IN THE UNITED STATES DISTRICT COURT FOR THE
NORTHERN DISTRICT OF OKLAHOMA

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|---|---|
| W. A. DREW EDMONDSON, in his capacity as ATTORNEY GENERAL OF THE STATE OF OKLAHOMA and OKLAHOMA SECRETARY OF THE ENVIRONMENT C. MILES TOLBERT, in his capacity as the TRUSTEE FOR NATURAL RESOURCES FOR THE STATE OF OKLAHOMA, | ) |
| Plaintiff, | ) |
| vs. | )4:05-CV-00329-TCK-SAJ |
| TYSON FOODS, INC., et al, | ) |
| Defendants. | ) |

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VOLUME I OF THE VIDEOTAPED
DEPOSITION OF BERNARD ENGEL, PhD, produced as a witness on behalf of the Defendants in the above styled and numbered cause, taken on the 8th day of January, 2009, in the City of Tulsa, County of Tulsa, State of Oklahoma, before me, Lisa A. Steinmeyer, a Certified Shorthand Reporter, duly certified under and by virtue of the laws of the State of Oklahoma.

Exhibit U

A P P E A R A N C E S

FOR THE PLAINTIFFS: Mr. Richard Garren
Attorney at Law
502 West 6th Street
Tulsa, OK 74119
-and-
Ms. Kelly Burch
Asst. Attorney General
313 N.E. 21st Street
Oklahoma City, OK 73105

FOR TYSON FOODS: Mr. Robert George
Attorney at Law
2210 West Oaklawn Drive
Springdale, AR 72762

FOR CARGILL: Ms. Leslie Southerland
Attorney at Law
100 West 5th Street
Suite 400
Tulsa, OK 74103
-and-
Ms. Melissa Collins
Attorney at Law
1700 Lincoln Street
Suite 3200
Denver, CO 80203
(Via phone)

FOR SIMMONS FOODS: Mr. John Elrod
Attorney at Law
211 East Dickson Street
Fayetteville, AR 72701

FOR PETERSON FARMS: Mr. Scott McDaniel
Attorney at Law
320 South Boston
Suite 700
Tulsa, OK 74103



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FOR GEORGE'S: Mr. Woodson Bassett
Attorney at Law
221 North College
Fayetteville, AR 72701

FOR CAL-MAINE: Mr. Robert Sanders
Attorney at Law
2000 AmSouth Plaza
P. O. Box 23059
Jackson, MS 39225
(Via phone)

ALSO PRESENT: Dr. Victor Bierman



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I N D E X

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W I T N E S S P A G E

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BERNARD ENGEL, PhD

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Direct Examination by Mr. George 6

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(Whereupon, the deposition began at 9:01 a.m.)

VIDEOGRAPHER: We are now on the Record for the deposition of Dr. Bernard Engel. Today is January 8th, 2009. The time is 9:01 a.m. Would 09:01AM
counsel please identify themselves for the Record.

MR. GARREN: Richard Garren for the State of Oklahoma.

MR. GEORGE: Robert George for the Tyson defendants, and I have with me Vic Bierman who is a 09:01AM
consultant for the defendants.

MR. McDANIEL: Scott McDaniel for Peterson Farms, Inc.

MR. BASSETT: Woody Bassett for the George's defendants. 09:02AM

VIDEOGRAPHER: And on the phone?

MR. SANDERS: Bob Sanders for the Cal-Maine defendants.

VIDEOGRAPHER: Thank you. The witness may be sworn in.

BERNARD ENGEL, PhD

having first been duly sworn to testify the truth, the whole truth and nothing but the truth, testified as follows:

DIRECT EXAMINATION



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BY MR. GEORGE:
Q Good morning, Mr. Engel.
A Morning.
Q My name is Robert George. You and I have met before; correct? 09:02AM
A Correct.
Q Dr. Engel, are you still employed as a professor at the university of Purdue?
A At Purdue University, yes.
Q And is your work being done in connection with this lawsuit an official university project or is it something you're doing separate and apart? 09:02AM
A It's something and apart.
Q Okay. Are you doing it through your individual capacity or do you have a consulting company that you provide these services under? 09:02AM
A I do this as an individual.
Q And do you have a staff that has worked with you on this case?
A I have one individual who has worked directly with me and probably, as we'll talk about later, I work with other experts that are part of the team. 09:02AM
Q Okay. Who is the individual that has worked with you directly on your analysis in this lawsuit?
A Dr. Ji-Hong, J-I, hyphen, H-O-N-G, Jeon, 09:03AM



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J-E-O-N.
Q And is he an employee of yours?
A Yes, he had been. So he has been working with me on a contractual basis.
Q If I refer to him as Dr. Ji-Hong, you know who we're talking about? 09:03AM
A Yes.
Q Okay. Has Dr. Ji-Hong also been affiliated with Purdue University?
A He was. He no longer is. 09:03AM
Q Okay. In what capacity was he affiliated with Purdue University?
A As a post doc.
Q A post doc in what program?
A In ag and biological -- agricultural and biological engineering. 09:04AM
Q Was Dr. Ji-Hong a student of yours?
A Not a student but a post doctoral associate.
Q Describe for me the relationship between someone such as yourself, a professor, or a research professor and a post doc student. 09:04AM
A Sure. A post doc would be someone who has completed a PhD program, and it would not be unusual then that someone who has done that might move into a post doc position, and in that position, they 09:04AM



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would tend to work with a professor on a variety of projects, often numerous projects.

Q How old approximately is Dr. Ji-Hong?

A Probably late 20s.

Q Would it be fair to say that his work for you as a post doc associate would be his first professional employment? 09:05AM

A Well, as a graduate student, one is getting professional experience and is employed, so actually as a graduate student would probably be the first professional employment. 09:05AM

Q Had Dr. Ji-Hong not spent time in the private sector, for example, before becoming a post doc student?

MR. GARREN: Object to the form. 09:05AM

A No, he had not.

Q Did Dr. Ji-Hong have any teaching responsibilities at Purdue University?

A No.

Q When did he obtain, if you know, his PhD? 09:05AM

A I'm not positive offhand. I would have to look at his CV.

Q Did he have his PhD when this lawsuit was filed in June of 2005?

A To the best of my knowledge, no. 09:06AM



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Q But still working towards it to the best of your knowledge at that time?
A Correct.
Q You said Dr. Ji-Hong was working on a contractual basis for you. What does that mean? 09:06AM
A So he was performing certain tasks and was being paid to perform those tasks.
Q Was he being paid by the hour?
A Yes.
Q Okay, and what was his hourly rate? 09:06AM
A $50 per hour.
Q In order to substantiate his entitlement to wages, did Dr. Ji-Hong maintain time records or timesheets that he submitted to you?
A No. So those were conveyed to me orally and 09:07AM those were then paid.
Q Did you actually write a check to Dr. Ji-Hong and then seek reimbursement from the plaintiff's attorneys in this case or was he paid directly by the law firms? 09:07AM
A I paid him and was reimbursed.
Q You've been paid for your work in this case, including reimbursement for Dr. Ji-Hong's time, by the Motley Rice Law Firm out of South Carolina; correct? 09:07AM



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A Correct.
Q And can you tell the court approximately how much you've been paid for your work in this case to date?
A You know, I didn't look at that before 09:08AM
recently, so I hate to speculate at this stage.
Q Have you been paid more than a million dollars for your work in this case?
A It would be less than a million certainly.
Q More than a half million dollars? 09:08AM
A I believe it would be less than that certainly.
Q You actually submitted invoices to Motley Rice in connection with your services in this case; is that right? 09:08AM
A Yes.
Q Okay, and did you retain copies of those invoices, Dr. Engel?
A Yes, I would have.
Q Okay, and would those invoices describe not 09:08AM
only the amount of time that you and Dr. Ji-Hong spent on the matter but provide some description of the services that you provided?
A They would provide probably limited
description of the services but some description. 09:08AM



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Q Okay. Dr. Engel, if I asked you to produce those invoices, would you be able to comply with that request?

A Certainly.

MR. GEORGE: Rick, I'm going to ask for 09:08AM production of Dr. Engel's invoices. I've looked through his considered materials and if they're in there and I missed it, I apologize, but I did not see any actual invoices.

Q Dr. Engel, who first contacted you about 09:09AM working on this case?

A It's been a while. I don't recall if it was David Page or Bob Nance. To the best of my knowledge, it was probably one of them.

Q Okay. Do you recall, Dr. Engel, approximately 09:09AM the time frame of your first contact in connection with this case?

A I believe it would have been late summer, early fall of 2005.

Q Do you recall if the complaint or the lawsuit 09:09AM had been filed prior to your being contacted?

A I don't have recollection.

Q What attorney have you worked most closely with in this case?

A Most closely would be David Page. 09:10AM



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Q Dr. Engel, are the opinions that you express in this case your opinions or David Page's opinions?
A My opinions.
Q If you're allowed to testify at the trial of this matter, will the testimony be your own 09:10AM
independent thoughts or the thoughts of David Page?
A They would be my independent thoughts.
Q You haven't been asked to simply parrot what David Page wants you to say, have you?
A No. 09:11AM
Q What about in connection with your testimony at the preliminary injunction hearing; were you told by Mr. Page what your testimony would be?
A No.
Q Let me hand you a document we'll mark as 09:11AM
Exhibit 1. Dr. Engel, I've put in front of you an E-mail chain from January 11th of 2008 between yourself, Miss Kelly Burch and David Page; do you see that?
A Yes. 09:12AM
Q And January of 2008 was a month prior to the hearing on the preliminary injunction; is that right?
A Yes.
Q Can you read the subject line of the E-mail 09:12AM



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chain?
A On the very first page?
Q Sure.
A OPL draft outline.
Q Turn to the second page of the document, Dr. 09:12AM
Engel. Do you see the exchange that began this
E-mail chain from David Page to yourself that says,
Bernie, attached is an outline we discussed for your
preliminary injunction testimony. Do you see that?
A Yes. 09:12AM
Q Okay. Why was Mr. Page sending you an outline
of what your testimony would be at the preliminary
injunction hearing?
MR. GARREN: Object as to form.
A So prior to this E-mail, we had had, you know, 09:12AM
ongoing phone conversations talking about what the
testimony would entail and the key points that were
in that testimony, and so, you know, this was a
draft of those key points that would be part of that
testimony. 09:13AM
Q This was David Page's draft of those key
points; is that right?
A I don't believe that it was David's draft. My
recollection was that, you know, I actually worked
with Bert Fisher in drafting that outline and 09:13AM



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probably this is a draft that, you know, was sent back and forth multiple times before this one.

Q Now, Dr. Engel, you were involved in a prior lawsuit that was filed in the Northern District of Oklahoma, were you not? 09:14AM

A Yes.

Q Okay, and do you recall that case involving the City of Tulsa and the poultry industry?

A Yes.

Q Okay. Describe for the court, if you can, your role in that lawsuit. 09:14AM

A So I was a court appointed expert, as I recall, for a Daubert hearing related to some modeling that had been done for that effort.

Q Were you asked by the judge in that lawsuit to evaluate the reliability of some modeling work done by Dr. Storm? 09:14AM

A Yes.

Q Okay, and the modeling work that you were reviewing was a watershed model; is that right? 09:14AM

A Correct.

Q And do I recall correctly that Dr. Storm in that case had put forward an opinion seeking to quantify the relative contribution of poultry litter through his model to a northeast Oklahoma reservoir? 09:15AM



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MR. GARREN: Object to form.
A Yes, that's what was done.
Q Okay. What model was used by Dr. Storm in that lawsuit?
A SWAT. 09:15AM
Q Is the SWAT model a watershed scale model or a field scale model?
A It's a watershed scale model, can be used with field scale as well.
Q In that particular case, was Dr. Storm using 09:15AM it as the field scale?
A No. He was using -- no.
Q Do you agree, Dr. Engel, that the SWAT model is more complex and sophisticated than the GLEAMS model that you used in connection with your work in 09:15AM this case?
MR. GARREN: Object to the form.
A Yes.
Q What was your recommendation to the court, Dr. Engel, with respect to Dr. Storm's model and his 09:16AM quantitative opinion regarding the percentage of the P load attributable to poultry litter?
A As I recall, due to limitations largely in datasets, you know, there were some limitations in the ability to quantify that. 09:16AM



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Q Did you advise the court, Dr. Engel, that Dr. Storm's modeling work in that lawsuit was not reliable enough to be used to assign a percentage allocation to poultry litter for the phosphorus load to that particular reservoir? 09:16AM

MR. GARREN: Object to form.

A I don't recall. I guess -- I haven't looked at that in quite some time, and I'm trying to recall those details. To the best of my recollection, again, there were limitations in assigning absolute 09:17AM percentages, but in identifying, you know, the significant contributors, you know, it was still on firm ground.

Q Okay, but in terms of the quantitative opinion that Dr. Storm sought to express using the SWAT 09:17AM model in that case, do I understand that your recommendation to the court was that that quantitative opinion was not reliable?

MR. GARREN: Object to the form.

A It was limited due to data and other issues 09:17AM that were identified.

Q Well, did you offer a recommendation to the court as to whether that quantitative opinion should be admitted or should not be admitted at trial?

A As I recall, the quantitative -- it was not 09:17AM



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but the qualitative was.
Q Was that consistent with your recommendation?
A Yes.
Q Okay. Let's clean up the Record, if we can,
of our conversation. So, Dr. Engel, I think we've 09:18AM
established, and you tell me if I've misunderstood
you, that your recommendation to the judge in the
Northern District of Oklahoma in the City of Tulsa
lawsuit was that Dr. Storm's attempt to use the SWAT
model to express a quantitative opinion as to the 09:18AM
relative contribution to phosphorus from poultry
litter was not reliable; is that right?
MR. GARREN: Object to form.
A It was not reliable because of a number of
issues that were identified. 09:18AM
Q Okay. What specifically about Dr. Storm's
modeling work in the City of Tulsa case was it that
you found scientifically lacking?
MR. GARREN: Object to form.
A You know, as I recall -- again, having not 09:18AM
looked at that in awhile, so this is my best
recollection of some of those details, there were
certainly some limitations with input data into that
model.
Q What type of limitations as best as you can 09:19AM



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recall?
A As I recall, one of the limitations was with respect to the land use land cover data.
Q Do you recall any others?
A There were probably some other data issues as well. As I recall, the period of observed data for calibration and validation purposes was somewhat limited. 09:19AM
Q Do you recall, Dr. Engel, being critical of Dr. Storm's work in that case because he had attempted to calibrate his model but had not had available sufficient data to try to validate it? 09:20AM
A That's related to my last comment. I -- you know, again, without looking at that detail again, my best recollection was that, you know, the period of total observed data was somewhat limited, and as a result, there was a tradeoff between calibration and validation and, you know, I think there was some limitations as a result of that limited data. So whether it was in the validation period, I'm not recalling that that -- I'm not recalling those specific details at this stage. 09:20AM 09:20AM
Q Do I recall correctly that you were of the opinion in the City of Tulsa case that hydrologic water quality models should be both calibrated and 09:21AM



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validated?
A Well, certainly in the --
MR. GARREN: Object to form. Sorry.
A Yes, and certainly in the watershed modeling arena, that's the tradition. You know, how that 09:21AM
holds in some other modeling areas, traditions tend to be somewhat different in some modeling communities.
Q Can you think of a scientific reason or rationale as to why both steps would be necessary in 09:21AM
a watershed model but not in another setting? I'm trying to follow your comment.
A Well, saying that it's always absolutely necessary even in a watershed modeling effort is probably an overstretch. So I can envision cases 09:21AM
and certainly worked with colleagues from time to time when, you know, it's not necessary to calibrate and validate.
Q Dr. Engel, have you ever worked on a model, whether it be a watershed model or a lake model or 09:22AM
any other kind of model, that was going to be used to assign liability in a court setting that you didn't believe needed to be both calibrated and validated?
MR. GARREN: Object to form. 09:22AM



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A The watershed models I've worked with in those kinds of settings I believe have always been calibrated and validated.

Q Dr. Engel, you agree with me, do you not, that there are higher standards in terms of reliability 09:22AM that should be placed upon modeling work that's done in litigation?

MR. GARREN: Object to form.

A Yes.

Q Dr. Engel, is your modeling work in connection 09:23AM with this lawsuit and your opinion regarding the percentage of the phosphorus load attributable to poultry litter more reliable or scientifically sound than the work and opinion put forward but excluded by Dr. Storm in the City of Tulsa case? 09:23AM

MR. GARREN: Object as to form.

A Yes.

Q Why?

A This is probably a fairly long discussion potentially. So I think there's several factors 09:23AM here. So, one, there have been numerous other studies for this watershed for the IRW in which others have applied a variety of models, a variety of analysis techniques and have tended to reach the conclusion that livestock that includes land 09:24AM



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application of poultry waste is responsible for
certainly more than 50 percent and some of these
documents well more than that of the phosphorus
reaching Lake Tenkiller. The mass balance --
Q Can I stop you there? You just stated that 09:24AM
you're aware of studies that have found that
phosphorus from livestock accounts for more than 50
percent. What do you mean by livestock?
A Well, if one looks at those studies, you know,
the livestock would include land application of 09:25AM
poultry waste and the other livestock present in the
IRW.
Q Well, what other livestock are you talking
about?
A I believe in those studies those would include 09:25AM
cattle, including dairy cattle, and swine.
Q Dr. Engel, are you aware of another study that
has concluded that just poultry litter, which is
what I understand your opinion to be, is responsible
for more than 50 percent of the phosphorus load to 09:25AM
the Illinois River watershed?
A I would need to look at those studies again.
I believe in most instances those studies have not
separated the livestock contribution. I'm trying to
recall if any of those did specifically pull those 09:26AM



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apart.
Q As we sit here today, do you recall one that apportioned between livestock, between poultry and cattle and swine and other types of livestock?
A I'm not -- I'm not certain that any did pull 09:26AM
those apart. I would have to look.
Q Okay, all right. We took a tangent. It was my fault and I apologize, Dr. Engel. You were telling me -- this is my characterization, not yours
-- what you had done in your modeling work that was 09:26AM
superior to the work of Dr. Storm. Please keep going.
A Okay. The observed dataset for calibration, validation purposes within the IRW had a more
extensive period of record. So that allowed better 09:27AM
calibration, allowed sufficient data for validation.
Q Anything else that comes to mind that you believe is superior with respect to your work compared to what Dr. Storm put forward?
A Well, there was also a mass balance, trying to 09:27AM
understand the nutrient inputs into the watershed that was done as well. So the mass balance identifies flows of phosphorus or identifies phosphorus that has been placed in the watershed
over the years, and if one, you know, uses that 09:27AM



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data, uses the observed phosphorus flows out of the watershed into Lake Tenkiller and computes, you know, contributions with that, poultry since the '70s is responsible for, you know, mid 40s to 50 percent of phosphorus reaching Lake Tenkiller. 09:28AM

Q We're going to get into the mass balance in some detail, but let me ask a conceptual question first, Dr. Engel. Does the mass balance study that you're referring to address the movement of phosphorus from land to water? 09:28AM

A Not directly.

Q So the percentages that are expressed in the mass balance study -- you recall the pie chart?

A Yes.

Q Okay, and I think the figure associated with poultry is 76 percent if I recall. Does that sound right? 09:28AM

A Something in that range.

Q That figure, Dr. Engel, you'll agree with me, is not a fair or scientific representation of the percentage of phosphorus that reaches a water body that comes from poultry? 09:29AM

MR. GARREN: Object to form.

Q Do you agree?

A That was -- there were multiple parts to that 09:29AM



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question or it was compound. So can we try that again?

MR. GEORGE: Can we try to read that back, Lisa?

COURT REPORTER: SURE.

Q If you don't understand it, I'll rephrase it.

(Whereupon, the court reporter read back the previous questions and answers on Page 23, Lines 15-24.)

A So at the present time that doesn't represent the percentages reaching the lake. 09:29AM

Q Dr. Engel, do you have a copy of your expert report that you've issued in this case with you?

A I do. It's in this binder to my left here.

Q And have you had an opportunity to look through that and see if it is complete? 09:30AM

A It does all seem to be there.

Q Okay, and you have issued more than one report in this case; is that correct?

A There were errata that were issued. 09:30AM

Q Okay. Which report, in terms of a date, do you have in front of you?

A I believe this report contains -- well, the front page says May 22, 2008.

Q Okay. Well, is what follows the front page 09:30AM



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your May 22, 2008, expert report?
A So the first section is the May 22, 2008, report.
Q Have you inserted some additional material from subsequent reports in the binder that's in 09:31AM front of you?
A Those are, yes.
Q Okay. Well, let's do this because I do want to focus to some extent on some of the differences between your two reports, so let's see if we can 09:31AM work with the reports as they were delivered to me. Is that okay?
A Okay.
Q I'll hand you -- I'm going to hand you a binder, Dr. Engel, that I believe is a complete and 09:31AM accurate copy of the expert report dated May 22nd of 2008 as it was produced. Could you take a moment and look at that and see if you can confirm that.
MR. GARREN: Are we going to mark this as an exhibit? 09:32AM
MR. GEORGE: Assuming he can confirm it's a correct copy, we will.
A Seems to be an Appendix G missing. Am I mistaken?
Q Look behind the letter perhaps. 09:34AM



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A Oh, it's behind the letter?
Q Perhaps. Look and see.
A I'm sorry. Ah, yes.
Q Dr. Engel, can you confirm that what I've put in front of you that we'll mark as Exhibit 2 is a 09:34AM
true and correct copy of the report that you issued on May 22nd of 2008?
A Yes.
Q And your signature is on the front of that report; correct? 09:34AM
A Correct.
Q Now, Dr. Engel, you have been working on this case for almost three years before issuing that report; is that right?
A Approximately three. 09:34AM
Q Okay, and in your May 22nd, 2008, report, did you set forth your scientific opinions and conclusions and the basis for those opinions and conclusions?
A Yes. 09:35AM
Q And were the opinions that you expressed in your May 22nd, 2008 report based upon, at least in part, the various charts and figures and graphs and tables that are reflected in that report?
A Different opinions were based on different 09:35AM



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graphs, figures, charts, yes.
Q Okay, and those graphs, figures and charts that are reflected in the May 22nd report were important to you in forming your opinions; is that right? 09:35AM
A Yes.
Q Now, I notice immediately when I received it that your report is pretty lengthy; do you agree?
A Yes.
Q Okay. Approximately 200 pages; does that 09:35AM sound about right?
A Maybe even more than that.
Q Okay. Let's -- for conversation let's go with 200. How long did it take you, Dr. Engel, to prepare this 200-page report that you issued on May 09:35AM 22nd of 2008?
A Are we talking about the entire analysis, time writing? Can you clarify?
Q Let's break it down. The -- I assume the analysis started before the writing; is that 09:36AM correct?
A Correct.
Q How long were you in analysis mode in connection with preparing this report?
A There was very limited analysis that began 09:36AM



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almost immediately after coming on board on this case, which again would have been late summer, early fall 2005, but it was -- certainly started off quite limited.

Q Okay. So would it be a fair statement then 09:36AM that the May 22nd, 2008 report was the product of analysis that you had been completing in this case for three years almost?

A Almost three.

Q Now, with respect to the actual construction 09:36AM and writing of the report, how long did that process take?

A There was certainly some small pieces written across time, but the majority of the writing would have taken place in April, May, 2008. 09:37AM

Q So a two-month process; is that about right?

A Approximately.

Q Now, Dr. Engel, both with respect to your underlying analysis and the writing of the report, did you approach your work in a serious and 09:37AM scientifically legitimate manner?

MR. GARREN: Object to form.

A Yes.

Q Were you careful when you were preparing this 200-page report that you issued on May 22nd of 2008 09:37AM



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to make it as accurate as possible?
MR. GARREN: Object to form.
A Yes.
Q Turn to Page 2 of your May 22nd, 2008 report, and I guess Arabic number 2 as opposed to Roman 09:38AM
numeral 2. Do you see that you've summarized some of your opinions on Page 2 under the heading hydrologic water quality modeling of the Illinois River watershed?
A Yes. 09:38AM
Q Could you read for the Record Opinion 8?
A Poultry waste land application in the IRW is a substantial contributor, paren, 45 percent between 1998 and 2006, and 59 percent between 2003 and 2006, closed paren, to P loads to Lake Tenkiller 09:39AM
representing the largest P source. WWTP P loads are the second largest contributors to P loads to Lake Tenkiller. Poultry plant discharges to WWTP represent a significant portion of WWTP P loads.
Q Dr. Engel, do you agree that's a quantitative 09:39AM
opinion?
A Yes.
Q Okay, and, Dr. Engel, is that quantitative opinion expressed in your May 2008 report the product of water modeling work that you've done in 09:39AM



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this case?
A It is.
Q You see the second opinion on the same page?
A The one numbered two?
Q Actually, I apologize. I meant the first 09:40AM
opinion, the one numbered one.
A Yes.
Q Could you read that for the Record, please?
A The hydrologic water quality model was able to
accurately model the P loads to IRW rivers and 09:40AM
streams and Lake Tenkiller.
Q All right, and are you referring in that
opinion to the models that you used to derive the
quantitative opinions that we just identified in No.
8? 09:40AM
A Yes.
Q Okay, and do I understand from Opinion 1 that
you just read, Dr. Engel, that you believed in May
of 2008 that the modeling results that you were
looking at in drafting this report were accurate? 09:40AM
A Yes.
Q When you signed this report in May of 2008, as
a general matter, Dr. Engel, did you think the
analysis that you provided, including the various
figures and tables and charts, were accurate and 09:41AM



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reliable?

MR. GARREN: Object to form.

A Yes.

Q Now, after you signed this 200-page report in May of 2008, did you discover significant mistakes in your report? 09:41AM

MR. GARREN: Object to form.

A Mistakes were discovered, yes.

Q Well, were they significant?

A They didn't significantly impact the conclusions. 09:41AM

Q Were there numerous mistakes that you identified in your report?

A One has to realize that a mistake in certain points in the process has cascading types of impacts, and so a mistake in one point impacts things that relied upon that data or that computation further into the process. 09:41AM

Q And is it fair to say, Dr. Engel, that subsequent to issuing your May 22nd, 2008 report, you identified one of these cascading mistakes that had an impact on a lot of the material in your report? 09:42AM

MR. GARREN: Object to form.

A It had an impact on Chapter 10 of the report. 09:42AM



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Q Which is pertaining to what type of analysis?
A Chapter 10, let me make sure I've got the right chapter. Yes, Chapter 10 was the hydrologic water quality modeling.
Q Tell me what the mistake was that was identified after you issued your May 22nd, 2008 report. 09:42AM
A Sure. So in calibrating the model for prediction of phosphorus loads, we had created an automated calibration program. 09:43AM
Q Who is we?
A Dr. Ji-Hong Jeon was the one that had written the code and was running that code. So the automated code was being used to calibrate the model with respect to input parameters for predicting phosphorus loads, and that piece of code was being applied to Caney Creek, to the USGS gauge on Caney Creek, at Baron Creek at that USGS gauge and at Tahlequah and the Illinois River. 09:43AM
The calibration code was set up to step through and model the various combinations of land use and soils and management for each of those watersheds. The calibration code had a loop in it to do that. That loop was set up initially for Caney Creek. Caney Creek had the smallest number of 09:44AM



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unique combinations of land use soils management, nine combinations was my recollection, and that code was copied for use in the other watersheds, and that nine was not adjusted to reflect the correct number of unique combinations of land use soils management 09:45AM for the Baron Fork watershed and for the Illinois watershed at Tahlequah.

So the net impact of that was that in that calibration process, the calibration program assumed only -- only used the first nine combinations of 09:45AM these land use soils management in Baron Fork and in Tahlequah, and as a result, attributed phosphorus loads only to those nine response units. So the impact then was that more phosphorus was attributed to those nine units in each of the Baron Fork and 09:46AM Illinois at Tahlequah than should have been. Those nine did have -- did represent the dominant land uses, forestry, pasture, urban, so those were all represented in those, and as a consequence, when recalibrating with the full set of those, the 09:46AM results really didn't change much and, you know, thus, the conclusions don't change.

Q When you say the results didn't change much, what are you referring to?

A The modeled results would be, you know, those 09:46AM



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that are summarized in the figures in the errata.
So those results ultimately changed because of the
issue we just talked about.
Q Dr. Engel, in describing the mistake that's
identified, you used the word code several times. 09:47AM
Are you referring to computer code?
A Yes. It was computer code.
Q Okay, and was this computer code in which the
mistake was present, was it part of the GLEAMS
computer code or something else? 09:47AM
A It was not the GLEAMS computer code. It was
code specifically written for this effort for
calibration.
Q Does this code have a name or description that
you can provide me? What program or operation does 09:47AM
it relate to?
A Calibration.
Q Is it -- I've seen something referred to in
your report in your materials SCE?
A Yes. 09:47AM
Q Is it related to that?
A Yes, it is.
Q What is SCE?
A Is shuffled complex evolution.
Q And for the Record what is that in terms that 09:47AM



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lawyers can understand?
A It's --
MR. GARREN: An assumption.
A It's not an assumption. It's an algorithm or
con -- it's an algorithm of sorts that is often used 09:48AM
in calibrating complex models, among other things.
Q You stated a moment ago, Dr. Engel, that this
particular computer code in which the mistake was
present was written specifically for this project;
is that right; did I understand you correctly? 09:48AM
A Well, the calibration code was, yes.
Q Okay, and that's where the mistake was was in
the calibration code; correct?
A Correct.
Q Who actually wrote the calibration code that 09:48AM
was used to derive results from the model?
A Dr. Ji-Hong.
Q Do you know, Dr. Engel, if this calibration
code that Dr. Ji-Hong wrote and used in this project
has ever been used in another water quality modeling 09:49AM
project?
A The specific code has not. The concept
certainly has.
Q So has Dr. Ji-Hong's calibration code that was
used in your work in this case been subjected to 09:49AM



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peer review in an academic or scientific setting?
A Not the specific code that had the error in it, no.
Q What about the corrected code because as I understand it, the mistake was identified by Dr. 09:50AM
Ji-Hong. He made a programming change; is that right?
A Correct.
Q Has the corrected code that was used in the modeling work in this case and written by Dr. 09:50AM
Ji-Hong been subjected to peer review?
A No, but it's not unusual that this -- that this code would not typically be written up for that purpose.
Q Well, has that code been used, the specific 09:50AM
code been used in any other water quality modeling project that you're aware of?
A The specific code, no.
Q What was the basis for -- I'm sorry, strike that. What was the scientific basis for the code 09:50AM
that was written by Dr. Ji-Hong that was used in the calibration process in this case?
A Well, the scientific or conceptual basis was to run the GLEAMS model for each combination of land use soils management, obtain an output, move on to 09:51AM



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the next of those in this loop I was describing, obtain an output until one got through running each of these management units or response units.

So once having run those, you know, results were summed and a comparison was made with observed 09:51AM phosphorus load data, and based on that comparison, this code then used this SCE, the shuffled complex evolution, concept that was outside of this code with the mistake in it in order to identify and adjust inputs into the GLEAMS model to move 09:52AM predicted phosphorus loads closer to observed phosphorus loads, and so this code would step through this process thousands, tens of thousands of times in identifying a best set of inputs to the GLEAMS model to match the observed phosphorus loads 09:52AM for the calibration period.

Q Did Dr. Ji-Hong write any other computer code that was used in the modeling work that you performed in this case?

A Certainly there was other code written to, you 09:53AM know, automate various aspects of the analysis.

Q And was that other code written by Dr. Ji-Hong?

A Yes.

Q Okay, and did you review his computer code for 09:53AM



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those other operations?
A I didn't look line by line at all the code.
Q You just counted on Dr. Ji-Hong to do it right; is that fair?
A Well, yes, I relied upon him to write the 09:53AM
code. I reviewed, summarized datasets, you know, to see if things were making sense.
Q But reviewing that summarized dataset wouldn't necessarily allow you to identify a mistake in the
code, would it? 09:54AM
A Well, it would typically allow one to identify major mistakes in codes. In this particular case, it didn't allow me to identify the mistake in the code.
Q Is it true, Dr. Engel, that Dr. Ji-Hong is the 09:54AM
scientist, if you will, who actually ran the GLEAMS model for your work in this case?
A Yes. He was the -- well, yes, he was the one watching over the computer runs of this.
Q Okay. Did Dr. Ji-Hong also make decisions in 09:54AM
setting up or configuring the GLEAMS model that was used in this case?
A Can you describe what you mean by setting up or configuring?
Q Well, Dr. Engel, you'll agree that there are a 09:54AM



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multitude of decisions that have to be made in using any model in an environmental setting; correct?

A Correct.

Q And some of those decisions relate to whether to use default values, for example, that are embedded in the programming or manual; correct? 09:55AM

A Yes.

Q The modeler also has the opportunity in certain instances to adjust values based on site specific data; correct? 09:55AM

A Correct.

Q Did Dr. Ji-Hong make any decisions regarding the use of or adjustment of default values used in the GLEAMS modeling work in this case?

A He would have made those in consultation with me. 09:55AM

Q Did he consult with you on every decision?

A Not on every decision.

Q Now, this mistake in the computer code that was developed by Dr. Ji-Hong was only identified after the defendants asked questions of you following the issuance of your report; is that right? 09:55AM

A Yes.

Q Let's go back to Dr. Ji-Hong for a moment. 09:55AM



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Other than preparing computer code and working on the setup of the GLEAMS model and running the GLEAMS model, what did Dr. Ji-Hong do in support of your work in this case?

A So could you repeat the -- I think you mentioned two items that you attributed to him. 09:56AM

Q My understanding is Dr. Ji-Hong participated in the setup of the GLEAMS model; is that correct?

A Correct.

Q Dr. Ji-Hong also was the person responsible for actually running the GLEAMS model; is that right? 09:56AM

A Correct.

Q And Dr. Ji-Hong was the programmer, if you will, who wrote computer code? 09:56AM

MR. GARREN: Object to form.

Q Is that right?

A Yes, he wrote computer code.

Q Okay. What else did Dr. Ji-Hong do related to your work in this case? 09:56AM

A He extracted and summarized data from the model output and provided those summarized data that I worked with.

Q Dr. Engel, did you ever examine the raw output data that was generated by the GLEAMS model being 09:57AM



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run by Dr. Ji-Hong?
A Some of it.
Q That was not your regular course, though, in your work in this case; is that right?
A No. I'm sorry. 09:57AM
Q Is that right?
A That was not my regular course.
Q Okay. Thank you. What did Dr. Ji-Hong do in terms of summarizing the output data or result from the GLEAMS model prior to your review of that 09:57AM information?
A Can you explain that further?
Q Describe for me the process that Dr. Ji-Hong went through to take raw output data and provide you with summarized data. 09:57AM
A So there were, again, computer codes that were created to extract and summarize some of those data, and those data were then, you know, provided to me as a file or a series of files that I continued to work with. 09:58AM
Q What information was lost in the summary, if you will? The summary is, by definition, less information than you start with.
A Sure. Oh, what is lost? Maybe the best way for me to describe that would be to describe the 09:58AM



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data I worked with. Would that be helpful?
Q Sure.
A So the data I was typically working with were data that represented phosphorus loads on a daily basis that had been summarized for the Illinois 09:59AM
River at Tahlequah, at Baron Fork and at Caney Creek.
Q Summarized how? I'm still confused.
A Daily. So those were daily values. Sorry.
Q As opposed to what; what type of values could 09:59AM
you have obtained from the raw data?
A Well, the raw data would have been daily values as well, along with other information that would have been reported on a daily basis and data that would have been reported for each of the 09:59AM
response units that were being modeled. So, you know, when I was looking at it, those were summarized to the gauge locations that I mentioned prior.
Q Okay. So Dr. Ji-Hong had available to him the 10:00AM
raw output data associated with each hydrologic response unit; is that right?
A Yes.
Q And what you received in the summaries generally was an aggregation of all of the 10:00AM



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hydrologic response unit data tied to the three gauging stations; is that right?

A That would be correct.

MR. GEORGE: Let's take a break and change tape. 10:00AM

VIDEOGRAPHER: We're now off the Record. The time is 10:00 a.m.

(Following a short recess at 10:00 a.m., proceedings continued on the Record at 10:09 a.m.) 10:08AM

VIDEOGRAPHER: We're back on the Record. The time is 10:09 a.m.

Q Dr. Engel, how were the phosphorus loads from each of the response units combined by Dr. Ji-Hong to arrive at daily phosphorus loads to the three 10:09AM particular gauging stations?

A I guess maybe I misspoke a bit based on your question here. So the data he was summarizing were the daily loads into the water that ultimately reaches the three gauging stations. So there was 10:10AM another step in that process.

Q Well, did he combine HRUs or not in his summaries?

A So in his summarized data, he provided data from those HRUs. 10:10AM



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Q From each HRU?
A It was summarized into a daily summary for a particular watershed.
Q How many watersheds did we have?
A It was the three associated with each of the 10:10AM
gauging stations.
Q Okay. I think I'm back to my same question. I apologize. Maybe we're not communicating. It's probably my fault. What was the basis or
methodology he used to combine the multiple HRUs in 10:11AM
a particular subwatershed to a single value for that watershed?
A So those were simply summed.
Q Just added up and divided by --
A No. Just summed. 10:11AM
Q Just summed. No weighting of the loads between the HRUs?
A Well, certainly -- so each HRU would potentially have a different area. So each HRU's
area was certainly considered in that summation. 10:11AM
Q How did he consider it?
A Well, it would have been area of HRU multiplied by daily phosphorus from that HRU on a per unit area basis to get an expected phosphorus
load from that HRU, and then that process repeated 10:11AM



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for other HRUs and that data summed.
Q Dr. Engel, did you ever personally run the GLEAMS model in connection with your work in this case?
A Yes. 10:12AM
Q On how many occasions?
A Oh, probably five to eight.
Q Were any of those five to eight personal GLEAMS runs that you completed the basis for the opinions you expressed in either of your reports? 10:12AM
MR. GARREN: Object to form.
A Trying to recall how those -- my recollection is that those five to eight were during the calibration period. So, you know, as calibration then impacts things further along in the process, 10:12AM you know, those ultimately would have entered into those results.
Q Let's get some context here. How many total GLEAMS runs of the model were completed in connection with your and Dr. Ji-Hong's work in this 10:13AM case?
A Be speculation as to how many.
Q Is it more than 20?
A What do you mean when you say GLEAMS run; can you help me? 10:13AM



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Q Well, I'm not the modeler. What does the model run?
A Maybe a little bit of context for you. So GLEAMS was being run for each response unit. So if we're counting, you know, a run on each response 10:13AM
unit, then they were being run multiple years, multiple times during calibration, and then multiple times for the other scenarios that were ultimately examined. So if we count each one of those, probably hundreds of thousands or millions of times 10:14AM
that the model would have been run.
Q Okay, and how many of those hundreds of thousand or millions did you actually --
A So --
Q Hang on. I'm sorry. Did you actually 10:14AM
complete as the guy who was at the switch running the model?
A Well, I wasn't the guy at the switch running the model most of the time.
Q You weren't, okay. That was Dr. Ji-Hong? 10:14AM
A Yes.
Q Okay. You indicated that perhaps you had some involvement in the running of the calibration runs; is that right?
A Yes. 10:14AM



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Q Okay. As between yourself and Dr. Ji-Hong, who was more involved in completing the calibration runs?
A Dr. Ji-Hong.
Q Okay, and can you describe for the Record, 10:15AM
please, what calibration means and what it entails generally?
A Yes. So the concept with calibration is you have an observed set of data. So in this particular
case, let's pick phosphorus, and you are adjusting 10:15AM
inputs into the model that's trying to predict that amount of phosphorus, so you adjust those inputs to some suitable level such that the model results for phosphorus and in this particular case, matched the
observed phosphorus. 10:15AM
Q Who decides what's suitable in terms of how far to turn the dial, if you will, on a calibration?
A Well, there are different ways to do that.
Q In connection with the work in this case, and
I understand that Dr. Ji-Hong was the person who was 10:16AM
performing the calibration physically, would Dr. Ji-Hong be the one who made the decision as to how far to turn the dial, if you will?
MR. GARREN: Object to form.
A No. 10:16AM



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Q Okay. Then who made it?
A Well, the piece of code that we've talked about in the prior hour was the place where that decision was being made.
Q The computer made the decision? 10:16AM
A The computer was making the decision.
Q Okay. Were all decisions with respect to calibration made by the computer code?
A Certainly not all, no.
Q Some of them were made by the independent 10:16AM judgment of the modeler; correct?
A Yes.
Q Okay, and that independent judgment in the calibration process most often would have been exercised by Dr. Ji-Hong; is that right? 10:16AM
A No.
Q Okay. Let me hand you -- let me go back for a second. You said the computer code makes most of the decisions regarding calibration; right?
MR. GARREN: Object to form. 10:17AM
A Maybe I wouldn't agree with that statement fully, and you want me to explain why?
Q Sure.
A So the computer code was written by Dr. Ji-Hong. The computer code was trying to maximize 10:17AM



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the fit or obtain a best fit between the modeled result and the observed data. The computer code had the ability to adjust model inputs within certain ranges. Those certain ranges were set by myself and Dr. Ji-Hong. 10:18AM

Q Set jointly by the two of you?

A Yes.

Q Where was Dr. Ji-Hong located when he was running the model?

A Depends on the time frame. 10:18AM

Q Well, break it in half, if you can.

A Okay. So in the initial phases of this, he was located in West Lafayette at the Purdue University campus. So I believe he departed the Purdue campus in late January, early February of 2008. 10:18AM

Q Where did he go?

A He took a faculty position at a university in South Korea.

Q What university? 10:19AM

A Andong I believe, A-N-D-O-N-G.

Q Where is Andong University located in South Korea, if you know?

A I'm not sure which city it would be in or near. I don't recall. 10:19AM



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Q And was the GLEAMS model actually loaded onto, if you will, a computer?
A Yes, it would have to be, yes.
Q You load it on a laptop computer?
A Generally it was on a -- the files were stored on a server. 10:19AM
Q Who owned the server?
A Let's see. So the server would have been a Purdue University server.
Q Okay. Did Dr. Ji-Hong take the files, the electronic files with him to South Korea when he left in January or February of 2008? 10:20AM
A He had access to the server.
Q Access through the Internet?
A Yes. 10:20AM
Q Okay. The running of the model, whether it be in a scenario or a calibration setting, was still occurring after February of 2008 when Dr. Ji-Hong went to South Korea; is that correct?
A Correct. 10:20AM
Q So some of the modeling work that Dr. Ji-Hong completed in support of your report in this case was done while he was located in South Korea; is that right?
A Yes. 10:20AM



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Q Were all of the model runs that were
ultimately used in your report with respect to
GLEAMS completed by Dr. Ji-Hong in South Korea?
A I don't believe so. I believe there were --
as I recall, the hydrology was -- we had completed 10:21AM
calibration of that prior to his departure.
Q What about all the nutrient simulations?
A I believe we were calibrating. So we were
calibrating nutrients and started that process prior
to his departure. That continued once he left. 10:21AM
Q Okay. How did you and Dr. Ji-Hong communicate
with one another after he went to South Korea and
continued to work on the modeling in this case?
A Typically by phone or Skype.
Q Phone or what? 10:22AM
A The Skype. It's Internet phone sort of --
Q You ever have E-mail communication with Dr.
Ji-Hong?
A Not about this.
Q Is he just not an E-mailer? 10:22AM
A Not a big E-mailer.
Q Do I understand that Dr. Ji-Hong's English is
perhaps -- is perhaps not proficient?
A That would be a reasonable characterization.
Q And is it in fact true that you and Dr. 10:22AM



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Ji-Hong have had some difficulty communicating because of the language barrier?

MR. GARREN: Object to form.

A Yes.

Q Now, would you be on the phone with Dr. Ji-Hong while he was running the model the whole time? 10:22AM

A Certainly not the whole time.

Q Okay. Let me hand you what we'll mark as Exhibit 3 to your deposition, which for the Record is an E-mail chain that began from me to Mr. Page July 12 of 2008 and ends with you being brought into the conversation by Mr. Page in an E-mail dated August 12th of 2008. Do you see that? 10:23AM

A Yes. 10:23AM

Q And you see, Dr. Engel, that in July of 2008, I have asked a series of questions related to the GLEAMS modeling, including some related to the calibration runs?

A Yes. 10:24AM

Q Okay, and there was some time that passed, and then I followed up with Mr. Page, and ultimately a set of steps for the -- how the model was calibrated was produced, and I believe that is attached. Do you see it? 10:24AM



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A Yes.
Q Very last page of Exhibit No. 3. What's the date of those -- the written document steps for P calibration?
A Looks like that says 8-12-08. 10:24AM
Q Why did it take, if you know, Dr. Engel, a little over a month for me to get answers to my questions regarding calibration?
A Looks like there was a response earlier than that; correct? 10:25AM
Q Partial response, yes.
A So, yes, there was a partial response prior to that and, as I recall, it took a while to get Dr. Ji-Hong tracked down and firm up the rest of those details. 10:25AM
Q Okay. Fair to say that part of the delay was because Dr. Ji-Hong, according to your E-mail of August 12th, was on vacation; is that right?
A Yes.
Q And you needed to collaborate with him, as I understand it, on exactly what were the steps in the P calibration; is that right? 10:25AM
A Yes.
Q Okay. So, Dr. Engel, you needed input from and confirmation from Dr. Ji-Hong in order to write 10:25AM



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up the, oh, one-quarter page summary on calibration that's attached to this E-mail; is that right?

MR. GARREN: Object to form.

A Yes.

Q Okay. Now, let's focus on the steps for P calibration for a moment, which is the last page of Exhibit No. 3. The third paragraph says that the GLEAMS files were manually modified. Do you see that? 10:26AM

A Yes. 10:26AM

Q That sounds different than this automated, computer-driven calibration you were talking about earlier. What is manual modification in the context of calibration?

A So following the automated calibration piece, there were minor modifications that were done to some additional model inputs to better match things across years. 10:26AM

Q Okay. What inputs were modified manually?

A I don't recall which ones specifically, but the list of potential inputs that were modified would be found in Appendix D, I believe. 10:27AM

Q Well, look at the last page of Exhibit 3. Do you see in that third full paragraph after the reference to manual modification it says, by 10:27AM



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modifying li -- how do you say that; labile?
A Labile.
Q Labile phosphorus concentration in the soil horizon; do you see that?
A Yes. 10:27AM
Q What is labile concentration for phosphorus in the soil concentration horizon; what does that mean?
A So this would be the phosphorus that is most available to become part of runoff.
Q Is that an important input parameter in 10:27AM
predicting runoff with GLEAMS?
A Yes.
Q Okay, and that input parameter was manually modified as opposed to being modified by the computer during the calibration process; right? 10:28AM
A It would have been modified by the computer during the automated portion of the process and apparently further modified by hand following that process.
Q And whose hand further modified that? 10:28AM
A That would have been Dr. Ji-Hong.
Q Why did he select that particular input parameter for manual modification?
MR. GARREN: Object to form.
A This particular parameter allowed a better 10:28AM



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match between the phosphorus across years, so it was one that was sensitive that would allow that.

Q Did he try other parameters first before settling on the labile phosphorus concentration?

A I assume he would have. 10:29AM

Q Well, do you know?

A I don't recall at this point. Without discussing that with him further, I don't recall.

Q To what extent did he modify the labile phosphorus concentration in the soil as part of 10:29AM calibrating the GLEAMS model?

A Well, we could probably look at those files and determine that.

Q Well, do you know how substantial the modification was? 10:29AM

A Not without looking at the files.

Q Where would I go to identify the file that would answer that question?

A It would be more than one file.

Q What are the names of those files? 10:29AM

A Without looking at a file structure and digging through all of these files, I'm not going to be able to sit here and give you a specific file.

Q Okay. What were the factors or the rationale employed by Dr. Ji-Hong in determining the extent of 10:30AM



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modification to this particular input parameter that was necessary in the calibration?

MR. GARREN: Object to form.

A Could you restate that or have it read back?

MR. GEORGE: Let's have it read back.

(Whereupon, the court reporter read back the previous question.)

(Whereupon, a discussion was held off the Record.)

A So prior to any calibration, there was a range of a potential values that have been identified and, you know, adjustments would not have gone outside that bound. 10:30AM

Q Well, those ranges were set in the automated calibration program; correct? 10:31AM

A Correct.

Q And what were the ranges that were allowed for modification manually after running that automated?

A They would not have been beyond the original bounds. 10:31AM

Q Well, if the computer had the discretion to adjust that parameter to that extent in the automated process, why would there be a need for a manual modification after that's run?

MR. GARREN: Object to form. 10:31AM



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A So the idea here was that, you know, the automated calibration had a specific set of goals in calibrating that was not necessarily looking at how the model performed across years, across all years, and so the goal in this further adjustment of the 10:32AM
labile phosphorus was to, you know, have it match better across years, better match the yearly pattern.

Q Is it fair to say, Dr. Engel, if I want to know why this particular parameter was modified and 10:32AM
the extent to which it was modified and what rationale went into that decision, that I would need to talk to Dr. Ji-Hong?

MR. GARREN: Object to form.

A No. One could look at the underlying files 10:32AM
and see how it's modified.

Q Will that tell me the basis for his rationale for his decision to modify it?

MR. GARREN: Object to form.

A The discussion I had with him, and as I 10:33AM
understand, the adjustment then was it was made to better match the yearly trends.

Q Are the modified values that Dr. Ji-Hong settled on for labile phosphorus concentration in the soil consistent with actual or expected labile 10:33AM



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phosphorus soil concentrations in the watershed?
A They would be, yes.
Q How do you know that?
A The range that was used was within expected
ranges. 10:33AM
Q What was the expected range?
A Again, I would have to look at a lot of this
underlying data to see that.
Q Have you gone back and compared the manual
modifications made by Dr. Ji-Hong to determine and 10:33AM
satisfy yourself that the modifications were
consistent with the environmental conditions in the
watershed?
MR. GARREN: Object to form.
A They were within the ranges that we had set 10:34AM
ahead of time, so yes, they would be consistent.
Q You're confident, Dr. Engel, that Dr. Ji-Hong
did not exceed in his manual modification the limits
that you established in your automated automization
-- automated calibration process? Sorry. 10:34AM
A Yes.
Q Have you gone back and checked that?
A Not -- I've not looked at that recently.
Q What was the range that was established for
adjustment of these parameters by the automated 10:34AM



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calibration program?
A Boy, I don't recall at the moment.
Q Was it the same range for every input parameter?
A No. 10:34AM
Q Are those ranges set out in your report anywhere?
A Oh, I don't know if they're described in Appendix D or not. I don't see that they're described. The ranges don't seem to be described in 10:35AM this appendix.
Q Let me refer you to page D-20 of your expert report dated May 22nd, 2008. Do you see in the second paragraph under calibration there is a reference to the optimization range was set at plus 10:36AM or minus 50 percent of the estimated values?
A Yes.
Q Is that related to the range discussion that we were having?
A So that would have been -- yes, that would 10:36AM have been the range.
Q So in the automated calibration program, an input variable can be adjusted by the computer to plus or minus 50 percent; right?
A Yes. 10:36AM



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Q Okay, and is it your testimony, Dr. Engel, that in making the manual modifications that Dr. Ji-Hong performed as part of the calibration process, that you're confident that he stayed within that same range of plus or minus 50 percent? 10:36AM

A Yes.

Q If he went outside of that range, that would be a breach of protocol; is that right?

A Yes.

Q How is the plus or minus 50 percent as a range for the computer to adjust the input parameters established? 10:37AM

A That would be a fairly typical range in watershed modeling.

Q Can you point me to any treatise or piece of peer-reviewed literature that establishes that plus or minus 50 percent is the appropriate range for optimization in a watershed model? 10:37AM

A I would have to look through some of those to find you one again. 10:37AM

Q Well, did you derive this from a particular treatise or piece of literature?

A I'm not sure it was derived from a particular one, but this is a value that's commonly reported when such values are reported. 10:38AM



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Q How did you determine that plus or minus 50 percent optimization was appropriate for the calibration of the GLEAMS model used and applied to the Illinois River watershed?

A Well, certainly I have a significant amount of 10:38AM experience with the model, and based on those experiences in other settings, that was a typical range.

Q Did you review any data from the Illinois River watershed to determine that that's an 10:38AM appropriate optimization range for your work in this case?

MR. GARREN: Object to form.

A What do you mean by any data?

Q Any environmental sampling data to determine 10:38AM the extent of variability in the watershed.

A I certainly reviewed ample data for the watershed, and my judgment was that based on experiences with the model, based on the literature, that this is a typical range for use in calibration. 10:39AM

Q So the plus or minus 50 percent is based upon your experience as opposed to any particular analysis related to this watershed; is that fair?

MR. GARREN: Object to form.

A Well, you know, examining the various data for 10:39AM



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this watershed and seeing the variability in the watershed, variability in the data, this was a suitable range.

Q Did you perform any statistical analysis to arrive at that conclusion or is it just judgment? 10:39AM

A It's my professional judgment.

Q Do you agree, Dr. Engel, that manual modification as part of the calibration process can introduce bias into the model?

A It can. 10:40AM

Q How could I get in touch with Dr. Ji-Hong?

A Probably call him.

Q Do you have his phone number?

A I may not have that with me.

Q I assume you have it in some contact 10:40AM information either in your office or on your phone; is that right?

A I would, yes.

Q Would you have it on your cell phone?

A I don't think it's on my cell phone right now. 10:40AM

Q Do you know Dr. Ji-Hong's E-mail address?

A Again, I would have to look that up as well.

Q I'm going to ask you, Dr. Engel, to look over lunch and see if you can find and provide us with some contact information. If you have an address, 10:41AM



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that's great. If not, E-mail and phone number would be fine.
A Okay.
Q Let me hand you what we'll mark as Exhibit 4 to your deposition, which for the Record is a copy 10:41AM of an errata report issued and signed by you on September 4th of 2008. Do you recognize that report, Dr. Engel?
A Yes.
Q And this was issued four and a half months 10:41AM after your original report; is that right?
A Approximately.
Q Okay. It was issued, as I understand it, after you had identified the error by Dr. Ji-Hong in some modeling code in response to questions posed by 10:42AM the defendants; is that right?
A Correct.
Q Dr. Engel, does Exhibit 4, your September 4th, 2008, errata report correct all of the mistakes or errors that were present in your report dated May 10:42AM 22nd of 2008?
A It did, but in the process of correcting those, a new one was introduced.
Q Okay. So there are still errors in your September 4, 2008 report; is that right? 10:42AM



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A There are some, yes.
Q Okay. Can you identify those for me?
A So Table 10 and Figure 10.1.
Q Can you give me a page number, please?
A Page number where? 10:43AM
Q At the bottom of the amended report.
A Okay, sorry.
Q That's okay.
A Would be Page 4.
Q Page 4. You said Table 10.1? 10:43AM
A Table 10.1, yes.
Q Was that the only table in which there were errors that you have discovered in your September 4th report?
A Just a moment. If I can, let me look at the subsequent errata to make sure I don't mislead you. 10:43AM
Q Please do.
A Did the copy you handed me earlier include the errata?
Q Did not. 10:44AM
A So this is a memory test? So the other impacted table was Table 12 that was part of Appendix D, which is on Page 48 of the errata.
Q Okay. Let's start with Table 10.1 on Page 4 of your September 4th errata report. What 10:45AM



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information in that table is inaccurate?
A Well, it would be the last column identified as observed total P load pounds.
Q And there are within that column ten values; do you see that? 10:45AM
A Yes.
Q All right. Are all ten of those observed total P load values incorrect?
A I believe the first one is correct, and I believe it's the next nine. So without looking 10:46AM at -- well, I can look in this and tell you for sure. So the first one was correct. The next nine were incorrect.
Q Now, Dr. Engel, did you discover this error in your second report, your September 4th, 2008 report, 10:46AM in Table 10.1 on your own or was it identified to you by someone else?
A As I recall, you asked a question about that or someone had asked a question through you, through David Page that, you know, made us identify that. 10:47AM
Q Okay. Let me hand you what we've marked as Exhibit 5 to your deposition, which for the Record is an E-mail chain that began with me on October 15th of 2008, and you're brought into the conversation the same day by Mr. Page. Do you 10:47AM



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recognize that E-mail?
A Yes.
Q And you see in the initial E-mail that I have asked a question regarding Table 10.1 in the observed total phosphorus loads? 10:47AM
A Yes.
Q Is that question what prompted you to discover there was a mistake in your report?
A Correct.
Q Why didn't you discover it on your own? 10:48AM
A Well, it was right in the original report, and in preparing the errata for -- that was submitted September 4th, an error was made in cutting and pasting values out of a file, and so the incorrect ones were inadvertently inserted in a spreadsheet. 10:48AM
Q Okay. Dr. Engel, were you careful when you put together the September 4th, 2008 errata which was designed to correct mistakes in your prior report?
A Yes. 10:48AM
Q Okay. You were intending to present information that was accurate; is that right?
A That was my intent.
Q And, nevertheless, you made a mistake; correct? 10:49AM



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A Correct.
Q Now, if you look at the E-mail that I handed you that is marked Exhibit 5, you say to Mr. Page with reference to my question, that you figured this out; do you see that? 10:49AM
A Yes.
Q Okay. What did you figure out?
A Well, I figured out that I had pasted the wrong observed phosphorus loads into a spreadsheet.
Q Okay. Did you actually complete that pasting 10:49AM procedure that resulted in the mistake or did someone else do it?
A That was me.
Q Now, the figure that is beneath Table 10.1, it's Figure 10.1; do you see that? 10:49AM
A Yes.
Q Is that figure correct?
A In the September 4 errata, no, because it's simply graphing the last two columns of Table 10.1.
Q Okay. So this mistake that you made in 10:50AM handling the data resulted not just in a table that was incorrect but a figure in a reported relationship between observed and predicted loads that was incorrect; is that right?
A Correct. 10:50AM



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Q Dr. Engel, why is it you only seem to discover mistakes in your work when the defendants ask questions?

