STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION COMMISSION
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO

13 June 1988

COMMISSION HEARING

VOLUME 1 OF 5 VOLUMES

IN THE MATTER OF;

A hearing in the matters involved in Cases Nos. 7980, 8946, 8950, 9111 and 9412.

CASES 7980, 8946, 8950, 9111, 9412.

BEFORE: William J. Lemay, Chairman
Erling Brostuen, Commissioner
William M. Humphries, Commissioner

TRANSCRIPT OF HEARING

A P P E A R A N C E S

For the Commission: Robert G. Stovall
Attorney at Law
Legal Counsel to the Commission
State Land Office Bldg.
Santa Fe, New Mexico

A P P E A R A N C E S

For BMG Drilling Co.:	William F. Carr Attorney at Law CAMPBELL AND BLACK P.A. P. O. Box 2208 Santa Fe. Mew Mexico 87504-2208
For Sun Exploration and Dugan Production:	W. Thomas Kellahin Attorney at Law KELLAHIN, KELLAHIN and AUBREY P. O. Box 2265 Santa Fe, New Mexico 87504-2265
For Mallon Oil Company:	Frank Douglass Attorney at Law SCOTT, DOUGLASS and LUTON Twelfth Floor First City Bank Bldg. Austin, Texas 78701
For Mallon Oil Company and Mobil Producing Co.:	W. Perry Pearce Attorney at Law MONTGOMERY and ANDREWS Post Office Box 2307 Santa Fe, New Mexico 87504-2307
For Amoco Production:	Kent J. Lund Attorney at Law Amoco Production Company P. O. Box 800 Denver, Colorado 80201-0800
For Koch Exploration:	Robert D. Buettner General Counsel and Secretary Koch Exploration Company P. O. Box 2256 Wichita, Kansas 67201-2256
For Mesa Grande Ltd. and Mesa Grande Resources:	Owen P. Lopez Attorney at Law HINKLE LAW FIRM P. O. Box 2068 Santa Fe, New Mexico 87504-2068

I N D E X

ERNEST BUSCH

WILLIAM W. WEISS

I N D E X

E X H I B I T S

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MR. LEMAY: According to Item 3 of Item 5 of the Statement, at 9:00 o'clock this morning you've been instructed to exchange exhibits, so we have some exhibits up here but let's begin by passing out the exhibits for the -- both the opponents and the proponents and for the case that we're going to put on.

MR. DOUGLASS: Mr. Chairman, may I suggest that the staff pass theirs out first and then the opponents and proponents in order?

MR. KELLAHIN: It might save some confusion just to let the staff circulate theirs and then we'll take a moment and --

MR. LEMAY: We'll start with the staff circulating theirs.

(At this time the exhibits were circulated among the parties.)

MR. LEMAY: At this time let the record show that at 9:00 a.m. this morning the exhibits to the captioned cases, being Cases 7980, 8946, 8950, 9111, and 9412 have been distributed, both the staff, the opponents and proponents. have been distributed.

MR. DOUGLASS: Mr. Chairman, excuse me, Frank Douglass on behalf of Mallon Oil Company.

I visited with Mr. Carr and

and both of us may have a few exhibits that are in the process of being drafted and reproduced now and we have made arrangements to exchange those.

MR. CARR: As soon as they're ready. We recognize the problems they face and we, I think by and large, have everything here.

MR. LEMAY: Fine. Well, in spite of the agreement, most of the exhibits have been passed out and those that are in the process of being finalized will be passed out as soon as they're completed.

Those cases that are being called, it's the Application of Mesa Grande Limited for consideration of horizontal boundaries of the West Puerto Chiquito Oil Pool and the Gavilan Mancos Oil Pool, Rio Arriba County, New Mexico.

In regard to these cases, the Statement of Hearing would be abided by as closely as possible for this short week of hearings.

