones, et al. publication was for 135 reservoirs in Missouri, and they were each sampled at a location near the dam. And that's important when you're comparing information among lakes,
If you're going to collect a sample to characterize a lake, not to do an in-depth study across the lake.
But to characterize a lake for a regional study, you typically sample at one location, that's the deepest part of the lake. It's called the index sample by EPA. That's how they do all their broad

surveys. In a reservoir, the deepest part of the lake is generally quite close to the dam.

And this particular study I was comparing to -- had data that were collected close to the dam. So that would be analogous to the index sample of EPA and analogous to the LK-01 site in the Tenkiller database.

Q. Doctor, based upon the analysis you've just described, how do the phosphorus levels at this location in Lake Tenkiller compare to the phosphorus levels in this report on Missouri reservoirs at similar locations?

A. Well, the median concentration in the Missouri reservoirs was quite a bit higher than the data that were presented by the plaintiff's Drs. Cooke and Welch in their report for the years 1974, '92, '93, 2005, 2006 and 2007.

Q. Doctor, did you include in your report a figure that displayed the data that we've been discussing?

A. Yes.

Q. Could you turn in your notebook to tab 7.

A. Yes.

Q. Could you find Defendants' Joint Exhibit 2275.

A. Yes.

Q. Could you identify this figure for the record.

A. It's a figure from my report.
Q. Was this figure prepared under your direction?
A. Yes, it was.
Q. Does it contain the water quality data from lake station 1 in Tenkiller and the 135 Missouri reservoirs that we've just been discussing?
A. Yes. The point of that was to compare apples with apples on the plot.
MR. GEORGE: Your Honor, I'd move for the introduction of Defendants' Joint Exhibit 2275.
THE COURT: Any objection?
MR. BULLOCK: I'm going to object to this in terms of hearsay as to representing what this other study says about 135 Missouri reservoirs.
MR. GEORGE: May I respond?
THE COURT: Yes.
MR. GEORGE: Neither Dr. Sullivan nor this exhibit is offering hearsay testimony about any conclusions or statements made in this study. He is simply using the data that is available, which is common practice for scientists, and I believe, therefore, qualifies under Rule 703.
MR. BULLOCK: It's not his data and he has not done the analysis, and so to arrive at what he claims to be the median value clearly is hearsay

from somebody else's work and calculations.

THE COURT: All right. Is it clear -- did the witness on the stand come to the conclusion regarding the median or was that reported?

MR. GEORGE: Let me lay the foundation, Your Honor.

Q. (By Mr. George) Dr. Sullivan, is the median value that is shown on Defendants' Joint Exhibit 2275 the product of a computation that you performed?

A. No.

Q. Okay. Is it the value that is reported with the sampling data in this study?

A. Yes.

Q. Okay.

MR. GEORGE: There you go, Your Honor.

THE COURT: I believe it's permissible under 703 for an expert -- Exhibit 2275 is admitted. What are we going to do since we're halfway between another witness? Is there some sort of agreement as to whether or not we're going to get the previous witness or attempt to get through with the previous witness today?

MR. GEORGE: Mr. Elrod and I were going to fight it out. No, actually, Your Honor, I'm about

five minutes away from a natural breaking point in the direct. If it's appropriate and the court is agreeable --

THE COURT: That would be fine. We're going to go back, correct?

MR. ELROD: Correct.

THE COURT: Mr. George.

MR. GEORGE: Thank you, Your Honor.

Q. (By Mr. George) Doctor, can you, using Defendants' Joint Exhibit 2275, explain how the phosphorus concentrations that you had available for lake station 01 and Lake Tenkiller compare over time to the reported values from the 135 Missouri reservoirs?

A. Yes, sir. During the period -- well, the three data points for 1974 through 1993 were all relatively comparable, and they were about .025 milligrams per liter of TP.

The most recent three years that were sampled by the plaintiffs and included by Drs. Cooke and Welch in their report for 2005, 2006 and 2007, they were all right around or right above .01. Both the values from the 1970 and through 1990 periods of time and the more recent values, they're both substantially less than the median.

In fact, the most recent values are substantially less than the 25th percentile of the Missouri data which is represented by that bar that extends above and below the median point.

Q. Doctor, did you limit your comparison of phosphorus levels in Tenkiller with other reservoirs to the 135 Missouri reservoirs, or did you look elsewhere?

A. I'm sorry, can you repeat that?

Q. I'm sorry. Did you, as part of your work in this case, provide a comparison of water quality at lake station 01 with any other data on reservoirs?

A. Yes, I'm sorry. Yes, I did that.

Q. And, Doctor, could you identify the other data that you had available to you to provide further insight into this comparative analysis?

A. Yes. It was the dataset from the central states. They were -- the samples were collected in Missouri, Iowa, Nebraska, Kansas and the southern part of Minnesota. It was in the study published by Graham, et al. in 2004.

In this case, these were not restricted to reservoirs. A reservoir is a type of lake. These are lakes.

Q. Doctor, within that other dataset that you

reviewed, did you have available any data on lakes in the Ozark Highlands?
A. I -- I'm not sure, to tell you the truth, if any of the Missouri data were in the Ozarks.
Q. I'm referring now to the central states study, Doctor. And perhaps if you could look at tab 8 in your binder and find Tyson Defendant Demonstrative 35 -- I'm sorry, 354.
A. Yes, I have it.
Q. And, Doctor, does this demonstrative -- first of all, was it prepared by you?
A. Under my direction, that's correct.
Q. And, Doctor, does it report the data that you had available from this other source on lakes and reservoirs outside of Missouri?
A. Yes.
Q. And does it include data on a region --
MR. BULLOCK: Judge, before we get any further into this, the same objection as previous. This clearly is hearsay being represented for the truth of the matter asserted.
MR. GEORGE: Your Honor, it would be the same response. The witness has simply taken data that's publicly available and has analyzed that, as experts are permitted to do. He's not going to

testify as to any conclusions or statements drawn by the authors in any study or report.

THE COURT: Overruled. Go ahead.

Q. (By Mr. George) Doctor, could you walk us through Tyson Demonstrative 354.

A. Yes. If we go to the green bar in the middle of the figure, those would be the same data from the Jones, et al. study we just talked about. That's placed there for context, as are the three blue bars on the right side, which would be the Lake Tenkiller data from lake site 01 from Cooke and Welch from their expert report.

The orange bars on the left side of the figure are different subsections of that study within the central states, so we have median total phosphorus concentrations reported for four different regions including the Ozark Highlands at the lower end on the left all the way up to what they call the Western Lake section on the right.

Q. Since we're creating a written record here, could you identify some of the numeric values on the median phosphorus concentrations, beginning in the data that you had available for lake station 1 in Tenkiller and then continuing on through the other available data.

A. Yes. The Tenkiller data for lake station 1, they were all around or a little bit above .01 milligrams per liter of total P. .01, .011 and .012, so very similar.

The Missouri values, again, were close to .04 for median. Then for the Graham, et al. study, the values ranged from Ozarks Highlands, which was about .012; Osage Plains, which was .045; dissected Till Plains, which is .079; and Western Lake section, which is .141.

Q. Doctor, the lowest value I see on there outside of the data reported for Lake Tenkiller is the .012 for Ozark Highlands; is that correct?

A. That's correct.

Q. How do the Lake Tenkiller data that's shown on this demonstrative compare to that value?

A. The recent values for Lake Tenkiller are very, very similar to that value.

Q. Doctor, what conclusions, if any, do you draw from the data that you have reviewed regarding lake phosphorus concentrations as compared to the Lake Tenkiller data?

A. I see no evidence that Lake Tenkiller is particularly unusual in terms of having high phosphorus; and, if anything, is actually low

compared to other lakes and reservoirs with the exception of Ozark Highlands, where it's comparable.
Q. Once again, Doctor, you applied your analysis in this demonstrative to the data that's available at the deepest part of the lake, correct?
A. In this study, they didn't specify that it was collected from the deepest part of the lake. They specified they were mostly pelagic samples, which is open-water samples. So we don't know to what extent is exactly analogous, you know, a la all EPA style of the index site. But clearly it's skewed in that direction based on how it was described.
Q. Doctor, I believe you have reviewed the testimony of Dr. John Connolly regarding the riverine portion of Lake Tenkiller. Did you see that testimony?
A. Yes, I have.
Q. Have you conducted any particular comparative analysis on the riverine section of the lake?
A. No, I have not.
MR. GEORGE: Your Honor, this is a good place to perhaps reinterject the witness that we were examining before lunch.
THE COURT: Very well. Let's do so.
Mr. Garren, you may resume your

very low STPs.

So my point is, is that there's a lot of fields in that IRW that still need to have phosphorus, whether you apply it as chemical or poultry litter, that's going to need that phosphorus in order to produce the forage they need to sustain the cattle in the watershed.

Q. You voiced -- what you said was that there was some criticism IMPLAN -- let me ask you this question. How widely used is IMPLAN?

A. IMPLAN --

MR. GARREN: Cumulative, Your Honor. He's already described its use.

THE COURT: Overruled. It was a matter on cross-examination.

THE WITNESS: IMPLAN is probably one of the most widely used models there is in the United States. It's used by businesses, it's used by county governments, it's used by state governments. Anytime there's an economic activity that somebody wants to consider, it's used to look at that impact.

Yes, there's lots of people that use the model that don't know what they're doing that produce results that may be a bit unscrupulous, but

MR. ELROD: Yes.

THE COURT: Now would be a good time to take a break. We're halfway through. Let's take our recess.

(Whereupon a recess was had.)

THE COURT: Mr. George, you may resume.

MR. GEORGE: Thank you, Your Honor.

DR. TIMOTHY SULLIVAN,

Called as a witness, being previously duly sworn, testified as follows:

CONTINUED DIRECT EXAMINATION

BY MR. GEORGE

Q. Dr. Sullivan, as part of your work in this case, did you review the sampling program and analysis performed by the State's various expert witnesses?

A. Yes.

Q. And in conducting that review, did you form any opinions as to the appropriateness of their sampling approach for purposes of evaluating potential sources of phosphorus that may impact water quality?

A. Yes, I did.

Q. And what was that opinion?

A. My opinion is that the sampling approach was very inadequate for doing that.

Q. How so?

A. Well, I think it's necessary to explain a little bit about how you might go about identifying sources.

Especially when we're talking about nonpoint sources, there are many different kinds, and they are located in many different places. That requires a very site-specific analysis. You need to bracket what you think might be sources, or your probable sources, and collect samples that will reveal whether they truly are sources or not.

So you would bracket your various land uses and your various activities, which could include your wastewater treatment plants; your urban areas with urban nonpoint source pollution; locations with high densities of cattle; locations with high densities of rural residential housing, septic systems; areas with a lot of road erosion; areas with streambank erosion, and on and on.

There are so many different possible source types. And a proper approach to evaluate that is to bracket those, collect samples above and below the locations of the sources. That's one tool that you can use.

But in terms of the overall sampling program for

the state, I just really didn't see much of that at all. It makes it very difficult to try to evaluate those sources.

Q. Based upon your review of the State's sampling program, did the State focus more closely on a particular source?

A. Yes, they did.

Q. What source, in your judgment, was the focus of the State's sampling?

A. The State's sampling was focused on their assumed linkage between poultry litter and water quality issues, especially phosphorus.

Q. What, if any, impact did that focus or that assumption have on the comprehensiveness of their investigation, in your view?

A. In my view, it wasn't comprehensive at all because there really was very little or, in some cases, no focus on these other issues in terms of where the samples would be collected.

Q. Doctor, as I understand it, one of the things you identified earlier as part of your work in this case is evaluation of potential sources; is that right?

A. That's right.

Q. And the court has heard some testimony from

Q. Doctor, is a mass balance analysis a tool that you have used in your work previously?
A. Yes.
Q. Can you explain what the concept of mass balance means to you.
A. Mass balance means balancing the inputs and the outputs to and from a system. You can construct mass balance on lots of different things.

For this case, the mass balance that was presented by Dr. Engel, calculated by Meagan Smith, was a mass balance on the watershed. So that would look at their estimates of phosphorus coming into the watershed and then phosphorus leaving the watershed primarily at this spillway at Lake Tenkiller.

But you can construct a mass balance on other things. You can construct a mass balance on the drainage water. And for the questions at hand in this case, I think the mass balance on the drainage water is really what's appropriate. What's going into the stream water, what's going into the lake water, what's coming out of the water, that's the mass balance that's really relevant to the case, in my view.
Q. Doctor, do you have an opinion as to whether

the State's mass balance is at all useful in evaluating potential impacts on water quality?

A. I think that a mass balance on the watershed can be of use. I don't really have a problem with somebody constructing one.

The problem I have is the way you use the results of that mass balance. And if you use that to try to say that because my mass balance says more phosphorus is coming into the watershed than is leaving the watershed, you know, therefore, that phosphorus is going into a stream, I think that's a big problem.

I can give you an analogy of that, if you would like.

Q. Sure.

A. If I built a warehouse in Fayetteville and I put 10 million tons of phosphorus in my warehouse and then lock the door, by the lines of argument that I've seen from the plaintiffs in this case, their conclusion would be, therefore, I'm polluting the Illinois River with phosphorus because I am the largest source of phosphorus coming into the watershed.

So it's mass balance on the water, on the drainage water in the stream and in the lake that's

really relevant to the case, not the mass balance -- out of the watershed.

Q. Doctor, you mentioned in your testimony previously land use. Did you evaluate land use in the Illinois River Watershed?

A. Yes, I did.

Q. Could you turn to tab 9 in your binder, please.

A. Yes.

Q. And find what's been marked as Defendants' Joint Exhibit 2238. And can you identify that exhibit for the record, please.

A. That's a map figure from my report.

Q. Okay. And was this map prepared under your direction?

A. Yes, it was.

Q. And can you identify the source of the land use data that is shown on this map?

A. It's the National Land Cover Dataset of EPA.

Q. Doctor, is that data shown geographically on this map?

A. Yes, it is.

MR. GEORGE: Your Honor, I move for the introduction of Defendants' Joint Exhibit 2238.

THE COURT: Any objection?

MR. BULLOCK: No objection.

THE COURT: Defendants' 2238 is admitted.

Q. (By Mr. George) Doctor, using this map, how would you characterize the land uses in the Illinois River Watershed?

A. I think that there are a couple of ways that I would characterize the land uses that are, in my view, quite important. The first one is, it's a patchwork of land use, it's a very interdigitated -- there's a lot of diversity of land uses across -- not the entire watershed, but many portions of the watershed.

Q. Let me stop you there, because you used a word that I'm not familiar with, "interdigitated." What does that mean?

A. If I take my fingers and I take my fingers where they do this, where they're inter -- my digits and put them together, that's -- sorry.

Q. In Arkansas, we could call that intermixed. Are you okay with that?

A. "Intermixed" is good.

Q. Same thing?

A. Same thing.

Q. Go ahead.

A. The other spatial issue that I think is

important is one that I actually mentioned before when I said that the watershed, in some sense, was upside down. And we can see that quite easily with this map because the top of the watershed is to the upper right, that's the main area, the headwaters, the main stem of the Illinois River. And then things move down to the lower portion of Lake Tenkiller.

As we can see on the map, most of the urban land is concentrated at the top, and then we have a fairly high density of agricultural land. And most of our forest land is more towards the bottom, which is the exact opposite of what we typically see.

Q. What impact, if any, does that reality in this watershed have on a scientist's ability to evaluate the impact of different sources of phosphorus?

A. It seriously messes with our ability to do that. The reason is because, as I mentioned before, the land use that's typically associated with your lowest phosphorus values is forest. That's almost universally true.

And at the top of the watershed, if you have urban land use, which is typically associated with one of the highest phosphorus contributors as a land use, and then you move to the agricultural

lands where you also can get more phosphorus than typically from the forest, so what happens is you get relatively high concentrations of phosphorus in the streams right from the beginning.

And that makes it difficult because if you start in the forest and you have low phosphorus, which you don't always, but often, then you move down and you start to pick up other sources, it's easier to identify those, along the lines of what I explained earlier of what I did in Tillamook.

When you start out with high values from the beginning and you've got things that are taking those values in different directions, you have new sources that are coming in at the same time that you maybe have phosphorus settling to the stream bed and that sort of thing. It makes it really difficult to figure out what the sources might be.

Q. Doctor, are you saying it's impossible to evaluate the impacts of different sources in this watershed?

A. No, it's not impossible. It's much more difficult, and it requires a lot more focus, in my view, on site specificity of your approach to tackling the problem.

Q. Doctor, are there sources, point versus

briefly described one of them.
Q. Okay. Doctor, did you prepare a chart showing your analysis of the paired sampling locations for the few wastewater treatment plant locations?
A. Yes.
Q. Could you turn to tab 10.
A. Yes.
Q. And for the record, could you identify what's been marked as Defendants' Joint Exhibit 2240.
A. That's a figure from my report.
Q. And could you identify the source of the data and information that is shown on that figure or exhibit.
A. Dr. Olsen's master database.
Q. And was this exhibit prepared under your direction?
A. Yes.
MR. GEORGE: Your Honor, I'd move for introduction of Defendants' Joint Exhibit 2240.
MR. BULLOCK: No objection.
THE COURT: Exhibit 2240 is admitted.
Q. (By Mr. George) Dr. Sullivan, I notice that there are three facilities that are shown, Stillwell, Prairie Grove and Siloam Springs; do you see that?