MR. GARREN: Object to form.

A I guess there was not a reason to be rereviewing all the underlying data after the report had been submitted. 10:51AM

Q Well, what about, what procedures did you have in place leading up to the issuance of a report that was going to be used in a court case to avoid mistakes such as those that have been identified? 10:51AM

A Well, certainly data were reviewed, and it intended to be summarized data that were reviewed throughout the entire process, but realized that there are tens of thousands, if not more, files with data in them. 10:51AM

Q Are there any other mistakes in your two reports, the one dated May 22nd and the one dated September 4th, that you simply haven't identified because the defendants haven't asked a question about them yet? 10:51AM

MR. GARREN: Object to form.

A I'm not aware of any additional mistakes.

Q You mentioned that another table or figure that was in error in your errata report dated 10:52AM



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September 4th is Table 12 on Page 48; correct?
A Table 12 is the other table that was incorrect.
Q Okay. What is incorrect about Table 12 in your September 4th report? 10:52AM
A So Table 12 relied upon the detailed data that were summarized in Table 10.1, and the mistake made in cutting and pasting the wrong observed load data into a spreadsheet that resulted in the mistake in Table 10.1 and Figure 10.1 also impacted an 10:52AM automated calculation that is reported in Table 12.
Q Are each of the six values reported in Table 12 incorrect?
A Oh, without seeing the second errata, my recollection is that some of those stayed the same. 10:53AM
Q Okay. Let's go back to the general purpose of the September 4th, 2008 report, Dr. Engel. Do I understand correctly that the intent of that report was to correct mistakes in your prior report; is that right? 10:53AM
A Yes.
Q Okay, and Exhibit No. 4, your September 4th, 2008 report, is 48 pages long; is that right?
A Maybe 49 if you count the cover page.
Q Okay, and with the exception of perhaps the 10:53AM



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cover page, every one of those 49 pages is devoted to correcting a mistake or mistakes that were present in your May 22nd report; is that right?

A These all flowed from the one mistake.

Q But every page corrects a mistake or an inaccuracy; is that right? 10:54AM

A Well, pages 1 and 2 describe what happened, why -- describe the mistake.

Q Okay. Fair enough. So Pages 4 through 48, which would be 44 pages, are devoted to actually correcting inaccurate information that was present in your prior report; is that right? 10:54AM

A Yes. This is providing that correction.

Q Do you have both of your reports in front of you, your original report and your errata report? 10:55AM

A Yes, I've got the original that's marked Exhibit 2. Is that --

Q Yes, the original is marked Exhibit 2. In your original -- I'm sorry. Let's go to your September report. On Page 3 you have a summary of your conclusions. 10:55AM

A Okay.

Q Now, Dr. Engel, in Opinion No. 2 of your September report, you predict, based upon your model, that if poultry litter continues to be 10:56AM



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applied in the watershed for the next hundred years, the phosphorus loads to Lake Tenkiller will increase in the next 30 years and then become stable for the following 70 years. Is that a fair summary?

A Yes. 10:56AM

Q Do you stand by that prediction or opinion today?

A Yes.

Q Okay. Now, that's not the opinion you offered in May of 2008 based upon a different model run, is it? 10:56AM

A I believe the -- let me look at that statement and make sure I don't misspeak.

Q I believe it's on Page 2 of your original report. 10:57AM

A I believe the differences in the statements is that declined slightly has been removed in that statement.

Q So you're not offering the same opinion in your September report that you were offering back in May in your original report; is that right? 10:57AM

A It is slightly different.

Q Okay. Back in May of 2008 you were predicting that after 30 years, the phosphorus loads would decline before stabilizing, were you not? 10:57AM



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A They would decline very slightly and would fluctuate around some value. So they would -- they were predicted to decline slightly.

Q Okay, but now you're of the opinion that that prediction is inaccurate; right? 10:58AM

A Well, the prediction changed very little. So if you look at the data, the prediction changed very little. So phosphorus loads increased during the first 30 years in both cases and then they began to fluctuate a bit, and in the original report, the 10:58AM model that had the minor mistake, the values declined a little bit for a few years.

Q Okay, but just so I'm clear, you're no longer of the opinion, are you, Dr. Engel, that the phosphorus loads in Lake Tenkiller, if poultry 10:58AM litter continues to be applied, will decline after 30 years before stabilizing?

A The model suggests that they will stabilize.

MR. GARREN: Object to the form. Did you say 30 years? 10:59AM

MR. GEORGE: I said after 30 years.

MR. GARREN: Thank you.

A So the model suggested that after 30 years, as this was corrected, that phosphorus levels to Lake Tenkiller would stabilize beyond that. 10:59AM



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Q But you no longer believe that that prediction is accurate; is that right?

MR. GARREN: Object to form.

A Which prediction? You've got me confused. Sorry. 10:59AM

Q The one that you made in May of 2008 based upon your GLEAMS model where you said on Page 2 that the phosphorus loads to Lake Tenkiller would decline after the first 30 years of continued litter application before stabilizing. 10:59AM

A So at this stage, I believe that they will stabilize and that they don't decline.

Q Okay.

A And that's consistent with what one, in reality, would expect. 10:59AM

Q Okay. So, Dr. Engel, as of today, what is your opinion; is it the one you expressed in May of 2008 or the one that you expressed in September of 2008?

MR. GARREN: Objection to form. 11:00AM

A It would be the one in September of 2008.

Q Okay. Are you confident in that prediction?

A Yes.

Q Okay.

A Sorry. 11:00AM



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Q You think you got it right this time?
MR. GARREN: Object to form.
A Well, it's not significantly different than it was in the original report.
Q I just want to know, Dr. Engel, when we get to trial in this case, are you going to take the stand and say that if poultry litter continues to be applied, there will be an increase in phosphorus loads for the first 30 years and then they will stabilize over the next 70 years. Is that your opinion? 11:00AM 11:00AM
MR. GARREN: Object to the form.
A That's my opinion as of today.
Q Well, do you plan on changing that opinion?
A I suppose if there were new data that came forward, you know, that could change. 11:00AM
Q If you ran your model again, it could change?
MR. GARREN: Object to the form.
Q Is that right?
A I didn't say that. 11:01AM
Q Do you really know, Dr. Engel, what the phosphorus concentration in Lake Tenkiller is going to do 30 or 70 or a hundred years from now if poultry litter continues to be applied?
MR. GARREN: Object to form. 11:01AM



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A Well, the model suggests something. You know, one would logically looking at trends that are in observed data over the past -- well, since the '80s, USGS has seen upward trends in phosphorus that tend to match growth in the poultry industry. So if one 11:01AM assumes that, you know, the industry continues to operate with the same practices, those trends are likely to hold.

Q All right. You said the model suggests. That's kind of how you started your answer, Dr. 11:02AM Engel, and I'm not interested in what the model suggests because the model can't testify; you can; right?

A Right.

Q So what does Dr. Engel believe, and it can be 11:02AM based on a model, to a reasonable degree of scientific certainty will happen in Lake Tenkiller 30, 70 or a hundred years from now if poultry litter continues to be applied?

A Well, to answer that question, you're going to 11:02AM have to make some assumption about land uses and other practices within the IRW, about weather, about other things. So is it okay if I make some assumptions there?

Q Is it okay from a scientific perspective to 11:02AM



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make assumptions?
A Certainly.
Q Okay. Do you agree those assumptions need to be well founded in reality?
A Yes. 11:03AM
Q Okay. So go ahead.
A So, you know, based on the modeled results, based on trends in data, long-term trends in observed phosphorus loads to the lake, you know, I would anticipate that one would continue to see 11:03AM loads increasing or at least of a comparable magnitude as to what we have now, assuming that conditions in the watershed don't change, assuming that, you know, there's not a drastic shift in weather, drastic change in land use and other things 11:03AM that would go into that.
Q Dr. Engel, is it reasonable to assume that land use will not change in the watershed in the next hundred years?
MR. GARREN: Object to form. 11:03AM
A Land use will likely change.
Q Okay, but your opinion is based upon the assumption that it will not, is it not?
A Correct.
Q Let's go back to your errata report, which is 11:04AM



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September. Do you have it? I want to look at
Opinion No. 3 on Page 3, and, Dr. Engel, in Opinion
No. 3 in September of 2008 you predict, based upon
your model, that if poultry litter applications are
halted in the watershed, phosphorus loads would be 11:04AM
reduced by 18 percent in the next ten years; is that
correct?
A Correct.
Q Okay. Do you stand by that prediction or
opinion today? 11:04AM
A Yes.
Q Okay. Now, that's not the opinion you offered
back in May of 2008 based upon a different model
run, is it?
A So the May opinion had a different reduction 11:05AM
level of 16 percent. So this suggests slightly more
reduction in phosphorus loads following cessation.
Q So back in May of 2008, you were predicting
the phosphorus loads would be reduced by only 16
percent in the next ten years; is that right? 11:05AM
A Correct.
Q You no longer stand by that opinion?
A My opinion today is that they would be reduced
by 18 percent.
Q Will they really be reduced by 18 percent if 11:05AM



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poultry litter is halted within the next ten years?
A There's certainly -- there are multiple lines that would suggest that that would be the case.
Q Well, what is your opinion? Will they really?
A Well, it certainly depends on other factors, 11:06AM
but assuming that the only thing we change is a change in poultry waste land applications, we turn that off, if we get the same weather that we've seen in the past -- from '97 to 2006, the expectation is that phosphorus loads would be decreased by 18 11:06AM
percent.
Q You're also assuming in that prediction, are you not, that there will be no changes in land use in the watershed in the next ten years?
A That's correct, so as I stated, if we hold 11:06AM
everything else constant.
Q You realize the world doesn't stay constant; right?
A That's correct.
Q Let's look at your September errata report, 11:06AM
Opinion No. 4.
MR. GEORGE: Let's go ahead and change out the tape.
VIDEOGRAPHER: We're now off the Record.
The time is 11:07 a.m. 11:07AM



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(Following a short recess at 11:07 a.m., proceedings continued on the Record at 11:18 a.m.)

VIDEOGRAPHER: We are back on the Record. The time is 11:18 a.m. 11:18AM

Q Dr. Engel, do you have your September report in front of you still?

A I do.

Q Okay, and would you look at Opinion 4 on Page 3 with me for a moment. 11:19AM

A Okay.

Q Dr. Engel, in your September report you predict if the poultry industry continues to grow over the next 50 years at the same rate that it has grown over the last 20 years, that the phosphorus 11:19AM loads to Lake Tenkiller will increase by 70 percent; is that correct?

MR. GARREN: Object to form.

A Yes.

Q Okay. Do you stand by that prediction or 11:19AM opinion today?

A Yes.

Q Okay. Now, that's not the opinion or prediction that you offered back in May of 2008 based upon a different model run, is it? 11:19AM



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A So it looks like in May the predicted increase was greater. It was predicted at 92 percent rather than 70 percent. So this -- this is one that went a different direction.

Q Changed significantly; would you agree? 11:19AM

MR. GARREN: Object to the form.

A Well, you know, a 70 percent increase in phosphorus attributable to land application of poultry waste versus 92 percent, both of those are quite large. 11:20AM

Q But is there a significant difference to you between 92 percent of a load allocation and 70 percent?

MR. GARREN: Object to form.

A I think it depends on the context. 11:20AM

Q Well, in the context of this lawsuit, is that significant to you, Dr. Engel?

A These are both quite large.

Q Do you want to answer my question? Is it significant to you? 11:20AM

A What is -- are you asking is 92 versus 70 significant?

Q I'm asking whether the difference between your prediction in May of 2008 of 92 percent and your prediction in September of 70 percent is significant 11:21AM



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to you in the context of this litigation?
A I would indicate again that both are quite large, and so my opinion that, you know, continued or increased waste application is going to exacerbate the problem, yeah. At 70 it does that; 11:21AM
at 92 percent it does that.
Q Okay. There's no real difference to you between those two numbers, the 70 and the 92 percent?
A The numbers are different. The conclusions 11:21AM
one reaches from that is not.
Q Okay. So you can -- your numbers can be off by as much as 22 percent and you still reach the same conclusion; is that right?
MR. GARREN: Object to form. 11:21AM
Q Is that what I heard you say?
MR. GARREN: Object to form.
A You're misinterpreting what I'm saying.
Q Now, in making the prediction that you stand by today of a 70 percent allocation to poultry 50 11:21AM
years from now, assuming the growth rate that you assumed, Dr. Engel, did you also assume there would be no other changes in the watershed in the next 50 years?
A Yes. So the assumption was that there were no 11:22AM



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other changes, and, you know, that's the purpose of modeling. So the idea here was to control all other variables and see what happens when we change the one input, poultry waste land application.

Q In the real world, though, more than one variable changes in a 50-year time span in a watershed, would you agree? 11:22AM

A It would but, again, the purpose of a modeling -- this is the way people would tend to use models -- is, you know, it allows one to control for those other changes if one desires. The goal here wasn't to change other things and see what happens. The goal was to understand if we see increased poultry production and increased land application of waste, what happens. If one wanted to go back and make more model runs to change, you know, these other assumptions maybe you want to change, yeah, the model would let you do that. 11:22AM 11:23AM

Q Dr. Engel, why was it not your goal in developing predictions based upon the model to describe what is actually likely to occur in the watershed? 11:23AM

A Again, you know, typically with models, you know, they allow you to ask targeted questions, and the targeted question here was, leaving everything 11:23AM

else the same, what happens if, and the if here was what happens if we see continued increase in poultry production and continued increase in land application of waste.

Q Who told you that was the targeted question 11:24AM
that you were to answer?

A That was the question I was asked to answer.

Q Asked by who?

A Asked by the State of Oklahoma's team.

Q Through who? 11:24AM

A Probably would have been through David Page.

Q Do you still have your September report with you? Can you look at Opinion 7? It's also on Page 3. In September of this year, your opinion, Dr. Engel, was that phosphorus loads to Tenkiller have 11:24AM increased at a rate of 8,000 pounds per year since 1954 and that poultry litter applications are responsible for 4,700 pounds or 59 percent of this increase each year. Do you see that?

A That's not exactly how it was read or how it 11:24AM
was written. I'm sorry.

Q Okay. Read it to me, please. I apologize.

A So P loads to Lake Tenkiller since 1954 have increased at approximately 8,000 pounds per year. Poultry waste application in the IRW is responsible 11:25AM



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for approximately 4,700 pounds of this increase each year.

Q Okay. What is the percentage of 4,700 compared to the 8,000 increase per year; do you know? 11:25AM

A I can calculate it.

Q Do it, if you don't mind. I don't think it will take you long.

A So to the nearest percentage, 59 percent.

Q Okay. So do I understand correctly, Dr. 11:25AM Engel, that the opinion in your September report is that poultry litter applications are responsible for 59 percent of the increase each year in the phosphorus load to Lake Tenkiller since 1954?

A Well, realize that this is a regression line 11:26AM through that. So indicating that that is happening each year is an overreach on this I think. So on average each year, it's increasing this amount.

Q 59 percent?

A 59 percent. 11:26AM

Q Okay. Now --

A No, I'm sorry. So the increase is not 59 percent. The increase was 8,000 pounds a year overall. 4,700 pounds a year attributable to poultry waste application, so -- 11:26AM



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Q And that poultry litter application share of
the increase is 59 percent; correct?
A The share of the increase would be 59 percent.
Q Okay. Thank you. Now, do you stand by those
opinions today, Dr. Engel? 11:27AM
A Yes.
Q Those are not the opinions you offered back in
May based upon a different model run, are they?
A So, again --
Q Can I get a yes or no first? 11:27AM
A Yes.
Q Those are the same opinions you offered back
in May?
A Yes, you can get an opinion.
Q Okay. 11:27AM
A Sorry. I was trying to --
Q Let's try it again. I do -- I'll give you a
chance to explain. I want a clear Record first.
Dr. Engel, the opinions that we just established
from your September report regarding the percent 11:27AM
increase each year associated with poultry litter
are different than the opinions you offered in 2008
based upon a different model run; is that right?
A So the opinion is different, yes, and, in
fact, based on the revision in September, the 11:27AM



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contribution percentage-wise, if you want to think of it that way, attributable to poultry decreases from 66 percent to the 59 percent we just computed.

Q Okay. So between your May report and your September report, the average annual percentage of the poultry contribution to the load to Lake Tenkiller has declined; is that right? 11:28AM

MR. GARREN: Object to form.

A I'm not sure I'm answering the right question here. So the average annual -- so, yes, the average annual poultry contribution percentage has gone from 66 to 59 percent, so it's declined. 11:28AM

Q Okay. Why did you not change then, Dr. Engel, in your September 2008 errata report the opinion that you had offered in your prior report as Opinion 8 on Page 2, that poultry litter is a substantial contributor between 45 percent from the time period of '98 to 2006 or 59 percent between 2003 and 2006? 11:28AM

A So Opinion 8 in the May report is based on a set of data that was correct in the May report. 11:29AM

Q Well, I thought you told me earlier that Opinion 8 was based upon the output of your model.

A Opinion 8 was based on the output of the model.

Q Okay, and you wrote the September report based 11:29AM



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upon the wrong output of the model; is that right?
A Realize that the -- could you repeat that question again, sir? I'm sorry.
Q You wrote your May report that contains this Opinion No. 8 based upon an incorrect run or the 11:30AM
inappropriate output from the model; is that right?
A Some of the -- just a portion of the report is based on an incorrect output of the model.
Q Okay. Let me ask it as basic as I can. How is it, Dr. Engel, that your opinion about the annual 11:30AM
contribution of poultry litter to the increased P load each year has changed but your opinion about the relative contribution of poultry litter to the phosphorus loads for the aggregated periods has not changed? 11:30AM
A Those are different model runs and different model outputs.
Q Well, do you have an opinion today as to what is the relative contribution of poultry litter between '98 and 2006? 11:30AM
A It was the same as what was reported in the May report.
Q 45 percent?
A Well, let's look at it. Yeah, at Opinion 8. Opinion 8 indicates between 1998 and 2006 poultry 11:31AM



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contribution was 45 percent.
Q Okay, and that remains the same today; you have the same opinion despite the fact that you've now concluded that you had previously overstated the annual contribution of poultry to the increasing 11:31AM
phosphorus loads?
MR. GARREN: Object to the form.
A Opinion 8 is the same as it was.
Q Help me reconcile those two. Do you see my difficulty in understanding? 11:31AM
A Sure.
MR. GARREN: Object to form.
Q Help me reconcile.
A So the model runs associated with Opinion 7 that we had just talked about is a different set of 11:32AM
model runs than that associated with Opinion 8.
Q What were the model runs associated with Opinion 8?
A So Opinion 8 used a set of model runs that, unbeknownst to me at the time, had been corrected. 11:32AM
Q Okay, but now they've been corrected, you haven't changed your Opinion 8; is that right?
A So, again, when the May report was written, Opinion 8 used a corrected set of results. I didn't know at that point that we had an error in other 11:32AM



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model outputs, and so Opinion 8 was based on a set of model outputs that had had this problem that we've talked about in the prior couple of hours corrected.

Q Okay, okay. So, Dr. Engel, maybe I now understand. When you wrote your opinion, your report in May of 2008, you wrote it based upon both -- in some instances, the correct model run and in other instances the incorrect model run; is that right? 11:32AM 11:33AM

A That's right.

Q All right, and it's your testimony, Dr. Engel, that Opinion No. 8 in your original report was written based upon the modeling runs that did not have the code error that was subsequently identified; is that right? 11:33AM

A That's right.

Q Okay. Why would you use two different model runs in preparing the same report?

A Well, actually there are numerous model runs that were used in preparing the report. 11:33AM

Q Right, but with respect to the phosphorus simulation and the scenarios that you were running and the opinions that you were expressing, based upon those runs, why would you use two different 11:34AM



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sets of those runs to offer opinions about the same general topic?

MR. GARREN: Object to form.

A So, again, there were multiple phosphorus runs, most of which were different, that went into the varying opinions here. 11:34AM

Q Let's talk about the relationship between your May 2nd -- I'm sorry, your May 22nd report and your September 4th report, Dr. Engel. Can we assume that all of the opinions, charts, figures and statements in your 200-page original report still reflect your opinion as of today unless they were expressly changed by Exhibit No. 4, your September 4th report? 11:34AM

A I guess there was also the October things that were also modified. 11:35AM

Q Okay. You're talking about the corrections to the tables that we identified in Exhibit No. 4?

A Well, there were, what, two tables, some figures.

Q Well, let me ask it this way: Is your original report still good and a reflection of your opinions unless expressly modified by the September 4th report or the October amendment that you are referring to? 11:35AM

A Yes. 11:35AM



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Q Okay. If it's in this report, unless it's changed by a subsequent document that we've already received, it's a reflection of your opinion today?
A Correct.
Q Okay. Did anyone other than you participate in the preparation of either your May or your September reports? 11:35AM
A Let's look here a moment so I get the right pieces attributed to the right people. So Appendix B, Appendix B, the Illinois River watershed phosphorus mass balance study, was authored by Meagan Smith under my supervision. 11:36AM
Q Let me stop you there for a second. We'll take them one by one. Does Meagan Smith work for you at Purdue University? 11:36AM
A No, she does not.
Q Where is Meagan Smith located?
A I believe she is here in the Tulsa area.
Q Okay. Did you hire Meagan Smith?
A No. 11:36AM
Q Okay. Did you pay for her work in this case?
A No, I did not.
Q How many hours did you spend with Meagan Smith working on the mass balance study that she authored as Appendix B to your report? 11:36AM



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A Well, giving you a specific number would be tough.
Q Ballpark it.
A A ballpark is okay. 150 to 200.
Q What specific changes in the report that she authored did you propose? 11:37AM
MR. GARREN: Object as to form.
A Boy, specifics is going to be tough. As I recall, this is probably in some of the E-mails and things produced. As I recall, there was a marked up copy, you know, that had some suggested edits and notes in it, you know. Throughout the -- well, throughout the analysis and throughout the preparation, there would have been, you know, ongoing dialogues and discussions. 11:37AM
Q Who actually performed the computations that are set forth in Appendix B, the mass balance study?
A So Meagan would have performed those.
Q Okay, and who would have actually reviewed the data on which those computations are based? 11:38AM
A Well, Meagan certainly reviewed the data. You know, I reviewed spreadsheets that contain summarized data. I reviewed some of the underlying data in some circumstances as well.
Q Did you count on her to review all of the 11:38AM



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data?
A She reviewed all of the data.
Q If I had a question about a specific detail of a computation or a data source used in her analysis, would that question be more appropriately directed to Meagan Smith? 11:38AM
MR. GARREN: Object to form.
A Probably depends on the specific issue.
Q There's some questions that would be more appropriately directed to her about the details of the analysis? 11:39AM
A Yes, certainly the details, she was involved in the day-to-day details.
Q In your view, Dr. Engel, is Miss Smith qualified to complete the mass balance analysis? 11:39AM
A Yes.
Q Have you read the transcript of Miss Smith's deposition?
A I did.
Q Did you disagree with anything she said in her deposition about the mass balance work? 11:39AM
MR. GARREN: Object to form.
A I guess probably the one thing that I would, as I recall, she was asked on -- at numerous times throughout that if this had anything to do with 11:39AM



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water quality, and I think her response was, no, it doesn't. You know, I would wholeheartedly disagree that this has -- that statement. This has everything to do with water quality.

Q Does Miss Smith's mass balance analysis take 11:40AM
into account internal as opposed to imported sources of phosphorus in the watershed?

A Well, as the analysis were defined here, the goal was to understand movement of phosphorus into the IRW system and out of that system and, 11:40AM
therefore, understand how much is accumulating in the IRW system. So from that standpoint, if something is internal, it's simply cycling the phosphorus internally. You know, it's not creating new phosphorus that's going into the system. 11:41AM

MR. GEORGE: Can you read back the question?

Q If you can answer it directly, please do so.

A Okay.

(Whereupon, the court reporter read back the previous question.)

A Can you tell me what you mean by internal sources?

Q Sure. Dr. Engel, there was phosphorus present in the watershed before the dam was ever constructed 11:41AM



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at Lake Tenkiller. Do you agree with that?
A Yes.
Q Okay. Does Meagan Smith's analysis take into account those internal sources of phosphorus?
A So, no, it does not assume a starting point 11:41AM
for phosphorus.
Q Is it your opinion, Dr. Engel, that only imported sources of phosphorus can affect phosphorus levels in surface water or groundwater in the
watershed? 11:42AM
A No.
Q How does Miss Smith's analysis take into account the effects of those non-imported sources?
A Well, the analysis is summarizing the
phosphorus that's moved into the watershed, and I 11:42AM
guess the little that's moved out as well for some sources has summarized that since, what, 1949 or whenever the analysis began. So it didn't look at the starting levels of phosphorus that were in the
watershed. 11:42AM
Q So in arriving at her 76 percent figure for poultry, did Miss Smith take into account the phosphorus that has always been present in soils in the Illinois River watershed?
MR. GARREN: Object to form. 11:43AM



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A Well, I think you are mischaracterizing the 76 percent. So the 76 percent, if you look at the table caption, and this is what I recall as well, it's the annual additions of phosphorus to the watershed. So poultry represents 76 percent of the 11:43AM annual additions. So this isn't -- this isn't talking about the total sum of phosphorus that exists in the watershed.

Q Is it talking about the relative contribution of sources to phosphorus that's present in the 11:44AM water?

A Well, one can move from -- you know, from the data that Meagan Smith pulled together to arrive at an expected amount of phosphorus in the water. It's actually pretty simple. 11:44AM

MR. GEORGE: You want to try my question again, please?

(Whereupon, the court reporter read back the previous question.)

A So, no, and let me continue. So, no, it's not 11:44AM explicitly telling us the percentages reaching water, but it's identifying the mass of phosphorus being left in the watershed, and from that, one can readily estimate the amount of phosphorus from the sources one would expect to reach water. 11:45AM



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Q Did Meagan Smith do that in Appendix B to your report?
A In Meagan Smith's analysis that was not done.
Q Okay. Did Miss Smith add up the known daily discharges of phosphorus directly into the streams 11:45AM
in the watershed by POTWs and back those discharges out in arriving at her 76 percent figure for poultry?
A Can you -- I think you've got two questions in there. Can you break that down for me? 11:45AM
Q Let's ask it again and see if you can answer. If you can, we'll try.
(Whereupon, the court reporter read back the previous question.)
MR. GARREN: Object as to form. 11:46AM
A So you've got -- I think you've got two questions in there to me it seems like, but can I break it apart when I answer?
Q Give it a shot.
A Okay. So the wastewater treatment plant 11:46AM
phosphorus -- I don't believe she works with that in this report.
Q I think you're right. Dr. Engel, do you agree that the phosphorus that is discharged daily by
POTWs into the streams in the Illinois River 11:47AM



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watershed, in fact, has a significant effect on the amount of phosphorus that's present in the streams and rivers?

MR. GARREN: Object to the form.

A Yes, it would have an impact on the amount of phosphorus. 11:47AM

Q All right. Let's go back. I think you were at the table of contents and you were going to identify for me portions of your report that were authored by others. We've covered Appendix B. Are there any other portions? 11:47AM

A Just a moment. So Appendix C, if we look at Appendix C, and I think it's clearly identified at the start of C as to -- so Appendix C was written largely by Tim Cox, Dr. Tim Cox. 11:48AM

Q Who is Dr. Tim Cox?

A So Dr. Tim Cox is a CDM employee who has been involved in this project.

Q The same CDM at which Roger Olsen works?

A Correct. 11:48AM

Q Okay. What are Dr. Cox's credentials?

A So, as I recall, Dr. Cox has a PhD in areas or has at least experience in his training in areas related to hydrology, field data collection, hydrologic water quality modeling and analysis. 11:48AM



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Q What kind of degree does he hold?
A I can't tell you as I sit here at the moment. I would have to look at his CV to refresh my memory.
Q What university did he attend?
A It's been long enough since I looked at his CV 11:49AM
that I don't recall that either.
Q How many occasions have you worked with Dr. Cox prior to this case?
A Prior to this case?
Q Yes, sir. 11:49AM
A None.
Q How is it, Dr. Engel, that a gentleman whose educational background you're not completely sure of and whom you've never worked for before authored something that finds its way into your expert 11:49AM
report?
MR. GARREN: Object as to form.
A Well, at the moment I don't recall his educational background, but when I looked at his educational background and experience and experience 11:49AM
in this area, I was satisfied that he had the right expertise, experience, skill set to, you know, to do this effort. It's just I can't recall, you know, those details of the university and the degrees at this point. 11:50AM



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Q Is it your view that Dr. Cox would be
qualified to offer these opinions himself?
A Which opinions?
Q The opinions contained in Appendix C of your
report. 11:50AM
A Are there opinions in Appendix C?
Q I don't know. You tell me. Are there?
A As I recall, the opinions are in chapter --
I'll have to look again to get this right. Looks
like Chapter 9. So Chapter 9 is authored by myself. 11:50AM
Q What page are you on, Dr. Engel?
A Just a moment here and I'll get there. Looks
like Page 42 at the bottom it's labeled.
Q Where is the analysis that supports the
opinions that you've offered in Chapter 9 of your 11:51AM
report?
A So those would be based on materials presented
in Appendix C.
Q Okay. Did you do anything independent of the
work presented by Dr. Cox in Appendix C to form the 11:51AM
basis for the opinions that you offer in Chapter 9
of your report?
A Well, certainly throughout the time that this
analysis was being done, I interacted with Tim Cox,
provided a framework for this analysis, and I can 11:51AM



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recall that we met on several occasions, probably three or four occasions here in Tulsa, to work on some of this.

Q Does the reflect of that -- I'm sorry. Is that work reflected in Appendix C, what you are talking about, the collaborative work with Dr. Cox? 11:52AM

A Yes.

Q And Dr. Cox authored Appendix C?

A So Dr. Cox wrote Appendix C. I think I probably provided some comments and some guidance in structuring that. 11:52AM

Q As between yourself and Dr. Cox, who is in the best position to address the details of the statistical analysis that is summarized by you on Page 42 of your report? 11:52AM

A Probably either one of us could.

Q Any other portions of your report authored by others?

A I think that is it.

Q Let's make sure we're clear. Appendix E, the cattle manure generation analysis, is that your analysis; did you write Appendix E? 11:53AM

A I wrote Appendix E.

Q Is that your analysis or did someone else participate in that? 11:53AM



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A There may have -- let me look at E to make sure I'm correct. Looks like Appendix E is me.
Q Okay. Did you have any help on that analysis or is it entirely yours?
A Looks like that one is entirely me. 11:53AM
Q What about Appendix F, contribution of cattle in streams to the P loads in the Illinois River watershed; did you author Appendix F?
A I did.
Q Did you have any help or assistance in the 11:54AM analysis that is reflected in Appendix F?
A So, yes, I did.
Q Who assisted?
A So Bert Fisher would have assisted with a couple of items in here. 11:54AM
Q What specifically did Mr. Fisher do that is contained within Appendix F?
A Let's see. So Dr. Fisher provided data that was -- looks like summarized here in Table 4.
Q Hang on a second. Did he -- 11:54AM
A Page F-2.
Q Thank you. Did he simply provide the data or did he summarize it for you and give you Table 4?
A I saw the data. I don't recall if he also provided this summary that's Table 4 or if I had to 11:55AM



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summarize that further, but I did see that data.
Q What else did Dr. Fisher provide or do?
A I believe that is it in Appendix F.
Q What about Appendix G, the potential septic
tank contribution; is that -- well, strike that. 11:55AM
Did you prepare Appendix G?
A Yes.
Q Okay, and is that your analysis in Appendix G?
A Yes, it is.
Q Okay. Did you have any help or assistance in 11:55AM
performing the analysis reflected in Appendix G?
A Looks like I would have received data
that's -- that is summarized in Table 1 but it was
raw data.
Q Throughout your report, Dr. Engel, there are 11:56AM
various figures, tables and graphs. Did you prepare
all those figures, tables and graphs?
MR. GARREN: Refer to which exhibit you are
referring to, please?
MR. GEORGE: Sure, Exhibit 2, which is his 11:56AM
May 22nd, 2008 report.
A You want to start with figures?
Q Sure. I don't really have a desire to go
through them one by one. I'm trying to determine as
a general matter, are the tables, graphs and figures 11:57AM



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in your report things that you prepared yourself?
A The majority would be. There would certainly be some that are not, and I believe those are identified.
Q In the reference? 11:57AM
A Yeah, I believe so, for example, Figure 2.1 and 2.2.
Q What page?
A Page 8. So I think generally those are identified as to the source that those came from. 11:57AM
Q Since you pointed it out, Figure 2.1 and 2.2, there is a line that says recommended. Do you see that on both of those figures?
A Yes.
Q And do the author -- do those lines appear on the plots created by the authors that you reference or did you insert that? 11:58AM
A These were on the plots prepared by the original authors.
Q Okay. Let's go back for a moment. Someone prompted me. I'll blame somebody at the end of the table had a question on Appendix G, septic tank contribution. Turn to that, please. Summarize generally what you did in Appendix G. 11:58AM
A Okay. So Appendix G was trying to understand 11:58AM



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for a group of watersheds that the so-called high flow stations that CDM monitored in 2005 and '6 I believe, I believe -- it says here 2005 and '6 -- the analysis in Appendix G is examining whether the phosphorus flows that were observed in these few 11:59AM rainfall events and a few base flow samplings, it was trying to examine if septic systems that were likely present in those watersheds, you know, even if, you know, they were all failing, would contribute phosphorus at a rate sufficient to 11:59AM explain the observed phosphorus loads. As it turned out, you know, they don't explain all the phosphorus showing up and, in fact, one would expect the phosphorus from those septic systems to show up at base flow, not these high flows anyway. 12:00PM

Q Why did you limit your analysis in Appendix G on septic tanks to the subbasins for which CDM had collected high flow samples?

A Again, the goal of the analysis was to understand the potential for septic systems to be 12:00PM contributing phosphorus in those watersheds that were part of this analysis.

Q Why did you limit your analysis to these particular subbasins within the Illinois River watershed? 12:00PM



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A I guess the analysis, the specific analysis reported in G is limited to those specific watersheds. You know, based on my reading of literature and reports specific to this watershed, you know, the conclusion is that the septics are not 12:01PM
a major contributor to the phosphorus loads into Tenkiller.

Q How many septic tanks are assumed or considered in your Table 1 analysis of the high flow station subbasins? 12:01PM

A Without doing a fair amount of math, I'm not sure of the specific number.

Q But you'll agree with me, there are more septic tanks in the watershed than are included in your analysis in Table 1? 12:01PM

A Yes, and, you know, Table 1 does not suggest that this is representative of the watershed and doesn't suggest that all the septic systems in these watersheds are failing and contributing at this rate either. 12:02PM

Q You do have -- you did have information available to you, did you not, Dr. Engel, as to the total number of septic tanks or likely septic tanks in the watershed?

A I believe I've seen a number that suggests a 12:02PM



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population affiliated with septic tanks.
Q Okay, and in Appendix G you have some values that you've used in this analysis as to the amount of phosphorus contributed per year per household to a septic tank; correct? 12:02PM
A Yes.
Q Dr. Engel, why -- strike that. Did you model septic tank as an influence or source in your analysis in this case?
A No. It was not -- could you clarify what you mean? 12:02PM
Q You ran the GLEAMS model in this case; right?
A Right.
Q And you used the GLEAMS model to allocate sources -- allocate phosphorus loads to specific sources; right? 12:03PM
A Right.
Q Okay. Did you include septic tanks in your modeling work with GLEAMS?
A In that part of the modeling they were not included. 12:03PM
Q Why not?
A Based upon, again, analysis and reports and literature and locations of those, they're not a significant contributor to the phosphorus loads 12:03PM



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reaching Tenkiller.
Q How do you know that?
A Well, if -- the numbers, as I recall them, there are about 73,000 people on septic systems in the watershed and, you know, pretty typical 12:03PM
assumption would be that 10, 20 percent of those might fail, and so if you do the calculations, you know, you arrive at a conclusion that that can't be a significant contributor to the phosphorus loads to Lake Tenkiller. 12:04PM
Q Dr. Engel, what is the basis for your opinion that only failing septic tanks can contribute phosphorus to either groundwater or surface water?
MR. GARREN: Object to form.
A Well, I don't think that I stated that only 12:04PM
failing systems could contribute.
Q Okay. That's fair enough. Let me give you an opportunity to state it clearly one way or the other. Do you have an opinion, Dr. Engel, as to whether or not a functioning septic system can 12:04PM
contribute phosphorus to groundwater or surface water?
A Yes, a properly functioning system could.
Q In fact, isn't the purpose of a septic system and a functioning septic system to take effluent or 12:04PM



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waste and to spread it out beneath the surface through lateral lines?

A It does but, again, you know, based on my analysis, if you look at the potential phosphorus there versus the potential phosphorus that's being 12:05PM spread in poultry waste on the surface even throughout the watershed, you know, the masses of those are very different. Poultry waste is orders of magnitude more.

Q Dr. Engel, in your approach to modeling in 12:05PM this case, did you choose to exclude all sources that were smaller individually than poultry litter was in your analysis?

A No.

Q Okay, and the reason I ask is you define 12:05PM significance with reference to the amount of poultry litter, and is that your test for significance in including or excluding a source from your analysis?

A No.

Q What was your test? 12:05PM

A Well, the -- you know, the test was are they contributing or likely to be contributing a significant load of phosphorus.

Q How much is significant?

A Well, it's tough to put a specific number on 12:06PM



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significant, and if you look at a definition of significant, you know, in this case we have a few small number of potentially significant contributors. In other cases it may be a substantially larger number, and so the magnitude of 12:06PM those contributors as to whether they're significant depends on the specific case.

Q So significance might mean different things with regard to different sources; do I understand you correctly? 12:06PM

A I don't think that's what I said. So --

Q Let's clean it up. Did you have a percentage or a statistical measure or an objective criteria for determining significant sources to include in your modeling in this case? 12:06PM

A Again, if we go back to the mass balance, that provided the guidance. So if you want to look at Table 29 in appendix -- I think it's Table 29 in Appendix B -- let me get this right.

MR. GARREN: Page 37. 12:07PM

A Is it Appendix B, though?

MR. GARREN: Yes.

A It is Appendix B.

Q It is Appendix B, yes.

A So, you know, if we look at the major flows of 12:07PM



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phosphorus here, the information here was used in guiding which ones of these two considered modeling in other ways.

Q Which one on this list did you leave out?

MR. ELROD: Are we in the mass balance? 12:08PM

MR. GEORGE: I believe so.

MR. ELROD: What page?

MR. GEORGE: Page 37.

A Well, let me maybe step through these. Certainly humans were considered but primarily 12:08PM through wastewater treatment.

Q Not through septic?

A Not through septics. So, again, if we look at the population served by septics, knowing how those are performing, my professional judgment was that, 12:08PM you know, that was a source that's not going to be in the significant range in this particular case.

Q What's the significant range?

A Well, one is going to have to look at -- I'm not going to put a specific number on this, but if 12:09PM we look at the top group of these, septics is going to be less than 10 percent.

Q Was that the criteria that you used in deciding to exclude septic, was that it was less than 10 percent? 12:09PM



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A No. You -- no.
Q Dr. Engel, did you have an objective statistical criteria for including or excluding known sources of phosphorus from your modeling work?
A So, no, there was not a statistical test to do 12:09PM
that but, again, based on the mass balance performed, professional judgment, review of data, that was the process used to identify, you know, the sources to consider further and those to not consider further. 12:10PM
Q Dr. Engel, I think we established earlier that discharges from wastewater treatment plants were not included in Meagan Smith's mass balance; right?
A Well, let me be careful in answering that. So in that, the contributions from humans were 12:10PM
considered in her mass balance. The contributions from wastewater treatment are considered here.
Q Are or are not?
A Are.
Q In her mass balance analysis? 12:10PM
A Yes.
Q Okay. Where is the contribution from wastewater treatment plants in her mass balance analysis?
A Well, so wastewater treatment plants in and of 12:10PM



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themselves aren't a source of phosphorus. So you've got human waste flowing into those. That's the source of phosphorus. You've got industrial effluence and, by the way, as I recall at Springdale, a substantial part of the phosphorus 12:11PM
inflows at Springdale has been your clients, I think upwards of 80 percent. Those are the sources of phosphorus. So the wastewater treatment plant is removing some portion of that phosphorus and then discharging some remainder of that phosphorus into 12:11PM
the waters. So that's not a source. It's -- you know, if we trace this back to the sources, it's the effluent from your clients; it's the people who are discharging waste to that waste treatment plant.

Q People who flush their toilets? 12:11PM

A Yes.

Q Dr. Engel, in your modeling work, you did not limit your analysis of wastewater treatment plants to the human portion that Meagan Smith analyzed in Table 29 of her mass balance analysis, did you? 12:12PM

A I'm not sure what you're asking. I'm sorry.

Q You told me that Miss Smith's analysis in the mass balance only captures the human portion of wastewater treatment; correct?

A Correct. 12:12PM



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Q Not all the industrial portions?
A Correct.
Q In your modeling work, what did you model as a source?
A Well, the model -- to be specific, the GLEAMS 12:12PM
model modeled the non-point source components. The wastewater treatment plant portions were summed and processed with the GLEAMS output to arrive at contributions of phosphorus to the three gauging stations. 12:13PM
Q But you used all of the wastewater treatment plant discharge, not just the human part; right?
A So it was -- it would have been --
Q Is that a yes?
A Yes, it was the reported wastewater treatment 12:13PM
plant discharge.
Q Okay. Why did you not add the phosphorus load from septic tanks to your wastewater treatment plant load for purposes of your analysis?
A Well, there's -- for the purposes of my 12:13PM
analysis, the wastewater treatment plants are discharging pretty directly -- not pretty directly. They're discharging directly into the streams and rivers, so those were included. The non-point source model calculated movement of phosphorus out 12:13PM



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of fields into ditches at the edge of fields or small streams. Septic tanks function differently, and the path for phosphorus from a septic system to reach those waters is such that you're likely only to see a very small portion of the effluent from a 12:14PM
septic system reaching streams. It's more likely -- if it is going to show up, it would more likely show up in -- as a contribution in groundwater.

Q Does groundwater reach streams?

A Some groundwater does reach streams. 12:14PM

Q Okay. Let's go back to the mass balance for a second. What was the criteria that Meagan Smith used for including a source in the mass balance analysis in terms of significance?

A Well, I'm not sure that it was a criteria 12:14PM
related to significance, whether it's -- to become part of the mass balance. So the criteria was to identify the largest sources, and I guess we erred on the side of identifying some of your favorite sources in some of this as well, the golf courses 12:15PM
and nurseries and some other things. You know, when you look at those numbers, they're so small relative to poultry contribution, they're not significant. I think even you would agree with that if you were to look at those data and, you know, so we even erred 12:15PM



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on the side of including those because we knew you would want to talk about them.

Q Have we spent that much time together?

A I think we have. We know each other well.

Q Let's get back to your report for a moment. 12:15PM

We were talking about figures. Can you look at Figure 9.3 and 9.4 of your report?

MR. GARREN: What page, Counsel?

MR. GEORGE: Just a moment. 43.

A So Page 43, Figure 9.1? 12:16PM

Q Yes.

MR. GARREN: You're referencing 9.3 and 9.4 in your question.

MR. GEORGE: Oh, I did. 9.3 and 9.4, I'm sorry, so that's actually Page 45 and 46. 12:16PM

A Okay.

Q Where do these figures come from?

A As identified in the captions, the underlying data from these came from Dr. Dan Storm.

Q Now, immediately above Figure 9.3 on Page 45 12:17PM you say that Storm 2008. That's a reference to Dr. Storm; right?

A Correct.

Q Analyzed P concentration in runoff and in base flow from various sources for the watershed. Do you 12:17PM



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see that?
A Yes.
Q And then there's some what I would characterize as opinions that follow. Significant relationships were found between poultry house 12:17PM
density and phosphorus in water, and relationships between urban and developed area and phosphorus in water were not significant. Do you see that?
A Yes.
Q Did Dr. Storm express those opinions to you 12:17PM
that I just read?
A I think those were probably my opinions.
Q Okay. Did Dr. Storm create either Figure 9.3 or 9.4?
A Well, the data that was provided was used in 12:18PM
creating the figures.
Q Well, did Dr. Storm plot that data in the fashion that you have presented it here along with the statistics that are out to the right and send it
to you or did he just send you data? 12:18PM
A I believe the spreadsheet contained these specific figures.
Q Okay. Did it have the statistics as well, including the R-squareds?
A Correct. 12:18PM



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Q Did Dr. Storm ever tell you, Dr. Engel, that he interpreted this data and the relationships that are shown in these tables as significant or not significant?

A My recollection is we did discuss these, and 12:18PM he did concur with my assessment, that the relationship between poultry house density and phosphorus concentrations was significant, has an R-squared of .47 and, you know, the other relationship in Figure 9.4 between the amount of 12:19PM urban area and phosphorus concentrations in water, again, in the IRW here with an R-squared of .03, that that's not a significant relationship.

Q Okay. What threshold did Dr. Storm use in defining significance statistically? 12:19PM

A You would have to ask him.

Q Well, did he tell you that an R-squared of .473 is significant to him?

MR. GARREN: Object to form.

A Well, one can't solely look at the R-squared. 12:19PM One has to have some context and examine the data here as well, but in this particular case, you know, this is a significant relationship.

Q To you or to Dr. Storm?

A How about both of us? 12:20PM



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Q Okay. What is your threshold on an R-squared value for significance?

MR. GARREN: Object to form.

A Again, it's going to depend on the specific circumstances. 12:20PM

Q Like what?

A Well, depends on the number of data points. Depends on -- the number of data points is going to be, you know, one of the big factors to consider in this. You know, the relationship that's being 12:20PM examined is also going to go into the consideration. You know, one could do a statistical test on this if you wanted, and these will -- this one will turn out to be a significant relationship.

Q What's the statistical test that you are 12:21PM referring to that can be used to evaluate whether there's a statistically significant relationship between two variables in a dataset?

A Well, there are several that can be used but -- 12:21PM

Q What were you referring to?

A Well, the one that would often be used here would be just to determine, you know, is this slope non-zero and do a t-test to see if this is a non-zero slope. 12:21PM



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Q Okay. Did you perform a t-test on this data?
A I didn't.
Q How do you know it's statistically significant if you didn't perform a t-test?
A Based on enough experience, this is in a range this is going to be significant. 12:21PM
Q What is the output that you get from a t-test; what's the value that comes from that?
A It's the student's t-value that you then look at and compare to understand if it's -- maybe we're going down -- 12:22PM
Q What are the ranges you would get in terms of numbers out of a t-test and what do they mean?
A Been a while since I've looked at the ranges on those. The computer often looks at those and reports those, but it's been a while since I've looked at those. I'm trying to answer your question. I'm sorry. So by looking at the reported t-test value and then a comparison, you can determine is this statistically significant or not. 12:22PM
Q What's the threshold for statistical significance on a t-test?
MR. GARREN: Object to form.
A Typically with these you are using a 5 percent Alpha on these. 12:22PM



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Q So anything above 5 percent is statistically significant?
A You've got it back -- it's the other direction.
Q Anything below 5 percent? 12:23PM
A If we're communicating correctly, yeah.
Q Okay. Have you -- are you aware that Dr. Storm was deposed in this lawsuit?
A Yes.
Q Okay, and have you seen the transcript from his deposition? 12:23PM
A I did.
Q Have you talked to Dr. Storm about his deposition?
A Yes, I did. 12:23PM
Q Okay. Did Dr. Storm tell you or did you read in the transcript that he was asked about these two figures?
A I saw in the transcript that he was asked.
Q Okay, and did you see where Dr. Storm testified that he was unaware that the data he was sending you was going to be used in your expert report? 12:23PM
A I saw that.
Q Okay. Did you not think that was important to 12:23PM



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tell Dr. Storm?
A I mean, yeah, it wasn't important at the time.
Q Okay. Did you see also where Dr. Storm told me that he did not tell you whether or not these relationships were significant? 12:23PM
A I don't recall that piece of the --
Q You don't recall?
A No, I don't recall seeing that.
Q If that is his testimony, is he just suffering from a poor recollection? 12:24PM
MR. GARREN: Object to form.
A My recollection is that we did discuss these, and that was the reason he sent these, that he believed that there was a -- when he had these sent, he believed at that time that Figure 9.3 showed a 12:24PM statistically significant relationship between poultry house density and phosphorus concentrations and, you know, the other didn't show a significant relationship between urban density and phosphorus concentrations. 12:24PM
MR. GEORGE: Let's take a break.
VIDEOGRAPHER: We are now off the Record. The time is 12:24 p.m.
(Following a lunch recess at 12:24 p.m., proceedings continued on the Record at 1:39



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p.m.)

VIDEOGRAPHER: We are back on the Record. The time is 1:39 p.m.

Q Dr. Engel, did you have a chance to look for the contact information for Dr. Ji-Hong? 01:39PM

A No, I did not.

Q Did you make an effort to?

A I don't have that on any of the devices I have with me.

MR. GEORGE: Mr. Garren, will you agree to obtain that information from Dr. Engel and provide it to the defendants? 01:39PM

MR. GARREN: I will respond -- we'll consider that to be a formal request that you're making. 01:39PM

MR. GEORGE: But you can't commit today whether you'll honor that request?

MR. GARREN: I have no clue whether I can or not.

MR. GEORGE: Do you consider Dr. Ji-Hong to be a consultant for the State in this case? 01:39PM

MR. GARREN: I'm not taking a position one way or the other right now.

Q Mr. Engel, are you familiar with a model that is known as the HSPF model? 01:40PM



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A Somewhat, yes.
Q What type of model is that generally?
A It would be a watershed model, yes.
Q Similar to the SWAT model?
A Well, similar in that's it's a watershed 01:40PM
model, yes.
Q Would the HSPF model be a more sophisticated
and complex model than the GLEAMS model for a
watershed analysis?
A Probably. 01:40PM
Q Okay. Are you aware that the HS -- HFPS (sic)
model was applied to this watershed in a prior
exercise?
A Yes, and as I recall, with that model, they
attributed a significant part of the phosphorus load 01:40PM
to livestock that included poultry waste land
application.
Q Do you recall whether or not in that prior
modeling work there was a specific portion of the
load that was allocated to poultry litter? 01:41PM
A As we sit here at the moment, I don't recall
if it was split apart or not. I would have to
review that report again.
Q Okay. We talked a little bit about Dr. Storm.
Are you aware, Dr. Engel, that Dr. Storm performed a 01:41PM



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modeling exercise in 2006 and published a report for ODEQ on the Illinois River watershed?
A Yes.
Q Okay, and have you reviewed that report?
A Yes, I've seen the report. 01:41PM
Q Okay. Have you reviewed the results of Dr. Storm's model?
A I reviewed the report. So in that the results were reported within the report, I reviewed the results. 01:41PM
Q Have you reviewed anything beyond the report related to that modeling work?
A No, I have not.
Q What involvement, if any, did you have in the work that Dr. Storm completed for ODEQ? 01:42PM
A As represented in the 2006 report?
Q Let's start there.
A So I had no involvement in the specific modeling or the report generation.
Q Were you working with Dr. Storm in that time frame, 2006, on any other work for ODEQ? 01:42PM
A No, not for ODEQ.
Q Okay. Do you believe that Dr. Storm's modeling of the Illinois River watershed using SWAT and the findings he reports in terms of load sources 01:42PM



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and relative contributions are reliable and scientifically valid?

MR. GARREN: Object to form.

A So within that report, there were limitations with some of the data. So I believe he is 01:43PM continuing to do some modeling that may refine that effort.

Q As that report and the results of the modeling stands today or as reflected in June of 2006 when he published that report, did you find his work and the 01:43PM conclusions that he reached to be reliable and scientifically valid?

A Well, there were some weaknesses again with some input datasets. So in that, you know, the model reflected the use of those data and the 01:43PM assumptions, yeah, it's reliable. In that there were maybe some assumptions and some data that could be improved upon that may have bearing, you know, the model could be improved.

Q Well, does his work, as reflected in the June 01:43PM 2006 report for ODEQ, meet the standard of reliability that you've applied to your own work in this case?

A I guess I've not evaluated that particular report with respect to, you know, a reliability sort 01:44PM



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of concept, but I guess I would just say that the approach he used and many of the datasets he used were standard approaches that are widely accepted by the watershed modeling community, and so in that respect, it would meet that standard. 01:44PM

Q What particular limitations or deficiencies were you referring to in terms of some of his data?

MR. GARREN: Object to form.

A As I recall, there were several items, and I probably won't get them all in a list, so this will 01:44PM be a partial list, but one that jumped out a bit, he assumed base flow phosphorus concentrations were zero, and based on data from the IRW and based on data from the twelve or fourteen watersheds that CDM gauged during 2005 and '6 and some other datasets, 01:45PM it became quite obvious that assuming zero phosphorus in base flow in the IRW was a bad assumption. As it turned out, there was a significant relationship between phosphorus and base flow and the presence of poultry houses in these 01:45PM twelve or fourteen watersheds that were examined within the IRW.

Q How does the modeling work that you've completed in this case address the contribution of phosphorus from non-point sources during base flow? 01:46PM



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A So I guess to provide some context, let me, I guess, describe kind of the overall modeling approach that was employed here so we can see how that fits. So the GLEAMS model was used in modeling non-point source loads delivered off fields to 01:46PM ditches, small streams. Wastewater treatment plant inputs were delivered into the streams. A routing equation was derived from observed phosphorus loads and observed flows at the gauging stations at Tahlequah, Baron Fork and in Caney Creek, and that 01:46PM was used in routing loads during base flow to the respective outlets of those watersheds.

Q How does that routing process account for the contribution of phosphorus during base flow conditions from non-point sources? 01:47PM

A Well, so the phosphorus during base flow is computed based on phosphorus that's been moved by the GLEAMS model into the system but not delivered to the particular gauging stations during storm flow events, and it's also accounting for the wastewater 01:47PM treatment plants that tend to be a little more prevalent in their contribution during base flow.

Q Does the routing model separate out those two sources of contribution during base flow?

A It's not separating them. 01:48PM



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Q Okay. I guess I'm trying to come full circle back to Dr. Storm and see if you can help me understand how the deficiency that you saw in his treatment of non-point source contribution during base flow is any different from the work that you've 01:48PM done in this case.

A Well, so what differs in this case is that, you know, I used a data-driven routing approach that was based on large amounts of observed data that reflected base flow contributions correctly. 01:48PM

Q Dr. Engel, is it true that you've been paid by the lawyers that you're working for in this case to work with Dr. Storm on his SWAT modeling to improve it for the work that he's doing for ODEQ?

A I've been paid to provide some input regarding 01:49PM ways to potentially improve that modeling, yes.

Q And you understand that's a project for the benefit of ODEQ that Dr. Storm is working on?

A I assume it's ODEQ. I'm not -- I don't recall which state agency specifically but -- 01:49PM

Q Do you have any idea why the lawyers would be paying you to work for -- with Dr. Storm on a project for ODEQ?

A Well, the involvement has been rather small. The involvement has been providing guidance on some 01:49PM



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better datasets that might be available that he might access and take advantage of, and that's been the -- kind of the extent of the effort.

Q Do you feel like you've answered my question?

A Repeat the question I guess. 01:50PM

Q Sure. Can you help me understand why the lawyers involved in this case would be paying you to work with Dr. Storm on a project for ODEQ?

MR. GARREN: Object to form.

Q Do you know? 01:50PM

A Well, I can make assumptions. If you want me to speculate, I can speculate.

Q If you have a theory, I'd like to hear it.

A Well, I think the goal here is to, you know, best model the IRW as one can, given the resources 01:50PM and data that are available, and best understand the potential contributors to the phosphorus problem, and so if, you know, it's possible to improve the modeling effort in order to predict the phosphorus loads to the lake, then, you know, that would seem 01:51PM to be an appropriate goal.

Q But haven't you already figured that out, Dr. Engel, with your work using GLEAMS and the routing model?

A I guess I would point out that, you know, and 01:51PM



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you've pointed this out as well, that there have been multiple modeling studies, among other kinds of studies, of the IRW and, you know, I think virtually every one of those studies has reached the same conclusions regarding phosphorus contributions, you 01:51PM
know, poultry is a significant contributor to the phosphorus concentrations, to the gauging stations and to Lake Tenkiller and, you know, and, therefore, you know, if we can have multiple lines of evidence that are all saying the same thing, and for all 01:52PM
intents and purposes these are, poultry is a significant contributor of phosphorus, you know, that just again provides evidence regarding, you know, the appropriate kinds of actions that may be needed to address the phosphorus issue. 01:52PM

Q I think I've already asked this question but at the risk of being repetitive, I'll do it again. Can you point me to a single other study, Dr. Engel, where a scientist other than you looking at the Illinois River watershed has come to the conclusion 01:52PM
that poultry litter accounts for either 45 percent or 56 percent of the annual load of phosphorus --

MR. GARREN: Object to form.

Q -- to Lake Tenkiller?

