STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION COMMISSION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION COMMISSION FOR THE PURPOSE OF CONSIDERING:

APPLICATION OF THE NEW MEXICO OIL CONSERVATION DIVISION FOR REPEAL OF EXISTING RULE 50 CONCERNING PITS AND BELOW GRADE TANKS AND ADOPTION OF A NEW RULE GOVERNING PITS, BELOW GRADE TANKS, CLOSED LOOP SYSTEMS AND OTHER ALTERNATIVE METHODS TO THE FOREGOING, AND AMENDING OTHER RULES TO MAKE CONFORMING CHANGES; STATEWIDE

CASE NO. 14015

REPORTER'S TRANSCRIPT OF PROCEEDINGS

COMMISSION HEARING

BEFORE: MARK E. FESMIRE, CHAIRMAN
JAMI BAILEY, COMMISSIONER
WILLIAM OLSON, COMMISSIONER

Volume VIII - November 14th, 2007

Santa Fe, New Mexico

This matter came on for hearing before the Oil Conservation Commission, MARK E. FESMIRE, Chairman, on Wednesday, November 14th, 2007, at the New Mexico Energy, Minerals and Natural Resources Department, 1220 South Saint Francis Drive, Room 102, Santa Fe, New Mexico, Steven T. Brenner, Certified Court Reporter No. 7 for the State of New Mexico.

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C U M U L A T I V E   I N D E X

(Continued...)

PUBLIC COMMENTS (Continued):

(Continued...)

(Continued...)

DIVISION WITNESSES (Continued):

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Commission Hearing
CASE NO. 14,015

DIVISION WITNESSES (Continued):

(Continued...)

DIVISION WITNESSES (Continued):

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(Continued...)

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Commission Hearing
CASE NO. 14,015

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Friday, November 9th, 2007 (Volume VI)
Commission Hearing
CASE NO. 14,015

(Continued...)

(Continued...)

(Continued...)

PUBLIC COMMENTS:

OGAP WITNESSES (Resumed):

DIVISION WITNESSES (Continued):

(Continued...)

PUBLIC COMMENTS:

* * *

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(Continued...)

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* * *

ALSO PRESENT:

JOHN BARTLIT, PhD
New Mexico Citizens for Clean Air and Water

* * *

WHEREUPON, the following proceedings were had at 9:02 a.m.:

CHAIRMAN FESMIRE: Okay, now we'll go on the record.

Let the record reflect that this is a continuation of Case Number 14,015 -- I probably should read the style -- the Application of the New Mexico Oil Conservation Division for repeal of existing Rule 50 concerning pits and below grade tanks and adoption of a new rule governing pits, below grade tanks, closed loop systems and other alternative methods to the foregoing, and amending those rules to make -- and amending other rules to make conforming changes; statewide.

Let the record reflect that Commissioner Olson, Commissioner Fesmire and Commissioner Bailey are all present, we therefore have a quorum, and we will continue with the hearing.

As per an agreement between counsel, it was decided that Dr. Neeper with the New Mexico Citizens for Clean Air and Water would be able to make his presentation today.

Ms. Belin, are you ready to proceed with that?

MS. BELIN: Yes, we are.

CHAIRMAN FESMIRE: Okay. Dr. Neeper?

Doctor, you haven't been sworn yet, have you?

DR. NEEPER: I have not yet been sworn.

CHAIRMAN FESMIRE: Would you please raise your right hand and be so?

(Thereupon, the witness was sworn.)

MS. BELIN: Do I need to use the microphone?

CHAIRMAN FESMIRE: If you want it recorded.

COURT REPORTER: Just leave it where it is --

MS. BELIN: Oh, okay --

COURT REPORTER: -- it'll be fine.

MS. BELIN: -- okay.

DONALD A. NEEPER, PhD,

the witness herein, after having been first duly sworn upon his oath, was examined and testified as follows:

DIRECT EXAMINATION

BY MS. BELIN:

Q. Dr. Neeper, would you please state your name?

A. My name is Donald Neeper.

Q. And where do you reside?

A. I reside in Los Alamos.

Q. Could you briefly summarize your education and relevant expertise?

A. I have a bachelor's degree in physics from Pomona College, master's and PhD degrees in physics from the University of Wisconsin.

And do you want me to proceed with the *curriculum* *vitae* materials?

Q. Yes.

A. My doctoral thesis appears as in low-temperature physics. What I was actually studying was heat transport in crystals and metals. Usually low-temperature physics means quantum fluids, but I was looking at other things. I subsequently did postdoctoral research at the University of Chicago, again looking at the transport of ions in liquid helium at low temperatures.

I bring up the word transport because I was looking for any common thread throughout my career that might bring me here, and it's that word if anything.

From Chicago I came to Los Alamos National Laboratory in 1968, where I was concerned with the transport of energy through thermonuclear devices. In other words, the total opposite end of the temperature spectrum, working at temperatures that make the surface of the sun look very cold.

I became -- After about eight years of that, I became fascinated with solar buildings and energy problems in buildings. I transferred to the solar buildings group at Los Alamos where I eventually, through no fault of my own, became group leader. But I was fascinated with the transport of how do you get solar energy from outside the building where you've got too much, to inside the building where you need it?

As solar things were winding down, I was fascinated in looking at a paper that reported chemical transport in tubes when you had oscillatory gas flow going back and forth in the tube. And as I was puzzling that I got a call from the Air Force saying, Is there anything you can do to help us out with our jet fuel spills?

We couldn't help them with their spills of jet fuel, but I began at that moment to see maybe there's a connection between this flow in the tubes and the flow in the porosity of the soil, and that led me off at that point -- it was about 1989 -- into what I call soil physics.

I studied that flow for a while. I then became an operational project leader for the RCRA facility investigation of several large waste dumps at Los Alamos containing hazardous and radioactive and volatile wastes.

I retired from the Laboratory officially about 14 years ago, continued working part time with various consulting companies on the problem of volatile contaminants in the vadose zone and eventually wandered from that to just carrying -- still carrying on my own research in the volatile issue study.

I am now officially a guest scientist at the Laboratory. That means I collect no pay, have no obligations. And the function that I contribute to them is, I sometimes find bugs in their computer code, and the function for me is, I get to talk to colleagues as I try to progress with problems of interest to me.

MS. BELIN: Mr. Chairman, members of the Commission, I believe Dr. Neeper has in prior proceedings been qualified as an expert in soil physics, and I would tender him as an expert in soil physics in this proceeding as well.

CHAIRMAN FESMIRE: Okay, that's my recollection. However, is there any objection?

Ms. Foster?

MS. FOSTER: No objection.

CHAIRMAN FESMIRE: Okay, Mr. Jantz?

MR. JANTZ: No objection.

CHAIRMAN FESMIRE: Okay, the doctor's credentials have already been accepted, and for purposes of this hearing he'll be re-accepted as an expert in soil physics.

MS. BELIN: Thank you.

Q. (By Ms. Belin) First, Dr. Neeper, I'd like to have you look at what are marked as Exhibits 1 and 2 of New Mexico Citizens for Clean Air and Water. They were attached to our prehearing statement. Can you identify and describe what Exhibit 1 is?

A. Exhibit 1 is my authorization from an officer of the organization to speak at this proceeding and at other proceedings on behalf of that organization.

Q. And Exhibit 2?

A. Exhibit 2 is a prehearing statement for today's presentation, describing my testimony and giving my *curriculum vitae*.

Q. I believe Exhibit 2 is your *curriculum vitae*. Is it a true and correct --

A. Correct.

Q. -- copy of your *curriculum vitae*?

A. You're correct, Exhibit 2 is a *curriculum vitae*, it is a true and accurate copy, and I prepared it myself.

MS. BELIN: Before we get onto Dr. Neeper's PowerPoint presentation, there are three of his slides that have had minor corrections, and I would like to, Mr. Chairman and members of the Commission, distribute to you and to counsel copies of those corrected slides.

CHAIRMAN FESMIRE: Okay, and are they anything more than typos?

Q. (By Ms. Belin) Would you like to respond to that, Dr. Neeper?

A. These are typographical corrections, they are numerical, none of the numbers that have been corrected propagated into any further calculation, and none of them have any effect on conclusions.

CHAIRMAN FESMIRE: Okay.

DR. NEEPER: I simply want correct numbers where I can put up numbers.

CHAIRMAN FESMIRE: Okay, would counsel like to have any objection to that, or would you like to --

MR. HISER: Having not seen them, I have no idea, but I doubt we do.

MR. BROOKS: The Division has no objection, your Honor.

MS. BELIN: I have six copies here, if you want --

CHAIRMAN FESMIRE: Pages 8, 14 and 17.

Q. (By Ms. Belin) Is that -- ?

A. That is correct.

Q. And Dr. Neeper, when you get to those slides in your presentation, will you make note of when you're working off of a corrected slide?

A. Yes. Each corrected slide should have an indicator at the top that it's been corrected, in some color, and some indicator in the number that has been corrected. I couldn't use a consistent color because the slides themselves are colored, but I will call attention to that which has been changed.

Q. Thank you. Are you ready to proceed with your PowerPoint?

A. Yes, we can proceed if the Commission and counsel are ready.

MS. BELIN: Before Dr. Neeper proceeds, I would like to follow the same general format that Mr. Brooks used with the OCD witnesses, that Dr. Neeper will basically go through his PowerPoint presentation. I would say because it's -- a lot of these materials are of a technical nature, it might make sense if members of the Commission have question -- I will try to ask questions if I feel that Dr. Neeper has not fully explained a slide, but it might make sense for you to ask him -- interrupt him at the time, rather than waiting to the end, if it's -- if you find something confusing in his presentation.

CHAIRMAN FESMIRE: Okay. Does that include counsel for the industry?

MS. BELIN: I think that -- let's -- If there's something very confusing, yes. I don't want the whole flow of it to get interrupted with too many questions, but if it's confusing, yes.

CHAIRMAN FESMIRE: Ms. Belin, except in a rare emergency, I think we'll go ahead and follow the presentation through and ask questions after.

MS. BELIN: Okay, fine.

CHAIRMAN FESMIRE: Is that satisfactory to counsel?

MR. HISER: Absolutely. We're prepared to ask questions at the end, so --

CHAIRMAN FESMIRE: Okay.

MR. HISER: -- that's fine with us.

MS. FOSTER: Just for clarification, would that be because you think I'll be confused all the way through?

(Laughter)

CHAIRMAN FESMIRE: Let the record reflect that the Chair did not respond.

Q. (By Ms. Belin) Dr. Neeper, you may proceed.

A. Thank you. I do welcome questions from the Commission, even though I recognize the Commission does not need my permission to ask questions at any time they may.

And for Ms. Foster I would preface things by saying, if you -- You should ask a scientist three times to explain what he's talking about. And if after the third time he cannot explain it in a way that you understand, he probably does not understand it himself.

I'm speaking on behalf of New Mexico Citizens for Clean Air and Water. This organization has been around working on pollution-type and contamination-type problems throughout the state for about 37 years. Usually we work on the technical side of issues and the regulatory side, as contrasted with political-type issues.

I've put in a couple of slides that simply deal with the topic soil physics, because sometimes this is confused, what we mean by soil physics compared with hydrology. I am not an hydrologist. Soil physics deals with the more microscopic issues of how do things move through the soil? versus, let's say, a larger issue of what is the flow of all the groundwater? The intersection between the two issues is large, and you can often find a hydrologist working in soil physics and vice-versa, but I happen to work in the soil physics area.

I'd just point out that the Soil Science Society of America, its first division is soil physics, which legitimizes the term. And I went to the Los Alamos technical library and simply asked the database there, or the card catalog, how many books have soil physics in the title of the book, and it was this number of books that you see, so it is a recognized discipline.

This is an outline of what I hope to cover with you this morning. You see a little red box at the top called Outline. I will periodically return to the outline, because I think it can get confusing, where are we going? And we need a roadmap. So I will occasionally return to the outline, and that little red box will have a word in it, Review, just so we can keep track of where we're going, because I have a rather long and technical thread to spin here to try to arrive at conclusions that are important to the considerations of this Commission.

I outlined it as a set of questions, what are we doing?

First question was, What was in the pits? And some witnesses have already addressed part of that.

A second question is, At what level is whatever it is that's in the pit is damaging?

A third question, If it's moving, how fast and how far is it moving?

That leads us to the fourth question, which I think is a central question for the Commission, Is trench burial secure? Can it -- meaning the items of concern to us, the wastes -- be treated or cleaned up? Is there another way out of this problem?

And finally the implications of these questions for the rule as it has been drafted.

So we come to the first question, What's in the pits?

Both OCD and the industry did sampling of pits that were ready for closure. I think some credit should be due to the industry here, when this question came up in the task force, for being willing to go out, get the data and share it. We're starting to see degrees of opening that I think should be honored and I'm very, very pleased to see that.

Q. Dr. Neeper, before you go further I think it might help if you gave a thumbnail sketch of your involvement in the task force and the development of the rule.

A. I was a member of the task force, I participated in most but not all of its meetings. At times I believe John Bartlit had to sit in my chair for me. We had far-ranging discussions. There was a free-flow of discussion. Most of the time it was very collegial.

Any other question I can ask regarding that?

Q. No, that's fine.

A. This is a slide that presents some of the results that industry gave us from their sampling. I tried -- I'm not giving you, by any means, all of the data. I've tried to abstract some of the data to illustrate the answers to our question of what's in the pits.

In the northwest we see the averages of chloride and some of the other key elements that were in the waste. One of the things that we noticed in the northwest -- Mr. Hiser, let me not shoot you in the eye with the pointer -- if I can make the pointer work. Yeah, you might have to sit low there. Thank you.

We notice that in the northwest chloride here at like 3900 average milligrams per kilogram on the solid sample is outweighed by the sodium, but the sodium ion weighs less than the chloride. So if they're 1-to-1 in the atomic count, the sodium would be weighing less. And that's somewhat of a clue to us that there's something more going on here than just straightforward salt.

In the southeast we can note that the chloride is much larger than in the northwest, as probably most of the participants here know, due to the fact that drilling often in the southeast has to be done with brine, because they drill with a salt formation.

But here we see sort of a more normal chloride-to-sodium ratio. The sodium weighs less than the chloride.

These -- Some of these numbers may look a little different than numbers that other people have. That's because these numbers were prepared from an updated table that I received on the 19th of November [*sic*] from these data. They've been reprocessed. So if you see a small difference here between a number you have and these numbers, it's because I used the updated data.

These are more particular instead of averages from three wells that were sample, the average chloride in the well, but also the range of chloride that was observed in the well, and we see a large range -- pit, excuse me, not well. And that tells us that by no means is a pit a uniform thing. We can't just say chemically this is the pit. Different layers apparently go into it at different times with different constituents in them.

I needed some context in which to place this, and the context I chose was the landfarm closure standards, because it's already been decided -- whether I agree with it or not is beside the point -- it's already been decided that's safe enough for a concentration in the soil for the State of New Mexico. And so I notice that generally the chlorides in the northwest are greater than the landfarm closure standards, so it doesn't feel good to walk away from it. But we notice that some of the particular samples are less, which could lead one to a hope that perhaps there's something we can do about it. At least we ought to hold that hope out there.

Diesel range organics are generally above -- sometimes not a lot above, but above the landfarm closure standard. And oil and grease, in the averages, meets the TPH standard except here at one of the wells it well exceeds it. But again, we see the range runs from very low to very high, so it's difficult to take a sample and say this is that pit.

This is a corrected slide. It says corrected at the top in red, and the numbers that are presented in red are the numbers that have been retyped. They do not alter any conclusions, nor do they propagate further.

What we see for OCD sampling in the northwest is, for most of their samples on the soil the chloride might meet a landfarm closure standard, but not always. So there is no guarantee, in a sense, that the pits are clean enough that, in terms of what we've already decided, you could just walk away from them.

I put up the sodium numbers in milligrams per kilogram, but to me the interest is the sodium-to-chloride atomic ratio of atoms or ions in the sample, and we see they're all greater than 1. There's another source of sodium somehow being put into the pits. It is probably sodium hydroxide, sodium carbonate, various agents to make the drilling fluids alkaline.

I'm not an expert on drilling fluids. I read that's desirable often to have them very alkaline to get the correct properties you want from the mud.

I also present here water samples from OCD sampling, that is, when there was water on the pits from which they could derive a sample. We see chlorides that would suggest that the water is not good for irrigation water. For most of these we're starting to see in the water something a little closer to saltwater. At least a few of them have a ratio close to one. There's a few where the sodium is again excessive compared to sodium chloride.

So we review the question, What's in the pits?

In the northwest the chlorides might sometimes meet landfarm standards, but the sodium and the other cations have higher concentrations. We can't -- We shouldn't, I think, just take the stuff out and distribute it on the landscape.

Petroleum hydrocarbon concentrations sometimes will exceed the landfarm closure standards.

In the southeast the salt is an overwhelming contaminant. I haven't shown that in detail. I can. I figured other people would show more of that, that other testimony would have shown that. But we can see that in the northwest there is some potential with salt or saltlike contaminants, so in the southeast the problem is yet much larger.

The question is, does it matter? At what level is it damaging?

Many participants in these proceedings will focus on the effect on groundwater or sometimes surface water. The function of a citizen, I think, in these proceedings is often to see what's missing, what's not being talked about. And so I enter, talking often about the surface of the ground. That's where plants and animals and people live. And I asked the question, Do these kinds of contaminants have an impact on the surface of the ground?

I therefore review some of the effects on the biota and plants. The Commission has seen some of this information before, so I don't review it in detail, but I felt at least an outline of it should be in the record of this hearing to establish why we are concerned with the surface of the ground. I'll look at the salt tolerance of plants, use of electrical conductivity as an indicator, why would we be concerned with that when usually we want to talk about milligrams per kilogram? So I will compare that with the chloride concentration. That's just to lead us to what chloride concentrations do we think are harmful in the units we usually speak about?

Why is the chloride of concern? That will bring us to the question of the osmotic pressure and the permanent wilt point in plants.

And finally the effect on soils, which is often talked about in terms of the sodium absorption ratio. What concern is it if we should put these contaminants in the soil itself?

EC is electrical conductivity. The tolerance is established in the literature, and I cite here some particular literature of Colorado State University Extension. Generally 4 is the limit accepted for electrical conductivity, with a paste that's made from the soil. You put a little bit of water in the soil, you make a paste of it, you use a vacuum to suck the paste off the soil and you measure the electrical conductivity in the resultant water that you pull off.

And so 4 is generally accepted. It is accepted by the American Petroleum Institute, which is legitimately concerned with spills of saltwater, that traditionally the objective is to get the EC to less than 4.

Well, we have all of these different measurements. I tried to find some way to leave with you a method to compare some of the different units that will appear or that people will talk about, so I made a couple of graphs of the properties of salt solution.

In the left graph I plot on the horizontal axis the percent salt by weight, because industry often talks about a percent, or the literature will talk about percent. And on the vertical axis I plot this electrical conductivity.

What I note is that this EC of 4 that the American Petroleum Institute and others talk about as being kind of a break point for plants corresponds to about .25 percent, about a quarter of a percent salt by weight. We can follow that up to how much sodium chloride you would have per liter.

We often talk just about chloride because it's the marker contaminant, it's the one that moves the fastest, moves without being adsorbed by the soil, so it's the signal contaminant. So I put on the bottom in color a milligrams of chloride per liter of solution, so that we could compare this with chloride.

Now this is a corrected slide, it says corrected in italics, and there is a number -- if I don't hit Mr. Hiser in the eye -- 1516. That is the corrected number on this slide.

What I want to not is that between saturated brine, which has about 212,000 parts per million chloride, and our EC of 4, there's a factor of 100. That's what we're talking about. Our sensitivities are at the level of about 1 percent of some of the materials we're dealing with.

The right-hand slide talks about the same thing, percent salt by weight, compared with the other measure often used in the literature, molality, which is the moles of contaminant or whatever you're talking about per kilogram of water. You measure it per kilogram instead of per volume because as you add salt to water, the water expands, it occupies a larger volume, so in some ways the chemistry is easier to talk about starting with an initial kilogram, and you add a certain amount of chloride to it.

Again, the place of a quarter of a percent salt by weight corresponds to about .04 in the molality, whereas your saturated brine out here is 6. You can dissolve about 6 moles in a kilogram or in a liter of water, and after that more cannot be dissolved.

This is a slide that we saw in the previous surface waste hearing. It simply is presenting a collection of data on the threshold where plant damage occurs. Naturally that depends on the species, so they are measuring it by electrical conductivity, which seems to be common in the plant literature, and a value of 4, which is generally accepted, kind of falls in the range of the middle of the -- middle of the range of grasses. These are a set of grasses. And that would correspond to something like about 600 milligrams per kilogram or milligrams per liter of chloride in the pore water.

And again I accent, this is in the water that's in the porosity of the soil, because that's what plant sees.

What is it that disturbs the plant? Chloride itself is somewhat chemically toxic. The effect is called chlorosis in plants. You may see it sometimes from watering your house plants, and the tips of the leaves turn brown. It's called tip burn.

Sodium is more toxic to various plant species, but one of the major effects of salt in the pore water is to increase the osmotic pressure, and this is the same osmotic pressure that we learned about in maybe high school biology where perhaps used some kind of a membrane like a catgut and put sugar solution on one side and pure water on the other, and the pure water went through the membrane.

What causes osmotic pressure is, if you have a material that's permeable to water but not to whatever is dissolved in water: in the case of interest to us, salt.

Let's picture just two tanks. This is the simplest diagram I can make of osmotic pressure. We have two tanks, one with pure water and one with saltwater, and we have this so-called semi-permeable material in here. It doesn't have to be a membrane, it could be any thickness.

If we let it sit there long enough, in essence the water will try to come in here and dilute the saltwater. And what will happen is, pure water will move into the saltwater until it builds up such a pressure that the pressure refuses to allow more water to come through. This is kind of an anthropomorphic way of looking at it. But you wind up with a high pressure on the salt side and low pressure on the water side, and that's the osmotic pressure. Osmotic pressure, I'm told, is responsibilities for many functions of life in how bodies of plants and animals operate.

Why is the osmotic pressure of interest to someone who's into soil physics? I had really had the though when -- about a year ago, that there might be some strong effects in the motion of pore water in the soils, in part due to osmotic pressure. One of the things I rather expected to find if I would look into it is that the clays would act as a semi-permeable effect, would tend strongly to retain the water within the clay, would therefore retain the salt within the clay, and perhaps be an entombment mechanism for salt.

So with another colleague, as really an academic -- a pure-science exercise, not directed at this hearing; a science exercise is something you do for the pursuit of knowledge itself -- we started a project to look at what all kinds of effects might occur in soils if you got a high enough salt content in the pore water.

This became an academic exercise. We were going to get this into one of the soil physics codes and then try to see what would happen on a large scale, that is, on the scale of rainfall and actual amounts of soil, because there were laboratory experiments in the scientific literature showing effects on a small scale or right at the evaporative surface.

And so we got fascinated, as scientists will, saying, This is a hot publication, nobody's looked at it in large case of what the systematic effects would be.

Well, I spent about four or five months just getting the physics in order to get the physics into the code. We never got the physics into the code, and so that piece of work never got done, in part because I got distracted with preparations for the hearing. But that was the background for looking into the osmotic pressure, because I thought it would -- there was a potential it was going to be a useful thing for us.

This is a graph of the osmotic pressure against the molality -- that is, the moles per kilogram -- where 6 is saturation. And at about .2, .22 moles, the pressure is 1.5 megapascals. Well, here comes another unit. That's 15 atmospheres, 15 times the pressure of atmosphere on us ordinarily. And that is cited in the literature as being the so-called permanent wilt point of most plants.

That is, if you take a plant just by drying the soil to where the suction in the soil exceeds that pressure -- and we'll talk about suction in a moment -- the plant will not recover when re-watered. That's what the wilt point generally means.

So I just wanted to look. And very crudely, if you have soil at about 1000 milligrams per kilogram chloride, about 15-percent volumetric moisture, which would be fairly common here in New Mexico, it would have -- and this is a round number; I think the actual number is 932 [*sic*] or so -- about 10,000 milligrams per kilogram chloride in the pore water.

So it's somewhere around 10,000 milligrams per kilogram in the pore water that the presence of salt by itself -- and this is a chloride count -- would reach the osmotic pressure equivalent to the wilt point.

In addition to perhaps being threatening to plants, the sodium in salt also can damage the structure of soils. And the damage often depends on how much calcium and magnesium you have available, so the damage is measured by a sodium absorption ratio. If that ratio is greater than 15 -- some authors will say 13 -- it causes the soil to be hard and cloddy. It loses its ability to hold moisture.

Clays are sensitive -- are more sensitive, and for clays the value is closer to 5. There's a citation from the literature. It was for that reason, in the surface waste hearing, for some parts, we were arguing at times for a value close to 5.

This probably will not affect our concerns here greatly, because very often in the drilling wastes there are calcium and magnesium, but the total amounts are so far out they're not even considered, the total concentrations are not even considered when people have looked at these effects in agricultural soils.

In case there was a question, I put in the easiest picture I could find that gives the -- some guidelines should you use water containing salt for irrigation. And both for sodium and the sodium absorption ratio, the recommended values are less than what you have on the soil. And that's because you apply irrigation water once, and then you apply it again, and so you keep adding in salt, basically, with it.

So we're reviewing the question, At what level is salt in drilling waste potentially damaging? It's damaging to plants if you get the EC past 4, and the damage -- a large part of the damage could be due to the osmotic pressure that's added to the matric suction in soils.

The point of this is, plants are more sensitive to salt in dry soils than in well-watered soils, and all of the plant literature that I can find deals with agricultural issues that are well-watered soils. Sodium is toxic, but it's damaging to soils when the sodium absorption ratio exceeds 15, or perhaps a number more like 5 in clay soils.

So we go ahead to the next question of, in some cases this can be damaging to surface -- concerns on the surface of the ground. The question is, Can it move to the surface of the ground if it's buried? If it moves, how fast is it moving and how far is it moving?

That takes us into a discussion of unsaturated hydrology. I think some little discussion of this is worthwhile in the record of the hearing because we need to refer back to this as we keep moving from milligrams per kilogram of soil to milligrams per liter. And is it liter in leach water, is it liter in the pore water of the soil? To make it clear, I wanted something that gives a picture of what we're talking about. So I'm going to talk a little about the pore structure of the soil, of which maybe we will be aware.

The moisture potential, which is the suction, which will turn out to be a key measurement when we go out in the field and try to measure some of these effects. For data I will show -- I will be showing moisture-potential data. I will then try to combine osmotic pressure, matrix suction and flow. How do these act together? What can we expect from them? And finally, what does that have to do with the transport of water in contaminants?

Soil is porous, it's usually composed of particles of various sizes, it's classified according to the size of particles. The volumetric moisture in a soil is simply the fraction of the total soil volume that's occupied by water. Most soils have a porosity of between 30 and 40 percent, so if you totally filled all that with water you would have a volumetric moisture of 30 or 40 percent.

The saturation, which is a term often used, is the fraction of the pore volume that's filled by water. So if you had a soil with 40-percent porosity and 40-percent volumetric moisture, it would have a saturation of 100 percent. And the calculations are often based on the saturation, because what we know about suction -- or suction is often expressed in terms of saturation.

As things move in the soil, contaminants can move on the water. Water will coat each soil particle, and between particles you'll have little lens-shaped bits of water that are held in place by capillary pressures, by the surface tension of the water, just like water rises up in a soda straw when you dip it in a glass of water. And if the soil isn't saturated you'll have air space, and air can move through that air space. But if you have contaminants dissolved in the pore water, they can move along the film and find a little lens and move better through the lens.

But you can have just diffusion with soil sitting there. One of the other witnesses has mentioned diffusion as a major mechanism. You can have diffusion along these moisture pathways in the soil.

If, let us say, there's some chloride over on this side of my diagram, we don't see a diffusion path to get to the other side. But, the soil being three-dimensional, there will be some path out of the plane of the drawing and around.

Water can flow according to suction. Moisture is held between grains by suction. We call it the suction.

It's a negative pressure, it takes energy to get it back out. It's again just that fact of how water rises in a soda straw. So water will move by unsaturated flow to a drier portion of the soil or, more reasonably, to a place where the suction is greater.

In this diagram, there isn't any way for water to move from one side of the diagram to the other because there's just an air space in between. But water vapor can diffuse through the air, steam if you will, from one side to the other.

And here's where another one of those tricks of soil physics comes in. When water vapor moves to the surface of some element of liquid water here, it doesn't have to diffuse through this tortuous path all the way to the other side to get out. If you let one molecule of water condense here and another one evaporate here on another side, it is the same thing as though you had transmitted the first molecule from one side of this wet pathway to the other, and it's called enhancement of vapor diffusion. It is sometimes treated in the literature. It can give you a factor of as much as 14 in the diffusion -- extra diffusion of water vapor, depending on the circumstances.

And one of my questions is, What does the presence of salt in the water do to that? It increases the enhancement of the movement of water vapor.

So I worked out enough of these correlations to put them in the code, but we never got them there, and I will deal with what that impact, not using that information, has on us. It won't affect us in the deep soil; it would affect what we were doing if we were trying to calculate things in the upper foot or two feet of soil where water motion is very dynamic.

This is a plot of characteristics of the moisture potential -- or the suction, if you will -- in two characteristic types of soil, plotted as a function of the water fraction of soil volume. Saturation, this is the saturation. Excuse me, this is the volumetric moisture, water fraction of total soil volume. It doesn't go to 100 percent. Most soils have a porosity of about 30 percent, and so we see here sandy soil. The chart starts at about 30-some percent.

We notice that the suction in sandy soil is a lot less than in clay soil. We can also notice that clay soil can hold a lot more water than the sandy soil. That's something we all sort of intuitively know. If you pour water in sand, it moves right through. The sand won't hold the water. The clay can hold the water, but it's harder to get it out because the suction is higher.

I put on the chart where the 1.5 megapascal or

15-atmosphere wilt point occurs. You are -- with sandy soil, you're down in the region where the water almost won't flow anymore. It's called residual moisture. The curve becomes very steep, and you're breaking the little lenses of water between the grains. With clay soil, that's kind of right in the middle of where you might possibly have the volumetric moisture.

The osmotic pressure and the matric suction -- matric suction is what the soil does just with the water all by itself -- add to form the total potential. You can think of that potential as how hard you have to suck to pull the water out of the soil, or you can think of it as the energy per unit volume needed to pull pure water out of the porosity of the soil. All of those things come out in the same units. They're pressure units.

For a salt solution, the osmotic pressure might be much greater than the matric suction, and even much greater than the permanent wilt point of 1.5 megapascals.

So osmotic pressure can kill the plants. And since the osmotic pressure is so much greater than the suction, we might expect it to be causing great movements of unsaturated water. I'm saying that the osmotic pressure is ineffective for causing flow, contrary to what I expected when I first got into this work.

This is a plot from peer-reviewed literature, *Soil Science Society of America Proceedings*, showing what is called the osmotic efficiency coefficient. That's just a measure of how well can the soil establish an osmotic pressure, compared to the ideal case of a perfect membrane or a perfect substance that would absolutely prevent the movement of salt and absolutely allow the movement of water through it. So a 1 on this scale would be a perfect osmotic mechanism or a perfect osmotic barrier.

And what we find with sodium chloride, the first three plots on this graph from the literature, is that the osmotic efficiency, the effectiveness, falls off very rapidly as you increase the amount of salt in solution.

These authors plotted it as normality at these concentrations. That's the same as molality. But I put on here an arrow to get us -- try to get us back to the kinds of units that we're familiar with. .01 here is equivalent to about 354 milligrams per liter of chloride. So it gives us a point. If we're down in the hundreds, the osmotic efficiency of clay has fallen off, and by the time we get to a higher concentration it's essentially down at the insignificant level.

So in a way I was disappointed. It meant that based on the literature there wasn't a way I could scheme to get clays to retain the moisture or selectively pull in moisture or serve as a barrier to withhold salt against water that might be up against the clays.

This is a quote from the literature, *Soil Science Society of America Proceedings*, and I bring it in literally:

> Throughout the soil moisture range encountered by growing plants, salt concentration gradients will not be an important factor for causing the movement of soil solution. However, at evaporating surfaces or freezing surfaces in soils, salt concentration gradients may be large and water film thicknesses may be very thin. Under these conditions salt gradients may become a major factor causing solution movement.

I will point out that evaporating surfaces and freezing surfaces are the regions near the surface of the ground. Particularly in New Mexico, that's where the water film thickness has become very thin.

And so we would expect salt, if it did get to within the top foot or two of the surface of the ground, potentially to have a very significant impact on the motion. It was that motion I wanted to study, for academic reasons as much as anything, and -- a situation we never got to. It was just too much work to do in an unfunded project, to get all that into the physics code.

What we can conclude from this is, At the burial depth of what industry has referred to as a burrito or a trench-burial, osmotic water flow and anion exclusion are negligible. In other words, I can't use the trench, loading it with clay, to help hold the salt itself, and that's one of the things I thought we might have.

So how is water transported?

We talked about it can be transported by saturated flow if you just load all the pores with water.

By unsaturated flow. Previous witnesses -- at least Dr. Stephens has talked about unsaturated flow where the water moves from particle to particle through the soil.

I discussed that it could happen through diffusion of water vapor and the enhanced diffusion of water vapor. In a salt gradient near the surface of the soil, this diffusion of water vapor might be highly significant, because even the enhancement is affected by the presence of salt.

At the surface we have evaporation and transpiration of water, but that is a surface consideration, near-surface.

And finally we have the question of the diffusion of contaminants. I mentioned that contaminants could diffuse right through the water. And I asked myself, Could that be a dominant mechanism?

So I throw up something we might be familiar with for diffusion. I simply took a wine glass, put water in it, let the water become very quiescent, sitting for hours, and then used a hypodermic needle to inject a small amount of food covering down in the bottom of the glass. And I covered up the glass when I wasn't taking pictures so that air currents wouldn't disturb things, and just let it sit and watched what would happen.

By the next morning you can see the coloring diffusing out. It will form a fairly concentrated front when it's diffusing into infinite media, with a long tail of concentration leading out in front of the diffusion front. So you can see the rest of the water becoming colored.

Well, there's a surface up here through which the coloring can't go, so I waited another 24 hours, and essentially, as far as your eye can tell, we've lost the gradient. The whole glass has become full, because what was diffusing out, you can't maintain the front diffusing on and on, there's no more water up here and the whole thing becomes filled.

That is just a view of diffusion, so we understand what diffusion means, as contrasted with movement of the water.

There are characteristic distances for diffusion of salt through water. The diffusivity of salt is known in bulk water, and for a distance of 1 centimeter the characteristic time would be 18 hours. We saw something like that, it moved a centimeter or two, about an inch, in the overnight tie, for what we could recognize as a significant change in coloring.

But the time for diffusion goes with the square of the distance. In diffusion of anything, a diffusion solution, all kinds of transport is often governed by the diffusion equation, and the time goes with the square of the distance.

So between one centimeter and one meter there is a factor of 100 in distance, a meter being about three feet plus three inches. That factor of a hundred, if you square it, is a factor of 10,000. And 10,000 times 18 hours is about 21 years.