I would like to introduce my fellow Commissioners. I'm Bill Lemay. This is Erling Brostuen on my left and Commissioner Bill Humphries on my right. We are the Oil Conservation Commission and we will be hearing this case, or cases, throughout the week.

In regard to the cases I'd

like to make my own opening remarks. What -- the process we're going to follow is on Page -- the last page of the statement, which will start this morning with the presentation by the Oil Conservation Division staff and our consultant in Socorro.

I anticipate this will just take the morning but we could go into the -- the afternoon on it, which will be followed by the opening remarks, proponents first, then the opponents, and then the proponents will put on their case, followed by the opponents.

We reserve, in fact, will call back after we hear all testimony, the Commission will call back selected witnesses to ask direct questions to those witnesses after we've heard both side of the testimony.

In regard to the hearing, I would like to make certain comments to the lawyers involved. I think all the lawyers realize that they are incompetent. For those of you who don't understand the phrase "incompetent", means if they want to present testimony, if they want to summarize what's been said by various members and put on cases concerning the porosity , permeability, and facts of the case, they could be sworn in as experts and they could provide expert testimony; otherwise, please don't

waste valuable time trying to show us how much science he knows. You're introducing the experts. The experts are giving the testimony. They in turn will present the cases -- the facts of the case, which we will analyze as a Commission.

I think we all recognize the time restraints we are placed under and therefor, those comments are directed mainly to conserve time and to make the time we have the most efficient time that we can use.

With that in mind, I'd like all the witnesses that are going to be presenting testimony in the case to please stand and be sworn in. Before we do that, I'm sorry, you can be seated for a minute, I called for appearances the first time around. Now repeat those appearances and tell me if I've missed anyone.

In May we called this case and got appearances for Mr. Kellahin, representing Sun and Dugan, Mr. Carr, with Campbell & Black firm, representing BMG; Mr. Douglass representing Mallon; Mr. Pearce, representing Mallon; Mr. Pearce, representing Mallon and Mobil; Mr. Lopez from the Hinkle firm, representing Mesa Grande; and Mr. Kent Lund, representing Amoco.

Are there any other additional appearances in these cases?

MR. BUETTNER: Mr. Chairman, I'm Robert Buettner. I'm General Counsel for Koch Exploration Company.

Koch is the owner of interest in both the Gavilan and West Puerto Chiquito fields and we did submit a written statement to the Commission prior to the prehearing conference. We would like to (unclear) --

MR. LEMAY: Thank you very much. I did receive that and I failed to recognize your appearance. Will you have any witnesses or just a statement?

MR. BUETTNER: I wanted to clarify that. We are a proponent and so classified and we expect not to present any testimony; just we'd like to reserve the right to make a brief statement or present rebuttal testimony in case it is found necessary.

MR. LEMAY: Thank you, Mr. Buettner, we'll accept that.

Additional appearances in these cases?

MR. STOVALL: Mr. Chairman, Robert G. Stovall appearing as Commission attorney in this case. I don't think my appearance had been entered previously.

MR. LEMAY: It has not, Mr.

Mr. Stovall, thank you for the record. That will be noted.

Yes, sir.

MR. MOCK: My name is Bob Mock. I'm from Phelps Dodge Corporation and at some point at the appropriate time I'd like to make a statement.

MR. LEMAY; Mr. Mock, thank you very much. We will -- we are calling for statements at the end of the hearing process, the opponents and proponents, if that would be acceptable.

MR. MOCK: Which would be?

MR. LEMAY: I'm going to guess Friday.

MR. DOUGLASS: Mr. Chairman, I think he's got an opening statement (unclear) --

MR. LEMAY: That would be fine. We can accept an opening statement, also. We can accommodate your time schedule, sir.

MR. MOCK: Fine.

MR. LEMAY: Are there additional appearances in these cases?

MR. STOVALL: Mr. Chairman, one matter I'd like to ask Mr. Lopez.

There are a couple of Mesa Grande Companies, I believe, is that correct? Are you representing. all of them or --

MR. LOPEZ: Both of them. Mesa Grande Limited and Mesa Grande Resources, Inc., yes.

