POLLUTION CONTROL HEARINGS BOARD
STATE OF WASHINGTON

WASHINGTON STATE DAIRY FEDERATION, the WASHINGTON FARM BUREAU, PUGET SOUNDKEEPER ALLIANCE, COMMUNITY ASSOCIATION FOR RESTORATION OF THE ENVIRONMENT (CARE), FRIENDS OF TOPPENISH CREEK, SIERRA CLUB, WATERKEEPER ALLIANCE, CENTER FOR FOOD SAFETY, and RESOURCES FOR SUSTAINABLE COMMUNITIES,	) PCHB No. 17-016(c)
Appellants,	)
vs.	)
STATE OF WASHINGTON, DEPARTMENT OF ECOLOGY,	)
Respondent.	)

HEARING
VOLUME IV
May 24, 2018
Olympia, Washington
Pages 662 through 899

Taken Before:

Andrea L. Clevenger, RPR, CCR #3041
Registered Professional Reporter
of
Capitol Pacific Reporting, Inc.
2401 Bristol Court SW, Suite C-103, Olympia, WA 98502
Tel (360) 352-2054 Fax (360) 705-6539 Toll Free (800) 407-0148

Tacoma, WA (253) 564-8494
Seattle, WA (206) 622-9919
Aberdeen, WA (360) 532-7445
Chehalis, WA (800) 407-0148
Bremerton, WA (800) 407-0148

www.capitolpacificreporting.com
admin@capitolpacificreporting.com

APPEARANCES

For the Appellants:

Charles M. Tebbutt
Dan Snyder
Sarah Matsumoto
Law Offices of Charles M. Tebbutt, PC
941 Lawrence Street
Eugene, Oregon 97401
541.344.3505
541.344.3516 Fax
charlie@tebbuttlaw.com

Katelyn J. Kinn
Attorney at Law
2720 3rd Avenue
Apt 310
Seattle, Washington 98121
920.782.0114
katelyn@pugetsoundkeeper.org

For the Department of Ecology:

Phyllis J. Barney
Assistant Attorney General
2425 Bristol Court SW
PO Box 40117
Olympia, Washington 98504
360.586.4616
360.586.6760 Fax
phyllisb@atg.wa.gov

APPEARANCES (Continuing)

For Washington State Dairy Federation and Washington Farm Bureau:
Elizabeth E. Howard
Virginia Nicholson
Schwabe Williamson
1211 SW 5th Avenue
Suite 1900
Portland, Oregon 97204
503.796.2093
ehoward@schwabe.com

Board Members: Heather C. Francks
Joan Marchioro
Kay M. Brown
Neil L. Wise

EXAMINATION INDEX

EXHIBIT INDEX

BE IT REMEMBERED that on Thursday, May 24, 2018, at 1111 Israel Road SW, Olympia, Washington, at 8:56 a.m., before ANDREA L. CLEVENGER, CCR, RPR, the following proceedings were had, to wit:

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JUDGE FRANCKS: First of all, yesterday Ms. Kinn presented an exhibit that we never marked, and I excluded it, but I would like a copy of it, and I'm going to mark it A-77 just so it's in the record. So if we can do that, that would be great.

MS. MATSUMOTO: Your Honor, we have an existing A-77.

JUDGE FRANCKS: Okay. Whatever the right number is.

MS. MATSUMOTO: So the next number I believe is A-81.

JUDGE FRANCKS: All right. I didn't have my right list in front of me. Okay. So A-81 is what it should be.

MR. SNYDER: We actually don't have a copy of this today. We could also send you by email electronic copy if that would be preferable?

JUDGE FRANCKS: Sure. Why not.

MR. SNYDER: Or tomorrow paper copy. Whatever works for you.

MS. HOWARD: And we never got a copy of just the two-pager.

MR. SNYDER: Perhaps we should just bring in our paper copy tomorrow.

JUDGE FRANCKS: That sounds great. So let's do that. The other thing is time.

When we began this hearing, as you know, I allotted each party ten hours to present their case, and according to the chess clocks, which you all have been doing very well and the adjustments that you have shared with me.

According to my calculations, here is where we stand today, Thursday morning: PSA has used just over eight hours. The dairy federation has used exactly three hours, and Ecology has used just over four and a half hours.

I'm not going to hold PSA to the ten-hour limit because they do have more issues that they have the burden of proof on.

MR. TEBBUTT: Thank you, Your Honor.

JUDGE FRANCKS: So -- but what I would like to hear right after lunch today is an estimate of how much time you need to present the rest of your case, all of you, because I'm trying to schedule.

So if we can do that right after lunch -- so let everybody think about, you know, what they think they have left, and we'll -- and then we'll talk about -- for example, I know Ms. Barney had mentioned that one of her witnesses on rebuttal has timing issues.

And so any issues like that, I would like to hear after lunch today.

Okay. So that's all I have for the moment. I will go -- unless anybody else has housekeeping issues for right now?

Okay. Then I'm going to go get the board and we'll be back in a couple minutes.

(Pause in the proceedings.)

(Board members enters.)

JUDGE FRANCKS: Let's go on the record. Good morning. Have a seat. And we are here on Day 4.

Mr. Snyder, you have a witness for us.

MR. SNYDER: Yes, Your Honor. We're going to be taking Dr. Keeney slightly out of order here. We began with Mr. Erickson yesterday. We'll carry on with Mr. Erickson later, but since we have the technology working, we'll go ahead and start with Dr. Keeney.

Dr. Keeney, the court reporter is going to swear you in now.

DENNIS KEENEY, having been first duly sworn by the Certified Court Reporter, testified as follows:

DIRECT EXAMINATION

BY MR. SNYDER:

Q Sir, could you start off by telling the board a little bit about your educational background.

A Yes. I came from a dairy farm. It was much smaller in those days and just a few cows, probably 20 or 30 to keep things going, but it's a place where you learned a lot. And very general group -- very general, diverse enterprise.

Then went to Iowa State University where I got a master's in agronomy and soil science, and moved on to University of Wisconsin in Madison where I got a master's degree in soil science, and then moved back to Iowa to do a Ph.D. in special program in nitrogen chemistry, but it was with a renowned chemist. There, I got the Ph.D. postdoctoral work.

Q And, Dr. Keeney, do you have Exhibit A-5 in front of you?

A That's the vitae? Yeah.

Q Yes, sir. If you could pull that up and just let me know, is that currently accurate?

A Yes. Except for the address, which has now been moved to

426 Wild Indigo Lane in Madison. We just moved.

Q Thank you, sir.

So, Dr. Keeney, you've been a professor at multiple levels in your career; is that right?

A That's correct.

Q And, sir, could you tell the board a little bit about your experience at the Leopold Center for Sustainable Agriculture?

A Yes. I came back from Wisconsin to start the Leopold Center for Sustainable Agriculture. It was a very exciting job. First one in the nation, in fact, almost in the world.

Sustainable agriculture was just beginning to be a household name in those days, and it ended up with me connecting a lot with the farmers again, much more than I used to as a Ph.D. student or as a professor.

Q So --

A Go ahead.

Q It's fair to say then that you were a founder of Leopold Institute?

A That's right. I was the -- I took the funding that came from the Iowa legislature and started the center from scratch.

Q And, sir, your CV, is it accurate that you have approximately 213 publications in your career?

A That's about right, yes.
Q Is it fair to say, sir, that you have substantial experience with soil science and agronomy?
A Soil science, agronomy, and you can add in water chemistry.
Q And how about groundwater impacts from agriculture? Have you looked at that in your career?
A Yes. That's been kind of a career objective also in my life, both in Wisconsin and in Iowa State where the Leopold Center was really founded because of water quality problems in the state of Iowa.
Q And was that from water quality programs from agriculture?
A From agriculture most exclusively.
Q Dr. Keeney, are you familiar with the nitrogen cycle, sir?
A Do that one again. You broke up.
Q Are you familiar with the nitrogen cycle, sir?
A Yes, very much.
Q And have you written any books or chapters in books about nitrate and its impacts on groundwater?
A Yes. I've written several probably and contributed to several other symposiums, and I never tried to count them, but I'm sure there's a half a dozen or so and a couple of self-authored books.

Q And, sir, just to clarify, as part of your experience, looking at agricultural impacts on groundwater, does that include CAFOs?
A Some of it has been CAFOs, yes. CAFOs play a big role in the Midwest because they're part of a whole ecosystem of very intense cropping.
MR. SNYDER: Your Honor, at this time, we would move into evidence Exhibit A-5. That's Dr. Keeney's CV.
JUDGE FRANCKS: A-5 is admitted.
(Exhibit No. A-5 admitted.)
MR. SNYDER: And, Your Honor, procedural question. This would be my first time with the PCHB with an expert witness.
Does the board want us to move Dr. Keeney in as an expert under ER 702 or just submission of the CV enough?
JUDGE FRANCKS: I think submission of the CV is enough.
MR. SNYDER: Excellent. Thank you, Your Honor.
Q (By Mr. Snyder) Dr. Keeney, can you turn to A-4, please.
A Okay. R-84?
Q No. A-4.
A A-4. Got it. Okay. Yes.
MR. SNYDER: And just for the board's

knowledge, Dr. Keeney has a full set of the exhibits that were exchanged prior to the start of this, so if something comes up, he should be able to answer questions.

Q (By Mr. Snyder) Dr. Keeney, is this a copy of the expert report that you created for this case?

A Yes.

Q And does this report contain a summary of your opinions that you have about the combined permits in this case?

A Yes.

MR. SNYDER: Your Honor, we'd move into evidence Exhibit A-4.

JUDGE FRANCKS: Exhibit A-4 is admitted.

(Exhibit No. A-4 admitted.)

Q (By Mr. Snyder) Dr. Keeney, I'm going to ask you a little bit about some of your opinions today as they pertain to the permit, and I want to start with surface water monitoring, sir.

Could you just take a minute and explain to the board, what is surface water monitoring, in your experience?

A My experience has been looking at the chemicals and bacterial and -- mostly bacterial agents, disease agents that are in surface water that might impact both water

quality and drinking water quality, depending on what the water is being used for.

Q And in your career, have you used surface water monitoring to look at potential surface water impacts from agricultural activities?

A Yes. In both the instances in Wisconsin, but more especially instances in Iowa where it's been very controversial as to how much surface water contributes to the water quality.

Q Why would you say it's been controversial, sir?

A It's been controversial because there's -- a lot of the agricultural community has been in denial for a number of years.

When they finally accepted the obvious fact that the battle has been paid for good cleanup and that is where it's been stuck right now for a number of years.

Q You mentioned an obvious fact. Could you explain to the board what that obvious fact is, please.

A Yes. Well, all monitoring just shows very simply that there's no -- people living in the watersheds, that they're very high in nitrate, and it does follow seasonal trends that might be expected.

Q And, sir, in your experience, is the source of that nitrate, at least some portion of it, from agricultural activities?

A Yes. It's been estimated in the 90 percent range.
Q And does that include applications of manure to agricultural fields?
A Yes, it would. It's hard to sort out the two, but part of it would have to be coming from manure.
Q Is there another source, sir, beyond manure applications?
A Yes. Fertilizers, a lot of fertilizers used as well and the major site recycling of nitrogen in the system where you can't decide which is one and which is the other.
Q Sir, do you have any opinions about whether surface water monitoring is something that should be required for CAFOs?
A Yes. I feel it should be. It's a major impact to the system. It's easy to measure relative to a lot of other things that we might be looking at, and it gives a lot of information on both seasonal flows and, if you do it properly, information on the sources.
Q Is it difficult to do, sir?
A No, sir. It can be set up for automated sampling in a number of watersheds that are towards an outlet, and its analyses mostly are pretty well automated and very inexpensive.
Q When you say it can be automated, is there a specific point or area where you would say automated sampling occurred?

A Yeah. It should be going towards the outlet where we are interested in using the water and then towards outlets of major tributaries to whatever stream you're looking at.
Q Dr. Keeney, are you familiar with something called tile drains?
A Oh, yes, sir.
Q Could you explain to the board what a tile drain is.
A They're placed to lower the water tables sufficiently in a drainage system, and then you can go ahead and proceed with planting and cultivation.

And the soil also warms up much faster, and it actually allows the seed to germinate. So without tile drains, in many situations you can't do agriculture, as we know it.
Q In your experience, sir, where do tile drains discharge to?
A They'll discharge to a stream, a stream that involves discharge onto whatever water source you're using.
Q So do you believe it's important to monitor tile drains for potential discharges of agricultural contaminants?
A Yes. Very important so you know where it's coming from and what actions you could possibly take.
Q And specifically in regards to CAFOs, would you be looking at the pollutants that are contained within manure?

A Yes.
Q Do those include some of the nutrients such as nitrate and phosphorous?
A Nitrate, phosphorous, some of the bacterial agents that might be an issue.
Q Will that include --
A And organic matter.
Q Would that include E. coli or fecal coliform?
A That's correct.
Q Sir, in your review of the records in this matter, did you see anything that said -- that spoke to the existence of tile drains in Washington State?
A I saw some reviews, yes, that spoke of them. Not a lot because they were more concerned with keeping the water table low enough for agriculture but not as much concerned with their outlet --
Q Do you recall --
A -- the discharge.
Q Do you recall reading anything, sir, about tile drains in the Sumas-Blaine Aquifer?
A Yes.
Q In your review of the permits, sir -- and this is Exhibit R-1, if you want to have it in front of you just for ease of reference. I'll give you a second to pull it up.

A Got it. Yes.
Q In your review of the permit, sir, did you see anything in here that required permittees to monitor tile drains in their agricultural fields?
A What was that again? Would you repeat?
Q In your review of the permit, sir, did you see any requirements that required a CAFO that has the permit to monitor any tile drains that may exist in their fields?
A No, I did not.
Q And, sir, do you have any opinions about whether that should be required?
A It would seem that's an important part of the hydrological cycle. It should be required.
Q And, again, I think you said this, but is it difficult to monitor tile drains?
A No, it's not.
Q We also asked you to look at, sir, the emergency winter field applications provisions of the permit. Could you turn to that? It's, I believe, Section S4.J.5 on Page 22 of Exhibit R-1.
A Okay.
Q When you --
A I have it.
Q When you reviewed this section, sir, did you have any concerns about surface water quality as applies to these

emergency winter fields applications?
A Yes, I did. I was quite concerned that overtopping of lagoons by dumping emergency waters into the landscape, you know, very poor water quality downstream, and it would mean putting too much nitrogen in the system to -- for it to assimilate. Essentially you'd have an emergency situation as you could -- without maybe a season or two.
Q And, sir, is it your understanding that this provision allows permittees to apply manure to their fields without regards to crop uptake or agronomic rates?
A Yes. There would be no evaluation of the -- even adaptive management section.
Q Sir, I want to specifically ask you about the west side of Washington.

What's your understanding of the winter conditions in the west side of Washington?
A The west side is fairly wet all the time, and it's not freezing and it's not as cold as the east side.
Q Is it fair to say, sir, in your experience, that, when you have a very wet winter, you'll have saturated fields?
A Sorry. Sometimes you break up, and I cannot hear you.
Q You let me know if I'm breaking up.

My question has to do with saturated fields in the west side of Washington.

A Yes.
Q Is it your experience that in winter the -- in areas where it's very wet, you will have fully saturated fields?
A Yes. Surface water tables coming to the surface.
Q And, sir, does that give you any concerns about the possibilities of runoff from fields -- sorry. Let me finish my question. One second.
Does it give you any concerns about runoff from fields if a permittee was doing one of these emergency winter field applications?
A Yes. There would be probably topping out runoff into the nearest stream or lake.
Q And, Dr. Keeney, do you understand the concept of hydrologically connected groundwater to surface water?
A Yes.
Q And in regards to these winter applications, do you believe it's possible or even probable that you could see those types of discharges occurring from these applications?
A Very possible that you could be connected through your groundwater system, yes.
Q And, Dr. Keeney, on the west side of the state in winter when it's very wet, do you have any opinions about whether crops will be uptaking nitrate or nitrogen or

phosphorous?
A Chances are, there will be little crop growth because they'll be too saturated for the roots to really be growing adequately, and so there probably won't be much crop growth there.
Q And, Dr. Keeney, on the east side of the state, is your understanding that the east side has a different climactic condition than the west side?
A Yes. I understand.
Q And what is your understanding of what winter conditions are like?
A Understanding of the east side is, it's cooler, has more dry spells and less rainfall. It will have frozen soils for months of the year.
Q Do you have any concerns, Dr. Keeney, about making applications in winter to fields that are frozen?
A Yes. They're almost certain to have runoff there, either through rainfall or snow melt, and that these sort of applications has been certainly looked at and also banned in any other states in the Midwest.
Q And by "banned," does that mean it's an absolute bar on applications in winter?
A Absolute bar unless you have absolutely no alternative.
Q And, Dr. Keeney, for crops that are growing in winter on the east side, do you expect those crops to be uptaking

nutrients from manure?
A Not if they're in that saturated situation, but otherwise yes.
Q In the frozen side of the state, sir, is --
A Frozen side of the state, not during the winter, no.
Q Not during the winter.
Is it fair to say, sir, that crops go dormant during the winter months?
A Yes. Or they're harvested.
Q So, Dr. Keeney, it's your understanding, in looking at this provision, that applications here are completely untethered to agronomic rates? Is that a fair assessment?
A That's fair, yes.
Q Do you think, sir, that permittees should be managing their manure operations such that they shouldn't have to have these emergency applications at all?
A Yes, they should. They should have enough storage so that you do not get the overrunning of the storage systems, and that means taking -- it's all that knowledge. Five-inch rains suddenly coming along are very difficult to manage.
Q And is one way that permittees can manage that, having more land to apply manure to at the outset?
A Yes. To keep the lagoons at low levels during the wet

periods in winter.

Q And, Dr. Keeney, we've spoken about the west side and the east side.

Sir, in your opinion, is it more likely than not that applications in these contexts will cause discharges to surface water?

A Yes.

Q And I want to ask you just in a practical matter, if you had to institute a surface water monitoring program for these types of discharges, how would you accomplish that?

A You'd have to set the monitoring up where the outlet is, whether it might be just an artificial outlet for a short time as the soil is saturated and water is running through. You can't just go out and take it out a little bit of a wet soil and call that monitoring. It'll have to be in the water itself.

Q And, sir, would you recommend perhaps an upstream sample, and downstream?

A I'm sorry?

Q Would you recommend an upstream sample and a downstream sample from the discharge point?

A By all means. That would be the way to monitor what's going on.

Q And, Dr. Keeney, you spoke about an outlet. Is there situations where field runoff can occur to nearby streams

when there's not even a distinct point source, if you would?

A Yes. That can happen. It's called surface shape flow, and it's actually a common phenomenon in some places where you just don't have enough slope in the system for a root to form to outlet to a stream.

Q And timing-wise, Dr. Keeney, is it important to monitor these potential discharges at the time they're occurring?

A Yes. It would be very important because it may not last very long, but you have to know quantitatively what you put in the system.

Q And if you didn't sample in close temporal proximity to the discharge, would you be able to tell whether water quality has been impacted by that discharge?

A Not until you get the actual results, which may be a year or two later, and you see water quality deteriorating.

Q So it's fair to say, in your opinion, sir, that if there is going to be a discharge, the permit should be monitored right away?

A Probably should, yes.

Q Outside, Dr. Keeney, of the tile drains in emergency winter field applications, do you have any opinion, sir, about whether permittees should be able -- should be required to monitor discharges regardless of when they occur to surface waters?

A So discharges you would be talking about would be?
Q Any type of discharge. If a permittee says, "Oh, I'm discharging to surface water," should they be required to monitor that?
A They definitely should, yes.
Q And would that be protective of surface water quality, in your opinion?
A They would be able to give an answer to the question, did you do it?
Q And ideally that would help inform decisions down the road so that they could avoid that situation in the future; right?
A Right. And protect the landowner.
Q Dr. Keeney, one thing that you looked at with this permit pertain to phosphorous. And I want you to explain to the board for a minute, why is phosphorous a nutrient of concern for the environment?
A Phosphorous, when it gets into open water systems, will be -- producing to algae formation, lower water quality. The nitrogen-phosphorous ratio in waste is typically way off from what the nitrogen-phosphorous ratio in waters might be for algae.

And so you're adding more phosphorous, even if you still are adding nitrogen. They're out of balance. And phosphorous then will continue to build up in the system.

It's conservative and has no place to go except hanging on to the soil particles usually because parts in a lake -- an intimate part of the lake sediment that's in the bottom, and it's just there forever. It cycles out back and forth from the water to the soil in sediment.

Q Dr. Keeney, is it common, in your experience, to find phosphorous in groundwater underlying CAFO?

A You always assume, and I think wrongly, from soil science that we don't have that issue, that soil would absorb any amounts of phosphorous. That's turned out to be wrong, and common sense says it would.

The chemical reaction is set up to keep an equilibrium, and so we're going to be building up more and more phosphorous in the tile drains as time goes on.

Q So there is an upper limit to how much phosphorous can be retained in the soil column?

A There probably is. Very difficult to interpret, but we can interpret that through soil tests.

Q And the fact that we're seeing phosphorous in groundwater indicates to you that phosphorous has been overapplied; is that fair?

A That's fair.

Q In your review of the permit, sir, did you see anything that set any limitations on land application rates for phosphorous?

A No.
Q And, in fact, didn't you review written discovery in this case from the Department of Ecology where they admitted that the permit does not limit land application rates based on phosphorous?
A Run that question by me again.
Q Sure. Perhaps we could do this. Could you pull up Exhibit A-6 for me, sir.
A A-6.
Q This is Department of Ecology's responses to the appellant's PSK, et al.'s first set of request for admission.
And, sir, could you turn to RFA 47. It should be very near the end, on Pages 20 and 21.
A All right. I have that page.
Q You have Request for Admission No. 47 in front of you?
A Yes. Yes.
Q Would you mind reading that, sir.
A "General permit does not limit land application rates based on phosphorous."
Q And the response that the Department of Ecology gave? It's on the next page there.
A Right. "Admit."
Q So when you reviewed the permit in conjunction with this written discovery request, you came to the conclusion,

sir, that there is no phosphorous limitations on applications; is that right?

A That's right.

Q And what do you think about that, Dr. Keeney?

A Again, I think it's a mistake. I think your overall environmental quality will be deteriorating over time, and you realize that your surface water has become very difficult to use, especially for recreational purposes or drinking water, and you wish you did something about it ten to twenty years ago.

Q Dr. Keeney, we also asked you, sir, to take a look at the soil sampling requirements of the permit.

Do you remember that?

A Yes.

Q And, sir, this is back on Exhibit R-1, and it's at Page 18. It's permit Section S4.1.

A S45?

Q And there's multiple provisions underneath that. I just want to ask you, Dr. Keeney, do you have any opinions about whether the soil sampling requirements in this permit are deep enough?

A Ones that ask for three foot are certainly deep enough. The ones that don't go deep enough because of various reasons just can't be helped.

So I think the three-foot requirement is probably

about as deep as you can go and still get information that is meaningful information relative to the cost.

Q So, sir, would you recommend that permittees of this permit take three-foot samples across the board?

A I think it's carefully explained in there that you don't necessarily have to, but it would probably be the best thing to do as long as you've already started the sampling system.

Q Would sampling down to three feet give permittees a better idea of how well their manure management system is working?

A Yes, it would. There might be a plume of nitrate moving down that you would miss if you did not sample that deep.

Q And so looking at the third foot gives the operator an idea of how much nitrate is leaching out of the crop root zone. Is that fair?

A That's fair, yes.

Q Why is it important to know that, Dr. Keeney?

A Because that nitrate is -- unless you have a very active denitrification system, that nitrate will end up in the groundwater.

Q And, Dr. Keeney, do you know whether there are situations in Washington where you have a very active denitrification system, as you put it?

A Yes. Some of the reports that I've read lately from this

project have indicated there is an active denitrification and right at the groundwater surface. I was surprised there was that much.

Q And even acknowledging that there is some denitrification that will occur, will that denitrification eliminate all nitrate that's going to groundwater?

A No. It's usually 25 percent of what's there. That would be a decreasing 25 percent. I think the point is made somewhere that, if you quit applying nitrogen entirely, you would have to let that 25 percent, more or less, work away for quite a while to clean up the groundwater.

Q And speaking about groundwater and this leaching phenomenon, do you have any opinion, sir, about whether these permits should require permittees to monitor the groundwater underlying their facilities?

A That would even be a more important monitoring point than getting an extensive amount of deep soil samples.

Q And why is that, sir?

A Because it's hard to predict exactly what the soil samples will deliver, and in some cases, the research that's been reported on these watersheds, so that there's not a relationship -- it's someone wondering what's happened, what's going on, means you have to start a good monitoring system for the groundwater, for the -- yeah.

Q So soil sampling then, even a three-foot level, in your

opinion, is not going to provide an operator with enough information to know whether their manure applications are causing nitrates to move to groundwater; is that right?

A Give you an indication of whether you apply too much, but it won't give the final answer.

Q Is the only way, sir, to know what's going into groundwater to monitor the groundwater in the first instance?

A That's correct.

Q And, Dr. Keeney, there is some lag time, is there not, between nitrate leaching and how long it takes to reach groundwater?

A Yes. Depending on a number of factors that are going into right now. There could be considerable lag time.

Q And for areas where there's a very shallow aquifer, is that lag time increased or decreased?

A That's decreased considerably. That could be almost an immediate response within the growing season.

Q So for permittees that have facilities located in areas where the water table is high, do you think groundwater monitoring would provide important information for them to use in managing their manure applications?

A Yes.

Q Could it tell them that they're applying too much manure?

A It can tell them that immediately, yeah, taking up enough

in crops.

Q And, Dr. Keeney, how would a permittee know without groundwater monitoring whether they are causing groundwater contamination? Is there any other way?