This means that diffusion in the soil for contaminants moving through water is important over short distances. It will tend to try to equilibrate concentrations, say, from one fast path or one preferential pathway to another But it will be a slow mechanism when you're trying to move large distances like many meters. It's there, it's always there, you can't stop it. It's slow, but it's sure. It's going to be 21 years for one meter. If you go up to 10 meters, you're up another factor of 100 in time.

The colligative effects -- this means effects of solution ganging up together on transport -- what are the effects of dissolved salt in water?

I have talked about the osmotic pressure and the fact that uncompressed clay is ineffective as a semi-permeable membrane. It leaves liquid flow unaffected except in thin films.

Now in the literature you can find cases where compressed clays, clays at several thousand feet deep, act as osmotic barriers if you have saltwater on one side and pure water on the side, and people have looked at actually measuring the osmotic pressure difference across those that occur naturally.

Water vapor pressure is an effect. The salt reduces the vapor pressure by 24 percent. So if you have a saturated brine, its vapor pressure will be reduced. And that will increase just the gradient of water vapor so that you increase a transmission of vapor, and that's in addition to this enhancement effect that I talked about. The enhancement factor normally varies for about 1 to 13, and salt can raise that, in the extreme, to about 26. That is, water vapor might be moving about 26 times as fast as you would expect it from straight-out diffusion theory.

Salt increases the surface tension, that will increase the suction.

And finally, salt will increase the density by as much as 20 percent, which would increase the gravity flow.

Laboratory experiments show that these effects can be very significant, and I again go back, for salt transport in dry soils.

I'm laying a groundwork here to tell you why modeling is legitimate, both my modeling and the modeling of other experts before this Commission, even though they didn't include these effects.

So I'm going to talk about some modeling, modeling of mine, and for that I think I should preface it with a little discussion of just what is a model?

There are different kinds of numerical models. Some models actually do a simulation of what's happening. You can divide up the soil into a series of little imaginary boxes and for each two boxes you can calculate what's the flow between those boxes, how much chloride moves between the boxes, what are the osmotic pressures or what are the suction pressures? Calculate all of these things and let a little bit of water move. Then you move on to the next pair of boxes and do the same thing.

And so you have advanced things by some small step in time. Then you advance the time and you go back and do this. And you do it and do it and do it, until you have done a year or 100 years, or whatever you're trying to simulate.

But the calculation actually simulates what you think is going on in the soil. You hope that you have included all the effects that are important, because you can't include everything.

Another type of model might include a correlation or a recipe. For example, you might have a membrane and may have done many tests on the membrane, and depending on the degree of damage and quality of the membrane and anything else you know about the membrane, you may have a recipe for how much water is transmitted by the membrane under what kind of conditions of pressure.

And this, then, is a recipe. You're not simulating the actual flow through the membrane, but rather you're applying a recipe in time to get how much water under a given condition flows through. And you can use one model to drive another model.

I believe that's probably what some of the OCD modeling did when they used one model at the top of the soil and another model beneath it.

All of these approaches are legitimate. But one must understand that, at least in my view -- and I've been doing modeling, I guess, ever since I had been back in the weapons business 30-some years ago -- that modeling is good to show you the effects of parameters. If I double the amount of rainfall, what's going to happen? If I change the porosity of the soil, am I going to get more flow or less flow? It will give you good estimates of time and motion.

If you want to get exactly the concentration of chloride to three significant figures or something, you're going to have to have a very exact model. And the thing that you are simulating, you have to know its properties very, very well.

Usually we don't know the soil properties that well. Usually soil properties will change from one place to another over a short distance by some amount. The porosity will change, the hydraulic conductivity will change, the soil will have different lithology in different layers. And so unless you include all of that in absolute detail in the model, you may not get an answer that gives you exactly what the chloride is going to be at some point in time. But you can certainly get an idea of about how far is it moving and how fast is it moving.

This is not an argument to invalidate anybody else's model. In a way, this is an argument to support many different models, because -- Dr. Stephens' model would show one answer, but as I understood him he used a given infiltration rate. That was like an assumption or a parameter of the model. He could have doubled that or halved that or done different things with it. He chose that as perhaps a very characteristic situation and showed what would happen under that circumstance. I will also show you with my modeling what would happen under the set of circumstances I chose.

I'm asking you not to be worried if I show at some point a different number than Dr. Stephens showed, because I don't think there's any conflict between what the two of us are presenting, and I wanted to have that up front.

My modeling is one-dimensional, that I show here. I'm looking at unsaturated flow again. I will have typical soil parameters for three soils. Instead of driving my model with either rainfall or an assumed infiltration rate, I'm going to drive my model with the moisture that was actually measured in the New Mexico soil as a function of time, and you will se that.

I am ignoring all the effects of solution, these colligative effects. That means what I'm showing you is not exact near the surface of the ground. And in fact, I will show you that I just approximate what's happening at the surface of the ground.

I think that's true in other cases. Dr. Stephens showed -- he didn't deal with how he got the 2.5

millimeters per year of infiltration. That's what we measure down low; let's start with that up high and see where that leads us.

The modeling conclusion that we'll get out of the modeling I show will reveal that chlorides move preferentially downward in sandy soils. And that would be congruent with, I think, what the Commission has heard from previous modeling studies presented here.

I will also show that the motion is upward when you get to what I call tighter soils or more claylike soils.

Excuse me for a minute, I'll wet this voice.

The code I use is the FEHM. It goes by its initials, it's named FEHM. That stands for finite element -- FE -- heat and mass. It is a code that simulates at a very basic physics level the motion of heat and mass -- being chemicals, water, chlorides or whatever else you might have -- through porous materials. It's a code developed at Los Alamos strongly for studies of the Yucca Mountain repository. The code is in the public domain, any person may have it for free, I believe. It is -- addresses to where you may obtain it are on the website. It is a research-level code. It is not at all user-friendly. It is a dynamic thing in that people adjust it every day as they need to for a particular problem they are working on.

So with that code you don't start by giving it some broad outline like so much rainfall and so much depth, and the code figures out itself what to do for you like some of the commercially available codes. This is a code in which it is almost assumed the user is working with the microscopic physics and puts in inputs according to that. So I don't recommend it for most users. At the risk of offending my friends, I'll say it's a nightmare to use. But it works, and it lets you do almost any physics you want. We were trying to put in additional physics for colligative solutions, and we just never got the job done.

The model I have, one-dimensionally, is a column of native soil, an aquifer at the bottom that is a saturated region. And I start the model -- My zero level of depth is actually about a half a meter or 20 inches under the ground. What I'm doing is telling the code, here, as a function of time, is the volumetric moisture at this point. How it got there, the code doesn't know and doesn't care. And I watch what happens.

The first thing I do is give it a year's worth of moisture. How does the moisture vary with time? And I run it year after year after year, maybe for a hundred years, to see how it establishes a moisture profile in the soil.

That profile is not the same as the static profile you would get if there were no evaporation up here and you just let the soil wick up moisture however it would from the groundwater. You get a very different profile from the dynamics, even from the small amount of moisture that we have in New Mexico.

Now that's a starting point. That moisture profile is a starting point for running the real problem when I insert waste between one and four meters, roughly between three and 12 feet -- three and 11 feet -- in the ground, and then let the moisture continue to be supplied at the top surface, and watch what happens.

And what I'm looking for is a question of how far does it go, how fast does it go, where does the moisture go, where does the chloride go, an inert tracer? And I do that for three soils.

The distances -- Let me back up, try and remember. The distances here are chosen to be of interest to us. The distance from the bottom of the waste to the aquifer here is about 52 feet, which is close to one of the distances established in the proposed regulation.

These are the -- this is a table of typical soils, taken from a US Environmental Protection Agency database. It's published under the report number that I give at the bottom. They cite that this came from the Carsel and Parrish paper published some years ago, and it was cited by Dr. Stephens.

I went back and looked up the original literature, and for all the various numbers I checked indeed the were the same. I chose to take it from the EPA, saying perhaps that's sometimes a more credible or acceptable citation.

So I list 11 types of soils, just for comparison so we can see how parameters vary.

This first column is the residual moisture. That's how dry you get as volumetric moisture, about at the point where moisture refuses to move anymore. You can't get any more moisture out of it by suction.

I list the saturation. That's the porosity. You notice most of them are about 39, 40 percent. Here's one at 45-percent porosity.

The parameters alpha and n are parameters that go into the so-call van Genuchten relations, which is just a way to calculate an approximation of the hydraulic conductivity when it's unsaturated and the suction when it's unsaturated. This is well established in the literature.

I list the saturated hydraulic conductivity characteristic of the soil, and I also calculated what would the hydraulic conductivity be if you were halfway between the residual moisture and fully saturated? That was a way of lining soils up into order. I find that kind of a more realistic number by which I can understand which soil is loose and which soil is tight.

From these I chose three soils, a sandy loam which I call loose, a sandy clay loam which is moderate, and a clay loam which is tight. Is there such a thing as a tighter soil? Yes, you can go to a pure clay. Are there looser soils? Yes, you can go to a pure sand.

But if we go out on the ground in New Mexico, we might reasonably run into soils somewhere of this type. And Dr. Stephens stated which one of these soils he used. I didn't write it down. I think it was the loamy sand. And someone else can correct me, otherwise. We're close together in this.

This shows the moisture profiles in that soil. The first upper-left graph, just so we can see it, shows what the suction would be as a function of saturation, as a function of the water fraction of pore volume. The suction goes down to zero as it gets to fully saturated. I put in a pure clay, just for comparison. We can see that the clay has very high suction, and we can see that the sand or sandy loam has very low suction and begins to reach its residual even before we hit the wilt point of about 1.5 megapascals. I show that as that horizontal yellow line.

And the right-hand graph, again, I put saturation on the horizontal axis, and I show the hydraulic conductivity in centimeters per day, unsaturated as you would calculate from the van Genuchten relationships.

These are really parameters. This is a recipe that is used by most codes. When you run an unsaturated hydraulic conductivity, it depends on how much moisture is in the soil. You need some relationships, and Mr. van Genuchten worked these out that are characteristic for many soils.

What we see is, as the soil gets dry the hydraulic conductivity drops way down. And so a tiny difference in here, in water fraction, can give you a huge difference in hydraulic conductivity. And that can lead to your changing your estimate, let's say, of what infiltration would be, where it would be equally valid to say the infiltration is a certain amount or twice that amount or half that amount. You can get varying estimates. You become very sensitive to a parameter, and therefore you have to be careful about getting an absolute number out of it.

I plot here depth below ground surface, going down to my 20 meters or a total of 65 feet, which would be about 52 feet below where I put the wastes in the final problem. And I show here in the steady state -- or in static equilibrium, excuse me -- if you just let moisture suck up from the surface of the ground, what would the profile look like?

You notice up near the surface of the ground, once you get a few meters away from the aquifer, this profile is fairly flat, flat, and so you can afford to make quite an error in depth here, and it doesn't change things much. If I were to take this aquifer and move it down another 30 feet, I wouldn't change this amount of moisture very much.

Here's the actual moisture with which I drove my problem.

The top plot shows the temperature and the volumetric moisture as measured at a 20-inch depth at an instrumentation column that is installed by the Natural Resources Conservation Service at the little place called Crossroads in Lea County, New Mexico. This was the most credible data I could find with which to drive the problem, and I wanted to drive it with something realistic.

What we see is a nice clear temperature plot, because temperature is easy to measure. We see some jiggles in the volumetric moisture. They provide hourly data, and you have to dig it out. This is, I believe, a radio-frequency instrument, and it generates a little noise. But it's not hard to draw a fairly smooth curve through that. In fact, for modeling purposes one could say for these 90 days here, we will just use a value of 5. And so it becomes fairly easy to break this up into times of the year when different things happen.

Well, the year 2006 was a particular year. How do we know that's a general year? We don't. We don't have a typical year. I could go back and try to model from the assumption and use typical rainfall, but then I would have to simulate how much do the plants transpire back to the surface, how much gets through, how much evaporates? And that becomes a very sensitive calculation to the parameters you use. That's 99 percent of the moisture, perhaps, or a lot of the moisture. But if I don't treat that correctly, I won't get what's happening below correctly.

So I chose to use the data from this depth. It shows changes, it shows both drying and wetting, so it will cause both the drying and wetting effects to influence the rest of the problem. And we'll get to see what those dynamics would do to something deeper in the problem, I hope in a very credible way.

Well, what would happen if we got a wet year? The data for this instrument go back only partway into 2005, and the data aren't valid for about half of 2005, because you can see the instrument re-establish itself -- you can see the moisture re-establish itself in the soil after the instrument was installed.

So to create just something I would call a wet year, I took the spring of 2007 when we had lots of rainfall in the southeast, and I took the last half of 2006, and I glued them together at a point where their temperatures and moistures were about the same and said, I'll use that as a characteristic wet year to ask myself, What happens during a wet year?

These are the results of the calculation, and I think at this point I should interrupt myself to assure you that these calculations were not done at Los Alamos National Laboratory. They had nothing to do with Los Alamos National Laboratory. It's true that I work with other colleagues there on the soil physics, but none of the information I present here was done at the laboratory. All of this was done on my own home computer, and certainly on my own time.

I'm showing here results for a sandy loam or what I call a loose soil, and I've got that same soil in the pit or the burial unit. Dr. Stephens also used that same kind of approximation with the same soil throughout.

What I have is the initial moisture profile in that equilibrium situation when it's being driven year after year by the same moisture driver. And so you see some wiggles up here near the surface of the problem. These graphs are all presented as things were on January

1st. January 1st is a dry time, and so you see the moisture near the top of the problem dropping off. This is, then, the starting condition.

With that starting condition I put in my burial unit, which I rather arbitrarily say has 80-percent saturation. It's not fully saturated, it's probably close to what might be called a field saturation or field condition. It's not a liquid, runny material, it's been dried to this point. And we follow what happens.

The left graph shows what happens to the water. The red line shows you what happens in one year. And the excess moisture that was in this material -- and I point out, I, as other modelers do, am neglecting the membrane. I have said the membrane has decayed, I do not have a model for the plastic encapsulation. Within one year a lot of this chunk of extra moisture has moved down toward the aquifer.

On the right-hand graph I show what's happening to the chloride. Within one year it moves a few meters, or about tens of feet, below the original bottom of the burial unit. And you say, Well, if it got only down here to 10 meters in a year but a lot of the water got all the way to the aquifer, what's going on? The chloride, as it moves out, is being diluted into the pore water that's already there. And so it doesn't move as fast as the water itself moves. It's being held back by this dilution.

Well, we can see what happens in 10 years, and the yellow curve gives you 40 years. You can see it has reached the aquifer. But I don't calculate what's in the aquifer, I just let it disappear at that point in my calculation. I'm interested in how far, how fast, and not into what's the motion of the aquifer and therefore what's the concentration in the aquifer. I'm try to ask, can t get there?

At 100 years -- that's the dotted line on the bottom -- it's all gone. And notice it's not up to surface. At the first year we saw a little wiggle. By the first of January, after the first year, some came up to the surface -- toward the surface. But in the long term it all went down.

This is the same soil, the loose, sandy loam soil, but now in the burial unit I have put a clay -- a tight soil, the tightest of the three, clay loam. There's some clay mixed in.

Again, we start with the same initial moisture profile, and after one year we have the red curve. Notice again, it's still dry on the surface -- going up toward the surface of the ground -- but a lot of the moisture looks like it's been retained in the burial unit. And yet we see this little blip headed downward toward the aquifer.

What's going on?

This material, remember, has high suction. So if something comes in from the surface of the problem, 20 inches under the ground, this material wants to retain it. It may transmit it but it wants to retain it, and you see a little buildup toward the bottom of the unit from moisture received from the ground.

If we look at what happens to the tracer, which represents the chloride, a little moves up after one year. Notice it doesn't move very far below the burial unit in one year. In 10 years it's come down here to 10 meters below the burial unit. In 40 years it's just now reaching the aquifer, and in 100 years most of it has gone into the aquifer, even though at 100 years you still find a lot of that moisture in the burial unit. It just isn't the same moisture.

This again is the same soil, clay -- sandy loam soil, the loose soil, the tight pit. And I simply went to a 35-meter depth. That is, the aquifer would be 100 feet under the burial unit because that's of regulatory interest. And what happens is, we get back about the same situation. I have carried -- At 40 years you don't see any difference. It really didn't matter where the aquifer was because that moisture profile in the soil was so flat. But it does show that at 100 years the pulse is still headed downward, and it's reaching the aquifer at 100, 102 or so feet below the burial unit. This is in the loose soil.

I now move up to a more moderate soil, and I use that same moderate soil in the pit, we go through the same exercise. We find the pulse of moisture moving down, but it moves more slowly. And in 40 years the pulse of moisture, original moisture in the pit, coupled with whatever comes from the surface, really hasn't even affected the aquifer yet, We see it in January dry at the surface. If we look at what's happening to the salt with this moderate soil, we see the chloride gradually moving down.

At 100 years the chloride is only about at 12 meters. That is, eight meters -- 24, about 28, 30 feet below the bottom of the burial unit. In a hundred years it hasn't seriously threatened the aquifer.

Uh-oh, look at what's happened. In one year it's come up partway, in 10 years there's a significant movement upward, and by the time you get toward 40 years or 100 years, there is a significant upward movement of the salt. Now remember, there's -- the top 20 inches of problem I haven't represented. I've just let the salt accumulate here. So in effect, I'm artificially building up a high concentration. That in a sense retards the upward motion. What I'm saying is, all of the things I've left out, the top surface that I left out, the colligative effects that I've left out, as far as I can make a judgment, are all in the region of minimizing the transport. In other words, I'm making an underestimate. And that's particularly true toward the surface of the ground in this case.

The concentrations I use, you may wonder why it's a scale of zero to one. That's because we don't have in this problem any of the colligative effects, the salt or the chloride in effect does not alter the transmission properties, and so you can consider this 100 percent of whatever was in the burial unit and multiply it, any number on here, by what you think the concentration was in the pore water of the burial unit. If it were nearly saturated, that might have been 100,000 milligrams per liter of pore water. You can put in whatever you would like. I think one estimate you could put in would be just 100,000 and say, These are the numbers on a scale of zero to 100,000.

Well, here is that moderate soil and a tight pit. What we see for the water is -- water is now, remember, with -- in one of the previous problems the moisture was held in the burial unit when I had the loose soil. Now that I've gone to a moderate soil, we don't see water being held so much. The water is decreasing over time in the burial unit. Why is that? It's because the soil outside the burial unit has more suction. It can suck the water back out, it's in competition. So water can still flow through. We see some water moving downward from the original pulse.

We can look at the chloride content, and again the chloride does not go all the way to the aquifer in this simulation. It gets down to about minus 10 meters. But we notice the dominant motion is upward.

Well, I don't want to bore you all day with these charts -- they may fascinate me but not fascinate other people -- so I go to a tight soil and tight pit. Again, we see more total moisture gets moved out of the burial unit because the soil is equal to the burial unit in suction. But if we look at what happens, we still see chloride moving downward to about the 10-meter level, and we see a very dominant motion upward.

Now if you were to look at this at different times of the year, you would see this upward spike going up and down, because in the summer when it rains fresh water moves in. That tends to move it down, we have a dynamic situation. By January 1 when it's dry, some has come back up but it doesn't go to zero. It's not sloshing all the way in and out.

CHAIRMAN FESMIRE: Doctor, would this be a good time to take a break?

DR. NEEPER: This is an excellent time.

CHAIRMAN FESMIRE: At the request of one of the Commissioners, who shall remain unnamed, we're going to take a 15-minute break instead of a 10-minute break. So why don't we reconvene at a quarter to eleven back in this room? Thank you.

(Thereupon, a recess was taken at 10:30 a.m.)

(The following proceedings had at 10:48 a.m.)

CHAIRMAN FESMIRE: Let's go back on the record. For the record, this is Case Number 14,015. Commissioners Bailey, Olson and Fesmire are all present, we therefore have a quorum. This is a continuation of the case.

And Dr. Neeper, I believe you were in the middle of your primary presentation. If you'd be so kind as to continue, I would appreciate it.

DR. NEEPER: Yes, we were discussing some modeling that I had done regarding the transport of chlorides in various types of soils. I'll continue at this point with a broader discussion.

Out of all this, what do we see? A scientist gets fascinated with charts and graphs and all the numbers, but for other people who don't find fascination in that, what do we see? The big answers are, at least as shown by the modeling:

In loose soil, the chloride travels from the burial unit to groundwater, say at 52 feet below the wastes, in something like 40 years. Or by the model, if you had groundwater at 101 feet below the wastes, the time of arrival is like 100 years. The point is, it's delayed, but somewhere it's still on the human scale.

If you go into a moderate soil it gets down only to 16 feet below the wastes in about 40 years and 20 feet below the wastes in 100 years. The motion is still going on. What happens after 100 years, it's still moving, it's just moving slowly. It's beyond kind of a human recognition or a human ability within a lifetime to relate to it.

If you get into tight soil, it gets 13 feet below the wastes at the 40-year point and 20 feet in a hundred years. It's very similar to the moderate soil, because they're both doing about the same thing with the moisture. And you have a continued very slow motion.

The moisture profile in the soil is dominated by the long-term average receipt of moisture from the surface, is what I learned in this model, rather than by the upward flow or upward suction from the aquifer as I modeled it. I didn't know what to expect before I did that modeling.

In the loose soil, the calculated recharge rate at -- this would now be 67 feet below the surface of the ground -- came out, depending on how I handled the moisture where I injected it, between 1.4 and 3.5 inches per year. well, 3.5 is a large number compared to anything we see. 1.4 is perhaps larger, certainly, than the average throughout the Ogallala, but it's not an unheard of, probably, local number if people think there is some recharge somewhere there.

In the moderate and tight soils the calculated recharge turned out to be less than .05 inch per year. What happened was, I ran through that steady-state calculation -- I think I ran it several hundred years, trying to get to the final point, and all we came up with was a very negligible kind of recharge.

So the question comes, How realistic is this? Does this relate to the real world?

I think it provides the size and the time scales of the activity, it shows you how far and how fast it's going. It doesn't give you an exact quantitative estimate. Exact numbers of chloride concentration would be sensitive to the numerical values of the permeability, for example.

The measured volumetric moisture at 20-inch depth, which is what I used as a driver, real data -- it injects and it withdraws water from the problem.

If you looked at a deeper measuring point in that same instrument, it would suggest the instruments are in loose soil. To me, when I'm out on the landscape, out in

Lea County, the soil looks sort of sandy and loose.

If you had a tighter soil but with that same instrumentation in it, the suction at the 20-inch depth, let's say, would be such that it would have shown a greater volumetric moisture. Namely, the suction is greater, it's going to hold water better, just as we saw in the type curves that I showed.

And therefore, for the tighter soils, the model probably has too little moisture in the subsurface profile, in the driver. And that, again, leads to an underestimate of chloride transport in either direction, up or down.

So as best I can estimate, all of the uncertainties that I'm generating are in the direction of underestimating the transport, but I don't have a solid basis to tell you how much. It's not factors of 10 away from what I think is a fairly realistic estimate, based on what we see out on that landscape, and based on the measured moisture that we saw in that one instrument.

Again in terms of how realistic is it, if you were to look at a three-dimensional model, you would see dispersion of chloride coming out sideways from a burial unit. Chloride would move horizontally, it would create a broader plume, and so it would be being carried down from the sides. If the burial unit is of tighter soil than the surrounding soil, then it's going to go down a little faster because it's less impeded by the assumed permeability of the pit material.

The year 2007 had a greater rainfall than 2006. I know because it rained out my drilling activities we'll talk about soon. I used 2006 as a typical year of rainfall, because that was a year from which I could get a consistent year of data without what I think is the unusually high springtime rains that we had this year. And I wanted to drive the problem with real data.

I did run problems, running six years of 2006 data and at every seventh year inserting one year of that artificial wet year that I really invented. It really didn't change things much. If every year were a wet year, I'm sure it would change things a lot. But one wet year every seventh year didn't change the transport a lot in moderate and tight soils.

In the loose soil it washed downward t the aquifer anyway, and so the seventh year being wet would just make it wash a little faster.

I again point out, the model did not include these colligative influences that I've talked about. They might have increased slightly the transport beneath the wastes, but that's not where the gradients are large, particularly the temperature gradients that add to this. It's the transport above the wastes that would be increased by the colligative effects.

We did not attempt to modeling of the region near ground surface. And this is kind of an imperial "we". I don't think any of my associates in the group worked on the modeling. Other people worked on some of our data reduction. So the "we" there means I.

The model confirms that except in loose soils we can expect chloride to accumulate in significant concentrations in the region beneath the ground surface. It may take it a while to get there, it may take a number of years.

Broad conclusions.

In loose soil moves downward. In moderate and tight soils, probably it's the upward motion that's going to concern us the most.

In the absence of preferential pathways, the time scales for migration to the pit region in the loose soils seem to be 40 to 100 years.

I did not run problems longer than 100 years. I could have. It's sometimes not easy. Some of the problems had very detailed spatial definition. I had calculational points sometimes every two to four centimeters in the problem, and so they were very long-running. They would sometimes run 10 or 15 hours for a problem.

The graphs show the concentrations at January 1st of a particular year so that the graphs could all show the same thing. The chloride concentration near ground surface varies seasonally and is smaller during seasons of rainfall.

Does the model compare with reality?

The conclusion to that is, the model calculation are consistent with the results of three field exercises to test both the surface and the subsurface samples for chloride.

I used the word "consistent". I do not say the model calculations are the same. There is no way I could know all the details and lithology of the soil to put in the model, to try to reproduce exactly what we saw in the sampling, and I don't know exactly the history of how things got to be where they are in the sampling. So the most I can do is say, Are we at all with reality?

The sampling was done before the modeling was done. Modeling is very useful for helping you to understand real-life data sometimes. That's one of the things you can do with modeling, is help you understand the data.

There was -- we did subsurface sampling near Caprock in the March-April time frame of 2006. Part of that was in preparation for the surface waste hearings, just going out and taking sampling on closed pits.

We did subsurface sampling out in the same places April 3rd of 2007. We were out earlier, and the rains came and the driller took off, fearing he'd get stuck. These are the vagaries, so I made an extra trip and had an extra callout of the driller for no benefit there.

And there was subsurface sampling near Loco Hills on June 30th. That was reported by Marbob Energy Corporation. And at this point, that came as a result of our discussions in the task force, and my talking about sampling I was doing.

This is a generosity, this is a courage in the industry that I think should be recognized. Data. Data that you don't know about ahead of time. Information that you don't know, where you're going out to get data and ask questions, can be dangerous or even fatal to either party in a controversy, because you don't know what's going to happen.

Marbob was willing to go out and sample and drill in one of their closed pits -- in two of their closed pits, not knowing what the answer would be. And I didn't know what the answer would be. They wanted to know, we wanted to know. And suppose they had -- we had drilled all the way to groundwater, if there's any groundwater out there, and they found horrendous contamination. Think what that would have meant to them. So I think some kudos are due here.

First slide just gives you a picture. These areas are just arbitrarily numbered according to the number of places that we had visited. This is a pit at a well that was completed in 1976.

I have deliberately not identified the well -- I will hope that's acceptable to the Commission -- because it is not my objective to raise any controversy about the present operator or the landowner or anything else. Our interest is in information.

Q. (By Ms. Belin) Excuse me, Dr. Neeper. Can you identify in your sampling which pits were lined and which were not?

A. Yes, I will do that. Thank you.

This pit was, as far as we can tell, not lined, particularly due to the age, but there was no evidence of plastic out there. What you see is essentially a dead area. And at the time this sampling was done my purpose in sampling was to try to sample to the edge of the vegetation, out into the snakeweed you see here in the foreground -- I would call that sparse snakeweed -- and finally into the grassland, because I was looking for the gradation in chloride content, if chloride was what was causing this.

It wasn't quite that simple.

I have a feeling that two slides went by. Can we back up? Ah, thank you.

This is a second unit that we sampled. This well was completed in 1996, so it's younger. It did obviously have a liner, and we can see the liner emerging from the ground, or perhaps it has always been that way.

Again, you can see the sharp edge here where the snakeweed starts, and a little while after the snakeweed the grass would start, and that was the important facts I was trying to bring into the surface waste hearing.

This is a remnant from the surface waste hearing. It just shows -- The numbers are sort of numbers of samples showing a given chloride content. And where I found from sparse snakeweed to dense snakeweed to sparse grass out into undisturbed grass, I just didn't ever find anything over 400 milligrams per kilogram of soil.

When I found high concentrations I was usually past the edge of the snakeweed and out in the middle. In other words, I couldn't find a gradation. The gradation in chloride content was quite sharp right sort of at the edge of the sparse snakeweed, and it was a tremendous correlation of dead area with high chloride.

So this year we wondered -- "we" here now is the group, I did do this in coordination with other members of the group and I had another person, a friend, helping me --

I wanted to know what --

Q. Dr. Neeper --

A. Yes?

Q. -- the group -- Who is the group?

A. The group is New Mexico Citizens for Clean Air and Water. This is a function sanctioned by the group, and we were spending some group money on it. I made the arrangements. I hired a drill rig, and we went out and did some environmental drilling.

This is that pit that I showed you that had the -- the more recently closed pit, had the plastic coming out. We drilled both of those pits that you saw before. Drilling can be a disappointing exercise because if you haven't been out, say, with a ground-penetrating radar or something to locate exactly what you're looking for, doing geophysics ahead of time, you're not guaranteed you're actually going to be in the pit, you might hit a berm, you might hit something else. In some cases we would drill a couple of holes hitting either cement or a board before we could get a decent hole going down. And so we spent money very rapidly.

The samples, most of them were analyzed in this analytical laboratory --

(Laughter)

A. -- which masquerades as a dining-room table at times. This is --

CHAIRMAN FESMIRE: Is there a Mrs. Neeper to whom we owe some sort of gratitude?

THE WITNESS: Well, at least I can assure you I was present when the picture was taken, although I did not take the picture. And we could have had a different person in here. Another person helped with some of the analytical work.

This is to say -- It's an amateur-looking show, it's not all entirely amateur. We are using chloride strips that were really introduced by Kerry Sublette of the Institute for Petroleum environmental consortium, so that operators could do a quick estimate in the field of what kind of chloride they had.

We find these things to be pretty credible. The announced method that is given by the Institute is approximate. You essentially mix equal volumes of water and soil and you get a reading. We evolved it a step further using an analytical balance back here as we got farther into this problem, using very -- given amounts of soil and water, getting then very consistent results.

The white instrument here was rented. In two different months I rented the instrument. It's for measuring the moisture potential. In fact, the company that makes these instruments used to sell them pretty exclusively to the food-processing industry, because you either want to dry out some foods like potato chips, or you might salt foods like pickles, or you might put sugar in foods like canned peaches, and the effect of those things that you dissolve in the fluids is to raise the osmotic pressure where, as I understand it, the bacteria can't live anymore, and you preserve the food. But now the company makes the instrument with a model specifically for doing soil analyses, and this was the soil instrument.

This thing is a hand-held electroconductivity meter, various bottles of distilled water and whatnot.

What you didn't see in the picture was the commercial drying oven. That was out in my garage, because if you bake the samples in the house you sometimes get a good small of crude oil, and there are certain parties who object to that.

The little blue dots I will show you on all these curves are the data analyses, are the analytical work we did ourselves. Occasionally you'll see a red dot. We sent some samples to the laboratory to get confirmation from a standard laboratory that we were doing the right thing.

You can look at these things all day. I'll try to hit some high points.

This is gravimetric moisture at that pit 5. That's the older pit without a liner, 31 years old at about the time we acquired these samples. You see a spike in moisture here at about four feet deep and a constant moisture down below.

If we measure the potential, sure enough, you see a drop in potential coincident with the spike in moisture, and you would expect that. The thing that might leave you puzzled is, the potential out here is at 4 or 5 megapascals, which is not what you find every day in the soils, even in New Mexico.

Notice pit 5, hole A. We did get a second hole in pit 5. You see some more noise in the gravimetric moisture, and down below we see a smooth peak in the moisture potential. And perhaps it's beginning to taper off here, perhaps this one is beginning to taper off, but we're getting smooth -- good curve in the moisture potential.

What you notice is, these stop at 15 feet. We stopped drilling at 15 feet. If we'd known what was out there, we wouldn't have. We were trying to do quick strip chloride analyses while we were drilling. The strips are too slow. That meant I'd have to hold up the drill rig. I think the charge was a hundred dollars an hour if I stopped the drill rig. I couldn't tolerate that, and by the time we'd hit a couple of false holes money was going away very rapidly. And at $28 a foot rig charge, I stopped the drilling at 15 feet. And I sort of wish I hadn't, but we got some information.

Pit 8 is that one that's 11 years old that had the liner emerging from the surface. There's a large gap here where we don't have any data. That's because right at about this point a piece of wood jammed up into the core barrel. We were taking continuous cores, so we could try to see what we were doing, and we lost all that data for that interval.

Again, we see perhaps a hint that the moisture potential tapers off somewhere 11 to 12 feet.

Now I'm showing the chloride related to the soil, and this is related to units of dry soil. We see where there's high moisture, for whatever reason -- I'm still a little puzzled -- the chloride drops way down. It's as though some of this year's rainwater got into that level and we got some fresh water down there. That's one -- one circumstance I can think of that might do that, if you had a preferential pathway, got some moisture down in that level right where we drilled.

If we look at the chloride content referred back to pore water, since we did measure the gravimetric moisture by drying the samples, we can now relate our chloride measure both to dry soil mass and the pore water. You see the same shape of curve. There's very little chloride in the pore water right at that point. Fresh water got down there somewhere, and yet we see this increase perhaps to the bottom of the pit -- we never could identify the bottom of the pit from the cores -- and then perhaps a taper.

Similar thing over in the second hole, there may be a taper here in the soil chloride, perhaps we're getting a taper in the pore water chloride.

In the pit with the liner we see a high pore water chloride. These numbers are like 100,000 milligrams per liter in the pore water, and then perhaps the hint of a taper. And it was the taper we were looking for as the leading edge of this thing to try to help us answer how far, how fast?

So what we can summarize from the Caprock sampling is, surface chlorides were of nominally somewhere around 3000 milligrams per kilogram in the bare area. The subsurface moisture didn't look unusual. The chloride, we did not find the plume as deep as we got, to 15 feet. It's somewhere below there.

And the moisture potentials I didn't bother to show you. Let me say they're consistent with the matric potential that we measure. I mentioned that the potential seemed high. That's consistent with a sodium chloride osmotic pressure, and I'll show you more on that, where we get better data, in the next sampling.

This was a bit of news. Somewhere in the last year, year and a half, there had been a spill near this site, because there's a little tank battery nearby. And apparently the spill occurred at the tank battery, there was soil excavated. And when we were back out this year, there were a couple new monitor wells. And OCD is aware of this. This is being handled through the appropriate channels.

The monitor well closest to the pit shows 2400 milligrams per liter, approximately, chloride, with groundwater at 30 feet. Prior to this we didn't even know whether there was any groundwater out there.

I want to point out, the source of contamination has not been officially established. The tank spill, whatever had been in the tank, occurred nearby. The nearest operating well out there, I think, is an oil well. It's got a dunking bird on it. But we can't for sure say that the source of contamination there came from the pit.

But when we're down to 50 feet -- 15 feet, we're only 15 feet away from groundwater, and we're still finding tremendous chloride in the pore water, it gives us the feeling that it's possible the pit could have contaminated the groundwater. Certainly not out of the realm of possibility.

