STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION COMMISSION

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

APPLICATION OF PENDRAGON ENERGY PARTNERS, INC., AND J.K. EDWARDS ASSOCIATES, INC., TO CONFIRM PRODUCTION FROM THE APPROPRIATE COMMON SOURCE OF SUPPLY, SAN JUAN COUNTY, NEW MEXICO

CASE NO. 11,996

ORIGINAL

REPORTER'S TRANSCRIPT OF PROCEEDINGS, Volume II

COMMISSION HEARING

BEFORE: LORI WROTENBERY, CHAIRMAN
JAMI BAILEY, COMMISSIONER
ROBERT LEE, COMMISSIONER

August 13th, 1999

Santa Fe, New Mexico

This matter came on for continued hearing before the Oil Conservation Commission, LORI WROTENBERY, Chairman, on Friday, August 13th, 1999, at the New Mexico Energy, Minerals and Natural Resources Department, Porter Hall, 2040 South Pacheco, Santa Fe, New Mexico, Steven T. Brenner, Certified Court Reporter No. 7 for the State of New Mexico.

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I N D E X

August 13th, 1999 (Volume II)
Commission Hearing
CASE NO. 11,996

(Continued...)

APPLICANT'S WITNESSES (Continued):

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E X H I B I T S (Volume II)

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(Continued...)

E X H I B I T S (Continued)

(Continued...)

E X H I B I T S (Continued)

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Whiting/Maralex	Identified	Admitted
Exhibit W-7 (Exhibit T-2, 1998)	565, 567	-
Exhibit W-8	569	-
Exhibit W-30	513	-
Exhibit JTB-16	332	-
Exhibit WA-3	330, 581	-

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A P P E A R A N C E S

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* * *

WHEREUPON, the following proceedings were had at 8:30 a.m.:

CHAIRMAN WROTENBERY: Okay, it looks like everybody's here ready to go. It's Friday the 13th, 8:30 a.m., and we'll continue where we left off yesterday.

Mr. Hall, your next witness?

MR. HALL: At this time we call Mike Conway to the stand, ask that he be sworn.

<u>MICHAEL W. CONWAY</u>,

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

DIRECT EXAMINATION

BY MR. HALL:

Q. Mr. Conway, where do you live?

A. I live in Duncan, Oklahoma.

Q. And by whom are you employed and in what capacity?

A. I'm vice president and technical manager for Stim-Lab, Incorporated.

Q. All right. Would you give the Commission a brief summary of your educational background and work experience?

A. I am by training a chemist, and by experience over the last 20 years a well-completions expert. I've basically been involved in all aspects of hydraulic fracturing, including fluids development, fracture-geometry predictions, measurement of properties related to fracturing, both from a research and from a practical field applications standpoint, for the last 20 years.

Q. And are you familiar with the Application that's been filed in this case?

A. Yes, I am.

Q. And have you studied the wells and the lands that are the subject of the Application?

A. Yes, I have.

Q. Have you, Mr. Conway, prepared an investigation in the form of written testimony for this case?

A. Yes, I have.

Q. And do you affirm and adopt your testimony here today?

A. Yes, I do.

Q. Would you please discuss your investigation and your conclusions?

A. Yes, sir. Rather than just go through the exhibits in detail, because I'm sure that the Commission has read the written testimony, what I would like to do is just talk through the issues at hand here and how we arrived at our final conclusions.

I was asked to study the fracture geometry that is potentially created by stimulation treatments both in the coal and in the Pictured Cliffs sandstones in the area in question.

This argument about what the fracture geometry might be for stimulation treatments attempted on coal or on sandstones has occurred many times to this and will occur many times after this hearing, so this is not a new issue. In years past it has been so confusing to me that I've spent approximately five years in detailed study, trying to understand how fractures propagate in coal, relative to the other rock types which are in the vicinity of the coal. That culminated in an SPE paper that I published last year, describing the stimulation of unconventional reservoirs.

What I'd like to do is just talk through that methodology, because that is precisely the same methodology that we used in this study.

Unfortunately, we have less information than I would like to have specifically related to the wells. We'd like to have more information on the stresses in the wells, we'd like to have more information of diagnostic pump-in falloff tests, which are key in many cases to resolving many of the details of stimulation treatments.

The only hard and fast data that we have in this study is the literature of analogous cases, the treating pressures for the actual treatments conducted in each of the wells and the production from the wells.

So I had to rely primarily on the treating pressures that occur during the treatments in both the coals and the sandstones. And that becomes a central premise.

Early in our study of hydraulic fracturing, it became clear that the treating pressure itself is the signature of where the fracture went. It's not always as unique as you would like it to be, but that is the signature that we have to believe in.

The first step in simulating the growth of a fracture is to define the stresses in the reservoir. I worked for a long time in developing a lithology-based stress model. By that it says, if we understand the properties of that rock layer, then its stress state in that reservoir can be estimated and predicted with some reliability.

Coal is probably the most difficult to understand conceptually.

Certain rocks in the reservoir, over geologic time, behave as a plastic rather than a rock. The classic case that you're probably most familiar with is marble. If you hit marble with a hammer, it breaks. But if you make a park bench out of marble and let it sit there for 200 years -- and there are measurements of this -- it will plastically deform under the weight of gravity. And so over geologic time it is a plastic.

Now, what does this mean to the *in situ* stress state in the reservoir?

There are three components for stress.

One is the reservoir pressure. We can reasonably measure that, and we did in these wells.

The second is, the weight of the earth is translated into horizontal stress. And it's done so through engineering terms, primarily Poisson's ratio, and that's basically just something you measure in the lab and then use it to say if we apply a weight. And in this case the weight of the earth is about 1.1 p.s.i. per foot of depth. So at 1150 feet, it's something above 1200 p.s.i., the absolute weight of the earth. If a rock is a plastic, then that total weight of the earth is translated into horizontal stress.

So anytime I do a coal design -- I don't care whether it's in Alabama, China or in the San Juan Basin -- the Poisson's ratio that I ascribe to coal is .5. That means that the overburden stress is totally translated into horizontal stress.

In this reservoir, the coal is the highest-stressed rock in the reservoir. The next would be the shales.

Now let's talk about the sandstone.

Sandstones typically -- I have never had to invoke plastic nature to any sandstone to explain its stress state. Here we had to estimate what the Poisson's ratio might be, based on the depth of the sandstone, the type of sandstone, its permeability and our experience in making measurements in the laboratory.

Palmer in his paper proposed a set of properties for the Pictured Cliffs sandstone at about 3000 feet. We've done a lot of measurements of the difference in the properties on the same rock at 3000 p.s.i. confining stress versus 1000 p.s.i. confining stress. Therefore, the properties that I assigned to the sandstones, siltstones and the shales were based on Palmer's published data at 3000 feet of depth, and then translated to a much shallower depth, where we are here, based -- Primarily Young's modulus is smaller, Poisson's ratio is higher.

When I put those in as the fixed input into the simulator as the primary cause of stress, there is one other component of stress, and that is tectonics. That is, somewhere a fault, somewhere, pushes on the rock. As it pushes, it creates an *in situ* stress at a wellbore. That stress concentration depends on the strength of that rock. The stronger rocks bear more of the tectonic strain.

The net result is, tectonics have very little to do with the stress state in coal, because it is so weak all the other rocks around it bear all the tectonic stress.

The sandstone is much more influenced by any tectonic strain.

In general, around the world, most rocks are in some slight compression. They're basically in incipient failure. The stresses occur, the rock cracks, we get a fault, release the stress for a while, and then it begins to move again.

I didn't have to invoke any particular strange events to arrive at a stress state for this rock, which was the starting place for my model for both the coals and the sands and all the treatments.

In this case we had one unique set of data that I normally don't have when we're discussing coal and sand fracs. That is, we do have fracture treatments that were initiated in the sands, and in the same area we have fracture treatments initiated in the coal.

Now, let's get to the only real piece of data that we can pull out of those treatments.

We all like to try to describe what's going on in terms of the bottomhole pressure during the actual treatment itself. That depends on our ability to calculate the friction pressure in the tubing during the treatment. And without going into any detail, it's difficult at best.

We do have the final shut-in at the end of the treatment. At least the frictional component is no longer part of the calculations. Of the Pictured Cliffs sandstone treatments that I examined, the final shut-in pressure ranged from 390 p.s.i. to 620 p.s.i. That's a gradient -- because we like to talk of these in terms of gradients -- that's .78 to .97 p.s.i. per foot.

Of the Fruitland Coal treatments that I examined, on the ones where you could determine the final shut-in pressure because a number of the treatments in the area that I looked at did screen out, the range in shut-in pressures was 1050 p.s.i. for the lowest to 1340 p.s.i. for the highest. That's a pore-pressure gra- -- I mean, that's an end-of-treatment gradient of 1.36 to 1.6 p.s.i. per foot. That is not the closure-stress gradient that we use in our models, because that includes the pressure required to propagate the fracture.

So we have no overlap between the pressure required to extend the fracture in the sandstone compared to extending the fracture in the coal.

Now let's look at what the simulator then predicts, based upon these observed pressures and where the fracture was initiated.

The simulator that I use is called GOHFER. It's a grid-oriented hydraulic fracture extension replicator. It was originally developed by Marathon, it is fully 3-D, and we have a lot of confidence in that simulator.

It shows when we look at the sandstone simulations that a fracture initiated in the sandstone can grow up to but not through the coal and honor the pressures that were observed at the end of the treatment. Had the pressures been higher, that would have been a different case. But given the pressures that we have observed in these treatments, the simulator says it is not possible for that fracture to propagate in the coal itself.

Now, that poses one issue: How close is close?

We know the bounding layer interfacial strength is critical to stopping fracture growth. It is possible that the fracture actually grew up to the coal.

That forces us to address one other issue, and that's what's the -- where is the sand that we put in this fluid at that point?

We've done a lot of laboratory simulations of proppant transport in foam. If we have a perforation here and the foam fluid is coming in, at that point when we start sand, it may be 5-volume-percent solid sand, 70-volume-percent nitrogen, and about 25-percent liquid.

Foam is not really thermodynamically stable at that percent of gas to water. Shaving cream that you look at and think of as something that's nice and stable contains about 90- to 95-percent gas. At 70-percent gas, this is a liquid system, it's wet.

Because of gravity, the gas tries to rise, the liquids try to separate. Foam is most stable at about 90 quality. So what we end up with is a layer of very high quality foam at the top with little if any sand in it, an intermediate layer that is basically of the composition that we're actually pumping in, and then a liquids-enriched and sand-enriched layer at the bottom.

So in the sand fracs, the simulator predicts that the sand is, in fact, primarily toward the bottom of the fracture. It shows little if any sand to be at the top of the fracture, for if the crack was formed, it was not propped open and would have very low, extremely low, conductivity, or ability to transmit liquids or gases.

On the other hand, then, we'll get the cases of fracture that was initiated in the coal itself. Remember that the lowest pressure that we saw at the end of a coal-stimulation treatment was 1050 p.s.i., much higher than that seen in the sandstone treatment. But it is perfectly consistent with the model predictions for that stress state. I had to do absolutely nothing to predict that shut-in pressure, other than to tell it the coal is a plastic and has this stress and this reservoir pressure.

Furthermore, we forced the simulator to allow the fracture to break out of the coal, to understand what the pressures would be if, in fact, it broke out of the coal --

out of the coal, into the sandstone, in the vicinity of the wellbore. It predicts shut-in pressures in the range of 700 to 800 p.s.i., much lower than what was observed.

So the first conclusion that we drew from that was, at least the simulator said, it's highly unlikely that these fractures grossly broke out of the coal in the area of the wellbore.

Nothing is always constant in coal. In 1993, when these wells were stimulated, there was adequate literature out that said that there is a certain probability that a fracture treatment started in coal can break out of the coal into the surrounding area, primarily the Pictured Cliffs sandstone, which had been studied the most. And I recounted some of Palmer's statistics of how often has this been measured? All that we can really draw from this is to say that there is a finite probability that somewhere a fracture initiated into the coal will actually break into the sandstone.

Now, what seems to be the driving force for whether or not it stays in the coal or breaks into the sandstone is the following:

The first question is, how can it stay in an area that's high-pressure? Mother Nature doesn't like to do that, likes to go to low-energy states if possible. The reason that it can is, we've got a very high pressure fluid inside a fracture in coal, but when it reaches that boundary, that boundary has very little strength, and it slips. So we're not translating the stress down to the adjacent rock. A practical example of that is a way to stop a crack in glass is to drill a hole in it, so that you don't have continuity in it. So we're not translating the pressure very effectively.

Now in Palmer's statistics, the sands being much lower stress than the coal and the shales being intermediate, as the distance between the sand and the coal gets closer and closer, there's a higher and higher probability that it will break out of the coal into the sandstone.

We know in this area that there are variations in the thickness of that shale, that upper shale between the bottom of the basal Fruitland Coal and the upper Pictured Cliff sandstone. Based on all of the work that we've done, it suggests that to honor the pressures that were observed in these treatments, that from a simulator standpoint we can't explain either sandstone fracs breaking into coal or coal fracs breaking into sand in the near-wellbore vicinity.

We were, however -- And remember, we've got two different cases here. You are at a much higher pressure in the coal than you are in the sandstone when you're actually fracturing. So if we're looking at the potential of a sand frac to go into coal, it must do so at a minimum 300 p.s.i. higher pressure, up to a maximum, just looking at these differences, of like 700 p.s.i. additional pressure required to break out of the sand up into the coal.

Conversely, you have the opposite case in the coal: You're from 300 to 700 p.s.i. higher pressure in the coal than you are in the sand.

Given the observation in this area that there is, in fact, a breach somewhere between the two separate reservoirs -- that is, the Pictured Cliff and the coal -- it's further clear that you can't just go through all of the data that exists and identify any singular wellbore where this magic communication occurred.

We propose that the logical explanation, which the simulator will agree with, is that the fracture that was formed in the coal at some point remote from the wellbore broke into the sand. And you can ask, what's your precedence of that? Well, at the time I did this I had none.

July the 20th, I was in a meeting in Bakersfield, California, in a totally unrelated rock type, the diatomite, but yet there were direct diagnostic measurements with downhole tiltmeters that showed a fracture that grew confined about 30 to 40 feet high, out some 200 feet from the wellbore, and then went right straight up.

So it is a plausible explanation that fractures don't necessarily break out zone. Because here it's not really the pressure, it's the potential that there is a change in the coal-rock contact. And we know that there are variations laterally in this area.

I was also asked to look at what the acid jobs might have done. The one I chose to look at was the Chaco 4, because it had the highest pressures during the acid treatment.

When we put the acid treatment as performed into the simulator, it says that it should take about 400 p.s.i. surface pressure, with that fluid at that rate, to grow -- to extend a fracture. And it said it should require about 200 p.s.i. to simply continue to dilate but not grow a fracture.

And in fact, that's basically what happened in the treatment. The breakdown pressure was something like 800 p.s.i. -- and these simulators do not model breakdown -- and then the pressures came down 400, 300. At the end of the acid stage it was about 200 p.s.i., and then it went on vacuum when the well was shut in. Perfectly consistent with what the simulator says it would take to generate a small fracture in the sandstone.

So my look at the acid job says it did, in fact, create a small fracture. And the exhibit -- I believe it is C-10 and C-11 -- proposes the simulator's geometry of a few feet, 15 or 20 feet of fracture geometry created by that injection.

As a conclusion to the work that we performed, I guess I could say that Whiting/Maralex knew in 1993 that there was a potential, a probability, that their coal-seam fracs could break out of zone. At that point they were not concerned about what it would do to the Pictured Cliffs sandstone, they were concerned about what it would do for their simulation treatment, and therefore judiciously -- Nothing I could see says they did anything to promote growth out of coal, because that's the last thing they wanted to do.

Now, I've proposed that these fracture links and this coal treatments are on the order of 1500 feet. And a lot of people will argue, Well, that's excessive, totally excessive. Unfortunately, the published -- There is no real published data about those kinds of frac links in coal.

There were extensive minebacks done in the Appalachian Basin by Consol that were never published, where they mined back many instances of perfectly contained 10-foot fractures in coal that extended from 1800 to 2200 feet long. None of that's ever been published. Those have been observed -- all of those -- Because it was in association with a coal mine, all of those fractures were mined back at some point in history. So there was a case where you had the pressure, you had the frac-treatment information and then got a chance to look at where that fracture went.

So it is highly plausible that you can have very long effective fracture links in coal. In this case, because of the length of the fracture, there's a large area on the order of, say, 1500 feet each way from the wellbore, that there's a possibility that there's enough change in the rock properties in the thick distance between the coal and the sand, that the treatment would go from the high-pressure area to the low-pressure area.

Therefore, based on the data that says there is unequivocal evidence of communication between the zone of the treatments that I looked at in detail, say the three treatments that I looked at in detail, one of them probably broke out of zone at some point remotely from the wellbore.

On the other hand, with respect to the Pictured Cliff treatments, there's no data anywhere that proposes that that's a major problem with Pictured Cliffs sandstone treatments, that they will break into coal.

The only published paper that I could find, related to Pictured Cliffs sandstone treatments and their problems, was published by Ray Johnson in this -- I don't know how close to this area, but in the Farmington area, where he discusses the problem of the fact that the coal -- that the PC fracs, want to go down. And they were trying to find, devise methods to minimize the downward growth of the fracture, because the better quality Pictured Cliffs sandstone tends to be at the top. So they were trying to explain Pictured Cliffs sandstone failures, not because the frac went up but because the frac went down, and the proppant ends up down below the zone of interest, and the fracture is not effective.

CHAIRMAN WROTENBERY: Mr. Hall, we're going on 25 minutes. Can we --

MR. HALL: Can you wrap it up, Mr. Conway?

CHAIRMAN WROTENBERY: -- wrap it up in a couple minutes?

THE WITNESS: That was what I was trying to do. That was basically the conclusion.

CHAIRMAN WROTENBERY: Okay.

Q. (By Mr. Hall) Does that conclude your statement?

A. That concludes my statement.

CHAIRMAN WROTENBERY: Do you want to deal with the exhibits, quickly?

Q. (By Mr. Hall) Mr. Conway, did you prepare certain exhibits in connection with your testimony here today?

A. Yes, I did.

Q. And were the exhibits prepared by you and at your direction and control?

A. Yes, sir.

MR. HALL: At this time we'd move the admission of Exhibits C-1 through C-17.

MR. GALLEGOS: No objection.

CHAIRMAN WROTENBERY: Okay, Exhibits C-1 through C-17 are admitted into the record.

Does Mr. Conway stand for questioning?

MR. HALL: He's ready for cross-examination.

CROSS-EXAMINATION

BY MR. GALLEGOS:

Q. Mr. Conway, when were you first put to work, if I may use that term -- when did you first start working on this assignment?

A. I don't remember precisely. It was well after the last hearings. So that would have been after what, last July?

Q. Well, was it this year?

A. It was -- My recollection is, it was late last year, early this year, initial discussions.

Q. No, but I mean as far as your actually having data and beginning to --

A. Oh, three months --

Q. -- do what I'd call a study of the --

A. The intense study, three months ago.

Q. And you say -- As you opened your statement you said that you lacked information, or there was a great deal more information you would like to have --

A. Yes, sir.

Q. -- something like that?

And what would that be? Give us some idea of what information it would be helpful to have that you do not have.

A. If this were a new project and somebody was asking me what information, at a minimum, I would like to have, I'd like to have a dipole sonic in at least one of the wells, dipole sonic log, and I would like to have a water-injection-falloff test conducted prior to the treatment, to examine and model.

Q. Anything else?

A. Well, I can -- I'm specifying that is the minimum that I would like to have. Certainly you can go to the extremes, which we hardly ever have, of saying we'd like to explore the possibility of doing *in situ* stress tests, and I don't just want to say microfracs and that sort of thing, because there's a certain -- those are not -- there's an engineering uncertainty in all answers. But yes, if you had your druthers, certainly, you'd like to explore those cases, yes, of what is the pressure to initiate a fracture in different zones?

Q. It was a given as you approached this study that there is communication between the Fruitland Coal formation and the Pictured Cliffs formation in the area of interest?

A. Yes, sir.

Q. And it was understood by you that your clients contended that their fracture treatments of the Pictured Cliff wells were not involved?

A. Yes, sir.

Q. If I took my notes correctly, you said the hard and fast data that you did have consisted of three things: one, the literature, the area; two, the treating pressures; and three, the production histories.

A. And reservoir pressure.

Q. And reservoir pressure, okay, those four things. All right.

And from reading your testimony I take it that the literature that you primarily relied on were the articles by Mr. Palmer and Mr. Johnson?

A. Yes, sir.

Q. Particularly I think there's three or four articles of Ian Palmer that you cited?

A. Yes, sir.

Q. Okay. The treating pressures you obtained from the various service company treatment reports?

A. Yes, sir.

Q. And the production history, where did you obtain that information?

A. Basically, I relied on data that had been collected by other participants in this case, so I would have to leave that to their source. Probably primarily *Dwight's* or operator records.

Q. Okay, and the reservoir pressure, what was the source of that information?

A. The reservoir pressure information in the Chaco wells were based on the pressures that were measured around the time of the stimulation treatments. I used 150 p.s.i. for the Pictured Cliffs. The coal wells were not --

Q. As a what? 150 p.s.i. -- You're talking about a bottomhole, surface shut in?

A. Bottomhole. Bottomhole pressure. Reservoir pressure, average reservoir pressure.

Q. All right.

A. For the coals, since they were just beginning to really be dewatered at the remote locations of the stimulation treatments relative to the Pictured Cliff treatments, we used the 250 p.s.i. initial reservoir pressure as the pressure in the coal.

Q. Now, let me see if I understand so we're sure we're talking about the same thing. So when you use the 250, you're using that as the reservoir pressure in 1993, at or about the time that the Whiting Federal wells, Gallegos federal wells, were fractured?

A. Yes, sir.

Q. And you're using 150 bottomhole reservoir pressure in 1995, at or about the time the Chaco wells were fractured?

A. Yes, sir.

Q. All right, across the board?

A. Yes, sir.

Q. And we should understand that when you say the last thing that Maralex wanted to do was to have its fracture treatments go down to the Pictured Cliffs, the reason would be that it would not want to be losing gas to that lower-pressure depleted reservoir, correct?

A. Well, you've added a lot of adjectives there. Let me just state an answer and see if you disagree with me.

By their interpretation of the status of the Pictured Cliffs, one answer could be no, they didn't want to frac into what they believed to be depleted.

But more importantly, that would compromise the length of the treatment in the coal itself. So regardless of the status of the Pictured Cliffs, they don't want to break out of the coal, they want to stay in the coal.

Q. The first issue that you state -- You sort of start out your paper by saying, Here I'm going to address four issues. And the first issue you stated at page 2 is whether the Pictured Cliffs stimulations could have breached the barrier between the Pictured Cliff and Fruitland Coal and created a conducive pathway between the two sources of supply?

A. Yes, sir.

Q. All right. The answer to that, it would appear, we might find from your Exhibit 7, where you did a fracture-stimulation on one of the coal wells?

A. Yes, sir.

Q. Is that correct?

A. We're saying 7?

Q. I'm sorry, I misstated, I said on the coal wells. I meant on the PC wells.

A. PC wells, yes, sir.

Q. Exhibit 7.

A. Yes, sir.

Q. Okay, do you have that before you?

A. Yes, sir.

Q. And the question is, did the fractures created in the Chaco wells breach the barrier between the Pictured Cliffs and the main Fruitland Coal?

A. Did they breach the barrier? My conclusion from this was no.

Q. Your conclusion is that the fracture-stimulation did not breach the barrier between the Pictured Cliffs and the Fruitland Coal?

A. And the basal Fruitland Coal, yes, sir.

Q. And the barrier being the shale layers. Is that what the barrier is?

A. The barrier, yes, would have to be the shale. So --

Q. The answer is yes, it breached the barrier, isn't it, Mr. Conway?

A. The answer is, the simulator predicts that there is a crack in the coal -- in the shale itself, yes.

Q. The simulator, your own simulation, shows that the answer to the question you posited is yes, it breached the barrier between the Pictured Cliffs and the coal; isn't that true?

A. The answer is, yes, the properties that I ascribed to the coal -- to the shale, were no special -- that it did create a small fracture in the shale.

Q. And you never discussed that further in the paper, and you never did tell us what the answer is to issue number one until right now, did you?

A. I discussed the fact that it did not penetrate into the coal.

Q. Okay, but it breached the barrier between the Pictured Cliffs and the coal? That's what your simulation shows?

A. It shows that we did create a crack in the shale, yes.

Q. Let's take a little closer look at what you have here. This simulation on Exhibit C-7 is addressing Chaco Well 2-R, correct?

A. Yes, sir.

Q. All right. Where are the perforations in Chaco Well 2-R?

A. The perforations are shown as that X on the figure.

Q. Well, give us a footage. Give us a footage from your data as to where the perforations are, and then we'll talk about the X.

A. Slightly above 1160 -- I don't have the precise footage here, but it's slightly above 1160 feet.

Q. The perforations in the 2-R, by the records that we have in this case, are from 1132 to 1142. But you do not have them placed correctly, do you, Mr. Conway?

A. You've got a letter that you wrote to Mr. Hall back in July where you have all the perforations set out on these wells. Do you have a copy of your letter? That's a handy reference.

A. Yes, I do.

Q. 1132 to 1142 on the 2-R.

A. You are correct on that, 1132 to 1142.

Q. So your perforations are off about 15 feet, aren't they?

A. And somehow I've got my depths misplaced.

Q. Just for the -- to help us out for the record here, I've put up on display this Walt Ayers cross-section, WA-3, and it has the Chaco wells so Mr. Conway can refer to it. Let me help you. Here's the 2-R, right there.

A. I'm looking for the depth track.

Q. Here. See, here's 1100.

A. I'm making sure that I did not mis-mark that X when I...

Q. Are you ready to go on, or are you still --

A. It will take me just one second to get to the perforation. Okay, not to hide any -- As you can see, I'm --

Q. Yeah, I'm trying to look over your shoulder. It seemed like you were busy here.

A. Well, here we can see the depths, right here, that this pointer is pointing at. So there's where the perforation was. So it's 1130 to 1140.

Q. Okay.

A. Now, I -- Somehow when --

MR. CONDON: Just for the record, if we could just make sure for the Commissioners' benefit that what he's doing over there on his computer is reflected in the record so that they know what you're referring to.

THE WITNESS: What I did was pull up the design file that was used to conduct the simulation, to confirm the depths on the depth tract.

The perforations marked in the simulation were that grid node between 1140 and 1150. Now, how when I made that report I got the depths off, I'm not sure.

Q. (By Mr. Gallegos) Okay, so your -- What you used for the perforations was off in depth, overstated the depth, or deeper than the actual perforations by 15 or 20 feet?

A. According to the depth tracks on that.

Q. Okay. Now, of all the four Chaco wells that were fracture-stimulated by Pendragon, you selected the 2-R, which is the only one of the three wells in which the perforations are below the top of the massive Pictured Cliff formation, as opposed to the others that have perforations up above the lower coal; isn't that true?

A. Yes, sir.

Q. And as Exhibit JTB-16 shows, the Chaco 2-R was by far the lesser of the four fracture-stimulated wells that showed a gas uplift after the rework by Pendragon?

A. By these cums through these dates, yes, sir.

Q. Well, and you looked at production history, didn't you say, as you entered into your study here?

A. Yes, sir.

Q. So you saw these production histories and decided you'd use the Chaco 2-R?

A. The selection of the Chaco 2-R is one to do -- the primary study is based on the fact that all of the evidence purported that it did not break into the coal. If the simulator can't get that right, then we have no chance of looking at the others.

And we did look at the other treatments. The answers are all the same. The simulator says that there can be a crack in the shales, there are not growth of fractures predicted into the massive body of the basal coal.

Q. Let me see if I understand what you just said. You're telling the Commission that because the evidence as you understood it indicated that the stimulation of the 2-R did not break into the coal, you selected that and illustrated this as Exhibit C to show that it did not break into the Coal?

A. Yes, sir.

Q. Let's see if we can get some basic understanding, because we're going to be looking at your stimulation illustrations, if we could use that term, as exemplified by Exhibit 7, and have some explanation.

You have a column on the right?

A. Yes, sir.

Q. Called "Interval"?

A. Yes, sir.

Q. Would you explain the column so we start having an understanding of your colors and what that means?

A. When you came over here and looked, that is a pasted picture out of the simulator that you saw when you looked at the screen here, and I simply copied that and pasted it over this report.

Q. All right, but would you answer my question, how do --

A. What the colors mean?

Q. Yes.

A. Black represents coal. And remember, I am constrained here to defining intervals based on the prominent lithology over a given area. So we've represented the coal in black. Silty materials are in whatever color you want to call that, olive, green. I don't know quite what color it printed.

Q. Sort of a yellowish --

A. Yeah.

Q. That's silty?

A. Yes. The -- Yes, sir. Yes, sir.

All right, the black is coal, the yellowish color is silty material. The red represents sandstone, and in this rendition the light gray would be shale.

Q. By "this rendition", do you mean if we see these interval columns on some of your other exhibits we can't assume that those same colors mean the same thing?

A. Well, on this it's clearly gray. On that it's a gray -- it's gray. It is gray, the shales are gray.

Q. All right. So the coal seam that we see on the cross-section that I put up here to help us, that thinner coal that's at about 1126 to 1129 or so, that doesn't show up on your column here?

A. No, sir, based on information that was given to me, that the thickness of that was very, very thin, I did not put it in as a separate lithological unit.

Q. So you ignore the coal that, if it were put in, would be right above the red that's slightly above 1160 there?

A. On 10-foot nodes I couldn't honor a one-foot coal as representing the average lithology there.

Q. Well, I don't think it's one foot, but anyway you

have to have a 10-foot interval in order to recognize it?
A. In the node size that is done in this simulation which says there is ten feet, so yes, ten feet.
Q. Okay.
A. Everything is averaged over ten feet.
Q. I see, all right. And then this color spectrum at the bottom doesn't have any explanation, but just trying to figure it out, does this tell us fracture width? You know, where you go from white to light green to finally dark red?
A. Yes, sir, the title is "Fracture Width", and then the scale relates to fracture width in inches.
Q. Okay, in the title up there.
So when we look, then, when we see your simulation of the fracture that starts out over here at the left hand and goes down in depth, those different colors tell us what the simulator, what GOHFER thinks the width of the fractures are?
A. Yes, sir.
Q. What is the shale thickness between the Pictured Cliffs and the coal that you used?
A. Twenty feet.
Q. And we should understand that that's the barrier that you referred to when you stated this issue of whether or not the Pendragon fracture breached the barrier?

A. Yes, sir, and I realize that -- as I'm looking at this -- Well, we'll get to that in a minute. Go ahead, restate your question, please, sir.

Q. My question was, to get back to this issue that you posited to begin with, did it breach the barrier? And you're talking about that 20-foot --

A. Yes, sir.

Q. -- interval, that's the barrier?

A. Yes, sir.

Q. Part of which is actually coal, and part of which, at least according to Mr. Nicol, is sandstone, the Pictured Cliff sandstone up there, not shale. Isn't that his testimony?

A. Without having the gamma-ray log in front of me, I'm sorry, I can't answer that in detail.

Q. Were you here yesterday to hear the testimony in this case?

A. Yes, sir.

Q. All right.

A. But I wasn't in a position to see the log exhibit.

Q. Okay, so the barrier didn't stop the fracture that you portrayed, even where you put the -- where you put the perforations, the barrier didn't stop Pendragon's fracture from growing to the base of the Fruitland Coal?

That's true, isn't it?

A. That is correct.

Q. Okay. When you ran this case -- And we'll talk more about the properties you've used here, but when you ran this case, what stress gradient did you use for the shale and what stress gradient did you use for the coal?

A. As I said, the Poisson's ratio used for the coal was .5, and --

Q. I wasn't talking about the Poisson's ratio, I was talking about the stress gradient.

A. The stress gradient is computed from the Poisson's ratio. I can answer that precisely in just a second.

If I go to total stress, which includes pore pressure and everything else, the total stress in the coal itself, at the bottom of the coal, was 1118 p.s.i.

Q. And per foot? Give that to me in p.s.i. per foot then, that depth. Here, I'll calculate it. What did you say the total stress was?

A. It's 1118 p.s.i. and 1115 feet, so that's 1 p.s.i. per foot.

Q. Pretty close. And for the shale?

A. The shale right under that at 1133 feet, I've got 808 p.s.i.

Q. Well, call it .80.

A. Point eight.

Q. Okay. did you run a case, assign a stress gradient of 1.0 p.s.i. per foot to the shale and .90 to the coal?

A. No, sir.

Q. You did not run that case?

A. No, sir.

Q. Without running it, you know if you did run it with those values, this fracture would have gone up into the coal; isn't that true?

A. No, sir, because there is another factor that very strongly influences the growth into a new area, and that is the ratio of the moduli of the two rocks.

The more dissimilar rocks are, the more likely -- The more dissimilar, the more unlikely it is that it will cross that boundary.

Q. Because you start getting some --

A. Because of --

Q. -- shear slippage?

A. And it's known even in metals. You can't put two different-moduli metals together and keep them from breaking at that junction.

Q. Well, I'm not asking that. I'm asking you, what's the --

A. So the physics are that --

A. He warned that they could be unreliable in that the absence of tracer might not necessarily reflect the absence of a fracture. He in no way addressed the case where the presence of -- If radioactivity was there, the fracture was there. He didn't address that as being a problem. He addressed the case where you don't see radioactivity in the potential, that that does not mean that there's a fracture there.

Q. Well, I was reading the SPE 21811 paper of Palmer's that you cited, and under the heading of "Proppant Tracer Observations" he states, and I'll quote:

> The method can only infer fracture height growth at the wellbore. The usual gamma-ray detectors have only a shallow field of view from the wellbore into the formation, a few inches at most. Furthermore, this means if the plane of the fracture is not exactly aligned with the wellbore the radioactive proppant may not be detected by the GR detector within a short distance above or below the coal.

Do you recall that --

A. Yes, sir.

Q. -- observation?

So based on that, is Palmer one of the skeptics you refer to in your testimony, skeptics about whether tracer surveys are reliable?

A. No, he simply said that if the fracture is not aligned with the wellbore, you could have growth out of the coal that would not be detected.

Q. Okay. Let's turn to the properties that you used, rock properties and stress gradients and fracture gradients and various what I'd call parameters that were used in your studies.

Varying the parameters can, of course, vary the results of your simulations; do you agree with that, Mr. Conway?

A. Yes, sir.

Q. It can make a big difference as to whether or not the GOHFER or any other simulator predicts that the fracture stays in zone or does not stay in zone?

A. Yes, sir.

Q. All right. Let me -- To help all of us focus on some of those, I've got a copy here, just to make it more convenient, of your Table 1. I think it is page 11 of your testimony.

A. Yes, sir.

Q. And that gives us some information on the rock properties that you used?

A. Yes, sir.

Q. All right. And then I think the other source we would have that gives us some information on the variables that you used would be your Exhibit Number C-4?

A. Yes, sir.

Q. It might be a good idea if we take that out and look at that.

All right. Now, in your paper, before we get into what you used, there's several references in your papers to Palmer. And you say -- there's a quote in there, you say that Palmer has meticulously examined a large number of treatments and attempted to characterize the expected results.

A. Yes, sir.

Q. And his work was -- a large bit of his work was done in the San Juan Basin, correct?

A. That's in these papers, yes, sir.

Q. Mr. Palmer was a geologist with Amoco?

A. He is a physicist.

Q. A physicist?

A. Yes, sir.

Q. All right. Amoco was one of the -- probably was the earliest company to drill, complete, produce and experiment with Fruitland coalbed wells in the San Juan Basin; you're aware of that, are you not?

A. Yes, sir.

Q. And his papers supply rock properties and stress gradients for the Fruitland Coal, for the Pictured Cliffs and for the shale in the San Juan Basin?

A. Yes, sir.

Q. But you did not use Mr. Palmer's properties and gradients, did you? If you just answer the question yes or no, and then you can explain, but --

A. The answer is no, I did not use those.

Q. All right.

A. And if you look in the details of the paper, those gradients, those properties are for coals and sands at 3000 feet. Ian does discuss in there -- First, I've spent many hours discussing and debating these issues with him. He does discuss what happens as you move to shallower depths, and he specifically cites that above 1500 feet, that the gradient for the Pictured Cliff ranges from .8 to 1.

Q. The gradient -- At a shallow depth, the gradient for the Pictured Cliffs becomes much higher --

A. Okay --

Q. -- right?

A. -- but the same way, the stresses arise because of the basic rock properties. If the stress changes, the rock properties change. And I related that we've just been involved in making those measurements.

At 1000 foot of depth, for the -- at 1000 foot of depth for the coal, we're at 1000 p.s.i. stress. At 3000 foot, we're at 3000 p.s.i. You do not get the same measured property at 1000 p.s.i. confining stress that you do at 3000. So I depth-adjusted his proposed data, based on measurements that we've made on rocks in general.

Q. Well, you have the Johnson papers and the Palmer studies. Johnson was dealing with wells with depths of 4000, 4500, Palmer 3000, 2500. And as far as Young's modulus functions, there was no change, that they saw no change. They have a coal-to-sandstone difference factor of 10, no matter what the depth was, isn't that correct?

A. It tends to be a factor of 10, yes, sir.

Q. But you used a factor of 5, didn't you? You can look at it right here, and what I've just handed out, between the coal and the sandstone you use a factor of 5?

A. I could just as well have used a modulus of -- In this study, yes, that's what I used.

Q. All right. Well, we'll talk about what you just as well could have used in a few minutes.

But in spite of those factors at varying depths, Palmer and Johnson, you used 5 versus their 10, as Young's modulus, all right?

Your Poisson's ratio of 0.50 is the highest theoretical ratio that can be assigned to anything?

A. Yes, sir.

Q. Correct? Rubber, steel -- I mean, that's the highest ratio you can assign --

A. Rubber.

Q. Yes.

A. Rubber, not steel.

Q. Okay. If you did not use the Poisson's ratio of .050 [*sic*], you would not achieve the results you did in your simulations, would you?

A. They would have been different. I can't say how different. They would have been different, yes, sir.

Q. Well, you had to use that ratio to get the results that you did, let me put it that way.

A. I have to use that ratio to get the pressures that we observed, because the shut-in pressure with that ratio, which says that the overburden is translated into horizontal stress, gives the shut-in pressures that we observed.