A Not really. You've got to be looking at the end result in the groundwater, and you can estimate what's going on through the soil samples, but the final proof is in the groundwater sample.

Q And if you had to design a groundwater monitoring plan, what constituents would you test for, sir, to make sure that you're looking at nitrate that's associated with manure?

A Probably test not only for nitrate but for organic matter that might give rise to existing denitrification.

Q Would you look at any of the other parameters that are associated with the manure, such as chloride?

A I would. Chloride is a good tracer because it's conservative, and what goes on through the chloride system is -- tells you what you missed with nitrate, but it's been used in some of the research they've got reported here, and it's an excellent use.

Q Dr. Keeney, I heard you use the word "tracer." Could you explain that a little bit for the board, what you mean by that?

A Yes. If you put in equal amounts of nitrate and chloride

in a test system and then let it leach through, you would find out whether nitrate was taken up, but the chloride will not be taken up since it's conservative. And so they can tell you, this is what's going on and how much of the nitrate you have recycled.

Q And would it allow someone to say and that nitrate is more likely than not from a manure application as opposed to some other source?

A It would be in this case because manure is fairly high in chloride and turned out to be a good tracer.

Q Are there any other tracers, sir, that you would recommend for general sampling of groundwater?

A Not in -- you could always use some radioactive tracers, but they're certainly not worth it for the money.

Q Okay. Dr. Keeney, beyond groundwater monitoring, we also asked you to take a look at Table 3 in the adaptive management provisions of this permit, and that's on Exhibit R-1. It's the table. Could you turn to that, please.

A Yes.

MR. SNYDER: And for the board, that's Page 24 of the R-1. It's also the big demonstrative up here.

Q (By Mr. Snyder) Dr. Keeney, looking at the low field risk level that's green, do you believe, sir, that having

residual nitrate levels of 15 part per million is protective of groundwater quality?

A Yes. It appears so, especially from their monitoring relating to water quality, but, yes, it is protective.

Q And just to make sure I got that right, you said especially if they were in conjunction with groundwater monitoring?

A Right. So you can prove that that was working.

Q And what about the medium level there, sir, 15 to 30 parts per million? Do you think having that in the soil at the end of the cropping season is protective of water quality?

A It would be running a little high. Certainly you'd want to think twice about leaving that much around to be leached during the next rainy season.

It would be right at the edge, but I'd say it's -- I would not really want that to be the goal. You want the goal to be the low system.

Q Sir, in your experience, your vast experience of looking at soil samples and understanding the literature, the medium range there, 15 to 30 parts per million, how does that square up with the literature?

A That's pretty close to what I would have guessed is from scratch. I think it's a good range.

Q Okay. So even at that range, though, you believe that

there's a risk of leaching to groundwater; is that right?
A That's right.
Q The high range, sir, 31 to 45 parts per million nitrate, do you have any opinions about that?
A That would be running too high, in my opinion. It would almost certainly have to back off whatever it might be to get it back down to medium to low range.
Q And when you review this permit, sir, how long can a permittee's fields be in the high range?
A Sorry. You're breaking up again.
Q No problem.
In your review of the permit in this table, sir, how long can a permittee be in the high range of residual nitrates?
A It should not be more than a year before it starts to back it off.
Q And the permit allows them to be in that range for three years; is that right?
A That would seem to be too long, yes.
Q Even at one year, sir, would you expect that residual nitrate level to have an impact to groundwater?
A Yes.
Q And at three years, would that have an impact to groundwater?
A It would continue to have the impact and it would build.

Q And, Dr. Keeney, what about the very high range? Do you have any concerns about that?
A Yes. That's the range where you have to realize you can't use that particular site for land application until you reduce the nitrate levels back to low to medium.
Q In your opinion, sir, if someone comes in at the very high level at the end of the season, should they be barred from making any more manure applications in that field the following year?
A If it's legally possible, they probably should be, but I don't know if I'm in that range of knowing what's -- what you can require.
Q Well, in your opinion, sir.
A My opinion, yes. Yes, they should be told not to use that system -- that soil.
Q Thank you, Dr. Keeney.
And, again, in the very high range, what are your feelings about groundwater impacts from that level of residual nitrate in the soil?
A Certainly be probably two to three times the public health limit, MCL.
Q Two to three times, so you're saying 20 to 30 milligrams per liter?
A That's right.
Q Could be the discharge concentration?

A The data that they have produced looks like that's about the right number.
Q Dr. Keeney, can you talk a minute to the board about timing of manure applications as it pertains to crop uptake.
A Timing should be definitely tied to crop uptake. Putting it -- obviously putting manure on too late when the crop is, in essence, close to being harvested, it's simply not going to be utilized.

Putting it on too early, there's an uptake curve, which is in one of these reports, the expert report, shows that you're putting it on and can be leached before the crop has a chance to take it up.

But at least in terms of annual crops like corn, corn silage, some of those, the grand uptake period is fairly short. And this has always made managing nitrogen quite difficult to do a perfect job.
Q So, sir, would you -- in your opinion, would it be more protective of the environment to have timing as a requirement for all manure applications regardless of field levels?
A Yes. Because it's all possible to put it on when it's being needed, and this is basically when fertilizer is managed in most places.
Q And that would be more protective of both surface and

groundwater quality; right?

A And groundwater quality and the value of your resource -- manure resource.

Q Speak to that a minute, the value of manure resource.

A Manure is not a waste, as we know. It's a very important fertilizer in many of these systems. And you are ahead of the game if you can use it in place of a sack of fertilizer to use on the crop. So you don't want to waste it. Wasting it means putting it into the groundwater.

Q And if you apply all your manure at one time, would you believe that that would be wasting some portion of the nutrients contained therein?

A Can't miss. If you got the opportunity to apply it during the growing season when you're having this grand uptake, that's when you should be using it.

Q Dr. Keeney, looking at Table 3, would you also include phosphorous limits on this table to be more protective of the environment?

A Yes. That's a different kind of a table because you're talking mostly about the phosphorous in the surface soil and not deep soil. Maybe looking at phosphorous in the groundwater, but it's difficult to detect it that low often.

So what you -- I would recommend being -- relying on

phosphorous in soil -- as the soil test, and there are certainly ways to do that. There's good tests out there that depend on the chemistry of the soil.

And then if your excessive range as experienced with crops, these are well documented and you put on more than that range, then you're -- you should really be backing off.

Q And, Dr. Keeney, while the permits do require phosphorous testing of the soil, is it your opinion that they should also require limitations on applications of phosphorous?

A Yes. They can look towards -- phosphorous can come in a high range, midrange, soil phosphorous, then you certainly should be looking at the application.

You're talking here about soil phosphorous that runs off during the raining and leaching events, and/or leaches into groundwater.

Q Dr. Keeney, I want to ask you about one more general topic, and that has to do with the acronym AKART and specifically soil moisture sensors. That's something that we spoke about.

What are soil moisture sensors, sir?

A There are several varieties out there, the kind you use in your garden to the professional types of -- through satellites. They take some kind of an evaluation of conductions from one ridge to another and that will give

you -- when calibrated, that will give you the moisture content, and they can tell you when you're in a saturated situation, put on too much water.

Q Why is that important, that saturated situation?

A That's where you're going to get your most extensive leaching before the crop has a chance to take up the nitrogen.

Q Dr. Keeney, are soil moisture sensors expensive?

A Not to my knowledge. You've got a large setup that you can do it electronically, and you're not really -- people don't have to be terribly involved here. Then you can do it quite cheap.

Q And are they, in your experience, common?

A They're common in some areas I've experienced in and especially in irrigation areas in Central Wisconsin where it's very sandy soil. They actually have -- basically controlling the irrigation system without even intervention by human.

Q And it would help operators know both when their manure applications are too high and also their irrigation waters; is that right?

A That's right.

Q So -- sorry. Go ahead.

A When you get too much rainfall.

Q So, in your opinion, Dr. Keeney, should soil moisture

sensors be a requirement in this permit?
A It certainly should be suggested, especially if you're running in the higher ranges of the table to Table 3.
Q So your opinion -- you would say, if you were in the high or very high range, that soil moisture sensors should be a requirement; is that right?
A That's right. In the suggested area because they're a good indication of what's been done right and what's been done wrong.

MR. SNYDER: Dr. Keeney, that's all I have for you on direct examination. What's going to happen next is, the counsel for Ecology and counsel for dairy fed may ask you some questions.

Since we're using one microphone, there may be a moment where I object, and you're going to have to have one of my opposing counsel stop you in the middle of a question if that happens. Does that make sense?

THE WITNESS: It makes sense.

MR. SNYDER: That's all I have, Your Honor.

JUDGE FRANCKS: So, Ms. Barney, are you going next?

MS. BARNEY: Yes.

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CROSS-EXAMINATION

BY MS. BARNEY:

Q Good morning, Dr. Keeney. Can you hear me all right?

A Good morning. I can hear you fine.

Q My name is Phyllis Barney. I'm representing the Department of Ecology that issued the permit in this matter. It's nice to meet you. Glad the technology finally worked.

I have some questions for you about your testimony today.

First I'd like to ask: You mentioned in your background that you did work with CAFOs. And I was wondering, are all those CAFOs permitted under the Clean Water Act NPDES system?

A I believe the ones I've looked at pretty much have. Some have been experimental sites, which wouldn't -- probably wouldn't have been permitted.

Q And your experience in working with those, have you worked with them to manage -- manage discharges from those facilities?

A No. I've been mainly observing what they're doing.

Q Okay. You talked a little bit with Mr. Snyder about surface water monitoring, and you made -- you described to us a little bit what you meant by that, and I'd like to talk a little more.

You mentioned surface water monitoring for CAFOs. You indicated that it would be easy to set up a surface water monitoring.

Could you give us a little more detail on that. You talked about outlets or particular points where you would set up surface water discharge.

How would you do that exactly?

A I would look for the outlet obviously where we're going to collect the water, where the system is collecting the water and discharging, and then have that done.

The automated approach, which are readily available and the samples then can be analyzed pretty much automated. So this is why I'm talking about it being easy. It can be handled by people and machines together and be pretty reliable.

Q So would that be -- where the water is discharging, is that -- would that be off of some sort of rivulet from the field? Would that -- does that need to be out of a pipe? Does that need to be -- where exactly would that take place?

A Mostly I think it would be out of a pipe somewhere.

Q So we just talked about tile drains, but outside of tile drains, is it your experience on CAFOs that there are pipes that lead off, say, a land application area that -- where you could set up such a system?

A I haven't seen such things very directly because I think they mostly don't want to do that. They want to keep that water on-site.

Q In terms -- you also mentioned that using upgradient and downgradient sampling would be helpful and informative. Can you tell us more about how that -- how you would envision that working?

MR. SNYDER: Objection to the extent --

A You --

MS. BARNEY: Hold on, Dr. Keeney, please. We have an objection.

MR. SNYDER: Thank you, Phyllis.

I just want to object to the extent that misstates prior testimony, upgradient, downgradient. I believe it was upstream, downstream.

Q (By Ms. Barney) I've been corrected by Mr. Snyder. I believe that you testified to upstream and downstream sampling points for surface water. Could you describe that a little more, please.

A We can be looking at what's going on just after the discharge to the water system and then what's in the water downstream several -- could be miles, could be feet, but you would get a good idea then of how the nutrients were -- especially the nutrients such as

nitrogen is behaving in the water system.
Q How would you filter out information from other discharges, say, even in that immediate area, other properties?
A Well, you have other discharges feeding in, so you have to be monitoring those as well.
Q So the discharge from any particular CAFO, you would also have to have discharges -- you would have to also monitor other lands and other properties?
A Probably would, yes, depending on what the system is.
Q Are you familiar, Dr. Keeney, with the concept of a first flush in storms for discharges?
A No, I'm not.
Q Okay.
A It means the first runoff from a storm?
Q Exactly. Would -- just in thinking about the first runoff, would you, in your experience, understand that there might be more pollutants that would run off with the first flush than maybe later in a storm?
A Yes. That's been proven for a number of watersheds.
Q So would that then -- if you're sampling through a storm system, would that -- the sampling that you take right there at the beginning, would that be representative of an entire storm event at a facility?
A No. It certainly wouldn't. You would integrate the

runoff and the concentration to get quantities.
Q Thank you. When Mr. Snyder was asking you about emergency winter land applications, I believe I heard you mention that overtopping of lagoons would be a serious problem?
A Yes.
Q And as well as land applications in response to that?
A Yes.
Q And do you have experience observing CAFOs in such a situation?
A I've had experience, if you want to call it, or secondhand experience reading papers on these issues and in the reading about it as it happens.
Q Well, I guess I'm kind of curious as to if you have an emergency situation -- I guess just the language of it, to me, it makes the point that this is an emergency.
Would you consider that it's such a point in time a facility would have the ability to then determine a sampling plan at that point in time?
A I'd hope they'd have a way to at least keep the sample on or the waste on land, but if not, sampling would have to be done, but it's difficult to initiate in the middle of a tornado.
Q Yeah. I think that would be one of the worst situations.
A Right. That's the kind of thing where you do get those

kind of heavy downpours.
Q Definitely. I would -- if you still have Exhibit R-1 up, could I ask you to turn to Page 21, please.
A Computer went to sleep on me here. 21. Okay.
Q Okay. I'm going to direct your attention to the Paragraph 3D. You see it starts in the middle of the page there?
A Yeah. Yes.
Q When you were speaking with Mr. Snyder, I wasn't quite sure of your understanding with regard to applications on the east side of Washington with frozen soils.
A Mm-hm.
Q I wanted to direct you to D -- the first two items there, little I and II --
A Yes.
Q -- where the permit says, "No land application of manure, litter, process water [sic], or other organic byproducts may occur to fields with a frozen surface crust two inches or deeper or if the soil is at or below zero degrees Celsius," and then II is "to fields that are snow covered."
So do you see that that's included in the permit?
A Yes, it is.
Q Okay. Thank you.
So you talked a little bit about field runoff being

sheet flow runoff off of a property.

And, again, the monitoring of that, how would you set up to monitor sheet flow for field runoff?

A That would be very difficult. Sheet flow has not been -- it's not been quantified in a lot of these situations, including soil erosion.

Q Okay. So I'm going to direct you back to the permit, to Page 20.

A All right.

Q The top of the page there, it says, "Yearly field specific nutrient budget"?

A Yes.

Q I'm going to read the first part of that paragraph.

"Each calendar year, the permittee must develop a field specific nutrient budget for each land application field they will control to which they plan to apply manure, litter, process water, or other organic byproducts.

"The yearly nutrient budget specifies the maximum amount of nutrients that may be land applied to the field during the year unless following the emergency special condition.

"Yearly nutrient budgets must be developed before the first land application of the calendar year."

And the yearly nutrient budget must include -- do

you see that list that -- from A to L there?
A Yeah.
Q And I see that nitrogen and phosphorous is included on that list that must be accounted for in the yearly nutrient budget.
A Right. Yes.
Q So if someone was developing a proper nutrient budget so that both nitrate and phosphorous are accounted for here, would that address your concerns with regard to application of phosphorous?
A It makes things more difficult because we've run into this situation in -- on CAFOs with a large number of -- large high number of phosphorous is being applied relative to nitrogen, and then we end up eventually with the soil being saturated basically with phosphorous.
Q But if --
A So that makes it -- that means you can't use it anymore.
Q Well, Ecology's interpretation -- if I can represent to you that Ecology's interpretation here is that the annual field budget is the limitation on how much both nitrate and phosphorous can be applied to the field.
MR. SNYDER: I'm going to object, Your Honor. Counsel is testifying to the fact.
Can you please --
MS. BARNEY: Can you hold, Dr. Keeney.

MR. SNYDER: Counsel is testifying here as to what's in the permit, not Dr. Keeney. That's improper.

Second of all, Ecology admitted in an RFA that the permit does not have application on phosphorous. There's been no attempt to amend that to change that. It should be accepted.

I would make an offer of proof that that's exactly what the permit does not do.

MS. BARNEY: If you -- if I may respond? Because that's inaccurate. If you look at what is in the RFA, the RFA addresses application rates, and here we are talking about field nutrient budgets. They are different and they are different parts of the permit.

MR. SNYDER: The field nutrient budget determines how much you can apply.

JUDGE FRANCKS: Okay. Well --

MS. BARNEY: Yes. And you asked him about rates, which is different.

JUDGE FRANCKS: Okay. I'm going to allow Ms. Barney to craft her question in the way that she wants to craft it, and so everyone will know what the question was. So I'm going to allow it the way that she -- and if you want to rephrase it, that's fine too, but --

MS. BARNEY: Thank you.

Q (By Ms. Barney) Dr. Keeney, I'm sorry. We've been having quite a discussion here. I know you couldn't hear most of that.

But essentially, if someone had crafted a nutrient budget and the permit required them to meet their nutrient budget, and phosphorous was one of the nutrients that is accounted for in the budget --

A You're breaking up. Yes, go ahead.

Q I'm sorry. So if phosphorous is accounted for in a required nutrient budget, would you -- and a facility cannot apply more nutrients to their fields than their budget allows, would you consider that to be limiting the amount of phosphorous that can apply?

A It's difficult to understand you. I'm sorry.

Q I'm sorry. My question must be too long. That's why I'm breaking up.

But basically, if a nutrient budget accounts for phosphorous and you cannot apply more phosphorous than is in the budget, would you consider that limiting phosphorous for field applications?

A Yes.

Q Thank you.

Dr. Keeney, you mentioned, when Mr. Snyder had you look at Table 3, and we were looking -- which is on

Page 24, and we were looking at the high level of nitrate, the 31 through 45 level.

A Mm-hm.

Q And you mentioned, I believe -- and I don't want to put words in your mouth, so please correct me if I got this wrong, but I believe you mentioned that at that point you would look to have a permittee stop applying at that -- at that level of nitrate?

A Sorry. Once again, lost you.

Q Okay. The -- the high level for field risk, the 31 to 45?

A I really can't understand you because of the mic breaking up again.

Q Okay.

A After "permittee," it kind of went sour.

Q All right. If we look at the high field risk level --

A Right.

Q -- what I understand you saying to Mr. Snyder was that a permittee should stop applying if their nitrate test showed they were in the high risk level; is that correct?

A That would be my interpretation of what we should be doing, yes.

Q And if you could look under the middle column that says "Required Actions" --

A Mm-hm.

Q -- the first bullet there says, "Adjust land application timing to correspond to peak crop uptake and stop land application after peak crop uptake."

Would that address your opinion that one should stop applying if you have a high field nitrate level?

A Yes. I think it pretty much would. The key in there is peak crop uptake. None of the other levels ask for peak crop uptake, but I think that should be true throughout the whole recommendations. However, that would certainly be a soothing part of the whole thing.

Q Thank you, Dr. Keeney.

And if you look on the next page there, Page 25, at the top --

A Yes.

Q -- Condition S4.L, which is irrigation water management, I think you spoke with Mr. Snyder about soil moisture sensors?

A Mm-hm.

Q And do you see there this paragraph of the irrigation water management? Did you look at that when you looked at the permit?

A Yes.

Q And would soil moisture sensors perhaps be a practice that a producer could use to properly manage their irrigation?

A Very definitely would be an important practice.
Q So that would be an option for them to utilize that here; correct?
A Yes. Yes.
Q Thank you.
You mentioned groundwater monitoring, Dr. Keeney. How would you design a groundwater monitoring plan for, for instance, a field, an application area for a field?
A Put it up into a number of wells, which have been finished and ready to sample, and then have those wells sampled periodically. Might be eight or ten wells per site.
You'd have to go with an expert opinion here with the hydrogeologist and then sample those wells on a regular basis, say, every week or two.
Q In your experience, in your work, have you performed academic studies that have done just such work?
A Yes.
Q And do you recall offhand what the cost of developing and implementing those groundwater sampling wells was?
A No. I wouldn't know because it was research.
Q But there was still costs associated with the wells; correct?
A Yeah. Cost associated, right.
Q And would you know what that is?

A No.

MS. BARNEY: Thank you. That's all I have. Thank you very much, Dr. Keeney.

THE WITNESS: Thank you very much.

MS. BARNEY: Now, I believe the dairy federation attorneys will have some questions for you next. Thank you.

CROSS-EXAMINATION

BY MS. HOWARD:

Q Good morning, Mr. Keeney. I'm Elizabeth Howard. You probably can't see me.

A No.

Q That's okay. I'll just -- I'm not even sure you can see me if I wave my hand.

A I can see you when you --

MR. SNYDER: Do you want me to move it for you?

MS. HOWARD: No. It's okay. I only have two questions so we should be pretty quick here.

Q (By Ms. Howard) So I represent the dairy federation, Washington Dairy Federation and the Washington Farm Bureau, and I just wanted to go back really quickly to your background and just get a little bit more clarification there.

I think I heard you say that -- that you worked

primarily in the Midwest. Is that a fair --
A That's correct. Although I did spend one year in New Zealand.
Q In New Zealand. I'm a little jealous of that.
Great. And how about Washington? Have you spent very much time in Washington itself?
A No. Not on the field. Certainly more in research meetings and that sort of thing.
Q Okay. And then also just with regard to your background, we're talking about that you were a soil scientist and did some chemistry work.
And what about agronomy? Are you also an agronomist?
A Yes.
MS. HOWARD: You know, those are all of my questions. Thank you very much.
THE WITNESS: Thank you.
MR. SNYDER: Brief redirect, Your Honor?
JUDGE FRANCKS: Sure.

REDIRECT EXAMINATION

BY MR. SNYDER:
Q Hello, again, Dr. Keeney. So I have a brief redirect for you.
Concerning surface water monitoring and how that

would be set up, is it fair to say --

(Telephone interruption.)

Q (By Mr. Snyder) I'll pause while you get that.

A Just ignore it.

Q Dr. Keeney, is it fair to say how surface water monitoring would occur at a site specific?

A Yes.

Q And is it fair to say that a CAFO operator would probably know best where the various outlets from his or her fields would be going to surface waters?

A They should, yes.

Q So they would probably know best on where to monitor?

A Correct.

Q On the emergency winter land application, sir, we spoke about the emergency aspect of it and how it can happen suddenly.

I believe you mentioned tornados, not all that common out here, but, you know, they have happened, but we definitely get large rain events.

And I just want to ask you: Because those emergencies can happen, shouldn't a sampling plan be devised and put in place at a CAFO ahead of time?

A It's best if you can devise a plan that can really address those needs.

Q And that way -- sorry. Go ahead.

A In all the research I've done on that kind of a runoff issue, they always happen Sunday mornings. So you have a hard time getting the troops to get out there.
Q Which is why having that plan in place and permit ahead of time is so important; right?
A Very important.
Q With regard to the emergency winter application, sir, is it your understanding that, for those applications, there is no regard to nutrient budgets?
A Doesn't appear so in the CAFO, no.
Q It's about lowering the lagoon levels; right?
A About lowering the lagoon levels so you don't get anything worse.
Q And I believe that you heard some questions about Table 3 and the timing -- about when timing manure application should occur.

And I just want to make sure your testimony on this point is clear. You would have that provision that you were asked about, adjust land application timing to correspond to peak crop uptake and stop land application after peak crop uptake. You would have that --
A Correct.
Q -- applied across the board; right?
A Across the board, yes.
Q The irrigation water management section that you referred

to, that makes soil moisture sensors an option, doesn't it?

A Yes.

Q And wouldn't you have them be a requirement of this permit?

A I'm not sure I would. That sounds like it might be going too far in terms of what's going on, but since they seem to be reasonable in cost, maybe making them permanent might not be a bad idea.

Q And I think, when we were doing your direct, you said if the field levels had been high for a certain amount of time, that's where you would require soil moisture sensors; right?

A That's right.

Q And is that because, at that point in time, you need to be monitoring below the crop root zone to prevent leaching?

A That's right. You need to prevent leaching by not adding too much water.

Q You also heard some questions, sir, about the costs of potentially installing a groundwater monitoring network?

A Mm-hm.

Q And I want to ask you: Do you know what the cost of remediating groundwater is once it's been contaminated with nitrate?

A There is no such cost because it can't be done essentially, unless you're in a site that's an emergency site of some kind.

Q And so preventing the nitrate contamination at the outset is perhaps the most important thing we can do?

A Absolutely essential for any groundwater situation is to --

(Videoconference disconnected.)

MS. BARNEY: I guess we're done. No.

MR. SNYDER: Dr. Keeney, we're going to finish up just on the laptop.

Your Honor, perhaps now would be an appropriate time for a brief recess before the board questions so I can get this back up.

JUDGE FRANCKS: Yes. Let's take at least a ten-minute break, so until 10:18. We're off the record.

(Recess taken from 10:08 a.m. to 10:18 a.m.)

JUDGE FRANCKS: Let's go back on the record. So we're back after break, and we took the break because Dr. Keeney -- the video had cut out, but during the break, I ascertained that the board did not have any board questions for Dr. Keeney.

So I believe we're finished with Dr. Keeney. Is

that true?

MR. SNYDER: That's correct, Your Honor. And Mr. Tebbutt and Mr. Erickson should be here any second. They're in the conference room.

JUDGE FRANCKS: Okay. And we're resuming with --

MR. SNYDER: Mr. Erickson, yes.

JUDGE FRANCKS: Okay.

MR. SNYDER: Thank you, Your Honor.

Your Honor, Ms. Kinn is going to do something really quick procedurally-wise that we talked about earlier this morning.

MS. NICHOLSON: What exhibit number is this?

MS. KINN: 81.

JUDGE FRANCKS: It is A-81 that we're going to mark it?

MS. KINN: Yes, it is. May I approach?

JUDGE FRANCKS: Thank you very much. Okay. So I'm going to mark it A-81.

So, Mr. Erickson, because we had a different court reporter yesterday, I'm just going to remind you that you are still under oath, which lets the court reporter know that she doesn't have to put you under oath.