A. Right.
Q. There are two bars associated with each of those facilities. What does that represent?
A. The orange bar represents the concentration of total phosphorus in the stream directly above the wastewater treatment plant outflow pipe location.
The blue bar represents that same total phosphorus location but immediately below the wastewater treatment plant location.
Q. And, Doctor, you understand there are more than three wastewater treatment plants in the watershed, correct?
A. Correct.
Q. Why did you focus your analysis on these three facilities?
A. These were the three facilities for which we had the data available for Dr. Olsen's database where -- on the same day he collected these samples. There were one or two other plants where I believe there was one, either the above or the below, but the corresponding data point was not there. These were the only three where we had both above and below.
Q. And, Doctor, did you form any opinions based upon your review of the sampling data above and

below these wastewater treatment plants?
A. Yes, I did.
Q. And what were those opinions or conclusions?
A. At all three sites, the concentration of total phosphorus in the stream water, all three sites above the wastewater treatment plants were all relatively low. They were in the vicinity of the .037 benchmark standard value.
And in all three cases, the samples collected below the wastewater treatment plant were substantially higher than that .037 standard.
Q. Based upon those observations, did you draw any conclusions about the impact of wastewater treatment plants on phosphorus concentrations?
A. Well, this indicates to me that these plants are important sources of phosphorus to the stream. And beyond that, that the quantity of phosphorus is actually quite high for two of them. The Siloam Springs one is over three milligrams per liter. That's an extremely high value of phosphorus.
Q. Doctor, these three facilities, do I understand that they actually have pipes that discharge into the river?
A. Correct.
Q. Is there any facility, wastewater treatment

plant or sewage treatment facility in the watershed that is not designed to be a discharging facility?
A. One that I'm aware of, yes.
Q. Which one is that?
A. It's at Watts.
Q. What type of sewage treatment system is present in Watts?
A. It's a total retention lagoon system.
Q. Total retention, does that mean, Doctor, that all of the wastewater and all of the phosphorus in that wastewater from the city of Watts stays in that lagoon?
A. No. The wastewater is periodically, after partial treatment, land-applied on a plot that's adjacent to the plant. It's sprayed on the plot.
Q. Are you familiar with the location of the Watts sewage lagoon and this application area that you just described?
A. Yes.
Q. And is it in close proximity to the Illinois River?
A. Yes, it is.
Q. Now, Doctor, as part of your work in this case, did you retrieve any aerial imagery of the Watts lagoons and the application area?

A. Yes.
Q. Can you turn to Defendants' Joint Exhibit 1454, please.
A. Yes.
Q. Can you identify for the record what is shown in the photograph in Defendants' Joint Exhibit 1454.
A. Yes, it's a figure from my report.
Q. And, Doctor, does this photograph accurately represent the location of the Watts lagoon in relation to the Illinois River?
A. Yes, I believe so.
MR. GEORGE: Your Honor, I move for introduction of Defendants' Joint Exhibit 1454.
MR. BULLOCK: No objection, Judge.
THE COURT: 1454 is admitted.
Q. (By Mr. George) Doctor, can you describe generally the features of this photograph and the facility that are important in the consideration of whether it would be a potential source of phosphorus.
A. Well, on the photograph, the land area that's above the three-basin lagoon system, the area above that is -- where you see circles on it, that's the irrigation area where the wastewater is applied to

the land periodically. And then the dark line across the top from left to right, that's the main stem Illinois River Watershed close to the bridge at Watts.

Q. Doctor, has the Watts facility been identified as a potential source of nutrients to the Illinois River?

A. Yes. They've had some problems at the facility. There was one instance that was documented by Dr. Ron Jarman for the defendants, and he provided to me a copy of some of the documentation of that, where the City of Watts was actually fined for leakage and improper distribution of the water, a problem that they had at the site.

Q. Do you know approximately how close the irrigation field for this lagoon system is to the Illinois River?

A. It's about a hundred feet, more or less.

Q. Doctor, did any of the State's experts offer any analysis of the potential impact on phosphorus levels in the Illinois River from the Watts sewage lagoons?

A. Nothing that I saw.

Q. Based upon the data that you've reviewed, should this potential source have been considered

and evaluated?
A. Yes.
Q. Doctor, did you review any data regarding sewage bypasses at point source facilities in the watershed?
A. Yes.
Q. For the benefit of the record, just briefly, what is a sewage bypass and how can it introduce phosphorus?
A. A sewage bypass can occur from a number of different problems in a wastewater treatment system, but it's a situation whereby raw sewage or partially treated sewage is accidentally released. So it can be released by a broken pipe or a broken pump station or excessive rain overwhelming the system.
There are different ways that bypasses can occur, but it will introduce either raw or partially treated sewage into the environment, which may or may not flow into a stream.
Q. Doctor, would that be phosphorus that is in addition to what comes out of the pipe of the facility that is reported that we've had a lot of testimony about?
A. Correct.
Q. Doctor, there's some evidence in the record of

this case regarding sewage bypasses. And I don't intend to take you through all of that for -- out of respect for the court's time. But based upon the data and information that you've reviewed, are the sewage bypasses a potentially significant source of phosphorus?

A. Well, they're certainly a potential source.

Q. Did any of the State's experts offer any analysis of the potential impact of sewage bypasses on phosphorus levels in the Illinois River?

A. Nothing that I saw.

Q. In your opinion, should that source or potential source have been considered?

A. Yes.

Q. Now, Doctor, you're familiar with Oklahoma's scenic rivers criterion of .037?

A. Yes, I am.

Q. And do you have some understanding or familiarity as to which stream segments that standard applies to in the Illinois River Watershed?

A. Yes, it's the scenic rivers.

Q. Did you prepare -- let me ask this question first, Doctor. As part of your work in this case, did you identify the discharge locations of all of the wastewater treatment plants?

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Q. Did you prepare -- let me ask this question first, Doctor. As part of your work in this case, did you identify the discharge locations of all of the wastewater treatment plants?

A. Yes.
Q. Is there any scenic river stream segment in the Illinois River Watershed that is not downstream from one or more of these discharging wastewater treatment plants?
A. No.
Q. Did you prepare some demonstratives to illustrate that?
A. Yes, I did.
Q. And could you turn to tab 12.
A. Yes.
Q. For the record, could you describe what is Tyson Demonstrative 60.
A. It's a map of the Illinois River Watershed. The larger streams are outlined in red from the locations of the wastewater treatment plants which are represented by the triangles, and it shows the flow path. The red lines would be the flow path of water down the streams from the locations of the wastewater treatment plants to the location of Lake Tenkiller.
Q. Doctor, could you turn to the next tab which has been marked as Tyson's Defendant Demonstrative 61. Did you prepare this demonstrative?
A. Yes.

Q. Could you identify the information that is illustrated on that demonstrative.
A. It shows the locations of the designated scenic rivers: Barren Fork, Illinois River, and Flint Creek.
Q. And so, Doctor, does comparing these two demonstratives that we just looked at illustrate the statement that you made regarding scenic rivers all being downstream of wastewater treatment plants?
A. Yes, it does.
Q. Now, Doctor, is it your testimony that point sources or wastewater treatment plants are responsible for every elevated phosphorus measurement in the watershed?
A. No.
Q. Why not?
A. Well, there aren't many other sources besides the point sources. There's a whole body of science out there on the importance of nonpoint source pollutants. We know they're there, and they're very well distributed throughout this watershed.
Q. Based upon your experience, training and the data that you've reviewed, Doctor, as part of your work in this case, what might cause an elevated phosphorus measurement not downstream of a

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A. Well, there aren't many other sources besides the point sources. There's a whole body of science out there on the importance of nonpoint source pollutants. We know they're there, and they're very well distributed throughout this watershed.
Q. Based upon your experience, training and the data that you've reviewed, Doctor, as part of your work in this case, what might cause an elevated phosphorus measurement not downstream of a

wastewater treatment plant?
A. Well, I think to answer that, I really need to back up and split it into two segments. One would be the nonpoint sources associated with the urban areas, and the other would be the nonpoint sources associated with -- for this watershed, with the agricultural areas in particular and, to a lesser extent, the forested areas.

So for the urban areas, we have a variety of nonpoint source pollution sources in urban areas. The thing that's really important about evaluating nonpoint source pollution in urban areas is the effect of people's building activities and other activities on the hydrology, on how the water flows in the urban areas.

In particular, you have a large -- relatively large percentage of the urban land use is occupied by what's called impervious area, or compacted soils. And the impervious area would be the areas like rooftops, driveways, sidewalks, streets, parking lots, all the places where when it rains, the water cannot infiltrate into the soil.

Then the compacted soils, you see a lot of that in conjunction with construction activities. So the more land disturbance and construction that

you have in the urban area, the more likely you are to have these compacted soils. And they can be impervious or semi-impervious.

But the key point is that when it rains and the water hits these areas, it's not able to infiltrate into the soils. And it can pick up all kinds of sources of phosphorus in the process of moving before it gets into a stream. So it can pick up a lot of dust, it's wind blown and small soil particles that have phosphorus adsorbed to them. There's the waste of pets and wildlife. There's fertilizer use.

So there are all these sources of phosphorus in -- there's breakage in the sewer line system, small leaks, large leaks, you know, accidents. But there are all these sources of phosphorus that are there from people and their activities and their pets. And the fact that so much of the surface is impervious provides an opportunity to move that water directly into a stream without the opportunity for the soil to pull the phosphorus out as the water moves down through it.

And this is especially complicated by the infrastructure that we install in our cities to deal

with rain water. We don't want the streets to flood, that's a problem. So we build storm drains and we build ditches and gutters and all kinds of systems to efficiently route the rain water away from our cities and into the streams.

Q. Doctor, let me ask a question. Mr. Bullock was about to pinch me. He wanted me to interject some questions to break this up, I think.

With respect to rural areas, are there multiple potential sources located in rural areas in this watershed?

A. Yes, very much so.

Q. Do you believe, Doctor, that the causes of elevated phosphorus measurements in the Illinois River Watershed can be evaluated, estimated or quantified on a watershed-wide basis with respect to nonpoint sources in particular?

A. No, there are too many and they're too distributed. They tend to be small. They're all over the watershed. You need a site-specific assessment to really sort that out.

Q. Now, Doctor, as part of your work in this case, did you review data and spatial patterns to attempt to identify potential nonpoint sources of phosphorus in the watershed?

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Q. Now, Doctor, as part of your work in this case, did you review data and spatial patterns to attempt to identify potential nonpoint sources of phosphorus in the watershed?

A. Yes, I did.
Q. And could you please describe what it is you reviewed in that regard.
A. Well, I think the main thing that I reviewed would be the data from Dr. Olsen's database on the Illinois River Watershed. And I looked at the concentrations of phosphorus at different locations within the watershed.
Q. Did you review information regarding the number and location of mammals, including humans?
A. Yes, I did.
Q. Did you review comparable information for livestock such as cattle?
A. Yes. The first one when you said mammal, so that would have been the humans and the cattle would be the two types of mammals.
Q. Good point. That's always been tricky for me.
Doctor, did you review Dr. Fisher's testimony in this court that the current human population in the watershed is approximately 300,000?
A. Yes.
Q. Is that consistent with the human population data that you reviewed?
A. Yes, it is.

Q. Could you turn in your binder to tab 14, please.
A. Yes.
Q. And find Defendants' Joint Exhibit 2280.
A. Yes.
Q. Could you identify Exhibit 2280 for the record, please.
A. That's a table from my report.
Q. And there is some human populations shown on that table; is that correct?
A. That's correct.
Q. Can you identify the source of the population estimates or data that is shown in Exhibit 2280.
A. The data for 1990 and 2000 are from the U.S. Census. The data from 2007 are data that are provided by ESRI, E-S-R-I, which is the group that produces the main Geographic Information System computer software that's used to analyze spatial data and environmental sciences. So they will model census data in the interim in between census periods. So the 2007 data is ESRI's model estimates to the population.
Q. Doctor, are both of these datasets that you described, the census data and the ESRI data, datasets that are commonly used in environmental

investigations?
A. Yes.
Q. Doctor, you've provided these estimates by the watershed. Does the U.S. Census or the ESRI group maintain population estimates by watershed?
A. No.
Q. So what did you do with respect to taking the data from those two sources to arrive and compile it into a figure that is representative, in your view, of the population in the watershed?
A. Okay. The census data are provided by what's called census block groups, small units. And so what we did was to look at the population in each census block group that occurred wholly within the IRW. And we added those up.
And then we took the census block groups that were partially in and partially out of the boundary of the Illinois River Watershed, and we computed the percentage of the block group that was inside the watershed and multiplied that by the population for that block group, and that gave us the estimate of the human population in the portion of the block group that was within the IRW. And then we added them up.
MR. GEORGE: Your Honor, I'd move for

1 introduction of Defendants' Joint Exhibit 2280.
2 MR. BULLOCK: No objection, Judge.
3 THE COURT: Not going to step on you this
4 time, Mr. Bullock. 2280 is admitted.
5 MR. GEORGE: Notice I got out of the way,
6 Judge.
7 Q. (By Mr. George) Dr. Sullivan, for benefit of
8 the record, what does this analysis show as to the
9 human population in the watershed from 1990 to 2007
10 and how it has changed over time?
11 A. There's been a very rapid increase in the human
12 population. Actually, northwest Arkansas, which
13 includes that upper region of the IRW, has been
14 called one of the fastest-growing metropolitan areas
15 in the United States in recent years. But the
16 increase has been quite dramatic. Just within the
17 decade of the 1990s alone, the human population
18 increased by more than 40 percent, based on these
19 census estimates.
20 Q. Doctor, if we compared the change from 1990 to
21 2007 -- I'm by no means a mathematician -- but would
22 it be a growth greater than 40 percent, I assume?
23 A. Actually, I don't think I've done that
24 calculation. I mean, the numbers that we can really
25 have the greatest confidence in are the actual

1 census numbers for 1990 and 2000. That was more
2 than 40 percent. But clearly the increase has
3 continued unabated and it's been a very large change
4 over a fairly short period of time.
5 Q. Thank you, Doctor. Doctor, how was the
6 information regarding -- I'm sorry, let me move to
7 the next exhibit. Turn to tab 15, please.
8 A. Yes.
9 Q. Could you find Defendants' Joint Exhibit 2239.
10 A. Yes, I have it.
11 Q. And for the record, could you identify what is
12 Defendants' Joint Exhibit 2239.
13 A. It's a figure from my report.
14 Q. Was this figure prepared under your direction?
15 A. Yes, it was.
16 Q. What's the source of the data that is shown in
17 this exhibit?
18 A. That would be the same as the previous exhibit.
19 MR. GEORGE: Your Honor, move for the
20 introduction of Defendants' Joint Exhibit 2239.
21 MR. BULLOCK: No objection.
22 THE COURT: 2239 is admitted.
23 MR. GEORGE: Thank you, Your Honor.
24 Q. (By Mr. George) Doctor, how was the information
25 that we've just looked at in terms of the size and

A. Yes, I did.
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3 THE COURT: Not going to step on you this
4 time, Mr. Bullock. 2280 is admitted.
5 MR. GEORGE: Notice I got out of the way,
6 Judge.
7 Q. (By Mr. George) Dr. Sullivan, for benefit of
8 the record, what does this analysis show as to the
9 human population in the watershed from 1990 to 2007
10 and how it has changed over time?
11 A. There's been a very rapid increase in the human
12 population. Actually, northwest Arkansas, which
13 includes that upper region of the IRW, has been
14 called one of the fastest-growing metropolitan areas
15 in the United States in recent years. But the
16 increase has been quite dramatic. Just within the
17 decade of the 1990s alone, the human population
18 increased by more than 40 percent, based on these
19 census estimates.
20 Q. Doctor, if we compared the change from 1990 to
21 2007 -- I'm by no means a mathematician -- but would
22 it be a growth greater than 40 percent, I assume?
23 A. Actually, I don't think I've done that
24 calculation. I mean, the numbers that we can really
25 have the greatest confidence in are the actual

1 census numbers for 1990 and 2000. That was more
2 than 40 percent. But clearly the increase has
3 continued unabated and it's been a very large change
4 over a fairly short period of time.
5 Q. Thank you, Doctor. Doctor, how was the
6 information regarding -- I'm sorry, let me move to
7 the next exhibit. Turn to tab 15, please.
8 A. Yes.
9 Q. Could you find Defendants' Joint Exhibit 2239.
10 A. Yes, I have it.
11 Q. And for the record, could you identify what is
12 Defendants' Joint Exhibit 2239.
13 A. It's a figure from my report.
14 Q. Was this figure prepared under your direction?
15 A. Yes, it was.
16 Q. What's the source of the data that is shown in
17 this exhibit?
18 A. That would be the same as the previous exhibit.
19 MR. GEORGE: Your Honor, move for the
20 introduction of Defendants' Joint Exhibit 2239.
21 MR. BULLOCK: No objection.
22 THE COURT: 2239 is admitted.
23 MR. GEORGE: Thank you, Your Honor.
24 Q. (By Mr. George) Doctor, how was the information
25 that we've just looked at in terms of the size and

1 census numbers for 1990 and 2000. That was more
2 than 40 percent. But clearly the increase has
3 continued unabated and it's been a very large change
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20 introduction of Defendants' Joint Exhibit 2239.
21 MR. BULLOCK: No objection.
22 THE COURT: 2239 is admitted.
23 MR. GEORGE: Thank you, Your Honor.
24 Q. (By Mr. George) Doctor, how was the information
25 that we've just looked at in terms of the size and

the location of the human population in the watershed important to your identification and analysis of potential nonpoint sources?

A. Well, it's very important, because the -- in terms of the nonpoint source contributions from urban areas, it's not just the size of the urban area or the population in the urban area that's important; it's also the development that's taking place.

And the reason for that is because where you have a lot of land-disturbing activities, that provides the opportunity to move more phosphorus and other constituents as well from those areas to the streams along nonpoint source flow paths.

And the reason is because in the process of disturbing the lands when you're digging things up for construction, you've got equipment working there, you're compacting soils and you're disrupting, you're expanding from areas that were not impervious to make them impervious and introducing all the disturbance at the same time.

That generates a lot of opportunity for erosional contributions to the streams, and erosion involves the movement of soil particles, many of which are small. And the smaller they are, the more

likely they are to transport phosphorus adsorbed to them.
Q. Doctor, what does Defendants' Joint Exhibit 2239 show about the location of this growing human population and urban development in the watershed?
A. Well, it shows what I think is pretty common knowledge within the watershed, and that is that most of the development in recent years has been concentrated in that upper portion of the watershed basically between Rogers and Fayetteville, and to some extent, around Tahlequah as well in Oklahoma.
Q. Doctor, you've identified some of the things that occur within urban areas that can impact nonpoint source phosphorus. I don't believe you've yet mentioned commercial fertilizer. Can commercial fertilizer use in urban areas have an impact?
A. Yes, it can.
Q. How so?
A. Well, it's the same kind of issue. In these urban areas, there are lots of opportunities to short-circuit the process of water moving down into the soil, infiltrating into the soil, where you provide the opportunity for phosphorus to be adsorbed to the soil particles and remain in the soil as opposed to passing into the stream.