MR. GARREN: I'm sorry. Object to the 01:52PM



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form.
A If we look in my Chapter 2, we can look at various studies that attribute loads to various sources. They quantify those sometimes with specific percentages. Sometimes they leave 01:53PM
livestock grouped together as a percentage, and when they do, they talk about poultry as being a significant contributor. So they may not take the step in identifying a specific percentage, but they conclude poultry is a significant contributor. 01:53PM
Q I'm going to ask that the question be reread and ask, Dr. Engel, if you can, to give me a yes or no answer to the question.
(Whereupon, the court reporter read back the previous question.) 01:54PM
MR. GARREN: Same objection.
A Okay. So let me try to respond again. So, no, others have not identified those exact percentages, but others have identified poultry as a significant contributor, so they just didn't happen 01:54PM
to match the exact numbers that you read.
Q Okay. It's your opinion then this case goes beyond just poultry as a significant contributor; do you agree?
MR. GARREN: Object to the form. 01:54PM



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Q That you've tried to quantify; right?
MR. GARREN: Same, object to form.
A Certainly wastewater treatment has been a significant contributor. You know, much of that problem has been reduced since 2003. You know, the 01:54PM
largest contributor that remains is poultry. So, you know, it's kind of logical that that's a next step to take in trying to address water quality issues in this watershed.
Q Move to strike, non-responsive. Let me hand 01:55PM
you Exhibit 6, which, Dr. Engel, is an E-mail chain involving, among others, yourself and David Page dating back to late July of 2005. Take a minute and look at that and see if you can recall the conversation that was being had. 01:55PM
A Okay. Yeah, I seem to recall at least some of this. It's been awhile.
Q Okay. So, Dr. Engel, you were a retained consultant in this case at least back as of late July of 2005; correct? 01:56PM
MR. GARREN: Object as to form.
A It looks as per this E-mail, that would be the time.
Q Okay, and what is the subject of this E-mail chain that I've marked as Exhibit 6? 01:56PM



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A So I guess that's starting on the third page of this. Looks like it is IRW SWAT modeling.
Q Okay, and do you see on that same page in the July 29 E-mail to yourself and Dr. Storm from David Page where Mr. Page says our plan is for Bernie; 01:56PM
that's you; right?
A Yes.
Q Our plan is for Bernie and his assistants to use Dan's model as a start point. Bernie would take the lead and develop with Dan's support. Do you see 01:57PM
that?
A Yes.
Q Do you recall that being discussed early on in connection with this litigation, that the SWAT model would be used in this case? 01:57PM
A Well, I think, yes, there were certainly some early discussions about the potential for doing that.
Q And was it also the plan back in July of 2005 that you would work with Dr. Storm in modeling this 01:57PM
watershed?
A That was one of the options that was on the table for consideration.
Q Why did you decide against using the SWAT model for this particular project in this lawsuit, 01:57PM



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Dr. Engel?
A Well, ultimately Dr. Storm was going to continue to use the SWAT model on this watershed for another purpose and I guess, as I understand it at this time, maybe for purposes of a TMDL. So given 01:57PM
that he was going down that path using that approach for that purpose, you know, that was fine, and as we step back from this a bit and took a look and began to frame the questions and the issues that we needed to be responsive to with the model, the goals maybe 01:58PM
of the modeling became more focused and became clearer with time. My decision -- my professional judgment was that we could use a technique that was more data driven and simpler and, you know, that that approach would certainly be an appropriate 01:58PM
technique for the stated goals of the modeling effort.
Q What were the stated goals of the modeling effort?
A Well, I think we can probably find those back 01:59PM
in Appendix D, I believe. It looks like on Page D-38 maybe they're spelled out a little bit clearer.
Q Point me to the particular language.
A So I guess about midway down on Page D-38 there's a sentence that begins the specific 01:59PM



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objectives of the modeling effort were to, one, quantify P loads to the three gauging station locations on streams and rivers closest to Lake Tenkiller and in parens, Tahlequah, Baron Fork near Eldon and Caney Creek, for the following and there 02:00PM
were I guess A, B and C subitems here. So there was historical conditions from '50 through '99 period that we wanted to do that on. There was a background scenario with background soil phosphorus and no poultry waste application, so no poultry 02:00PM
waste ever applied in the IRW as a scenario, and there was a group of future scenarios that included continued poultry waste application to pastures, cessation of poultry waste application, growth in the IRW poultry numbers and corresponding waste 02:00PM
application, cessation of poultry waste application combined with buffers along streams, and then the second, I guess, objective here would be -- was to allocate P loads, the most significant sources for current kinds of conditions. 02:01PM

Q Thank you, Dr. Engel. With respect to those objectives for the modeling effort, which of those objectives is it more appropriate in your view to use the GLEAMS model over the SWAT model for?

MR. GARREN: Object to form. 02:01PM



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A This is not an either/or kind of modeling choice. As you pointed out, HSPF was a model that's been used here, and, you know, there's a variety of models that would be suitable and appropriate to apply in addressing these questions or other 02:01PM questions. So my choice ultimately was to use the GLEAMS model combined with a routing technique based on observed flow data.

Q Well, Dr. Engel, did you endeavor to choose the model that was most suitable for the exercise? 02:02PM

A The model I chose was certainly suitable for this exercise.

Q Well, was it the most suitable model for this exercise?

MR. GARREN: Object to the form. 02:02PM

A In my opinion it was the most suitable.

Q Okay. So what is it about GLEAMS that you believe makes it more suitable than SWAT or other watershed scale models for the objectives set out for the modeling exercise on Page D-38 of your 02:02PM opinion?

A And some of that is discussed within the report, but there would be several factors, and if I miss some, there's probably others described in the report here. So, one, we were looking for something 02:03PM



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that was relatively simple. You know, a general principle in modeling is use the simplest tool that will get the job done. You know, often there's a misperception that using a more complex model will provide a better result. Well, you know, the 02:03PM
literature has proven that that's not necessarily the case and typically not the case. So, you know, one wants to use a fairly simple model if it will meet the -- if it will allow one to meet the goals of the modeling project. One has to look at the 02:03PM
available data and factor into that decision making the kinds of data that are available, what additional data might be required, what are the important processes within a watershed to capture with this modeling effort and, you know, based on my 02:04PM
consideration of these factors, among others that are described here in the report, you know, the choice was to go with GLEAMS because we could represent management with it fairly well. You know, as it turns out, the nutrient components in GLEAMS 02:04PM
are the same nutrient components in SWAT and a number of other models of this type. So, you know, there are often -- in often cases the models are related, so one can pick one that's going to serve the purpose that maintains the simplicity that 02:04PM



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allows one to meet the goals and you're going to have equally good results. So the scientific literature has shown this over and over. You know, it's well accepted in the modeling community that one does this. 02:05PM

Q Do you agree, Dr. Engel, that one factor that should be considered -- strike that. Do you agree, Dr. Engel, that different models are designed to answer different questions?

A Yes, I would agree with that. 02:05PM

Q Okay. What is the, at its most basic contours, question that GLEAMS is designed to answer as a field scale model?

A Well, so GLEAMS is answering questions about hydrology and contaminant movement, but let me point 02:05PM out that, you know, I didn't use GLEAMS in isolation here, that the modeling system employed had GLEAMS as one component. You know, there were other components in that modeling system that took care of other processes that are important here. 02:06PM

Q Okay. Let's -- we'll talk about all aspects of the modeling system but let's stay with GLEAMS for a moment. Do you agree with me that GLEAMS is designed to answer the question how much phosphorus can be contributed from a field to the edge of the 02:06PM



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field?
A That's a question that GLEAMS can answer.
Q Okay. GLEAMS itself, you'll agree with me, is not designed to answer the question of how much phosphorus from a field reaches a reservoir; is that 02:06PM right?
A GLEAMS by itself could be used to do that. In this particular case because of the importance of transport, the characteristics of this watershed, we added a routing component to that. GLEAMS, combined 02:07PM with that routing component, is similar to approaches employed by SWAT and by other models. You know, these are techniques that are found throughout the literature in modeling studies. I mean, they're well accepted. They're routinely 02:07PM used, commonly employed. This was not unique.
Q How can GLEAMS be used to estimate the amount of phosphorus from a field that reaches a reservoir?
MR. GARREN: Object to form.
A Well, if we want to talk hypothetically about 02:07PM how that can happen, we can certainly do that.
Q Let me do this. In this watershed.
MR. GARREN: Object to form.
A In the IRW, because of the size of the IRW, because of other processes in combining phosphorus 02:08PM



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or the need to combine phosphorus with phosphorus discharge from wastewater treatment plants, you know, one needs to worry about routing and so, again, GLEAMS was combined with routing equations. This technique is similar to what's employed in SWAT 02:08PM and other watershed models where you model phosphorus identically to what was done with GLEAMS and then you employ routing techniques to move that to the reservoir.

Q How many acres of land comprise the Illinois 02:08PM River watershed?

A My recollection is that it's a little over a million acres.

Q Dr. Engel, have you used GLEAMS in the past in other modeling projects? 02:08PM

A Yes.

Q Okay. Prior to this litigation, what was the largest number of acres to which you have applied GLEAMS in a peer-reviewed published modeling report?

A The state of Indiana. So the state of Indiana 02:09PM is substantially more than the million acres.

Q You applied GLEAMS to the entire state of Indiana?

A Yes.

Q What was that project about? 02:09PM



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A Oh, there have been several efforts. Probably the most recent would be a paper with probably -- Mark Thomas is first author if you're looking, and that effort was in evaluating the impacts of the government USDA EQIP, E-Q-I-P, Environmental Quality 02:09PM Incentives Program, so it's a program that targets a variety of practices for non-source point source pollution control and, you know, we were doing some evaluation in the state of Indiana to understand how effective those programs might have been. So that's 02:10PM one example. There's several others.

Q Well, Dr. Engel, in that work, did you model with GLEAMS the losses of phosphorus from all fields in the state of Indiana?

A Let's see. So I believe we modeled -- I 02:10PM believe we did, and beyond that then we modeled specifically locations for which some of these best management practices had been targeted and, as I recall, then if one takes the difference between modeling everything and then the modeling of the 02:11PM best management practice locations, I think we use that information to identify the benefits of that group of best management practices that have been applied.

Q Were you using GLEAMS in that project to 02:11PM



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estimate the amount of phosphorus that's reaching a reservoir in the state of Indiana?

A Well, in that particular case, you know, the goal was not to route things to specific reservoirs. Again, as I recall, without looking at that paper again, we were looking at regions of the state. We were looking at maybe eight-digit hydrologic unit areas. You know, those are big areas, as big as or bigger than the IRW. 02:11PM

Q Were you using GLEAMS to predict the amount of phosphoruses -- I'm sorry, phosphorus that reaches a particular water body in those HRUs? 02:11PM

A So GLEAMS was used to predict the amount of phosphorus that one would anticipate would ultimately reach waters leaving those eight-digit hydrologic water unit areas. 02:12PM

Q What was the receiving water body?

A There were numerous receiving water bodies. So it was in the waters in the state of Indiana.

Q Do you consider that project to be a watershed modeling exercise, Dr. Engel? 02:12PM

A There were watershed modeling components in that certainly.

Q Well, was it a project that was analogous to your work in this case? 02:12PM



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A There would certainly be similarities.
Q Were you allocating phosphorus losses to any particular source?
A We were -- I'm not sure that we were allocating to them to specific sources. It was kind of the flip side of that. It was allocating reductions in phosphorus loads to specific sites, to specific locations based on where best management practices has been applied, and there may have been some runs within that that were also done that, you 02:13PM
know, did look at a broader scale application of a variety of best management practices.
Q And I apologize, Dr. Engel. I know I have seen the Indiana project that you are referring to but I can't find it in my materials so we may get to 02:13PM
save that for tomorrow. I'll have to find it in my hotel room this evening. Let me hand you what I've marked as Exhibit 7, which for the Record is a paper which you co-authored with a Mr. Thomas, among others, entitled Modeling the Average Annual 02:14PM
Nutrient Losses of Two Watersheds in Indiana Using GLEAMS. Are you familiar with this paper?
A Yes.
Q Okay. Is this related to the work that you were just describing? 02:14PM



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A This is actually a different effort. So I could describe this effort if you would like.
Q Let's get some basics down first. This paper was published in 2005; is that right?
A Yes. 02:14PM
Q Okay. Now, Dr. Engel, in this particular published modeling exercise, what watersheds were you applying GLEAMS to?
A As I recall, let me look here to make sure I get this exactly right. So these were two 02:14PM watersheds within Black Creek called Driesbach and Smith-Fry.
Q And how large are those two watersheds in acres, if you could?
A Do you see -- 02:15PM
Q Look at Page 1741 perhaps.
A Oh, in the text. Sorry. Okay. So Smith-Fry is 2,327.7 acres and Driesbach is 1,764.3 acres.
Q And, Dr. Engel, were you using GLEAMS on these two watersheds to estimate the relative contribution 02:16PM of various sources or land uses in the study area?
A Let me refresh my memory here.
Q Look perhaps at Table 2 on Page 1741.
A Yes. So certainly, you know, land uses were split into the land use categories you see in Table 02:17PM



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2. What I'm trying to recall, without looking back here in the results a bit more, you know, is there a table that allocates things back to these. So certainly the model was run and one could have allocated nutrient losses in runoff and the other 02:17PM things that were modeled to these. I just don't recall without more carefully looking at this if that were done.

Q Okay. You'll agree with me, will you not, Dr. Engel, that the Smith-Fry watershed and the 02:17PM Driesbach watershed are considerably smaller than the Illinois River watershed?

A Yes, they would be smaller.

Q Okay. Dr. Engel, can you point me to any peer-reviewed article or paper in which a scientist 02:17PM has used GLEAMS to determine the relative contribution of various sources of phosphorus to streams, rivers or lakes in a watershed as large and as complex as the Illinois River watershed?

MR. GARREN: Object to form. 02:18PM

A There's certainly a number of papers out there, so this is a bit of a memory test here. As I recall, there's a paper that used either GLEAMS or CREAMS, which was a predecessor to GLEAMS, in something very similar for the Lake Okeechobee 02:18PM



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watershed.
Q Was the goal of that modeling exercise to allocate relative contribution of phosphorus to different sources in the Okeechobee watershed?
A Without looking at that paper specifically, 02:19PM
you know, I'm not sure without looking at that paper specifically, but this concept of using models to identify sources, allocate sources is not uncommon. You know, GLEAMS has been used to do that. Other models have been used to do that. You know, other 02:19PM
models that use the key components out of GLEAMS, SWAT, have been used to do that. You know, the key components in GLEAMS for the nutrient components are the same components in SWAT. They're the same components in EPIC. So there are a number of models 02:19PM
that people use routinely to do these kinds of things. The underlying science is the same in these. In fact, the underlying equations is often the same in these, and so it's routine practice to use models to identify constituent loads from 02:20PM
various pollutants, whether it be phosphorus or nutrients or other nutrients or pesticides, and then I, you know, allocate them, do other analyses with them.
Q Dr. Engel, my question wasn't about models 02:20PM



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generally. It was about the GLEAMS model. So let me try it again, and I recognize your answer is only as good as your memory right now, but as we sit here today, Dr. Engel, can you identify for me a single peer-reviewed article or paper in which a scientist 02:20PM has used GLEAMS, not another model, GLEAMS, to determine the relative contribution of various sources of phosphorus to streams, rivers or lakes in a watershed as large and complex as the Illinois River watershed? 02:21PM

MR. GARREN: Object to form.

A The premise of the question here is flawed. So you're assuming that because I can't point out one where someone has done that with GLEAMS, that that's an inappropriate technique and, again, there 02:21PM are numerous models that have been used to do this. Components out of GLEAMS are in those models and, you know, if we find the paper I'm thinking about for Lake Okeechobee, it's either GLEAMS or its predecessor that was used to do exactly that or 02:21PM something very similar. You know, here you provided me a paper where we essentially did that with a smaller watershed. You know, the only thing that differs is -- well, there are a couple of things that differ. So the data inputs to the model differ 02:21PM



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to represent the IRW. It was necessary in the IRW, because it was bigger, that we consider routing. We didn't have to consider routing for the time scales that were employed here, so that wasn't necessary. So, you know, this is a valid technique. This is 02:22PM well accepted by the scientific community.

Q Move to strike, non-responsive. Dr. Engel, you're going to have plenty of opportunities to defend your approach. I want an answer to my question. So I'm going to ask Lisa to go back to 02:22PM where that last question was and reread it and ask you if you can answer it directly.

(Whereupon, the court reporter read back the previous question.)

MR. GARREN: Same objection. 02:23PM

A And, again, my recollection is that there are one or two papers from Florida for Lake Okeechobee or that region that do something identical or similar.

Q Those are the only ones you can recall? 02:23PM

A Well, there certainly are potentially others that I'm not recalling at the moment.

Q Dr. Engel, do you agree that GLEAMS is an agricultural land use model which is not designed or intended to simulate runoff from developed urban 02:23PM



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areas?

MR. GARREN: Object to form.

A I would disagree with that statement.

Q Okay. What algorithms, soil types, vegetation or ground cover present in GLEAMS resemble developed 02:24PM or urban areas?

MR. GARREN: Object as to form.

A Well, one has to look underneath the model hood, if you will, just a little bit, and GLEAMS employs partially the curve number method for 02:24PM hydrology, and that's a technique widely used in other models for representation of runoff from a broad suite of land uses, including urban.

Q There are various curve numbers available to the modeler to choose from depending upon land use 02:24PM within GLEAMS; correct?

A Correct.

Q Is there a curve number that the designers and creators of GLEAMS have identified for urban and developed land use, including impervious areas? 02:24PM

A I would have to look at the manual but, you know, it wouldn't be the GLEAMS modelers that would identify curve numbers for that use. So we need to step back from this just a bit because, you know, the curve number method is a method commonly 02:25PM



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employed in many watershed models, and curve number of values, the tables that have what you're asking about, typically are independent of those models, although sometimes in the model documentation, people will republish those, and if you trace this 02:25PM back to the original USDA sources, you'll find tables with curve numbers for a range of land uses, including urban.

Q Okay. Are there any curve numbers within GLEAMS that are represented as urban land use? 02:25PM

A One can certainly represent urban land uses within GLEAMS.

Q Does the code itself and the choices that are set up within the model identify any of the runoff curves or soil types available within GLEAMS as 02:26PM urban land use?

A That's not the way the model works.

Q Isn't it true that the reason those are not there is that GLEAMS is an agricultural field scale model? 02:26PM

A Well, the curve numbers are placed in input files to the model. So the curve numbers you're talking about aren't implicitly or aren't explicitly built into the model. Those values are picked up in input files to the model that describe the land use. 02:26PM



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So like other models that use the curve number, those numbers aren't built into the model. They're part of the inputs.

Q What input values did you use in your modeling exercise with GLEAMS to represent and depict the conditions that are present in urban and developed areas? 02:27PM

A We would need to look at the underlying calibrated input files to see what that range of values might have been. 02:27PM

Q What about what soil type; do you know what soil type you used for urban areas?

A Well, the soil types that were used came from STATSGO. So the STATSGO soil properties were used as inputs. 02:27PM

Q What kind of land cover did you assume was present in urban areas for purposes of your modeling work for GLEAMS?

A Well, you know, the land cover would have represented, you know, housing and urban kinds of conditions. 02:27PM

Q Is that an option that's available within GLEAMS?

A One can describe that within GLEAMS.

Q Did you describe that within GLEAMS? 02:28PM



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A Yes, it was described.
Q How so?
A Well, again, within the model input files, there are a number of parameters that the modeler describes, and so one can describe a broad range of 02:28PM
land uses and covers using, you know, the available inputs that can be used to represent any number of land use conditions.
Q Have you examined the input files to see how -- what type of data was used to represent urban 02:28PM
areas?
A I've looked at those, yes.
Q Okay, and you have no recollection of what those input data were?
A Without refreshing my memory by looking at 02:28PM
those and, you know, again, there are hundreds, if not thousands, of those files one would need to look at to be fully responsive to what you are asking.
Q Who made the decision between those various input values that were available to represent urban 02:29PM
areas, you or Dr. Ji-Hong?
A I -- well, Dr. Ji-Hong routinely consulted with me, and we had a routine discussions that you would typically have in a project like this in picking out the particular ranges of values that 02:29PM



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might be used and by identifying the input data sources. In fact, the majority of the input data sources came from me. You know, we worked together and then making sure that, you know, those got represented in the input files and, you know, then 02:29PM
he did the modeling with consultation from me.
Q Do you recall, Dr. Engel, specifically discussing with Dr. Ji-Hong the input files and data sources for urban areas that were to be used in the GLEAMS modeling? 02:30PM
A I do, but I don't recall specific values we talked about. You know, so again without consulting these hundreds or thousands of files, you know, it would be tough for me to tell you what those specific values were as we sit here. 02:30PM
Q Dr. Engel, did you tell Dr. Ji-Hong to specify alfalfa hay as the crop that is grown in urban and developed areas in the GLEAMS model?
A We would not have described it as alfalfa hay.
Q If we examine your input files for urban areas 02:30PM
and discover that the model was configured to specify alfalfa hay as a crop being grown in all of the urban areas, is that a mistake?
A I would be surprised if that's what it indicated. 02:31PM



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Q You would agree with me, would you not, that the conditions present on an alfalfa hay field are not representative of typical urban areas?
A Well, realize that --
Q First of all, do you agree with what I said? 02:31PM
A I'm sorry, could you repeat the question?
Q Sure. You agree with me, do you not, Dr. Engel, that the conditions present on an alfalfa hay pasture are not representative of urban areas?
A Yeah, an urban area would be different than an 02:31PM
alfalfa hay pasture.
Q Okay. Now you were about to say something. If you can recall it, you are welcome to.
A You know, again, just because something may be
labeled alfalfa hay or that may have served as a 02:31PM
starting point in describing a particular land use, that doesn't mean that label is correct. It may not have been modified in the input files. Nor does it mean that the other representations that ultimately
were arrived at don't represent urban. 02:32PM
Q You're aware, are you not, that GLEAMS has some default values for alfalfa hay as a land cover that is available for representation in the model?
MR. GARREN: Object to form.
A Yes, the model has some defaults. 02:32PM



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Q Okay. So are you speculating that if the input files contain alfalfa hay as the description for ground cover in urban areas, that Dr. Ji-Hong must have just labeled it alfalfa hay but it really is concrete or sidewalks? 02:32PM

MR. GARREN: Object to form.

A My recollection is that Dr. Ji-Hong picked up a group of input files, some of which came with the model but had, you know, a starting template for describing the inputs to the model, and some of 02:33PM those starting templates, as I recall, even talk about broiler waste application in Georgia. So, you know, I think he picked those up from Georgia, used those to modify to represent pasture, for example, and so, again, you know, as those files were edited, 02:33PM they were edited to represent conditions for the land uses that were modeled.

Q Who edited them?

A Well, it would have been potentially two sources. So Dr. Ji-Hong, under my direction, would 02:33PM have edited those initially to get these things described, and then, you know, as we talked about earlier in the day, some group of those inputs would have been available to the calibration code that was doing the calibrating to adjust those to reflect the 02:34PM



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conditions specific to that land use.
Q Dr. Engel, would it surprise you to hear that there are lawn care companies in northwest Arkansas who get paid to fertilize lawns in these highly developed urban areas in the watershed? 02:34PM
A No, that wouldn't surprise me.
Q Okay. You've lived in a city. You understand that goes on; right?
A Yes.
Q In your modeling work with GLEAMS in this 02:34PM case, did you apply a commercial fertilizer to any of the urban areas?
A I don't recall at this point, again, without digging through all the code to see if it was specifically applied. 02:34PM
Q Should you have applied commercial fertilizer to urban areas?
A Well, it depends on the type of urban areas as to whether that would be necessary. You know, again, if we step back a bit, this calibration 02:35PM process in which we're getting the model to match the observed phosphorus loads is also taking care of some of that. So during calibration, you might find out that the calibration suggests that some of these things be turned off, some of these things be 02:35PM



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increased, others decreased as part of the calibration process.

Q Did you make any changes to the way in which you treated commercial fertilizer in urban areas as a result of your calibration process? 02:35PM

A Again, without, you know, looking at hundreds, if not thousands, of specific files, you know, I would have to look at those to tell you for sure.

Q Do you agree with me, Dr. Engel, that if the goal of the exercise is to realistically simulate 02:36PM the environmental conditions in the Illinois River watershed, that you would need to apply in your model commercial fertilizer to urban areas?

MR. GARREN: Object to form.

A Well, that's assuming a couple of things that 02:36PM are not necessarily correct. So, you know, the goal here was to identify the significant contributors, and based on my experience, you know, even though you're going to tell me that, you know, urban has been growing at a great pace in that part of the 02:36PM state, in that part of the watershed, and you're going to tell me that it's, what, 10 percent of the land use within the IRW, that still represents a fairly small part of the overall phosphorus that reaches Lake Tenkiller. 02:36PM



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Q How do you know that if you haven't modeled it?
A I've certainly modeled phosphorus losses from a variety of urban landscapes, including that region and including in the modeling reported here, and the 02:37PM
urban contribution is -- you know, it's nowhere near the level of poultry. You know, all these other reports that we've talked about, these other modeling efforts, everyone says it's livestock; it's poultry being a significant part of that. You know, 02:37PM
the urban is just not that big at this point.
Q Dr. Engel, if you are relying upon the statements in prior reports as to what sources are significant and which ones are not, why did you even bother to run your model? 02:37PM
A Well, you know, certainly it was confirmation of what others found. So, you know, maybe in retrospect, it wouldn't have been necessary. So there are a number of reports. They all conclude this. Federal and state governments conclude the 02:38PM
same thing. USGS has consistently identified phosphorus as increasing in this watershed and attributes that to poultry. Their analysis says, gee, we see these trends of increasing urban; we can't find a statistical relationship between that 02:38PM



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increasing urban in this region and the phosphorus loads. Gee, we see increasing fertilizer sales; we can't find a statistical relationship between fertilizer sales and increasing phosphorus loads in water, but we can find a statistically significant 02:38PM relationship between increases in livestock production, that include poultry land waste application, and increases in phosphorus loads in water. That's from this region.

Q What study are you referring to, Dr. Engel? 02:39PM

A There's several USGS reports, and I believe the one that has some of that specifically is one that was issued in June of 2008. There were several prior to that that were specific to the IRW that looked at these trends, had similar findings. 02:39PM There's some that go back to analysis of data in the '80s that do the same. You know, at the end of the day, you know, this isn't real complex. You know, a lot of phosphorus from poultry going out on the landscape. It runs downhill. It shows up at the 02:39PM lake.

Q Move to strike, non-responsive. Can you identify for me the study by USGS, Dr. Engel, that you believe and have represented shows a -- the absence of a statistically significant relationship 02:40PM



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between urban development and phosphorus concentrations?

MR. GARREN: Object to form.

A Yes. It's a USGS report I believe issued in June of 2008, something about trends in nutrients and sediments within the south central region. 02:40PM

Q Dr. Engel, that's not a report that's specific to the Illinois River watershed, is it?

A It includes the Illinois River watershed.

Q Does it provide any separate analysis of the Illinois River watershed? 02:40PM

A It does.

Q Okay, and in their separate analysis in the Illinois River watershed is it your representation that the USGS concluded that there is not a relationship between urban development and phosphorus concentration in receiving waters? 02:40PM

A That analysis was not done for specific watersheds, so it was not done for the IRW. It was done for this region of which the IRW was located in. 02:41PM

MR. GEORGE: Let's take a break and change the tape.

VIDEOGRAPHER: We're now off the Record. The time is 2:41 p.m. 02:41PM



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(Following a short recess at 2:41 p.m., proceedings continued on the Record at 2:54 p.m.)

VIDEOGRAPHER: We are back on the Record. The time is 2:54 p.m.

Q Dr. Engel, before settling upon or even after settling upon GLEAMS as the field scale model of choice for this case, did you happen to check to see what EPA had to say about the limitations of GLEAMS and the circumstances in which it should and should not be used? 02:54PM

A I guess I'm not familiar with what EPA said, so --

Q Okay. So you're not aware of any comment by the EPA on GLEAMS and the circumstances under which it should be used? 02:54PM

A Looks like you're holding a document. I'm not sure I've seen that document, so -- is the document related to the GLEAMS and other models?

Q I'm just wondering if you're aware of any comment by the EPA on the appropriate use of GLEAMS before we talk about -- 02:55PM

A The document, okay. I guess not specifically from EPA. I've seen a variety of papers and other materials that talk about potential application of models under various circumstances. 02:55PM



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Q I'm going to hand you what we've marked as Exhibit No. 8, which for the Record is an EPA document, which is marked draft, that is dated August of 2008 entitled Guidance on the Development, Evaluation and Application of Environmental Models. 02:55PM
Have you seen this document before, Dr. Engel?
A Let me look quickly here to see.
MR. GARREN: Can you identify the source of this document?
MR. GEORGE: EPA. 02:56PM
MR. GARREN: That was smart. Did you get it online; do you know?
MR. GEORGE: (Shakes head from side to side).
A To my knowledge, I've not seen this. 02:56PM
MR. GEORGE: By the way, let the Record reflect that the entire document, if you download it, is far larger than what I put in front of Dr. Engel because it would run about 400 pages.
MR. GARREN: Did you just take out the good parts or what? 02:56PM
MR. GEORGE: No, sir. I took out the parts I wanted to ask about that I thought were necessary for the context of the questions.
Q Are you familiar with the Office of Science 02:57PM



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Advisor, United States Environmental Protection Agency, Dr. Engel?

A I'm aware that office exists.

Q What's your understanding of that office and its role? 02:57PM

A It provides advice to EPA regarding matters of environmental science.

Q Okay. Turn to Page 1 of the document, which after you get past the table of contents is a few pages back in, under the heading introduction. Do 02:57PM you see the paragraph that begins with as models? It's about a little more than halfway in, a paragraph that describes --

A As models.

MR. GEORGE: I apologize, Lisa. 02:58PM

Q Could you read that paragraph into the Record, please, that describes the purpose and scope of this document, slowly.

A Slowly, okay. As models become increasingly significant in decision making, it is important that 02:58PM model development and application processes conform to appropriate protocols or standards that help ensure the utility, scientific soundness and defensibilities of models and their outputs for decision making. It's also increasingly important 02:58PM



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to plan and manage the process of using models to inform decision making, in parens, Manno, et al, 2008. The guidance document, hereon referred to as guidance, aims to facilitate a widespread understanding of models and, thereby, promote their 02:58PM
appropriate application to support informed decision making. The principles and practices described in the guidance are intended to be generally applicable to all models used to inform agency decisions, regardless of domain, mode, conceptual basis or form 02:59PM
or level of rigor, in parens, i.e., varying from screening level applications to complex analyses, cited US EPA 2001. While the guidance includes discussion of the links between the modeling and decision processes, many of the recommendations 02:59PM
apply equally to non-regulatory modeling projects.

Q Dr. Engel, do you agree that it's important that model development and application processes conform to appropriate protocols or standards that help ensure the utility, scientific soundness and 03:00PM
defensibility of models and their outputs for decision making?

MR. GARREN: Object to form.

A Yes, it's important that models follow accepted protocols and processes. 03:00PM



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Q Turn to the appendix and, Dr. Engel, I'll represent to you that Appendix A to this document has what is called model fact sheets, a lot of different types of models that apparently are used in the environmental setting I've attached to this 03:00PM exhibit to the Appendix A to the EPA guidance documents for the GLEAMS model.

MR. GARREN: Again, this is out of context with regard to the entire document since you've skipped some 200 pages? 03:01PM

MR. GEORGE: There's more to this document than I have attached to the Record, that is for sure.

Q Are you there, Dr. Engel?

A I think I'm here. 03:01PM

Q Okay. Do you see the contact information that is listed for EPA's model fact sheet on GLEAMS? It's at the very top of the page.

A Yes.

Q And are you familiar with Frank Davis from the 03:01PM Southeast Watershed Research Laboratory?

A I am.

Q And who is Frank Davis?

A Frank is the maintainer of this model and potentially some other models as well. 03:01PM



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Q Put it in terms as I understand it, would it be fair to say he's the creator of GLEAMS?
A He's the programmer. He's not the lead scientist behind this.
Q Okay. Is he an individual who a significant 03:01PM
portion of his day-to-day life is devoted to maintaining GLEAMS?
A It's -- I wouldn't know that it's a significant part of his day-to-day activity. You
know, he's the person that does the programming 03:02PM
associated with GLEAMS.
Q Okay. When you downloaded the programming for GLEAMS, did you download it through Mr. Davis' Southeast Watershed Research Laboratory?
A We've been working with GLEAMS for more than 03:02PM
20 years. So it probably would be -- initially did not come from this site. We were probably working with the model before websites existed. So we would have gotten via other means initially. We've stayed
up to date with it over time. 03:02PM
Q Where do you get your updates from?
A It would have been this laboratory. So whether it was this specific site, I couldn't tell you for sure.
Q Okay. In the model fact sheet for GLEAMS 03:03PM



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that's attached to EPA's guidance document, do you see that GLEAMS is described in this paragraph that says model overview as a field scale model that assumes that a field has a homogeneous land use, soils and precipitation; do you see that? 03:03PM

A Yes, I do.

Q Do you agree with that description of GLEAMS?

A That's the assumption that one would often make with GLEAMS.

Q Are the actual fields in the Illinois River watershed homogeneous? 03:03PM

MR. GARREN: Object to the form.

A So there's potentially variability in actual fields within the IRW. That doesn't preclude representing those fields within GLEAMS or other models that use the same components as GLEAMS. 03:04PM

Q If you are going to represent them differently to account for the variability in actual field conditions, do you have to classify certain fields, group them together for analysis in GLEAMS? 03:04PM

A Well, typically with GLEAMS or most other models for that matter, you're grouping like kinds of things together at various levels, and it certainly is appropriate to group like kinds of things together using STATSGO soil units and land 03:04PM



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use maps. So in that case you're not going to represent absolutely every little bit of variability. That's not necessary in trying to understand the questions that we were addressing.

Q Okay. How many fields did you have or groupings, however you want to define it, in your simulation of the Illinois River watershed using GLEAMS? 03:05PM

A I believe the number of hydrologic response units was 21 for the Illinois River at Tahlequah, 20 at Baron Fork and 9 on Caney Creek. 03:05PM

Q Okay. So how many actual fields are there, separate parcels of land in the Illinois River watershed?

MR. GARREN: Object to form. 03:05PM

A I'm not sure of the number of actual fields, and for the modeling I was doing, it wasn't necessary to know the number of actual fields.

Q Do you see in the Appendix A, model fact sheet, that there's a description of the model areas supported by the GLEAMS model? 03:06PM

A Okay.

Q And beside watershed, what is the level of support that is identified for the GLEAMS model?

A So it looks like in this document it indicates 03:06PM



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low, and the reason it would indicate low, this assumes application of the GLEAMS model by itself without any other modeling capabilities wrapped around it. So, again, if we get back to the IRW, the GLEAMS model wasn't applied independently by 03:07PM itself. There was an additional model to take care of the processes that are important at the watershed scale, the routing of that phosphorus to the gauging stations that ultimately reaches Tenkiller, and so, you know, representing that the support level for a 03:07PM watershed would be low, while accurate as described here, is inaccurate in the way that I happened to apply this.

Q Okay. The only other model that you wrapped around GLEAMS, to borrow your term, was your routing 03:07PM model; correct?

A Oh, is that entirely accurate? So let me think about that a moment. So there was processing code to do the calibration. So within that code to do calibration, there was a calibration algorithm 03:08PM that might be termed a model and, again, the purpose of that was to reduce the bias and the inputs to the model. There would have been post processing code. I wouldn't probably call that a model, and then the routing model as you mentioned. You know, the 03:08PM



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routing model was very important to take things that left fields and move those at the right times downstream to ultimately reach the gauging stations.

Q Okay. Let's stay with the GLEAMS model for a moment, Dr. Engel. Would you agree with this 03:09PM document, Appendix A, that GLEAMS by itself has low support or utility for modeling a watershed?

MR. GARREN: Object to form.

A I wouldn't necessarily agree with that and, again, we can go back to the paper you provided 03:09PM earlier where we talked about the use of GLEAMS for two watersheds in northeastern Indiana. Again, we talked about the other paper where GLEAMS were applied throughout the state of Indiana. The peer review process on that said, gee, great idea. That 03:09PM paper was published. It was applied to hydrologic unit areas. So the literature, you know, doesn't necessarily agree with this. There are certainly cases in which one could apply it at a watershed level, and people have applied it at that level and, 03:10PM you know, the science community has embraced it. So, you know, when this says, you know, whether -- to what level it's supported at a watershed level, it's a more complex question and issue than that.

Q Okay. Let's turn to the next page, 211. 03:10PM



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There's a listing in this Appendix A, model fact sheet, to some model limitations for GLEAMS. Do you see those?

A Okay, yes.

Q Do you see where the author of this appendix says that the model -- one of the model limitations of GLEAMS is that it's limited to an agricultural field of a very small size. Do you agree with that statement? 03:10PM

A No, I wouldn't agree with that statement. 03:10PM

Q Okay. Another model limitation identified in Appendix A is that it is not suited for bigger watersheds. Do you agree with that statement?

A I think that was the discussion that we just had, that, you know, it depends on the question, depends on the context, and by itself, it's going to be limited in being applied to bigger watersheds, but when you combine that with other modeling components and create the overall model that's examining, you know, the fate and transport of phosphorus from the most significant sources, yeah, it can certainly be used for that. 03:11PM 03:11PM

Q So you disagree with the author of this fact sheet that models are -- I'm sorry, that the GLEAMS model is not suited for bigger watersheds; is that 03:12PM



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true?
A Yeah, I would disagree with this characterization as a blanket statement.
Q Do you also disagree with the statement of limitation on the GLEAMS model contained in this 03:12PM
appendix that says it is not suited for urban land uses?
A Well, again, it depends on the questions being asked. So if this is being used to try to model
transport of heavy metals from urban areas, GLEAMS 03:12PM
is not the model to do that. So, again, you have to have the right context in interpreting these statements. So if one is looking at runoff, looking at transport of nutrients, you know, the
capabilities are fine for use in urban areas. 03:12PM
Q What is it about GLEAMS that you believe makes it suitable to evaluate runoff of nutrients from urban areas but not runoff of metals from nutrient (sic) areas?
A Well, they're not routines -- using metals as 03:13PM
the specific example here again, there are not routines in GLEAMS that are accounting for metal buildup and movement in urban areas in GLEAMS.
Q And isn't that the case because GLEAMS is not
a model that deals with metals at all? 03:13PM



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A That's correct.
Q So GLEAMS would not be an appropriate model in an agricultural setting either, would it?
A No, it would not. So my interpretation of this statement, and I think if you would check with 03:13PM
the author and if you consult the scientific literature, you know, GLEAMS is routinely used in watersheds that have urban areas. In fact, again, back to this paper from northeast Indiana, some of the land use there was urban. 03:14PM
Q Let's go back a page, I'm sorry, to Page 210 of this appendix. Do you see that the model feature for GLEAMS is described as an edge of field simulation model?
A Which line? I'm sorry. 03:14PM
Q I'm sorry. Page 210 under model features.
A Okay, yes.
Q What do you understand that to mean, that GLEAMS is an edge of field simulation model?
A So what that means is that, you know, GLEAMS 03:14PM
is going to perform computations that calculate runoff movement of constituents, whether they be nutrients, pesticides, sediment to the edge of the field, and then at that point from its point of view, the world ends. So it doesn't do anything 03:15PM



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further with those other than report that, you know, that that water and the constituents being carried with it have reached the edge of the world according to the model.

Q Dr. Engel, what did you do to calibrate the GLEAMS model to edge of field data? 03:15PM

A So in this instance, we didn't do specific calibration to the edge of the field because it wasn't necessary. We did that indirectly, and the process, you know, was to calibrate this such that 03:16PM the nutrients that arrived at Tahlequah, Baron Fork near Eldon and at Caney Creek gauges so that that phosphorus was correct over the ten-year period or I guess five-year period for calibration and looked beyond that for a validation. I'm not sure I said 03:16PM that right. Five years initially for calibration and then five years for validation so that the phosphorus over that period matched the observed phosphorus when combined with the wastewater treatment plant phosphorus that was reaching those 03:16PM gauging stations. So it turns out that, you know, because phosphorus is a conservative substance, you know, that's a perfectly acceptable technique that one could employ to calibrate the model and, therefore, it wasn't necessary to match this to 03:17PM



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every single edge of field; it wasn't a necessary step.

Q Did you match it to any single edge of field sample?

A I didn't. Others have. It wasn't necessary in this case. 03:17PM

Q Dr. Engel, how can you confirm that the GLEAMS model, as you used it in this case, accurately predicted the amount of phosphorus leaving fields that had received poultry litter if you did not compare the results of the GLEAMS model to any edge of field environmental sampling data? 03:17PM

MR. GARREN: Object to form.

A Could you repeat that again?

Q Probably not but we can have it read back. 03:18PM

(Whereupon, the court reporter read back the previous question.)

A Okay. So, again, through the calibration process at the scale of the gauging stations at Tahlequah, Baron Fork at Eldon or near Eldon and Caney Creek, through that calibration, because of the representation of the unique combinations of soils and land uses and management and weather within each of those watersheds, when one calibrates the parameters assigned to those hydrologic response 03:18PM 03:19PM



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units, are going to ensure that there's a match between observed phosphorus reaching the lake, observed -- yeah, observed phosphorus at those gauges.

You know, there were I guess some early model 03:19PM
runs made, you know, to look at how GLEAMS was responding for a range of inputs. If one looks at the mass balance again, you know, more guidance on what expectations should be, so, again, this is not
done in isolation. There are a lot of things that 03:19PM
one is looking at while they're doing this to make sure things make sense.

Q Dr. Engel, isn't it true as a technical matter that your GLEAMS model that you used in your case is
not calibrated for edge of field conditions? 03:20PM

A The model is calibrated.

Q Did you hear the rest of my question?

A I'm not sure what you mean by is it calibrated to edge of field conditions. It's calibrated. It's
predicting movement of phosphorus to the edge of the 03:20PM
field.

Q What did the phosphorus concentrations -- the observed data at the three gauging stations that you used at the top of the reservoir, if you will, tell
you about the accuracy of the predictions from the 03:20PM



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GLEAMS model in terms of how much phosphorus is leaving fields that have received poultry litter?

A Well, the -- okay. So the GLEAMS model is telling us what it expects to be leaving edge of field for the dominant land uses. The model is 03:21PM calibrated to match the observed data, and this is a standard technique. It's no different than calibrating SWAT, no different than calibrating HSPF. You know, there are -- SWAT is using the same equations for movement of nutrient and HRUs to edge 03:21PM of fields as this is using and then it is simply picking those up with a different routing technique than I employed. I employed one that was more databased, more driven by observed data from this watershed. So that question -- that question 03:21PM doesn't make sense to the scientific and modeling community.

Q Can you identify for me, Dr. Engel, any peer-reviewed study in which the authors or scientists have purported to calibrate a field scale 03:22PM model by comparing it to data 50 miles downstream?

A Well, I guess that question seems to mischaracterize the modeling process that I employed.

Q Dr. Engel, don't worry about whether you like 03:22PM



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my question or not. Just answer it.
A Well, the question --
Q We're going to try it again.
MR. GEORGE: Lisa, can you read it back, please? 03:23PM
(Whereupon, the court reporter read back the previous question.)
MR. GARREN: Object to form.
A You know, actually I think there are probably a couple of papers that I wrote that did that using 03:23PM GLEAMS, and certainly there's some work that I was involved with with Dr. Keon J. Lim in which we did that. So if we look at my CV, I think I can probably point you to a paper.
Q Do you have it with you as part of your 03:23PM report?
A My CV I don't believe is in this binder.
MR. GEORGE: Anyone have a CV with them?
MR. BASSETT: I think I might. Let me look real quick. 03:24PM
(Whereupon, a discussion was held off the Record.)
Q Let me hand you what we'll mark as Exhibit 9 to your deposition transcript, Dr. Engel, and ask if you can put a star with your pen and identify for 03:24PM



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the Record the studies that you are referring to where you believe you have calibrated a field scale model by comparing it to data from 50 miles downstream.

A So the question again was what? 03:26PM

Q You had told me, Dr. Engel, that you could identify some prior peer-reviewed studies that you had published in which you had calibrated a field scale model by comparing it to data from 50 miles downstream. 03:26PM

A Okay. It may not be exactly 50 miles but it would be a distance. Without looking at a couple of these, I've got a couple of question marks by some of these.

Q Does question mark mean -- means what? 03:29PM

A I would have to look at the paper to see how far away the calibration was and that there was calibration on those.

Q Did you identify any papers from your CV, Dr. Engel, that you think are responsive to my question? 03:29PM

A Again, without looking at this one, this Lim and Engel 2003, I know the work done here did include this. Whether it's described in this paper and how it's described, I don't recall. This was one of those earlier I was trying to recall in which 03:30PM



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GLEAMS had been applied to large areas, so I think that is one.

Q Is that the Indiana study?

A That is an Indiana study.

Q Is it the one we were talking about earlier where you said you modeled the entire state of Indiana? 03:30PM

A It's a different one in which the entire state of Indiana was modeled. It's the second one.

Q All right. Keep going. 03:30PM

A So technically this Choi, et al, 2003, again, I'd have to look at this one to see. My recollection on this one is that it's -- you know, the L-THIA model being calibrated for a fairly sizeable watershed and its curve number and pollute runoff coefficients with no routing. So I think technically that fits your -- the definition of field scale model. So that would be an example. 03:31PM

Q Did you calibrate it based on data 50 miles downstream? 03:31PM

A I don't recall the particular distance but it was some distance away.

Q Okay. Any others?

A This Lim 2005, again, without looking at this, though, I don't want to misrepresent this, but I 03:31PM



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would need to look at that one. I don't recall this Lim, the second Lim 2005 that has a question mark, if that one has a calibration component in that, but the sediment computation in this one is certainly field scale that's then, you know, scaled up to a 03:32PM much larger area. This Tang one, it's a big watershed. I don't recall if that was calibrated for the hydrology there or not.

Q Did it involve field scale model?

A Again, it involved a model that, you know, 03:32PM didn't include routing. So in effect it's a field scale model, scaled with GIS, and I guess as I think about it, there are plenty of examples in the literature where people are scaling field kinds of things with GIS, and they're calibrating some of 03:33PM those.

Q Dr. Engel, in any of the four studies that you've identified here, did you seek in those studies to assign a relative contribution to a particular land use or source up in the watershed? 03:33PM

A I believe so.

Q Which ones?

A Let's go back to the beginning here. In this Lim paper, so here we were trying to understand contribution of pesticides and nutrients from 03:33PM



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varying land uses and land use management practices. So how that is split out in that paper, without again looking at that paper, I don't recall. Let's see.

Q Dr. Engel, my question really is not focused so much on hydrology calibrations as it is phosphorus calibrations. Do any of those papers involved attempt to calibrate for phosphorus a field scale model based upon phosphorus concentrations located 50 miles downstream? 03:34PM

A This Lim one may. So this Lim one looks at pesticides and nutrients, and I know as part of that overall study, we did what you are describing. What I don't recall, without looking at this paper, if that portion is reported in this paper or not. It would have included -- looks like it included nutrients. 03:34PM

Q Is that the only one of the ones you've identified where the calibration for phosphorus you believe might have been made based upon data collected from streams 50 miles downstream? 03:35PM

A The exact distance may not have been 50 miles.

Q Okay, but is that the only one that fits that category if you set aside the distance?

A You know, I don't recall if phosphorus is 03:35PM



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included in the calibration and these others are not.

Q Dr. Engel --

A I would say most likely phosphorus was probably not included in a couple of these others. 03:36PM

Q Okay. You actually put a star or question mark by those that you just identified?

A I did.

Q On Exhibit No. 9?

A Yes. 03:36PM

Q Okay. Dr. Engel, is GLEAMS designed to predict or simulate the transport of phosphorus from the edge of field where it has run off to a definite stream, river or terminal reservoir?

A Well, GLEAMS is, depending on how it is figured, is modeling movement of phosphorus to the edge of the field. Again, to clarify things here, I didn't stop with the models at that point, so if there were other modeling components that picked up phosphorus that had been moved by GLEAMS and then 03:36PM continued to move that through the water network of the basin.

Q Dr. Engel, as GLEAMS was used in this case and configured and set up for this particular project, was it capable of simulating the transport of 03:37PM



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phosphorus from edge of field where it has run off to a definite stream or river or terminal reservoir?

MR. GARREN: Object to form.

A So GLEAMS doesn't do that. It was not used that way in this study, and it wasn't necessary to use the model that way in this study because there were other modeling techniques that were employed to take care of the concern that you're raising. 03:37PM

Q And that's the routing model; right?

A So the routing model would be taking care of that. 03:37PM

Q Okay. So the routing model, Dr. Engel, it's your testimony, was designed to simulate the transport of phosphorus from the edge of field where GLEAMS predicted it would run off to a definite stream or river and then ultimately downstream to the terminal reservoir; is that right? 03:37PM

A Well, the routing model, and model may be a strong term here, the routing model was an equation that was derived from observed data in this watershed, in the IRW, and so based on a regression, a well, well-accepted technique, between observed phosphorus load and wastewater treatment phosphorus loads into streams and based on phosphorus delivered by GLEAMS to edge of fields, it took care of the 03:38PM 03:38PM



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relationship between wastewater treatment, non-point source phosphorus delivered to those locations and ultimate arrival at the three gauging stations.

Q When you say it took care of, what do you mean by that? 03:39PM

A It's a regression equation. So, you know, the regression equation said -- it's simply in this case a relationship between observed phosphorus at the three gauging stations, so unique to each of those, and phosphorus inputs into the system and flow, and 03:39PM then the regression equation takes care of the timing of arrival at the gauging stations. It's based on observed data.

Q Dr. Engel, is your routing model a physically based model that is designed to simulate the 03:39PM physical processes that occur, such as attenuation, deposition, absorption, settling of nutrients as they move through a stream and make their way to a reservoir?

MR. GARREN: Object to form. 03:39PM

A So, again, it's a regression equation, and by using observed data, that regression equation represents the things that you described. It does so implicitly.

Q What do you mean implicitly? 03:40PM



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A Well, we can't ask the regression equation how much deposition occurred on a particular date or a particular location because, again, you know, that wasn't of importance here. So, you know, the goal was not to predict the nutrients spiraling through 03:40PM the stream system. You know, the goal here was to understand how much phosphorus is delivered from the various land uses and practices of wastewater treatment plants to the gauging stations on a given day, and those ultimately reached the lake. You 03:41PM know, it's really pretty simple.

Q I thought the goal was to allocate phosphorus loads to sources?

A I guess it was necessary to model these processes to ultimately allocate to the various 03:41PM sources, but if you look, again, at the goals, there were goals to understand how this system behaved for various scenarios, including, you know, continued land application of waste, cessation and the other scenarios that were described. 03:41PM

Q Does your phosphorus routing model include any physically based parameters that would assist you in allocating phosphorus back to sources in the watershed?

A No. The equation is simply a regression 03:41PM



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between observed phosphorus loads, flows, inputs.
Q Let's look at page D-21 of your report. Let's talk about this P routing model. By the way, by P, we mean phosphorus; right?
A Yes. Sorry. 03:42PM
MR. ELROD: Page what?
MR. GEORGE: D-21.
MR. ELROD: D as in dog?
MR. GEORGE: Yes, sir.
MR. ELROD: Thank you. 03:42PM
Q Dr. Engel, in your report you state at the top of Page D-21 that a P or phosphorus routing model was created for each gauging location used in the modeling effort; correct?
A Yes. 03:42PM
Q Okay, and that's the routing model that you and I have been talking about for some time here today; correct?
A Correct.
Q Okay. What is the name of this routing model 03:42PM that you created?
A Well, model is probably too strong. So this is simply an equation for which coefficients were identified or values for coefficients were identified through regression. 03:43PM



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Q So it's not a model?
A Well, certainly one could call an equation a model, so --
Q So does it have a name?
A You know, throughout the report it's typically referred to as the routing equation or routing model. 03:43PM
Q Have you used this particular routing model in any previous application, Dr. Engel?
A Again, this is simply a regression equation. So, again, it's an equation that used observed data over a ten-year period, and coefficients for that equation were calculated to match. So it's a simple regression equation. 03:43PM
Q Let's -- so we have a clear Record of this, can you read what the equation is that you are referring to as either your P routing model or your P routing equation? 03:44PM
A Okay. So I guess P load equals A plus B times Q times P accumulation plus C times Q squared times P accumulation. 03:44PM
Q Dr. Engel, have you used that equation in any prior modeling application?
A I've not used this specific equation but certainly, you know, the use of regression equations 03:44PM



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is a well-accepted approach for taking care of relationships between things.

Q Dr. Engel, can you point me to any peer-reviewed study in which the equation that you just read has been used to simulate the physical processes that occur as phosphorus moves from the edge of field downstream to a reservoir? 03:45PM

MR. GARREN: Object to form.

A So, again, this equation is simply based on observed data. It's not modeling those physical processes. It's simply a relationship between phosphorus inputs into the streams or edge of field and what ultimately reaches the three gauging stations. So, you know, creating regression equations of this type is standard practice when working with data. This isn't out of the ordinary; this is not unique. This is a standard data-driven technique. You know, it's based on real observed data from the IRW. So it's not a theoretical equation in which we have to fit a bunch of coefficients and try to figure out how to make it work. It's based on years of observed phosphorus load data and flow data from the specific watershed. 03:45PM 03:45PM

Q Move to strike, non-responsive.

MR. GEORGE: Rick, if we keep having these 03:46PM 03:46PM



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speeches that don't answer the question, I'm going to start deducting those from my allotted time. I don't want it held against me.

Linda, could you -- I'm sorry. Lisa, could you read back the question and, Dr. Engel, could you answer it this time?

(Whereupon, the court reporter read back the previous question.)

A So the answer you are looking for would be no but let me qualify it. So one would not expect to find this specific equation that was uniquely derived for this watershed from data. So it's unique to the data from this watershed. You can't get much better than a relationship between all this observed data in this watershed. 03:47PM

Q Dr. Engel, have you independently tested your phosphorus routing model or equation to determine if it is a valid and realistic simulation of what actually happens in the stream systems in the Illinois River watershed? 03:47PM

A There's no reason to perform that test. It's not -- it's not necessary for the project.

Q Please take me through the detailed process using site-specific data that resulted in the development of this equation that you are referring 03:48PM



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to as your routing model in this case, Dr. Engel.

MR. GARREN: Object to form.

A So you're asking for a step-by-step process of how this equation was arrived at or --

Q That's correct. 03:48PM

A Okay.

Q First of all, you agree you don't really explain that in your report, do you, how this equation was developed?

A That's a good question. I don't know if I did or not. 03:48PM

Q I've read your report many times. If you could point me to it, I'd love to see it.

MR. GARREN: So, Counsel, are you saying it's there and he needs to find it? 03:49PM

MR. GEORGE: I'm saying I just can't find it, but he left the Record unclear in terms of whether it was there, so --

A Well, there's a little bit of description. I would admit there's not a lot of description on the prior page on D-20. So in reviewing the observed data from '97 through 2006, and there may have been even some observed data before that that I reviewed, observed data being -- well, I definitely reviewed observed data prior to that involving flows and 03:49PM 03:50PM



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phosphorus, so --
Q Can I stop you there? Flows and phosphorus where; in what type of sampling media?
A So flows at the three gauging stations, Tahlequah, Baron Fork, Caney Creek, and phosphorus 03:50PM
at those same locations in samples from those locations.
MR. McDANIEL: Can we be clear that when he says phosphorus, are you talking about phosphorus concentration? 03:50PM
A Yes, it would be phosphorus concentration. Sorry.
MR. GEORGE: Thanks, Scott.
Q Keep going. So you had data from '97 to at least 2006 in terms of phosphorus concentration in 03:50PM
flows at those three stations.
A And I believe there certainly were flows before that, some phosphorus concentration data prior to that as well. So in reviewing those and in calculating the phosphorus loads associated with 03:50PM
that combination of flow and phosphorus concentration data, it became apparent that, you know, there are trends in that data. So if you plot some of those data, examine those data, you see during low flows, as you would expect, low 03:51PM



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phosphorus loads, low phosphorus concentrations. As flow increases, one in this particular watershed sees that phosphorus concentrations increase and as flow increases even more, the concentrations increase even more. So based on that data, based on 03:51PM use of the load est model to calculate phosphorus loads and looking at the relationships, it became apparent that there was a strong relationship between phosphorus loads and flow and including flow squared. So, again -- 03:52PM

Q What does that mean, flow squared?

A So the form of the equation includes a component that is directly proportional to the rate of flow, so the flow of water out of the particular watershed. At particularly high flows one couldn't 03:52PM explain all the additional phosphorus concentration without using a flow squared term. So if you take the flow that is observed and square that value, that would be the flow squared term.

So viewing that data, it became apparent that 03:52PM there was a strong relationship in this particular location or I guess in each of these locations that -- between phosphorus loads, flow, flow squared. So knowing that relationship exists and now backing up where we're using the GLEAMS model and the 03:53PM



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wastewater treatment inputs, one could, through regression techniques, create or through this regression equation create and identify coefficients that provided a fit between phosphorus being delivered by the wastewater treatment plants into 03:53PM the streams, phosphorus being delivered by the GLEAMS model to the edge of field, and so that's where this phosphorus accumulation component in this equation came from, and so then using wastewater treatment phosphorus, using the GLEAMS modeled 03:54PM phosphorus to the edge of field, using the observed phosphorus at the gauging stations, one could identify the appropriate coefficients for this model or equations, more realistically a simple equation here, and then this data-driven equation based on 03:54PM data from this watershed can be used to describe the arrival of phosphorus from wastewater treatment and the GLEAMS delivery of phosphorus to edge of fields to each of the gauging stations.

Q How exactly did you take that data and the 03:54PM observed relationships that you saw and translate them into this equation? You said using regression techniques but I need more than that.

A Okay. So -- well, so the form of this equation was identified and then the coefficients, 03:55PM



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the A, B and C coefficients for this were identified by forcing a match between the phosphorus delivered by the wastewater treatment in the model and the timing of delivery at the three gauging stations.

MR. GEORGE: Let's take a break. 03:55PM

VIDEOGRAPHER: We're now off the Record. The time is 3:55 p.m.

(Following a short recess at 3:55 p.m., proceedings continued on the Record at 4:07 p.m.)

VIDEOGRAPHER: We are back on the Record. 04:06PM The time is 4:07 p.m.