This is just one photograph of sampling out near Loco Hills in the Burch Keely Unit. It was well number 49. The well was operated by Marbob, who hired the drill rig.

We are on the pit. There may be a little surface indication here. This is a very wet spring, you notice things are growing very well. And in the background, I think off the pit, there are some sunflowers. This area received a lot better treatment than the previous areas. I can't say everything else. I don't know anything about the company's procedures but I simply want to say, Give credit where credit is due. It may be all snakeweed, it may be sparse, things may be tough, but this is -- certainly shows a lot better care of the land.

Well 49 was spudded in 1976 and was unlined. Well 321 was spudded just six years ago, and it was lined. I first have the gravimetric moisture. And this time at least there were more people out there, so I took it on myself to try to log, as best I could, the cores. I am not a geologist, this is not a geologist's technical logging, but I could see sand in the cores and I could see clay, and I kept track of where I saw sand and where I saw clay as the five-foot core barrels were opened.

What we notice is that the sand can often -- the sand regions tend to correlate with low moisture. As we said, sand has low suction. The clay regions tend to correlate with higher moisture.

We see a low region right here in the middle of things. That happened to be sand. I didn't know it was low moisture at the time, I just observed the core barrel and said it's sand. Down in here it seemed to be a mixture of sand and clay, and we see a taper in gravimetric moisture.

The hole 321 with the lined pit, right up in here somewhere, four or five feet, we did pull up a piece of liner, confirming that it was lined. We pulled up a little piece of cement that was still almost dripping wet. You could squeeze it through your hands. And as we set it out in the sunshine it dried and hardened a little bit.

Again, it was sand in the upper layers, became clay down in the region where the moisture is high. Sand at a low point, more clay correlated with high moisture, and the moisture tapers off and we're finding sand in the lower units.

We tried out there to drill a background hole, away from the pit, and I tried the same thing at the other units where I was on -- my own drilling. I just ran out of money at the other units.

And here we did get down to 15 feet and got augur refusal, couldn't go any farther because in the pit region the caliche has been removed in the upper part where the pit's been dug, but here it has not, and so by the time you had 15 feet of augur hanging down there the upper part is grinding in the caliche, and the rig operator said I've got to pour water down the hole in order to keep going, I can keep going. Well, if you pour water down the hole we've lost the information we want. So we had to stop drilling in the background hole.

But we see we're running -- once you get below the surface where the sun is beating on it, we see a gravimetric moisture something like 10 percent in the background hole. Not too different form what we're seeing in the pit, 10, 12 percent. And then down below the pit we think it tapers off.

This gives us the moisture potential and soil chloride. Here I'm plotting moisture potential versus depth, and we see a definite peak in the older pit. We see in the newer pit a couple -- a high peak and a low point and a high peak in the moisture potential. Remember we were going sand to clay to sand and clay, going back and forth.

And in the background hole we see the moisture potential going up as high as 3 megapascals. Again, that's high, but we're back in -- we're in caliche, that's hard, dry stuff.

I just want to look at the comparison. Here, for whatever you might say about the moisture potential, we're in the region above 5 and we're running as high as 20. Remember that 1.5 is the permanent wilt point. So we're in the death zone.

Here in this pit we're running up to 5. This shows the depth against soil chloride referenced to the dry soil, and we can see this peak that shows in the moisture potential showing up as a coincident peak with the soil chloride. There is no question but what the chloride is showing the potential.

Why do all these measurements? To see if we're consistent. The moisture measurements, the chloride on soil and the potential all hold together as a consistent package. And I think you have to measure everything like that if you're going to try to understand your work.

The red dots are samples that were sent to the analytical laboratory. So we're not too far off on our measurements.

In the hole 321 we see the soil chloride rising by my measurements, and right between two points I had where I took samples, the field technician took one and the lab got a very high reading. I believe that. I believe that because we see a high potential at that point. I think that's just where it went, and I didn't take a sample at that point.

Other than that, our dry-soil chloride measurements coincide pretty well with the laboratory measurements, so I feel that our technique, while approximate, was good enough to understand what's happening.

The chloride in the background hole was less than 200 throughout, and that's from the field measurements taken by the technician that Marbob had come.

This is the pore water chloride as a function of depth.

Again for the older hole we see it peak, like -- just like we saw the moisture potential peak. And I'll get out my own sheets so I can see the numbers.

We see this peak occurring about 30,000 milligrams per liter in the pore water. These peaks in the lined pit -- it's a newer pit, it's had less time to lose moisture and chloride, it also had a liner for whatever good the liner might have done. It's showing -- peaking out here at about 70,000 to 80,000 milligrams per liter in the pore water.

And for comparison with these, I now take these numbers, which is chloride in the pore water, and plot them against the potential that I've shown you in a previous slide. And what -- I do this for all of the measurements, and what I find for hole 321 is this nice smooth curve.

For hole 49, a smooth curve that's right about on it, but we didn't get to such high potential. It had less chloride in it. And at the bottom we see a peak going way high that's caused, really, by about one point of very dry stuff I picked up from the soil. It was baking in the sun, and it can get very dry right in the top half inch.

The shape of this curve is exactly the same as the shape of the osmotic pressure curve. You can translate one right onto the other. And yet it's higher than the osmotic pressure curve by quite a bit. And I puzzled on that because the suction in the soil itself, the matric suction, was only about 3 of these megapascal units, and this difference is bigger than 3. The soil suction adds to the matric -- the soil suction adds to the osmotic pressure, so the sum of the two would be what you measure, but this is more.

I puzzled over what's going on until I finally recognized that there are other things in the drilling fluids besides sodium chloride. For instance, we found in some of those I pointed out a high ratio of sodium to chloride. There are other things out there, so there's other things dissolved in that water. I would give a guess that's what's *adding* to the potential. We haven't analyzed for all those other possible constituents, but at least it makes it credible that you could measure a potential that's greater than the sodium chloride potential.

What conclusions do we draw from this?

The variation in soil properties with depth, both in and outside the pit, make it hard to do quantitative agreement with a model or with any model. Pits differ. The older and the newer pits confirm that chlorides are not retained by the hydrologic properties of the pit material. That thing I once was looking for, well, the pits just hang on to it. But they can move several meters in time scales of decades, and that's kind of the conclusion from the modeling.

On Caprock the chlorides extend more than 15 feet total depth. We didn't find the bottom.

On Loco Hills, the first pit 30 years old and the second pit six years old, the surface soils were not contaminated. But they are sandy, and it's raining a lot this spring. And we're out there in the springtime, we'd expect it to be washed down, that's at least consistent with the modeling. Both pits show a leading edge of a chloride plume somewhere down at 25 or 30 feet. That's not totally inconsistent with the modeling effort for a moderately loose soil. At this point it's probably moving slowly.

So we review.

The question was, If it moves, how fast and how far?

How fast? In sandy soil probably a few meters per decade, tens of feet per decade. In tighter soils maybe only one meter per decade. It moves downward in all soils, it moves upward unless the rain can keep washing it back downward in a sandy surface soil.

How far is it going to move? Well, it will keep moving until either you -- it is diluted to background by just the presence or ordinary moisture in the soil, or until maybe it's carried away by surface water or groundwater.

And that moves me on to the next question. Well, then, is trench burial secure?

I was curious as I was preparing for the hearing and I wondered -- I just had a piece -- This is 12-mil pit material, or liner material, and I was curious. I just stapled it to a 2-inch board in which I drilled a 2-inch hole. The only firm round thing -- I don't want to hit it with something sharp -- I had was this ball and a hammer. So I laid the ball of the hammer on the hole and I gave it a tap. Not as hard as I would be driving a nail, but I gave it a tap with this little two-pound hammer I had. I expected it just to bounce, but it punched through.

That is not a scientific test, that is not an ASTM test, but it convinced me that probably if trench burial is allowed -- I'm not in favor of trench burial, but if it is allowed it's probably wise to have a heavier liner in the trench, because I can see a rock or something of that size being underneath the liner at the time wastes are dropped in from a trackhoe at a considerable height of 10 or even 20 feet, and it could be possible to punch a lightweight liner under that kind of thing.

A little surprise came up in this. This is the current year when I went back out to this pit 5, as I've called it, to do the drilling, and there was a little depression in the ground out there I hadn't noticed a year ago, and I'd made several trips out there in previous years. I think I would have noticed it. I set my distilled water jug out by it, backed off and took a picture. Big rainy year. Rained so much it rained us out when we were trying to drill. So occasionally a snakeweed does grow.

And there's a little depression there, depression leading to it. So I moved up close, curiously enough, and what I found was something that would be consistent with pit subsidence. If there were water gathered into this little channel out here that goes to the left, it would have been running right down and into this hole in the ground. Drainage would have been right into the pit. So that does show me things -- unplanned things can happen.

So I questioned about burial units, do we favor or not favor burial units? The -- regional-type burial units are a definite improvement over just leaving the stuff in the ground, but it still leaves it there.

Now I drew a plot as though there were 40-acre well spacing. If you look in the rule, there are many different well spacings, 160 acres, 640 acres, 80 acres, you can find many numbers. I just drew a picture for a 40-acre. I think I have seen some applications that mention for -- special permission for shorter things.

The point that I would make, if it were 40-acre and you had the rectangular layout, the farthest you could get from a pit or an on-site burial unit would be 311 yards. And that sounds short. But if I multiplied this by four, say, it wasn't 40 acres, it's four times 40, 160 acres. Maybe that's more realistic.

Well, if you double the area, or if you multiply the area by four, the area goes with the square of the distance, you only double the distance. And so if it were a 160-acre unit, you have about 600 and some yards between burial units. And that makes me think of -- in the term -- it's a mathematical term, but it's used almost everywhere -- at some point you're a certain distance from a unit, if you move you will get closer to another unit. And it is the number of units that concerns my organization, not just one unit.

So we come to the question, Is trench burial secure? Well, a liner can be penetrated in a trench. Aside from that, one hole wouldn't generate much unsaturated flow, but the durability of the entire liner throughout all future time concerns us. A burial is something for all future time. In some sense, then, the burritos are time bombs.

I did show subsidence. If you have subsidence above a trench, it could lead to ponding and infiltration, just as we saw at that one pit accidentally, number 5. It's the existence of entombed waste throughout the landscape. We see it places some kind of a future prejudice on the land. Certainly, I think in economic terms, a land if you were selling it would have less value with burial units on it than a land that did not have burial units on it.

But there's additional other prejudices, that is, limits of what some person or some thing or some natural thing might do with the land that I can't see at this point, trying to look forward far into the future.

The question, well, if you can't bury it, or if you shouldn't bury it, is there any hope to clean it up?

I think one consequence of the rule would be a motivation for this industry to ask if it can handle its wastes in some other way. To the present there hasn't been a motivation, there hasn't been a need. If you can just leave your wastes -- that clearly is the cheapest thing to do -- why do something more?

So I started out thinking, this might be our answer. It had been mentioned by an industry spokesperson a couple years ago, and I wanted to look at natural encapsulation in a naturally occurring thing in desert soils called the chloride bulge.

I looked a little bit at cementation, which has been tried here. And really as an exercise I looked at heap leaching. Just -- I'm not saying these are answers, I just wanted to look at them.

These graphs were also -- they're the same graphs and the same origin, presented by Dr. Stephens, showing that in desert soils you get a natural bulge in chloride at a depth of sometimes like two, three, four meters under the ground.

And you'll also find a high peak in the moisture potential here called water potential. Same thing, it's just measuring the pressure in terms of head of water; this would be equivalent pressure.

And so the question arises, if those -- if nature can deposit rainfall over 10,000 years with chloride in it and it accumulates at that layer, why can't man put chloride at that layer and have it stay there?

I think one of the big answers is, man's tendency would be to put much higher concentrations there. Concentrations such that if they do move up it will inhibit the plants, and the plants are the thing that cause the recycling of moisture back to the atmosphere that causes the chloride bulge.

And so we are very sensitive to having those plants on the landscape to maintain that. If we do put in very high concentrations, I think there's a danger it wouldn't last for all future time.

Cementation and solidification I think was a great thing to try. At one point it was being discussed here, and our group encouraged a trial of cementation in New Mexico. We were disappointed that -- we had hoped it would be kind of a science exercise, that we'd get back reports of material tests and *in situ* monitoring. Data didn't come back on that. We don't imply that cementation has no benefits, but the available data we can find suggests that it is not sufficient to retain the salty waste.

This is a quote from a report by Argonne National Laboratory. They have a drilling waste management information system, it was a sponsored effort at the Laboratory. The put out fact sheets, and this is a quote.

I will read it into the record just from their fact sheet:

In contrast to these examples, others (in particular, ChevronTexaco, one of the companies that partnered with Argonne to develop this website) have tested different additives and found that they either did not achieve the desired goals once the solidified or stabilized wastes were placed into the environment or that the cost of using the additive was prohibitive. Most of the solidification/stabilization systems produce conditions both of high pH and high total alkalinity. Much concern has been expressed about the long-term stability of the processes. Of greatest concern is the failure of the additives to keep the waste constituents from releasing into the environment over the long term or the sudden release of contaminants due to breakdown of the matrix. No long-term data are available because the technology has only been practiced for about 20 years, although ChevronTexaco has tested about eight different commercial products and found that all failed leachate testing.

And they cite a reference for that. That is their citation, not mine.

There is an older paper which is available. It's entitled, A Study of the Leachate Characteristics of Salt Contamination Drilling Wastes Treated with a Chemical Solidification/fixation Process. It was presented at an international symposium on oil and gas exploration and production waste management practices clear back in 1990, people were working on this problem. It's one of the very few actual technical efforts, laboratory-type efforts, to look at this that you can find in the open literature, or that I could find.

A surrogate waste sample was solidified with a commercial process and placed in a drum of sand, and then it was repeatedly leached with 2-inch applications of water until the unit had received 24 inches of water. Basically, water flowed in and down and out the bottom of the container. They had results both with and without a rain cap over the sample, and they compared the results, both with solidification and with a surrogate waste sample without solidification.

If you bring all the results back to a summary, without the rain cap, the untreated sample lost about 46 percent of its chloride in that sequence of tests, whereas the solidified sample lost 17. That certainly is a great improvement.

When they added a rain cap to keep the water from actually hitting the top, the untreated sample lost about 31 percent, and their best treated sample lost only 9 percent.

Well, you would say, Does that offer us a promise of something better?

Well, this was done in sand, which has low suction. The sample wasn't exposed to a long-term exposure in soil moisture, as we would have with natural burial in New Mexico. This was kind of a quick-shot process of flowing water. And I -- Even if this were the limit, I think we probably wouldn't want 9 percent of the chlorides leaching out, but this -- this was a one-time effort. It just didn't hold the chlorides.

Well, brings up the question, Is there a possibility for innovative treatment?

I spent less than one day just trying to invent one. Not meaning somebody should use it, just trying to say, if I had to do this, where would I start?

Some people, I understand, in New Mexico are trying heap leaching. That is, stacking their wastes with a liner underneath the waste, letting rain go on it, and seeing if it will wash out into the liner and some of the chloride wash away.

Well, one of the things we find is, with rainfall in New Mexico, if you have much of a heap, moisture will go in and moisture will come right back out the top surface. It doesn't always go through, depending on the properties of the soil.

So I just said, What would happen if instead we took the rain -- kept the rain off the surface, let it go down to the bottom where the liner is, and then just tried to evaporate off the top of the heap? Could we bring chloride up the heap? It was just a wild idea.

But I had a model, I could run a model, same kind of modeling you saw before.

This is just a one-meter-depth heap. It starts out with a concentration of chloride in pore water of one unit. You can make it 100,000 if you wish, it's just one of some unit, and with moisture at about 70 percent throughout saturated at the bottom and dry at the top. And then I just let it go with the climate.

What I found was, in one year it pulled quite a bit of the moisture out. In two years with the green curve, there was a little more moisture that came out.

And then I shut off the bottom. I made it as though the bottom went dry to say, Can we suck the remaining moisture back up out of the soil, have that really bring the chloride with it?

Well, it got a little drier, not a lot. What was going on? Why did we get more water up here?

If we look at the chloride in the first year, quite a bit of chloride was pulled up. In the second year a little more was pulled up. But in that third year of drying, absolute drying, no chloride moved. The dots are in the same place as the green curve. So how can I move moisture and not move chloride? Well, this is near surface, it's vapor transport. And the moisture moved up by vapor transport, vapor doesn't move chloride. And I didn't think of that ahead of time, I saw the result and was surprised.

Do I advocate this as a process? No, I advocate innovation as a process. But I'll note that with a one-day effort what I did is move about half the chloride from a depth of about two-thirds of a meter or a couple of feet up into the top. You can never get this perfectly clean down here, and if you clean up a waste you have more concentrated waste. You are just stuck with that, unless it's something you can biodegrade.

So you will always have waste that you have to dispose of properly, and plenty of it. But I just wonder if there isn't opportunity for doing innovative work on this?

All right. The review was, Can it be cleaned up or treated? We find no data of successful long-term retention of salts by cementation. If there's data out there, we don't have it.

We encourage regulation that offers motivation for development of new methods, and I think the current rule does that.

So we should discuss the rule. These are the questions with which we approached it. What is in the pits? Down to the question, Might it be treated or cleaned up, is there opportunity for treatment or cleanup?

How do these things affect the rule?

Damaged pit liners. We notice -- This is a small point, but in a double-lined permanent pit the rule is unclear whether both liners must maintain integrity. It says the operator should replace "the liner" with "any" -- we suggest replacing the words "the liner" with the words "any liner" that might have had damage or a leak.

Why would I say that? I do remember there was one operator with a double-lined installation in New Mexico who had a primary liner failure and continued to operate, relying on the secondary liner.

Disposal. We would oppose on-site disposal of wastes as long as they're harmful. I don't want to get into a discussion of toxic and hazardous. Those are technical terms. As long as they're harmful...

We don't seek to prohibit on-site disposal of wastes that are proven harmless.

Buried wastes, if they're harmful, are probably going to cause some harm in the future.

Buried encapsulated wastes will hold for a while, but in effect they're time bombs.

Our largest concern is not one burial unit. Our largest concern is a vision of the future with many landfills almost everywhere, how you might define that to an area of land, leaving some prejudice on future uses of the land.

If on-site disposal is permitted by the rule, then we would suggest disposal should not be allowed where groundwater is less than a hundred feet. We're suggesting changing that 50 to 100. At least it's within the realm of our modeling to be able to see that chloride can be carried down to a hundred feet below the bottom of the waste.

In sandy loam soil, the modeling predicts that dissolved contaminants can reach groundwater at 50 feet in 40 years and 100 feet in about 100 years.

Exceptions to the rule.

The notice of an application for exception goes to the surface owner and to a one-time publication. We think an exception to this rule, rather uniquely, is likely to be of statewide interest, not only because a rule might benefit operators or it also might nullify some important part of the rule. We would think it should just as easily be published in a newspaper of statewide circulation. It's just one publication. We're not advocating that the operator be burdened with repeated or all kinds of publications.

We would advocate that it be published on OCD's website at the same time the notice is approved, and we would advocate that it be distributed to OCD's e-mail list. Presently OCD maintains a list of persons who receive docket notices. That would do, or other list that OCD might maintain.

I'm trying to suggest that if there are exceptions to the rule, a wider list of the public, a wider distribution among the public, should be notified of this. But we should not burden the operator with a whole lot of mailings. And I think it's adequate to give an e-mail notice to people. It's not formal, you can't prove it, but it should be done and it's a very low-cost item.

We should be a little sensitive to the amount of paperwork we lay on an operator. I can say that because I have worked for a party regulated under RCRA, and I know what that kind of paperwork can be.

Exceptions to the rule -- modifications is what I'm trying to say. Exceptions.

If the rule -- the rule does provide that if an exception has technical merit, or if there's significant public interest, the Director may set an application for a hearing.

I would like it to require a hearing if there is technical merit, because the technical merit is likely to be argued by persons who are outside of the landowner -- or persons who might see a publication in a local newspaper. There can't be any significant public interest if the public doesn't know about it.

An exception could strongly affect the relative costs of different operators. It might improve or it might diminish environmental protection, and as a result I tend to think everybody should know about it if they're interested enough to receive the e-mails.

With that, I would like to come back to why we think the things we do, to offer some conclusions.

Q. (By Ms. Belin) Dr. Neeper, I'm sorry, but I have a page 84 on modifications. Did you want to cover that? Do you have one more slide?

A. If you have a slide and I don't --

MS. BELIN: Does every- -- I think everyone else has it, so...

CHAIRMAN FESMIRE: Is it the prehearing documents that you filed?

THE WITNESS: It is at least in the slides.

A modification could be a significant to the intent and the provision of the rule. It's a judgment call whether it is. We're suggesting that a modification, if it's equivalent to an exception, should be subject to the notice and approval procedures required for that exception.

There. With that I'd like to just review, in the few minutes I have left, the things I have thought about as I have come this far in the proceeding.

The function of a citizen, I think, in these proceedings often should be to try to bring up what's missing. There are experts of all sides, far beyond the -- often, the expertise a citizen has. The citizen should try to bring up what's not being heard, what's not being discussed.

I see discussions and very great concern over the lack of availability of landfills and yet if -- even if no entrepreneur were to try to move in to fill a requirement, should the rule require it, I would not see that it would be impossible for the industry to cooperate together to build their own landfill. I would think that an industry that can build offshore platforms can build a landfill.

The question of distributed versus common burial, I said, we prefer to have common burial rather than many units throughout the landscape. We -- In that process we are suggesting we think it better to put the waste in one concentrated unit, in one place.

I think in earlier proceedings I was the one that coined the term, that's a sacrifice zone. It's sacrificed for all geologic time from at least some future uses. And we have agreed on that, and that's to be done, and it's marked, it's better taken care of. So we prefer burial in a common place.

Your proposed rule would allow burial at sites that are more than 100 miles from the landfill, and that's based on an economic consideration for the industry. And we think there should be economic considerations.

But the location of a drill site relative to a waste facility is an economic condition of business. Just like if I want to put up a shopping center, I'm better off if I can put it near an intersection of major roads in a town than if I put it off someplace nobody will find it.

And so where somebody chooses to drill, to some extent, is a business decision. And the fact that it may be more costly because he's a greater distance from the landfill is part of the business decision.

Most other industries take care of their harmful wastes. There are a few scattered industries who don't. Sometimes dairies don't, hog farms don't, mining. Those industries are allowed in some cases to externalize their costs onto the landscape or basically in some way onto the public. But that doesn't necessarily mean it's the proper thing to do for all industries, either for them or for the petroleum industry.

There is a very legitimate concern with marginal operators, I think, but that must be considered also in the context. It is always cheaper to abandon your wastes, but we can raise the question in this sense: Should the state subsidize marginal operators, or should the state in some sense subsidize all operators because some operators are marginal?

The logic keeps going. Should the state subsidize a marginal operator by allowing him to dump his wastes or put them onto the landscape? If so, shouldn't the state also relieve that marginal operator of the expense of bonding? But bonding is largely brought about because of the fear that a marginal operator might go out of business and leave the state -- leave the well for the state to plug.

So I would not advocate release of marginal operators from the responsibilities of wastes that they generate.

There's some question and confusion I heard over the proposed 250-milligram-per-kilogram so-called delineation standard for indicating a release, has a release occurred beneath a pit?

Based on my experience of sampling and my use of the little chloride strips that are available -- it's about a dollar a strip or less; we buy them in bulk, and they come with the calibration on the bottle -- I would find it quite easy, once the liner had been raked off the pit, immediately to go through and do a lot of spot samples. It might take me a half hour or more to do one sample, because you sort of need to wait for the mud to settle out. But if it took me a half hour to do one sample, with a half hour and another 10 minutes I could do 20 samples.

So an operator has an opportunity to sample very cheaply and see if he's approaching that 250 delineation limit and whether he needs to go farther. He doesn't need to go out and take a bunch of formal samples and send them to the lab to find out if he's had a leak, because I think the chloride is a great indicator of a leak, and you can test for it in a hurry and test for it very cheaply and test for it with amateur personnel. Kerry Sublette's organization has really done a great service by providing those kits, and they provide them free, so your first effort can be for free.

The philosophy behind this, in a way, is that from what I've seen thus far no site has proved its case, no site has proved it's absolutely necessary to leave waste, no site has proved it's necessary absolutely to move the wastes.

All truth can't come from one side. I can't give you all truth, neither can anybody else. I can give you may part of the story.

But I think precaution is called for. And if precaution has merit, on whom should the burden of proof be placed? I think it should be placed on the actor, those who are likely to leave the wastes.

As such, this can't be answered by computers. It's even very difficult to answer by calculations. The Commission is a human institution, and it has to weigh human values. If we could do this by sheer mechanics, it would be done by computers and we wouldn't need people to do it. You have to judge this based on all of the values you see involved in this, and I am very glad that you people are doing this, and not a mechanistic exercise.

I think you for your attention.

CHAIRMAN FESMIRE: Thank you, Doctor.

MS. BELIN: Mr. Chairman and members of the Commission, might I ask just a couple of follow-up questions that were raised in my mind during that presentation?

CHAIRMAN FESMIRE: Yes, ma'am.

MS. BELIN: Thank you.

Q. (By Ms. Belin) Really about your modeling, Dr. Neeper. I may reveal my own ignorance, but I think that you said that your modeling neglected a membrane, or that a membrane was not part of your modeling, which I assume is sort of tantamount to modeling an unlined pit versus a pit, and I just wanted you to comment on that.

Do you think your modeling is valid for pits, whether they're lined or unlined, or what is your comment on that?

A. Both Dr. Stephens and I approached this the same way of neglecting the liner in a burial unit. The OCD used a model of the liner in their calculations. I didn't have that model, so I approached it also simply. So my calculations basically apply after you would say the liner fails. If we have a liner that is good in perpetuity, then I think my calculations are irrelevant. I haven't seen, I don't know about, a liner that's good in perpetuity. But this form of waste, if buried, will be there for a long time. If it's buried in the liner and the liner holds, you still have a burial unit on that landscape. I don't worry about one, but I worry about many.

Q. And as I understood it, your modeling was just applying to chloride transport. I wonder, does your modeling have any relevance or applicability to transport of other contaminants?

A. Chloride is the marker contaminant that everybody uses because it moves through the soil without sorbing onto the soil particles. And so it is not only the easiest thing to detect chemically and cheapest thing to detect, but it's the first thing you'll see, so it's a clear indicator of a leak.

When chloride moves, something else has to go with it. It's charged, it's electrically charged, it's dissolved in solution. And so some other cation has to go along with it. Stop and think, cation, anion. Another ion, possibly, charged ion, has to go along with it. Sodium would be the likely choice.

Sodium often sorbs on the soil. If it does, it usually destroys the soil for agricultural purposes. In doing that sodium would release -- It's the fault of old age, I can't say the name of the chemical. If somebody wants to help me, it starts with C.

FROM THE FLOOR: Calcium.

THE WITNESS: Calcium, yeah. Sodium would likely release the calcium, and calcium would travel along with it. But other things could be going on. So given the wide variety of things in the pits, something else is going to be moving along with it, and there will be a plume of something else along behind the chloride that you will be able to detect.

What I'm saying, it isn't necessary -- it may be necessary for proof check, if OCD wants to proof check, but it's not necessary to go out and sample for sodium if you want to know if you've had a leak, because every pit out there that we've seen data on has enough chloride that if you've had a leak you're going to detect it. And so it's very easy to detect it.

Now there's another question comes in, and that is, if you look at these pits most of them have very high pH. There's a few in the data that show pH down around 8, some at 7, but a lot of them have pH around 11. If I -- When I read the books I find that pH of 11 is often desired by drillers for getting the right properties in the muds.

That has a very -- That pH could have a very significant effect on plants. And so again, that's something you wouldn't detect. It would be following along to some extent with the chloride, the alkalinity would be moving -- you'd expect it to move somewhat with the chloride, but it wouldn't be necessary to detect it, because you could detect a leak with the chloride.

Q. (By Ms. Belin) I think you said that your model also assumes no preferential pathways. I guess my question is, how does that correlate with reality here in New Mexico? Would you expect that there usually are or are not preferential pathways present in real-live pit situations?

A. It can happen, I would think, either way. Other witnesses have testified sometimes other ways to that. You might not be dominated at all depths by a preferential pathway, but at some depth you'd have preferential pathways.

We certainly found this in Los Alamos when we were looking at vapor transport, we found preferential pathways for vapors to travel. We could detect that.

Preferential pathways can -- near the surface can sometimes create themselves, as we found in my picture of that one pit where subsidence or something had happened, and a column of water had formed a little channel and run over and gone right down the hole in the pit, going right down into the pit. So it can happen.

Q. Okay. A preferential pathway is a crack, or what is preferential --

A. A preferential pathway is usually a macroscopic crack, hole, some way in which moisture or air can travel faster than in the general background. That's the use of the term. In some sense all of the soil is preferential; there are big pores and small pores. But when we say preferential pathway we mean usually something macroscopic. It might be the size of a tip on a pencil, or it might be a size of the pencil itself, but it's in the macroscopic size.

Q. Dr. Neeper, can give me just a ballpark estimate of how much time you've spent working on the material that you've presented today and working on the pit rule over the last year?

A. I can for an accidental reason. I obviously have white hair. The senior center in Los Alamos asks people who do work for voluntary nonprofit organizations to tally their time, and every quarter they add up all the time from all these volunteers, and I don't know what they do with it but they get some kind of credit for it. Whether they get some money, I don't know.

So our organization registered as an organization with them, and I have tried to keep my time. That is, the day goes by, I scribble a number on my calendar, some estimate of time that day.

We're right now at 800 hours. That's not -- That's exclusive of the scientific research I was trying to do to get colligative properties into a transport code. This is actual at-home, and drilling work and all other work just for this procedure.

Q. And I take it from your comments that no one has paid you for this work?

A. No, the money flow has been in the other direction.

(Laughter)

MS. BELIN: There's one other matter, and a few items relating to Dr. Neeper's testimony have come up during earlier witnesses' testimony, and Dr. Neeper would like to discuss those and present three additional slides, which obviously were not with our prehearing statement, and which we could distribute at this time.

CHAIRMAN FESMIRE: And they are rebuttal-type exhibits?

MS. BELIN: Yes.

CHAIRMAN FESMIRE: Okay. Mr. Hiser, would you have any problem, given this witness's scheduling difficulties, in allowing his rebuttal testimony at this time?

MR. HISER: No.

CHAIRMAN FESMIRE: How long do you think it will take, Ms. Belin?

THE WITNESS: Less than 10 minutes.

MS. BELIN: Less than 10 minutes.

CHAIRMAN FESMIRE: Okay, why don't we go ahead and do it then?

Ms. Foster, would you object to that?

MS. FOSTER: No. Actually, Chairman Fesmire, I was under the impression that we were going to break for lunch --

CHAIRMAN FESMIRE: We are going to break for lunch soon, but we still have public comments after this.

MS. FOSTER: Okay, I just --

CHAIRMAN FESMIRE: I'm thinking about 12:30.

MS. FOSTER: -- wanted to remind you that there some folks in the audience who --

CHAIRMAN FESMIRE: Right.

MS. FOSTER: Thank you.

Q. (By Ms. Belin) Do you have -- Proceed.

A. The first -- What I'm really trying to do again is ask what's missing and bring information to the Commission.

The first is really my sense of rebuttal to some of Mr. Price's testimony and the condition in the proposed rule that would have the 5000 milligrams-per-liter leach standard as being suitable -- a suitable standard for the burial of wastes in a lined trench.

So I worked out some numbers, I used the numbers that were in Dr. Stephens' standard because I feel they are more favorable. But what it's important to do is to recognize just how much material we are saying that standard pertains to.

So in my mind -- We heard many discussions and things got confused. I'm trying to make it simple. I say, Let me start with an imaginary 1 kilogram of waste. It has been discussed that that's often mixed with clean soil, so I mix 2 kilograms of clean soil, making a 3-kilogram mix. It's then leached with 60 kilograms of water, 20 kilograms per kilogram of the material. The result is -- in Dr. Stephens' standard, is 3500 milligrams per kilogram -- or per liter of leach water, and that's even less than Mr. Price testified for at 5000.

The total chloride that got washed out, then, is 60 liters multiplied by that 3500, or 210,000 milligrams. So the chloride per kilogram of mix is 210,000 milligrams per 3 kilograms of mix, or 70,000 milligrams per kilogram.

Now maybe that sounds like what we're seeing out in the pits at some times or seeing in the soils. If we say how much salt is that?, take it from chloride back to sodium chloride -- and I pointed out there's more than enough sodium to usually make it sodium chloride -- it would come out to 346,000 milligrams per 3 kilograms or 115,000 milligrams per kilogram of solid material. That is to say, about 11.5-percent salt in the more mild of these two standards we've heard proposed.

Now this is after you've diluted it about 3-to-1. The chloride per kilogram in the original waste would be 210,000 milligrams per kilogram of that original 1 kilogram of waste we started with, or the salt per kilogram of waste is about 34-percent salt.

We're talking about burying some very salty stuff with these kinds of standards, and I think we should be aware of what it means, because the 5000 and the 3500 sounds like kind of a small number.

Some concerns with the pH I had mentioned. This is the sampling data that came from OCD sampling in the northwest. For about five out of six the pH was 11 or above. In the southeast for several pits it's 10 or 11, and a few are down in the 10's, and then there's a few that would come close to 8.

Our concern is, the pH itself can be toxic. This is -- I cite this: When crop production declines due to high soil pH, it is usually because the pH is 8.5 or higher, and the water movement into the soil is drastically reduced.

Let us consider 9, and many of our pits are at a pH of 11. 11 is a hundred times more alkalinity than 9. This is a logarithmic scale.

I have a -- The best chart I could find on a short-term notice is this little chart showing toxicity at a pH of 9. Alkali toxicity occurs at above pH 9.0, strong alkalinity above 8.5. This is from a botany book. It's kind of old, but it at least presents it in graphical form of where strong alkalinity occurs above about 8.5, and moderate at 8, as they call it.

So I simply again am calling attention to this and suggesting that we be cautious that not all of our concerns with pits are strictly focused on the chloride.

CHAIRMAN FESMIRE: Okay, Doctor, let me go on record as objecting to anything originating in the mid-1950s as old, okay?

(Laughter)

THE WITNESS: My wife bought me the book. It was all I had, and counsel may exclude that exhibit if counsel wishes.

MS. BELIN: Mr. Chairman, members of the Commission, that concludes Dr. Neeper's testimony.

I should note that these last three slides we're labeling as NMCCAW Exhibit Number 4, and at this time I would move into evidence Exhibits 1 through 4.

CHAIRMAN FESMIRE: Any objection?

MR. BROOKS: No objection, Mr. Chairman.

MS. FOSTER: No objection, Mr. Chairman.

MR. HISER: No.

MR. JANTZ: No objection, Mr. Chairman.

CHAIRMAN FESMIRE: Okay, NMCCA [*sic*] Exhibits 1 through 4 will be admitted into the record.

As Ms. Foster and I talked about a minute ago, we're going to go ahead and take public comments now. At the end of public comments we'll break for lunch, come back at a time -- depends on how long it takes us to get through the public comments. But I guess we will start with the cross-examination of Dr. Neeper at that time. Mr. Brooks, I guess you'll be prepared to do -- to begin that?

MR. BROOKS: Okay. At what time?