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A. Yes, it can.
Q. How so?
A. Well, it's the same kind of issue. In these urban areas, there are lots of opportunities to short-circuit the process of water moving down into the soil, infiltrating into the soil, where you provide the opportunity for phosphorus to be adsorbed to the soil particles and remain in the soil as opposed to passing into the stream.

So where you have a lot of lawn fertilizing in conjunction with sprinkler systems that are adjacent to sidewalks and the rest of it, you're just providing an enhanced opportunity for phosphorus that people place on the land in this urban environment, and when it rains hard, especially coupled with sprinklers or even independent of the rain, just the sprinklers, you have the chance of moving this water with phosphorus into the conduits that run directly into the streams without the opportunity for soil interaction.

Q. Dr. Sullivan, the court has been treated with some analysis of urban development by Dr. -- or by Wayne Grip. Are you familiar with Wayne Grip?

A. Yes.

Q. I'm told that His Honor even donned some 3-D glasses, and I wasn't here to see it, which is regrettable.

Did you also review Mr. Grip's analysis of aerial photographs in this corridor in northwest Arkansas of urban development?

A. Yes, I did.

Q. How was that information useful to you in your analysis of potential nonpoint sources?

A. Well, it was useful to just reconfirm what the

other analyses were suggesting, that there's been a large increase in the human population and in the amount of development in the upper watershed. And it is the same thing I could see visually when I toured the upper watershed myself. There was a lot of construction going on.

Q. I've been given -- handed a note that I did not ask you about cats and dogs. And --

THE COURT: Or Tontitown.

MR. GEORGE: Or Tontitown, which I'm going to stay away from for personal reasons.

Q. (By Mr. George) Dr. Sullivan, did you review any information to try to get a handle on how many cats and dogs there are in the watershed?

A. Yes, just a rough estimate. I used national figures of how many dogs and cats per household and number of people per household and did some simple mathematics. And based on national numbers, if the people who live in the IRW have pets at the same rate as people elsewhere in the country, then there are -- it was over 400,000 cats and dogs.

And the reason that's important is not so much because it's 400,000 cats and dogs; it's because they're going to be concentrated where the people are. And so many of these cats and dogs are

going to be in these urban environments.

It's the same issue is that if you put fecal material from a pet in a place where your lawn sprinklers and the rain can move that quickly and easily into the flow system independent of the soils, then you've got significant opportunity to transport the phosphorus and other things that are contained in that fecal material into a stream.

If the water takes it down into the soil, then you expect most of that phosphorus or all of that phosphorus to be adsorbed. But in an urban environment, there is much less opportunity for that to happen.

THE COURT: You're not offering a comparison between the contribution of nonpoint source phosphorus from cats and dogs relative to poultry, are you?

THE WITNESS: No, sir, I'm not. What I'm doing is just trying to indicate that in the urban environment, there are many, many sources. And because of the hydrology of the urban environment, there's a dramatically enhanced opportunity to move any or all of them into a stream; whereas, in the pasture environment -- not everywhere, but in general, when it rains, the water infiltrates into

the soil, and you have that soil contact.

THE COURT: We did broach a new subject here after four months.

MR. GEORGE: Absolutely.

Q. (By Mr. George) What you're saying, Dr. Sullivan, is if a delightful young man who lived in Tontitown, owned four large Golden Retrievers, that I might be a potential source?

A. I suppose it's possible.

Q. Okay. Doctor, did you conduct a spatial analysis of water quality in association with the urban areas that we've been discussing?

A. Yes, I did.

Q. And tell us generally how you went about that spatial analysis.

A. Well, I looked at the data from Dr. Olsen's database and plotted the locations throughout the watershed, including around the urban areas, of the total phosphorus that was measured in the samples. And, again, I used a geomean of five or more samples to represent individual locations.

Q. Did you prepare any figures for your expert report demonstrating this analysis?

A. Yes.

Q. And could you turn to tab 16 in your binder,

the soil, and you have that soil contact.

THE COURT: We did broach a new subject here after four months.

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Q. Did you prepare any figures for your expert report demonstrating this analysis?

A. Yes.

Q. And could you turn to tab 16 in your binder,

please.
A. Yes.
Q. And could you -- actually, let's take them in a group, if we can. Could you look at Defendants' Joint Exhibit 2244, which is behind tab 16, and Defendants' Joint Exhibit 2245. Do you see both of those?
A. Yes, I do.
Q. Can you identify those documents for the record, please.
A. Yes. Those are figures from my report.
Q. Okay. Were these figures prepared under your direction?
A. Yes.
Q. And generally, can you describe the data or information that is illustrated or shown on these figures?
A. Well, in both cases, it would be data from Dr. Olsen's database in the IRW. Five or more samples reported as a geomean for each location where we had five or more samples.
The difference between the two maps is the first one shows all of his data regardless of the flow condition, and the second map shows his data for the sampling occasions for which he classified

the sample as a base flow sample when it was not an elevated flow because of a rainstorm, for example.

Q. Doctor, to be clear, the data that is represented is phosphorus data; is that right?

A. Total phosphorus.

Q. And there are bars on here. Do the heights of the bars correspond to concentrations of phosphorus?

A. Yes, it's the same style of presentation as those Oklahoma maps we looked at earlier, that the bars are colored green if they're below the .037 standard. I believe -- yes, and then they're colored orange if they're above. And the height is proportional to the concentration. And there's a scale bar that shows you the height of a bar that would be at a concentration of 0.5 milligrams per liter of total phosphorus.

MR. GEORGE: Your Honor, I move for introduction of Defendants' Joint Exhibit 2244 and 2245.

THE COURT: Any objections?

MR. BULLOCK: No objection.

THE COURT: 2244 and 2245 are admitted.

THE WITNESS: I apologize, Mr. George. I was explaining what was there, and I neglected to say something important. The municipal boundaries

are also indicated and the locations of the wastewater treatment plants on the figure -- on the map as well.

Q. (By Mr. George) Why is that information important to your analysis?

A. Well, the question was to what extent was I looking at the potential involvement of the urban areas in the transfer of phosphorus to streams. So for that, we want to look at both the point and the nonpoint source components of that.

The point source would be the wastewater treatment plants, and the nonpoint would be the municipal boundaries.

Q. Doctor, on both of these maps, I notice that there's a bar that's visible, and it's high in comparison to some of the bars on this map right in the middle of the watershed. Do you see that?

A. Middle top?

Q. Actually, middle-middle. Let me approach it this way. Are you familiar with the location of the Westville wastewater treatment plant?

A. Yes.

Q. And is that shown on both of these maps as a triangle?

A. Yes, that's a good point. It's hard to see

behind the bar, isn't it? It's there.
Q. Just so we're clear, could you go to the map and just point that location out one time, because it is hard to see the triangle.
A. Right there. (Indicating.)
Q. Now, Doctor, what conclusions, if any, do you draw from your spatial analysis of phosphorus concentration downstream from urban areas?
A. There's a very strong pattern in Dr. Olsen's data. And we see the same pattern with both -- considering all flow conditions and also in considering just the base flow conditions.
But the pattern is that the highest bars on the map, which correspond with the areas that have the highest total phosphorus concentrations expressed as a geomean of multiple samples, but those are very strongly associated with both the urban area locations and also the wastewater treatment plant outflow locations.
We don't have the data that would really allow us to separate out those two very effectively because the data don't bracket the urban areas independent of wastewater treatment plants. So it's difficult to tease it out.
Based on other analyses, our expectation is

that much of the phosphorus there is coming from the point source. But we don't really have a good way of estimating how much additional phosphorus is coming from the urban nonpoint source.

But the spatial pattern is very clear that the high bars are uniformly downstream from the urban areas and wastewater treatment plants.

Q. Doctor, do you see that same spatial analysis or association even when you look at Defendants' Joint Exhibit 2244, which you described as having data from all flows, high flows and low flows?

A. Yes.

Q. Now, Doctor, did you review Dr. Jan Stevenson's testimony in this courtroom that urban land use results in a large increase of total phosphorus in streams in the Illinois River Watershed?

A. Yes, I remember that.

Q. Was that testimony consistent with your own observations and conclusions?

A. It is.

Q. Now, Doctor, based upon the data and information that you have reviewed, are urban areas a significant enough potential source of phosphorus that they should have been considered in an investigation of causes of phosphorus loading to the

Illinois River Watershed streams and rivers?

MR. BULLOCK: Leading.

THE COURT: Sustained. Rephrase.

MR. GEORGE: Your Honor --

Q. (By Mr. George) Dr. Sullivan, did you see any meaningful analysis of urban areas in the expert testimony and reports put forward by the State's experts?

A. There were analyses that were done that they considered point sources. I didn't see any analyses that really addressed the nonpoint component of the urban contribution, and I didn't see pairs of samples that would allow me to do that investigation either. So the data simply were not collected in such a way to allow an investigation of urban nonpoint sources.

Q. Should urban nonpoint sources have been considered in the investigation and evaluation?

A. Definitely.

Q. Now, again, Dr. Sullivan, are you testifying that all elevated phosphorus readings in the watershed correspond to urban areas?

A. No.

Q. Let's move away from urban areas and talk about some potential nonurban impacts on water quality.

You mentioned erosion from construction sites. Are there other forms of erosion that we might see even in rural settings?
A. Yes.
Q. Could you describe those, please.
A. The most important ones would be erosion associated with roads, and that's most pronounced for unpaved roads, for dirt roads.
Q. Did you say unpaved roads?
A. Unpaved. So the dirt roads -- the roads in general are well known as significant sources of phosphorus -- of erosion, and the dirt roads in particular.

The other source that would be particularly important, or the second source, would be streambank erosion, of which there's quite a significant amount in this watershed.

Then finally, erosion associated with other land-disturbing activities. And in the nonurban environment in a watershed like the IRW, there's really not much row cropping. That's a major issue in many places. There's not too much of that in the IRW. There's some.

But the other issue is activities of the livestock of removing vegetation and trampling the

soil and disturbing the soils. So there can be erosion associated with that.

Q. Have you worked on erosion-related water quality issues outside of this lawsuit?

A. Yes.

Q. Could you describe when you had those experiences.

A. We address erosion -- it's an important part of all of our watershed assessments. Erosion is a big issue with respect to aquatic habitat health, fisheries, water quality, riparian zone integrity. So there are many aspects of erosion that are important.

It's always an analysis that we do in our watershed assessments, watershed analyses for federal agencies and for watershed councils.

Q. I didn't mean to interrupt you.

A. Well, I've done some other research on it myself as well.

Q. Go ahead. I'm sorry.

A. In some of the Tillamook studies that I described earlier where we collected samples at the forest/ag interface and then at the base of the rivers before they flowed into the bay, that forest/ag interface represented a nice transition in

the watershed where, above that, there was no agriculture, there were no urban areas, there was almost no rural residential housing. It was just forest.

And the sources of erosion and phosphorus, which was one of our main interests in that, were really from two things: From logging, which was prevalent, but was not excessive, and from logging roads, dirt roads, which were very commonplace. And that -- so we did analyses on evaluating --

MR. BULLOCK: I object to the relevance of this. It doesn't appear to have -- it's certainly not responsive to the question, and it doesn't appear to have any relevance to the matter we're talking about.

THE COURT: Sustained. Mr. George.

Q. (By Mr. George) Dr. Sullivan, is it generally recognized that erosion from dirt roads and streambanks contains phosphorus?

A. Yes, it is.

Q. Have you seen any reports from Oklahoma agencies discussing erosion as a source of phosphorus in the Illinois River Watershed?

A. Yes, I have.

Q. Doctor, have you yourself personally seen any

evidence of substantial amounts of streambank erosion, for example, occurring in the watershed?
A. Yes, I have.
Q. Could you please describe that and how it was that you came to see it.
A. I saw it really three ways. The first would be on a canoe trip that I took with a group of defense lawyers and experts.
MR. BULLOCK: Judge, I think this is cumulative of our video highlights of the other day of streambank erosion.
THE COURT: I think this is cumulative. Sustained.
MR. GEORGE: Your Honor, and I'll proceed and see how it goes. But just for the benefit of the court, there is a photograph that was taken that I would like to move into evidence. I do appreciate there is some evidence in the record, so I'm going to attempt to do that. And if Mr. Bullock objects and you sustain it, I'll move on, of course. But I want you to appreciate that I did hear Your Honor.
Q. (By Mr. George) Dr. Sullivan, could you turn to Exhibit 18.
A. Yes.
Q. And you'll find -- I'm sorry, tab 18, which has

been marked as Defendants' Joint Exhibit 633-0031, 633-0055, 633-0072, 633-0075, and 633-0089, 633-0015.

Dr. Sullivan, do you recognize those photographs?

A. Yes, I do.

Q. Were you present when they were taken?

A. Yes, I believe so.

MR. GEORGE: Let me correct something for the court's benefit. Which one did I invert, Mr. Todd?

I'm told I can't read numbers, Your Honor. The last one is actually 633-0105. My apologies.

Q. (By Mr. George) I'm sorry, Doctor. Were you present when these photographs were taken?

A. Yes.

Q. Were they taken on a float trip along the Illinois River?

A. Yes.

Q. Did you personally observe the streambanks that are shown in these photographs?

A. Yes, I did.

MR. GEORGE: Your Honor, I move for the introduction of those previously identified exhibits.

MR. BULLOCK: While cumulative, we're not going to object.

THE COURT: Very well. Those exhibits are admitted. Mr. George.

MR. GEORGE: Thank you, Your Honor.

Q. (By Mr. George) Doctor, do those photographs show eroded streambanks?

A. Yes, they do.

Q. Doctor, based upon your floating of the Illinois River, are the conditions shown in those photographs common or uncommon along the stretch that you've at least been exposed to?

A. Well, I wouldn't say that the entire stretch is eroded to this extent, but the levels of erosion that we see here are quite commonplace throughout the stretch of river that we canoed. And I could observe similar conditions from a flyover that I did in the watershed as well.

Q. Doctor, would you expect streambank erosion to contribute phosphorus to streams during high flow or base-flow conditions?

A. Primarily high flow.

Q. Now, the court has heard about these pulses of phosphorus that move through the stream and river system during high flow or runoff conditions. Would

that pulse include phosphorus from eroded streambanks?
A. Yes.
Q. Now, in addition to introducing phosphorus, can erosion and, for that matter, resuspension of sediment material have any other harmful impacts on water quality?
A. Yes.
Q. What are those?
A. It increases siltation, so buildup of sedimentary materials. In Lake Tenkiller, for example, and other impoundments in certain areas of the stream system, it increases turbidity, can have a detrimental effect on various life forms. For some fish, there's spawning beds, for example, that would -- for some fish, it's gravelly areas, and if you fill those in with fine sediments from erosion, that can degrade the spawning habitat. Same thing for some of the insects that provide food for the fish.
Q. Doctor, can erosion have any impact on the color or the appearance of water during high-flow events?
A. Yes.
Q. There's been some testimony in this case and

photographs shown of brown water during high-flow events. Have you seen that?
A. Yes, I have.
Q. Is that a common result of erosion?
A. Yes. Erosion -- and the color is going to depend on the color of the soil particles that are eroded. So I've seen rivers and streams that look red in color as a consequence of erosion, and others look brown, and some look tan. And I mean, it really depends on what the soil is. But it can impart a substantial color and make it so that you can't see through very much of the water column.
Q. Now, Doctor, you also mentioned erosion from dirt roads. What is it about dirt roads that makes them a potential source of phosphorus to streams?
A. Several things. One is that when you have a lot of roads and you have a lot of streams, they cross each other. Where a stream crosses a road, typically you have a culvert. I mean, if it's a large stream and a large road, it's typically a bridge. For the most part, we're talking about a culvert.
Also, roads tend to have ditch lines that run parallel to them to carry the water away so they don't flood. If a lot of water moves to those

ditches, sometimes there's no vegetation in them which makes the soil in the ditch more erodible.

The road surface is impermeable or relatively impermeable and, therefore, dust blown from adjacent fields or from anywhere that accumulates on the road when it rains can be washed into the ditch and through the culvert and carried, if it flows into a stream -- which it may or may not -- carry the materials into that stream.

So it's a case of the locations of the roads relative to the streams and the setting in which the road is placed will determine the extent to which that's going to happen, but it's a very well-understood phenomenon.

Q. Did you review any data or information to determine the degree to which dirt roads are present in the watershed?

A. Yes, I did.

Q. And what information did you review?

A. U.S. Census TIGER files that have the road distribution information.

Q. Doctor, based upon your review of that data, can you provide the court with any information that would put into perspective the magnitude or mileage of dirt roads in the watershed?

A. It's over 5,000 miles of road in the Illinois River Watershed. 5,100-something miles of road in the watershed. It's close to half and half between Oklahoma and Arkansas, a little bit more in Arkansas, I think.

And then we have -- for the Arkansas side, we have data to tell us which ones are paved and which ones are not paved. We don't have that for the Oklahoma side.

Q. What percentage was paved in Arkansas?

A. About half.

Q. Half of the -- the total number was for the watershed, 5,000, right?

A. Yes. So the total amount of unpaved road in Arkansas was around 1,300 miles. And then it's probably a somewhat similar number for Oklahoma.

Q. Okay. Now, Doctor, based upon the data that you've reviewed, is erosion from streambanks and dirt roads a significant enough potential source of phosphorus that it should have been considered in the investigation in this case?

A. Yes.

Q. Was it considered by the State's experts, based upon your review of their work?

A. No.

Q. Now, let's talk about septic systems. Did you evaluate the extent to which the human population in the watershed is serviced by septic tanks as opposed to wastewater treatment plants?
A. Yes, I did.
Q. And did you review Dr. Engel's testimony in this courtroom that there are approximately 73,000 septic tanks in the watershed?
A. Yes.
Q. And is that consistent with the data that you reviewed?
A. Yes, it is.
Q. Doctor, did you include in your report any data regarding the use of septic systems in the IRW?
A. Yes.
Q. Can you turn to tab 19 in your materials --
A. Yes.
Q. -- and find Defendants' Joint Exhibit 2279.
A. Yes.
Q. Can you identify that exhibit for the record, please.
A. That's a table from my report.
Q. And, Doctor, was this table prepared under your direction?
A. Yes.