Q. With the other variables that you use --

A. Yes, sir.

Q. -- to get your match. We'll talk --

A. The stress -- Poisson's ratio determines the stress.

Q. All right. You indicated -- I just caught a bit of your testimony, I wanted to come back to it. You're talking about, we just studied thee properties at lower depths?

A. At lower -- lower stresses in general.

Q. Well, I got -- I thought there was something you said, you have just done a recent study on this, something different than what's in the literature?

A. Well, I'm saying we have been involved recently in what happens to the properties as you go from -- on the low stress range, as you go from 1000 p.s.i. to, say, 3000 p.s.i. confining stress on the samples in the laboratory, what happens to the properties --

Q. In the laboratory, that's what I was trying -- Yeah, when you gave an answer, it had two or three points of interest, and I wanted to try and come back to that. Sorry I'm a little vague about this. Something that you've been doing in the laboratory --

A. Yes, sir.

Q. -- at Stim-Lab.

A. Yes, sir.

Q. Well, could you share that with the Commission?

A. I can share with the Commission that the --

Q. No, I mean your reports or the actual data.

A. No, sir, those are proprietary to clients.

Q. Was it on the Fruitland Coal and the Pictured Cliffs in the San Juan Basin?

A. No, I didn't imply that. We're talking here about purely a sandstone, and I implied that I have made personal measurements of sandstone, and the Young's modulus decreases as the stress on the sample decreases. That's all I intend to imply.

Q. Okay, so we're clear, your laboratory has made no measures on the values of the Fruitland Coal or the Pictured Cliffs sandstone that we're dealing with?

A. I'm not implying -- No, we have not made those measurements --

Q. All right.

A. -- on those units, no.

Q. Okay. The stress gradients on Exhibit C-4 would have to be calculated? I mean, they're not set out here? Am I right? With what you've got here, we could make a calculation?

A. Yes, sir.

Q. All right. Now, let's go to the coal, because I thought just -- if I read C-4 correctly, you've got a stress in -- stated in p.s.i. of the coal. That's the very far right-hand line that runs out there?

A. Yes, sir.

Q. I'd read that at maybe 1320 or something like that?

A. Yes, sir.

Q. 1320 p.s.i. at 1150 feet?
A. Yes, sir.
Q. I didn't take a note on it, but just a few minutes ago I thought, when I asked you how you calculated, you said you used 1100 p.s.i.
A. In the testimony that -- in the written testimony, I demonstrate the difference between an overburden gradient, which is normally assumed to be 1 p.s.i. per foot, and what happens with an overburden gradient of 1.1 p.s.i. per foot, which is usually what you get if you actually integrate the density log from the surface to the depth in question. And I explored in there exactly what difference it makes, those two numbers, using 1.1 and 1.

In this particular thing I'm using 1.1, and it is described in the exhibits and in the written testimony what the effect was by making those different assumptions. Both of those cases are shown.
Q. All right. And if I calculate from C-4 1320 p.s.i., divided by 1150 feet, that would be about 1.15?
A. Remember, the equation -- You have to go back to the fundamentals. The fundamentals are that the stress at a given depth is the overburden weight times Poisson's ratio, over one minus Poisson's ratio, and it's overburden stress minus pore pressure times that ratio, Poisson's

ratio over one minus Poisson's ratio, then plus pore pressure again.

Q. Well, I'm not sure I followed, but there's a simple way to just calculate what you show as stress and divide by depth and get your stress gradient, isn't there?

A. Yes, sir, and I'm --

Q. When I do the division, I get 1.15, and my question is simply, is that what you used?

A. The overburden gradient that I used was 1.1 in this figure.

Q. Well, I'm talking stress gradient for the coal.

A. I did not put in a stress gradient, I put in the properties of the coal and computed the stress gradient.

Q. Okay, and what did you get? That's the 1.1?

A. I'm not sure from looking at this graph that I can precisely say that I can tell the difference between those -- the scale. It should have given very close to 1.1.

Q. All right. Well, this exhibit is entitled "Total Stress used in Fruitland Coal Simulation", and I'm trying to find out, since you don't set it out here, I'm trying to find out what you actually used as your stress gradient. So we'll understand 1.1 for the coal?

A. Yes, sir.

Q. All right.

A. Closure stress gradient.

Q. All right. Sort of synonymous, closure stress, stress gradient. The terms are kind of used interchangeably, aren't they?

A. We've got to be real careful, because the only data we've got is final shut-in pressure gradient, which is not closure stress gradient. So I'm just trying to make sure we understand, that's closure stress gradient.

Q. All right, which means what? Explain.

A. Which means that that is the point when there's no longer open fracture.

Q. You're not making a fracture anymore, it just --

A. More than is -- That is the pressure at which the fracture is closed.

Q. After having been opened?

A. After having been opened, yes, sir.

Q. All right. For the shale, your gray stuff here, the -- or your dark gray. You've got a light gray. Dark gray. At a little bit above 1200 feet it looks like it comes out, I read that as maybe about 900, 920 p.s.i.?

A. Yes, sir.

Q. And if that's 1185 feet, which is the closest I could figure -- we don't have it exactly here -- that's a stress gradient of .77 for the shale?

A. In that range, yes, sir.

Q. That's about what you used?
A. Again, it's computed. The Poisson's ratio used was .346, and the stress is computed from Poisson's ratio.
Q. And the sandstone, the red material here, at -- well, 1200 about, maybe 1175 feet, that's at 600. Your zig-zag blue line goes right up there next to it at 600 --
A. Yes, sir.
Q. -- p.s.i. So that's a stress gradient of only 0.5?
A. Yes, sir. 0.5-something, but...
Q. So let's see, maybe we can -- Do you have what Palmer -- what gradients Palmer used? Maybe you can put them --
A. Do you have a copy of his paper handy?
Q. Yeah, I've got it handy here.
A. I've got it back there, but it would take me a moment to find it.
Q. I can remember the coal. You used 1.1, Palmer uses .090. Shale, you use 0.77; Palmer uses 1.0. PC, I think you're pretty close, five-O, and I think Palmer's about five, wasn't it?
A. He ranged from .45 to .6.
Q. Depends, but as it got shallower, actually he -- what Palmer says, .50 to nearing -- he doesn't say one, but let's say -- do the engineer thing. He says as it gets

shallower, PC goes up to approaching 1.0, correct?

A. (Nods) Now, have you asked me a question here related to these numbers?

Q. No, I just wanted to establish that here's the Palmer who you cite very frequently, here's the stress gradients that he uses for these different zones, and here's the gradients that you use. So that -- So we have that out for the Commission. Because you said the variables you put into the simulator make a difference in what the results are?

A. Yes, sir.

Q. Now, let's take a look at your Poisson's ratio that you used, because I think, if I can find that here, some of the literature has some pretty good -- I think Bell and Jones, there's an article. I don't know if you cited that or not, but are you familiar with their work where they actually do some testing in various producing provinces, including the San Juan Basin, to get a Poisson's ratio for the coal?

A. Yes, I'm aware of Arfon and Greg's work, and one of the things that we must do is realize that when we started this discussion we involved in both -- the role of geologic time.

The principle of Poisson's ratio is to compute the *in situ* stress which occurs over geologic time. One of the biggest problems with all of the rocks that we quoted in this study as being plastic rocks, you will never measure .5 on that sample. Coal, you will not measure .5 in the laboratory in the short term for Poisson's ratio on marble, you will not measure it on anhydrite. You will measure a Poisson's ratio significantly lower for all of those samples in the laboratory in the short term.

Q. So in the real world, when you try and deal with the coal, you don't get a Poisson's ratio of .50; only when you theorize it?

A. And relate first principles to the observed stresses, yes, sir.

Q. Well --

A. We can address the same issue here. You realize when you write down a -- Ian and I have had many discussions about this. When you say that the stress gradient in the shale is 1 p.s.i. per foot, you're basically saying that that shale is behaving as a plastic with a Poisson's ratio in excess of .5 -- .45 over geologic time.

Had I used a bigger stress -- a bigger Poisson's ratio in the shales themselves, I would have shown again that I wouldn't even break into those shales at all. I tried to use values --

Q. It would have been a contained fracture?

A. It would have been much more contained.

Q. Okay. Let's look at what we do have for people who've actually made the experiments, and this is a copy of the Bell and Jones paper, and Figure 1 --

MR. CONDON: Is that just for the Commission, could you identify where that is? Is it one of his exhibits?

MR. GALLEGOS: No --

MR. CONDON: Oh, okay.

MR. GALLEGOS: -- this is --

MR. CONDON: Do we have copies?

MR. HALL: What is this? Is this a new exhibit?

MR. GALLEGOS: No, this is literature that I'm going to cross-examine an expert on, literature on a subject which he's testifying about.

COMMISSIONER LEE: Can I take a look?

MR. HALL: Well, what is the source of the literature? Is it an exhibit from Mr. Robinson, his group of exhibits? Could you tell us?

MR. GALLEGOS: It is a paper, I'll identify it.

Madame Chairman, there is no rule of evidence that says you have to have something as an exhibit when you're talking about an expert witness and he's on a subject and you're cross-examining him on the literature in that area. I don't understand what the discussion is even about here.

MR. HALL: Well, under the scheduling order --

MR. GALLEGOS: This is not an exhibit, this is literature in the field of expertise this man is talking about, and I'm going to cross-examine him on it. If he doesn't know about something such as this, then he can say it. He's already said that he's familiar with this work.

MR. HALL: Well, if it's the same thing, it's a way of introducing new evidence contrary to the understanding under the scheduling order. I would object. It wasn't included in --

MR. GALLEGOS: It doesn't have to be.

MR. HALL: Excuse me, it wasn't included in Mr. Conway's exhibits. It's not proper for him to try to introduce a new exhibit this way.

MR. GALLEGOS: I'm not introducing it as an exhibit, I'm not making it an exhibit.

CHAIRMAN WROTENBERY: Just a second.

(Off the record)

MR. HALL: Madame Chairman, may I make a comment?

CHAIRMAN WROTENBERY: Uh-huh.

MR. HALL: If we could have some clarification from Mr. Gallegos, the purpose of the examination on this material. If it's in the form that he's asking Mr. Conway to assume certain facts or assume certain materials in the article, and it's contained within the body of scientific literature, I think Mr. Conway can be examined on that.

But I would object to the introduction of this as an additional exhibit. I think it would be contrary, if he seeks to introduce the article itself now. But if he's simply asking him to assume or make some of the same assumptions that the author did, I think that's allowable.

CHAIRMAN WROTENBERY: Mr. Gallegos?

MR. GALLEGOS: I'm not asking him to assume anything. He testified that the only hard and fast data he had were four things. One of them was his search of the literature.

This is literature, a subject on which he's testified. It is universally accepted in any court, and under the rules of evidence that you can cross-examine an expert in the field on the literature in that field, and it doesn't have to be made an exhibit, it wouldn't be made an exhibit, never would be made an exhibit. The rules of evidence accommodate this totally.

I don't even understand why we have an objection. I'm not offering it as an exhibit. As an exhibit, it's hearsay. But you can certainly cross-examine a witness who purports to have said that he knows the subject and he's studied the literature, on literature that's directly related to what he's talking about.

MR. HALL: I think it would be proper if Mr. Gallegos were to provide the witness with a full copy of whatever the piece of literature is, as well as counsel and the Commission.

MR. GALLEGOS: Well, I think it might be proper, if you think that's proper, I happen to have two copies, and I've provided one to Mr. Conway.

CHAIRMAN WROTENBERY: I think what we'll do right now is just take about a ten-minute break and then start back up at about ten after ten.

(Thereupon, a recess was taken at 9:59 a.m.)

(The following proceedings had at 10:28 a.m.)

CHAIRMAN WROTENBERY: We're back on the record.

We just wanted to have a brief discussion here before we get started again with Mr. Conway about how we're going to handle a couple of issues, one of them being additional exhibits that come in, either through -- in the form of -- or as part of rebuttal testimony, on the one hand, or even in the context of the cross-examination of one of the witnesses.

Unfortunately, this was not one of the issues that we addressed in the prehearing order, and so we're needing to try to resolve some of the questions that have come up.

Because we didn't address it, and because I think we feel like everybody should have an opportunity to put on a rebuttal testimony and accompanying exhibits, I think we should allow for that kind of additional evidence during the course of this particular hearing. And in fact, we've already done that yesterday. We had a couple of additional exhibits that came in.

MR. HALL: In the form of rebuttal exhibits.

CHAIRMAN WROTENBERY: In the form of rebuttal exhibits.

MR. HALL: I understand.

CHAIRMAN WROTENBERY: Yeah. So I don't know that there's any reason not to continue that practice through the rest of the hearing.

I also think that there will be occasion where in the process of cross-examination there may be a need to present and discuss additional exhibits, and we'll have to consider those, I think, one by one to determine if they are indeed admissible. But we will continue to address those one by one.

Do we need to say anything more on -- as far as general ground rules?

MS. HEBERT: I think that covers it.

CHAIRMAN WROTENBERY: Okay. Anybody have any questions about that?

Then we need to get back to this particular question that has come up in the context of the cross-examination of Mr. Conway.

MR. HALL: I don't object to the examination on this material that we just discussed.

CHAIRMAN WROTENBERY: Okay, so you have withdrawn your objections. Then we can go forward. Okay, thank you.

Q. (By Mr. Gallegos) Before we go back to the Bell and James [*sic*] article, Mr. Conway, I have made an abstract of a portion of your testimony, page 17, and handed that to the Commissioners and to you. And so the record will have it, I'm going to read it, and it is a quote that follows:

> Any expert in this area must be allowed to vary the necessary parameters, based on their experience to explain what has happened. However, the Commission is due the clear identification of the key factors used to make any calculations of geometry. With the identification of the key parameters used to simulate the reservoir conditions, the validity of one scenario will become obvious compared to other alternative fracture geometries.

Is that an accurate quote from your testimony?

A. Yes, sir.

Q. So that's what we're trying to examine here, is the parameters. Because as they vary, it will vary the fracture geometry?

A. Yes, sir.

Q. Okay. And so back to the Bell and James article, I simply wanted to refer you to their study of the mechanical strength of different rocks. And in the case of Figure 1, they demonstrate the Poisson's ratio that they obtained on their experiments with coal. And you're familiar with this work, I would --

A. Yes, sir.

Q. -- imagine, are you not?

A. Very much so.

Q. All right. And where they list Cretaceous rock and show it on this figure for calculating the Poisson's ratio, the little -- what I call a vertical rectangle, Cretaceous coal, those are samples from the San Juan Basin Fruitland Coal formation, are they not?

A. You've obviously read this recently, so I'll accept your statement.

Q. All right. I think that -- You check it, but I represent to you --

A. I will.

Q. -- that's the case.

And of the samples, would you agree that the range of the Poisson's ratio for the coal that they found varied from -- oh, I don't know, .23 to one sample that's past .4?

A. Yes, sir.

Q. So of all the samples -- and I think I counted 13, one sample was greater than 0.4, and 13 samples were -- the rest were below 0.4?

A. Yes, sir.

Q. Okay. And just to place this in context, the Poisson's ratio you used is 0.50?

A. Yes, and can I explain that?

Q. Well, I think you have, but if you'd like to again --

A. I would like to again.

Q. Okay.

A. This article was published in 1989, which was the year we got our Gas Research Institute contract to study the factors affecting coalbed methane stimulation treatments.

When I started looking at this work, if, in fact, first principles apply, that is, the stress state in the reservoir depends upon the mechanical properties of the rock, the mech- -- people who specialize in rock mechanics, who certainly Arfon Jones is one of the world-renowned rock mechanicists -- there are equations to calculate the *in* *situ* stress.

With these low values, coal would have a fracture gradient on the order of .6. That was the problem that I started with when we were trying to understand coal stimulation. You measured it in the lab, it said the frac gradient ought to be low, and you go out there and pump the treatment, and the frac gradient is twice that or more.

So the five years that I said I spent trying to understand coal stimulation was based on the fact that the measured data that we measured did not explain what happened in the field when you did a coal stimulation treatment.

I've made these measurements myself. Yes, I go to the laboratory with a piece of Fruitland Coal, and I will get numbers measured like this. And I have done the test every way I know how, because that doesn't agree with field results.

So it has to do with time. That's what we determined was the central missing feature, is geologic time is a long time, and plastic creep, which is the technical term for this, plastic creep, occurs over geologic time. And therefore the Poisson's ratio, the effective Poisson's ratio, is that of a plastic that has creeped over time. You won't measure it in one day in the laboratory, you won't measure it in a week. So...

Q. All right, let's examine that, see if we can find an answer to this dilemma, because with this dilemma of what you see and do in the lab and what you see on pumping a fracture-treatment site, that doesn't match up, so you're going to use the highest theoretical Poisson's ratio possible. All right? That's where we are in your testimony?

A. Yes, sir.

Q. All right. Now, when you pump a fracture in sandstone, you would expect that you get a nice single fracture going out from the wellbore, correct?

A. Yes, sir.

Q. All right, by the nature of the rock? Your answer is yes?

A. In a nice, homogeneous, well-behaved sandstone, yes, sir.

Q. All right. Now, coal -- Coal is a very different material in which there are already natural fractures or what -- miners' terms, I think you use cleats? Cleating. So you already have this system of various fracs or cleats that naturally occur in the coal. You're aware of that?

A. Yes, sir.

Q. Okay. But when you start pumping fluids to do a hydraulic fracture-stimulation into the coal, you're not getting a nice linear, single fracture as you would in the sandstone, hypothesize, but multiple fractures going -- some turning at angles, and a multitude of fractures. Isn't that what happens?

A. In some coals, yes, that is exactly what happens. In others, they have been mined out singular, very nice fractures. So nothing is always.

Q. Well, but the literature -- And we're not talking about something that nobody has ever studied. The literature says that you expect that's what's going to happen in the coal, is a multiple-fracture system, because of its natural cleating. Correct? And that takes much more energy to propagate those fractures, even though the Poisson's ratio would be probably what you see by the laboratory experiments.

Do you dispute that?

A. Now you're bringing up the issue that is not resolved in our industry, and that is, what is the role of multiple fractures in creating an increased pressure required to create a fracture?

If we go back to the laboratory and try to generate multiple fractures as are being described as what goes on in coal, you can't do it. Mother Nature says, I will pick the lowest path energy possible and available to me to create a fracture.

So yes, that is a common hypothesis in the industry, that multiple fractures result in high stimulation treating pressures. Yet when you go to the laboratory, you can't reproduce that at all.

Now, I'm not saying it doesn't happen, and it's not a cause or a potential cause of the high pressure. I'm just saying that we have found an alternative explanation for the high pressures in coal which we believe to be sound. And that's what I published, was the results of that, to say this is our belief.

Q. And Mr. Palmer's belief in his paper SPE 8993 that you cite, he believes that the answer is because there's multiple fractures formed in the coal, and in fact has figures that illustrate that?

A. He and I have spent many hours arguing those points.

Q. All right, we don't know who's right?

A. And we -- You're absolutely correct.

Q. Still talking about your parameters, because of the importance that they have as to the outcome of your simulations, I read at your testimony at page 15 that you state that the stress in the coal is 400 p.s.i. higher than in the Pictured Cliffs sand. Do you find that?

A. On page --

Q. Page 15?

A. Yes, sir.

Q. Okay. But when we go over -- and we've already looked at your Exhibit C-4, which is entitled "Total Stress used in Fruitland Coal Simulation", you've got a difference, a stress difference, 1320 minus 600, that's over 700 p.s.i., 720, 750 p.s.i. difference. And of course, that's going to make a difference in your simulation; isn't that right?

A. Yes, sir. I apologize for the unclarity here. I think I was relating to the field-measured differences between the two and implying that from the field measurements we see on the order of 400 in that closure gradient, and that was probably judicious license to -- because -- If I go by these numbers, I simply quote a larger difference.

Q. Well, you use the larger difference. You use the 720.

A. Yes, sir, in the simulation, yes.

Q. Okay, which is to say, to put it in context -- which is to say, a fracture coming out of the Pictured Cliff, to go into the coal, has to exert a difference in stress not of 400 p.s.i. but over 700 p.s.i. if you follow the parameters that you put into your GOHFER simulation?

A. Okay, yes, sir.

Q. Now again, Mr. Palmer's same paper, 8993, he says that a -- if a shale is bounding the coal, the fracture --

the shale bounding the coal confines the fracture to the coal, but that a fracture in the shale is attracted to the coal, will go to the coal. Are you acquainted with that?

Let me read from it. He's going on with his discussion, he says -- This is a paper that you quoted, or cited:

> Finally, note a corollary of the above results: If a coalbed bounded by a shale confines a vertical fracture to the coal, then a fracture initiated in the shale bounding zone should be attracted into the coal, provided the interfacial shear strength is sufficient.

Okay?

A. And --

Q. And you agree with that?

A. No, the operative there is --

Q. You don't agree with that?

A. I do not agree with that. The operative word there is "should be". Right after the published data of that paper, there were some experiments done in Alabama where they, in fact, perforated the shale to try to grow the fractures into the coal. That was a dismal commercial failure.

Q. So we're finding out now that these various papers, the literature that you cited, footnoted in your testimony as authority, now you're rejecting that, we can't rely on that?

A. I don't know that that's the method of scientific inquiry. It says, this is the literature that exists. Some of it stands up, some of it we question.

Q. Well, you sure didn't tell us in your testimony that we couldn't rely on the literature that you were citing, did you?

A. That issue was not addressed in that. I mean, I didn't specifically address that, no, sir.

Q. Unlike the Chaco 2-R that you did the simulation on, in the case of the Chaco 4 and the Chaco 5, the fractures were initiated in the shale; isn't that true?

A. No, sir.

Q. Well, I thought you called this the shale. I know Mr. Nicol calls it something else. He says this is the upper PC sandstone. But between this on your vertical column, you show that as shale, with the gray below the black coal.

A. That is the 2-R simulation, that is not the model that one would use for the Chaco 4.

Q. Oh, you wouldn't initiate it where it was actually where the perforations were?

A. You would initiate it, but the sand lithology unit there -- This log rendition has got me totally confused. The logs that I relied on were in Mr. Nicol's exhibits. So can we put those up there with this?

MR. HALL: I would agree, and I would --

MR. GALLEGOS: Sure.

MR. HALL: -- object to the use of Mr. Ayers' testimony to reflect Mr. Nicol's testimony. So I think it would be more appropriate to look at --

MR. GALLEGOS: You're welcome to do that, but we want to look at your -- the intervals --

THE WITNESS: I understand, and --

MR. GALLEGOS: -- because under the large coal on C-7 -- and we've already been through this -- under the large coal, until you get to the red Pictured Cliff, you have told us that that was 20 feet of shale.

MR. HALL: Let's not mischaracterize the testimony. Let's look at Exhibit N-4.

MR. GALLEGOS: Sure.

CHAIRMAN WROTENBERY: N-4?

MR. HALL: Yes.

THE WITNESS: I really wish I had my magnifying glass. This is 7-1, right?

Since this is the one I'm familiar with, let me relate to this one. If we look at N-4, there are two logs that I used here to help characterize the lithology in the area of the Chaco 2-R.

Q. (By Mr. Gallegos) May I look over your shoulder, because by the time I did mine out --

A. In this representation, we have the logs for the 7-1 coal well and the log for the 2-R. The gamma ray is available in the coal well, and if we look at the gamma ray, we see no indication of the sandstone between the -- in that interval between the basal coal and the top of the Pictured Cliffs sandstone.

I don't have a gamma-ray on the 2-R, but in his cross-section he shows the absence of the upper Pictured Cliff in those two wells, so I left it out because this is what I relied on.

Q. So something's there, and the something is shale, right?

A. Is shale, and that's what I put in my simulation for the 2-R.

Q. All right. Now, what I was asking you about is the Chaco 4 and the 5. My question was, isn't on the upper curves what you referred to as shale?

A. My representation of the stress state in Chaco 4 would not be identical -- of the lithology in Chaco 4 would not be identical to the lithology in the 2-R --

Q. Well --

A. -- most notably with the inclusion of five foot of sandstone, where the perforations are.

Q. So you have -- Did you do a simulation on the Chaco 4?

A. I've done simulations on Chaco 4, including the acid-injection test, so let's look at the acid-injection test.

Q. Well, let's -- what I'm asking about, which is, then, between -- If we look at the Chaco 4, between the Pictured Cliffs and the coal you would have not the gray shale, but you would have the sandstone, or I guess coal and sandstone, the thin lower coal and then sandstone?

A. If you look at the Chaco 4 log, I would have had five foot of shale below the coal --

Q. Before the large coal?

A. Below the large coal, because in this case I had to go to five-foot nodes to even start to represent the lithology changes. So I would have had five foot of shale, five foot of sandstone, five foot of shale, and then I do not remember whether I represented that thin coal as a five-foot coal segment or went straight to a sand and just incorporated that into the shale above it.

Q. And you would have had your fracture initiated at perforations that are two to four feet below the large coal?

A. It would have been in that five-foot sandstone, so it would have been five -- By my representation, it would be five foot below the bottom of the basal coal.

Q. And you simulated a fracture in that situation?

A. Yes, sir.

Q. Okay. And the fracture grew into the coal?

A. The fracture grew into that five-foot shale, it did not grow into the coal.

Q. Oh, it just stopped at the coal?

A. The same way that it stopped at the coal in the 2-R simulation.

Q. With the fracture initiated not down in the lower Pictured Cliffs but up in the --

A. Yes, sir.

Q. -- shale, four feet or so from the lower coal?

A. Yes, sir.

Q. I mean the upper coal, the big coal.

A. Yes, sir.

Q. All right. And you have that, so we can see it?

A. It would take some time. I would ask that I had time to go through, because I've got many files on here, and find the one that is that simulation. But yes, I could find it, given time.

Q. You can't just call it up on the screen?

A. I've got many -- They're just file names. I have to go through them and figure out what was that run? I can, in fact -- I could get them and provide them, given a little bit of time, like my lunch period. I think that's a reasonable request.

Q. All right.

MR. HALL: Are you asking that be done?

MR. GALLEGOS: Yes, I'd like to see that.

THE WITNESS: I will get them.

Q. (By Mr. Gallegos) When you ran the simulation on the Chaco 4, did you have a pressure match with the treating pressures?

A. Since I did that so long ago, I'll bring what I've got and we'll see what I've got.

Q. Chaco 5 as well?

A. I started working on those, then I spent a lot of time on 2-R. So I'll just have to go back and refresh my memory. I've run so many of these, I don't remember each one specifically.

Q. All right. Well, I think we've got a pretty good grasp of the various rock properties and parameters you used. Let's take a little time now and examine -- We started looking at, but let's examine, your fracture-stimulation of the Chaco well that you haven't used in your testimony, which is the 2-R.

A. Yes.

Q. And I think your Exhibits C-6 and C-7 are particularly pertinent as relates to what you did to simulate a fracture on the Chaco well that you selected for your illustration --
A. Yes, sir.
Q. -- is that correct?
A. Yes, sir.
Q. Okay. And it might be helpful when we're looking at these things -- I've got a copy of the plat that we were using before, just to show the relative location of these wells to each other. This is a copy of Exhibit 1 from Mr. Brown's testimony.
The 2-R is down there in the southwest of Section 7, correct?
A. Yes, sir.
Q. Do you find it on the map?
A. Yes, sir.
Q. It very closely offsets the Gallegos Federal 7 Number 1 well?
A. Yes, sir.
Q. Do you know how close they are in terms of the --
A. Well, from -- No, no --
Q. Well, you can't tell from this, but I thought maybe you had that data.
A. No, sir.

Q. All right.

A. I mean, I think you have other exhibits that give precise --

Q. We have some exhibits that show --

A. -- that give the precise footage.

Q. Right. All right. Did you compare the fracture treatment sizes between the 2-R and the 4 and 5. You know the Chaco 1 and the 2-R were done in January --

A. Yes, sir.

Q. -- and the 4 and 5 were done in May, and there was some difference in the fracture-treatment sizes, was there not?

A. I'm sure there is, but I don't recollect -- I mean, I've got the files but I don't recollect the volumes at this point.

Q. All right. Now, according to your analysis on Exhibit C-7, we already know that you agree that the fracture grew right up to the coal but then it stopped there. And the length of that fracture, as we look at Exhibit C-7, would be 250 feet?

A. Yes, sir.

Q. So what we have here is, we've got a fracture that goes up to the coal and then it runs along the base of the coal 250 feet, is what's shown on Exhibit C-7?

A. Yes, sir.

Q. But we're not really talking about 250 feet running along the coal, we're talking about 500 feet, because although it's not shown here what we have is, then, we have the fracture going out in the other direction, correct?

A. Yes. Yes, sir.

Q. That's what we could expect to see if we could get underground?

A. Yes, sir.

Q. All right. So 500 feet we've got this fracture running along the base of the coal, correct?

A. Yes, sir.

Q. And according to your simulation, that fracture grew up to -- along the base of the coal, oh, could we call it six-tenths of an inch in width?

A. No, that --

Q. Looking at your color spectrum down there at the bottom. At the top of the fracture it looks like it's orange, and orange falls between .55 and .6- --

A. Let's say half an inch, yeah. Half inch.

Q. Okay.

A. Could be, yes.

Q. Okay. All right. So it grew up there. They're pumping fluid in there, the fracture breaks through the underlying formations, a half inch wide, along 500 feet of coal. Okay? About how many of the natural fractures, so-called cleats in the coal, do you think that 500-foot fracture crossed, Mr. Conway?

A. I have no idea.

Q. Hundreds?

A. Hundreds, yes, I would suspect hundreds.

Q. And fact, when -- and I think you've already discussed that -- when that kind of fracture meets a barrier, which you've input over 700 pounds of stress pressure difference, isn't what you would expect to happen is to have a slippage and have a horizontal fracture begin to grow? In other words, a T. It comes up and then it T's and starts going between the two --

A. Absolutely --

Q. -- formations?

A. -- not at these pressures, it can't happen. I'm sorry, we don't have enough pressure here to lift the overburden. That I can say with assurance did not happen, that's easy.

Q. Okay. But when a fracture meets a barrier it can't penetrate -- you say it didn't penetrate the coal -- and the gradient is over 1.0, then you would have a horizontal fracture?

A. If we're over that gradient --

Q. Okay.

A. -- it's potentially possible, and we're not.

Q. All right. How do you calculate that? Tell us how you arrive at that. We don't have a fracture gradient of over 1.0 p.s.i. per foot.

A. If you take the shut-in pressure at this -- If you take the final shut-in pressure at the hydrostatic for the water column in the well at the end of the treatment, divide it by the depth, you don't get -- you do not get greater than 1 p.s.i. per foot. It's in my table.

Q. All right. Now of course, Palmer says shales fracture if the stress gradient is 1.0, which would take to --

A. I'm going to go back and say, for me to accept that I have to go put in a Poisson's ratio of .5 for my shales in there, and suddenly we're not having this discussion. I -- Because it's not going to break into it with that stress.

Q. Okay.

A. Now --

Q. So what you're saying is, it would just be a vertical fracture that runs along the 500 feet, and it doesn't go horizontal?

A. And it would be at the base of the shale, not at the base of the coal.

Q. We've already said -- You've already said it goes up to the base of the coal.

A. I didn't put a Poisson's ratio of .5 in for the shale, I put .3 for it. I haven't given the stress in the shale of 1 p.s.i. per foot.

Q. All right. But --

A. If I did, it will not penetrate it.

Q. It would not penetrate the shale?

A. It will not.

Q. Okay. With the parameters you used, it grows up, grows along for 500 feet, but does not go horizontal?

A. No, sir.

Q. All right. And if I understand your testimony, and maybe anticipating these questions, you're telling us that that fracture is a pumping -- when the pumping stops, that fracture is not going to stay propped open?

A. That's correct.

Q. So what Halliburton and all these companies do, then, really doesn't work as far as keeping the fractures propped open? It all goes down?

A. For that very reason, there is a lot of literature in this area that says you ought to cross-link the foam and do all of these things to keep the sand up.

If you'd ask Halliburton whether for this particular fluid design, if you'd ask them whether or not that would keep the sand at the top of the fracture, they will say no. They will say, We need to do this to make sure -- to ensure that it does.

Q. Well, they use chemical, the use surfactants, so that will happen, don't they?

A. No, the surfactants don't do it. They use cross-linkers for the polymer that was in there.

Q. All right, to keep the proppant --

A. To improve the proppant transport. That also improves the damage potential. And Mr. Blauer chose to go with minimum damage potential compared to maximum transport capacity.

Q. So if the chemicals and the design is effective, you know, 50-, 70-percent effective, even, to spread the proppant through the fracture, we would have a propped fracture, maybe not a half inch but a propped fracture open for these 500 feet along the base of the coal?

A. Even with very excellent transport, when we run our simulations in the laboratory, there is a strong difference between pushing the sand up with fluid pressure and viscosity and sand going down. There would be a very marginal concentration of sand at the top of that fracture under any circumstances, with any fluid that I know of you could pump.

Q. Aren't there also some principles that say because overburden stress fractures tend to grow up rather than down, all things being equal?

A. All things being equal, and in this case they're not. There's shale up and sand down.

Q. But if you have equal stresses or --

A. If there is an equal lithology due to the difference in overburden stress, yes, fractures would tend to grow up, not down.

Q. So basically what we understand you to say is that the fluents and the fluids and the various chemicals and cross-linking and all this stuff that the service companies design to get the proppant spread through the fractures don't work, or don't work efficiently?

A. We have an industrial consortium that's funded by all of the service companies that you're discussing and operators that have spent ten years looking at all of the problems with sand transport, and I will assure you, in the thousands of hours we've spent doing it there are lots of problems. Many of them, in fact, do not work as advertised. We do performance evaluations.

Q. All right. Now, you did a fracture-stimulation on one of the Whiting wells?

A. Yes, sir.

Q. And that was the 26-12-6 Number 2?

A. Yes, sir.

Q. And we find that, the 6 Number 2 is over here on the exhibit we've got laid out here. I'm trying to find it myself now. It's in the southwest quarter of Section 6.

A. Yes, sir, 6-2.

Q. 6-2, okay. And the Chaco 4 and 5 are around there, you know, offsetting it, if we see, and then the Gallegos Federal 12-1.

A. Yes, sir.

Q. All, you know, fairly grouped around where those four corners come together.

A. Yes, sir.

Q. All right. Let's start off with your Exhibit C-12. I think to help the Commission -- and you correct me if I'm wrong -- I think C-12, C-13 and C-14 and C-15 and C-16 all relate to what you did concerning your computer modeling of the fracture geometry on this well?

A. Yes, sir.

Q. Is that correct?

A. Yes, sir.

Q. All right. C-12, pull that out. Explain what this is, this exhibit which is entitled "Variations in Shut-In Pressure with Assumptions about Overburden Stress".

A. All right. As I had mentioned, the only thing that -- the only real solid match pressure that we really tried to get in a case like this is a match on the final shut-in and the final falloff in this treatment, which unfortunately the reported data I had was a very short period.

Q. About a minute is all you had for a shut-in pressure; isn't that right?

A. Right, and that's all I have.

Q. Okay.

A. The -- So we put in --

Q. Then, Mr. Conway, may I interrupt you just to help the Commission?

What's being talked about, about the shut-in pressure, would be where this line is going south after they quite pumping, and then it turns what I say east, it turns to the right, just --

A. About that far, yes, sir.

Q. Yeah, just a little bit, about a minute down there around 34 minutes --

A. Yes, sir.

Q. -- into the job?

A. Thirty-four minutes basically is the shut-in time, yes, sir.

Q. Okay. Go ahead, I just wanted to make sure we're all looking at the same thing here.

A. When I put in the assumed overburden gradient, Poisson's ratio of .5, and put in the job characteristics as described here in terms of what sand and what rate, unfortunately in my simulation I have to use a constant liquid rate -- Or I don't have to, but I did not change the foam quality. I used a constant foam quality of 70 percent. So that would have said that the liquid rate was constant. I didn't adjust for changes in quality.

We estimated the friction pressure first based on that that would have been observed if this was, in fact, water, because the base fluid was water without friction reducer in it. And it comes pretty close.

Then I -- But yet my shut-in pressure is about 50 p.s.i. too low. If I say the overburden stress is about 1.1 p.s.i. per foot, which the only way you can confirm that is integrate the density from the ground level down, and I didn't have any logs that had density from ground level down to that depth. But I know in previous studies it's going to range between -- and I think I quoted in here, the numbers we've seen worldwide range from .95 p.s.i. per foot to 1.1 p.s.i. per foot.

So I just used the other one, and it gave us 50 p.s.i. too high. So I said that is reasonable, somewhere in between there we can honor the shut-in pressures with the geometry that has been shown in the next figure. And that is a perfectly contained, very long fracture in the coal.

Q. Okay, let's back up here. What is shut-in pressure?

A. It's the observed pressure at the time the pumping ceased.

Q. And that's all you matched? I mean, that's the only thing you matched to do your simulation?

A. Well, you can see I adjusted the friction pressure to try to make the surface pressures during pumping agree as closely as possible with that was observed.

Q. Yeah, but you didn't try to match any other pressures?

A. Yes, I did. I'm saying --

Q. I'm sorry, I didn't catch that, then.

A. The simulator is predicting a bottomhole pressure at all points in this simulation. I varied parameters in the simulator in two ways. One, the stress which adjusts what that final shut-in pressure is going to be, and the friction pressure to get the pumping pressures to agree with some reasonable degree.

So by varying the friction pressure to match the pumping pressures, and with the same rock properties that we tried to match the shut-in pressure, this is what I got.

Q. Okay, but wait a minute. So if I understand you, what you're saying is, you did some kind of calculation so you were calculating all along through the job the bottomhole pressure?

A. Yes, at every point.

Q. Okay, and the bottomhole pressure is going to tell us something that the surface pressure doesn't about fracture growth, right?

A. Yes, sir.

Q. Because when you're pumping at the surface, I mean, you just keep pumping, if you're growing a fracture you're just pumping. But bottomhole pressure, you're going to get some breaks when you're fracturing, right? Dropoff in pressure?

A. You can get breaks, you can get increases, you can get decreases. Yes, the bottomhole pressure is what dictates what's going on in the fracture.

Unfortunately, Brad and I have nothing to look at for these treatments but surface pressure, so we have to compute an equivalent bottomhole pressure from the surface pressure. Or in my case, the simulator predicts bottomhole pressure and I compute a surface pressure, which is what I've given here. It's the computed surface pressure.

MR. HALL: You might want to identify who Brad is.

THE WITNESS: Oh, I'm sorry, Brad Robinson.