DAVID ERICKSON, having been previously duly sworn by the Certified Court Reporter, testified as follows:

DIRECT EXAMINATION (Continuing)

BY MR. TEBBUTT:

Q Good morning again, Mr. Erickson.

A Good morning.

Q Welcome back to -- what are we? -- Day 4 of PCHB hearing. When we talked yesterday, I asked you a question about the piping infrastructure at the -- in the permit; correct?

A Yes.

Q And you used -- you have in your conceptual model you were using, which is part of Exhibit A-67, you discussed the piping infrastructure at facilities as being a significant potential source for contamination; correct?

A I did.

Q Okay. Let's take a look at R-1 for a moment. R-1 is behind you. Should be in the green binders, I believe. And, sir, yesterday I asked you whether the piping infrastructure was -- as it relates to groundwater contamination was covered in the permit, and I believe your answer was no; correct?

A That is correct.

Q Okay. Let's take a look at S4.C of the permit, please, which is on Page 16. You have that in front of you?
A I do.
Q Okay. And explain -- why did you say no to my question yesterday?
A You know, perhaps my answer wasn't thorough enough, but the reason I said no is that what the permit says to do is daily inspections, and you can't inspect underground piping on a daily basis.
Q Okay. What kind of inspections are done? Permit refer to that?
A Yes. It refers you to S5.A.
Q Okay. Let's take a look at S5.A. It's Page 31.
A Correct. And then S5.A says, "Clean and wastewater lines inspect daily."
Q And how does it say to inspect them?
A Visual inspection.
Q How do you inspect stuff visually underground?
A That was my point, that the permit does not really address a realistic inspection of underground piping because there's no way to know, based on a visual inspection, if the lines are leaking from the surface.
Q And in your experience on dairies in Washington, is the piping infrastructure underground?
A A vast majority of it, yes.

Q Sir, did you also prepare an expert -- supplemental expert report in this case?
A I did.
Q And if you take a look at A-2, please, is this the supplemental expert report that you prepared for this hearing?
A It is.
Q And what is the subject matter of the supplemental expert report?
A The main focus is ongoing groundwater monitoring program that has been conducted as part of the CD settlement on wells downgradient of the dairy.
Q When you say the CD settlement, is that the consent decree between CARE and the dairies in the case?
A That's correct.
Q And so there was a settlement consent decree entered between CARE and CFS and the -- each of the dairy entities that we've talked about in a cluster; correct?
A Yes.
Q And is that a lengthy document?
A It is.
Q Does it have a lot of detail in it?
A It does.
Q And a lot of requirements for the dairies to do things to -- to remediate and stop pollution coming from the

site?
A That's correct.
Q And is one of the -- one of the parts of the consent decree that there be a clean drinking water program established to provide people with contaminated homes alternative water?
A Yes. When we started, the EPA was requiring the dairies to supply water to some of the residents that had impacted wells. And then once the CD was entered into, the water supply and testing was part of that agreement.
Q Right. And so agreement between EPA and dairies had I believe it was one mile downgradient from the dairies that homes would be provided with -- tested and provided with alternative water, if necessary; correct?
A That's correct.
MS. HOWARD: Your Honor, I apologize for interrupting. I want to keep us moving as well, but I am concerned that a number of these questions are very much leading the witness and is putting into testimony things that are not being said by the witness, so I do have an objection, leading the witness.
JUDGE FRANCKS: Okay. I'm going to -- I'm going to allow you to lead, but I think we need to understand what his understanding of the consent decree is.

So to the extent that we talk about what he understands what the requirements are, that's the way to proceed.

Q (By Mr. Tebbutt) Okay. All right. And you understand that the consent decree had an expanded area to test and provide for alternative water to homes?

A I do. I was involved in the negotiation or setting of that expanded area out to -- instead of a one-mile radius, three miles downgradient of the cluster.

Q Okay. And did you assist CARE at all with helping to develop the protocols for testing homes?

A I did. We came up with a parameter list, identified the laboratory that we were going to use, and made sure that the samplers were trained by the laboratory to collect the samples.

MR. TEBBUTT: Okay. Your Honor, I'd like to move into evidence A-2.

JUDGE FRANCKS: A-2 is admitted unless -- do you have an objection?

MS. HOWARD: Your Honor, I think we continue to have a relevancy objection to this evidence as it relates to a very specific area and not necessarily to the issues before the board. So, yes, we do have a relevancy objection.

JUDGE FRANCKS: I'm going to overrule

that. I think that we'll just get as much information as we can in this case, and then the board can give it the weight it deserves.

(Exhibit No. A-2 admitted.)

MR. TEBBUTT: Thank you, Your Honor.

Q (By Mr. Tebbutt) We'll get back to that in a minute. I just wanted to have this in evidence in case we talked about it through our discussion here.

But let's now take a look at your expert report, which is A-1 in this case. And, sir, let's turn to Page 30 of your expert report.

Do you have that in front of you?

A I do.

Q Okay. And the section heading is "CAFO Permits Authorized Discharges to Groundwater in Violation of Washington's Antidegradation Requirements."

Do you see that section?

A I do.

Q And so that section comprises Paragraphs 51 through 61; correct?

A Yes.

Q Okay. Is it -- based on the information that you have collected at the cluster dairies and other dairies in the state of Washington, is it your -- what is your opinion about whether the dairies are causing or contributing to

groundwater contamination in the Lower Yakima Valley?

A To go a little bit back to what we talked about yesterday, this dairy cluster was selected by EPA for a couple reasons. One of the main reasons is that there's not other sources of nitrate contamination in the area.

I think we've heard testimony last couple days about not being able to differentiate between septic systems, wastewater treatment plants, and dairies, but this dairy cluster sits up at the head end of a groundwater float bath. There's no real sources other than five dairies, lagoons, application, and the operation.

So it's an opportunity to separate out dairies from a lot of background noise and look at exactly what's coming off of them.

In this location, we see groundwater impacts. The other interesting part of this location is, there's been a lot of discussion about shallow groundwater and deep groundwater.

This is a very deep groundwater system. Groundwater is over a hundred feet below the ground surface. So there's no chance that the water table is within the lagoons or any of the noise that we've been talking about enters.

And we still have groundwater concentrations below the application fields and below the lagoons that are in

the 200 part per million range.

So this is a really good example and a good case where we get to look directly at the dairy impacts to groundwater.

Q And, sir, you're familiar with the EPA report that was done in this case as well?

A I am.

Q And you just referred to that.

So how did the EPA report account for other sources of contamination in the area?

A There are sections in the report where they listed the other sources in the valley, and I believe they were septic systems and wastewater treatment facilities for local municipalities.

Q Okay.

A So they -- they added them up in the total input into the whole area, but none of these wastewater treatment plants sit within that dairy footprint, and there's literally a handful of septic systems that are within that footprint.

So the contributions from the other potential sources is very minor compared to what the dairy may be contributing.

Q As part of your duties in the Cow Palace litigation, did you do an assessment of the loading of the -- of nitrogen in the cluster area -- did you do an assessment of the

sources of loadings?
A I did.
Q And did you come to a conclusion about what the approximate percentages of loadings were from the dairies versus other sources?
A Yes, we did.
Q And do you recall what those numbers were, or would you need to look at your report?
A I would need to look at my report.
Q Okay. And that would be in the Cow Palace report, which is attached to A-1; correct?
A Correct.
Q So if you would take a look at A-1, the Cow Palace report, fairly lengthy report, and let's see if we can pinpoint this.
Do you recall where in the report that calculation appears?
A It's -- I think it's toward the back.
Q Well, while we're looking for that --
A In the -- can't find it right offhand, but the -- my recollection is that the -- if you look at the volume produced, Cow Palace or the dairy cluster, was 99.9 percent more than any of the other sources in that area.
Q Okay. Well, I think that's close enough.

A And we can -- you know, if you look at it at a -- just the raw numbers, typical septic system discharge is about a 100 to 150 gallons of liquid a day.

Cow Palace with 10,000 cows on the facility generates about 1.4 million pounds of waste a day. So that gives you a little bit of a flavor for what's being produced.

Q And, sir, raising issue of septics, are you familiar with septic systems?

A I am.

Q And tell the board what your familiarity is with septic systems.

A I've been working with -- working in designing septic systems since about 1993. There was some regulations in Montana that kicked in that required a much closer look at the type of septic on individual homeowners.

By about 2006, we had identified some areas within Montana, rather large areas, that were impacted by nitrates, and we started developing a secondary treatment for septic systems called the septic net to remove that nitrate from the septic discharge.

Q All right. Let's not go into it too far, but I just want the board to know that you're familiar with -- your expertise in human septic systems.

And so you're very familiar with human septic

systems?
A Correct.
Q Okay. And so when you made those calculations, it's not just based on some theory? It's based on years of actual field testing and understanding?
A It's based on the data we used to develop that septic system or we went and monitored individual systems, sampled, collected a lot of data.
Q And how much nitrogen is produced by a particular -- by a septic system versus one cow, for instance?
A I don't think I can break that one down without a little more analysis. I don't have those numbers off the top of my head.
Q Okay. But, generally, what's the -- does animal waste have more nitrogen in it than human waste?
A It does, yes.
Q Do you recall the approximate proportion?
A I do not.
Q Okay. Getting back to Page 30 of your expert report, A-1, can you just summarize what the conclusions are in this section, sir?
A In general, what this permit attempts to do is allow an acceptable amount of seepage through a liner that won't impact groundwater quality.
It is very difficult to discharge from a pipe, from

a treatment system, at a level that won't impact water quality.

So without a lot more knowledge about what's leaching out of the -- what's leaching out of the lagoons, what's going into the ground on the application fields, this is something you really can't say, "If I have a liner at ten to the minus six, then I'm protective of groundwater quality," because, one, construction techniques are difficult to control to that level; two, the operation of the lagoon over time changes.

These lagoons fill up with manure. They have to be cleaned. When they clean them, they actually dig up the liner with the equipment they use to clean.

So, in general, it's, I would say, impossible to come to the conclusion that this permit is protective of groundwater. There's too many variables.

Q Right. And, in fact, doesn't your experience show that -- well, as you said, it was impossible, but let's try it this way: Is it your opinion that a lagoon even built to NRCS standards will continue to pollute groundwater?

A It is. That's true.

Q And at -- at or above water quality standards?

A From what we've seen from our data, yes.

Q You talk a little bit about, I think, the liners being

removed.

Now, let's ask this: You were involved with designing some of the Cow Palace lagoons; correct?

A Correct.

Q And in designing -- and then implementation -- overseeing implementation of the double-lined leak detection systems?

A We did the design, worked with the EPA to get it approved, and then installed it according to strict construction QA/QC requirements.

Q Okay. And with respect to the first lagoon that you -- where you installed a double-lined leak detection system, what did you do to prepare that lagoon for installation of that system?

A The first step is to clean out all the manure that's accumulated and then excavate deeper to form the shape and the slopes that you need to put the liner in.

Q Okay. Describe for the board what was done specifically in that first lagoon that you did, how the lagoon was prepared for that installation of a double-lined leak detection system.

A Okay. So when we were hired by Cow Palace to start working on these lagoons, we had to look at the whole site from an engineering perspective, and that is, are they controlling stormwater? What are the stormwater

inputs? What are the daily wastewater inputs, where are all the piping is, and what we needed to change.

So the first thing we did is change the shape of the lagoon a little bit and change the inlets to filter a lot of the solids out of the stormwater going into the lagoon.

Q Let me interrupt. Did you deepen that first lagoon?

A Correct. That's where I was headed.

Q All right. Sorry about that. Go ahead.

A So the lagoon was about 12 feet deep when we started. Based on our calculations, Cow Palace definitely needed more volume than they had available.

So the first thing we did was steepen the side slopes. The requirement for liners is that you got a 3 to 1 side slope and then deepen the lagoon to provide more storage for the additional waste that they needed to handle.

Q So what happened when you deepened the lagoon? What was the process of deepening the lagoon? Was it essentially -- how far down did you go to deepen the lagoon?

A So in the first lagoon, the northwest catch basin, we went down about an additional five to six feet below the existing bottom.

Q And what did you find?

A Basically almost saturated ground conditions. So as we dug deeper, the soil was wet, and it was wet with waste material that had seeped down to the full depth of the excavation.
Q The full depth being six feet in that particular circumstance?
A Correct.
Q Okay. And did you run tests on any of that material?
A We did collect soil samples, but you didn't really need to because, as you dig and expose it, you can smell cow manure in the soil.
Q All the way down to six feet?
A Correct.
Q Are there different -- what was the makeup of the soil? What types of soil were underneath there?
A So the Yakima Valley is a -- what we call a Louisville deposition. The material was deposited by the river over the several last hundred thousand years.

And so what you see is layers of silt, layers of sand, layers of gravel, occasional layers of volcanic ash from probably Mt. St. Helens or Rainier or one of the volcanos. So you see highly variable soils with depth.
Q Okay. Did you see highly variable soils right near the bottoms of the lagoons before the -- before the excavation?

A Correct. So once the lagoon is scraped off and you're at depth, you can see one pocket that contained a lot of sand. One corner actually had a little bit more silt in it.

And we couldn't get the corner to meet compaction requirements because it was so wet that the -- the -- when the compactor went over it, it -- it became plastic.

So we ended up excavating more material out of that whole corner of that lagoon and bringing in good fill material that we could meet our compaction requirements with.

Q When you say it was kind of plastic, is that like squeezing a sponge and seeing water come out?

A Exactly.

Q Okay. And the lagoons, do you know if the lagoons that -- now, how many lagoons have you done at Cow Palace so far?

A We've completed two. We're on our third this year.

Q Okay. Do you know whether the lagoons were built to NRCS standards?

A We were -- we were told that they were all built to NRCS standards during the lawsuit, but we only found documentation on one of the lagoons at Cow Palace that had -- was an attempt to prove that it was built to standards.

Q Okay. So the second lagoon that you did, how big was that one?
A The second lagoon is a 25 million gallon lagoon, so as part of our analysis, we start working towards these liners.

It's cheaper to build bigger lagoons than multiple smaller lagoons just because of construction costs, so we actually combined lagoon two and three and four into one lagoon. So it's a rather large lagoon.
Q So is that deeper than the original lagoon that was there or lagoons that were there?
A It is. It's both wider and deeper than the original.
Q How much deeper?
A That one we went about 12 to 15 feet deeper.
Q Okay. And what did you find -- now, when you say 12 to 15 feet deeper, that's 12 to 15 feet deeper than the bottom of the liner that already existed, right, the so-called liner?
A That is correct.
Q And what did you find in that 12 to 15 feet below those lagoons?
A Again, we saw that same layered sediments, so there was silt layers and then good sand and gravel layers. But since it was a much bigger footprint, one of the things that we could see in the sand layers is staining.

And by that, I mean, because of the conditions at the bottom of the lagoon and the -- both the organic matter and the conditions, the sand layers actually got stained different colors.

One was a gray color, and you could smell the decomposition. One was a red color because of the iron oxidizing in that, and one was a black color.

Q Okay. And what do those different colors mean?

A Mostly the chemical conditions at the bottom of the lagoon, and it means that the -- the liquid from the lagoon is actually seeping into those sand layers and migrating along.

Q And what was the moisture content of the material that you saw down below?

A It's not -- it's not saturated because it's drained, but it is wet. But geologists wouldn't describe it as moist to wet, so more than field capacity. Definitely free draining.

Q So when you say -- I'm a lawyer, not a scientist, so when you say "field capacity," what does that mean in terms of the transport of water and nitrate down through soil?

A So when soil is at field capacity, it has a moisture content that is at such a level that water is actually not moving through the soil.

So once you're below the ground surface deep enough

where you don't have the evaporation or root uptake, the water will sit -- or the soil will sit there, and it's damp.

And the best way to think about it is, if you put in another drop of water at the top, it will move through that column and another drop will come out the bottom.

So the soil isn't fully saturated, but it's wet enough that any input results in an output.

Q So kind of like a full glass, if you will? If you add a drop, it will overflow in a sense?

A Similar.

Q Not quite, because it comes out the bottom?

A Correct.

Q You're a geologist; correct?

A That's my background, geological engineering.

Q And you're also a hydrogeologist?

A Correct.

Q And you also have lots of experience in fate and transport of chemicals?

A Yes.

Q So did you sample any of the material down in the bottom of that Cow Palace lagoon?

A We did collect samples, yes.

Q And what did you find?

A Very high organic nitrogen, which is the solids that are

within the liquid.
Q So manure solids?
A Manure solids.
Q Okay.
A Very high ammonia initially. And then as you excavate deeper, you find higher nitrates because the ammonia converts to nitrate.
Q And when you say "very high," can you give us some numbers? Approximations?
A Yes. I don't have that data in front of me, but on the order of hundreds of parts per million nitrate.
Q And that was at 12 to 15 feet below the bottom of the lagoon?
A Correct.
Q What does that indicate to you?
A That there's significant seepage from these lagoons that hits down towards groundwater, even lagoons that are designed or said to be designed to the NRCS standard.
Q Right. Is there any question in your mind that these lagoons are causing or contributing to water quality standard violations in the Lower Yakima Valley aquifer?
A No.
Q And, sir, in your experience, is this the most extensive work that's ever been done on the bottom of an operating lagoon?

A It's definitely the most extensive work I've done. I know there's been some other studies dating back to the '90s where they have sampled the bottom of lagoons. Most of what I'm talking about is well known and documented literature.

Q But are you familiar with any studies that have actually dug 12 to 15 feet down below a lagoon and done what you've done?

A I am not.

Q So it's -- let's take a look at A -- I'm sorry. Not A. It's Figure -- R-15, Page 18, I believe it is.

Oh, I'm sorry. It's -- I'm sorry. It's Page XVII, which is PDF 19 of R-15.

Looks like you have the evidence in front of you?

A I do.

Q Okay. And this is, what, a picture of a nitrogen cycle basically?

A Yeah. Depiction of the nitrogen cycle.

Q Okay. And did you do one as well for -- as part of your slides for this case?

A I did.

Q Okay. And does yours differ at all with the one that we see here?

A It does a little bit, yes.

Q Okay. And how does it differ?

A So this is really what --
Q Do you have your laser pointer with you today?
A I do.
Q Okay.
A This is really what we've been talking about as far as mineralization, nitrification, denitrification. It's a really good depiction of what actually happens in the subsurface.

There's a few arrows missing on this one that are important, however. You have to realize that, if nitrogen is applied perfectly to the soil, then the cycle continues where it's used by the plants, harvested in the grass, but any overapplication results in this leaching component right here.

Q Okay. So you said there was some other arrows missing. Are there other arrows where you would have arrows? In fact, you did in your own demonstrative exhibit?
A Correct. So if we're talking about a site with a shallow groundwater table, instead of a deep groundwater table, then the ammonia component can leach directly to groundwater.
Q Okay. Again, explain the nitrogen process here a little bit more detail using this -- this figure.
A All right. The manure is applied at the ground surface, and it leaches into the soil where it's either uptake --

uptaken by the roots or moves down deeper into the soil. So with a perfect application, the roots and the plants use the nitrogen for growth.

With any overapplication or over-irrigation, then the nitrate gets down below the root zone.

Q Okay. And so you're an expert in nitrogen cycle as well and understand the nitrogen cycle?

A I do understand the nitrogen cycle.

Q So when the manure is applied, what forms of nitrogen are available for the crops?

A When it's applied, it's typically organic nitrogen, which is the solid -- the solid portion, and ammonia. The liquid manure that sits in the lagoons is anaerobic, and a majority of it is in the ammonia form, so that's shown right here.

Q Okay. And then what happens to the ammonia as it sits in the soil?

A Once the ammonia is exposed to oxygen, it is converted to nitrite and nitrate. Nitrite is a very quick intermediate state, and then it becomes nitrate, which is more available to crops and used by crops for growth.

Q You said nitrite. Is nitrite a more -- as far as drinking water is concerned, is nitrite a more dangerous substance than nitrate?

A It does have a lower MCL. It does have more risk. It's

a higher risk to drinking, but it's not present for very long in the conversion system.

So it's fairly rare to see nitrite. It's only under very specific conditions.

Q You see some nitrite in the monitoring wells under the cluster?

A We do.

Q And that's, again, at 100 feet sometimes those wells?

A They vary from over a hundred to about 30 feet, yes.

Q Okay. And the ammonia -- when the ammonia is present, how does it convert to nitrate and what ratios?

A Almost evenly.

Q So, in other words, one part per million of ammonia would become one part per million of nitrate?

A Correct. I don't believe there's a big difference in that conversion. The difference is, is that -- there's another technical term that we need to talk about -- is the ammonia is absorbed through the soil much stronger than the nitrate.

So we use a term called a partitioning coefficient, and what that is, is it tells you how much that compound is going to partition to soil versus how much is going to partition to water.

So what's very interesting is, the ammonia -- and not so much in this example, but in the lagoon example,

the ammonia is going to be tightly bound to that upper few feet of soil under the lagoons. It's tightly bound to three or four, five feet below the lagoons.

Once it's exposed to oxygen, it becomes nitrate. Then the partitioning coefficient goes to zero, which means the soil is not going to absorb any nitrate. It's going to move the soil moisture down through the system.

That becomes -- I'm going to talk about that quite a bit more today because it's very important under the lagoons on why we only have -- or why we have two or three hundred parts per million nitrate -- or ammonia under the lagoons or in the soil, but we only have five or six parts per million nitrate.

It's because that soil is holding that ammonia, and it's releasing that nitrate.

Q Okay. So the nitrate then moves, as you said, with the water through the vadose zone?

A Correct. It moves with the water.

Q Moves with the water to the vadose zone.

And where does it end up?

A Again, it ended up in the groundwater.

Q Okay. Is there any question that it ended up in the groundwater?

A There's probably a slight question, but if we had to summarize it, 99.9 percent of it ends up in groundwater.

Q So a little bit of it might do, what, denitrify?
A Might be hung up in a perched groundwater level -- layer. May denitrify. May be absorbed by organic matter in the subsection.

So there's a very small percent, but, for the most part, nitrate is very mobile. I think you heard the last witness say you could use chloride as a tracer because it's conservative, and it moves through the soil with no attenuation.

The next most conservative tracer is nitrate. It also moves very quickly. The only loss of nitrate is usually uptake by the plant. So once it's below that root zone, it's gone. It's headed down.

Q And you've heard some talk about denitrification.

Is there any conditions that you've seen in Eastern Washington where denitrification is likely to occur?
A Yes. I believe denitrification does happen, but it doesn't happen efficiently. So, again, though it's happening, it's not a large component of the total equation. It's really why I brought up the septic net and the septic system development.

So what we do with septic net is, we have reactors on four different reactors. The waste flows in as ammonia in the first reactor, and we aerate it, and there's a specific microbe that changes the ammonia to

nitrate.

Then we go into basically an empty reactor, and we settle out those bugs that do that, and then we go anaerobic.

Once you go anaerobic, it's a different set of bugs that require more organic carbon, and they convert nitrate to nitrogen gas and oxygen.

So this is a highly controlled environment where we're looking at pH dissolved oxygen, organic carbon, and we're enhancing the growth of those bugs artificially.

While that may happen under lagoons, it only happens in very specific areas, and I don't think it amounts to -- I'm sure it's less than 1 percent of the total conversion.

Q Okay. Let's take a look at Page 33 of your expert report, A-1. You have that in front of you, sir?

A I do.

Q Okay. And what is that subsection entitled?

A "The CAFOs Permits' Affluent Limitations for Groundwater Discharges is Unenforceable and Violates the Monitoring Requirements of WAC 173-226."

Q Okay. And the section that discusses this comprises Paragraphs 62 through 68 to your report; correct?

A Correct.

MS. BARNEY: Ecology would like to

object to the portion of the expert report here to the extent that it's drawing legal conclusions.

JUDGE FRANCKS: Do you have a response?

Q (By Mr. Tebbutt) Sir, in your expertise, do you interpret regulations?

A Unfortunately, every day.

Q And in what context do you do so?

A Most of my career is focused on reading regulations, complying with regulations, designing either remediation systems or lagoons according to regulatory requirements.

Q Okay. So the kind of regulatory requirement you're talking about here, WAC 173-226, is the kind of regulatory requirement that you deal with on a regular basis?

A Correct.

MR. TEBBUTT: Okay.

JUDGE FRANCKS: So I'm still deciding on the objection.

MR. TEBBUTT: All right.

JUDGE FRANCKS: That was your response to the objection?

MR. TEBBUTT: Just laying a little more foundation, yes.

JUDGE FRANCKS: Okay. I'm going to

allow that testimony.

Q (By Mr. Tebbutt) And, sir, Paragraphs 62 through 68, are they essentially describing why groundwater monitoring is necessary in the permit?

A Yes, they are.

Q And tell us why groundwater monitoring, in your opinion, is necessary.

A The permit seems to be set up in a manner that says, if we only input X into the soil or infiltrate Y through the lagoon liner, then we're only going to have this effect on groundwater, but --

Q Let me stop you there. Do you believe those assumptions in the permit are correct?

A I do not.

Q And please explain why.

A A lot of it goes back to the nitrogen cycle that we just talked about. It's very difficult to control a natural system where you've got a conversion of ammonia to nitrate.

You've got nitrate mobile moving through soil moisture. You always have varying moisture soil inputs because of precipitation, the timing of precipitation.

So the real question for this section is, can we say that this is limiting impacts to groundwater to -- let's just leave it at impacts to groundwater first.

And we can't. We know this is going to impact groundwater. We don't know how much it's going to impact groundwater, and the only way to tell that is to actually monitor the groundwater.

Q But we do know that the impacts are significant enough to violate the water quality standards, right, the maximum contaminant level for nitrate at ten parts per million?