Q. And could you identify generally the source of the data and information that is shown in this table.
A. The human population data were taken from the U.S. Census. And then for the various municipalities, Ron Jarman did an analysis of wastewater treatment plant point sources for the defendants, and he reported to me which ones of these communities were on centralized wastewater treatment systems.
The reason for that is if a community is not on a centralized system, then people are using septic systems for the most part.
Q. Did you then take that data and try to remove from the overall human population those that are serviced by wastewater treatment plants to arrive at a number?
A. Correct.
Q. What did your analysis show as to the use of septic systems in the watershed?
A. Well, it certainly varies by the municipality, but overall I came up with an estimate of a little over 76,000 people in the watershed on septic systems.
MR. GEORGE: I'm sorry, Your Honor, I

failed to move to introduce this. At this time, I'd offer Defendants' Joint Exhibit 2279.

THE COURT: Mr. Bullock.

MR. BULLOCK: No objection.

THE COURT: 2279 is admitted.

MR. GEORGE: Thank you.

Q. (By Mr. George) Doctor, can septic tanks deliver phosphorus to groundwaters and surface waters?

A. Yes, they can.

Q. Is there one that they're more likely to impact than the other?

A. It really depends. Again, it's a site-specific thing. It's going to depend on whether or not the septic system is causing a problem and, if it is, what the nature of that problem is and where it's located.

Q. Do septic systems have to be malfunctioning to contribute phosphorus to groundwater or surface water?

A. Well, I would say that certainly for surface waters, if they're not malfunctioning or improperly located, then it's not likely that they're contributing much or at all. But the problem is if they're not placed in the proper locations or

they're malfunctioning, then there is a possibility of contributing to some stream waters.

Q. What about groundwater; can a septic system, even if it's not malfunctioning, contribute phosphorus to groundwater?

A. Well, again, the answer is it depends. It's going to depend largely on the depth of the soil and the depth of the location of the lateral lines of the septic system. And that's going to depend to a large degree, I would assume, on when the system is built and if it was built to proper specifications or not. So in that instance, we're probably looking at more of a malfunctioning issue.

Q. Doctor, based upon the information and data that you reviewed, are septic tanks a significant enough potential source of phosphorus that they should have been considered?

A. I certainly think that they should have been considered, yes.

Q. Did you see any meaningful analysis of phosphorus from Illinois River Watershed septic tanks and the works completed -- and the work completed by the State's causation experts?

A. I saw some analyses and some discussion that addressed septic systems, but I saw nothing there

they're malfunctioning, then there is a possibility of contributing to some stream waters.
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A. I certainly think that they should have been considered, yes.
Q. Did you see any meaningful analysis of phosphorus from Illinois River Watershed septic tanks and the works completed -- and the work completed by the State's causation experts?
A. I saw some analyses and some discussion that addressed septic systems, but I saw nothing there

that I considered to be meaningful.
Q. Did you review the work of Dr. Engel and Dr. Cox on their correlation analysis of phosphorus concentrations with certain things?
A. Yes.
Q. And did you find in that work any information relating to septic tanks as a potential source?
A. Yes.
Q. What did you find?
A. Well, they reported a statistically significant correlation between the density of septic systems across the landscape in their 14 small watersheds that they studied. So it's a correlation between septic system density and phosphorus concentration in the stream. They found a significant correlation between those two variables.
They dismissed that as an artifact of another correlation that they found with poultry house density, but there was no adequate basis for that dismissal, in my view.
Q. Doctor, you mentioned cattle as another potential source of phosphorus earlier. Did you review data on the extent and location of cattle in the watershed?
A. Yes.

that I considered to be meaningful.
Q. Did you review the work of Dr. Engel and Dr. Cox on their correlation analysis of phosphorus concentrations with certain things?
A. Yes.
Q. And did you find in that work any information relating to septic tanks as a potential source?
A. Yes.
Q. What did you find?
A. Well, they reported a statistically significant correlation between the density of septic systems across the landscape in their 14 small watersheds that they studied. So it's a correlation between septic system density and phosphorus concentration in the stream. They found a significant correlation between those two variables.
They dismissed that as an artifact of another correlation that they found with poultry house density, but there was no adequate basis for that dismissal, in my view.
Q. Doctor, you mentioned cattle as another potential source of phosphorus earlier. Did you review data on the extent and location of cattle in the watershed?
A. Yes.

MR. GEORGE: Your Honor, this is another area where I appreciate the court has been exposed to some information by Dr. Clay on cattle, and I don't intend to repeat any of his testimony, but Dr. Sullivan has taken some of that information and mapped it so that we can have benefit as to where those cows are located generally. With that understanding, I'm going to proceed.

Q. (By Mr. George) Dr. Sullivan, did you review Dr. Clay's testimony regarding his calculation that there are approximately 200,000 head of cattle in the watershed, and those cows deposit approximately -- manure containing approximately 3,100 tons of phosphorus per year?

A. Yes.

Q. How, if at all, are cattle important to your analysis of potential nonpoint sources?

A. Well, they're very important by virtue of the size of the cattle population coupled with the ways in which cattle behave and the locations in which you find cattle. So they're very important.

Q. Let's talk about location. Did you examine data showing cattle concentrations across the state of Oklahoma so that we could have some context as to whether this is a high or a low density cattle

area?
A. Yes.
Q. What was the source of the data that you looked at in that analysis?
A. The Oklahoma 2002 Census of Agriculture.
Q. And could you turn to tab 20.
A. Yes.
Q. Find Defendants' 2250. Could you identify that for the record, please.
A. That's a figure from my report.
Q. And is the USDA census data for the state of Oklahoma that you just described shown graphically on that exhibit?
A. Yes. It's shown graphically as cattle density by county.
Q. Was this figure or exhibit prepared under your direction?
A. Yes.
MR. GEORGE: Your Honor, I move for the introduction of Defendants' Joint Exhibit 2250.
MR. BULLOCK: No objection.
THE COURT: 2250 is admitted.
Q. (By Mr. George) Doctor, what conclusions, if any, did you reach based upon your review of this information?

A. That the density of cattle across Oklahoma exhibits certainly some variation. But the IRW location is shown with the black line around the watershed there to the right. And what that indicates is that the density of cattle in the IRW is relatively high or moderate compared to the rest of the state. It's certainly not lower.

Q. Using the key in the left-hand corner for the benefit of the record, could you identify the cattle density by square mile in the counties that are comprised within the Illinois River Watershed.

A. Yes. For much of it, it's between 100 and 150 cattle per square mile. For the lower section, it's a little bit lower than that.

Q. Now, Doctor, I believe you testified to this earlier, but if not, I want to make sure. Have you been involved in the past in any scientific studies on the impact of cattle and cattle manure on water quality?

A. Yes.

Q. Does that relate to the work that you conducted in Oregon watersheds?

A. Yes.

Q. And the BMP project that you discussed earlier?

A. That's correct.

MR. GEORGE: Your Honor, with the court's indulgence, we have a physical model that I would like to use with this witness. And I by no means want to be condescending to the court. I appreciate that the court has some familiarity with cattle and cattle operations and probably has a grasp on much of the impacts. And this particular model was prepared at a time when we believed we might have a jury. But I think it might be useful to spend a few minutes with the witness just talking through, with that as a framework, his opinions regarding cattle and the potential impacts.

THE COURT: I've not seen this. Will it really be helpful, Mr. Bullock?

MR. BULLOCK: I've got an objection to principle on this. I don't think it's very helpful. But my principle is this: Clearly this model was prepared -- this diorama, as they call it, was prepared well in advance of this trial, as counsel says. We didn't receive notice of this until a quarter of ten on Saturday night. So it wouldn't even be timely -- it wouldn't be timely until Wednesday. Now here it is Monday, and they're saying they want to use it. So I object.

THE COURT: Is this it over here?

MR. GEORGE: It is, Your Honor. And with respect to the disclosure, I don't quarrel with Mr. Bullock's statement. The circumstances, just so the court understands, no gamesmanship here, I, candidly, had forgotten about the diorama until Dr. Sullivan showed up with it, and it reminded me that it was something that had been put together.

Again, Your Honor, if the court thinks it would even be mildly useful, we're happy to use it. We think it would be slightly helpful, but if the court has reservations or is sensitive to Mr. Bullock's concern, we understand that, too.

With respect to the disclosure issue, candidly, Your Honor, it's not that difficult to look at the model and understand it. So I don't think there's any prejudice.

THE COURT: With all due respect, I just don't think it's going to be helpful. Is there anything special about it that would -- I grew up, as you know, partially on a farm, not a big farm, but, look, I don't know that it's going to be helpful to the finder of fact.

MR. GEORGE: The aspects we wanted to discuss, and that will be shown by the model, is some of the hydrologic considerations with respect

to cattle behavior, areas in pastures that can be hydrologically active and that have unique impact on the water quality aspects of cattle.

THE COURT: We've gone over that here. I'm pretty familiar with it. With all due respect, Mr. Bullock's objection is sustained. Go ahead. I think we can talk about it, but I think we're all familiar with those impacts.

MR. GEORGE: I appreciate that, Your Honor. I'll move to the questions.

Q. (By Mr. George) Doctor, can you provide the court with an explanation as to how cattle grazing can adversely impact water quality in terms of phosphorus?

A. Yes. But it's a pretty complicated issue. There's a lot to it. It mainly has to do with the water flows, where the water moves, and the behavior of the cattle.

So let's start with the behavior of the cattle. So when cattle have access to streams, they tend to spend a disproportionate amount of time in and around those streams. And when cattle deposit their feces in the stream, that's obviously a direct source of phosphorus to the stream.

Also, when they deposit their feces in the

riparian area and in areas that are close to the stream, there's an increased likelihood that these feces will be deposited on land that is hydrologically active, because the land in close proximity to a stream has a higher probability of being hydrologically active than does land further upslope. Frankly, that's the reason for the regulations that say don't spread litter close to streams.

And so the fact that the cattle have access to those areas to deposit their feces in locations that are more likely to be hydrologically active and that they disturb the soil in those areas, too, both of those things are going to promote the transport of phosphorus from erosional sources and from cattle to the stream.

Q. Let me interrupt you, Doctor, and ask you a question. What do you mean by "hydrologically active"?

A. Hydrologically active areas are the areas that are prone to contribute overland flow. And I guess maybe if we haven't heard much about this in the proceedings, I would need to back up and describe the different types of flow and what overland flow is. Is that appropriate?

Q. Sure. Let's take it stepwise, if we can, and let me interject some questions as we go so we can break this up.

Can you provide the court with your definition of overland flow.

A. Overland flow is, when it rains, water flow from the rain going over the surface of the ground. So in the case of pastures at issue here, it would be water flowing over the pasture surface during that rainstorm.

Q. Okay. Are there different types of overland flow?

A. Yes. There are two primary types of overland flow. They're similar that in both cases, what's causing it is that the spaces between the soil particles are full of water, and so when additional water comes along from rainfall, it can't go down into the soil, it can't infiltrate because the spaces are already full. That's why it flows over the surface. Otherwise, in most soil types, it would -- excluding clay -- but in most soil types, it would tend to infiltrate down into the soil.

But if the spaces are full, it can't and, therefore, it's got to go somewhere. It's going to follow gravity, and that's overland flow.

But there are different things that cause the spaces to be full. One is that it's raining so hard that the rate of rain exceeds the rate of infiltration that the soil are capable of.

Q. What's that called?

A. I'm sorry, what?

Q. Is there a particular term or phrase to describe that?

A. Yes. That's called infiltration excess overland flow. It's also called Hortonian overland flow, H-O-R-T-O-N-I-A-N, named after a hydrologist named Horton that described this process. So that's one type of overland flow.

Q. What's another type?

A. Another type is what's called saturation excess overland flow. And what causes that is that if the water that's flowing through the soil flows to these relatively lower elevations in the watershed and fills up those soil spaces, then that water table is going to rise and, in some cases, go all the way up to the surface of the ground.

It's a phenomenon associated with a rising water table, coupled with flow down in the soil profile itself, which is called interflow. And that combination of water building up typically in areas

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The reason this is important is because overland flow is very well known and recognized to be the principal vehicle for transporting a lot of nonpoint source pollutants, including from pastureland and including the pollutant phosphorus.

Q. How can cattle impact overland flow?

A. Cattle can impact overland flow because the amount of vegetation, the density and the health and vitality of the vegetation has a large influence on the rate of infiltration of rainfall into the soil.

So if you have a good stand of vegetation, grasses, hedges, shrubs, trees, whatever, you've got a good stand of vegetation, it provides opportunity for that rainfall to move down into the soil.

When you remove that vegetation -- so this is -- it happens gradually as you degrade the vegetation, but it's especially pronounced when you have bare soil. The bare soil crush over at the top. You don't have the roots providing avenues for

water movement, and you get a dramatically reduced amount of infiltration when it rains. So you're promoting the occurrence of overland flow that otherwise would not happen there.

And that vegetative cover is an important parameter that's used in evaluating phosphorus indices and all of these things. That's why, is because of its influence on infiltration.

Well, the cattle will trample and eat and otherwise destroy the vegetation in the areas where they concentrate, and those areas are often very much associated with the riparian zone around the streams.

So when you damage vegetation and when you remove the vegetation near the streams, you're further increasing that overland flow in a situation with that very close proximity to the stream. So you put any source of phosphorus there, it is going to be, in many cases, but not always, naturally prone to overland flow anyway. And then you further accentuate that with the behavior of the cattle, and the end result is a much more marked transfer or transport of the constituents, phosphorus, bacteria, whatever you're talking about, into the stream.

Q. Doctor, are you familiar with a term

"channelization" as it relates to cattle behavior in riparian areas?
A. Yes.
Q. For the record, what is that?
A. It's a description of an erosional process that occurs. Cattle, in the areas that they frequent, will tend to follow the same pathways, not always, but often, and those pathways get worn and the vegetation gets degraded or removed. And that encourages erosion when it rains for the reasons that I just talked about, that it crusts over and you don't have the conduits for infiltration.
So that encourages erosion, and as that soil erodes away, you get these little mini canyons across the landscape, and that just further accentuates all of these processes that we're talking about.
Q. Doctor, are you familiar with the term "loafing" as it relates to cattle?
A. Yes.
Q. Is it commonly recognized that cattle tend to loaf in riparian areas?
A. They loaf in areas where they have good access to water and shade, and that's often, but not always, in the riparian areas.

Q. You're familiar with the term "compaction" as it relates to cattle behavior?
A. Yes.
Q. What is compaction?
A. They're pretty heavy animals, and that weight is distributed across relatively small feet, and so the soils get compacted, coupled with the destruction of the vegetation, and that compaction makes the soils less pervious. They're becoming more like the impervious land that we talked about in the urban areas, although certainly not to that extent. It's another process that favors overland flow of water and, therefore, overland transport of whatever is available to that water.
Q. Doctor, the State's experts have testified that the potential impact of cattle on water quality can be discounted because cattle are simply recyclers of nutrients. Do you agree with that?
A. Well, I certainly agree --
MR. BULLOCK: Objection, Your Honor, I don't believe there was anything in his opinions concerning recycling.
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the expert reports to which Dr. Sullivan should have responded to if he had an opinion relative to it.

MR. GEORGE: Your Honor, I'm told that the recycling discussion is, in fact, in Dr. Sullivan's expert report.

MR. BULLOCK: Where, and I'll withdraw my objection?

MR. GEORGE: Page 96. If Mr. Bullock is not satisfied, I'll provide you a copy. You may have a copy of his report, Your Honor.

MR. BULLOCK: I forgot about it, Judge. I withdraw my objection.

THE COURT: Mr. George.

MR. GEORGE: Thank you, Your Honor. And thank you, Mr. Bullock.

Q. (By Mr. George) The State's experts have testified that the potential impact of cattle on water quality can be discounted because cattle simply recycle nutrients. Do you agree with that?

A. Well, I can't give a yes or no answer to that question, and here's why: When cattle are on the upland pasture away from the stream in areas that are not hydrologically active, they consume forage that contains phosphorus that has been brought up by the plant roots from the soil, and they consume that

forage and they defecate. And that phosphorus is recycling through the system, and the extent to which that phosphorus then is eventually moved back into the soil, then that becomes recycling. So there are certainly situations under which cattle are recycling nutrients. I would not dispute that.

But with respect to the issues at hand in this case, we're concerned about the transfer of phosphorus from pastureland, from whatever source, to a stream. When cattle consume forage in the upland pasture and then they walk down to the stream to drink, to loaf, to -- and then they deposit their feces there, that's not recycling in the pasture. That's a transfer process of taking phosphorus that would otherwise be recycled and moving it to the stream itself when they defecate in the stream or to these areas -- riparian areas that are far more likely to be hydrologically active.

There's no recycling about it in that case. I mean, you might say relative to the entire watershed, it's still in the watershed. That's absolutely true. But relative to -- we talked about this mass balance on streams versus watersheds. Relative to the stream, that is not recycling at all. That's moving the phosphorus from the upland

pasture to the stream.
Q. Based upon the data that you have reviewed, are cattle a significant enough potential source of phosphorus that they should have been evaluated in this case?
A. Yes.
Q. Did you see any meaningful analysis of phosphorus from cattle in the work of the State's causation experts?
A. No, I didn't.
Q. One last potential source I want to discuss with you, Doctor. To what extent, if any, might people recreating in the Illinois River Watershed impact water quality?
A. I think there's certainly a potential for impact there.
Q. Could you explain that potential, please.
A. Well, there are a lot of people that recreate in the Illinois River Watershed. I mean, I observed that when I was there myself. And I read Dr. Caneday's report, and he talked about millions of visitors to the watershed and he talked about some 150-odd (sic) floaters on the river per year, I believe, was the figure, as I remember.
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Dr. John Connolly about potential sources and fate and transport. How is your analysis different from Dr. Connolly's, in a general way?