Q Dr. Engel, before we get back into the questions, I need to correct a mistake I made with regard to a document that is an exhibit, and it relates to the discussion we had of Exhibit A and in 04:07PM particular, Appendix A to Exhibit A. It has been pointed out to me, and I apologize for this, that Appendix A, which I have now marked Exhibit 8A, and I'll hand back to you, came from another EPA study, and this evening I'll print out a copy and provide 04:08PM this for the Record, entitled TMDL Model Evaluation and Research Needs by Leslie Shoemaker that was published in 2005, and it actually has an EPA project number. It's EPA 600 R-05149. So these are both EPA publications but two different reports, so 04:08PM



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I have pulled those apart and I wanted you to know that, and I apologize for combining two things.

Let's go back to this P routing equation, Dr. Engel, on D-21 of your report, and I think you told me that this equation serves to take the output from 04:08PM the GLEAMS model in terms of runoff from edge of field and the wastewater treatment plant load that you add in separately and to fit those two combined phosphorus loads to the observed data downstream; is that correct? 04:09PM

A Well, it's taking wastewater treatment phosphorus, as you indicated, and it's taking GLEAMS phosphorus delivered to edge of field. I think you maybe said runoff, but it's the phosphorus from GLEAMS to the edge of the field, and then identifies 04:09PM a relationship between that observed flows at the three gauging stations and observed phosphorus at the three gauging stations.

Q And isn't it true, Dr. Engel, that the reason that you need this phosphorus routing equation is 04:09PM that the combination of those two sources of P, the amount of phosphorus computed by GLEAMS and the amount of phosphorus from wastewater treatment discharges, generally exceeds the observed phosphorus downstream at Tenkiller? 04:10PM



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A Well, so, no, it doesn't generally exceed it.
This equation is simply finding a relationship so
that these match, and it's not creating or losing
phosphorus as it moves the wastewater treatment
phosphorus and the GLEAMS edge of field phosphorus 04:10PM
to the three gauging stations. It's simply figuring
out the timing, the arrival time of that if you want
to think of it that way. So it's not creating new
phosphorus; it's not losing phosphorus, and I guess
to be more responsive to your question, on a given 04:11PM
day, the inputs to this routing equation may be
greater than the observed load at the three gauging
stations or it may be less than the observed load at
the three gauging stations. So this is just making
sure that, you know, the phosphorus that is dumped 04:11PM
into the streams by the wastewater treatment plants,
the phosphorus that leaves the many fields in the
IRW, it just simply takes that, moves it at the
right time to the gauging stations. It's really
quite simple. 04:11PM
Q Does the phosphorus routing equation keep the
phosphorus load from wastewater treatment plants and
the load computed by GLEAMS separately, separate;
does it keep it separate as it moves downstream?
A No. It's not -- it's summing -- it's summing 04:12PM



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the two together. So it's not tracking them independently, although one could write an equation to do that.

Q But this equation doesn't do that; right?

A This equation doesn't do that. 04:12PM

Q Okay. So then if I understand correctly, Dr. Engel, with respect to the phosphorus load that the equation transfers or fits to the data downstream, this equation cannot tell the difference between a pound of phosphorus that comes from a wastewater 04:12PM treatment plant and a pound of phosphorus that came off of a field that received poultry litter; is that right?

MR. GARREN: Object to form.

A That's correct, but there's -- you know, 04:12PM again, for the purposes of this study, you know, it wasn't necessary to track those with this particular equation. That was, you know, additional complexity that wasn't called for.

Q Your study didn't call for the tracking of 04:12PM phosphorus and allocation back to particular sources?

A Well, let me describe what we did for the wastewater treatment phosphorus. So we made the very conservative assumption that all wastewater 04:13PM



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treatment phosphorus reached each of the gauging stations or the appropriate gauging stations every year. So, you know, so when we took that off the top, if you will, to do allocations, the assumption was always that wastewater treatment phosphorus 04:13PM
reached those locations. In reality, quite a bit of that could be detained for some period. So, you know, we tended to err on the side of attributing probably more to the wastewater treatment plants than what might reality suggests. 04:13PM
Q Is your phosphorus routing model or equation, Dr. Engel, capable of differentiating in terms of what is delivered to Lake Tenkiller between a molecule of phosphorus that GLEAMS predicts comes off of a field located a mile upstream as compared 04:14PM
to a field that's located 20 miles upstream?
A It's not making that distinction. Again, that distinction wasn't necessary for purposes of this effort.
Q Can your phosphorus routing model 04:14PM
differentiate in terms of the phosphorus that it simulates reaching the lake between phosphorus that GLEAMS predicts comes off of urban areas as opposed to pastures?
A So, again, this equation is not making a 04:14PM



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distinction. So it's just treating all phosphorus the same.

Q Okay. So your phosphorus routing equation really tells you nothing about the source of the phosphorus that reaches Lake Tenkiller; is that fair? 04:15PM

A Correct. This equation is not identifying the sources.

Q Now, if you look on the following page, D-21 of your report, Dr. Engel, there are some values that are referred to as coefficients that are used in your phosphorus routing model listed in Table 7; do you see that? 04:15PM

A Okay. I'm on Page D-22.

Q I'm sorry, what did I say? 04:15PM

A I think you said D-21.

Q I apologize, D-22, and in particular, you have for each of the subwatersheds, Tahlequah, Baron Fork and Caney Creek, a coefficient for the value A, B and C; do you see that? 04:16PM

A Yes.

Q And A, B and C are three of the variables that appear in your equation, phosphorus routing equation; correct?

A Correct. 04:16PM



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Q What are those coefficients that are listed there? For example, one of them, B for Tahlequah is 4.88 times 10 to the minus 7; what does that mean?
A Well, so that particular coefficient was identified along with the other coefficients here, 04:16PM
so that the equation on Page D-21 would match the observed phosphorus loads at Tahlequah -- we're talking about the Tahlequah location -- with the wastewater treatment inputs into the Illinois River watershed that drains to Tahlequah and the GLEAMS 04:17PM
edge of field phosphorus loads that were delivered to or that were delivered within the Illinois River watershed draining to Tahlequah.
Q Well, Dr. Engel, how was this particular number that you use in your equation for the 04:17PM
coefficient B, 4.88 times 10 to the minus 7, established?
A So this was established to make the relationship match that I just described.
Q I don't want to know what it does. I want to 04:17PM
know how it was established.
A So this was established using a piece of code to calculate these coefficients using the relationships that I described.
Q What kind of code? 04:18PM



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A So looks like it was the shuffled complex evolution piece of code but unique to fitting these coefficients as opposed to the same technique that was employed in calibrating the GLEAMS model.

Q Well, who wrote this code that you're talking about from which the variable or the coefficient for B was determined? 04:18PM

A So the shuffled complex evolution code was written by Dr. Ji-Hong for this particular application. 04:18PM

Q What did he base that code on?

A Well, the code is a well established or the algorithm approach from shuffled complex evolution is a well-established technique. So relying upon equations that are described in the literature for that technique, he developed code to best fit A, B, C, such that that equation would create the proper relationship between observed phosphorus at Tahlequah and the wastewater treatment inputs and the GLEAMS inputs for that particular watershed. 04:19PM

Q Did Dr. Ji-Hong create the code that was used to calculate all of the coefficients that were used in your phosphorus routing model or equation? 04:19PM

A Well, he created the code to compute A, B and C. 04:20PM



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Q Okay.
A I created the form of the equation that we talked about back on Page D-21.
Q I'm not interested in the equation right now. I want to know about the code that was used to 04:20PM
create the coefficients in Table 7. Did Dr. Ji-Hong create all that code?
A So if we're talking about the code to calculate the coefficients from the observed data, yes, Dr. Ji-Hong wrote that code. 04:20PM
Q Okay. Now, this particular numerical value for B, which is at Tahlequah, which is 4.88 times 10 to the minus 7, does that number have any physical meaning in the environmental system of the Illinois River watershed? 04:20PM
A Let's see. There would probably be some physical meaning that one would interpret from it. I'm going to have to think about that. I hadn't thought about that question. So, you know, what it's doing, it's indicating that that coefficient 04:21PM
times flow at Tahlequah times phosphorus that's been put into the Illinois River from GLEAMS and from the wastewater treatment plant, it's indicating that essentially this portion or at least this coefficient times these other two things identifies 04:21PM



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the phosphorus load, the phosphorus mass delivered to Tahlequah along with the rest of the equation. So the physical meaning -- it's a regression equation. Essentially this is a regression equation between observed and inputs. So wrapped up in this 04:22PM
coefficient are some of the processes that you were asking about earlier then. So those would be wrapped up in this coefficient, and it would be tough to untangle those, and it would be tough to untangle those and assign a physical meaning I guess 04:22PM
to each of those things.

Q Okay, and maybe that's the way to approach it. If I have this value, 4.88 times 10 to the minus 7, and I go to the gauging station at Tahlequah, does that number tell me anything about the conditions on 04:23PM
the river, the flow, the phosphorus concentrations, or is it just the product of an algebraic equation that shows a relationship between all these variables you have in your phosphorus routing model?

A Well, it's the -- it's the product of a set of 04:23PM
equations anyway that identified this as the best value and, again, trying to assign physical meaning to that is probably a bit of an overstep here. So, you know, it's a value identified by matching observed data and model data. So it's just a 04:23PM



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transfer function I think as you described it earlier, so that would be a good description as well.

Q Now, in the -- let me strike that. You discuss in your report a procedure with respect to 04:24PM your routing model called optimization using this shuffled complex evolution approach; you're familiar with that?

A Yes.

Q Okay. What is optimization? 04:24PM

A Well, it may not be explained very well in the report, but the optimization was to identify the values for A, B and C for each of the three gauging stations that provided a best fit.

Q So is optimization another way of saying 04:24PM you're varying the data or the inputs into the model or in this case the equation?

A Probably a better -- maybe a better term would have been it's a calibration or identification of these values that are optimized to fit the equation 04:24PM between the observed data and the modeled data.

Q Dr. Engel, with respect to the optimization of your phosphorus routing model, were there any limits on the degree to which these coefficients and the values associated with them, A, B and C, could be 04:25PM



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moved in one direction or the other by the computer?
A No, there would not have been, and one would -- again, because there's not a physical meaning tied to these, there would be no reason to constrain these. So in fact, you know, these could 04:25PM
vary from zero to some very large number I suppose, and I guess if they were assigned a value of zero, there would be meaning to that. So a value of zero would indicate that that term in this equation didn't provide any further explanation in explaining 04:26PM
the relationship between phosphorus delivered to the three gauging stations and the wastewater treatment model inputs to those equations.
Q If there's no limit on the extent to which these coefficients can be altered by the computer as 04:26PM
part of the optimization, then what good are they I guess is my question; why have them at all if the computer can change them however it wants?
A Well, maybe step back and take another tact at explaining this. Once -- so the process here during 04:26PM
a calibration period was to identify a relationship between phosphorus inputs from wastewater treatment, phosphorus inputs as modeled by GLEAMS and the observed phosphorus at the gauging stations, and so once that relationship was established for the 1997 04:27PM



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to 2006 period, these coefficients that we're looking at were then constant. So these didn't vary beyond that. So that's where this is like identifying coefficients in a regression equation. You know, this was identifying coefficients in the 04:27PM
simple equation that were then held constant so that we had a relationship between phosphorus inputs, wastewater treatment, GLEAMS model phosphorus and phosphorus delivered to Tahlequah, Baron Fork, Caney Creek. So the coefficients didn't vary after they 04:28PM
were set.

Q Okay. So the computer could move them as far as it wanted initially, but at some point in time you went with the values that had been established and used those in your future P routing model? 04:28PM

A Correct, and that would be -- so it's comparable to a calibration where you're identifying the best values to use, the optimum values to use here. Once those are set, you know, there was no reason to change these. Once those were set in 04:28PM
other models, the only things you would change would be to represent different conditions that you're trying to model. So there was no reason to change these once they have been identified.

Q Let's move to the far right-hand column of 04:28PM



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Table 7 on Page D-22. One of the other coefficients that is listed in here for each of the subwatersheds is something referred to as initial P accumulation in pounds. Do you see that?

A Yes. 04:29PM

Q What is that?

A Well, if we look at the equation again, there's a P accumulation term in the equation on Page D-21.

Q What does the phrase P accumulation mean? 04:29PM

A Okay. It probably didn't explain that particularly well here. So excuse me. So the -- so what this equation is doing, it's stepping through time one day at a time, and it's saying, okay, what's the load today of phosphorus at Tahlequah. 04:29PM Well, the expected load today of phosphorus at Tahlequah is this coefficient A, and we can read the A now out of the table, the coefficient B that's described the flow, the daily flow at Tahlequah, that's the Q, times the P that has accumulated in 04:30PM this stream system network, and so to start this on day one, we need an initial P accumulation. So that's -- the initial P accumulation on day one is the P accumulation over here, and then the equation continues that it's times C times flow squared as we 04:30PM



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talked about earlier, the daily flow at Tahlequah times itself times again phosphorus accumulation.

So once we've computed phosphorus for day one, we now have wastewater treatment phosphorus that's being added to the P accumulation term, so we have 04:30PM some daily amount that's added from wastewater treatment, and we also have potentially if it rained -- today it wouldn't, but if it were raining and there were enough rain to transport some phosphorus in the GLEAMS model, we would potentially 04:31PM have it added to this P accumulation term, and then we would just repeat this process on day two, and we would step through whatever period of time one day at a time using that concept.

Q Who decided, Dr. Engel, that the initial P 04:31PM accumulation used in your routing model, for example, for the Tahlequah location would be 500,000 pounds?

A Well, that was one of the parameters that was identified through this shuffled complex evolution 04:31PM approach in identifying the values that one should use.

Q So the computer decided that; is that right?

A Well, the computer decided that based on matching, again, the observed data with the modeled 04:31PM



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data. So, again, the computer is not creating new phosphorus. It's not losing phosphorus. It's simply finding the best starting value for this.

Q Dr. Engel, I just want to make sure the Record is clear. It's not as though you or someone working for the State went out to the gauging station at Tahlequah and took some samples and ran a test and determined that there was accumulated phosphorus within that particular subbasin equal to 500,000 pounds? 04:32PM

MR. GARREN: Object to form.

Q Is that right?

MR. GARREN: Object to form.

A Well, it's not necessary to have that measurement. You know, this is a parameter that can be calibrated, and to actually make the measurement you're describing, you know, all of us working the rest of our lifetime and beyond couldn't make that measurement, so this is an example and, again, well accepted in the scientific community, we can't always measure everything that's an input into some of these equations, and so we use observed data and we calculate the best value for these. That's what was done here. 04:33PM

Q Dr. Engel, you ducked before I swang or swung. 04:33PM



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I wasn't suggesting you needed a measurement. I just wanted to confirm there was not a measurement.

A So sorry for the dialogue. So there was not a measurement. So this was a calculated value.

Q Dr. Engel, was the range of allowable values for this additional coefficient, initial P accumulation, constrained during the calibration or optimization process? 04:33PM

A Yes, it was.

Q And what was it con -- how was it constrained? 04:34PM

A Within this code that was computing these, there was a constraint on the values.

Q And by constraint, does that mean that there was some limitations on how far up or down this particular value could go based upon the shuffled complex evolution? 04:34PM

A Correct. So, you know, physically certainly this doesn't make sense to go below zero. So zero would have been a constraint.

Q What was the upper constraint? 04:34PM

A Without looking again at the particular values, I don't recall the upper constraint that was ultimately used. I do know that there was some experimentation with ranges of values in that and some experimentation then to see, you know, what the 04:35PM



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relationships between predicted and the model looked like.

Q Who performed these experiments?

A I performed a group of those, and I don't believe Dr. Ji-Hong did. So I think I was the one 04:35PM that performed that group of things and suggested a set of ranges for these.

Q And you don't recall the upper bound range that was established for the initial P accumulation variable? 04:35PM

A Without looking at that, I would be speculating.

Q Given that the initial P accumulation is not based upon a measurement in the field, what is the rationale for having an upper constraint on it? 04:35PM

A Well, there has to be -- I mean, there's logically some upper constraint on these, and I guess, you know, the other piece of this that went into this consideration was that there was an examination once these values had been identified 04:36PM preliminarily to look at this ten-year period and see what happened to this P accumulation in that period. You know, were we gaining significant amounts of phosphorus with that term, were we losing significant amounts of phosphorus out of that term, 04:37PM



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and that went into the consideration here as well, and so as I recall, for this ten-year period, there was little change in the values when we used these starting points, and I think if we looked at the relationships in some of these graphs, I think we 04:37PM would see -- I know we would see how well these fit the observed datasets.

Q Dr. Engel, where would I go or where would you go is probably a better question to identify for me the actual upper bound limits that were in place for 04:37PM initial P accumulation for each of the three subwatersheds that were addressed in your routing?

A There would be a set of code that was used in computing these values. As I recall, that might be called lake.exe or something. As I recall that's 04:38PM probably reading a group of files, and within one of those files, this would have been set.

Q Okay.

A I don't know which particular file.

Q How would it be called out or identified in 04:38PM that file?

A I would probably have to look at that file, you know, to look through there and interpret and maybe find that.

Q Do you have that file? 04:39PM



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A Boy, I don't know -- I mean, I don't as I'm sitting here.
Q Do you have it somewhere?
A But it would have been in the considered materials. 04:39PM
Q Well, unless you can tell me how to identify it within your considered materials, that doesn't help me much, and so I'm wondering, and I'm looking for some help here, Dr. Engel, as to how best to go about identifying the upper bound constraint that 04:39PM was placed upon the initial P accumulation value for each of these three subwatersheds.
A Well, we could -- if you've got stacks of materials, we can probably dig through to look for it. I don't know. 04:40PM
Q How long would it take you to find this value, do you think, if you had the materials?
A Well, I would have to isolate -- you know, from the group of materials, I would need to isolate where this is located and then isolate within that 04:40PM file or group of files what that value or values might be.
Q Okay. If you called Dr. Ji-Hong, would he know or have access to this information?
A So this -- if this was the piece that I was 04:40PM



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doing -- so although he had written that code, I think I was the one that was running that the last group of times. So, you know, although he may have had a prior version, it may have changed; it may not have changed from that. I couldn't tell you for 04:41PM
sure without looking, but, you know, at the end of the day, this is a value that's identified to fit a relationship, so -- you know, so the upper bound is not a significant issue here.

Q Okay. Dr. Engel, if I brought a copy of this 04:41PM
lake.exe file with me tomorrow, do you think you would be able to identify this upper bound value?

A If I -- yeah, I think it's in a -- it's not in the lake.exe file itself but it's in probably another file that it's reading. 04:41PM

Q Do you know what that file is called?

A That's what I couldn't recall earlier. I don't know the specific name.

Q I'm going to bring you some files tomorrow and we'll see if we can find this. Okay? 04:41PM

A Sounds like a test.

MR. McDANIEL: Can I make a little Record on something?

MR. GEORGE: Sure.

MR. McDANIEL: To the extent we're 04:41PM



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inquiring or Mr. George is inquiring about specific information we need to understand how this modeling exercise was constructed and performed, and we can't get answers to that question, then I think it's reasonable for us to take the position that the 04:42PM
plaintiff will not be in a position to offer that evidence at a later time if it's not provided to us in time for our expert to use it and evaluate it.

MR. GARREN: You're making an assumption that it hasn't been provided. He's testified that 04:42PM
it has.

MR. McDANIEL: The question is pretty clear about we need identification of a particular file to understand, and getting a disk full of stuff and asking the man to tell us where it is on the disk, 04:42PM
if he can't answer it, that's what I'm referring to.

A Well, if I saw a group of file names, I could get us close but without --

MR. GARREN: There's no question.

Q We'll try the exercise tomorrow and we'll see 04:43PM
how it goes. I'll hand you, Dr. Engel -- first of all, Dr. Engel, is it your testimony that the phosphorus routing model coefficients were calibrated or optimized through an automated process as opposed to manually? 04:43PM



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A I believe initially those were calibrated through this automated process, and those may have been adjusted by hand a bit in the errata.

Q Okay. If you look at your report on Page D-22, the last sentence of the first paragraph says, 04:43PM the coefficients were optimized using an automated approach; right?

A They were, but then as I said, I think with respect to the errata, it's possible that those were modified a little bit. 04:43PM

Q Why would -- why was it necessary to adjust the coefficients manually as between your original report and the errata, if you did?

A Well, recall that there was, you know, the mistake that we talked about at length earlier today 04:44PM that caused the errata, and as part of that, it was necessary to go back through the process of identifying the coefficients that went into the equation on D-21.

Q Did you have to run the routing model again or 04:44PM did you just go back and realize that there was some manual adjustments made?

A Well, in looking at observed data with respect to the modeled data, I believe there were some adjustments to those to improve the fit between 04:45PM



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those for a couple of large events to my recollection.

Q What do you mean by large events?

A I'm sorry. Large flow events.

Q Let me hand you what we'll mark as Exhibit 10 to your deposition, which, for the Record, is a letter to me dated December 8th of this year from Claire Xidis. Do you know Claire? 04:45PM

A Yes.

Q You understand Claire is one of the attorneys that work for the Attorney General's office in this case; she actually works for the Motley Rice Law Firm? 04:45PM

A Yes.

Q Okay, and in this letter, which is written in response to some requests that I made regarding the information underlying your errata report, Miss Xidis describes the optimization program that I had asked about in the very last sentence of her letter. Do you see that? It's on Page 2. 04:45PM 04:46PM

A Yes.

Q And do you see where Miss Xidis says that the optimization program, this lake.exe file that you've been talking about, was not used in adjusting the values; rather the initial values obtained from that 04:47PM



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process were used and then adjusted manually; do you see that?

A Yeah, that's consistent with my recollection. Then that in that errata, the values that had been optimized or calibrated would be a better term, 04:47PM calibrated initially were adjusted by hand by me, and ultimately I settled on the values that were reported in the errata in -- I guess I don't have that in front of me, in whatever that table is.

Q It should be Exhibit 4. Do you not have 04:47PM Exhibit 4?

A I believe it's -- is that the right one? I guess it would be. Sorry. So I believe those would be the ones in Exhibit 7 of the September errata.

Q Table 7 on what page? I apologize. 04:48PM

A I'm sorry. Looks like Page 45 at the bottom.

Q Dr. Engel, if the purpose of this automated optimization program was to adjust the values in such a way as to give you the best fit, what's the rationale for you or anyone else coming along 04:48PM afterwards and manually adjusting those values?

A As I stated earlier, there were a couple of large flow events for which this process was not performing well, and so my professional judgment was that it was important to pick those up, and so I 04:49PM



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made further adjustments of these parameters and this would be -- this would be typically done in calibration. This is not unusual.

Q What was the basis for your adjustments in terms of how far and in what direction; how did you decide that? 04:49PM

A Well, the basis for the adjustments was to -- I guess I was looking at the statistics reported on the graphs on pages -- well, a graph that would be Figure 15, so that's a calibration one, 16 and 17, and trying to -- trying to pick up some of those larger flow events that had had large amounts of phosphorus observed at the respective gauging stations. 04:49PM

Q So how does Figure 15 tell you whether to turn the initial P accumulation knob for Tahlequah four degrees to the right or 7 degrees to the left? 04:50PM

A Well, not unlike common approaches in calibration, that's trial and error largely. It's well accepted in scientific literature that in the calibration process is in fact the majority of those would be done manually. It would not be automated, so you would have someone making a decision about every one of these things to modify, and they would modify them until they, you know, were comfortable 04:50PM 04:51PM



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with the performance.
Q What do you mean comfortable with the performance?
A Well, they would typically be looking at data like we see in Figure 15, 16 or 17. They would be 04:51PM
looking at the relationship between the observed value, the predicted value. You would be looking at R-squareds. You might look at some other things potentially as well, and based on your professional judgment, would be deciding when those relationships 04:51PM
were suitable to move on to the next step. It's a well-accepted process, well-accepted technique that, you know, most modelers in watershed modeling employ.
Q While we're looking at Figure 15 in your 04:52PM
September 4, 2008 errata, and I think this observation is true of all the figures that you produced in both of your reports, why are all of these graphs labeled series one and linear series one? 04:52PM
A Probably means I was lazy.
Q What does that mean, series one and linear series one?
A Vic knows I was lazy. So I think what that means is that within Excel, the default, 04:52PM



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unfortunately if you don't change the labeling, it labels it series one, and then the line that it draws through there is the linear fit for that relationship and, again, it's linear series one is the default. So this suggests that I did these in 04:53PM the spreadsheet and never cleaned up the labels.

Q And the other thing that seems consistent with all of the figures that you produced in both of your reports, Dr. Engel, is the absence of any description of what the X and Y axes reflect and 04:53PM their units. Do you see that?

A Is it just the things in D here?

Q I see the same thing in Appendix D to your May 22nd, 2008 report.

A It looks like most of the figures prior to 04:53PM this were better labeled. So one of these is going to be predicted and one of these is going to be observed, and it should be predicted on the Y, observed on the X axis here.

Q Dr. Engel, prior to you telling me that, how 04:54PM was I or the experts working for the defendants supposed to know that?

A It looks like this was an oversight on my part in getting those labeled.

Q What are the units for the X and Y axes on all 04:54PM



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of the figures that you included in your Appendix D to both of your reports?

A Well, they're phosphorus loads and they're daily phosphorus loads and the units. Is that the remaining part of the question? 04:55PM

Q Yeah. I am interested in the units.

A I believe those are going to be in kilograms, but to be absolutely certain, I would need to look at the spreadsheet in which these were produced.

Q As we sit here today, you're not sure what the units are? 04:55PM

A Well, they're kilograms or pounds.

Q There's a difference, isn't there?

A About 2.2 would be the factor of difference, yeah. I believe they're kilograms, but I would need to look to -- so I didn't mislead you. 04:56PM

Q All right. Dr. Engel, let's move to another exhibit. I'm going to hand you what I've marked as Exhibit 11 to your deposition, which is an October 2007 which you are listed as the principal author, along with Dan Storm, entitled A Hydrologic Water Quality Model Application Protocol, published in the Journal of American Water Resources Association. Do you recognize this article, Dr. Engel? 04:57PM

A Yes. 04:57PM



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Q Am I correct, you are the principal author?
A Correct.
Q Let's take a step back and give me the 30,000-foot view of what was the purpose of this article. 04:57PM
A So I guess the -- kind of the genesis of this was in some conversations with the colleagues that became co-authors following the Eucha-Spavinaw case that involved the City of Tulsa and the poultry industry. You know, the observation was that there 04:58PM was quite a bit of disparity in the way that people approached application of models and documentation of various aspects of that, and so this was an attempt to begin moving the watershed modeling community down a path that would suggest additional 04:58PM documentation and description of modeling processes.
Q Okay. We've talked a little bit about calibration and calibration of the GLEAMS model that you used in this case. Can you turn to Page 1230 of this article that you and Dr. Storm wrote. You have 04:59PM a discussion, do you not, of calibration and what it is and some general principles?
A So, yes. It looks like that begins on Page 1230.
Q And do you see in the bottom of the right-hand 04:59PM



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column on Page 1230 under model calibration there is what I would call a definition provided of calibration that says, estimating parameters for these relationships is called calibration; do you see that? 05:00PM

A I see that.

Q Okay, and then if you skip the next sentence and then pick up with a sentence that begins similar, can you read what you and Dr. Storm had to say about describing calibration in this article? 05:00PM

A Similar to an analytical instrument, models are calibrated by comparing the predictions and output for a given set of assumed conditions to observed data for the same conditions.

Q Do you agree that that generally describes the goal and process of calibration, comparing predictions or output for a given set of assumed conditions to observed data for the same conditions? 05:00PM

A This would be kind of a high level overview of what calibration is about. 05:00PM

Q So if I can put that in layman's terms that I can understand, calibration involves comparing what the model was designed to predict with data that would reflect the reality of those conditions; is that right? 05:01PM



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A I might phrase that potentially just a little bit differently. So, you know, with calibration, you're comparing the model-predicted values to an observed set of values, and then you take that a step further. In the calibration process, typically 05:01PM you modify some inputs to that model so that that model better reflects those observed data.

Q Okay. So, for example, and I may regret this question. We'll see. If I had developed a model that I believed allowed me to predict the number of 05:02PM blond-headed children in the metropolitan area of Tulsa, okay? You follow that?

A Okay.

Q If I wanted to calibrate that model, I would calibrate it by comparing those predictions with 05:02PM some data about the actual number of blond-headed children in Tulsa; is that right?

A Well, some -- I think the key there is some data. So you wouldn't need to have a census and identify every blond-headed child, but you might 05:02PM have, through whatever you deem an appropriate technique to arrive at, a representative sample for which then you could adjust your model.

Q All right. In the same article on Page 1226 under model application and protocol steps, you 05:03PM



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state in the last paragraph on the right-hand column, second sentence, that in most instances it will be necessary to make various assumptions and decisions throughout the modeling project; do you see that? 05:03PM

A Yes, I see the sentence.

Q Is that a true statement?

A Yes.

Q Okay, and do you agree, Dr. Engel, that in a modeling setting, if your assumptions are wrong, 05:03PM that affects the reliability and accuracy of the results you get from the model?

A It has the potential to do that.

Q What assumptions were made in connection with your modeling work and the modeling work of Dr. 05:04PM Ji-Hong in this case?

A Well --

Q Give me some examples.

A That could be a pretty big list potentially. The underlying assumptions that the hydrologic water 05:04PM quality model is starting with, you know, are as basic as water runs downhill. So I don't know if you're talking of that kind of level of assumptions you are looking for.

Q Well, did you have the option in the modeling 05:04PM



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exercise to make the assumption that water runs uphill?

A Well, one could have done that. It probably wouldn't have been a very good assumption, and I would agree with you on that but -- 05:04PM

Q All right. I'm not -- let me approach it this way: Do you agree that your modeling work in this case assumes that all of the litter, poultry litter that is generated in the Illinois River watershed, other than -- I think it's 900,000 tons that are 05:05PM exported by BMPs a year --

MR. GARREN: Object to form then.

MR. GEORGE: Hang on.

Q And some amount exported by George's is applied in the Illinois River watershed? 05:05PM

MR. GARREN: Object to form again.

A So I guess let me back up just a moment. So I've done some calculations of waste that's been generated in the IRW, and I've seen some of the data that talked about how much has been exported, and I 05:05PM believe in your question you indicated there was 900,000 years -- 900,000 tons a year being exported?

MR. McDANIEL: What?

Q Oh, 90,000. I'm sorry. Zero, 70 percent, 90 percent, it doesn't matter, 900,000, 90,000. All 05:06PM



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right. Let's clean it up. We did well with
900,000. Let's approach it this way, Dr. Engel.
Can you look at Page D-18 of your appendix?
MR. GEORGE: Actually let's take a break so
we can change the tape out before we get into this 05:06PM
page.
VIDEOGRAPHER: We're now off the Record.
The time is 5:06 p.m.
(Following a short recess at 5:06 p.m.,
proceedings continued on the Record at 5:21 p.m.) 05:20PM
VIDEOGRAPHER: We are back on the Record.
The time is 5:21 p.m.
Q Dr. Engel, can you look at appendix Page D-18
to your report?
A Okay. I'm on that page. 05:21PM
Q And does Appendix D-18 talk about the amount
of poultry litter that was used in your simulations
or modeling exercises?
A So, yes, that's what is being described.
Q And you see the figure 223,000 tons per year? 05:21PM
A Correct.
Q Okay. Is that figure -- does it represent the
assumption that you made as to the amount of poultry
litter that is applied on an annual basis in the
Illinois River watershed? 05:22PM



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A So this value served as the starting point prior to calibration.
Q Okay. Let's stay with the starting point because that's the assumption you made initially, correct, 223,000? 05:22PM
A Correct.
Q And what was the basis for that 223,000 figure?
A So this was the calculated weight based on Meagan Smith's mass balance report as was documented 05:23PM in my Appendix B.
Q Where did Meagan Smith get the 223,000 tons per year number?
A So I'm not misrepresenting this, let me take a quick look again to refresh my memory. 05:23PM
Q Sure.
A So this value would have been calculated based on the number of active poultry houses associated with the defendants within the IRW and data from nutrient management plans from the Eucha-Spavinaw 05:24PM watershed.
Q Did Miss Smith assume in computing this number based upon the number of houses in the watershed that all litter generated in the watershed was applied in the watershed? 05:24PM



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A Well, the mass balance would have represented this is the amount of phosphorus that moved into the watershed as a result of production of the poultry, and it does not speak to export of litter.

Q So then is the answer to my question yes, that 05:24PM this calculation assumes that all litter generated in the watershed stays in the watershed?

A This number would represent that all litter stays in the watershed.

Q Okay, and is that a realistic assumption, Dr. 05:25PM Engel?

A In recent years, no. Historically, yes.

Q Okay. Well, did this number, this initial starting value of 223,000 tons of poultry litter applied in the watershed per year, was it the same 05:25PM starting value for both your historical model runs and your forward or predictive model runs?

A You've got two cases there, right, so the historical -- what do you mean by the historical model runs? Could you make sure I'm clear on that? 05:25PM

Q Well, you have one set of model runs that are designed to simulate conditions between -- well, let me find them. Conditions over the last 50 years, correct, and what has caused those conditions?

A From 1950 to 1999? 05:26PM



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Q Right.
A Well, so 223,000 tons would not have been the number that was used in 1950.
Q What was the number used in 1950?
A Well, the number used starting in 1950 would 05:26PM
have been derived from Meagan Smith's table. It's going to take me just a moment to find this I'm afraid. So it would have been derived from Table 11.
Q On what page? 05:29PM
A I'm sorry. It would be Appendix B, Page 20.
Q All right. Dr. Engel, I don't see 223,000 tons on Table 11. Do you?
A So let me describe the relationship then. So
the phosphorus was converted via a calculation into 05:29PM
the tons of litter. The model is concerned about the total phosphorus applied, and so to represent the litter applied, the values from Table 11 for the all poultry would have been computed or would have
been used to compute the amount of litter necessary 05:30PM
to contain that level of phosphorus.
Q I don't understand the computation. You're going to have to explain it to me. How do I get from Table 11 to 223,000 tons of litter per year;
what number do I use? 05:30PM



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A I thought the question you asked about was for 1950, how that was done.
Q Well, we circled to 1950 at some point, but tell me -- let's go back to D-18.
A Okay. 05:30PM
Q What years did you use the rate that is reflected of 223,000 tons of poultry litter being applied in the watershed per year as the starting point in terms of an input value for your modeling?
MR. GARREN: Object to form. 05:30PM
A So the 223,000 would have been used for the modeling from 1997 through 2006.
Q Okay. So as an initial matter, the GLEAMS model, I think that's the model into which this data goes; correct? 05:31PM
A Correct.
Q The GLEAMS model, the initial input value for the amount of poultry litter applied in the watershed each year from 1997 to 2006 was 223,000 tons; is that right? 05:31PM
A Correct.
Q Okay. Where did that value of 223,000 tons come from?
A So the 223,000 tons was the waste, poultry waste associated with the 4,642 tons of phosphorus 05:31PM



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from Table 11 back on Page 20.
Q How do I get from 4,642 tons of phosphorus in poultry litter according to Meagan Smith in Table 11 to 223,000 tons of poultry litter?
A I believe in addition to the 4,642 tons, I 05:32PM
think I actually have a waste associated with that back in a prior chapter in my report.
Q Would you find it for me, please?
A I'm looking. So this would have been a
conversion of the 354,000 tons reported in Chapter 05:33PM
3. I think it's discussed in multiple places, but you can find that in Table 3.8 on Page 17.
Q The 354,000 tons that is listed beside Dr. Fisher?
A Correct. So that would have been an 05:33PM
as-removed weight of litter from the poultry barns.
Q Well, you told me just a moment ago that the 223,000 was converted from Meagan Smith's Table 11, which had 400 -- I'm sorry, 4,642 tons of phosphorus
and now you've told me it was converted from Dr. 05:34PM
Fisher's table -- reference in Table 3.8 that has 354,000 tons of poultry litter. Which one is it? I'm confused.
MR. GARREN: Object to the form,
mischaracterization. 05:34PM



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A Well, I think I indicated that the historical applications came from the Meagan Smith table. The starting 223,000 tons was computed based on the 354,000 tons that Dr. Fisher and I computed.

Q Okay. How did you get from 354,000 tons to 223,000 tons, which is the actual input value that you used in the model? 05:35PM

A The GLEAMS model expects the input of litter to be on a dry weight basis. So the conversion to arrive at the 223,000 tons was to account for the conversion from an as-removed from the poultry barns that contained moisture in that to a dry weight basis that the model was expecting. 05:35PM

Q What conversion factor did you apply to the 354,000 tons shown on Page 17 to arrive at the 223,000 tons? 05:35PM

A I'm having to calculate that real quickly here.

Q Wouldn't you expect to find that in your report somewhere, Dr. Engel? I mean, I'll take your calculation, but why wasn't it in your report? 05:36PM

A It looks like it's approximately 65 percent.

Q All right.

MR. ELROD: 65 percent dry?

A The conversion that was used here to go from 05:36PM



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as-removed from the poultry houses to dry was 65 percent.

MR. ELROD: Which assumes 35 percent moisture?

A I believe that, yeah, I guess that would assume 35 percent moisture in this specific case. 05:37PM

Q Dr. Engel, you see if you look back at Page 17, the starting point for this input, and from Table 3.8 is poultry waste generated in the Illinois River watershed; do you see that? 05:37PM

A Yes.

Q Okay. Is it your understanding that this 354,000 tons, which you have converted to 223,000 dry tons reflects the estimate by Dr. Fisher of the total amount of poultry litter that is generated in the watershed each year? 05:37PM

A That value represented a specific year. You know, it didn't represent -- I don't think Dr. Fisher indicated that that represented things historically. So, you know, again, if we look at Table 3.8, there are a range of values, all of those bigger than 354,000. You know, I chose the lowest value, the most conservative value from the defendants' standpoint to use in making that computation. I could just as well have picked 05:38PM 05:38PM



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something that was more than 500,000 or approaching 500,000 and, in fact, if I used data that the defendants supplied based on poultry production from 2001 to 2006, the amount of waste generated would have ranged from 421,000 to 482,000 tons a year. So 05:39PM
the selection of 354,000 is obviously on the low end and obviously favors the defendants.

Q How does that favor the defendants?

A Well, if -- it's fairly straightforward. So if more poultry waste is being generated and, you 05:39PM
know, if we believe your number as to the amount that's been exported from the watershed, the remainder is being land applied, and as it's land applied, you know, all the literature indicates some of that is going to run off, and it's going to run 05:39PM
off proportional to the amount that's been applied, and so if we picked a bigger number, applied more of that in the landscape in the IRW, we would have attributed even more phosphorus to poultry.

Q Okay. So, Dr. Engel, if you had used, let's 05:40PM
say, a million tons per year of poultry litter being applied to the watershed, as your input value in your model, you would expect to see a larger percentage of the load at Lake Tenkiller being allocated through your modeling exercise to the 05:40PM



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poultry litter application; is that right?
A No, and let me tell you why.
Q Why not?
A So because the model was calibrated and one of
the values that was adjusted was the amount of waste 05:40PM
that was land applied. So, you know, if we had
been -- you know, if we had chosen not to calibrate
that parameter, then the answer would have been we
could certainly have attributed substantially more
to poultry if we had not been willing to calibrate 05:41PM
that parameter. So from that standpoint, you know,
this assumption -- you can think about this as an
assumption in the modeling. You know, this
assumption of the modeling benefitted your client a
great deal. You know, if we had not been willing to 05:41PM
make that adjustment, we could certainly have argued
you don't need to make that adjustment because we
know this amount of poultry waste has been generated
and we know that it's being land applied and we know
it's running off, everything says it does, you know, 05:41PM
we could have -- the model could have predicted
substantially more being attributed to poultry.
Q Okay. Just so I'm clear, Dr. Engel, because I
want to make sure I understand this, based upon the
way you chose to calibrate your model, your modeling 05:41PM



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work in this case cannot differentiate in terms of the percent allocation to the poultry litter applications between 354,000 tons of litter being applied in a year and a million tons of litter being applied in a year; is that right? 05:42PM

A I'm not sure I quite understand your question.

MR. GEORGE: Well, let's read it back, please.

(Whereupon, the court reporter read back the previous question.)

MR. GARREN: Object to form.

A That's incorrect. You are misrepresenting my statements.

Q Okay. Does the load attributed through your modeling methodology to poultry litter go up if you increase the amount of poultry litter the model assumes is applied? 05:42PM

A Yes, it does, as reflected in, you know, the historical growth scenario. So in that case, you know, it clearly showed that, you know, as you apply more poultry waste, it goes way up. Whether it's 70 percent or 92 percent, I think you would agree with me that, you know, both of those are large increases in the amount of phosphorus that comes off, and the only thing changed in that model scenario is the 05:43PM



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additional land application of poultry waste. So there's nothing else to attribute that increase to but land application of poultry waste. So, you know, the model can clearly reflect those changes.

Q You would agree with me that if your model cannot reflect changes in the -- one of the central inputs, which is the amount of poultry litter that's applied in the watershed, then that calls into question the reliability of your model? 05:43PM

MR. GARREN: Object to form. 05:44PM

A But the model is reflecting --

Q I asked a hypothetical. Can you answer it?

A The hypothetical, again was what? I got --

Q Sure. Dr. Engel, would you agree with me that if your model cannot differentiate and reflect differently between wide variations in a central input value, the amount of poultry litter that is applied in the watershed, that that calls into question the reliability of your model? 05:44PM

MR. GARREN: Object to form. 05:44PM

A But the model does represent those differences. So you're talking about something in the abstract here that doesn't make sense in this case.

Q Wouldn't make sense if your model couldn't do 05:44PM



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that; right?
A The model reflects increased phosphorus losses for increased poultry waste land application into the landscape of the IRW. That's consistent with literature, consistent with observed data. You 05:45PM
know, it's consistent with the scientific community that's looked at this issue.
Q Okay. Let me be more clear in my question. With respect to the loads that are being predicted or received at Lake Tenkiller, can your model 05:45PM
differentiate between the changes in the amount of poultry litter that is applied in the watershed?
A Yes.
Q Okay, and if it cannot, if you get the same number at Lake Tenkiller, no matter how much poultry 05:45PM
litter you put in your model, then your model is not reliable; right?
MR. GARREN: Object to form.
A But the model is not doing that.
Q What's doing that? 05:45PM
A I'm sorry. The model is not -- the model is not predicting the no change hypothetical that you're are asking.
Q If it was, Dr. Engel, would that call into question the reliability of your model? 05:46PM



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MR. GARREN: Object to form.
A But the model is not doing that.
Q Dr. Engel --
MR. GEORGE: And, Rick, I'm going to ask
for your help here because we're either going to 05:46PM
start back on the phone with the magistrate judge or
I'm going to get an answer to this question.
Listen, I understand, Rick, that he doesn't believe
it's occurring in his model. My question is, if it
is, does it call into question the reliability of 05:46PM
his model, and he can answer a hypothetical.
Q So, Dr. Engel, you can either do it or we'll
be on the phone with the court tomorrow morning.
What would you like?
A I think I'm trying to answer the question. 05:46PM
Q No, you're not. I'll try it one more time and
then we're going to be done with this question one
way or the other. Dr. Engel, if your model cannot
tell the difference in terms of loads at Lake
Tenkiller between a large variation in the amount of 05:46PM
poultry litter that you assume is applied in your
modeling effort, that calls into question the
reliability of your model, does it not?
MR. GARREN: Object as to form.
A So, Robert, I'm sorry, but the model is 05:47PM



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predicting loads to Tahlequah, Baron Fork and Caney Creek. So if you mean that to be equivalent to Tenkiller, then we can keep going.

Q That's exactly what I mean.

A Okay. So you mean that. 05:47PM

Q Correct. If you get the same prediction for those three places from your model no matter what you put in for poultry litter, then that calls into question your reliability of your model; correct?

MR. GARREN: Object as to form. 05:47PM

A It would.

Q Okay. Thank you. Now back to D-18, do we agree, Dr. Engel, based upon all the steps we went through to figure out where this 223,000 tons per year came from, that in your modeling work you 05:48PM assumed that all poultry litter generated in the watershed in a year, in particular from '97 to 2006, was applied in the watershed?

A So, yes, the starting inputs assumed it was all land applied. 05:48PM

Q Okay. Do you know how much poultry litter was actually applied in the watershed any year from 1997 to 2006?

A Based on data I've seen, there's some indication that in 2008, 2007, 2006, I believe those 05:48PM



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are the correct years, that there have been some effort to transport waste out of the watershed.

Q Okay. Now, so we don't get out on a rabbit trail, I'm not asking you to make a calculation based upon generation and then subtract what you 05:49PM know has been exported. Okay? Let's set that aside for a moment. I want to know if you, Dr. Engel, had information available that demonstrated and documented the actual amount of poultry litter that is applied in the watershed as opposed to generated. 05:49PM

A Well, I had data that indicate -- well, I have indirect data that one can use to calculate the expected amount that would be land applied, and just to carry that a step further, you know, because the model is being calibrated, it's not necessary that 05:49PM we have the exact 223,000 tons being applied at the start of this. So because of the calibration process, this is one of the items that's being adjusted via calibration and, therefore, you know, this is a detail that, you know, isn't necessary. 05:50PM

Q The actual amount land applied wasn't necessary for your modeling work; is that right?

A We needed a reasonable starting point for the amount being land applied. We had a reasonable starting point for the amount being land applied. 05:50PM



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That was the value that was used. That doesn't impact the conclusions. That doesn't impact the opinions that were reached.

Q Can you look in your report at Pages 19 and 20, Tables 4.1 and 4.3? Dr. Engel, you actually had 05:50PM available to you, did you not, and you've set out in these two tables in your report the results of your review of records regarding actual land applications in the watershed; correct?

A Well, so -- okay. So on Pages 19 and 20? 05:51PM

Q Uh-huh.

A So pages -- the tables on Pages 19 and 20 -- well, let me start with the table on Page 19. So this table is identifying via ODAFF records the amount of waste that was generated within the IRW 05:51PM and whether it was applied inside, on the border or outside of the IRW. I would take that a step further and indicate that by no means are the ODAFF records complete and by no means do those represent the entirety of waste that would have been land 05:52PM applied within the watershed.

Q How do you know that?

A Well, again, if you look at the literature, if you look at nutrient management plans from producers in Arkansas, this is ODAFF data so it doesn't pick 05:52PM



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up Arkansas producers. If you look at, you know, the reports from -- multiple reports from Storm, state agency reports, federal reports, the USGS analysis, all of these sources including your own Tyson's environmental practices handbook, indicate 05:53PM that poultry waste is land applied and it's typically land applied near where it's produced.

Q Okay. Dr. Engel, who do growers in the state of Oklahoma, in the Oklahoma portion of this watershed, report to in terms of the location and 05:53PM amount of their litter application?

A You said the Oklahoma portion of this?

Q Yes, sir.

A My understanding is that, you know, they're reporting data to ODAFF. 05:53PM

Q Okay, and you in Table 4.1 have tallied up over a multiple year period the amounts of litter that ODAFF has received reports on in terms of litter application in the watershed; correct?

A Correct. 05:53PM

Q Okay, and these numbers, by the way, if you look at the inside Illinois River watershed in terms of tons, those numbers reflect a combination of multiple years' worth of reports; correct?

A I believe that's the case. 05:54PM



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Q Okay. Do you recall how many years?
A Not without looking at some background data.
Q All right. We don't have time to look. Turn to the next page, Table 4.3. On the Arkansas side of the basin, who receives reports in terms of 05:54PM
regulatory body on the amount of poultry litter that's applied by Arkansas growers?
A As I recall, the ANRC has some data. It's not a dataset that allows one to readily see via the data that's available and reported to see where all 05:54PM
the waste is land applied.
Q All right. So in Table 4.3, do I understand that you've summarized the information provided by the Arkansas regulator in terms of the amount of poultry litter applied in four years, from 2004 to 05:55PM
2007, in the Arkansas portion of the basin?
A What were the years?
Q 2004 through 2007.
A Oh, is that what it says?
Q Table 4.3. 05:55PM
A Oh, yes.
Q Okay. So, Dr. Engel, if you added up any given year's worth of data in terms of the actual records of documented litter application in the watershed from the two regulatory agencies, would 05:55PM



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you ever get a year that reflects 354,000 tons of documented land application of poultry litter?

MR. GARREN: Object to the form.

A These two tables and those two datasets don't represent all of the waste that's been land applied. 05:55PM

Q And how do you know that?

A You can look at nutrient management plans. You can look at literature. You can look at other scientific reports cited in the earlier parts of this chapter and, in fact, your own experts want to 05:56PM be -- want you to be compensated for the amount of waste that's being land applied. Rouser and Dicks assume every bit of it is land applied, and they assume every bit of it has been land applied historically. 05:56PM

Q Are you basing your opinion on the opinion of Rouser and Dicks, Dr. Engel?

A That's one place, one among many sources.

Q Do you consider them to be reliable sources of information? Well, you wouldn't rely on an 05:56PM unreliable source, would you?

MR. GARREN: Object to form.

A Their assumption regarding land application of waste, I think they are correct with that assumption. 05:57PM



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Q So you believe they make reasonable assumptions in their analyses then?

MR. GARREN: Object to form.

A That carries my statement a little further than I think I would carry it. 05:57PM

Q All right. I think the only data source that you identified in your list of things, other than records, was nutrient management plans. Did you tally up the values reported in nutrient management plans for all growers in this watershed in terms of 05:57PM the amount of poultry litter that's being applied?

A I didn't have access to all nutrient management plans for this watershed, nor does anyone else to my knowledge have access to all nutrient management plans for the watershed. So, yes, I 05:57PM think that's a mischaracterization of, you know, what the reality might be.

Q All right, but you didn't do it because you didn't have that data available; right?

A Right. 05:57PM

Q And in the absence of data in modeling, sometimes you have to make assumptions; right?

A Yes.

Q And one of the assumptions that was made in your modeling work was that in each year the 354,000 05:58PM



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tons of poultry litter wet that are generated are applied in the watershed; is that right?

MR. GARREN: Object to form.

A Well, again, there's ample evidence in the literature and in the reports that I mentioned in other modeling studies that have been done on this watershed, you know, that indicate that that is a valid assumption. 05:58PM

Q Okay. You believe that to be a good assumption; right? 05:58PM

A I guess we're talking about an assumption that would be well accepted and is well supported by the literature, well accepted by the scientific community.

Q Okay. So, Dr. Engel, despite all that, how well accepted you believe your assumption is, if that assumption is markedly off in terms of reality, that affects the output of your model; right? 05:58PM

A What do you mean by markedly off?

Q Let's say in reality there is only 200,000 tons of poultry litter applied in the watershed each year. Would that affect the outcome of your model? 05:59PM

A If it were that low?

Q If it were that low, yes.

A Well, I mean, if it were -- we can't have the 05:59PM



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soil test phosphorus levels that we currently see in this watershed with all these assumptions you are wanting to make. So stepping back as a modeler, you have to look at the data that's there. You're not looking at one piece of data when you're making 05:59PM these decisions, and you're looking at the soil test phosphorus and you say, well, that's high, how did it become high. Everything points to land application of poultry waste as to the reason that that has become high. In fact, I think Mr. Ryan, in 06:00PM representing Tyson in the preliminary injunction, indicated that poultry waste had been over applied in many instances in the watershed. So, you know, there are numerous sources that point to this being a valid assumption and an assumption that, you know, 06:00PM any reasonable modeler would make.

Q Move to strike, non-responsive. Dr. Engel, another assumption that you made in your modeling, is that all parcels of land identified in your dataset as pasture in the Illinois River watershed 06:00PM received poultry litter each year; is that right?

A That's correct.

Q What was the basis for that assumption?

A Well, knowing how the model works and understanding that we needed to allocate poultry 06:00PM



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waste to the landscape, an appropriate assumption was to apply that poultry waste to all pasture areas each year. So the net impact of that on the ability to model the phosphorus reaching the three gauging stations, the ability to model the phosphorus 06:01PM
attributable to each source was negligible. So, in fact, that assumption benefits the defendants. You know, that assumption puts low amounts of phosphorus, low amounts of waste on the pasture. The model is going to indicate that higher amounts 06:01PM
are more susceptible to runoff and movement. Literature suggests the same, and so by applying these lower amounts, you know, the net effect of that assumption was to underestimate the poultry contribution to phosphorus runoff. 06:02PM

Q Dr. Engel, do you believe that all mistakes that were made in your modeling should be excused if they benefit the defendants?

MR. GARREN: Object to form.

A Assumptions -- the assumption we just talked 06:02PM
about in applying poultry litter to all pastures is not a mistake. That was an assumption, not a mistake.

Q Okay, but you will agree with me that if your assumption is unrealistic, then it can affect 06:02PM



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whether or not the results from your model are realistic; right?

MR. GARREN: Object to form.

A Well, one has to know how these assumptions propagate through the model. So, you know, if I 06:03PM assumed all the phosphorus was applied in a small area, yeah, that would be a really bad assumption. If I assume because I understand how the model works and I understand the equations and the theory in the model, by spreading it across all pasture, I'm able 06:03PM to estimate phosphorus movement from the watershed. I'm able to estimate that so that it matches the observed data, and the net impact of that is that I'm allocating less phosphorus loss to poultry than what reality would be based on the documented waste 06:03PM application processes within the watershed.

Q It's your testimony, Dr. Engel, that your assumption that more pastures receive poultry litter in your modeling than actually receive poultry litter in the real world is an assumption that 06:04PM benefits the defendants; is that right?

A Yes.

Q Okay. Is it a realistic assumption in terms of reflecting the conditions and land uses and application practices that actually exist in the 06:04PM



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watershed?
A For the purposes of the model study, it wasn't necessary to reflect the actual spreading patterns. So the answer to your question is, no, it doesn't reflect the exact application patterns but it's not 06:04PM
necessary to reflect the exact application patterns, for this scale of analysis for the questions that were being asked.
Q Who says it's not necessary; you?
A As a modeler and based on my professional 06:04PM
experience and judgment, yes, and if we look in the literature, again, we're going to find that this is a very commonplace assumption. If we look at the USGS reports that identified trends between
increased phosphorus loads and livestock that 06:05PM
included poultry land application, they didn't allocate that. You know, they were working at scales comparable to the gauges on the IRW. They found trends. You know, it's not necessary to
represent what you're suggesting I should have done. 06:05PM
It wasn't necessary.
Q Okay. Let's get out of model work for a moment and get into reality. You do agree with me, as a matter of reality, that not all pastures in the
Illinois River watershed receive poultry litter 06:05PM



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every year?
A I would agree with that statement.
Q Okay. Another assumption, Dr. Engel, that you made in your modeling work is that all 354,000 tons of poultry litter generated in this watershed was 06:06PM applied on a single day each year; is that right?
A That's correct.
Q Okay, and what day was that, at least in your initial model setup?
A I believe that was the first of March or so. 06:06PM
Q Look at the bottom of D-18, Dr. Engel.
A Looks like the 1st of April.
Q So in the initial setup of your model in this case, you assumed that all 354,000 tons of poultry litter went down in one event on April 1st on all 06:06PM pastures in the watershed; is that right?
A That's correct.
Q Okay. Now, Dr. Engel, you do agree with me, do you not, that the season and timing of application, particularly in reference to rainfall, 06:07PM can affect the amount of phosphorus that is lost from a field?
A It can.
Q Okay, and you do agree with me, do you not, Dr. Engel, that in the real world, not the model 06:07PM



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world but the real world, that poultry litter is applied on more than one day a year?

A Yes, and, in fact, I think back in an earlier chapter there's some documentation as to what those patterns might look like. 06:07PM

Q Let's look at that because that reminded me. Page D-18 -- I'm sorry. Page 23 of your report, do you see Figure 4.1?

A Okay. I've located it.

Q Okay, and sticking with April because April 1st was the date that you used in your model, according to the information that you reviewed, real data from the watershed, what percentage of poultry litter is historically applied in April? 06:08PM

A It looks like in April a little more than 17 percent and March is about the same. 06:08PM

Q Okay, and there's no single month, is there, Dr. Engel, in the data that you have been provided in which the percentage of the total amount of poultry litter exceeds 20 percent? 06:08PM

A No.

Q So, Dr. Engel, is your assumption that all poultry litter is applied on April 1st each year in the watershed a realistic assumption?

A It's realistic for modeling. So it was 06:09PM



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certainly an appropriate assumption for modeling again.

Q If your goal is to actually simulate the conditions and practices that are occurring in the real world, is it a realistic assumption? 06:09PM

MR. GARREN: Object to form.

A So, again, here, the goal was to be able to model phosphorus loads and arrivals at the gauging stations and then to be able to use various scenarios with those. That was one group of goals, 06:09PM and the other was for allocation purposes. So, again, you know, for that set of purposes, this is a perfectly fine assumption.

Q You don't believe that using April 1st was a foolish assumption? 06:10PM

MR. GARREN: Object to form.

Q You can answer.

A It was April Fool's Day I suppose, wasn't it?

MR. BASSETT: It was a good question.

MR. ELROD: It's my contribution. 06:10PM

MR. GEORGE: How much time do we have left, Lisa?

COURT REPORTER: Five minutes.

MR. GEORGE: Let's stop here. It's as good a place as any. 06:10PM



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VIDEOGRAPHER: We're now off the Record. The time is 6:10 p.m.

(Whereupon, the deposition was recessed at 6:10 p.m.)



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SIGNATURE PAGE

I, Bernard Engel, PhD, do hereby certify that the foregoing deposition was presented to me by Lisa A. Steinmeyer as a true and correct transcript of the proceedings in the above styled and numbered cause, and I now sign the same as true and correct.

WITNESS my hand this _____ day of _____, 2009.

_____

BERNARD ENGEL, PhD

SUBSCRIBED AND SWORN TO before me this _____ day of _____, 2009.