CHAIRMAN FESMIRE: Well, we haven't decided yet.

MR. BROOKS: Oh, okay.

CHAIRMAN FESMIRE: Okay, how many folks have a comment that they would like to put on the record today?

Okay, sir, why don't you come forward and we'll start on this side of the room?

We have an option in our rules. You're allowed to either make a statement of position, or you can make a comment -- testimony on the record. If you make testimony on the record, you're sworn and you're subject to cross-examination. So do you have a selection in that option?

MR. LIVINGSTON: Under oath, please.

CHAIRMAN FESMIRE: Okay. Would you raise your right hand, please?

(Thereupon, the witness was sworn.)

CHAIRMAN FESMIRE: And would you start with your name, please, sir?

KENDALL LIVINGSTON,

the witness herein, after having been first duly sworn upon his oath, testified as follows:

DIRECT TESTIMONY

BY MR. LIVINGSTON:

MR. LIVINGSTON: My name is Kendall Livingston. I am a vice president of Sweatt Construction Company. It's a 45-year-old dirt construction business located in the southeast portion of the state, and we've been in business -- been doing -- I'm also a ranch owner, as well as a part owner in a landfarm at this current point.

In the last 10 years since I've come back from college, I've either done it myself or supervised somewhere in the numbers of thousands of these cleanups and the different types, ways and shapes and forms and -- haul-offs, you know, deep-buries, with and without liners. So I have a pretty knowledgeable experience as far as the dirt-moving portion of what we're talking about.

My main concern to bring to the table is, we feel like -- that the more that the drilling cost, I'm sure everybody in here knows, goes up, the less likely that the people or our operators are going to be able to afford -- what you guys are calling marginal operators, are going to be able to afford drilling in New Mexico.

And being -- My mom has been an administrator for years. She's real concerned with the lack of money towards the schools that have been flowing in the last few years. But main concerns are, we're starting to see a lot of work shift into Texas because of some of the past rules. And it's probably going to affect, I would assume, the future of the State of New Mexico as far as the oil and gas industry.

I'm kind of sitting in a place that's a little bit tough because I work with everybody in this room at a certain different point. We kind of feel like we're in the middle of it all, but we are here to support the -- an industry as an industry. And I'm not here to testify to any of the -- like the professionals can as far as the salts and other things, but I can testify to the fact that we've had numerous successful deep-buries with lines as far as the last five to six years since we've started lining pits. I can't go any farther than that, obviously, because we haven't been doing that as a practice for -- since before that.

I mean, it's like my grandfather, he's passed a lot of information on to us and he says there was a long period of time where things weren't, you know, knowledgeable, so we didn't do them the way that probably should support environmentally protecting the water sources.

But we also feel like there's also information out there that supports, from our own findings -- Eastern New Mexico -- I'm sorry, New Mexico State University agricultural division that -- their study of a project there in Artesia, even mentioned one time to us that there was 80 tons per acre of chlorides. And to my knowledge, I don't know how deep they were talking about. It was just in passing of just the natural farmland, and that's why they had to flood the farms to be able to keep the crops growing. Otherwise they would come to the surface and not be able to, you know, grow anything.

But I do feel like that we have to find some kind of a common medium that helps the industry provide funds for this state, for the schools, for the highways, and we feel like that there is a lot of other things to think about. I'm sure most people in here have talked about it. I've sat through about half of this hearing so far, I've been able to make it to, and I think it's been discussed before about the amount of miles put on the highways and the amount of diesel used to haul these contaminants off.

And so my personal opinion, I don't -- I'm not going to say either way whether the pits should be done, but if I can help in any way and -- with my knowledge of the dirt industry, then I will sure do that.

I will always support, of course, our customers, and I will always support our government. As far as what we need to do, we'll go do it for our customers. We always have. But at this point I feel like I can already see a difference in our customers' likelihood of drilling in Texas versus New Mexico. And I know of -- personally, of quite a few customers that are waiting on some of these rules to decide their next year's budgets, they're going to depend on some of the rules because it obviously affects the cost of drilling in New Mexico.

Now, we're -- out of the 45 years we've never intentionally -- or never, you know, done a whole lot of work in Texas. But this last few years we've got probably a quarter, 25 percent of our work force is driving across the state line to move dirt. And it was not something that we wanted to do, it was just something that our customers have asked us to do.

They seem to be -- We've watched the drilling rig count go from somewhere in the range of 75 about a year and a half, two years ago, down to in the 40s right now, as well as we watch a daily -- the permitting that goes through, that's submitted to the state in this whole Permian Basin area. And I've watched where it used to be anywhere from 60-percent Texas permits to 40-percent New Mexico permits dropping now to, I'd say, 90-percent Texas permits and maybe 10-percent New Mexico permits.

I can't conclude the whole reasoning or the whole justification of why that is happening, but I do know that it costs them more because of -- the cleanups happen to be done differently in New Mexico versus Texas. But I also feel like in Texas you have -- you know, you have particular landowners, and you don't have as near as much, I guess, outside concern because, you know, it's easier to -- for a farmer to say, I think it'll be okay or not okay, and then they make a certain agreement with the com- -- you know, and then the deal is done.

You know, I'm not here to testify to anything past what the future will bring because of it, but it will, I think, negatively affect, at least for a little while, the income from taxes and oil and gas production going at least somewhat down until possibly Texas adopts some of the same type stuff, protection features.

Make sure there wasn't anything else I was -- noticed that I would like to put in.

We have from -- last year and a half, supported the testing and protecting of underneath -- we've done it on our own accord, not because of any customers -- well, we've had a few customers like it, and they wanted copies of it.

But we've been testing underneath our cleanups for almost a year and a half now, and so we've got some -- pretty good amount -- I mean, there's a small percentage of them that did get liner breached, and it was a lot to do with the types of areas that they were putting the pits in, or -- and of course in my opinion, if you bury -- well, and this is from my experience, because we've dug into old deep-buried trenches that have been lined, and in my experience they've been just as wet 10 years after the fact as they were the day they were buried. Now I don't say every one of them is, but I know the ones that we have actually fell across to digging into, they're holding the water pretty well.

But my grandfather's always had the belief that -- and I do too, that if we're allowed to let that -- soils and those drill cuttings dry to a certain extent and maybe possibly encapsulate, then it may in some areas be an acceptable form of deep-burying some of these contaminants.

Like I say, I don't know much about what is in those constituents other than salts, because that is what we've been testing for. I know the levels of the chlorides and a lot of the different areas, and there still are a lot of areas in New Mexico that -- and that's mainly between the Caprock, in my mind, and the Pecos River that don't have any retrievable water source. So that does leave some places for landfills to maybe possibly help the industry get back on its feet and have an option.

As for the 100-mile radius, the only thing that I could say about that is, it's real easy for me to see that within a 100-mile radius could turn into anywhere from a 150- to a 200-mile drive, because you do have to think about some of the other -- I mean, we don't -- we're not flying that mud over there, but we do have to drive it down highways. And so sometimes it's -- it could end up being a 300-mile, 400-mile round trip. And that does, of course, increase the cost significantly.

And as of my own experience, I've done cleanups, haul-offs as far -- as cheap as anywhere from $40,000 to $50,000, depending on where -- how close it is to a disposal. But I've also seen some rise up to as close as in between $200,000 and $300,000, depending on how far they have to haul it.

I think that's all I've -- Yeah, that's all I have to contribute, unless anybody -- I'm sure you guys want to question me, so...

CHAIRMAN FESMIRE: Okay, thank you, Mr. Livingston.

Are there any questions of this witness?

MR. BROOKS: No questions, Mr. Chairman.

CHAIRMAN FESMIRE: Have you got a question?

MS. FOSTER: One question.

CHAIRMAN FESMIRE: Okay.

EXAMINATION

BY MS. FOSTER:

Q. Just a point of clarification. The conversation that you had with the -- who was at New Mexico State concerning the chloride levels, that was the discussion of the natural background levels --

A. Natural, yes. Yes, ma'am.

MS. FOSTER: Thank you.

CHAIRMAN FESMIRE: Mr. Hiser?

MR. HISER: No questions.

CHAIRMAN FESMIRE: Mr. Jantz?

MR. JANTZ: No questions.

CHAIRMAN FESMIRE: Commissioner Bailey?

COMMISSIONER BAILEY: (Shakes head)

CHAIRMAN FESMIRE: Commissioner Olson?

COMMISSIONER OLSON: No questions.

CHAIRMAN FESMIRE: Mr. Livingston, I do have a couple of questions.

EXAMINATION

BY CHAIRMAN FESMIRE:

Q. You said you dug into old pits. Is that something that happens regularly?

A. No, sir.

Q. Okay.

A. In fact, I can only think of it one time --

Q. Okay --

A. -- in my personal experience.

Q. When you did that, what did you do then?

A. We called the OCD and we approached and re-buried that same contaminants in a new liner with a new top, tested around it. And we've done most of this testing just to protect us in case something later comes along. If it helps our customer, you know, some -- you know, any question comes along that -- contaminated something, at least we have proof that when we cleaned it up, everything that we dug into, we stopped at a clean point. And we have, you know, tests to prove that. And we keep them on file for, I guess inevitably, so we don't ever get rid of our files on those types of situations.

Q. Okay. Now you talked about the decrease in the rig count from 75 to 40. You're not talking statewide, are you?

A. No, sir, I was talking about the Permian Basin, in the New Mexico portion, yes, sir.

Q. Now you made an interesting statement. You said that there's going to be a negative effect for a little while, while Texas adopts the same features. What did you mean by -- by that statement?

A. Well, you know, from listening to the progression of New Mexico through these rules -- they talked about Louisiana, you know, they've had their problems and they've had a lot more water, and I think they ran into these issues a lot longer before we did. And you know, as much as I can say, it probably will help our business to see these go through. I can see the progression is going to probably take place in other places, I mean, within a certain amount of time.

But I also think, you know, we've got to think about our economy, and it is going to negatively affect some people. But I think that, you know, as an economic standpoint that always happens.

CHAIRMAN FESMIRE: Does anybody else have anything of this witness?

Mr. Livingston, thank you very much.

THE WITNESS: Thank you.

CHAIRMAN FESMIRE: Rachel, did you have something you wanted to say next?

MS. JANKOWITZ: Yes. Should I come up front?

CHAIRMAN FESMIRE: Please. Do you want to make a statement, or would you like to be sworn?

MS. JANKOWITZ: Unsworn statement, please.

CHAIRMAN FESMIRE: Unsworn?

MS. JANKOWITZ: Unsworn.

CHAIRMAN FESMIRE: Okay. Would you start with your name, please?

MS. JANKOWITZ: My name is Rachel Jankowitz. I am employed by the New Mexico Department of Game and Fish in the position of habitat specialist, and I'm making this statement on behalf of that agency.

New Mexico Game and Fish strongly supports adoption of proposed Rule 19.15.17 because it includes several provisions that will go further to protect wildlife habitat than the existing regulations.

In particular, we support the siting requirements at 19.15.17.10 which prohibit pit construction in buffer zones surrounding perennial and ephemeral watercourses, lakebeds, sinkholes, playa lakes, springs, wetlands and floodplains. These features are identified in the New Mexico comprehensive wildlife conservation strategy as key aquatic habitat for wildlife species of greatest conservation concern.

In addition to issues of contaminant transport, prohibition of pits near these sensitive habitats will prevent adverse water quality effects due to spills, leakage or outright violation, rather than relying on after-the-fact remedial action.

This prohibition will also incidentally reduce the quantity of sediment movement into surface water following clearing and construction of roads and pads.

Okay, also we believe that OCD's mission to protect human health and the environment includes the obligation to see that sites are reclaimed so as to support pre-development uses, such as wildlife habitat, through the restoration or soil productivity. In other words, the possession or leasehold of subsurface mineral rights should not confer the right to permanently impact surface resources.

Therefore, we also support the incorporation into the rule of the guidelines for design and construction of pits and liners and closure procedures which include the testing of soils for salt as well as hydrocarbon contaminants.

There are aspects of the proposed rule with which we cannot agree.

Fencing as described at 19.15.17.11.D will do nothing to protect wildlife and may, in fact, present an additional injury hazard to animals attempting to cross the fence. The netting requirements described at 19.15.17.11.E are better, but we do not believe that they are adequate to protect bats or migratory birds as written.

The proposed procedures for pit closure and disposal of contents and the replacement of soil cover and stockpiling of topsoil should allow for site conditions that favor the establishment of healthy vegetation similar to the surrounding area. However, we are concerned that the definition of re-vegetate at 19.15.17.7 and the requirements in 19.15.17.13.H do not provide the adequate authority to assure that a suitable vegetative cover will actually be established.

To sum up, the Department of Game and Fish supports adoption of the rule. We do have some minor disagreements with it.

I've tried to be brief here and I, just close, would like to -- for more detail on any of the topics which I have mentioned here, would like to refer members of the Commission or interested members of the public to our written comments on the proposed rule and to the New Mexico Game and Fish Oil and Gas Development Guidelines, which are available to view or download on our public website.

CHAIRMAN FESMIRE: Thank you, Ms. Jankowitz.

There were some more people who had -- I'm trying to work my way that way, so is there anybody -- Why don't you come forward, sir, please?

You've heard the options. Do have a preference?

MR. MEADOR: I'll take an oath.

CHAIRMAN FESMIRE: Okay. Would you raise your right hand and be sworn, please?

(Thereupon, the witness was sworn.)

CHAIRMAN FESMIRE: And start with your name, please, sir.

<u>DWAYNE MEADOR</u>,

the witness herein, after having been first duly sworn upon his oath, testified as follows:

DIRECT TESTIMONY

BY MR. MEADOR:

MR. MEADOR: My name is Dwayne Meador. I'm from the northwest region, I'm a landowner and a contractor, dirt contractor, as the first gentleman was, in the same type business. I'm kind of -- some of the same concerns.

I can see a real economic impact if these rules are put through what we're hearing. In our end of the state it's going to hurt us bad. I can see our customers cutting way back already, waiting on these rulings to see what's happening. My workload, I'm about -- probably 70 percent of the employees that were -- you know, I had about three months ago. So it's gone down real fast. Everybody's kind of waiting on this to see what's going to happen.

The pit closing, I've been hearing a little bit here, kind of getting the idea that some people think it's a standard practice to tear the pit liner out. We do in my company probably close to 300 pit closures a year, just reserve pits. This is not the little production pits, which most of them that were unlined from the '50s and '60s have been cleaned up, the contamination hauled out to disposal sites and other types of metal, fiberglass-type of pits installed in there. From my experience, the most of the contamination that we seen in our area was from those type of pits, not from the reserve pits.

But in our cleanup process, we save that liner. We -- As for our in-place rules now, you take the top off down to mud line so you don't have the masses like the film that we seen a while ago. And that one, my assumption of that film we were watching was, all the plastic -- was a re-dug pit, a lined pit that had been dug out. The well was re-worked, is why that liner was on top of the ground instead of the bottom.

And we have dug into those before on a rework of a well. And the same thing, we re-line -- dig it out, we stack it over, the well is reworked, all of that contamination is put back in on top of a new liner.

The -- I'm the owner of my company, I have my own -- sole proprietor, take a lot of pride in our work. From the Bureau of Land Management we have received a couple of reclamation awards for our work. The outcome of our work, you can drive all over the country up there and see.

The vegetation on the pits -- if we have the rainfall, it's good. But without rain it's not going to work. If it don't work in the two-year period, we go re-vegetate again. And that's a commitment of our customers, the operators, to do that until -- you know, you may do it several times, but at some point you're going to get enough rain to get that vegetation going. And that is our goal, to leave the land as we seen it, as best as we can.

And there's a lot of the pits, old pits that were unlined from the '50s and '60s that you will see, the brush, the trees, everything growing up. I mean, full-size piñon and juniper trees, you go in the old pit areas. So I don't think we're seeing a lot of salt even in those times, and the contaminants of the old drilling mud have faded away and vegetation is growing good.

And in the recent years, you know, everybody lives and learns, and the fluids that they drill with and what is in that drilling mud is pretty much what came out of the ground natural. You don't see anything in there, or I haven't, that is really harmful to the environment on top. And as long as that liner is kept in place underneath, I think we have pretty well trapped any of the contaminants that were there.

And along with the BLM recognition that we've had over our -- you know, through the Energy and Minerals Department, we have come up with the same deals from the wildlife department, the -- within our gas and oilfield work, of making water holes for the wildlife, and a lot of these being right next to the well sites. But they're not finding that they're contaminated or that they're worried about the animals being contaminated with them being that close. So it's working. And I think the rules we have in place are going good as they are.

We have done four, five closed-loop systems in the past year, all of them being where the water table is high. And we know as well as anybody, we can't dig a reserve pit in water. It's not going to work. So if we have high water tables, it's closed-loop system anyway.

But when we get up in the hills away from the groundwater, the close-to-ground water, then we -- I think the pits that we are doing are sufficient and our reclamation is working, and a good field trip around the country up there will show you that.

So that's pretty much what I had.

CHAIRMAN FESMIRE: Okay, are there any questions of this witness?

MR. BROOKS: No questions, Mr. Chairman.

MR. HISER: No questions.

MS. FOSTER: No questions.

CHAIRMAN FESMIRE: Oh, there she is.

Mr. Jantz?

MR. JANTZ: No questions.

CHAIRMAN FESMIRE: Commissioner Bailey?

COMMISSIONER BAILEY: No.

CHAIRMAN FESMIRE: Commissioner Olson?

COMMISSIONER OLSON: No questions.

EXAMINATION

BY CHAIRMAN FESMIRE:

Q. Mr. Meador, I've got two quick questions.

You talked about taking the top off down to the mud line when you closed a pit. What is that process? What exactly did you mean?

A. The excess pit liner. When the rig comes in and set up, we've got a liner comes all the way out the top, comes out on the ground so there is no spill from the -- under the mud pits or the rig. Everything has to go to that reserve pit.

Q. Okay, so you cut if off --

A. -- at the mud line, so we don't have that sticking of the top of the ground.

Q. For some of the lawyers here, why don't you explain what the mud line is?

A. The top of the drilling mud.

Q. Okay, the maximum height in the pit of the drilling mud?

A. Right.

Q. Okay. And what did you do with that excess liner?

A. We take it to a licensed landfill. And there again, we keep all of our disposal tickets and -- for every well, so we have proof that that's where that went. There's nothing extra buried on site around. We have a disposal ticket for every well we clean up.

Q. Okay. And you talked a little bit about four or five closed-loop systems. So the equipment is available to drill closed-loop in the northwest?

A. There are a couple. You can't just take any rig and do it. It -- I'm not in the drilling business, but being around them and talking to them, the time it takes to do a closed-loop system and the expense is quite high.

Q. Okay. But the equipment -- You said you can't do it with any rig. What does it take to make a rig capable of drilling closed-loop?

A. I couldn't tell you for sure. I know there's a lot of extra pits, extra loader to load the mud, trucks to haul the mud out, to take it to a different site, you know, whatever we've got to do. But a lot of extra expense of equipment on location with it.

Q. Okay. I guess I'm going to make the point one more time. It can be done, I guess, is what you're telling us?

A. I know it can be done. Being economically feasible, I can't say that, no.

CHAIRMAN FESMIRE: Okay. Are there any other questions of this witness?

Mr. Meador, thank you very much.

THE WITNESS: Thank you.

CHAIRMAN FESMIRE: There was at least one more person. Sir? Why don't you come on forward?

Would you want to make a statement, or do you want to be sworn?

MR. LEONARD: I want to be sworn.

(Thereupon, the witness was sworn.)

CHAIRMAN FESMIRE: And start with your name, please, sir.

MIKE LEONARD,

the witness herein, after having been first duly sworn upon his oath, testified as follows:

DIRECT TESTIMONY

BY MR. LEONARD:

MR. LEONARD: Thank you. My name is Mike Leonard. I live in Aztec, New Mexico. I am employed by a company called Key Energy Services, Incorporated.

My comments are going to be mostly along the line what the doctor talked about earlier, about the human element and the human effects of the proposed pit ruling.

Let me tell you a little bit about Key Energy to start with. Key Energy Services, Incorporated, is headquartered in Houston, Texas. We offer our customers, primarily oil and gas producers, an advanced array of onshore energy production services. We offer new well completions, workover services, fluid logistics, downhole fishing and rental services, pressure pumping, electronic wireline and drilling. Our drilling specialty is in coalbed methane.

And I'm in the business development group of Key Energy, so I get to talk with a lot of customers. And in conversations with a lot of customers lately, we've been told that if the pit ruling passes they'll be forced by economic constraints to dramatically cut their exploration and development programs. Many of these operators have leases in marginal areas, and the additional costs incurred by the pit ruling would make these projects not economically viable, and they'll be dropped.

Many independent producers -- and we have a lot of independent producers -- do not have the luxuries that some of the major oil companies have to redirect their funds to other states. They're New Mexico-based, and their employees, just like Key Energy Services' employees, will be tremendously impacted by this ruling.

At the present time -- I have the list here -- Key Energy employs 774 people within the State of New Mexico. And each of those employees' prosperity, from clerks to dispatchers to drillers to truck drivers, is directly linked to the oil and gas activity level within the State of New Mexico.

Considering this, and the fact that most of those employees have immediate family that depend upon their income, the effect of the pit rule changes could be felt by many more people than just those 774 New Mexico employees.

In fact, when the numbers are added up, with the number of people within the company touched by the steep decline in the state's oil and gas activities, that number could be greater than many of our communities, entire communities, in the State of New Mexico. So I would just like you to consider that.

Thank you.

CHAIRMAN FESMIRE: Any questions of this witness?

MR. BROOKS: Thank you, Mr. Chairman.

EXAMINATION

BY MR. BROOKS:

Q. Mr. Leonard, you mentioned trucks. Is your company in the hauling business?

A. Yes, we are.

Q. Do you haul oilfield waste?

A. No, we haul produced water.

Q. Okay, you do not haul other forms of waste, then?

A. No.

MR. BROOKS: Thank you, that's all I have.

CHAIRMAN FESMIRE: Mr. Hiser?

MR. HISER: No questions.

CHAIRMAN FESMIRE: Mr. Carr?

MR. CARR: No questions.

CHAIRMAN FESMIRE: Ms. Foster?

MS. FOSTER: Yes.

EXAMINATION

BY MS. FOSTER:

Q. Does your company have rigs? Do you maintain rigs?

A. Rigs?

Q. Yes.

A. Yes, we do.

Q. Okay, and do you use any of your rigs for closed-loop systems drilling?

A. We have not in this area as of yet used any of that, and we do not have the closed-loop systems.

Q. Okay, so you need to actually add hardware onto --

A. We would have to add the system -- we'd have to manufacture the systems, put them together or purchase them from another company at additional expense. It's quite -- they're quite expensive. We've had some people come in and talk to us about it and different things, so...

Q. Okay, could you give us a range of how expensive a closed-loop system --

A. I can't give you an exact number.

Q. And do you do workover rigs?

A. Yes.

Q. And how many do you have operating now in New Mexico?

A. In New Mexico, probably -- I can't give you an exact number. It's in the hundreds.

Q. Okay. Is it possible to use a workover rig, or do a workover in a closed-loop system?

A. Absolutely, yeah.

Q. It is possible?

A. Certainly.

Q. Okay. So you wouldn't need any open pits at all to do workovers?

A. We wouldn't if we had that, but it would be much -- it would take a lot more time, it would be much more expensive.

You'd have much more surface disruption. That's something that needs to be considered. With all the hauling of all these additional pits and equipment in, you're going to have surface disruption. The roads -- many of the roads in a lot of our areas are just two tracks, almost, a lot of them. And of course you're going to have erosion issues and different things when you're moving much more equipment, and it's going to take a lot more equipment.

MS. FOSTER: I have no more questions, thank you.

CHAIRMAN FESMIRE: Mr. Jantz?

MR. JANTZ: No questions, Mr. Chairman.

CHAIRMAN FESMIRE: Commissioner?

EXAMINATION

BY COMMISSIONER BAILEY:

Q. Can you give me a rough idea of the contrast of how much acreage is disturbed with regular drilling, as opposed to having --

A. I can't do that, because it would vary so much. Because you don't know, if you're leaving a county road or a maintained state highway, how far that you're going to have to travel on that to get to the drill site, to get to the location site. So it would vary. You know, you may be a half a mile off or a couple hundred yards, or you may be 30 miles.

Q. With on-site --

A. On-site.

Q. -- what's the difference between normal drilling and closed-loop drilling for acreage disturbance?

A. I can't tell you. It is substantially more. And many of our locations are quite small, because we are in national forest areas and in Bureau of Land Management areas. We try to keep that footprint as small as we possibly can to keep it workable, but to keep it as small as we possibly can.

We -- You know, so you don't want to be stacking these its out into the piñons and the -- you know, cedars and different things like that, so...

COMMISSIONER BAILEY: That's all I have.

CHAIRMAN FESMIRE: Commissioner Olson?

COMMISSIONER OLSON: No questions.

EXAMINATION

BY CHAIRMAN FESMIRE:

Q. Mr. Leonard, you made a statement. A lot of the -- a lot of your customers are New Mexico-based, and they don't have the option of leaving the state. Did I hear that correctly?

A. To redirecting their funds to other projects in other states.

Q. So they'll be working in New Mexico?

A. They're working in New Mexico, if they have the funds and it's an economically viable thing.

Q. Okay. The point I'm going to make may not be in Key Energy's best interest, but if some operators leave the state, what's going to happen to the cost of drilling and completing a well in New Mexico with the rigs that are available?

A. With the rigs that are available, if some of the operators leave? There's going to be a lot more available rigs.

Q. And what's going to happen to the cost of those rigs?

A. It's going to go down, probably, as will -- as will commensuration, wages and everything that goes along with that.

Q. Okay. Now, you said that you all operate workover rigs --

A. Yes, sir.

Q. -- is that correct? And I'm assuming that you're talking about reverse units and things like that?

A. Well, we do in some areas.

Q. How are the pits handled on a reverse unit?

A. You know, that's not my specialty so can't answer that.

Q. Okay. But you push reverse units and the pits associated with that --

A. Right.

Q. -- don't you? And those are steel pits, aren't they?

A. Right, they are steel.

Q. And those are essentially closed-loop systems?

A. They are essentially -- they are closed steel pits. Most of them, if you're using them, they're hard-lined together or they're hosed together to where you're not having any spilling.

Q. And in fact, if you didn't, you know, have an extraordinary situation, most workovers can be done with what is essentially a closed-loop system?

A. That's correct.

CHAIRMAN FESMIRE: Any further questions of this witness?

Okay, thank you very much, Mr. Leonard.

THE WITNESS: Thank you.

CHAIRMAN FESMIRE: Sir, would you -- I assume that you meant that you needed -- you wanted to make a statement?

MR. SEIP: Yeah, I'm sorry, I didn't mean to jump in. I thought you were through.

CHAIRMAN FESMIRE: That's okay.

MR. SEIP: Do I have the same options?

CHAIRMAN FESMIRE: You have the same options, sir.

(Thereupon, the witness was sworn.)

CHAIRMAN FESMIRE: And start with your name, please, sir.

<u>DANNY SEIP</u>,

the witness herein, after having been first duly sworn upon his oath, testified as follows:

DIRECT TESTIMONY

BY MR. SEIP:

MR. SEIP: Thank you. My name is Danny Seip, I'm --

CHAIRMAN FESMIRE: Could you -- I'm sorry?

THE WITNESS: Danny Seip.

CHAIRMAN FESMIRE: S-i-p-e?

THE WITNESS: S-e-i-p. Not like Brian Sipe the quarterback.

I'm a businessman that's been involved in the San Juan Basin for almost 40 years in an independent wireline cased-hole service company. We have -- like I said, we've been there for 40 years. We've been through the cycles, the ups and downs and so forth. And the -- for every decrease in the cycle that we see in the industry, there's always been an up side.

Unfortunately, in the San Juan Basin there's a total of about 76 oil companies, gas and oil companies, that are stationed in the immediate Basin itself. We've broken that down as an independent contractor and broken it into two categories. These two categories are majors and independents.

And our category, as far as service is concerned, we have got 11 major companies, and they range from -- everywhere from 25 projects to 300, 400, 500 projects. The remainder 65 of the companies that are working in the San Juan Basin operate as an independent structure.

These 76 companies -- I deal with a huge work force base in the San Juan Basin with my company. We visit most all of these 76 throughout the year several different times, either in a technical standpoint or in a sales position.

We've been very diligently putting together, and have put together in the last 15 years or so, a huge database which contacts and monitors permits, drilled wells and so on and so forth, which is the base of our industry. We've put together -- and just using one example is, in 206 [*sic*] we used that there -- between completions and new drills and permits, there would have been about 1700 wells that were either permitted to be drilled or in a recompletion status.

Unfortunately, in 2008, after going back and revisiting these people several different times, not just particularly in '06 but in '07 as well, we have seen a tremendous decline, not only in just permits but also in the opportunity for reworks, to the tune of about 40 percent is what we're seeing for the impact of '08.

With those numbers in mind -- as a small independent company we have a staff of 26 people we run four cased-hole logging units -- if this impact at these numbers are correct, I'm going to have to eliminate at least one unit. That's three men with a support group of two people.

Economically that is going to take five men and put them, actually them and their families, into an unemployment situation and consequently also putting my company in a position of financial burden.

But more importantly, we look at this in a whole spectrum of the San Juan Basin. And the Basin approximately employs directly, indirectly, sixteen-some-thousand people that are associated with the oil and gas industry.

It takes approximately one -- I mean, it takes -- for every one well drilled, it takes approximately eight to 10 people from the start to the finish of this project. If you look at that with the downgrade of the numbers in the wells to be drilled or completed, it puts us somewhere in the neighborhood over the next two years of possibly losing positions upwards of 5800 people.

Immediately on the service sector of it, we're looking in the neighborhood of about 3400 jobs lost, basically as soon as the regulations or -- go into effect, complete effect.

Like I said, these are related -- unrelated jobs, very -- very close to the actual industry itself. It reminds me very much of the same situation we went through in 1987, except the oil and the gas industry did rebound from 1987. The possibilities happening from this, from the pit rule, 50, being in place, I don't know if it's going to happen. The industry at that point may go into a vital tailspin.

With that, I end my statement.

CHAIRMAN FESMIRE: Thank you, Mr. Seip.

Are there any questions of this witness?

MR. BROOKS: No questions, your Honor.

MR. HISER: No questions.

CHAIRMAN FESMIRE: Ms. Foster?

MS. FOSTER: No.

CHAIRMAN FESMIRE: Mr. Jantz?

MR. JANTZ: No questions.

CHAIRMAN FESMIRE: Commissioner --

COMMISSIONER BAILEY: (Shakes head)

CHAIRMAN FESMIRE: Commissioner Olson?

EXAMINATION

BY COMMISSIONER OLSON:

Q. Yeah, I guess this has been coming up as -- been thinking about this with a lot of witnesses that are coming in opposition, and excuse me if I just happen to ask you this, because it was just -- I was just thinking about this. But are you saying -- I guess you saw some of the earlier testimony today that says we'd have some problems, potential problems, with drilling pits. Did you hear that?

A. Yes, I did.

Q. Are you opposing any new regulations to try to protect groundwater from these types of pits?

A. I'm not in favor or opposing any of these regulations. And the fact is, I'm not totally addressed to the rule itself. I just am -- to the impact that this rule can do to our industry.

Q. As proposed by the Division?

A. Right.

Q. So would you agree that just from potential threats from the pits, there is maybe something we need to do, just -- you're not just in agreement with the rule as proposed by the Division?

A. Exactly.

COMMISSIONER OLSON: Okay, thank you.

EXAMINATION

BY CHAIRMAN FESMIRE:

Q. Mr. Seip, kind of following up on that, what would you change?

A. That's a great question. I don't know exactly where to go if there needs to be a change or if the industry needs to take it upon themselves to do a better job. I don't know. I'm not an expert in that field, and would hate to put either side in a position.

Q. Okay. But it sounds like you agree that something needs to be done?

A. Something needs to be done to protect the industry as a whole.

Q. To protect the industry?
A. The industry and the environment as a whole. The industry is a huge benefit to the State of New Mexico. The economy is a huge factor to the State of New Mexico as well. I think that they both need to be on a straightforward parallel line, working together.
CHAIRMAN FESMIRE: Thank you very much, Mr. Seip.
Is there any other questions of this witness?
Thank you, sir.
With that we'll break for lunch and we'll reconvene at two o'clock in this room.
Oh, I'm sorry, excuse me --
MR. FELLABAUM: One more. I'll be brief.
CHAIRMAN FESMIRE: Okay, don't let the fact that people are packing up and leaving affect anything.
(Thereupon, the witness was sworn.)
CHAIRMAN FESMIRE: And please start with your name, sir.

RON FELLABAUM,

the witness herein, after having been first duly sworn upon his oath, testified as follows:

DIRECT TESTIMONY

BY MR. FELLABAUM:
MR. FELLABAUM: Certainly, my name is Ron Fellabaum, F-e-l-l-a-b- --

CHAIRMAN FESMIRE: You get that look a lot, huh?

THE WITNESS: I do.

CHAIRMAN FESMIRE: -- -a-b- -- ?

THE WITNESS: -- F-e-l-l-a-b-a-u-m. I own San Juan Casing Service, LLC. It's a business that has been in the San Juan Basin -- in 2008 it will be 50 years.

I work for almost all the majors and all the independents in the San Juan Basin area. I have -- like Mr. Seip, have talked to many of the producers.

This closed-loop system that you're proposing, it will be devastating to the San Juan Basin and many of the producers, i.e., the service companies as well. If drilling rigs are not running, I will be out of business. That is the only thing I do.

I always thought it would be a poor business decision on my part that might accidentally put me out of business. Instead, it's regulations that are going to put me out of business.

I have 33 employees. I've grown the business over the past three or four years, and now I kind of wish I hadn't because there's many friends that are employees that are going to have to be laid off if this happens.

Quite honestly, the impact of just the rumor of it has already impacted my business. Since July my business is down about 30 percent. Of the drilling rigs that are running now, I've been talking to many of them, they're looking at the same thing. I've had numerous employees from drilling rigs coming in, looking for work because they think the drillings are going down. I tell them, If they go down, I'm down too. You need to find something else, maybe McDonald's. They're not used to wages and working in that environment, if you will.

I know you folks are trying to do some things for our environment. I personally think that there's enough regulation that are in place that if everything is done as per the regulation, we don't need to do anything else. I see all the drilling rigs, I've been on most all of the drilling rigs in the Basin. They do a tremendous job about protecting the groundwater and fencing it.

I listen to the Fish and Game talk about that. The animals are not afraid of the drilling rigs, and they don't mess with the pits. I've watched elk walk right over the location, and when they're fenced they walk around it. There's no harm there, no way that they're going to fall in it. If they do, they walk right out of it too.

I think the last thing I'd like to say is, the muds that are being used now are nothing like they were in the '50s and '60s. I know quite a few drilling companies, and they drill with fresh water. And as long as they can do that, there is virtually nothing besides water and earth that is back in those pits.

I just hope you guys think about the impact it's going to do to people's lives. And I understand what you're trying to do on the environment, and I think you're going to injure many more families throughout the State of New Mexico by this regulation.

CHAIRMAN FESMIRE: Thank you, sir.

Any questions of this witness?