A. In a general way, Dr. Connolly, he focused a lot of work on Lake Tenkiller. I focused almost no work on Lake Tenkiller. He focused quite a lot on the issue of growing algae, that biological response, which is not something I addressed.

In terms of water quality, his work was mostly on point sources in the Illinois River and their influence on Lake Tenkiller and the influence of the total phosphorus on Lake Tenkiller. My focus was more on the entire watershed and looking at the -- some of the field issues and some of the more local issues for both point and nonpoint source pollution.

Q. Doctor, as part of your work in this case, did you review the mass balance analysis sponsored in this courtroom by Dr. Engel?

A. Yes, I did.

Q. What is your understanding of the role of this mass balance in the State's overall expert theory of the case?

A. My view is that the mass balance is very critical to the State's approach to the case.

Q. Doctor, is a mass balance analysis a tool that you have used in your work previously?
A. Yes.
Q. Can you explain what the concept of mass balance means to you.
A. Mass balance means balancing the inputs and the outputs to and from a system. You can construct mass balance on lots of different things.

For this case, the mass balance that was presented by Dr. Engel, calculated by Meagan Smith, was a mass balance on the watershed. So that would look at their estimates of phosphorus coming into the watershed and then phosphorus leaving the watershed primarily at this spillway at Lake Tenkiller.

But you can construct a mass balance on other things. You can construct a mass balance on the drainage water. And for the questions at hand in this case, I think the mass balance on the drainage water is really what's appropriate. What's going into the stream water, what's going into the lake water, what's coming out of the water, that's the mass balance that's really relevant to the case, in my view.
Q. Doctor, do you have an opinion as to whether

the State's mass balance is at all useful in evaluating potential impacts on water quality?

A. I think that a mass balance on the watershed can be of use. I don't really have a problem with somebody constructing one.

The problem I have is the way you use the results of that mass balance. And if you use that to try to say that because my mass balance says more phosphorus is coming into the watershed than is leaving the watershed, you know, therefore, that phosphorus is going into a stream, I think that's a big problem.

I can give you an analogy of that, if you would like.

Q. Sure.

A. If I built a warehouse in Fayetteville and I put 10 million tons of phosphorus in my warehouse and then lock the door, by the lines of argument that I've seen from the plaintiffs in this case, their conclusion would be, therefore, I'm polluting the Illinois River with phosphorus because I am the largest source of phosphorus coming into the watershed.

So it's mass balance on the water, on the drainage water in the stream and in the lake that's

really relevant to the case, not the mass balance -- out of the watershed.

Q. Doctor, you mentioned in your testimony previously land use. Did you evaluate land use in the Illinois River Watershed?

A. Yes, I did.

Q. Could you turn to tab 9 in your binder, please.

A. Yes.

Q. And find what's been marked as Defendants' Joint Exhibit 2238. And can you identify that exhibit for the record, please.

A. That's a map figure from my report.

Q. Okay. And was this map prepared under your direction?

A. Yes, it was.

Q. And can you identify the source of the land use data that is shown on this map?

A. It's the National Land Cover Dataset of EPA.

Q. Doctor, is that data shown geographically on this map?

A. Yes, it is.

MR. GEORGE: Your Honor, I move for the introduction of Defendants' Joint Exhibit 2238.

THE COURT: Any objection?

1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

3

4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 JANUARY 12, 2010
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 92, A.M. SESSION

16

17 APPEARANCES:

18

19 For the Plaintiffs: MR. W.A. DREW EDMONDSON
Attorney General
20 MS. KELLY FOSTER
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21 State of Oklahoma
313 N.E. 21st St.
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agreeable to that with one qualification, and Mr. Bullock and I discussed this. That is, notwithstanding the interruption, we will complete the cross-examination and direct of this witness today so he can leave town.

MR. BULLOCK: Yes, sir. Steve Thompson.

(Witness sworn.)

THE COURT: State your full name for the record, please, sir.

THE WITNESS: Stephen A. Thompson.

THE COURT: I understand you have a dentist appointment; is that correct?

THE WITNESS: I do.

THE COURT: We'll try to get you out of here.

Mr. Nance.

MR. NANCE: We appreciate the accommodation and appreciate the defendants' accommodation as well.

STEPHEN A. THOMPSON,

having been first duly sworn, was called as a witness and testified as follows:

CROSS-EXAMINATION

BY MR. NANCE:

Q. Mr. Thompson, are you the director of the

Department of Environmental Quality?
A. Yes.
Q. And are you the same Steve Thompson whose deposition was played to the court just before Christmas?
A. Yes.
Q. In that deposition that was played, you said you believed that the TMDL process would result in an unfair allocation of load reductions. Do you remember that testimony?
A. Yes.
Q. Let's pursue that in a little greater detail. Do you anticipate that a completed TMDL on -- in the IRW in Oklahoma would result in a determination that phosphorus loadings need to be reduced?
A. Yes.
Q. And why is that, sir?
A. Well, the waterbody is impaired for phosphorus, so definitionally, you would need -- it would require reductions.
Q. Do you anticipate that a completed TMDL for the Oklahoma portion of the Illinois River Watershed would result in required loading reductions for both point sources and nonpoint sources?
A. Yes.

Q. Thank you. Doctor, we talked a little bit yesterday about overland flow, and I want to kind of pick up there, if we can.

Are there some substances that are more susceptible to various types of overland flow than others?

A. I think the way I would phrase it is not so much susceptibility to overland flow as an issue whereby the flow paths followed by the water will have different likelihoods of carrying substances.

In particular, the flow paths that have a lot of contact with the soil, the deep flow paths that -- the interflow through the shallow soils lose a lot of opportunity for interaction between the water and the soils.

In those flow paths, substances that are what we call conservative, like nitrate, for example, or chloride, they tend to not adsorb to soil particles, and they move right with the water. But substances like phosphorus tend to adsorb to soils and not move with that water when it has a lot of contact with soil.

But for the overland flow where there's less contact with soil, there's more opportunity to transport the phosphorus. But in that overland

flow, you also can transport the conservative substances as well.

Q. Doctor, what factors on a field, say a pasture, control the propensity of phosphorus to move off a field in overland flow?

A. Well, the main controlling factor is whether, in fact, you have overland flow. That is, by far, the most important consideration. There will be some pasture areas that may have it, and there will be many pasture areas that will not.

And whether or not you have overland flow is determined by, in particular, the soil characteristics, the infiltration rate, the distribution of sediment sizes, soil texture, and the steepness of the slope. So those are all involved in determining if you have overland flow.

Then plus the hydrology we talked about yesterday is the groundwater coming up during storms in certain locations to the point where it saturates the soil.

Q. Doctor, I've already been handed a note that you and I both need to slow down again, so I'm reminding myself. Now I'll remind you.

MR. GEORGE: Sorry, Your Honor.

THE WITNESS: Thank you.

Q. (By Mr. George) Doctor, are you familiar with the term "critical source area"?
A. Yes.
Q. And what does that mean with regard to the movement of nutrients?
A. A critical source area is an area where you have an overlap of source and opportunity for transport. So with respect to phosphorus, in order for phosphorus to move in any appreciable quantity to a stream, you need to have a quantity of phosphorus at that particular site, and the transport has to be able to move that phosphorus from that site to the stream. And that's what we discussed; that largely is the overland flow process. So when those two overlap, that's the critical source area.

If you've got the supply but no transport, there's not a major risk to movement into the stream. If you've got the transport and not the source, similarly, there's not a major risk of movement. It's where the two overlap.

Q. Doctor, in light of that, in order to understand the potential for phosphorus to run off of a particular field, is it sufficient to look only at soil test phosphorus?

Q. (By Mr. George) Doctor, are you familiar with the term "critical source area"?
A. Yes.
Q. And what does that mean with regard to the movement of nutrients?
A. A critical source area is an area where you have an overlap of source and opportunity for transport. So with respect to phosphorus, in order for phosphorus to move in any appreciable quantity to a stream, you need to have a quantity of phosphorus at that particular site, and the transport has to be able to move that phosphorus from that site to the stream. And that's what we discussed; that largely is the overland flow process. So when those two overlap, that's the critical source area.

If you've got the supply but no transport, there's not a major risk to movement into the stream. If you've got the transport and not the source, similarly, there's not a major risk of movement. It's where the two overlap.

Q. Doctor, in light of that, in order to understand the potential for phosphorus to run off of a particular field, is it sufficient to look only at soil test phosphorus?

A. No. Soil test phosphorus is one way to get a handle on the source, but it tells you nothing about the transport. You have to look at the two together to identify where those critical source areas are. They are also called hotspots by a lot of scientists.

Q. Doctor, let's talk about some of the factors that may influence the transport potential of the critical source discussion that we've been having.

To what extent does the water flow path impact the transport potential?

A. That's the most important determination is the flow path.

Q. As we were discussing yesterday, we defined some terms including "overland flow" and different types of overland flow. One thing I think we missed and I want to cover now is runoff. You're aware the term "runoff" has been used throughout this trial?

A. Yes.

Q. And do you have a working definition of "runoff," and can you explain how it may be different from overland flow?

A. Okay. There are a couple of issues here. One is, is that the term "runoff" is used in different ways. It's my belief that those differences can

introduce a lot of confusion. And in reviewing the testimonies in this trial, that was apparent to me that people were using the term in different ways.

Runoff is a hydrological term, and what it means is during storms, water that moves into the stream, that's runoff. And so you can quantify runoff as the total amount of stream flow. And that gives you an indication of all the water that -- for example, we can talk about the runoff to Lake Tenkiller. What's the total amount of stream water during a storm, storm runoff that gets to Lake Tenkiller. But for -- the water gets there from rainfall, but it follows different pathways to get there.

And we talked about the overland flow. We talked about the interflow and the deep flow, these different pathways. And with a substance like phosphorus, the pathway followed has a very important influence on the transport of that phosphorus.

But in terms of breaking runoff down so we can say, well, we've got the overland flow part and we talked about two different types of overland flow, but the end result is the same. We've got interflow, which is shallow and lateral, then the

deep flow.

Some people, when they use the term "runoff," they're talking -- I believe they're talking about the overland flow component by itself. And that's really an incorrect way to evaluate that.

Also sometimes when people use the term "runoff," what they mean is movement of phosphorus or some other constituent into a stream. And I recognize that people commonly use the term that way, but in the scientific evaluation like this, I think we have to be more precise about the words that we use. And "runoff" is really a hydrological term. It's talking about movement of water, not moving of phosphorus. I think we need to be careful to keep those distinctions in mind.

Q. Doctor, are all pastures and all areas of all pastures created equal in terms of their propensity to generate overland flow?

A. No.

Q. Does it require a site-specific evaluation?

A. Yes, very much so.

Q. Doctor, if phosphorus moves off of a field, does it necessarily reach flowing waters?

A. No.

deep flow.

Some people, when they use the term "runoff," they're talking -- I believe they're talking about the overland flow component by itself. And that's really an incorrect way to evaluate that.

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Q. Doctor, are all pastures and all areas of all pastures created equal in terms of their propensity to generate overland flow?

A. No.

Q. Does it require a site-specific evaluation?

A. Yes, very much so.

Q. Doctor, if phosphorus moves off of a field, does it necessarily reach flowing waters?

A. No.

Q. Why not?
A. Well, if the water moves off the field -- like, for example, on a field, you can have areas that generate overland flow. And then as you move further down the field, you may get to an area where it no longer generates overland flow in that particular storm size and the water infiltrates down into the soil there. So you may have a hill slope, you have some overland flow at the top, and it percolates and infiltrates down into the soil where it's no longer overland flow.

So somewhere in that hill slope, it had the chance to interact with soil, thereby removing much or all of that phosphorus that was in the overland flow originally. So that's one issue.

But another issue is that the fields are located at variable distances from streams. Sometimes there's a stream right in the field or right below the field. Other times, the nearest stream might be a mile away or more. So you can have overland flow in different places that eventually infiltrates and never gets to a stream without that soil contact.

You can also have overland flow go into a ditch line, but that ditch line can have multiple

fates. It may flow into a stream, it may not. It may -- it may be dug all the way to a stream, but before the water gets there, it infiltrates down into the soil in the bottom of the ditch.

There's all different types of situations in terms of whether or not that water will eventually reach a stream.

Q. Doctor, you've reviewed the testimony of Dr. Engel in this courtroom, have you not?

A. Yes, I have.

Q. And you saw that Dr. Engel testified that once phosphorus begins to move off of a field, it will necessarily continue in motion until it reaches the reservoir at the bottom of the watershed? Did you see that?

A. Yes, I've seen that.

Q. Do you agree with that assumption?

A. No. There's no basis for that claim at all, in my view.

Q. Doctor, as part of your work in this case, did you review any regulations or restrictions placed on the use of poultry litter as a fertilizer or soil conditioner in the watershed?

A. Yes, I did.

Q. Specifically, what type of regulations or

restrictions did you look at?
A. In terms of the on-the-ground restrictions?
Q. Yes, sir.
A. Setbacks for litter application from streams, instructions to not spread on areas that flood, to not spread on frozen soils, to not spread on steep terrain, to not spread on shallow soils. So there are a number of rules that are in place that govern the application of litter.
Q. Doctor, did you review the restrictions such as those you've just described in Code 590?
A. Yes.
Q. Did you review Animal Waste Management Plans or Nutrient Management Plans as well?
A. Nutrient Management Plans, yes.
Q. Doctor, are you a legal expert in the rules and regulations governing litter application?
A. No.
Q. Was it necessary for you to be a legal expert on the rules and regulations to perform your work in this case?
A. No.
Q. How were the rules and the restrictions and the plans that you've just described important to your work in this case as a scientist?

A. Well, as a scientist, what was important is for me to see if the rules and regulations made sense relative to the state of the scientific understanding on phosphorus movement. And the scientific understanding on phosphorus movement has to do with these critical source areas or hotspots and the reasons for those and the different flow paths followed by the water.

So what was important to me was to see if those kinds of considerations were appropriately incorporated into the regulations. And it's my view that they are.

Q. Based upon your review of Animal Waste Management Plans or Nutrient Management Plans and the rules and regulations that we've talked about, do the systems in place from a regulatory standpoint in this watershed account for some of the hydrologic factors that have an effect on the generation of overland flow?

A. Yes, they do.

Q. Did you note any restrictions on the application of litter to frozen or saturated soils?

A. Yes.

Q. Is that important in your analysis?

A. Yes. If the soils are frozen, then that

provides an enhanced opportunity for overland flow, if it rains on frozen soils.

Q. Did you note any restrictions on litter application on areas with steep slopes?

A. Yes.

Q. And how was that important to your analysis?

A. Well, one of the issues that helps regulate the risk of overland flow is the steepness of the slope. And in general, all things being equal, if the slope is steeper, there's a higher risk.

Q. Doctor, I believe you mentioned that one of the things you noted was some setback requirements from streams; is that right?

A. Yes.

Q. How was that important to your analysis?

A. Well, the hydrologically active areas, the areas that are likely to generate overland flow in a sufficiently large storm, you can find them anywhere, but they tend to be most commonly found close to the streams.

And the major reason for that is because the groundwater movement is moving from the hill slope down towards the stream, and so you have a higher likelihood that you will get the type of overland flow that results when the groundwater

comes up right to the surface, and then when it rains, there's no place for the water to go except sideways as overland flow.

And that's our saturated -- our saturation excess overland flow. So that type is far more likely to occur in proximity to the stream in those riparian areas.

Q. Doctor, did you note any restrictions in your review on the application of litter to shallow soils?

A. Yes.

Q. And was that important to your analysis?

A. That really was not important to the analysis that I conducted, because I was focused on the potential for impacts on the streams and the soil issues. I think it's important that that regulation be there as a way of protecting the groundwater resources.

Q. Now, Doctor, based upon the Nutrient Management Plans you reviewed, including those from the state of Arkansas, in your judgment, do those plans take into consideration both source and transport considerations?

A. Yes.

Q. Okay. All right, Doctor. Let's move to your

review of some of the specific work of experts for the State of Oklahoma in this case.

As part of your work in this case, did you review the reports and work of various State experts?

A. Yes, I did.

Q. Let me ask you about some of the specific lines of evidence that have been put forward by the State to support its claims of impact upon streams and rivers from poultry litter. You reviewed the State's edge-of-field sampling program?

A. Yes, I have.

Q. And in your judgment, how important are these edge-of-field samples to the State's causation case?

A. I think they're critical to the State's causation case because the edge of field is really the type of data that the State uses in a number of these expert reports and analyses to try to establish a connection between what's on the field and what's in the stream.

Q. Doctor, I believe you testified yesterday, but I want to make clear, you have actual field experience in gathering and using edge-of-field samples, correct?

A. Yes, I do.

Q. Based upon your review, are the edge-of-field samples collected by the State in this case representative of what runs off of a litter-amended field?
A. No.
Q. Why not?
A. The edge-of-field samples were collected largely from ditches. There was no permission granted to go onto the landowner's land and set up an apparatus with which to collect flow coming off of pastureland. And by and large, those samples were not collected from flowing water; they were collected from a ditch that was convenient to the road where the samplers could get without having permission to get onto the land.

So there's no way to know where that water came from. Perhaps some of it came off a field. We don't know. It may have come from something upslope associated with that ditch. And if it did come off the field, we don't know what the source of phosphorus on the field was that may have contributed the phosphorus to the edge-of-field water.
Q. Doctor, you mentioned that some samples were collected from ditches. Did you note in your review

any samples that were collected from puddles?
A. Yes.
Q. Are those sort of edge-of-field samples representative of what flows off of a litter-amended field?
A. There's no way to know where the water came from. It could have come from one place or from many different places. And what that place was, there's no information to really tell us that.
Q. Now, Doctor, in addition to reviewing the photographs, did you look at the field notes from the team that actually collected the samples?
A. Yes, I did.
Q. And in terms of documentation of flow, what did you see in those field notes?
A. I didn't really see documentation of flow. In terms of documentation of flow, there were, you know, a few instances and testimony that I saw, a few cases that they may have been flowing water, but by and large, that was not the case.
Q. Is that important to your analysis?
A. Well, it is, because -- for two reasons. Number one is trying to figure out where that water came from. We don't know where it came from. I'm not sure what value it is in this kind of

investigation.