_____

Notary Public

My Commission Expires:

_____



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C E R T I F I C A T E

STATE OF OKLAHOMA )
) ss.
COUNTY OF TULSA )

I, Lisa A. Steinmeyer, Certified Shorthand Reporter within and for Tulsa County, State of Oklahoma, do hereby certify that the above named witness was by me first duly sworn to testify the truth, the whole truth and nothing but the truth in the case aforesaid, and that I reported in stenograph his deposition; that my stenograph notes were thereafter transcribed and reduced to typewritten form under my supervision, as the same appears herein.

I further certify that the foregoing 261 pages contain a full, true and correct transcript of the deposition taken at such time and place.

I further certify that I am not attorney for or relative to either of said parties, or otherwise interested in the event of said action.

WITNESS MY HAND AND SEAL this 13th day of January, 2009.

_____

LISA A. STEINMEYER, CRR
CSR No. 386



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IN THE UNITED STATES DISTRICT COURT FOR THE
NORTHERN DISTRICT OF OKLAHOMA

W. A. DREW EDMONDSON, in his )
capacity as ATTORNEY GENERAL )
OF THE STATE OF OKLAHOMA and )
OKLAHOMA SECRETARY OF THE )
ENVIRONMENT C. MILES TOLBERT,)
in his capacity as the )
TRUSTEE FOR NATURAL RESOURCES)
FOR THE STATE OF OKLAHOMA, )
)
Plaintiff, )
)
vs. )4:05-CV-00329-TCK-SAJ
)
TYSON FOODS, INC., et al, )
)
Defendants. )

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VOLUME II OF THE VIDEOTAPED DEPOSITION OF BERNARD ENGEL, PhD, produced as a witness on behalf of the Defendants in the above styled and numbered cause, taken on the 9th day of January, 2009, in the City of Tulsa, County of Tulsa, State of Oklahoma, before me, Lisa A. Steinmeyer, a Certified Shorthand Reporter, duly certified under and by virtue of the laws of the State of Oklahoma.

A P P E A R A N C E S

FOR THE PLAINTIFFS: Mr. Richard Garren
Mr. David Page
Attorneys at Law
502 West 6th Street
Tulsa, OK 74119
-and-
Ms. Kelly Burch
Asst. Attorney General
313 N.E. 21st Street
Oklahoma City, OK 73105

FOR TYSON FOODS: Mr. Robert George
Attorney at Law
2210 West Oaklawn Drive
Springdale, AR 72762

FOR CARGILL: Ms. Leslie Southerland
Attorney at Law
100 West 5th Street
Suite 400
Tulsa, OK 74103

FOR SIMMONS FOODS: Mr. John Elrod
Attorney at Law
211 East Dickson Street
Fayetteville, AR 72701

FOR PETERSON FARMS: Mr. Scott McDaniel
Attorney at Law
320 South Boston
Suite 700
Tulsa, OK 74103

FOR GEORGE'S: Mr. Woodson Bassett
Attorney at Law
221 North College
Fayetteville, AR 72701



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1 FOR CAL-MAINE: Mr. Robert Sanders
Attorney at Law
2 2000 AmSouth Plaza
P. O. Box 23059
3 Jackson, MS 39225
(Via phone)
4
5 ALSO PRESENT: Dr. Victor Bierman
6
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I N D E X


| W I T N E S S | P A G E |
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(Whereupon, the deposition began at 8:06 a.m.)

VIDEOGRAPHER: We are back on the Record for the deposition of Mr. Bernard Engel. Today is January 9th, 2009. The time is 8:07 a.m. Would 08:07AM
counsel please identify themselves for the Record.

MR. GARREN: Richard Garren for the State of Oklahoma.

MR. GEORGE: Robert George for the Tyson defendants, and I have with me a consultant, Vic 08:07AM
Bierman.

MR. McDANIEL: Scott McDaniel for Peterson Farms, Inc.

MR. BASSETT: Woody Bassett for the George's defendant. 08:07AM

MS. SOUTHERLAND: Leslie Southerland for Cargill.

VIDEOGRAPHER: And on the phone?

MR. SANDERS: Bob Sanders for the Cal-Maine defendants. 08:07AM

VIDEOGRAPHER: Thank you.

BERNARD ENGEL, PhD

having first been duly sworn to testify the truth, the whole truth and nothing but the truth, testified as follows:



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CONTINUED DIRECT EXAMINATION

BY MR. GEORGE:

Q Good morning, Mr. Engel.

A Morning.

Q One housekeeping matter. Yesterday when we 08:08AM
were discussing your routing model and the
coefficient shown on Page D-21 of your report, we
had a dialogue about whether those coefficients were
constrained by any limits. Do you recall that?

A Correct. 08:08AM

Q Okay, and I believe you told me that A, B and
C were not physically based coefficients, so they
were not upper bound but that the initial P
accumulation you thought did have an upper bound;
does that sound right? 08:08AM

A It did, yes.

Q Okay. Let me hand you what I've marked as
Exhibit 12 to your deposition, which is a file that
was obtained from your considered materials. Do you
recognize this file? 08:08AM

A Right. In fact, I think I looked at that last
night.

Q Can you describe for the Record what Exhibit
12 is?

A So Exhibit 12 is an input file to a program 08:08AM



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that was used to obtain coefficients A, B, C and initial phosphorus accumulation that was used in the equation we were discussing. So it provides a range of parameters required for the model and then the bounds on those that were to be used during this 08:09AM
particular run.
Q And the one page that I've handed you that's marked Exhibit 12, is it for a particular subwatershed that is reflected in your model?
A This indicates it's for the Illinois River, 08:09AM
which would be the Illinois River at Tahlequah.
Q Would you have a similar file for the other two watersheds?
A Yes, there would be.
Q Okay. Let me hand you, and I should have 08:09AM
grouped this as one, two more documents and ask if you can identify those as the same information for the other two watersheds, Caney Creek and Baron Fork?
A Yes. 08:10AM
MR. GARREN: You want to just group these with 12?
MR. GEORGE: Yeah. Let's put them all with 12.
Q And, Dr. Engel, would those materials in front 08:10AM

of you from your computer files, can you now tell me whether there were upper and lower bounds established or placed upon the coefficients used in your routing model?

A Yes, there were. 08:10AM

Q Okay, and what were those upper and lower bounds for? Let's start with coefficient A.

A So it looks like for A, for -- you want to go one by one or all three cases?

Q Let's go all three cases. 08:10AM

A We'll go the same for all three cases. For A, between .1 and 90.

Q Okay, and what was the basis for establishing those ranges in which the model could move the coefficient A? 08:10AM

A So let's see. A would represent the amount of phosphorus delivered per day at no flow. So a lower bound would be quite small. The upper bound at low flow would also be small. As it turns out, the calibrated value I think was at the lower bound or 08:11AM near the lower bound in those.

Q I think you told me yesterday that these coefficients weren't physically based; is that right?

A I guess A probably does have a little bit of 08:11AM



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physical meaning.
Q Did you review any data or take any measurements or perform any field analysis in order to establish the upper or lower bounds for the coefficient A? 08:11AM
A Well, logically A -- so it's I guess no to your question, and logically A, if there's no flow, there can't be phosphorus being delivered beyond what might be delivered that would be below the flow threshold that would be measured. 08:12AM
Q Okay. Let's move on to coefficient B. What were the upper and lower bounds that you placed upon coefficient B in the optimization of your routing model?
A So B would -- for all three cases again would vary from -- would have bounds from zero to 100. 08:12AM
Q What's the rationale for the coefficient B being allowed to go all the way to zero?
A If there were no relationship between flow and phosphorus delivery, the program would find that the value for B should be zero, so that would be the basis for a zero. 08:12AM
Q What's your rationale for the upper limit of a hundred for coefficient B using your routing model?
A The program that was used to identify the best 08:13AM



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values for A, B, C in the initial P accumulation value needed some range in which to search and, therefore, an upper bound needed to be provided. So following the operation and identification of the coefficients, that coefficient was well below that 08:13AM
upper bound. So that indicates that that would be a suitable assumption.

Q With respect to coefficient B used in your routing model, did you review any data from the Illinois River watershed or measurements in order to 08:13AM
establish the upper or lower bounds?

A Well, there would not need to be -- so no -- well -- so, I did look at relationships between flow and phosphorus delivery. So based on that observation and then based on plots between outputs 08:14AM
of the modeled -- once these had been established, the A, B, C, initial phosphorus accumulations, the ones that had been established, and that result plotted and compared to the observed phosphorus loads, this was reasonable. 08:14AM

Q Let's move on to the P accumulation, initial P accumulation values. Did you have an upper and lower limits in your P routing model on the extent to which those values could be optimized?

A There were. 08:14AM



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Q Okay, and can you tell me for each of the three separate watersheds addressed in your routing model what were the upper and lower limits?
A So for Illinois River, lower bound was 100,000; upper bound was 500,000. For Baron Fork, 08:15AM
lower bound was 10,000; upper bound was 100,000, and this indicates that Caney Creek was 100,000 to 350,000. I believe there was another backup file for Caney Creek that had a lower bound in it, and in
looking at that last night, I believe that backup 08:15AM
file to Caney Creek was used, and if I can look at a note in my pocket, I think in that backup file for Caney Creek the range was zero to 350,000, if I've got this noted correctly.
Q And how does that vary from Exhibit 12? 08:15AM
A So for Exhibit 12, it looks like Caney Creek in this file had a lower bound of 100,000.
Q So in the other backup file that you believe was used in optimizing your routing model, there was
no lower bound limit on Caney Creek; is that right? 08:16AM
A I believe it was set at zero so it wouldn't go negative. So it potentially could have -- potentially could have gone negative, and that would not make physical sense.
Q What is the file name of this backup file for 08:16AM



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Caney Creek that you believe you used in your optimization process?

A I believe it would be the same file name sce.dat.bak.

Q And where would I find that in your electronic materials? 08:16AM

A It would be in the same directory that these were found.

Q Dr. Engel, in the optimization process can the P accumulation assume any value except zero? 08:17AM

A Well, it shouldn't be negative.

Q Well, any positive value except zero?

A Well, in the -- as -- as the program was run, it was reading this range between the minimum and the maximum, so it would not report a value outside those ranges. 08:18AM

Q Does that mean it can assume any value, any positive value except zero?

A Well, so that would mean that it would be constrained between zero and the upper bound. 08:18AM

Q Let's stay with files for a moment related to your routing model. Let me hand you what we've marked as Exhibit 13, which is a spreadsheet or document printed from your considered materials, Dr. Engel, and I've written at the top in handwritten 08:18AM



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text the file name so I'd have a reference of where I obtained it from. So Exhibit 12 (sic) came from an Excel spreadsheet that was included in your materials that was identified as P-model-8-29.xls. Do you see that? 08:19AM

A Yes.

Q What is Exhibit 12 -- I'm sorry, Exhibit 13?

MR. GARREN: 13.

A Well, without looking at the specific file, is there more information in this spreadsheet or is 08:20AM this the only contents of that spreadsheet?

Q No. It's the only tab that's in it, Dr. Engel, and it was included in the materials related to your routing model.

A So this looks like -- so without looking at 08:20AM the file and putting this in context a bit better, this seems to be at the top the modeled phosphorus, one group of that in kilograms per year. Another seems to be the conversion to pounds per year. So the top slice would seem to be the modeled. The 08:21AM bottom slice is labeled observed, and it would seem to be the phosphorus loads that were observed that correspond to the predicted values above.

Q Okay, and I think you told us yesterday that the purpose of your routing model or the goal was to 08:21AM

match predicted loads to observed loads; is that right?

A Correct.

Q Okay, and so do you believe this spreadsheet to be part of the mechanics of that process where you would make that comparison between what the model predicts and what is actually observed? I'm trying to understand what this is. 08:22AM

MR. GARREN: Object to form.

A That's what this seems to be. 08:22AM

Q Now, how do you convert from the left-hand side of the spreadsheet phosphorus from the model in kilograms per year to phosphorus in pounds per year on the right-hand side of the spreadsheet?

A Right-hand side, so looks like that would be just a conversion factor to go from kilograms to pounds. 08:22AM

Q Okay, and are there some -- is there a recognized conversion factor in the literature to go from kilograms to pounds? 08:23AM

A Yes, there would be.

Q Okay, and do you know what that conversion factor is?

A So, let's see. I believe if we divide kilograms by .45 -- I'm going to have to look to 08:23AM



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remember the last digits on that.
Q You could take a number there and divide it and figure out; right?
A I could.
Q If I hand you what has been represented to me 08:23AM
to be a calculator, but it's the most complicated device I've ever seen, could you do the math?
A Oops. Could I have the $4 one? I don't use this particular one, so it's --
DR. BIERMAN: Sorry. Not many people do. 08:24AM
It's a legacy; it was a gift.
MR. McDANIEL: Let the Record reflect a $4 Walgreen's calculator just replaced a thousand dollar --
MR. GARREN: Can we establish that Bierman uses it?
MR. McDANIEL: -- 1982 Hewlett Packard.
DR. BIERMAN: That was purchased in 1986.
(Whereupon, a discussion was held off the Record.) 08:25AM
A Looks like .4535 for the one or I -- .4536 for the one I selected.
Q Okay, and is that -- I'm sorry. Go ahead. Is that from the model at the top or the observed at the bottom? 08:25AM

A Let's see. So that was from the top.
Q Okay. Could I burden you to do one from the bottom from the observed section to make sure you are using the same conversion factor there? Pick one of your choice. 08:26AM
A Looks like it's the same.
Q .4536?
A Yes.
Q Okay. Now, at the top of this spreadsheet where I had written the file name, what is the 08:26AM significance of 8-29 in terms of how -- is that a date?
A That was probably the date when that was saved initially.
Q Okay, all right. Let me hand you what we'll 08:26AM mark as Exhibit 14. Actually before we get there, the observed loads, Exhibit 13 at the bottom right-hand corner where you've got '98 through 2006, do you see that range?
A Yes. 08:27AM
Q Okay. That's the same range for which you've computed load ests, observed loads that you referred to in your report; is that right?
A I believe they were also computed for '97.
Q Okay. Can you look at Table 5.3 in your 08:27AM

expert report, which is on Page 25?
A Okay.
Q Do the observed loads that you report on Page 25 in your expert report match the observed loads that are shown in Exhibit 13? 08:28AM
MR. GARREN: Object to form.
A Looks like they do not.
Q Do you have an explanation for that, Dr. Engel?
A Give me a moment and let me look and see if 08:28AM they happen to match the values from this errata of September 4.
Q Okay. Please do. You're consulting Exhibit 4?
A Exhibit 4, yes. 08:29AM
Q Okay. Dr. Engel, do they match Table 5.3 in the amended report?
A Well, it seems --
MR. GARREN: Object to form.
A It would appear that Caney Creek matches. It 08:29AM appears that Baron Fork does not, and it appears that Tahlequah does not. So this seems to be, you know, the error that was fixed in that subsequent errata in October seems to have addressed this issue. 08:30AM



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Q Well, Dr. Engel, didn't your subsequent errata in October simply restore the observed loads reported in your original Table 5.3?
A Wait a minute here. So --
Q Can you answer that question first? 08:31AM
A I'm sorry.
Q That's okay.
A The question again was?
Q Sure. Dr. Engel, you referred to your subsequent errata, which was a letter I believe from 08:31AM counsel in October of 2008, and my question was, didn't that subsequent errata simply restore the observed loads that you reported in the original Table 5.3 in your May report?
A There were other changes beyond that, yes. 08:31AM
Q But with respect to observed loads, you didn't create a third set of observed loads; you simply said that the ones in your original report were correct; right?
A Yes. 08:31AM
Q Okay, all right. You were about to say something. So go ahead.
A So I guess I can't tell from -- we need to back up a bit. So I misspoke a bit when trying to compare this with the errata of September. So I 08:32AM



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guess I can't tell in looking at this Table 10.1 as to whether these match without doing some additional calculations here.

Q Okay. Well, let's look at another document, Dr. Engel. I'll hand you what I've marked Exhibit 14 to your deposition, which is a file that is similar in its format that came from your considered materials from an Excel spreadsheet that was labeled P-model-10-15.xls. Did I read that correctly, Dr. Engel? 08:32AM 08:33AM

A Yes.

Q Okay, and this looks like the same process and data. Do you agree that's what was in Exhibit No. 13?

A Looks like the same type of data but looks like some of the data are different. 08:33AM

Q Okay, and once again, this spreadsheet, when you go from the left-hand side to the right-hand side, you're having to convert from kilograms to pounds; is that right? 08:33AM

A Yes.

Q Okay. Now, can you look at the -- let me go through the same exercise and see if you can check the conversion factor that was used in converting from kilograms to pounds at the top of the 08:33AM



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spreadsheet with respect to your model output and then at the bottom of the spreadsheet with respect to observed loads. Again, you can pick two numbers at random to do your division.

A So looks like .4356. 08:34AM

Q Relates to observed or modeled?

A Both.

Q Give me the two numbers that you divided at the top on modeled.

A So, let's see. At the top for 1998 Tahlequah, 08:35AM 182,424 divided by 4 -- so the corresponding 402,170.

Q Okay, and when you do that division, what number do you get?

A .4536. 08:35AM

Q Okay. Now, let's go down to the observed loads and tell me which numbers you divided by.

A Let's use again the first one, 18,421 rounding to 8, divided by corresponding value of 422,906 -- woops, I mistyped that. Looks like it's transposed. 08:36AM I get .4356.

Q Okay. Just so our Record is clear, you get a different conversion factor with respect to your conversion of observed loads from kilograms to pounds than you get when you are converting your 08:36AM



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modeled loads from kilograms to pounds; is that right?

A So it would seem in the spreadsheet, the 3 and the 5 were transposed in that calculation.

Q Which conversion factor is right, Dr. Engel, the .4536 or the .4356? 08:36AM

A .4536.

Q Does that mean that the observed loads that are shown in the right-hand bottom portion of Exhibit 14 are wrong? 08:37AM

A So it looks like they are incorrect by about 2 percent.

Q How did you get 2 percent? I'm just curious.

A Maybe it's 4 percent. Give me a moment. Sorry. It's about 4 percent. So if I do the conversion with the non-transposed factor, looks like for the first one at Tahlequah the result would be 406,122, and if you divide that by the value that's there, the difference is about 4 percent. 08:38AM

Q Okay. Dr. Engel, are the incorrect loads that are shown in Exhibit 14 also used in your expert report, in particular, if you look at Page 25 of your expert report, Table 5.3? 08:38AM

A Yes. They seem to be the same values that are in this spreadsheet you handed me that's Exhibit 14. 08:40AM



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Q So, Dr. Engel, given that we've established that the loads that you used in your routing model are incorrect or off by 4 percent, what does that do to the overall results of your routing model?

MR. GARREN: Object to form. 08:40AM

A I'd have to look at the routing model to see that the wrong values were used in that. The routing model is using daily values and I would need to look at the conversion if there was a conversion done there between these. So what we're seeing in 08:40AM Table 5.3 and what we're seeing in the data that you handed me in Exhibit 14 is a summary of daily values. So to answer your question, I need to see underneath this quite a bit more to see the values that were used. So I have no reason to believe 08:41AM without seeing underneath this to believe that the incorrect conversion was used in the routing model.

Q Let's go to -- back to your GLEAMS model for a moment, Page D-19 of your expert report. On Page D-19, Dr. Engel, you identify some nutrient input 08:42AM parameters or values that were used in the model; is that correct? Do you see at the top of the page?

A Excuse me. Yes.

Q Now, you list several nutrient input parameters, but I want to take a step back for a 08:42AM



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moment. If you look at the actual input files, the nutrient input files for your GLEAMS runs, there are more parameters than those that are listed on Page D-19, are there not?

A Yes, there would be. 08:42AM

Q Okay. There are -- I haven't counted them, but there are 30 or 40 at least, different values that GLEAMS needs to run its programs on in the nutrient input file; correct?

A Maybe even more than that. 08:42AM

Q Okay, and some of those values relate to soil features or characteristics and some relate to characteristics of fertilizer, including animal waste; is that right?

A Correct. 08:43AM

Q Okay. How many of those nutrient input parameters that were used in GLEAMS were based upon default values that were already present in the GLEAMS programming?

A Without seeing a list, I would be -- and 08:43AM looking at the files, I would be hard pressed to give you an accurate answer.

Q Okay. You agree with me that the majority of those items were based upon default values?

MR. GARREN: Objection to form. 08:43AM



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A Probably default would be too strong. So many of the inputs were derived from data that, you know, that represent -- that represented spatial inputs to the model. There probably were some that were default values. There were a group of these that 08:44AM
were calibrated with -- that were calibrated during the process in which the model was adjusted to match the observed phosphorus loads, and so in that respect, even though they may have been defaults initially, their values would have changed during 08:44AM
calibration to reflect expected conditions in the field and, in fact, match what phosphorus was leaving the watershed.

Q Let's talk about the initial model setup, Dr. Engel. As best as you can, and I recognize you may 08:45AM
not be able to give me a precise number here, what percentage of the total number of input values that you need to run GLEAMS were based upon site-specific data from the Illinois River watershed?

A Well, without looking at the input files, I'm 08:45AM
going to be really hard pressed to answer that.

Q Do you have any reason to believe that more than 20 percent of the input values required by GLEAMS were developed from site-specific data from the Illinois River watershed? 08:45AM

A I'm not going to speculate as to the exact number.

Q Let's see if we can find something we can agree on. You will agree with me, will you not, Dr. Engel, that in many instances, you and Dr. Ji-Hong 08:45AM used default values that were present in the programming or values that were pulled from the GLEAMS manual as opposed to site-specific data?

MR. GARREN: Object to form.

A Well, the question assumes that use of 08:46AM site-specific data is necessary to set up many of those parameters. So -- so -- again, I don't know exactly how many were, but just because, you know, defaults were used doesn't mean they didn't represent conditions in the Illinois River 08:46AM watershed.

Q Dr. Engel, I'm going to ask you not to argue with the premise of my question but rather to answer it.

MR. GEORGE: Let's have it read back, Lisa. 08:46AM

Q And if you could, Dr. Engel, answer it directly.

(Whereupon, the court reporter read back the previous question.)

MR. GARREN: Objection. 08:47AM



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A So some defaults were used. I don't know how many defaults were used. Those defaults would have been based on observation of data within the watershed, and when it was appropriate to leave them at default values, they were left at default values. 08:47AM

Q Dr. Engel, it's not your testimony, is it, that the default values present in GLEAMS were developed from environmental data in the Illinois River watershed?

MR. GARREN: Object to form. 08:47AM

A The default values in GLEAMS and other models like it come from a broad set of data and experiences that the model developer had had, and so in that sense, they're not necessarily unique to a given location. 08:48AM

Q Okay. What did you do or did Dr. Ji-Hong do to assure yourselves that the default values that you used from GLEAMS programming or the manual were representative of actual conditions in the Illinois River watershed? 08:48AM

A Are we talking about -- there's so many parameters, it's tough to be very specific here without looking at these in many files and almost looking at these one by one.

Q Did you have a process in place to confirm 08:48AM



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that the default values that were present in the GLEAMS programming or the manual that you used were in fact representative of conditions in the Illinois River watershed?

A Well, based on knowledge of the watershed and 08:48AM
its characteristics and reading about the watershed, the behavior, the processes, the soil information, having experience and applying the model in other places, you know, all of that would have gone into
deciding which parameters to adjust, which 08:49AM
parameters for which default values could have been used. I guess I would carry that a step further as well, in that based on past experiences with the model and models like this, for the conditions
within this watershed, there are a group of 08:49AM
parameters that are less sensitive, and so one could use defaults for things that are less sensitive, therefore, less likely or would have little impact on the model results, and the most sensitive
parameters were then adjusted during the calibration 08:50AM
process. That calibration process then allowed one to look at those sensitive parameters to see. Do those match expectations within the watershed and if those do match expectations within the watershed,
based on all this observed phosphorus data, then 08:50AM



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that's certainly an appropriate set of values to use. So that was kind of the general overall decision-making process.

Q Dr. Engel, did you have a written protocol for evaluating and the steps that you would take to 08:50AM evaluate the representativeness of default values?

A I guess the protocol for determining representatives of default values was probably not written down -- was not written down in totality. There's some documentation in this appendix that 08:51AM speaks to use of some of those values. Again, based on experience in using this model, using other models, those default values were, you know, were left in some cases. The items identified as most sensitive were calibrated. 08:51AM

Q You referred to a group of input values or parameters that were most sensitive that you gave, I believe, special attention to in terms of selecting values. Can you turn to Page D-41 of your appendix to your May 2008 report, which is Exhibit 2? When 08:52AM you made those statements, Dr. Engel, were you referring to this list of seven parameters that appears on Page D-41?

A Looks like there are seven for the hydrology and certainly the hydrology also impacts nutrients 08:52AM



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and then it looks like -- maybe I miscounted. Looks like there were eight -- eight for the hydrology, seven for nutrients.

Q So fifteen parameters. These were the ones you were referring to when you said the ones that 08:53AM were most sensitive?

A These are the ones I identified as most sensitive.

Q Okay. Dr. Engel, did you perform in connection with your work in this case any 08:53AM sensitivity runs or analysis to determine, based upon the way in which you were using the model and the manner in which you had it set up, which parameters were the most sensitive to changes?

A We did not perform sensitivity analysis 08:53AM specific to the entire IRW as we were modeling it. You know, it wasn't necessary based on prior experience and given the calibration that we were doing.

Q One of the -- let's go back to where we were, 08:54AM Page D-19 of your report. I apologize. We were talking about nutrient inputs. On Page D-19, Dr. Engel, you have identified some sources of phosphorus that you input, if I read this correctly, into your GLEAMS model; is that right? 08:54AM

A Yes.
Q And do I understand correctly that what Page D-19 tells me is that you input into the model 177 tons of phosphorus from swine, 319 tons of phosphorus from dairy cattle, 105 tons of phosphorus 08:54AM
from beef cattle and 455 tons of phosphorus from commercial fertilizer. Is my understanding correct?
A Those would have been the inputs, yes.
Q Okay. Where did those input values come from?
A I believe these inputs came from the mass 08:55AM
balance study by Meagan Smith, so I believe these would represent the 2002 values. So I would need to look at that to be certain.
Q Please do. Tell us what you settle upon when you look through your document and that would be 08:55AM
great.
A So it looks like these were the values from Table 29 in Appendix B.
Q What page, sir?
A I'm sorry, Page B -- 37 in B. 08:56AM
Q And, Dr. Engel, we talked about this mass balance study yesterday. You do appreciate, do you not, that Meagan Smith's analysis and her quantification of sources was limited to the net import and ignored internal sources; correct? 08:56AM

A Well, this represents a net addition of phosphorus to the watershed.
Q Okay, all right. Do you believe those are appropriate parameters for modeling the effect of, for example, beef cattle deposition of manure in the watershed? 08:57AM
A Well, beef cattle are recycling existing phosphorus, so the beef cattle aren't creating new phosphorus. They're not importing new phosphorus with the exception of a little bit of feed that's brought in for those beef cattle. So cattle are recycling phosphorus. That's consistent with what others have done. That's consistent with, you know, analyses by Slaton and others in this region. 08:57AM
That's consistent with, you know, other analyses in the literature, you know, that are identified in the report. 08:57AM
Q Dr. Engel, does Lake Tenkiller know the difference between recycled phosphorus that is moved to it and imported or new phosphorus? 08:58AM
MR. GARREN: Object to form.
A So, no, Lake Tenkiller wouldn't recognize a difference in phosphorus.
Q And the phosphorus loads at the bottom of the watershed to which you are optimizing your model, 08:58AM



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you will agree with me are not limited to internal -- I'm sorry, to imported sources of phosphorus?

A Well, so either it's phosphorus that has been in the watershed or it's phosphorus that's being imported. 08:58AM

Q Some portion of the load at Lake Tenkiller is from internal sources that got moved there and some is from new sources; do you agree with that?

A Well, the internal sources had some original source as well. So I think it's a matter of, you know, when we call times zero as to whether they're internal or external. 08:59AM

Q Okay. Let me ask the question a little more directly. Do you believe, Dr. Engel, that the 105 tons of beef cattle net additions of phosphorus that Meagan Smith has calculated reflect the total contribution of cattle manure to water quality in the Illinois River watershed? 08:59AM

MR. GARREN: Object to form. 08:59AM

A Well, the -- the phosphorus that cattle are consuming and then excreting is largely phosphorus that's been land applied to pastures, and so in that sense, they're simply recycling and potentially facilitating to some extent movement of that 09:00AM



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phosphorus to water.
Q We'll follow up on that but, first of all, I want an answer to my question.
MR. GEORGE: Can we have it read back, Lisa? 09:00AM
(Whereupon, the court reporter read back the previous question.)
MR. GARREN: Same objection.
A No. The 105 tons is the new imported phosphorus. The remainder is simply recycled 09:00AM phosphorus by the cattle.
Q Now, Dr. Engel, give me the scientific basis for your statement that the phosphorus excreted by cattle in the Illinois River watershed comes, quote, largely from poultry litter. 09:01AM
A Well, if we -- you know, if we step back and look at the literature a bit, Slaton and co-authors did an analysis in northwest -- well, did an analysis in Arkansas in examining inputs of nutrients into areas, and in that analysis, the 09:01AM cattle aren't introducing new phosphorus. So, you know, they consider that cattle are simply recycling phosphorus that's imported into the system. Marc Nelson in an analysis at Bridge 59 on the Illinois River did a mass balance and examined phosphorus -- 09:02AM



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examined phosphorus inputs into the landscape and examined the amount of phosphorus that was flowing past Bridge 59 and indicates that, you know, the cattle are simply recycling phosphorus that's been imported into the watershed that ultimately is put 09:02AM
back in the landscape in the form of poultry waste.
Q Dr. Engel, what was the scientific basis of those conclusions?
A Well, the scientific basis would be that, you know, cattle aren't creating new phosphorus. The 09:02AM
cattle are simply consuming phosphorus that exists. So in that sense, you know, they can't be creating the phosphorus.
Q But, Dr. Engel, there's some phosphorus already in the soil that makes its way into plants 09:03AM
that cattle eat; correct?
A Correct.
Q You don't have to have poultry litter in order to grow grass, do you?
A Well -- 09:03AM
Q Do you?
A Some grass would grow without -- certainly some grass would grow without poultry litter.
Q Dr. Engel, what percentage of the phosphorus that is excreted by cattle in the watershed has its 09:03AM

origin in poultry litter as opposed to phosphorus present naturally in soils?

MR. GARREN: Object to form.

A Well, without doing a calculation, it would be tough to answer that question. 09:03AM

Q Didn't try to answer that question, did you, Dr. Engel?

MR. GARREN: Object to form.

A To some extent, that's answered in the allocation. You know, another quick way, if you 09:04AM want to try to quantify that, natural background phosphorus in the soil is about 20 in this region.

Q 20 what?

A Is that parts per million or pounds per acre? I'm going to need to -- let me look that up, if 09:04AM you'll give me a moment, in the report. I think it's pounds per acre. It's not going to matter for the analogy I want to make because the other number will have the same units. So if we think about this as a percentage, the units are going to be 09:05AM irrelevant. So if the background phosphorus is 20 and as I recall, the average phosphorus content in many of the pastures within at least the Arkansas side of the watershed are about 400. So the ratio of 20 to 400 would indicate that background is about 09:05AM

4 percent -- I'm sorry, about 5 percent of the phosphorus that would be consumed by cattle. In fact, you know, much of that years ago would, you know, would have been consumed by the cattle and would in fact have been exported in the live -- in 09:05AM the cattle themselves as they were sold out of the watershed. So, you know, conservatively, you know, looks like about 5 percent is probably phosphorus consumed by cattle that might be from background or other sources. 09:06AM

Q Dr. Engel, we're going to need to take a break but before we do, I want to alert you to what my question is in case you need to look up the answer. I'm going to want to know the basis for your opinion as to the background level on soils in pastures in 09:06AM Arkansas. Okay? I want you to point me to the data.

VIDEOGRAPHER: We're now off the Record. The time is 9:06 a.m.

(Following a short recess at 9:06 a.m., 09:06AM proceedings continued on the Record at 9:17 a.m.)

VIDEOGRAPHER: We are back on the Record. The time is 9:17 a.m.

Q Dr. Engel, before we broke, I alerted you that my next question was going to be to ask you to 09:17AM



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identify the soils data on which you base your opinion regarding the background level of phosphorus in soils on Arkansas pastures. Can you show me that?

A Not for Arkansas pastures, but for a pasture within the watershed that I believe is in the Oklahoma side, there's a value on Page 36 of the report. 09:18AM

Q One value?

A I'm sorry. Looks like there's a range of values for forested and a range of values for a pastured area. 09:18AM

Q I'm looking for the pasture. Where is that on Page 36?

A It's the second set of numbers, the 28 to 37. 09:18AM

Q How many samples were taken of pastures at the Nickel Reserve to establish this background level for phosphorus?

A As I recall, this was some sampling that Roger Olsen or CDM under the direction of Roger conducted. I don't offhand know the number of samples. 09:19AM

Q If I told you it was two, would you have any reason to disagree with me?

MR. GARREN: Object as to form.

A As I said, I don't know the number of samples. 09:19AM



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Q Okay. Let's assume it's two, Dr. Engel. Are two samples in a watershed of a million acres sufficient to establish the background level of phosphorus in soils?

MR. GARREN: Object to form. 09:19AM

A It could be.

Q Is it?

MR. GARREN: Object to form.

A So if this pasture is representative of background conditions, it would be. 09:20AM

Q Well, I apologize, Dr. Engel, but that's circular. Is this pasture representative of background conditions? That's the question.

MR. GARREN: Object to form, asked and answered. 09:20AM

A My understanding from conversations with Roger Olsen, who provided the data, was that this was representative of a background pasture for which poultry waste had not been applied at least in recent history or long -- medium-term or even 09:20AM long-term history.

Q Dr. Olsen told you that?

A Yes.

Q You are relying upon Dr. Olsen for your opinion that these two values, 28 to 37.4 pounds per 09:20AM



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acre of phosphorus, is a reasonable background number for all pastures in the Illinois River watershed?

MR. GARREN: Object to form.

A Well, there would also be STP data from University of Arkansas and OSU from the soil fertility testing labs or whatever the appropriate names are of those institutions. 09:21AM

Q What does Arkansas report as the background level for phosphorus in pastures in the Illinois River watershed? 09:21AM

A I don't know if they specifically report what they term a background level, but looking at those data, one could determine what a likely background level might be. 09:21AM

Q But you didn't undertake that analysis, did you, Dr. Engel?

A I had no reason to.

Q Okay. Just so our Record is clear, Dr. Engel, can you point me to a single soil sample in the state of Arkansas that you believe reflects background conditions for phosphorus on pastures in the Illinois River watershed? 09:21AM

MR. GARREN: Object to form.

A As we sit here at the moment, no. 09:22AM



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Q Let's go back to this discussion we were having about cows and soil test phosphorus levels. Can we agree that cows eat grass?
A Yes.
Q Okay. Do you acknowledge, Dr. Engel, that 09:22AM
plants, such as grass on pasture, only take up phosphorus from -- only take up the phosphorus from soil they need to grow?
MR. GARREN: Object to form.
A That would be my understanding. 09:22AM
Q They don't take up more phosphorus than they need; they take up what they need to grow; is that right?
A I've seen a little bit of literature that indicates they might take up a little more under 09:22AM
higher STP conditions, but I think as a general rule, as I understand, they use what they need.
Q Okay. Are you aware that the Attorney General contends in this lawsuit that litter should never be applied on soils that have sufficient phosphorus to 09:23AM
grow grass?
MR. GARREN: Object to form.
A I've seen that statement, yes.
Q Okay. Now, let's assume for purposes of my next few questions, Dr. Engel, that the agronomic 09:23AM

rate or the plant's requirements for phosphorus for grasses in the Illinois River watershed is 65 pounds per acre. Do you understand that assumption?

A Yes.

Q Okay. If all pastures in the Illinois River 09:23AM
watershed on which cattle graze only had 65 pounds of phosphorus per acre, do you agree that cattle would eat grass and excrete the same amount of phosphorus that they excrete on pastures that have 400 pounds per acre of phosphorus? 09:23AM

MR. GARREN: Object to form.

A They may not and here's why: So -- so the reason that we have high STP soils is because of the practice of over application of poultry waste. The nitrogen in that is allowing production of more 09:24AM
grass, so that's why it's being applied, and as a result, that makes it possible to have more cattle. More cattle are consuming more grass presumably then because there are more of them, and so the more cattle would be excreting more phosphorus from the 09:25AM
additional grass production.

Q Okay. I'm not necessarily interested in a long dissertation about how we got to the number of cattle we have in the watershed, okay? So let me reframe my question and see if we can get to a more 09:25AM

narrow point. If there's a cattle in the watershed grazing on a pasture that has 500 pounds per acre phosphorus, does that cow excrete more phosphorus than a cow grazing on a pasture in the watershed that has 65 pounds per acre phosphorus? 09:25AM

A Based on the earlier conversation, it may excrete a little more because, again, from some literature I've seen, it does seem to be some potential for forages and grasses to use a little more phosphorus. However, again, you know, if the 09:25AM phosphorus were not at 500, that number of cattle would likely be fewer. So it's tough to answer this hypothetical question.

Q Okay. You do agree, Dr. Engel, that in the example that we just went through, the cow on the 09:26AM 500 pound per acre field would not excrete significantly more phosphorus than the cow on the 65 pound per acre field?

A We're talking about one cow?

Q Yes, sir. 09:26AM

A Yeah, I would concur.

Q Okay. Is it your understanding that this lawsuit is about reducing the number of cattle in the watershed?

MR. GARREN: Object to form. 09:26AM



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A It may have -- it has the potential to have that impact I suppose, but I don't think that's the -- that's not the central theme. You know, the goal here is to improve the quality of water in the streams and rivers and in Lake Tenkiller and improve 09:27AM the biological activity and recreational uses of those waters.

Q Let's go back to D-19 of your report. We were talking about some of these inputs of phosphorus from sources other than poultry litter that came 09:27AM from Miss Smith's mass balance analysis.

A Yes.

Q And one of the inputs is commercial fertilizer, 455 tons of phosphorus; do you see that?

A I'm having trouble with my binder here. I'm 09:27AM sorry.

Q That's okay. D-19, Doctor.

A Yes.

Q That figure for commercial fertilizers also comes from Table 29 of Miss Smith's mass balance 09:28AM report; correct?

A Correct.

Q All right. How does that figure of 455 tons of phosphorus from commercial fertilizer compare to the actual amount of phosphorus from commercial 09:28AM



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fertilizer that is applied in the watershed in a year?

A I'm not sure I quite follow the question. Could you --

Q Well, let me ask it a different way. Is it your belief, Dr. Engel, or understanding that only 455 tons of phosphorus from commercial fertilizer hit the ground in the watershed each year? 09:28AM

A So my understanding is that this is the commercial fertilizer sold that through the analysis that Meagan Smith did, I believe in consultation with Gordon Johnson, and maybe even Gordon did that analysis, his calculated value of commercial fertilizer sold, I think this is a sold value, and presumably that's land applied within the watershed, is the 455 tons for 2002. 09:29AM

Q Dr. Engel, do users of commercial fertilizer in the watershed buy commercial fertilizer from outside the watershed?

A They potentially do. 09:29AM

Q The lawn care companies operating in northwest Arkansas, do you know, Dr. Engel, do they buy their fertilizer from outside the watershed and then apply it inside the watershed?

A I don't know if they do or don't. 09:30AM



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Q What did you do to try to discover the reality of the relationship between where fertilizer is purchased and where it is applied in this watershed?

MR. GARREN: Object to form.

A I didn't do anything specifically to collect 09:30AM
data from this specific location because, again, based on my professional experience, you know, this is not a significant source of the phosphorus that ultimately reaches the streams, rivers and Lake Tenkiller. So because it wasn't a significant 09:30AM
source, you know, it wasn't necessary to represent that very minor level of detail that would have very minor impact in the results and would have no impact in the conclusions.

Q Dr. Engel, how do you know if a source is 09:31AM
significant if you don't quantify it?

A One doesn't have to calculate absolute numbers and calculate, you know, the fertilizer to the nearest ton to know that it's not going to be a significant source. You know, if you want to make 09:31AM
some assumptions about how much phosphorus is applied to, you know, to the lawn care or by the lawn care industry, you know, a quick analysis of that indicates that, you know, that's inconsequential compared to the, you know, 4,500 09:31AM



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plus tons of poultry litter phosphorus that's being generated and land applied.

Q Dr. Engel, do you agree that on a pound-per-pound basis, commercial fertilizer has a disproportionate impact on water quality compared to poultry litter because it is more soluble? 09:32AM

A I've seen studies that indicate that in some instances there is greater potential for commercial fertilizer to run off. I've seen other studies that -- relative to poultry litter. I've seen other studies that have indicated the contrary and, again, the amount of commercial fertilizer sold relative to the other significant sources is so small that it wasn't necessary for -- you know, to reach the conclusions that were reached here to, you know, to consider it. 09:32AM 09:33AM

Q How does the amount applied as opposed to the amount sold compare in terms of quantity with poultry litter?

A Well, the amount applied is not going to be substantially different than the amount sold. 09:33AM

Q Can you give me the basis for that?

A Again, based on experience and based on knowledge of, you know, the kinds of applications that would be made typically and land uses that 09:33AM



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would be receiving this.
Q What type of application is typically made?
A Of what to what?
Q Let me strike that question and approach it
this way: You said you have some experience that 09:33AM
leads you to conclude the amount applied would not
be different from -- significantly different from
the amount sold in the watershed, and I want to know
what specific experiences you have had in
investigating or studying that relationship. 09:34AM
A Between the amount sold and the amount
applied?
Q Yes, sir.
A You know, I guess -- you know, I've not
collected specific data that would allow one to 09:34AM
create a correlation between the amount sold and the
amount applied, but once again, there's no reason
based on the literature to believe that. When the
model was calibrated to match the substantial amount
of observed data of phosphorus in water at the three 09:34AM
gauging stations, you know, there was no reason to
believe that that was something that needed to be
considered further.
Q Dr. Engel, in your modeling and allocation
methodology in this case for phosphorus loads, what 09:35AM



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happens in terms of allocation to the phosphorus that reaches a water body that came from one of these sources that you have determined to be insignificant; how does it get allocated?

A I'm not sure I'm quite following your 09:35AM
question.

Q Well, let's say, for example, that commercial fertilizer -- I'm not asking you to agree with this. It's just an example -- accounts for 5 percent of the phosphorus load in the watershed. You don't 09:35AM
have an allocation for commercial fertilizer in your analysis, do you, in terms of relative contribution?

MR. GARREN: Object to form.

A As I recall, the contribution from that specifically was not pulled out. 09:35AM

Q Okay, but that -- if I'm correct in 5 percent of what reaches the water comes from commercial fertilizer, one of the other sources which you do allocate is getting that phosphorus in the allocation; is that right? 09:36AM

A But, again, I think this is a hypothetical. As I recall --

Q Can you answer whether that is right first?

MR. GARREN: Object to the form then.

A Could you restate that? 09:36AM



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Q No, but we can have Lisa read it back.
(Whereupon, the court reporter read back the previous question.)
A Well, let me think through this. So in the calibration process, you know, we're not losing or 09:36AM
creating phosphorus. So the phosphorus from that -- so if that weren't represented at all in the calibration process, then it would be assigned to something else.
Q All right. Let's go back to D-19. We were 09:37AM
talking about these various other input sources of phosphorus, swine, dairy cattle, beef cattle and commercial fertilizer and, Dr. Engel, can you explain for us how and where and what files you used to specify these phosphorus loads as inputs into 09:37AM
your model?
A I would have to look at the underlying files to make that determination.
Q How would these inputs be labeled or identified in your modeling files; is there a swine 09:38AM
input file?
A I don't believe there would be a swine input file. I believe there would be -- there would be nutrient input files that -- so there would be nutrient input files, a series of nutrient input 09:38AM



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files.
Q Okay, but in those nutrient input files, where would I find the 455 tons of phosphorus from commercial fertilizer?
A I would need to look through those to be able 09:38AM
to identify where that would show up in those.
Q Dr. Engel, you do appreciate, do you not, that in order for us to be able to understand your modeling work, we need to be able to find the input
files that you say you included in your model and if 09:39AM
they're not labeled beef cattle, commercial fertilizer, dairy cattle and swine and they're labeled something else, that makes it impossible for us to do our job?
MR. GARREN: Object to form. 09:39AM
Q How are we supposed to determine, Dr. Engel, where you physically included those phosphorus contributions in your model if you didn't label them?
MR. GARREN: Object to form. 09:39AM
A I -- I guess I would need to be able to look at those to identify where that information would be located.
Q Here's what we're going to do.
MR. GARREN: Counsel, are you asking that 09:39AM



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you don't know where they are?
MR. GEORGE: I don't know where they are. I absolutely do not know, Rick.
MR. GARREN: We'll identify them for you.
MR. GEORGE: I'd like to have them identified today. 09:40AM
MR. GARREN: Okay. We'll see what we can do about it over lunch maybe.
MR. GEORGE: I want them identified.
Q Let's step back from the technical question about the file and what it's named, Dr. Engel, and tell me conceptually how you treated these inputs across the landscape of the Illinois River watershed. What land use did you apply them to? 09:40AM
A As I recall, the waste would have been applied on pasture. As I recall, there was very little agriculture that showed up in the land use map, and so I think it was applied on pasture. 09:40AM
Q Do you not know; you just think?
A Again, I would need to look at files to determine that. 09:40AM
Q What nutrients inputs did you apply to areas that were identified as croplands in the watershed?
A I believe there was commercial fertilizer applied in those areas. 09:41AM



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Q You agree there should be commercial fertilizer applied in your model to croplands?
A There should have been commercial fertilizer applied to croplands.
Q Did you apply poultry litter to croplands in your model? 09:41AM
A I don't believe that it was.
Q Are you aware of anyone in the Illinois River watershed that actually applies poultry litter to croplands, row crops? 09:41AM
A Not -- I'm not aware of anyone specifically.
Q Okay. So you wouldn't have, based upon the information that's available to you, any basis to assume that cropland receives poultry litter; is that right? 09:41AM
MR. GARREN: Object to form.
A I don't have specific knowledge one way or the other.
Q Well, would Ji-Hong have reason to know whether or not cropland in the Illinois River watershed receives poultry litter? 09:42AM
MR. GARREN: Object to the form.
A He would have had that information only through me, so --
Q Would it surprise you to know, Dr. Engel, that 09:42AM

Dr. Ji-Hong set up the model in such a way as to which croplands are simulated as receiving poultry litter?

A Again, I would need to look at the files to see how that was specifically set up. 09:42AM

Q Well, let's assume I'm right. Does that surprise you?

A I suppose, you know, it's possible that it was set up that way.

Q Did you intend for it to be set up that way? 09:42AM

A The intention probably would have been to apply the commercial fertilizers to the cropland and not the poultry waste.

Q If you'd look at D-18, one of the input parameters that you included in your modeling and 09:43AM that you indicated earlier was one of the more sensitive parameters is this thing called rate; right? Do you see it on D-18 at the very top?

A Yes.

Q Is there more than one input parameter, if you 09:44AM know, in the GLEAMS model work that you did in this case for rate?

A I'm not sure what you're asking specifically. Sorry.

Q I've only been able to find one actual field 09:44AM

or value in the input files that has the title rate, and I'm wondering, does that input parameter reflect the rate of poultry litter application only or the rate of all animal waste being applied to the surface of the land; do you understand that 09:44AM question?

A Right. So, again, without seeing the specific value, given that Dr. Ji-Hong was setting those up and running, I've looked at some of that, but without reviewing that and providing some further 09:45AM context, I'm not sure I can answer the question as I'm sitting here.

Q That's another one I'll warn you, I'll probably want an answer to before we leave. So if there's something you can look at on a break or a 09:45AM call you can make, I would strongly encourage you to do that. Dr. Engel, do you -- strike that. Was it your intent to treat poultry litter and other animal manure as an input separately in the modeling?

A I believe that at least initially it was. 09:45AM Ultimately, you know, it's possible they were combined. Again, without looking, I'm not certain.

Q Dr. Engel, if you combined all animal waste, not just poultry litter but cattle manure and dairy effluent and swine manure into a single input 09:46AM



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parameter, would that not complicate your ability to allocate back sources of phosphorus to just poultry?

MR. GARREN: Object to form.

A If those are combined, that does -- that would certainly complicate it. 09:46AM

Q Well, let's talk for a moment about the rate of application for poultry litter. Okay?

A Okay.

Q And you've got some calculations on Page D-18 that all begin with this 223,000 tons. Do you see that? 09:46AM

A Yes.

Q Okay. Now, you had different application rates for pastures in different zones of the watershed; correct? 09:46AM

A Correct.

Q And why is that?

A The -- excuse me. The density and distribution of poultry houses varied throughout the watershed. 09:47AM

Q So is there embedded in that the assumption that litter is applied more heavily in more densely populated areas in terms of poultry houses?

A Correct.

Q How large are these zones, these four zones in 09:47AM



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terms of acreage?
A In terms of total acres, each -- I'm not certain. If we looked with respect to pasture acres, those are shown in -- on D-18.
Q Okay. They're shown as hectares, aren't they? 09:47AM
A Yes.
Q What is a hectare?
A So a hectare would be -- is it 2.47 acres? I would need to probably look at that conversion to make sure I've got that right. 09:48AM
Q I think you're right, but maybe you could, if you still have your calculator with you, convert the acreage of pasture in each of those zones shown on Page D-18 to acres using that conversion factor.
A Okay. I've done the conversions. 09:48AM
Q Okay, and could you tell me how much acreage in terms of pastureland you have represented in the model for Zone 1?
A So the 47,720 hectares is using 2.47 as a conversion. 117,868 acres. 09:51AM
Q Okay. Now --
MR. ELROD: How many was that?
A 117,868.
MR. ELROD: Thank you.
Q Now, Dr. Engel, in terms of application rate 09:51AM

across all 117,868 acres in Zone 1 of the Illinois River watershed, in your modeling did you assume the application rates on each acre were constant?

A Yes.

Q Okay. So every one of those 117,868 acres 09:51AM
received the exact same amount of poultry litter; is that right?

A It should have, yes.

Q Okay. Is that consistent with reality in
terms of what happens with poultry litter in the 09:51AM
Illinois River watershed?

MR. GARREN: Object to form.

A In reality, in a given year it's probably applied on less than that total acreage. So, again,
the impact of that on the model, given that the 09:52AM
model is being calibrated, though, to match the extensive set of observed data is insignificant.

Q Well, let's stay away from total -- well, strike that. With respect to the rate of
application, do you agree that there is variation 09:52AM
within Illinois River watershed, including within Zone 1, as to the number of pounds or tons of poultry litter that are applied to an acre?

A Yes, there would be.

Q Some farmers apply at one rate and other 09:52AM

farmers in the same zone apply at a different rate; you're aware of that?
A Yes.
Q Okay. What is the rate per acre that you assumed in your initial setup for poultry litter 09:52AM application in Zone 1 of the Illinois River watershed?
A It looks like I need to convert one ton per hectare to --
Q Do you still have a calculator? Yes. 09:53AM
A It looks like that would be approximately .40 tons per acre.
Q Let me make sure I understand what this means. Based on the conversions that you've just done for me, and I appreciate that because my mind works in 09:54AM acres as opposed to hectares. Your initial setup of your GLEAMS model assumed that all 117,868 acres of pastureland in Zone 1 of the Illinois River watershed received .4 tons of poultry litter per acre per year; is that right? 09:54AM
A Correct.
Q Okay. Is -- strike that. Is .4 tons of poultry litter per acre a realistic and reasonable assumption as to the rate of application in this watershed? 09:54AM



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MR. GARREN: Object to form.
A For the purposes of modeling, that was an appropriate assumption.
Q Is it consistent with the actual practices in the watershed? 09:54AM
A Well, it's consistent in that the expectation would be for this amount of waste to be applied in this zone. The assumption made here was that it was applied uniformly to, you know, to the pasture within that zone. So, you know, I suppose in most 09:55AM cases, it may not be applied at that specific rate to each specific acreage year, but on average this is the application rate within that area.
Q Doctor -- go ahead.
A So I was just going to add so that, you know, 09:55AM the model can use that information, and through calibration, then we're matching the observed phosphorus loads in the streams and rivers that eventually reached Tenkiller.
Q Dr. Engel, are you aware of a single poultry 09:56AM farmer or cattle rancher or litter applicator in the Illinois River watershed that has ever applied poultry litter at a rate of .4 tons per acre?
MR. GARREN: Object to form.
A I've not -- I guess I've not had that 09:56AM

conversation with them. So, you know, as I sit here at the moment, I couldn't point you to any that do.

Q All right. Dr. Engel, what's your understanding of the actual typical application rates per acre in this watershed; do you have one? 09:56AM

A I believe in more recent periods, it's on the order of two tons per acre. Historically I think it was a bit larger than that maybe.

Q Okay. Can we go through the same conversion exercise for the other three zones? 09:57AM

A Okay.

Q And I want to know the total number of pasture acres that you have included in each zone and the application rate for poultry litter per acre in each zone. Okay? 09:57AM

A Okay.

Q Which one are you going to start with?

A We just did Zone 1. So we're done with that one; is that right?

Q Yes, sir, we are. 09:57AM

A So how about if I move on to Zone 2?

Q Okay.

A So for Zone 2, the area would be 122,159 acres, and poultry waste application in tons per acre would be 0.34. 09:58AM



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Q .34?
A Yes.
Q Can you do Zone 3, please.
A Let me calculate it. So the area would be 211,575. The application rate would be 0.66 tons per acre for Zone 3. 09:59AM
Q Thank you. Zone 4, please.
A So for Zone 4 the area is going to be 26,960 acres and if we round this litter, it looks like it's 0.1 tons per acre. 10:00AM
MR. McDANIEL: Could I ask you to repeat the area? I didn't hear it.
A Sorry. 26,960 acres.
MR. McDANIEL: Thank you.
MR. ELROD: And zero what? 10:00AM
A And the waste was 0.1 tons per acre.
Q Dr. Engel, someone has pointed out to me that the tons of litter that are shown on Page D-18 are -- have been converted to dry matter tons; is that right? 10:01AM
A Correct.
Q Can you remind me, and I apologize, how you convert back to wet tons?
A Give me just a moment here to think about that. 10:01AM

Q Sure.

MR. ELROD: 65 percent.

A It's 65 percent, so we're going to divide by .65 I believe, but let me double check that. Looks like the actual value that was used was 63 percent. 10:02AM

Looks like I calculated that by hand yesterday and it should be 63 percent. So if we divide these values by .63, we'll get the expected tons as applied.

Q Okay. Could you, and I apologize, could you 10:02AM do that for each of the litter application rates that you've calculated for the four zones starting with Zone 1?

A Okay.

Q If it helps, you told me four tons per acre 10:03AM for Zone 1 dry.

A So it looks like that one would be 0.63 tons per acre.

Q Okay. So 2 converted to wet, please.

A So that one would be 0.54 tons per acre. 10:03AM

Q Thank you.

A Zone 3 would be 1.05 tons per acre.

Q Thank you.

A Looks like Zone 4 would be 0.16 tons per acre.

Q Okay. Thank you. Dr. Engel, I'm going to 10:04AM



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hand you what I've identified as Exhibit 15, which is a map of your four zones, and I've been recording the calculations you've given me, and I'm just going to ask you to take a look at Exhibit 15 and tell me whether it reasonably reflects the assumptions, at 10:05AM
least in terms of initial model setup, that you made as to the numbers of acres of pasture in each zone that receives poultry litter and the rate, both wet and dry, of application of poultry litter assumed in those zones. 10:05AM

A Yes, this represents the conversation we've just had.

Q Bear with me. I've misplaced something. Can you find your modeling protocol articles in the stack of exhibits that's in front of you? 10:07AM

MR. GARREN: Exhibit 11, Counsel?

MR. GEORGE: If you say so.

MR. GARREN: Is that it?

MR. GEORGE: It is, yes.

MR. GARREN: All right. 10:07AM

A Okay. I've got Exhibit 11.

Q If you look at the very bottom of Page 1231 of Exhibit 11 of your article, you'll see the last sentence on the page that begins with the word the and then carries over. In your article you say, the 10:08AM

model is typically calibrated first to obtain acceptable performance in the hydrologic components, then for sediment and finally for nutrients, pesticides, bacteria or other constituents; do you see that? 10:08AM

A Yes.

Q Okay, and is that describing the general order in which you typically calibrate a model; that's the sequence you ordinarily follow?

A That would be pretty typical, yes. 10:08AM

Q Okay, and, Dr. Engel, did you calibrate the GLEAMS model for sediment?

A No.

Q Why not?

A Based on the observed sediment information 10:08AM within the watershed and that was reaching Lake Tenkiller, my judgment was that sediment was not significant pathway in movement of phosphorus through -- through the -- through the system to Lake Tenkiller. 10:09AM

Q What particular data or information did you look at, Dr. Engel, that told you that sediment was not a significant pathway for the movement of phosphorus through this system to Lake Tenkiller?

A Well, the core data from Lake Tenkiller 10:09AM



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suggests that the amounts of sediment reaching Tenkiller are relatively low and, in fact, quite low. So that was -- that would have been the initial piece of data that was examined. I guess that was reinforced with -- subsequent to the report 10:10AM with a study that USGS had provided that indicated the sediment loads at Tahlequah, as I recall, at Tahlequah. So that was a USGS report that I believe we were talking about yesterday.

Q You referenced some core data. What do you 10:10AM mean by core data?

A The sediment cores, not the Army Corps of Engineers, but the sediment cores that were taken as part of this study.

Q Okay, and how was it that by examining that 10:11AM data, Dr. Engel, you came to the conclusion that sediment is not a significant pathway for phosphorus in this watershed?