A The sites that we've worked on, the impacts from lagoons, application field, the facility itself, have impacted groundwater to above the standard and sometimes 20 times the standard.

Q And so we talked about in the conceptual model yesterday the different constructions: animal pens, compost areas, the piping infrastructure, the lagoons, and application fields.

Are they all contributing sources to the problem?

A They are.

Q And we talked about the varying levels, so we won't go through that again, but they're all at different levels, but they're all contributing to the problem; correct?

A Correct.

Q And so in order to address that kind of a problem, what would you do? How do you address those different sources?

A Really, the only way to do it is to control the source

and monitor. So when we're talking about application fields, we need in-field monitoring that tells us what's going on beyond the one-foot level.

We've heard different testimony on you need two feet. You need three feet. We're doing a lot of soil sampling at this area cluster, and we're seeing the response to changes in application rates very quickly.

But the only reason we're seeing that is because we're monitoring, and the only reason we can control that is because we're monitoring, so we can answer the question, how much can I put on the field without leaching into the vadose zone, if you will.

Similar to lagoons, the only way to control a lagoon is actually put down an adequate liner, and that means a liner that we're not guessing, a liner that's not designed to leak, and a liner where we're not guessing what's moving through the system.

Q And in your career, you've looked at lots of different industries that have earthen lagoons; correct?

A Correct.

Q Have you ever found one that isn't impacting groundwater, in your experience?

A No, I have not.

Q And you've done site investigations for industrial facilities; correct?

A Since about 1988, yes.
Q And what kinds of industrial facilities? Have you inspected earthen lagoons?
A Municipal landfills, hazardous waste landfills, lagoons at coal-fired generator sites with different types of waste, a couple of different Superfund sites, acromion manufacturing facility. There's a list of them that -- you're testing my memory on basically.
Q Yeah. I think you talked yesterday about phosphorous too; correct?
A Yes. Some of the processing facilities in the Soda Springs, Idaho, area.
Q Did they have earthen lagoons?
A They did 20 years ago.
Q Okay. And do you believe that earthen lagoons are the industry standard for protection of water quality?
A Not even close.
Q How long have they -- when was it, in your experience, earthen lagoons were not appropriate technology?
A Well, different industries have come to that conclusion over time. In the '80s we were working on municipal landfills where we did have a two-foot compacted clay and actual clay requirement.

And the construction -- in order to meet that construction quality, it's very difficult. When you're

laying that clay down and it rains one day and you've got too much moisture in the clay, you can't meet the requirements.

That is really why they invented the geosynthetic liners because we can put a decent base underneath it nice and smooth so there's no rock to poke through it, and we can lay a GCL down in a matter of hours, and then you've got a lagoon that doesn't leak.

Q And the GCL technology has been around for how long? About 20 years, you said?

A At least 20 years. Became more popular in the early '90s, and now it's used everywhere.

Q Did you bring a sample of GCL liner with you today?

A I did.

Q Do you have it handy?

A So there's multiple products today.

Q So how many different products do you have with you today?

A Probably four or five.

Q All right. Can we stick with one just for purposes of simplicity today? Let's not spend too much time on all the different ones but just pick one of them.

How many samples of one do you have with you?

A I have four, five.

MR. TEBBUTT: May we hand the board a

copy of --

JUDGE FRANCKS: Have other parties seen all of this?

MS. BARNEY: No, Your Honor, we haven't. We were just about to register an objection.

MR. TEBBUTT: They're just demonstratives.

JUDGE FRANCKS: I think we're outside of the relevance. I mean, I understand that there are liners, and I think you've established that.

MR. TEBBUTT: All right.

Q (By Mr. Tebbutt) So you talked a little bit about the types of technologies.

Is it more expensive or less expensive, in looking at all the impacts to the environment, to put in protective measures such as a lagoon detection system, or is it cheaper to remediate the pollution when it's already happened?

MS. HOWARD: Objection, Your Honor. Foundation. We haven't established the foundation about costs in any way.

JUDGE FRANCKS: I'm going to sustain that objection.

Q (By Mr. Tebbutt) So are you familiar with the costs of prevention versus remediation?

A I am.
Q Okay. And have you -- in your career, have you spent time assessing those different costs?
A I have on a lot of sites. A lot of the lagoons you're talking about, the earthen lagoons, we were hired to come in and do the investigation to determine what leaked, how far it went, and how to remediate it.

So we've put in remediation systems at multiple sites. And then on the same token, we went back in and repaired that lagoon or changed the liner system in that lagoon so that it no longer contributed to that problem.
Q So what's the first step you do in dealing with known discharges?
A First step is always source control. So it doesn't make a lot of sense to try to clean up the groundwater plume or the impact until you've eliminated the source that's contributing.
Q Okay. And then can you take a look at Paragraph 69 through 71 of your expert report. You discuss the cost of remediation of contaminated groundwater there in your expert report?
A I do in general.
Q Okay. And what are your conclusions?
A That prevention is always cheaper. If you can eliminate the source or eliminate the impact in the first place,

it's much cheaper than any type of remediation.

Q You heard Dr. Keeney testify earlier today about the cost of remediation and the feasibility of remediating a large aquifer like the, for instance, Lower Yakima Valley aquifer near the cluster dairies; correct?

A We did. I think he said it's impossible.

Q Do you agree with that?

A I believe it's impossible to remediate a back to background conditions. I believe it's possible to remediate it to back to drinking water standard where it was historically.

Q And what would be the approximate initial cost of stopping the pollution versus trying to remediate it once it's already out there?

A I don't have an exact number, but remediation is orders of magnitude more expensive than prevention.

Q Thank you. Let's take a look at Paragraphs 72 -- yeah, 72 through 85 of your expert report. Starts on Page 37.

And -- this section is entitled "Surface Water Monitoring should be Required in the CAFO Permits"; correct?

A Correct.

Q And this section, again, comprises Paragraph 72 through 85 of your expert report?

A Yes.

Q Tell the board your general conclusions about why surface water monitoring should be required in the CAFO permits.
A It's very similar to my position on groundwater monitoring. If you don't know what's being discharged and what the impact is, you don't know how your site is performing.

And by that, I mean, the dairies can't know what they're discharging if they're not sampling.
Q Yeah. Let me just stop you there. Like, for instance, one of the terms of the permit is thou shalt not discharge in amounts that violate the water quality standards; correct?
A Correct.
Q Is there any means in the permit to determine whether they're discharging in violation of the water quality standards?
A Not without monitoring either surface water or groundwater or both.
Q Sir, if you could take a look at Exhibit A-67, I'm going to change topics here for a second. Page 199, start to get that in front of you, and I'll ask you some background questions.

How would you compare -- well, let's start this way: How many dairies in Eastern Washington have you been on?
A At this point, ten to twelve.

Q Okay. And how many have you seen in the Lower Yakima Valley?
A What do you mean, seen?
Q Well, I mean --
A Drove by?
Q Driven by, let's say.
A Thirty to fifty.
Q Okay. And how would you compare the operation, at least visually, the operations at Cow Palace versus the other dairies that you've seen in the area?
A Cow Palace, from my observations, is a much better run facility than -- than any of the other facilities that I've been on.
Q Okay. And you're familiar with Judge Rice's decision, aren't you?
A I am.
Q And did he find that the Cow Palace facility was causing or contributing to an imminent substantial endangerment to public health?
A He did.
Q I'd like you to take a look at very quickly A-67, Page 199, and also 201 and 203. So I'm going to ask you just to take a quick look at those.
A Okay.
Q And are these graphs representative of the soil

post-harvest nitrate in application fields at the Cow Palace facility, the first one?

A They are. This is based on the field monitoring that we've been doing, so we can see the label at the bottom. You've got one-foot, two-foot, and three-foot samples.

And on the X axis, you've got 400 pounds of nitrate per acre in the soil at the one-foot level, 250 at the two-foot level, and from here, it looks like a little under 150 at the three-foot level.

Q And these -- this testing started as part of the administrative order of consent in dairies and EPA in 2013?

A Correct.

Q That's why it starts in 2013?

A Y axis is in years, so you've got 2013, '14, '15, '16, and our latest data for '17.

Q Okay. And in 2015 was when the consent decrees between CARE and the dairies were entered; right?

A Correct.

Q Okay. And let's take a look at the next page, Page 200.

Are these --

MS. HOWARD: Your Honor, I apologize. I would like to renew our objection to this exhibit.

This document actually was not provided to us in the exhibit list, so this is actually the first time we're

actually reviewing or understanding what this documentation is.

And so I'm just a little concerned about the timing here, in that we're having extensive testimony on a document that we didn't see until the exhibit list.

MR. TEBBUTT: Well, this was provided before -- you know, the exact same information was provided in discovery. So I don't understand what the problem is.

These same reports have been provided multiple times. Each annual report has the very same information in it. It was divulged in discovery early on. These are the EPA reports. They had access to them since the beginning of this case.

MS. HOWARD: This particular document is -- I think is a draft. It's dated March 1st.

And, again, the first time we saw this document including this graph that we were just looking at was on -- when we got it on the exhibit list.

MR. TEBBUTT: And it's already been admitted in evidence.

JUDGE FRANCKS: I am going to allow some questions, but I will warn you that I think we're on the edge of relevance here. I think that we have -- we've established that there's a problem.

MR. TEBBUTT: Yeah. But you can't -- one of the arguments that industry is making about relevance is that just looking at a couple of dairies doesn't translate to all the rest of them.

And so this is a very relevant topic and a critical topic for this because, as Mr. Erickson just testified, Cow Palace is one of the best facilities. So we shudder to think at what the rest of them look like, so there's --

JUDGE FRANCKS: I'm allowing you to question. I'm just saying, I don't think we need to spend more hours of testimony on this.

Q (By Mr. Tebbutt) All right. Let's look at Page 198.

Is that a picture of the Cow Palace -- well, describe what's in -- on Page 198.

A So that's a map view of the dairy cluster area, and the picture is showing Cow Palace property in purple.

Q Is that really more kind of grayish up there?

A It's purple on the map or blue on the map.

Q Doesn't translate as well up there.

A The yellow is Bosma, and the -- it's actually red on the page, but it does look more purple. There is the DeRuyter dairies and those are the application fields for those three dairies.

Q Okay. So Page 198 goes with 199 and the Cow Palace data

field application data?
A Correct. Then 199, which is the average residual post-harvest nitrate, is an average of all of those fields put together.
Q Okay. And same with -- looking at Page 200 and 201, do 200 and 201 go together?
A Correct. 200 is just showing the specific fields within Bosma that are being monitored --
Q Okay.
A -- where manure is being applied and monitoring is occurring.
Q Okay. And then 202 and 203 go together with the DeRuyter facility?
A Yes.
Q Page 202 and 203?
A That is correct.
Q Okay. And did you prepare a slide that has the comparison of the three facilities side by side?
A I did.
Q Okay. And, sir --
MS. HOWARD: Your Honor, we're going to -- I might have just jumped in front of Ms. Barney. But we've already -- these are the slides you've already ruled may not come in as demonstratives we're looking at right now.

MR. TEBBUTT: They're already in evidence, Your Honor.

MS. HOWARD: I'm going to object. I'm sorry.

JUDGE FRANCKS: So I'm confused. Ms. Howard, you think they're not in evidence?

MS. HOWARD: They are not -- the slides that we're looking at right now I believe are the PowerPoints you ruled were not coming in as evidence, the late demonstratives.

JUDGE FRANCKS: Right. I remember that.

MS. HOWARD: So that's what we're looking at right now, so I'm objecting on those grounds.

JUDGE FRANCKS: So where is this in what I've admitted?

MR. TEBBUTT: This is in that slide show, but we have proven that these three --

JUDGE FRANCKS: Okay. Where --

MR. TEBBUTT: Just a minute, Your Honor, if I may for the record.

These three documents are already in the record. This is just a slide that, for ease of the board's consideration, can show the three next to each other.

JUDGE FRANCKS: And if I said you

couldn't use it, then you can't use it.

MR. TEBBUTT: Well, that was before these documents were entered into evidence. This is now evidence in the case, and you're telling us we can't use it just for a simple couple of questions?

JUDGE FRANCKS: In this combination, no.

MR. TEBBUTT: Well, just makes it more difficult to present the case to the board when this evidence is already in.

Q (By Mr. Tebbutt) All right. Let's do a narrative then, Mr. Erickson. This will take a little longer now to do.

Let's take a look at 199 and have also accessible 201 and 203 of A-67.

How does the nitrate level -- and this is relevant to the question of how Cow Palace performs compared to Bosma and DeRuyter.

How does Cow Palace's -- or how do Cow Palace's fields compare to Bosma? Let's start with that.

A Okay. So the easiest way to look at that -- and, again, these are averages, so there's a lot of data that goes into these graphs, but the total pounds per acre at Cow Palace when we started in 2013 was about 400 pounds per acre.

Q All right. And what about at Bosma?

A So we go forward two pages. The total pounds per acre at Bosma -- we started in 2013 -- was over 700 pounds per acre, so roughly almost double of what the Cow Palace fields were.

Q And then let's take a look at DeRuyter, two pages later.

A And the total residual nitrate in the fields at DeRuyter was almost 900 when we started, and is now, after four years, is now getting down into the 500 range.

And if we go back one --

Q Sorry. Is that 300 or 500?

A I'm going to split the difference with you. It looks like 400.

Q And, again, this is a compilation of the fields; right?

A If we go back one slide, we can see a little bit more. So this is the -- so Page 202 shows the DeRuyter fields individually.

And you can see that, since monitoring has occurred and since there's been efforts being made to reduce it, you can see pretty good reductions in concentrations in all fields except one. One is often backed up because of overapplication.

Q And where is that one located in respect to the actual dairy operations?

A So the two DeRuyter dairies sit right here and right here, and the field that's popped back up is the field to

the east. (Indicating.)

But the big point is that, while these look like they're showing good decreases, we are still above this very high range in the current permit.

So there's a red line -- it might be yellow. It looks like red up there. It's 45 parts per million on all of these graphs, and you can see they are all above that very high risk in the permit.

MS. HOWARD: Your Honor, I can't talk. I'm sorry. I'm going to object again on relevance.

So we are now talking about more dairies that have apparently testing that's in the very high range that the permit actually has addressed specifically.

So I'm trying to be respectful here and, again, not interject too often, but my concern is that we, again, are just very, very far away from the actual permit terms and the actual issues in the case and how this information is relevant to those issues.

So that was a long way to say relevance objection. I apologize.

JUDGE FRANCKS: Mr. Tebbutt?

MR. TEBBUTT: Yeah. I'd like to add to this that Mr. Jennings testified these are all similar activities. The general permit is supposed to cover similar activities. These are all similar activities.

So these are some of the biggest dairies in the state, and they are terrible performers. They are causing significant problems to groundwater.

And Cow Palace being the best, these are similar activities, and so it's directly relevant and contradictory to Mr. Jennings' testimony, among other things.

MS. HOWARD: Your Honor, we -- may I respond?

JUDGE FRANCKS: You may respond.

MS. HOWARD: Okay. Thank you.

We have not established that these permit -- or these dairies are actually working under the terms of the CAFO permit. We have not established that these dairies are even operating under the terms of a nutrient budget.

So we are not in the realm of talking about information that are relevant to the terms of the permits.

Again, concern is relevance at this point and also just concerns about time too.

JUDGE FRANCKS: So I am going to sustain this objection. I think that we have gone beyond relevance to the 2017 CAFO permit and its terms.

I understand that you want to go back in time and I've seen that you've gone back in time. This is in our

evidence, but I don't think we need to belabor it.

MR. TEBBUTT: The point is, it's still going on in 2017, so it's directly relevant to what's going on now.

JUDGE FRANCKS: Okay. And we have that and we've talked about that.

MR. TEBBUTT: All right. If the board members feel they have enough, then we'll move on.

JUDGE FRANCKS: If they don't, they'll ask.

MR. TEBBUTT: All right. Very good.

Q (By Mr. Tebbutt) Let's take a look at A-1, Page 128. Sir, in your Cow Palace report, you talked about erosional features; correct?

A Correct.

Q And there's been some discussion, I believe Ms. Redding -- you heard Ms. Redding testify about erosional features and her being aware of them only in, like, the sides of lagoons; right?

A Yes.

Q Have you seen erosional features in the bottom of lagoons?

A I have.

Q And is the photograph on Page 128 an example of erosional feature that you've seen in the bottom of the lagoon?

A It is. It shows basically a washout all the way from the inlet pipe all the way down into the bottom of the lagoon. There is liquid in the bottom. There is a better example of that in these pictures.

Q Okay. And is that on Page 158?

A It is. So if you look at this picture, this lagoon was emptied and lined per NRCS standard with data that suggested that the liner met the spec.

And what you see is inlet pipes. There's two of them here. You can probably see them better on your screen than you can on the projector. And down from those pipes, you see erosion of that liner all the way to the bottom of the lagoon.

And that was really one of the points I was trying to make yesterday, is while we talk about this as being a clay liner, this is not clay. It's basically silty sand with maybe a little bit of clay in it, or a silty material, even gravelly, sandy clays and silts.

So the spec is not hard to meet, but it's not -- it's not a clay liner, per se.

Q Right. And so these erosional features, have you seen these in multiple lagoons?

A Just about every lagoon we look at.

Q So what happens to the permeability level of one times ten to the minus six when you see those erosional

features?

A So if you achieve one times ten to the minus six with the liner and it's eroded off, then you're down to the permeability of whatever the natural soil is, which is probably higher than that.

Q So you're familiar with some of the soils in the Yakima Valley area.

What are the permeability ranges of those soils?

A Some of the good gravels out there will go ten to the minus two, ten to the minus three, and on that scale -- and I a little bit misstated the scale yesterday too. The scale actually goes from one to ten to the minus twelve, not zero.

So when you're in the ten to the minus two, ten to the minus three range, that is a really good aquifer that produces irrigation quantities of water.

In some of these zones that we're seeing out here are in that area, a lot of the more near surface stuff are probably in the ten to the minus four to ten to the minus five range.

Q Okay. So, in other words, when you see these erosional features, you're well above permeability of one times ten to the minus six?

A Correct. And that's what's represented in the model like with the other lagoons in this case.

Q Okay. Let's take a look -- before we head there, let's take a look at Page 161.

Is this another example of erosional features that you're discussing?

A Yes. So this is a really good example of a -- what we see typically at these lagoons. One, you can see that discharge pipe kind of top middle of the page; two, you can see naturally occurring layers of soils here, so there is no liner to speak of on top of that material; and then, three, you can see the manure and the erosion down through below that pipe.

What you can't see is right where this tractor is parked, there's a large stormwater component that comes in from the left to right, and this whole area here is also eroded.

So the edge of the lagoons are -- typically show a lot of erosion, some vegetation growth, not things that are conducive to a ten to the minus six.

Q Right. So we talk about, you know, one -- being built to one times ten to the minus six or one times ten to the minus seven, that's all great theory; right?

A Correct.

Q But, in practice, isn't this what happens every time you see them?

A This is typically what we see, and what you have to

realize that these lagoons fill up with manure, depending on the size, every year to every five years, and the dairy has to have a maintenance program to clean out the manure solids.

And they go in and maintain them. They go in with front-end loaders and scoop the manure out, and there's no way to differentiate between removing manure and removing whatever liner they built in there, so every year to five years when they clean these.

Q If they do?

A If they do, they're back to that ten to the minus six permeability, no manure seal, and every year they're losing some of that liner to the cleaning.

Q So you don't even know then at that point, once you've scraped that liner, whether you're even meeting one times ten to the minus six; correct?

A Correct. Because you don't meet compaction. So you don't know how much of the liner you've removed. As far as I know, nobody has ever checked.

Basically what we've seen in most cases is, there's really no visible liner when we go to rebuild these lagoons.

Q And in the Cow Palace case, in the determination that Judge Rice made, what was the permeability factor that he used to determine that Cow Palace was discharging from

its lagoons over three million gallons a year?
A So he used the ten to the minus seven permeability.
Q He used the most conservative number; right?
A Correct. So in the -- the three million gallons is a little -- it sounds like a lot, but when you use the ten to the minus seven calculation, it literally comes out to 924 gallons per day per acre of lagoon.

And these dairies don't have one lagoon. Some of them have five, six lagoons. Some of them have 20 lagoons.

Q How many acres of lagoons does Cow Palace have, approximately?
A I believe when we started, Cow Palace had about 14 acres of lagoons. By the time the engineering is done and the lagoons are built properly to handle everything that they're going to have to handle, which we had to remove seepage from that equation because now with the liners, they're no longer going to seep.

So that's a component to that. We're probably going to be 15 or 16 acres of lagoons, and they're going to be deeper than they previously were.

Q That was my point, the 15 or 16 acres is surface area; right?
A Correct.
Q But now you're also deeper?

A Right.
Q And some of the Cow Palace lagoons in the old days were -- how deep was the deepest earthen lagoon?
A I believe lagoon one is right at 30 feet deep.
Q And so we talked about hydraulic head yesterday. I think -- or Ms. Redding talked about hydraulic head and Darcy's law and the driving forces of water through a permeable system; correct?
A Right. So if we go back to that three million gallons a day that -- the assumption that the judge used is, you've got ten to the minus seven permeability and nine feet of head. So the NRCS standard lagoon comes out at -- with a diagram that says nine feet of liquid.

I don't have any idea why they did that, but that was the assumption that we used in the calculation. Now if we had 18 or 20 feet of head, that three million gallons goes up linearly with head.

Q And so also if the discharge is at one times ten to the minus six -- or the permeability is at one times ten to the minus six, the discharge would be one times three million; right?
A Correct.
Q And ten to the minus five, it would be ten times that, or 300 million?
A Correct.

Q Are you also familiar with a concept called preferential pathways?
A I am.
Q And what is that? Please explain to the board what preferential pathways are.
A We make the assumption that the lagoon seepage coming out of that liner is even everywhere. We say homogenous and isotropic. Those are two words that just mean it's uniform and doesn't vary over -- in any direction.

But what really happens and what we've seen at Cow Palace is, you've got these sand layers or naturally occurring permeable pathways. Sometimes it's root zones.

Q Let me ask you to just move the microphone a little closer.
A I'm moving away from the microphone.
Q Yeah.

MS. HOWARD: Your Honor, I'm sorry. I should have jumped in earlier, but, again, just going to object on foundation here.

We are using "typical" and "always" and those sorts of comments a lot here, and what we haven't done is establish that this actually is typical or common across dairies.

And so, again, I'm going to object on the grounds of foundation on this question.

JUDGE FRANCKS: I'm going to overrule that objection.

But I am going to ask now if this would be a good time to stop for lunch or do you have a few more questions?

MR. TEBBUTT: Just a couple more on this particular line of inquiry, and then I think it would be a good time to break.

JUDGE FRANCKS: Okay.

Q (By Mr. Tebbutt) So I -- we were interrupted. Talking about preferential pathways. Please continue.

A Okay. So the big point is that this flow doesn't occur uniformly and changes in the subsurface, which there are many, cause areas to flow a lot more or seep a lot more than other areas.

So this is not a uniform front leaking from the lagoons.

Q Okay. And then just to address Ms. Howard's issue, you've now seen how many lagoons would you say in Eastern Washington, dairy lagoons?

A "Seen" is a tough term. Probably --

Q Well, let's say you've been on-site and seen up close, about how many?

A Probably approaching 70 lagoons at this point.

Q And Bosma has about how many?

A Bosma has 20.
Q And DeRuyter?
A Six.
Q Okay. And in terms of acreage, how much acreage of lagoons does Bosma have?
A I think total Bosma is probably approaching about 30 acres of lagoons.
Q And DeRuyter?
A Probably closer to 15.
Q Okay. So, again, preferential pathways, is it kind of like the bathtub effect? I mean, water is going to find an easier flow path; correct?
A Yes.
Q And so if there's an erosional feature in a lagoon, it's kind of like the bathtub. Isn't it the water going to flow to that area, flow out where it can?
A It does. More water is going to flow out of that area than is flowing out of the rest, or seep in this case.
Q Right. And is that a reason why a particular lagoon may not have saturated conditions under it uniformly?
A Correct.
Q And explain a little bit more of that concept for the board, please, and then we'll take a break.
A Again, we go back to the idea of these lagoons seeping uniformly. If there's a -- if there's an area that has a

higher permeability, then you're going to have a lot more seepage moving through that area.

Whereas, if you have an area of lower permeability, there's a lot less seepage. So what that does is, it affects -- think we've talked a lot about -- we don't know how long it takes for contamination to get from a lagoon to a monitoring well. That's because we don't know all of the pathways that are in between the two locations.

Now, in general, we do. We know what the groundwater flow direction is. We know the depth of the water, but specifically there could be units within the subsurface that make this happen a lot faster than we would predict.

Q And you drew up some diagrams of that, that you're just narrating right now, correct, in your slide show?

A Correct.

MR. TEBBUTT: Okay. We would ask, Your Honor, that you revisit that issue and allow us just to use those diagrams -- either Mr. Erickson can use those diagrams or he can draw it on a board, but it would be a lot better if we used the actual picture.

JUDGE FRANCKS: The diagrams that I already said you couldn't use?

MR. TEBBUTT: That's correct. We're

asking you --

JUDGE FRANCKS: No.

MR. TEBBUTT: -- to reconsider that.

Okay. All right. Well, let's take a break for lunch.

JUDGE FRANCKS: So let's be back at one o'clock.

MR. TEBBUTT: Thank you.

(Recess from 11:55 a.m. to 1:00 p.m.)

JUDGE FRANCKS: Have a seat. And we're back on the record after lunch, and I've asked the parties to give me an estimate of how much longer their case will take from now.

Who wants to go first?

MR. TEBBUTT: Well, as we have our witnesses going right now, I would suggest that Mr. Erickson will likely go until -- we're going to close to midday break with him.