But then beyond that, even if we knew where it came from, we don't know whether it was flowing somewhere else or it just stayed in that puddle or that ditch and eventually infiltrated into the soil.

Q. Doctor, did you also review Dr. Engel's and Dr. Stevenson's poultry house density correlation analysis?

A. Yes, I did.

Q. What did you understand to have been the purpose of that analysis?

A. The purpose of that analysis was to evaluate the relationship between poultry house density, as they estimated it, and the phosphorus concentration in the stream and perhaps other parameters as well. But the main focus was phosphorus.

Q. Do you agree that the correlations they calculated between poultry house density and phosphorus concentration show that poultry litter application is responsible for elevated phosphorus concentrations?

A. No.

Q. Why not?

A. Well, for multiple reasons. One is that a correlation does not demonstrate causality. It just

investigation.

But then beyond that, even if we knew where it came from, we don't know whether it was flowing somewhere else or it just stayed in that puddle or that ditch and eventually infiltrated into the soil.

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A. The purpose of that analysis was to evaluate the relationship between poultry house density, as they estimated it, and the phosphorus concentration in the stream and perhaps other parameters as well. But the main focus was phosphorus.

Q. Do you agree that the correlations they calculated between poultry house density and phosphorus concentration show that poultry litter application is responsible for elevated phosphorus concentrations?

A. No.

Q. Why not?

A. Well, for multiple reasons. One is that a correlation does not demonstrate causality. It just

indicates that two variables are related to each other in space or in time. We can talk about that in detail, if you want, but that's the first reason.

Q. What is a cross-correlation?

A. A cross-correlation is a situation whereby you look at two variables and they related to each other, but that relationship may be influenced or mediated by a relationship with a third variable or multiple other variables.

So if A and B are correlated, you might say, well, A causes B. But perhaps C causes A -- or C causes B, but A and C are related. So it confounds the interpretation of what the correlation means.

Q. Did the State's regression analysis account for alternative potential causes that cross-correlate with poultry house density?

A. Well, Dr. Engel actually did report a statistically significant correlation between septic systems and poultry house density. But then he dismissed that for what I believe to be insufficient grounds.

Q. Does that cross-correlation confound the analysis, in your view?

A. Yes.

Q. Doctor, did you perform any analysis to examine other cross-correlations between poultry house density and potential sources of phosphorus?
A. Yes, I did.
Q. Can you turn in your binder to tab 21. Actually, 22.
A. Yes.
Q. And find Defendants' Joint Exhibit 2257. Can you identify that document for the record, please.
A. That's a figure from my report.
Q. Was this figure prepared under your direction?
A. Yes.
Q. And can you describe generally the source of the data or information that is shown in this exhibit?
A. Yes. The source of the information would be Dr. Engel's materials.
Q. Let's do a few of these at a time. Can you turn to the next tab, Doctor, and find Defendants' Joint Exhibit 2258.
A. Yes.
Q. And can you identify the source of the data that is shown.
A. Yes. That's also information from Dr. Engel's considered materials presented as a figure in my

report.
Q. Was this exhibit prepared under your direction?
A. Yes.
Q. And then the last tab, tab 24, Doctor, could you find Defendants' Joint Exhibit 2259.
A. Yes.
Q. And could you identify generally the source of the information and data that's shown in this figure.
A. This was from -- data from USDA Census of Agriculture.
Q. Is Dr. Engel's poultry house density data also shown?
A. Yes, it is -- oh -- yes, that's right. Well, that was not restricted to Dr. Engel's poultry house density necessarily; it was the plaintiff's poultry house density data layer.
Q. I'm sorry. Thank you. Was this figure also prepared under your direction?
A. Yes, it was.
MR. GEORGE: Your Honor, I'd move for introduction of Defendants' Joint Exhibits 2257, 2258, and 2259.
THE COURT: Any objections?
MR. BULLOCK: I have no objection to 2257

and 2258. I do object to 2259, as the caption on that states this is based upon the calculations of Billy Clay, and Billy Clay is not before the court and hasn't presented these matters before this court.

MR. GEORGE: Your Honor, perhaps we could, without objection, have the first two exhibits introduced, and then I'll move to lay a further foundation.

THE COURT: Very well. 2257 and 2258 are admitted.

Q. (By Mr. George) Doctor, let's talk about the first two, then we'll come back to the third exhibit.

Can you look at Exhibit 2257 and explain what is shown there and how it is relevant to your analysis of cross-correlations.

A. What's shown is the density of poultry houses. And there are two poultry house densities that are used based on Doctor Engel's characterization as all poultry houses on the top figure, and just the active -- what he identified as what he believed to be active houses on the bottom figure.

Then on the X axis, or the horizontal axis, we have the septic density. And these are based on

the subwatersheds that were studied by Dr. Engel. I believe there were 14 of them. And he had deleted from consideration in calculating his regression statistics a couple of subwatersheds because they had urban influences in those watersheds.

Q. Do you agree that that was appropriate to delete those subwatersheds?

A. Yes, I do. I think it's appropriate to zero in on the influence of land that's separate from the urban influence, but I do think it's really important when you do that to make sure you communicate that caveat, that the results of the analyses are purposely excluding whatever impact you may have in the urban environment. I think it's appropriate to do that. I would do it the same way, but I think that if you fail to communicate that caveat, that's misleading.

Q. Doctor, were there any other subwatersheds that, in your judgment, were impacted by urban land uses that should have been deleted from the analysis?

A. Yes. There was one other that had -- I think it was seven percent of land use. It was more than five percent. So I thought that for the same reasons as Doctor Engel had deleted the other two,

that the third one should be deleted as well.

Now, I didn't delete them from the figures. I showed the data, but I didn't include them in calculating the regression line.

Q. Can you continue to show what -- to describe what your analysis shows.

A. What it shows is a statistically significant relationship between the density of septic systems in these small subwatersheds and the poultry house densities that Dr. Engel estimated for these same small subwatersheds.

Q. I'm a lawyer primarily because I'm not good at statistics. Can you tell us what it is about this figure that defines statistical significance.

A. It's the P value. And it's -- both of those plots were P less than 0.01. The main -- the main standard that's used for evaluating significance on regressions like this would be if the P value was less than .05. That's what's called the 95 percent significance level. That's what people typically use. So a P of less than .01 is of higher significance than that.

Q. Doctor, based upon the analysis shown in this exhibit, are the presence of septic tanks in rural areas where poultry houses are located a confounder

in the analysis?
A. Yes, because if you're going to try to use a regression between stream phosphorus and poultry house density and say from the results of that that the poultry houses are causing the stream phosphorus, well, first of all, you can't say that the significance of the correlation means that those are causal anyway; but independent of that, the fact that something else that's a possible source is also correlated is certainly a confounding factor.
Q. Doctor, could you turn to the next tab, Defendants' Joint Exhibit 2258 which is in evidence. And could you describe the analysis that is shown in this figure and how it's relevant to cross-correlation.
A. Yes. This is essentially the same analysis as the previous figure, except that on the X axis, we're looking at the density of roads in those subwatersheds rather than the density of septic systems. But again, we see the correlation between poultry house density and, in this case, road density.
Q. Doctor, does the presence of roads in areas where poultry houses are located constitute a confounder in the analysis?

A. Yes, for the same reason as we discussed with septic systems.
Q. Doctor, I note there's one other statistic on these figures that we haven't discussed yet, which is the R^2 value. Do you see that?
A. Yes.
Q. That's present on both of the exhibits that we've been discussing?
A. Yes.
Q. What is the R^2 value, and what does it tell us?
A. It tells us what percent of the variation between the two variables is explained by the relationship by the regression. So we're on this Figure 8-6, and if we look at the top, the top panel, it gives an R^2 of 0.57. That means that 57 percent of the variability in the poultry house density can be explained by its relationship with road density.
Q. Thank you. Now, Doctor, did you also evaluate -- let me back up.
Based upon your review of cattle populations in the watershed and your own personal observations in the watershed, are cattle generally associated with the rural areas in which poultry houses are situated?

A. That's been my observation, yes.
Q. Doctor, as part of your review of the work of Dr. Stevenson and Dr. Engel, did you investigate the statistical correlation between where cattle are located and where poultry houses are located in the watershed?
A. Yes, I did.
Q. And as part of that analysis, were you provided with data from Dr. Clay regarding cattle locations?
A. Yes.
Q. Doctor, is the -- if you could turn to tab 24 and find Defendants' Joint Exhibit 2259.
A. Yes.
Q. With respect to the information provided by Dr. Clay, can you provide us with a description of that information and how it was assembled for your use.
A. Well, the information would be the cattle densities from the census of agriculture. And Dr. Clay aggregated those by ZIP code because that was a way to give us a number of spatial units within the overall IRW that we could use to evaluate relationships between cattle and some other variable. We did not have cattle estimates by Engel subwatersheds.

So then the next step would be, well, what other units of geography can we use to evaluate the spatial relationship. And the best that we could come up with to do that was the cattle by ZIP codes.

Q. Doctor, when you looked across the watershed at poultry house density and cattle by ZIP code, did you find the statistical relationship?

A. Yes.

MR. GEORGE: Your Honor, I move for the introduction of Defendants' Joint Exhibit 2259.

MR. BULLOCK: Judge, even by his own testimony today, it remains hearsay as to the cattle density. I don't believe that he can testify as to cattle densities.

MR. GEORGE: Your Honor, under Rule 703, an expert is entitled to rely upon hearsay for purposes of his analysis. We're not offering the underlying ZIP code statistics by Dr. Clay for the truth of the matter. We're simply offering them as the basis for an opinion and an analysis that this expert has done. I think that's proper.

THE COURT: This is part of his report?

MR. GEORGE: It is, Your Honor.

THE COURT: Rule 703 would permit it not for the truth of the matter asserted, but as being

of a type reasonably relied upon by experts in a particular field. The Exhibit 2259 is admitted.

Q. (By Mr. George) Doctor, we heard testimony, and I think you reviewed it, by Dr. Engel that his analysis was based on 14 subwatersheds within the million-acre watershed. Did you see that?

A. Yes.

Q. Did you see any analysis in Dr. Engel's work that would support the extrapolation of his results for the 14 subwatersheds to the watershed as a whole?

A. No.

Q. Doctor, did you also analyze the manner in which Dr. Engel and Dr. Stevenson counted poultry houses in their correlations?

A. Yes.

Q. And what did they do generally?

A. Well, they had a database of poultry house locations that was obtained, it's my understanding, from aerial photography. And they did some analyses to try to determine which ones were active and which ones were not. I have no idea how valid that is, but that's something they did, and I took it at face value.

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But in performing their analyses, their

correlations, they also assigned a two-mile buffer around each of the subwatersheds. So you'd have a subwatershed for study, and then expand that out two miles in all directions and create a buffer.

And then in calculating the number for the density of poultry houses, what they did was, for some analyses, they just did the poultry houses in the subwatersheds, and I don't have a problem with that. But for other analyses, they tabulated the number of poultry houses in the subwatersheds plus in those two-mile buffers.

I can stop there and see where you want to go from there.

Q. Doctor, what is your understanding of the purpose of these two-mile buffer zones in their analyses?

A. How it was explained was that there's a possibility that poultry litter is trucked from the poultry house location to the area it's going to be spread, and they contend that that area is rather short, and they identified two miles as what they believed to be the area from which poultry litter may be imported into the subwatershed.

But they did not account for the fact that there's an equal possibility or probability that

poultry litter from a house inside that subwatershed could be trucked the same two miles outside. So it was a very biased analysis.

Q. Doctor, what is the impact -- and maybe you got there just a moment ago. What is the impact of that accounting method on the reliability of the results?

A. My opinion is it renders those results unreliable, because it's a faulty logic constraint on the analysis. If there's an equal possibility or probability of trucking poultry litter in as trucking poultry litter out, then if you want to conclude half of that in your analysis, you need to somehow include consideration of the other half as well. Otherwise, you're biasing your analysis.

Q. Doctor, did you review the impact that these buffer zones had on the actual poultry house counts used in the subwatershed analysis?

A. Yes, I did.

Q. And what was that impact?

A. Well, the end result was that the total number of poultry houses that they counted in their subwatersheds plus buffers was about the same as the total number of poultry houses that they estimated for the entire IRW. That was because they were double and triple counting poultry houses within

1 those buffers.
2 Q. Now, Doctor, did Dr. Stevenson present any
3 density regression analysis that did not use these
4 buffer zones?
5 A. I don't believe so, no.
6 Q. Doctor, based upon all the data and the reports
7 and studies and testimony that you've reviewed and
8 the work that you've done in this case, do you agree
9 with the State's proposition that poultry litter is
10 responsible for injuring water quality in the
11 Illinois River Watershed?
12 A. No, I've not seen any indication that that
13 proposition is proved at all.
14 MR. GEORGE: Thank you, Your Honor, I'll
15 pass the witness.
16 THE COURT: Cross-examination.
17 MR. BULLOCK: Judge, we asked defendants if
18 we could interrupt Dr. Sullivan. At this time, we
19 ask rather than defendants asking, so we could go
20 ahead and do Mr. Thompson's cross. He has a dental
21 appointment that he has to make, so we thought we'd
22 drill him without Novocaine before he gets the
23 treatment.
24 THE COURT: Very well.
25 MR. GEORGE: Your Honor, the defendants are

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Department of Environmental Quality?
A. Yes.
Q. And are you the same Steve Thompson whose deposition was played to the court just before Christmas?
A. Yes.
Q. In that deposition that was played, you said you believed that the TMDL process would result in an unfair allocation of load reductions. Do you remember that testimony?
A. Yes.
Q. Let's pursue that in a little greater detail. Do you anticipate that a completed TMDL on -- in the IRW in Oklahoma would result in a determination that phosphorus loadings need to be reduced?
A. Yes.
Q. And why is that, sir?
A. Well, the waterbody is impaired for phosphorus, so definitionally, you would need -- it would require reductions.
Q. Do you anticipate that a completed TMDL for the Oklahoma portion of the Illinois River Watershed would result in required loading reductions for both point sources and nonpoint sources?
A. Yes.

Q. Would you tell the court, please, what point sources exist in the Oklahoma portion of the IRW.
A. For the Illinois River, the city of Tahlequah and the city of Westville, city of Stillwell discharges to an arm of Lake Tenkiller.
Q. Do each of these point sources have Clean Water Act NPDES permits?
A. Yes, they do.
Q. Do each of these permits have phosphorus limits?
A. Yes.
Q. Would you tell the court what your agency's authority and responsibility is regarding these permits to ensure any load reductions that might be required by a TMDL?
A. It's our responsibility to set limits in the permit to meet the requirements of the TMDL.
Q. And if a reduction was required in loading, would there have to be lower limits in the permits?
A. Yes.
Q. Would any phosphorus limit reductions be merely voluntary, or can they be legally required of permit holders?
A. They are legally required.
Q. Can you give the court, please, an example of

Illinois River Watershed rank in the list of priorities for TMDLs?
A. It would be a high priority if we could work through this issue.
Q. Okay. Returning to my prior question. If the Water Resources Board does not respond and engage you or your staff in the discussion of these concerns, what options under law do you have?
A. We have the -- we have no option but to do a TMDL.
Q. According to the standards as written?
A. Yes.
Q. If you are engaged by the Water Resources Board in a technical discussion of these different viewpoints and you simply cannot agree, or the Water Resources Board does not agree, are your positions the same, that being you must proceed by law to generate the TMDL?
A. Yes.
Q. Sir, how will we know when we are at that point where you recognize that you are at an impasse and that you have no other choice but to comply with law and release this project for completion?
A. Well, we will continue -- I've asked Ms. McClary -- Chard-McClary to work with the water

board. At some point when we are told -- it's my understanding they've continued to evaluate it and have not made that decision.

If at the point the water board makes the decision that they're not going to change it, that's when we would do so.

Q. Okay, sir. And my specific question is, we're in a court of law, we have the judge on the bench who's a decision maker, and I think it's important to know, sir, can you tell this court, give this court a time frame or a date by which this will either be resolved between your two agencies or not, meaning that you will then have to proceed to develop the TMDL as required by law?

A. It would depend upon the water board making a final decision that they are not going to change.

Q. I don't want to argue with you, sir. Do you understand my question? How long will this go on until you recognize it's not going anywhere with the water board and you're going to have to issue the order to your staff to develop the TMDL?

MR. NANCE: I object as asked and answered, Your Honor.

THE COURT: Overruled.

THE WITNESS: I -- we will continue to work

with the water board to establish a change. At the point where the water board decides that they are not going to change, definitively they are not going to change -- it's not my understanding that that has occurred -- but at the point when they make that decision, we will have no choice but to go forward.

Q. (By Mr. McDaniel) All right. Out of respect for you and your position, sir, I'm not going to argue with you further. But you can't give the court a date, can you?

A. Well, I can tell you that we are going to pursue it. I can tell you that we will continue to try to work through the technical issues. I can't tell you when the water board will definitively make that decision.

Q. All right.

THE COURT: A couple of questions here. Down to brass tacks here. In terms of point source, because you contend that requiring the geometric mean unfairly points to point sources, which of these wastewater treatment plants do you suspect would require these expensive upgrades or changes in the event that the sampling regime or protocol is not changed? Tahlequah?

THE WITNESS: Tahlequah and Westville.

will provide information. And she will assess the technical basis on which the model and the process will proceed.

Q. As far as Oklahoma's comments, feedback, will she be the conduit into the EPA process for -- let me put it this way. Will she be Oklahoma's voice at the table in this process?

A. Yes.

Q. Turn to the second page of the letter, please, sir. Let me read a little bit from this top paragraph. Mr. Flores says, "We expect this modeling effort may lead to the development of one or more Total Maximum Daily Loads for the Illinois basin. EPA will take the lead in developing such TMDLs, and we encourage active participation by both Oklahoma and Arkansas. Along with the modeling work, we are now initiating other factors that may influence future TMDL decisions for the basin."

Sir, do you know what Mr. Flores is referring to when he says, "other factors that may influence future TMDL decisions for the basin"?