MR. BROOKS: No questions, Mr. Chairman.

MR. CARR: No, sir.

MR. HISER: No.

MS. FOSTER: No questions.

CHAIRMAN FESMIRE: Mr. Jantz?

MR. JANTZ: No questions.

CHAIRMAN FESMIRE: Ms. Belin?

MS. BELIN: No questions, Mr. Chairman.

CHAIRMAN FESMIRE: Commissioner?

COMMISSIONER BAILEY: (Shakes head)

EXAMINATION

BY COMMISSIONER OLSON:

Q. Just one question. You seem to be under the impression that the Division is proposing closed-loop systems for all drilling; is that correct?

A. That's what my impression is, yes.

Q. So you weren't here for their testimony on the proposed rule that closed-loop systems will only be required where there's less than 50 feet to groundwater?

A. No, did not. But I think in saying that too, you're still going to make an enormous amount of wells that are uneconomical for the producers to drill. This is a high-dollar deal to put together for the drilling companies and the producers.

Q. I guess you've worked on a lot of well sites. How many -- What percentage of the well sites in the San Juan Basin are in areas where it's less than 50 feet to water?

A. I cannot tell you that.

Q. Okay.

A. I don't know what the groundwater is in different areas. But I've been in the San Juan Basin for 30 years and have been involved in the drilling side of it for many of those years as well. That rig that's on your wall, I used to be the president of that company.

COMMISSIONER OLSON: That's all I have.

EXAMINATION

BY CHAIRMAN FESMIRE:

Q. Mr. Fellabaum, I don't want to give the impression either that the arguments you're making and concerns you're raising are not -- you know, they do weigh heavy on us. But I need to point out something.

How much of the casing that you sell is surface casing?

A. I do not sell casing. All I do is go and screw it together on the drilling rigs.

Q. Okay, how much that you install is surface casing?

A. Depends on the depth of the well. Some of it's 350 feet, some of it's 600 feet.

Q. And you realize that most of that surface casing, not all of it, and not necessarily all of it on each well, but most of that surface casing is the result of regulation by the OCD?

A. Absolutely, sir.

Q. So that regulation is okay, but some of the other regulations aren't?

A. No, I think -- I think there's plenty of regulations that are in place to take care of our business as it is.

CHAIRMAN FESMIRE: Any other questions of this witness?

Okay. Thank you very much, Mr. Fellabaum.

MR. FELLABAUM: Thank you.

CHAIRMAN FESMIRE: Is there anyone else? And I apologize to Mr. Fellabaum, I didn't -- didn't see him back there.

MR. FELLABAUM: Not a problem, sir.

CHAIRMAN FESMIRE: Okay. With that, we will break for lunch and return at two o'clock.

Thank you all very much.

(Thereupon, noon recess was taken at 1:00 p.m.)

(The following proceedings had at 2:05 p.m.)

CHAIRMAN FESMIRE: Ready to go back on the record? I'm assuming everybody's ready.

This is a continuation of Case Number 14,015. We're reconvening after lunch on Thursday [*sic*], November 14th, 2007. Let the record reflect that Commissioners Olson, Bailey and Fesmire are all present, we therefore have a quorum.

I believe we were about to start the cross-examination of Dr. Neeper, were we not?

DR. BARTLIT: Excuse me --

CHAIRMAN FESMIRE: Dr. Bartlit?

DR. BARTLIT: -- I think you misspoke. I think you said Thursday.

CHAIRMAN FESMIRE: Thursday? I'm having a real good time.

COMMISSIONER OLSON: If it was Thursday we wouldn't be here now.

CHAIRMAN FESMIRE: Dr. Bartlit, thank you. I stand corrected, it is Wednesday, November 14th. I've got a little magnifying glass in my watch so I can see the date now.

And we will begin with the cross-examination of Dr. Neeper.

I think, Mr. Brooks, in the scheme of things it's probably your turn, isn't it?

MR. BROOKS: We will accept that, your Honor.

DONALD A. NEEPER, PhD (Resumed),

the witness herein, having been previously duly sworn upon his oath, was examined and testified as follows:

EXAMINATION

BY MR. BROOKS:

Q. Good afternoon, Dr. Neeper.

A. Good afternoon.

Q. My cross-examination is going to be very brief, and hopefully everyone else will take the cue and be equally brief.

And while we're embarrassing the Chair about his misspeaking a minute ago, I was going to raise a similar issue with you just to make sure the record is clear.

You said -- You were talking about having a rule that encourages innovation. Do you recall that testimony?

A. That is correct.

Q. And what you were talking about specifically had to do with the rule being structured in such a way that if people can find new ways to treat waste and render it harmless, that they would be able to have an opportunity to demonstrate that?

A. Yes, I expected that they might be able to render some part of the waste harmless. We're always going to have waste that comes off in the treatment process.

Q. Okay, the particular clarification I wanted to be clear on was, according to my notes you said you thought the current rule was adequate for that purpose, and I was wondering if you meant the current rule in terms of the one now in effect or the currently proposed rule, i.e., the one that is the focus of this proceeding.

A. That is the currently proposed rule.

Q. Okay, thank you.

Now I'm going a little bit out of order because this is the order my notes are in, and it will make us go a little bit faster, I think, if I just go in that order rather than trying to go through.

But I need to find the graphs where you plotted the time effects -- the movement over time in different colors. And here we're getting into the -- On page 37.

First of all, just to clarify, I think everybody understands what you did, but just to clarify, the times that you're showing are the times -- in terms of chloride movement, as I understand it, these are the times that the chloride from the pit will first reach groundwater, correct? In your zero line?

A. The graphs show when the chloride reaches groundwater, or approximately, in page 37, which is on the screen. The yellow line at 40 years shows its leading edge just hitting the 20 meters below the start of the problem, below the top of the problem. So you would say the chloride is then just reaching the groundwater.

Q. Yeah. Unlike Mr. Hansen's slides, which undertook to show when the chloride level -- when the chloride would reach the groundwater in a certain concentration; is that correct?

A. I can't comment on his slides right now unless they're right in front of me.

Q. Yeah. But you were not plotting the time at which the chloride would reach the groundwater in particular concentration, just when it would do so?

A. No, I did not ever calculate a concentration in groundwater. In effect, I set my groundwater to a high speed. That is, as soon as the chloride reached that point in the problem, it was washed out. I maintained essentially a zero concentration at that point because --

Q. Okay --

A. -- there are too many variables in the groundwater, and I -- that wasn't what I was trying to get to.

Q. Now when you -- in your plotting of these graphs, in the one that I focused on, on page 37, you actually show in a hundred years the chloride reaching the groundwater in quantities somewhat larger than that in the 40-year example, right?

A. What I show at 100 years is, almost all of this chloride pulse has reached the groundwater. If you look at the dotted line on the curve which represents 100 years, we see that the concentration back up in the burial region is zero, and there is just a little bit of the chloride pulse left, still traveling downward toward the groundwater.

Q. Okay, I'm sorry, I was looking at the wrong page here.

On page 41, now, you have plotted several different time curves. You've plotted a five-year, a 10-year, 40-year and 100-year for the clay loam soil, right?

A. Correct.

Q. And none of those reaches groundwater at any point, correct?

A. None of those reaches groundwater within the 100-year limit of the model.

Q. Now if you were to plot a longer period of time, say 200 years, would you expect at some point that it would reach groundwater?

A. If I ran it for a very long time, it might reach groundwater. I can't say when by extrapolating from this, because it moves slowly. I can't say at what time. It might be a thousand years. It's going to have a long, gradual slope. It's starting to show a long gradient here.

I would guess -- I cannot prove -- I would guess that what would happen is, that gradient will stretch out so you'll have a long gradient all the way down to groundwater at that time, because preferentially it's establishing that gradient all the way to ground surface and is even -- whereas our original concentration in the burial unit was a unit of one -- whether that's 100,000, what it might be -- we're seeing more than that being pushed upward. We're seeing chloride moving upward.

Q. Thank you. So bottom line, you're saying that you think, although you have not done the work, eventually at some point in time, if you extrapolated those curves they would reach groundwater?

A. I would not be surprised to see it reach groundwater. If I could run it for a million years and it never reached groundwater, I would be interested in investigating why and what's going on in that long gradient. It would be worth investigating what's happening at the microscopic scale.

Q. Okay, thank you.

You're familiar with Dr. Buchanan's materials that were submitted in this case?

A. I have seen the prehearing materials. I may remember a given material you discuss and I may not.

Q. Well, I wasn't going to discuss them in detail, actually, especially since he hasn't testified yet. But in general principle, as I understand Dr. Buchanan's work -- and as you may have noticed, I'm not much of a scientist, but as I understand his work he is reporting on empirical work -- empirical studies that tend to show that the upward movement of salts in the vadose zone would be limited -- would be limited to the first foot of material above the cover of the waste. Is that a correct interpretation of what he's saying?

A. I can't interpret what he's saying, that would be a dangerous ground to get into, putting words in his mouth. I would rather refer back to the graphs by Michelle Walvoord and -- the chloride bulge graphs that I showed. They appear many places in the literature. But there you find the peak of a natural chloride bulge down about four feet. And so you could be saying, Well, can that move upward to only a foot or so from that level?

The accumulation there is caused by natural forces by the roots extracting the -- as much as they can of the fresh water that falls out of the sky. And so in fact, there you have natural chloride moving downward to the region it involves. Depending on the hydrology, you may have a little moving upward from the underlying aquifer over a 10,000-year period. So you have that conjunction of forces.

Now to bury a certain amount of waste at a certain depth in the ground and go from what happens in that natural long-term circumstance to concluding that therefore it can't move more than a certain distance is, to me, an unsupported extrapolation.

Q. Well, your opinion, based on your research, is that given enough time -- I'm paraphrasing my understanding, and tell me if I'm wrong. You told me to ask three times and that I would get it the third time.

(Laughter)

Q. My understanding is, from what your -- that your opinion, based on your work in this subject, is that given enough time, and in certain types of solvent, there is a probability that salts in waste buried four feet beneath the earth will move upward and affect -- into the root zone and affect plants on the surface. Is that a correct statement of what you've said?

A. Yes, it's dependent on the -- to some extent it's dependent on the soil type. The looser soil and the kind of moisture that we think is characteristic of southeastern

New Mexico, it's most likely to be washed down. But if you -- the modeling shows that if you have a tighter soil, then it will get washed downward much more slowly, but there will be a much greater tendency toward motion back toward the surface.

Q. Now that motion up toward the surface would be quite slow, would it not, in most instances?

A. Well, let's look at the chart that's up. This is page 41. Now this is a -- what I'd call a tight situation. It's a clay loam soil, which is a tighter soil, the tightest of the three. And the pit material is clay loam, which I thought would be somewhat representative of pit materials which contain clay.

If we look at the red line, which is five years, you can see you've already got some chloride at zero depth here, which is 20 inches under the soil.

Now you could maintain that none of that will get up the next 20 inches. I didn't -- I have acknowledged, I did not try to calculate the dynamics in that region because it is so dynamic. You have to get what the roots are doing right, you have to get the plants right, you have to get the rainfall right, you have to get the sunshine and the evaporation right, and that's a very touchy problem to try to model exactly.

But we see it moving up, it's up to 20 inches here in five years. That means that you're going to have an impact coming up into the root zone.

Q. You would have plant roots at 20 inches, would you not, in some places?

A. Depends on the plant, but I would certainly think so, because some of the desert bushes, I'm told, go down matters of feet with their roots.

Q. Now, if I understand correctly -- and this graph tends to show that -- upward movement and downward movement of the salts from this waste deposit are not mutually inconsistent? That is, it wouldn't be correct to say it will either move up or it will move down?

A. No, this --

Q. They move both up and down?

A. This calculation has it moving both directions.

Q. And the looser and more sandy the soil, the more rapidly it will move down, other things equal?

A. The more rapidly and the more preferentially.

Q. Thank you.

A. Now remember that that requires a certain amount of moisture. If you change the rainfall or change my moisture input of 20 inches, you might alter that circumstance. As a hypothetical case, you might totally shut it off.

Suppose you just made that, my input layer, dry.

That will tend to suck the moisture right buck out of the problem, and you'll get all kinds of upward flow, so --

Q. You'd get a lot less downward flow?

A. Yes, you would force everything to be flowing upwards from the aquifer. And that happens, particularly with shallow groundwater, but when -- where I grew up in San Luis Valley, Colorado, we got great layers of carbonates and other salts on the surface from the shallow -- fairly shallow groundwater, and we called it alkali.

Q. Now Dr. Stephens had some diagrams of places where he had plotted the upward movement of the water. Do you recall those?

A. I recall that he had it, but I don't recall the diagram. I'd have to see that.

Q. Okay. But he said that the water would move upward primarily as a vapor and would not take the salts with it, and of course you concurred that the salts don't move in the vapor, correct?

A. That's correct.

Q. But you nevertheless think that in very dry conditions there would be upward movement of the salts; is that true?

A. Yes. The flow -- unsaturated flow of liquid water will go to whatever direction has the lowest potential. That doesn't mean the smallest number, that means the biggest negative number. So the water can get sucked upward or downward. You have drying in New Mexico on the surface of the ground, the sun and whatnot. If you have a more moist layer underneath, you can be drawing water upwards. I think all of us have had the experience somewhere of dipping a towel in the bathtub and the water in the bathtub, pretty soon it's wet coming up the towel. Same thing happens in soils.

Q. Next question I believe is on page 54. Now on pages 54 and 55, and also on pages 58 and 59, you have plotted the chlorides and moisture potential, as I understand it, by depth in your boreholes; is that correct?

A. That's correct, I put depth on the vertical axis to make it a little more intuitive, and I didn't do all that in my modeling plots just because that's how they came out.

Q. Now on page 58, where you've plotted the deep -- the hole that went down to 35 feet --

A. Yes, both holes.

Q. -- you have kind of a zig-zag pattern where it goes way off to the right and then moves back to the left and then goes off to the right again. Is that --

A. You may be talking about the left graph, labeled 49A.

Q. The two left graphs on --

A. Yes.

Q. -- page 58.

A. Two different holes, they both show a zig-zag pattern in the gravimetric moisture.

Q. Now would that be a similar pattern if you had -- well, let me go -- then on page 59 you -- I don't have to ask you a hypothetical, because on page 59 you've actually plotted the 35-foot hole with the chlorides against depths, right?

A. Yes.

Q. And they show a similar zig-zag pattern?

A. You're referring now to page 59?

Q. Page 59.

A. The upper graphs show the potential on the horizontal axis.

Q. And the lower graphs show the chlorides?

A. And the lower graphs show the chloride?

Q. And both graphs show a zig-zag pattern?

A. To some extent, the middle graph with 321 shows a bigger zig-zag in the potential, but there is some zig-zag in both graphs.

Q. Now the one over -- the graphs on the 15-foot hole don't show nearly as much of a zig-zag, correct?

A. That's correct.

Q. Now would you expect if you had drilled that hole deeper and been able to graph the function down, that you would find a similar zig-zag pattern?

A. I wouldn't have any idea until I did it. What I noticed when we were drilling in the Burch Keely Unit, or after I analyzed the data and I put the labels of sand or clay, my observations of the nature of the soil on the plot, then I saw that the gravimetric moisture tended to correlate quite well with the nature of the soil.

And if you have more moisture in one place than another, you're likely to have more salt per kilogram of soil, because if you -- you're counting the amount of salt that's actually held there in the moisture, usually.

Q. Do you recall Mr. Price discussing his concept of enveloping in chloride plotting?

A. No, you'll have to re-explain the concept.

MR. BROOKS: Well, that would not be very good for me to do, because Mr. Price explained it.

May I approach --

THE WITNESS: Maybe you can rephrase the question.

MR. BROOKS: -- the witness and show him Mr. Price's graphs?

CHAIRMAN FESMIRE: Is that an exhibit in the --

MR. BROOKS: Yes, it's part of Exhibit 10A, I believe.

CHAIRMAN FESMIRE: It's already been admitted into evidence?

MR. BROOKS: It's already been admitted.

CHAIRMAN FESMIRE: You may, sir.

THE WITNESS: It has now come back, that I begin to see your graph. I remember what he meant by envelope.

Q. (By Mr. Brooks) Yes, the next several pages are all similar graphs.

A. Yes.

Q. Were your findings that you plotted in your exhibits consistent with that?

A. I will say that my findings are not inconsistent with that. I find peaks in moisture, and I find peaks in potential and peaks in chloride, all of which seem to tell a consistent picture and to be consistent with basically varying the lithology on a small scale. So it's very reasonable to me that you could do a sampling somewhere else and find peaks and valleys in the chloride.

It could be due to other circumstances. You could have a double pulse of moisture at some time, driving in two peaks from a given source. So there could be other causes for it.

But it's not surprising to find peaks, and I found his scheme of kind of tracing out the peaks to try to guess whether or not there could be an increase in concentration in a region not yet sampled to be an intriguing observation.

Q. And do you recall that Mr. Price testified that he used a relatively low chloride delineation level for testing underneath the pits --

A. Yes.

Q. -- at 250 parts per million?

A. Yes.

Q. And do you recall that he also testified the reason he did that was because with this tendency of enveloping, there might be much higher levels of chlorides at a lower depth as a result of that contamination?

A. Yes, you can certainly find more chlorides at greater depth. And I'm just -- if I glance at the screen and look at hole 321, the lower middle graph on the screen, we can see a fairly low chloride up here near the surface, and some very high peaks just a few feet under the surface.

Q. So is -- bottom line, is Mr. Price's recommendation of the low delineation level for tracing contaminants at the surface -- is that consistent with your knowledge of soil physics and your work on the subject?

A. Yes, I did not see anything wrong with setting a 250-milligram-per-kilogram level for leak detection.

MR. BROOKS: May I approach the witness to retrieve the exhibit, Mr. Chairman?

CHAIRMAN FESMIRE: You may, sir.

Q. (By Mr. Brooks) Now you said, if I recall correctly, that you would not be concerned about one encapsulated buried pit waste mass, but you were concerned about having them everywhere; is that correct?

A. That's very close to what I said. I had used the term, which comes from some mathematics, called almost everywhere. It means --

(Laughter)

A. It means that really, the farther yo get from one, the closer you get to another one.

But our bigger concern is with a systematic -- a systemic effect, whether on the water or on the landscape as a whole. If there's one buried unit out there somewhere, I don't think that will have near the impact on the future as if you have a large area with buried units that are sometimes difficult to avoid.

Q. Now first of all, let's talk about the distance between wells. You assumed a 40-acre spacing pattern?

A. I used that as an example. It doesn't mean that OCD specifies that. I believe I have seen requests for such a spacing, but my point was -- I happened to draw 40 acres first, but if you take that up four times the amount to 160, you now have only doubled the distance that you're talking about.

Q. Well, assume with me that OCD's statewide spacing rules for oil wells provide for 40-acre spacing units but allow up to four wells per 40-acre spacing unit so that in effect you could have an average of one well per 10 acres.

A. Yes.

Q. Would that make the almost everywhere even more almost everywhere?

(Laughter)

A. Even more almost. I try sometimes not to give an absolute extreme of an example.

Q. Yes, sir. Thank you.

Okay. Now the concept you're talking about, is that -- when I was examining Dr. Stephens, I used the phrase cumulative effects. Is that concept that you were talking about -- is that properly called cumulative effect or --

A. There would be -- Potentially, if you had units that were discharging or contributing to contamination of groundwater, then you have a cumulative effect, because you have many sources, all feeding into a common aquifer.

On the surface of the land I guess you could call it a cumulative effect. If there is one pit out there, somebody may accidentally run into, let's say, for human use of the land. If there are pits many, many places and a human wants to use the land for a shopping center, he may have a very hard time trying to fit his shopping center in there, and particularly might not know just where the pits are. So he's going to have to go out and do geophysics to find them.

I think similar things may happen in various natural uses of the land. If you've got contamination coming upward from one pit in a hundred square miles, it wouldn't have much effect on the general ecology. If you had contamination coming up from units every 20 acres, it might have a significant effect on surface ecology.

Q. Would the same thing tend to be true of the groundwater?

A. Yes, that was my first part of this answer, is, groundwater is the case we first think of because if you have many sources contributing to the contamination of groundwater, you have a much larger problem.

Q. Okay. Now one other line of questioning, and then I'll turn you over to others.

You said something about allowing industry to externalize costs. Would you explain that concept?

A. The concept is used in the economics literature that I have read. I am not an economist. But if a business incurs a cost and the business does not actually have to pay that cost but can somehow enable somebody else to live with it or somehow avoid it, but push it to another place, another location, another entity, then it has externalized the cost.

An example that occurred in the literature at the time when, let's say, power plants had no scrubbers, they were externalizing the cost of the sulfur dioxide and various other contaminants coming out of the power plant, onto the rest of society where some penalties were played, whether through corrosion or health effects or some other effect. And so you could say they were externalizing the costs of their business.

Q. In the world that existed before, say, the 1960s, the air and the water were free, essentially?

A. They were considered free, as free sinks or free dumps.

Q. So if you wanted to dispose of your waste, you could blow it out into the air or dump it in the water, and you didn't have to pay anything for doing it?

A. That was commonly done at that time.

Q. And the result would be that that cost did not become part of the cost structure for the product you had to sell?

A. It did not show up in the price of the product, it did not show up as a monetary cost to the industry concerned.

Q. But if -- since the industry generates the waste, you would regard the cost of disposing of that waste so that it does not create effects on other people to be properly treated as a cost to that industry for doing business; is that what you're trying to say?

A. I prefer in general that the price of the product reflect all of the costs that go into the manufacture of that product.

Now we can always take that to an extreme, because you can say I am breathing, I am delivering carbon dioxide to the atmosphere, and I am not in any way paying the rest of society or the earth for what I am causing. So that brings in this whole factor of judgment into the problem, and therefore judgment has to be used in how we handle these things.

But I prefer that the costs of an industry, and particularly its wastes, not be externalized. That's the lesson we've learned in the environmental activities of the last 30 years.

Q. Now if the cost is imposed on the industry, you said something about it would affect the marginal operator, correct?

A. Well, I will say I have heard discussions that the marginal operator will be affected first and affected the most.

Q. Now is the marginal operator the one who is producing the product at the highest cost? That is, he's producing the less -- the least amount of product as of all operators, the marginal operators, producing the least amount of product for the cost -- for the cost that he pays?

A. I can't say, because we're out of my area both of knowledge of the industry and my expertise. By marginal operator in this case, I used the term, I would mean the one with the smallest operation or the one with the least available capital.

MR. BROOKS: Well, I'm not sure I would agree with you, but I think if we've gotten to the limit of your knowledge we perhaps have exhausted that subject.

Pass the witness.

CHAIRMAN FESMIRE: Mr. Hiser?

MR. HISER: Just for the record, Mr. Chairman, I would note that we got the -- I personally didn't receive these exhibits until the actual presentation today, and so I apologize if things are rougher than they might otherwise be. Apparently there was some miscommunication with the terms of the CD that we had and what all was in that, so I'd just note that for the record.

We're prepared to go ahead, because I know that Dr. Neeper is only available at the time we -- go ahead and proceed forward.

MS. BELIN: Just to clarify, we did provide two written copies to Mr. Carr --

MR. HISER: Yes, that's correct.

MS. BELIN: -- complete copies of testimony.

MR. HISER: And that's correct, Mr. Carr had a complete copy. Alas, Dr. Neeper is my witness, not Mr. Carr's.

(Laughter)

CHAIRMAN FESMIRE: Mr. Hiser, I just need to clarify the record. You're not objecting to the procedure or anything that is -- you're just notifying --

MR. HISER: No, I think it was simply an inadvertent thing that happens in these kinds of hearings, and we're prepared to roll with the punch.

CHAIRMAN FESMIRE: Okay.

MR. HISER: But I may not be as elegant as I might otherwise be.

CHAIRMAN FESMIRE: Always elegant, sometimes not as elegant. Okay?

MR. HISER: Whatever Mr. Chairman says.

(Laughter)

EXAMINATION

BY MR. HISER:

Q. Dr. Neeper, I have a number of questions, and I think I'm going to try to generally follow the outline that you've put forward of your slides, and then occasionally I'll probably wander off because I've got like four different sets of things I'm trying to watch.

Now you started off your thing by looking at the question of what is in the pits, correct?

A. That's correct.

Q. And you compared the industry and the OCD data, and as a part of that you also included a reference to the landfarm standards; is that correct?

A. That's correct.

Q. And in the landfarms, are those materials typically left on the surface, or are they buried?

A. Those materials are typically left on the surface, but I think I should explain why I entered that information into the exhibit.

When you consider numbers like this, you need a context. You look at a number and it's 100,000. What does it mean? I was trying to put some context on this, and the landfarm standards are about the only kind of context we have for saying, What does this mean? Landfarm standards are something that have been established, and they've said, All right, this has been approved there. So it's put there as a context. I had no other context.

Q. So you chose that context in lieu of, say, an NMED standard or an EPA standard or a preliminary remediation goal or any number of other things that you possibly could have chosen?

A. Yes. NMED does not deal with these exempt wastes.

Q. So NMED does not deal with these exempt wastes, but it doesn't deal with the chlorides and the various metals and the TPH?

A. That's right, I will agree with you, if it is your point, that I could have put up NMED standards, I could have put up screening levels, I could have chosen all kinds of other things as context.

I thought of this as context because it's within the industry, it's within the familiarity of the Commission. It's not -- I wasn't trying to go somewhere else and bring in numbers from elsewhere.

Q. Now in this, your slide page 10 -- and we're in Exhibit 3 -- you talk about, The most immediate effects are often on the surface of the ground, where plants and animals live. Is that correct?

A. Allow me to look at page 10. Yes, we are saying the most immediate effects are *often* on the surface of the ground.

Q. And so in large part, the bulk of your testimony has been really meant to redress what you -- what I would perceive as an industry person is going to be too much focus on groundwater and not enough focus on surficial impacts of pits; is that correct?

A. Yes. There's a reason for that. As I stated this morning, the thing that a citizen can bring to these proceedings is sometimes a view of what's missing. I had expected that much of the attention in these proceedings would be focused on the groundwater, so I focused on the surface of the ground.

Q. And how much land area are we talking about, on an annual basis? Five acres, 50,000 acres, 5 million acres?

A. It depends on what you would establish as your almost everywhere. I've heard various persons, even within this proceeding, use numbers that would say hundreds of wells installed in a year. I could go back and look in the OCD records and see how many wells were drilled in a year --

Q. And if there were --

A. -- but --

Q. -- quote, hundreds of wells --

A. I'd like to finish my answer.

Q. Oh, sorry. There was a pause --

A. So --

Q. -- I thought you were --

A. -- if within a given region you may drill hundreds or thousands of wells, then you have that impact within that region.

Q. And to which my question remains, what type of acreage are we looking at that is being affected at the surface?

A. All right, let us suppose you have a 20-acre -- What did we have? 40-acre well spacing. If you have 1000 wells at 40-acre well spacing, you then have 40,000 acres.

Q. And so your testimony is that all 40,000 of those acres are affected by the pit operation?

A. The prejudice of the future of 40,000 acres will be impacted, that is correct.

Q. And when you talk about the prejudice to the future, explain to me how that prejudice to the future is occurring outside the area affected by the pit itself.

A. If you own, let us say, 160 of those acres and you wish to sell them on the market, and your neighbor across the road also owns 160 acres of the same land, and yours has pits every 40 acres and his doesn't, I would make an estimate that his land will sell at a higher price than yours.

Q. So your concern is actually just a surface owner diminution in value, concern?

A. That is not the case. As I've testified --

Q. That's what you just said.

A. -- I am -- I'm concerned not just with the human use of the land, but with whatever unforeseeable uses, natural though they may be, there may be of that land.

I can see that at a close enough well spacing, if you have surface impacts from multiple buried units, you can soon begin to effect the ecology of that region.

For instance, the pits that I was out drilling on, you notice, were dead areas. Now you can give whatever reason you want for the dead areas, but they certainly were impacted by chlorides.

I think if you had one of those areas every 20 acres or every 40 acres, you'd have a significant impact on that landscape.

Q. All right. But the question, I guess, then, I would ask you, Dr. Neeper, is that, Is it your position, then, that the practice of the industry 30 years ago or 11 years ago or six years ago is the practice of the industry today?

A. The practice of the industry has changed a lot, and I gave credit for that by noting the difference between that landscape and the landscape in the Burch Keely Unit where Marbob voluntarily drilled.

Q. Which you did, and we appreciate that. Now --

A. So let's look forward from that.

Q. So --

A. The practice is different, but that does not mean you necessarily know what the future impact will be of your practices today.

Q. Let me write that down. We'll come back to that.

Now, when you were out driving around to the pits that you selected, the one from 30-some-odd years ago and the one from 11 years ago, was it your observation that the area that was affected as the area of the pit, or is it your testimony that you saw the entire land surface strata in that 40-acre well spacing -- we'll stipulate that may have been what it was on -- was affected?

A. What I observed was what you saw. We toured some area out there, observed a number of such sites. The spacing at that -- at the current time, is not anywhere that close. But as I stood there sampling, I could look around and see rigs all around me. So the spacing is getting closer.

Q. But the spacing is under the control of the Commission at some level, yes.

A. Yes, the Commission controls the spacing, I don't.

Q. And so out of that spacing anyway, what you saw was primarily impact at the pit boundaries, or the approximate pit boundaries, on the surface?

A. I did not run a geophysical survey to tell you exactly where the pit boundaries were. I could only tell you where the chloride boundaries were on the surface, and it correlated remarkably with changing vegetation, but I could not tell you where the pit boundary was.

Q. How big was that area in the vegetation with the, quote, marked change?

A. Let me give you a very crude estimate. Something like what you might see as -- in a high school football stadium, the area of the ground in a football stadium. Order of magnitude, about the same.

Q. So you're saying it was 300 feet by 75 feet?

A. Could be something like that, 300 by 150, perhaps.

Q. Now you were here earlier, I believe, this week when we were hearing testimony about the number of drilling pits -- or drilling that is being done per year, were you not?

A. I believe persons giving public statements were talking about the number of drilling units being done.

Q. Do you remember an approximate number that was bandied about during that testimony?

A. Well, I remember the discussion of rig count, if you -- if this is where you'd like to take the conversation. Is that what you are meaning?

Q. If I were to tell you that, say -- assume that there were like 1200 pits -- or 1200 wells a year that were going to be drilled, could you give an estimate of the acreage that would be affected on the direct surface for the pits?

A. I can say, Oh, this will be a certain fraction of an acre per pit, half acre or three-quarters acre or something affected by the pit or rig. The recent platforms I've been out on ran about three to five acres, and I couldn't understand why they destroyed that much land. But that's up to them.

Q. Okay. So anyway, half to three-quarters of an acre for the pit is your understanding?

A. Well, the typical pit -- when pit drawings are made, they sometimes show it as 150 by 150 feet, but it depends on the size of the pit.

Q. That was more for the southeast as well --

A. Yes --

Q. -- was it not?

A. -- but that's not the extent of the impact.

Q. Now in addition to the impact of the pit itself on the surface, isn't there also issues with compaction?

A. With compaction?

Q. Yes, of the surficial soils?

A. I didn't testify on compaction. I have not measured compaction. I would expect there would be, based from current platforms that I've been on. But I have no technical testimony on compaction.

Q. I thought that you said that you were familiar with the soil physics, and so that should that should allow you to draw some conclusions as to the impact of compaction, would it not?

A. Well, you'll have to ask a specific question, because you're about to get into soil mechanics. And I have not dealt with soil mechanics; I work in transport, so...

Q. Okay, so you're not prepared to address the effects of mechanical issues on infiltration or soil condition?

MS. BELIN: Objection, he said he is not prepared to testify on compaction --

MR. HISER: And I didn't infer that --

MS. BELIN: -- and just -- said something quite different.

MR. HISER: -- that's what he said. And I guess I would let him answer if he would want to.

CHAIRMAN FESMIRE: We'll overrule the objection. Doctor, if you're -- if you --

THE WITNESS: I --

CHAIRMAN FESMIRE: -- you can answer it that way.

THE WITNESS: I can make estimates, I can make guesses. But it's not within my technical experience to measure hydraulic conductivity versus compaction.

Q. (By Mr. Hiser) On page 11 of your exhibit, you talk about different factors that are effects on the biota and the soils, and you list here things like salt tolerance in plants, electrical conductivity, osmotic pressure and wilt point, sodium absorption ratio.

Let's start with the -- on the next page, this is sort of what I would say is a summary page, it says, I'm going to talk about these issues --

A. Yes, I've tried to provide a road map because there are so many topics that come in. It's sometimes difficult to provide an order that's understandable.

Q. Now on page 12, then, you proceed on to talk about the EC, which would be the electrical conductivity tolerance levels of crops; is that correct?

A. That's correct.

Q. And what crops are you talking about?

A. I am giving you a table that's adapted from the cited reference there. If you want to go back you can see the crops. The point I would make with this is that almost all of the literature on this topic that I can find deals with agricultural issues, not with natural landscape, such as we have much of in New Mexico.

Q. Right. And in fact, crops here is, as you said, primarily dealing with food crops, is it not?

A. Not necessarily. Forage comes in too, and I did show you a slide that included grasses.

Q. And if we -- we're talking here -- What percentage are you aware of the San Juan Basin or southeast New Mexico is devoted to food crop production?

MS. BELIN: Objection, he just said that this doesn't talk just about food crops, so it's not --

THE WITNESS: I am not a geographer. I have my own idea from driving --

CHAIRMAN FESMIRE: Okay, Doctor, let's rule on the objection.

Ms. Belin, if he doesn't know the answer, he can answer that. So we'll overrule the objection.

MR. HISER: Thank you.

THE WITNESS: I'm not a geographer, so any number I gave would only be a guess.

Q. (By Mr. Hiser) Okay. Are you aware of -- What are some of the native species that would be used for forage use in the San Juan Basin or southeastern New Mexico?

A. I have talked to ranchers about that and asked them about what their cattle preferred and did not prefer. But anything I answered thereby would be hearsay. I am not an expert on agriculture, and so I would prefer not to say what is a best forage species.

Q. And so are you prepared or not prepared to address what the EC tolerance is of native plants and -- many of the native plant species in the San Juan Basin and southeastern New Mexico?

A. I have looked into that, particularly when we were preparing for the surface waste hearing. There is not a lot of quantitative information on that, and I'm not prepared to present you numbers on it. There are species, such as your four-wing saltbush, which is much more salt-tolerant than some other species.

But there is a relative range of things, and the fact that you can find one specie that's salt-tolerant does not necessarily, I think, imply that you can build a whole ecology on that. You may have a naturally salty area, and you may then have salt-tolerant species in that area. But that does not mean, I think, that you should alter the salinity of an area.

Q. But you don't really have any knowledge of what the salt tolerance of the native community would be?

A. It's material that's hard to find, other than particular examples and particular cases.

Q. And so you do or do not know whether these values would be representative of native vegetation in New Mexico, the numbers from zero to 8?

A. You can always find exceptions. I did not find a single table for species in New Mexico. I've look at a few particular species, but not at broad brushes of species -- broad breadths of species.

Q. And would that influence your recommendations to the Commission if that type of information was available to you?

A. It would not influence my suggestion that we deviate from thinking of something like an EC of 4 or what we think might be its equivalent in some other way that we wish to measure, for saying whether or not a soil is becoming contaminated.