A Well, based on the amount of deposition within the lake and the time period over which that 10:11AM occurred, the anticipated -- the erosion rates would be, as I recall, less than half a ton per acre per year. So the -- it may even be less than that. So the sediment loads, based upon the observed core data and the period over which that was deposited, 10:11AM



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indicate that it's not a significant pathway in this particular watershed. So, you know, so the decision was made that we don't need to focus on that component, that through calibration with the observed phosphorus data that is reaching the three 10:12AM
gauging stations, you know, we can calibrate the model to, you know, to move the proper amounts of phosphorus to those locations, and because we do have so much data, you know, the confidence in those results is going to be quite high. 10:12AM

Q Dr. Engel, you said that the sediment cores indicated to you an erosion rate of .5 tons per acre per year; did I understand that correctly?

A I would have to try to reconstruct that.

Q Let's assume that's the number, and I won't 10:12AM
hold you to it. It is whatever it is I guess. What rule of thumb or benchmark or standard did you apply to that erosion rate to determine whether transport of P by sediment was significant?

A You know, again, for the purposes of modeling 10:13AM
and based on experiences with the model, my judgment was that we didn't need to calibrate the sediment piece of this because the, you know, the total phosphorus reaching Tenkiller was low, certainly on a per unit area basis for as large as this watershed 10:14AM

would be and, again, through the calibration process with this observed phosphorus load data, once we have calibrated the model, we're correctly predicting movement of phosphorus to the edge of the fields and then we're adding that with wastewater 10:14AM
treatment data and routing that to the gauging stations. So, you know, the process ensures that we're moving the right amounts of phosphorus to the gauging stations into Tenkiller. The sediment piece of that, based on my examination of the core data, 10:15AM
knowing the characteristics of the watershed for the size and things, you know, erosion is not -- not a substantial pathway.

Q Dr. Engel, if erosion or sediment is not a significant source of phosphorus or pathway for 10:15AM
phosphorus to Lake Tenkiller, does that mean that the phosphorus on pastures that has received poultry litter that is bound in soil from prior years of application is not a significant source of phosphorus to Lake Tenkiller? 10:15AM

A No, that's not what that statement indicates.

Q Well, how is -- how can that be true, that particulate-bound phosphorus from pastures that have received poultry litter are a significant source of the phosphorus to Lake Tenkiller if you have 10:16AM

concluded that erosion is not a significant source of phosphorus to Lake Tenkiller?

A Well, you know, the phosphorus in the soils interacts with runoff or interacts with the rainfall. So as the rain falls, there's some 10:16AM interaction of that water with the phosphorus in the soil. That phosphorus -- some of that phosphorus will move with that water that becomes runoff. In fact, there are -- you know, there are a number of papers from this region that indicate that 10:16AM phosphorus moves proportionately to the amount of phosphorus that's in the soils. A number of those studies have been done in this watershed or adjacent. So it's well established that, you know, that there is going to be movement of phosphorus in 10:17AM runoff.

Q Dr. Engel, do the observed phosphorus concentrations at the outlet stations in your modeling work, the three stations that you used for calibration, do they represent dissolved phosphorus, 10:17AM particulate phosphorus or both?

A They're representing total phosphorus, so I believe, as you've stated that, that would be both.

Q Okay. Did you investigate, Dr. Engel, to determine the ratio of particulate phosphorus to 10:17AM



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total phosphorus at those three gauging stations?
A I've examined those data. As we sit here at the moment, I don't recall the specific values of each and just because some of it may be attached to particles by the time it does reach the gauging 10:18AM
stations doesn't indicate that it came out of the fields that way. So, you know, there's certainly ample opportunity and, in fact, you know, the model indicates that, you know, phosphorus is often detained once it leaves the fields for some period 10:18AM
before it reaches the gauging stations, and so if it, you know, were soluble that entire time, you know, it's not going to be detained to the extent that it is. So, you know, the indications are that there's some interaction in the streams prior to 10:19AM
getting to the gauging stations.
Q Last question before the break, Dr. Engel. If you're wrong, and let's entertain at least the possibility that you are, you don't have to agree that you are, and sediment or particulate-bound 10:19AM
phosphorus and erosion is a significant pathway for phosphorus in this system and you've not calibrated your model for sediment, that undercuts the reliability and confidence that we can place in your model results, does it not? 10:19AM

MR. GARREN: Object to form.
A I would disagree with that statement.
Q You would be offering an opinion in that scenario based upon a model that's not calibrated to a significant component or source; right? 10:19AM
MR. GARREN: Object to form.
A But, again, you know, if we're going through a calibration process here, you know, the end result of that calibration is the model matching the extensive set of observed data. So -- so, you know, 10:20AM based on that, you know, there's every reason to believe that the model is going to be quite reliable, you know, as it's reproducing the observed data and is using extensive amounts of other data that represent the specific watershed. So the 10:20AM confidence would be quite high that the model is going to reproduce this.
MR. GEORGE: Let's take a break and change tape.
VIDEOGRAPHER: We're now off the Record. 10:20AM The time is 10:20 a.m.
(Following a short recess at 10:20 a.m., proceedings continued on the Record at 10:30 a.m.)
VIDEOGRAPHER: We are back on the Record. 10:30AM



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The time is 10:30 a.m.

Q Dr. Engel, in your work in this case, you ran several different what I think are called scenarios of your model to reflect different conditions or circumstances in the watershed; is that right? 10:31AM

A Right.

Q Okay, and one of the scenarios that you ran has been referred to in your report and in the papers that were produced as no waste in soil background. 10:31AM

A Okay.

Q Okay. Can you tell me what was the rationale -- the reason behind that run and how it was used in your allocation of phosphorus to various sources? 10:31AM

A There seemed to be several pieces to that question, so --

Q Wade into it and then we'll --

A Okay. So, let's see. The background -- the background soil and no waste application scenario 10:31AM took the model that had been calibrated for hydrology, had been calibrated to match the phosphorus loads at the gauging stations, and then reset the inputs to reflect no poultry waste application and to reflect background soil test 10:32AM



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phosphorus levels.
Q Okay, and then you ran the model and you got predicted loads; is that right?
A Sorry. Yes. So once those had been reset, the model was run using weather from '97 to 2006, 10:32AM
repeating and just running that forward with that set of weather.
Q How long was that run in terms of the number of years?
A Let me double check. So I believe those were 10:33AM
100-year runs.
Q And which page are you referring to for that information?
A Sorry. Oh, that would be -- and these would have -- I believe these are modified in the errata, 10:33AM
so you want me to --
Q No. I think for purposes of this question, probably the original is fine.
A Looks like they start on Page 76 in the original report, and those representations continue 10:34AM
through Figure 10.30 on Page 81.
Q Okay. Why did you run the no waste plus background soil P scenario over a hundred years?
A How or why?
Q Why? 10:34AM



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A The idea here was to understand how the watershed -- well, how the three watersheds represented at each of the gauging stations would behave under that scenario.

Q And as a general matter, was the scenario that you were trying to simulate that everything in the watershed remained the same, except there was no poultry litter application and the soil test phosphorus levels were background? 10:35AM

A I believe those would have been the only things we set. I think everything else would have stayed the same. 10:35AM

Q Okay. Dr. Engel, what were the animal wastes other than poultry that were included as inputs in your 100-year no waste plus background soil P simulations or scenarios? 10:35AM

A Again, I would need to look at the individual files to tell you for sure. Those -- yeah, I would -- it would be best if I probably looked at the underlying files to make sure I was reflecting that accurately. 10:35AM

Q Well, conceptually, was it your intent to include animal wastes as inputs other than poultry litter?

A Yes, that would have been the intent. 10:36AM



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Q Okay, because you're trying to get at if I understand -- you can tell me if I'm wrong. You're trying to get at the Delta, if you will, with poultry litter and without poultry litter; right?
A Correct. 10:36AM
Q Okay, and if you changed other things that are unrelated to poultry litter, such as the amount of animal waste and commercial fertilizer that hits the ground, then the difference or the Delta would be off; right? 10:36AM
A Yeah. It would potentially be off.
Q Okay. So there should be in your GLEAMS input files for the 100-year no waste plus background soil P scenarios input values for commercial fertilizer and non-poultry animal wastes; right? 10:36AM
A I would have to look to be sure but --
Q But there should be?
A I believe there should be.
Q All right. Now, how did you use -- strike that. Did you use the results of this 100-year no 10:37AM waste plus background scenario in your methodology for allocating the phosphorus loads to poultry litter that are shown as relative contribution percentages in Opinion No. 8 on Page 2 of your report? 10:37AM



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A Yes. That background would have been used in that set of computations.
Q Okay. Now, Dr. Engel, can you show me anywhere in your report where you explain how you actually arrived at the 45 percent and 59 percent 10:38AM relative contribution allocation to poultry litter that is expressed in Opinion 8 in your report.
A I'm not seeing much of a description of process up there.
Q Okay, and, Dr. Engel, why is that? 10:40AM
A Looks like that may have been something that was not fully addressed in the rush to meet the deadline.
Q You weren't playing hide the ball on the basis for your Opinion No. 8, were you? 10:41AM
A That certainly wasn't the intent.
Q Dr. Engel, you do appreciate, do you not, that Opinion No. 8 as to the relative contribution of poultry litter to the phosphorus load at Lake Tenkiller is an important opinion in this case? 10:41AM
A It's an important opinion and it is consistent with what others have found.
Q Okay. Do you have Exhibit 11 with you, your article on modeling protocol?
A Okay. 10:41AM



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Q And do you see that you list some requirements in the modeling plan that should be met beginning on Page 1223 and continuing over to 1224. They're numbered one through seven I think.

A Okay. 10:42AM

Q Can you read for the Record what you said was a necessary part of a modeling plan in your article at No. 5?

MR. GARREN: Object to the form.

Q Can you read No. 5? 10:42AM

A Well, this seems to be a list that's referenced from an EPA publication. So this seems to be an EPA list, and which number again? I'm sorry.

Q No. 5. 10:42AM

A No. 5, clear documentation of assumptions, theory and parameterization that is detailed enough so others can fully understand the model predictions.

Q Did you meet that standard in your report in this case with respect to the basis for Opinion No. 8? 10:42AM

MR. GARREN: Object to form.

A There probably could have been more documentation in the document to describe that but, 10:43AM



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you know, there are plenty of underlying materials that have, you know, that have that information that was relied upon.

Q Can do you identify those other materials anywhere in your report so that someone wanting to 10:43AM investigate the basis for your opinion and the reliability of your work related to that opinion could easily find those materials?

MR. GARREN: Object to form.

A Well, there are, you know, again, very large 10:44AM numbers of files that were used in this process, and certainly not every single one of those is fully documented.

Q Is that, no, you didn't identify the materials that were used to support Opinion No. 8 in your 10:44AM report?

MR. GARREN: Object to form.

A Well, so materials are not clearly identified by the report.

Q Dr. Engel, could you turn to Page 93 of your 10:44AM report?

A Okay.

Q Do you see on page -- strike that. Page 93, Dr. Engel, I'll represent to you, is the only place that I've been able to find in your report that 10:45AM

seems to relate to these 45 percent and 59 percent figures that you express in Opinion No. 8. Can you tell me with respect to Table 10.14, which is entitled IRW P Load Allocation to Sources, the source of the data that is contained in that table? 10:45AM

A Well, this would represent a summary of a large amount of underlying data. So it's a summary of numerous other spreadsheets of data.

Q Can you point me to the spreadsheets that form the basis for Table 10.14? 10:46AM

A Without, again, looking through the materials carefully to see how those came together, you know, I can't as I'm sitting here at the moment.

Q Okay. Are the values that are reflected in Table 10.14 for wastewater treatment plant, forest, 10:46AM crop, urban and pasture, are those the product of output of the GLEAMS model?

A So wastewater treatment is simply the calculation of the wastewater treatment plant inputs. 10:47AM

Q Well, let me stop you there. The value under wastewater treatment plant is the number 30. What does that mean?

A I'm sorry. That's 30 percent.

Q Okay. How did you get 30 -- strike that. 10:47AM



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Does the 30 percent allocation of phosphorus to wastewater treatment plants come from either the GLEAMS model or your routing model; did they spit out a percentage like that when you run the model?

A No. The model is not providing that 10:47AM
percentage.

Q Okay.

A So that was calculated.

Q Calculated outside of the model; correct?

A Correct. 10:47AM

Q Outside of both models; correct?

A Both models being --

Q GLEAMS and the routing model.

A Yes.

Q And that calculation was performed by who? 10:47AM

A Well, there were portions of that performed by Dr. Ji-Hong and portions of that performed by myself. So the ultimate calculation of the 30 percent would have been a calculation that I did.

Q Now, the next four categories in Table 10.14, 10:48AM
forest, crop, urban and pasture, are all land uses, are they not?

A Yes.

Q Okay, and these four land uses are land uses that are simulated in the GLEAMS model; is that 10:48AM



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right?
A Correct.
Q Okay. Now, the values beneath these four land use categories, for example, forest, is one and one. Is that percentage again? 10:48AM
A These would all represent percentages.
Q Okay, and crop is less than one; correct?
A Yes.
Q And urban is 7, and pasture is 62 percent in one instance and 76 percent in another; is that 10:49AM correct?
A Correct.
Q Now, Dr. Engel, when you run GLEAMS, does it spit out a percentage of the phosphorus load that is attributable to these four land uses? 10:49AM
A It, you know, provides data about the phosphorus loads, and that data was used to compute the percentages.
Q Does it provide a total load that GLEAMS believes is attributable to each of the four land 10:49AM uses that are shown in Table 10.14?
MR. GARREN: Object to form.
A It provides total loads of phosphorus that would have been -- that would have to be summed to arrive at a total. 10:49AM



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Q Okay, and it would do that for each of those four land uses; right?
A Well, it would provide the outputs and someone would need to sum those.
Q What outputs would have to be summed? Is it a -- I'm sorry. Do you have an output for each zone that you have to sum? 10:50AM
A Well, there would be -- there would be outputs for each hydrologic response unit that would need to be summed. 10:50AM
Q And every one of your hydrologic response units is classified as one of these four land types; right?
A They would have one of those types, yes.
Q So GLEAMS will give you the output of total phosphorus that's predicted coming off of each of the HRUs for forest; is that right? 10:50AM
A Yes.
Q And then you have to add all of those up; right? 10:50AM
A That would be correct.
Q Now, I don't see in the output descriptions here from GLEAMS in Table 10.14 a source that is identified as poultry litter. Do you?
A I agree. 10:51AM



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Q Okay. So is it true, Dr. Engel, that GLEAMS does not have the ability in and of itself to predict the amount of phosphorus that is originating from poultry litter as opposed to forest, crop, urban and pasture? 10:51AM

MR. GARREN: Object to form.

A Well, the model, without interpreting the results, you know, is not identifying poultry litter as the phosphorus source. So, you know, it's going to require one's interpretation of those results in 10:52AM order to, you know, to arrive at a poultry contribution.

Q Okay. Just so our Record is clear, when you run your GLEAMS model and your routing model for that matter, you do not get an output from the 10:52AM computer that says here is the percentage of phosphorus load that is attributable to the source poultry litter; right?

MR. GARREN: Object to form.

A So the model doesn't provide that but, again, 10:52AM the model provides output data that can be used to calculate that portion. So this isn't different than the approach that other models would take.

Q Which one of the land uses that GLEAMS can simulate did you use and focus on in deriving your 10:53AM



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45 and 59 percent phosphorus allocation to poultry?
A So this would have, as identified here, come out of the portion that's pasture.
Q So we're clear, Dr. Engel, you took the pasture prediction from GLEAMS in terms of 10:53AM
phosphorus that comes off of pastures and you had to develop a methodology to break that pasture load down to a poultry portion and then other portions; is that right?
A You know, describing that as development of a 10:53AM
methodology is probably an overstatement of what was required. So it was, you know, a computation that was done, you know, much like any computation you would do with another model. So it wasn't development of a new methodology. 10:54AM
Q Who decided how the computation would be done to break pasture down into poultry and other source?
A I did.
Q Okay, and did you derive that computation from a piece of scientific literature somewhere where 10:54AM
someone else, some other scientist had taken the output from GLEAMS on pasture and broken it down between poultry and other sources?
A There really wasn't much to derive here, so --
Q Can you answer my question first? 10:54AM



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A Could that be reread, please?
Q Sure.
MR. ELROD: When the witness asks his own question to be reread, you know he's getting into the project. 10:55AM
(Whereupon, the court reporter read back the previous question.)
A So this was not -- this was not unique or specific to GLEAMS. This was the same process that, you know, Dan Storm and others have used with SWAT 10:55AM in identifying a poultry contribution. So it's not a unique process or method.
Q Dr. Engel, point me to the piece of scientific literature or a report by any other scientist where the same methodology or computational approach was 10:56AM used by anyone other than Dr. Engel ever before in the history of man to break the pasture output from any model down to a poultry number and a number that reflects other sources.
MR. GARREN: Object to form. 10:56AM
A Were unique to GLEAMS or any model -- you said any model? My recollection is that, you know, the Storm effort in Eucha-Spavinaw is an example of something, if not identical, very similar.
Q Is it identical? 10:56AM



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A Without reviewing that report --
Q Tell me Dr. Storm's methodology there as you understand it.
A Well, the concept would be -- and this is more of a concept than a process or method. We're trying 10:57AM
to find the Delta, as you described earlier, that's attributable to a specific source, and so, you know, the concept is you take the model outputs with the variable interest turned on. Then you take the
model outputs with that variable turned off. In 10:57AM
this case, poultry waste application. In this case, though, too, one has to turn back soil test phosphorus because part of the contribution of poultry waste to the phosphorus being lost would be
due to that increased soil test phosphorus. So by 10:57AM
turning those off and looking at this difference, you know, the interpretation of that is that, you know, that must be the amount of phosphorus in this particular case that would be attributable to
poultry. 10:58AM
Q Did Dr. Storm break his pastureland use category down using the same computations or methods that you used as shown on Table 93 -- I'm sorry, Page 93?
A Well, certainly his computation would have 10:58AM



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been different. The methods may have been a little bit different, as he was using a different model.

Q Dr. Engel, let me stop you. Do you know what computation or methods Dr. Storm actually performed in order to break down the pastureland use category 10:58AM results from his modeling and allocate that between poultry and other sources?

A Well, to identify the immediate reduction in phosphorus from litter, it was a matter of turning off litter. So that again was identical to what I 10:59AM did, and as I recall in the Eucha-Spavinaw effort that he performed with the SWAT model, you know, the effort there was to turn off the soil test phosphorus as well, and so that would be identical. In the work he did for the Illinois River watershed, 10:59AM yes, it's different because he was answering a different set of questions.

Q Let me hand you, Dr. Engel, what we've marked as Exhibit 16 to your deposition, which is a spreadsheet that was printed out from your 11:00AM considered materials.

MR. GARREN: Two pages?

Q Two pages. There were two tabs in the spreadsheet. The first tab was identified as allocation and the second tab was identified as 11:00AM

sheet three. I believe the file name was -- hang on a moment -- allocation, underscore, 5, underscore, 2.xls workbook. Do you recognize that document, Dr. Engel?

A Yes. 11:01AM

Q What is it?

A So this seems to be where the final set of calculations were done in arriving at the values that are reported in Table 10.14 and Table 10.15 or at least a portion of those final calculations. 11:01AM

Q Okay. So, Dr. Engel, the exhibit I've put in front of you, Exhibit 16, the spreadsheet, reflects the approach and the computations that support your opinions that poultry litter accounts for 45 percent or 59 percent, depending upon which time period 11:01AM you're talking about, of the phosphorus load to Lake Tenkiller; is that correct?

A Correct.

Q Did Dr. Storm do this, what is reflected in Exhibit 16, in arriving at his allocation to poultry 11:02AM litter?

MR. GARREN: Object to form.

A No. I mean, conceptually he was doing the same thing, but, you know, he didn't use this specific set of calculations in this spreadsheet. 11:02AM



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Q Have you subjected, Dr. Engel, your conceptual model for how you ought to allocate the pastureland use back to poultry litter and the actual methods and computations that are reflected in December -- I'm sorry, in Exhibit 16 to peer review by the 11:02AM scientific community?

MR. GARREN: Object to form.

A So at this stage, you know, this specific set of calculations has not, but once again, you know, this conceptual approach is commonly employed and, 11:03AM you know, widely used, so, you know, trying to tie this down and be unique to this specific calculation, this specific calculation just reflects a general methodology that, you know, that would be employed by modelers doing comparable kinds of 11:03AM thing.

Q Okay. If it's a general methodology, I ought to be able to find it in the peer-reviewed literature; correct?

MR. GARREN: Object to form. 11:03AM

A I mean, this level of detail may not be described in the general literature, but I think you would find a, you know, conceptual discussion of this in the general literature.

MR. GEORGE: Lisa, can you go back to the

prior question to which I didn't get an answer?

(Whereupon, the court reporter read back the previous question at Page 350, Lines 1-6.)

MR. GARREN: Same objection.

A So the answer would be, no, I have not done that, but this conceptual approach is employed in modeling. 11:04AM

Q Okay. Dr. Engel, there are two tabs, and hopefully I've kept them in order. Do you have the one that -- mine looks a little different than yours. Yeah, you've got them in the right order. The first tab that is identified in the electronic file as allocation, does this spreadsheet contain the results from your GLEAMS model? 11:04AM

A Looks like there are probably several things in this. So a portion -- a portion of this would be summarized results from the GLEAMS model. 11:05AM

Q Okay. Can you identify for me the data or numbers on the first page of Exhibit --

A 16. 11:05AM

Q -- 16, thank you, that come directly from the output of the GLEAMS model?

A Well, so once again, the GLEAMS data that would be here are summarized GLEAMS data. So is that -- 11:05AM



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Q Okay. I'll include summarized GLEAMS data. What summarized GLEAMS data is present on Tab 1 of Exhibit 16?

A Okay. So that would be -- this column forest load would reflect outputs from GLEAMS. The column pasture load would; the column crop load would, and the column urban load would. 11:06AM

Q What about total load?

A Looks like total -- I think total is probably including this point source load over here. 11:06AM

Q Okay, and you got two sets of values in those four columns, four land use columns that you've just identified, '98 through 2006, and then 2003 through 2006; correct?

A Correct. 11:07AM

Q And is the output of GLEAMS used in both sets of those numbers?

A Yes. These -- the columns continue from the top here looks like.

Q All right. So let's go back then. The P to river loads point source, do you see that? Let me see yours. Point source load. Sorry. See the point source load? 11:07AM

A Okay.

Q Where do those figures come from? 11:07AM

A So let's see. So these point source loads are based on the observed point sources -- I believe those are reported back in a prior chapter here. Looks like those were reported in Chapter 6.

Q What page? 11:08AM

A Well, looks like this would be from Table 6.1 I believe.

Q Well, Dr. Engel, I don't see those numbers on Table 6.1. Do you see them?

A So it looks like Exhibit 16 is in kilograms 11:09AM here and -- I believe looks like the point sources are in kilograms.

Q Okay. Where at; point sources on Exhibit 16 are in kilograms?

A That's what it looks like. 11:09AM

Q Okay. Whereas, the information on Table 6.1 is in pounds; is that right?

A Correct.

Q We could go through the conversion exercise again, Dr. Engel, but I'll tell you I've tried to 11:10AM convert them and I can't make these loads match Table 6.1. Is there another source that you -- well, should they match Table 6.1 if you convert them?

A Looks like they should but looks like maybe 11:10AM



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they are not matching exactly, are they?
Q I can't make them match, but I'm not a scientist. Okay. Let's keep going on -- I'm sorry. Are you doing some math?
A I was just going to do a quick check on 11:11AM
something. Looks like those are bigger than the values in Table 6.1.
Q Can I see your exhibit for just a moment? I apologize. Now, out at the far right-hand side of Exhibit 16 there are two other columns, poultry and 11:11AM
cattle. Do those come from the GLEAMS model?
A Looks like poultry -- poultry would have been a difference in a set of GLEAMS outputs with poultry waste applications on and soil test phosphorus as observed in recent years and then that less those 11:12AM
things turned off.
Q Okay. Make sure I understand. There's a value under poultry all the way to the end at the bottom; right? It's 1,166,953. Is that kilograms?
A I believe it is. 11:13AM
Q And what does that number represent?
A So this would represent the -- would represent phosphorus loads from '98 to 2006 with -- from the model with poultry waste applied and soil test phosphorus at current levels, less the background, 11:13AM



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which was representative of the same conditions with no poultry waste and with soil test phosphorus set to a background level.

Q Okay. What land uses are you using in those two comparisons to arrive at the figure that's under poultry? 11:14AM

A So those would be pasture because, again, in the earlier discussion we had, if you recall, poultry waste was applied to all pasture in the modeling. 11:14AM

Q Okay. So you took the output from pasture in two different scenarios, one being your historical; correct?

A Correct.

Q And one being your hundred years no poultry with background soil conditions; correct? 11:14AM

A Correct.

Q And you subtracted; is that right?

A Let me think about that a moment and make sure I don't misrepresent this. So, yes, that's what this number would reflect. 11:15AM

Q Okay. Now, Dr. Engel, the other column that appears on the first page of Exhibit 16 is cattle; do you see that?

A Yes. 11:15AM



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Q And you have some values in kilograms for each year under cattle, and it happens to be the same value, 16,145; do you see that?
A Yes.
Q What does that figure represent in terms of cattle? 11:15AM
A There was a computation in appendix -- let me turn to the right appendix. Looks like that's going to be Appendix F.
Q And just so we create a Record here, Appendix F to your report is entitled Contribution of Cattle in Streams to P Loads in the Illinois River Watershed; correct? 11:16AM
A Correct.
Q And you told me earlier that Bert Fisher assisted you with the preparation of Appendix F; is that right? 11:16AM
A I believe he helped with Table 4 in -- am I getting this right -- Table 4 in Appendix F.
Q Why are you pulling into your modeling work and your allocation values from Appendix F? Just help me understand. What's the concept? 11:16AM
A Sure. So the concept here was that, you know, I do recognize that cattle are, well, recycling some phosphorus, are certainly also transporting some 11:17AM



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phosphorus closer to the streams and, in fact, even into the streams in some instances in which they've not been fenced out of those streams. So if they have access to the streams, you know, they in fact do deposit some waste there that contains 11:17AM
phosphorus. So the concept here was to try to capture that more immediate contribution from cattle through the set of calculations that's reported in Appendix F.

Q Okay. Dr. Engel, is it true that the numbers 11:17AM that are pulled over from the in or near stream analysis of Appendix F for cattle are the only credits or contributions that you assign in your load allocation analysis to cattle?

A Let me make sure before I answer that. 11:18AM

Q Sure.

A There would be some dairy cattle contribution that's split out here as well based on some of the waste that one might expect to be land applied. So there's a small portion from that that's looped -- 11:19AM
excuse me, grouped with some other things that would include swine, dairy and background.

Q What about grazing cattle as opposed to dairy cattle, swine?

A So, again, you know, the cattle are recycling 11:19AM



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phosphorus, so they're not contributing new phosphorus. Again, however, you know, I would indicate that cattle do potentially facilitate transport of some of that phosphorus that came from poultry land waste application into riparian areas 11:19AM into streams, so they're helping transport and speed the loss process up, and so the portion that -- of that waste that one would expect to happen in the streams or within ten meters or so of streams is calculated, and it's Appendix F again, and that's 11:20AM the value that's reported in this column on Exhibit 16.

Q And I don't necessarily want to debate the reasonableness of your assumptions. I just want to know what they are, Dr. Engel. Do I understand 11:20AM correctly that your allocation approach, as reflected in Exhibit 16 and carried over into your report, assumes that the only phosphorus from grazing cattle, for which grazing cattle are responsible, that reaches the Illinois River or Lake 11:20AM Tenkiller is the phosphorus deposited within ten meters of streams as quantified in Appendix F?

A So, yes, that's the representation and, again, the rationale for that is that, you know, the cattle are simply recyclers of phosphorus. They're not 11:21AM

introducing new phosphorus into the system.
Q Now, look back at Appendix F, in particular
Table 6. I don't find the 16,144 number. Do you?
A I believe -- let me check my math here. I
believe that's a conversion from kilograms to pounds 11:22AM
or vice versa here. So it looks like that would be
a conversion. In Table 6, if you look at the lower
right-hand corner under 660 feet in total, there's a
value of P in pounds per year that's represented as
35,594, and if one converts that to kilograms, looks 11:23AM
like that's 16,145 as shown in Exhibit 16.
Q Okay. So the value 16,145 is a conversion of
the total on Table 6?
A Yes.
Q Okay, all right. Now, in the -- I believe at 11:23AM
the bottom of Exhibit 16 there is a grouping or
summary of wastewater treatment plant, forest, crop,
urban, pasture, poultry waste, poultry waste minus
cattle; do you see that grouping?
A Okay. 11:24AM
Q Are the numbers beneath each of those headings
percentages?
A Yes. These would reflect percentages from
looks like the above computation.
Q Okay. Dr. Engel, I want to focus on the last 11:24AM



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three groupings, pasture which has some percentages underneath it, poultry waste which has percentages underneath it and poultry waste minus cattle. Do you see that?

A Okay. 11:24AM

Q Are these three columns and percentages related to one another?

A Well, they're related in some way and I'm trying to recall the specific relationships here. So -- 11:25AM

Q Is it not true that's where you break down the pastureland use results and assign it to poultry waste and then other sources?

A Right. So it looks like -- thinking back here on Table 10.14 and Table 10.15, this is where these 11:25AM data are pulled apart from 10.14 into Table 10.15. So pasture represents the total attributed to pasture in Table 10.14.

Q Total attributed by you or by GLEAMS?

A Well, by my interpretation of GLEAMS outputs. 11:26AM

Q Okay.

A And, again, when we say pasture here, then one has to look at what's making up the phosphorus coming from the pasture. So one can then break that pasture on into additional sources -- well, one can 11:26AM



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further break down the pasture into the sources that make up the pasture total. So that's what is being done here.

Q Okay, and is the general premise or approach here, Dr. Engel, that you're taking the value that 11:27AM you would get for the pastureland use and you're subtracting allocations that you have made to cattle and to background, swine and dairy, and the balance of what's left in the pasture group you are attributing to poultry litter? 11:27AM

A That's the concept, yes.

Q Okay. Hang on. Let's flip to the other page for just a moment. Sheet 3, which is the second page of Exhibit 16, what's the source of the data?

A Looks like -- it looks like the first three 11:27AM columns here, so Illinois River, Baron, Caney, all have a P to lake pounds. These look like GLEAMS modeled phosphorus loads.

Q Dr. Engel, is this the output of the routing model? 11:28AM

A Without looking at the -- without looking at the underlying data here and making that comparison, I'm not sure if it is or not. So it's either going to be the output from -- it seems to be the output from the routing model is what it seems to be, but I 11:29AM



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think I would need more context to make sure that I'm not misleading you on that, but that's what it appears to be.

Q Well, Dr. Engel, it's your document; right?

A But, realize, this document doesn't exist in isolation. So that's my point, is that there are other documents I may need to look at to put this in context or maybe a table in here. 11:29AM

Q Dr. Engel, we're about to take a lunch break, and I would encourage you to use some of your lunch break to figure out the source of the data in the spreadsheets that you used to assign 45 percent of the phosphorus load or 59 percent of the phosphorus loads to the defendants who have been sued in this case. 11:29AM

So when we get back after lunch, I'm going to ask you the source of this data and I hope you'll be prepared to answer. 11:30AM

MR. GEORGE: Let's take a break.

VIDEOGRAPHER: We're now off the Record. The time is 11:30 a.m. 11:30AM

(Following a short lunch at 11:30 a.m., proceedings continued on the Record at 1:29 p.m.)

VIDEOGRAPHER: We are back on the Record. The time is 1:29 p.m.

Q Dr. Engel, one housekeeping matter. For the 01:29PM



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Record, I have now corrected Exhibit 8A to add the correct article to the appendix that we discussed yesterday, and so it's just a matter of Record that has now been supplemented as I said it would be yesterday. I apologize again for that. 01:29PM

Dr. Engel --

MR. GARREN: I have some things I need to make for the Record, too, before we get started with regard to efforts we made over lunch in order to accommodate some issues that you created for us. 01:30PM

First off, I would represent that when you inquired first of Dr. Engel with regard to Exhibit 13 and you asked him to identify what it is and that he said, and I'll quote, well, without looking at the specific file, is there more information in the 01:30PM spreadsheet or is this the only contents of that spreadsheet? Your answer to him was, no, it's only -- it's the only tab that's in it, Dr. Engel, and it was included in your materials related to your routing model. 01:30PM

Now, at your request at lunch we went and undertook some efforts to try to find some information. In doing so, we discovered that your representation is not accurate as made to him on this Record, and as a result, the file you pulled a 01:30PM



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clip of for Exhibit No. 13 is but maybe 1 percent of the entire spreadsheet that was referenced and, in fact, there was a second tab in that spreadsheet, though empty.

So from now on, we will not -- he will not 01:30PM have the ability to answer questions relating to full spreadsheets when you are giving him clips of those spreadsheets for specific purposes geared, in my opinion, to misrepresent the Record.

MR. GEORGE: Are you through? 01:31PM

MR. GARREN: No, I'm not. And that holds true with Exhibit 14 and 16, where we've now learned also that those are clips specifically pulled out of a huge spreadsheet for purposes that I believe were intended to misrepresent what it was he needed in 01:31PM order to try and answer your questions.

MR. GEORGE: What are the other two exhibits you're talking about?

MR. GARREN: 14 and 16. Now, with regard to the input files you asked him to identify, that 01:31PM will take many more hours, some hours more than he's attempted to take over the last hour and a half, and we'll not be able to get that to you on the Record today. We'll be prepared to give it to you at a later time when he can go and review those files. 01:31PM



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Now, as I told you yesterday, it's my intention that I will have need of probably more time now today after hearing today to complete my cross examination of this witness. So it's clear we'll be coming back. My suggestion is that will allow you to ask questions about the input file list at that time and with regard to identifying all source data on the 45 to 55 percent range because, as you may inquire further of him, and obviously I want you to do that, he can't do it all without 01:32PM being here many hours to complete a complete itemization in response to your request. That's what our plan is, and I think it's reasonable.

MR. GEORGE: Well, I don't believe it's reasonable, Rick, and a couple of things in 01:32PM response, and we will actually, once the lawyers get through quarrelling with one another, Dr. Engel, we'll get back to some substantive questions, but I intend to complete my examination today, and if this witness is unprepared to answer questions about his 01:32PM input files that he knew would be at issue with respect to the modeling work that supports his opinions in this case, that is unfortunate, but I do not intend to come back for another day of deposition. 01:33PM



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MR. GARREN: Well, there will be a cross examination period.

MR. GEORGE: Well, Mr. Garren, I understand that you want a cross examination period, and I intend to stay here as long as I need to today to allow you to complete your deposition. 01:33PM

MR. GARREN: It's impossible to do it here today because I'm not going to ask him to sit here more than seven hours.

MR. GEORGE: And you may need to reconvene the deposition or renotice your own witness for a deposition in the future. I'm not going to agree that you have a right to reconvene this deposition at a later date after you've spent hours with the witness in preparing testimony that you want to elicit in what is supposedly a cross examination. So I think we'll have a difference of opinion, and we'll see where we are at the end of the day and then make a decision as to how you want to proceed. 01:33PM

With respect to the accusations, that I do take personally, Mr. Garren, that I have sought to misrepresent or mislead the witness with respect to either Exhibits 13, 14 or 16, I take great exception to those claims. The spreadsheets at issue, as you can well appreciate, are voluminous, and I have 01:33PM 01:34PM



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pulled the information that is pertinent from those spreadsheets to the questions I want to ask, and I want the Record to reflect that with respect to each of these three exhibits that you seem to be upset about, they are ultimately the work product of the 01:34PM
witness, they're his files, and if there was something missing or additional materials that he felt was necessary to answer the question, I would expect an expert witness to know that from reviewing the file and to request that information. The fact 01:34PM
that he doesn't have his entire file with him present is unfortunate. It's not within my control.

MR. GARREN: It's not within his responsibility to bring things in anticipation of what you might ask and, secondly, to give him simply 01:34PM
an excerpt of what is clearly an excerpt of an entire file and then try to get him to answer questions about that, I think that's what is inappropriate. It's unfair to him.

MR. GEORGE: Maybe we can solve this issue 01:35PM
on a going-forward basis if it's one that causes great concern. Mr. Garren, do you want to broker an agreement that will hold true for all witnesses in this case that no witness, expert witness will be questioned about a file, an electronic file unless 01:35PM



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the questioning attorney presents the entire electronic file?

MR. GARREN: I'm not in here -- I'm not in a position to be brokering anything for everybody in this case. Okay? Are you representing that for all of the defendants? 01:35PM

MR. GEORGE: I am simply asking whether you want that to be the rule.

MR. GARREN: I'm not asking that to be the rule. I'm saying it's unfair, and all I'm pointing out to you is if you expect that he's going to need that or you anticipate that he might need it, it should be available to him in order that he can do his testimony completely, and to make it as though he should or should not know an answer from a clip from -- a very small clip from a very large spreadsheet is unfair, and I think that's what misleads the Record. 01:35PM

MR. GEORGE: I'm not wasting my time arguing with you on the Record, Mr. Garren. 01:36PM

MR. GARREN: Let's move forward then.

Q Dr. Engel, with respect to the exhibits that you have now reviewed, apparently entire files or spreadsheets for Exhibits 13, 14 and 16 that Mr. Garren is upset about, do you want to change or 01:36PM



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alter any of your testimony based upon your review of the additional materials contained in those spreadsheets?

A Which is 13 and 14?

Q I'm sure your counsel will hand them to you. 01:36PM

MR. GARREN: It will be necessary.

A So okay. So Exhibit 13 was part of a spreadsheet called P, underscore, model, underscore, 8, underscore, point 9 dot xls. Exhibit 14 is an updated version of that information. 01:36PM

Q Can you provide the data on that?

A Sure. The name of the file is P, underscore, model, underscore, 10, underscore, 15 dot xls. So in both cases this represents a small fraction of that overall file, and in both cases the observed 01:37PM data as reported in kilograms per year was data that was summarized from a number of columns to the left in this spreadsheet that were the location in the spreadsheet where the calibration of the routing -- excuse me -- where the routing equation was applied 01:37PM for some period of time that covers 1998 through 2006 at least.

Q I'm sorry. Let me interject a question there, Dr. Engel. The additional material from the left of the spreadsheet, I think is what you said, are those 01:38PM



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daily values as opposed to annual values?
A Those are daily values, correct.
Q All right. Please proceed.
A And so the observed P in kilograms per year is
a summary of those data to the left. So the mistake 01:38PM
that was made, as we discussed earlier, was in
converting those summarized kilograms of phosphorus
per year that were summarized from the correct
yearly or correct daily data. So the mistake was in
the conversion of those to the data we see in the 01:39PM
lower right-hand corner of this exhibit.
Q Okay.
A And, again, that error was a transposition in
two numbers in the coefficient that was used to make
that conversion from kilograms to pounds. 01:39PM
Q Okay. Dr. Engel, was the mistake made in --
well, strike that. Did you also convert on the
left-hand side of the spreadsheet with respect to
daily loads?
A The daily loads were in kilograms. 01:39PM
Q Right.
A So the daily loads are summed to arrive at the
values in the lower left-hand corner of this.
Q Are the yearly loads that are summed, the only
loads that are converted from kilograms to pounds 01:40PM



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or, I'm sorry, pounds to kilograms?
A Kilograms to pounds.
Q I'm sorry. Are they the only loads or did you convert each one of the underlying daily loads?
A Well, if the values here on the left-hand side in this table are a sum of the loads in kilograms per day, summed across the appropriate days to get kilograms per year. So I -- again, without looking at the entire spreadsheet and looking back in the other data that I can't see on this piece of paper, I don't believe that those are converted to pounds per day. 01:40PM 01:40PM
Q The reason I ask, and maybe I'll ask it directly, and you can help me. Does anything that you just told me in terms of the fact that there are also daily loads in this spreadsheet change the fact that you made an error in converting the annual summed loads? 01:40PM
A Well, the error was made, but that seemed to also imply that everything that -- you know, before and after this was also in error, and that's not correct. 01:41PM
Q Exhibit 14 was one of the other exhibits that your counsel identified as one that you felt misled upon. Tell me what changes you want to make, 01:41PM



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if any, based upon your review of additional information available in the electronic file that I referred to as Exhibit 14.

MR. GARREN: Object to the form.

A I think the discussion we just had was related to 13 and 14. 01:41PM

Q Okay. So we've covered it. Same observation, it is the fact that that file also contains daily loads; is that right?

A That are reported correctly, and those daily loads were summed to get the yearly loads, and then the mistake was made in converting from kilograms per year to pounds per year. 01:42PM

Q Exhibit 16, do you have a concern about what has been provided to you as Exhibit 16 based upon your review of the electronic file? 01:42PM

A Well, Exhibit 16 does seem to miss some additional lines that are in at least this -- what's the front page of this.

Q What is missing from the paper copy that you saw in the electronic copy? 01:42PM

A I believe there were some additional lines that further pulled apart values reported in what are the bottom lines, bottom two lines of Exhibit 16. 01:42PM



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Q Explain more what you're talking about.
A I believe the lines that are missing are the lines that ultimately were used in creation of Tables 10.14 and 10.15, I believe.
Q Can you -- did you write the lines on there? 01:43PM
I'm still not following you. I don't know what lines are missing.
A Well, they're missing from Exhibit 16, and I didn't have Exhibit 16 to be writing on.
Q Did you examine on the break, Dr. Engel, the 01:43PM
electronic file that is Exhibit 16?
A I did.
Q Okay, and is there information contained in that electronic file on the screen, not all the
computer programming behind it, that is not present 01:43PM
on the printed out version of Exhibit 16?
A There is missing information.
Q Okay, and tell me again, maybe you did and I didn't catch it, what information is actually
missing from Exhibit 16. 01:44PM
A I believe -- hopefully this isn't a memory test, but I believe it's probably the three lines that make up Table 14 and the lines that make up Table 15.
Q An actual reproduction of the information 01:44PM



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that's in Table 10.14?
A And Table 10.15.
Q Okay, all right.
MR. GEORGE: Rick, in order to avoid any unnecessary controversy about these three exhibits 01:44PM
that you have raised concerns about, I would like to, and I'm interested in your reaction, to provide Lisa, the court reporter, following this deposition with the actual electronic files for these three exhibits so that they can become part of the Record 01:44PM
in this case, and we can mark those as Exhibit 17.
MR. GARREN: Okay.
MR. GEORGE: You okay with that?
MR. GARREN: I am.
MR. GEORGE: We'll set aside a sticker. Do 01:45PM
you have the jump drive?
MR. ELROD: That's a virtual exhibit.
MR. GEORGE: A virtual exhibit. Someone is going to have to buy Dr. Bierman a jump drive.
Q All right, Dr. Engel. Now, also included on 01:45PM
Exhibit 17 were some nutrient input files from the GLEAMS model. Did you notice that when you reviewed the electronic files that were Exhibit 17? I'm talking about this.
A Sorry. So we're not on Exhibit 16? 01:45PM

Q We're going to get back to that. I'm still on the subject of homework.
A Yes.
Q Did you review the electronic files on Exhibit 17? 01:45PM
A Well, not every single file.
Q But did you notice there were nutrient input files from the GLEAMS model that were provided to you by Dr. Bierman on the jump drive?
A Yes. 01:46PM
Q Okay, and did you review those files, Dr. Engel, to provide me with the answers to the questions that I asked earlier about, for example, what is the input parameter that reflects the other non-poultry animal waste that you claim to have 01:46PM input into your model?
A It's going to take a little more time to look at those than we had during lunch. So I want to be careful in going through those and not misrepresent them. 01:46PM
Q Did you try to identify that input parameter and data in the input files that were provided?
A I did look at a portion of those input files, and, you know, I did identify lines that would have had some of those inputs in them and did not have a 01:46PM



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chance to look at all the files and, you know, carefully examine all the content of each file.

Q Did you find input files or parameters that were identified as swine, commercial fertilizer, dairy cattle and beef cattle? 01:47PM

A In the files that I looked at, there were. Some of those were represented.

Q Were they labeled as that?

A That's the part where I probably need to look carefully. I'm not sure without cross checking 01:47PM between some documentation and those files as to, you know, what tables are reflective of what's actually represented numerically.

Q Okay. So, Dr. Engel, as we sit here today at 1:48 on January 9th, you cannot -- 01:47PM

MR. McDANIEL: Friday.

Q -- you cannot identify for the defendants and their consultants the files that you used to simulate the input of phosphorus from beef cattle, swine, dairy cattle and commercial fertilizer in 01:48PM your GLEAMS model that is the subject of your expert report; is that true?

MR. GARREN: Object as to form, and my statements made earlier about his need to see all of the input file. 01:48PM

Q Did you understand my question?
A I can generally identify the files and locations of where those files would have been, but without reviewing the specific files, I can't tell you absolutely what's in them. 01:48PM
Q Well, tell us generally, and speak to Dr. Bierman who is seated to my right, Dr. Engel. Tell Dr. Bierman where he needs to go in your electronic files that were produced in this case to find the inputs that you used in simulating the application 01:49PM of those other sources of nutrients in the GLEAMS model.
A So those inputs would be in a group of nutrient input files of the form one or two N, N for nutrients, and then typically a letter following 01:49PM that as well, dot P-A-R, and those would be in the group of files associated with each of the watersheds, whether that be Illinois, Baron Fork or Caney. The files that -- there would be comparable files for the run that represents the calibration 01:50PM that would be nested underneath Illinois, Baron Fork or Caney in a directory called origin input or something to that effect that represents the original input files. Let me see if I wrote that down. Looks like it would be O-R-G-I-N-P-U-T, and 01:50PM

that will contain a group of dot P-A-R files, some of which would represent nutrient inputs for calibration.

Q Dr. Engel, Dr. Bierman believes all of those files that you've just described were on the flash drive that he just gave you. Can you confirm whether or not the material that you're describing would be located in the directory that's entitled 1.1, future, underscore, 100 year? 01:51PM

A Without seeing the directory structure, again -- 01:51PM

Q Dr. Engel, I'm going to hand you -- I'm breaching every protocol known to man -- a computer for our expert, Dr. Engel, that has your input files loaded on to it, and he's pulled up the directory that he believes you are talking about. Can you find the input files that you're talking about within that directory? 01:52PM

A So it looks like the input files for the calibration period would have been this group of files here at the bottom that are 1nu.par, 1nf.par, 1nc.par, 1np.par, 2np.par, and I guess these would be reflective of starting values for the Illinois-Tahlequah region. There would be a corresponding similar structure for Baron Fork, 01:52PM 01:53PM

Caney Creek, and so those were the -- those would be the nutrients at start of calibration I believe.

Q Can you actually open one of those input files?

A (Witness complied). 01:53PM

Q And can you show me, Dr. Engel, in the file in which you opened, which for the Record is the -- what's the file name of this one?

A It's right here at the top.

Q 2np.par. Where can I -- which one of the 01:54PM numbers or values reflected in this electronic file reflects inputs of phosphorus from swine, beef cattle, dairy cattle or commercial fertilizer?

A Well, looks like -- let's see. Again, without some additional manuals and documentation, I think I 01:54PM know, but without looking at further documentation related to, you know, the GLEAMS model, I don't recall what every one of those numbers is going to represent certainly.

Q Well, Dr. Engel, do you agree with me that the 01:54PM input file you directed us to does not contain anything in terms of a description that would allow one to readily determine which of those data points is designed to relate to those other sources of phosphorus? 01:55PM



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A I would agree with that, and I would also note that the specific format here is a format required by the GLEAMS model and, therefore, there's not a readily transparent and handy way to insert that type of a comment in that file. Otherwise, this 01:55PM file I don't think will run or won't work when you try to run this.

Q Well, and I understand that, and that may very well be, but how, Dr. Engel, were the defendants and their experts supposed to figure that out, what 01:56PM input files you were actually using and associating with those other sources of phosphorus?

A Well, if -- I guess if you traced through the input files, you'll find that those are the files used to represent nutrient inputs. 01:56PM

Q Dr. Engel, how long do you think it would take you to review whatever material you need to at your office to determine the answer to my question?

A The question again was --

Q Specifically identify the input files that 01:56PM were used in your various GLEAMS model scenarios to represent the phosphorus contributions from dairy cattle, beef cattle, swine and commercial fertilizer.

A So that would probably -- and this is for all 01:57PM



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scenarios?
Q The actual condition scenario for 1997 to 2006.
A Probably --
Q I'm sorry, and the no litter or no animal 01:57PM
waste and soil background 100-year scenario, those two runs.
A So to be on the safe side, might take five or six hours to make sure that I don't mislead you with the response. 01:58PM
Q Okay, and, Dr. Engel, you are aware that you and I have had a history in this case of communicating back and forth between counsel via E-mail for information as to the location of certain files? 01:58PM
A Correct.
Q Okay. Do you have any objection to providing me with that information through Mr. Garren in an E-mail?
A Assuming that Mr. Garren is okay with that, 01:58PM
that would be fine with me.
Q Okay.
MR. GEORGE: I'm going to make that request, Rick.
Q Okay. Let's go back to Exhibit 16, Dr. Engel, 01:58PM



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which I think is the load allocation spreadsheet.
One of the other questions that was left hanging
that I had asked you to see if you could discover
the answer to on your break was with respect to the
second tab of the spreadsheet that has been marked 01:59PM
Exhibit 16, what was the source of the data
contained in that tab. I told you that I believed
it came from the routing model but you were not
sure. Have you been able to confirm that?
A I began to track that down, but due to looking 02:00PM
at these other issues, didn't have an opportunity to
pursue that to completion. So as I sit here at the
moment, I can't specifically tell you which files
this would have come out of.
Q And let's start general and then we'll get 02:00PM
more specific before we get into exactly which file.
Can you confirm that the loads that are reflected in
the second sheet of Exhibit 16 under P to lake came
from the output of your routing model?
A Without looking again at those specific files, 02:01PM
I didn't have a chance to firm up where this is
coming from. So, you know, at best it would be
speculation at this point without seeing the broader
group of files and being able to verify that.
Q Well, Dr. Engel, you are familiar with the 02:01PM



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approach and the method that you used to allocate back sources of phosphorus to, among other things, poultry litter as reflected in Exhibit 16, are you not?

A I am. 02:01PM

Q That's your work; right?

A Correct.

Q Surely you know the source that was intended for the basic information that was used in -- as a starting point for that computation, do you not? 02:01PM

A It's been a number of months since this computation was done, and there are thousands of files, if not tens of thousands of files. So, you know, this is -- I did not review which file flowed into this one in preparing for the deposition, and 02:02PM during lunch didn't have a chance to backtrack as to where this specifically came from. So I don't want to speculate for you as to, you know, the exact source as to which this came from right now.

MR. GEORGE: Let me get somebody on the 02:02PM phone.

(Whereupon, a discussion was held off the Record.)

Q All right. So, Dr. Engel, to summarize where we are, and you tell me if you disagree, as we sit 02:03PM



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here today, you cannot advise the defendants or their experts as to the source of the information that you used in terms of phosphorus to lake, which was an integral part of your allocation of phosphorus to poultry litter as reflected in Exhibit 16? 02:04PM

A Well, Exhibit 16 contains values. I need to identify the source of that -- of those values by looking through additional files before I'm going to be confident in telling you where they came from. 02:04PM

Q So is the answer to my question that's correct? Do you recall my question?

A Could you repeat your question?

MR. GEORGE: Lisa, could you read it back, please? 02:04PM

(Whereupon, the court reporter read back the previous question at Page 383, Line 24 to Page 384, Line 6.)

A Correct, with the explanation I provided prior. 02:05PM

Q Dr. Engel, on this same page of Exhibit 16, Tab 2, there are some land use categories again; we see crop urban and forest?

A Correct.

Q Okay, and there are a series of numbers I 02:05PM



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think that are intended to be kilograms of phosphorus associated with each of those land uses; correct?

A Without studying this further, I'm not sure what the units are here. 02:05PM

Q Okay, but there are a series of numbers in terms of phosphorus load associated with each of those three land use categories; is that right?

A There are, but for whatever reason, they seem to be averaged here across time. 02:06PM

Q Okay. Where do those numbers come from?

A Again, without spending some time with this spreadsheet and other materials, I would hate to speculate as we sit here.

Q Dr. Engel, can you at least confirm that the numbers in this tab on Exhibit 16 beneath the land use categories, crop, urban and forest, are the output or some output of the GLEAMS model? 02:06PM

A They would be.

Q Okay. Can you tell either from your memory or from looking at Exhibit 16 which GLEAMS run or scenario was used to derive the numbers that are reflected? 02:06PM

A I can't recall that but, again, I'm going to have to look at the spreadsheet and related 02:07PM



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materials in more detail to understand that again.
Q Okay. Dr. Engel, same question as before.
Once you get back to your office and you have
available to you all of your file materials,
including electronic files, how long do you believe 02:07PM
it would take you to answer the question as to the
source of the numbers in the column P to lake and
the source of the numbers in the columns, crop,
urban and forest?
A Once I can make time, probably three or four 02:07PM
hours.
Q Same question as before, Dr. Engel. Would you
have any objection to providing that information to
your counsel, Mr. Garren, so that he can provide it
to me? 02:08PM
A If Mr. Garren is okay with that, that will be
okay.
MR. GEORGE: Rick, are you okay with that?
MR. GARREN: So noted.
MR. GEORGE: Does that mean yes? 02:08PM
MR. GARREN: Doesn't mean anything.
MR. GEORGE: So you're not willing to
say --
MR. GARREN: I'm not saying anything right
now, but I'm sure given what he can provide to us, 02:08PM



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if you all still can't figure it out, we want to help where we can I'm sure.

MR. GEORGE: I'm not sure what to make of that. I guess we'll see what the future holds.

Q Dr. Engel, can you go to the other page of Exhibit 16, which is the allocation page, Tab 1. 02:09PM

A Okay.

Q Can you see the -- can you explain, Dr. Engel, how in this allocation process you backed out the portions of the phosphorus load from pastures that you were attributing to swine, dairy and background soil conditions? 02:09PM

A Is commercial fertilizer in that group as well?

Q I'm sorry? 02:10PM

A Was commercial fertilizer in that group as well?

Q I don't know, but let me amend my question. Can you explain how you backed out those sources, plus commercial fertilizer? 02:10PM

A So these would have been from a -- so at a higher level without going into specific files, this would have been a run in which poultry waste would have been off. Soil test phosphorus would have been set to background levels. 02:10PM



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Q Well, I understand that, but how did you get specific values from that analysis for the portion of the phosphorus load that you were attributing to swine, dairy cattle and background soil?

A So if -- so from that model run that I was 02:11PM
describing, if you remove forest, crop, urban, the remainder would have been attributable to pasture. I guess wastewater treatment would need to be excluded here as well, and a portion -- whatever the
portion calculated here and represented in Exhibit 02:11PM
16 that was attributed to cattle as we talked about earlier today, that was taken out of the pasture as well. So the portion that remained in pasture then would be attributable to background, swine, dairy.

Q And poultry? 02:12PM

A Remember, poultry was turned off in this.

Q So is that methodology that you have just described what led to the -- if you look at Page 93 of your report -- the 11 percent values for swine,
dairy and background that you report in Table 10.15? 02:12PM

A Correct.

Q Okay. Where is commercial fertilizer in your table?

A I believe commercial fertilizer would be in
the crop mix or in the category labeled crop over 02:13PM

here then.
Q Did you actually apply commercial fertilizer to cropland?
A I believe so. Again, without looking through those input files and confirming for you, I wouldn't 02:13PM
want to speculate as we sit here.
Q Go back to Exhibit 16. The second tab, it has at the top of it this P to lake reference. Do you see towards the bottom portion of the exhibit there is a column referenced pasture -- actually it's a 02:14PM
row that says pasture pounds and then out to the right of it has the figure 260,983?
A I see that.
Q Okay. What sources does this pasture load include? 02:14PM
A Without, again, being able to look at a broader group of files, as I'm sitting here at the moment, I could only speculate. I think I know what it is but, again, I wouldn't want to speculate without an opportunity to consult that broader group 02:14PM
of files.
Q Tell me what you think it is, and if you decide after looking at something that your memory wasn't exactly right, you can notify me of that later. Where do you think it came from and what 02:15PM



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sources do you believe are included in that pasture load?

A Excuse me. Without an opportunity to, you know, see the equations and calculations behind this and the other supporting files, it's a real challenge to sit here and even speculate without being very speculative at this stage. 02:16PM

Q Isn't it true, Dr. Engel, that to arrive at that pasture load, that you started with the total amount of phosphorus that is received at the outlet stations in the watershed directly above Lake Tenkiller and you subtracted GLEAMS edge of field phosphorus loads and assumed that the balance comes from pasture? 02:16PM

A I'm not certain as I look at this at the moment without an opportunity to look behind this more and look at supporting files, so -- 02:17PM

Q Does it make sense, Dr. Engel, and do you believe it is valid for purposes of allocating phosphorus load to sources to be subtracting GLEAMS edge of field output loads from routing model loads to Lake Tenkiller given that they're two different models? 02:17PM

MR. GARREN: Object to form.