MR. LEMAY: Yes, sir.

MR. OWENS: My name is Greg Owens. I'm here representing Hooper, Kimball and Williams, Inc. We'll probably have a closing statement.

MR. LEMAY: Fine. Are you aligned on either side or just making a statement in terms of your --

MR. OWENS: We're a proponent.

MR. LEMAY: Proponent. Yes, sir.

MR. PETITT: I'm Bruce Petitt with Reading & Bates Petroleum Company. (Not audible to reporter.)

MR. LEMAY: Okay, thank you. Additional appearances in the cases?

Fine, if all the witnesses who plan to give testimony will stand and be sworn in.

(Witnesses sworn.)

MR. LEMAY: Thank you. You may be seated.

We will begin by recognizing Mr. Stovall.

MR. STOVALL: Mr. Ernie Busch, would you please come forward and take the witness stand?

ERNEST BUSCH

being called as a witness and being duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. STOVALL:

Q Mr. Busch, would you state your name and place of residence, please?

A Yes, my name is Ernie Busch, Aztec, New Mexico.

Q And what is your present employment, Mr Busch?

A I'm the New Mexico Oil Conservation Division District Geologist, District 111 Geologist.

Q Have you ever testified before the Commission and had your qualifications accepted?

A Yes, I have.

Q Are you familiar with the subject matter in the cases which are before the Commission today?

A Yes. I've -- I'm familiar with the case

through examining the exhibits. Also, when the Gavilan Study Committee was in session we received copies of their proceedings and I've also studied those. I've attended the various hearings.

Q How long have you been employed by the -- by the Division in Aztec?

A Four years and eight months.

Q And does that period encompass the entire period since these cases were initially brought before the Commission?

A Yes.

Q And you have had some involvement with these cases since the original discussions and hearings in these matters?

A That's correct.

Q Have you made any studies and prepared any exhibits with respect to the Mancos formation in the area which is covered by these cases; that is, the Gavilan Mancos Oil Pool and the West Puerto Chiquito Mancos Oil Pool?

A Yes, I have.

Q At whose request have you done these studies and prepared these exhibits?

A The Commission requested that I -- that I do a study of the -- of the C zone contribution by utilizing production logs, production log surveys, production

surveys, production tests, and other OCD official documents; also any documents or exhibits that had been previously presented as testimony in previous hearings for this -- for these cases.

Q What specifically were you requested to do in making these studies? Were you told what to look for or what -- what -- what information did the Commission want when they requested you to do this work?

A I was asked to -- to examine, to examine all the data that pertained to the C zone in the Gavilan and West Puerto Chiquito and surrounding areas, and make an evaluation of the contribution or the lack thereof from -- form that zone.

Q And what data have you used to do this analysis and examination? Let's get more specific with that, if you wouldn't mind.

A I've prepared exhibits in the form of production logs, production tests that have been conducted. Some of the production tests and production logs have not previously been presented to the Commission for approval. I will present -- present those today.

Q Let me -- let me stop you right there, Mr. Busch. Who generated the original data? Did you do independent data generation or have you used data which was provided to you by someone else?

A Yes, I've used -- I've used data that -- that was generated by all the members of -- of the Gavilan concerned and also the West Puerto Chiquito and conducted an independent study of that data.

Q When you say "members" you're talking about operators, working interest parties in the two pools, is that what you mean?

A That's correct.

Q Now, is -- is all of the data in the form of official reports required to be submitted by the -- to the OCD or is there other information in addition to the official, officially required reporting?

A Yes, there is -- there is other information that is not required to be official reported to the -- to the OCD. I might go over just -- just that type of -- type of report.

I've used production log surveys, which are sent to the -- sent to the OCD, and also information off of C-115's, which is also submitted to the OCD, GOR tests, as well.