Q. (By Mr. Gallegos) Okay, so the surface pressure we're seeing on Exhibit C-12 is not the surface pressure that was on the treatment report by the service company?

A. The one that's labeled "Observed Surface Pressure" is the service company's surface pressure.

Q. Okay, that's what I took it to be. And the computed bottomhole pressure that you say that you worked out in your computer, that's not on here?

A. No, sir. I gave my computed surface pressure, predicted surface pressure.

Q. Okay, so -- But the only thing that comes off of the field data, the data that was made available to you that you're going to be honoring, is that one minute of shut-in pressure?

A. No, sir, the whole thing. We have surface pressures, but I'm saying the most reliable point -- there are less steps between -- The only step between computing surface pressure from bottomhole pressure -- because that's what I'm dealing with, the simulator predicts bottomhole pressure -- the only step between computing bottomhole pressure from a shut-in pressure is, in fact, the hydrostat of the liquid from the perforations to the surface.

So that is more precise than the calculation of a pumping surface pressure, which includes friction pressure plus hydrostat, which you have to estimate what the hydrostat was at any point in the treatment, and the friction pressure.

So I'm saying the most reliable point is, in fact, the shut-in pressure. But you've got to honor, if possible, with simple friction-pressure changes, what went on during the actual treatment. And I'm saying I only used one friction pressure correlation for the whole treatment. It adjusts for sand concentration for normal fluids but not foams, and that's what I get.

Q. Okay. But to get to the crux of the reason that you did this whole thing was so you could get an assumption about the overburden, the overburden stress?

A. And how it related to the observed pressures in this treatment, yes, sir.

Q. Yeah, that was the whole purpose of --

A. Yes, sir.

Q. -- of what you did here?

And what it appears to me is, you predicted an overburden pressure, 1.1 p.s.i. per foot, you ran your line, that didn't quite match, you ran it at overburden of 1 p.s.i. per foot and that underpredicted it, so you bracketed it?

A. Yes, sir.

Q. Okay. And if you bracket it, then, in my simple way of looking at things, between 1.1 and 1.0, 1.05 would be the answer?

A. At this level yes.

Q. Did you run it at 1.05 to get a match?
A. No, sir.
Q. And you didn't use 1.05 as the overburden?
A. No, sir.
Q. So even though you run this test and you had a nice bracket that would say 1.05 would be your overburden assumption, you didn't use that?
A. No, sir. However, there is another figure that if you're going to leave it at point there's another figure you have to look at.
Q. Well, this is what you were doing this for, is to get your overburden assumption, and you ended up using something higher, didn't you?
A. I must direct your attention to Exhibit C-15.
Q. Well, just a minute, we'll get there.
A. Okay.
Q. But let's tell the Commission --
A. At that point I used 1.1 for the coal simulations, I used an overburden gradient of 1.1 for the rest of these simulations, yes, sir.
Q. Which did not match with your shut-in pressure?
A. At that point, no, it did not.
Q. Okay. All right, now C-13, then, is where you run a simulation, you take the actual treating information that you had from the service company on one of the Whiting

wells, the 6 Number 2, and you run a model, fracture simulation. That's what C-113 [*sic*] shows?

A. Yes, sir.

Q. Okay. And you've got -- Where are the perforations in the coal on this well?

A. In --

Q. You've got them centered at 1158, but where are they actually?

A. In the simulator they're simulated in the two, and I suspect based on what you've pointed out before, that I've probably got a one-node offset in the computation of the depth track. But I can assure just as we saw before, that the black represented in the picture that has the title "Interval" came out of the simulator, and that is precisely where the perfs are.

Q. Well, when we look at your node graph, and if we recognize that the perforations in that well are from 1138 to 1157, the depth is not correctly portrayed, is it?

A. I said what you've pointed out, and I have not checked this, is that our algorithm that computes the depth tract in this report has an error in it, and it's off by one node, apparently, and I had not caught this. This is an output of a commercial software that we sell, and unfortunately we have just identified a bug in it. It misses the Fruit- -- the depth is offset by one node. And

I know why it happens, I just had never caught it.
Q. This is GOHFER?
A. Yes, sir.
Q. And you all sell GOHFER?
A. Yes, sir.
Q. Is it your computer proprietary program that you designed?
A. The interface, the Windows interface, yes, that's ours.
Q. Stim-Lab sells GOHFER.
A. And the hard code, the Fortran engine, is Marathon's, and we have a worldwide license to sell that product.
Q. All right. So we know on Exhibit C-13 what your variables were used, would you go through those and tell us what were your rock properties?
A. The Poisson's ratio in the coal was .5, Poisson's ratio in the shale was .34-something, .346. Sandstone was .3 for Poisson's ratio. I show no silt in this. There probably is. Had there been silt, it would have been .28. And the Young's modulus are as per the table.
Q. All right. 0.2 for the coal and 0.1 for the sandstone -- I mean 1.0 for the sandstone, excuse me, and 1.2 for shale?
A. Yes, sir.

Q. And again, your Young's modulus difference between the coal and the sandstone, a difference of 5?

A. Yes, sir.

Q. And for your frac gradients, frac gradients --

A. Yes, sir.

Q. -- not stress gradients but frac gradients for the coal, what did you use?

A. Again, I computed -- the same thing we just went through. It is computed based on a Poisson's ratio of .5.

Q. And that's all you have to put into the computer?

A. That's what we mean by we follow first principles. You tell it what the rock is, and it uses the correct engineering equations to compute the total stress --

Q. All right.

A. -- including pore pressure and all of the other things that go into it.

Q. Okay. And so when you've done all this you find out, and as you say at page 23 of your testimony, Voila, you can't make the Whiting fracture go out of the coal, it's contained?

A. In the near wellbore.

Q. Okay. You say at page 23, and I quote:

No case could be generated where the treatment broke into the PC sandstone in the near wellbore vicinity and honor the pressures observed in the actual treatments in the Gallegos wells involved in this cause.

A. Yes, sir.

Q. Okay. So that doesn't do any good for Pendragon in this case, does it?

A. It doesn't -- No, sir.

Q. Okay, so you had to decide you were going to start varying things and try and see if you could do some kind of a run or some kind of a case that would not be contained in the coal?

A. Yes, sir.

Q. And so the first thing you did is, you played like, you theorized that there were perforations that didn't actually exist in the Gallegos Federal well? That's the first try you took, right?

A. Yes, sir.

Q. And that's demonstrated, I think, on your Exhibit C-14?

A. Yes, sir.

Q. So by gosh, if you go down and put a fracture where it's actually initiated down in the Pictured Cliffs sandstone, you'll have a fracture that's not in the coal but it will be in the sandstone. That's all that C-14 says, isn't it?

A. Well, I had already done this same attempt in trying to screen out fractures in the sandstone and force them into the coal, so I took the same approach here of -- We're talking about one foot. And when it said I put a perforation, I put only one perforation in the shale. And at a flow rate of 60 barrels per minute, that's not going to allow much fluid to go in that shale. All it does is pressure-equilibrate that shale.

We use this almost every time that we do a real simulation of trying to understand what happens. These are the kinds of variances we do to see what might have happened.

If the cement was a little weak, if anything -- All we're saying is, if for some strange reason that pressure got down into there, what would happen? That was all we were trying to do. And the answer is, it doesn't explain the pressures.

Q. Well, Mr. Conway, if we look at Exhibit C-14 and we bear in mind that the actual perforations are at 1138 to 1157, and you put one perforation down in the PC, essentially all of your fracture is drawn out from that one perforation. I mean, there's hardly -- There's a slight, slight green line to the opposite -- the real perforations.

Isn't this what it shows?

A. At the end of pumping, yes, sir.

Q. Okay, so theoretically the way you did it, one perforation would actually --

A. If you look at the details of the simulation, the fluids coming in at the bottom of the coal and going down, the bulk of the fluid -- and that's one of the things you can get out of this: Where was the fluid going?

Q. Okay, but you can't really get much out of it, of course, because there wasn't such a perforation down in the Pictured Cliffs?

A. And the pressures are wrong, so that is not the explanation --

Q. All right.

A. -- by my judgment.

Q. So then if I understand your earlier testimony, what you said to yourself is, I don't know that this is the case but I'm going to hypothesize that somewhere out there, away from the wellbore, the zones just change, the lithology just changes. Correct?

A. Yes, sir.

Q. And instead of the lithology that I've got when I look at the log on the well -- and I've got it right here on C-13, of where the coal is and where the shale is and the Pictured Cliff, with a log that tells me that, I'm not going to use that? Correct? You can't use that lithology on the log to do your case where you get it to break out?

A. That's correct.

Q. Okay. So the Commission knows, you just said, Because there's communication and because I think the Gallegos federal wells would be guilty of the communications, I'm going to decide that the geology changes somewhere out there? Correct?

A. Correct.

Q. All right. And since you say we ought to know what your parameters are so we can judge whether your fracture geometry should be accepted by the Commission or not, you tell us what you changed.

A. And I'm going to take just a second to make sure that I don't perjure myself by saying something that I didn't actually do, so...

I'm going to have to ask for the same -- I know what I intended to do. What's actually depicted here, I'm going to have to check the exact file and determine exactly what I changed. What I -- the things I --

Q. Do you need a recess to do that? Because I think it's pretty important that we know what you changed.

A. Okay, if we take that lunch recess and give me time to find precisely --

Q. Can you do it in five minutes? It's only 11:30.

A. Oh, I'm sorry, I'm on the wrong time here.

(Laughter)

CHAIRMAN WROTENBERY: Shall we take a five-minute break?

THE WITNESS: Please.

CHAIRMAN WROTENBERY: Okay, make it ten.

(Thereupon, a recess was taken at 11:28 a.m.)

(The following proceedings had at 11:40 a.m.)

MR. HALL: We may want the question read back, state it again.

MR. GALLEGOS: Well, I'll back up here, Mr. Hall, just so the record is clear.

Q. (By Mr. Gallegos) Mr. Conway, to try and set the context again, now that we've had a recess and you've had a chance to look at some of your notes, Exhibit C-13 you did a fracture-stimulation on the 6 Number 2 well, and the fracture was contained.

A. Yes, sir.

Q. Exhibit C-16, you do a fracture simulation on the same well, 6 Number 2 well, and you have it going out of zone, turning down south on about 800 feet or so out there --

A. Yes, sir.

Q. -- and so the question is, what is the difference in the parameters that you used? What did you change and from what to what? If you'd give us that detail, please.

A. Okay. In the simulator -- and I've just shown here just the pertinent points that we changed. In the original simulation we had coal with a Poisson's ratio of .5, Young's modulus of .2, and I didn't put the -- can I borrow your -- and we had a shale layer right underneath it that had a Poisson's ratio of .346 and a Young's modulus of 1.2.

But in the simulator terminology, between 750 and 800 feet, I simply told the simulator -- I was trying to do everything I could do to make sure that it just broke out. This was a hypothesis. So I told it that we had gotten an ashy, basically an ashy intrusion with no strength, a cracked-up ashy intrusion into the coal. And so I said it has a -- still has fairly high stress.

Q. What's an ashian intrusion?

A. Basically, ash --

Q. A-s-h-i-a-n?

A. A-s -- Ash, a-s-h.

Q. -- i-a-n, ashian, isn't that what you're saying?

A. No.

MR. HALL: Ash intrusion.

THE WITNESS: An ash intrusion.

Q. (By Mr. Gallegos) Oh, okay.

A. A parting, a coal parting. In Alabama terms there's a parting, for example, between the Blue Creek and the Mary Lee. It's a very small layer. But just say it had ash in it, which happens a lot of places in coal.

Now remember, I'm not trying to imply physically that this is the mechanism. I just -- Knowing the simulator, I know I have to gradually reduce the stresses and contrast for that to happen.

So that's what I simply did. I gave it tensile strength of 50, and a Poisson's ratio of .4 -- now it's slightly lower stress right there than it is around it -- and a Young's modulus of 1, left this, the same Poisson's ratio, same Young's modulus, and it breaks down. Once it starts down, then it goes to the sand. I just had to make it go through those nodes, that's what I had to do.

Q. When you say a tensile strength of 51, what units --

A. Fifty.

Q. Or fifty --

A. p.s.i.

Q. -- what units?

A. p.s.i.

Q. p.s.i.

A. GOHFER uses tensile strength, FRACPRO uses fracture toughness. They do use a fracture toughness.

Q. So to put it in lay terms, you just turn the dials --

A. Yes, sir.

Q. -- until you could get it to break out. And you say if it breaks out there, then what I've got to say is, there was this -- somewhere out there, this ash instead of coal that has a lot different --

A. No, I do not imply that that's what happened. In this simulation run that was a convenient way to do it. That's what I did. In fact, I did one run to make that happen. That did it. I didn't pursue it any further.

Q. But to turn the dials and make it happen, to give some kind of a logical explanation to that, you have to say something happened in the geology out there?

A. Yes, it implies a geological change over some area.

Q. You know, with no log data or anything else that shows you --

A. We have log data from lots of wells around there, and the only thing you can say for sure is, the log at any location is slightly different than the log at another location. So yes, we do -- The one thing we do have is guaranteed heterogeneity in that area from wellbore to wellbore. That we have guaranteed.

Q. Okay, but we don't see anything like this in any of the logs?

A. All it would take is for that shale to be a little thinner, and there's already arguments about that shale and that coal, how different they really are, up in that region. We're talking about over a couple of feet there that I'm representing -- that shale there -- I don't know, somebody that's better expert in this area than me is going to have to tell me whether that's two or four feet. It's not very much. So we're -- my experience --
Q. So what you're saying, if I understand, you're saying you're hypothesizing that somewhere you just don't have any more shale and the Pictured --
A. Well, it gets to the point it's no longer effective --
Q. -- and the Pictured Cliff is right up next to the large coal?
A. Yes, sir.
Q. Right up next to the large coal.
A. But if for some reason that happens, here's what would happen.
Q. All right.
A. And the only point was that that's consistent with the observed -- it is -- That kind of occurrence is consistent with the observed pressures; therefore you can't say it didn't happen. Nor can you say it did.
Q. And of course, this case, out of zone only works

by your selection of the rock properties that you put in and turn the dials to make it happen?

A. (Nods)

Q. The answer is yes?

A. Yes, sir.

MR. GALLEGOS: That completes my questions, thank you.

CHAIRMAN WROTENBERY: Commissioner Bailey?

COMMISSIONER BAILEY: (Shakes head)

CHAIRMAN WROTENBERY: Commissioner Lee?

COMMISSIONER LEE: (Shakes head)

EXAMINATION

BY CHAIRMAN WROTENBERY:

Q. I wanted to make sure I understood what had happened -- We were talking about C-7, Exhibit C-7, and we had the discussion about the perforation zone, and I'm not sure I followed the discussion all the way through. What is the actual perforation zone there?

A. If I might just show you what happened --

Q. Okay.

A. -- and what's wrong. This picture right here comes out of the simulator. That's on the side so you can keep track, and it gives depths.

When we write this report out of the simulator, it computes this depth, and it is off by one node size, in this case ten, in this computed depth track. The picture is correct.

So in fact, the actual perforations are right there where that X is. What's wrong is, this computed depth track is off by ten feet, totally off. It's ten foot too low.

Q. Okay. When you ran your model, did you use the correct perforation?

A. Yes, I did, and Mr. Gallegos confirmed over my shoulder that, in fact, it was the right footage in the model.

Q. Okay.

A. That's correct.

MR. GALLEGOS: I'm not sure I agree. I'm not disputing --

THE WITNESS: Well, I showed him the depth --

MR. GALLEGOS: I don't know how to read --

THE WITNESS: -- I showed him the pointer. It has a little box there that's giving you the depth, and I showed him the pointer, and it confirmed that the perfs in the simulation were correct.

CHAIRMAN WROTENBERY: Okay. Thank you.

THE WITNESS: At depth, the exact depth.

This report, which is a separate button. The buttons say, write a report --

CHAIRMAN WROTENBERY: Okay.

THE WITNESS: -- it's computing the wrong depth track, off by one node size, which is ten feet here. And I apologize for the --

Q. (By Chairman Wrotenbery) And then also I just wanted to clarify, you gave us information on the simulation that you ran on the Chaco 2-R. You also ran simulations on some of the other Chaco wells. Which one --

A. Some were on 4 and some on 5.

Q. Okay, and you were going to obtain that information over the course of the lunch --

A. And I was going to go back and see just exactly what I did over lunch. I didn't attempt to complete any studies of those, and I'm going to see what I've got, and I'll review what I have.

CHAIRMAN WROTENBERY: Okay, thank you. That's all I had.

Mr. Hall, did you have -- ?

MR. HALL: Yes.

REDIRECT EXAMINATION

BY MR. HALL:

Q. Mr. Conway, early on in Mr. Gallegos' cross-examination of you, you responded to a question to the effect that some of the fracs in the Pictured Cliffs breach the barrier, the shale barrier, between the sand and the

coal. Do you recall that?
A. Yes, sir.
Q. Mr. Gallegos didn't ask you the obvious follow-up question to that, What happened then? Was a conductive path created between the coal and the Pictured Cliffs by that fracture?
A. In our experience and professional opinion, we do not believe that there was any proppant in that area that could have created a conductive path.
Q. And why is that? Where did the proppant go?
A. The proppant is down, it's very low. In fact, if I had reviewed these -- If somebody had said, These frac jobs didn't work, and I had reviewed it and I said, It's obvious, the proppant is not where it belongs, it's too low in the Pictured Cliffs.
Q. All right. Then we had some confusion with respect to Mr. Ayers' cross-section. You were asked to identify a 20-foot interval on Mr. Ayers' cross-section in conjunction with testimony which Mr. Nicol gave on his Exhibit N-4. Are you satisfied now that we've explained that to the satisfaction --
A. I think we have. I used what Mr. Nicol had provided me, which does not agree, and I guess that's a point of contention with Dr. Ayers.
Q. All right.

A. So that -- That's what I represented in my simulation.

Q. Now, in response to questions from Ms. Wrotenbery, with respect to the depth log on the exhibits for the 2-R, the fact that those are off a little bit, they were still modeled correctly; is that accurate?

A. Yes, sir.

Q. Did the fact that the depth logs were off change your conclusions or result at all?

A. No, sir.

Q. You were also asked by Mr. Gallegos about some assumptions that -- a concept someone had derived with respect to fractures that were initiated in a shale being attracted into a coal. Do you recall that?

A. Yes, sir.

Q. And there was some discussion about that concept having been applied in Alabama --

A. Yes, sir.

Q. -- do you recall that?

A. Yes, sir.

Q. Can you explain, what was that incidence there?

A. My earliest knowledge of that practice was through information derived from John E. Lee who was, at that time, with Holditch and Associates, and basically the plan was -- and that may have been even related to GRI work, to go in and perforate in the shales above the coal, grow the fractures into the coal. Basically, it was unsuccessful and the company went bankrupt, so...

Q. What company was that?

A. That would have been Transco.

Q. Big bankruptcy then?

A. Yes, sir.

Q. And who designed that concept?

A. I'm saying my first recollection of it is through John E. Lee because he was involved in that and was giving GRI seminars as this is a way to stimulate coal.

Q. Who did Mr. Lee work for?

A. He worked for Holditch at that time.

Q. Let's talk about Mr. Palmer's article a little bit further. You were asked questions about that. Where he discussed coal wells, where he knew the fracture broke out of the coal, did he see high pressures in those instances?

A. He quotes there in that case, that 50 percent of the time he saw tracer in the sand, and the frac rating is still greater than 1 p.s.i. per foot, i.e., looked liked a coal frac, even though they found tracer in the sand 50 percent of the time.

My simulator can't do that. It breaks into the sand near the wellbore, it says the pressure will be lower.

Q. Now, as you said before, as the sand and the proppant goes to the bottom -- correct? -- what closure stress would be transmitted back to the wellbore? What would you read back at the wellbore?

A. In the case where it broke out of zone remotely from the wellbore, then all you would see is the closure stress and the stresses related to the coal. You would not see those sandstone stresses.

Q. Let me ask you a question. Do you agree with our friend, Mr. Brad Robinson here, when he said that we believe the hydraulic fracturing the Whiting Fruitland Coal wells has created a fracture that extended down to the Pictured Cliffs? Do you agree with that?

A. Yes, sir.

MR. HALL: That concludes my redirect.

MR. GALLEGOS: I have a few more questions.

CHAIRMAN WROTENBERY: Mr. Gallegos?

RECROSS-EXAMINATION

BY MR. GALLEGOS:

Q. On the subject of our 500-foot fracture that goes up and stops and runs along the base of the coal, that subject now, I'm going to try a little artwork. I'm not guaranteeing the quality of this but...

Probably should have made the coal black. I'll put the coal up above it here.

A. That's gutsy to do that in real time.
(Laughter)
Q. (By Mr. Gallegos) That's taking a real risk, isn't it?
Here's our fracture. I better do this back here too, 3-D.
So we've got the fracture, talking about a Chaco well, Pendragon well. Fracture up through the shale, and the coal is black here. But coal is -- I'm not going to go on and on with this, but what I'm trying to do to illustrate the coal, you've got this natural fracture. In fact, your permeability in the coal is basically through all these cleats --
A. Yes, sir.
Q. -- isn't that right?
A. Yes, sir.
Q. And so when we were talking about -- We were talking about this -- the fluid and talked about whether it carries a proppant up there. The fact of the matter is, with this system of natural fractures, your fluids that reach that are going to go on up into the coal --
A. They could do that.
Q. -- isn't that right? They could go up into the coal. And then you would have a different mechanism, or possibly a different mechanism, in terms of carrying

proppant up into the coal and farther up into that fracture; isn't that true?

A. I think there is a lot of work that's been done that proves the one thing we don't do with fractures is put sand up there in -- by leakoff of natural fractures. We don't do that. I mean in the cleat system. We don't put proppant up there, we don't put proppant in there. We do the worst possible thing, put in gelled fluid, which is known to damage the coal.

Q. So that apart, at least you agree that the proposition that the fluid would just stop at the base of the coal is incorrect? You would have the fluid --

A. The growth --

Q. -- transmitted up into the coal?

A. It could potentially leak off and hence damage the permeability of the coal even further, damage the connectivity, because when it recloses then the whole thing they were designing in their stimulation treatments not to do.

Q. But if the fluids are going on up into the coal, then the efficiency of carrying proppant on further upward into the fracture in the shale is increased; isn't that correct?

A. We have a real problem here. Look at these shut-ins. There is not dramatic leakoff. We don't have evidence of very high leakoff anywhere. To get enough leakoff to create that loss of fluid, we'd be talking about losing half of the fluid up to get enough velocity to raise that. There's not that kind of leak off in this area. Look at the shut-ins. There's very slow pressure decline at the end of treatment.

Now, there are places where you see within five minutes after shut-in, the pressure is all gone, yes, I might argue that that's correct there. But here we don't have that.

Q. I'm going to try my hand at a little more artwork. But as I do, I want to reference your Exhibit C-7 again, which is your simulation of the fracture on a Chaco well.

A. Yes, sir.

Q. All right, if you might have that.

Now, what you show on your simulation is, you show that the fracture growth went right along something like -- stuck to the --

A. Yes, sir.

Q. -- base of the coal?

And you were doing that with a Poisson's ratio consistently in the coal of 0.50?

A. Yes, sir.

Q. All right. So what happens, Mr. Conway, when you do like you did on the Whiting well and you say, Oh, there's got to be an ash pocket out here, and I'm going to change my Poisson's ratio in the coal to .40?

A. What's going to happen?

Q. What's going to happen is, the fracture is going to grow up into the coal?

A. No, sir. Not at the observed pressures that we've got here, no, it won't. It can't. .4 is still much higher stress than .3, which is the sandstone stress.

Q. Did you run that? Did you run that simulation like you did on C-7 and say, Well, here it stayed right at the base of the coal; let me see what happens when I reduce this coal barrier from .50 to even .40, which was the Bell-James [*sic*]. I mean, that was way out on the Bell-James, but it reduces to that. Did you run that?

A. I have not run that, but I certainly can.

Q. All right.

A. And I'm willing to. I mean, it's just -- No, it has not been run to date.

Q. All right. And you're going to run -- or you're going to show us your run on the Chaco 4?

A. I'm going to look and see what I have done, and not do any new work, but see what I have done up to and see where we were at there, yes, sir.

MR. GALLEGOS: All right, thank you. If you'll do that, that concludes my questions.

CHAIRMAN WROTENBERY: Thank you, I believe Commissioner Lee had one other question.

EXAMINATION

BY COMMISSIONER LEE:

Q. Is this a 3-D model or 2-D model?

A. This is a fully 3-D model.

Q. 3-D model. So how do you determine what's the stress conditions in this case?

A. Now, when I say it's -- It's 3-D, but we are basically saying the two horizontal stresses are the same, and the vertical stress --

Q. What is the direction of your vertical stress?

A. It is mapped in the fracture plane. So basically whatever --

Q. So you are not telling me exactly where the fracture is?

A. I'm not telling you the azimuth of the fracture, no, sir. It's saying that the plane is a cross-section in the direction of the fracture.

Q. When you drill a well, your stress condition changes?

A. Yes.

Q. How do you determine your stress around your well?

A. As you drill a well, yes, the stress -- The stress near the wellbore is altered by drilling the well.

Q. I see.

A. That's one of the arguments about the problem with microfracs. In these level of simulations, the stress at a short distance past the wellbore will dominate it, the far-field stresses will dominate where the fracture goes, and the influence from the wellbore is lost very, very quickly.

Q. I think that those simulators -- Do you couple with your fluids?

A. In GOHFER the pressure and the fluid are moved, so yes, there is a perfect couple between the fluids and the fracture geometry. It basically says in this node the fluid pressure is, and therefore that node either opens, and if it opens, the fluid is transmitted to the next node and to the next node. So yes, there's a perfect couple there.

Q. Your momentum equation, how many momentum equations have you got?

A. I cannot answer that, sir.

Q. So you are fully coupled with the --

A. It is my understanding that it's fully coupled. One of the options that we don't use here and is not fully operational yet is a fully coupled 3-D reservoir simulator behind it, so the physics for fluid -- The physics for fluid movement, it is my understanding, are completely there, to the point of being a reservoir simulator also. So the fluids are coupled to the fracture geometry.

Q. Okay. How about the displacement of your wellbore? What condition did you guys use?

MR. HALL: Is that a question?

CHAIRMAN WROTENBERY: The question may come up.

THE WITNESS: I can answer it with respect to ours. In GOHFER, the initial condition is that when you set a perforation in a particular zone, then it preinstalls an existing frac of .001 inches. That gets away from all of the issues of what are the dynamics of breakdown for that first -- That's where the issue of what's the breakdown pressure comes into, and I said previously we do not model breakdown. We get away from that by saying there's a pre-existing crack one node size at the wellbore.

Q. (By Commissioner Lee) Who designed it? You designed it or --

A. No, sir, Dr. Bob Barree, who originally developed the program.

Q. So it's very arbitrary, for all the simulators?

A. It's reasonably arbitrary. And the reason I know how arbitrary it is is because that assumption doesn't work anymore, the minute you try to fully couple the reservoir, so that is having to be changed. Because you've got to handle wellbore storage if you're going to do reservoir transient work.

Q. So how much confidence do you have with the simulator?

A. My experience with this simulator over time, I know that even the fact that it could predict or confine fracture in coal totally astounded the developer of the program. He feels that he modeled the physics. He would not have ever predicted that it would show that a fracture could stay confined in coal, ever. It does. I'm not aware of any other simulator that can show a fracture staying confined in the coal.

So I have confidence in it, yes, sir. The answer is, I have confidence.

Q. Do you believe in the coal or sandstone, do you believe you have a full picture about the shale behind it, the embedded shale?

A. No, sir, not --

Q. So your simulator is just an approximation?

A. The simulator can only do what we know to tell it. And when you say in the shale behind it --

Q. If you have embedded shale in your sandstone, some strip is going to affect your propagation?

A. You're saying remote at some place --

Q. Right.
A. -- I've got an intrusion or invasion or --
Q. Right.
A. If I know that that's there, I can -- in this simulator I can spatially vary properties. I don't have to tell it a layer property. I can go up -- But I have to know that that exists.
Q. What's the grid block you use in your simulator?
A. In these two I used either five- or ten-foot grid blocks.
Q. So you used on grid block to cover one of your formations, or you used multiple --
A. I'd like to use multiple, but when you have these thin of zones I'm basically condemned to using one node -- The minimum resolution, as you well know just from the memory size of the computer, I can't go less than five feet adequately. And so I'm basically saying everything is in -- And I'm saying the coal is one five-foot block, the shale is one five-foot block, or multiples of that if there's enough area.
Q. So your rough is five feet?
A. Yes, sir.
COMMISSIONER LEE: Okay.
CHAIRMAN WROTENBERY: Mr. Hall?
MR. HALL: May I confer with the witness briefly?

I may have one additional question. I may not.

CHAIRMAN WROTENBERY: Certainly.

(Off the record)

MR. HALL: That concludes Mr. Conway's testimony.

CHAIRMAN WROTENBERY: Okay, thank you very much for your testimony, Mr. Conway.

Time for a lunch break, I think.

MR. HALL: Yes.

CHAIRMAN WROTENBERY: We'll start up again at -- Will a quarter after one give everybody time?

MR. GALLEGOS: That will be fine.

MR. HALL: Fudge on that a little, yeah.

CHAIRMAN WROTENBERY: Okay.

(Thereupon, noon recess was taken at 12:08 p.m.)

(The following proceedings had at 1:20 p.m.)

CHAIRMAN WROTENBERY: Okay, we're ready to go.

MR. HALL: At this time I'll call Kenneth Ancell to testify and ask that he be sworn.

KENNETH L. ANCELL,

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

DIRECT EXAMINATION

BY MR. HALL:

Q. For the record, state your name.

A. Kenneth Ancell.

Q. Mr. Ancell, where do you live and by whom are you employed?
A. I live in Houston, Texas, and I'm employed by the consulting firm of Fairchild, Ancell and Wells, where I'm a principal.
Q. And in what capacity are you employed?
A. My title is actually vice president. I spend almost all my time working coalbed methane problems for various clients around the world.
Q. Would you give the Commission a brief summary of your educational background and work experience?
A. Yes, I graduated from Colorado School of Mines, 1964, with the degree of petroleum engineer. I spent the first several years of my career in the natural gas business where I was -- in 1973 I was chief reservoir engineer for Panhandle Eastern Pipeline Company, looked after gas reserves and gas evaluations and gas deliverabilities.
At that time I joined a group in Houston with the same company to build a coal gasification plant where we were going to mine coal and convert it chemically to synthetic natural gas.
When it looked like that there wasn't going to get enough money in a big enough pile to build one of them, I joined a consulting firm that was in the process of

evaluating unconventional gas resources, coalbed methane being one of them. It wasn't called coalbed methane in those days. And they asked me if I would do the work on a industry-sponsored research project, which I did from 1976 to 1977, where we were the first ones to really research how gas is stored and migrates in coal seams. Out of that came the first reservoir coalbed methane simulator, which we published a few years later.

And after that I spent three years developing the first really coalbed methane -- commercial coalbed methane projects in Alabama.

And after that I've spent the remaining 20 years or so consulting in natural gas reservoir engineering and coalbed methane projects.

Q. Are you familiar with the Application that's been filed in this case?

A. Yes, I am.

Q. And are you familiar with the lands and the wells that are the subject of the Application?

A. Yes.

Q. Have you prepared written testimony which has been submitted in this case?

A. Yes, I did.

Q. And do you affirm and adopt your testimony here today?

A. Yes, I do.
Q. Have you also prepared certain exhibits in conjunction with your testimony?
A. I did.
Q. Those are Exhibits A-1 through A-11?
A. Correct.
Q. Have you previously testified before the Division and had your credentials accepted as a matter of record?
A. Yes.
MR. HALL: At this time we'd offer Mr. Ancell as a qualified petroleum engineer and move the admission of Exhibits A-1 through A-11.
MR. CONDON: No objection.
CHAIRMAN WROTENBERY: We accept Mr. Ancell's credentials and we admit exhibits A-1 through A- -- What was it? How many?
MR. HALL: Eleven.
CHAIRMAN WROTENBERY: Eleven. A-1 through A-11 into the record.
Q. (By Mr. Hall) Mr. Ancell, would you give a summary of your analysis in this case for the Commission?
A. I want to give a very brief summary, and I would ask the Commission to refer to just two of the exhibits, Exhibit A-7 and Exhibit A-9, and I'll discuss those in my brief summary here and then just allude to the rest of

them.

The things I was asked to do was to investigate the Whiting/Maralex coalbed methane wells to see if they were in some way unusual coalbed methane wells, did they follow the theory of what coalbed methane should do, those sorts of questions.

Then I was asked to investigate to see if I could find any effects of the Chaco Pictured Cliffs wells on the production of the Fruitland Coals wells, and I responded to that last year when we were here and I testified that I could not find any effects of the Chaco wells on the production of the Fruitland Coal wells. And I still can't.

As we sat here through the three-day hearing last summer, we started getting these pressures that showed very dramatic communication between wells. When the Chaco wells were shut in and the field was shut down, the pressures came up on the wells immediately, and over a period of a few days the most dramatic of them changed, I think, about 16 p.s.i., which is dramatic between -- in those distances.

And so I said, What am I missing here? If there's that dramatic a communication, why couldn't I see anything? Where did I miss it? Where was I wrong? there should have been something dramatic.

And so when they asked me to review this same question again, we expanded it to look at the other -- to work, really, the right problem this time instead of the wrong problem, and that is to see what effects the Fruitland Coal wells had on the Pictured Cliffs wells. And my problem was, the reason I didn't see this last year, I was working the wrong problem.

I also learned at that hearing that these wells were making significant quantities of water, which was somewhat news to me, at the hearing. So if you look at Exhibit A-7 and you say that that is a Gulf Coast, shallow Gulf Coast sand well, you jump out and you say, Hey, this well is watering out. By that I mean, we're getting increased water production at the tail end and the gas rate is falling off because we can no longer lift the liquids. And the relative permeability of the gas is going down, and so our gas rate is going down.

So I undertook to see if that was really truth, and I expanded my investigation to look -- go back and look at all of the daily pumper reports in these wells, to investigate whether or not they really made a significant amount of water.

And what I learned is that all of these wells have always made water, they've always made some water. I don't believe it was very much. For instance, even the Chaco 4 that we see here got up to all of 11 barrels a day at the end, as it was increasing. The biggest one was about 20 barrels a day.

You look at the pumper reports, and across the 1995, 1996, 1997 and early 1998 in the pumper reports, there are very few references to any kind of water production. For instance, the Chaco 4 that we're using here in Exhibit A-7, when it was turned on the last two days of April in 1995, it showed 20 barrels of water a day, right after a frac job. It was cleaning up. The water wouldn't necessarily go down. After the first two days, for months and months and months, there was no reference to any water in the daily production reports.

But as you went along, there were little notes on there that indicated these wells were making some water. There was a note that said separator dump valve hung open, blow drip. All of those things indicate that there was some water around, albeit I don't believe it was very much.

The well came on and made about 400 MCF a day. And in these same pumper reports, from time to time, just like has been in the last year, from time to time the El Paso plant was down, the well was shut in. And each time that was done, before they turned the well on, the pumper noted the pressures, the tubing and casing pressure, and I think in all cases they were all within one or two p.s.i. of each other, and almost always they were the same. Which says that there wasn't any liquid in the wellbore, or that's what it told me.

And I have plotted for the Chaco 4 on Exhibit A-7, I have plotted those shut-in pressures. What I found was that these wells aren't making a lot more water, probably, now, than they ever did.

So the question I had, then, what caused the production to start to nose-dive at the end of 1997? I take the shut-in pressures, and I find out that these wells -- this well, particularly this one, the Chaco 5, the Chaco 1 -- they aren't markedly damaged; their backpressure performance is pretty much what it was before. So they aren't watering out.

But what happened is that they lost pressure. Notice the trend of the first five points that lasted from right after the well was completed until late 1997, middle of 1997, and the trend of the reservoir pressure as measured by the shut-in pressures is coming down fairly slowly, and the gas rate is also coming down very slowly.

But notice what happened between the pressure point in July of 1997 and the pressure point in April of 1998. Our gas rate was down significantly, but yet the shut-in pressures turned down dramatically. We lost 40 pounds of pressure. It's 136 on -- 136, I believe, was the pressure in July, 1997, at the end of July, 1997, and it was like 88 in April of 1998.

What happened during that time to cause that to happen? The performance of the well didn't change, except that we lost reservoir pressure.

So I took the same data, the same Chaco 4 data, and plotted on the same scale with the Gallegos Federal 12 Number 6 -- 12-6 Number 2, which is Figure A-9. And you'll notice when you compare the production of the Chaco 4 with the 6 Number 2, you find that when the well came on, started producing in 1995, it made about the same amount of gas that the 6-2 was making, a significant amount of gas.

The 6 Number 2 is a typical coalbed methane well. In fact, a darn good one, and a very, very good one for this area. The water rate, shown in blue, is coming down, has been since early 1994. The gas rate has been going up.

But yet the Chaco 4 comes on and is just as good a gas well as the 6-2 is. And I submit to you that if that's really a coalbed methane well, if that well is really completed in the Fruitland Coal, then we better rethink the way we complete Fruitland Coal wells. Because you could do this well much less expensive than you could drill and complete the 6-2. Being copycats, somebody out to be out there copying that formula. You don't see that happening.

Yet when the 6-2 well was put on compression -- this one happens to be in January of 1998; the 7-1 well was put on compression a couple of months earlier than that -- the gas production nearly doubles. It goes from about 13,000 or 14,000 MCF a month to something over 25,000 in a matter of two or three months, and most of it came immediately. The pressure and the production on the Chaco 9 went down dramatically.

Q. Do you mean to say Chaco 4?

A. I mean the Chaco 4. What did I say?

Q. Nine.

A. Oh, I'm sorry, I was thinking --

Q. It's Exhibit 9.

A. -- Exhibit 9.

The Chaco 4 was placed on compression in April of 1998. It got a very modest increase in gas production, nothing like what the coalbed methane wells get when they go on compression.

What did the reservoir see when that happened? All the reservoir saw was a reduction in the flowing bottomhole pressure of the coal wells, and that reduction in reservoir pressure in December of 1997, the line pressure was between 45 and 55, about 50 p.s.i.

After the well was placed on compression, the wellhead flowing pressure was about 10. There was a 40-pound decrease in flowing pressure. Yet that caused a tremendous increase in the gas production, and that in turn caused a decrease in the production from the Chaco 4, caused by the reduction of reservoir pressure. When the pressure got down to in the range of the 90 p.s.i. that we have here, like 88, 86, 83 when the well was shut in, the well simply doesn't have enough reservoir pressure to lift any liquids at all.