JUDGE FRANCKS: Okay.

MR. TEBBUTT: And then I didn't get a chance to talk to counsel about this, but the idea of trying to stipulate to some of the issues that Mrs. Reddout would talk about that are kind of really more background things.

If we could get those, then we wouldn't have to call her, but I would like if -- if we need to call her, I would like to call her first thing tomorrow morning. And that shouldn't take more than a half hour.

JUDGE FRANCKS: Okay. And that was going to be by phone?

MR. TEBBUTT: Yes. But I know -- I don't think it's going to be all that effective, so I'd like to try to get a stip, if we can, and I'll talk to them on break, but then our case in chief is in.

JUDGE FRANCKS: All right.

MS. NICHOLSON: Well, we haven't had a witness on yet, and we think it will probably take two days.

JUDGE FRANCKS: Okay. And you will -- do you have -- you have Harrison, Haggith, and then you've listed Reck.

Do you anticipate doing more with that deposition?

MS. NICHOLSON: There may be one or more two pieces we just want to call to the Court's attention, but that wouldn't take very long.

JUDGE FRANCKS: Okay. And then Lindsey, Neibergs, and Wood?

MS. NICHOLSON: Right.

JUDGE FRANCKS: Okay. Just making

sure. All right.

And, Ms. Barney?

MS. BARNEY: Yes. Just to correct the math a little bit, I think Ecology has the most issues in this case since we're forced to respond to all of them.

JUDGE FRANCKS: So true. So true.

MS. BARNEY: But, you know, our case in chief is sort of half in at this point. We anticipate -- I anticipate potentially as much to an hour with Mr. Erickson on cross and then two hours with Mr. Moore and Mr. McGowan, and then potentially time for rebuttal.

JUDGE FRANCKS: Okay. Yeah. Is everybody including cross-examination in their estimates?

MR. TEBBUTT: I was saying, no, just for my direct of Mr. Erickson will probably go close to 3:00 today.

JUDGE FRANCKS: Okay. What kind of cross do you expect to have of the dairy people?

MR. TEBBUTT: Well, it kind of depends. I mean, their export reports don't have much in them, so if they go outside of them, it depends on objections and how they're ruled upon.

If stuff is allowed in, then we'll have to spend more time. If it's not, then it won't take terribly

long. We'll expect crosses not to go more than half an hour to an hour on each witness.

JUDGE FRANCKS: Okay. And were you building that into your two days?

MS. NICHOLSON: I was hoping to, yeah.

JUDGE FRANCKS: Okay. All right. Okay. That's good information for me. I'm going to think about that and see what that looks like.

All right. So let's carry on.

DIRECT EXAMINATION (Continuing)

BY MR. TEBBUTT:

Q Mr. Erickson, before we get into your hydrous model, which is a demonstrative that was going to be allowed to be used, I wanted to just ask you: You were here when Mr. Jennings testified that, from his perspective, he had heard that lagoons were in good shape.

Do you remember that testimony?

A I do.

Q Is it your experience that the lagoons that you have seen are in good shape?

A You know, there's a mix of lagoons out there, but I can say that most of the lagoons that we've looked at don't meet any type of specification that I can imagine. So my conclusion would be that they're not in good shape.

One of the things that -- in other industries, we

see like a regular inspection process that looks at potential breaches in the dikes, liner condition, way of action, and some type of monitoring to determine if they're leaking or not. And in this case we don't see any of that.

Q All right. Now, are the pictures that we've showed today in Exhibit 1, Pages 128, 158, and I believe 161, are they representative of the shape that a lot of the lagoons are in that you've seen?

A I think they present a pretty good cross section of what we've seen in the field.

Q Okay. Let's take a look, sir, at your hydrous model, which is a demonstrative --

MR. SNYDER: Your Honor, may I approach the witness?

JUDGE FRANCKS: Is there something that we get to look at?

MR. TEBBUTT: Oh, yeah. You'll get to see it too. It will be on the screen, but you guys also have the better version of this on your own screens.

JUDGE FRANCKS: Which is where?

MR. TEBBUTT: It will be coming up just a second.

JUDGE FRANCKS: Which one is it?

MR. TEBBUTT: It's the demonstrative

DeRuyter. That was the one that was allowed in.

JUDGE FRANCKS: And is it in our electronic exhibits? It's not on your exhibit list. We don't have it in front of us.

We can all look at it on the screen.

MR. TEBBUTT: Yeah. Just doesn't show up as well. Can we dim the lights?

JUDGE FRANCKS: Sure. We can close more blinds.

Q (By Mr. Tebbutt) Okay. Now, before we start this, please explain to the board what we're about to see, Mr. Erickson.

A So obviously the lagoons' seepage rate and leakage rate has been a topic of conversation and argument.

Q Can you get the microphone a little closer to you, please. Thank you.

A So obviously lagoon seepage or leakage is a topic of conversation in a very important point in this permit.

So during the litigation for Cow Palace, we decided to model actual seepage from the lagoon, given site parameters that we collected during the investigation.

We wanted to get a clear picture of how fast this moves from the subsurface, how much moves through the subsurface.

So we used a model that's called hydrous, and when

we're talking about groundwater flow. We're talking about saturated flow. When we're looking under a lagoon where you have seepage and a liner. We're talking about unsaturated flow. So we're talking about flow around the soil pores that are underneath the lagoon.

This model -- the algorithm for this model mimics that flow and allows us to put site-specific conditions in.

Q And you were deposed about the hydrous model, were you not?

A Couple times.

Q And in this case too?

A Yes.

Q Okay. All right. Why don't you run it and stop it in various places and describe for the board what is depicted in this model.

A All right. So this was specific to one of the lagoons in the dairy cluster, and we started with a liner that -- the E to the minus six is ten to the minus six centimeters per second permeability.

And the reason we keep talking about centimeters per second is because that's a standard measurement. It could be feet per day. It could be centimeters per year.

We can change that unit to better understand -- in order to have people better understand the units, but

it's standard in our industry.

Q Can you describe what that conversion is, centimeters per second or feet per day or miles per year or whatever --

A Yeah. Just an example to make it a little more realistic, ten to the minus six centimeters per second under standard conditions equates to about 30 to 35 centimeters a year of migration.

So we're talking about a liner that has water migrating through it at a rate of 30 to 35 centimeters per year.

Q And a centimeter is about, what, two inches -- or no. The other way around. There's --

A Two and a half centimeters per inch. So we use very specific site conditions and soil characteristics for the model.

And keep in mind that this is unsaturated flow, so it's -- the units are a little different.

THE WITNESS: So it's not on your screens?

JUDGE FRANCKS: No.

A Okay. So what we have is a lagoon liner that's ten to the minus six, and we have soil conditions that are ten to the minus four.

And we've put a clay layer in here that's ten to the minus seven because at this site we've seen a lot of

layering and we wanted to model what would happen if you encountered a layer.

What's really difficult to see is, there's little red dots all along this liner, at least it's difficult from back here, and those are particles.

So we're going to do some particle tracking. We're going to let this -- the conditions of the lagoon with nine feet of liquid run over time, and we can watch how fast the particles get to groundwater.

And, of course, this is speeded up. Otherwise, we'd be here 30 days to watch this --

Q (By Mr. Tebbutt) Before you hit that, I just want to ask just a little bit more background so we can sort of head off potential cross as well.

What -- you mentioned nine feet of water in the lagoons. What other facts did you insert for the variables?

A So we've got a ten to the minus six two-foot soil liner, and we've got a one-foot by one-foot washout or breach in that liner that puts us down into the native soil.

And that's similar to what we've seen in the pictures where the waters wash the liner away or it's missing.

The other thing we have is DeRuyter, the upper DeRuyter dairy. It's about 100 feet to groundwater. So

the distance from the top of this liner to groundwater table right here is 30 meters, which is roughly 100 feet.

Q All right. Continue, please.

A Okay. So what we want to -- when we run this forward, I'm going to run it just for a few days so we can see where the breach is and what starts coming through the liner.

So within a few days, you start seeing liquid form or seep underneath that breach in the liner.

Q Let me stop you there for a minute. At the bottom of that little brown area, as it appears on the screen, is the red dot -- is that what we're following from the surface?

A Yes. So that particle of water was inserted via the model into that breach, so we're going to track how fast that's moving through the breach, but we've also got red dots all along the liner so we can take a look at seepage through the liner itself.

There's also a red dot, a particle, underneath this clay lens. We wanted to see what the effect of the clay lens was on overall transport times to groundwater.

So I'm going to run it about ten days, and you can see the -- of course, the particles have started to move. The one is actually moved on to the top of that clay liner, and it's starting to spill over. This represents

preferential pathways.

We're trying to show that it's not just the seepage that causes the problem, but it's what's in the subsurface that makes it difficult to interpret how fast it moves and at what concentration it gets there.

Q Let me stop you for just a second. When it's ten to the minus six permeability, that's just at the lagoon liner. Once it gets below that, the permeability is much higher; correct?

A Correct.

Q Much faster?

A Yes.

Q Okay. Go ahead.

A So it went a little bit fast, but you can see over here that within about 20 days, the seepage from the lagoon liner went 30 meters deep, impacted groundwater.

And this -- what's important about this is, it's the moisture that carries the nitrate. The ammonia is still going to be hung up around this liner.

What you're also seeing is very important is that after that 20 days, you start to see this light blue halo form around the liner. That's actual liner seepage that's occurring at the same time.

So we have a leak or a breach in the liner, a washout, that's leaking the majority of liquid, but the

ten to the minus six liner is still leaking significantly.

Q And it leaks up along the side walls as well as the lower areas; is that correct?

A Yeah. If you want to get really -- real technical look at it, you can see more of the light blue right under the bottom of the liner. That's because there's more head pressure.

And as you go up the side of the liner, there's less seepage because of less head pressure on the side of the liner than the very bottom of the liner.

Q But there's still seepage from those areas?

A Correct.

Q I want to ask you -- I just forgot the question. Keep going. I'll see if I remember.

A The other thing you can see here is a few of the dots. The particles along the liner have started to move, so that's another indication of seepage. The one directly underneath has moved further than the ones on the side.

The particles that came through the clay layer are sitting out here in front, and, of course, they're reaching groundwater slower than the direct conduit to groundwater.

So after 40 days, the particle that went through the clay layer hit groundwater, and you can see that there's

several or quite a few other seepage channels that have also impacted groundwater.

Q And so the lagoons that we're talking about here, for instance, DeRuyter, which is related to this funnel, those lagoons have been in place for decades; correct?

A That's correct.

Q So they reached -- they started discharging to groundwater decades ago?

A Yes.

Q And they're still discharging today, as we speak?

A Correct.

Q Still contaminating like today, hitting the groundwater and contaminating the water that thousands of people drink from?

MS. HOWARD: Objection, Your Honor. We have not laid the foundation for this at all.

JUDGE FRANCKS: I'm going to sustain that objection.

But I don't think we need to lay the foundation because I think we're beyond relevance as well, so --

MR. TEBBUTT: Really? The groundwater that's contaminating thousands of people is beyond relevance to the permit?

JUDGE FRANCKS: The contamination at DeRuyter based on the decades of one lagoon is outside

the relevance of the issues before the board today.

MR. TEBBUTT: Okay.

Q (By Mr. Tebbutt) And Cow Palace lagoons have been in operation for decades?

A Yes.

Q And the Bosma lagoons have been in operation for decades?

A Yes.

Q And as far as you know, most of the dairy lagoons in the state that were built in the 1980s and 1990s and 2000s would all be discharging to groundwater, as we speak today; correct?

MS. HOWARD: Objection, Your Honor. Again, lacks foundation.

JUDGE FRANCKS: I'm going to sustain that one too, because I think we've gone beyond the dairies that he's been talking about earlier today, so -- but, as I say, don't lay the foundation.

MR. TEBBUTT: I'm creating the record. That's all I'm doing here.

Q (By Mr. Tebbutt) All right. Keep going, please. So -- okay. You go ahead.

A So then all that happens going forward is, we run it out to about 120 days, and what you get to see is that the particles of what used to be on the liner have moved down to groundwater and out laterally from the lagoon.

The more saturated zone has continued to transmit liquid with nitrates to groundwater, and so at this point we're -- at steady state conditions almost all the particles that we put up there have reached groundwater.

Q Okay. Thank you.

Now let's move on to some of the actual impacts.

JUDGE FRANCKS: If we're done with that, can we turn the lights back on?

MR. TEBBUTT: Sure.

Q (By Mr. Tebbutt) All right. Mr. Erickson, let's take a look at Page 62 of your report, A-1.

A Okay.

Q You have that in front of you?

A I do.

Q And what is Table 7?

A So it is a table of cumulative groundwater data for two of the monitoring wells for multiple parameters from 2013 up to 2017.

Q Okay. And let's take a look at one of the particular wells. Let's see. Hang on just a second.

So Table 7, the complete list of the wells, again, this is cluster dairies; correct?

A Yes, it is.

Q The complete list of all the wells' cumulative information goes on for a number of pages. Goes on, on

Page 62 to -- goes on to Page 94; correct?
A Correct.
Q Let's just take a look at DC-03. What is DC-03?
A So DC-03 is the label for one of the monitoring wells at the dairy, kind of in the center of the cluster, downgradient of some of the Bosma lagoons.
Q Okay. And what are the nitrate levels, just quick highlight, from January 2nd, 2013? What's the nitrate level in DC-03?
If you could use your laser to point to it up on the screen, that would be helpful.
A Right here it's 190 parts per million nitrate. (Indicating.)
Q Okay. 190 parts per million.
And then let's look at DC-03 for June 4, 2014.
A So that's a few steps down. It is --
Q 234?
A -- 234. And the reason you collect this data is because there's cycles in groundwater, and so this -- not only do the concentrations change over time, depending on the inputs, but so do the water levels, the elevation of groundwater table.
So there's variation throughout the year and throughout larger seasonal fluctuations, and that's why we collect multiple data points.

Q Yeah. And that reminds me, one of the data points that's collected is the water elevations in the wells; correct?
A Correct.
Q And you've reviewed that?
A I have.
Q And that's in this report, correct, the water elevations in A-67?
A It is.
Q And what does that groundwater elevation data reflect, the fluctuations in the groundwater data?
A It indicates a change in how much recharge is reaching groundwater compared to how much groundwater is flowing away from that location. So it's a net change in groundwater elevation over time.
Q Does that also reflect -- is that an indicator of movement from the surface to the groundwater?
A It is.
Q In terms of recharge?
A Yes.
Q And so how quick -- I mean, have you been able to draw any conclusions about how quickly the surface activities impact the groundwater through the data that's been collected over the last four or five years?
A It -- a lot of times it depends on the well location, but in the case of the clusters, we have multiple wells that

show an almost immediate reaction to the irrigation season.

As soon as they start irrigating on the application fields, the groundwater table goes up on the order of two, three, four feet, and as soon as they quit irrigating, it goes back down.

Other --

Q So it's showing then seasonal, like, within a couple of seasons impacts, not multiple years, but the impacts can be seen within a couple -- within a year, within a couple of seasons?

A The water table elevation fluctuations appear to be able to be seen within weeks. It's a very immediate response. There's other wells that are slower to respond, so it depends on where you're at on the site.

Some of the wells respond to filling of the canals, the irrigation canals. Some of the wells respond to larger precipitation events. It just depends on what their recharge area is.

Q And irrigation is another potential driving source; right?

A Correct.

Q Okay. All right. Let's take a look at -- and just keep this in mind, this graph here, because we're going to switch to a visual now.

And let's look at A-1 -- sorry -- A-67, Pages 186 and 187.

You have that in front of you, Mr. Erickson?

A I do.

Q Let's take a look at 186 first. And describe for the board what's depicted in Figure 4.

A All right. So this is a -- the background is a figure that you've already seen as far as application fields. There's three different dairies. Again, yellow is Bosma, blue is Cow Palace, and purple is DeRuyter.

The leaders all point towards the monitoring wells around the site, and then the boxes show nitrate values for four quarters of monitoring in 2017.

Q Okay. And let's take a look at DC-03 for 2017, bottom left of the figure; correct?

A So the data for DC-03 is -- sits right here. The well itself sits in this location, and just for a little background, the Bosma dairy sits right here. (Indicating.)

Q Okay. So that's the Bosma dairy and Liberty dairy is just a little further up to the left?

A Liberty is right here. (Indicating.)

Q And those are -- they have same manure management constructs; right? They use the similar lagoons? They transfer from one lagoon to the other, that sort of

thing?
A Correct. Their lagoon system starts right in this area, and then there's a pipe that transfers over to approximately 15 lagoons that sit right in that area there. (Indicating.)
Q And then they go as far down as where?
A They end about -- let's see. They end a little past DC-03, right about there.
Q And how far is that from the Sunnyside Canal?
A It is directly adjacent to the canal.
Q All right. And the numbers starting in the first quarter of 2017 are 179; second quarter, 181; third quarter, 192; fourth quarter, 207, correct, for DC-03?
A That is correct.
Q Okay. And let's take a look at YVD-11, fourth one down on the right-hand side.
A So that's the data here.
Q Right.
A And the leader --
Q And describe where that is in relation to the dairies, please.
A So YVD-11 is directly downgradient of an application field that sits right here and dairy that sits right in this location here. (Indicating.)
Q And that's the DeRuyter; right?

A Correct.
Q Both the application field and the dairy are right there; correct?
A Yes.
Q And what are the numbers in YVD-11?
A They range from 77 in quarter 1 to 97 in quarter 2, 103 in the third quarter, and 84 in the fourth quarter of '17.
Q Okay. And there's a little J next to -- where it says Q3 for YVD-11. There's a J next to that.

Can you describe what that J means?

A The J's are usually a qualifier from the lab that tells you that there was -- there was something that was off with the QA/QC during the lab analysis.

So they usually qualify the data and say -- let me find that again. The 103 has a J next to it. So they say the best estimate of the concentration is 103, but it's not as accurate as if the analysis was perfect.

Q So there -- it might be a variation of about what percentage? Do you know?
A It usually depends on the -- on what happens. You have to look into the lab data, but usually it's no more than a few percent.
Q Okay. Thank you. Is there similar information for phosphorous?

MS. HOWARD: Your Honor, I'm going to object, again, on relevance grounds how individual results of these particular dairies pertain to the issues in this case.

JUDGE FRANCKS: Okay. I'm going to overrule that. I think you can proceed.

A There is. On Page 187, we have the exact same background figure, but instead of just nitrate, we have the -- all the nitrogen products that we've been talking about, ammonia nitrate, nitrate, probably a new one, total Kjeldahl nitrogen, and phosphorous listed.

Q (By Mr. Tebbutt) Okay. And has phosphorous been detected in a number of wells at the cluster dairies?

A Yes. I think -- I think all of the wells have detected some level of phosphorous.

Q And what does that indicate to you, sir?

A That, in itself, is just an indication that there's -- there's low levels of phosphorous in the groundwater.

Q Okay. Is it unusual to see phosphorous in groundwater that deep?

A We typically see some level of phosphorous in the groundwater. So as a comparison, your example of YVD-11, which is right over here, while the nitrate is 70, 80, and 100 parts per million, the phosphorous is actually in fractions of a part per million, and that's because it

doesn't migrate through the soil as readily as nitrate.

But if we look at the data as a whole, you'll start to notice that the higher phosphorous numbers correlate with the higher nitrate numbers.

So even though the concentrations are much lower, it's an indication that we're seeing higher phosphorous in the same areas we're seeing higher nitrate, and that's an indication that we have some breakthrough nitrate for groundwater.

Q And breakthrough phosphorous as well?

A Excuse me. Breakthrough phosphorous to groundwater along with the nitrate.

Q And, sir, as part of your work in Cow Palace case and this case, have you reviewed studies by the U.S. geological survey about how the aquifer here in the Yakima Valley interacts with the Yakima River?

A I have.

Q And tell us what you understand the connection is between aquifer and the Yakima River.

A As with most rivers, the groundwater levels start off high in the valley, and groundwater flows down towards the river.

And in the case of the Yakima River, ultimately groundwater discharges to surface water either in -- along the tributaries or in the river itself.

Q All right. And we know all of us who have lived here or in Washington and been to Eastern Washington know it doesn't rain there a whole lot, so is the Yakima River dependent on groundwater for its perennial flow?
A It is.
Q And the phosphorous and nitrate that's in the groundwater that's under the cluster dairies, is that going to eventually reach the Yakima River?
MS. HOWARD: Objection, Your Honor. Lacks foundation. We haven't established in any way what the hydraulic continuity is between the groundwater and the surface water in this particular example.
JUDGE FRANCKS: I'm going to sustain that objection.
Q (By Mr. Tebbutt) Mr. Erickson, you've reviewed Mr. Tebb's deposition transcript, haven't you?
A I have.
Q And Mr. Tebb came to the conclusion that the Yakima -- the groundwater table in the Yakima Valley also impacted the Yakima River, didn't he?
A I believe he did, yes.
MS. BARNEY: Objection. Mr. Tebb has not been offered as any kind of expert with regard to hydrogeology other than the fact that he's the hydrogeologist and his deposition is just that.

MR. TEBBUTT: His highlighted testimony speaks directory to this point.

JUDGE FRANCKS: I'm going to allow it.

Q (By Mr. Tebbutt) And so, sir, what are your concerns about -- well, nitrate and phosphorous are so-called nutrients; right?

A Correct.

Q What does the term "nutrient" mean in this context?

A It's basically a food source for different plant types.

Q Do nutrients cause any particular effects on surface water?

A They do. Typically -- most surface water systems are actually phosphorous limited, which means they have a lot of nitrates in them, but they don't necessarily support plant growth or alga blooms until they have enough phos to add to that nutrient mix.

So in most cases, the nitrate, again, is migrated through the system faster, has entered surface water faster. And when you really start seeing problems is when the phosphorous starts coming through the system and adding phosphorous to the surface water body.

Q Okay. Let's take a look at A-74 real quickly, please. And, particularly, I'd like you to look at deposition pages -- or starting at deposition Page 64.

You have that in front of you?

A I do.
Q And is deposition Page 64, Line 12, through deposition Page 62 -- 66, Line 22, the discussion about the interrelationship between the Lower Yakima aquifer and the Yakima River?
A It is.
Q Okay. Thank you.
So you heard me question Ms. Redding about the concept of whether she knew what the concept of mounding was.
Do you recall that?
A I do.
Q And, sir, what does the concept of mounding mean to a hydrogeologist?
A Similar to what we discussed about the groundwater table, the groundwater elevation is changing over time. If you have a leaky pipeline, an irrigation ditch, any water source at the surface that seeps down through to groundwater table, it actually mounds on top of the groundwater table.
You're adding more water to a system that can only flow so much through the permeable material, that additional water to that system causes the groundwater table to rise.
Q So essentially backing up --

A Correct.
Q -- in a sense?
Could you draw for us on that piece of paper what the concept of mounding is, and I'm going to give you a couple of parameters to use for your drawing.
So I'd like you to start with drawing the bottom of a lagoon or what -- you know, just the side view of a lagoon. Okay. And then let's draw a water table at two feet below the bottom level of the lagoon.
A (Witness complies.)
Q Okay. So can you draw two feet separation like an arrow from the -- two feet. Okay.
A (Witness complies.)
Q And please draw for us what you were just describing, concept of mounding. How does that influence --
A All right. So we just looked at the hydrous model that shows a little bit of seepage from the sides, and we'll use a bigger arrow to show additional seepage from the bottom. We know that occurs because there's more head.
So as these -- as the water seeps down into groundwater, what happens is, the groundwater actually starts to mound up, and depending on the permeability of the subsurface, the more water that seeps, the higher the groundwater mounds similar to what we see if we have, like, a small creek or a river that leaks.

There's two different kinds of rivers: one that is losing to the groundwater table, so the groundwater table is lower than the river, and the river is seeping out into the water table; and then the other one would be one that's gaining so that the groundwater is recharging the river table -- the river. So your water table would look like this when you know you have groundwater going into the river.

So the Yakima River looks like this, flow off the highlands down into the valley that recharges the river flow. (Indicating.)

Q Okay. And so there's been discussion -- you can sit down, if you'd like.

There's been discussion about an NRCS requirement for two-foot vertical separation between the bottom of a lagoon and the water table; correct?

A Correct.

Q In your experience, when a lagoon leaks like a lagoon that's built to NRCS standards with one times ten to the minus seven, is mounding going to occur?

A Yes.

Q How many lagoons in your career have you investigated that have the mounding effect under the earthen lagoons?

A Almost all of them. Right now we're working on a project that some of these -- some settling ponds where we have

data from the designers back in the '80s and '90s where they came in and sited these ponds, dug holes in the bottom of the ponds, measured groundwater elevations to be ten or twenty feet below the pond, built the liner.

These ponds have been full for ten, fifteen, twenty years, and now our groundwater elevation has come up 30 and 40 feet from the leakage from those lagoons mounded around them.

Q So above the bottom left foot of the lagoons themselves, as you've depicted in your picture?

A Much above the bottom level. Almost to the actual elevation of the lagoon.

Q And you've studied some of the Whatcom County groundwater elevations, haven't you?

A I have.

Q And how shallow is the groundwater table in much of Whatcom County around the dairies that you've looked at?

Speaking of dairies, I'm talking about studies, not actual on-site stuff; correct?

A Right. Some of the studies I've seen have groundwater elevation above the bottom of the lagoon. Matter of fact, most of the lagoons that Dennis Erickson investigated have groundwater evaluations that are at or above the groundwater lagoon.