A There could be instances where that would 02:18PM



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certainly be valid.
Q Would it be valid here?
A Again, without an opportunity to look at what is going on here --
Q Dr. Engel, I'm not asking you at this point 02:18PM
what you did. I want to know if what I just described would be valid.
A Could you describe again what you -- sorry.
MR. GEORGE: Lisa, can you read it back?
(Whereupon, the court reporter read 02:19PM
back the previous question at Page 390, Lines 18-23.)
A And, again, my answer would be that, yeah, it could be. You know, I would need to understand the
context further and see if that were reasonable. 02:19PM
Q All right. Let's go back to Appendix F for a moment. Do you recall that we did establish that one of the -- I'm sorry, that central to the way in which you backed out the cattle contribution from
your allocation was the analysis completed in 02:20PM
Appendix F; right?
A Yes.
Q Okay, and in particular, you scaled back, if you will, the pasture load and allocated it to
cattle based upon this 35,594 pound number reflected 02:20PM



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in Table 6; right?
A Correct.
Q Okay. Now, does that figure, Dr. Engel, the 35,594 pounds, reflect the full amount of cattle manure that is, or I'm sorry, phosphorus from cattle manure that is deposited onto the land surface in the watershed? 02:20PM
A No, it would not.
Q Okay. It's a small subset of what cattle actually defecate; do you agree? 02:20PM
A It's a subset, yes.
Q Okay, and it's a small subset; right?
A Without looking at that -- that computation may be in here someplace as well.
Q Okay. Now, in Appendix F you describe what is called a capture zone analysis. Do you recall that terminology? 02:21PM
A Correct.
Q For the Record, what is a capture zone analysis? 02:21PM
A Make sure I've got the context correct. So are we on --
Q At two.
A At two. Well, the purpose of the analysis, if we can start there, was to identify potential 02:21PM

pastures and, therefore, cattle that would be in those pastures that would potentially have access to streams or I guess third order and higher streams in the IRW.

Q Okay, and did you place some limitations on how close the cow had to be to the stream in terms of defecating in arriving at your 35,594 pound per year figure in Table 6? 02:22PM

A I guess there are two -- as I recall, there are two numbers here in the works. So are we still talking about the capture zone analysis and the materials on F-2 or are we talking about Table 6? 02:22PM

Q I'm back to F-3, Table 6.

A Table 6, okay.

Q And, here, let me help you or at least help you understand the question. In the paragraph above Table 6, do you see that paragraph that starts with using? 02:23PM

A Yes.

Q In the first sentence, and it's a long one, you say that you have computed the annual P deposited in or within 10 meters of streams, and that is shown in Table 6; right? 02:23PM

A Yes.

Q Okay. So in order to make it into the number 02:23PM



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that you used in your allocation, the cattle, based on your analysis, had to be defecating within 10 meters of the stream; is that right?

A Or in the stream.

Q Or in the stream? 02:23PM

A Yes.

Q Okay. Now, so in order to do that, you had to identify the number of pastures in the watershed that had access for cattle to streams; right?

A Right. 02:24PM

Q And you didn't actually physically identify them; you made some assumptions; right?

A Assumptions that a calculation was made in doing that, yes.

Q Okay, and that -- those assumptions and that 02:24PM calculation led to a number as to the total acreage or the total number of cattle on pastures that had access to streams in the basin; correct?

A Correct.

Q Okay. Now, in arriving at this 35,594 pound 02:24PM per year of phosphorus figure that is represented as the amount of phosphorus deposited by cattle within 10 miles of streams, did you use all of the pastures that you had identified as having access to streams?

MR. ELROD: You said miles. 02:24PM



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Q I'm sorry, 10 meters.
A Okay. So the capture zone analysis calculated the expected number of cattle that would likely have access to streams. Realize, too, that not all cattle within those areas would have access to 02:25PM
streams. A fairly significant percentage would be fenced out, and the percentage that was based -- that was fenced out was 45 percent based on a conversation with Mr. Ed Fite regarding his experiences in the watershed and opportunities to 02:25PM
observe how many pastures along this type of stream would typically have fence.
Q Okay. So that gets to my question, Dr. Engel. The number that is reflected in Table 6, 35,594 pounds of phosphorus per year, and that you used in 02:26PM
allocating a portion of the pasture load to cattle, has been reduced by 45 percent based upon a conversation that you had with Ed Fite; is that right?
A So, yes, it would be reduced by 45 percent. 02:26PM
Q Okay. Now, tell me when you had this conversation with Ed Fite about the percentage of pastures in the watershed on which cattle had been fenced out.
A When? 02:26PM

Q When.
A This would have been -- well, certainly prior to May of 2008.
Q For fence but I had to figure that out.
A My recollection, though, is that it was 02:27PM
probably in March or April of 2008.
Q Where were you when you had this conversation with Mr. Fite?
A I believe I was on my cell phone, and Bert
Fisher was part of that conversation as well. 02:27PM
Q Well, were you in Oklahoma or northwest Arkansas on your cell phone?
A No. My recollection was that I was someplace in Indiana. I don't know exactly where.
Q Okay, and where was Mr. Fite when you were 02:27PM
talking to him on the phone?
A I don't recall.
Q Okay. Did he call you and you just happened into this conversation or did you make a specific
call to Mr. Fite to secure this information? 02:28PM
A A specific call was made because there was a need to understand how many cattle, due to fencing, would not have access to streams.
Q Okay, and who determined that Mr. Fite would
be the person with the best knowledge on that 02:28PM



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subject?

MR. GARREN: Object to form.

A I believe that was a result of a conversation with Bert Fisher.

Q Okay. How many times prior to this phone call had you had opportunity to talk with or work with Mr. Fite? 02:28PM

A I had not worked with him prior to this.

Q Had you ever talked to him prior to this?

A Not to my knowledge. 02:28PM

Q Okay. Do you know who Ed Fite is?

A As I recall, he's been involved with the OCC.

Q Which is the Oklahoma Conservation Commission?

A Conservation Commission I believe. So I don't recall if he's director or executive director. All I know is he's had an affiliation with that organization. 02:29PM

Q Okay. What's Mr. Fite's educational background?

A I'm not sure. 02:29PM

Q Okay. Is Mr. Fite a cattle rancher?

A My recollection is that he does have some cattle or at least certainly has experiences in the watershed with cattle and observation or opportunities to observe cattle, and the OCC has 02:29PM



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funded or has been involved in implementation of best management practices, including fences, and so Mr. Fite would be knowledgeable of fencing of cattle out of streams in this area.

Q Okay. Did Mr. Fite provide you with any study or data or evidence to support the claim that you make on Page F-3 that 40 to 50 percent of pastures that touch streams in the Illinois River watershed fence cattle from the stream or river? 02:29PM

A If there were a specific study, we could have used it and cited it. So I don't believe there was a specific study that would be representative of the IRW. Again, and I think this was based on his personal experience, there may have been some studies on some smaller areas from what I recall. So whether those were considered in his estimate, I don't recall as we sit here. 02:30PM 02:30PM

Q Okay. Tell me and tell the court exactly what Mr. Fite told you about the percentage of cattle that are fenced from the stream or river in the Illinois River watershed. 02:31PM

A So, again, we're talking about third order streams and larger streams, and his estimate of the amount of the pastures that would have access to these types of streams or rivers, his indication was 02:31PM



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that 40 to 50 percent of those pastures would have fence that would preclude the cattle from walking into the riparian area or walking into those streams.

Q Did he use those figures, 40 to 50 percent? 02:31PM

A 40 to 50 percent was his number, and that's what I reported here in F-3.

Q Okay, and did Mr. Fite limit his answer to third order and higher streams?

A I believe that the -- you know, that the 02:32PM discussion or he was -- Bert described what third order streams would tend to look like and how those would be represented on maps, and it was based on, you know, Mr. Fite's interpretation of those as to the amount of fence. 02:32PM

Q Did you explain to Mr. Fite that you wanted to use information obtained from him to support a scientific opinion to allocate fault to defendants in a lawsuit?

A I think we told him about the analysis we were 02:32PM trying to conduct. Whether it was conveyed to him -- I believe it was conveyed to him that this was going to be part of an analysis that was going into an expert report.

Q Are you confident of that, that you told Mr. 02:33PM

Fite that the information he was providing was going to be used in analysis in a report that you were going to submit to the court?

A That's my recollection.

Q Okay. 02:33PM

MR. GEORGE: Let's take a break and change tape.

VIDEOGRAPHER: We are now off the Record. The time is 2:33 p.m.

(Following a short recess at 2:33 p.m., 02:33PM proceedings continued on the Record at 2:41 p.m.)

VIDEOGRAPHER: We are back on the Record. The time is 2:41 p.m.

Q Dr. Engel, do cattle that are grazing in the Illinois River watershed defecate within 10 meters 02:41PM of first and second order streams?

A Yes, some do.

Q Okay. Why did you exclude pastures that have access to first and second order streams from your cattle analysis in Appendix F that form the basis 02:41PM for your allocation of phosphorus loads to cattle?

MR. GARREN: Object to form.

A I'm just making sure that I'm correct that this was third order, if you don't mind for just a moment. 02:42PM



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Q Sure.
A So third order or larger. Typically those smaller streams are not flowing for a significant portion of the year and, therefore, the decision in the analysis was to exclude those because presumably 02:42PM
one of the reasons the cattle are coming down and spending time within 10 meters or within these streams is for water, and because the smaller streams would tend only to have flow during a much more restricted part of the time, they were excluded 02:43PM
from the analysis, and in retrospect, having seen some more recent literature, you know, the time the cattle spend in and near streams is probably overestimated in the analysis represented in F-2, so I'm comfortable with the analysis. 02:43PM
Q Dr. Engel, these first and second order streams in which cattle might actually be grazing in the stream when there's not water there, are they full of water when you get heavy rains in the watershed? 02:43PM
A Well, during a significant runoff event, yes, those smaller streams would have water in them, but I think characterizing those smaller streams as streams that cattle are going to be grazing in is probably a mischaracterization of those smaller 02:44PM



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streams.
Q If a cow has been grazing in or near a first or second order stream and has left behind what you leave behind when you graze, which is cattle manure, what happens to the phosphorus from that cattle 02:44PM
manure when that rainfall events occurs and that first and second order stream fills up with water?
MR. GARREN: Object to form.
A So it would certainly be an opportunity for some of that phosphorus that was in that cattle 02:44PM
waste to move during that scenario that you've described.
Q Okay. Dr. Engel, who is Indrajeet Chaubey?
A He's a professor that is within my program at Purdue, a colleague of mine. 02:45PM
Q Is he within the same department as you?
A Correct.
Q And what is that department?
A Agricultural and biological engineering.
Q Does Dr. -- am I saying his name correctly, 02:45PM
Chaubey?
A Chaubey, yeah.
Q Does Dr. Chaubey report to you?
A Yes.
Q Have you talked with Dr. Chaubey about your 02:45PM

work in this case?
A Only in very limited conversations.
Q What conversations have you had with him in terms of subject matter about this case?
A So the subject matter would tend to be 02:45PM
probably far ranging, you know, certainly discussions about his experiences in this watershed or areas adjacent to this watershed. You know, I'm certainly, you know, aware that, you know, he has a
lot of those kind of experiences and, you know, 02:46PM
significant expertise, you know, in this landscape in not only modeling, hydrologic water quality modeling, but also in data collection within the field and analyses of those data. So the
conversations would have been regarding some of 02:46PM
those subjects typically.
Q Have you asked Dr. Chaubey to perform any work in connection with this lawsuit or the Illinois River watershed?
A No, I have not. 02:46PM
Q Is it true, Dr. Engel, that you have asked Dr. Chaubey to meet with the lawyers representing the State of Oklahoma in this case?
A I think that the request was from the lawyers
to meet with him, and it wasn't a specific request 02:47PM



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from me. It may have come through me.
Q Okay. Did you talk with Dr. Chaubey about the fact that the lawyers representing the State of Oklahoma wanted to meet with him?
A I did. 02:47PM
Q Okay. Did you encourage him to grant such a meeting?
A You know, I wouldn't characterize it as encouraging or discouraging. You know, he's a conduit of the information and, you know, so it was 02:47PM neither encouraging or discouraging.
Q What did the attorneys for the State of Oklahoma want to meet with Dr. Chaubey about?
A I believe it was some of the same topics we talked about, given that he has a substantial 02:47PM experience with modeling of parts of this watershed, adjacent or nearby watersheds, significant experience with collection of water quality datasets in the field, significant experiences in observing the way things work within this watershed or within 02:48PM this landscape, and so he would be an expert on a number of subjects that would be related to those topics.
Q Well, doesn't the State of Oklahoma already have an expert on those topics? 02:48PM

MR. GARREN: Object to form.
A Yes.
Q And aren't you supposed to be that expert?
MR. GARREN: Object to form.
A I'm an -- one of many experts. 02:48PM
Q Is Dr. Chaubey going to go to work for the State of Oklahoma in this lawsuit?
MR. GARREN: Object to form.
A I don't know.
Q Tell me about the meeting you attended with 02:48PM attorneys for the State of Oklahoma and Dr. Chaubey.
A So there was a meeting with Dr. Chaubey and some attorneys for the State of Oklahoma.
Q Which attorneys?
A So Mr. Garren, Miss Burch. 02:49PM
Q The same Miss Burch who is present in the deposition today?
A Yes, and hang on. I'm drawing a blank.
MR. GARREN: Bullock.
A Mr. Bullock. Sorry. 02:49PM
Q Those are the only attorneys?
A I believe that's correct.
Q About how long ago was this meeting?
A Maybe November, so approximately November, mid November, end of November, maybe early December, in 02:50PM



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that general time frame.
Q Where was the meeting?
A The meeting was in West Lafayette.
Q West Lafayette, Indiana?
A Indiana, yes. 02:50PM
Q On the Purdue campus?
A Yes, it is.
Q Okay, and just so the Record is clear, you said the meeting was in November. Was that November of this year, 2000 -- I'm sorry, November of 2008? 02:50PM
A It was 2008. So whether it was November or December, it was in that time frame.
Q All right, and how long did the meeting last?
A Oh, my recollection is that it -- the meeting was about three hours maybe. 02:50PM
Q Any other technical people besides yourself and Dr. Chaubey in the meeting?
A That would be the only -- so Dr. Chaubey, myself and the three attorneys that we identified earlier were the people that were in the meeting. 02:51PM
Q Okay, and that was excluding the attorneys from technical?
A From technical, okay.
Q Mr. Page attend this meeting?
A No. 02:51PM



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Q What sort of documents did you and Dr. Chaubey and the three lawyers look at during this three-hour meeting a month or two ago in West Lafayette, Indiana?

MR. GARREN: Object to form. 02:51PM

A I believe it was a group of papers that Dr. Chaubey had authored. I don't know if there were -- I don't recall that there were reports or papers beyond that. My recollection was that it was, if not solely, certainly largely papers that had been 02:52PM authored by Dr. Chaubey. There may have been -- there may have been a couple other papers now that I think about it that were examined as well.

Q What papers not authored by Dr. Chaubey were discussed during this meeting? 02:52PM

A The one that I can recall is a paper from the Delmarva area as I recall. I don't recall the specific authors at this point, but it was generally a paper about phosphorus in drainage ditches there that they were attributing to poultry. 02:52PM

Q So what specifically did you discuss about these papers with Dr. Chaubey for three hours a month or two ago in West Lafayette, Indiana?

MR. GARREN: Object to form.

A You know, the discussions were generally about 02:53PM

the highlights or his -- you know, I guess his conclusions within some of those papers and what he felt were highlights within those documents.

Q What conclusions by Dr. Chaubey in prior papers or in papers that he didn't author were being discussed? 02:53PM

A Well, again, it would have been conclusions related to his experience as presented in those papers with hydrologic water quality modeling, with data that he had collected, studies he had been involved with within the watershed. So, you know, I suppose -- well, I don't suppose. So I know those papers had a range of conclusions, some related to modeling, some related to data, many of those related to certainly movement of phosphorus from a variety of sources that would include poultry land waste application. As I recall, several of those examined certainly other phosphorus sources as well. 02:54PM

Q Did you discuss with Dr. Chaubey his work on the Arkansas phosphorus index? 02:54PM

A I don't recall if that work was specifically discussed or not. It may have been.

Q Either in this meeting or in any of your other conversations with Dr. Chaubey, have you ever heard him express concerns, reservations or doubts about 02:55PM



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the validity of the Arkansas phosphorus index?
A I'm not sure we've had specific conversations about the Arkansas phosphorus index other than, you know, that he had had maybe some involvement in some aspects of it, so I'm not sure that we -- at least I 02:55PM
don't recall having a conversation with him about any of the technical details, no merit or lack thereof potentially of that approach, so --
Q Have you shown Dr. Chaubey your expert report in this case? 02:55PM
A No, I have not.
Q Has he seen any of your work product in connection with this lawsuit?
A To my knowledge, no.
Q Did you encourage Dr. Chaubey to come to Tulsa 02:55PM
voluntarily to give a deposition at the request of the State of Oklahoma?
A I -- again, I didn't encourage nor discourage, you know, that activity. So, you know, he did indicate that he was considering it. I wasn't sure 02:56PM
that he had -- well, I'm not sure that he has decided to do it or not, but I knew he was considering it when he indicated that was the case prior to some travels.
Q You believe Dr. Chaubey is a competent 02:56PM

modeler?
A Yes.
Q Do you believe Dr. Chaubey is capable of identifying problems and deficiencies in the modeling work of others? 02:56PM
A Sure.
Q Let me go back just a moment to Exhibit 16. I apologize. This is the only version of Exhibit 16 that I have been able to find in your considered materials, this load allocation spreadsheet. Are 02:57PM there others or is it the only one?
A To my knowledge, this is the only one. My recollection was that this was done fairly late in the analysis. So, again, without looking through materials, to my knowledge this is the one. 02:57PM
Q And, Dr. Engel, I think we established earlier at least some of the information used in the computations reflected in Exhibit 16 are the output of the GLEAMS model; correct?
A Correct. 02:57PM
Q Okay. Now, you are aware, are you not, Dr. Engel, that between the first report that you signed dated May 22nd of 2008 and your September 4th errata report, there was this additional GLEAMS modeling run that came to light? 02:58PM



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A Correct.
Q Why then, sir, do we not have at least two versions of Exhibit 16?
A Again, as we have talked about the GLEAMS modeling that was being done, you know, examined 02:58PM
some of the scenarios and things first, Dr. Ji-Hong discovered and -- unbeknownst to me discovered and corrected that error and continued then in using the GLEAMS model system, and given that the information that's presented in Exhibit 16 was done late in that 02:58PM
process, by the time I was working with summarized data that he was working with in me preparing, that issue had been resolved and so, therefore, the data that were used for Exhibit 16 represented the corrected version of the modeling system. 02:59PM
Q As we sit here today, Dr. Engel, do you believe that Exhibit 16 is the only load allocation spreadsheet that you have completed in connection with your work in this case?
A I believe that's the case. 02:59PM
Q Okay. Dr. Engel, in the errata that was produced on September 4th, the output from the routing model changed, did it not?
A September -- which outputs are we specifically talking about? Sorry. 03:00PM



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Q The total predicted loads of phosphorus at the three outlet stations.
A I believe those -- the predicted -- I believe the predicted may have changed again. I would need to look. 03:00PM
Q It's Exhibit 4 if you want to take a look. Your errata is Exhibit 4.
A So certainly there was some things that changed in the errata as represented by Exhibit 4. I'm just trying to think. 03:01PM
Q Let me back up for a second and maybe I can help. Isn't it true, Dr. Engel, that the purpose or at least one of the main purposes of the September 4th errata is that you had rerun your routing model and you had new predicted loads? 03:02PM
A So, yes, the routing model was rerun, and how that interacts with Exhibit 16, at the moment without stepping back and stepping through this but generally --
Q Can I take another run at it? 03:03PM
A Sure.
Q Dr. Engel, if the output of the routing model is part of the information that's used in the waste load allocation in Exhibit 16 and the routing model output changes after you developed Exhibit 16, then 03:03PM



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you ought to have a subsequent P load allocation spreadsheet based upon the results of the new phosphorus routing model; correct?

A That's what I'm trying to understand here is, yeah, if that routing data that you speak of went into Exhibit 16 or not here at the moment. 03:03PM

Q In light of the uncertainty around this and the recognition that there has been a new phosphorus routing model run, Dr. Engel, can you tell us today whether or not Opinion No. 8 on Page No. 2 where you state that 45 percent or 59 percent, depending upon the time frame, of the phosphorus reaching Lake Tenkiller comes from poultry litter is still a valid number in light of the new results from the phosphorus routing model? 03:04PM

A I guess I would probably want to recheck this at this stage given some of the questions you've raised about Exhibit 16, but would just indicate again that, you know, the waste allocation here in Opinion 8 is consistent with the findings of others in this watershed. 03:04PM

Q Okay. Let's switch topics and go to Page 37 of your report, Dr. Engel.

A Okay.

Q Page 37 and for a few pages thereafter in 03:05PM



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terms of context, it seems to me that you are evaluating, using some runoff coefficients, the potential phosphorus load based upon the amount of poultry litter applied in the watershed; is that fair? 03:05PM

A That's a fair characterization.

Q And the bolded opinion that appears on Page 37, you state that based upon that analysis, between 432 pounds to nearly 500,000 pounds annually of phosphorus from poultry litter application is lost 03:06PM to water; do you see that? I did a horrible job. Can you read your bolded opinion?

A Sure. I'll try to get the hundred thousand piece slid back in there.

Q Go ahead. 03:06PM

A So average annual P loads to water in the Illinois River watershed attributable to poultry waste application to pastures is calculated between 432,000 pounds to nearly 500,000 pounds annually based on poultry waste P application to the 03:06PM landscape in literature, P loss coefficients.

Q What do you mean by the average annual P loads to water in that opinion; what type of water are you talking about?

A So these would be loads to the streams and 03:06PM



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rivers within the IRW that one would potentially expect to reach the gauging stations.

Q All right. A couple of things and let's pull it apart. Dr. Engel, you're not contending, are you, that based upon this runoff coefficient analysis, that 432,000 to 500,000 pounds of phosphorus per year from poultry litter makes it to Lake Tenkiller? 03:07PM

A Well, so, no, it does not, because based on the last ten years, the average load of phosphorus to Lake Tenkiller is a little bit more than 500,000 pounds per year. So these numbers are based on coefficients in the literature, coefficients that have been used actually in this watershed by several authors, and one, in fact, arrived in this watershed up to I guess the gauging station at Bridge 59 near the border. 03:07PM 03:08PM

Q Isn't it true, Dr. Engel, that the studies that you're referring to are edge of field runoff studies? 03:08PM

A No, not all of them are.

Q Okay. For example, the work of Dr. Sharpley that you referred to, is that an edge of field runoff study?

A That's actually I believe from a group of 03:08PM



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studies that would be edge of field types of runoff.
Q Okay, and you cite Dr. Sharpley for this 5 percent figure; do you see that on Page 37?
A Yes.
Q Okay, and that figure is lifted from a study that is an edge of field runoff study, is it not? 03:08PM
A Again, I believe it's from a group of studies.
Q But it's a group of edge of field studies; right?
A Yes. 03:09PM
Q Okay. Now, you do appreciate, do you not, Dr. Engel, that there's a difference between edge of field runoff studies and a study of the amount of phosphorus that reaches a stream or river?
A Yes. 03:09PM
Q Okay, and you've used this 5 percent edge of field runoff coefficient in arriving at your 432,000 to 500,000 pounds numbers; is that right?
A Correct.
Q Okay. 03:09PM
A But I guess I would point out, there was another source that also used something more than 5 percent within this watershed, Will, et al, and that was not to represent edge of field. They were modeling export of phosphorus from the watershed, 03:09PM



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the IRW watershed.
Q Who is Dr. Sharpley?
A I believe he's a faculty member and/or USDA employee in the Fayetteville area.
Q Do you know Dr. Sharpley? 03:10PM
A I know of his work. I don't know that -- I wouldn't know him personally.
Q Have you ever met him?
A I don't know if I have or not.
Q Ever had a conversation with him? 03:10PM
A Not that I recall.
Q Have you been to seminars or meetings at which Dr. Sharpley was presenting?
A Again, not that I can specifically recall.
Q Dr. Sharpley is a pretty well written and read 03:10PM scientist; would you agree?
A Certainly.
Q Would you agree that Dr. Sharpley is considered by the scientific community, including yourself, to be an authority on phosphorus 03:11PM management and phosphorus losses from poultry litter applications?
A Yes, he would, yes.
Q Okay. Have you talked with Dr. Sharpley about your work in this case? 03:11PM



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A No. Given that we've not had any conversations that I recall --
Q I understand that.
A -- I have not.
Q Do you know whether or not Dr. Sharpley agrees with the way in which you've used his 5 percent phosphorus loss coefficient in your analysis? 03:11PM
A I'm not sure that that is only his 5 percent coefficient. So, again, it's from others. You know, other scientists studying the IRW have also used something bigger than 5 percent even. 03:11PM
Q Well, regardless whether it's his or his and others, do you know whether or not he agrees with your use of it in this case?
A I don't know. 03:11PM
Q Okay. Would it surprise you to know that Dr. Sharpley disagrees with what you've done and your report on Pages 37 and following?
A Yeah, I suppose he would have an opinion but, again, you know, others have used this value and, in fact, you know, as I recall, Marc Nelson computed a value that was 4 percent at Bridge 59. That's not edge of field, but that's, you know, Bridge 59 on the Illinois River, and in Nelson's analysis, if one excludes the phosphorus that cattle are recycling -- 03:12PM 03:13PM



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so Mr. Nelson initially included that in the total mass of phosphorus going into the landscape on an annual basis. So if one excludes that, the computed coefficient turns out to be a little over 5 percent at Bridge 59. So, you know, there's an observed 5 03:13PM
percent in this watershed at Bridge 59, and that's certainly a pretty good sized watershed and certainly not edge of field.

Q Did Dr. Nelson go back and redo his study to exclude cattle and reach the conclusion that you 03:13PM
just expressed?

A Dr. Nelson indicated that cattle were in fact recycling phosphorus in that study. Dr. Nelson did not in that study remove the cattle and recompute the coefficient. I removed the cattle contribution, 03:14PM
recomputed the coefficient at greater than 5 percent.

Q Has Dr. Nelson come out with a subsequent publication in which he embraces the same analysis and numbers that you just attributed to his study? 03:14PM

A His study stands as presented. So his number and his study that includes cattle was 4 percent.

Q Including cattle?

A It includes cattle.

Q Okay. Did Dr. Nelson actually validate and 03:14PM



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perform any field experiments to validate the 4 percent or did he just assume that based upon literature?

A No. It was a computed value from this watershed. 03:14PM

Q Computed from what?

A Well, give me a moment and I'll explain that. So there were a period of years for which Dr. Nelson collected observed phosphorus data at Bridge 59 on the river there. From that computed phosphorus 03:15PM loads, used wastewater treatment plant inputs to the river draining to that location. He subtracted those from the observed loads. That left the amount of phosphorus that one would attribute to non-point source pollution. Mr. -- Dr. Nelson computed masses 03:15PM of phosphorus that were being input into the landscape by fertilizer, by poultry waste land application, by cattle, and I believe he even included biosolids as I recall, and from that, computed a total mass of phosphorus on an annual 03:16PM basis going into the watershed, had an observed mass of phosphorus less the wastewater treatment plant phosphorus leaving the watershed, and if one divides those as he did, the coefficient he found was 4 percent. 03:16PM



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Q Okay. Dr. Engel, did Dr. Nelson measure phosphorus concentrations running off of fields that have received poultry litter?
A No. That wasn't the goal of the study. He measured phosphorus at Bridge 59. 03:16PM
Q Okay. Now, there are a whole body of studies and work out there in the scientific literature where people have actually, including Dr. Sharpley, measured the phosphorus losses at the edge of field on fields where poultry litter has been applied; 03:17PM correct?
A Correct.
Q Okay. Do you believe, as a scientist, as a general matter, when you have a measurement, you ought to go with it over a computation? 03:17PM
A Generally, yeah. I mean, generally if you can measure, if it's readily measurable, that's typically preferred to having to compute it.
Q Dr. Engel, let me hand you what we'll mark as Exhibit 18 to your deposition, which for the Record 03:17PM is an E-mail sent on July 21st of 2008 from David Page, one of the lawyers representing the plaintiff in the case, to yourself and Gordon Johnson and, among others, Mr. Garren. Do you see that?
A Yes. 03:18PM



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Q Do you recall this E-mail?
A Yes, yeah, I recall this.
Q And you'll see the E-mail originates a few days earlier from Bert Fisher to David Page?
A Yes. 03:18PM
Q And in the original E-mail dated July 19th Bert Fisher describes the report that he is forwarding that is attached; do you see that?
A Correct.
Q And how does he describe the report? 03:18PM
A Talking about Mr. Fisher here?
Q Yes, sir.
A Looks like he indicates, I recently reviewed the attached report written by Andrew Sharpley regarding implementation of ESPI in the 03:19PM Eucha-Spavinaw watershed.
Q What's the Eucha-Spavinaw watershed?
A It's a watershed adjacent to this watershed.
Q Is it true, Dr. Engel, that you have in your analysis in this lawsuit used information, including 03:19PM environmental data and information about poultry litter from the Eucha-Spavinaw watershed, because you believe the conditions there to be similar to the conditions in the Illinois River watershed?
A Yes. 03:19PM

Q Okay. Have you had an opportunity to read the report that Mr. Page asked you to look at by Andrew Sharpley that's attached?
A I did, although, again, it's been five or six months since I've looked at this, so it's -- I'm not 03:20PM going to have total recall of what the content is.
Q Now, can you turn to Page 14 of the Sharpley report that's attached?
A Okay.
Q Do you see the paragraph under potential water 03:20PM quality impacts entitled Poultry Litter Application and P Runoff?
A Okay.
Q Can you read that paragraph, please? It's short. 03:20PM
A Sure. Numerous studies have reported the potential for P loss in runoff following poultry litter application to pastures. These have been summarized in Appendix Table 7, parens, Page 25, closed paren. In all cases, these studies have used 03:21PM small plots and in some cases simulated rainfall following applications. Inasmuch, they represent the worst case scenario for P loss and should not be used to estimate --
Q Used as an estimate? 03:21PM



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A I'm sorry. Yes. I got tripped up there.
Should not be used as an estimate of field scale
loss. However, the average loss of P as a percent
of P applied in litter was 2.7 percent, Appendix
Table 7, Page 25. 03:21PM
Q Okay. Do you disagree with Dr. Sharpley's
summary of the literature regarding these simulated
rainfall studies?
A I think there are a number of points here that
I would take issue with. 03:21PM
Q Let's identify all of them.
A So let me -- can I look at Table 7 for a
moment here?
Q Certainly, certainly.
A Okay. So a couple of things. I believe 03:22PM
there's some additional studies that are not
characterized here that I've seen. In fact, my
recollection of the -- of some of the Edwards' work
was that the actual ranges were 2 to 7 percent. So
I don't recall if that was a different paper or the 03:23PM
one that's reportedly summarized here in Table 7,
but my recollection is that in some of the work that
Daniels did early, you know, those losses were 7
percent in some instances. These studies represent
relatively short periods. So certainly some of the 03:23PM



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phosphorus that one would attribute to poultry land application of waste is not just from the waste itself but, in fact, from the elevated soil test phosphorus. So these studies are relatively short and tend to look in many cases here only at a very 03:24PM
few rainfall events or very few simulated events on these locations. You know, the phosphorus that's lost is not truly reflective of the landscape. So these would tend to under represent that.

Q Can I stop you there, Dr. Engel? 03:24PM

A Sure.

Q Can you identify for me any of the longer term studies that you think would be representative than those listed on Table 7?

A I didn't say that there were longer term 03:24PM
studies that looked at things in this manner. So the longer term studies -- let me back up. I guess I wouldn't characterize them as longer term studies. There are other studies that consistently observe that as soil test phosphorus is increased due to 03:25PM
land application of poultry waste, that some of the phosphorus runoff is attributable to the increased soil test phosphorus. That would only make sense. So increasing soil test phosphorus, water interacts with the soil with that phosphorus in it. That 03:25PM



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phosphorus runs off. It moves off site. So as you raise the soil test phosphorus, you lose more phosphorus, and that's directly attributable to poultry waste application as well. So, you know, there are a number of those studies that one would 03:26PM
have to weave together with this to get a complete picture of this.

Q Are those other studies you are referring to, Dr. Engel, edge of field studies, edge of field runoff studies? 03:26PM

A Some of them would be edge of field studies. In fact, I believe there may be a group of small watersheds or maybe they are edge of field studies that Edwards and some of the same authors here have done I believe even in the IRW that have looked at 03:26PM
some of that issue, but I think you're correct, that they tend to be small watersheds.

Q Let's get out of the weeds a little bit if we can and go back up to Page 14 of the report by Dr. Sharpley. 03:26PM

A Okay.

Q With respect to the scientific literature on these small plots simulated rainfall studies, do you recall that the runoff coefficients reported in those studies represent the worst case scenario and 03:27PM



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should not be used as an estimate of field scale loss?

A They don't represent worst case scenario, and I disagree with the statement that they shouldn't be used, and let me tell you why. You know, I had an 03:27PM opportunity -- you know, we can perform the same study in a few minutes that Nelson performed at Bridge 59 with data at the three gauges, and if we do that, 505,000 pounds of phosphorus a year on average reaching those three gauges. If we take out 03:27PM wastewater treatment, we're left over the '97 to 2006 period with about three and a half million tons of phosphorus, or excuse me, three and a half million pounds of phosphorus. If we look at the Meagan Smith mass balance study looking at 03:28PM phosphorus going into the landscape, we compute a coefficient that, guess what, turns out to be a little over 2.8 percent, and that's representative of observed data in the IRW. So, you know, that data tells me that 2.7 is maybe low. 03:28PM

Q Move to strike, non-responsive. Dr. Engel, is Dr. Sharpley just wrong when he says that these -- the values reported in these small plots simulated rainfall studies represent worst case scenario and should not be used to estimate field scale loss? 03:28PM

A My experience with the analysis I just talked you through indicates based on IRW data and, you know, it's IRW data, indicates that Mr. Sharpley, Dr. Sharpley is incorrect.

Q Okay. Thank you. Do you see on the Appendix Table 7 on Page 25 where at the end of his review of the literature, Dr. Sharpley reports the average minimum and maximum phosphorus loss from land application of poultry from these studies; do you see that? 03:29PM

A On Page 25?

Q Yes, sir.

A Okay, yes, I see that at the bottom.

Q And what is the average?

A It's the same average he reported back in the prior paragraph at 2.7 percent. 03:29PM

Q Okay, and do you recognize, Dr. Engel, that these small plot simulated phosphorus loss or simulated rainfall studies involve applications of litter that are often far in excess of the rates really applied and portions of rainfall that sometimes resemble a hundred year flood? 03:29PM

MR. GARREN: Object to form.

A Well, certainly not all of these represent that. So, you know, looking down here, one of the 03:30PM

biggest losses, fescue .9 tons per acre and, in fact, that's less than what would typically be applied. You read on across here. Looks like 4.4 percent was lost in a one-year study. Looks like -- one can't tell without looking at the paper and 03:30PM learning more. It's unclear what the soil test phosphorus might have been then.

Q How much rainfall is poured on that plot?

A Is that reported here?

Q No. 03:30PM

A I'm not sure that it is.

Q You sounded familiar with the study. Are you?

A I'm not familiar with the study, so I don't know the rainfall.

Q As a general matter, and I don't want to get 03:31PM hung up in any particular study, but you are aware, are you not, Dr. Engel, these rainfall simulations in small plot poultry litter runoff studies usually involve extreme conditions designed to create runoff so it can be measured? 03:31PM

MR. GARREN: Object to form.

A They apply a large amount of rainfall, rainfall that's representative of this region. So, yeah, you apply a large amount of rainfall. You have poultry litter on things, and it runs off, and, 03:31PM

yeah, I agree with that, and these studies say the same.

Q You agree, do you not, Dr. Engel, that it would not be scientifically valid to base your runoff coefficient analysis on a small plot rainfall simulation study that has rainfall artificially induced far in excess of what is representative in this watershed? 03:31PM

MR. GARREN: Object to form.

A Well, again, when I compute a value using the techniques that are identical to Nelson with observed data from this watershed, the coefficient turns out to be near this average, and so, again, you've got to realize that these are short-term studies. Yes, I'll agree with you that they do apply large amounts of rainfall, but what they're missing here are, you know, that phosphorus moves from the numerous small rainfall events that ultimately gets to the water to the lake. 03:32PM 03:32PM

Q Can you answer the question that Mr. Page posed to you in his July 21st, 2008, E-mail attaching Dr. Sharpley's report, which for the Record is, how did the P runoff rates, and I believe he's talking about in the Sharpley report, relate to your analysis for GLEAMS? 03:32PM 03:33PM



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A So GLEAMS is modeling rates that are -- well, GLEAMS combined with the routing --
Q I want to stay with GLEAMS, not the routing.
A Okay. So GLEAMS has been calibrated using observed data from this watershed, and through that 03:33PM
calibration process, it's matching the observed data at three gauging stations near Lake Tenkiller and, therefore, it's going to predict rates that are comparable to the 2.8 percent that we've been talking about because, again, the model has been 03:33PM
calibrated based on what's been observed over this ten-year period. You know, it's a fairly simple sort of concept that the model is matching that, so, therefore, the model is reproducing about 2.8 percent. 03:34PM
Q What percentage of phosphorus in poultry litter land applied in the watershed does your GLEAMS model predict runs off to the edge of the field?
A Well, again, we're going to be back to Exhibit 03:34PM
16 and I guess table -- you asked the question differently, didn't you? Sorry.
MR. GEORGE: Lisa, can you read it back?
Q And Dr. Engel, I don't care what table you have to go to. I just want an answer. 03:35PM

(Whereupon, the court reporter read back the previous question.)

A It's going to be approximately 2.8 percent.

Q How did you get there?

A Well, again, because it was calibrated, so I 03:35PM
guess I didn't compute that as a percentage. So, again, here's the logics of it. Because it was calibrated to match the observed data, we know the phosphorus loads in that coefficient is about 2.8 percent. GLEAMS is reproducing that. So, you know, 03:35PM
without doing a calculation specific to GLEAMS, it has to be about 2.8 percent.

Q I'm lost, and I need you to help me, Dr. Engel. What coefficient are you referring to that is 2.8 percent? 03:36PM

A That would be the amount of phosphorus or -- yes, the amount of phosphorus in poultry waste that's land applied that one would expect to see in an average year based on '97 to 2006 at the three gauging stations in the IRW. 03:36PM

Q When I heard you say coefficient, I thought you were describing an actual input to the model. Did I misunderstand that?

A I'm sorry. You know, there's not -- there is not a specific coefficient that I put into the 03:36PM



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model. So I'm sorry if I misrepresented that.
Q GLEAMS will tell you, will it not, the amount of phosphorus that comes off of a pasture that has received poultry litter; correct?
A Correct. 03:37PM
Q And I could go into GLEAMS and look at all of those pasture outputs and add them all up; right?
A Correct.
Q And I could compare that to the amount of phosphorus that you told GLEAMS had been land 03:37PM applied in the watershed; right?
A Correct.
Q If I had those two values and I divided one by the other, I would know what percentage; correct?
A Correct. 03:37PM
Q And have you done that calculation?
A I've not done the specific calculation you are asking about.
Q Then how did you answer Dr. -- Mr. Page's question? 03:37PM
A Well, the -- you know, the discussion -- so I didn't do the analysis that you described, and so the discussion was, you know, this little bit higher level, you know, as I've been explaining that, you know, that if we simply look at the observed 03:38PM



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phosphorus loads, look at the observed phosphorus going into the landscape, the coefficient is about 2.8 percent. You know, GLEAMS is reproducing results that are in that same range. So without doing that long drawn-out calculation, it's of the 03:38PM same magnitude.

Q Did you respond to this E-mail from Mr. Page?

A I believe we did talk about this but, again, I didn't do the calculation you are describing.

Q Did you send him an E-mail in response? 03:39PM

A I don't recall if I did or didn't.

Q Last question, Dr. Engel, for me, and then I'm going to hand you off to somebody else. Have you submitted for publication and peer review anything related to your work in this lawsuit? 03:39PM

A I have not.

Q You're not listed to your knowledge, Dr. Engel, as even a co-author on any paper that has been submitted to a scientific journal for publication that relates to your work in this case? 03:39PM

A I've edited -- I believe I've seen two papers that I've provided suggested edits and comments on.

Q Who are the primary authors on those papers?

A Oh, I believe Roger Olsen is leading one of those. I believe Dr. Tim Cox is leading the second 03:40PM



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of those or Dr. Cox and Dr. Olsen maybe together on the second of those, and there are probably other people that they consulted with that may be authors potentially on those.

Q Do you have an understanding as to whether, given your consultation on those papers, if you will be listed as a co-author? 03:40PM

A I believe -- so in answering your question, just to make this clear, I don't know the status of those papers. So, you know, if they've been submitted -- they've not been submitted to my knowledge. 03:40PM

Q Can you answer the question as to whether you are intended to be a co-author on either of those papers? 03:41PM

A That's my expectation.

Q Okay. What journals have been discussed for which those papers would be submitted?

A I don't know if we talked about specific journals on those or not. I think there have been maybe some discussion about what would the potential journals be, but I'm not sure those have been identified. 03:41PM

Q What journals have been discussed as potentials? 03:41PM



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A Wow. Without looking back at -- you know, that was probably a phone conversation, and I don't recall, you know, which one. So I think, you know, Dr. Cox was exploring -- I think the charge to Dr. Cox was to look at a group of potential journals and 03:41PM come back, and I'm not sure that I've seen a response from him regarding that request.

Q Dr. Engel, do you have a copy of the articles that you marked up and edited?

A Probably do. 03:42PM

Q Why were they not produced in your considered materials?

A I believe that happened in December I believe.

MR. GEORGE: I'm going to call for the production of those, Mr. Garren. We have 03:42PM outstanding discovery on that subject, and they should have been produced already. Let's take a break.

VIDEOGRAPHER: We're now off the Record. The time is 3:42 p.m. 03:42PM

(Following a short recess at 3:42 p.m., proceedings continued on the Record at 4:07 p.m.)

VIDEOGRAPHER: We are back on the Record. The time is 4:07 p.m.

MR. GEORGE: One matter for the Record 04:07PM



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before we get back into examination, Exhibit 17, which was the jump drive with the electronic copies of file materials obtained from Dr. Bierman but ultimately the source was the considered materials of Dr. Engel, has been converted by the court 04:07PM reporter to a CD, which we have now marked as Exhibit 17 and will be part of the transcript of this deposition, and she will produce copies of that with the transcript. The original jump drive is being returned to Dr. Bierman. 04:08PM

I'll pass the witness.

A Before we do that, I need to correct the Record here a bit. So when Mr. George was asking about my Opinion No. 8 on Page 2, I would like to reflect now that after having a chance to think 04:08PM about that over break, you know, I stand by Opinion 8 on Page 2, and let me tell you why.

So the analyses that went into that was an analyses that came late in the process. Dr. Ji-Hong had, unbeknownst to me as we talked about, had 04:08PM corrected the data that are used in that analyses and, therefore, this is an accurate reflection of my opinion.

Q Thank you, Dr. Engel. Who did you meet with on your break? 04:09PM

A During break I was in Mr. Garren's office. So Mr. Garren was there; Miss Burch was there; Mr. Page was there.

Q And did you discuss the question at hand as to whether or not you stand by Opinion No. 8 with 04:09PM counsel during that break?

A We discussed a variety of things during break and, you know, a variety of the things that happened since the prior break, so --

Q Was that one of the things? 04:09PM

A Since this was one of the things that happened between that period, yeah, we did review this.

DIRECT EXAMINATION

BY MR. McDANIEL:

Q Dr. Engel, Scott McDaniel representing 04:09PM Peterson Farms. Let me ask you to look at Page 38 of your May report, please. Figure 8.1, you pulled that figure from Sharpley, et al, 2007; am I correct?

A Yes. 04:10PM

Q Okay, and I see in the center of the page the text that says P runoff, in parenthesis, 5 percent, correct?

A Yes, it's in the diagram.

Q Okay. This discussion that you and Mr. George 04:10PM



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had over about the last 30, 40 minutes referring to this coefficient, runoff coefficient, is that depicted on Figure 8.1 as this 5 percent?

A Yes. This 5 percent would represent this runoff coefficient. 04:10PM

Q Okay, and is it your intention, by presenting this in your report and in this manner, to indicate that Dr. Sharpley and others in this 2007 study are stating that 5 percent of the phosphorus as applied to the surface of the land on fields on average runs 04:10PM off to the edge of a field?

MR. GARREN: Object to form.

A I think you would have to ask Dr. Sharpley. This is Dr. Sharpley's figure.

Q Well, I'm asking you why you presented it and 04:11PM the point you expect to make with it.

A Okay. So I think this is a pretty good depiction of many of the processes within the IRW and other watersheds.

Q Well, my interest is only in the 5 percent, 04:11PM not the rest of the graph.

A Okay. Sorry.

Q That's okay.

A So this is just a depiction that shows that there's at least the potential for 5 percent to run 04:11PM



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off and, again, you know, as you indicated, with the dialogue with Mr. George, you know, a calculation of this value specific to the IRW turns out to be about 2.8 percent.

Q All right, and your text about -- regarding this figure that's on Page 37, you say Sharpley, et al, 2007, indicates 5 percent of poultry waste applied to the land is lost in surface runoff. See Figure 8.1; correct? That's on your prior page. 04:11PM

A Oh, sorry. 04:12PM

Q Second paragraph. Do you see the reference?

A Ah, yes, okay, yes.

Q First, you're not really saying 5 percent of poultry waste; you mean 5 percent of phosphorus in poultry waste; is that more precise? 04:12PM

A My intention, yes, was to indicate phosphorus. I would have to look back to that original paper to see how that was stated.

Q Well, Figure 8.1 just refers to phosphorus; correct? 04:12PM

A It seems to be -- yes, it says P runoff, although I've seen other papers that indicate that in fact --

Q I'm just asking about the Sharpley reference, sir. 04:13PM



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A Okay. So the Sharpley reference, based on the figure, seems to indicate P runoff.
Q All right. Now, where is this -- this is runoff to the edge of a field. That's what I wanted to get clear in my mind. Is that what this is 04:13PM intended to convey to the reader?
A Based on this figure, yes, it appears to be edge of field.
Q All right. In your model in GLEAMS, GLEAMS runs its processes on a field scale level; right? 04:13PM
A Correct.
Q And computes an output of phosphorus for each of the fields as it operates on the field; correct?
A Yes.
Q Okay, and for each of the fields that GLEAMS 04:13PM generates a field-specific output, that is an edge of field number; correct?
A Yes.
Q All right. Then your overall process of collecting this together, you sum up all of the edge 04:14PM of field outputs and that is the GLEAMS output?
MR. GARREN: Object to form.
A Yes, that's correct. Let me add just a little bit of clarification to that. So GLEAMS has been calibrated in my process so that the GLEAMS inputs, 04:14PM



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along with the wastewater treatment plant inputs to edge of field or to streams, ultimately reaches the three gauging stations near Lake Tenkiller. So, in fact, GLEAMS has been calibrated to reproduce values that match observed values at those staging stations. 04:14PM

Q All right. Well, I understand there's two steps or two components to get to a gauging station. I'm just asking you about the GLEAMS operations on a field scale. It computes an output for an edge of field value for each field? 04:15PM

A Correct.

Q Okay, and GLEAMS doesn't know the difference between a field that is right beside the Illinois River water and one that is half a mile from the Illinois River? 04:15PM

A It would in some sense, and let me tell you how. So GLEAMS is -- I guess maybe it does not. I'm sorry.

Q Okay. All right. Let me jump to the issue of source selection, and when I say source selection, that means the sources that you, the modeler, elected to use as inputs into your modeling. 04:15PM

A Okay.

Q And you discussed this with Mr. George, so I 04:16PM



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don't want to recover that ground, but let me ask you to look at your report, Appendix D, Page 41.

A Okay.

Q In the very first paragraph you say, a phosphorus mass balance for the Illinois River watershed will be completed to identify the important P sources to be considered in modeling. Point and non-point sources of P of significance, parenthesis, greater than 2 percent of P based on mass balance, closed parenthesis, will be considered. Did I read your text correctly? 04:16PM 04:16PM

A Yes.

Q Is it a correct interpretation, Dr. Engel, that the sources that you selected to model were those that were greater than 2 percent as reported by the mass balance study? 04:17PM

A I guess I better double check that to make sure. So it looks to me like those bigger than 2 percent were considered.

Q All right. Now, is there any written criteria for which potential sources of phosphorus in the Illinois River watershed would be included in the mass balance study? 04:17PM

A So I'm not sure that there was written criteria, although there was ongoing conversations 04:18PM

about, you know, trying to identify what the most significant sources were and --

Q Well, sir, I'm short on time. I just need to know if you had a written criteria. If you did something else, that's okay. That's not my 04:18PM question. I only want to know if you had a written criteria.

A Criteria, I don't believe they were written down. If they were, they were -- would be early in Meagan Smith's report, but my recollection, they 04:18PM weren't written down.

Q Okay, and you did not use as an input to your model any source that was not included in the mass balance study?

A Correct. 04:19PM

Q All right. So if there was an internal source of phosphorus to water, an example might be erosion from deforestation or in-stream mining, et cetera, those were not treated as source inputs to the model? 04:19PM

MR. GARREN: Object to the form.

A So what you're describing as internal sources would not have been considered as the mass balances reporting inflows here of phosphorus into the watershed. Based on reports, literature for this 04:19PM

watershed for the local region my judgment, again, was that mining of gravel is a minor source of erosion.

Q Sir, I didn't ask you to give me your feedback on them individually. I just wanted a yes or no. 04:20PM

Internal sources were not modeled, I believe you answered it no; correct?

A Internal sources -- well, the internal source I guess that would have been included would have been soil test phosphorus that one would attribute 04:20PM as being internal or background kinds of levels. So from that standpoint, that one would have been included.

Q Okay. Now, you discussed yesterday the decision not to include septic systems as an input 04:20PM into the model; correct?

A Correct.

Q So for purposes of your modeling, the only human waste input that made it into your model is that human waste that went through one of the sewage 04:20PM plants in the watershed?

A That would be correct.

Q Let me hand you what I've marked as Exhibit 19. It's a document produced to us by the State of Oklahoma labeled as generated by Oklahoma Department 04:21PM



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of Environmental Quality. Sir, have you ever seen this document?

A I can't say that I have. Does this document stand alone or are there other pages associated with this? 04:21PM

Q This is the format in which I've seen it. So if there's some State file and it's with some other document, I can't answer it.

A I've seen maybe a similar document that was a report regarding septic tanks or septic systems from 04:22PM Oklahoma. So if it was in that report, I probably saw it, but I don't recall, you know, seeing this single page in this format.

Q All right. The report you referenced yesterday was actually a 1997 study. Do you recall 04:22PM that, the septic tank study?

A Right.

Q Okay. Now, there was a gentleman by the name of Robert Huber -- certain about his last name, questionable about his first name -- that testified 04:22PM for the State of Oklahoma. Did you review his deposition?

A I don't believe I've seen that deposition.

Q Have you reviewed any reports generated by Oklahoma Department of Environmental Quality with 04:23PM



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regard to complaints in the Illinois River watershed regarding function or malfunction in septic systems?

A The report that you mentioned from yesterday, was that an OCC report or was that an ODEQ report?

Q It was a DEQ, so I think that would be 04:23PM responsive to my question.

A So I did review the DEQ report. '97, is that --

Q Okay. Anything else?

A Let me just double check the references a 04:23PM moment.

Q And when I said reports, I actually meant the inspection reports, as in when an inspector responds to a complaint. That's what I meant by report if I was confusing. 04:23PM

A Okay. I've not reviewed inspector reports from Oklahoma DEQ.

Q All right. I'm going to show you -- I'm not going to make it an exhibit unless Rick wants. I'm going to show you the comprehensive basin management 04:24PM plan for the Illinois River basin prepared by Shannon Haugherty, technical writer, water quality division, Conservation Commission from May 1999. Have you ever -- the reason I'm not going to put it in the Record is because it's in the Record in a 04:24PM



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dozen depositions in this case. Have you reviewed this report as part of your work?
A Yes, I've reviewed this.
Q Okay. Did you review the information in there with regard to septic systems in the Illinois River watershed? 04:24PM
A To the extent that the material is in here, I would have reviewed it.
Q Do you recall the overall conclusions made by the Conservation Commission about the condition of septic systems in the watershed? 04:24PM
A I -- if you can point me to that page, I could refresh my memory.
Q Well, it speaks for itself. I'm just asking if you happen to remember it. 04:25PM
A I don't recall it offhand.
Q Now, you started to speak about mining in the watershed a moment ago in response to another question, and when I speak of mining, I'm referring to gravel mining in the stream. As part of the work that you've done, did you consider any data or reports related to gravel mining in any of the streams in the Illinois River watershed? 04:25PM
A I do recall that -- in fact, there may be a section in this report related to gravel mining. I 04:25PM



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believe I've seen several documents, and I couldn't point you to the specific documents, as we sit here at the moment, that describe gravel mining activities and potential impacts.

Q Okay, but mining was not an input? 04:25PM

A No, it was not.

Q Okay. What -- did you review any studies, reports or data involving stream bank erosion in the Illinois River watershed within the context of your work in this case? 04:26PM

A Some of these studies did speak to stream bank erosion.

Q The comprehensive study in front of you does. Was there anything else that you read about stream bank erosion? 04:26PM

MR. GARREN: Object to form.

A There may have been. Again, as I sit here at the moment, I'm not sure if there were, but I do recall reading at least in one place, maybe more than that. 04:26PM

Q Have you ever heard of a gentleman by the name of Russell Dutnell, D-U-T-N-E-L-L, former employee of the Oklahoma Conservation Commission?

A The name doesn't sound familiar to me.

Q I'll represent to you that he is or was a 04:27PM

fluvial geomorphologist with the OCC. Have you reviewed the deposition he's given in this case?

A I wasn't aware that he'd given a deposition, so, no.

Q All right. Let me hand you as exhibits 20 and 21, and I don't want to ask you substantive questions, but I want to ask you, sir, have you reviewed either of these reports as part of your work in this case? 04:27PM

MR. GARREN: Which one is 20? 04:27PM

MR. McDANIEL: Good question. The one, bank erosion and riparian vegetation, is 20.

Q Did we speak over your answer, sir. I'm sorry.

A No, you didn't. I'm sorry. As of 20, I don't recall ever having seen 20. I don't recall seeing 21 either. 04:28PM

Q Okay. You can set them aside. Within the context of sewage handling systems or wastewater treatment systems, do you know what the terms upset and bypass mean? 04:29PM

A I'm not sure. I'm familiar with upset but, you know, I understand what bypass means.

Q Give me your brief understanding of the term, please. 04:29PM



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A So as I understand bypass, during rainfall events, there may be a need to not send all the wastewater through the treatment plant and so, therefore, you are bypassing the plant and it may be discharged into the stream then. 04:29PM

Q If there are bypasses of sewage that have occurred in the Illinois River watershed, that is a potential phosphorus source that is not captured within your modeling as it's currently structured; correct? 04:29PM

A It would not be. I guess I have seen the Jarman, I believe the Jarman expert report, that did seem to try to quantify the bypass phosphorus contribution, and that analysis indicated that it was on the order of 100 pounds of phosphorus a year 04:30PM attributable to that source.

So, you know, from the big picture standpoint, you know, that's quite small relative to other sources and certainly relative to poultry land waste application. 04:30PM

Q All right. Dr. Jarman you referred to, that's a report he issued a little over a month ago; correct?

A Correct.

Q Okay. As part of the work you did, did you or 04:30PM



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anyone on your team conduct any investigation to assess the extent to which there had been raw sewage bypasses in the Illinois River watershed?

A No, we didn't.

Q I'm going to provide you what was provided to us. Another individual at the Department of Environmental Quality, a Mr. Michael Madden, testified on behalf of the State of Oklahoma, and he provided us with a database and -- of upsets, and so I've marked that as Exhibit 22. Have you seen this data on any similar type of upset or bypass data of raw sewage from the systems in the Illinois River watershed -- 04:30PM 04:31PM

MR. GARREN: Is -- excuse me.

Q Let me finish my question. Other than what you reviewed in Dr. Jarman's report? 04:31PM

MR. GARREN: Is this a document you obtained through DEQ with discovery process with the State or was this independent?

MR. McDANIEL: He brought it to the deposition and gave it to us on a disk. It's Exhibit 3 to his deposition, which it was produced in a disk. 04:31PM

Q All right. Go ahead.

A Could you define what you are meaning by upset 04:31PM



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for me? I'm sorry.
Q Sewage that escapes the system other than through the treatment and permitted discharge processes.
A And again the question that included upset? 04:32PM
I'm sorry.
Q Fair enough. Have you reviewed any data, other than Dr. Jarman's report, identifying or summarizing upsets or bypasses occurring with sewage treatment systems in the Illinois River watershed? 04:32PM
A No, I haven't.
Q Do you, sir, have an opinion what is the expected phosphorus concentration range for raw domestic sewage?
A I've seen the numbers but, as I sit here at 04:32PM
the moment, I would need to look those up.
Q Am I asking a question outside your area of your expertise or are you comfortable with the topic?
A I've certainly worked with some of this area, 04:33PM
but I don't recall the typical ranges. Like many things, this would be something I would look up when I need those values.
Q You're just simply not prepared today to state a value? 04:33PM



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A Correct.
Q Would you disagree if I said the literature suggests a range of between 4 and 15 micrograms per liter --
MR. GARREN: Object to form. 04:33PM
Q -- of phosphorus for untreated domestic sewage?
A Yeah, again, I would need to check a reference. So I would have no basis to agree or disagree with that. 04:33PM
Q All right. In the course of your work in this case, have you become aware of any evidence that users of poultry litter in the Illinois River watershed are not following their respective nutrient management plans? 04:33PM
A I saw a document that indicated that, you know, there had been some violations of various types. I believe that was in a document produced by Rausser and Dicks. There was a document that I believe was an ANRC document that did indicate that 04:34PM within Arkansas anyway there had been some violations. I don't recall if it was nutrient management plans or other violations or a combination of violations.
Q Okay. Let me ask a better question and maybe 04:34PM

I can get a more precise answer. Are you aware of any evidence that users of poultry litter in the Illinois River watershed are -- have violated or are violating those provisions in their nutrient management plans with respect to the land 04:34PM application of poultry litter?