A. Not specifically, no.

Q. Well, if you look in that -- continuing in the paragraph, he makes reference here to a reevaluation -- excuse me, "Oklahoma's reevaluation

of the phosphorus criteria for Scenic Rivers pursuant to the 2003 statement of joint principles and actions." Do you see that?
A. Yes.
Q. Do you believe that may be one of the factors Mr. Flores is referring to?
A. It may be.
Q. Sir, to your knowledge, did Oklahoma commit in the 2003 statement of joint principles to reevaluate the 0.37 Scenic River phosphorus standard by 2012?
A. Yes.
Q. If I understand the dialogue that we had at your deposition and that we've had this morning before the court, your desire that the criteria or implementation criteria be reevaluated is something that could be addressed as part of reevaluating the Scenic Rivers standard; do you agree? Particularly the geometric mean and the number of samples.
A. It could be, yes.
Q. Sir, to your knowledge, does the State of Oklahoma intend to fulfill this commitment by reevaluating the Scenic Rivers standard?
A. It does not fall within my jurisdiction, but to the best of my knowledge, it does, yes.
Q. Tell me, if you can, sir, what you know about

the timing for reevaluating the Scenic Rivers standard.
A. I don't know anything about it.
Q. Sir, do you know whether the Oklahoma Water Resources Board is now accepting comments with regard to its triennial review of Oklahoma water quality standards?
A. I don't know that specifically.
Q. Does ODEQ have any role in that process?
A. Well, we, as with any state agency, will have comments on the process.
Q. Is it normal for your office to remain apprised of what's going on in the Water Resources Board with regard to water quality standards?
A. Yes.
Q. But you don't know if OWRB is in the midst of its triennial review as we speak?
A. I know there's been some discussion of it, but whether they are in the midst of it, I don't know.
Q. Sir, do you know whether the Water Resources Board has included the 0.37 milligram per liter scenic river standard among the standards it intends to review during this triennial review?
A. No.
Q. Now, with regard to the EPA initiative, sir,

A. It's the quality assurance plan by which any activity would be done.
Q. And by 2004, you'd also retained some scientists at the university to do some preliminary modeling in connection with the TMDL; isn't that right?
MR. NANCE: Judge, it's beyond the scope of cross.
THE COURT: I don't believe so. Overruled.
THE WITNESS: Yes.
Q. (By Mr. Hopson) Dan Storm was one of those scientists, right?
A. Yes.
Q. And Dan Storm's report is actually one of the things that caused you to have some concerns about the unfairness inherent in the phosphorus criterion, isn't it?
A. What caused me to have concern was a report given to me by my water quality division director Jon Craig. Mr. Craig may have -- that's what caused my concern.
Q. Well, let me ask the question this way: Do you know and do you recall that Dr. Storm actually concluded that 100 percent litter export would have no impact on meeting the phosphorus criterion in the

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IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 93 - PM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

JANUARY 12, 2010

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

settings.

When the heavy rains come, the water will find those channels and flow into the larger streams; right?

A. That can certainly occur, yes.

Q. Okay. And, in fact, if we looked at a picture of the stream networks of the IRW, it would show third-, fourth-, fifth-, and I think the river itself gets to a sixth-level stream; correct?

A. Sixth and seventh.

Q. Okay. And the first- and the second-order are these ephemeral streams that we've been talking about; is that true?

A. I would not characterize it that way, no.

Q. Okay. What are the first- and second-order streams?

A. Well, if you're talking about the moderate resolution NHD, which is what most people use for most purposes in my view, the first -- the first- and second-order streams would be what I would consider to be small streams. Some of them may be intermittent. I wouldn't characterize most of them as being intermittent certainly. But if you move to the high-resolution NHD, then you would pick up a larger proportion of streams that would be considered to be

I want to know whether you are aware of whether or not one of the risk factors examined by the PI index, whether there is any -- let me rephrase.

In the Arkansas PI index, are you aware of whether or not it takes into account, or whether there is an assessment of, the extent of compaction, channelization, or overgrazing in any particular fields?

A. Yes.

Q. Okay. And where did you see that?

A. That is in the -- in the Arkansas phosphorus index, what it includes is an estimate of runoff risk potential. In calculating that runoff risk potential, they include the vegetation information that would express some of these kinds of issues.

Q. Some of them?

A. Yes.

Q. Is there -- are you saying that in terms of doing the maps of these areas, that there is any assessment of, for instance, a channelization caused by cattle?

A. No, I'm not aware of any assessment like that.

Q. Okay. And in terms of the on-site assessment of these areas, is it your testimony here that the

extent of overgrazing is assessed in that Nutrient Management Plan?

A. Are we talking about the phosphorus index or the Nutrient Management Plan?

Q. Yes. Well, let's talk about the nutrient management plan, first of all.

A. Well, the Nutrient Management Plan uses the phosphorus index. So --

Q. I understand. So let's talk first about the Nutrient Management Plan where they do the on-site assessment of these farms, okay?

A. Okay. Yep.

Q. Are you aware of whether or not those Nutrient Management Plans do an assessment of the health of the compaction -- or the degree of compaction on any particular field?

A. Well, there is an assessment of the pasture condition. And as I said -- you correctly stated I'm not an expert on these, but it's my understanding that a trained soil scientist or other trained individual will go out and evaluate these pastures individually and they will provide that information that feeds into the phosphorus index calculation which does include pasture condition as a component of estimating the runoff risk potential.

regulations.

Q. But you wouldn't describe those soils as constituting a warehouse, would you?

A. No.

Q. Okay. Let's talk about your other potential sources -- or other sources.

Doctor, at the conclusion of your testimony, I understood you to say that you had seen no data and no study which supported the view that phosphorus from poultry is getting into the waters of the Illinois River. Do you recall that testimony?

A. I don't think I said "no study." If I addressed study, it would have been no defensible study.

Q. Okay. No defensible study. In fact, have you not, read several government studies which directly point to poultry as both a possible source and as an actual source, have you not?

A. Well, I've certainly read reports that point to poultry as a possible source.

Q. Okay.

A. I believe that there were reports that claim that poultry was a source but didn't provide the data to back up such a claim.

Q. Okay.

A. But I did not see any study that demonstrated to me that the poultry litter contributed to phosphorus in Lake Tenkiller.

MR. BULLOCK: If I might approach, Your Honor?

THE COURT: Yes, sir.

(Discussion held off the record)

Q. *(BY MR. BULLOCK)* I have handed you what has been marked as Defendants' Joint Exhibit 640. It's a Comprehensive Basin Management Plan for the Illinois River Basin in Oklahoma.

You recognize that, do you not, Doctor?

A. Yes, sir.

Q. In fact, you cite to that some 19 times in your report as being a reliable source?

A. I didn't state whether it was a reliable source or not, but I would agree with you that I've cited it multiple times, yes.

Q. Okay. Let's go to page 86, down at the bottom of the page, the last paragraph where it says -- and I'll wait for folks to catch up -- "In the past, much of the attention concerning nutrient sources in the Illinois River Watershed has focused on the poultry industry, and indeed this industry is a significant primary source of many of the nutrients

specific report, maybe I can respond a little bit more clearly.

Q. Okay. Just to go back one more step in terms of the basin management plan, in terms of your review of potential sources of pollution in the IRW, isn't it true that that basin management plan was at the top of your list of sources?

A. That the plan was at the top of my list of sources? I don't quite understand that question.

Q. Well, that it was at the top of your list of information concerning possible sources in this watershed.

A. I would agree with that.

Q. Okay.

A. For this particular watershed, this plan does a good job of identifying potential sources.

Q. Okay.

(Discussion held off the record)

MR. BULLOCK: If I might approach this time, and I'll try not to make -- I think I'm going to leave it dry here for a few minutes. When you get burned --

THE WITNESS: Thank you, sir.

Q. *(BY MR. BULLOCK)* Doctor, I've handed you what is -- and I believe this is admitted, but for

these purposes we don't need to determine that -- Exhibit 5862, Oklahoma Exhibit. It is a USGS report entitled, "Phosphorus concentrations loads and yields in the Illinois River Basin, Arkansas and Oklahoma, 2002-2004."

Do you recognize that?

A. Yes, sir.

Q. Okay. And that's one of the sources that you consulted in this matter?

A. I have looked at this, yes.

Q. Okay. Let's go to page 4.

A. Yes, sir.

Q. Okay.

(Discussion held off the record)

Q. *(BY MR. BULLOCK)* Down at the bottom of the first column there, about the final paragraph, about the fourth line, the middle of the line --

A. Okay. Just a minute, sir.

Q. Okay.

A. So we're on page 4 and the first -- the first column?

Q. First paragraph?

A. First paragraph that starts "phosphorus" --

Q. I mean -- I'm sorry. First column.

A. Okay.

Q. Last paragraph.
A. Okay.
Q. Fourth line down.
A. Okay.
Q. Middle of that line.
A. Where it says, "such as runoff"?
Q. No. Where it says, "phosphorus concentrations" --
A. Okay. Gotcha.
Q. -- "in Ozark streams are typically greater in streams draining agricultural lands than in those draining forested lands."
You would agree with that; correct?
A. Yes, I would.
Q. And that's consistent with your testimony?
A. It is.
Q. "Because runoff from pastures fertilized with animal manure are probable substantial sources of phosphorus for the rivers in this basin."
Do you see that?
A. I do.
Q. Okay. And do you disagree with that?
A. Yes, I do.
Q. Okay. Are you also --
A. That's not a conclusion of the study; it's an

assumption.

Q. Okay. Are you also aware of any reports from the State of Arkansas regarding the same subject matter?

A. I have seen other studies besides this that would state that poultry litter or the use of animal manure would be a probable source of nutrients to the streams, but none of those were studies that documented that. People assumed that -- people have assumed that for years, but that doesn't mean that it's a correct assumption.

It's necessary to collect the data and determine if that assumption is correct or not, and the studies that I've seen in this watershed that address this are not studies that quantified that issue at all.

Q. Okay. Then all of those studies would, in your view, be in error?

A. No. Many of those studies are probably good studies. We're not talking about a conclusion of a study here; we're talking about an assumption. In this case, it's in the study area description. It's just -- it's just an initial premise or an assumption that the authors made. The study was not intended to address it at all.

Q. Okay. Then let me ask you the inverse.

Have you seen any study which comes to the conclusion that poultry is not a substantial source of the phosphorus in the streams of the IRW?

A. I've not seen a study that was designed to look at that question. So the answer is no.

Q. Okay. And you didn't conduct such a study?

A. I did not conduct a field study in the IRW.

Q. Okay. Did you look for any study which supported that proposition?

A. I looked for whatever studies I could find and I ended up looking at quite a few studies. I was certainly not trying to include or exclude any study based on its intent or what it was pointed towards, no.

Q. Well, let's get on to the sources that are potential sources, possible sources, that you do discuss.

One of the sources is wastewater-treatment plants; correct?

A. That's correct.

Q. That's a source because we can see the pipe coming out of the ground and we know that it flows into the stream and the stream connects on down to the lake?

A. Precisely.

Q. Okay. Now, you are aware, though, that studies directed at that have determined that only 90 to 83 percent of the phosphorus load going into Tenkiller comes from point sources, are you not?

A. I'm aware of studies that such percentages of the flow into Lake Tenkiller occurred under high-flow conditions. But I don't think that characterizing it as point source -- I'm not sure -- the point source is a moving target, it's been changing quite a lot over the last 10 years. Ten or fifteen years ago it --

Q. Oh, I'm sorry. I'm sorry. Counsel just pulled my chain and rightfully so.

Actually, it's 90 to 83 percent come from nonpoint sources of the loading to the lake, phosphorus loading; isn't that correct?

MR. MCDANIEL: Excuse me, Your Honor. There's no foundation for Mr. Bullock's question. It assumes facts not in evidence.

THE COURT: Sustained.

Q. *(BY MR. BULLOCK)* Okay. Doctor, the loading from the point sources in this watershed is a very small percentage, is it not?

A. The loading from the point sources has been changing dramatically. There was an estimated 40

MR. GEORGE: Your Honor, the only point I would make is that Dr. Sullivan has not offered relative contribution opinions, and so I want to be careful that we don't head into an area that this witness was not proffered on direct.

THE COURT: Well, to the extent that he did opine, as I recall, that this is an area that should have been looked into, I think this impeaches that. The objection's overruled.

Go ahead.

MR. BULLOCK: Okay.

Q. *(BY MR. BULLOCK)* So let's take that to your 76,000 figure, and, in fact, just for some ease of calculations, let's take the number of people on septics to 80,000, round it up, okay?

A. Okay.

Q. And then I'm going to take the 3.7 and round it up so that it takes four full broilers to equal one of those people, okay?

A. Okay.

Q. Easy math, we get 320,000 chickens at that point, poultry broilers.

A. That would be correct.

Q. Okay. And testimony in this court is that that would -- 20,000 per broiler house, we're only

talking about 16 broiler houses worth of phosphorus here, aren't we?

A. I wouldn't disagree with that.

Q. Okay. And you're aware that there's approximately 1,800 broiler houses in this watershed, are you not?

A. I would say the number's probably not too different than that.

Q. Okay. And so do you still contend that -- and by the way, that calculation would presume that all of the phosphorus from all of these people that are on septic systems bypasses the septic systems and goes directly into the stream, wouldn't it?

A. Yes, it would.

Q. Okay. And so you still contend that that is a potential source that was necessary for the plaintiffs to -- for the plaintiff to investigate in order to determine that poultry is a significant source of the phosphorus in the rivers?

A. Yes. And I can explain why.

Q. Okay. Well, you can do that on cross. Let's go to the sewage bypass.

Isn't it true that the total point-source contribution to the lake is less than 20 percent?

A. Today, I think that's probably correct. It's

in that range somewhere.

Q. And it has been in that range even prior to the sewage upgrades, wasn't it?

A. I saw estimates that were closer to double that from ten to fifteen years ago.

Q. Okay.

A. And also estimates that the amount has decreased by 40 percent over roughly a ten-year period. So it's been changing quite dramatically in recent years.

Q. Well, let's go to the less than 20 percent of the point sources.

In light of that -- now, the sewage bypasses, are those occasion, as you say, when you have a broken sewer line, you have a backed up sewage system, and you have some fault with the plan itself; correct?

A. Those would be examples of that, yes.

Q. Okay. Most days the system works pretty well, doesn't it?

A. Typically.

Q. Okay. So is it still your testimony that in light of the loading that's coming from the point sources themselves, that it was necessary for the plaintiffs to evaluate -- do a detailed evaluation of the sewage bypass in order to determine whether

A. The evaluation is actually the portions of the field that might be subject to transport. So you don't expect the whole farm to be in that category, no.

Q. We're talking about a specific field. That specific field, the field with the 2,000 STP, your testimony is that unless somebody goes out and proves that that's in a high-transport area, there's no reason for concern that it is contributing one of those thousand cuts --

A. No.

Q. -- to the waters of the IRW?

A. No, that's not what I'm suggesting. What I'm suggesting is that across that field an evaluation will be made to determine the increased risk of runoff, and that's made across the entire field. It's not just a one number for one field. You look at the soil types that occur across that field, you look at the hydrologic soil type that occurs there, you combine that with the vegetation coverage information, you combine that with the slope, and you generate a probability of increased runoff.

Q. Well, I'm --

A. And that's all done -- that information is collected to feed into the phosphorus index, and

that's how the evaluation is made.

Q. Doctor, I'm not talking phosphorus index here. And it looks like you and I are going to have to spend more time on the phosphorus index than I had anticipated.

But so far as you are concerned, a 2,000 STP, until somebody proves it's in a high-transport area, is going to be, like, locked up in your warehouse?

A. A 2,000 STP, if there's no transport, I mean, it is essentially locked up if there's no mechanism provided for transport.

Q. Okay. Now, as we said, this is a mere schematic and you haven't evaluated the IRW in terms of, first of all, how extensive the high P sources might be in the IRW, have you?

A. I have not performed a study to try to quantify that. That's something that's been addressed by many other experts in this case.

Q. All right. And you haven't attempted to evaluate the potential for high transport in the IRW, have you?

A. Well, there's a lot of information on potential for high transport in the IRW and elsewhere, but I have not tried to conduct a field investigation of that, no.

1 document about mineralization and the residual effect
2 of phosphorus lease -- or release. Do you recall
3 that question?
4 A. Yes.
5 Q. And the sentence there that is discussed is
6 talking about a residual release a year after
7 application; is that right?
8 A. That's right.
9 Q. Okay. If you read the very next sentence --
10 and read it to yourself first, Doctor -- is it true
11 that one of the adjustments that was made in the
12 phosphorus index was to add a mineralization factor to
13 address that?
14 A. That's true. But I don't see which sentence
15 I was supposed to read.
16 Q. I'm sorry. The sentence that begins with
17 "hence."
18 A. Hence, yes.
19 Q. Okay.
20 A. I see that.
21 Q. All right. Doctor, you were asked about some
22 of the potential sources, and I believe a fair
23 characterization of the cross was that Mr. Bullock
24 believes that some of the sources that you identified
25 might be small and within the context of the entire

watershed. You were asked about septic tanks, for example, as one example of that.

Doctor, can a potential source that may be small in the scale of the entire million-acre watershed nonetheless have a large localized impact on water quality in small streams?

A. Yes, it can.

Q. And we saw in your spatial analysis, didn't we, that there are a few small tributaries that are not downstream from either urban areas or wastewater-treatment plants that have some elevated phosphorus readings; correct?

A. Correct.

Q. Okay. Can sources, such as septic tanks or even dirt roads, account for or perhaps influence those elevations in phosphorus readings in some of these localized areas?

A. Well, whether or not they would account for them is really difficult to say without doing a proper study. But, I mean, certainly there's a lot of information in the scientific literature on the importance of septic systems and the importance of erosion, including bank and road erosion, on phosphorus contributions.

So the sufficient justification, based on the

scientific literature, that one would want to look at that issue, particularly in these smaller basins.

Q. Okay. Doctor, you were asked about the Watts sewage lagoon. Do you recall that?

A. Yes, I do.

Q. And we went to your table and found the number of people that are serviced by that lagoon.

Do you recall whether there's been a history of a large release from that lagoon?