I've also received some -- or do have some exhibits today that pertain to the Rule 1105, which is the confidentiality rule in our -- in our rules and regulations that -- that gives the operator 90 days to hold anything confidential prior to it being released to the

public, and this particular information is on the Bear Canyon 3 Well of Amoco's.

Essentially what it is, it's a -- it's a completion report. It's a completion report and well log and GOR test and it's not been released to the public as of yet.

Q And Amoco understands that this information will become public information today pursuant to the provisions of Rule 1105?

A Yes, they do. In communicating with Amoco they asked me to hold the information confidential until this time, which I've done.

Q In other words, if I understand correctly, what you're saying is that all of your analysis is of data which has been provided to you by the various parties, operators and working interest owners in the pools, and that you have not actually gone out and conducted on your own independent tests of wells, formations, whatever, to generate the exhibits which you're going to present today, is that correct?

A That's correct, Mr. Stovall.

MR. STOVALL: I'd now offer Mr. Busch as a qualified expert to testify in this case.

MR. LEMAY: His qualifications are acceptable.

Q Mr. Busch, just as a background matter,

would you just describe the approach you used to the data which was provided to you in order to make your analysis?

A Yes. As I previously mentioned, I used exhibits, copies of exhibits that had been previously tendered to the -- to the Commission and I've, as I've previously mentioned, have copies available here of the production log surveys that comprise a certain number of exhibits and are generally -- have the same basic conclusion as -- as I proceed here.

Q Let me ask you now, have you been available to discuss what you'll present today with the parties previously and have you consulted with them or accepted input from them in preparation of your testimony and exhibits?

A Yes, I have.

Q Is there any formal manner in that or have you simply made yourself available to review the data and talk with them?

A I spent -- I spent several hours, approximately 10 hours, with Welex logging personnel discussing the logs that -- that their company ran for these wells. The Welex logs are what we see as comprising the majority of these -- of these production logs.

I've also contacted and talked to individual operator representatives about various questions,

asking for clarification, asking for the data that I sought that I needed, and that type of thing.

Q In analyzing the various information, particular the logs and other information which was created by Welex or other parties, have you made your own, independent analysis of those logs or are you relying on somebody else's analysis?

A No, I've made my own, independent analysis of the data.

Q Let's turn now to the specific exhibits, Mr. Busch, if you wouldn't mind, and let's go to Exhibit Number One. Would you tell the Commission what that exhibit is and what purpose it has in your testimony?

A Yes. Exhibit Number One is a copy of the fluid analysis, or two pages of the -- of the fluid analysis that Core Laboratories performed on the Loddy No. 1 Well, Sun Exploration and Production Loddy No. 1 Well when the reservoir was above bubble point pressure and the exhibit consists of -- Page 1, giving a relationship of the -- of the pressures, PSIG in the first column; the second column, Solution Gas/oil Ratio; and for my -- my study I've not used Columns 3 or 4. I did use 5, the Oil Density, grams per cubic centimeter, for -- for the various oil densities.

I've not used Columns 6, 7 or 8.

In examining these production logs, the

density curve becomes very, very, important, the pressure is equally so. In many cases for these production logs the spinner portion of the tool that is supposed to register flow was unable to do so because of the low rate of flow which was apparently coming from -- from the formation, and after having talked to Welex about this, the type spinner used isn't able to register flow below approximately 120 barrels of oil a day through 5.5 inch casing. And I might add, the density accuracy of this type of tool was given to me as plus or minus .05 grams per cubic centimeter

I wasn't able to get any -- any feel of that kind for the temperature and pressure measurements of the accuracy of the tools, so I don't have any -- any qualifications of the temperature and pressure; just took them at face value.

Q All right. When you're referring to "spinner", you're referring to a logging tool that Welex used to generate the logs used in further exhibits, is that correct?

A Yes. Yes, that's right.

Q Let's turn now to Exhibit Number Two and would you identify that briefly?

A I might -- I might indicate, before we go to Exhibit Number Two, Page 2 of Exhibit Number One is a graphic representation of the -- of the first two columns on

Page 1, and I've -- I've used this -- this chart to determine my solution gas/oil ratio.