The well was shut in, the pressure continued to go down into the low 80s, and sometime in about September of 1998, somebody went out there, repeatedly, on several nights, and opened the casing valve that sucks water into the well, and the well sits there dead, full of water, and it can't flow. It probably will never flow again.

The same thing was repeated at the Chaco 5 two months later, and that's shown on Exhibit A-11, I believe, but it was removed two months. And it was two months later that the other Fruitland Coal well was put on compression, and exactly the same thing happened.

So my conclusions from this is that the Fruitland Coal wells, when they lowered their flowing bottomhole 40 pounds -- doesn't sound like much, but it's tremendous against a reservoir that has only 100 pounds reservoir pressure -- that that made a -- breached a block someplace between the coal reservoir and the Pictured Cliffs reservoir, and a portion of the gas that was produced by the coal wells came out of the Pictured Cliffs reservoirs that had been being produced by the Chaco 4 and Chaco 5 and Chaco 1.

Whatever you do, whatever happens, however -- at the end of the day, whatever you do has to account for this phenomenon. I'm not saying that my solution is the only one, but it seems to me to be the most likely, that the connection between the two reservoirs occurred either at or very close to the Fruitland Coal wells. And the demise of the Chaco wells has been that they have lost reservoir pressure and have not been allowed to produce all the gas that they had at the end of 1997.

That's a summary of my testimony.

MR. HALL: He stands ready for questioning now.

MR. CONDON: Thank you.

CROSS-EXAMINATION

BY MR. CONDON:

Q. Mr. Ancell, are you speaking in support of Pendragon's Application today?

A. Yes.

Q. Mr. Hall asked if you were familiar with that Application --

A. Yes.

Q. -- and you are familiar with it?

A. Yes.

Q. So when the Application asks for an order confirming that the Gallegos Federal wells are completed within the vertical limits of the Basin-Fruitland Coal Gas Pool and producing from the appropriate common source of supply, are you supporting that?

A. Am I supporting that?

Q. Yes.

MR. HALL: Well, I'm going to object because that is only a portion of the Application and it's not --

MR. CONDON: Well, I'll just limit it to that portion of the Application.

Q. (By Mr. Condon) Are you supporting that portion of that?

A. I'm saying that -- what I -- Let me tell you what I'm saying.

Q. Okay.

A. I'm trying to find the truth, and what I believe the truth to be is that the Fruitland Coal wells are completed in both the Fruitland and the Pictured Cliffs. If that supports my client, so be it. If it doesn't, so be it.

Q. Okay. Now, are you familiar with Order R-8768, the order that established the Basin-Fruitland Coal Gas Pool?

A. Not in any detail, and not recently.

Q. Are you familiar with the fact that the Division has articulated certain factors to be investigated in determining whether a well is producing or not producing from the Basin-Fruitland Coal Gas Pool?

A. No, I'm not familiar with that.

Q. You don't know what those factors are?

A. No, I do not.

Q. All right. So you didn't make any attempt in your analysis to look at the factors that the Division has specified in your analysis?

A. No, sir.

Q. Now, as I understand it, your role has expanded from the first hearing; is that kind of a fair assessment?

A. Only in a correlative sort of a way.

Q. All right. You said you were asked, I believe, to determine if the Whiting wells were acting like typical coal seam gas wells?

A. Yes.

Q. That's accurate? And your determination is that they are?

A. They were.

Q. Okay.

A. At the time the Pendragon wells were completed and through most of their life, I have to say that, yes, they were performing very much like a coalbed methane well.

Q. Okay, well -- and are you putting -- Let me just read your first conclusion to you. It says:

Whiting's Fruitland Coal wells are part of a pattern of coal bed methane wells in the coal reservoir and have been performing like COAL BED METHANE wells are supposed to perform with all the characteristics of typical COAL BED METHANE wells.

Do you still agree with that?

A. Yes, I agree with that.

Q. Okay.

A. Yeah, that's...

Q. All right. Now, in your testimony in the first proceeding, and I just want to kind of see if we can establish if there are any significant changes in your testimony, and this is from page 458 of the transcript,you were asked the question:

I've heard nothing that indicates that you looked at, did a study, analyzed the performance of the Pendragon alleged Pictured Cliff wells.

And you said:

I guess I left that out. The only thing I was going to say about that is, in looking at those -- at that set of data, the conclusion I would make is that the Whiting wells look like coal wells...

...and that's consistent with what you've said here today...

...and the Pendragon wells look like sandstone-reservoir wells.

Do you still agree with the second part of that statement?

A. I still agree with the second part of that statement.

Q. Now, let's turn, if we could, to your conclusion number three, where you talk about the shut-in pressures taken on the Pictured Cliff wells demonstrating communication between the Fruitland formation and the Pictured Cliffs formation.

A. Yes.

Q. What shut-in pressures did you use? Where did you get those from?

A. The were the pressures that were measured daily by the pumpers, and they were furnished to me by Mr. Nicol.

Q. Okay, were they just off the pumper reports?

A. No, they were the -- Starting in July or the first -- in July of 1998, he had built a spreadsheet that had all the pressures, and he put his corrections on them and all -- and that. And that's the spreadsheet that he gave me.

Q. Okay, and when did you receive that spreadsheet? I mean, when did you start this part of the analysis to look at the shut-in pressures?

A. Probably -- I didn't do anything on this project from the time of the hearing last year until probably May of this year.

Q. So about May of 1999?

A. May of 1999, something like that.

Q. Are you aware that the wells, the Pendragon Chaco wells, were shut in at the end of June, 1998?

A. Yes.

Q. Okay. Did you have any shut-in pressure information available to you for the period of June 30, 1998, prior to the hearing at the Division, which I believe began July 28th, 1998?

A. I had only the first very few days of that shut-in at that time.

Q. Prior to the hearing?

A. Prior to the hearing, right.

Q. And Mr. Nicol, I believe, testified yesterday that a couple of the Chaco wells showed an immediate pressure response after the shut-in. Did you observe that in the data that you were furnished prior to the Division hearing?

A. I don't think they showed any immediate response. It wasn't until they were shut in that they showed any response. I mean --

Q. Right, and that's my question, is if they were shut in June 30th and they showed a response within the first week, then that information would have been available --

A. It was not available to me, because it came to me as quite a shock at the hearing when I learned of it.

Q. Okay. And in fact, at the Division hearing Whiting used that evidence to argue that there was definitely communication between the two formations, didn't it?

A. Yes, yes.

Q. Now, you said that your opinion is that communication has been established at two of the Fruitland Coal wellbores. Now, you -- and -- That's what your written testimony says, is at two of the Fruitland Coal wellbores. And as I understand your summary, it's at or near the wellbores?

A. Well, yes, okay.

Q. Okay.
A. In the vicinity of.
Q. All right. And what is the basis for that conclusion, that it's at or near the wellbores?
A. The correlation between the reduction in pressure and production from the Chaco wells, correlating with the big increase in gas rates at the Fruitland Coal wells.
Q. So when you're talking about identifying the location of the communication, you're just basing that on pressure and production data, correct?
A. Well, I'm basing that on production data.
Q. Okay, all right. You haven't done anything -- You haven't looked at anything besides the production data to reach that conclusion?
A. The pressures said that they were communicated, so with that I knew that there was some sort of communication, and I should be able to see it in the production. That's what I set out to do.
Q. Right, and that's the only reason I asked you the question, is, you're relying on pressure and production data.
A. I was trying to make the two fit.
Q. Okay, all right. Now, which two Fruitland Coal wellbores, in your opinion, are involved in this communication?

A. I'm not sure exactly. I think that the -- I would have to say that the 12 Number 1 is.

Q. Okay.

A. And then either the 6-2 or the 7-1, or both.

Q. Okay. So in terms of your testimony that the Whiting coal wells are responsible for the communication, is it fair to say that we can eliminate the Gallegos Federal 26-13-1 Number 1 and the 26-13-1 Number 2 from your theory of communication?

A. I cannot correlate those with anything that I have seen, so they may or may not. I can't say that they are, but for the same reason I can't say that they are not.

Q. Okay. Well, do you have any evidence to present to the Commission today at this hearing in support of Pendragon's Application to show that they are responsible for --

A. No, that's what I just said, I cannot show that they are.

Q. Okay. So you can't support any request for any of the relief that Mr. Nicol requested yesterday as it pertains to the Whiting wells with respect to 26-13-1 Number 1 or 26-13-1 Number 2?

A. I'm not requesting anything of the Commission. I'm trying to give the Commission my opinion and the facts.

Q. Okay. Now, you talk in finding number 5 -- and I believe you -- you don't say that in the conclusion, but you used it in the written report and in your testimony, the demise of the Chaco wells. All right? And I believe that your theory as to the Chaco 4 is that the demise of the Chaco 4 correlates with the 6-2 being put on compression?

A. It correlates quite well. It also correlates with the 7-1. I chose to display here the 6-2 --

Q. Okay. Well, and that's --

A. -- because it's closer, that's the only reason.

Q. Okay. Well, how would we determine whether it's one or the other or both of the Gallegos Federal wells that are responsible for the communication that you believe is affecting the Chaco 4?

A. I don't have a good answer for that, and neither does anybody else. There's been all kinds of proposals of testing to be done, and no one has ever come up with a way to definitively do it, nondestructively, that is.

Q. On your Exhibit A-9, just out of curiosity, in -- around April of 1997, there appears to be a difference in production between the 6-2 well and the Chaco 4 well, and that was prior to the Gallegos Federal well having been put on compression, wasn't it?

A. Yes.

Q. Okay. Do you have an explanation for that?

A. The coal system was just working. You were getting an increase in gas relative permeability and hence an increase in gas rate. Certainly didn't correlate with anything that was going on at the Chaco 4.

Q. At what point in time do you believe that the phenomenon occurred where the wellbore flowing pressure at either the 6-2 or the 7-1, whichever we're to determine somehow caused the communication, became lower than the pressure in the Pictured Cliffs formation, causing the change in the flow direction?

A. When the flowing pressure was lowered by -- I think it was about 40 p.s.i.

Q. And that was when the wells were put on compression?

A. That's when the wells were put on compression.

Q. All right. So if in your theory we look at when the 6-2 versus the 7-1 was put on compression and compare that with the effect on the Chaco Number 4, we ought to be able to distinguish which of those two wells might be more likely to be the culprit?

A. If you can do it that precisely.

Q. And just so I understand, at what point in time do you believe the communication between two formations first arose?

A. At that point.

Q. You think the communication between the Fruitland and the Pictured Cliffs formation arose at the time that the Gallegos Federal wells were put on compression?

A. I believe that's the case.

Q. Why would putting the Gallegos wells on compression cause communication?

A. Because you've created a significant higher pressure drop between the two reservoirs, and if you had a propped fracture down into the Pictured Cliffs that had been saturated with water all this time, you could break that water block and produce gas.

Q. Okay you're assuming that there was a propped fracture prior to the Gallegos wells going on compression?

A. That's one possibility, yes. There could be natural fractures that did the same thing, maybe. I don't know whether there's natural fractures there or not. I know there is in the coal.

Q. All right. Well, do you have any opinion as to whether it was the result of a fracture stimulation or a natural fracture that is the cause of a fracture being there and open between the two formations?

A. I can't tell. I have no way of knowing.

Q. All right. So prior -- Is it your testimony that prior to the time the coal wells were put on compression, that there was no flow of water or gas from the Fruitland formation down to the Pictured Cliffs by virtue of this fracture, however it got out there?

A. I can't detect any. The only thing I can detect is that there may have been an increase in water production at these wells. That's the only thing that I -- it's not -- At the hearing last year I thought that would be what I would call a smoking gun. It turned out not to be.

I do believe there has been an increase -- There's definitely been an increase in water-gas ratios at those wells, but I do not believe that we have had a significant loss of gas relative permeability in those wells caused by invading water, although there might be some.

Q. Now, of the fracture possibilities, you've discussed the possibility of a fracture initiated with the Fruitland wells, and you've discussed the possibility of there being a natural fracture out there. Is there a possibility that the fracture could have originated with the Chaco wells?

A. Not close to the wellbore.

Q. Not close to the -- Which wellbore are you talking about?

A. Not close to any of the Chaco wellbores.

Q. Why not?

A. Because if it had happened there, those wells would have made a lot more water -- they would have made more water. The Chaco 4, look at Exhibit A-9. At the time the Chaco A-4 [*sic*] came on production, the folks whose coal well was producing, what, 80 barrels a day? And the Chaco 4 never made anywhere close to 80 barrels a day. It would have had -- It was making the same amount of gas. It was in an area remote from the wellbore of all the Fruitland Coal wells, so it had to have had a higher water saturation, so it would have had to produce more water for the same amount of gas, and it didn't.

Q. Okay, when you say didn't, let's talk about that. You were here for the testimony yesterday, correct?

A. Yes.

Q. And you heard the testimony that indicated that Pendragon and Edwards, for the period from May or June of 1995, when the 4 and 5 were frac'd, until February of 1998, did not report any water production? You heard that?

A. I heard that, yes.

Q. All right. As a scientist, and if you're going to reach a conclusion in a case like this, based on water production, wouldn't you want reliable water-production figures?

A. I certainly did want reliable water-production figures.

Q. Do you feel like you have reliable water-production figures for the period prior to February, 1998?

A. The water-production figures we have, I believe, are reliable. The problem is, we just don't have very many. But we have the first few days of production of this well, and it was like 20 and 30 barrels a day, nothing like the 80 or 90 that it would have to be. And that's on the pumper's report.

Q. Now, how was that measured?

A. I have no idea.

Q. And where do you get that figure of 20 to 30 barrels a day during the first few days after the frac treatment?

A. Off the pumper reports.

Q. And that was flowing into the unlined open pits they have out there?

A. I have no idea what it was like. I don't know whether they had frac tanks there still or not. It was right after the frac job.

Q. Well, then I guess it gets back to my question: Do you believe that you have reliable water production information upon which to base a scientific opinion in this case for the period prior to February, 1998, in the Chaco wells?

A. I would like to have had metered water production for every month that the wells produced. And that's probably available on one percent of all the gas wells in the country.

I believe that the water-production data, when it was reported, is of equal quality now as it was back in 1995. My guess is that it was taken by a bucket test where they fill a five-gallon bucket and see how long it would take, and convert that to a number of barrels per day.

Q. You assume that's the way --

A. That's what I assume it is.

Q. You haven't talked to anybody to determine that that's, in fact, how they did it?

A. Yes, I think I have. I talked to Paul Thompson and asked him how they did, and he said they did a bucket test. Now, whether they did it exactly the way I said, I don't know.

Q. Okay, all right. And you understand that Pendragon and Edwards, the Applicants, are the parties who are responsible for the fact that we don't have better water-production records for that period prior to February, 1998, as the operator?

A. They're ultimately responsible, yes.

Q. You would hold the --

A. Yeah, the operator is ultimately responsible.

Q. Sure. Now, to go back to your testimony about what you called the demise of the Chaco 4, you'll agree with me, won't you, that in the present circumstance, and certainly since June 30th, 1998, the biggest impediment to production from the Chaco 4 is the fact that it's been shut in by orders of the District Court here in Santa Fe County and the New Mexico Oil Conservation Division?

A. The demise of the Chaco 4 happened before that happened.

Q. All right, so -- okay, well, then -- well, let's talk about that. When you say the demise of the Chaco 4 -- and let's see, your Exhibit A-7 -- Do you have an exhibit that depicts the production of the Chaco 4?

A. A-7.

Q. A-7? And that is -- Okay, what is it about that production that makes you say that that indicates the demise of the well?

A. The fact that the production rate went in less than half, and still by lowering the wellhead flowing pressure they still could not get back to pre-1998 production rates, and the fact that the reservoir lost 40 pounds of pressure.

Something -- Whatever reservoir, whatever tank of gas the Chaco 4 was connected with, starting sometime after July of 1997 and before April of 1998, somebody -- something else started taking gas out of that tank.

Q. Well, doesn't that assume that the tank is full?

A. The tank is always full.

Q. A conventional gas reservoir is always full?

A. Is always full. There's no vacuum in it, it's always full --

Q. Well, full of gas --

A. -- the only thing that matters --

Q. -- full of gas?

A. It's always full of gas.

Q. Okay, recoverable gas?

A. No.

Q. Okay.

A. It's always full of gas, and the only thing that we know is how much gas is reflected by the pressure.

Q. I guess what I'm getting at is, in any conventional gas well, you're going to hit a point in the production life of that well where it starts to go on a steeper decline than it has experienced prior to that time?

A. No.

Q. No?

A. No.

Q. Okay, during the course of your investigation, were you asked to look at the production history of these Chaco wells since the fracs in 1995, to determine whether they were acting like typical Pictured Cliff wells?

A. Yes, I even went back before that, yes.

Q. Okay, all right. Well, let me just ask you, then, this is our Exhibit Number 23 from the Examiner hearing, which depicts the production history of the Chaco 1, 2-R, 4 and 5 for the period from when they were originally drilled until 1994, just prior to the frac jobs, and then the production volumes for the -- typically about a three-year period after the frac jobs.

Now, do you think that those production volumes are typical of production for a conventional gas well in the Pictured Cliffs formation?

A. They're very good Pictured Cliffs wells.

Q. Do you think they're -- Okay, so you think they're atypical for Pictured Cliff wells?

A. They're very good. Whether they're atypical, I haven't looked at enough Pictured Cliffs wells to say the whole population.

Q. Okay.

A. But they're quite good wells, yes.

Q. And then let me just ask you about the Chaco 4, and this again is another production history, daily average MCF for the Chaco 4, which shows the initial production level at virgin reservoir conditions, and then the production level after Pendragon frac'd its wells in 1995. Do you believe that that kind of a response is typical of a Pictured Cliffs conventional reservoir gas well?

MR. HALL: Let me ask a question with respect to the use of these exhibits. Are these -- These are exhibits from last year's hearing?

MR. CONDON: Correct --

MR. HALL: I understand --

MR. CONDON: -- and they are part of our W series.

MR. HALL: And part of the new W series as well?

MR. GALLEGOS: Well, actually, this is --

MR. CONDON: No.

MR. GALLEGOS: -- this is part of JTB series. That's --

MR. CONDON: And that's --

MR. GALLEGOS: -- Mr. Brown's.

MR. CONDON: -- also part of JTB.

MR. HALL: That's all.

THE WITNESS: I'm sorry, what was the question?

Q. (By Mr. Condon) The question is, do you think the production levels that are shown on that chart reflect a typical production response in a Pictured Cliff conventional reservoir gas well after fracture stimulation?

A. There's only one way that that could have happened, and that is that the well prior to 1994, 1995, was badly damaged.

Q. And do you have any evidence of that?

A. A little. Not much, but a little.

Q. Have you done a study of that?

A. Nothing but a cursory -- The question I asked that -- the thing that led me to believe that these wells have always made water is, I asked the question, when they pulled tubing at the Chaco wells, when they were ready to frac -- acidize and frac them, what did it look like? And the answer I got was, they had a whole bunch of scale, and water had been standing in it, and it looked like something that it was just plugged off. Now, that's in an interview, I didn't write it down. That's the description of what the bottom of those tubings looked like.

You have to keep in mind that these wells are very small. They're actually tubing cemented as casing, so they're very small diameter, they had a very few number of holes, and they sat there and produced some water that had carbonate in it for several years, and the wells could have been completely sealed off from the reservoir.

Q. How do you know the water had carbonate in it?

A. I don't know that.

Q. All right, so just so I can make sure I have an answer to my question, do you believe that this chart does or does not reflect a typical Pictured Cliff well, producing from the Pictured Cliffs formation, after a frac job?

A. It's atypical in the ratio of improvement, that's atypical.

Q. All right. And you said --

A. Now, whether it's atypical for one to produce 400 MCF a day, I'm not expert enough in the PC to know.

Q. That's a very dramatic improvement, isn't it?

A. From almost nothing to 400, yes.

Q. And that occurred after the Pendragon frac, correct, on that well?

A. Yeah, the one in 1997. It's the only one that well had, I think.

Q. And you said that skin damage or some kind of damage to the well might explain the dramatic increase in production. Couldn't communication with a higher-pressured full formation also explain the marked increase in production?

A. As I said, it could. But if it produced that much gas out of the coal, it had to produce a lot of water.

Q. So then just so I understand your testimony, you don't believe that there was any interference with the Chaco 4 prior to when either the 6-2 or the 7-1 went on compression?

A. I can't identify any, no.

Q. Okay. Did you compare -- or did you run any P/Z curves for these Chaco wells in order to determine or gauge the level or extent of interference?

A. I don't know why you would look at P/Z to look at interference.

Q. Well, if you're saying that the Fruitland well is interfering with production from the Chaco well and you're basing that on production figures from the Chaco well, wouldn't you want to know what you had previously expected the Chaco well to produce?

A. It wasn't my purview to try to quantify the difference. If you were trying to quantify it, then you would use a P/Z plot and extrapolate it before and after.

Q. But you didn't do any --

A. I didn't do that.

Q. -- quantitative analysis?

A. I didn't -- In my testimony, you won't find any calculations. I'm looking at the data as it was recorded and trying to give a reasonable explanation for it.

Q. Now, you've got a statement in your prefiled testimony, as I read it, that indicates that the fact that there's water now in the Chaco 4 is going to contribute to the demise of the well, or it's going to ruin the well. Is that accurate, is that what you're saying?

A. Well, that will be the ultimate -- The ultimate demise of the well is that the reservoir pressure is so low that the amount of water that the well makes can't be lifted by the well, so it can't flow. They might be able to prolong the life of the well by putting a pumping unit on it. They've already tried a compressor; that didn't work. The next thing is a pumping unit.

But that -- It won't produce very much in my experience.

Q. All right.

A. My experience tells me it won't ever produce very much again, and if it were my well, I wouldn't try.

Q. All right. And again, have you run any quantitative analysis on that?

A. I have run some spot calculations of what it takes to -- what the bottomhole flowing pressure has to be for various quantities of water. And that says that that well will lift -- that number said that well will lift about ten barrels a day, and that's it. And that's what it was lifting.

Q. And you referenced some unknown person opening the casing side of the well and blowing the well down.

A. Yes.

Q. Where do you find that? Where is the reference on that?

A. That was in Mr. Nicol's spreadsheet on the pressures. I believe it's part of one of his exhibits.

Q. Just so the record is clear, you're not attributing that to anybody associated with Whiting or Maralex, are you?

A. Did I intimate that?

Q. Yeah -- No, I just want to make sure for the record --

A. No.

Q. -- that you're not.

A. I wanted to make sure that I didn't either.

Q. I mean, okay --

A. I don't know who would do such a thing.

Q. -- it's just in there, it says, "In September some unknown person opened the casing side of the well and blew the well down." So --

A. I --

Q. -- if you have any information about that --

A. Let me give you an anecdote on that. There's an underground storage field inside the city limits of Houston that sits there, and there's wells all over, out behind the bowling alley and down the street from the filling station, and they sit there with 2600 p.s.i. on them, and people come out and crank those valves open in the middle of the night and create very dangerous things, very -- I would never accuse anybody of doing that, particularly somebody that was knowledgeable.

Q. Now, in your theory, at what point in time do you believe -- and I assume -- I've been assuming for purposes of this question, that whichever well, whether it's the 6-2 or the 7-1, was responsible for the communication, if either one was, that that would also be the well that would be drawing out PC gas; is that correct?

A. Yes.

Q. All right. At what point in time do you believe that any of the Gallegos Federal coal seam gas wells, which you previously described as acting like typical coalbed methane gas wells, began drawing gas out of the PC formation?

A. Sometime about the -- either the last month or two of 1997 and the first month or two of 1998.

Q. And what is the basis for that conclusion?

A. Just when the wells started on -- when they were put on compression, they got big increases in gas rates. How long it took PC gas to get from the PC to that well, that's the reason I'm hedging. I don't know how long it takes for the gas to migrate that far. I don't think it would take very long.

Q. Okay, you haven't done any transient analysis?

A. I told you, I have not done any calculations in this testimony. I believe Mr. Cox had some of that on his testimony.

Q. And have you attempted to determine what percentage of the gas that's being produced out of any of those coal wells is coal gas versus PC gas?

A. I've made no attempt to find any damages or any allocations of the amounts of gas.

Q. Have you made any attempt to analyze the gas that's being produced out of any of the Fruitland Coal wells?

A. I have not seen any of the Fruitland Coal analyses since last year's hearing.

Q. So the answer is no?

A. So whether -- The answer is, I have not looked at any, no.

Q. Will -- Okay. What do isotherm curves tell you to expect when you put a coal well on compression?

A. What do you mean, what do they tell you? They tell you -- You use them to tell you how much gas is in place.

Q. And have you done gas-in-place calculations for the coal-seam gas wells in order to judge the production that's coming from those wells versus what you would expect to come from those wells --

A. Have I done --

Q. -- in terms of if they're producing anything other than coal-seam gas?

A. These particular wells?

Q. Yes.
A. No, I have not.
Q. Would there be a point in time where the Chaco wells, the 1 -- Well, I guess we eliminate the 1, because your theory is that the Chaco 1 is being interfered with by a coal well, but it's not any of the Whiting --
A. It's not any of the Whiting wells.
Q. All right.
A. Or I couldn't correlate any of the Whiting wells with that.
Q. Okay, but you correlated some other coal wells --
A. Yes.
Q. -- with the decline in production on the 1?
A. That's right.
Q. And were any of those coal wells -- Who were the operators of those coal wells?
A. Pendragon operates one of them.
Q. That's the Hard Deal?
A. The Hard Deal. The other ones are the Dome Navajo and the -- and I can't tell you who operates them.
Q. Dugan?
A. Dugan operates one of them, and somebody else operates the other one. Maybe Dugan operates both of them, both the Galvan and the Dome Navajo.
Q. All right, so this is just another phenomenon

that's occurring in this area where other Fruitland Coal well operators seem to be doing something that we can't specifically identify exactly what they did, but that's causing interference with the Chaco wells?

A. That's right.

Q. At some point in the life of the Chaco 1, 4 and 5, would they become economic without interference?

A. In the future life?

Q. Yes.

A. Would they become economic -- is there some --

Q. Uneconomic.

A. Uneconomic?

Q. Right.

A. Well, I think the Chaco 4 is uneconomic now.

Q. Okay.

A. I think the Chaco 5 probably is, and the Chaco 1 will be shortly.

Q. Okay. Assume no interference, as you've described in your study.

A. Yes.

Q. Would there nevertheless be a point in time when those wells would become uneconomic simply by virtue of having the pressure in the reservoir go down to the point where those wells could not produce enough gas to be economically operated?

A. Yes, if you did the P/Z curve you could get a production decline from the 1995-through-1997 time frame and extrapolate that out to about the 90 or 100 p.s.i., that's going to be the abandonment pressure of that reservoir.

Q. And you haven't attempted to do that?

A. I haven't done that, no.

Q. So just so we're clear, at the top of page 12 you say -- and it's a sentence that carries over from the bottom of page 11, when you're talking about the histories of the Pictured Cliff wells, "...they are entirely and logically consistent with the conclusion that the Fruitland Coal wells communicated with the Pictured Cliff wells." But you don't identify which Fruitland Coal wells.

So as I understand it, the three that you're looking at as possibilities are the 6-2, the 12-1 and the 7-1?

A. Yes.

Q. Then I had a question on the paragraph that begins on line 13 on page 12. Second sentence, "At that time the bottom hole flowing pressures in the Fruitland Coal wells were lowered below the Pictured Cliffs pressure, the fluid injection stopped..." And I thought you had earlier said that there was no fluid injection from the Fruitland formation down into the Pictured Cliffs as a result of these communications.

A. There's none that I can tie my hands on. The only thing I can say is that if that communication existed, which it ultimately showed that it did, then there had to have been some kind of flow at some point in time in there.

Q. A flow from the Fruitland --

A. Fruitland --

Q. -- formation down to the PC?

A. -- down to the PC. Because the PC was lower pressure than the Fruitland.

Q. Right. Now --

A. And at some point in time, that had to have been reversed. The pressure drop had to be reversed, is what I was trying to say.

Q. Okay. And so there would be some point in time when the production in the Fruitland wells, that you're saying is coming from the Pictured Cliffs, would actually be gas that originated in the Fruitland formation?

A. You can get that scenario, yes.

Q. Okay. And then that sentence continues and says, "...some of the fluids in the Pictured Cliffs wells were produced through the Fruitland Coal wells." Are you saying that the drawdown was so dramatic that it was actually pulling material out of the wellbores, or is that --

A. Out of the reservoir.

Q. Okay.
A. Out of the reservoir.
Q. All right. So "wells" should be "reservoir"?
A. Okay.
Q. All right, I just wanted to make sure about that.
A. I guess you could take it to the extreme, that during the times the Chaco plant was down and gas came from -- the reservoir around the Chaco 4 was pressured up by about 15 p.s.i., then when the wells came out, that had to have resulted in some gas coming into the wellbore. Then as the coal wells were put back on production and that was -- some of that left there, and some of that could have made it to the wells. So the --
Q. Okay --
A. -- you know --
Q. -- is that hypothesizing or --
A. That's hypothesizing, that's splitting hairs.
Q. All right. Now, as I understand it, one of your assumptions is that at this point in time water production in the Chaco wells is increasing; is that correct?
A. At this point?
Q. Or that it increased from February of 1998 to June of 1998 when they were shut in?
A. The production -- I think the data that I show in there, that came out of the pumper report, shows that the

water rates were about the same. The Chaco 4 had a big increase, went from one to 11 or 12 barrels a day, if I remember right.

Q. Okay, and that --

A. But the gas rates were going down significantly during that time, so the water-gas ratios were going up.

Q. And that's the table that you have on page 9 --

A. Yes.

Q. -- of your testimony?

A. Yes. That's about the most reliable production data I could get out of the pumper report.

Q. And just so we're clear, you've included the Chaco 2-R on that table, but you don't believe there's any evidence of communication between the Fruitland and the Pictured Cliffs related to the Chaco 2-R?

A. No.

Q. Okay. So really, for purposes of that, the 2-R figures are not particularly relevant to your conclusion?

A. No, I didn't use those numbers at all.

Q. Okay. And then the Chaco 5 starts out with a report in February of 1998 of one barrel of water per day, and then it does not have any --

A. That's correct.

Q. -- after that. And then the Chaco 1 shows traces in February and March, goes up to 28 in April, and then is back down at 21 for May and June?

A. Right.

Q. Now, if it turned out that the water production rates for these wells pre-February of 1998 were greater than the water production rates that we're seeing post-February of 1998, would that change your conclusions?

A. If they were shown to produce 50 or 100 barrels a day, yes, that would change my conclusions. If they were -- If the Chaco 4 was shown to produce 15 or 20 barrels a day, no, that wouldn't.

Q. If the water-gas ratio is actually declining instead of inclining in these wells, would that affect your conclusions?

A. State the ratio again?

Q. If the water-gas ratio --

A. -- were actually --

Q. -- were declining --

A. -- declining --

Q. -- rather than inclining for these Chaco wells, would that change your conclusions?

A. If the amount of -- You have to be careful here, because I need to interpret some of those numbers. The Chaco 5 hasn't stopped producing water, it just can't raise it out of the wellbore. So its water-gas ratio has gone down, it just can't raise the water.

Q. Well, wait a second. Are you saying that it wasn't producing anything and it wasn't lifting the water back in 1998 when you had these figures?

A. That's what that tells me, is that that well is beginning to load up.

Q. In 1998?

A. In 1998.

Q. But again, getting back to my question, if the water-gas ratio is declining rather than inclining, does it change your conclusion?

A. If it's declining significantly, and we were lifting all of the water out of the well, or pumping it or whatever, and making sure that we were producing all the water and gas that were available to the wellbore, then I might have to rethink my conclusions, yes.

Q. Okay. Now, as I understand it, the only three wells, the only three Chaco wells that you see as being in communication with the Fruitland formation also -- I mean, you say it correlates with pressure and production data in the Chaco wells, correct?

A. Yes.

Q. Doesn't it also correlate with the wells that Pendragon fracture-stimulated in the sands below -- or between the two coal formations in the area? Isn't there a correlation there?

A. Well, all three of those wells were similar, the Chaco 2-R was slightly different.

Q. Correct, because the Chaco 2-R was not stimulated in the sand between the two -- Right?

A. That's right.

Q. Okay.

A. Well, that's the difference.

MR. CONDON: That's all I have.

CHAIRMAN WROTENBERY: Commissioner Bailey?

EXAMINATION

BY COMMISSIONER BAILEY:

Q. Is the Pictured Cliffs a water-drive reservoir?

A. No, ma'am, not to my knowledge.

Q. Gas drive?

A. It's depletion drive. It has some mobile water in what we call that third bench down there. But in general, I don't think you would ever say that it was a water -- even a partial water -- Well, you'd have to say it was a partial water drive, but it's way down on the bottom end of it. In a strict sense, all reservoirs are partial water-drive reservoirs because there's some expansion of water.

Q. Exhibit A-7, you said that you do not have enough experience with Pictured Cliffs wells in order to say whether or not this was a typical decline curve for the

A. Well, all three of those wells were similar, the Chaco 2-R was slightly different.

Q. Correct, because the Chaco 2-R was not stimulated in the sand between the two -- Right?

A. That's right.

Q. Okay.

A. Well, that's the difference.

MR. CONDON: That's all I have.

CHAIRMAN WROTENBERY: Commissioner Bailey?

EXAMINATION

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Q. Exhibit A-7, you said that you do not have enough experience with Pictured Cliffs wells in order to say whether or not this was a typical decline curve for the

Pictured Cliffs; is that right?

A. That's correct.

Q. How about conventional sand reservoir --

A. Conventional --

Q. -- in your experience?

A. Oh, yeah.

Q. Is it atypical from conventional sand --

A. No, this looks like a typical, low-pressure gas reservoir -- a well completed in a low-pressure gas reservoir, yes.

COMMISSIONER BAILEY: Okay, that's all I have.

CHAIRMAN WROTENBERY: Commissioner Lee?

EXAMINATION

BY COMMISSIONER LEE:

Q. Yes, what's your opinion if somebody says, when you fracture it you get a higher pressure? Is that possible?

A. When you fracture, you get a high pressure?

Q. (Nods)

A. I'm sorry --

Q. Well, the reason the Chaco 4 had a better production, any fractures, is that very typical? What's your opinion on that?

A. Of the -- I'm sorry, I'm not following you.

Q. One of the --

A. I don't want to -- I'll try not to be dense.
Q. One of the charts, the Chaco 4 has a production, and after the fracture they produced more than the IP.
A. Oh, okay.
MR. CONDON: This one?
THE WITNESS: That one.
Q. (By Commissioner Lee) So what do you think about this point?
A. What do I think? I think that in that time from 19- -- let's say 1981 through 1994, that that well was essentially scaled off --
Q. Well, how about 1978?
A. In 1978? Mr. McCartney will speak to this in a little bit more detail later. These wells had initial potentials much better than what they show that they produced.
So they were curtailed, perhaps, limited by markets. I don't know what happened in 1978.
Q. After the fracture, I think one side says the pressure increased. Is that possible?
A. If we were really restricted with those little bitty perforations and that little bitty casing, with a little bit of scale, and you put a little acid on it, you would all of a sudden see the true reservoir pressure that that well had. It's been shut in essentially for 10 or 15

years. So it should be a good average reservoir pressure.

Q. But you say the resistance is going through the wellbore, some of the resistance. That resistance, only the gas flow, and that assists you -- the gas stayed there for it to -- pressure differences?

A. If you have a wellbore that's been sitting there for ten years and it effectively didn't produce anything -- I'm not sure that it ever even produced that little bump there, actually. That was -- Those were likely to be allocated numbers. The wellbore -- The perforations could have been totally closed, totally scaled up, sitting there with water sitting on them.

Q. They're totally scaled up, then what's the pressure reading? The pressure reading is still the reservoir pressure, right?

A. If it were anything but totally closed up, it would have to -- the bottomhole -- inside the bottom of the well you would have to be seeing the reservoir pressure.

COMMISSIONER LEE: Okay, thank you.

EXAMINATION

BY CHAIRMAN WROTENBERY:

Q. The pumper's reports that you indicated show water production immediately after the frac job in -- I can't remember which of the Chaco wells it was we were --

A. The one we were talking about is 4, yes.

Q. -- we were talking about it. Four?

A. Uh-huh.

Q. Is that part of our materials? I couldn't remember whether I had seen that --

MR. HALL: Those are the pumper reports themselves.

CHAIRMAN WROTENBERY: Uh-huh. This was the only evidence that we had, and --

THE WITNESS: I thought they were --

CHAIRMAN WROTENBERY: -- the water-production rates --

THE WITNESS: -- or I would have put them in, I would have made them an exhibit.

MR. CONDON: Yeah, I don't know that we've ever --

CHAIRMAN WROTENBERY: Immediately --

MR. CONDON: -- seen those. We'd like to see those --

CHAIRMAN WROTENBERY: -- after the fracture?

MR. CONDON: -- exhibits.

MR. HALL: We've produced them through discovery, and we can make those an exhibit.

CHAIRMAN WROTENBERY: If you would, appreciate that.

THE WITNESS: Do you want to do that right now?

MR. HALL: Sure, if you have those, it's a good time to do it.

THE WITNESS: What this is, is a compilation by well, all the way -- They start in like February, 1995, all the way through September of 1998, and they're each monthly -- the monthly sheet that the pumper reports to the operator.

MR. HALL: Would you like us to make copies and provide this to the Commission, or shall we come back after the hearing and retrieve this and reproduce it?

CHAIRMAN WROTENBERY: If you would make copies and provide those.

MR. HALL: All right. For the record, then, we'll tender this as Exhibit A-12, then.

THE WITNESS: Mr. O'Hare --

CHAIRMAN WROTENBERY: Okay, I guess when we get the copies available and everybody has --

THE WITNESS: Mr. O'Hare, I think he has an exhibit in his testimony that is almost exactly the same. So I'm sure it had to come from the same documents.

MR. HALL: Yeah, they got this in discovery so...

CHAIRMAN WROTENBERY: Uh-huh. Yeah, I just --

THE WITNESS: So I thought everyone had it, I didn't know it wasn't in --

CHAIRMAN WROTENBERY: -- I hadn't picked up on it in my review of what we had.

MR. CONDON: Yeah, I'm not sure what we have. We just want to see the complete set so we know if what we've got is complete or not.