Q Dennis Erickson is no relation to you, as far as you

know, is he?
A Correct.
Q All right. Well, let's take a look at R-11 and specifically Page 36, which is PDF 46.
It's actually right here. Engineers never listen to lawyers anyway, and vice versa, I would say.
A What were the page numbers?
Q Let's start with Page 36. That's the number on the bottom of the page. Do you have that in front of you?
A I do.
Q And are you familiar with the -- R-11, the study that was done by Dennis Erickson?
A I am.
Q And you've read it both for the Cow Palace litigation and for this case as well?
A That's correct.
Q Tell us what's significant about figure -- the figures on this page.
A So if you -- the bottom figure is a plan view of the dairy. You can see the barn, the lagoon, the silage pit.
The top figure is a cross section, and it shows similar to what I've drawn here. Maybe I'll give him a little credit. It looks a little better than what I've drawn. You can see the lagoon right here.
You can see the monitoring wells that he installed

on both sides of the lagoon and water supply well up above the lagoon, and he shows the geology that he encountered in the subsurface.

So we've got silt and clay in the upper 25 feet. We've got a gravel layer at about 25 feet. And the wells are installed through the silt and clay into the gravel.

However, the water levels within those wells are shown by the little tick marks up around the lagoon with a date next to them.

So that triangular -- upside-down triangle is a symbol we use for water level or water elevation.

Q So the water level is basically right at the level of the bottom of the lagoons?

A It looks to me like on one -- the bottom measurement, which is at the same date -- it's right at the bottom of the lagoon and the second monitoring, which I can't see the month -- it was in '92 -- is actually up above the bottom of the lagoons into the lagoon itself.

Q Okay. Now, let's take a look at Page 41 of R-11, which is PDF 51.

And, sir, let's -- this was Table 1, the summary of waste storage pond design and construction.

Do you see that?

A I do.

Q And the one discussed here is the Sheridan Dairy, Lewis

County?
A Yes.
Q That's what we were just referring to back with Figure 31 on Page 36?
A Yes.
Q And is there anything you disagree with about the information that's contained on that line about Sheridan Dairy?
A There is. He says 25 feet to groundwater, or separation distance from the lagoon to groundwater is 25 feet. And that is not true.

What we -- if you read the report, he used a different drilling method. There would be water levels up in those clays that he bypassed, went down to the sand and gravel.

I believe that if he would have completed the wells in the upper water table, you would see contamination from that lagoon too, impacting the groundwater table.
Q Why do you believe that?
A It's based on my experience with lagoons, the fact that the water table is within the lagoon itself, and they know what is in that lagoon and seeps out of that lagoon.
Q So the well then was screened at a much greater depth?
A Correct.
Q So what happens when you screen like that?

A Then you only collect water from the area where that screen is to sample. So his water samples were from 25 feet below the lagoon when we know the lagoon seepage would have been right adjacent to the lagoon in that case.

Q So that would dilute out the potential impacts as well?

A You never see the impacts because they'd actually be floating above the open area of the monitoring well.

Q Okay. And when the nitrate hits the top of the water table, what's the -- how does it react with that top of the water table generally?

A Typically it -- when the nitrate hits the top of the water table, that's where the highest concentrations of nitrate are and then dilutes out from there, going slightly deeper in the aquifer but mostly running along groundwater flow direction in the downgrading area and spreading out from there.

Q So if you're taking a sample down from 25 feet, you're not going to see that impact; right?

A You're not going to detect the impact.

Q And if it's actually -- if the water from the whole 25 feet is sampled, then -- in some kind of a representative way, it's going to show -- it's going to be diluted from what the impacts are at the top of the aquifer; correct?

A That is correct.
Q All right. Let's take a look at -- oh, so, just to bring this to conclusion, that study, the Erickson study, said that one lagoon was not impacted by nitrates from the lagoon, right, or there wasn't enough information to determine whether the groundwater was impacted by that?
A No. He said that that lagoon did not impact groundwater.
Q Okay. And do you disagree with that conclusion?
A I do.
Q All right. Now let's take a look at R-20. This is the so-called Baram study.

Do you have that in front of you, sir?
A I do.
Q And is this a study that you have studied?
A It is.
Q And did you study it both in connection with the Cow Palace case and with this case here before this board?
A I believe I did see it during the Cow Palace case.
Q And the Baram study is -- there is actually kind of a series of work that's been done by Baram in Israel; correct?
A That's correct.
Q And they're all -- the site that is studied is all Israel; right?
A Yes.

Q Did the Baram studies conclude that dairies were not causing an impact to groundwater?
A They did not.
Q In fact, they concluded that there were impacts to groundwater from the dairies; right?
A That's correct. That they were the major source of nitrate contamination in the area.
Q Okay. And where -- is there someplace in that report that is of significance to you in this discussion that indicates that? Maybe look just to your right there.
A So the Baram study is -- he's worked through several studies of lagoons.
Q Are you looking at a particular page, sir?
A I'm working up to Page 1629. 1629.

He's worked through a couple of different studies of lagoons, trying to find out how they leak and what happens when they do leak.

And this is one of his latest work that talks about actually sampling the soil and pore water on the way down to groundwater to see what the concentrations are to see what the effect of lagoon seepage is.

So if I look at Figure 5 in that study, most of the -- most of the data in Figure 5 has to do with nitrate concentrations soil, and if you look at the data, for the most part, you can see a peak in nitrates and

then it tailing off in nitrates as you go deeper into the soil.

But what is apparent is, he included one data point right here at the bottom, which is the groundwater concentration under that lagoon, and even though the scale changes across the top, on the nitrate impact, the groundwater concentration is still somewhere around 100 parts per million, which is ten times the drinking water limit.

So even though the study goes to prove that you are degrading nitrate in subsurface through biological means, you still have highly impacted groundwater in the lagoons.

Q And that lagoon was much shallower than most lagoons you see in Washington, wasn't it?

A Correct.

Q How deep was it?

A I think it was only about six feet. I'd have to find that.

Q Might have been even a little less than that. Might have been a meter deep?

A I'd have to look for that.

Q Would you please just real quickly, see if you can find that.

A Yes. Based on Figure 1, it looks like it might be a

little over a meter, so maybe four feet deep.

Q So a lot less hydraulic head in that lagoon than in most of the lagoons you've seen in Washington?

A That's correct.

Q I do want to ask you about the lagoons in Eastern Washington.

You've spent a lot of time at the Cow Palace Dairy; correct?

A Correct.

Q And the operating lagoons, how often are they -- do they have -- over a period of time, how often do they have the significant amount of water?

A You'd have to define "significant."

Q I know. That's terrible language.

How often are they more than half full, let's say, a particular lagoon over the course of a year?

A If they're managing them properly, they're half full or greater for half of the year.

Q Okay. Let's take a look at A-1. Let's put that away. Put that one to bed.

Let's get back to A-1, Page 186.

Sir, yesterday and I think maybe even earlier today you talked about the compost area at Cow Palace.

Are these pictures of the compost area?

A They are.

Q Okay. And what's shown in the top picture on Page 186?
A So in the top you can see a pickup truck for scale, but these are mounds of compost that they're running through a screen in order to sell.

And then in the background of that, you can see rows of compost extending off about halfway through the picture.
Q Off into the sunset as they'd say almost.

All right. Bottom picture, what does that depict?
A So this is what we've been talking about. This is a geoprobe, so it's a hydraulic hammer that we drive into the subsurface to collect soil samples.

We are -- we have driven down between two compost rows, and we're collecting a soil sample in the -- in the compost area. You can see multiple people doing oversight on what we're doing and getting ready to sample.

What we talked about yesterday is that compost rows --
Q Sorry to interrupt you for a second.

Are those the National Inquirer paparazzi there, taking pictures of you doing that or --
A No. Just photographers.
Q For the dairies?
A For the dairies.

Q Okay.
A What was evident when we drove out there to do the investigation work is, when you actually put your tire tracks on the edges of those compost rows, it's saturated with liquid.
So that's water that's been within the compost, could have been 140 degrees warmed up and is seeping into the ground.
Q Through gravity; right?
A Through gravity, correct.
Q Okay. And so did you -- you sampled there obviously.
That's your machine, is that right, your rig?
A Correct.
Q And are the sample results reflected on Page 188?
A They are.
Q And that particular sample event went down how far?
A That one went to 18 feet total.
Q Okay. And let's -- let's talk about the phosphorous.
You see the phosphorous column there?
A I do.
Q And what does the phosphorous data indicate to you?
A So we have high phosphorous to start, and within the first two feet of the soil, we're up around 270 to 300 parts per million phos.
Then it decreases down into the 50s and mid-20s, and

then we see an increase in the layer from seven to nine feet that jumps back up to 400 and then another layer that's at 1900 parts per million.

Q So that indicates movement of phosphorous down through the soil column?

A It's an indication of movement of phosphorous, and it's also an indication of what we talked about earlier is that it doesn't move uniformly. It moves through preferential flow paths.

So we have high concentrations at the top. They decrease somewhat, and then we have another high concentration at the nine-foot level.

And what that tells me is that we get one boring this big with soil data. We don't know what's going on out from us laterally.

So we know that contamination is moving down to that depth somehow, probably hitting a layer, coming back under, and we just penetrated that layer and collected the sample at that location.

Now, it's still moving somewhere else, but we don't see uniform sampling all the way down because soil is not uniform.

Q Okay. And let's look at the ammonia for a moment, couple columns over. The ammonium levels at that same level where the phosphorous is, what does that indicate -- or

what do the ammonium levels at that level indicate to you?

A So we see a similar pattern with ammonium. We see a high concentration up top, and then in that same eight-to-nine-foot level, we see the ammonia bump back up to around 100, but over three feet as compared to the increase in phos.

And so, again, we know that there's a layer in that zone that's transmitting those contaminants somewhere.

Q And so the highest phosphorous level is also the highest ammonium level at the same eight-to-nine-foot level; correct?

A That's correct.

Q And so describe for us how the nitrate information relates to what we're talking about.

A So in this case, we don't see as much nitrate as we see in other borings, but that's because it's in the ammonia form. It hasn't converted yet.

There's some areas where you can see the ammonia concentration drop down to four and a half right here, and it correlates with the higher nitrate concentration, so --

Q Ammonia is converted, would you say, at that four-to-five-foot level?

A Exactly. What we're getting to see is chemistry in

action. We're getting to see that ammonia conversion to nitrate.

Q Well, then how do you explain, sir, the low numbers of nitrate as you go deeper?

A Then we have to look at the difference between ammonium and nitrate again with what we talked about yesterday with that petitioning coefficient. The ammonia is strongly bound to the soil. The nitrate is strongly bound to the soil moisture.

So while we have -- and these are soil samples. So what we're sampling is concentration in that four-ounce jar of soil, and what it's telling us is that there's a lot of ammonia bound to that soil, but when we sample the nitrate, we see only the nitrate that's bound to the pore water.

So the less saturated the soil is, the lower the nitrate number is. That doesn't mean it's not migrating. It's migrating in that soil moisture.

If you put all of the compost and pen data together, then it starts to make a lot more sense. There's areas where we see a really extensive layer of organics in the pens.

In those borings we see more ammonia underneath it in the subsurface because you don't have the oxygen. There's areas where we see no ammonia. It's all

converted to nitrate.

So it's really not as simple as saying the pens aren't the source. There's multiple things going on in these locations that should be looked at as a source and investigated.

Q So what did you consider to be AKART for compost areas?

A That's a tough question. We have worked for two different actual commercial compost operations that are converting human sewage sludge to compost.

And in those cases, they actually do the compost operation on -- in a concrete -- on a concrete slab. These are in a building because it's an area with a lot of rain.

They put pipes in the compost so that they can move the oxygen in and out and make it compost faster. They have a stormwater system to collect any leachate from the compost. The leachate is collected and then put back on the compost that needs more water to degrade.

So that would -- in my opinion, that would be one of the most protective ways to deal with compost.

Q Right. In the Cow Palace situation, what did you do for trying to reduce the loading to the groundwater from the compost areas?

A So we've -- we've instituted some different management techniques. One is to reduce the permeability of the

soil under the compost. So we've worked on compaction and additives.

Number two is to line all of the stormwater ditches and drains from the compost and get it into the lagoon system as fast as possible so that it's not infiltrating.

And then number three is to select locations that are -- that have more slope so you're actually -- the liquid that's coming out of the compost is running off and getting into a controlled environment faster.

Q So that will reduce the infiltration in groundwater; correct?

A That's correct.

Q But, in your opinion, it won't eliminate it?

A No. It's not -- it's not a complete solution.

Q And what's the compaction level that you need to achieve? Is there a term of art you use in your business for compaction that needs to be reached at the very minimum when you're doing a compost area like that? Is it to decrease runoff?

A Well, one of the -- it's not so much that you're trying to get a compaction. It's that you're trying to meet a permeability spec.

Q Okay. So what's that permeability spec called?

A If you have a goal or a standard that you're trying to meet, then you can test the soil and determine what level

of compaction you need in order to meet that permeability spec.

So in this case, we're trying to meet a 95 percent compaction in order to achieve that lower permeable soil.

Q Okay.

A The problem is, you know, this was part of a negotiation, and I'm really not happy with it because what you see happen is, they haul the compost out to the field or to the compost area, and the soil -- it's in the spring of the year. Everything is wet. Tractors are sinking in the mud.

Everything you've done to achieve that permeability and compaction gets destroyed just about every year. So I don't believe we've came up with an answer on how to address those compost areas.

Q Right.

A I believe we've come up with a step that needs to be taken further.

Q So you weren't happy with what the lawyers came up with in that consent decree as far as staffing the discharge to groundwater; right?

A That's correct.

Q Just want to circle back for a minute. AKART for lagoons, I think we've maybe talked around a lot of the issue.

But what's your opinion about what AKART is for lagoons, just so we're clear on the record?

A So currently at Cow Palace we're doing double-lined lagoons with leak detection, which, instead of just having one synthetic liner, now we have two synthetic liners.

And in the middle, we have a permeable fabric that would transmit any leak from the top liner to a collection system. So we know, if that top liner is leaking, then we can go in and fix it, and it's -- everything is captured between the two liners.

In addition to that, we have a fabric on the bottom that is a gas-fed system. When you build -- when you build these lagoons on existing lagoons, this is more of the engineering, but it directly relates to what's happening in the subsurface.

When you build a lagoon on an existing lagoon, there's a lot of organic material from the manure that's seeped into the ground, and once you cover it up with a liner, it starts producing gas.

It will actually bubble up the liner. So we have to put a gas-fed system underneath them just to protect from the venting.

So that is the specification for a hazardous waste lagoon liner, and I think that's a little more than where

we need to be. The silt or sandy silt liner is definitely less than we need.

So somewhere in between there is happy medium, and I think the medium may be around a true double liner or a true two-foot clay liner with a geosynthetic on top.

So I don't think we need to go quite as far as we went in Cow Palace, but we definitely need to go more than the specification that we're looking at in this.

Q And that technology that you're just referring to has been around for decades; correct?

A It has. We -- I did the first one of those in my career in about 1992. So it's common practice at this point.

Q And how many of those kinds of lagoons have you designed over the years?

A That's a good question. Probably total within our company -- definitely over a hundred. We're probably working on ten or fifteen currently.

Q Okay. And I know I asked you about surface water earlier, but are you familiar with tile drains?

A I am.

Q And have you seen tile drains in some of the work that you've done in Washington dairies?

A I have.

Q And how easy is it to monitor a tile drain for discharge?

A There's equipment available. It's a standard practice.

I think, as the last witness stated, it has to be automated. It's tough to collect in a rainstorm specifically. It's tough to be on-site.

Q All the time, but there is a lot of information available to do that?

A There is.

Q And the tile drains, you're familiar in your work the Clean Water Act compliance in lots of cases?

A Correct.

Q Dozens? Hundreds?

A Dozens.

Q Okay. And you're familiar with the term "point source"?

A Yes.

Q Is tile drain a point source?

MS. HOWARD: Objection, Your Honor. Calls for a legal conclusion.

MR. TEBBUTT: I think I laid the foundation.

JUDGE FRANCKS: I think he can testify about what his understanding is.

A I do believe that's a point source.

Q (By Mr. Tebbutt) I'd like to take a look at A-2. And this is your supplemental expert report in this case; correct?

A Correct.

Q And A-2 talks about the CARE drinking water project and some data and pictures related to the CARE drinking water project; correct?
A That's correct.
Q And let's look at Page -- oh, I just want to ask, before we get into that, this actually -- on Page 12 of A-2, you also talk about winter applications; correct?
A Yes.
Q And in relation to tile drains in particular, what we were just talking about; right?
A Yes.
Q So there's -- in A-2 are your additional opinions about surface water monitoring requirements; correct?
A Yes.
Q So let's take a look at Pages -- Exhibit B to your supplemental report, and particularly Pages 30, 31, 32, 33.

What are these numbers?

A So these are nitrate concentrations in groundwater from private drinking water wells around the downgradient of dairy cluster.
Q And so these reflect -- the nitrate numbers reflect whether somebody is above the maximum contaminant level or not; correct?
A Correct. These are actual data from people's drinking

water wells that they are drinking.
Q And so the CARE drinking water program makes people eligible for a reverse osmosis system to put on their kitchen sink when nitrates are ten parts per million or greater; correct?
A Yes.
Q In the reverse osmosis system, do they cover the whole house?
A They do not. Just what's coming through the kitchen sink. It's called a point of view system, so just that flow.
Q So if people were to drink out of the bathroom sink or the garden hose, they'd be drinking the raw nitrates unfiltered; correct?
A Correct.
Q And are the -- is the data that's reflected in these tables summarized on the figure, Page 35, Figure 1 of A-2?
A I think so, but it's very difficult to see.
Q It's very small, isn't it?
A Yes.
Q You created some other maps of plotting the points of the CARE drinking water project, didn't you?
A We did.
MR. TEBBUTT: Your Honor, I need to

find these. I know they're in -- have been admitted already. I don't know if we want to take a break for just two minutes.

JUDGE FRANCKS: I'm always happy to take a break. Let's take a ten-minute break. So we'll be back at 2:31.

(Recess from 2:21 p.m. to 2:32 p.m.)

JUDGE FRANCKS: Have a seat. We are back on the record after a break.

Mr. Tebbutt, you may proceed.

MR. TEBBUTT: Thank you.

DIRECT EXAMINATION (Continuing)

BY MR. TEBBUTT:

Q Mr. Erickson, I want to ask you -- before we turn back to A-2 and A-1, I just want to ask you a couple questions about your familiarity with the Whatcom County water table.

Are you familiar with that?

A I am. Looked at several studies from the area and reports.

Q What do you understand to be the depth of water in general? I know everyplace is different in a specific area, but, in general, what's the water table like in Whatcom County?

A Because of the amount of rain they get, the water table is a lot more shallow than it is, at least in the dairy cluster area of Yakima. Quite often right at the surface.
Q And just a couple feet below?
A Couple feet below, yes.
Q And you've seen lagoon studies that indicate that water table is very close to the bottoms of shallow lagoons as well?
A In many cases within the same elevation as the lagoon bottom.
Q And, sir, as a hydrogeologist, where does that water table go?
A Flows down the groundwater gradient and typically discharges to a spring or surface water.

In the cases of Whatcom County, quite often it ends up in a tile drain and results in direct discharge into a ditch or surface water body.
Q And the surface water body could be a stream, a river, or an estuary itself into the Puget Sound?
A Correct. I'm not aware of dairies right around the estuary itself, but I'm more aware of them further up in the valley.
Q Okay. But the dairies then -- the water table under the dairies is hydrologically connected to the nearby surface

waters?
A Correct.
Q All right. Let's take a look back at Figure 1 of A-2. It's up on the screen.
Just describe for us -- I know it's kind of hard to see, but everybody, except for the people in the audience, have a little bit better picture in front of them on their computers. Just expanded it a little bit.
Let's go up to the top of Figure 1 a little bit. You can see it a little bit better.
Is this the same area that was depicted in Page 186 of A-1 that we were looking at?
A It is. You can see Cow Palace dairy here, one of the DeRuyter dairies here, Bosma sitting right in this area, Liberty over on this side. (Indicating.)
Q Okay. And the compost area at Cow Palace that we showed photos of, where is that?
A So Cow Palace actually has two compost areas. You can see the pen area in here. The compost area encompasses about 90 acres here, and then they have a second compost operation that sits right over in that area. (Indicating.)
Q And did you take some samples of that second compost area too?
A We did not.

Q Okay. And at DeRuyter, where is his compost area?
A Let's see. I think you can just --
Q The top DeRuyter.
A The top DeRuyter has a new compost area. His old area didn't -- was basically a depression, so when it rained, it filled up with water and was wet most of the year.
So there's a new compost area almost off the map up here in the top right-hand corner. (Indicating.)
Q Okay. And let's go down to Bosma and Liberty.
Where are their compost areas?
A So Liberty has a compost area that sits right in about eight acres right here, and Bosma has 20-acre compost area just north of the Bosma facility. (Indicating.)
Q Okay. Let's go down the screen a little bit.
And so all of these blue dots depicted on here, what do they represent?
A So the blue dots represent wells that have been sampled in the area and downgradient area of the cluster dairies. The yellow labels represent the nitrate concentration that was depicted in the wells.
Q And a lot of them are fairly low, right, 0.38 you see, some one points; right?
A Correct.
Q And in your -- from what -- you've looked at a lot of well logs from the area?

A We looked at all that we could get ahold of.
Q Okay. And what -- those lower numbers of nitrate, do they tend to be in the deeper wells?
A They do. As you move downgradient from the dairy cluster, the depth to groundwater decreases. So the groundwater table is shallower than up around the dairies.
Q The first groundwater table, but there might be more down below that?
A Correct.
Q Okay.
A But most of the wells are drilled through that upper water table and down deeper into a decent producing zone.
Q All right.
A On average, they were 100 to 250 feet deep.
Q So the ones that -- the wells that have greater contamination, do you know approximately what the depth to water is for those residential wells from the well logs you reviewed?
A The first zone of them, just down from the dairy cluster, are probably depth to waters of 30 feet, approximately.
Q And is that -- you know, 30 to 60, 80 feet, is that about the range for the ones that have the higher nitrates?
A It is.
Q And would you expect that -- from what you talked about

earlier, how the nitrates usually hit the top of the water table, and would you expect the higher nitrate levels to be in that upper aquifer?

A We would, for the most part, but -- at least near the source. But when you start looking at a plume of this scale, you have to realize that the units that were deposited by the river have the dip that goes downriver.

So as the groundwater flows along -- at the surface of the water table, it encounters these sand lenses. It also dives down deeper in the aquifer.

So at this point we're in our monitoring plan. We're not just monitoring the top aquifer. We're monitoring those zones that are deeper, and we're finding that that contamination is diving deeper along some of the sand layers and gravel layers in the subsurface.

Q Okay. And just for the record, earlier when you were showing the hydrous model, is something very similar depicted on Page 8 of A-1? Let's move to A-1 now, Page 8.

A Yes. Those are just snapshots of the hydrous model over time.

Q All right. So if the board wanted to reflect on your discussion today, that would be a good place for them to look?

A Correct.

Q Okay. All right. Now, let's take a look at Pages 11 through 14 of A-1. Kind of tipped you off subject. Was about to lead into that perfectly and then blew my own lead-in.

These pictures here on Page 11 through 14, what do they depict?

A So we took all the data from the monitoring program with the dairy clusters.

Q The stuff we just saw on Figure 1?

A The stuff we saw on Figure 1 plus the monitoring well information around the clusters.

Q And that monitoring well information, just for the record, includes the wells required under the EPA administrative order and consent and the consent decree orders; correct?

A That's correct.

Q Okay.

A So we took them all and put them in a program used to depict concentrations based on color. It's a geostatistical program that basically creates the data in order to show areas that are contaminated and areas that are not based on the data that we have.

Q Okay. So all the blue points are the wells themselves?

A All the blue dots represent wells. In the red area, they represent mostly monitoring wells. Outside the red area

to the south, they're almost all private drinking water well data.

Q Okay. And just so we're clear on this, the blue that's represented as the dots of the wells is not related to the colored graph, the rainbow on the left-side column; correct?

A That's correct. It just shows the location of the well.

Q The location, not the nitrate concentration?

A Correct.

Q Nitrate concentration is depicted by the other colors on these -- these representations; correct?

A Correct. So if you look at the scale on the left, you can see that if you start with the yellow, that represents concentrations from 10 and above; the red represents concentrations from about 30 to 180.

So it's a way to show the area of the aquifer that's impacted by the nitrate from this dairy cluster and from other sources in this case.

Q Okay. So, sir, I'm going to ask you to talk about all four of these pictures together and what they mean in sequence. So you can lead the charge, if you will. I'll help direct as necessary.

But look at each one and describe maybe just briefly what's in each of the four pictures, starting at Page 11, running through Page 14.

A Okay. Move on to Page 12. Page 12 is just a close-up of that same group of dairies that we've been talking about.

Q The red hot spot?

A Yep. Cow Palace to the north. DeRuyter is over here. Liberty and Bosma over here. (Indicating.)

You can see the red represents a concentration of about 80 to 180 parts per million nitrate, so 8 to 18 times the standard drinking water standard.

And you can see that that plume extends down to the south right around the Bosma lagoons, which sit right there, and then further below that, you still have consistent concentrations in the 15 to 30 range in the whole area. (Indicating.)

So what that tells us, based on the location of the wells such as this one right here, is that the most likely source of contamination for that well is the application fields that are directly above it and a gradient.

But if we look at these lower wells that have the highest concentrations, they are adjacent to the lagoons, so that's probably a result of lagoon seepage from multiple lagoons in the area.

So that's where we get into the discussion yesterday is, what is the largest contributor. It's really hard to tell because almost all of the potential sources are

causing some impact to groundwater.

Then if we move on to Page 13 --

Q Yep, please.

A -- this is changed slightly. Instead of blue dots, the dots now represent -- also represent the well but they represent the concentration, and we've changed our outer contour limit, the ten milligrams per liter.