Q Thank you. Now let's turn to Exhibit Two at this time.

A Exhibit Number Two is a locator for all of the wells of the logs and data that I'll be talking about today. Up in the lefthand corner you'll see the well names by the letter designations, and I'll be referring the Commission to this exhibit briefly.

Q Now let's go more into the specifics of the log interpretation which you have done and by doing so, let's turn to Exhibit Number Three.

Would you describe in some detail what Exhibit Number Three shows? In particular I'd ask that you describe how the tests were conducted to create the logs and information that's shown in this exhibit.

A Yes. Let's -- since we're dealing with the C zone only here, let's -- let's turn to Page 3 of the exhibit where I have -- I've labeled the pressure information that runs diagonally down the -- down the righthand side of the log.

Also I've labeled the top of the C zone by a line using a "C" with little marks there -- by a line above which I've noted a "C" indicating the top of the C zone.

I've also labeled the spinner data and for this -- for this particular run at the bottom of the page you'll note a zero. That's a zero flow rate sensor the spinner is showing there.

The next would be the density. That's the long, dashed line to the right of the spinner, and gives us our information thusly. The .5 density reading is halfway across the page there, that middle black vertical line, and the next vertical line, black vertical line, heavy one, is the 1 density, which is the density of water.

Q Now when you're referring to "black line" you're talking -- referring to the darker --

A Yes.

Q -- black line on the straight lines, vertical lines on the scale, is that correct?

A Yes. The next -- the next darkest vertical line to the right of the density reading, that should be .5, with the 1.0.

Now, if we go all the way into the left track of the log, we'll notice right there with the gamma ray indicator, which is the squiggly, the most squiggly line, anyway, on that track, the short dashed line, vertical line running up and down the log, is the temperature indicated, and the scale for that, starting with the lefthand side, would be 100 degrees Fahrenheit. The righthand side of that

track would be 300 degrees Fahrenheit.

Q So the individual increments, then, are --

A Oh, excuse me, yes, the individual increments are 20.

Q Would you tell the Commission, please, what -- what is the significance of the various measurements or information which is shown on this log? What were you looking for when you analyzed the log?

A Well, of course, I was hoping that the spinner would show us something but it did not in the C zone. Although we can't ignore the density reading averages that we see, for instance, if we look at the 1 gram per cubic centimeter density line there, we notice that that's got to be water, and could -- could have some frac fluid, or something, but in any event it's closest to the density of water and then as you approach the bottommost perf we would naturally expect there to be water below that, and there is. And we look up into the perfed section to the bottom of the -- the top of the C zone, excuse me, and we notice that the density curve is indicating something quite a bit lighter than water.

So not having a spinner to work with, I'm looking at density, at variations in temperature, and if we look over to the temperature line at about -- well,

through the interval and the perforations there, where the top of the C zone is labeled, down to the bottom, indicates approximately 171 degrees Fahrenheit.

Now, getting an average density is a little difficult, you know, using the naked eye. It would be better if you could digitize this, put it in a computer and get an exact figure, but referring back to -- to Exhibit Number One, the Loddy PVT data, it's apparent to me in looking at the pressure, at the pressure at that depth, averaging, oh, around 1080 psig, if you would come back and look at the oil density, the fifth column on Exhibit Number One, you'd -- well, rather, excuse me, if you'll look at -- if you'll look at Column Number 1, excuse me, you'll note that the pressure fits right in there under 1100 pounds, and pulls you over to the density and gives you a -- gives you a feel for what -- what this density probably averages out.

Looking at it with the naked eye it looks like about .72, but it could very easily be .71 something, just under .72, and pull us down to somewhere between 423 standard cubic feet per barrel and 480 standard cubic feet per barrel of gas.

Q You're looking now, when you say those numbers you're looking at Column Number 2, the gas/oil ratio, is that correct?