CHAIRMAN WROTENBERY: Thank you.

MR. HALL: So we'll get this in the record, then.

CHAIRMAN WROTENBERY: Thank you.

Did you have any redirect, Mr. Hall?

MR. HALL: Just briefly.

REDIRECT EXAMINATION

BY MR. HALL:

Q. Mr. Ancell, you might want to refer back to your Exhibit A-9 on this question, talking about water. To your knowledge, did any of the PC wells that you studied ever -- were they ever on pump?

A. Not to my knowledge. And you know, I looked at all those -- In 1995, at least, I didn't see any evidence that they were ever on pump.

Q. All right. And on Exhibit A-9 you show water production rates for the Gallegos Federal 6 Number 2, and in 1995 you're showing rates of what? In excess of 80 barrels a day?

A. I could look it up and see exactly what it is. About -- It looks like a little over 2000 barrels a month, so that's 70, 80 barrels a day.

Q. Okay. Could those volumes of water have been lifted without pump from those coal wells?

A. I don't believe so.

Q. Mr. Ancell, In your opinion are the water-reporting data that you looked at sufficiently reliable to support your conclusions?

A. Yes.

Q. Now, with respect to your conclusion that there is water from the Fruitland Coal formation invading the Pictured Cliffs formation, from that do you conclude that there is a waste of Pictured Cliffs gas reserves being caused?

A. In the sense that they're being produced by a well that's supposed to be completed in a different reservoir, yes. They aren't being wasted in the sense that they're going off into the atmosphere.

MR. HALL: That concludes my redirect.

CHAIRMAN WROTENBERY: Any follow-up?

MR. CONDON: One more, yes.

RECROSS-EXAMINATION

BY MR. CONDON:

Q. You haven't done any analysis, quantitative or otherwise, to determine whether the volumes of water would be liftable without pump on the Whiting wells, have you? Mr. Hall just asked you about?

A. No, no.
Q. And you mentioned the third bench, and that's that low portion of the Pictured Cliffs?
A. Right.
Q. All right. And I believe that's the area you believe might be responsible for the water in the 2-R; is that correct?
A. Well, that's a possibility, yes. I think that's probably the most likely possibility.
Q. Is the third bench a possible cause of water in any of the other Chaco wells?
A. Obviously, there had to have been a source of water way back a long time ago. If I'm even sort of right, these wells had to have been making some water, essentially from time zero. And that source had to have come from either this -- one of the benches of the PC, and you calculate higher water saturation at the bottom one, so you automatically think that's where it's coming from.
Q. But you don't think it comes from the third bench on any of the other Chaco wells, besides the 2-R?
A. No, I'm saying that they produced water also, and they could have -- the water could have come from those also.
Q. Could have communicated with the third bench?
A. Yes.

Q. And you just don't know what --

A. Could have come from the second bench too, as far as that's concerned. I don't know -- I haven't calculated water saturation, so I don't know.

MR. CONDON: That's all.

CHAIRMAN WROTENBERY: Anything else?

Thank you very much, Mr. Ancell.

MR. HALL: May I take just a moment --

CHAIRMAN WROTENBERY: Sure.

MR. HALL: -- to prepare for the next witness?

CHAIRMAN WROTENBERY: Why don't we go ahead take a break?

(Thereupon, a recess was taken at 2:28 p.m.)

(The following proceedings had at 2:36 p.m.)

CHAIRMAN WROTENBERY: We're ready.

MR. HALL: At this time we'd call Jack McCartney to the stand and ask that he be sworn.

<u>JACK A. McCARTNEY</u>,

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

DIRECT EXAMINATION

BY MR. HALL:

Q. For the record, sir, please state your name.

A. I am Jack A. McCartney.

Q. Where do you live and how are you employed?

A. I live in Lakewood, Colorado, and I'm employed by McCartney Engineering, L.L.C.

Q. In what capacity?

A. I am the manager of McCartney Engineering, L.L.C. We're a petroleum consulting firm.

Q. Would you give the Commission a very brief summary of your educational background and work experience?

A. I graduated with an undergraduate degree in petroleum engineering from Colorado School of Mines in 1965, worked in industry a couple years, went back at night school, got a master's in engineering, petroleum engineering, in about 1972, and then there have been -- worked in industry for various companies for, oh, about seven years, and then formed McCartney Engineering, Inc., in 1972 -- in 19- -- yeah, maybe it was -- I don't know, 1979, I guess it was, 1978, something like that, about 25 years ago, and have been consulting ever since in the area of reservoir engineering.

Q. Are you familiar with the Application that's been filed in this case?

A. Yes.

Q. Are you familiar with the wells and the lands that are the subject of the Application?

A. Yes.

Q. And have you prepared testimony and certain exhibits in conjunction with your investigation into this case?

A. Yes.

Q. And do you affirm and adopt the testimony you've prepared for this case?

A. Yes, with a couple corrections.

Q. And you've also prepared some exhibits labeled M-1 through M-36 in this case?

A. Yes.

Q. And you've brought forward additional exhibits, I understand. There's a new Exhibit M-9, replacing the previous M-9?

A. A corrected exhibit, yes.

Q. And then there's a new Exhibit M-37, M-38 and M-39; is that correct?

A. Yes.

Q. Those exhibits were created by you or at your direction and control?

A. Yes.

MR. HALL: At this point we'd tender those exhibits M-1 through M-39, and the substituted M-9 as well.

MR. GALLEGOS: We would ask that the Chair reserve ruling on Exhibit 37, 38 and 39, which are brand-new exhibits we haven't had a chance to look over. I'm sure Mr. McCartney may be able to explain.

M-9 is a correction. We don't have an objection on that, so we would not object to 1 through 36.

CHAIRMAN WROTENBERY: At this time we'll admit M-1 through -36 into the record.

Q. (By Mr. Hall) Mr. McCartney, would you provide the Commission with a summary of your investigation and the conclusions you reached in this case?

A. Yes, what have been asked to do in this case is to look at the performance of the wells in question, both the Whiting wells and the Pendragon wells, and evaluate the volumetric reserves of both formations in this area, review the pressure histories that have been recorded particularly over the last year and make an analysis as to the likelihood of sufficient gas reserves to support the production in both the Coal formation and the PC formation, review the potential for reservoir damage in the Pictured Cliffs wells, and to reach conclusions particularly whether this reservoir had been depleted, had been pressure-depleted, prior to the time that Pendragon -- or Edwards frac'd their wells, the PC wells, and then to compare to the performance of the Pictured Cliff wells and the Whiting wells, as well as to determine if any reserves had been lost due to the shut-in order that took place about 13 months ago on the PC wells.

With respect to the performance, I've put some of the exhibits up here on the wall. To start with, the -- and it's been explained before -- the Fruitland Coal wells began acting a whole lot like Fruitland Coal wells right off the -- from the very start.

Q. Mr. McCartney, why don't we identify for the record which exhibits you're referring to as you go through this?

A. That particular exhibit is Exhibit M-3. High initial water production. Water production rates on the Whiting wells range from 100 barrels a day to 180 barrels a day in the early life of these wells. Gas production was relatively low to start with.

And then as the reservoir pressures went down, gas evolved from the coal and was produced with an upwards trend in gas production. This particular well in Exhibit M-3 is the 6-2 well. That well was put on compression, it appears, early 1998, which caused another increase in production for a while, and then increased again in production once the Whiting -- or once the Pendragon wells were shut in. But a typical performance, particularly up until the last year or so, very typical of the coal gas wells.

What we can see -- Another thing we ought to observe on this is when they installed compression the gas jumped -- the gas rate jumped dramatically over previous levels, which you would expect from wells producing from the coal, because you lower the pressure, more gas evolves, and more gas is produced.

The Pictured Cliffs wells started out back in the -- most of it in the 1970s, produced fairly good initial rates and then started on a decline for a while. In the first few years, the decline was not too severe, but then we see a shift in the decline on some of these, a downward shift in the decline, which indicates that something's happening with the reservoir, the transmissibility of the reservoir is decreasing over time on most of these wells, and we see a -- basically a shift in the performance curve, which is actually a shift in the transmissibility of the formation, or the reserves in the formation.

Q. For the record, you were referring to Exhibit M-10, M-11 and M-12.

A. Thank you. Another thing I want to put on these exhibits -- I've got a set here that -- the IPs on all these wells are not reflected by the initial production rates. Even though the initial production rates on several of these wells are quite good, the IPs are even better.

The Chaco 1, which is Exhibit M-10, had an IP of 342 MCF a day, which would be about 11,000 or 12,000 a month, and I'm marking on this exhibit about where the IP was of 342 MCFD.

The Chaco 4 had an IP of 480 MCF a day, which is just 15,000 a month, and that's Exhibit M-11. I'm marking on at about -- just short of 15,000 a month, where the IP was.

And on the Chaco Number 5, the reported IP was 1029, a little over a million a day, was the IP on that, and that's a little over 30,000 MCF a month. I'll put a mark on there that says 1029.

Q. And that's Exhibit M-12?

A. And that's Exhibit M-12.

I also observed that the IPs, the original IPs on all wells, all three of these wells, exceeded any production levels that have since been attained by those wells.

The reason I believe, if you look at the data, why these wells declined so rapidly here after a few years and did not perform like a high permeable gas reservoir should perform is because we had damage being created in the reservoir during this period of time. What I've done to investigate that damage, a couple things.

First of all, the performance of some of these wells, to me, did not look like typical gas wells should perform. It may be somewhat hyperbolic on the front here, but then they should have a long, linear decline. The only way that they cannot do that with the permeability that we have out here, which is anywheres from 25, say, to 100 millidarcies -- the only way is to have a limited reservoir or damage. Well, there's several ways. Limited reservoir, damage.

Looking at the cross-sections that Mr. Nicol put up and examining the geology of the area, the potential for limited reservoirs in every single case to me is very remote. I think we have a blanket deposition in there. I don't think we have a limited-reservoir situation. So therefore, I think the problem with these wells is damage.

Mr. Thompson tells me when he pulled these wells, when Edwards bought them, they had scale in the wells and they had some water in the wells. Water obviously imbibes into sandstone reservoirs and decreases the relative permeability of gas and makes it very difficult to produce.

These all have 2-7/8-inch tubing, which is about the size of that bottle. In fact, that's just about the size, it might fit inside of it. Very small area. One barrel of water will fill up, oh, about 1600 feet. I think it's six barrels per 1000 feet they use in the field. So if we had one barrel of water in that casing, that would result in a back pressure of some 70 pounds.

So if we have low bottomhole pressure anyway, original pressures on the order of 240 pounds, it doesn't take a whole lot of water to log it off entirely to where the well wouldn't produce.

And as Mr. Ancell explained, if the gas rate gets down, it won't lift very much water. So it won't take much water invasion into these wellbores to cause problems.

Then, if we have scale in the bottom of the hole and we have low temperature, we're dropping the pressure in the reservoir, we probably have scale in the reservoir itself. That's why a mere small acid job probably wouldn't do much good.

Not to have -- You know, if we didn't have pressure transmission in here, that meant something had to be plugged up entirely, like Mr. Ancell testified.

In many cases, these wells were left open to the pipeline, and so they actually tried to flow where they weren't able to build any appreciable pressure because they tried to flow.

In the cases where they're shut in, there's a high likelihood they had water in the well that cause the surface pressure readings to be much lower than they otherwise would be.

Most of the damage -- Or the damage calculations I've done, shown on M-25, Exhibit M-25, what I did there was, I pulled out the deliverability tests that were supplied to the State of New Mexico, which shows in most cases a flowing pressure, a line pressure and a flowing rate. And from that data you can calculate, with a few other reasonable assumptions, you can calculate the effective permeability seen by those wells.

And what I found out was, as we go through time, that permeability calculation, the calculated permeability, which is the same as, you might say, transmissibility, the ability of the wells to produce, went down dramatically. On these three wells it went down as low as nine percent of the peak rate that was observed, and that doesn't even count the IP. If the IP were considered, well, then, the effective permeability out here later in the life is way down. And that's why these wells wouldn't produce worth a darn.

Now, talk has been made of the incremental increase from 4, 3, 2, 1 MCF a day at -- say, in early 1995, to 400 MCF a day, saying, well, that's a huge increase for a frac job. Well, we are going to show that at this point the reservoir was not pressure-depleted. We had 150,000, 160,000 here, which is -- from 240 pounds, we're depleted a ways, but we still have quite a bit of pressure in there, number one.

Number two, we had significant damage in the reservoir here that we evidently frac'd past, and we opened that reservoir up, created a long fracture in there, and now we've got good production.

We see in every case the production declines, some a little more than others, but the trend is a declining trend. Particularly in 1998, we see a dramatic decrease, and I think that's caused -- that's about the time that offset Whiting wells were put on production -- I mean put on compression where their flowing bottomhole pressures were lowered dramatically, and there may have been some fluids drawn back out of the PC reservoir because of the frac treatments in the Whiting wells.

Post-stimulation, we've got these rates up here, 300- and 400-MCF-a-day-type rates, do not look like coal wells, for the same reasons that Mr. Ancell said. Primarily, absence of water production is a big, big characteristic.

We did not produce, in my opinion, very much water on this at all. We have some reports. The highest I believe I've seen on those reports is 40 barrels a day, and it appeared that that was on the Chaco 1 in March of 1995, and it could have been about the time that well was frac'd, so that could have been bringing back frac fluid. So maybe introduced fluid that it was producing, instead of reservoir fluids.

Absent that 40-barrel number, everything else is down to either zero or up to 30 barrels a day on these wells.

The Chaco Number 5, which has produced a lot of gas, has virtually never produced any water. Had this been completed at the wellbore, at the PC wellbore, into the coal, it would have produced a lot of water.

The other thing is, these wells always flowed. Initially, I think Paul Thompson said he had a little bit of problem getting them to flow. Naturally, they frac'd them. They pumped 100, 200 barrels of water in there and it took a while to get it back. But through their work they got them to flow, and from that point on they flowed continuously up until the time that they had a little problem loading up here in 1998 or 19- -- yeah, 1998, it appears, and then of course they've been shut in for the last 13 1/2 months.

The fact that these wells produce gas and no water and the Whiting wells produce lots of water as well as lots of gas, there's stark contrast in the way these wells have produced, and that's shown on one of my exhibits also.

Now, I also looked at the volumetrics. One of the exhibits, the new exhibit, M-37, is the detail behind the volumetric analysis that I made for the Chaco 1, the Chaco 4 and the Chaco 5 wells.

What this shows is that we digitized the log, basically, on a two-foot -- sometimes one-foot -- two-foot intervals, put down the necessary characteristics from the log, calculated the porosity, the percent shale, the water saturation and the hydrocarbon pore volume on an interval-by-interval basis.

I've broken these up into two sections. One I'm calling, basically, the perforated zone, and -- in my list of exhibits -- and the other is what I'm calling the lower zone.

Basically, the difference is, the perforated zone or the zones -- basically the upper bench and the middle bench, as per Nicol terminology, that have been perforated and completed in these wells. The lower bench has not been perforated in any of these wells. I believe there's a likelihood that the fracture-stimulation treatments may have penetrated and connected up the lower PC intervals in these wells. That would add some gas supply to the system.

What I have calculated here is only the gas that equates to a gas saturation of greater than 35 percent. Or the other way around, if I reached a water saturation greater than 65 percent I said there will be no appreciable flow of gas, and so I did not count any gas reserves if the analysis indicated saturations in excess of 65-percent water.

What that means in accordance to the production is that if we take these three wells -- which are the only wells that had sufficient logs to make such analysis as I've made here -- take those three wells, compare that to their cumulative production, we'll find that the average well has drained about 218 acres of these three wells, which are, of course, our three best wells.

The other well that was fracture-stimulated is the Chaco 2-R. The reason that I did not do log analysis on it is, it does not have a porosity log, it does not have a density log. So you need porosity to determine the other reservoir parameters like water saturation and hydrocarbon pore volume. That well does not have one, although if you look at that well it has about 24 feet of the upper -- or the middle bench in there, that has good enough resistivity to be -- probably calculate pay. So I believe that well has about 24 feet of pay, but it's not included in this particular analysis.

If we include -- My 218 acres is only considering the perforated intervals -- perforated zones, that would be a more correct term. If we include all the gas supply that we believe -- that I believe -- may be available to these wells, then it's produced about 137 acres worth at this point in time.

By contrast, the coal wells have produced volumes much more in excess of their available reserves in the coal alone. If we look at only the -- If we look at the 6-2, or the Section 6 Number 2 well and the Section 7 Number 1 well, those wells have already produced more gas and are still producing at the highest -- nearly the highest rates they've ever seen in their life. They've already produced more gas than you can put in the coal in 320 acres.

In fact, at current production or current cumulative production, they indicate they've already drained all the recoverable reserves on 350 acres, and that's using my estimate of 110 standard cubic feet per ton for gas in place in the coal.

Mr. Robinson uses 100 standard cubic feet on the high end and 80 cubic feet on the low end. If we use those numbers, the areas expand to 385 acres or 481 acres.

The actual measured gas content at the pressures that I'm working with is calculated to be about 73 cubic feet per ton based on the core analysis in the Lansdale Federal, and that's described in the testimony. If the gas content is only 73, then they've already drained 535 acres.

I don't believe -- I really don't believe the gas content is as low as 73. I think it has to be up there in at least the 110 range. It could be higher, it could be higher.

If we take the area, for instance, including the 6-2, the 7-1 and the 12-1 wells, which are all located no more than three-quarters of a mile away from each other, and maybe not even quite that far, if we take those wells there, those wells together have already made 2.8 BCF. That would take 943 acres to account for that out of the basal Fruitland Coal formation.

If those wells continue to produce on the declines that I have estimated in my analysis, then they will end up draining about 2000 acres. 2000 acres is just about a mile in radius. So you can draw a circle around this whole area. That's how much gas -- Irrespective of the production of these other wells in the area, that's how much gas these wells appear to be producing from the coal alone.

So the question I ask is, where's the problem? These wells are producing better -- A couple of these wells are the very best wells in the whole area, three out of four of the best wells in the area. And the other best well down here in Section 19, also a Whiting well, that's a good well. That's made -- I'll have to check, maybe 600,000 MCF.

Those four wells -- one, two, three, four -- are the very best coal wells in the area. You can go to Brad Robinson's exhibit where he shows the average of the Whiting wells that's in this set of exhibits, his set of exhibits. He'll show the average of the Whiting wells.

While you're looking at that exhibit, look at the magnitude of production of these wells. It's much, much higher, maybe more than twice as high. So these are the very best wells in the coal in the whole area.

Now, Whiting makes a claim that not only do they get all the -- that they're producing all the coal gas, that we're also producing coal gas.

Now, if the PC wells is truly coal gas, then it's almost unimaginable how much area must be drained. If you'd add the production from the PC to the production from the coal and then calculate the volumetrics, it's just not reasonable.

The reason -- One of the major reasons why these are PC wells and not coal wells, not only the lack of water production, large water production, the 100- to 180-barrel-a-day ranges that they saw, but the reservoir pressures. The reservoir pressures in the PC wells prior to the last six, eight months, year or so, have always, always been lower than the coal pressures, every single day since they've produced.

And most of them, except for the Chaco 4 and 5, just recently, which we know -- we've agreed, I think, that they're in communication, the PC and the coal is in communication in this area around the 4 or 5, the 6-2, 12-1, maybe the 7-1, other than that, the pressures in the coal -- or the pressures in the PC is always lower. It cannot be that way if they were completed in the coal.

Even with the Chaco 5. Chaco 5 had an initial reported pressure like 240 pounds. In 1979 they reported 174 pounds, and they had produced 51,000 MCF. Now, I'm not purporting to say that 174 pounds is real good pressure, because I don't know the conditions under which it's taken. But it is relatively early in the life of the well.

When Edwards went in there to frac that well, it had produced 63,000 MCF. Now, if you extrapolate that pressure -- it looks like originally it was 225 -- through 174 at 51,000 and you go to 63,000, that says it still should have 161 pounds reservoir pressure. And I believe that's real close to what they observed after they frac'd that well. So that well to me looks like it's clearly a PC well also.

What we have now, which we didn't have before, is we've got over a year's shut-in pressures. Actually available to me is about a year's shut-in pressures. I have the pressures through about June. Didn't have that a year. Well, we had -- As alluded, maybe we had a week or two of shut-in pressures there, or a few days of shut-in pressures, it wasn't a week or two, but three or four days of shut-in pressures, that was made available at the hearing last year.

What have we learned about the reservoir pressure in this last year? We've learned, number one, that the 1-J well has been in the 190-pound range all the time. So that represents PC pressure at the location of the 1-J, which is real close to the 1-1 coal well.

We have seen no indication of pressure drop in the 1-J due to the production from the 1-1 well. That means to me that there's no interference between those wells. I cannot say that that frac in the coal went into the PC. If it did, it has not affected at all the 2-J.

Q. I'm sorry, are you referring to --

A. The 1-J is down here. I'm sorry, the 1-J is in the southwest quarter of Section 1, close to the 1-2 well. Better get my pressures correct here.

Okay, it's the 2-J, the 2-J up here. And it's right on the numbers. It's about 190 pounds up here, the 2-J.

The 1-J has also stayed flat, and it's flat at about 147 pounds. And it graphs like Exhibit M-28, Chaco 1-J, basically flat, changes up and down a pound or so. But it sees no interference from any other wells in the entire area.

What's that tell us? It tells us that in this part of the PC reservoir you've got 190-some pounds reservoir pressure here, we've got 147 pounds' pressure over here in the Chaco 1-J.

Very similar, particularly the 147 -- 147 pounds, very similar to the same pressures that were encountered in the Chaco 4, Chaco 5, the Chaco 2-R and Chaco 1 when they were frac'd.

Now, what -- The other thing it says is that the 2-R well in Section 7, close to the -- fairly close to the 1-7, or the Section 7-1 well, is not in communication with the Fruitland Coal formation. Even though it was frac'd, it's not in communication, I don't believe, because the pressure net reservoir has built from about 57 pounds when it was shut in to about 79 pounds. And I believe Mr. Nicol said that took ten months or so to build, but there's a graph of the pressure in the exhibits.

Q. And you're referring to the 7-1 well, rather than the 1-7 well?

A. Yeah, the 7 -- Section 7 Number 1 well.

So the 2-R indicates that it still has -- that it has ability, but it takes a long time to build pressure. But it doesn't appear that it's being affected by another production that we can tell, not materially affected by any production in the area.

Not so with the Number 1, Number 4 and Number 5 Chacos.

The Number 1 Chaco sits way down here to the south. It's some 4400 feet away from the nearest Whiting well to the north, maybe a little further away from the Whiting well in Section 19. I'm not even sure that's their Whiting well, but anyway it's a long ways away from the nearest production.

Even the Lansdale Federal well, north -- I believe that's it over here in the northeast quarter -- is -- Actually, the Lansdale Federal is up here. It's a long ways away from any well. It's maybe 3300 feet away from any well, but we see that well suffering a pressure decrease.

That tells us two things: One, that reservoir energy is leaving the drainage area, affected area of that well, because of pressures going down, gases leaving that area, causing that pressure to decrease.

But number two, it shows that that well can see pressure -- sees pressure response from a long ways away, at least 3300 feet. And these nearest wells aren't producing very much gas. So that well is seeing in the PC reservoir a very large area. That tells us that these wells have the ability to drain a very large area. That's not even our best well.

The same could be said for the 4 and 5. Those have suffered pressure drops, pretty substantial pressure drops, but it appears that's directly related with the nearby coal wells. I'm not sure which coal well, because I haven't really studied that. There may be other experts that have opinions on that, but I don't. But I do believe that it's one or two or three of the Whiting coal wells located in Section 6, Section 7 and Section 12.

What's happening there, same thing: Gas is leaving that PC interval. It's going someplace, presumably out the coal wells. This probably happened about the time the coal wells were put on compression in November of 1997, and about January and February, 1998. They substantially dropped their surface flowing pressures, substantially dropped the reservoir pressures, and maybe have caused gas from the PC formation then to be attracted towards that wellbore and produced out of it.

Prior to that time, the PC wells were pretty much holding their own in the reservoir with the coal wells, in the PC reservoir.

CHAIRMAN WROTENBERY: Mr. Hall, it's been about 30 minutes. How much --

THE WITNESS: I've got about one more thing. I'll be brief.

It's a fact that the PC reservoir was not pressure-depleted. That is a fact. The wells may have not been producing in economic quantities, but it was not because of lack of reservoir pressure, it was because of damage.

And the only thing we can say about the last thing is, what happened when we were forced to shut in the Chaco wells in the Pictured Cliffs formation? The Exhibit M-35 shows the gas-water ratio -- which is just the reverse of a water-gas ratio -- it shows the gas-water ratio, which means as this blue curve goes up, that represents the combined gas-water ratios of the Whiting 6-2, 7-1 and 12-1 wells. And the red curve here represents the gas production from the Chaco Number 4 and Chaco Number 5 wells, which are in very close proximity. So there's three gas coal wells, two PC wells.

What we see when these wells went on compression, you may have seen a little jump, a little bit of jump in the -- but not much of a jump, in the gas-water ratio. But what happens when we shut in the PC wells? We see a very dramatic increase in the gas-water ratios. What that means is that the coal wells are producing a much higher percentage of the gas with respect to water than they were prior to those wells being shut in.

A couple explanations. One would be, they are sucking PC gas out of the PC reservoir, causing a new source of primarily gas, no water, to enter these wells, which causes a big increase in the gas-water ratio, or that they are seeing some initial desorption of gas from the coals by virtue of their compression. But I would have anticipated this to be a little more smoother curve, and this coincidental jump just when these wells shut in as very, very suspect. That, coupled with the loss of pressure we're seeing in the 4 to 5 suggests that that gas may be produced from those coal wells.

MR. HALL: Thank you, Mr. McCartney.

Madame Chairman, shall we have him authenticate the new exhibits that have come in?

CHAIRMAN WROTENBERY: Yes, I think we need --

MR. HALL: Get those in.

CHAIRMAN WROTENBERY: Well, he talked about M-37 --

MR. HALL: Correct.

CHAIRMAN WROTENBERY: -- I believe, already.

MR. HALL: Shall I just interrogate him briefly about those?

Q. (By Mr. Hall) Mr. McCartney, you've already discussed new Exhibit M-37 and what it shows. Would you discuss, first of all, what is the change to Exhibit M-9?

A. M-9 was corrected from the previous exhibit. In the column that's labeled "Estimated Drainage Area", what I had neglected to do in calculating that area was to account for a recovery factor. So the previous numbers that were in that column were divided by, I believe, 76-percent recovery to get the area that would be affected, considering the -- just the recoverable gas, not the entire gas volume. So all those numbers increased by a factor of about 1.4 --

Q. All right.

A. -- because of the correction.

Q. All right, how about Exhibit M-38? What does that show?

A. And I might add that that correction also would result in a correction in the text of my previous testimony to reflect these new numbers.

The M-38 is in response to -- or actually is a graph, set of graphs, for the Chaco Number 1, Chaco 2-R, Chaco 4 and Chaco 5, showing the producing gas-water ratios based upon the production data that was obtained from pumpers' reports and tabulated by Mr. O'Hare in his Exhibit Number 44.

Q. M-39?

A. M-39, I believe, is a comparative analysis of the water sample or the water analyses that were taken by the OCD Aztec office in February of 1998. And what I've done is basically, for the convenience of the Commission, shown those values and then represented those values in bar graphs for each of the components that differ. There's a couple components in there that are the same for all the wells, and I didn't bother to graph those.

But the graphs shown show the 6-2 well, the 7-1 well, the 12-1 well, which are all coal wells, and the Chaco 2-R, the Chaco Number 4 and the Chaco Number 5, which are all PC wells. The coal wells are the three bars on the left, and the PC wells are the three bars on the right on each graph.

And you'll see there's differences in some of the compositional ingredients in the water analysis between these coal wells and PC wells.

Q. Were Exhibits M-37, M-38 and M-39 created by you?

A. Yes.

MR. HALL: At this time we'd move their admission.

MR. GALLEGOS: No objection.

CHAIRMAN WROTENBERY: Exhibits M-37, M-38 and M-39 are admitted into the record.

MR. HALL: Mr. McCartney is ready for cross-examination.

CHAIRMAN WROTENBERY: Mr. Gallegos?

CROSS-EXAMINATION

BY MR. GALLEGOS:

Q. Mr. McCartney, it's twenty till four, and I'm going to try and just get to the crux of things here so we can get this done.

I think in your testimony you put the issue you're addressing real succinctly. You said the question, who is producing whose gas?

A. Correct.

Q. Okay. And basically to -- This may not be very scientific vernacular that I use, but what you're telling the Commission is, the gas, recoverable gas, in the Fruitland formation is modest compared to the production of the Gallegos Federal well, and the recoverable gas reserves in the Pictured Cliff formation, you think, are very sizeable, and hence the answer to the question must be that the Whiting wells are producing Pictured Cliffs gas? That's an oversimplification, but that's the crux of what you're saying, isn't it?

A. Well, the gas reserves in the PC are not necessarily modest.

Q. No, I said in the coal. You're saying the gas reserves, compared to what the Whiting wells are producing are modest, the gas reserves in the Pictured Cliff formation are great, and when we see the production from the Whiting wells, hence, we must say the gas is coming from the Pictured Cliff formation?

A. No, that's not -- I mean, those are great coal wells, they produce a lot of gas, they've produced about 347 BCF of gas -- well, even more than that, pushing 4 BCF of gas. That's a lot of gas. So it's not modest production or reserves in the Fruitland Coal.

Q. But aren't you trying to tell the Commission there's not enough coal gas in the Fruitland formation to explain the 3.7 BCF of gas that the Whiting wells have produced?

A. Yeah, they must either be affecting a big area, or there's another source of gas, that's true.

Q. Yeah, that's what you're saying. And the other source, you say, because you do some studies here, and you say the Pictured Cliffs gas, in spite of some information that it's a depleted reservoir within pay and so forth, you're saying, no, it has large recoverable reserves in this area?

A. Well, Counselor, I'm not saying thin pay, depleted pressure, depleted reservoir at all.

Q. No, I'm saying others have --

A. So quite to the --

Q. -- characterized it --

A. Quite to the --

Q. -- that way.

A. Well, that --

Q. I'm saying others have characterized it that way, but you say to the contrary, no, that it has extensive, wide pay and high pressures and large recoverable reserves, the Pictured Cliffs?

A. Well, the Pictured Cliffs is in places at least 100 feet thick, and portions that are gas-saturated and productive, and that's not exactly thin. So they -- I will characterize it as I have in my testimony, and whoever wishes to characterize it, that's -- obviously, they have their opinion.

Q. Yeah, well, maybe you're not -- I mean, my question is not clear, you're not hearing it. I say, others have characterized it as thin pay, low pressure reservoir with mod- -- with slight reserves. And you're saying, to the contrary, it is thick pay, high pressure, large recoverable reserves?

A. No, it's got relatively good pay section. It's low pressure: 240-pound pressure is not high pressure; 13,000 pounds is high pressure. So it's low pressure --

Q. All right.

A. -- but it's not necessarily thin.

Q. Let's take each of those -- Let's take a look at what you've done to arrive at the information you've presented concerning the Fruitland Coal formation, all right? And then we'll talk about the Pictured Cliffs shortly.

Now, start with -- you say, to date the five Whiting wells have produced about 3.7 BCF of gas.

A. I believe that my data was through the end of

April of 1999, so they've produced that plus 200,000 or 300,000 thousand feet, that's right.

Q. And in fact, if the -- since the fracture stimulations on the Chaco wells, we have a production from those wells in which some people believe the origin of the gas is the Fruitland formation. There's another .9 BCF of coal gas that has been produced from the Fruitland formation. Wouldn't that be true?

MR. HALL: I object to the form of the question.

THE WITNESS: I do not believe that is true, no.

Q. (By Mr. Gallegos) No, if you assume -- Just assume that the production from the Chaco wells, after they were fracture-stimulated in 1995, and until they shut in, in July of 1999, had its source in the coal, then you would have an additional quantity of production from the Fruitland formation.

A. If you combine -- I will answer it this way, if you -- Mr. Gallegos, if you'll allow me: If you combine the production post-frac from the Chaco wells with the total production of the Fruitland Coal wells, you do add approximately a BCF of gas to that volume, that is true.

Q. That's exactly what I was asking you.

A. Not quite, but okay.

Q. All right. So now, when you make your calculation as to the gas in place and the recoverable gas in place from the Fruitland Coal formation for this area, you use 110 standard cubic feet per ton of gas?

A. Yes.

Q. And that is a critical assumption to your calculations?

A. Yes.

Q. All right. If that assumption changes -- For example, if you use 166 standard cubic feet per ton, it makes a very significant difference, and you come out with a very different answer, isn't that true?

A. It would be true, yes.

Q. Now, did you calculate -- Did you make a calculation of the recoverable reserves in the Fruitland Coal formation using 166 standard cubic feet per ton?

A. No.

Q. All right. When I look at your Exhibit M-1, which is entitled "Isotherm of Gas Content as a Function of Pressure", I see the 110 standard cubic feet per ton, and I see a reference to isotherm from the Lansdale Federal Number 1 core-derived data.

A. Yes.

Q. Does that give -- Is that supposed to be an indicator or a foundation for your use of the 110?

A. Well, what the graph shows is what the actual measured data, the average data from the Lansdale Federal, equated to with respect to gas content and as a function of pressure, and that's the lower curve on there. And that would represent at my assumed bottom -- original pressure, about 72 cubic feet per ton.

I believe that was too low. At the last hearing I used 110. That was substantially the same as the Whiting experts -- I shouldn't say "expert". Mr. O'Hare, I believe, had a similar opinion at the time. That opinion may have changed.

Mr. Robinson now says 80 to 100, which is lower than 110, so it's -- anything -- anything that we go -- differs from the actual measured value is obviously a change from known data. I went up.

Q. Well, when we talked about known data, I'm interested in whether you made an observation from what was provided on this very same issue by Pendragon's expert, David Cox, because at page 37 Mr. Cox refers to the Lansdale Federal Number 1 cores taken in 1978, and he says, and I quote, "Laboratory isotherms on three samples indicated the maximum volume of gas that the coal could hold range from 149 to 190 standard cubic feet per ton, with an average value of 166 standard cubic feet per ton." End quote.

Were you aware of that information?

A. Well, the Langmuir pressure, Langmuir volumes that I used in my analysis came from Mr. Cox.

I don't -- I didn't hear you reference a pressure. Now, sure, that may be the maximum that it could hold. Look at my graphs. They go clear on up, they're inclining up. You put 500 pounds pressure in there, it will hold a lot more gas than it will at 250 pounds pressure. And that may very well be what Mr. Cox is referring to, and you can address that with Mr. Cox.

But these -- The derivation of this particular graph came from Mr. Cox, and it is an average of several of those readings. It isn't any single one.

Q. Have you made any effort, Mr. McCartney, to investigate into the literature or into what is being documented in experience in the San Juan Basin in regard to what have been earlier calculations of gas in place in the Fruitland Coal formation, as compared to what experience has shown to be recoverable reserves?

A. I've looked in this area. I am familiar with stuff up further north, particularly Fairway production up in -- further north in the Basin.

Q. So you're --

A. I knew they have a lot higher gas contents, yes.

Q. Well, but you're acquainted -- Whatever the beginning gas content would be, then you're acquainted with the fact that Amoco has experienced that the recovery in the Cedar Hills field has been over 100 percent of what they calculated the recoverable gas to be, based on what was used as their standard cubic feet per ton. Are you aware of that?

A. Well, I haven't reviewed that. I do know that the estimates have evolved.

Q. And it's being found out, commonly being observed by all the operators that the standard-cubic-feet-per-ton estimates that they were using have been incorrect, have been in error, and they've been recovering more gas than that rule of thumb would indicate is even in place?

A. And that's --

Q. Isn't that what's being experienced?

A. And that's precisely why I increased these numbers 50 percent, because I didn't really think the 72 was representative. The 110 I think is more representative.

Q. Are you aware of work that has been done and reported by the Gas Research Institute concerning this very issue of the large variance between what the standard-cubic-foot-per-ton calculations have been and what the experience has been in the recovery of coal seam wells in the San Juan Basin?

A. Well, I know that there's been some research on it. Matt Maver has done a lot of that, and I've talked with Matt Maver on some of this stuff. But I'm sure there's lots of opinions and various techniques they use to measure the gas contents. So I don't think there's a common answer.

Q. Are you aware --

A. But I believe -- Yeah, I think that from the earlier stuff that Matt Maver did, not speaking to Amoco or anybody else, his earlier estimates of gas content he found to be too low.

Q. Well, the paper by Dr. Charles Nelson of Gas Research Institute, published in 1998, indicates that they have found that in some established coalbed gas fields, the long-term cumulative gas production greatly exceeds the initial-gas-in-place estimates. It goes on to say, "This large variance indicates that the reservoir parameters used to calculate the initial gas in place were inaccurate and that significant potential may exist for large reservoir growth in many existing fields."

Are you familiar with that --

A. No.

Q. -- the results of that research?

A. I'm not familiar with that particular paper.

Q. But you are familiar with the fact that the Gas Research Institute for the last few years has been studying this very issue?

A. They've spent a lot of money in coal gas development, yes.

Q. Your study refers to none of the literature, or relies on none of the literature, none of that study?

A. Well, I don't quite any literature in my analysis here. Some of the theory, again, is obviously from the literature.

Q. In your calculation -- Just a question or two more about the coal gas reserves. In your calculation, do you take into account whether or not the fracture stimulations in the Whiting wells would have opened up some of the coal seams that are above the thick coal, or did you strictly confine your calculation to the coal in which the perforations are located.

A. I've only calculated the basal coal in the wells that are completed, perforated in the basal coal. I have included the upper coal zones in the well, the -- I believe it's the 1-2 well, that is completed, purposely completed, in those upper zones. But unfortunately, it turns out to be by far the poorest well of the group.

My conversations with operators in the area indicate that they don't think those upper zones contain hardly any gas.

Q. All right, let's turn to your calculations on the Pictured Cliffs recovery. If I understand your testimony, you approach your analysis of the Pictured Cliff reserves by doing P-over-Z calculations, volumetric calculations -- and then maybe this is the same -- material balance calculation. Or is material balance part of the volumetric estimate?