A My recollection is that that set of materials that I described, at least one of those violations was a land application violation of some type.

Q Okay. One in particular you recall? 04:35PM

A It was a small number. So it was in the one to three range that would have been in that category.

Q All right. So the phosphorus load you attribute to poultry waste in your modeling exercise 04:35PM is the runoff from fields where the owners applied the litter in compliance with nutrient management plans; correct?

MR. GARREN: Object.

A I guess I didn't make any assumption about 04:35PM whether they were applying consistent to the waste or to the -- sorry, to the nutrient management plans. So, you know, as we talked about earlier today, that waste was uniformly applied within the zones that we talked about at the rates we talked 04:36PM

about. So I guess I don't know if those rates violated nutrient management plans or not.

Q Okay, but the loading that you attributed to poultry litter usage in the watershed, the practices associated with that loading that are occurring in the real world that created the observed data you modeled to, you're not aware of any violations of nutrient management plans other than the one we spoke of earlier? 04:36PM

MR. GARREN: Object to form. 04:36PM

A It may be one, two or three, but it's in that range, so I'll agree with that part. So the modeling did what the modeling did.

Q All right. The -- now, all of your work that I've reviewed and I've listened to your testimony attributes phosphorus loading to let's call it a commodity or a substance that is poultry litter. You call it poultry waste; correct? 04:37PM

A Literature uses both terms, and I've been using waste, yes. 04:37PM

Q All right. You have not specifically, for instance, attributed any phosphorus loading in particular to Lake Tenkiller as a consequence of acts or omissions of my client, Peterson Farms?

MR. GARREN: Object to form. 04:37PM

A Well, in that -- there's documentation that shows Peterson Farms growers applied waste within the watershed. You know, the model indicates that that runs off, carries phosphorus. Literature indicates that when it's land applied, it runs off 04:37PM and carries phosphorus, carries bacteria, carries other things. So it does carry a suite of potential contaminants.

Q But you haven't attributed any mass of phosphorus or any percentage of the total loading to 04:38PM either Peterson Farms or Tyson Foods or Simmons Food or George's or any defendant in this case; that's correct, isn't it?

MR. GARREN: Object to form.

A Correct. I've not performed that allocation. 04:38PM

Q On Page 28 of your report, your summary table of the sewage treatment plants, Table 6.1.

A Okay.

Q Why is it you have zero load attributed to the Watts sewage treatment plant? 04:38PM

A It looks like it was not zero in the early part of my analysis, in the '90s through 2002. Looks like I'm attributing zero to that from 2003 to present, so --

Q Why is the question? 04:39PM



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A So the data from 2003 to present was based on the permit compliance system data from ODEQ and the Arkansas Department of Environmental Quality. So I believe based on that -- I guess based on that data, there was not a load attributed to Watts or at least 04:39PM that data was not discovered.

Q Okay. Do you know if that's an accurate statement, that Watts represents a zero load of phosphorus into the Illinois River watershed; did you look behind that report? 04:40PM

A I looked at the report, looked at the underlying data. Again, without being able to access and look through that underlying data, it's going to be -- I'm not sure if there was -- you know, if there were discharges or not without 04:40PM looking. Looks like my analysis indicates that there was no discharge from 2003 to present from Watts.

Q Do you know what kind of sewage treatment system the City of Watts employs? 04:40PM

A No, I don't.

Q Have you reviewed any type of -- other than the discharge reports, if that's what you were referring to a moment ago, have you looked at any other type of report, commentary, discussion about 04:40PM

the function or malfunction of the Watts sewage treatment system?

A I don't believe I've seen other information about the Watts system.

Q All right. I'm handing you with I've marked 04:41PM

as Exhibit 23, a letter authored by Thomas J. Alexander to Jeannine Hale of the Attorney General's office. Do you know Thomas J. Alexander, Dr. Engel?

A I believe I do.

Q That's Meagan Smith's boss, isn't it? 04:41PM

A Then I do, yes.

Q Okay. It's dated April 20th, 1988. It's labeled Report of the Watts, Oklahoma Sanitary Sewage Lagoon, City of Watts, Oklahoma in Adair County. Have you ever seen this? 04:41PM

A No, I haven't.

Q Okay. You can set it aside. You understand that your work was the source of the phosphorus load to Lake Tenkiller information that was utilized by Dr. Wells and also Drs. Welch and Cooke; correct? 04:42PM

A I know at least Dr. Wells used that as an input to his models, and I believe to some extent Cooke and Welch also considered that information in forming opinions.

Q All right. Your loading output, if I can use 04:42PM



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that term, was that the three gauging stations that we've discussed for almost two days; correct?
A Yes.
Q Did you ascertain any additional loading into the Illinois River-Tenkiller system below those 04:42PM
gauging stations?
A I did not.
Q Are you aware of anyone else doing that?
A I believe Dr. Wells may have accounted for some small additional tributaries that provide some 04:43PM
inputs into Tenkiller but, you know, to be certain on that, you would need to ask Dr. Wells.
Q Okay. You were not engaged in assessing phosphorus contributions from littoral properties around the lake or near lake operations or 04:43PM
activities?
A No, I was not.
Q To your knowledge, has any court of law accepted the GLEAMS model for purposes of assigning liability? 04:43PM
MR. GARREN: Object to form.
A I'm not aware of any, but I wouldn't be in a position to necessarily be aware that that's been done or hasn't been done.
Q All right. The land use land cover data that 04:44PM



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you employed, was that data that was derived by remote sensing?

A The land use land cover data would have been, yes.

Q All right. Was there any ground truthing done? 04:44PM

A The agency that prepared this would have done some ground truthing, yes.

Q Were you provided the ground truthing information with the dataset? 04:44PM

A No, I was not and, you know, I don't know that it's available with the dataset.

Q So you haven't seen any ground truthing data associated with the land use land cover data; is that correct? 04:44PM

A Correct.

Q Did you or anyone on your behalf as part of this project do any type of accuracy assessment with regard to the land use land cover data?

MR. GARREN: Object to form. 04:44PM

A No, we did not.

Q You know what best management practices or BMPs are certainly?

A Yes.

Q Were BMPs directly represented in your 04:45PM



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modeling?
A They would not be directly represented, but they would be represented in that the model was calibrated to match observed phosphorus loads. So as a result of that calibration, in order to match 04:45PM
the observed data in that best management practices were in place, they get implicitly represented.
Q Did you quantify the effects of any BMPs present or being employed in the Illinois River watershed? 04:45PM
MR. GARREN: Object to form.
A Let me break that down just a bit. It's going to take a couple of responses I think to address that. So in the calibration process and in runs that did not include representation of stream 04:46PM
buffers, in that set of cases, best management practices were not explicitly considered, nor was there a reason to do that for that set of model runs and during model calibration.
If you recall, there was a set of model runs 04:46PM
in which buffers were represented along streams of varying sizes. I believe there were a couple of those runs. So in that particular case, hypothetical best management practices were represented. 04:46PM



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Q All right. You answered some questions Mr. George posed about sensitivity analysis. You certainly understand the terminology?
A Correct.
Q All right. Did you vary the soil phosphorus inputs to the model to test its effect on the output? 04:46PM
A Those were, as I recall, let me double check, in Appendix D. So one of the parameters that was calibrated represents the labile phosphorus concentration in the soil. So -- so as a result of the calibration process, the starting values were adjusted to identify a set of values that would best represent, best reproduce the phosphorus loads in the calibration period. So in that that would represent a sensitivity analysis, those were adjusted. 04:47PM 04:48PM
Q Did you adjust the soil phosphorus inputs in order to gauge how sensitive the model was to those changes? 04:48PM
A I guess, you know, I didn't do that. The calibration process made those adjustments.
Q But a sensitivity analysis is a different process from a calibration; you agree?
A Yes, it often would be, but it could be part 04:48PM



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of the same.
Q Okay, but you testified earlier to Mr. George, didn't you, that in this modeling exercise, you didn't do sensitivity analysis?
A Sensitivity analysis unique to the IRW was not 04:48PM
done. Certainly I've done sensitivity analysis with this in a range of other soil phosphorus conditions.
Q Well, okay. You answered the question with regard to this specific modeling exercise, there was not a sensitivity analysis? 04:49PM
A No, there was not for this specific effort.
MR. McDANIEL: I'll pass the witness.
DIRECT EXAMINATION
BY MR. ELROD:
Q Dr. Engel, my name is John Elrod. I think 04:49PM
we've met before, have we not, sir?
A Yes.
Q I'll start by asking you a few questions about Dr. Ji-Hong. How long have you known him?
A Let's see. I believe he joined my group. 04:49PM
Q Which means what?
A I'm sorry. He joined my research group in -- sometime in 2006, I believe, and I guess I had met him and knew of him probably six months or so prior to that, so that may move back into the 2005 period. 04:50PM

Q He's a South Korean national?
A Yes.
Q And if we were to question him, would it be necessary for us to use an interpreter?
MR. GARREN: Object to form. 04:50PM
A Boy, that's probably outside my expertise a bit. So, you know, his communication skills are okay. They're not -- you know, they're certainly not of a native English speaker, and so I'm not sure I can fully address that question. 04:51PM
Q Is he difficult to understand?
A Can be.
Q How old is he?
A I believe in his mid to late 20s.
Q And where did he get his doctorate? 04:51PM
A Without reviewing his CV, I don't recall the specific university. It was a South Korean university.
Q Was he in terms of what at least I would call a bachelors degree, a masters degree and a doctorate 04:51PM degree, were all of those educational activities of Dr. Ji-Hong in South Korea?
A Yes, they were.
Q When he came to the United States, did he first come to Purdue University; is that where he 04:51PM



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came to?
A Yes, correct.
Q And that would have been in 2005?
A I believe it was 2005 or '6.
Q Why did he come to Purdue? 04:52PM
A He came to be part of the research group that I work with to conduct research on a variety of hydrologic water quality modeling and related kinds of issues.
Q And if Dr. Ji-Hong were here in this room and 04:52PM I said to him, Dr. Ji-Hong, what are you, what do you do for a living, what would his response be?
MR. GARREN: Object to form.
A Currently he's an assistant professor at Andong University in South Korea. 04:52PM
Q Were you able to find his contact information?
A I've not had a chance to find that.
Q You're going to diligently look for that when you return home; is that true?
A I will look for that. 04:52PM
Q And so if I asked him what he did for a living, would he say he was a hydrologist?
A Yes, yes. He would -- that would be one of the terms he would use.
Q Did you recruit him or did somebody from 04:53PM



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Purdue recruit him to come to the United States?
A I recruited him.
Q How did you find out that he existed?
A That would have been through some other colleagues in South Korea. 04:53PM
Q Did you specifically search him out or were you looking for -- were there a number of candidates for this job?
A I was looking for someone to join the group to be involved in a group of projects. So, you know, 04:53PM he was one of probably five or six that I considered.
Q And was he the only one of those five or six that you actually asked to come join you?
A Yes. 04:53PM
Q What were the group of projects?
A One of the initial -- so he's been involved in several projects. One of the initial projects was in some work with HSPF and phosphorus routing. There was another effort with urban runoff and 04:54PM trying to identify regional values for a group of models that would improve the general ability to predict runoff without having to calibrate that model for each and every location. There was another effort in which he added a base flow 04:54PM



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component to the L-THIA model. So that's a model that estimates runoff and non-point source pollution from urban areas, among other areas. So when one would apply that, often there may be areas that are non-urban within a watershed potentially, too, to 04:55PM which it's applied, and one of the challenges with some types of pollutants is trying to best characterize those, and the challenge is during low flows. During base flow, you know, the pollutants are different. The way they are transported is 04:55PM different. This model didn't characterize base flow, and so he came up with a very innovative technique that allowed us to calibrate from observed data a group of coefficients associated with an equation to calculate base flow. 04:55PM

Q Who were the sponsors or clients for these projects?

A So the different projects would have had different sponsors and clients. So as I recall, the last project I was speaking about, this base flow 04:56PM piece, was an effort that we were working on from US EPA, so that -- the Environmental Protection Agency. The regionalization of parameters to go into models to improve runoff calculations without calibration, that would have been a U.S. Department of 04:56PM

Agriculture project.
Q How can I get my hands on the pieces of paper that were generated?
A So there would be a variety of things that are in draft form at this stage, so I'm trying to 04:57PM
recall. I don't believe any of those have moved into -- all the way through a peer-reviewed publication process yet.
Q Are you the chief investigator for each of those? 04:57PM
A Yes.
Q Would we be violating any of the rules under which you work if we were able to get your work in progress for those projects and see what he actually did? 04:57PM
MR. GARREN: Object to form.
Q Is there any reason why we can't get those things?
MR. GARREN: Object to form.
A Probably no reason that you couldn't. I guess 04:57PM
I would want to confer with Mr. Garren as to, you know, whether that's permitted.
Q I mean, the project sponsors or the grants under which you work would have no prohibition on draft reports being handed to outside third parties? 04:57PM

MR. GARREN: Object to form.
A I don't think any of these would.
MR. ELROD: I'm going to make a request for whatever that body of work is.
Q How would we describe it? 04:58PM
A It would be --
Q Everything he's worked on while at Purdue.
A Sure. It would be a series of draft reports.
Q Can we call them the Ji-Hong draft reports?
A That would probably be an appropriate name. 04:58PM
Q Okay. Now, why did he return to South Korea?
A He had an opportunity to take a faculty position.
Q And does he -- it sounds to me like he has skill sets that you don't have that you needed? 04:58PM
MR. GARREN: Object to form.
Q Is that true?
A Well, I guess -- this is a natural progression of modelers. It's typical that, you know, I did the same things he was doing day in, day out a number of 04:58PM years ago, and as I grew, the size of the research group grew into other responsibilities. You know, then you begin to work with others that have the day-to-day responsibility for the kinds of things he was doing. So this is, you know, a typical process 04:59PM

in which, you know, a professor manages a research group, interacts with a research group and, you know, the day-to-day responsibilities for these efforts are with post docs, with graduate students, with research associates, with others that are part 04:59PM of that group and others that that group might collaborate with.

Q So does he have skill sets that you don't have?

A He would -- 04:59PM

MR. GARREN: Object to form.

A He would certainly have some skill sets that I would be hard pressed to be as efficient at today as he might be, so things like programming, for example. 05:00PM

Q Okay. What is programming?

A So programming would be writing of a language or code that a computer could interpret to do some series of things, and so an example I guess in the case at hand here was that a program was written by 05:00PM Dr. Ji-Hong to do -- to automate the majority of the calibration process.

Q In this case?

A In this case. So that's an example of a program. 05:00PM



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Q And he began working on this case during what month and what year approximately?
A So this would have been probably August, the August sort of time frame, August, September time frame in 2007. 05:01PM
Q And he left for South Korea when?
A Late January, early February 2008.
Q So he was working on this project for approximately four to five months?
A That would be correct. 05:01PM
Q Was that the only thing he was doing during that period of time?
A No.
Q What percentage of his time was dedicated to this project during that time? 05:01PM
A This would be an approximation, so I would -- it would hard to pin a specific percentage on this. It would be on the order of -- probably on the order of 50 percent.
Q Then what was the status of his work product when he left for South Korea in terms of percentage of completion? 05:01PM
A Percentage of completion? Well, if we want to just talk about how many additional months it took to complete that, that might be the easiest way to 05:02PM



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think about it. So, you know, there was continued work on this through the production of the report in May of 2008. So it would be tough to assign a specific percentage as to how much was complete at that point in time. 05:02PM

Q So from January to May he was in South Korea completing the work?

A Among other things.

Q And you and he were communicating during that period of time? 05:02PM

A Yes.

Q By what means?

A Typically by phone and by Skype.

Q Skype is an ability to speak over a computer?

A Correct. 05:02PM

Q No E-mails?

A I don't believe there were.

Q Why not E-mails?

A It was easiest to have a dialogue about the things that were being done and to make those -- to take care of those in dialogues. 05:03PM

Q Now, after your May report was issued -- by the way, at the time your May report was issued, you had been working on this project for about three years; is that true? 05:03PM



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A So from late summer or summer 2005 until May 2008.

Q And when you issued your May 2008 report to the court, you certified that over your signature as being true and accurate, did you not, sir? 05:03PM

A Correct.

Q And it was not true and accurate, was it?

A Subsequently a mistake was identified and corrected.

Q And was that the mistake the mistake of Dr. Ji-Hong or was that your mistake? 05:03PM

A Probably -- so Dr. Ji-Hong made a mistake in the calibration piece of code. That code didn't step through enough of the response units during the calibration process, and so it incorrectly assigned phosphorus to too few of the response units. So that mistake was Dr. Ji-Hong's. 05:04PM

Q Was he embarrassed by that?

MR. GARREN: Object to form.

A I'm not sure. I would assume he might have been. 05:04PM

Q Well, did you and he talk about it?

A Yes, we did.

Q And did he express embarrassment to you?

A Yes, he did. 05:04PM



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MR. ELROD: Do we have permission to contact him, Rick, directly?

MR. GARREN: I don't know how to get ahold of him yet, so I don't know how to answer that.

MR. ELROD: Is he a consultant of the State? I mean, I'm concerned about the ethical issue. 05:04PM

MR. GARREN: No. Dr. Engel is ours.

MR. ELROD: So we're free to contact Dr. Ji-Hong? 05:05PM

MR. GARREN: I'm not saying that. I don't have an answer for you, John.

MR. ELROD: Okay. Are we going to get one?

MR. GARREN: Yeah.

MR. ELROD: Let's go ahead and change tapes. I'll be through in about ten minutes. 05:05PM

VIDEOGRAPHER: We're now off the Record. The time is 5:05 p.m.

(Following a short recess at 5:05 p.m., proceedings continued on the Record at 5:21 p.m.) 05:20PM

VIDEOGRAPHER: We are back on the Record. The time is 5:21 p.m.

Q Dr. Engel, I'd like for you to help me understand something that's in your original report, and I want to look at Page 25, Table 5.3, and Page 05:21PM



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28, Table 6.1. Let's take the first one first. Is it true that Table 5.3 on Page 25 displays observed phosphorus loads based on USGS and OWRB phosphorus data and USGS flow data?

A Yes. 05:21PM

Q And the years that are displayed would be 1997 through 2006; is that true?

A Correct.

Q And so these would be loads to Lake Tenkiller?

A Well, these would be loads. 05:22PM

Q If you total them?

A Well, so I guess specifically these are loads to Tahlequah, Baron Fork, Caney Creek. In that those are close to Tahlequah, they would represent loads to Tahlequah -- or I'm sorry -- to Lake 05:22PM Tenkiller.

Q Let's look at the year 2003. Tahlequah, which would be at the Highway 62 bridge; is that true? Tahlequah is really the Highway 62 bridge?

A I believe that's the one, yes. 05:22PM

Q Which is basically right at the head of the riverine section of Lake Tenkiller?

A Correct.

Q It's 94,684 pounds?

A Yes. 05:22PM



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Q And Baron Fork, which is a tributary of the Illinois River that flows in further downstream from Tahlequah, is 10,107; right?
A Right.
Q Caney Creek, which flows in directly to Lake Tenkiller avoiding the Illinois River main stem, is 3,485? 05:23PM
A Yes.
Q And the total for that year is 108,276 pounds of phosphorus for 2003; is that true? 05:23PM
A Yes.
Q Now, if you turn to Table 6.1 on Page 28, and is it true that Paragraph or Table 6.1 displays the total P discharge to streams and rivers within the IRW from wastewater treatment plants? 05:23PM
A Yes.
Q And if you'll look at the column on the right, it says 2003 to the present?
A Yes.
Q All right. For all of those WWTPs, wastewater treatment plants, for 2003, the total phosphorus loading is 90,155 for the year 2003 forward; is that true? 05:23PM
A Correct.
Q Now, if you look back at Table 5.3 for the 05:24PM

year 2003, the total P loading to Lake Tenkiller is 108,000; right?

A Right.

Q And the total P loading at Table 6.1 just from wastewater treatment plants is 90,155 or 90 percent of the total; right? 05:24PM

MR. GARREN: Object to form.

A So it's 90 percent -- if we're just doing math --

Q Yeah. 90 over 108? 05:24PM

A If we're just doing math, that's correct. However, you have to realize that not all of the wastewater treatment plant phosphorus in this particular year is likely making its way to these three gauging stations. 05:24PM

Q If all of it did make it to the gauging stations, approximately 90 percent of the total phosphorus loading to Lake Tenkiller per these two charts, actual observed data, came from wastewater treatment plants; isn't that true? 05:25PM

A I mean, you are asking a hypothetical here. So if we want to talk about just the math, just -- if we just do the division, you're correct, but let me explain why that is happening, and then if we look to the next year, we see a very different 05:25PM



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situation. So 90,000 divided by more than a million in 2004, now we're at less than 10 percent.

Q Okay. I don't see on either Table 6.1 or Table 5.3 the number you're talking about. Oh, 1,147,000 on 5.3? 05:25PM

A Yes, and 5.3 for year 2004. So what has happened, 2003 was a drought year. Flows were quite low, and as a result, much of the phosphorus from wastewater treatment plants and other phosphorus that moved out of fields into streams was retained 05:26PM for that year, maybe even beyond that year in the stream and river network. So this is well understood that this happens, and so what we then see in 2004 when we get significantly more flow, things have changed and now we see movement of 05:26PM phosphorus, some of which had been detained for a while in the streams and rivers, along with new phosphorus from the wastewater treatment plant that year and new phosphorus as modeled by -- well, I guess this is an observed value -- new phosphorus 05:26PM has moved out of fields, that include fields with poultry waste land application, is now moving all the way to Tenkiller that year.

Q If you ran your GLEAMS model for 2003 for the hydrology that was present in the watershed for 05:27PM



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2003, would it tell us that 90 percent of the total phosphorus that reached Lake Tenkiller in 2003 came from wastewater treatment plants or would it tell us something else?

MR. GARREN: Object to form. 05:27PM

A It would -- so we would have to look at GLEAMS combined with the routing equation in 2003. Is there a table in here that does that? So there's probably -- there's a graph in here that would -- I'm not sure -- 05:27PM

Q Would you take the time and go do that?

A I'm thinking without -- we may need to look at underlying data to see how that percentage turns out. Let me just look --

Q Take a quick look and see if you can tell me what GLEAMS says for 2003. What page are you on? 05:27PM

A Just a moment here. I think I need -- we need Exhibit 4.

Q Which is what?

A The errata. 05:28PM

Q The first one?

A Actually, did I ever get the corrected errata, a copy of that, because that's the table I would want to see?

Q I don't know what you're talking about. 05:28PM



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MR. GARREN: You talking about the October?
A The October.
MR. GARREN: I don't think it's ever been introduced.
MR. ELROD: Have you got one for him? 05:28PM
MR. GARREN: Was there not one in that book?
A Mr. George, do you know?
MR. GEORGE: Just for the Record, I don't think it's an errata; I think it's a letter from 05:29PM counsel that he's referring to, but be that as it is, if someone wants to attach it to the Record, he can.
MR. GARREN: Mine is all marked up.
MR. ELROD: I just want him to see it to 05:29PM answer my question.
MR. GARREN: Well, okay. That's fine. I'm going to introduce it in a minute.
Q Tell the Record what you are looking at, Dr. Engel. 05:29PM
A I'm sorry. So this is, Mr. George, the letter -- what did you refer to this as?
MR. GEORGE: I believe there was a letter that accompanied those documents, none of which were signed by you as near as I can tell, a letter by 05:30PM



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counsel.
A Okay. So this is a letter from counsel with
looks like four pages that provide corrections to
the September 2008 errata to properly represent
this. 05:30PM
Q Okay.
A So we're talking about 2003?
Q Yes, sir. What table or chart are you looking
at?
A I'm sorry. It would be Table 10.1. So Table 05:30PM
10.1 indicates that the model total in 2003 would be
148,516 pounds. This would be the model total that
results from the wastewater treatment inputs to the
routing equation and the GLEAMS inputs to the
routing equation. So it's those combined and 05:31PM
routed.
Q Is it GLEAMS totaled P loading to Lake
Tenkiller?
A This doesn't allow me to pull those apart
without looking at underlying data. So this is the 05:31PM
combined modeled loading to Lake Tenkiller and so
indicating that 90,000 of this or 90,000 and
whatever the remainder of that was is directly
attributable to wastewater treatment plants that
year would be incorrect because some of that 05:31PM



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phosphorus is being detained in this year because
it's such a dry year and the flows are so low.
Q Well, it's true that -- are you saying that
the chart, Table 6.1, on Page 28 of your original
report saying 90,155 total pounds of P came into 05:32PM
Lake Tenkiller from wastewater treatment facilities
is a good number or a bad number?
A Well, this number doesn't represent -- well,
Table 6.1, the title represents this as wastewater
treatment total P discharges to streams and rivers 05:32PM
within the IRW. It doesn't represent that this is
the load that reaches Lake Tenkiller in a specific
year.
Q What was the load that reached Lake Tenkiller
from WWTPs in 2003? 05:32PM
A So that portion, again, without looking at
underlying data, I can't -- I guess I can't tell you
in just looking at the materials I have in front of
me as we sit here at the moment.
Q Let's return to -- your GLEAMS model says 05:33PM
148,000 pounds reached Lake Tenkiller in 2003?
A It was GLEAMS, combined with wastewater
treatment, combined with the routing equation.
Q So that would be the total that GLEAMS -- that
you opined from running the GLEAMS model reached 05:33PM



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Lake Tenkiller in 2003 was 148,000; correct?
A Well, the model -- models -- modeling system indicates that it was 148,000 and whatever the remainder of that was. So it's not just GLEAMS. It's, you know, again, GLEAMS with wastewater 05:33PM
treatment, with the routing equation, so it's that combination.
Q That's your opinion in this case?
A Yes.
Q And the United States Geological Survey, an 05:33PM
agency of the United States Government, the Oklahoma Water Resources Board, an agency of the State of Oklahoma, utilizing USGS flow data, tells us that the correct number for 2003 was not 148,000; it was 108,000; isn't that true? 05:34PM
MR. GARREN: Object to form.
A So the 108,000 in 2003 is, yes, the computed observed load and, again, you know, the model would not be expected to match year by year by year exactly right. The model has been calibrated to 05:34PM
match this ten-year period, 1997 to 2006. So you'll see that some years out of this ten years, in some years the observed phosphorus is bigger than the modeled. In other years that's turned around.
Q So why is it that the GLEAMS model does not 05:35PM

have the capability of being accurate for any particular year, twelve months?

MR. GARREN: Object to form. You talking about the one he ran or you talking about just in general? 05:35PM

MR. ELROD: The one he ran.

A So the modeling system I employed, like other models or modeling systems, is not going to predict exactly the observed load each year.

Q I understand that, but 108,000 divided by 148,000 is a rather significant mismatch; isn't that true; wouldn't you agree with that? 05:35PM

A No. So one has to look at the broader context here. One has to -- in looking at the model performance, the well-established techniques for reviewing that would be to plot observed versus -- I'm sorry, predicted versus observed, as is done in Figure 10.1, and then you look at the relationship between those, and in this particular case, the R-squared is above .97. Typically an R-squared for these kinds of data over this scale or over this time scale, if those are above .6, the modeling community would embrace that as a model that's performing well. 05:35PM 05:36PM

Q Over what? 05:36PM

A Over 0.6. The value here is 0.97. So this indicates that for this ten-year period, this model is able to very well reproduce the observed data and --

Q For the year 2003, Dr. Engel, it was 108,000 divided by 148,000. Whatever that percentage is, that was the percentage of accuracy for 2003, isn't it? 05:36PM

MR. GARREN: Object to form.

A That's not the way the modeling community would assess how well the models were. 05:37PM

Q Well, how do you think a jury of regular people in Tulsa, Oklahoma might think about that?

MR. GARREN: Object to form.

A I guess I'm not a member of that jury, so I'm not certain how they would respond but, again, I would just say, well established in the scientific community, that the statistics one looks at or reported here and the figures one would look at are reported here in Figure 10.1, and when one does that, a hydrologic water modeler working with watersheds would conclude this model performs very well; this modeling system performs very well. 05:37PM

Q Are you telling this jury that the scientific community, people who model and use models to try to 05:37PM



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re-create real-world activities are proud of trying to hit a percentage that is 108,000 divided by 148,000, that that's acceptable?

MR. GARREN: Object to form. What is that percentage? 05:38PM

MR. ELROD: Whatever 108 over 148 is.

MR. GARREN: Object to form then.

A So, again, you are mischaracterizing the way that the scientific community would review this.

Q Well, what I understand your testimony to be 05:38PM is that to those of you who model, trying to re-create real-world activities through computers, that a result that gives you a percentage of accuracy of 108,000 over 148,000 is acceptable; is that true? 05:38PM

MR. GARREN: Object to form again.

A But the context is broader than that one specific point. So you can't look at one year in isolation. You have to look at the longer period. In this particular case we had the opportunity to, 05:39PM you know, to use ten years, and so, you know, therefore, when one looks across the ten years and looks at the relationship, the model performance would be deemed, you know, very acceptable.

Q Does GLEAMS pretend that all chicken litter 05:39PM



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that's spread in the Illinois River basin is spread next to the river?

MR. GARREN: Object to form.

A Well --

Q Does it pretend that? 05:39PM

MR. GARREN: Object to form.

A GLEAMS is not pretending anything. So as the modeler, one has to provide input data to the model, and in describing inputs to the model, the inputs were described such that poultry waste was applied 05:40PM to pastures irrespective of location.

Q Yes, sir. So it measures output of phosphorus runoff at the edge of a field; correct?

A It predicts; it doesn't measure. So it predicts phosphorus at the edge of the field. 05:40PM

Q So it is pretending that every field on which land -- which receives chicken litter, that the edge of that field is also on the edge of the Illinois River, isn't it?

MR. GARREN: Object to the form. 05:40PM

A No. This modeling system would not make that assumption. You know, the modeling system -- again, let me describe it in fairly simple terms.

Q I need that.

A You know, it's identifying unique combinations 05:40PM



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of land use, such as pasture, soils, management, land application of poultry waste and weather, and for each one of those unique combinations, GLEAMS is being run -- well, I guess if we step -- well, GLEAMS is being run. It's estimating delivery of 05:41PM phosphorus from each of those combinations, those response units that I mentioned.

Q But the assumption is that whatever leaves the edge of that field enters the water?

MR. GARREN: Object to form. 05:41PM

A And that is a good assumption, and let me tell you why. It's a good assumption because the model has been calibrated with observed phosphorus at Tahlequah, Baron Fork and Caney Creek. So through that calibration process, you know, we're informing 05:41PM the model as to how much it should predict, when it should predict the phosphorus to move and, you know, as a result then, as it steps through time and experiences changes -- if we decide to change management, it would allow us to change management, 05:42PM see what happens. So, you know, it simply is stepping through time, reproducing observed data when we ask it to reproduce observed data because it's been informed on how to do that or if we changed scenarios and say what happens with 05:42PM

cessation of poultry waste application, we can ask it what happens.

Q But, Doctor, it pretends that a 40-acre field that is flat with virtually no hydrologic outlet south and east of Bentonville, Arkansas, the 05:42PM farthest reaches of the watershed, is going to be treated the same as a 40-acre field with a 6-degree slope on the edges of the Illinois River, doesn't it?

MR. GARREN: Object to form. 05:43PM

A That's not entirely true, and it's not true in that because GLEAMS was run for these hydrologic response units, the vast disparity in conditions that you describe would probably mean there's a difference in soil types, and because the soil types 05:43PM were used in identifying these and the soil parameters from these soil units were used as inputs into the GLEAMS model, what you are describing would not happen.

Q It pretends that all chicken litter applied in 05:43PM the Illinois River basin is applied on April 1st of each year, doesn't it?

MR. GARREN: Object to form.

A Well, pretend is your word. So, you know, the assumption in starting the modeling was that that 05:44PM



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was the date on which it was applied.
Q And does it also pretend that it rains on April 1st every year?
MR. GARREN: Object to form.
A No, it doesn't, and so the weather that it's 05:44PM
using is the observed rainfall data for the gauges that are identified back in Appendix D for the period 1997 through 2006, and so, you know, it was real data that was used, real rainfall data that was used, so, you know, that wasn't pretend data. It, 05:44PM
you know, used that for the calibration period because that was the period for which we had observed data at Tahlequah, Baron Fork and Caney Creek, and then rather than speculate as to what weather might look like in the future, that ten-year 05:45PM
period of weather was repeated then in the scenario analyses. So when we looked at, you know, continue business as usual, no changes in the watershed, that ten-year period of weather was repeated every ten years going out 100 years. When we looked at 05:45PM
cessation of poultry waste application, that same ten-year period of weather was repeated every year going out for 100 years and same thing for the other scenarios, I guess the exception being a historical scenario that used weather from 1950 to 1999. 05:45PM

Q Is it your position, Dr. Engel, that the agricultural land uses and behavioral patterns in the Eucha-Spavinaw watershed can be pretty well extrapolated to the Illinois River watershed?

A There would certainly be many similarities. 05:46PM

Q Is it true that the GLEAMS model that you used pretends that all pastureland in the Illinois River basin receives chicken litter in each year?

MR. GARREN: Object to form.

A Well, so once again, I think I've answered 05:46PM this question but, once again, you know, the model is not pretending nor assuming that. The model is simply reading inputs that I provide as a modeler.

Q Yes, sir.

A And those inputs, as this model were initially 05:46PM calibrated, assumed a starting or assumed an application on all those pastures.

Q Now, if you would, look at Dr. Sharpley's report, and I don't know what exhibit number this is quite frankly. It's this one. 05:46PM

A I think -- I assume it's near the top.

Q It's got its own distinct font.

MR. GEORGE: It's got an E-mail on top of it in your copy.

A It doesn't have Dr. Sharpley's name on that 05:47PM



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one.

MR. GARREN: Exhibit 18.

A What was the number again?

Q 18 I think somebody said.

A Got it. 05:47PM

Q This is what -- look at Page 9, Table 5. In the Illinois River basin there's about 450,000 acres of pastureland compared to about 1,108,000 total acres; is that true?

A Those are roughly the right proportions. 05:48PM

Q So it would be about a little over 40 percent of the total land mass in the Illinois River basin is pastureland?

A My recollection is it was a little higher than 40, but it's close to 40. 05:48PM

Q Okay. Now, look at Table 5 on Page 9 of the Sharpley reports. It is true that the percentage of the Eucha-Spavinaw watershed actually receiving chicken litter in 2004 was 7 percent and in 2005 was 6 percent and 2006 it was 7 percent and in 2007 it was 6 percent; isn't that true? 05:48PM

A That's what this table reports, yes.

Q Now, if those same percentages hold true for the Illinois River basin, then the GLEAMS assumption that all pastureland in the Illinois River basin 05:49PM



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receives chicken litter is just wrong, isn't it?
MR. GARREN: Object to form.
Q It's wrong?
MR. GARREN: Object to form.
Q It's wrong? 05:49PM
MR. GARREN: Object to form.
MR. McDANIEL: You need to strenuously object if you want to put a stop to that.
A Well, that assumption doesn't impact the modeling results and the conclusions that one 05:49PM reaches from those results. So although there may be some discrepancy between, you know, the description or things that you described them, you know, that's not impacting the model results nor the conclusions that one reaches from it. 05:49PM
Q Would you look at Appendix B, which is the mass balance report?
A Okay.
Q Look at Page 35.
A Page 35? 05:50PM
Q Are you there?
A Just about.
MR. GARREN: Hold on.
A Okay. I'm on Page 35.
Q Meagan Smith testified that you were the 05:50PM

source of the -- her conclusion that per Table 27, 75 tons a year of phosphorus leaves Lake Tenkiller via the spillway; is that true?

A Yes.

Q How did you reach that conclusion? 05:50PM

A So this was a calculation based on the outflow of water from Tenkiller for over a several year period, 2004 and '5 or 2004, '5, maybe part of 2006, and based on the modeled concentration of that outflow by Dr. Wells. So by looking at daily 05:51PM outflows and looking at modeled phosphorus concentrations and then converting that set of units to arrive at an average tons per year, it was 75 tons per year.

Q Surely there is observed data below the 05:51PM spillway of phosphorus concentrations?

MR. GARREN: Object to form.

A In looking at observed data, the next location or the location downstream of the dam that had observed data was sufficiently far downstream that 05:52PM you would have additional flows, additional potential contributions of nutrients from, you know, from other watershed kinds of areas, and so that data was not used in making this calculation.

Q Where was the sampling point; at Gore? 05:52PM

A Without reviewing a map that shows those locations and reviewing --
Q Let me sure be I've captured your testimony. Is it your testimony that the actual sampled phosphorus concentration numbers below the dam were too far away from the dam to be useful to you in using actual observed data as opposed to calculated data to determine the amount of phosphorus loss over the spillway? 05:52PM
A So my recollection is that the available phosphorus data was sufficiently far away to call into question how well that represented what was being discharged from the Lake Tenkiller spillway. 05:53PM
Q 75 tons would be 150,000 pounds; is that right? 05:53PM
A I've got somebody's calculator here yet so I can calculate that. Looks like that would be 150,000 pounds.
Q And is it your testimony that that is -- 150,000 pounds leaves via the spillway year in and year out? 05:53PM
A For the period for which this was calculated, the value was approximately 150,000 pounds per year.
Q And for clarification purposes, when you say spillway, you're talking -- actually you're talking 05:53PM

for the most part through the powerhouse?
A Yes.
Q Okay, and it would actually be the spillway only during those rare flood events when they actually have to open the spillway? 05:54PM
MR. GARREN: Object to form.
Q Or what do they do?
A This would be the combination via those pathways.
Q The -- you recognize that there is a trout 05:54PM fishery below the dam?
A That's my understanding, yes.
Q And you recognize that among the fish kingdom, that trout require some of the highest dissolved oxygen levels of all fish, game fish in the area? 05:54PM
A We're starting to get to the edge of my knowledge. So that's my understanding, but I'm no means a fish expert.
Q And tell the jury what section, what vertical section of the lake at the dam the water through the 05:54PM powerhouse is drawing from. That was a bad question. I think you understand it.
MR. GARREN: I don't.
MR. GEORGE: Doesn't matter if you do.
A I understood the question enough to realize 05:55PM

that, you know, this is not my area of expertise, so --

Q Do you know at what level above sea level the powerhouse gets it water?

A I'm not certain. 05:55PM

Q All right.

MR. ELROD: Those are my questions, thank you.

MR. GEORGE: It's your witness, Rick.

CROSS EXAMINATION

BY MR. GARREN:

Q Dr. Engel, do you know whether or not the spillway, when it's allowed to evacuate water from the dam, is controlled in any way to avoid harm to the biota and the fish downstream? 05:55PM

A That would be my understanding, that it would be operated in that manner.

Q And what kind of potential harm would exist to the biota and the fish downstream from the waters released from Lake Tenkiller? 05:56PM

MR. GEORGE: Object to the form.

A Well, certainly the rate of release of the flows could certainly impact the fish and biota downstream, as could constituents being carried by that set of flows. So that combination, along with 05:56PM



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the temperature of that water, may also have an impact on those.

Q Okay. Mr. Elrod asked you about the 7 percent in Eucha-Spavinaw, that table, which is I think at Page 9, Table 5. 05:56PM

A So this was in Exhibit 18?

Q Is that where it is? I lost the exhibit here.

MR. GEORGE: Yes, Exhibit 18.

Q Now, you mentioned that this -- there are certain impacts that the model either does or does 05:57PM not take into consideration with regard to its modeling compared to this percentage of the watershed receiving litter in the Eucha-Spavinaw. Can you tell the court, if you would, please, what are those impacts and how it might be distinguished 05:57PM from Eucha-Spavinaw?

MR. GEORGE: Object to the form.

A Well, so in the modeling that I did for the Illinois River watershed, again, poultry waste was applied to all pasture, and through this calibration 05:57PM process, the GLEAMS model, combined with wastewater treatment and combined with this routing equation that was derived from observed data right here in the Illinois River watershed, was able then to reproduce phosphorus concentrations from various 05:58PM

sources, including pastures with land application of waste, and it was able to reproduce those such that it matched the observed data at Baron Fork, Caney Creek and Tahlequah for the period 1997 through 2006. So then once that is done, one can use that 05:58PM
model to analyze other scenarios that may or may not include land application of poultry waste.

Q Let's back up a little bit. You said I think earlier in your testimony that you have done court appointed work in the Eucha-Spavinaw/City of Tulsa 05:58PM
case involving application of poultry litter in that case?

A That's correct.

Q Can you describe briefly what you did there in order to show the court and jury your experience and 05:59PM
knowledge of that watershed?

A Certainly. So I was an expert for the judge in that particular case to examine some of the hydrologic water quality modeling and the supporting datasets, an effort that went into the modeling of 05:59PM
phosphorus loads reaching Eucha and Spavinaw.

Q How did you come to act in that capacity?

MR. GEORGE: Object to form.

A As I recall, Judge Eagan was the judge in that case. Initially someone from her office contacted 05:59PM

me after having I guess talked with other watershed hydrologic water quality modeling experts throughout the country and had identified myself as someone that they wanted to learn more about and see if, you know, if I might be able to help the judge. 06:00PM

Q Did they request of you any documentation or background information?

A Yes, they did.

Q Tell the jury and court what you provided them. 06:00PM

A They requested a copy of my curriculum vitae or resumT.

Q And did you provide them anything else, writing examples or articles?

A There may have been some papers that were 06:00PM provided as well. I'm not certain at this point.

Q Did you interview with the judge in order to -- as part of your process of being appointed by her?

A I did, and, as I recall, there were several 06:00PM phone conversations, a couple of those particularly fairly lengthy in discussing my experiences, my background, my expertise and talking about whether I might be able to help inform the court regarding the modeling that had been done in the Eucha-Spavinaw 06:01PM



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watershed.
Q During the process of your consideration, did you become aware of any other candidates that were being screened for the purposes of assisting the court in that Eucha-Spavinaw/City of Tulsa case? 06:01PM
A I did become aware of some others, yes.
Q So you weren't the only one that was being considered?
A That's correct.
Q Do you know how many others there were? 06:01PM
A As I understand, there were at least two others, three others that -- at least names that, you know, that the judge did share with me. There may have been others.
Q Okay. Do you know -- do you have a 06:01PM recollection who those might be or who they were?
A So as I recall, Dr. Saied Mostaghimi, who is a hydrologic water quality modeler at Virginia Tech, was one of the people being considered, an individual with significant amount of modeling 06:01PM experience and other experiences as well. Dr. David Beasley was another person that I know the judge had considered, again, someone that actually created and wrote probably the first watershed model that looked at phosphorus. So that was back in the '70s that he 06:02PM



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initially wrote that model, developed datasets that -- field observations that supported the development of the model, and the ANSWERS model is the name of that particular model. That model has continued to be used. So he was another individual that was in consideration. 06:02PM

Q Can you think of any other names while you're sitting here today?

A I believe Ken Campbell in Florida was another that the judge had and I had discussed. Ken was someone that has done a lot of phosphorus modeling with the respect to some of the issues in Florida and Lake Okeechobee and the phosphorus issues there and in particular, many of the livestock waste, dairy being the primary problem, with respect to livestock in that watershed and the other production practices from which phosphorus was being lost. 06:03PM 06:03PM

Q Do you know whether or not Dr. Bierman was considered by the judge in this case?

A He was not to my knowledge. 06:03PM

Q All right. Let's talk a little bit more about what you did in order to discuss the similarities between the IRW and the Eucha-Spavinaw. Did you examine land use in that Eucha-Spavinaw area?

A I certainly did examine land use land cover 06:04PM



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maps for Eucha-Spavinaw from several sources.
Q Did you make personal inspections or visits to the Eucha-Spavinaw watershed?
A During which matter?
Q At any time have you done that prior to your 06:04PM
writing a report in this case?
A Yes, I have visited that watershed.
Q All right, and did you undertake any investigation with regard to the farming and in
particular, the poultry land application -- the 06:04PM
poultry waste land application practices in that watershed?
A So based on my review of a number of reports and literature, my conclusion ultimately was that
the practices within Eucha-Spavinaw, at least prior 06:04PM
to 2004, those may have changed since that time, that, you know, poultry waste was more widely applied to pastures. You know, the production techniques for pasture for cattle, for poultry
within that watershed given the proximity to the 06:05PM
Illinois River watershed, you know, based on the reports, is identical.
Q Can you tell us just briefly what the topography and the geology is in relation to what
you see in the Illinois River? 06:05PM

A Well, given that this is an adjacent watershed, there's certainly similarities.
Q And what kind of similarities did you observe?
A You know, some of the geology and things began to get outside of my expertise a bit but, you know, 06:05PM
the types of soils that reflect geology are certainly quite similar. The land use patterns have many similarities. The slopes, similar ranges. So certainly a lot of similarity between the two watersheds. 06:06PM
Q Prior to your writing of a report in this case, did you have an opportunity to talk to a John Everett?
A John Everett?
Q The special magistrate in Eucha-Spavinaw. 06:06PM
A Right. So I'm not sure I specifically talked to John Everett. Dr. Fisher, another expert, retained in this case for the State is someone that I understand has probably interacted more with Mr. Everett, and I've interacted a great deal with Dr. 06:06PM
Fisher. So that contact would have been somewhat indirect.
Q All right. Let's talk a little bit about the Illinois River watershed data. You've used over and over for the last two days the term observed data, 06:07PM

and I don't believe at any time that's been defined for the purpose of the jury and the court. Can you tell us what that means in the context of what you've been doing?

MR. GEORGE: Object to form. 06:07PM

A Certainly. The Illinois River watershed has a wealth of data that have been observed in the field, so have been measured in the field. So a variety of state, federal agencies and others have endeavored to collect a variety of data, and this will not be 06:07PM an exhaustive list, but that would include USGS with an extensive record of flows of water in the Illinois River, in the Baron Fork branch and Caney Creek. So some of those records go back to 1950 and even beyond that. It's a fairly extensive set of 06:08PM data for a watershed of this size. So that's a very useful and very well documented set of data.

At those three gauging stations and, in fact, at some other locations within the Illinois River watershed, the USGS has collected phosphorus 06:08PM concentrations within flowing water in those streams and rivers. In more recent years OWRB has also collected observed phosphorus data, has collected water samples that have been analyzed to document the phosphorus concentrations of those waters, and 06:08PM



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then beyond that, you know, the -- I'm sorry, the weather data for this region have been collected by the Weather Service, so that would include, you know, daily rainfall data that would be quite useful in understanding how things behave. The land use 06:09PM
data that has been collected for this area is the land use data from the U. S. Geological Survey derived from remotely sensed data using standardized techniques that they've applied nationwide for a number of years, well documented, well understood, 06:09PM
well accepted within the user communities of those data. Like other locations, the USDA has collected soils data that describe the soil properties extensively.

Q Do those properties include what's been 06:09PM
referred to as soil test phosphorus?

A The data collected by USDA does not include soil test phosphorus. It speaks more to the physical properties of the soils and does not include phosphorus levels that one would find, and 06:10PM
the reason they wouldn't is that phosphorus levels are highly site specific because of local activities. So measuring -- and one might imagine this, that although the same soil might be found in the Illinois River watershed, you might find that 06:10PM



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same soil to the west of that watershed in a region where there's not been extensive poultry production, and because of that difference in locale and the difference in management practices, then that soil near poultry production would likely have elevated 06:10PM
or would likely have higher soil test phosphorus levels than that same soil outside of a region where there had been extensive use of poultry waste on pastures. So one would need to find another source for soil test phosphorus data. 06:11PM
Q That leads to my next question. Is there a source that you might have relied on or used that related to the soil test phosphorus data in the IRW?
A There was. So fortunately the University of Arkansas and Oklahoma State University still have 06:11PM
soil laboratories that do analyses of soil phosphorus, and as part of that ongoing effort, those data are captured in a database at each institution, and some information about locations, types of crops that were being grown in those 06:11PM
locations is captured as part of those data.
Q How would you characterize the volume and the wealth of data that you've encountered in your work in this case for this watershed versus other watersheds you've worked in elsewhere? 06:12PM



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MR. GEORGE: Object to form.
A Certainly this watershed has far more data than most any other location for a watershed of this size in the country. So it's not at all unusual that one, you know, would be working with a location 06:12PM like this and not even have -- or have very minimal observed flow data. You know, this watershed has a long-term record there, for example, as well as a number of locations at which flow has been measured. The water quality datasets here that would include 06:12PM phosphorus are extensive. Again, one would often find that that is a much smaller dataset if it exists for other watersheds of comparable size.
Q Does the quality and the breadth of the data that exists in the IRW weigh in any way in your 06:13PM choosing to use the GLEAMS model?
A Certainly it did.
Q And how is that?
A Well, you know, with models, as we've talked about earlier, it's important to have sufficient 06:13PM data to be able to calibrate them.
Q In your opinion in this case, did you have that sufficient data?
A Absolutely, no question about it.
Q And as I understand your testimony, there's 06:13PM



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been a validation process in your work with that model; correct?

MR. GEORGE: Object to form, leading.

A So there has been a calibration process as one would typically do with hydrologic water quality 06:13PM modeling of watersheds when sufficient data exists and so, you know, the desire of a hydrologic water quality modeler would be to have data like is available here in this Illinois River watershed so that one can perform a validation step as well. 06:14PM

Q Did you perform a validation process in using your model?

A Yes.

Q Does that require data to be available to do so? 06:14PM

A Yes, it does.

Q And was sufficient data available in order that you could do that appropriately and as typically seen by a scientific community that you work in? 06:14PM

A Yes, and, in fact, the available data provided an opportunity to look at a longer period than would typically be done in a validation and in a calibration for most locations, and so the data was above and beyond what most hydrologic water quality 06:14PM

modeling scientists would expect or hope for within a watershed.

Q Does the quality and the volume of the data available to you assist you in any way in rendering your opinions in this case? 06:15PM

A Yes.

Q And tell the court how that is.

A Well, the available data help in a number of ways. So they help in providing the opportunity to calibrate the models such that the model can 06:15PM reproduce what's actually occurred with respect to flows and phosphorus being delivered to the three gauging stations and ultimately to Lake Tenkiller. So for the model, you know, those data are extremely useful, but beyond that, you know, those data also 06:15PM allow one to examine trends, examine other properties of those data as a number of others have done and have reported in a variety of scientific reports and publications for this watershed.

Q You talked earlier about rain data in 2006 and 06:16PM so that I'm clear, you looked at -- did you look at rain data for the entire ten-year data or just a smaller portion?

A Well, the rain data that was used for calibrating the model and the subsequent application 06:16PM



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for the model was rain data that covered daily the period 1997 through 2006.

Q Did you compare that to any other data and in doing so, do you have an opinion whether or not that time frame was truly representative of what we see in the IRW? 06:16PM

MR. GEORGE: Object to the form.

A I did have a chance to do that, and if I could turn to, excuse me, a table in the report, I can address that a bit better. So if we turn to Page 27 of the report and to Table 5.5 and in analyzing the rainfall statistics for the rain gauge noted in Table 5.5, which was a key rain gauge here in the hydrologic water quality modeling, if one looks at the period of rainfall from 1950 through 2006, the average rainfall in that period was 50.15 inches with a standard deviation of 10.2 far -- 10.24 and a range of 27.51 to a little more than 81 inches. 06:17PM 06:17PM

Comparing that to the 1997 to 2006 data, you can see that for that period the average was about 51 or a little over 51, so a little more than one inch greater than the long-term average. However, you can see the standard deviation was less, and that's reflected in the range. So the range of observed rainfalls was lower in that period, '97 to 06:18PM 06:18PM



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2006. It was lower in that it was between a little more than 36 and a little less than 60 inches, and the consequence of that, as is well documented in the literature, when we have these years with more rainfall, we also tend to have larger rainfall 06:19PM
events, and so the rainfall data for '50 to 2006 would likely have more runoff, and the data does bear that out, and it also moves more phosphorus during these larger rainfall events.

So the '97 to 2006 rainfall data is certainly 06:19PM
representative of the last ten years and would be representative of the period of record and, if anything, would tend to err on the side of having years with -- you know, that did not have as much rainfall as what would have occurred in other years. 06:19PM

Q Did you -- were you aware of the rainfall data that occurred in the year 2008?

A I did see some of the rainfall data and also some of the corresponding runoff from 2008.

Q How would you characterize that data compared 06:20PM
to what you've used in the modeling report?

A Well, the 2008 flow data certainly suggests that, you know, the flows were substantially higher than the period 1997 through 2006, and that has a profound impact on the transport of phosphorus. So 06:20PM



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larger flows as reflected by the observed data and reflected in the routing equation that I used, larger flows have the ability to transport more phosphorus that's been detained in the stream network and river network. It also has the 06:20PM
opportunity -- if we look in the GLEAMS model, it has -- the greater rainfall would tend to move more phosphorus to the edge of the field that ultimately reaches the three gauging stations and reaches Lake Tenkiller. 06:21PM

Q So in reality, if we had had that data in this case, there likely would be a higher phosphorus level for load as shown in your model?

MR. GEORGE: Hang on. Objection, Rick. You are now trying to solicit new and untimely 06:21PM
opinions from the expert on subjects that were not discussed in the direct examination. To the extent you are trying to use your time to submit through the deposition Record an addition to the expert report, it's violative of the scheduling order, and 06:21PM
we object. Answer, if you like.

Q Let me do this then because we're about to run out of time and I want to get a few questions in before that happens. I know it's been a long two days for you but, Dr. Engel, you've rendered 06:21PM



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opinions in this case and they're set forth in this report both in May of 2008 and the errata in September of '08; is that correct?

A Correct.

Q Explain -- we've not marked it but -- 06:22PM

MR. GARREN: What's our next exhibit, please?

COURT REPORTER: Be 24, I believe.

Q Identify Exhibit 24, which is the October errata that's been provided to defense counsel in 06:22PM this case, please.

MR. GEORGE: Object to characterization.

A So this is a set of corrections to the September errata, yes.

Q And are they intended to replace those items 06:22PM that are otherwise set forth in your May report and/or your errata of September?

A Yes.

Q And where they're designated as such, they would replace that which is designated the same in 06:22PM either of those reports of May or September?

A That's correct.

Q Okay. Now, you've -- I asked you to look at your opinion section that's pretty much high -- or outlined in your executive summary conclusion at 06:23PM



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Page 2 of your main report and on Exhibit 4 of Page 3 of your September errata.

A Okay.

Q So that the Record is clear, your September errata contains opinions dated or numbered 2, 3, 4 and 7. Are those intended to replace those that are shown in the May report numbered identically 2, 3, 4 and 7? 06:23PM

A Correct.

Q So based upon your testimony here for the last two days, has your opinion differed or is it different than that which is set forth in your May report and your September errata on those eight items listed? 06:23PM

MR. GEORGE: Object to form. 06:23PM

A My opinion is not different as set forth in these documents.

Q All right.

MR. GARREN: While we're on the Record, I want to reserve time to complete my examination. I've not done so, and since we've come in at seven hours, fourteen hours for this gentleman, I intend to reconvene this at a time where it's available for everybody. 06:24PM

MR. GEORGE: Before we go off the Record, 06:24PM



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the defendants object to reconvening the deposition. We'd ask that you complete your examination today while all parties, including counsel from out of town and the witness from out of town are present, and defendants and defense counsel are prepared to 06:24PM continue the deposition today and complete it.

MR. GARREN: What witness from out of town is here?

MR. GEORGE: Your witness.

MR. GARREN: Oh, my witness. I thought you 06:24PM were talking about a witness for the defense. It's no problem bringing him back. I understand your objection and you understand my claim.

MR. GEORGE: I understand we have a difference of opinion. I believe the deposition is 06:24PM concluded; you believe it's not, and we'll deal with that later.

MR. McDANIEL: Just so the Record is clear, you're stopping the deposition now? That's all I want to clarify. 06:25PM

MR. GARREN: Well, I'm stopping it both because it's in compliance with the Rules and --

MR. McDANIEL: I heard your justification. I just want to be clear that it's your decision that we're terminating. We're ready to continue. 06:25PM



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MR. GARREN: Right.

VIDEOGRAPHER: This concludes the deposition of Dr. Bernard Engel. We're now off the Record. The time is 6:25 p.m.

(Whereupon, the deposition was concluded at 6:25 p.m.) 06:25PM



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SIGNATURE PAGE

I, Bernard Engel, PhD, do hereby certify that the foregoing deposition was presented to me by Lisa A. Steinmeyer as a true and correct transcript of the proceedings in the above styled and numbered cause, and I now sign the same as true and correct.

WITNESS my hand this _____ day of _____, 2009.

_____

BERNARD ENGEL, PhD

SUBSCRIBED AND SWORN TO before me this _____ day of _____, 2009.

_____

Notary Public

My Commission Expires:

_____



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C E R T I F I C A T E

STATE OF OKLAHOMA )
) ss.
COUNTY OF TULSA )

I, Lisa A. Steinmeyer, Certified Shorthand Reporter within and for Tulsa County, State of Oklahoma, do hereby certify that the above named witness was by me first duly sworn to testify the truth, the whole truth and nothing but the truth in the case aforesaid, and that I reported in stenograph his deposition; that my stenograph notes were thereafter transcribed and reduced to typewritten form under my supervision, as the same appears herein.

I further certify that the foregoing 257 pages contain a full, true and correct transcript of the deposition taken at such time and place.

I further certify that I am not attorney for or relative to either of said parties, or otherwise interested in the event of said action.

WITNESS MY HAND AND SEAL this 14th day of January, 2009.

_____

LISA A. STEINMEYER, CRR
CSR No. 386



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CORRECTIONS TO THE DEPOSITION OF

BERNARD ENGEL, PhD

Volume II

| PAGE AND LINE NUMBER | CORRECTION |
| --- | --- |



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