A Yes. Column Number 2.

Q All right. What is this measuring the density of? I assume it's a fluid. What fluid would that be?

A Yes, that's correct. I interpret this to be oil with -- with that amount of gas in solution.

Q So the density is the density of a fluid that is being measured by the -- by the log, is that correct?

A That's correct.

Q And based upon the pressure measured in the wellbore, the density is measured in the wellbore, that state of temperature would be consistent with an oil fluid with a gas mixed into it at a GOR of approximately 423 to 480, is that what you're saying?

A Yes, that's correct, Mr. Stovall. Also I'd like to state at this time that the Loddy PVT data was the data, the PVT data that was accepted by the Gavilan Study Committee and used as a standard for analysis.

There exists another PVT on the --

Q We haven't brought that into exhibit, have we, as a --

A No.

Q And you're saying -- when you say that this has been accepted --

A I just wanted to mention that there is another one that exists over in the West Puerto Chiquito on the Canada Ojitos Unit Well L-11.

Q Okay, but what you're saying, then, is that this -- this PVT chart, Exhibit Number One, has previously and consistently been accepted by the operators in the two pools as representative of the characteristics of fluids in the formation.

A Yes, that's correct.

Q Turning back then to Exhibit Number Three, what kind of conclusions can you draw from the data shown in Exhibit Number Three?

A Well, again looking at Exhibit Number One, if you will, stock tank oil, in the event that the well was used, the oil was used to kill the well, and in this particular case 100 barrels, approximately 100 barrels was used to -- to kill the well, we want to differentiate between -- between that possibility and oil with gas in it coming from the -- from the formation, and that's what, that's what I've done here.

Q Okay, let me -- let me stop you for a minute there.

When you say, you referred to using oil, stock tank oil, to kill the well, would you describe that process for the Commission just briefly to -- as to what

you mean by that?

Q Yes. You, prior to running the production log tool, you have to go in and kill the well so that you can move the tubing uphole so that the tool is exposed to -- or the formation is exposed to the tool, perforations are exposed to the tool.

You have to pull the tubing up above the perforated interval to -- so that the tool can be exposed to the formation perforations directly.

Q Okay, then you do that, and then what is killing the well? When you say using stock tank oil to kill the well, what actually happens? What physically goes on down in the well?

A Okay. The well is flowing prior to -- to the procedure and when you load oil into the wellbore it essentially stops the well from flowing so that you can perform this operation.

Q And stock tank oil, does that contain any gas or other fluids in it generally, or is it pretty --

A No, no. It's -- it does not contain any gas and the thing to know is that this PVT data was taken at 170 degree Fahrenheit standard so the stock tank oil at that depth would read an approximate density of .78 grams per cubic centimeter and anything less to me has got to be something else.

Q Okay, just for the benefit of we lawyers in this -- in this group, what you're saying, then, is you lower this tool which you've identified as the spinner into the well which has been killed with stock tank oil. One of the things, then, it's looking for is the flow from formation into the wellbore of fluids, but it has to be at a high enough rate so that took can measure, is that correct?

A That's correct.

Q Then another thing which this log shows is the density, the temperature and density of whatever fluid is in the wellbore where the tool is measuring, is that correct?

A Yes, that's right.

Q And so if I understand what you're saying correctly, that if it were the stock tank oil that is being put into the well to kill the well, that is, stop the flow, that at that depth, at a temperature of 170 degrees you would expect the fluid that the device was measuring to have a density somewhere in the neighborhood of .77, .78 grams per cubic centimeter?

A That's right.

Q And looking at this particular exhibit you find that the density is something less than that. It's .71, .72, in that range?

A That's right. It approaches oil with gas.

Q And what does that tell you? What conclusions do you draw from that?

A That the C zone in this particular well, and I'd better refer you to Exhibit Two so that we can identify the location of this, this is the Sun Exploration Homestead Ranch No. 2, which is identified as Item A on Exhibit Two.