A. Well, it's yes, yes, material balance is the same as P over Z.

Q. All right. So there are two approaches?

A. Yes, volumetric and pressure-related, yes.

Q. All right. And since -- You would not disagree with the representation that in the Chaco wells the perforations are open to pay on the extent of roughly 15 to 18 feet, maybe 13 feet, 16 feet --

A. I'm sure I have those --

Q. -- maybe 22 feet in the three wells that you particularly gave attention to?

A. That's in the range. I do have those numbers, if it's important to the Commission, but is a range of usually less than 20.

Q. But your approach is, you do not confine the look at reserves to that maybe 13 feet or 22 feet of pay that's open, but rather you look down into the depths of the lower benches of the PC to justify the conclusion that there's more reserves?

A. I've looked at all the intervals that I believe to be potentially productive in the PC wells. The perforated intervals are generally are what's referred to as the upper bench and the middle bench. And if they would, for instance, perforate the top five feet of the middle bench, and the middle bench is 15 feet thick, well then I say that's perforated -- completed zone.

Then if we have a shale break and we go into the lower bench that may or may not be communicated in the wellbore absent stimulation, that's what I call the lower zone.

So the perforated zones, I believe, are those zones that are available to be produced from current perforations.

Q. Let's see if we can get an answer to my question, which is, you do not confine your calculation of reserves in the Pictured Cliff to the portion of the Pictured Cliff in which the well is completed?

A. I though I just answered that. Yes, I -- Of course I do. If a zone is perforated, whether it's one foot or ten feet --

Q. -- then you include the ten feet? If it's perforated one foot, you --

A. Certainly, I --

Q. -- include the ten feet?

A. -- I include the zone --

Q. Well --

A. -- which is common practice in the industry.

Q. All right. While these may not represent the exact numbers, do these exhibits demonstrate your approach for calculating the reserves using the P/Z approach?

A. No, I'd rather refer to the actual exhibits themselves, which I've presented to the Commission. They represent my methodology. That's --

Q. That doesn't represent your methodology?

A. No, you won't find two curves on my exhibits. There's one.

Q. Well, but your curve utilizes the production from the Pictured Cliff wells that resulted in 1995 and continued until July, 1998, after these wells were fractured; isn't that correct?

A. Both pre-stimulation and post-stimulation, yes.

Q. But you do not draw a P/Z calculation and estimate reserves based on the curves, the production points, prior to the frac?

A. Well, those points are certainly on the graph, yes, and they're certainly honored.

Q. But that's not your curve on which you based the calculation of your reserves, is it?

A. Well, certainly that first point, for instance, Chaco Number 1, sitting up there at the -- it looks like

230 --

CHAIRMAN WROTENBERY: What are we looking at here? I'm sorry.

MR. GALLEGOS: Well, these are exhibits from Mr. Brown's -- Let me give you the numbers. Mr. Brown's exhibits.

COMMISSIONER LEE: This is not P/Z.

THE WITNESS: That's true.

MR. GALLEGOS: No, it's not.

THE WITNESS: That's just wellhead shut-in pressure versus --

Q. (By Mr. Gallegos) Right, I was --

A. -- cumulative production.

Q. -- trying to use this as a -- Let's look at your exhibits. I'm trying to get to the point as fast as I can. The point is, you've made your calculation, P/Z calculation, utilizing the gas that was produced from these wells after the frac, not following a curve based on their production history before the 1995 fracs; isn't that correct?

A. I've honored all the data, that is correct.

Q. All right. So if the gas produced from the wells in 1995, after they were fracture-stimulated, had its source in the Fruitland Coal formation, then that is not representative of reserves in the Pictured Cliffs formation; isn't that true?

A. That is true.

Q. All right. Mr. McCartney, let me show you what has been marked as Exhibit W-30 and represent to you that that is a compilation of the production history of all of the WAW-Fruitland-Pictured Cliffs wells from the beginning of development of that pool up until this year. If you will assume with me that that is what the data shows, then have not all of the wells in this Pictured Cliff Pool exhibited the same production history, the same decline history, as the Chaco wells?

A. Well, it certainly can't be derived from this exhibit.

Q. Well, basically the Chaco -- Before these wells were fracture-stimulated, they exhibited -- and this is the Chaco Number 4, for example, and this is an exhibit from Mr. Brown's testimony -- and that they exhibited initial production levels, this particular well maybe up to 200 a day, and then a decline curve over the years, down basically to no production. And what I'm saying, that is typical of what all of these wells in this reservoir have done, at least up until the time that the Chaco wells were reworked; isn't that a fact?

MR. HALL: I think the question is vague. Do you understand the question?

THE WITNESS: Well, that is not a fact, and that is not true, that not all the wells in the Pictured Cliffs represent this type of behavior.

Q. (By Mr. Gallegos) Well, you're saying the Chaco well behavior, and I'm talking about -- Understand, I'm asking you about the period of time before we have the dispute, because of the fractures in 1995.

A. Yes.

Q. The Chaco wells behaved in terms of initial production and decline in a manner that was typical of the other wells in this WAW-Fruitland-Pictured Cliff reservoir; isn't that a fact?

A. They all perform differently, and not all of them exhibit this type of behavior. A lot of them do, but not all of them. So I can't characterize this as being all of them.

Q. I didn't say that. I said it was a typical representative. In any group of this many wells, I'm not saying there's not exceptions, but these wells produced, declined and came basically down to a noncommercial status in a manner that was typical of the other wells in this field, in the Pictured Cliffs?

MR. HALL: I'm going to object. I think the question asks the witness to assume that all Pictured Cliffs wells perform equally the same. I don't think the exhibit shows that.

CHAIRMAN WROTENBERY: I'm not sure that the question asks him to --

MR. GALLEGOS: No, it doesn't.

CHAIRMAN WROTENBERY: -- make that assumption. At the same time, I'm -- I think the witness has already said that he doesn't think that he can derive any conclusions about the wells in the pool from this graph. So maybe it would help if you talked a little bit more about what you want to show with this graph.

MR. GALLEGOS: Well, I just asked him, and I guess, looking at this, if the Chaco wells don't appear to --

MR. HALL: I'd be happy --

MR. GALLEGOS: -- don't appear to have a history before 1995, that it's a typical production curve for wells in this field.

MR. HALL: Well, then I think the question has been asked and previously answered.

THE WITNESS: Well, we'll take a look at a couple of these. How about the Bartlesville well that evidently is operated by Edwards? It shows --

Q. (By Mr. Gallegos) By your client, yeah.

A. It shows a dramatic increase in production in the last few years on your deal.

Q. That's exactly right. In fact, that's part of what this shows, isn't it? There's an interesting uplift in 1994 and 1995 in this field, and if you see in which wells that has occurred, they've almost all been Pendragon wells.

MR. HALL: I'm going to object to Counsel's testifying.

MR. GALLEGOS: Well, that's what Mr. McCartney's looking at in the last page.

MR. HALL: No, it's what you're --

THE WITNESS: I'm looking also at the Coleman State Number 1 well. It looks like it's substantially increased in production. So I think your statement is too general and can certainly not be answered by the representation on this graph, and it can be answered, particularly if we look at the individual performance history of every one of these wells, which I'd be happy to do.

Q. (By Mr. Gallegos) Well, would it be your testimony that the wells on here, the many, many wells on here that, over the period of time of basically mid-1980 to -- on up to the present, have gone to noncommercial status are all in that condition because of skin damage?

A. I'd have to review -- I can certainly review every one of these wells and the data associated with these wells and then render an opinion on that --

Q. Would you render an opinion of just --

A. -- but I can't from -- Absent studying the information, it's illogical to render an opinion on that.

Q. Okay. If you look at the data, the performance of all of the wells in this reservoir, up until 1994, would you agree that it indicates that this is a depleted reservoir?

A. No, there's no pressures indicated on this graph, Counselor, it's only production.

Q. All right.

A. Depletion has to do with pressures, not production.

Q. And pressure has to do with the question of skin damage that you rely on to justify the results we see on the Chaco wells where they -- after the fracture treatments in 1995, they have produced more gas per day or per month than they ever produced when they were originally completed?

A. Well, they all IP'd higher than they've ever produced subsequent, as I've already said. And I did not characterize the formation damage as skin damage.

Q. I'm glad you mentioned the IP. When you're talking about that, you're talking about an initial completion and a three-hour absolute open flow test to the atmosphere?

A. Not in all cases. I don't know what the back pressure was on those particular tests.

Q. Well, that's probably what you're talking about, isn't it --

A. Well, I do too know what --

Q. -- the open flow to the atmosphere?

A. I guess I do have that information. We will see what we're talking about.

Q. Let's see what you have.

A. Well, in the case of the Chaco 4, there was no reported casing pressure at a 3/4-inch choke. In the case of the --

Q. What is the date on that, and what is that taken from?

A. That was a -- I believe it was a completion report of May 3rd, 1977.

Q. Well, there's a form, the OCC has a form for that and the delivery test. Do you have that? Then we would know the conditions under which that test was taken.

A. That is available. I think I was supplied that from Mr. Thompson, and I just wrote down all the numbers that were related to that.

Q. So you don't know what the circumstances are when you say that this was the IP or initial production?

A. Well, I know what the report said. But I wasn't there, that's right.

Q. No, that's not the question. You know what the report says in a numerical amount; that's what you're telling us?

A. Yes, I know it was perforated, I know where the perforations were. They're 19 feet perforated --

Q. Well, we're asking about the IP, Mr. McCartney --

A. The IP --

Q. -- that's all I'm asking you about.

A. The IP was 480, it was on a 3/4-inch choke, it was an hour and a half, and there was no reported casing pressure, no report of water production.

Q. So open to the atmosphere, it would read 480 --

A. No, it doesn't say that.

Q. Well then, you don't know whether it was or not?

A. Not on that one. Others there are, like the Chaco 2-J, five-and-a-half-hour test, 1/2-inch choke, 208 MCF a day, 150-pound casing pressure, produced four barrels of water.

Q. But that doesn't tell us whether or not that was absolute open flow. That's what I'm asking you.

A. Well, that probably tells us that for sure was not an absolute open flow, because it had significant back pressure -- well, tubing pressure, tubing pressure, 27 pounds. So that wasn't an AOF.

These others had nothing in the column with respect to tubing pressure, and some had nothing in the column with respect to casing pressure, so it's indeterminate.

Q. Do you have an understanding of what -- a reporting of the initial -- the IPs, which means initial potential, right? Is that what the "IP" stands for?

A. Yes.

Q. Do you understand what the practice is and what the forms called for, the OCD, or what they did at the time these wells were being completed in the late 1970s?

A. I observed what they put on the form, yes.

Q. No, I'm asking you what the conditions were supposed to be for making that initial potential test.

A. I guess I don't --

MR. HALL: Do you want to show him a form so you can interrogate him on that?

MR. GALLEGOS: Well, all he's doing is, he's got some notes, and I'm trying to find out what conditions, because you throw out some numbers, under what conditions were the tests taken?

THE WITNESS: I'm sure we have those forms that I took this off of. If that will answer your question, we'll supply those to you.

Q. (By Mr. Gallegos) Are you trying to tell the Commission that initial potential test means that those wells would produce at those levels on any kind of a sustained basis, Mr. McCartney? You're not saying that --

A. No.

Q. -- are you?

A. No, they were tested at those rates.

Q. Now in the matter of damage. You say -- Let's take the Chaco 4, for example. It's down -- By 1984, all the way up until May of 1995, that's basically a noncommercial, nonproductive well; isn't that true?

A. Well, that -- It's either noncommercial or somebody doesn't spend any money operating it at those levels, because it's not producing hardly any income at those levels, that is true.

Q. All right. For some eleven years?

A. For a long period of time, it appears on the graph, yes.

Q. All right. And the wells were owned at that time by Merrion, Merrion Oil and Gas, Bob Bayless. Are you familiar with those operators?

A. I don't personally know either one of those gentlemen.

Q. Have you heard of them?

A. I've heard of them, yes. I see their names on these reports.

Q. All right. And what you're telling us is that these people did not realize, as do you, that the only reason these wells weren't producing something 300 or 400 a day is because they had skin damage?

A. I don't know what they thought, because I haven't talked to them.

Q. All right. If a well has skin damage and it is shut in for a period of time so that the pressure will stabilize, it is a fairly fundamental investigation to draw -- to come to the conclusion whether it has such damage or not, isn't it?

A. Well, it certainly is. I believe I did that in this analysis.

Q. I'm saying the well may not be productive, but if it's shut in for the pressure to stabilize, it's still going to reflect the pressure that indicates that it could be productive?

A. Well, the bottomhole pressure, if it has communication with the reservoir, should be representative of the reservoir pressure. The surface pressure may have no relationship to the bottomhole pressure in these instances, because just a small amount of water makes a big difference in the hydrostatic head in such small casing, and so the surface pressures could be entirely unreliable because of water loading.

Q. Well, let's talk about -- First of all, the example you gave with your water bottle there being a 2-7/8 and one barrel of water filling up 1600 feet, you were off by a magnitude of 10, weren't you? 2-7/8 --

A. I don't believe so.

Q. 2-7/8 tubing, one barrel of water would go about 166 feet; isn't that --

A. Oh, okay, it's 1000 feet for six barrels. 166, 70 pounds, yeah.

Q. Yeah --

A. So that --

Q. -- you said 1600.

A. -- the results -- yeah. I'm sorry, yes.

Q. Okay. Now, if you shut in -- if the well is shut in -- Let's say it's got water in the casing, or here it's almost -- we're talking about a tubing that's used as a casing. If it's shut in for the opportunity for the pressure to stabilize, at the surface, even after an extended period of time, you're not going to be able to get a reading that would indicate to you what the bottomhole pressure is?

A. Not unless you know the fluid level in the hole.

Q. Well, and you can do that. I mean, there's simple ways to calculate that. You can have an instrument that -- placed on the well and shoot the fluid level?

A. You certainly could.

Q. Then -- Yeah, and then you'd know what your bottomhole pressure is?

A. You can make a lot better estimate than just using surface pressure, that's correct.

Q. And if the pressure indicates to you it's, let's say, 50 or 60 pounds, you say, Heck, there's nothing in this reservoir and we're not going to do anything with the well. Right? We're not going to worry about skin damage?

A. Well, you've made a lot of assumptions, I guess, and if I were truly convinced that the reservoir pressure was depleted, then obviously, no matter if it was this well or a coal well or whatever well, if it's truly depleted there's no use messing with it.

Q. All I'm trying to make clear for the Commission is that to determine whether a well is not productive, whether the reason is, a), a depleted reservoir, which doesn't justify the attempt to produce, or, b), because of skin damage, there is a fairly straightforward way to come to that conclusion, isn't there?

A. Well, you could break down the formation and then let it flow back and take a bottomhole pressure to make sure you communicate. Number one, you've got to know whether you're communicated with the formation, and that's not apparent from the surface. Just standing there looking at a valve or shooting a fluid level, you don't know for sure if the perfs are all sealed off, scaled off or not.

Mr. Thompson told me when he pulled the tubing on these particular wells, that there was scale on them and they could tell that there had been water in the hole because it looked like it had been laying on the floor of the ocean. So there was evidence of water in the hole on these wells.

Now, whether somebody would have gone out there, Mr. Bayless or whoever, and as a routine basis took the surface pressure and shot fluid levels and -- assuming you could shoot a fluid level in a 2-7/8-inch hole, which I don't really know if you can or can't accurately. But if they had gone to that, or had they run bottomhole pressures, we would have had better information.

What I'm saying, and OCD staff in Aztec will confirm, that these pressures that are reported are not reliable, they're basically no good, those early pressures, so you can't rely on them.

Q. Let's see if we can come to agreement on one simple point. Even if the well is nonproductive of gas, because of what you refer to as skin damage, it will still reflect pressure of the reservoir, and that can be ascertained in ways that are commonly used by oil and gas operators?

A. You're making the assumption, again, that you have communication with the reservoir, irregardless of skin.

Q. Well, if you have --

A. I don't think skin is necessarily the problem in here, but you use the term all the time, but that's not my term.

If you have communication with the wellbore, if there's no fluid in the well, or you know what fluid is in the hole and you know the density of that fluid, well then easily you can calculate the density of the column, and you can measure the surface of the pressure, add the two together and get the indicated bottomhole pressure, that is correct.

Q. Well, and if you have no communication with the reservoir, then you're not going to have any pressure reading?

A. Well, you may not.

Q. At page 16 of your testimony, you set out your material balance analysis on five of the Chaco wells.

A. Yes.

Q. How are those calculations made?

A. They're made as demonstrated in Exhibits M-19 through M-24, where you plot the bottomhole pressure divided by Z against cumulative gas production, and then you create what you feel is the best fit of that data, using the data that you think is the most reliable, and then extrapolating that will give you an indication of the material-balance-derived gas in place.

Q. So it is derived, at least derived in large part from your production over time plots on the well?

A. It's cumulative production and pressure, is what is needed for the analysis.

Q. All right. And let's take a look at what this shows. And of course, this would employ the gas-production volumes from the wells that resulted during the period after their fracture stimulation in 1995 and up to the time they were shut in?

A. The entire production history --

Q. The entire --

A. -- pre-stimulation, post-stimulation.

Q. Okay. And for the Chaco Number 1 you would indicate an original gas in place of 720,000 MCF?

A. Yes.

Q. That well was fracture-stimulated by Pendragon in January of 1995?

A. Yes.

Q. For the Chaco Number 1, you indicate original gas in place of 75,000 MCF?

A. Yes.
Q. That well was never fracture-stimulated by Pendragon?
A. That's true --
Q. But --
A. -- as far as I know.
Q. But your calculation indicates that it has a gas in place for that well of 75,000 MCF?
A. Based on material balance, that's correct.
MR. GALLEGOS: Right.
MR. HALL: You're referring to the 1-J; is that correct?
MR. GALLEGOS: I'm referring to the 1-J. Did I not state that?
MR. HALL: I thought I heard 1. Just make sure.
Q. (By Mr. Gallegos) For the Chaco 2-R, that well was fracture-stimulated in January of 1995, but that is the same well that Mr. Conway selected, and that is the one of the four wells that was fracture-stimulated in which the perforations are below the top of the massive Pictured Cliff, correct?
A. I don't characterize it below the massive Pictured Cliffs. I call it the middle bench of the Pictured Cliffs in that well.
Q. All right.

A. Maybe terminology, but yes, that's -- the upper Pictured Cliffs is not present in that well, I don't believe.

Q. Well, unlike the Chaco 1, the Chaco 4 and the Chaco 5, it is not perforated and was not fracture-stimulated above the lower coal and near the upper thick coal, correct?

A. The question is whether it's perforated above the lower coal and below the massive coal?

Q. No. Unlike the Chaco 1, 4 and 5, it was not perforated and not fracture-stimulated above the lower coal and near the upper thick coal?

A. To respond to that question, I suppose I'll have to check your perforations on your graph.

Q. Please do.

A. Counselor, I don't believe that's correct in the Chaco 1, because I don't see a lower coal in that Chaco 1 well. The perforations appear to be represented correctly in the Chaco 1.

Q. The Chaco 1 is right over here. Here's the Chaco 1. Is that what you're looking at?

A. Yes, and that doesn't appear to have the coal in there, so that's in correct with respect to that well.

Q. This doesn't appear to have a --

A. Well, it's perforated below that -- If that represents the coal, it's perforated below that.

Q. And also perforated above it?

A. Yes.

Q. Well, that's what I was saying.

A. Oh, okay, I'm sorry.

Q. The Chaco 2-R is the only one of the four wells that were fracture-stimulated, that the perforations are completely below any of the coal seams? Put the question that way.

A. Okay, I'll agree to that.

Q. All right. And the Chaco 2-4 was the well that after fracture stimulation had by far the less gas uplift of all of the four wells that were frac'd in 1995 by Pendragon; isn't that correct? I've placed a copy of JTB-16 in view here, if it will help you with the volumes before and after the --

A. Yeah, I believe that -- That appears to be correct. It also was by far the poorest well frac'd by Edwards or Pendragon in this particular area.

Q. And then the wells that you come up with using P/Z analysis for your material balance, where you have almost approximately a BCF of original gas in place are the Chaco 4 and 5 wells that were fracture-stimulated in May of 1995?

A. Yes, they were stimulated and they do have significant reserves, that is correct.

Q. Yeah, based on your use of the production -- total production, as you put it -- from the beginning, including what occurred after 1995, correct?

A. Correct.

Q. Let me ask you a few questions about new Exhibit 37 here. You're taking us down, I take it, sort of down the hole, in the first page of this exhibit on the Chaco Number 1, deep -- from the upper Pictured Cliffs or whatever you want to call it, from -- down into the deeper or third bench of the Pictured Cliffs formation?

A. Yes, sir.

Q. Okay, and this is your justification for saying that there's additional reserves, that as you go down below where the well is perforated, there are still recoverable reserves?

A. Very possibly could be, yes.

Q. All right. You were asked about the lower zone back in July, were you not, whether that held any kind of potential? You did testify --

A. Yes.

Q. -- last July, didn't you?

A. Yes, I probably was asked more than one question, even.

Q. Okay. Well, at page 344, when we were talking about this lower portion of the Pictured Cliffs, you said:

It's my understanding that operators were hesitant to frac their wells, particularly in the -- because of fear of the frac migrating down into the lower portion and loading the wells up with water.

And then at 397 you were asked:

And are you aware that it is essentially universal practice in the Basin that operators do not perforate what you have designated here, colored in green and called the lower zone?

ANSWER: I would anticipate it's common practice that that zone is not perforated.

QUESTION: Okay, why would you anticipate that?

ANSWER: Because it's not perforated in these wells subject to this analysis, and it exhibits low resistivity and low gas saturations, high water saturations, higher clay content, and is probably not in itself commercially producible resource.

Wasn't that your testimony at the hearing last summer?

A. If this is verbatim from the transcript, I agree that it was.

Q. Okay. But now we understand that you have a bit of a different view regarding this lower portion of the Pictured Cliffs; is that true?

A. I'm not so sure about that. I think I stated then that the common practice was not to perforate that zone. Back in the early 1970s you probably had 20-cent gas out here, and if you handled any water you probably couldn't make commercial gas wells with that low gas price. And handling water, I understand, in those days was extremely expensive with respect to the economics, and operators just stayed away from that.

I believed then, and I believe now, that there's mobile gas in those lower zones that could be produced, and you'll probably make some water. But I don't think I've changed my position on -- that there would be available gas in those lower zones to contribute to the production if it were completed. In fact, there are some wells that are completed in those lower zones, and they produce gas.

Q. Would it change your views if, when the Chaco wells were completed in 1978 and 1979, that Merrion and Bayless had long-term gas-purchase contracts with El Paso Natural Gas providing for area rates, and that under the NGPA in 1978, 1979, 1980, these were new gas wells bringing over three dollars an MCF?

MR. HALL: Well, I'm going to object. Are you asking him to assume that those gas contracts were honored?

Q. (By Mr. Gallegos) In those years, absolutely, because they were.

MR. HALL: Well, it assumes facts not in evidence. I object.

MR. GALLEGOS: Well, the facts will be supplied in evidence if the witness wants to talk about 20-cent gas.

Q. (By Mr. Gallegos) Let's -- Assume with me --

A. Yeah, in the early 1970s. By about the 1980s, the gas price started up. And I do have that information, and maybe they had a -- You know, I don't know what the contract or obligation was, but if they had three-dollar gas, well then, it was worth going after and looking after the wells.

Q. Okay, but the wells have not been perforated and produced from this lower portion of this zone, because it exhibits low resistivity, low gas saturation, high water saturations, higher clay content, and is probably not in itself commercially producible; isn't that true?

A. Well, they're frac'ing these wells now like crazy, and they may be frac'ing into that zone, it doesn't bother them today. But then, you don't find very many wells, it's true, that were perforated down there.

Q. Other than --

A. I would have initially perforated that upper part.

Q. Other than Pendragon, who is frac'ing these wells like crazy?

A. Coleman.

Q. With Paul Thompson doing the work?

A. I don't know whether he's doing the work or not, but I'm informed that Coleman is frac'ing PC wells.

Q. Frac'ing PC --

A. And I'm not aware that Pendragon is frac'ing PC wells out there in the last year or so, but Coleman is --

Q. And Paul --

A. -- and maybe others, I don't know.

Q. So -- And if you know about that, then you know that this work is being done by Paul Thompson, the same --

A. I don't know any of the contractual arrangements that Coleman has with anybody.

Q. But the operators in this field, like Texaco, Bayless, Dugan, for all these years they stayed away, and have stayed away up to this time, from that portion of that formation? Isn't that true?

MR. HALL: Well, I'm going to object. The question he's being interrogated on with respect to his earlier testimony is whether the lower zone in itself was a commercially viable zone. I think that's a little bit different than what Mr. Gallegos is asking him now. It mischaracterizes the prior testimony.

CHAIRMAN WROTENBERY: Would you repeat your question, Mr. Gallegos?

MR. GALLEGOS: Well, I think Mr. McCartney understands it. He's looking through --

THE WITNESS: Well, I don't see Texaco as a major operator out here anymore, for one thing. And I don't know whether these other operators, Dugan and the others, are actively planning to frac PC wells or not, or whether in fact they have at this date.

Q. (By Mr. Gallegos) Let me just get a little basic information from you quickly on your Exhibit M-37. Let's turn to that. Your water-saturation cutoff is 65 percent?

A. Yes.

Q. By that point, you can no longer recover any meaningful gas if you have a water saturation that high?

A. Well, you could recover gas. Gas is probably mobile, you know, clear up into the 80s, but you probably wouldn't produce very high rates. But 65 percent is kind of a standard for water cutoff in sandstones, and it has been my observation that gas can be produced from zones that exhibit less than 65 percent.

Q. Okay. Let's just go down, if you would, your parameters, please, and give us the information so our people will be able to understand what you've used here to make your analysis.

A. Okay, you have standard Archie-equation coefficients A, m and n, and they'll know what that means. R_w is the resistivity of the water, .22 ohmmeters. We have the resistivity of the shale of 2 ohms right off the logs. The matrix density we used was 2.65. We used a fluid density of 1.0.

The gamma-ray of clean -- Clean gamma-ray shale was 135 units on this particular log -- or actually gamma-ray shale was 135, gamma-ray clean is 55.

And we didn't consider it to be productive if the shale content would exceed 30 percent. We didn't consider it productive if the porosity is less than ten percent, so as a cutoff for productive if the water saturation were above 65 percent, and leaves a formation volume factor of .0616.

Q. How did you get the resistivity of the connate water, the R_w?

A. I think it's from water analyses.

Q. That was just given to you, provided to you?

A. I think I have water analyses there. I believe that's where it's derived.

Q. Okay, and that would be in the -- would that -- We'd find that in your -- I thought you had a water analysis, Exhibit M-39?

A. There are water analyses. I don't know -- It gives a bottomhole resistivity there, it gives the conductivity at standard conditions.

Q. But is there something that you've supplied us, though, that we can --

A. Well, I suppose you can derive it from that conductivity. Or I can supply you with where that came from, yes.

Q. All right, if you would, please.

A. Okay.

Q. Okay. And now, apart from your various calculations, as a result of Mr. Nicol's testimony yesterday, I believe we have two nontheoretical, real-world examples of wells in this Pictured Cliff field, one where the fracture stimulation has fractured down into the lower coal, and one where there is perforations actually in the lower coal. Are you familiar with those two examples he gave us?

A. I don't believe so.

Q. Okay. Well, the one -- Did I say coal? I'm sorry, I meant Pictured Cliffs, and I may have thrown you off on that.

The two Pictured Cliff well examples, they were both Dome Federal wells. Mr. Nicol said the Dome Federal

17-27, 17 Number 3, was fractured -- Remember, that was on his exhibit. I think it was N-33, where he also had the tracer survey on the Bartlesville well. You're not familiar with that?

A. I am familiar with the well that had a tracer survey run out there. It very well could be the same well.

Q. Well, wouldn't you want it -- You're coming before the Commission, and you're saying, I'm theoretically calculating that there's more reserves down in the Pictured Cliffs below where operators have typically opened it up and produced it, I'd like to be able to come before you and show you some examples where that's actually happened?

A. Okay, I do recall a tracer survey that indicated that the frac in the PC went down and would have communicated, I believe, those lower benches --

Q. Right, I think --

A. -- on that particular well.

Q. I think Mr. Nicol read it -- you might get the exhibit if you like -- read it as going down 35 feet or so. Do you have that, Mr. Hall? N-33?

MR. HALL: Yes. We're looking at the Dome now?

MR. GALLEGOS: We're looking at that Dome Federal Number 3.

THE WITNESS: Yes, I think I've seen that.

Q. (By Mr. Gallegos) Okay. So that's one real-world example of where the fractures opened up. What does it look like to you? I may be mistaken. I thought Mr. Nicol said he thought it was 35 feet down below the lowest perforation?

A. Thirty-something, it looks like.

Q. Right.

A. That's pretty close, yeah.

Q. And then he also brought to our attention a well in 26 North, 13 West, Section 2, the Dome Federal 13 Number 1, and he said that was actually perforated in the lower PC.

A. Okay.

Q. I don't remember what exhibit he had on that, but I think he just maybe testified about that without having an exhibit.

All right, so if that's the case, then you'd have two examples of what kind of reserves could be recovered in this lower portion of the Pictured Cliff formation?

A. I believe the High Roll Number 4 up there also is completed in the lower zones, but that Dome Federal well is located right here, I believe.

Q. Okay, in Section --

A. Section 12.

Q. -- 13? Section 12.

A. Southwest of 12, yes.

Q. Southwest of 12, okay.
Now, with those examples, are you aware that the Dome Federal Number 3, shown on Exhibit N-33 produced from 1979 to 1992 a grand total of approximately 14,000 MCF?
A. I haven't checked that, but that's verifiable. If that's what the record shows, I would agree to that.
Q. Really a noncommercial well?
A. Doesn't sound very good, no.
Q. Two or three MCF a day, probably, over that time, right?
A. Well, I couldn't characterize it without looking at the history. I doubt that it -- I suppose it was more than that.
Q. Okay. Well, if you will assume --
A. At one point in time it --
Q. I'm sorry.
A. But...
Q. If you will assume with me that that was its production --
A. Uh-huh.
Q. -- over that period of time, as an example of a well with a fracture opened up to the lower portion of the PC, that would not be indicative of a commercial well, would it?
A. Well, those volumes probably would not, you know,

unless you're getting your three-dollar gas price -- Well, getting your three-dollar gas price, you might actually pay it out at 17,000. But that's not a very good well in the area, no.

Q. Over 13 years, about 1000 MCF a year. Not a good well, would you agree?

A. Not a good well.

Q. All right. And then the one that was actually perforated, the Dome Federal 13 Number 1 that was actually perforated, produced over the period of 1981 to 1999, up to date, 18 years, it's made 95,000 MCF. Not a good well, do you agree?

A. Well, it hasn't performed very well to date -- Well, that's not bad, 100,000. But it's not as good as these wells. Performance indicates -- The performance hasn't been as good, that's true.

Q. Just one other thing I'd be interested in having the information, if you can provide it. Mr. Nicol tells the Commission that the real impetus for fracture-stimulating these Chaco wells was the Chaco Plant Number 5 that his partner, J.K. Edwards reworked in 1993. Are you familiar -- You're familiar with that testimony?

A. Yes.

Q. Are you familiar with the well?

A. I've seen the performance history on that well, yes.

Q. And did you do an estimate of the original gas in place and recoverable reserves on that well?

A. No, I haven't to date.

MR. GALLEGOS: That's all the questions that I have.

CHAIRMAN WROTENBERY: Commissioner Lee?

COMMISSIONER LEE: (Shakes head)

CHAIRMAN WROTENBERY: Commissioner Bailey?

MR. HALL: Madame Chairman, I might interrupt before Ms. Bailey begins her questioning.

Mr. Conway has about 45 minutes before he needs to leave, if you want to take the time and question him now.

I also have additional questions for Mr. McCartney, so however you wish to proceed.

CHAIRMAN WROTENBERY: Two minutes? Okay. Yeah, if you want to go ahead.

MR. HALL: His material is printed out as well.

CHAIRMAN WROTENBERY: Okay.

MR. GALLEGOS: I'd like to see.

MR. HALL: Shall we have Mr. Conway assume the stand?

CHAIRMAN WROTENBERY: Yeah.

MR. GALLEGOS: Well, may we -- The objective here was, we'd have an opportunity to see these things, not Just on the spur of the moment.

MR. CONWAY: I got that on my computer. I apologize, but we had to print those out individually.

CHAIRMAN WROTENBERY: We'll start with Commissioner Lee's questions.

MICHAEL W. CONWAY (Recalled),

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

EXAMINATION

BY COMMISSIONER LEE:

Q. I'm sorry, I'm very interested in your simulation.

Can you tell me how many GOHFERs you've sold in the San Juan Basin?

A. How many GOHFERs we've sold? BJ has them, Permian has them in Midland that they've used in the San Juan Basin.

Q. Any independent users?

A. In the San Juan Basin, no.

Q. Okay, so zero.

Okay then, would you please tell me -- I want the other side also to listen to this.

MR. CONDON: Gene?

MR. HALL: Mr. Gallegos?

MR. GALLEGOS: Pardon me.

Q. (By Commissioner Lee) You know, when you present a simulation, I see the black box. Okay? There are 20,000 knobs you can -- So would you please provide me all the equations you have to construct your simulator?

A. Yes, sir, I can do that.

Q. Okay, and also how you handle the interface, what trick you use for the interface.

A. Okay. Yes, sir.

Q. All right? And also clearly tell me the initial and boundary conditions of your domain.

A. Yes, sir, I can do that.

Q. Okay?

A. Now, to provide all of the equations, we've basically got them in Power Point presentations, primarily --

Q. I don't want presentations, I just need to know what is the constant equation, your flow equation, your momentum equation and maybe your energy equation, plus your interface equation.

A. Okay, those are basically contained in three SPE papers, three or four SPE papers --

Q. I want you to write it down.

A. Okay, I will --

Q. All right.

A. -- but it will take time to do that, yes.

Q. Yes. And what is the trick to handle the interface between the layers, and also what is your initial and boundary condition? After doing that --

A. Excuse me just one second. Momentum equation --

Q. -- flow equation -- Your momentum equation, maybe have U and V, okay? And C. I want to see if --

A. Okay.

Q. -- U, V and W, displacement.

A. Yeah.

Q. And the initial conditions, boundary conditions. After you submit this one to me, then what is your variable?

A. Okay. Yes, sir, I understand.

Q. Is that agreeable?

MR. GALLEGOS: Yes.

CHAIRMAN WROTENBERY: And I think Commissioner Lee will be asking for the same thing --

MR. CONDON: Yeah.

CHAIRMAN WROTENBERY: -- from --

MR. CONDON: -- I understand --

CHAIRMAN WROTENBERY: -- your expert.

MR. CONDON: -- yes.

MR. HALL: I will see that it's supplied to all. He'll supply it through me, be glad to do that.

THE WITNESS: I'll work on that this weekend, because I have to get the papers put it together, and you'll get it Monday, and then you can forward it?

MR. HALL: Will do.

THE WITNESS: Is that acceptable? Okay.

MR. HALL: Shall I send it directly to Socorro? Would you like that?

COMMISSIONER LEE: Yeah, that's fine.

CHAIRMAN WROTENBERY: We'll need a copy for the record here as well.

MR. HALL: Will do.

COMMISSIONER BAILEY: I think you know my address.

MR. HALL: I know your address.

CHAIRMAN WROTENBERY: Anything else?

COMMISSIONER LEE: No. Thank you.

CHAIRMAN WROTENBERY: Okay.

MR. HALL: Are we finished with Mr. Conway?

CHAIRMAN WROTENBERY: We need to discuss, I think, this material, don't we?

EXAMINATION

BY CHAIRMAN WROTENBERY:

Q. What is it that you have --

A. Okay, I'll -- Just let me go through them. There are three pages there.

Q. We can look on together here.

A. I went back to my records, as I agreed that I would do, and I found that I had an older simulation that I had done on the Chaco 5. And so the first of those is a predicted fracture geometry at the end of pumping for the Chaco 5 treatment.

Again, we've got the same problem in terms of the depth track on the right-hand side. It is one node, or five feet, too deep. But the pictures are correct.

On the next slide is the array of formation parameters used for the simulation. I just simply printed that out.

Or -- Maybe I've got them out of order. Is the next one a graph or a -- ? Okay, it's a graph of the predicted pressures compared to the observed pressures.

Now, obviously what I was most interested in in this is, what was the predicted shut-in pressure? The predicted shut-in pressure in this simulation is slightly over 500 p.s.i., which is less at this point than the observed shut-in pressure of about 600 p.s.i. But like I say, I spent no time trying to understand what might cause that pressure increase.

But the basic effect is, it still shows that the fracture grows up to and terminates at the base of the coal, the base of the basal coal.

EXAMINATION

BY MR. GALLEGOS:

Q. Well, if I might, first of all, the second page shows that you did not match the shut-in pressure?

A. That's correct.

Q. And you didn't try and run one to match the shut-in pressure?

A. This is the first simulation that -- on the bottom of one of those, on the next one, it says this is Chaco 5, 01. It was the first and only run I did with that, because then I started working on the 2-R.

Part of the problem is, this is constructed on five-foot nodes, to even start to represent the reservoir properties and the complexity in that zone, the time that it takes for the simulator to run goes up to about a factor of 16 as you cut the node size in half, so it's a very long simulation. And no, I never got back to it.

Q. I would read this first page as indicating that your fracture is up into the coal by maybe a couple of feet.

A. No, sir.

Q. Can you enlarge that on your screen to help us try and read it?

MR. HALL: First of all, I don't think we got the answer to that question. Mr. Gallegos asked you if this showed a fracture up into the coal. What was your answer?

THE WITNESS: The answer is, no, sir, it does not. It may be my failure to take that little picture and get it exactly oriented, but there are two -- According to the right-hand track, at 1155 there are two coal nodes below 1155, so there would be a coal node from 1155 to -60, -60 to -65. The top of the fracture is at 1165.

This operates on nodes, it can only paint pictures by node. I apologize if it's --

Q. (By Mr. Gallegos) Well, can you answer that, whether you can help us, by enlarging this?

A. I'm doing so as we speak.

Q. Are the little X's there on the right hand of your interval column, are those supposed to be the perforations?

A. Yes, sir. I'll have it expanded in just a minute. It's loading the -- loading. You're quite welcome to look, it's just loading it.

CHAIRMAN WROTENBERY: While he's doing that, could we mark this for identification?

MR. HALL: Sure, you bet. I believe this will be C-18, for the record.

THE WITNESS: The top of the fracture is one node above here. It's marked "perforation". You can see here, there's the perforation. One node above the perforation is the top of the fracture. There's the top of the fracture, and then one node above that is the --

COMMISSIONER LEE: Is this a --

THE WITNESS: This is -- Yes, sir.