Q. Even if an EC of 4 is considerably below the normal salt tolerance of the species that would naturally be present in the area?

A. If the EC 4 is less than the species that are naturally present, then probably your natural EC that's there is above 4. So you don't have that issue to deal with.

What I'm dealing with is whether you take a normally -- a soil that is normally fairly free of salt, and you begin to add salt to it, and I'm suggesting you should not go, then, beyond an EC of 4.

Q. And your contention for that arises primarily from your experience with this model that you've put together or borrowed from the Los Alamos Natural Lab -- National Lab -- and looking -- that you showed us, that shows that the chloride may tend to come up? Because we're starting, are we not, with the chloride four foot down?

A. My contention regarding specific levels for chloride content in soils, such as an EC of 4 or an SAR value, does not in any way come from that model. It comes from the literature that I could peruse.

Now, whether salt goes up or down was not a conclusion that I got straight from my modeling. It was something that I highly suspected from visiting, shall we say, what appeared to be damaged areas in the southeast. And I therefore suspected that they might be damaged by salt, but I wasn't sure, so I took it on myself to go out and measure.

Q. Well, Dr. Neeper, if we turn, then, to those pits that you went out -- because you saw damage and that was a concern to you, would it not be possible that the salt damage that you were seeing there in the surface is a result of somebody having taken the pit contents and simply churned all that whole mess up and then put the whole thing back in place?

A. It's true that you do not know the history of any particular site, unless you know someone who knows the history of that particular site. So you can't re-establish the history from any particular measurement. What you can establish is that the salt does the damage. I've had a rancher tell me it grows, that he fights it and it keeps growing. I don't know that from my own experience, that it keeps spreading, nor do I absolutely know how it got there.

That was one reason for doing the drilling, was, I wanted to see if we found gradients in the salt to indicate that you might conclude the salt is moving. Generally, if you find a gradient in concentration, it indicates a transport of some kind, and then you can go back and look at the transport model.

Q. Okay. But in the context of the proposed rule, the rule contemplates that there will be -- if there is deep-trench burial as suggested by the Division, that that would be covered with -- I believe it's minimum of four foot of cover, is it not?

A. My memory of the rule -- proposed rule, is that four feet of cover is required.

Q. And so presuming that the operator is not going out and finding highly salt-ridden material to put down as the cover material -- and I think the rule forbids that -- we'd be looking at a regular growth media type topsoil for at least part of that four foot, would we not?

A. In practice, you would probably be using material that had been excavated from the pit.

Q. So you think they're going to take the material from the pit, and then this would be prior to the pit being placed there and then putting that back over the top?

A. Or material that was excavated within the trench.

Q. And if that material is local, would it not tend to have the same EC profile as the native soils?

A. It would probably have the same kind of properties as it had before it was excavated.

Q. Let's flip on a couple pages to your exhibit, page 15, which is the chart with threshold for chloride damage to grasses, and on here -- of these different things on here, how many of these are commonly used for forage or are native to New Mexico? And you may tell me that you don't really know, in which case we'll just pass over this exhibit.

A. Let's pass over this, even though I have asked ranchers about it.

Q. If we then move on to your discussion of osmotic pressure, and here what you're trying to do is to demonstrate for us the concept of how osmotic pressure works; is that correct? That's what this --

A. That's correct --

Q. -- diagram?

A. -- it's usually shown as a membrane and a manometer with different levels of liquid, and I was trying to find an even simpler, more direct way to show it.

Q. And from the ecological perspective, why osmotic pressure is of concern to us is because of the impact that that may have on plants as they're trying to extract water from a substrate; is that correct?

A. That's one of the reasons for being concerned with it here today.

Q. What's the other reason?

A. Another reason, as I explained, was, I have -- Let me put it bluntly. I have heard industry experts say that the presence of -- I'm trying to rephrase my words here correctly -- the presence of the clays would result in a barrier that would not transmit -- basically would not transmit chloride. You would have a selective barrier --

Q. Right.

A. -- due to the microscopic nature of the bipolar layer in the clays --

Q. Right.

A. -- and therefore the wastes would not come out.

I thought it's possible that that's credible, I should look into it. And then I thought this might really be a handy thing, maybe we've overlooked something.

So I started investigating this in a bigger way and trying to find out, could that really be the case?

Q. Right, and you talked about the results of that investigation, and --

A. Yes.

Q. -- if I may be as blunt as you, have you heard any industry expert in this proceeding make that suggestion?

A. I have not heard any industry expert in this proceeding, nor did I want one to make that suggestion. And it was not the hearing, and the expert was not sworn at the time.

Q. So -- But is there other reasons that you're concerned about osmotic pressure, then, besides the impact on plants and this possible -- I think what was called the anion effect which was spoken of in a past meeting? Are those the two major things that you were concerned about with osmotic pressure?

A. There are other related issues. One is whether osmotic effects would tend to cause a larger motion of pore water than you otherwise would expect. That is, in the literature you'll often see it stated, osmotic pressure simply adds to the matric pressure, to the normal suction that would be there. Once in a while I find articles in the literature where they add the two together and calculate the flow based on that.

So I was concerned with it from the point of view of flow, not just from the point of view of isolation of the wastes, but from the point of view of trying to get the flow right. And then you start to get to the other colligative effects, which you might or might not call osmotic effects.

Q. But the results of that investigation, though, as I understood it, was that generally you found that osmotic pressure didn't have much impact on the flow of water, with the possible exception of the evaporation or freezing phase; is that correct?

A. I concluded that at depths of four feet and greater, it's likely to have a very minimal effect. But if we concerned ourselves with details at the near-ground surface, say in the top two feet or so, to do good calculations one really ought to include those effects.

Q. Of the salt-gradient effect on the top?

A. All the colligative effects.

Q. Okay.

A. Osmotic pressure, not necessarily, because you don't have a selective membrane. But you have a selective effect in that vapor does not carry salt --

Q. Correct.

A. -- and so that forms a selective thing that I suspect it could set up a liquid-to-vapor cycle that would alter the way in which you predicted the movement of moisture. That's combined with the temperature gradients that occur near the surface. I think it could alter the way in which one calculated moisture movement in the near surface in a complicated way.

Q. Yes, but wouldn't that complicated way be mostly in the effect of downward and of fixing it at a lower level? Because as you agreed -- and I think we're agreed that salts don't move in the vapor phase; is that correct?

A. That's correct.

Q. So in that case when things are moving up and they're in the vapor phase, we're leaving salts in more concentrated form at a lower level, we're taking water out, putting it into the atmosphere, potentially, with plants, correct?

A. You can evaporate it or transpire it by the plants.

Q. And so if the salts were being left down below, if there was any osmotic effect in terms of gradient towards the salt layer, wouldn't that tend to move water from the surface down?

A. Let me alter your question a little, and then you can tell me if I'm still within your question. I would replace the word osmotic by colligative effects. That means including all of the effects of having salt in solution with the water.

Q. I find that that masks the question I'm asking, and so I'd rather ask about the osmotic effect.

A. The osmotic effect -- We're into a problem of definition. If you consider, for instance, the reduction of vapor pressure to be an osmotic effect or a colligative effect. It's certainly a colligative effect.

Q. Even if we reduce the vapor pressure and hence increase vapor transport or vapor dispersion, once again that only moves more water to put in the vapor phase, and hence leaves the salts where they are, does it not?

A. If that were absolutely true, I never would have seen square miles of white alkali out on the grounds in Colorado where I grew up. That would be my feeling for that. I don't think you can say ahead of time exactly what's going to happen. You can get salts moving upward and you can get salts moving downward.

Q. Well, but Dr. Neeper, I must be confused now because it seems to me that just five minutes ago you had assured me that salts didn't move in the vapor phase, when we were talking about the vapor phase --

A. Right, but you --

Q. -- in that question.

A. -- but if you evaporate water, the natural suction of the soil may move more liquid water in to replace that evaporation.

Q. Right.

A. If the liquid water comes in bringing salts, that will alter the vapor pressure and various other properties.

Q. Correct.

A. You may now have a rather complicated situation if you're trying to calculate --

Q. Now your modeling that you did basically excluded the top some number of inches from your consideration, correct?

A. I excluded the top 20 inches, in part to take advantage of a measured moisture level at that depth.

Q. And in the discussion that you've just made with the -- talking about the evaporative effect, and as I lose water vapor I then create a lower matric potential in the soil down at some level below that, and as a result of that lower matric potential I may have water, and as that water moves I may bring contaminants with it. But doesn't that leave out the annoying little complication of plants?

A. Well, it accents why you may have problems with your plants because the salts will get to the roots before they get to the surface.

Q. Well, Dr. Neeper, is that necessarily true? Because what is the primary focus of a plant root?

A. It's to acquire water --

Q. It's to acquire water, and so --

A. -- and also, often, to exclude some of the thing that are dissolved in the water.

Q. Okay, so it acts as a -- actually acts as a membrane --

A. It's a membrane --

Q. -- osmotic effect --

A. -- sometimes tries to be selective.

Q. Okay. And so if I've got all these roots down -- and did you hear Dr. Stephens' testimony about how those roots tend to lay in the desert environment?

A. I heard his testimony.

Q. Okay. And do you have any reason to disagree with that testimony?

A. I don't disagree with his testimony. He did not deal much with the various depths to which roots could go. He mentioned they're spreading horizontally.

Q. Right.

A. I believe I asked him in cross-examination about the depth to which roots might go.

Q. You did, and I believe he gave you an answer as well.

And so if I've got roots, now the effect of the roots is going to be what on the water as it's moving around?

A. Roots will generally abstract water from the soil, if they can, if the plant needs it.

Q. Okay. And so if the roots are some distance below ground, in fact, that would have a tendency to slow the upward movement of the water in the liquid phase, would it not?

A. One has to be careful of making very rapid answers to these things, because you're saying now we have an imaginary problem, a hypothetical problem, which at one point had a moisture sink, something that withdrew moisture at a particular level in the problem. And you're saying that withdrawal will necessarily change the upward rate of flow.

Q. Well, I believe that, Dr. Neeper, you had suggested that you thought that the evaporative effects and other things from the presence of salts would cause more water vapor to leave the soil column in a vapor form, lowering the matric potential at some level lower in the soil column, as a result of the reduced matric potential at that level in the soil column, that water which would be at a lower matric potential -- higher matric potential below that, would then start to move up, because water tends to follow the gradient. Is that an accurate summary of what you had said?

A. I don't find correlation between what you said and what I believe I said.

Q. Okay, let's start over, then, with what you think you said, and then I will ask my questions again based on what you now rephrase what you're saying, because I want to make sure -- I don't want to put words, basically, is what I'm trying --

A. Very well.

Q. -- to make sure I'm not doing.

A. What I said was, the best estimate I could make, the best guess in this case, was that my neglect of the upper 20 inches, of trying to simulate that -- which I think really hasn't been done well; that's why we were trying to do it as a research exercise --

Q. Uh-huh.

A. -- my neglect of that, as best I could tell, probably underestimated what might be the salt transport.

Q. Well, that's an interesting --

COMMISSIONER BAILEY: I couldn't hear the last --

Q. (By Mr. Hiser) Okay, that's fine.

Do you think that the model that you presented underestimates the soil transport, particularly in the upper four-foot matrix that we're talking about now? I think you said that in your direct testimony, I think you just reiterated that.

A. (No response)

Q. In that modeling that you've done, how did you address the effect of direct precipitation on the land surface?

A. I didn't. And again, as I stated a few minutes ago, if you want to start with direct precipitation you had better be very good at your modeling if you think you can get the right answer. And from my perusal of the literature, there are both modeling exercises and experimental exercises at looking at these conditions with salts sometimes in the water and looking at the differences.

None of them ever got, that I could review, quite so far as to the full natural circumstance of rain and sunshine and all of these in a satisfactory way, and therefore that would be a very challenging problem for a couple of researchers to take on --

Q. I agree --

A. -- so I ignored that -- or I got a -- had to find a way around it.

Dr. Stephens found his way around it by imposing a given moisture flux at the top, just a continuous input of water.

I have my way around it by saying somebody out there measured the volumetric moisture at that depth hour after hour for a couple of years, and I will take their measurement and use their measurement as the driver for my problem.

Q. Okay. But it seems to me, Dr. Neeper, that if you're doing that, are you not avoiding consideration of the leaching effects of convective flow through the upper layers?

A. I don't understand the question.

Q. Well, you understand what convective flow is?

A. The leaching effect of the effective flow.

Q. The leaching effect of convective flow from surface downwards under the effect of gravity.

A. I did not neglect that from 20 inches down. That is, from the missing part of my model on down, that was in there. I only neglected it in the part of the problem that you did not see, where I said we can see things going up. Where they would go after this if you include the entire problem --

Q. Well --

A. -- I cannot predict in detail.

Q. -- is that actually true, Dr. Neeper? Because your model is assuming a soil hydration perspective, as I understand it, at 20 inches based on a gauge at a science center, correct? And I'm sorry, you told us where the gauge is, and I just don't remember.

A. It's at the place called Crossroads, it's in Lea County, New Mexico.

Q. Okay. And as a result of that, you're assuming that everything is already in an unsaturated condition at the point that reaches the 20 inches below the land surface, correct?

A. If you look at the plot, throughout most of the year it's unsaturated. In the year 2007 -- 2006, that we used as the characteristic year to use, because that was the data available, I don't think that depth ever reached saturation. I would have to look back at the plots, as you are now doing, to see if we hit saturation and if it reached saturation at any of those times.

Q. Right.

A. If you can say the page number, I will look at the graphs too.

Q. I'm looking at the same one, I think it's pages 34 -- 35 of your exhibit. Not that I necessarily want to go there yet, but...

So your contention, then, is that you did consider convective and gravity flow and relatively high moisture level in the upper levels of this model that you did, correct?

A. Yes, the model was given the measured moisture at the top of the model, and it thereafter responded with whatever had to happen below in order for that to occur at the top.

Q. And the model is based upon hourly measurements;

is that correct?

A. Please say the question again?

Q. Your data is based upon hourly measurements of the soil moisture?

A. These were hourly data, is what they --

Q. Did you then aggregate them again into like dailies for purposes of --

A. Yes, I aggregated them into whatever intervals fit, because you see both the temperature and the moisture changing. So as I expressed this morning, it might have been possible to represent the volumetric moisture in the year 2006 for the first, oh, about 88 to 90 days by a single value. But I couldn't necessarily represent the temperature by that.

So I chose blocks that tried to represent changes in the curves as best I could without getting too many breaks in it, and I would wind up with, often, about 14 different representations throughout the process of a year. It didn't change things a lot, as I remember, to alter the breakout of that.

I didn't drive the model with an hourly value, or even a daily value --

Q. Okay, but some --

A. -- for a practical reason.

Q. I understand. I think I'll come back to your model, but I want to sort of proceed back through your -- till we come back to where it was in its proper place.

On exhibit page 18 you talk about something called sodium absorption ratio.

A. Uh-huh.

Q. What's the distinction between sodium absorption ratio and sodium adsorption ratio?

A. Adsorption is with the binding of a sodium atom to something. It could be adsorbed on the surface of anything. Adsorption means binding to the surface.

The sodium absorption ratio is a particularly defined ratio of the equivalence -- that's a chemical term -- of sodium to calcium and magnesium, and you take the square root thereof, of those concentrations.

Q. And so your particular concern here is with something that would be absorption, with a b, rather than the adsorption ratio, with a d?

A. The point I was making with this -- because this testimony again was prepared not knowing exactly what all the arguments might be here. It's saying that you might have trouble, in your future ecology, not only from the chloride; the sodium can have effects. And this is about the simplest statement that you can find of the effects of sodium on the soil.

Q. Okay.

A. We're simply establishing that sodium can have an effect on the soil.

Q. Now is the sodium absorption or adsorption ratio by itself going to affect the structure of the soil, or is it a dynamic relationship with another constituent?

A. I -- You're just beyond the edge of my expertise in this, because what I get I get from the literature. I haven't worked with these directly, I haven't measured these things. It's generally stated as the sodium absorption ratio, as a thing you need to measure. And you'll find that particularly in the agricultural literature.

Q. Okay, so the agricultural literature, when they're talking about sodium absorption ratio, it's typically in the context of damage to soil structure, is it not?

A. It's generally given as changing the moisture-holding properties and the structural properties of the soil.

Q. A lot of times seen as reduction of infiltration rate. Would you accept that as the --

A. You can --

Q. -- agricultural --

A. You can make it so it's unable to absorb moisture, is the terms they often use.

Q. And it's your testimony today that this is sort of at the edge of your knowledge, but you believe that SAR, or sodium absorption ratio, is the thing that controls that?

A. It is a measure of that, it is a commonly used measure of that. I don't think it's a controversy in this hearing. But if the issue of sodium were brought up as saying, That never is a contaminant of concern, then I would say it is a contaminant of concern, because the literature of basically plant ecology does worry about it.

Q. But you're not aware of any particular dynamic relationship it has with any other constituents? I mean, it's the sodium plus magnesium plus calcium, that's the relationship?

A. You can get other positive ions in there that will change things, and I have read about that, but I'm not prepared to testify on exactly what you're changing with those ions.

Q. Okay, I understand. If we turn then to page 19, these are interpretive guidelines for irrigation water analysis. And I'm going to ask on irreverent question for which I apologize in advance, and that is, Dr. Neeper, how much of these things is found in rainwater?

A. You might find almost any of these in rainwater. I'm not an expert on rainwater, but you can certainly find some chloride in rainwater, because that is often listed as being important for the so-called chloride bulge.

Q. Absolutely. But do you have a sense of what the magnitude of that is? Are we talking tens or twenties or hundreds of milligrams per liter of chloride?

A. Not in rainwater.

Q. Not in rainwater. And would your expectation be the same with regard to most of the other anions that are found listed in this sheet here?

A. I would expect that you would not find, usually, milligrams per liter of these various ions in rainwater, but I haven't checked out rainwater.

You must understand, the purpose for this slide is to inject an idea that perhaps, much as we might like to, we can't use pit waters for irrigation.

Q. Okay, so this is really -- your idea is to show that pit water may not be acceptable for irrigation use --

A. Yes.

Q. -- which I think would not surprise any rancher?

A. I don't think it would surprise anybody present. But it otherwise was not in the record of the hearing.

Q. Okay, I think we can accept that and we can flip right on.

(Laughter)

Q. Okay, now we're to sort of just a restatement of your contentions in the first part, and we're ready to move to 3, which is a discussion of unsaturated hydrology, and that starts about exhibit page 21 for you?

Now I want to make sure that I understand and that the Commission understands what we agree are the various forces at issue here as we're looking at unsaturated flow. And maybe -- It would be great if Mr. Hansen could put up exhibit twenty -- page 22, which is the nifty little soil particles with water around them. Okay.

So if this is our soil matrix -- and I appreciate what you said earlier today, that this is actually a three-dimensional thing and it's not the nice two-dimensional picture that we have here -- the forces that would allow water to move upward -- and we're talking about water now -- are going to be -- what? I won't lead you, I'll just let you answer that question.

A. I don't understand the question.

(Laughter)

Q. The question is, what forces are going to --

CHAIRMAN FESMIRE: Maybe you should lead him.

(Laughter)

Q. What are the different natural forces or effects that would tend to cause water to move up through this matrix?

A. Yes, usually it is the suction or the matric potential.

Q. Matric potential.

A. I think that's what you're looking for.

Q. Okay. Is there anything else?

A. Well, you can have vapor flow moving up --

Q. Okay.

A. -- you can have advection due to air flow, so I drew a red arrow for air flow.

Q. And advection is what, just physically pulling the water molecules up --

A. Advection is flow of the fluid, whether that fluid be liquid or air -- or gaseous.

Q. Okay. And so we've got vapor flow, matric potential, and a little bit of contribution maybe from advection. What would be the forces that would be pushing this water downward?

A. Gravity is a prime force pushing it downward.

Q. Okay. And there are other forces that would be moving it downward as well?

A. Matric potential can be moving it downward. If the soil is in that sense more dry below one location than another, the matric potential would be such as to move it downward.

Q. Okay.

A. And so you can see in many soils the matric potential sometimes reversed in one direction from what it is somewhere else in the soil.

Q. Now sometimes we talk about something that we've thrown around in this hearing called capillarity. What's your understanding of what capillarity is?

A. Capillarity is the -- our expression for the force on the water and the reaction force on the soil particle, if you will, at the boundary of a little liquid lens or droplet. Now, it is expressed in quantitative terms as matric potential.

Q. Okay, so it's actually just sort of a form of matric potential, correct? Sort of a specific application of it?

A. Well, if I'm trying to explain it to someone I might say the water is moved by capillary action. If I'm talking technically I will say water moves toward the region of lower matric potential. The two are the same statement.

Q. Right. Now is capillarity limited at some point? Is there a limit to how far the water can climb as a result of capillary action or moving towards that lower matric potential?

A. If you remove water from the soil until you reach the -- again, you'll have to help me with the noun term, the limiting moisture, the limiting amount of moisture.

Q. Permanent wilting point?
A. Say it again?
Q. Permanent wilting point; is that what you're --
A. No.
Q. Residual --
A. Residual moisture.
Q. Residual moisture.
A. If you reach the residual moisture, then that generally is regarded as the point at which you no longer have capillary flow, you're breaking the contact between the particles.
Q. Okay. So capillary flow in most cases has a maximum vertical extent that it can reach, is that not true, as a result of gravity and other forces that balance it out?
A. That's not true.
Q. That's not true, is that your testimony?
A. Let us do this by hypothetical example. If you give me a depth to groundwater, let us say 100 feet --
Q. Okay.
A. -- and if I understand the soil properties correctly, and if there is no evaporation going on at the surface -- we've just sealed the surface in our minds -- we can calculate what is the profile of moisture content in that soil between the saturated point at the aquifer and

up.

Now we can do that for whatever height you want to do. If you want to put the groundwater at 1000 feet, we can do that. Eventually you will reach such a depth that you come to the limiting moisture potential -- or the --

Q. So, Dr. Neeper --

A. -- the limit.

Q. -- maybe we should put this in more concrete terms.

A. Yeah.

Q. If I have a straw, and it's in water as opposed to whatever may be in this, this matric potential or the capillarity that we're talking about is going to tend to cause the water to go up that a little bit. You see the meniscus that forms, correct?

A. I tried to draw menisci in the diagram.

Q. Okay. If you're correct and that can proceed infinitely, why isn't it crawling out of the straw right now and pouring out the top of my straw?

A. The straw has to large a diameter.

Q. Okay, and so it's driven by the -- by the diameter of the little -- the soil -- the soil pores, is your testimony? And so the smaller the diameter, the higher my water may be able to go?

A. Generally that is the case. And in particular for soils, clays are generally small-diameter particles, that's how they are characterized, and we showed that clays have higher suction than sands, for example.

Q. And so I want to return back to my original question which is that, Is there a point where that matric potential is counterbalanced by other forces that may be pushing in an opposite direction, such as gravity?

A. I don't want to seem obstreperous, but your question doesn't make any sense to me.

Q. Okay, well that's an answer, which is that it doesn't make sense to you to think about gravity and matric potential in the same sentence; is that accurate?

A. No.

Q. Okay, tell me what -- Tell me what you're thinking, then, and I'll see if I can clarify my question, or if we're at a point where I just need to move on.

A. For given properties of the soil, if we establish saturation at some level that we describe, then as I showed in one of the slides, I believe, you will have decreasing volumetric moisture as you go upwards, assuming gravity is working on that day, farther and farther above the saturated region. If there's nothing else causing flow, so the soil -- the moisture isn't having to flow, and you give it enough time, it will reach an equilibrium --

Q. Okay.

A. -- and that will -- that can occur over a long distance until you are at such a distance that the amount of moisture, there being less and less moisture in the soil, you have reached the residual saturation. And after that, it will not climb anymore because it's not moving anymore.

Q. Okay, I think I understand where you're coming from.

Now when we have -- Let's move, I think, on a little bit.

CHAIRMAN FESMIRE: Mr. Hiser, would this be a good place to take a break?

MR. HISER: This would be a great place for a break. I know it's been sort of dry to listen to.

CHAIRMAN FESMIRE: At this time we'll take a break and return at a quarter to four.

(Thereupon, a recess was taken at 3:33 p.m.)

(The following proceedings had at 3:48 p.m.)

CHAIRMAN FESMIRE: Let's go back on the record. Let the record reflect it is essentially a quarter to three. We are going to reconvene Cause Number 14,015. let the record also reflect that all three Commissioners are present and there is a quorum present.

We were in the middle of cross-examining --

COMMISSIONER OLSON: It's actually quarter of four.

CHAIRMAN FESMIRE: Quarter of four. You've got a tired, dyslexic Chairman, I apologize.

We were in the middle of the cross-examination of Dr. Neeper by Mr. Hiser.

Mr. Hiser, you may continue.

MR. HISER: Thank you, Mr. Chairman. Welcome back, Dr. Neeper.

Q. (By Mr. Hiser) We're currently at page 23 of your exhibits, moving on to page 24.

In page 24 you're talking about osmotic pressure, matric suction or matric potential and flow --

A. Yes.

Q. -- and in here you talk about the permanent wilt point, and you said that in general the literature that you've reviewed puts that permanent wilt point at about 1.5 mega- -- is it milli- or -- I guess it would be megapascals; is that correct?

A. Megapascals.

Q. And do you know what the permanent wilt point is for the native vegetation typical to the San Juan Basin or the southeast New Mexico area?

A. I would expect desert vegetation to be a little different. I wouldn't know if they would even actually exhibit a permanent wilt point. That's in the area of the plant physiologists.

Q. Okay. And by saying you expect it to be a little bit different, you'd expect it to be greater or lesser?

A. Well, if they actually exhibited the wilt point phenomena, I would expect it to be a little greater than the general plant community. I've puzzled over why this number is so general, but it was generally used throughout the literature.

Q. Okay. On exhibit page 26 you have a quote here from Kemper and Rollins from the *Proceedings of the American Soil Science Society*, and here you talk about two things. And the first part of that says, Throughout the soil moisture range encountered by growing plants, salt concentration gradients will not be an important factor causing movement of soil solution.

Is it your understanding that that states the general case?

A. You must be careful in interpreting that sentence. They say the moisture range encountered by growing plants. Bear in mind, these people are thinking probably not of the desert but all of the rest of the world of growing plants. So they're talking about something we might call moist soil.

Q. Okay, and so you believe, then, that this is only the rule in moist soils?

A. Well, as they say, the moisture range encountered by growing plants. What they're talking about is how thin is that film on the soil particles, because as the film becomes thin you can begin to get osmotic-type effects, and that is probably what's behind their statement here. We'd have to go back and read in the rest of the article to get the full context of their statement.

Q. And by this you're referring to the second part of this quote that you have, the one that starts with, However, at evaporating or freezing surfaces?

A. Well, at evaporating surfaces you may get the soil quite dry, the layers could become -- the layer of moisture could become thin, osmotic effects then could become significant.

Q. And if this -- if the water film thickness has become very, very thin -- or very thin, as it says in this quote -- how much capacity does that water have to transfer a contaminant?

A. It isn't going to transfer the contaminant much while it is so thin. What you're interested in is the dynamic. How much does it transfer at one time when it is thick, and then when you have thin layers can that cause other motion?

That's the reason for wanting to investigate this, is not to take just one specific situation, like the thickness is now very thin and therefore nothing of interest will happen. But to say if we expose that to hydrologic cycles and temperature cycles and all of the various complicating things that can go on, what will happen? And I don't totally know the answer.

Q. Well, but Dr. Neeper, doesn't the quote that you've given us basically answer that by defining two separate general parts of the universe: part 1, the top of the sentence which is, Throughout the soil moisture range encountered by growing plants, salt gradients don't have and aren't an important factor in movement, but where you have evaporating or freezing surfaces they may become large with water film thicknesses thin, and then it may become a major factor?

A. An osmotic pressure or an osmotic change -- an osmotic pressure may be significant for movement of the water under particular conditions when you can have the osmotic efficiency that I talked about. Right? Remember I showed a slide of osmotic efficiency. In that case it was a graph of osmotic efficiency versus concentration.

Q. Can you find that slide?

A. I can, but I don't want to go there till I answer this question.

It is not the static situation that we're concerned with of saying we get to a certain situation and then very little transport of contaminants taking place. It is the dynamic situation, when things are changing over the period of a year. Sometimes you have high moisture, sometimes you have low moisture, sometimes you have large temperature gradients. Now if you mix in with also salinity gradients and osmotic pressure, can any of these things act together to bring about an effect that you hadn't foreseen because you couldn't do them all together in your mind at one time?

That's the situation I was driving at when I said if you're going to calculate these things in the upper surfaces of the soil, in the near-surface conditions, in the presence of salts, you have to be careful and try to do a good job.

Q. And so given that that's so complicated, is our best recourse going to be, then, empirical evidence, or what would we be looking for?

A. What we -- what I looked for in this is that I could go to the burial depth and get answers that I felt were credible without having to include the colligative effects of salt on the solution. I then didn't say exactly what's going to happen in the top 20 inches, I could only say that I see salt going that direction --

Q. So you see --

A. -- in the calculations.

Q. -- you see salt going from the putative burial depth up towards the 20-inch where your model --

A. Yes, under certain circumstances --

Q. Under certain circumstances --

A. -- but not always.

Q. But you're not taking a position on what's happening in that very top fraction --

A. No.

Q. -- the top 20 inches?

A. No. If you're going to calculate that, you have to develop more physics than we had in this code.

Q. Okay. Now if we look at exhibit page 27, which is the return of your diagram here and all that, in saturated flow it's possible for us to have not only water flow but also contaminant flow; is that correct?

A. Would you repeat the question, please?

Q. In saturated flow, not only may we have a flow of water, but we may also have a flow of contaminants being borne by that water?

A. In saturated flow, yes. Advection of water can carry contaminants.

Q. Okay. What about unsaturated flow? Are contaminants carried in that as well?

A. In unsaturated liquid flow contaminants can be carried.

Q. Okay, what about diffusion of water vapor?

A. What about it?

Q. Are contaminants carried in diffusion of water vapor?

A. Not the kind of contaminants of interest to this Commission. Tritium would be.

Q. Tritium would be. And that's a good clarification.

And the same would be true, then, of enhanced diffusion of water vapor, since that's just essentially the same thing as the diffusion of water vapor?

A. Now is the time where we have to be cautious. The diffusion or the enhanced diffusion do not carry chlorides, do not carry sodium, non-volatile contaminants. But particularly in drier soils the water vapor diffusion can become an important mechanism for movement of water --

Q. And --

A. -- and now what happens to the cycle to -- back to liquid water when that condenses, may be another question.

Q. Okay, and I'm going to ask you two related sub-questions to that. It becomes important in the movement of water because it changes the matric potential, and that may cause water movement, for the first part. Yes? So --

A. I wouldn't answer that question, stated that way.

You'll have to state a third question first.

Q. Okay, your que- -- you said that you didn't want to give the same answer for diffusion of water vapor -- for enhanced diffusion of water vapor, because it may cause water movement.

And my question is, is causing that water movement because -- has the water that's moving out by enhanced diffusion going out by vapor, it causes a lower matric potential at some other place in the soil column, and therefore, because there's a lower matric potential there, there will be a tendency for water in a higher matric potential area of the soil to move to that area of lower matric potential, hence causing a liquid movement in the soil?

A. I think I understand where you're going, and rather than saying I'm providing a direct answer to your question I will state a circumstance and see if you feel it describes or adequately answers your question.

Q. As long as I can ask my question again if it doesn't.

A. All right, you may ask your question again. You have to ask three times, and if in three times you don't understand the answer it presumes that I'm incapable of giving you something that I understand. So I have to be very cautious here or else I'll make myself look very bad.

Enhanced diffusion of water vapor is just more diffusion, much greater than you'd expect from the normal diffusivity, and it can be increased by the presence of salt.

Q. Correct.

A. Vapor is not carrying either sodium or chloride.

Q. Correct.

A. However, the vapor may move to another location in the soil, may there become -- transfer from vapor to liquid, raising -- increasing the amount of liquid at that point in the soil. Thereafter, other things may happen. It's part of the dynamic. And now the moisture potential is changing, so the movement of vapor can affect the moisture potential in different areas. It's a way of trying to equilibrate, it's another mechanism by which nature tries to equilibrate.

But in most of the soils we're dealing with, the presence of the salt does not add to the potential for purposes of moving the liquid.

Q. Yeah.

A. It's the ineffectiveness of this most of the time.

Q. Okay. Now evaporation of water, does that move contaminants directly?

A. The question is inexact, so I will try to answer it again.

Q. Okay.

A. Evaporation of water -- the water that is evaporated is as a vapor, and it does not carry with it nonvolatile contaminants.

Q. Correct.

A. However, evaporation of water may be part of an entire system, it may affect the hydrologic dynamic of the system, which would carry contaminants if there's movement of liquid water.

Q. Absolutely.

A. In addition, you may have diffusion.

Q. So if I have evaporation and that goes up into the clouds, we then get precipitation down and have saturated flow or a much heavier advective or convective flow of the water through the soil, I would see movement of contaminants at that time?

A. Yes.

Q. Okay. And what about transpiration? Does transpiration move contaminants by that process itself? We're talking now about chloride and salt.

A. Literally, you've asked me whether transpiration moves water by evaporation, and usually the two effects are separated. Transpiration is seen as a movement of water from root to atmosphere by the plant.

Q. Okay.

A. Now it has to evaporate from the leaf of the plant. You might call that an evaporative process.

Q. But when the root is taking the salt in -- or the water in, most roots try to exclude some of those other hangers-on of the water and get water?

A. Some do. There are also toxicities to sodium and chloride, and when I first got into this it was through the toxicity of sodium to pine trees.

Q. Okay. And then diffusion, on the other hand, is a way that contaminants may move through an existing water mass or water body?

A. Yes, including a film or a lens of water in the soil.

Q. Absolutely. And then you had a picture showing the diffusion of the food coloring through a glass, and I think in exhibit page 29 you gave us a distance and time, for example, to move a centimeter and a meter, making the point that it's the square, I believe -- the time increases with the square of the distance, correct? We're now on page 29 of your exhibit.

A. Yes, I'm just simply trying to go there. It's on the screen.

This does not mean you get a sharp front, this means it's a characteristic distance. If you get one -- a given pattern in diffusion, it's characterized on the centimeter scale in 18 hours, and diffusion is the process, then you would get a very similar pattern in 21 years --

Q. Correct.

A. -- at one meter.

Q. And I believe that when you were giving this example, you said that this was distances that would occur if the diffusion was occurring in bulk water; is that correct?

A. This is distances that would be -- that you would see for diffusion in bulk water, that's true.

Q. Okay. Now --

A. You would also see it, interestingly enough, in moisture films. It would be affected by other things such as the tortuosity, and there are other factors that come in, but diffusion is still active.

Q. And that was, I guess, exactly where I was going, Dr. Neeper, so thank you, as you went there.

Although we don't have the picture of your little soil things, if you go back, Glenn, two slides to the picture of the soil matrix, which is exhibit 27 --

A. It's that one.

Q. This one here.

A. Would do it, yeah.

Q. And so if we're looking at the water films, if I have just water, the diffusion can occur in all directions equally towards the lesser concentration gradient. But when you say tortuosity are you then talking about out here, if I'm trying to get to here I might have to go around like this, and it will take me additional time to navigate my way around the various soil particles.