So this figure shows the area around the dairy cluster that is impacted with nitrates in groundwater above the state drinking water standard.

So every private well within the colored area has concentrations above the drinking water standard that the residents are using for their source of drinking water.

Q All right. Let's take a look at the next photo.

What's this one depict?

A The last one is similar to the first one with a contour limit of five milligrams per liter. The only difference is, we've tilted the view a little bit just so you can tell that we're not looking at just one layer, one discrete layer of contamination. The nitrate --

Q Use your microphone, please.

A Oh, sorry. We're not looking at one discrete layer of contamination. The nitrate impact actually has a thickness to it, and that's because the data is from wells that are screened across multiple depths.

So in the upper area, the contamination may exist only in the upper five to ten feet of the water table, but down below, we're seeing these concentrations 30, 40, 50 feet below the top of the water table.

So as this nitrate plume leaves the site, it continues to spread both laterally and vertically and impact more of the aquifer.

Q And so these pictures here were the same as Slides 26 through 30 of your contaminant concentration slide show; right?

A That's correct.

Q And so one of the -- this one here would have shown something a little more interactive; is that right?

A Yes. Yeah. You can actually pick it up, rotate the screen on the computer, and look at the shape.

Q Right. But even though this is in your expert report, we're not allowed to use that today, so I just wanted you to know that we can't use that.

That's on Page 14; correct?

A Correct.

Q Okay. What's the feasibility of doing groundwater monitoring? Obviously we've got lots of -- let me try that again.

What would you do around a lagoon that you know is leaking even at one times ten to the minus seven? How

would you know how much it's leaking without groundwater monitoring? Is there any way to know?

A No, there's not. There's too many -- too many variables to estimate it. You need actual data.

Q And so what do you need to do to assess that lagoon, using groundwater monitoring?

A Typically, with any kind of a contaminant source, we install one upgradient well and two or three downgradient wells, depending on how much we know about the site. The more we know about the site, the lesser number of wells is required to monitor.

Q Right. And because we know that all these lagoons, earthen lagoons, leak, even if built to NRCS standards, there's no need to do a lagoon assessment at this point; right?

MS. HOWARD: Objection, Your Honor. We have not laid the foundation for that question.

MR. TEBBUTT: Just laid it for the last day and a half.

JUDGE FRANCKS: I'm going to allow it.

A No. I don't believe there's a reason to do a lagoon assessment.

Q (By Mr. Tebbutt) Right. And the lagoon assessment is one of the permit's so-called requirements; right?

A It is, yes.

Q There's enough information today to say that all these lagoons are leaking and causing groundwater contamination, so the next step is to know -- is two things: One, to know how much it's causing; correct?

MS. BARNEY: Objection. Lack of foundation.

MS. HOWARD: And leading the witness.

JUDGE FRANCKS: I'm going to sustain both of those, actually.

So can you rephrase?

Q (By Mr. Tebbutt) Yes. We know -- we've already established through your testimony that all lagoons built to one times ten to the minus seven leak; correct?

MS. HOWARD: Again, objection, Your Honor. Lack of foundation. We have an opinion, but we have not established that.

MR. TEBBUTT: That's his opinion. That's why I'm asking. It's his opinion.

Q (By Mr. Tebbutt) Let's try it this way: Is it your opinion that all lagoons built times one times ten to the -- one times ten to the minus seven centimeters per second leak significant amounts of nitrate?

A It is my opinion mainly because they were designed to leak.

Q Right.

A That permeability of a liner, they are designed to leak.
Q Actually, you know, that raises another question that I was thinking about earlier.

When you were designing the -- redesigning the Cow Palace lagoons, how -- did you have to design for more capacity?

A Yes, we did.
Q Why?
A If you're going to solve the engineering problem of lined lagoons, you know, you have to add more capacity because the lagoon is no longer going to seep into the ground.

So you know that you have to add that 900 gallons per day or whatever your permeability is to your equation.

Q And, therefore, you need more volume?
A Correct.
Q Was one of the other reasons -- are there other reasons for increasing the volume, such as climate change?
A There are. That's one of the things that, as an engineer, we have to compensate for. You know, it's predicted that we have bigger rain events, more rain events, more damaging rain events.

So truthfully, that is one of the other problems with the NRCS design, is, it's for one 25-year storm event, and some of the other industries that we design

lagoons for, we have to design for back-to-back hundred-year events because that's more common now than it used to be in the past.

Q More common in the last ten years than it used to be?

A Ten to fifteen, yes.

Q And you don't see anywhere in the permit that accounts for climate?

MS. BARNEY: Objection. This issue was decided on summary judgment and is no longer before the board.

JUDGE FRANCKS: I'm going to sustain that.

MR. TEBBUTT: We have to create a record, Your Honor, to take up.

JUDGE FRANCKS: You've already established that. The record is what your summary judgment motion said.

MR. TEBBUTT: All right. Well, there are facts that go along with it that are important and those are some of them.

JUDGE FRANCKS: And they've been excluded from this hearing.

MR. TEBBUTT: Well, that's a reversible error, I have to say.

Q (By Mr. Tebbutt) So how many square miles of

contamination do we see depicted in the photographs that we just discussed on Pages 11 through 14 of your expert report?

A So the lateral distance from east to west here is about eight or nine miles, and the distance from north to south is probably on the border of -- depending on where you pick, if you pick this downgradient, this slope here, probably on the order of five miles, so this is probably 40 to 45 square miles.

Q I was just going to channel Gerald Ford and say there's going to be some math here.

So five times eight is about 40; right? 40 square miles of contaminated aquifer?

MS. HOWARD: Objection, Your Honor. We have not laid the foundation for that.

MR. TEBBUTT: We just did.

MS. HOWARD: I'm looking at the map. It doesn't actually show that.

Q (By Mr. Tebbutt) Based on your knowledge, Mr. Erickson; is that correct?

A That is correct.

JUDGE FRANCKS: I'm going to allow it.

Q (By Mr. Tebbutt) And these dairies, there are dozens more dairies in the Yakima Valley; correct?

A There are.

Q And they haven't been assessed like this -- this area, had they?
A They have not, no.
Q Would you come to the same conclusion -- would you come to the same opinion, that the dairies are causing the same kinds of contamination that these dairies are?
A Based on my observation of multiple dairies, I do believe that to be true, yes.
Q And from your observations of being in the area, there are hundreds and even thousands of homes in that area that are dependent on drinking water for their drinking water supply; correct?
A That is correct.

MR. TEBBUTT: That's all I have.

JUDGE FRANCKS: Okay. Who's going next? Ms. Barney?

MS. BARNEY: That would be me.

JUDGE FRANCKS: All right.

CROSS-EXAMINATION

BY MS. BARNEY:

Q Good afternoon, Mr. Erickson.
A Good afternoon.
Q I'd first like to start with the diagram that you indicated was illustrative of the video that you showed us, so that's on Page 8 of A-1.

A Yes.
Q And I believe you testified that this is the hydrous model. So these are depictions of different periods of time within that video that you showed us?
A Correct. Timestamps within the video.
Q Okay. Just want to be sure sort of -- the figure that's farthest to the left where it's just -- where the event is just beginning, the impetus of this event was a simulated breach of the lagoon; correct?
A The --
MR. TEBBUTT: Objection to the extent it mischaracterizes prior testimony.
JUDGE FRANCKS: I think she's asking.
A The purpose was the model, both a ten to the minus six liner and a breach, correct, and an area that has higher permeability similar to what we've seen in the lagoons that we've visited.
Q (By Ms. Barney) And in reading the text that's here on Page 8 with a one-foot-by-one-foot area where inflowing wash water removes the manure coating?
A Yes.
Q Is that a definition of a breach?
A I believe it fits the definition of the -- of a breach in the liner, yes, because you've removed the manure coating from the liner.

Q Okay. So this -- everything that happens after this one-by-one area where the manure coating is lost then is also affected by the fact that that area is missing; correct? I mean, there seems to be definitely a point of origin?
A I believe that's true, yes.
Q So the -- without that point of origin, do you believe this model would look substantially similar with regard to the way the rest of the video played out with the water from the lagoon flowing down underneath and underneath that clay layer?
A I believe it would. It would just take more time.
Q So longer than the 40 days depicted?
A Correct.
Q Okay. Thank you.
So you had --
A Actually, I want to back up on that a little bit.
Q Okay.
A It would look very similar as far as the flow. The colors or the soil saturation would be different. It wouldn't achieve the same amount of soil saturation without that breach, so the amount of soil moisture would be less if that breach wasn't there.
Q Okay. Thank you. That's actually a great clarification. I appreciate that.

You testified that you had -- in Washington State you had been on approximately ten to twelve dairies?
A Correct.
Q And that what we've been -- the Yakima cluster, the cluster dairies, are five sites basically with three different owners, five different facilities?
A Yes.
Q And you said that on-site you had seen approximately 70 lagoons?
A I believe that was the total I'd seen in the Yakima Valley.
Q And are those the lagoons primarily on the Yakima cluster?
A About 40 of those are on --
Q About 40. Okay.
A Approximately 40, 35 to 40.
Q So for -- if -- for instance, Cow Palace had how many?
A Six, I believe.
Q So if Cow Palace was managing those lagoons, you would expect them to be similar in how they were -- how they were managed in the condition they were in under the same owner?
A That's not what we saw. One of the lagoons was built more recently, so it had gentler side slopes and more of what looked like a liner on it, while some of the lagoons

were -- had vertical slopes and were obviously just cut into the native material.

Q So age is a factor perhaps when the lagoons are constructed?

A I believe so.

Q Okay. Thank you.

JUDGE FRANCKS: Ms. Barney, we're having a little trouble hearing you, so I don't know whether you've gotten a little --

MS. BARNEY: Sorry. That was me. I hit it.

JUDGE FRANCKS: Thank you.

Q (By Ms. Barney) Mr. Tebbutt referred several times to your familiarity with Judge Rice's decision?

A Yes.

Q That was a case that was decided under the Resource Conservation and Recovery Act; correct?

A That is correct.

Q That's not a Clean Water Act case?

A I believe that's true.

Q So the decisions that were made around waste were made under a different statutory scheme than the NPDES permits that were issued today -- or that are under appeal today?

MR. TEBBUTT: Calls for a legal conclusion. Objection.

JUDGE FRANCKS: I let him make a legal conclusion with you too. I'm going to allow it.

A I believe that's true.

Q (By Ms. Barney) Thank you.

It's going to be a little while because Mr. Tebbutt covered quite a bit of ground, so I'm going to be as expeditious as I can, but -- so earlier in your testimony, in discussing the dairy clusters, you said there were a group of five clusters that EPA had identified?

A Correct.

Q So much of the work on which you then based later work and potentially some of your decisions were weighed by the EPA in their study?

A Yes. We use their study as reference material for designing our study.

Q And then you also said that they had approximately 40 monitoring wells at Cow Palace, or was that for the clusters?

A That's for the whole cluster.

Q Okay. And you added to those?

A We did.

Q How many?

A I believe we added 14.

Q And what was the cost to add those 14 wells?

A Each well in this location costs about $10,000.
Q And what factors go into the cost when it comes to installing a monitoring well?
A Drilling method and depth mainly. There's also a permitting and compliance part where you have to get all the right permits and locations selected.

So for the most part, in general, what runs up the cost is drilling method and the depth of the monitoring well.

Q Okay. Thank you.

So I'd like to talk a little bit about the sampling you did at the pens in the compost area, and I think I'm going to tend to group those together because it seems like some of the same -- some of what I heard from you was the same in relation to those.

The sampling that you conducted there, going to depth and doing a core, how many -- at Cow Palace, how many core samples did you do in the compost area?

A I believe we did one.
Q And in the pens?
A So just Cow Palace?
Q Just Cow Palace.
A I think we did two difference pens at Cow Palace.
Q Okay. Were -- do you have information on the historical use of the -- of the -- that particular land at the

property?
A I do not.
Q So you don't know whether or not in the past those might have been land application fields?
A I don't know that, no.
Q Okay. In terms of the lagoons and lagoon maintenance, I believe you testified that the permits do not have any provisions that relate to requiring the lagoons to be maintained?
MR. TEBBUTT: Objection. Mischaracterizes prior testimony.
MS. BARNEY: I'm trying to --
A I don't think I said that.
Q (By Ms. Barney) Okay.
A I don't remember talking about lagoon maintenance.
Q I believe you said something to the effect that your experience on CAFOs was that there was -- there was not -- that they didn't do erosion -- control for erosion and other aspects of the lagoons.
A I believe I did say that on existing lagoons that we've looked at to date.
Q And my recollection was that Mr. Tebbutt then said, "And the permit doesn't require that," and you said "correct"? Do you recall that?
A I do not.

Q Okay. Can we look at R-1, which is the permit, so it will be in the green binder.

And if we turn to Page 14 -- so under Section 1B and 1C, there's a section on structural maintenance and then volume maintenance. I'll just read a little bit of C there.

Periodically remove accumulated solids from lagoons or other lagoon storage structures if necessary in order to maintain volume and then ensure any liner in lagoon or other liquid storage structures not damaged.

And then -- and that -- and up above, structural maintenance, prevent damage and maintain the integrity of their lagoons and other liquid storage structures by controlling vegetation and animals and by repairing the structures necessary to bring back up to design specifics.

Do you see those sections?

A I do.

Q Do you consider those adequate?

A So the problem I have with those right now is, the dairies are required to maintain and inspect their lagoons under NRCS standards, and what we're -- we're not seeing that maintenance.

Q Are those facilities that are under a permit?

A No, not that I know of. They may be under a permit.

Q And are the NRCS standards required standards?
A They are not. They're guidances.
Q Okay. And then this kind of leads back over to when you were talking about the underground piping and other structures.

So if you turn the page over to Page 16, which I think Mr. Tebbutt directed you to right after lunch or maybe first thing this morning. I can't remember. It's all going together.

In terms of operation and maintenance of infrastructure, both above and below ground -- and I think you mentioned there also that you didn't think that this was sufficient for an operator?
A Correct.
Q Not insufficient direction?
A Correct.
Q So you would be more prescriptive about this?
A I would be.
Q And what would you require?
A We required videotape and pressure tests on the underground lines so they -- the operator had to come in and clean the lines first and then run a camera through them to see if there was any leaks or breaks in the line.
Q Can you tell us approximately what the costs of that would be.

A I can't exactly. It depends on the amount of lines and how much inspections required.
Q That makes sense.
A My issue was that a visual inspection of underground lines is not really possible unless you dig them up. So my position was, is that there has to be more in this section in order to actually maintain the lines.
What we've seen at the dairies we worked on is, as soon as we did that inspection, there was extensive repairs mostly because these facilities were put together piecemeal, if you will, as the dairies grew, and the piping changes from concrete to plastic to steel. And the longer it's in the ground, the more opportunity you have for a leak.
Q Okay. The lagoons that you are working on at the dairy cluster, you had said that there were two of them that have been completed and one that's in progress due to be online by the end of this year; is that correct?
A Correct.
Q And then after that, you anticipate --
A -- the remainders to be -- it's an annual schedule, one lagoon per year.
Q Okay. And then --
A And that's not quite accurate. I'm sorry. In many cases we're combining lagoons to save money on the lining. So

instead of just lining one lagoon, we're making a bigger lagoon that would combine several of the lagoons.

Q Since you brought up money, I'm wondering about the cost of installing -- well, what liners are you installing exactly?

A So at Cow Palace we're working under an EPA administrative order, so we're required to put in double lined with leak detection.

And there's an added expense that I talked about once, is that we have to put in a gas venting system under the liner because of the organics that had previously leaked into the subsurface. Once they start decaying, they're going to produce methane.

So what we're looking at is really -- on the first one was a four-liner system that, between the first one and the second one, manufacturer came out with a new product that's called a drain liner. So it's got the drainage layer built into the liner, and so now we're down to a three-liner system.

Q Okay. So let's talk about one that was installed under the old system, not the three layer system with the new product, but the original.

A Sure.

Q What was the cost of the liner itself?

A So the first lagoon I kind of have to give you a little

scale because they're different size lagoons.
Q Absolutely.
A So the first lagoon was about a four-million-gallon lagoon, and the liner itself cost about $200,000.
Q And I think better in acres than gallons.
Approximately how large was that surface area?
A Two and a half acres.
Q Okay. So that was $200,000.
And then how much did the installation cost?
A About the same, about another $200,000 and that's mainly because we were -- there was a lot of work to do on that lagoon to get it to the shape and size we wanted and a fairly large stormwater structure that went along with it.
Q So the second lagoon then, was it approximately the same size?
A No. The first one I said was four million. This was 25 million gallons, so much bigger.
Q Okay. And acreage?
A Probably four and a half acres, but much deeper. So that's where the volume is picked up.
Q Okay. Obviously the liner is going to be larger?
A Much larger.
Q And what was the cost of that liner? Do you recall?
A I believe the liner was about three hundred -- probably a

little over $300,000, all the components of the liner and the leak detection system.

Q And then the installation cost?

A Probably very similar to the liner cost, so probably another $300,000.

Q Okay. And the one you're contemplating now, is that going to use the new system you described with the three layers?

A So the second one did.

Q Oh, it did? Okay.

A And this one will also.

Q Okay. And do you -- how big is that one?

A It's the biggest lagoon that was on the property. I believe it's also going to be in the 22-million-gallon range.

Q Okay. And the cost that you anticipate for that? I know it's ahead of you as opposed to --

A Yeah. And we're -- we've seen bids on it, so we're looking at about a 20 percent reduction in the liner cost by using a new system versus the original one.

Q Okay. So maybe $160,000?

A No, ma'am. Would be almost 50 percent, so I'd say more like two --

Q Oh, of the bigger one?

A Yeah.

Q You're right.
A 220. Those are just general. I'm --
Q Yeah. We understand.
A I'm going off the top of my head, so --
Q That's okay. And I believe Mr. Tebbutt asked you if earthen liners were the industry standard to protect water quality, and I believe your response was not even close?
A And I think the question referred to other industries, not just the dairies. I think that was a wider topic question.
Q Well, I think so too, and that's what I wanted to clarify.

So have you seen -- so in those other industries, I believe you also testified that a synthetic liner -- each -- various industry sectors had come on board over a period of time to using synthetic liners; is that correct?

A Correct.
Q Have CAFOs done that?
A I have seen, I believe, two lagoons of the group that we talked about earlier that are synthetically lined. So two of the 70, other than the ones we're doing.
Q Outside the ones that you're doing?
A Correct.

Q And that was on ten to fourteen CAFOs within the state of Washington?
A Yes.
Q Okay. Thank you.
Once a groundwater monitoring well is installed --
A I got to back you up. Actually, three of them.
Q Three?
A Three of them. One is a stormwater pond and two of them are waste lagoons.
Q A stormwater pond at a CAFO?
A Correct.
Q Okay. Once a groundwater monitoring well is installed, I noticed that it appears that, at least in your -- in referring to the EPA annual report, it appears they're doing quarterly sampling.
And I realize that that sampling regime is going to change. It might be annual. It might be semiannual. It might be quarterly.
But each time a sample is collected, do you have an estimate of how much that costs?
A It depends on the -- how many analytes you're running at the lab. The lab fee can be the same as the sampling costs quite often, so --
Q Let's start with the sampling cost --
A Okay.

Q -- itself, the actual collection.
A So do you want to look at the parameters we're sampling for at the dairies or --
Q Let's look at nitrate.
MR. TEBBUTT: Your Honor, I'm going to object. This is outside the scope of direct.
JUDGE FRANCKS: I'm going to overrule that objection. Talked a lot about sampling in the direct.
MR. TEBBUTT: Not the costs.
JUDGE FRANCKS: It's an issue in the case.
A Okay. So each parameter analyzes costs, a certain amount of the analysis done, and, again, I haven't looked specifically at nitrate for quite a while, but I would guess that that's about $15 per sample.
Q (By Ms. Barney) Is there cost associated with actually collecting the sample out of the well?
A There is. We have to have a person go out, properly purge the well, containerize the sample, and ship it to the lab. So there's some labor costs there.
Q Do you know approximately what that would be?
A It varies, depending on depth and size of the well, but typically, if we're doing multiple wells, we can probably sample a well in about a half an hour.

Q Okay. Thank you.

If we pull up A-67, which is the EPA annual report, and if we can just look at Page 186, I'm not sure you're going to need to turn to it. I think you might be able to answer my questions just based on what's up here.

So I believe you walked us through some of the data that's on this visual?

A I did.

Q And I guess my question is that the lines are drawn toward monitoring wells; correct? So the round circles that are -- that are hashed black and white are monitoring wells?

A That's correct.

Q Okay. So with all these areas in proximity, I think you walked us through a couple of these, saying that, "Well, this particular well might be most impacted by the land application well. Another well might be most impacted by a lagoon area."

Is there a way to ascertain that for certain?

A Yes, there is.

Q Which is what?

A So what you're looking at is a very simple figure showing well locations, but you have to realize the background. So every time we put in a well, we log the geology so we know what the units are that we encounter as we drill.

We run a full set of geochemical samples so that we can characterize the natural characteristics of the water, the major minerals.

We also collect groundwater elevation data so we can put together groundwater flow maps. Just take a quick look here, and it doesn't look like this particular report has that in it. I thought it did.

Anyway, the groundwater contour maps tell us groundwater flow direction.

Q Mm-hm.

A So based on flow direction and chemistry, we can usually tell what the source is that has impacted the well.

Q Okay. If -- I think you testified that, when you turn on the irrigation, you can tell the difference in water table, even the fluctuation can appear even with a week's time?

A That is correct.

Q Is that -- is the fluctuation that's related to where the groundwater table is, can you say the same thing about the nitrate that's in that groundwater?

A If you collect data on a -- on a similar time frame as what you're looking for, like, if we know when they're going to apply, if we collect below -- before they apply and then after they apply, we can typically see that impact, especially in the shallow situation.

So this is a little bit different because we've got 100 feet to water, and it takes a while to get there, but on sites where you've got shallow groundwater close to the surface where it impacts it quicker, you can usually correlate between the two.

This -- the groundwater fluctuations, a few of the wells we actually put recording transducers in there. So it's an instrument that you put in the well, and it monitors the water level on an hourly basis.

So we can see daily fluctuations and long-term fluctuations very accurately with those.

Q Of water level?

A Of water level.

Q But not, say, a nitrate level?

A Correct. We don't monitor nitrate realtime.

Q So in terms of wells that -- well, actually, let's look at -- go back to A-1 in your report and Page 11 that we looked at, which is the illustration of nitrate concentration and water supply wells.

A Yes.

Q The water supply wells that are downgradient here -- well, first of all, are there upgradient sources of nitrate above the dairy cluster?

A There seems to be some background concentration like in the zero to two parts per million, so there are no

significant upgrades. The dairies are the first sources along those flow paths.

Q And so you had collected groundwater data, or EPA did at least, and are you continuing to collect the groundwater data?

A Yes.

Q So you have five dairies in close proximity. Is there any way to tell if any given practice at a dairy is responsible for nitrate in a downgradient well?

A In this situation, we can't pinpoint the exact practice that it's causing it amongst all of the parts of the dairy.

What I said is, we've got wells that only have application fields upgradient, and we're seeing impacts from the application fields. Got wells that only have lagoons upgradient, so we're seeing impacts from the lagoons. Really what we're seeing is, we're seeing an overall increase in concentrations as you flow down.

So we did put together what we call loading curves based on this data, and they were -- they were in my slide show, but what they show is areas of the dairy where nitrate is increasing.

So from that data, you can conclude that this application field or these lagoons or this dairy facility, which would be the pens and compost area, is

adding nutrients to the subsurface.

Q But if all the groundwater is connected when you hit the water table, the groundwater is connected, and then you're flowing then to drinking water wells, how can you then go back and pinpoint a particular practice at a dairy that is affecting those downgradient drinking water wells?

A That's based on the monitoring well data. That's why we put the monitoring well -- monitoring wells in across the facility so we can actually look at what's upgradient, how the concentrations increase, and what practices may be causing that increase to groundwater.

Now, once you get past the dairy to a drinking water well, then it is mixed. It's -- technically, there's no additional source. You get this average concentration here, which is 30 or 40 parts per million.

And maybe this is your question. Based on what you find in the drinking water well, you can't tell where it came from, but you can tell if you have a monitoring system in place.

Q I thought you had testified earlier that there actually were a few other sources within the -- within this diagram?

A Once you get down to the -- to the south end of this, then we start to encounter more dairies. There's about

seven or eight dairies right along the end of my diagram, but we don't have monitoring data down that far. One of the -- we just recently -- so this is an ongoing problem -- program.

We just recently found a well right down here off this end that, if I would have added it to this map, it would have showed up as a red spot right there that happens to be a downgradient of another dairy.

So based on the water well data, we know that that dairy is causing a problem to groundwater also because it's -- the groundwater is cleaner above it and has higher concentrations of nitrate below it.

Q Are there -- in this particular area of Yakima, are there municipal sources?

A Not in this area. Everybody is on wells and septics in this area. You've got to get closer to the river to encounter any kind of a municipal system.

Q In other parts of the state that you visit -- I think you mentioned you've been in Whatcom County?

A Correct.

Q Is it only dairies? Are there other sources potentially there? Municipal sources?

A Yes.

Q Stormwater sources?

A And, again, that's why this site was selected, is because

it's a -- there's -- we call them commingled plumes. There's not the chance for that here.

This is -- the data is pretty clean because there's not a lot of other sources other than agriculture here.

Q So this scenario of trying to plan groundwater monitoring, if there were significant upgradient sources would be far more complex than what's pictured here?

A Don't agree with that. There's been more monitoring wells installed at this site than needs to be because it's part of an EPA administrative order.

So, if anything, they put quite a few more wells off laterally than would need to be to characterize this site.

Q But then you added some?