Q. (By Mr. Gallegos) A node is five feet?

A. Yes, sir.

CHAIRMAN WROTENBERY: Mr. Conway, would you mind summarizing for the record what you told us just now?

THE WITNESS: Okay. What I -- I just made a blow-up of the plot so we could be clear. The top of the fracture is one node above the top perforations, which puts it at the base of the coal.

MR. HALL: And you're referring to a graphic display on your laptop computer, which we haven't printed out --

THE WITNESS: Yes, sir.

MR. HALL: -- an exhibit of that today.

THE WITNESS: It's source data for Exhibit 18.

Q. (By Mr. Gallegos) So the top perf is 1165 in that well. About 1170 is where you say is the top of this fracture that you --

A. No, the --

Q. -- simulated?

A. -- perf is 1160.

Q. What? The upper perf is 1160?

A. I mean -- I'm sorry. You said 1170, you went down a node, and --

Q. No, no, I said 11- -- Oh, did I?

A. Yes, sir.

Q. I said 1160? I probably did, I'm sorry.

A. And it's one node above the --

Q. Yes.

A. -- top perf --

Q. Yes.

A. -- yes.

Q. Which would be 1160?

A. Yes, sir.

Q. Thank you. So you -- we've got a fracture, oh, 370 feet along the coal in one direction and 370 feet in the other direction, and a total of 740, 750 feet?

A. Yes, sir.

Q. And for the coal you show a permeability value at 25 millidarcies over here on your input array?

A. Yes, sir.

Q. If, for example, the coal permeability was 150 millidarcies, that would have a bearing on how much of the fracture fluid would transmit up into the coal, would it not?

A. It would affect the leakoff, yes, sir.

Q. Yeah, there would be considerably more leakoff?

A. Yes, sir.

Q. And you maintain the 0.50 Poisson's ratio for the coal?

A. Yes, sir.

Q. Didn't we talk about this morning your running the simulation on the 2-R, I think, where we were talking about the -- where if you went ahead and made your hypothesis that the coal turned to ash and the Poisson's ratio dropped down to 0.40, and you were going to do that for us?

A. When -- At the original discussion, it was my understanding I was going to do that this weekend and provide --

Q. Oh, I'm sorry.

A. And so, no, I haven't started --

Q. Okay.

A. -- no, sir.

Q. I thought that was something you would have for us. But you'll do that over the weekend?

A. Yes, sir.

Q. Okay. You could readily do that also on the Chaco 4, could you not?

A. I can do it much easier on the Chaco 2-R, because those are 10-foot nodes, and I don't have my high-speed computer with me. To do the what-if's I would prefer to do it on the 2-R, just because it takes 24 hours to make one run on this computer on five-foot nodes --

Q. All right.

A. -- and about an hour to do it on the ten-foot nodes, so I prefer to do the what-if's on -- If I were at the lab I could do it on our high-speed computer, but I'm not there, and I won't be there.

Q. All right. Well, whatever we can have, we'd like to have it.

A. Yes, sir.

Q. Mr. Robinson recalls, I didn't, that you also said you had done one of these on the Chaco 4?

A. I did on the acid job on the Chaco 4.

Q. On the Chaco 4.

A. That's in the exhibits.

MR. GALLEGOS: Yeah, we have that.

CHAIRMAN WROTENBERY: Any further questions on --

MR. GALLEGOS: No, thank you --

CHAIRMAN WROTENBERY: -- what's been --

MR. GALLEGOS: -- Madame Chairman.

CHAIRMAN WROTENBERY: -- marked as Exhibit Number C-18?

MR. GALLEGOS: No, Madame Chairman, thank you.

MR. HALL: Move --

CHAIRMAN WROTENBERY: Any objection to -- Sorry.

MR. HALL: I'll move its admission, Madame Chairman.

MR. GALLEGOS: No objection.

CHAIRMAN WROTENBERY: Okay, Exhibit Number C-18 is admitted into the record.

Thank you, Mr. Conway.

CHAIRMAN WROTENBERY: Commissioner Bailey had some questions, I believe, for Mr. McCartney.

JACK A. McCARTNEY (Resumed),

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

EXAMINATION

BY COMMISSIONER BAILEY:

Q. For Exhibit M-3 you had the decline curve for the Gallegos Federal 26-12-6 Number 2. Have enough Fruitland Coal wells reached decline stage that you can with a great deal of certainty give a decline rate for Fruitland Coal wells?

A. I'm sorry, there's a noise, and I don't hear that good. Let me first find that exhibit.

Q. Okay.

MR. HALL: M-3?

COMMISSIONER BAILEY: Yes. This is just an example of gas production from the Gallegos Federal --

THE WITNESS: Okay.

COMMISSIONER BAILEY: -- 26-12-6 Number 2. It's probably up here. Yes, all right.

Q. (By Commissioner Bailey) And the question is, have enough Fruitland Coal wells reached the decline stage that you can with a great deal of certainty give the decline rate for Fruitland wells there?

A. Not really, this is -- Well, in essence it's not started to decline here, and so we forecast like a 20-percent annual decline on this.

Q. Is that 20 percent based on conventional reservoirs or based on Fruitland well declines?

A. Well, it's my estimate for a Fruitland well here. Now, if this continues to go up, it may turn over and decline faster on the tail end.

My last year's estimate, frankly, is conservative to this one, because I had to forecast a declining rate here, and it actually increases instead of decreasing.

Q. Which goes to the heart of my question, is, can we tell yet, what the typical decline rate is for Fruitland wells?

A. I don't believe so on these particular wells. A better method might be a material balance method, if we had good data to work with. That would be a better way to determine reserves, or wait until it starts declining.

Q. Okay, switch subjects. Exhibit M-39, the water analyses --

A. Yes.

Q. -- is this a one-time analysis of each of these wells?

A. Basically, I believe. It was taken in February. I think there's two dates, but I believe they took most of them on one date and then took some others on another date, but it basically is all from February of 1998.

Q. Are the calcium figures calculated in order to come up with the hardness? Because there seems to be a large discrepancy between the calcium cations for the PC wells and the calcium calculated for the coal wells. I'm just wondering, is that a calculated figure?

A. No, all these came straight off of the tabulated data that came off the water analyses.

Q. So to differentiate between the coal water and the PC water, can we look, in your opinion, at the calcium, the fluorides and the chlorides?

A. Frankly, it would be better addressed to the chemist than to me. I know they're different, but I don't know if -- It certainly looks like there's some differentiation in water. Whether it's a distinct difference that you could count on from well to well to well, I'm really not sure. They certainly are different than this example.

Q. If we could assume that those three cation/anions make a differentiation between the two different types of waters, would you logically expect to see changes over time in those constituents if there is cross production between the Fruitland and the PC?

A. I think that would be a reasonable expectation, if you're moving waters from the one type into waters and commingling with waters of another type and producing it, naturally it should reflect a change.

Q. Over what period of time would you expect to see that change in the water compositions between the two wells that may -- or these different wells that may be in communication?

A. It would depend on a lot of factors, like the sourcing of the communication. If it's sourced over here 500 feet away and moving through the formation, it may be gradual. You know, gradual mixing, and its source at the well itself, it should be at immediate -- it would be much more immediate.

But I don't have any experience in tracking cations in waters. My only related experience would be like a waterflood where obviously there's a big distinction between the injected fluids and the produced fluids, and you see that, and you see like the water cut gradually rising in producing wells because the injected water is mixing with the oil, so you see a gradual increase in that.

But -- And the same might work for water, if the waters were being sourced from a distance as, say, the Fruitland fracs in the Whiting wells, and it was sourced there and moving through the formation. It might be gradual.

Q. But this could be one area, line of inquiry, in order to make a more definite analysis --

A. Yes.

Q. -- of whether or not there's communication between the two formations?

A. Uh-huh, yes.

COMMISSIONER BAILEY: Thank you, that's all I have.

EXAMINATION

BY CHAIRMAN WROTENBERY:

Q. And I just wanted to ask, do you have the filings with the Oil Conservation Division from which you derived the IP numbers? They may be in our materials already, but I just don't recall where they were.

A. They're in Mr. Thompson's pickup outside.

CHAIRMAN WROTENBERY: Ah, okay.

MR. HALL: Would you like us to provide those?

CHAIRMAN WROTENBERY: Yes, if you would provide those, appreciate it.

That was all.

MR. HALL: Some brief redirect of Mr. McCartney, if I might.

REDIRECT EXAMINATION

BY MR. HALL:

Q. Mr. McCartney, Mr. Gallegos asked you some questions about the cum production from the Dome Federal well, which was, I think, on the order of about 100,000 MCF. Is that --

A. Yeah, 90-some-thousand, as I recall, yes.

Q. 95,000 MCF, yeah. And that well is producing from what we've been calling the lower bench; is that correct?

A. Yes.

Q. And I think the point Mr. Gallegos was trying to make, that production from that zone alone is not necessarily great production?

A. Yes.

Q. And I think that is in accord with what you testified to last year in these proceedings. I don't want to mischaracterize your testimony, but in the handout Mr. provided with us, you talked about the lower bench is probably not in itself commercially producible resources. Is that accurate?

A. Yeah, in a general sense. If it produces 100,000

MCF, that's -- You'd have to run the economics on that to see if it's commercial or not. But in a general sense it's not nearly so -- expected to be as prolific as the upper zones.

Q. Right, and that's in accordance --

A. Yeah.

Q. -- with what you've been saying. And the point is, isn't it true that where you have the lower bench and the higher zones as well, it's more often than not, the higher zones are the targets for producers; isn't that right?

A. Yes, in this case, yes.

Q. And so it would be appropriate to, when you evaluate a well that includes multiple benches like that, to include the reserves contributed by the lower bench in evaluating the well?

A. Yes.

Q. Mr. Gallegos identified several operators in the San Juan Basin who --

A. If I might --

Q. Go ahead.

A. -- go back to that question?

I guess another point which may not have been brought up is that in that instance, the lower bench did contribute 90,000 cubic feet of gas. So it's not entirely without reason to anticipate that we'd get a contribution, maybe a significant contribution, in our Chaco wells from that same lower bench, because it actually did contribute -- you know, it didn't have an upper bench there to help, so it did produce reserves from that lower bench.

Q. And as you say, that's in accord with industry practice when you evaluate a well, to include all productive zones?

A. Yes.

Q. Let's turn to page 21 of your testimony, if you have that in front of you there, Mr. McCartney. Could you -- You have a tabulation there styled "Reserve Loss". Do you see that?

A. Yes.

Q. Could you elaborate on that for the Commission? What was the purpose of this tabulation?

A. Well, the purpose of the tabulation is to determine the amount of gas that has been lost from the Chaco Number 1, Number 4 and Number 5 by virtue of the shut-in period the last 13 1/2 months.

And basically what the analysis is, is if you look on the P/Z curves for those wells, in 19- -- I believe the last point is -- There's two points there. One is basically close to the time they were shut in, in 1998, and the other point is here more recent, the last production date I had -- or the last pressure date I had. And one point is on top of the other point. In other words, there's a difference.

In order to calculate the gas loss from the well, you merely calculate the difference between what would have been produced down to that same pressure in the well, and I might be able to better demonstrate with one of these curves.

Well, for instance, the Chaco 4 well --

Q. Let's identify the exhibit.

A. -- Exhibit M-23, we see two points here at about the middle of the graph. One appears to represent a pressure of about 114 p.s.i.a. The other appears to represent a pressure of around 89 p.s.i.a., and that's a corrected bottomhole p.s.i.-over-Z number.

But if you draw a horizontal line from that lower point over to where it intersects the P/Z curve, that amount of gas is what has been lost. And rather than produce this gas, we now have lowered the pressure in the reservoir, so we should be over here on our cum production graph rather than where we're at, and that's how I calculate the loss of gases between those two points. And that is what we see as the loss of gas in the area that those wells are currently seeing. And that's how those numbers were derived.

Q. And you conclude that the lost reserves you've tabulated in your testimony is attributable to production from the Whiting Fruitland Coal wells; is that correct?

A. I believe it's a very good assumption with respect to the Number 4 and the Number 5 well, and frankly it's more difficult to arrive at that opinion for the Number 1 well, since it's so far away. We may or may not be losing gas to that particular -- to the nearest particular coal well. It may be lost to other wells in the area.

So it might not -- In the case of the Chaco 1, it may or may not be entirely the fault of the Whiting request to shut in.

Q. And these reserve-loss figures are current up to what date?

A. Well, they're current to the end of the pressure graphs that are shown in Exhibits M-27, basically, which looks like it's to the end of June, 1999, last pressure data I had.

Q. All right. You were asked to provide information with respect to the conduct of the deliverability tests on the wells?

A. Yes.

Q. Let me hand you that information. Will you simply read into the record from those completion reports?

That will establish what --

MR. GALLEGOS: Well, may we see this? This is supposed to be the information on the initial potential test?

MR. HALL: This is Exhibit T-2 from last year's hearing, and it shows the conditions.

MR. GALLEGOS: I think those are the IPs.

MR. HALL: Well, the question was, what were the conditions when the tests were conducted?

MR. CONDON: Actually, I think the direct question was Madame Chair's question of what were the Division documents that the witness was referring to on the testimony?

MR. GALLEGOS: I'm familiar with the form, but I can't remember the designation of it, but this is not the form. There's a form -- When you do the test, there's a form that's got the formula --

MR. HALL: Four-point deliverability tests?

MR. GALLEGOS: Yeah, that tells the whole condition of what -- under what circumstances. This doesn't -- This is just the end result.

MR. HALL: Well, why don't we let the Chair decide?

MR. GALLEGOS: Well, I -- Fine, I object, because this does not provide the information that tells us under what conditions these IPs were derived.

CHAIRMAN WROTENBERY: This may actually be responsive to my question, I'm not sure. I asked if you had the forms from which you derived the IP numbers that you were citing --

THE WITNESS: Yes, and those are --

CHAIRMAN WROTENBERY: -- early on in your testimony.

THE WITNESS: Those are -- That is the source of the numbers I testified to.

CHAIRMAN WROTENBERY: This is the source. Okay. Then that may lead to the second question, which is whether you have the reports on the tests.

THE WITNESS: No, that was the sole source of the information I testified on. It showed the produced -- you know, the rates that were reported to the Commission on that particular form.

CHAIRMAN WROTENBERY: Okay. Is that something you could obtain for us?

MR. HALL: Probably not. We will look and see.

CHAIRMAN WROTENBERY: Okay.

MR. HALL: We're going to look downstairs.

CHAIRMAN WROTENBERY: I know we should, but how do we get them in? Can we take notice of those?

MS. HEBERT: (Nods)

CHAIRMAN WROTENBERY: Okay.

MR. HALL: I might have them in my car, actually. Do you want me to take a break --

CHAIRMAN WROTENBERY: Well --

MR. GALLEGOS: We have the -- what I think is a pretty complete well file on all these Chaco wells. Let's see if we don't locate that in here.

MR. HALL: For the record, what we're reviewing now is labeled Exhibit T-2 from the 1998 hearing. We'll be glad to supplement the record with copies of that same exhibit.

MR. GALLEGOS: Okay, here's the Chaco Number --

MR. CONDON: -- 4.

MR. GALLEGOS: -- 4.

MR. CONDON: And it's our W-7.

MR. GALLEGOS: And it is Exhibit W-7, absolute open flow. This is the form I was trying to think of. It's a C-122 form.

MR. HALL: Right.

MR. CONDON: We can pull copies of all those that we've got in --

CHAIRMAN WROTENBERY: But this is available in --

MR. CONDON: We've got them, and they're in the exhibit.

CHAIRMAN WROTENBERY: In the exhibit.

MR. CONDON: Yes.

MR. GALLEGOS: Yeah, and we intended to --

CHAIRMAN WROTENBERY: Okay.

MR. GALLEGOS: We intend to offer the full well file on these wells.

CHAIRMAN WROTENBERY: Okay. Are these the same numbers that you were using earlier?

THE WITNESS: Doesn't appear to me that they're the --

MR. GALLEGOS: If I may just --

THE WITNESS: -- same numbers.

MR. GALLEGOS: Are you having trouble finding it on the form? 385 absolute open flow?

THE WITNESS: This shows a 385. The completion report showed 480. So they are different.

MR. GALLEGOS: What did you have on the Chaco 5? Because I've got the --

MR. CONDON: Just for the record --

CHAIRMAN WROTENBERY: Uh-huh.

MR. CONDON: -- the last testimony was on the 4, just so the record shows that.

MR. GALLEGOS: Yeah, on the Chaco 4, and looking at Exhibit W-7, the C-122 --

THE WITNESS: Okay.

MR. GALLEGOS: All right. And the Chaco Number

5, look at Exhibit W-8, the C-122 test made 5-19-77, absolute open flow 710. So what did you have?

THE WITNESS: 1029.

CHAIRMAN WROTENBERY: The numbers that you're citing today came off of the completion report?

THE WITNESS: Yes.

CHAIRMAN WROTENBERY: Could we go ahead and have a copy of those for the record?

MR. HALL: Yes, we'll get those -- I'll --

CHAIRMAN WROTENBERY: We can, I think, take official notice of those particular files.

MR. GALLEGOS: They're -- Madame Chairman --

CHAIRMAN WROTENBERY: They're already in 2?

MR. GALLEGOS: They're in here.

CHAIRMAN WROTENBERY: Oh, okay.

MR. GALLEGOS: This is a complete file, so it will have the APD and the completion report --

CHAIRMAN WROTENBERY: Okay, great.

MR. GALLEGOS: -- sundry notices and --

CHAIRMAN WROTENBERY: Good.

MR. GALLEGOS: -- the whole works.

CHAIRMAN WROTENBERY: Thank you.

I'm sorry, were you finished?

MR. HALL: I've finished my redirect of Mr. McCartney.

CHAIRMAN WROTENBERY: Okay. Mr. Gallegos, do you have anything else?

MR. GALLEGOS: Just a question or two.

RECROSS-EXAMINATION

BY MR. GALLEGOS:

Q. On the decline curves on the Gallegos Federal coal wells, where you assumed a 20-percent decline rate, are you familiar with the experience of operators that when the coal wells go on decline it is a -- once they top over, go on decline, it's a very rapid decline rate?

A. I've looked at a lot of coal wells up in the northern part of the Basin, and I really couldn't characterize them all as any rapid decline rates.

A lot of them are low decline rates, and it depends. It depends a lot.

The higher the production rate, well, then, naturally the faster it has to fall off. The lower the production rate over the life, it may take a seven-percent decline, for instance.

Q. And your observation is that these Gallegos Federal wells have been at a very high production rate for wells in this area --

A. Uh-huh.

Q. -- is that correct?

A. Yes.

Q. If the Gallegos Federal 7 Number 1 for the last ten months has been on a decline rate of 50 percent, would that indicate to you that that is probably the rate to be expected once these wells top over and start to decline?

A. After -- You know, I'd have to review the situation, I guess, on that, if that's -- and, you know, if it's an established decline, and particularly if you had pressure data to go with it, you could -- you might be able to quantify it closer than a 20-percent decline, that's for sure.

Q. Well, assume with me that that's what the facts will show, Mr. McCartney. Then that would be a more reliable indicator of what we can expect the decline curve to be than just simply assuming arbitrarily 20 percent; isn't that true?

A. Well, I'm looking at the 7-1 performance, and it be hard to quantify a 50-percent decline based on just that information I'm looking at here.

Now, Whiting may have better -- may have more information. I've got April, that was supplied in pre-hearing documents. Now, maybe you've got May, June estimates, I don't know.

Q. Well, let me -- if you'll listen to the question, because assume that we will provide that information and that it will show for a ten-month period the 7-1 has been on a decline rate of 50 percent.

Wouldn't that be a more reliable indicator of what the decline rate for the other four wells will be than an arbitrary 20 percent?

MR. HALL: Well, let me object. Are you also asking him to make certain assumptions with respect to the line pressures during the time? Are you going to provide that as well?

Q. (By Mr. Gallegos) The wells are on compression, so we're not dealing with that as a significant variable.

A. I would certainly honor that data along with the rest of the data.

Q. That would supply you something, rather than just selecting a -- assuming some arbitrary rate?

A. It would certainly help if we had more history on the wells, and in a few years I guess we'll know.

MR. GALLEGOS: All right, thank you.

CHAIRMAN WROTENBERY: Any other questions of Mr. McCartney?

Thank you, Mr. McCartney, for your testimony.

Let's take a ten-minute break and then come back.

(Thereupon, a recess was taken at 5:30 p.m.)

(The following proceedings had at 5:52 p.m.)

MR. HALL: We call Neil Whitehead to the stand and ask that he be sworn.

NEIL H. WHITEHEAD,

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

DIRECT EXAMINATION

BY MR. HALL:

Q. For the record, would you state your name, please, sir?

A. My name is Neil H. Whitehead, III.

Q. Mr. Whitehead, where do you live, and how are you employed?

A. I reside in Conifer, Colorado, and I'm an independent consulting geologist.

Q. Mr. Whitehead, you've not testified before the Division or Commission, I understand. Would you give the Commissioners a brief summary of your educational background and work experience?

A. I have a bachelor's degree in geology from the University of Louisville, a master's degree in geology from the University of Illinois in Urbana-Champaign, and a PhD in geology from the University of North Carolina at Chapel Hill.

And I have four years of experience teaching college at the University of Louisville, worked as an exploration geologist for Gulf Oil and Chevron in Casper, Wyoming, and then as a production geologist for Chevron in

Oklahoma City and Houston, and petroleum geologist with the New Mexico Bureau of Mines in Socorro, and have been an independent consulting geologist since 1995.

Q. In fact, you've consulted with Mr. Gallegos here, have you not?

A. That's correct.

Q. You're familiar with the Application that's been filed in this case?

A. Yes, I am.

Q. And you're familiar with the subject lands and the wells that are in the Application?

A. Yes, I am.

Q. Have you prepared testimony and certain exhibits which you've submitted to the Commission in this case?

A. Yes, I did.

Q. And do you today affirm and adopt your testimony?

A. Yes, I do.

Q. And were Exhibits 1 through 21 prepared by you or at your direction and control?

A. Yes, they were.

MR. HALL: At this point we'd offer Mr. Whitehead as a qualified petroleum geologist and tender -- or move the admission of Exhibits W-1 through W-21.

MR. GALLEGOS: No objection.

CHAIRMAN WROTENBERY: We accept Mr. Whitehead's credentials and admit Exhibits 1 through 21 -- is that right? --

MR. HALL: Yes.

CHAIRMAN WROTENBERY: -- into the record.

Q. (By Mr. Hall) Mr. Whitehead, would you please summarize for the Commission your investigation and your conclusions in this case?

A. Well, I had three issues that I investigated, the first of which was the nature of the boundary between the Pictured Cliffs sandstone and the Fruitland formation throughout the San Juan Basin.

The second issue I investigated was essentially to test the correctness of the Applicant's stratigraphic model of the upper Pictured Cliff sand against the independent mapping efforts of others within the Basin.

And the third issue was to address pool boundaries versus rock stratigraphic or formational boundaries, specifically the definition of the Basin-Fruitland Coal Gas Pool.

And after so doing I reached the following conclusion, that the upper Pictured Cliffs sand of Mr. Nicol is marine in origin and is similar in map pattern to other upper Pictured Cliffs marine tongues elsewhere in the Basin. And thus, the perforations within this upper Pictured Cliffs sand of Mr. Nicol were made within the appropriate common source of supply.

And I'll summarize my testimony by using one of my exhibits, and this is a blow-up of Exhibit W-12, and you have that as page size in your binder. And this is a stratigraphic cross-section constructed by Dr. Ayers and Ms. Zellers, and is from a 1994 publication. Southwest is on your left, northeast is on your right.

This cross-section is in the vicinity of the Navajo Lake and Dam, Reservoir area in the northern part of the San Juan Basin, and this stratigraphic cross-section is hung or constructed on the Huerfanito bentonite, and this is a volcanic ashfall, essentially a geologically instantaneous event, an ideal horizon upon which to construct a stratigraphic cross-section.

Overlying the Huerfanito bentonite in this shale pattern is the Lewis shale, which is an offshore marine mud, and the coarse-dotted pattern through here is an interbedded zone between Pictured Cliffs sandstone and Lewis shale, which represents storm sands carried off into offshore or marine muds.

The pink interval is the massive Pictured Cliffs sandstone, or what I term main body Pictured Cliff.

The yellow interval is what Dr. Ayers referred to as UP1 and UP2, and this stands for upper Pictured Cliff sandstones, and these are marine Pictured Cliff sandstone tongues.

The white area is the Fruitland formation. The black bars and thinner lines are the coalbeds. And this is overlain by the Kirtland shale, which is a nonmarine unit.

So this cross-section shows upper Pictured Cliffs, Pictured Cliff marine sandstone tongues, which sit above the main body or massive Pictured Cliffs sand. And these thin in a landward direction which, to the southwest thicken, and a seaward direction to the northeast, and eventually join the main body in this area.

This is the same map pattern that's shown by Mr. Nicol's mapping, and this is his Exhibit N-50. And this is an isopach map of the upper Pictured Cliffs sand, which he has mapped and which is the subject of much of the discussion in this hearing.

And it shows a thinning to the southwest, a thickening to the northeast, and a joining with the main body of the Pictured Cliffs sand in a seaward direction, and eventually to merge in a similar fashion into the main body of the Pictured Cliff. And this map pattern is repeated throughout a number of exhibits that I have presented.

And let me use this cross-section to discuss the Fassett and Hinds 1971 definition of the Pictured Cliff and Fruitland formation boundary. And that full definition is presented in your exhibits as W-5, my Exhibit W-5. And in many places the Fassett and Hinds definition works.

And that specifically, and I'll quote:

The contact is placed at the top of the massive sandstone below the lowermost coal of the Fruitland...

...end quote. And for example, on this area in the southwestern part of the cross-section, that particular definition is valid. And this is also valid in the case of the Cedar Hill Pool in the northwestern part of the Basin, and that's where the type log of the Fruitland Coal coal gas pool is.

Then Fassett and Hinds go on to say, except, quote -- except, unquote, where there are tongues of the Pictured Cliff. In this case they determine, or seek or find the highest marine sandstone and place the Pictured Cliff contact on top of that marine sand. In the subject area, this is what Mr. Nicol has proceeded to do. So his definition of the top of the Pictured Cliff is, in my opinion -- conforms to Fassett and Hinds' definition.

And I might add that the Fruitland formation/ Pictured Cliffs sandstone boundary is placed as placed by industry, Maralex and Whiting excepted, at the top of what Mr. Nicol calls the upper Pictured Cliffs sand. And this fully conforms to the dictates of the North American Stratigraphic Code and International Stratigraphic Guide, and that will be important in potential downspacing considerations that may arise in the Fruitland formation and Pictured Cliff formation in the future.

And moving on, Order 8768, which establishes the Basin-Fruitland Coal Gas Pool, defines the vertical limits of that pool as, quote:

> Comprising all coal seams within the equivalent of the stratigraphic interval from a depth of approximately 2450 feet to 2880 feet, as shown on the gamma-ray bulk density log from the Amoco Production Company's Schneider Gas Com B Well Number 1.

End quote.

And this interval, from exhibits and testimony at the 1998 Examiner Hearing, was established as the Fruitland formation. And you'll note that in this actual Order it doesn't mention massive sandstone or anything. It's simply picks on a log. But from a reading of the exhibits and the testimony, it is, in effect, the Fruitland formation.

So as I -- in my opinion, so in effect, so all coals in the Fruitland formation in the San Juan Basin are part of the Basin-Fruitland Coal Gas Pool.

Moving back to the subject area, the rocks below the top of the upper Pictured Cliffs sand of Mr. Nicol are Pictured Cliffs sandstone. Therefore, they are not Fruitland formation, and it follows that they are not part of the Basin-Fruitland Coal Gas Pool or part of the WAW-Fruitland-Sand Pool.

And this concludes my direct oral testimony.

Q. Briefly, Mr. Whitehead, from your investigation do you conclude that the subject Chaco wells are completed in the Pictured Cliffs formation?

A. Yes, I do.

MR. HALL: No further questions. Stand for cross-examination.

CHAIRMAN WROTENBERY: Thank you, Mr. Whitehead, for that concise summary.

Go ahead, please.

CROSS-EXAMINATION

BY MR. GALLEGOS:

Q. Before we get going here, maybe, Mr. Whitehead, if we put this up over where the Commissioners can see it, this is Mr. Nicol's cross-section, N-4.

A. All right.

Q. Would you mind -- I'll give you a hand here. I don't think -- I'm not sure, did you identify this?

A. Yes, that's my Exhibit W-12.

Q. Okay, put this up here.
We've got up in view Mr. Nicol's cross-section. We've put up for reference Dr. Ayers' cross-section, which is WA-3. And I have a few questions.
Your degrees are in stratigraphy, Mr. Whitehead?
A. Yes, sir.
Q. Okay, and stratigraphy, would you define that for us?
A. Yes, that would be the science of studying strata or essentially layered rock.
Q. So the formations and their lateral relation to each other?
A. Yes.
Q. Okay. There's a different field of geology known as sedimentology, is there not?
A. Yes.
Q. And that's an area of expertise, as you know, of Dr. Walter Ayers, correct?
A. Well, sedimentology is more -- essentially before the rocks got hard, I guess, you might -- In general, that's --
Q. Well, sedimentology --
A. -- they're related, quite intimately related. But yes.
Q. Wouldn't a better definition maybe be the study

of the environment, the depositional environment in which formations were formed?

A. That's certainly one important part of sedimentology.

Q. Okay. Which would include the issue of whether or not a particular formation was formed in a marine environment or a nonmarine environment?

A. Yes, it would.

Q. Okay. Let's see, you start out -- and I think almost everybody in this area, sort of the jumping-off point for this study would be the well-known Fassett and Hinds sort of seminal paper in 1971 --

A. Yes.

Q. -- right?

And that is where you have -- You've taken a figure, Figure 2 from that paper? That's your Exhibit W-30?

A. W-30? I don't have anything above W-21.

MR. HALL: Go back.

Q. (By Mr. Gallegos) I'm sorry, getting late. W-3.

A. Yes. Yes, sir, that's from his 1971 paper.

Q. Okay. Can you give the Commission just a little background of what the -- the extensiveness of the study of Fassett and Hinds, relate that article?

A. That report which was published in 1971, I believe Mr. Fassett actually did his master's on the Fruitland and then continued to work on it and then published this essentially Basinwide study of the Fruitland formation and in part the Pictured Cliff and the overlying Kirtland shale. And that represented for the first time a bringing together of a lot of the data for the Fruitland formation in the San Juan Basin, the first time anybody had looked at it in totality.

Q. Figure 2 illustrates the contact between the top of the Pictured Cliffs sandstone and the bottom of the Fruitland formation, does it not?

A. Which exhibit are you referring to?

Q. Figure 2 of your Exhibit W-3.

A. All right, could you repeat the question?

Q. The question is, Figure 2 illustrates the contact between the top of the Pictured Cliffs sandstone and the bottom of the Fruitland formation?

A. At one well it does.

Q. Well, it's meant to be a --

A. And this was Mr. Fassett and Mr. Hinds' so-called type log.

Q. Okay. And they illustrate the Pictured Cliffs sandstone as being, oh, probably -- maybe 70 feet in depth, and over in the explanation as a sandstone, as opposed to being shaly or silty or the like?

A. If you'll look through the columnar symbol section in there, there are some dashed lines indicating at least some shale beds within that interval indicated as sandstone, but primarily sandstone.

Q. Primarily sandstone, with maybe the slight occurrence of some shale beds?

A. Well, that could be six to eight feet, at least, right there.

Q. All right. And the total of the interval, the total thickness, would be about 70 feet?

A. Yes, that appears to be correct.

Q. Okay. And the Fruitland formation is recognized as having seams or layers of coal interbedded with shales and, oh, silt, siltstones, the like, based on the column explanation?

A. Yes, sir.

Q. All right. And of course you recognize that when the New Mexico OCD was confronted with defining the Fruitland formation, it was recognized that it was composed of alternating layers of shale, sandstones and coal seams?

A. I guess I'm not totally sure, did they recognize that the Fruitland formation -- I would have to refer back to the Order. Is that what you're referring to, the Order that --

Q. That's what I'm referring to, Order Number

R-8768 --

A. -- all right.

Q. -- and I will quote from it --

A. Okay.

Q. -- where it says:

Geologic evidence presented by the Committee indicates that the Fruitland formation, which is found within the geographic area described above, is composed of alternating layers of shales, sandstones and coal seams.

A. Then I will accept --

Q. End quote.

A. -- that the Fruitland is, according to their definition, composed of that.

Q. Are you aware that the reference in that Order to "the Committee" refers to the San Juan Basin Coalbed Methane Committee that was formed and instructed to undertake an extensive study in order to advise the New Mexico OCD on this matter?

A. Yes, I am.

Q. Okay. Did you serve on that committee?

A. No, I didn't.

Q. Are you aware, in the defining the Fruitland formation by that Order, it is defined as including all coal seams?

A. All coal seams within the Fruitland formation.

Q. Yes. So when we see the Fruitland formation here on this particular type log, your Exhibit W-3, it would include from the top of the Pictured Cliff to the last or highest coal within the Fruitland formation, would it not?

A. At this particular location where this well was drilled.

Q. Oh, and no other location? We can't apply this -- This is no guide for anything other than just this well; is that what you're trying to tell us?

A. Well, that the -- As I've discussed and illustrated on this cross-section by Dr. Ayers and Ms. Zellers, that there are variations that indicate a more complex nature than this well log shows.

Q. I think that the crux of what you try and tell us in your testimony is that above the Pictured Cliffs sandstone there can be occurrences of another layer or intertongue that is recognized also as a Pictured Cliffs sandstone?

A. Yes, based on the fact that it has a marine origin.

Q. Okay. Well, and based on more than that from the literature. It says you have to do more than that to be able to accurately geologically characterize it as a Pictured Cliffs sandstone; isn't that true?

A. I believe the primary defining factor would be that it is marine in origin.

Q. Okay. Well, and one way to find -- The literature talks about marine in origin, and I'm not sure of the terms, but it's that you can examine pores of the rock and find evidence of -- the term, but marine life?

A. Yes, fossils, both --

Q. Snails, fossils --

A. Trace fossils.

Q. -- little fish, kind of thing?

A. Yes, sir.

Q. What's the term for that?

A. Tracks and trails would be trace fossils.

Q. Then I think you say that Dr. Ayers' type log, which you published in 1994, supports Pendragon's Application?

A. Yes, sir.

Q. Your W-4 contains a copy of Dr. Ayers' type log and his article published in 1994?

A. Yes, sir.

Q. Okay. And you're aware Dr. Ayers has done extensive study of the coal and sandstone formations in the San Juan Basin?

A. Yes, sir.

Q. Okay. And a study commissioned by the Gas Research Institute was conducted by Dr. Ayers to advise the Coalbed Methane Committee. You're aware of that?

A. I'm not sure if that's correct. I know there was a study commissioned by the Gas Research Institute, of which Dr. Ayers was principal investigator and I was subcontractor, at one time. So -- But that, in my knowledge, was not directly constituted to advise -- that reports that emanated from that contract would not directly advise the Coalbed Methane Committee.

Q. I'm sorry, you lost me on that answer.

A. I guess there -- Yes, sir, there was a report, there was a contract by the Gas Research Institute, of which Dr. Ayers was principal investigator, and that study did -- that contract effort did produce reports. But I was not aware that those were directly funneled into the Coalbed Methane Committee. They may have read them, but we were not in direct support of the Coalbed Methane Committee.

Q. You're not aware that a presentation was made?

A. He may have made presentations to the Coalbed Committee, but I was not aware that the Gas Research Institute contract was directly supporting his presentations.

Q. Well, let's go to your Exhibit W-4 where you assert that Dr. Ayers' type log supports this Application. It contains a tongue of the Pictured Cliff within the Fruitland formation?

A. Yes, sir.

Q. And that tongue, which is designated UP1, upper Pictured Cliff 1, appears to me to be about 60 feet in thickness.

A. Yes, sir.

Q. Do you agree?

A. Yes, sir.

Q. Do you agree that a 60-foot-thick formation would be characterized appropriately as massive?

A. It would have to be -- I could see some, just based on the gamma-ray log on the left side of this columnar well-log section, that there is quite a bit of serrations in there, but again some of those beds may be 10 to 20 feet thick. So it's possible that, from the full-scale detailed log, that some of those beds may be considered as massive.

Q. Well, as portrayed by Dr. Ayers, as set out here, it's approximately 60 foot in thickness?

A. But that's composed of many beds. The interval is approximately 60 feet in thickness, but that would be composed of a number of actual sandstone and shale interbeds, thin shale interbeds.

Q. Do you consider that interval as being massive?

A. Well, possibly.

Q. In Dr. Ayers' 1994 article, you recognize that he said no such tongue should be recognized unless at least 20 feet in thickness; isn't that true?

A. It was my understanding that he mapped no such tongue less than 20 feet in thickness.

Q. All right.

A. That they were actually -- and that was one critical point that I found. In other words, in my opinion of what he has done, he stopped mapping when it got less than 20 feet in thickness. So his scale of resolution or resolving power for marine sandstone tongues within the Pictured Cliff was not captured or was not potentially fully portrayed.

So his work simply didn't carry out to thinner sandstone tongues, which we are discussing in this case.

And he may -- For example, the sandstone tongue that Mr. Nicol has mapped, Dr. Ayers would not even consider it, because it's not 20 feet in thickness or more, so he didn't simply map it.

Q. So what Dr. Ayers has done in his 1994 publication contradicts rather than supports the Pendragon position here?

A. No, he simply didn't map anything thinner than 20 feet, and they're out there and they -- I presume they are out there, and he didn't simply recognize them.

Q. All right. And his figure -- illustration, and your Exhibit W-4, which is taken from his 1994 article, shows or would indicate that this upper Pictured Cliff pinches out or terminates?

A. This particular well log would need -- You can't make a determination from its lateral extent, from this single well log, about this upper Pictured Cliff body from this one location that requires cross-sections or isopach maps.

Q. And in fact, you have some cross-sections as exhibits to support your testimony that we can look at to see whether that upper Pictured Cliffs, as a large-thickness interval, in fact, does continue out across the Basin; isn't that true?

A. Yes, sir. This one on the wall, W-12 is one from his publication and shows the UP1. And this type log -- I have another exhibit, I believe it's W-6, which shows the position of this cross-section and the approximate position of this type log on Figure 4 and -- so you can see the relationship.