A. That's generally given as the origin of the tortuosity term.

Q. Okay. And so that would tend to take a longer period of time than if it was in an equivalent volume of just water?

A. You would still have the characteristic of diffusion with time going as the square of the distance. It would, in a sense, take a longer time because the tortuosity, in effect, multiplies the diffusivity.

Q. Okay. Now if in my same soil column here we postulate that this is -- although it doesn't look like it, but let's for purposes of this question postulate that this an area of high matric potential, and that I'm still trying to go here, but over here I have an area of very low matric potential. What's going to happen to that diffusion effect in that situation?

A. First I'm going to just characterize high and low, because I've been myself a little careless in that. By high matric potential you mean a large negative number, very dry?

Q. Yes, very dry.

A. So an upper area in your hypothetical example is very dry, lots of suction, and the lower area is more wet, with less suction.

Q. Now maybe I have it reversed. I believe I said that we're looking for the area of lower matric -- No, you're correct, I did have it reversed. Thank you.

The greater suction, if you would, is down here below, and the lesser suction is up above. And we're postulating my molecule which wants to diffuse this way. What's going to happen?

A. You're saying you have opposite gradients -- a potential gradient in one way, and a salt gradient in the other direction. It's going to depend on the relative rates of advection and diffusion. One is, you might say, trying to go one way, the other is going the other way, and it's much an analogy like a swimmer in a river if he's trying to swim upstream. If he swims slower than the river flows he'll get washed downstream, if he swims faster than the river flows he'll make progress upstream.

Q. Okay, great. Let's flip on backwards through your presentation, and we come now to your modeling simulation that you did. And I believe that you gave us the name of the model, and I don't know that I got the full name of the model down. We're now on your exhibit page 31. Could you repeat that for me?

A. Yes, I want to be careful with my language here. The name of the computer program, or code as it is often called, is FEHM, as in finite element heat and mass. The fundamental physics in the code is a finite element method of calculation for -- it started out for moving heat and chemicals.

Q. Okay, and this is a model that exists at Los Alamos?

A. This is a computer code that is in use at Los Alamos, developed at Los Alamos. It's under continuous use and continuous development. It is available to the public on a user-beware basis at no cost --

(Laughter)

Q. Okay.

A. -- and it's used internationally. I've been at seminars that they held with people from Japan and elsewhere coming to learn about the code, and I had great sympathy.

Q. And -- but this is not -- there's been some discussion in the past testimony about EPA-approved models, and this is not one of those, is it?

A. No, and that's where I say we want to be careful about using the word modeling, because I would describe model as that picture I drew of a soil column with water injected at the top and all of those things.

Q. What we would call --

A. That's a model.

Q. In modeling terms we'd call it a conceptual model for what's going on?

A. Yes.

Q. Okay.

A. And usually that means in something that the EPA has approved, it has recipes in it for handling various things for which you cannot and do not wish to try to calculate the microscopic physics.

Q. Okay. And Dr. Neeper, have you provided us with the input files or the output files from the algorithm that you ran on FEHM?

A. I have not, but I am prepared to give you any particular problem you might like to have. In preparation for this question I brought one I hope is on my memory stick, because it was the smallest amount of output at something like 30 megabytes.

Q. Okay, we're familiar with that. Okay, yeah, I think we would be interested in seeing that.

Now, I'd like -- Now when we turn to your -- what I would call your conceptual model, which is on page 32 -- and you had two different conditions here. One was your native soil through the complete soil column, and another one was the native soil with the insertion of waste in that column; is that correct?

A. That's correct.

Q. Did you run your algorithm or the FEHM on the native soil, just by itself?

A. Yes. This was run -- the reason this is shown is, that was to set up a starting condition for the real problem, which is the second one with the waste in it.

Q. Okay.

A. I just ran the native soil year after year until I established a steady-state moisture distribution within the soil.

Q. Okay, so you started by running a -- running multiple years to get steady-state moisture in the column.

A. See, if I let myself dictate any moisture distribution in the soil I wanted at the start of my waste problem, I could probably generate about any answer I wanted to. And I should use something that's realistic and that belongs to the problem.

Q. Okay, now -- Then you testified, I believe, that what you're doing is, at the zero point, which is actually -- I've heard variously .5 meters or 20 inches below the land surface -- that's where you then injected the moisture that was observed by the -- and I forget the name of the probe, but --

A. They call it Pedon number such-and-such.

Q. Pedon, yeah, it's Pedon number. Is that correct?

A. Yes. The moisture was set at the top node in the problem, which was -- represented 20 inches below the surface.

Q. Okay. How did you address boundary issues?

A. In a one-dimensional problem there are two boundaries, the top and bottom, because otherwise it's just a long chain of calculation nodes. The top boundary has its moisture content established by this measured boundary condition. Whether that requires moisture to flow up or down in the problem is -- that's the way it has to be.

Q. Okay.

A. The bottom boundary was established by having a very nearly saturated condition, at a saturation like .99 or so, which represents proximity to an aquifer.

Q. Okay.

A. Chloride -- or tracers, actually -- that reach the bottom boundary simply disappeared from the problem. Chloride was not allowed to escape from the top of the top boundary.

Q. It was not allowed to?

A. Not allowed to escape.

Q. And basically you testified that because of the complexities of that top layer you sort of put that off to the side and looked at what happened from your Pedon point down, to see what you would see happening with the salts and the liquid -- or moisture levels?

A. That's correct.

Q. Now this model would tend to show in -- when we get to the later pages, pages 39, 40 and 41, where we are getting to increasingly tight plays in the soil in the pit, that chloride tends to be flowing upward, at least within the model domain; is that correct?

A. As we go to the -- what I call the moderate and then tighter soils, we find the tendency for chloride to move upward that you did not see in the looser soil.

Q. Okay. And did you address in your testimony what you expected would happen to that chloride once it hits the .5-meter or 20-inch, whichever it is, end of your model domain?

A. I don't remember if I addressed it in my testimony, but I just addressed it here. It's not allowed to escape.

Q. Okay. And are you offering any testimony as to what you think will happen to that chloride once it's at that -- poised at the zero meter mark in the, quote, real world?

A. In the real world there would be the additional

20 inches up there, and it enter the dynamic of those 20 inches.

In this case it tends to retard further upward movement of chloride, because it can't escape the problem.

Q. Right. Now Dr. Neeper, are you aware of any empirical data that supports the results of the modeling that you're presenting here?

A. I'm thinking back through all of the technical literature that I have read. I have not seen anything to my memory, let us say, that contradicts this. And in terms of empirical data I would suggest that at least what we've learned by drilling is not at great variance with this.

The pits with which we had at least a known history were the two Marbob pits. A representative of the owner of those wells was there, he could tell us that they'd been closed, or cleanly closed, and one had been wrapped in its liner. And sure enough, we found some liner right at the top. And we found evidence of chloride front reaching down to about 30 feet or so.

That supports the idea that you can have chloride movement to such depths --

Q. Okay.

A. -- and I would say that is an empirical evidence.

Q. Okay, for the --

A. The second part of that empirical evidence, that wasn't too surprising to me, was, the surfaces were a little sandy, we had a very rainy spring, and so we didn't find chloride up at the surface. And that struck me, then, as not so surprising, because they did have some vegetation there, the soils hadn't been so harmed, when I compared that to our results with what we might call the other two dead pits over the Caprock where we find a lot of chloride up at the surface.

Q. Okay. But so basically your testimony today is that you're not aware of anything that would contradict the hypothesis that you've advanced in the literature and that is consistent with what you observed at the Marbob pit and the two pits in the Caprock area?

A. I would say the modeling is consistent with what we found in those pits. It does not mean that either the pits proved the model or the model proves the pits. You'd have to do an awful lot more work to join those two absolutely.

Q. We'd actually have to validate --

A. And it doesn't mean that there isn't somebody out in the scientific literature who hasn't published a paper that would say, dissolved substances can never go up. Somebody may have published such a paper. I have found papers showing, particularly -- they use sodium chloride, I think, moving into the surface.

Q. Okay.
A. But they are all laboratory -- usually laboratory surface --
Q. Okay. Now if we look at page 41, which is the tightest of the tights that you have, it shows that the chlorides actually begin to move into the zero point relatively quickly, actually within less than five years under the simulation from that FEHM; is that correct?
A. Yes.
Q. And so as a result of that, would you expect that we would have seen salts coming up in clay soils empirically as well?
A. It would depend on what you did with those salts. I would say it might mean, if you went down and buried a high concentration of salt at about four feet and then gave it this characteristic moisture, depending on the vegetation that you had there and what was actually the moisture down in the soil, not at the surface, you would expect to see some upward movement. It doesn't mean that it would be utterly impossible to find someplace where salt did not move up. You've got to study each of these circumstances.
Q. Okay. Moving on, then, to page forty- -- and -- I don't -- Okay, when we get to page 45, you also want to then talk about that we can't think about pits just in two

dimensions, but we need to think about the third dimension is as well. And for you that third dimension is the -- what I would call the -- That's a good question. The X and Y, as opposed to the Z axis --

A. All right.

Q. -- so that would be horizontal movement that you may have, instead of just looking at is it going up and down in the soil column; is that correct?

A. Yes.

Q. As -- If there is dispersion from the pit and you get a broader movement beyond the boundaries of the initial pit, what would be the effect of that when we get down to the groundwater? What's the effect of having, in this case, the chloride move horizontally as well as downwards by the time you reach the groundwater? Assuming 50 foot to groundwater.

A. Now bear in mind, I did not run a two-dimensional problem, let alone a three-dimensional problem.

Q. Right.

A. I could have, it's three-dimensional code. My time is limited.

One might expect that since, if you had a pit and you magically in your mind removed the liner, or the liner degraded, some chloride moved out horizontally from the pit, that's another opportunity for it to move in whatever direction the native hydrology is going to take it.

So if it's moving towards groundwater, if you have sufficient infiltration, you might have a greater path, more being taken down to groundwater. There can be other effects, like, if the rate is significant, you might deplete your source sooner. You might wash more into groundwater faster and eventually have your source disappear.

Q. I guess the last question I really have on the model, Dr. Neeper, is, we've heard testimony both at the surface waste hearing and now at the pit hearing about the presence of the so-called chloride bulge.

A. Uh-huh.

Q. How does your model account for the formation of the chloride bulge? And did you observe a chloride bulge form when you were running your model to establish the steady-state condition?

A. The chloride bulge is formed by thousands of years of gradual chloride input from the atmosphere, the withdrawal of moisture by transpiration of plants, and some effects, potentially, from the groundwater. In some desert areas you can have upward flux from the groundwater.

If you put all these together, you can get a chloride bulge. Namely -- At least you don't have enough recharge to take it all away, so you get a buildup at some place where the moisture is being removed, in this case by the plants.

I did not attempt to run a 10,000-year problem with the slow input of chloride at the surface. Instead, you might say, I made one humongous, large -- that is a large word -- one very large chloride bulge at a particular depth and watched what would happen in this problem.

Q. Now, you've referred a couple times to upward flux from the groundwater. And does that occur at any depth to groundwater, or is it more common in a particular circumstance?

A. Usually that occurs with shallow groundwater and a dry climate. But that isn't restricted to that.

Q. And when we're talking about shallow groundwater, what type of depth are you looking at for shallow groundwater?

A. When I said usually --

Q. I understand you said usually.

A. Yes. -- that may mean feet to tens of feet. It may not mean thousands of feet.

Q. Okay. But you would think that in the tens of feet range that we would see a groundwater -- upward flux from the groundwater to the land surface?

A. No, not at all necessarily so. I'm saying it can occur there. I've seen an agricultural diagram on this that I think we had in the surface waste hearing, showing groundwater at about four feet, and you're getting a continuous upward flux because the surface is drying.

Q. Right, that was at four feet, as opposed to tens of feet?

A. Yes. So you can get an upward flux in many circumstances, and I have measured the potential where we were drilling in Bandelier tuff, where above a certain level the moisture was flowing downward and below that level it was flowing upward, and we were puzzled with what was the cause of this.

Q. Now in terms of, sort of, does the model correspond with reality, you went through a number of photos that showed the Caprock pits, and I think we agreed that we don't really know very much about what was actually done at those pits?

A. We don't know --

Q. We know they were there.

A. We don't know the history there. The photographs were there to show you where we were, what was the concern and what's going on.

Q. Then in exhibit 51 you have a number of samples in each category of vegetation with the chloride content, and you have -- I think on the left of this is in black, which you call sort of within the dead area, to the edge of the snakeweed. And then to the right you have out more where the vegetation was either not or less affected.

A. Dead to sparse.

Q. Dead to sparse. And it was your contention that you saw more higher numbers in the dead area than you were seeing in the -- what's in the green box? Is that what you've suggested?

A. This was an attempt to organize data in a place where I expected to find a continuous gradient and could not find one.

Q. Okay.

A. And the green box is saying, wherever I found anything from sparse snakeweed out to undisturbed grass, the chloride -- any measurement I made was less than 400. And what I was trying to do was define, where is there a gradient? Isn't there a gradual change of chloride with a gradual change of vegetation? And in these cases I just didn't find that. Essentially, I could find chloride at about 400, or I could find it above the 1000, so --

Q. Okay.

A. -- but I couldn't find a nice, continuous correlation there. Wherever there was dead area, there was high chloride usually. Wherever there were good green things, there was usually low chloride.

Q. Okay. In exhibit page 59, you went and you actually drilled in conjunction with Marbob Energy one of their Loco Hills pits; is that correct?

A. I didn't, Marbob hired the rig.

Q. Okay, but you were present?

A. I was present.

Q. And you noted that in the -- there is a significant dry soil chloride spike at the distance of approximately 20 feet, and I think with Mr. Brooks you were sort of speculating about why that might be. Do we know -- or do you know the point at which you penetrated the bottom of the pit, what that depth was?

A. I could not identify the bottom of the pit clearly in the cores. I had certainly hoped we could identify it. I thought we would see a definite change --

Q. Did the --

A. -- but I did not identify it --

Q. And the Marbob representatives didn't make any statements about what they believed the depth of the pit was?

A. No, we would have hoped maybe even to find from the lined pit a piece of plastic come up, and we did not.

Q. Okay. All right, I believe that you had said either in your direct testimony or in response to cross-examination from Mr. Brooks that pH has an impact on plants and that alkalinity would move along with the water; is that correct?

A. I was concerned with pH. I found some literature that indicated pH did have an effect on plants. There had been a prior testimony that indicated pH's lower than what I thought the sampling generally showed, so I felt it important to bring in what the pH sampling was and the reason why you would be concerned with that pH.

Q. Okay. Do you know what the typical soil pH is in the San Juan Basin in southeast New Mexico?

A. No, I don't deal with the typical soil pH in the San Juan Basin. I have ideas, but nothing quantitative.

Q. Okay. I think that you also addressed about this time our mutual favorite topic of preferential pathways; is that true?

A. I think you should ask me a direct question and I might be able to answer it.

Q. Oh, okay, so -- Fair enough. I believe that Mr. Brooks asked you whether the existence of a preferential pathway could change the rate at which water might migrate from what was portrayed in the model; is that correct?

A. If you state his question correctly, I remember a question to that effect.

MR. BROOKS: Mr. Chairman, that question may have been asked, but I don't think I asked it. That's just an observation. If the record shows otherwise, I stand corrected, but I did not -- but I don't think I asked --

CHAIRMAN FESMIRE: But you're not objecting that it was asked, you're --

MR. BROOKS: No, I don't object to his asking about that. But I think it would be false to assume that I asked that question.

CHAIRMAN FESMIRE: Okay. Mr. Hiser, are you representing that it was asked by someone?

MR. HISER: I remember the discussion of preferential pathways.

CHAIRMAN FESMIRE: Okay.

MR. HISER: My little antennae go up every time I hear that term.

(Laughter)

MR. BROOKS: -- Dr. Stephens.

MR. HISER: Be that as it may, I will make the -- I'll just ask the question without reference to Mr. Brooks, in case he may be right.

CHAIRMAN FESMIRE: Okay, in that respect we'll grant Mr. Brooks a semi-objection and ask you to rephrase the question.

Q. (By Mr. Hiser) All right. Dr. Neeper, I believe that you stated that preferential pathways might change the speed at which water was moving in the subsurface; is that correct?

A. In general, one would think, all other things being equal, that water would move faster along a preferential pathway than it would in the general -- what's sometimes called the diffuse recharge area of the soil.

Q. Okay. And by a preferential pathway, when we're talking about a pit, could you give me a description of a typical example of a preferential pathway that you might be concerned about?

A. I wish to understand your question. You want me to identify an example of a preferential pathway that concerns a pit and that is typical; is that correct?

Q. Yes. And -- But if you want to give a hypothetical example, I would accept that as well.

A. Well, I think the best I can give you is perhaps what I would see as a real-world example, and that was the photograph I showed of what appeared to be a subsidence, and much evidence that water had gathered along a very small stream path and run directly into that subsidence.

Q. And so there --

A. That would become a preferential pathway.

Q. Right. And in that case it would be a saturated-flow preferential pathway, at least at the top of that hole where the water is -- the liquid water is physically going down?

A. In that case there was evidence of saturated flow having entered that.

Q. Okay.

A. I would be cautious before saying all preferential pathways have to have saturated flow. That's not necessarily true.

Q. Okay, and in a saturated-flow preferential pathway, the assumption is that in many cases that saturated flow will be moving at a greater rate than the surrounding water in the unsaturated area might be moving?

A. Yes, but I would be cautious before I called the pathway a -- the saturation does not describe the pathway, the saturation describes the hydrologic condition at the moment. The pathway is there whether or not it is saturated.

Q. Right, so if, for example, to use the infamous 50-foot-deep gopher hole where if I have a gopher hole which extends more or less straight down from the land surface to the surface of the water table, and I poured water down that, you would expect that liquid water to very rapidly go from the top of the 50 foot down to the water table in a saturated -- if it was in a saturated-flow condition?

A. Yes.

Q. Okay.

A. You would expect water to go down a hole rapidly if you poured it down there. And I've seen just that gopher hole in a waste pit, not one that concerns this Commission.

Q. Okay, and -- But if there was a plug in that gopher hole, say, two foot down, what would happen to the water at that point?

A. It depends totally on the circumstance. We dealt with preferential pathways in the cooling fractures of Bandelier tuff. Often they would become filled with clays, and so you could -- you might have flow down until you hit the plug, and then the flow would go outward into the matrix and saturate the matrix at that region. And so you're getting more net downward transport, but where it goes depends on the particular problem at hand.

Q. Right. But let's say that the water went around the plug and was now on the face of the gopher hole. Would it resume its saturated-flow rate?

A. Depends how much water you have available. You would expect that once you had a plug, probably you had gone unsaturated, you might not gather back enough to form a fully saturated flow in that particular preferential channel, that particular size.

Q. Okay, at which point, then, it would proceed by unsaturated flow at whatever rate it would otherwise be flowing at?

A. Not necessarily, because often you'll hit some hydrologic barrier, the water will move out horizontally until it finds another preferential pathway and go down that.

Q. And in the unsaturated zone, what tends to form the preferential pathway? Where is it easier for the water to go? Is it easier for it to be in a highly coarse media, or in a finer media?

A. A preferential pathway means a pathway that is different from the characteristic of the media. And so a preferential pathway doesn't -- the fact that there can be one doesn't necessarily mean you can't have it in a fine media as well as a coarse media. It could happen in any one of these cases, depending on your definition of fine and coarse.

If you have uniform media, then you don't expect a preferential pathway in it. But whether you have achieved that uniformity is the circumstance at the moment.

Q. Well, Dr. Neeper, I'm a little bit confused then. If your definition of a preferential pathway is that it's a place where we're departing from the otherwise uniform condition, what would cause that, other than a change in the texture of the media or else a macropore of some form?

A. It could happen through a change in the texture of the media, it could happen through a macropore. But your question to me was whether it would happen in fine-grained media or coarse-grained media --

Q. Okay, I guess that perhaps I --

A. -- as I understood your question.

Q. -- misspoke, which is that -- Well, I guess my real question is, isn't the typical preferential pathway going to arise out of either a change in the texture which the water finds preferable to follow, or the existence of a macropore or similar interruption in the subsurface?

A. It will often happen as a function of some interruption in the subsurface. If you have a rock-type media it can be a fracture. If you have a growing zone it could be a root channel.

Q. Okay. But if it finds one of those -- say a fracture or a root channel or something like that, the flow rate that's going to occur there is going to be the flow rate which would be endemic to either that rock fracture or the root channel or, if it was a fine-grained media versus a coarse-grained media, the fine-grained media or whatever.

So it's still going to have a flow rate which is determined by the characteristics of whatever that pathway is?

A. The rate of flow in a preferential pathway is going to determine how the water or, in some cases, the air got there. In other words, what was behind it? What's the driving force? How much head is on it? What did it have to go through to get to the point where it finds the preferential pathway? I'm failing to understand where your questioning is leading.

Q. Well, I think that you've answered my question, which is that it's going to depend on a number of factors that are present both in the water and also in the pathway itself, so I think we can probably move on.

Now I want to come to page 67. We're pretty close now, I think, to the end of your presentation, and here you have a statement in the last paragraph that, The existence of, quote, entombed waste units throughout the landscape places a future prejudice on the land for all time.

Did I misunderstand your modeling, Dr. Neeper, or did it show that -- the fact that at some point in time, that you had removed the mass?

A. I showed one model calculation in a sandy-type soil, in the soil I characterized being more loose, and I showed that in that calculation the waste unit became depleted of tracer --

Q. Uh-huh.

A. -- during the time period of the calculation. And --

Q. But in all cases you showed a reduction of the mass in the basic source?

A. Yes. Now I'll point out that in that first case where I showed that all of the tracer in the waste unit had moved to the aquifer, you no longer had an entombed waste unit.

Q. Right. And at that point what would be the impact of the former entombed waste unit on the groundwater?

A. I did not calculate the impact on the groundwater. If the groundwater were static, you would find all the salt in the groundwater.

Q. And how often is groundwater static in New Mexico?

A. I am not familiar with the statistics on groundwater motion. I could tell you how fast Dr. Stephens said it was moving, but then I would be quoting Dr. Stephens.

Q. Okay.

A. I want to get back at where you're driving, is that these things may cure themselves, that the prejudice may be removed at some time. Well, the prejudice is removed only when the waste is no longer entombed there.

So if you're maintaining that your liner is good and you're going to hold the waste there for all time, now I will say you have placed a prejudice on the future of that land for all time. So perhaps I should have said, Existence of entombed waste units places a prejudice on the land for as long as your entombment can hold.

Q. Right. But if the waste goes away, which might perhaps be an argument for no liner, then that prejudice would go away at that point in time. Although there's a question about what prejudice, I'm sure that you would say, happened to the people downgradient.

A. Well, I would put it in a larger term than that. You used the term, away. People like to throw things away, and what they're finding out is that away just means somewhere else.

Q. Right, and I think you agreed that the same prejudice would occur at the area that you call a landfill or a sacrifice area, but that we're willing to accept that?

A. That's correct.

Q. What would be --

A. We have designated -- I see us collectively -- us, then, being the society, if we choose to use a landfill, as designating that as a sacrifice area. We are admitting to ourselves we are doing something to that region. And our future uses and maybe other future uses will be limited.

Q. Now Dr. Neeper, you're here representing the New Mexico Citizens for Clean Air and Water; is that correct?

A. I am speaking on their behalf. I believe representation is a legal term.

Q. Okay, but you're speaking on behalf of the New Mexico Citizens for Clean Air and Water?

A. That's correct.

Q. And did you evaluate what the collateral impacts of this proposal that you're supporting would be in terms of the impact on the air?

A. We did not do an air calculation. I have heard the statements, I have not yet seen quantitative statements of that. But I have seen much confusion as to what people are regarding as the impact of this rule.

A principal confusion that I see is, many people feel this rule dictates closed-loop systems and all that that requires. I see a major requirement of this rule is that through most of the productive areas wastes would need to be taken to a designated receiving facility. And so a major impact, at least on people, and on the producer, would be the cost of moving it and the fee to dump it and what happens between those.

But not many of the other aspects that I hear discussed -- they may not be required by the rule.

Q. Are there collateral effects of transporting that waste from the pit to the landfill?

A. There are collateral effects, yes, just as there are collateral effects from blading all those roads into the mesas to put the wells there in the first place.

Q. And did the New Mexico Citizens for Clean Air and Water consider any of those effects in reaching their decision to support this rule as you said they did?

A. No, we've reached our decision based on the -- what we see as the impacts to the landscape from leaving wastes in place.

Q. And so your concern is really the land's surface, as opposed to either, in this case, the air or the water impacts?

A. We are concerned with water impacts. We did not focus on those; we expected many other witnesses to focus on those. We did not expect many other witnesses to focus on land surface impacts, and so we have focused on that.

Q. And so on the groundwater side, which is, I presume, the water part that we're talking about here, did you -- did New Mexico Citizens for Clean Air and Water evaluate their preference between the sacrifice area and the concentrations that might be seen in the groundwater from those, versus this more dispersed model that has been used in the past for the groundwater impacts? Or are you relying on the Division's presentation?

A. We were not relying on the Division's presentation. What we were relying on for that is the rule that specifies construction standards for landfills, even though not all landfills in existence now will meet -- have met those standards, nonetheless, some existing landfills are what I think are fairly safe geology or fairly safe groundwater circumstances. So that is what we are relying on for water protection.

Q. And so, Dr. Neeper, when industry is working with their pits, we have a problem with the unforeseeable future consequences of our actions, but yet landfills it's foreseeable that they will comply and that everything will work out perfectly; is that basically what you're saying?

A. We are hoping very much that at least for construction there will be adequate enforcement of the rule. Evidently not adequate enforcement of the rules in all places and at all times, and we often puzzle over why the Legislature seems unable to fund this agency adequately, given the amount of money that, shall we say, the industry virtually donates as tax money to the Legislature.

MR. HISER: Okay. I think that may be about the last of my questions. Give me just a second.

CHAIRMAN FESMIRE: While he's doing that, Ms. Belin, is Dr. Neeper available tomorrow morning?

MS. BELIN: I believe so. Let me check.

MR. HISER: I think that in the interests of time

I will say that I am done. I'll be happy to pass the witness. Thank you very much, Dr. Neeper.

CHAIRMAN FESMIRE: Mr. Carr, do you have any --

MR. CARR: (Shakes head)

CHAIRMAN FESMIRE: Ms. Foster, I'm sure you've got some questions, don't you?

MS. FOSTER: A few.

CHAIRMAN FESMIRE: How long do you think it will take?

MS. FOSTER: Ten minutes.

CHAIRMAN FESMIRE: Okay, let's go for 10 minutes.

EXAMINATION

BY MS. FOSTER:

Q. Okay. Dr. Neeper, I just want to clarify some of the things that you said towards the end.

What do you see in your mind as an exception for an operator not to have to do the closed-loop system?

A. I'm understanding that the rules says -- the proposed rule -- if you have a drill site that's within this hundred-mile radius the rule describes, you are not allowed to dispose of your wastes on site.

I would see -- I imagine myself as being an operator, and I might choose to operate in the fashion I've been operating -- that's very normal -- and so I could see it possible to dig the contents out of the pit that I'm accustomed to using, putting it in a truck and having it hauled to the disposal site.

I would not necessarily see that I would have to dry those contents. I might be able to reduce their volume by a factor of two, three or more, over what would need to be put into a trench burial.

Q. Okay. Then reducing the contents, how would you suggest doing that?

A. By not mixing it with clean soil.

Q. Or if you put through a closed-loop system, does that not reduce the quantity of the drill cuttings --

A. I have heard closed-loop operators say that, but I'm not an expert on the operation of closed loops, so I can't testify to that.

Q. Okay. But in comparing the closed-loop system to an open pit, are there not different requirements for -- for example, of having the closing requirements for a temporary pit or a drying pad?

A. The regulations talk about drying pads, that's correct. I believe the proposed rule or the assumption behind the proposed rule, then, is that perhaps the operator of a closed-loop system would want a drying pad, would want to use one.

Q. Because there's different regulatory requirements, correct? Under the -- For example, you don't have to test under the drying pad, whereas with a temporary pit you'd have to test underneath it or move it over into a deep-trench burial if it's possible to do that?

A. That's your statement. Let us remember that what I have testified is that we are generally opposed to on-site burial of wastes We did not testify as to what business decisions the operator may make to get there or the various regulatory conditions or opportunities that are laid down in the rule by which you can achieve that end.

Q. Right, but what I'm trying to clarify is the statement that you made that you believe that the only limitation to closed-loop systems is the 50 foot to groundwater?

A. I don't believe I said that.

Q. Okay, well --

A. We'd have to check the record. I believe what I was trying to indicate was that the operator who is within the 100-mile limit is not required to have a closed-loop system, but he can still have a pit. He just may not bury the contents of his wastes --

Q. Okay, but --

A. -- on site.

Q. -- by extension, if he cannot bury on site, wouldn't it make more sense to do a closed-loop system?

A. That's his business decision. I can't get into that.

Q. Okay. Looking at your slide number 7, I just wanted to clarify that industry pit sampling was of all drilling pits, correct? There were no reserve pits that were tested in there?

A. As I understand it, but I can't testify to that. I understood these were all reserve pits.

Q. All right. Drilling pits or workover pits?

A. I cannot tell you which. My belief was, they were drilling pits. But I wasn't there, I don't --

Q. Okay, and then the OCD pit sampling that you looked at, there is a permanent pit in that list; is that not correct?

A. I believe there -- My memory was that there were two production pits in that set, but I could be wrong.

Q. All right.

A. You couldn't tell exactly from looking at the photographs.

Q. Now based on your experience as a scientist and having reviewed all the different types of pits, would it be a fair statement to say that the chloride levels or the constituent levels in the permanent pits are significantly different than the constituent levels that are in drilling pits?

A. I haven't done a study on that. I would expect some differences. The origins are different. The permanent pit is usually a production pit.

Q. Okay, but in a production pit are the chloride levels generally different? Higher, lower, more concentrated?

A. It's going to depend on the content of the produced water. Let me try an example, and I'm on the very edge of my technical expertise here.

I would expect produced water in the southeast with an oil pit might be more saline than a -- one particular, perhaps, drilling pit in the northwest. That's an expectation, that may not be true. It's certainly not a general rule. Could happen, I'm saying it could happen, because drilling in the northwest is usually done with fresh water. You might be pulling up saline water somewhere in the southeast.

Q. Okay. And I want to talk a little bit about the clay discussion that you had. To the lay person, which I am -- I'm not a scientist, I'm just a lawyer -- reviewing your slides, it would appear to me that a clay liner, specifically one made out of bentonite, would provide adequate protection under some of the modeling that you did. Would that be an accurate finding?

A. You're meaning a clay liner in a production pit, or a clay liner in a drilling pit? I just --

Q. In a drilling pit?

A. And again, I have to clarify your question. You're meaning if the operator installed a compacted clay liner in a drilling pit, would that be adequate? Let us say, for example, that he did that rather than to use a plastic one?

Q. That's right, for a drilling pit, which we will assume is, you know, for temporary purposes, it's not out there for a long period of time like the permanent pit would be.

A. This is into pit engineering. My judgment would not favor that. I don't think economically it would be favorable. But the activities around a drilling pit, I would think, might more easily disturb a clay liner than they would disturb a --

Q. Okay, are you familiar --

A. -- that's --

Q. -- are you familiar with the clay compressed liners that are being used in the northwest now?

A. I'm not familiar with the commercially prepared liners. I was understanding that you were talking about creating one by compressing clay on the surface.

Q. Right, and it's my understanding that they are used in the northwest now, compressed clay liners.

A. Yeah. I can't -- I simply can't answer your question, I haven't looked into liners.

MS. FOSTER: Okay, I have no further questions, then. Thank you.

MR. CARR: Mr. Chairman, could I ask just two or three questions following up on that? They're only -- I just want to be sure I understand what the New Mexico Citizens for Clean Air and Water are recommending.

CHAIRMAN FESMIRE: Okay, Mr. Carr, go ahead.

EXAMINATION

BY MR. CARR:

Q. Dr. Neeper, if I understand your testimony, your testimony focused on contaminants in soil that are there as a result of temporary oil and gas drilling pits; is that the area you were focusing on?

A. I'm trying to think of an exception to that. We were looking at wastes, we were considering usually solids. That usually comes from drilling pits. I'm trying to think of the odd circumstance. You might get some solids from a workover pit, but we were generally focused on the question of on-site burial of wastes.

Q. And as you started your presentation I thought you were looking at levels of contamination that you thought could damage plant growth, and you had listed all kinds of sample results.

A. We were giving this as a reason for being concerned with ground surface, as contrasted with focusing strictly on groundwater.

Q. And I think you showed that some of those -- some of those individual measurements, in fact, might be able to meet appropriate standards so that they wouldn't damage plant growth?

A. In terms of chloride, yes. What I -- The question I was really trying to ask, is there hope for being able to treat wastes? Is there a good reason for seeing the rule as a motivation? And if so, the most likely initial target is in the northwest where the concentrations are considerably less than in the southeast.

Q. And you testified -- or recognize that all pits are different?

A. That's right, so --

Q. And --

A. -- it's hard to make a blanket rule that says all pits are clean enough.

Q. And yet across the board, is it your organization's position that you oppose all on-site burial of waste?

A. We have in the past made the statement, and I would make it again, that we do not oppose on-site burial of harmless minerals.

Q. Are you opposed to exceptions to that provision, an exception to on-site burial, if there is a showing that the level of contamination would not impact re-vegetation?

A. I think the exception, any exception, has to be considered on its own merit. An exception is an individual case. If you are saying there is nothing in the rule that kind of establishes the boundary between zero and something else, that is probably right.

Q. And the point of this question was, you talked about prejudice on the land, leaving that behind in the form of some source of contamination. And my question was, Are you opposing exceptions if the operator -- if they accept your recommendation, are you opposing exceptions if an operator could show that what they're proposing is protective of human health and the environment and won't interfere with plant life?

A. I very much might object or oppose that exception --

Q. And why --

A. -- because for one operator that might not have much impact. But if you do that for, let us say, another 5000 pits in the same area, that might have a significant impact, either on the environment or on future uses of the land that we cannot foresee.

Q. And so you're saying you wouldn't support a case-by-case exception process? That's what I'm hearing.

A. We're saying if you have an exception process, it has to be case-by-case --

Q. But you cannot look at that case, you have to play it out in a broad, undefined context; isn't that right?

A. I think that those who consider the case have to consider whether if they make an exception, would not this same exception apply to other operators --

Q. And then they'd have to --

A. -- and is it correct if another 1000 pits are drilled according to this exception? And it might be correct and might not.

Q. And would you have to, before you can make that decision, determine whether or not it would apply to thousands of pits or that there would be applications for thousands of other applications? Aren't you really saying that you oppose exceptions?

A. No, we have said that we feel in some of these cases that notice should be given. There have to be exceptions. No rule can be omniscient. There have to be exceptions, there has to be a way to do it, but there has to be a route for input to those if someone has technical information.

Q. And would you agree with me that the standard to apply for obtaining an exception should be protection of human health, the environment, groundwater and allow for plant growth?

A. That may be necessary, it may not be sufficient. Because I think one also has to consider, then, the regional scale if you make these kinds of exceptions.

You may have one that has a unique case, would have no implications at a regional scale. Fine, consider that.