A Correct. We chased them downgradient because of the impacts to drinking water wells. So we wanted to know how far it went. Those wells were not sited to find the source. They were sited to define the extent of the plume.

Q Mr. Erickson, have you ever worked for a regulatory agency?

A I have.

Q In what capacity?

A We've performed specific projects for Montana DEQ, either surface water monitoring such as TMDL work, groundwater

investigation or done some underground sewage tank cleanups for the State of Montana.

Q Have you ever written a permit in the regulatory context?

A I have not.

Q And on what basis do you believe that your experience at the dairy clusters can be expanded to the experience in the -- in the CAFO industry statewide?

A Can you try that one again?

Q Is -- well, I believe you've testified that EPA selected these sites because there were known impacts, the dairy cluster, and I believe you've also testified that your -- what you have observed at dairies across the state is that all of the facilities have similar practices to what you've observed at the dairy cluster facilities.

Was that your testimony?

A Yes.

Q Then your testimony is that a permit that would -- well, were these facilities under the CAFO permit?

A All of the facilities we're talking about?

Q Well, the dairy cluster.

A I don't know that. I don't believe they are.

Q Were the facilities in compliance with -- let's just say, were they land applying at an agronomic rate when they land applied?

A I don't believe they were, no.

Q Because I believe -- didn't Judge Rice's decision specifically call out the fact that they always ignored their dairy nutrient -- or their nutrient management plan and overapplied?
A I believe that's true, yes.
Q And, you know, we've looked at -- you know, and I know we just looked briefly at some of the language in the permit with regard to lagoon maintenance, but from the photographs you showed us, it seems like they were not -- there's potential that they were not properly maintaining their lagoons.

Would you agree with that?

A I would agree with that.
Q Okay. So I guess I'm struggling to find the applicability of the experience at Cow Palace where there were overapplications and -- of two -- to land of nutrients and not followed -- properly following nutrient budgets as well as problems with lagoon maintenance.

How is that related to the terms of this permit?

A And I think through testimony, I've stated my opinion is that that is -- even the terms of this permit are not strict enough for lagoon liners, for instance.

I've listened to the testimony that if you build the liner to the ten to the minus six, manure seals it to ten to the minus seven, and there won't be enough seepage to

impact the groundwater above ten parts per million nitrate.

First of all, I don't believe that ten to the minus six is protective enough. I don't believe that the language in the permit gives you the proper amount of control over what's headed to groundwater.

And the only way you're going to know what's headed to groundwater is to monitor groundwater, so that's a big shortcoming.

As far as the application rates, some of the individual field grass we showed you were really good example of what happens. If -- first of all, they have to go through several year periods being in that high to very high range.

You're going to have impacts to groundwater that lasts for years. If they do some kind of a winter application that is outside of their agronomic budget, then you're going to have --

Q Right. But that's, again, being out of compliance? The permit requires them to follow a nutrient budget and only in very specific situations allows a winter application.

And, in fact, wasn't that data showing that if --

A What are they out of compliance of? The soil concentrations? But you never know if they're out of compliance for groundwater concentrations. That's --

Q But that was soil data that we were looking at.
A Correct. And your permit has said if you meet these standards, you're not going to impact groundwater, but -- and I don't know if you want to use the standard or not, but if you meet these requirement in the permit, you're not going to impact groundwater.

I don't think you know that. I don't think your permit addresses -- one of the tables in the permit talks about the concentrations going towards groundwater in soil, but you never know what the impact is.

So in my opinion and with my background, that's the biggest shortcoming that I see. And we've -- in my deposition we've talked about I'm not an agronomist. I'm just merely looking at contaminant transport in the soil. I'm not looking at root uptake or any of those issues.
Q Right. So if we flip the scale, can you describe for us the simplest groundwater monitoring rate that you have installed.
A So we've looked at several other dairies in the valley, and our proposal was for eight monitoring wells at a facility that was, I believe, 2500 CAFO facility. We had two upgradient so you knew if any other dairies were contributing to your or any other source was contributing to your groundwater. One or two below the lagoon system. A few below the application areas.

This particular dairy had a separator system that peeled off the raw solids, if you would, and just stockpiled them on the ground. So we also put one down below that. So with that eight well system, I do believe you can characterize groundwater flow.

Now, we already knew a few things because we worked at the dairy cluster, and this was downgradient. We had a good idea of groundwater flow direction, depth to water.

But as you install these systems in all dairies, you would know more about the surrounding area as you worked there.

So my simplest monitoring system was an eight well system. We didn't install it. It was a proposal.

Q And approximately what was going to be the cost of installing the infrastructure for that?

A So this -- groundwater depth was about ten to fifteen, so these wells would have been a lot cheaper than the Cow Palace wells, on the order of about $4,000 apiece.

So, you know, overall I think we were talking forty to fifty thousand total for the installation.

MS. BARNEY: Okay. I believe that's all I have.

JUDGE FRANCKS: Okay. Ms. Howard?

MS. HOWARD: Your Honor, would it be

okay if we took a really quick break?

JUDGE FRANCKS: Sure.

MS. HOWARD: I could just use a five-minute.

JUDGE FRANCKS: So let's say 3:50.

(Recess taken from 3:42 p.m. to 3:51 p.m.)

JUDGE FRANCKS: We are back on the record after a brief break.

Ms. Howard?

MS. HOWARD: Thank you, Your Honor.

CROSS-EXAMINATION

BY MS. HOWARD:

Q Mr. Erickson, thank you for your time. Elizabeth Howard, on behalf of the dairy federation and the farm bureau.

So start at the beginning: Do you have any Washington licenses or certifications?

A I do not.

Q So your time working in Washington, has it been limited to the five dairies that we talked about, that -- calling them the clustered dairies?

A Not necessarily. There's been additional dairies that we've looked at and toured and been on and been involved with.

Q And have you actually done testing on those other

dairies?
A No, we have not.
Q Okay. And that would be the other five to seven dairies?
A Correct.
Q Okay. You mentioned some other dairies that you had driven by. Remind me how many you said you had driven by.
A I think I guessed at 30-plus. There's a lot of dairies just in the valley between Sunnyside where I usually stay and the clustered areas, so --
Q And have you actually been on any of those dairies that you've driven by?
A I have not.
Q And back to the other five to seven. How many times have you been on those five to seven dairies outside of the cluster dairies for each one?
A I believe we've toured them all at least once and some of them twice.
Q Do you know how many dairies there are in Oregon -- or how many dairies there are in Washington?
A I do not.
Q Let's not talk about Oregon today. That's way outside the scope.
A I heard testimony earlier that there was 400-plus. That's the extent of my knowledge on how many.

Q And when you're normally doing statistical analysis, how many samples do you need in order to have a good idea of whether the information you have is representative?
A How many samples? It depends.
Q Just in a percentage.
A Depends on the population you're analyzing.
Q Would it -- so it would vary, depending on the variability of the population?
A That also, both the number and variability.
Q Okay. And would you normally do random sampling if you're trying to do a statistical analysis?
A Not necessarily. It depends on how much you know about the population. You might sample a certain amount from each population that -- if you can be more specific, I'd answer more specific.
Q No. But I think what you're saying is that you actually have to know about the population you're sampling to know whether or not the sample set that you have is reflective of the overall population.
Am I understanding you correctly?
A Correct.
Q So specific to -- I do not like the term "cluster dairy," so I'm going to call them Cow Palace dairies, if that's okay, but I'm referring to all five of the farms that you were on.

If you -- with regards to those five farms, how many of the lagoons did you actually take soil samples from?
A Since we started working there or specific to the investigation?
Q Well, specific to your expert report here.
A I think -- the expert report in this case or the Cow Palace expert report?
Q I believe your expert report from the Cow Palace case is in your expert report for this case; correct?
A Correct.
Q I'm talking about the whole thing. Sorry that wasn't clear.
A Up to the point of Cow Palace, I believe we'd sampled -- and your question was the bottom of the lagoons? Is that your question or --
Q I'm asking -- I asked how many of the lagoons in these five dairies did you actually take soil samples from.
A And I'm asking, are you asking in the lagoon or adjacent to the lagoon?
Q You can define it however you would like. And then please tell me what you decided.
A I believe we sampled next to three lagoons during the investigation, and since then, we've sampled two additional lagoons because we're trying to plan closure of the lagoons. So we've collected soil samples from the

bottom of those lagoons also.
Q And where are those -- so five lagoons total?
A Correct.
Q And where are those lagoons?
A Those two are on Cow Palace.
Q You just said five lagoons.
A Yes. So four -- let's see. Four of the lagoons are on Cow Palace. One of them was on the Bosma dairy.
Q And is all of that data in your expert report?
A It is not.
Q Okay.
A There's been samples collected since my expert report.
Q Okay.
A That's why --
Q What date -- so in your expert report, how many lagoon soil samples do we have?
A I believe there's three.
Q And where were those lagoons?
A One was Bosma, and then there was one in between two lagoons in Cow Palace.
Q Okay. The Haak data, is that also Bosma?
A No, that is not.
Q Okay. So that's not one of the lagoons that we're talking about where you took soil samples?
A Correct. You asked specific to these cluster dairies,

and the Haak dairy is not part of these cluster dairies.
Q Okay. So the -- so let me back up then.
How many soil samples from lagoons do we have in your expert report?
A And I'm not trying to be -- dodge the question.
Q No. I know.
A Some of the lagoon samples in each core we collected eight or ten samples or twenty samples.
Q So I'm talking about the full core.
A So how many cores have we taken?
Q Perfect. Good question.
A We've collected two cores, one at Bosma, one at Cow Palace, and then one at Cow Palace was right between two lagoons.
Q Okay. Thank you.
A At Haak we collected an additional core that I'm not counting into that bunch.
Q Okay. But the Cow Palace one was not in a lagoon. It was in between the lagoons. That's what you just said; right?
A That's why I asked you earlier, did you want them in the lagoon or adjacent to the lagoon?
Q So, yes, it was between the lagoons?
A Yes, it was.
Q Okay. Thank you.

So there are actually just two lagoons then you sampled from that are -- that information is included in your report?

MR. TEBBUTT: Objection. Asked and answered.

MS. HOWARD: I'm just trying to make sure I understand.

JUDGE FRANCKS: I'm not sure it is, so I'm going to overrule that.

A And I --

Q (By Ms. Howard) I'm not asking about samples. I'm just asking about how many lagoons were sampled. There are two lagoon sample results in the report.

A So I'm going to have to back up. Samples from the lagoons --

Q Yes.

A -- themselves?

Q Yes. That was my question.

A I believe there's only one sample boring within the lagoons in my report.

Q And which one is that?

A That's the Haak dairy.

Q Okay. Thank you.

So where was the Bosma sample taken from?

A The Bosma sample was taken adjacent to their furthest

downgradient lagoon. I don't remember the number of the lagoon.

Q Okay. Thank you. I'm sorry that was so difficult.

A Just trying to be accurate.

Q No. I appreciate that. Me too.

So let's talk about the Haak data for just a minute then, while we're turning there hopefully.

So did you -- did you investigate the Haak lagoon?

A No, we didn't. One boring in the lagoon bottom is part of a settlement negotiation. I believe it was. I couldn't tell you.

Q And -- but you included that data in your expert report?

A I did.

Q Okay. When you -- did you -- I assume you observed the lagoon, the Haak lagoon?

A I did.

Q And did you see any sort of a liner in the Haak lagoon?

A There are some pictures of that in my expert report. What we saw was areas where there was manure on the side walls, and the bottom of the lagoon had been scraped and cleaned before we got there.

Q Okay. So were you able to observe a liner on the lagoon?

A We didn't see anything that looked like a liner, but a lot of these -- all they do is compact the existing soil, so it's hard to tell if they considered that a liner or

not.
Q Did you ask them if there had been a liner on the lagoon?
A I don't believe I did, no.
Q Okay. And -- but you included this information in your report to support your testimony about impacts to groundwater from lagoons; is that correct?
A Correct.
Q Okay. Can we actually take a look at that data? It's on page -- stay tuned.
A So it's Exhibit A-1, Page 170.
Q Thank you. Unfortunately, I have one that doesn't have all the exhibit numbers on it, and that -- perfect. So that's PDF Page 170 as well.
So just -- I think you had testified that nitrates bind to moisture; is that correct?
A They move in the moisture, yes.
Q And they're more bound to the soil moisture than they are to the soil particles?
A Correct.
Q Okay. Did you take soil moisture data for this particular -- out of this particular sample?
A I'd have to look back at the lab data to see that, but it's not reported in this table that we did.
Q Would information about the nitrates in the soil moisture give us a better understanding of whether -- where the

nitrates are in the sort of profile here?
A It would, yes.
Q Okay. Did you happen to do any sort of permeability testing when you took your core sample from the Haak lagoon liner?
A We weren't allowed to do that.
Q Okay. And did you have any data about whether it was constructed to NRCS standards?
A We did not have any data that said that one way or the other.
Q Either way. Okay.
Where is the Haak lagoon in comparison with the maps that we've been seeing of the other dairies, just geographically?
A About five or six miles to the east.
Q Okay. So is it within the kind of area where you've been -- like that rabbit -- what looks like a rabbit graph of the wells?
A It is not.
Q Okay. Sorry. That's the lawyer -- that's what I see.
Okay. So we haven't seen any well data related to the Haak lagoon; is that correct?
A Correct.
Q Okay. When you're typically -- so -- so your -- the work that you do, you are a consultant for others related to

hydrogeology, geology, contaminant loading, those sorts of things?

A Correct.

Q So are you normally called in when there's a problem to solve?

A Typically, on the contaminant side, that's true. But we also do design work for new construction, the engineering siting, stormwater controls, all the site design work for them also.

Q So that makes sense. I understand that.

I'm just trying to get a sense for when you're actually doing an evaluation of like, for example, the dairies here. There's a problem that's at issue when you're called in to do the consulting work.

Is that a fair statement? So, in other words, with new construction, would you be doing groundwater monitoring?

A In some cases, yes. Yeah. Right now we're doing a lot of work in the coal-fire generation arena, and before they build a new lagoon, we have to put in wells and monitor for a full year before they can even build the lagoon because they want to establish background groundwater quality before anything is added to the lagoon.

So in those situations, we're called in before

there's any, you know -- any chance or type of contamination or even any construction, so not -- not -- we're not always there because there's a problem, but I guess -- or a release. It just depends on the client and the regulations.

Q And have you had any of that kind of experience with the -- a dairy in Washington where you've been called in beforehand to do that kind of monitoring where there wasn't a problem, already existing concern?

A No, we have not.

Q So I understand you didn't take any soil samples within the lagoons at Cow Palace, but were you able to similarly observe the lagoons themselves?

And let me make that a better question.

Were you able to observe the lagoons when they were empty?

Let's talk about the two where -- let's talk about the two where you took a core sample in between the two of them so I can narrow that question a little bit more.

A Okay. While we were on-site doing that work, the lagoons were not empty. One of them was probably a third full and the other one was full.

Q Okay. Did you try to -- I think you had mentioned, though, that you -- something about whether or not they had -- you understood that they were built to NRCS

standards or not.

Can you -- what did you come to understand about whether the lagoons on Cow Palace were built to NRCS standards or not?

A So as part of the litigation, we were told that they were all built to NRCS standards and that the NRCS had lost the records, and they were able to produce one -- one set of records for the newest lagoon they built, Lagoon 4, where they showed some -- I neglect to call them as-builts because they were fairly rough drawings and some testing on the construction of the lagoon.

Q And was Lagoon 4 one of the two lagoons on either side of the sample that you took?

A It was not.

Q Okay. So I thought you had testified, though, that you saw the lagoon bottoms, and you said they were just sort of silt and sand and kind of natural soils.

Where did you make that observation at?

A So during construction of the two we recently lined --

Q Okay.

A -- we excavated the old lagoons out and then made the lagoons bigger by digging them deeper and expanding the side walls.

So on those, yes, we did stand on the lagoon bottoms after they were empty and -- as excavation was occurring.

Q And were either of those lagoons the ones, again, that you took the sample nearby?
A They were not.
Q Okay. So have you done any -- so when you were looking at NRCS standard, are you aware the NRCS actually requires, when you build a lagoon to their standards, that you do compaction studies beforehand -- before you complete your lagoon to ensure that it meets the permeability requirements?
A I am. And Lagoon 4 had that data.
Q Okay.
A Well, let me back up.

Lagoon 4 had a design document and a construction document that included one permeability sample from the completed lagoon.

Q And -- but, again, you didn't take any data from Lagoon 4; correct?
A That is correct.
Q Okay. So did you take any permeability samples from the lagoons that you dug out before you -- before you dug them out?
A Not permeability samples, no.
Q Okay. So when you were doing your analyses that you referenced in your report, you then were making assumption about what the permeability was of those

lagoons when you ran your calculations about seepage because you didn't actually have data about that; is that correct?

A Correct. We were assuming that the lagoons were completed, according to NRCS standards, as we were told.

So we used the permeability data from that standard to run our seepage calculations except for Lagoon 4 where we actually had one data point. Then we used that information.

Q Okay. And if the lagoons didn't actually have the permeability that was required by NRCS standard, then you weren't actually calculating what was really happening on those lagoons; is that -- am I understanding you correctly?

MR. TEBBUTT: Objection. Mischaracterizes testimony.

JUDGE FRANCKS: Can you rephrase?

Q (By Ms. Howard) Yeah. Let me try again.

So I think you just said you didn't have the data about permeability in those lagoons, but you did run calculations about seepage from those lagoons; correct?

A Correct. The data we had was, we were told that they were completed according to NRCS standards.

Q But you weren't able to verify that?

A That is correct. We weren't allowed to verify that.

Q Let's -- I have a quick question for you about phosphorous and your testimony on phosphorous.

So this is Exhibit 67 -- A-67, Page 187, is what I'm looking at. And you were looking -- I think you were looking at YBD -- oh, no. I'm not sure which ones you were looking at here, but I think, when we were looking at this slide, you said something about the lines of -- sorry. I lost -- did I lose you?

A-67, Page 187. Mr. Snyder generously agreed to do my exhibits for me. Thank you. 187. Thank you.

And I think, when we were looking at this slide, you were saying that phosphorous levels tend to be high when nitrates are high.

And I was looking at those top two boxes, YBD-02 and YBD-07. And just noticing -- so NH3 is the symbol for nitrates; is that correct?

A That's ammonia.

Q Okay.

A So it's NO3. That's nitrate.

Q Okay. All right. Thank you for that clarification.

A So --

Q That's all right. I don't have a question now. Goodness. It's been a long week. Thank you.

MS. HOWARD: Can we -- sorry, Daniel, to make you flip back. Can we look at A-1, Page 8.

Q (By Ms. Howard) This is the -- kind of the still of the hydrous model that you worked on, so I guess one question I have for you here is about the soil. You said, I think, that the soil in this area is -- is fairly variable.

The soil information that's in this hydrous model, is it also variable?

A It is not. It's more of an -- it's more of -- kind of an average permeability for the area of a silty material. The only variability is, we purposely put that clay lens in there in order to show some of the borings we did.

We saw these little clay lenses and sand lenses with depth, and we wanted to show what the effect of something like that in the subsurface is on that saturated flow.

Because what we -- what we really think is happening under the dairy cluster is, instead of the seepage going straight down, because we know that the deposition is alluvial, which means it's layers of sand, layers of silt, multiple layers, that it's actually moving along a dip of that and displacing the plume somewhat to the southeast, so it --

Q But this -- that was too complicated to model here?

A No.

Q It wasn't?

A We could have modeled it more complicated, but the --

Q But that isn't what this actually reflects. This is just --
A Right.
Q -- one -- like, the soil is all the same except for that clay?
A That clay lens.
Q Okay.
A So we could have modeled it a little more complicated, but the purpose was to kind of dispel the argument that you have to have saturated conditions to actually move nitrate to groundwater.

And so the hydrous model is an unsaturated model. So we just wanted to show somehow how transport in the subsurface can occur under unsaturated conditions.
Q And what figure did you use for -- is K sat -- I'm learning all these terms -- is K sat the variable in this hydrous model that looks at how saturated the soil was? Is that the letter K there?
A No. That's permeability.
Q Okay.
A That's --
Q What is the variable that represents saturation in that equation that's there on the left-hand side?
A Okay. So that's not an equation.
Q Okay.

A So what I'm saying is, the permeability -- it's another way to represent ten to the minus six as E to the minus six.

So all I'm saying in that is that the permeability of the liner is ten to the minus six centimeters per second. So it's not an equation. It's just a different way of showing ten to the minus six.

Q Okay. So how can we tell how saturated this soil is in this --

A So if you remember the video clip that we showed before we showed the model run, we actually showed a scale bars of saturation. There was one -- couple frames right upfront that showed what the different colors represented.

Q Right. Right.

A And that's -- that shows the degree of saturation is the different colors.

Q Okay. So when we're seeing the different color, it's different levels of saturation?

A Correct. So the red would be the highest saturated, and my recollection is that the most saturated sections were about 40 percent saturated.

Q And I think I remember correctly, there was a little red dot underneath the clay liner?

A Correct.

Q And that it started to move after there was saturation underneath the clay liner. Did I catch that correctly?
A Yes, you did.
Q Okay.
A So that goes back to that assumption that, before there's a liquid input, you're at field capacity. So the soil is sitting there damp but not wet enough to drain.

So when we put the particles in, we're assuming that they're not going to move because we've already told the model, here's the soil type -- here's all the parameters and here's the degree of saturation.

So before those dots could move, we have to increase the saturation and start migration into the ground.
Q Okay. Thank you.

So this is showing saturation but is this showing contamination?
A No. It's not related to concentration. As we discussed before, we know that the partitioning coefficient for ammonia is about 200, and the partitioning coefficient for nitrate is zero. So just to generalize somewhat, ammonia is 200 times more likely to be bound to the soil.

So in situations where you have ammonia converting to nitrate under the liner, we know that the liner -- or the nitrate moves in the soil moisture.

So all this model shows is how -- how much and how

soil moisture moves beneath that liner.

Q Okay. And I think you had said earlier that their head is one thing that can be a driver of soil or how quickly water moves.

Did you make any assumptions about that with regards to this model?

A We did. And I believe I said that early on is we assumed that the lagoon had nine feet of water in it.

Q And what did you assume regarding -- did it have nine feet the entire duration of the modeling exercise?

A It did. So the model ran for about 40 to 60 days, and during that time, it was assumed that the lagoon had nine feet of water.

Q Okay. So --

A We didn't --

Q Would you call that a constant head or something along those lines?

A We would.

Q Okay. So, again, this might be a dumb question, but I just want to make sure I understand.

If you have a constant head, then, were you also assuming there was no evaporation occurring from the lagoon when you were running this model? Is that -- am I getting that correctly?

A The evaporation is not part of this model. I mean, we

just held the liquid level in the lagoon at nine feet. There's nothing -- there's nothing in this model that accounts for evaporation. It's not even in the program. It's not something you do.

Q Okay. Though, in real life, we do have evaporation that just wasn't accounted for in this particular model?

A You know, we've looked at the lagoon operation quite a bit, and typically what will happen -- when the lagoons are full, they keep them full until the spring when they apply.

So, you know, over the winter there's minimum evaporation, so I don't think it would be significant. I mean, you might -- we left nine feet of head in the lagoon, and if it evaporated, you might lose an inch over that period, so it's not a significant consideration.

It wasn't modeled in this model using this software.

Q Okay. Leave it at that.

A It's way complicated if we go any further than that.

Q Okay. Deal.

A I'm going to start getting confused here pretty quick.

Q Me along with you.

Okay. And, again, this was a model of a -- did you say a one-foot-by-one-foot hole?

A Correct.

Q Okay.

A Not really -- not a hole, but just an area where the liner doesn't meet the ten to the minus six spec.
Q What did it meet?
A It was ten to the minus five.
Q Ten to the minus five.
A Yeah.

MS. HOWARD: Your Honor, do we want me to stop? I'm at a breaking point, but I can certainly keep on going for 15 more minutes if that --

JUDGE FRANCKS: So how much do you have?

MS. HOWARD: I have more than 15 more minutes.

JUDGE FRANCKS: Okay. And then, Mr. Tebbutt, do you have a sense of your redirect?

MR. TEBBUTT: Probably about five to seven minutes.

JUDGE FRANCKS: Okay. And, Mr. Tebbutt, have you resolved your question about Ms. Reddout?

MR. TEBBUTT: Yeah. We're going to have to call her, I'm afraid.

JUDGE FRANCKS: So we'll do that tomorrow morning.

MR. TEBBUTT: Yes.

MS. HOWARD: And I'm happy to keep on going for 15 minutes, but I just --

JUDGE FRANCKS: If this is a good stopping place, I think we stop as long as Mr. Erickson -- you have to come back tomorrow anyway apparently.

THE WITNESS: I didn't want to. If we can finish, I'll stay.

JUDGE FRANCKS: We can't and get out the door by five o'clock, and that's one of our important rules.

So we will wrap up for the day right now. We're off the record.

(Proceedings adjourned at 4:30 p.m.)

C E R T I F I C A T E

I, ANDREA L. CLEVENGER, a Certified Court Reporter in and for the State of Washington, residing at Olympia, authorized to administer oaths and affirmations pursuant to RCW 5.28.010, do hereby certify;

That the foregoing proceedings were taken stenographically before me and thereafter reduced to a typed format under my direction; that the transcript is a full, true and complete transcript of said proceedings consisting of Pages 662 through 899;

That I am not a relative, employee, attorney or counsel of any party to this action, or relative or employee of any such attorney or counsel, and I am not financially interested in the said action or the outcome thereof;

That upon completion of signature, if required, the original transcript will be securely sealed and the same served upon the appropriate party.

IN WITNESS WHEREOF, I have hereunto set my hand this 18th day of June, 2018.

(Court Reporter, CCR No. 3041)