So essentially this W-4 Exhibit, his type log, would be drilled in a similar position to here, because it's not on this actual line of cross-section.

Q. Okay. Well, let's take this a step at a time so we can look at some actual cross-sections.

First of all, it should be understood that you did no independent study of the particular area in question, studied logs or constructed cross-section; isn't that true?

A. I reviewed Mr. Nicol's cross-sections and his isopach maps.

Q. My question, Mr. Whitehead, is, you did no independent study of this area, did not study logs and construct a cross-section?

A. No, sir.

Q. All right. What you did is, you took some other cross-sections that had been done by others and presented them as supporting your testimony?

A. Yes, sir.

Q. All right, let's see if they do that. To start with, your Exhibit W-6 is intended to give the Commission an idea of the locations in the Basin where you have cross-sections --

A. Yes, sir.

Q. -- that you're going to provide and discuss?

A. Yes, sir.

Q. All right. And so let me ask you this. As we look at the Basin, W-6 will show us down what I would call the southwest portion of the Basin? Rather large portrayal of it, but that is the area in question?

A. Yes, I've outlined what Mr. Nicol had mapped in detail in heavy black lines.

Q. And that should at least roughly correspond to the area on the cross-section N-4 that we put up on the wall?

A. That would include part of that area.

Q. You would agree with me that's in the southwest portion of the San Juan Basin?

A. Yes, sir.

Q. And are you aware of a structural hingeline where the northern part of the Basin was subsiding more rapidly than the southern part during the Cretaceous period?

A. I'm aware of a thickening of strata and generally trending -- the hingeline generally trending -- or what is referred to by Dr. Ayers as the hingeline, generally trending northwest to southeast, yes, sir.

Q. And approximately where would that hingeline be where you had a difference or more rapid subsidence of the Basin at the northern part?

A. The area of the hingeline as mapped by Dr. Ayers --

MR. HALL: Excuse me, Dr. Whitehead, I don't think the Commission can see.

MR. GALLEGOS: Yeah, I think --

MR. HALL: Why don't you stand on this side?

MR. GALLEGOS: -- if you stand to the right of it, and maybe you could just mark that.

THE WITNESS: All right. From approximate memory, I'd say that Dr. Ayers' hingeline runs something like that.

Q. (By Mr. Gallegos) Which you've marked in red?

A. Yes. And a thicker stratigraphic interval occurs to the northeast of that line.

Q. Okay, which would be the area of more rapid subsidence of the Basin?

A. At least more -- certainly more subsidence.

Q. Or more extensive subsidence --

A. Yes.

Q. -- it might be referred, right?

All right, let's quickly take a look at your Exhibit W-8, which I believe is your first cross-section that you indicate on W-6 that you used.

A. All right.

Q. All right, that's a cross-section of five well logs, which was prepared by the Department of the Interior, US Geological Survey?

A. Yes, sir, by Ms. Sandburg of the USGS.

Q. Okay, and the US Geological Survey is a governmental body with no interest in the outcome of this proceeding?

A. Yes, independent.

Q. Independent. The log on the far left would be located where? Would that be at A?

A. That would be at -- This is cross-section A-A', and the log on the far left would be at the southwest end of the cross-section.

Q. And the log on the far right would be at A', which would be at the --

A. -- the northeast end.

Q. All right And in fact, that well which is logged and identified as the 1-10 Case well is in Colorado?

A. Yes, sir.

Q. In La Plata County, Colorado?

A. Yes, sir.

Q. And is north of the hingeline?

A. Yes.

Q. All right. And that well, and only that well on this cross-section, illustrates the Pictured Cliffs sandstone having two components, a lower sandstone and an upper Pictured Cliffs sandstone; isn't that true?

A. That is correct.

Q. And the upper Pictured Cliffs sandstone would appear to be -- that certainly is not a thin interval, is it?

A. It's about 70 or 75 feet thick.

Q. You would agree that's not a thin interval?

A. No, it's not thin.

Q. Do you think that would be considered by geologists discussing this as a massive sandstone?

A. Well, again, it gets down to the definition of "massive", which we haven't established.

Q. All right, let's just settle with it's not thin and it's about 70 feet in thickness.

A. Well, the interval, again, essentially the thickness of a rock unit, because it's thick doesn't mean it's massive, I guess, is what I'm trying to say.

Q. Well, is the Pictured Cliffs sandstone below it that begins at a depth of what looked to me like about 2280 feet, going to about 2450 feet, is that a massive sandstone?

A. Well, I would essentially say that massive -- each one of these scale divisions is ten feet. So for example, the top of the -- what I would call the main body of the Pictured Cliff at about 2280 is roughly -- that sand looks to be about 10 feet thick, so in most cases, standing on an outcrop if you saw a sandstone bed 10 feet thick, you might consider that massive. Again, that's relative terminology, a field term.

Q. I understand. What are you talking about 10 feet thick? The USGS has classified from 2280 to 2450 as Pictured Cliffs sandstone.

A. Yes, sir --

Q. That's not 10 feet.

A. -- the Pictured Cliffs sandstone itself, as a rock stratigraphic unit or formational unit, is composed of many different individual beds. If there was a single clean sand that was several hundred feet thick, yes I'd consider that massive without question, and I think everybody would.

But by looking at the serrate nature of the gamma-ray log trace, which is on the left side of this well log, those would indicate clean sands separated by shale intervals and so forth, and you can approximate the thickness of that, and it really boils down to establishing the term of "massive", and then we can move forward.

Q. Well, the problem here, as I'm -- You told us that you start off with a reference to the Fassett and Hinds as being an authority, and their description of the contact point, and I quote, is:

...at the top of the massive sandstone below the lowermost coal of the Fruitland, except in the areas where the Fruitland and the PC intertongue.

And that's why I'm asking this, because that's their definition, and --

A. Well, it would help a lot if we could establish the definition of "massive".

Q. If what?

A. If we could establish the definition of "massive".

Q. You don't understand what that means?

A. Well, it's a difficult term to define.

Q. Is 100 feet massive?

A. If you're dealing with beds much thinner than 100 feet, yes, 100 feet is massive.

Q. Is 10 feet massive?

A. If you're dealing with beds that are generally one foot thick, 10 feet is massive.

Q. So you can't really apply the Fassett and Hinds definition, it's of no use?

A. It is of use, it's simply -- The term "massive" is relative.

Q. Well, evidently the USGS and their geologists had no difficulty classifying the entire interval from 2280 to 2450 as a Pictured Cliffs sandstone. You don't argue with that, do you?

A. That terminology, Pictured Cliffs sandstone, doesn't necessarily mean that it's exclusively sand. That's the dominant lithology. There may be shale beds and other lithologies within that interval.

So I mean, it is composed of actually a number of individual beds.

Q. We're trying to get at a practical, usable definition, and that's what Fassett and Hinds were trying to do; isn't that right?

A. Yes, sir.

Q. And as a practical, usable definition, recognizing that an interval may not be homogeneous, but the USGS has said, that you can classify as a Pictured Cliffs sandstone; isn't that true?

A. Yes, sir.

Q. All right. And above it, the interval we talked about as the upper, they classify as a Pictured Cliffs sandstone, that 70-foot interval?

A. Yes, sir.

Q. And will you tell us, above that upper Pictured Cliffs sandstone there, do you see coal, the coal formation?

A. I see several beds at about 2060, about 2080, that have a clean gamma-ray, which is the excursion to the left, and high resistivity, which is the excursion to the right. So those are probably coal beds.

Q. Uh-huh. And there is a distance with probably some shale or --

A. They're probably --

Q. -- silt or --

A. -- separated by shales.

Q. From the upper Pictured Cliff they're probably separated by shales by, oh, what distance would you say?

A. Well, those shales are probably six to eight feet thick, or at least one of them is.

Q. Okay. But the USGS, on this cross-section that you use to support your testimony, shows that the Fruitland formation starts at the top of this upper Pictured Cliff formation, even though the coal is still seven feet above that; isn't that correct?

A. Well, actually the cross-section shows that the Fruitland formation exists underneath the upper Pictured Cliffs sand, or this tongue of the Pictured Cliff sand. It actually shows some Fruitland starting at --

Q. You're correct --

A. -- 20 --

Q. -- there's a stringer of coal starting at about -- I don't know, 2260?

A. I would say that's -- There may be a stringer of coal at about 2290. There's a --

Q. Oh, I'm sorry --

A. -- three or four feet of --

Q. -- I was looking at the wrong --

A. There's a gamma -- There's a resistivity peak at about 2292 or -3 or -4, and that's three or four feet of coal.

Q. Good, I'm glad you pointed that out, because what we have here on that 1-10 Case log up in Colorado, north of the hingeline, we have an example of the Fruitland formation, as you've pointed out, on the top of the bottom Pictured Cliffs sandstone, intertongued with a 70-foot interval of the Pictured Cliffs sandstone, and so labeled by the USGS. That's what we're seeing there, isn't that right?

A. Yes, sir.

Q. All right. Then as we go to the south, as we move to the south, the upper Pictured Cliffs sandstone disappears, and we simply have the basic or massive Pictured Cliffs sandstone as shown on this cross-section; is that true?

A. Well, I would call it -- I would prefer to call it the main body, but --

Q. All right.

A. -- as mapped here, these five well logs over the 30 or 40 miles, they show a pinchout of the upper Pictured

Cliff tongue to the southwest. And then they also show areas represented by these sort of lightning-bolt lines of potential intertonguing or interfingering, which may not be shown on the cross-section, or is not shown on the cross-section. But the geologist felt that any intervening areas, if there was more data, it may shown thinner marine tongues of the Pictured Cliff.

Q. How do you know the geologist felt that, back here in 19- --

A. Because that's a common way of depicting on a cross-section that, based on variations and thickness of rock units, that you think in between there, there is something going on, but you don't have enough data to actually get at it and say it for sure, but you think so, or you infer that it does.

Q. Okay. But there is no more upper Pictured Cliffs sandstone mapped here in the four logs that go on down, as you say, 30 or 35 miles to the southwest?

A. Yes, sir, that's correct.

Q. But by way of example, just to take the middle log here, the Tafoya Number 14, which is now down into northern San Juan County, would you agree that the first occurrence of the coal there -- Is guess this is resis- -- resistiv- -- res- --

A. Resistivity.

Q. -- resistivity log, appears at about 2210 through maybe 2240?

A. It's hard to say. That's probably a coal. There's no gamma-ray log. Of course, ideally you -- There's no density or neutron log, so as a qualitative answer I would say that's probably, but a coal, I can't be sure.

Q. Okay. But the US Geological Society [*sic*] geologist places the bottom of the Fruitland formation on the top of the main body, we'll use that term, main body of the Pictured Cliffs sandstone?

A. At that location, yes, sir.

Q. And so what is above that is the Fruitland formation?

A. Yes, sir.

Q. Okay. And that comports with the Fassett and Hinds definition?

A. With one portion of it or one aspect of it.

Q. All right. And we have now seen, when we apply the Fassett and Hinds definition, except in those areas where the Fruitland and PC intertongue, we have seen that that occurs in the 1-10 Case well up in Colorado, north of the hingeline?

A. Yes, sir.

Q. I'm going to try and make this as quick as we can. I think your Exhibit W-7 is your next cross-section, B-B'?

A. Yes, sir.

Q. Without spending a lot of time, can you just agree with me that there's no -- this cross-section shows no upper Pictured Cliff, no so-called upper Pictured Cliff intertongue? Everything is the main Pictured Cliffs sandstone?

A. It shows no tongues, but the geologist infers that there are potentially tongues there.

Q. It shows none?

A. It shows none.

Q. And the contact point for the -- between the Fruitland formation and the Pictured Cliff formation is the top of the main body of the Pictured Cliffs sandstone --

A. Yes, sir.

Q. -- correct?

A. Yes, sir.

Q. The Atlantic State Number 4, in the Blanco field, gives us a pretty good example of having sort of lower thin coal seams and then a thicker -- what Dr. Ayers refers to as the B coal? Would you agree with that interpretation of that log?

A. Well, I can't make any correlations that great a distance away from the subject area, so I can't -- And I feel that that's going to be a very difficult correlation to make.

Q. Let me see if you agree with this, that if you look at the log, up above the Pictured Cliff/Fruitland contact point you probably have a coal at about 3160, maybe about 10, 12 feet of coal?

A. Well, the -- That's probably a coal --

Q. All right.

A. -- based on this log. Again, you would need, really, gamma-ray and neutron density to be sure, but that's probably a coal.

Q. And then there's a sandstone above it, maybe 20 or 30 feet of sandstone above it?

A. Well, there's -- At 3150 to 3160 there is an inflection on the SP curve and on the resistivity curve, and that's probably a sand. I can't say definitively, Yes, sir.

Q. About how thick?

A. I would say about eight feet thick.

Q. All right. And the USGS geologist certainly didn't consider that as Pictured Cliff -- upper Pictured Cliff intertongue, did she?

A. Well, based on the lightning-bolt pattern to the northeast of that well, the geologist considered that somewhere in that distance between those two wells there was an intertonguing or a thinning of the Pictured Cliff formation.

So based on this information it's only suggestive that there may be thin sandstone tongues, thinner than the 20 feet that Dr. Ayers made his cutoff at that would be upper Pictured Cliff sandstone marine tongues.

So it's possible that that is an upper Pictured Cliffs sandstone tongue.

Q. It was not considered so by Ms. Sandburg in doing this, that certainly is not indicated on this document as being part of the Pictured Cliffs formation, is it, sir?

A. It's not indicated on this document.

Q. But is a sandstone, eight or so feet sandstone that appears above the --

A. Yes, sir.

Q. -- Fruitland?

And that is quite similar to what we see in Mr. Nicol's cross-section where he has two feet, six feet, eight feet of sandstone between coals; isn't that true?

A. Similarity in log patterns does not imply correlation. Correlation means that a rock unit has some real meaning. Just similarity in log patterns is not the same as correlation, and there's a very significant difference in those two terms. So it may be similar, but that is not necessarily correlative.

Q. Well, above the lower coal in Mr. Nicol's N-4, in one well there's -- this sandstone that he's trying to label upper Pictured Cliff completely disappears. Taking the 2-R, it's not even there, is it? Do you want to check?

A. No, sir, it's not there.

Q. All right. And then in one or two of the wells it's about two or four feet thick, correct?

A. Yes, sir, it varies in thickness.

Q. Certainly not a massive sandstone, is it?

A. Well, at that location, two to four feet -- Again, it gets back to the definition of "massive", and we haven't resolved that definition. Speaking from an unresolved definition of "massive", that's probably not massive.

Q. You do recognize that on cross-section B geologist Sandburg is working at the project of an isopach map of interval between the top of the Pictured Cliffs sandstone, and that's what she was working on here?

A. Yes, sir, and I did not present that portion as an exhibit.

Q. All right. We can go to your W-12, but we could probably save time if you just agree with me, if we look at your W-12 we're going to see basically the same thing, we're not going to see an intertongue of the upper Pictured Cliffs, because the only place --

A. This is W-12 right here.

Q. Okay, but the only place that occurs is up there in the northern part of the Basin?

A. No, sir, I believe it occurs -- a similar phenomenon occurs within the area that Mr. Nicol has mapped.

Q. As far as the resource information you had to back up, other than what Mr. Nicol did, your cross-sections show one instance, and that is in the northern part of the Basin, north of the hingeline, as we've already seen; isn't that right?

A. My cross-sections do. I have a geologic map which shows surface indications, or it maps a tongue of the Pictured Cliff in this portion of the Basin.

Q. You have an outcrop, you don't have a log cross-section, do you?

A. I have no log cross-section, but a geologic map.

Q. Seventy-five miles to the southeast of the area we're interested in, you have an outcrop. Isn't that what you're talking about?

A. Yes, sir.

Q. And you're saying we're supposed to take that as evidence of this intertonguing of the upper Pictured Cliffs into the Fruitland Coal?

A. I'm saying that these cross-sections that I have presented here are examples. Dr. Ayers has mapped in his paper with Ms. Zellers essentially these sands in yellow throughout more or less this entire area, which comprises 40 percent of the Basin. So 40 percent of the Basin has been established by Dr. Ayers as having marine sandstones of the Pictured Cliffs above the main body of the main body of the Pictured Cliffs.

He stopped mapping -- he made a cutoff of -- When it got less than 20 feet in this direction, he stopped mapping.

Q. We're not just looking at what Dr. Ayers has done, we've been looking at what the USGS has done.

A. Yes, sir, and that's -- I have -- well, I have examples. This is a USGS cross-section. This is -- We've examined these two, and these are USGS quadrangle maps.

So I guess we could say Dr. Ayers and the United States Geological Survey.

Q. And all they have found where you have the intertonguing, that they recognize it's an upper Pictured Cliff, is in that northern part of the Basin, north of the hinge line; isn't that true?

A. Yes, sir.

Q. Now, your Exhibit W-14 purports to be a summary of what you have found when you start looking at the thickness of the Pictured Cliffs?

A. It was a way of trying to organize how thick these tongues were and compare them to the area that Mr. Nicol had mapped.

Q. Okay. Well, the ones that actually involve cross-sections based on well logs are your W-4, -8, -9, -10 and -12; isn't that correct?

A. Yes, sir.

Q. And if my math is correct, the average thickness of those intervals is 67 feet. Would you argue with that?

A. No, I wouldn't.

Q. All right. And when we go to N-4 up here, what Dr. Nicol -- or Mr. Nicol, excuse me -- is mapping as the upper Pictured Cliff sandstone, varies from zero to a maximum of about eight or nine feet; isn't that correct?

A. Well, I believe on his isopach map it may go up to about 12 feet.

Q. I didn't find that. Where does it go to 12 feet?

A. Not on this cross-section, but somewhere I believe on his isopach map --

Q. Oh, well --

A. -- 12 feet.

Q. -- we're dealing with what's actually based on logs and wells, and it doesn't go up beyond eight feet, does it?

A. On that particular cross-section, no, sir, it doesn't.

Q. From zero to eight feet?

A. Yes, sir.

Q. Did you give any consideration in your study to the actual property rights that Pendragon has, based on the conveyance from their predecessors in interest in the Chaco wells?

A. Yes, sir, I did.

Q. And so you're aware that that transfer rights reads, and I quote, Limited from the base of the Fruitland Coal formation to the base of the Pictured Cliffs formation?

A. Yes, sir.

Q. And as we've discussed, and I won't take a lot of time, you recognize that the definition of the Pictured Cliffs formation, based on Order Number R-8768, consists of all coals?

A. Well, it really didn't define, sir, the Pictured Cliff formation. It was actually defining the -- It defined an interval on a log as -- Are you discussing a formation or a pool definition, sir?

Q. I'm discussing a formation. This is --

A. Oh.

Q. This transfer is not --

A. Yes, sir.

Q. -- a pool definition, is it?
A. Yes, sir, it is not.
Q. Okay. It's an interval or formation --
A. Right.
Q. -- definition?
And the Basin-Fruitland Coal Pool is defined as all coal seams within the equivalent of the stratigraphic interval -- and then it goes on to reference the Schneider B Com as the type log, correct?
A. Yes, it essentially defines only the -- in that written portion of the pool definition it only defines, in my opinion, the Fruitland formation.
Q. As inclusive of all coal seams?
A. Within the Fruitland formation.
Q. So are we to understand you ignore or you honor the lower coal, the thin coal that's shown in the logs and both by Mr. Nicol and Dr. Ayers?
A. I honor the top of the marine sandstone as mapped by Mr. Nicol as the top of the Pictured Cliff sandstone formation.
Q. Which is another way of saying you ignore the lower coal as being part of the Fruitland formation. Is that what we should understand?
A. I do not include that within the lithostratigraphic or rock stratigraphic definition of the

Fruitland formation, based on Fassett and Hinds' 1971 definition.

Q. Well, the Nicol sand is not massive, is it?

A. No, it's not massive.

Q. The Nicol sand is not below the lowermost Fruitland Coal, is it?

A. I don't accept that as a Fruitland Coal.

Q. Well, if that is a Fruitland Coal, that sandstone is not below the lowermost Fruitland Coal, is it?

A. If it were a Fruitland Coal.

Q. And aren't those the defining features of Fassett and Hinds' 1971 definition?

A. Well, he has additional portions to his definition.

Q. Well, and not only Fassett and Hinds but even the atlas that you refer to, North American Stratigraphic Code, says when you're trying to make these definitions of formations, you want something that is readily traceable over the entire area; isn't that right?

A. And I feel that Mr. Nicol has readily traced his upper Pictured Cliffs sand over the area to which it extends, yes.

Q. Okay. So what you're saying is that as opposed to the top of the Pictured Cliff massive sandstone shown by Dr. Ayers, what you consider as readily traceable is this interval of Mr. Nicol that goes from zero, disappears in one log, and up to eight feet, and that's a readily traceable interval?

A. Within the study area, yes.

MR. GALLEGOS: I have no further questions.

CHAIRMAN WROTENBERY: Commissioners?

EXAMINATION

BY COMMISSIONER BAILEY:

Q. I would like to refer to an exhibit by someone else who testified, Exhibit C-16. Testimony was given that different parameters, turning your dials, if you will, in order to make this break that we see, and that the only dial that was changed was the lithology to include an ash intrusion into the coal.

Based on your examination of the logs and the Fruitland Coals, is it possible that there are ash intrusions within the coals of such thickness that they could possibly develop this type of scenario?

A. I would say, based on my personal field examination of outcrops along the -- more or less the entire southwest and north sides of the Fruitland formation, there are ash layers referred to as tonstines, volcanic ashfall, deposits which are white or light gray in color, so there are ashfalls present in and sometimes common in the Fruitland formation coals.

Q. How thick are these --
A. Offhand --
Q. -- that you've seen?
A. -- I would say maybe six or eight inches thick, some of them, and that's well documented and illustrated in the literature.

So there are -- I mean, again, when you say -- a lot of times in the analysis of coal, one of the components is ash, and -- but in this case volcanic material would be an actual volcanic settling from suspension of a volcanic eruption, such as Mt. St. Helens, that blankets a large area. In this case it settled out into a coal swamp.

So yes, there are ash beds in coals, and they are characterized by generally high gamma-ray response and low resistivity.
Q. I'm not talking in general, I'm talking specifically San Juan Fruitland Coals --
A. Yes, I've observed --
Q. -- specific --
A. -- hundreds of ash beds, various locations.

COMMISSIONER BAILEY: And that's only question I had.

CHAIRMAN WROTENBERY: Commissioner Lee, do you have any questions?

COMMISSIONER LEE: (Shakes head)

CHAIRMAN WROTENBERY: I had a couple of questions.

EXAMINATION

BY CHAIRMAN WROTENBERY:

Q. Going back to -- I think it was W-8, was the USGS cross-section, particularly the northeast end --

A. Yes, ma'am.

Q. -- of this cross-section. We were looking at the Pictured Cliffs tongues. When you have a tongue like that -- Let me ask, just looking at this cross-section, and at this log, we have the base of the Pictured Cliffs sandstone, and then we have a -- I guess what you could call a tongue of the Fruitland formation. Is that what that would be --

A. Yes, that would be Fruitland, yes.

Q. -- there? But -- you know --

A. There is essentially what I --

Q. -- between about 2225 and 2280, something?

A. Yes, ma'am, that would be -- that's mapped as a tongue of the Fruitland formation.

Q. -- formation. And then above that a tongue of the Pictured Cliffs.

A. Yes.

Q. And then above that the Fruitland formation?

A. Yes, ma'am.

Q. In that type of situation, where would you define the base of the Fruitland formation?

A. Well, that assumes that if you want to force the situation and say it only has one base, I guess it's possible to attack it that way and -- otherwise, you may say it has several bases.

In terms of drilling, if you were to log this well while you were drilling it, you would drill through the Fruitland and then you would note Pictured Cliff marine sand, you'd say top of Pictured Cliff. And then you would drill a while further, and if you didn't quite know what you were going to expect then you'd say, Gee, I've gotten back into something that may resemble Fruitland, and you drill on and so forth.

So you would perhaps put in a series of formational contacts, if you were somehow drilling this thing and didn't quite know the arrangement of the beds underneath.

Q. Okay. And then if we could look at -- I think it's N-4, Mr. Nicol's cross-section, if I've got the right number?

MR. HALL: A-A'.

THE WITNESS: A-A'.

CHAIRMAN WROTENBERY: Yes, that was, I think -- I think that was N-4.

MR. HALL: Yes.

Q. (By Chairman Wrotenbery) In this particular area, I guess -- Let's look up the Chaco Number 5 by way of example. There what you have told us is that you interpret that upper Pictured Cliffs sand to be a tongue of the Pictured Cliffs formation. I believe that's what you said, but I want to ask.

A. Well, to be a tongue of the main body of the Pictured Cliffs sand, which would actually join, if you were to move -- this is pretty much -- It runs, if you'll look at the index box on the -- next to the title block, it sort of runs from -- more or less from north to south, and that's parallel to the ancient shoreline more or less, somewhat subparallel to the position of the shoreline which trended sort of northwest-southeast. So this is actually running, in a sense, along the beach, as opposed to at right angles to the beach, this particular cross-section.

But if you were to move to the east or northeast, that essentially would join with the main body of the Pictured Cliffs sandstone.

Q. Okay. Let me ask you about that interval below that upper Pictured Cliffs sand. It's white, I guess, on this map, and then right below that is a blue bed that I think we've talked about as a coal bed. But -- And you've talked a little bit about the coalbed, but what about that white interval there? What would that be part of? What can you tell us about that particular interval?

A. Well, I would consider that part of the Pictured Cliff formation, and I would consider that to be lagoonal or estuarine in terms of a depositional environment and that it would represent accumulations behind the beach or barrier-bar portion of the Pictured Cliff sandstone. So it basically would be behind the beach in quiet water, but still under the influence of marine conditions.

Q. In that case, you wouldn't really call that upper Pictured Cliffs sand a tongue, precisely? At least not in the same sense that we --

A. Well, it really was breaking out as a tongue of the upper -- a tongue of the Pictured Cliffs sandstone, meaning that Mr. Nicol's upper Pictured Cliffs sand is a sandstone, and it has a tonguelike shape, meaning it thins in one direction and it thickens back and joins, like your tongue does to your body.

So it's -- In this case the stuff underneath your tongue, so to speak, would be still considered primarily nonsandy, primarily shaly, and it would be considered still part of the Pictured Cliff formation.

Q. In this particular area?

A. Yes, within the study area.

CHAIRMAN WROTENBERY: Okay, thank you, that's all

I have.

Did you have some redirect?

MR. HALL: Yes, I do.

REDIRECT EXAMINATION

BY MR. HALL:

Q. Why don't you keep your Exhibit N-4 in front of you there, Dr. Whitehead. I believe Mr. Gallegos had some problem with the fact that this cross-section, anyway, the upper PC was not readily traceable across this. Do you recall that line of questioning?

A. Right.

Q. Why is that so with respect to this particular cross-section?

A. Well, the upper Pictured Cliffs sand that Mr. Nicol has mapped is -- essentially, it's a shoreline deposit, and it thins in a landward direction.

So if you were to look at his overall isopach map -- and this cross-section is going to run -- roughly, the cross-section A-A', his Exhibit N-4, runs from in the bottom here and then through the south end here, so it -- basically there are variations in the thickness of this unit.

You're going to lose it as you move in this direction because this was the source, the main area, the ocean shoreline trended through here, and as you -- the sand was carried in a landward direction, and it moved over into essentially nonmarine deposits, ultimately of the Fruitland formation, that were going on contemporaneously over here.

So this is a critical aspect, that these rock units -- that in a chronostratigraphic sense, in other words, the time sense, if you were to strap on boots or tennis shoes or what have you and walk through here, these environments were happening at the same. You'd walk on the beach, then you'd go behind the beach, then you would go potentially and ultimately into coal swamps in this direction on the same day, and then those formations have been ultimately lithified as Fruitland and Pictured Cliffs. So this is ultimately a complicated arrangement, because these things were going on at the same time.

Q. So the reason that the sand may come and go on N-4 is because the A-A' overlay occurs on what is in fact just the edge, you're looking at just the edge of the sand?

A. We're looking at the southwestern landward edge of this sandbody, and there will be -- and there is a definite distinct limit to this upper Pictured Cliffs sand that he has mapped, and it's shown by the edge of the yellow trace.

Q. So that's what you're looking at, the limits, beginnings?

A. The limits.

Q. And isn't it true that a better picture of the areal extent of the upper Pictured Cliffs sand would be an isopach --

A. Yes.

Q. -- as he's mapped on N-50?

A. Right, and this isopach map is, in a sense, a summary or a way of organizing all of the cross-sectional data into a picture of his view of the upper Pictured Cliffs sand, and this is what I was attempting to do through these cross-sections.

And it wasn't so much that something was 50 feet thick or 70 feet thick. There is a continuum, in my opinion, of tongues of marine sand from a few feet thick to ten feet thick to 50 or 100 feet thick, and obviously the thicker ones have been more easily identified. And Dr. Ayers in his Basinwide comprehensive study basically says that he stopped mapping when it got less than 20 feet thick, and he didn't map it.

So things that are this scale, 12 feet or what have you, fell through his cracks in terms of mapping, in his Basinwide study, comprehensive study. So maybe he has mapped additional work, but that's -- The crux of my effort was to find other people that had done this, as opposed to some *ad hoc* creation of Mr. Nicol to satisfy whatever he needed.

So I was seeking to find others independent of him that had mapped similar features and show that, yes, this was a common phenomenon throughout this whole progress whereby the main shoreline originated in this area and prograded in this direction, and this process of shoreline building was moved from the southwest to the northeast, and there were fluctuations where the shoreline was stable, and then there were essentially shoreward stepping events, of which Mr. Nicol has mapped one of them.

So it wasn't a constant process where the shoreline just went thataway. At some points it built up and fluctuated back and forth, and then some places the shoreline moved back a few miles, and this is upper Pictured Cliffs sand. The body represents a shoreline shift to the southwest, in a landward direction, and that's the origin of this sandbody.

Q. The fact that a sand or a tongue maps out at less than 20 feet thick doesn't mean it doesn't exist, does it?

A. That's -- They exist; it was simply not mapped by Dr. Ayers because, I presume, of limits of time and manpower and what have you. And 20 feet thick on a full-scale log is going to be one inch, and that's a pretty substantial sand when you're looking at it on a log. And he simply, I presume, after examining --

MR. GALLEGOS: Well, I object --

THE WITNESS: -- hundreds of thousands of logs --

MR. GALLEGOS: I object to presuming what Dr. Ayers did --

THE WITNESS: All right.

MR. GALLEGOS: -- or did not do or thought. He's going to be here, he can -- He'll speak for himself. I move that the testimony be excluded.

MR. HALL: Well, he's allowed to testify about his understanding of the body of literature, it's entirely a product --

MR. GALLEGOS: He's not entitled to -- That's not what he was testifying about. He's not entitled to assume or try and tell us what somebody else was thinking.

Q. (By Mr. Hall) Dr. Whitehead, is the use of a 20-foot cutoff arbitrary?

A. Yes, it is.

Q. By ignoring Pictured Cliffs sandstones that occur in deposits less than 20 feet thick, are we ignoring substantial resources?

A. Yes, we are.

Q. Ms. Wrotenbery asked you about the Chaco 5 well on Mr. Nicol's cross-section, N-4 there. Let me show you Mr. Nicol's Exhibit N-53, which is the J-J' cross-section. Is this a better depiction of the geometry for the upper

Pictured Cliffs sand? What can you tell us about this?

A. First, this cross-section, J-J', is what I would call a stratigraph dip cross-section, because it runs from the southwest to the northeast, and that's essentially at right-angles to the shoreline, and so the previous section was a stratigraphic strike section that ran more or less parallel to the ancient shoreline.

And essentially it shows a southwestward thinning of this upper Pictured Cliffs sand, and this area in there to the northeast is the main body of the Pictured Cliffs sand, and essentially as you move to the southwest in a landward direction, the upper Pictured Cliffs sand continues through here and then pinches out, and that's the map pattern, that's the overall map pattern that's essentially shown on here.

So in terms of characterizing based on the cross-sections, it's good to have one that's parallel to the ancient shoreline and one that's perpendicular to the ancient shoreline, to give you a -- at least in two cross-sections, a view of what you're trying to show.

Q. So it allows you to look at the heart of the formation, rather than looking at it on edge?

A. Right.

Q. So the upper Pictured Cliffs sand is readily traceable?

A. Yes.

Q. In terms of the pool definition for Fruitland Coal formation, does that definition use the word "massive" anywhere in it, any order?

A. No, it doesn't.

MR. HALL: No further questions of Dr. Ayers -- or Dr. Whitehead.

RECROSS-EXAMINATION

BY MR. GALLEGOS:

Q. The Fassett and Hinds definition that uses "massive" is referring to the sandstone, not the coal, isn't it, Dr. Whitehead?

A. Yes, it does.

Q. Okay. And the Order R-8768 doesn't use "massive", it says all coals, doesn't it?

A. All coals within that interval on that log.

Q. Okay. If I understand your testimony, what you've told us is, the Fruitland Coal or the coals would have been laid down inland from the shoreline of the sea? Is that --

A. That's correct.

Q. -- your description? Okay. So those would be Fruitland formation coals, laid down --

A. Yes.

Q. -- in a nonmarine environment?

A. Yes.

Q. Okay. And it seemed to me that on your Exhibit W-8 we've had an answer before that maybe you departed from a little bit when Chairperson Wrotenbery asked you about --

MR. CONDON: This is it.

Q. (By Mr. Gallegos) Yes, let's pull that out again, because I want to address the log of the far right-hand A', the 1-10 Case log.

A. Okay.

Q. Didn't you testify before that the bottom of the Fruitland formation was the lowest coal just above what you call the main Pictured Cliffs sandstone?

A. If you want to construct a system where there is only one contact, yes. That's the lowest occurrence of the Fruitland formation.

Q. Okay.

A. I guess it's maybe -- Yes, this is the lowest occurrence of the Fruitland formation in this well.

Q. Would you mark that on the exhibit that the Commission is viewing, so we'll have that, where that lowest coal is?

A. Well, this is the -- I presume that's the coal, and that this is the lowest occurrence of the Fruitland formation in this well log.

Q. All right, and would you describe where that is for the record?

A. The depth on the well log is approximately at 2280 feet in depth.

Q. All right. And that's on the log for the 1-10 Case well on Exhibit W-8, correct?

A. Yes, sir.

Q. All right. Let's get a little more information about the occurrence of ash in the coal formation. Are these what you've seen -- Would you describe these as pods of ash? You said there were six or eight inches.

A. They're sheetlike bodies, meaning they're like a sheet, their lateral extent is much greater than their vertical thickness.

Q. Well, do they just occur at the bottom of the coal, or is this something that you --

A. They occur --

Q. -- find in the coal and --

A. They occur at many different horizons, potentially.

Q. Okay, so you wouldn't have any idea where they would be, not necessarily the top, the bottom?

A. There's no specific preferred position to these things. In other words, based on information in outcrops, it's not -- In other words, this is a volcanic eruption that occurs at the volcano's schedule and has nothing to do with a peat bog's schedule in terms of occurrence. So this just falls out of the sky and essentially falls into a quiet-water peat bog or small compartment and forms a layer.

Q. Okay, so we've got -- what we would have in the depositional sense is, we would have the coal forming in a marshy environment, peat building up, maybe it's a few feet, and then there's a volcanic occurrence and you get some ash, just sort of a lens of a few inches of ash on it, and then we get back to building that --

A. Yes.

Q. -- that coal?

A. Typically, yes.

Q. So typically, it would be sort of a lens somewhere within the coal?

A. Well, it's most commonly found in the coals because they are quiet-water environments, and the ashfall is not disrupted or disturbed by movement in currents.

In the sand -- You almost never find them in sandstone, simply because the sand -- the moving current action carries the ash and distributes it and mixes it up with the other sediment. It's sort of preserved very well in a quiet swamp environment.

Q. All right, but where you would find this would be somewhere up within the coal?

A. It could be at any position within the coal.

MR. GALLEGOS: Thank you.

MR. HALL: Briefly, Ms. Wrotenbery?

CHAIRMAN WROTENBERY: Okay.

FURTHER EXAMINATION

BY MR. HALL:

Q. Marking the Commission's cross-section, would you take this blue pen and on the well log for the well in La Plata County, mark on the Commission's copy the highest point where the Pictured Cliffs sandstone appears on there.

You marked that in blue. Could you identify the footage location for the record?

A. I marked the occurrence of the highest Pictured Cliffs sandstone at approximately 2150.

MR. HALL: Thank you, Dr. Whitehead. Nothing further.

MR. GALLEGOS: Nothing further.

CHAIRMAN WROTENBERY: Thank you very much, Dr. Whitehead, for your testimony.

What we have determined is that we'll be able to start about 10:30 a.m. on next Thursday, August --

MR. GALLEGOS: Madame Chairman, do we understand that completes the Applicant's case, save for the witness they're calling out of order, Mr. Cox?

CHAIRMAN WROTENBERY: I think they have possibly one other fact witness. Is that -- Did I understand correctly?

MR. HALL: Yes, we do. Mike Wagner, potentially Wes Hahn, work for Paul Thompson, may come down to testify about water in the pits, among other issues.

And as we say, we have Mr. Cox coming in on Thursday morning as well.

MR. GALLEGOS: Well, I thought the understanding was, the Applicant was putting its case on these two days and we were to put it on the two days next week, but there was a dispensation because of Mr. Cox's unavailability, and I think that's what we should limit it to. If they were going to call Mr. Wagner -- He was here yesterday, I think. They should have had him.

MR. HALL: No, he wasn't. They're also --

MR. GALLEGOS: Well, maybe I didn't recognize him, but there was somebody with Mr. Thompson I took to be Mr. Wagner.

MR. HALL: They're also rendering testimony in the nature of rebuttal testimony in response to the opponent's prefiled testimony as well, so...

CHAIRMAN WROTENBERY: I think that's what we'll do is take up, probably, Mr. Wagner's testimony as a rebuttal witness after we hear from Whiting.

MR. HALL: That will be fine.

CHAIRMAN WROTENBERY: We'll do it that way. But we'll start with Mr. Cox, 10:30 a.m. next Thursday.

MR. HALL: Thank you.

CHAIRMAN WROTENBERY: Thank you very much, I appreciate your staying.

MR. GALLEGOS: Thank you.

(Thereupon, evening recess was taken at 7:15 p.m.)

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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 September 1st, 1999.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 2002