And from this I conclude that there is some contribution coming from the C zone. It's -- it's difficult to quantify exactly how much is coming but something to note is that up hole the spinner starts kicking in. Let's say the well made 150 barrels of oil a day, and the C zone itself made 50. Well, that would be too low for the spinner to pick up, but nevertheless, a good of that, of that flow, should be attributed to that -- to that C zone.

Q Okay, is that -- in conclusion, then, based upon this information, it's your interpretation of this log information as relates to the -- to the PVT chart, Exhibit Number One, that there is in fact oil, oil and gas mixed together from the reservoir, being measured by the tool which is in the C zone, is that correct?

A That's correct.

Q Have you made this same type of analysis with any other wells in the area?

A Yes, I have.

Q Would you identify the wells and if you have exhibits, the exhibits which are associated with those --

A Yes.

Q -- various wells?

A The Mobil Producing Texas & New Mexico Lindrith B No. 37 is represented -- is Exhibit Number Four, and is identified as Item B on Exhibit Two.

The Mallon Oil Company Howard Federal 1-8 is Exhibit Number Five, and identified as Item C on Exhibit Two.

The Benson-Montin-Greer Canada Ojitos 31 -- N-31 Well is Exhibit Six.

Q Excuse me, let's -- is that Six? My copy looks like Number Seven.

A It's Seven, Seven, that's correct. Exhibit Number Seven, identified as Item E on Exhibit Two.

Benson-Montin-Greer Canada Ojitos F-30, Exhibit Number Eight, identified as Item F on Exhibit Number Two.

And, finally, no, we have two more.

Benson-Montin-Greer Canada Ojitos L-27,

Exhibit Number Nine, identified as Item G on Exhibit Number Two.

Benson-Montin-Greer B-32, Exhibit Number Ten, Item H on Exhibit Number Two.

Q Now if I looked at each of these exhibits I would find similar types of logs, is that correct?

A That is correct.

Q And you have marked them showing the top of the C zone in each case?

A That's correct and identified the density curve, the temperature and pressure, if present.

Q So I could go and look at those curves and make a similar analysis using this -- the Exhibit One PVT chart and hopefully draw some conclusions with respect to the contents of the fluid in the wellbore, is that correct?

A That's correct.

Q Have you done so with each of these logs?

A Yes, I have.

Q And do you find similar conclusions or similar results and come to similar conclusions with respect to each of these? Or are there variations or --

A There are variations. For the most part

yes, I do see contribution from the C zone on -- from all of these wells with the exception of the Benson-Montin-Greer Canada Ojitos Well L-27.

Q That's Exhibit Nine?

A Which is Exhibit Number Nine, Item G.

Q Let's look at that for a moment and just tell the Commission what the -- what the difference is between that and the other -- other wells and logs you've looked at here.

A Well, let's turn to Page Number 3 where I've marked the top of the C zone, and examine the density curve here.

If we look in the bottom of the log there or -- well, a third of the way down the page, we'll see the designation on the righthand tract FDM and then in parentheses G/DC, and this is the density reading that we need to examine.

Midway is the density of 1. You can see to the right of that number that we have a density: therefor it's apparent to me that -- that there isn't anything but water coming from or in this zone.

Q What would be the density for water?

A One.

Q And it's a little above water, so it --

A That's correct.

Q -- water and something heavier, if I understand that correctly.

A That's right. It -- it may be a little too light for KCL but I think KCL should read in there about 1.2, so I'm just calling it water.

Q Okay. Is that the only well which in your opinion does not show oil coming from the formation in the C zone on the exhibits that we've got before us?

A Yes.

Q Have you had the opportunity to look at the manner in which the logs were taken and to verify or confirm in your own mind the accuracy and adequacy of the logs?

A Well, I've had a great deal of difficulty with some of them.

If we'll refer to Exhibit Number Four, Item B on Exhibit Number Two, the Mobil Lindrith B-37 Well was very difficult for me. A logging engineer indicated that he found TD to be at 6878. Mobil's completion report put the PVT at 6958, which is 80 feet deeper.