A. Yes, there was.

Q. Do you recall the quantity?

A. I don't recall -- I don't recall the number. It was a large release for which Watts was fined by the DEQ.

Q. Let me ask you to refresh your recollection. Do you have your report with you?

A. Yes, I do.

Q. And could you find it and turn to page 33 of your report?

A. Okay. I have page 33.

Q. Okay. And if you could just look at the last paragraph on page 33 and see if that refreshes your recollection as to the size of that release.

A. Yes. Thank you, Mr. George. It was 275,000 gallons of treated wastewater.

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

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1 IN THE UNITED STATES DISTRICT COURT

2 FOR THE NORTHERN DISTRICT OF OKLAHOMA

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4 STATE OF OKLAHOMA, ex rel.)
W.A. DREW EDMONDSON, in his)
5 capacity as ATTORNEY GENERAL)
OF THE STATE OF OKLAHOMA,)
6 et al.)
)
7 Plaintiffs,)
vs.)CASE NO. 05-329-GKF-PJC
8)
TYSON FOODS, INC., et al.,)
9)
)
10 Defendants.)

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TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS
14 JANUARY 13, 2010
BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE
15 VOLUME 94, A.M. SESSION

16

17 APPEARANCES:

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25

A. Yes.
Q. We'll use both terms today for the benefit of the court reporter.
What are the MCLs that EPA has established for trihalomethane?
A. The numerical values for the MCLs are 80 parts per billion for trihalomethanes and 60 parts per billion for HAA5.
Q. How long have these been EPA's mandatory standards?
A. Since 1998.
Q. Now let's talk about -- let me back up. Since 1998, was that in any way affiliated with the Stage 1 DBP rule?
A. Indeed, it was the stage one DBP rule.
Q. That set those rules?
A. Yes.
Q. Let's talk about EPA Stage 2 DBP rules. Did you have anything to do with the creation of the Stage 2 rule?
A. Yes.
Q. What did you do?
A. As a continuation of the stakeholder meetings that occurred in '92/'93, there were a series of the meetings in 1996, '97 and in 1999, 2000 where I was

A. Yes.
Q. Can you explain EPA's requirement?
A. The ability of a utility to comply with the MCLs for trihalomethane and haloacetic acids is dependent upon an averaging whereby under the Stage 1 rule, there's a quarterly average of all the samples collected during that quarter, which these four quarterly averages are then averaged again into something called the running annual average. It is that running annual average that is then compared to the two MCLs of 80 and 60 parts per billion.
Q. Why is it a running annual average?
A. Trihalomethane and haloacetic acids are not considered to be acute toxic compounds. The regulation is based more on chronic toxicity. If they were considered as acutely toxic, they would be regulated like nitrate, for example, which means thou shalt not exceed it at any time. But that's not the case.

For these compounds, because of their health characteristics, which I'm not going to talk about, they are regulated as they are chronic toxicants. That means averaging over a long period of time.
Q. Dr. McGuire, under EPA's rules, is a utility in

THE COURT: Thank you. Go ahead.
Q. (By Mr. Jorgensen) Dr. McGuire, have you studied the water utilities in the Oklahoma portion of the IRW?
A. Yes.
Q. And how many water utilities are there?
A. Eighteen.
Q. Are you aware of their physical locations?
A. I am.
Q. Let me show you a map of the plants, the drinking water utility plants that has been put into evidence by the State. I'm talking about Oklahoma Exhibit 5202.
MR. JORGENSEN: And, Your Honor, this is already in evidence. May we, therefore, display it?
THE COURT: Yes.
Q. (By Mr. Jorgensen) Do you have this, Dr. McGuire, or can you see the electronic version?
A. Yes.
Q. Great. Does this accurately show the locations of the drinking water facilities that are within the IRW?
A. Yes.
Q. And in your investigation, did you learn whether these facilities draw surface water near the

Oklahoma Department of Environmental Quality's website, what did you learn about the DBP tests of the 18 drinking water facilities in the Oklahoma portion of the IRW?

A. I learned that the frequency of noncompliance was actually relatively low and grouped in a few utilities.

Q. When you say "relatively low," higher or lower than the numbers reported by Dr. Teaf?

A. Lower. Well, except for the 6.3 percent. I'm not quite sure what that meant.

Q. Let's talk about what you just said, very few exceedances and group at just a few plants. We'll go through those one by one.

When you went through the Oklahoma data, how many actual violations of the EPA DBP standard did you find, and I'm talking total, for all the years, for all 18 facilities?

A. 24.

Q. And I know you gave an answer as to time, but generally what years are covered?

A. Again, from 1997 to 2008. Most of the data from 2003 to 2008.

Q. Now let's talk about what you mentioned about grouping. When you say the exceedances are grouped

at just a few utilities, can you give us an idea of the size of the grouping?
A. Of the total 18 utilities in the watershed, only six of them have had any exceedances of the MCLs. Three of them have had continuing problems with meeting the MCLs.
Q. Let's focus on that last three. What percentage of all of the exceedances are accounted for by just those three utilities?
A. Sixty-seven percent.
Q. Two-thirds. Can you name the three facilities that are having problems?
A. Yes. Cherokee County No. 13, Gore PWA and East Central Oklahoma.
Q. Did any of the 18 utilities in the IRW have absolutely no violations?
A. Yes.
Q. How many?
A. Twelve.
Q. Talking about those three, Cherokee Central No. 13, East Central and Gore, have you had an opportunity to investigate why these three facilities have DBP exceedances when the other utilities in the IRW do not?
A. Yes.

to that, it's filtered through, in this particular case, layers of anthracite coal and sand, and then finally into a clearwell and into the distribution system.

Q. This practice of adding the chlorine first and then beginning the coagulation and filtration process, in your experience, is this good practice?

A. It's not good practice if you're trying to control trihalomethanes and haloacetic acids.

Q. Do the other two utilities that you mentioned, collectively of which the three of them are responsible for two-thirds of the DBP exceedances in the IRW, do they have similar practices to this?

A. The practices are similar, but the treatment processes actually are quite different. In the case of Gore, for example, they don't -- do not have a clarification process. They just have these filtration modules. So they have no opportunity for removal of the TOC in a sedimentation basin or clarifier. And Cherokee County No. 13 uses a membrane filter plant with no addition of chemical for coagulation at all.

Q. Did you testify a minute ago that there were three water treatment utilities other than the three we've just been discussing that have also had

occasional problems with DBPs?
A. Yes.
Q. Have those instances of the DBPs exceedances, have they been frequent or infrequent?
A. They've been infrequent.
Q. Have you investigated whether these infrequent problems are due to the water or the way it's treated?
A. It was due to the way the water was treated at the beginning of the time when they had to comply with the regulation. In this specific case, for example, of LRED Woodhaven, which uses a slow sand filtration process, they were adding clearly too much chlorine.

And if you look at how their trihalomethane levels changed over time, they had an exceedance at the very beginning, the first quarter when they could actually run a quarterly running annual average, and they determined they were in violation of the MCL.

They subsequently, clearly from the data, cut back on their chlorine usage, and they then, from then on until the present, have been able to comply with the regulation.
Q. I want to make sure this is crystal clear in

the record. Have any of these three utilities that we've been talking about, not the group of three that's responsible for two-thirds of the violations, but the next group of three that's responsible for all of the remaining violations, have any in that group changed their operating procedures and either reduced or eliminated their DBP violations?

A. Yes, they have. All three of them have.

Q. You mentioned LRED Woodhaven. Let's give the example of Sequoyah County Water Association. Did you do any investigation of the Sequoyah County Water Association?

A. I did. In addition to reviewing the deposition by the operator and the materials provided by that utility, I also visited the plant site.

Q. Did you prepare a chart of what you found?

A. I did.

Q. Let's turn to page B-9 of that same exhibit. It's already in evidence. Exhibit 6024, B-9. Can you tell us what this shows.

A. Once again, this is a schematic of the treatment processes for Sequoyah County Water Association. They have an intake structure on Lake Tenkiller, and the water is pumped into a mixing facility where polymer is added. And they have the

the plant engineers, do you have any other evidence that suggests to you whether the violations at the three plants we've talked about, the three plants that are responsible for 67 percent of the violations, whether that results from errors in the design and operation of those plants or whether it results from the water?

It wasn't a great question. Let me do it again.

Other than visiting the plants and reviewing the depositions of the plant engineers, do you have any other evidence suggesting whether the violations at these plants result from errors in the standard operating procedures as opposed to problems with the water source?

A. Yes.

Q. What evidence do you have?

A. The withdrawal points for those utilities are very close to withdrawal points for other utilities on the lake, for example. All three of these utilities that have the continuing problem are taking water from Lake Tenkiller.

The lower left-hand side of the map shows the outtake for Gore, PWA and East Central Oklahoma. In fact, it is the same withdrawal point,

and the same pipeline feeds both water treatment plants.

That is really within a few hundred feet of Sequoyah County Water Association's withdrawal point. And that utility has -- except for beginnings -- problems with the DBP rule in the very beginning of their operation they have been subsequently completely in compliance because they moved their point of chlorination until after filtration.

Again, it's a very good comparison of the fact that it's not the water quality that's the issue here; it's how the water is treated.

Q. Do you have any other examples that -- on that same vein?

A. Cherokee County RWD 13 is about two-thirds of the way up the lake. The withdrawal point is on the eastern shore. Right across the lake from Cherokee County RWD 13 is LRED Lakewood, which has had no violations of the DBP rule. And just down lake from Cherokee County is LRED Chicken Creek that also has had no violations.

So, again, these utilities are successful in meeting the THM and the other parts of the DBP regulation.

Q. Dr. McGuire, what, if anything, do you draw from the fact that the utilities who are having the vast majority of the problems -- and I believe the only ongoing problems -- are physically close to utilities that are having no problems?

A. Again, I think it's not because of the quality of the water in the lake; it's because of how the water is being treated. If the water is treated properly, if chlorine is added in the proper position, then they can easily comply with the regulation.

Q. Let's switch topics entirely, if we can, Dr. McGuire. I'd like to talk now about -- I'm going to say this slowly for the record first -- trihalomethane forming potential.

Are you familiar with the test for trihalomethane forming potential?

A. Yes.

Q. Have you had any involvement with its creation?

A. I was involved with the early discussions with Al Stevens from the U.S. EPA laboratory in Cincinnati when this concept was originally being developed.

Q. Did you hear Dr. Teaf's testimony in this courtroom about trihalomethane forming potential?

It's -- this is not a random issue. It's something you actually know to be true.

Q. Let me switch topics with you, Dr. McGuire, unless the court has taste and odor issues -- or questions. "Issues" was the wrong word. Let me apologize.

THE COURT: You may move on.

Q. (By Mr. Jorgensen) Let's talk about cyanobacteria, Dr. McGuire. You mentioned your experience with cyanobacteria.

A. Yes.

Q. What are cyanobacteria?

A. Cyanobacteria is another word for blue-green algae. Organisms have been around literally for billions of years that photosynthesize and live in just about any environment you can imagine in this world.

Q. Have you heard of cyanotoxins?

A. Yes.

Q. What are cyanotoxins?

A. Some species and indeed some variants of species will exude organic compounds that can be toxic to other organisms. Those are generally grouped in the heading cyanotoxins.

Q. Do all cyanobacteria produce cyanotoxins?

A. No.
Q. We are not going to talk about today, you and I, whether the federal government, EPA, has any regulations regulating cyanobacteria, whether the state of Oklahoma has any regulations governing cyanobacteria and whether the science has been considered and rejected by those agencies. We're going to leave that for Dr. Gibb.
So let's just move on to, in this case, have you seen any data for the presence of cyanotoxins in Lake Tenkiller?
A. There's very limited data, essentially only two samples that were collected as part of this sampling effort throughout this entire investigation that were found to be positive for cyanotoxins, specifically for microcystin LR.
Q. So the data that was gathered on cyanotoxins, how do the levels that were shown compare with levels of cyanotoxins across the United States?
A. They're generally on the low side. These are very low concentrations and not unusual, in fact, and found in lakes especially throughout the upper midwest.
Q. Did you see any tests in this case, any tests at all for cyanotoxins in tap water?

A. Cyanotoxins were never monitored in tap water.
Q. Have you heard the testimony in this court that when cyanobacteria are pulled into a drinking water system, they break open and release their cyanotoxins and that the standard treatment process is ineffective in removing those cyanotoxins? Have you seen that testimony?
A. Yes, I have.
Q. What's your opinion of that?
A. Well, it's true if they exist; however, there's certainly been no demonstration that those particular variants or species of algae do exist and are producing a problem.
Also, for the vast majority of the utilities in this watershed, they are removing particulates, including algae, prior to the addition of chlorine.
Q. Have you seen the statement that the standard treatment processes cannot destroy cyanotoxins?
A. I have seen that statement.
Q. In this case?
A. Yes.
Q. Do you agree with that?
A. No, I don't.
Q. Why not?

A. There's plenty of evidence that shows that. There are peer-reviewed publications that show that chlorine alone with sufficient contact time, really similar to what's available in these water treatment plants, will inactivate or remove cyanotoxins.

Q. Dr. McGuire, as one of the leading drinking water experts in this case -- excuse me, in this nation, I want to ask you: Is there a problem with drinking water in the Illinois River Watershed?

A. Not to my view. This is an excellent water quality.

MR. JORGENSEN: I'd like to pass the witness, Your Honor.

THE COURT: Cross-examination.

CROSS-EXAMINATION

BY MS. XIDIS:

Q. Dr. McGuire, my name is Claire Xidis. I'm one of the attorneys representing the State in this matter. And we haven't met before, have we?

A. No.

Q. It's nice to meet you in person. I do have a couple of questions about your background and your time at Metropolitan which we heard about this morning. I believe in your deposition, you testified that during your time at Metropolitan

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IN THE UNITED STATES DISTRICT COURT

FOR THE NORTHERN DISTRICT OF OKLAHOMA

STATE OF OKLAHOMA, ex rel, W.A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA, et al.	)	
Plaintiffs,	)	
vs.	)	No. 05-CV-329-GKF-PJC
TYSON FOODS, INC., et al.,	)	
Defendants.	)	

VOLUME 95 - PM

TRANSCRIPT OF NONJURY TRIAL PROCEEDINGS

JANUARY 13, 2010

BEFORE GREGORY K. FRIZZELL, U.S. DISTRICT JUDGE

REPORTED BY: *BRIAN P. NEIL, CSR-RPR, RMR, CRR*
United States Court Reporter

A. The plaintiff's own experts, Camp Dresser McKee, found no evidence of microcystin in the examples they took. Cooke and Welch cited a paper by Lynch and Clyde in which there were five samples taken in Lake Tenkiller. Two of them contain microcystin, one was at 3.3 micrograms per liter and the other one was at .35 micrograms per liter.

Q. And are those the only references to demonstrated microcystin concentrations that you saw in your investigation of this matter?

A. That is the only data that I am aware of that demonstrate microcystin in the Illinois River Watershed.

Q. Okay. Dr. Gibb, do some states regulate concentrations of microcystin?

A. There are two states that I'm aware of that regulate, Oregon and Vermont.

Q. And are the concentrations of microcystin that you just mentioned that were found by Mr. Lynch and -- or Dr. Lynch and Dr. Clyde, are they above or below any existing state regulatory levels?

A. They are below.

Q. Has the State of Oklahoma issued any regulations or guidance for cyanobacteria or microcystin?

go.

MR. GREEN: Okay. Thank you.

THE COURT: Let's try to have a basis for your objections before --

MR. BULLOCK: I just didn't remember it. I apologize.

THE COURT: Yeah, I understand. It's a big topic. Let's go.

Q. *(BY MR. GREEN)* With respect to these two constituents I just mentioned -- and I'll provide the reporter with the spelling -- but what's the difference between cylindrospermopsis and cylindrospermopsin?

A. Well, cylindrospermopsis is the genus, the taxonomic genus, and cylindrospermopsin is the toxin.

Q. Okay. With respect to the toxin now, cylindrospermopsin, in the course of your analysis for this case, have you seen any evidence that any cylindrospermopsin has ever been detected in Lake Tenkiller?

A. No. And that's, you know, what I read to you from my report, is that Lynch and Clyde detected no cylindrospermopsin in Lake Tenkiller.

Q. Has any state or federal agency reported cyanobacteria outbreaks in either drinking or

recreational water in the state of Oklahoma?

A. No.

Q. What conclusions, Doctor, have you reached regarding health risks presented by the presence of any cyanobacteria in Lake Tenkiller or the surface waters in the IRW?

A. Well, there was no microcystin detected by the plaintiff's experts, Camp Dresser McKee, in Lake Tenkiller. The microcystin concentrations that were cited by Cooke and Welch of Lynch and Clyde -- of the Lynch and Clyde report reported low concentrations. There was no cylindrospermopsin detected in Lake Tenkiller.

Cyanobacteria is common throughout the United States, it's not, you know, unusual. You know, it defines cyanobacteria in a lake. So I -- and there was no Centers for Disease Control reports of cyanobacteria problems in the Illinois River Watershed, or Oklahoma for that matter, and there was none reported by the Oklahoma Department of Health.

Q. So, Doctor, do you believe that if there is any cyanobacteria in the Illinois River Watershed and Lake Tenkiller, do you believe it presents any risk to human health?

A. No.

recreational water in the state of Oklahoma?

A. No.

Q. What conclusions, Doctor, have you reached regarding health risks presented by the presence of any cyanobacteria in Lake Tenkiller or the surface waters in the IRW?

A. Well, there was no microcystin detected by the plaintiff's experts, Camp Dresser McKee, in Lake Tenkiller. The microcystin concentrations that were cited by Cooke and Welch of Lynch and Clyde -- of the Lynch and Clyde report reported low concentrations. There was no cylindrospermopsin detected in Lake Tenkiller.

Cyanobacteria is common throughout the United States, it's not, you know, unusual. You know, it defines cyanobacteria in a lake. So I -- and there was no Centers for Disease Control reports of cyanobacteria problems in the Illinois River Watershed, or Oklahoma for that matter, and there was none reported by the Oklahoma Department of Health.

Q. So, Doctor, do you believe that if there is any cyanobacteria in the Illinois River Watershed and Lake Tenkiller, do you believe it presents any risk to human health?

A. No.

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5 *WITNESSES ON BEHALF OF THE DEFENDANTS*

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