But if you make an exception that in principle could apply to many, many operators, many, many pits, you have to consider the regional effects.

Q. Wouldn't that be part of showing it protects human health, the environment and groundwater?

A. Well, when you say environment, you may not be including that thing I called future prejudice on the landscape, which is the case when you have many, many buried waste units. Can you tolerate many of these things within your view of this exception? Is this exception going to generate many of these things, or will it generate only one in the whole history of the state? Those are legitimate questions for the exception procedure.

Q. And it depends on your definition of environment?

A. I presume. It's really going to depend on the definition of environment, as seen by those who make the judgment on the exception.

Q. And wouldn't that go beyond just a prescriptive standard? Wouldn't you have to look at the actual performance of the individual case before you make a determination?

A. I don't understand the question, because an exception is an exception to a performance standard.

Q. Or is it an exception to a prescriptive standard?

A. Or an exception to a prescriptive standard. It can be an exception to either one.

MR. CARR: That's all.

CHAIRMAN FESMIRE: Thank you, Mr. Carr.

Mr. Jantz, did you have any questions of this witness?

MR. JANTZ: No questions of this witness.

CHAIRMAN FESMIRE: Okay, let the record reflect that Mr. McMahon has joined us. I'm assuming you have no questions of this witness?

MR. McMAHON: No, Mr. Chairman, no questions.

CHAIRMAN FESMIRE: Okay, Mr. Huffaker?

MR. HUFFAKER: Nothing, Mr. Chairman.

CHAIRMAN FESMIRE: Okay. Chairman [*sic*] Bailey?

COMMISSIONER BAILEY: Yes.

CHAIRMAN FESMIRE: Okay. How long do you think it'll take?

COMMISSIONER BAILEY: Ten minutes.

CHAIRMAN FESMIRE: Okay, I've heard that before.
(Laughter)

EXAMINATION

BY COMMISSIONER BAILEY:

Q. Thinking about the burrito method of burying pit contents, if there's the potential for generation of any kind of gas from the organics and the chemicals that are there, would their fate be similar to what you've testified for water vapor or for fluids?

A. No, you can't assume that an organic vapor is going to transport the same way water vapor will. It can be sorbed as it moves. It will have a diffusivity. I can't put the two into exactly the same prediction.

Q. Knowing what you know, is there potential for generation of secondary gases or secondary compounds from the pit contents?

A. Presuming that the pit contents are buried with some of the lightweight organics in them -- as I understand, sometimes kerosene is used, for example, in drilling -- I would presume that there is. It is not within my expertise to deal with the chemistry, but I can't see why you wouldn't generate secondary gases from decay.

Q. Just because you did not indicate vegetation in that top 20 inches, or use that, does not negate the importance of vegetation in your results or your models; is that correct?

A. It does not negate at all the importance. And in fact, in a sense, you see, vegetation was included. As I understand that Pedon site, and from pictures of it, it's a vegetated site, and I was trying to let that in a sense be taken care of by the fact that I used the moisture measurement down below the grasses at site.

Q. So you call vegetation an important -- or even of vital importance in the results of your modeling?

A. I would think that vegetation is vital -- of vital importance in the future of how wastes, buried wastes, will behave. In my model, literally the thing of importance was the volumetric moisture that was specified at the top of the problem.

Now that measurement was in part determined by the vegetation on that landscape, as well as the rainfall and the sunshine.

Q. Then given the vital importance of vegetation in the transport of contaminants and the suppression of dust and the prevention of erosion, shouldn't re-vegetation standards be as detailed and as stringent in this rule as they are in Rule 36?

A. I would, myself, prefer more stringent vegetation standards. We discussed that in the task force, and I somewhat relinquished my more stern position with some sympathy for industry's position that you can't always describe it, you -- the background vegetation may be very sparse, it's difficult to say what's there. And so therefore we didn't get a numerical specification as we had in the surface waste rule.

Q. But you would prefer personally to see one?

A. I would be happy to see one.

Q. Even if the pit contents are removed, isn't re-vegetation to specific standards necessary to protect the environment?

A. I would prefer to have re-vegetation as an environmental protection, yes.

Q. You made a side comment on the role of caliche and its effect on transport, saying that it sucked water into its vicinity. Would you care to elaborate on that role of caliche in the southeastern part of the state where it's often fractured but often very thick?

A. I'll try to go back to that, trying to remember what it was I said. I can remember what I was probably trying to get at, at the time. There is often a caliche layer there, and it may have very different moisture properties than a sandy or a loamy soil. And it's possible it could have a greater suction.

Now generally, as far as I understand it -- and I have not investigated the caliche -- I think it's often fractured and has this thing you might call preferential pathways, but I cannot testify by examining to that effect.

Am I getting close to answering your question? What I know is, it stuck the augur. And that hurt us.

CHAIRMAN FESMIRE: That was before you tried to wet it, right?

THE WITNESS: We didn't wet it.

COMMISSIONER BAILEY: That's all I have.

CHAIRMAN FESMIRE: Commissioner Olson?

COMMISSIONER OLSON: Yeah, I just have a few questions.

EXAMINATION

BY COMMISSIONER OLSON:

Q. I guess coming back to some of the questions you were having from the industry attorneys, I want to get on, make sure I understand what New Mexico Citizens for Clean Air and Water is recommending or what their position is. And do I understand it, then, that your testimony is, because of the cumulative effects we shouldn't allow on-site burial, but if we do we shouldn't allow it within 100 feet to groundwater?

A. Yes.

Q. Okay. And I think I asked this of somebody else earlier today. I don't know, you may not know the answer either. But what percentage of the land where we have the oil and gas operations would be affected by the 100-foot-depth-to-groundwater limitation?

A. I have not looked into that. I can tell you where some of my impression comes from, and that is in the northwest, at least, there used to be a considerable amount of area that was exempted. We called it exempted, or it was called exempt. And so I had tended to review that -- or view that as an area in which the groundwater was not likely less than 100 feet to the surface. But I did not go and get a map, hydrologic map, to look for that.

Q. So I believe what you're referring to was, there was the exempted areas, and then there were what was defined as the vulnerable groundwater areas in the San Juan Basin?

A. Correct. And my impression was that most of the area was exempt area, just in terms of sheer square miles of area, there was more exempt area than there were of river channels and of basins, and so that there is considerable potential area there where one might be able to site a landfill.

Q. And so for the San Juan Basin, this -- the largest portion of that is, then, exempted area where you think the groundwater would be at depths greater than 100 feet?

A. I would imagine that the depths would be greater than 100 feet, that's correct.

Q. Okay.

A. I have not checked that, so that is not exact testimony, you understand. I would not be surprised to find that that were the case.

Q. Well, I guess what you're saying, that's the larger percentage of the area, is exempted areas in the San Juan Basin, according to your -- from your knowledge?

A. (Nods).

Q. And what about in southeastern New Mexico? Do you have any ideas on the percentage of lands that would be affected in southeastern New Mexico?

A. I don't have any ideas of percentage of lands. For example, I was told by the rancher that where I was interested in looking at old pits there was no groundwater, and a year later I find a monitor well there with 30 feet to groundwater. So I cannot hazard a guess.

Q. Okay. And coming back again to your recommendations, I notice we had a document submitted earlier, I think dated October 5th, 2007, and this contains some proposed language from the New Mexico Citizens for Clean Air and Water in the new rule?

A. Yes, I did not -- I deliberately did not address all of our comments in testimony, just preferring not to be too repetitive with the Commission.

Q. Okay, that's what -- I was trying to understand what your proposed changes -- your proposed changes are in both the October 5th document a well as your testimony here today?

A. We supported some of the October 5th changes in testimony today. And in addition I believe I brought up other things as the concerns came up. In particular, I don't think the difference between the liner and any liner was in the earlier comment.

Q. Because I don't know if I saw your 100-foot requirement in the October 5th --

A. It's entirely possible that you did not.

Q. -- document.

A. This has taken a lot of puzzling out. You might notice that comment has applied to burial of wastes. I did not comment about pits.

Q. So you're proposing, then, that we look at both your October 5th proposed language and any proposals in your testimony here today?

A. I would hope that you would do that, yes.

Q. Okay. And then you were talking about the site in Loco Hills that you looked at -- I guess these are the Marbob sites you were referring to -- and I wasn't sure if I understood what you were saying. You were saying that when you drilled the holes at those locations, you did not go through the old pit location, or you don't know if you did?

A. We believed we were drilling through the pit. That was our intent. And to the best of the operator's estimate and everybody's estimate on site, we tried to site the drill rig where it would go through the pit. And as soon as we went down a few feet, we began seeing chloride because Marbob had a technician on site, a hired technician, who was doing some field testing, and we were using that to guide the drilling.

The second pit, I believe 321, we actually pulled up a piece of plastic from the top.

Q. So you believe on that -- on 321, because it had a liner, you actually did -- or you saw some liner, you actually went through the pit contents?

A. Yes, yes. Again, I don't think there's a way to prove that we absolutely hit the pit. But we didn't hit that caliche layer, and I remember the Marbob person saying, We know we're in the pit, we didn't hit the caliche.

Q. And that was a lined pit, I think you were saying, from -- that was done and closed approximately six years ago?

A. I believe you're referring to pit 321? I hope I'm right.

Q. That's right. And how was that pit closed? That wasn't done by the burrito system we're talking about here today, was it?

A. I'm close to giving you hearsay testimony. I will tell you what the Marbob man told me, and again this was to the best of corporate memory, was that the liner had been just folded over the wastes in that pit and dirt put on top. We were hoping it was somewhat like a burrito in structure.

Q. And then I'm -- I guess from your data from what you saw on the drilling, it's your testimony, though, and I guess from what you observed, that even in using that system you still saw chloride migration from that liner system, into below that system?

A. We still saw chlorides down to about 30 feet in both pits. And so a conclusion made on site was, well, I guess that liner didn't help us as much as we all hoped it would.

Q. What was the depth of the burial of that liner and the contents?

A. Again, I was the only one reading core. I hoped that Marbob would have a geologist out there to read core. That's kind of standard when you're doing this, unless you're doing it as cheaply as I was doing it. But they had just a field tech, came with some things they'd hired. And

so I was trying to read core.
I at least had time to do it, because there were other people around doing things, but I'm not a geologist. I could not identify a clear distinction at the bottom of the pit.
I believe on one of those diagrams I put an indicator where there seemed to be a good indication. I have to go back and look at the diagram. But it's not like we absolutely know this is where the pit bottom was. We didn't hit the plastic on the bottom, and we were counting on that.
Q. Okay.
A. We didn't bring up the plastic in the core, that's the way to put it.
Q. And I guess one of the things I just -- I observed, and I observe this correctly? I'm looking at page 59 of your PowerPoint, because it looks like you're seeing greater depth of penetration of the chlorides from this lined pit than you were from the unlined pit? Am I looking at that correctly, if I look at the -- ?
A. That's the way I interpret it. And what we did is stop drilling when we thought the chlorides had reached a fairly insignificant level of a few hundred or so, and so it seemed to come a little deeper in that pit than the other pit. And what one can make of that, I don't know.

Q. And I think I just have one other line of questions. If I look at your page 28 where you did your little demonstration of diffusion of contaminants in water -- and this is what you're maintaining what will be happening in the groundwater, I guess, is what -- as contaminants migrate down through the vadose zone and contact the saturation at the water table?

A. Well, many of us are familiar with the technical term diffusion, but I wanted to provide an illustration of what this means, rather than saying, Oh, that's when the flux is proportional to the gradient and going on with more mathematical language.

And so the purpose of this was to illustrate what we mean by diffusion in water. And it certainly goes on in pore water just as it goes on in a glass of water; it is just that the path is more tortuous.

Q. And that's also what would be happening at the aquifer as the contaminant comes to the vadose zone and hits the water table?

A. That will happen in the aquifer, but I think most hydrologists view the aquifer as moving fast enough and with enough mechanical dispersivity that that usually overwhelms just the binary diffusive -- those effects are larger. But if you have a very quiescent aquifer, diffusion will take place. Diffusion is hard to stop.

Q. Well, I guess that gets me back to some of the testimony from industry's representative, talked about how we have instantaneous mixing across the full 50 feet of the aquifer when that contaminant comes through at a rate of 2.5 millimeters per year. This seems to indicate outside of the mechanical dispersion that's going on that diffusion is going to take some period of time to disperse this through the aquifer; is that correct?

A. That would be correct.

Q. So --

A. There would still be a tortuosity, because there are all the little particles of soil that force a tortuous diffusion path.

Q. So would you expect that there's -- in their model assumption, that you have instantaneous mixing over the whole 50 feet of the aquifer, seem to be a valid assumption?

A. I would not make that assumption, but I can in a sense accept it because I can say, Well, for my interests I don't care what happens right there, I'm interested in a more regional scale. And so by the time it gets downstream somewhere it will probably be mixed. The dispersivity will be such that it will get mixed.

My concern is that by the time it gets that far downstream it will have gone through underneath three or four or five more pits, and now what's the circumstance?

Q. But you understand that for compliance purposes with the rules, we're not measuring the regional impact on the groundwater, we're measuring it at a point that is directly adjacent to the pit; is that correct?

A. Yes, I understand that if you take a measurement and standards are exceeded, you are not being concerned with whether it has diffused across the aquifer, you have an exceedence at that point, and that is the regulatory condition.

Q. And so the 50-foot instantaneous mixing zone may not be appropriate, then, for that purpose; is that -- for compliance and enforcement purposes; is that correct?

A. I would not make that assumption myself, certainly. It does not look good for compliance. But that leaves me judging the circumstance in the aquifer, and I have not actually sat there and run an aquifer problem with a regional dispersivity of 10 centimeters and the velocities that people use to kind of see what kind of an effective mechanical diffusivity you get back out of this. So I just don't have that number in my pocket.

It strikes me that expecting very rapid dispersion across 50 feet would not be what I would expect. I'd be surprised to see it. But I haven't run that problem.

Q. I guess especially if it was coming through at a rate as low as 2.5 millimeters per year, you wouldn't expect that to be instantaneously mixing across the aquifer?

A. Yes, that's a very low rate of arrival.

COMMISSIONER OLSON: Okay, I think that's all I have.

CHAIRMAN FESMIRE: Mr. von Gonten, would you go to Exhibit 3, page 65, please?

MR. VON GONTEN: Is this exhibit -- 65?

CHAIRMAN FESMIRE: Yes, please.

EXAMINATION

BY CHAIRMAN FESMIRE:

Q. Doctor, this picture concerned me more than anything. With respect to the input parameters and all the modeling that we've seen so far, what kind of effect would this behavior or this phenomenon have on the assumptions we've made concerning the inflow or the recharge rates on the models that we've seen so far?

A. Well, all of our assumptions have been for diffuse flow or dispersed flow. We haven't considered a concentrated flow such as I believe happened in this case. I didn't watch it while it rained. I almost wish I did. So we just haven't looked at that. My estimate would be, that would send a concentrated plume of water down. How far is going to depend on the circumstance.

I have seen the so-called famous gopher holes, I've seen hundreds of them going through a nice clay layer that was supposed to have closed it at a waste dump. And so I've seen things like that happen by circumstances other than this. You can get a hole, and I've seen a water channel go right into a gopher hole. It's frightening.

CHAIRMAN FESMIRE: Okay. Ms. Belin, this is a question of you, not your witness. And it is a leading question and I'm expecting a one-word answer. Do you have any redirect on this witness, of this witness?

MS. BELIN: I have about two questions.

CHAIRMAN FESMIRE: Okay. We've got to be out of here by six o'clock.

MS. BELIN: Literally two questions.

CHAIRMAN FESMIRE: Okay, let's go ahead with the redirect, and hopefully they don't generate much recross.

MS. BELIN: I'm even going to put down my third question.

REDIRECT EXAMINATION

BY MS. BELIN:

Q. Going back to Mr. Hiser's cross-examination, he asked you if evaporated water can move contaminants. You answered, Not directly but as a part of a larger process. And tell me if you recall this dialogue.

He then suggested, Such as in evaporation to clouds and then followed by rain?

And I believe at that point you said yes. Do you remember that dialogue?

A. Yes, I do.

Q. So my question is, other than the evaporation to clouds followed by rain, are there other combined or larger processes that are wholly within the ground that can also move contaminants that involve evaporation?

A. Yes, and that's why I said yes. I thought he was making an analogy to that circumstance. You can set up an evaporation-condensation cycle somewhere.

Q. So it could happen within the ground, just as it -- as he described one in the --

A. Yes.

Q. -- air?

Second question is -- has to do with your slide 45 about horizontal dispersion of chloride --

A. Uh-huh.

Q. And the question is, if the chloride is dispersed horizontally on the ground, is there more chance that it may encounter one of these preferential pathways or a crack to move downward more rapidly?

A. You said if it's dispersed on the ground. You don't mean --

Q. Yes, I'm assuming --

A. -- in a burial unit, you mean if we have the surface of the ground with chloride spread around on it?

Q. Yes.

A. Then you'd expect there's more possibility for hitting a preferential pathway if there's one around.

MS. BELIN: That's all I have.

CHAIRMAN FESMIRE: Mr. Hiser, do you have a recross on those subjects?

MR. HISER: Itsy-bitsy one --

(Laughter)

MR. HISER: -- since she opened up the questions for me.

FURTHER EXAMINATION

BY MR. HISER:

Q. Dr. Neeper, how long would you expect that crack to persist?

A. It totally depends on the nature of the crack.

MR. HISER: Next.

CHAIRMAN FESMIRE: Any other questions of this witness?

MS. FOSTER: No, thank you.

CHAIRMAN FESMIRE: Thank you.

Mr. Jantz?

MR. JANTZ: None.

CHAIRMAN FESMIRE: Mr. Huffaker?

MR. HUFFAKER: None.

CHAIRMAN FESMIRE: With that, we're going to go ahead and adjourn for this evening.

We -- Tomorrow we'll meet at nine o'clock, and we're going to go until 11:30. We've got some scheduling conflicts we've got to address tomorrow.

We will meet all day Friday starting at nine o'clock and going to 5:30.

Yes, ma'am?

MS. FOSTER: I believe that there's some people that --

CHAIRMAN FESMIRE: Oh, yes, I'm sorry, that was the reason we were in a hurry.

Are there any -- Is there anyone here who would like to make a public comment or comment on the record?

Are you the only one, sir? Okay, why don't you come forward? We have -- In our rules we have two public comments that are -- kind of public comments that are allowed. You were here earlier and you heard that?

MR. WALTNER: Yes.

CHAIRMAN FESMIRE: And you've decided you want to be sworn? Okay.

(Thereupon, the witness was sworn.)

CHAIRMAN FESMIRE: And please start with your name, sir.

MARLYN WALTNER,

the witness herein, after having been first duly sworn upon his oath, testified as follows:

DIRECT TESTIMONY

BY MR. WALTNER:

MR. WALTNER: Thank you, Commission, for -- First of all, name is Marlyn Waltner, W-a-l-t-n-e-r.

I'm with a company called Raven Industries. I've been employed by Raven Industries for 14 1/2 years. I've been involved in -- First of all, what we do is, our division manufactures polyethylene liners, propylene liners, okay, for covers, miscellaneous -- different applications.

I've been involved in the sales part of it and the development of these liners for the last 14 years. We've -- Raven was -- We've been in business since 1956. We started converting material in the late 1960s, started actually extruding materials in the early 1980s, so we've been at it for a long time.

CHAIRMAN FESMIRE: Could you speak up a little, sir?

THE WITNESS: I'm sorry. I would estimate that 80 to 90 percent of the pit liners currently used for reserve pits in the State of New Mexico we have supplied.

That's an estimate and I have no proof of that, but that's an estimate.

I've been present for many or most of the task force meetings that have been going on over the last year or so. I've been involved with OCD with many decision-making processes, back to some of the waste-management rules as well. Okay.

I'm going to be talking about a couple different types of liners. I'll be mentioning LLDPE, which is in the proposed rule. Okay. I'll be talking about HDPE and also PVC.

Just a real quick definition.

LLDPE stands for linear low density polyethylene. Okay.

HDPE stands for high density polyethylene. Okay. Very similar materials. I'll get into more detail about those in a little bit.

PVC is polyvinyl chloride, totally different material than LLDPE or HDPE.

Over the last week and a half I've been at these meetings, and I want to talk about how long does a buried geomembrane last. Okay. To be honest with you, I don't know if anybody knows for sure the maximum length. I think some people have some good ideas or good understanding about what possibly the minimum might be.

Dr. Robert Kerner, who's with GRI, who is GRI's -- Geosynthetic Research Institute, they're with Drexel University. He's a professor there. Their main studies is solely with geomembranes. Okay. He has stated that the half-life may be 450 years. In that same document he also stated, To our knowledge there's never been a degradation issue on covered geomembranes. And he was mainly talking about polyethylene geomembranes, because that was his focus in his paper. Okay. That was in a GRI white paper, Number 9, dated July 10th, 2006. Okay? That fly likes me.

Talking to Dr. Kerner, and also to -- we also actually called up to get clarification on that, what was actually in that paper? And the paper is pretty detailed and lengthy. We talked to Dr. Grace Huswan. She's also a professor at Drexel University. Okay. Her statement to clarify where this half-life came from and so forth was this. She's talking about this paper: As illustrated in Figure 2, which obviously you don't have, in this paper entitled Geomembrane Lifetime Prediction, the lifetime of an HDPE geomembrane is arbitrarily defined as time to reach 50-percent reduction in a mechanical property such as tensile, break, elongation. Okay. It should be recognized that the geomembrane is still a fully intact impermeable liner at that time. Okay. If there is no large sudden movement in the subgrade of the site, the geomembrane will continuously serve its initially designed purpose as a liquid barrier.

It is reasonable to assume that the overall lifetime of a buried HDPE geomembrane can range from 500 to 1000 years, depending on the oxygen content and ambient temperature. Okay. And again, I have quotes from her if anybody needs that information.

I guess my question is, how long is long enough? I know the number of 270 years has been brought up and so forth, and again I think there's some misconceptions of saying, Hey, that liner is gone in 270 years. Not the way that I read this information.

I guess if using a dig-and-haul system where you haul stuff away using a closed-loop system -- I get the impression from some people here that that waste just disappears, it goes to South Dakota or something. There's still waste there, you still have to do something with it.

My question is, what is -- where these waste sites are being placed or how they're designed, how are they designed? What's the liner in there? How long does that liner last? Okay. If there's a liner at all.

Talk about PVC because that's been brought up a little bit. I'm going to talk about PVC for a couple reasons.

Number one, PVC is in a couple of the sections in this proposed rule. It's under the permanent pit section and below-grade tank section. 30-mil PVC is also specified liner in the waste management rules. Okay.

Like I mentioned, there's a big difference between PVC and polyethylene.

First of all, when comparing PVC, if you look at PVC documentation on their websites or manufacture of PVC, they're always going to compare it to HDPE, which is high density polyethylene. You want to make sure when you're doing comparisons that you look at comparisons to linear low density polyethylenes. Like I said, there's a very similar chemical resistance, a very similar UV resistance, but LLDPE is much more flexible and elongates much more than high-density polyethylene. Okay. I just want to make sure you compare the right things.

There are really two advantages of PVC in my experience. Okay?

PVC can be -- number one, is very flexible. It's almost like an innertube, so yes, it's very flexible, very stretchy.

The second one is, it can be bonded together with solvents. Some people call it welding. I don't call it welding, to me it's being glued. The reason it can be glued is because of its lack of chemical resistance. Polyethylene can't be glued as easily because it's more chemical resistance and does not let the solvents into the material. Okay.

The following is taken from a 1990 -- a little bit old, but a 1990 valuation of a 10-year-old 30-mil PVC liner at the Delaware Solid Waste Authority. Okay? Again, this is GRI 116 white paper dated October, 1990. I'm not going to read the whole thing because I know everybody wants to get out of here. But basically what they did is, they were -- had to re-do part of the landfill and move some of the materials so they exposed this 10-mil liner. I'll read just the last part:

Eventually the liner became so brittle that walking on it caused cracking in some areas. It was also noted that the PVC shattered as samples were cut. Cracks would radiate through the material from both sides of where a cut was made.

PVC -- real short -- PVC in its natural state is PVC pipe like you might see in your house for plumbing. That's its natural state. To make PVC flexible they have to use what's called plasticizers. Those plasticizers naturally migrate away from that material. At that point, the material becomes brittle and cracks. Okay.

PVC is not resistant to hydrocarbons. Okay. There's applications where PVC works. If you have to glue something, there's a lot of pipe penetrations, it's an okay material. Okay? But around hydrocarbons it's the last material you want to use.

This is taken -- the next statement I'm going to read real quickly is taken from the PVC Institute's website, which is basically -- that's all they promote, is PVC. It's obviously a sales piece of literature. There's no author, no date, but it's obviously a literature for PVC. But they even say this themselves.

There are applications where very high levels of solvents, oils and greases will extract most of the plasticizers or actually soften the geomembrane to a point that it will not function. In these cases PVC geomembrane should not be used.

There's such a thing out there as called oil-resistant PVCs. There's a reason why they make oil-resistant PVCs, because standard PVC is not oil-resistant. I don't know the exact costing, I know it's a lot more money for oil resistance. Okay? If you're going to use PVCs at all, it better be oil-resistant in this application.

Let me talk about reinforced versus nonreinforced. Okay. Mr. Hansen brought up some points about some pinhole. Not to get into a lot of details, but when you extrude polyethylene there is an outside chance, and it can happen, that when you're blowing that material you can get what's called a blowhole where a chunk of unmelted polyethylene resin gets stuck in a die, and possibly you have a small hole. That can happen in a standard monolayer or co-extruded material.

The materials that are in the proposed rule is a three-layer material. Okay. It's a string-reinforced LLDPE. We actually start with two solid layers of polyethylene, we put the layer of string between it and we laminate with another hot layer of polyethylene. So technically there's three -- three layers of polyethylene. There's -- The only way you'd have a pinhole is if you had one of those holes accidentally line up and then somehow the lamination layer didn't cover those holes. Okay. Now I'm saying that's in the manufacturing process. Yes, obviously in handling, installation and so forth, there can be other issues. Okay.

Pinholing is mainly brought up when you're talking about a woven coated material. That's made totally different. You have a spray ribbon and you actually coat polyethylene over the top. You start stretching that material, you can have what's called pinholes.

I believe -- and I can't guarantee, I tried to zoom in on most of the pictures that are on the OCD website. Most of those that I saw on there as far as the failures were woven coated material, and I've got samples if somebody wants to see the difference.

As far as -- again, going back to reinforced versus nonreinforced. Basically tear strength is one of the main reasons. Okay? To me, with the string-reinforced material you're getting the best of a lot of worlds as far as specifications. You can look at -- there's other materials that have better puncture, maybe better elongation, maybe better tensile strength. A string-reinforced LLDPE gives you a good combination of all of those. It gives you good elongation, gives you good tensile and especially good tear strength. Okay.

Nonreinforced materials -- and I know I had a competitor here last week that was, you know, saying, Hey, we don't need to have reinforced film, and so forth.

The problem with nonreinforced -- and just to clarify, we do manufacture nonreinforced films as well. Okay? By the pound we probably do more of this than we do reinforced. But for this application I truly believe what's in the proposed spec is a good material and what they've been using for the last three years. Okay.

This is a 20-mil nonreinforced LLDPE. Okay. The problem is, like I said, there's really nothing to stop that tear. Once you start tearing it, nothing really stops it.

When you go to a reinforced film -- you know, and this is even a 12-mil reinforced. It's hard -- it's hard to keep that thing tearing. Okay. 20-mil obviously is just harder yet. Okay. It's just a little more material. It's the same reinforcement, just thicker skins, is what it is. Okay? It's the same way. It's just those strings bunch up and it stops your tear.

Strength-to-weight ratio. I believe with a string-reinforced material, versus a nonreinforced, that you can have a similar strength and a lot thinner material and hence lighter weight. Okay? To me it's a big deal because you can have bigger field panels going to the field that are factory welded, instead of field seams.

In fact, I talked to some of the people from industry. There's a good chance that we could provide, depending on the size of the pits -- I've talked to a few, but mostly what they've talked about, if you're really concerned about the welding in the field or the sewing in the field, that with a reinforced liner they could get by with a one-piece liner. Okay. Now I don't want to speak for them, but we could make a panel that's 54,000 square feet out of a 20-mil reinforced and probably 65,000, 68,000 square feet out of a 12-mil. Okay. In one piece. Now again, I say one piece. Yes, it's got factor welds. I don't think you're concerned about factory welds.

You would need approximately a 30-mil -- at least a 30-mil nonreinforced LLDPE liner to match up with a 20-mil reinforced. That's kind of your differences. Okay?

I believe there's some concern about how you patch this material. That's one thing, PVC. Yes, you can patch it pretty easy, again you can glue it. With these materials that are in the proposed specification, a couple different ways you can do it. You can use hot air. Okay. You can take a hot-air roller and put a patch around it and melt it, and it'll definitely weld. Okay.

We do have some real heavy-duty high-end adhesives that will stick to it. No, it's not actually welding it like PVC, but it works extremely well, that I would have good faith in for a small hole. I'm not talking about a big, gaping hole. If it's a big cut for some reason, yeah, you don't want to have that welded. Okay.

I know one of my competitors last week mentioned that the reinforced films were much harder to heat-seal than some other ones. We've manufactured this last year, in the last 12 months, over a half a billion square feet of string-reinforced materials, and every single square foot is welded. So that tells you, yes, it can be welded very well. Okay?

Contrary to what was testified last week, again by our competitor, we are not the only manufacturer of this material. Okay? This type of material. There are two to three others that have materials right now, and there's two to three others that have the capability in the United States to make this type of material. Okay, so we definitely have competition, no question about it. We're probably the best at it, but we definitely have competition.

Also, I think it was stated that New Mexico is the only state using this type of material right now. Okay? Definitely not true. We have shipped over 300 million square feet in the last three years just for this application, just for pit liners, okay? The majority of it is used in Texas. We also ship it to Pennsylvania, Ohio, Wyoming, North Dakota, Colorado, and I'm sure a lot of other places. Since we go through distribution, I don't know where they all end up sometimes, but...

In Texas the use a lot of actually a 6-mi -- again, same material, but 6-mil and 8-mil version of this -- with success. Okay? I know in Texas -- and it's probably the same way here, but a lot of it is used for simply containing fresh water. Fresh water is obviously hard to come by in the west Texas area, in the Permian Basin. Water is expensive to haul. If they weren't having success -- If they lined a pit, filled it with water, came back the next morning and there was holes in it, I'd be hearing about it. Okay?

So can things happen? Sure they can happen. But is it generally working? My situation, I say yes. Okay.

Last page.

One recommendation I would make -- and the reason is, is we're seeing some other films that I would consider string reinforced materials come into the United States. This one might look like it's a good material -- That's not what you want in your pit liner. Okay?

So I just have one minor recommendation to add to the standard, is that, number one, it has to be manufactured by a United States manufacturer, in the US, and it should be an iso-9001-certified manufacturer. It just helps that quality control, those standards are in place, make sure you get a good-quality material. Okay?

Also, and I've mentioned this previously, but my suggestion that the method 9090A be removed. Some of these are minor issues but 9090A is in the requirement right now, in the proposed requirement. 9090A does not provide a specification limit. All it does is, it gives -- it does not give you any pass-fail criteria. It tells you how to test the material for certain leachates or whatever, but once you test it -- So there's not -- it's not saying, Okay, this material passes 9090A. I think there's a big misconception there. Okay.

Plus when you use method 9090A, you have to test specific fluids that are going to be contained. I guess what I've heard in testimony is, fluids can change about every pit. Okay? So that 9090A spec really doesn't work.

12-mil versus 20-mil reinforced. You know, right now I know they're using a lot of 12-mil reinforced liners, and 20-mil covers, is what I believe, reinforced covers, a lot of people are using that. On the proposed spec it's 20-mil reinforced.

I would say in rocky areas -- if you have caliche, some rocky stuff, yeah, 20-mil will have a lower chance of being punctured, no question about it.

There's advantages to 12-mil. Like I mentioned before, you can have a larger liner taken out to the field than 12-mil. It's easier to handle, it's probably a little bit easier to work with.

So there's advantages of both.

I'd say both materials, in my mind, have been proven to work very, very well. Okay?

The OCD, I've talked to them earlier, and they were concerned about -- or they asked me some questions about installation, certification. There is something they can go to as far as installing of the liner, heat welding. There's an organization called IAGI, stands for International Geosynthetics Installers Association. They don't get into how you build the pits and maybe some of the more critical things, but they would certify a welder to say, Hey, they know how to weld this material, they are certified to install it, as far as the welding portion of it.

Like I said, they do not do anything with the berms or anything else, it's just simply welding. And they would -- and it's a pretty reasonable certification process to deal with.

GRI does offer classes and courses on installation processes that people could go to. They don't have the certification process, but there is courses that GRI would have. Okay.

I guess my final comment, again, a lot of these things over the last couple years here -- it just -- it doesn't make sense to me personally to take wastes out of what I would call a sufficiently lined pit, okay, haul it up to 100 miles away or more, dump it into an unlined waste facility, or, at best, lined with 30-mil PVC. Okay.

This is what's specified for the waste liners, this is 30-mil PVC. Okay? I'm sure anybody here could tear that material. That's 30-mil, not 20-mil.

And it's going to break down in a very short amount of time because of the plasticizers involved, especially around hydrocarbons.

And again, hauling things out of a lined pit to two of the sites that I've been informed that are totally unlined just doesn't make sense to me.

So I appreciate your time, and I am finished.

CHAIRMAN FESMIRE: Thank you, Mr. Waltner.

Are there any questions of this witness?

MR. BROOKS: In deference to the hour, we'll ask no questions.

CHAIRMAN FESMIRE: Thank you, Mr. Waltner, very much.

Like I said, at this time we're going to go ahead and adjourn until nine o'clock --

MR. BROOKS: Mr. Chairman, I have one scheduling issue I want to raise before we adjourn. Mr. Brandon Powell was here all last week. We didn't bring him back yesterday because we knew [inaudible]. He is not available on Friday for important family reasons. We would like to put him on tomorrow, but it probably would involve further postponing the cross-examination of Mr. Jones, so we leave that to the Commission and other counsel to work out. But that would be our request.

MR. HISER: Mr. Chairman, we -- I -- don't have any objection to the postponing of Mr. Jones, just with the note that I'm not here on Friday because of a prior commitment, and so that's my only concern.

CHAIRMAN FESMIRE: Okay. Why don't we put off a decision on that issue until we get everybody else out of here, because State Parks has this room at six o'clock. There will be other people in here. If you have something you want to leave, bring it up and put it close to this.

Dave, you are here tonight, aren't you?

MR. BROOKS: I am.

CHAIRMAN FESMIRE: Could I talk to the attorneys real quick before we clear out?

(Thereupon, evening recess was taken at 5:51 p.m.)

* * *

CERTIFICATE OF REPORTER

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

I, Steven T. Brenner, Certified Court Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Commission was reported by me; that I transcribed my notes; and that the foregoing is a true and accurate record of the proceedings.

I FURTHER CERTIFY that I am not a relative or employee of any of the parties or attorneys involved in this matter and that I have no personal interest in the final disposition of this matter.

WITNESS MY HAND AND SEAL January 3rd, 2008.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 16th, 2010