The logging engineer also indicated that he encountered sludge or fill at the -- at that depth and didn't try to get any deeper.

The completion report also indicates --

well, let me -- let me refer you to the completion report. It is the last page on this exhibit.

The completion report indicates that there is a 5-1/2 inch, 15-1/2 pound casing set at a depth of 6831, under Section 28 on the -- on the completion report, but on the log it states that a 4-inch liner, and if you'll -- you'll turn back to the actual production log, the first page down in the run section at the bottom of the -- of the description, the first page of the log there, the 4-inch liner is set from 6244 to 6966.

Our office records couldn't -- couldn't verify that, so after communicating with the Mobil personnel, we were told that the hole was deepened and 4-inch liner was hung at 6262 and TD was 6974. It was not known where the tubing was setting prior to the production log survey and it's not known whether the well was killed prior to the survey or if it was, what it was killed with. The logger didn't get a good rathole reading on this log because of the fill that he ran into, but he did make a surface calibration. So the reading he got made him suspicious. His reading, density reading, was 1.10 grams per cubic centimeter. So he adjusted his tool from that to .98 and used that a standard for water.

1.10, I feel, is a better figure because that's -- that's water with, perhaps, some frac fluid or KCL

in the event that the well was killed with -- with that medium.

In the -- in the month of February, 1987, the well made an average production of 27 barrels of oil a day, 249 MCF a day and 4 barrels of water. The well was shutin for five days prior to testing. Production during the test was 288 barrels of oil a day, 833 MCF a day, and no water to surface, and this information can be verified by referring back to Exhibit Number Four, page one, the lower portion there.

The lower rate in February can be accounted for by the reduced allowable that was in effect, that the well was choked back. The choke was then opened up to the test and that's the reason for the higher production.

The well was then produced for 24 hours prior to running the test. A rising water column was observed near TD at 6860 and rose 42 feet from 6860 to 6818 in 6 runs over a period of three hours, or the duration of the test, and that can be illustrated on next to the last page of Exhibit Four, showing Run 6 and then the previous run being Run 1, which shows that (unclear.)

Q All right. What type of readings, then, would you summarize what Exhibit Four shows you? I mean apparently it's -- you have less than complete confidence in the testing that was done there.

A That's correct. That's correct, and so if we -- if we back up our readings for an average reading of .73 grams per cubic centimeter and the density to .85, as it should be, indicates one of two things, either gas with water or gas with oil and water, and that's -- that's my conclusion.

Q So you're then concluding, then, that you're still getting some oil contribution from that zone, is that where you are?

A That's right.

Q All right, so with the exception of the Canada Ojitos L-27, each of these wells which was tested is indicating that there is oil contribution from the C zone as a result of -- based upon the interpretations in these exhibits.

A That's right.

Q Did you do any other tests or get actual production information in which the C zone was isolated from the A and B zones to determine whether or not there was an oil contribution from the C zone?

A Yes. If you will -- if you'll turn to Exhibit Number Six, Item D on Exhibit Number Two, this is a graphic presentation of the Mallon Oil Company, Mallon/Mesa Grande Resources exhibit that was previously exhibited in a hearing, showing the results of pumping a well below a

packer, isolating the C zone in the Fisher Federal 2 No. 1 Well of Mallon's and there's something to be noted on this. You'll notice there's a lot of what appears to be down time. It's very difficult to -- to pump a zone below a packer, and this type of effect is something you might expect.

Also, the rates or rather the production that's shown on this exhibit are a lot lower than -- than are illustrated here. If you'll come over to the lefthand side of this graph, come up to what appears to be about 51 barrels of oil a day, you'll see, 1, 2, 3, 4 points across there and indicating with Mallon Oil Company we discovered that the production, or the production secretary mistook 51 for SI, shut-in.

Q In other words, are you saying that there at it appears to be Day 6, Day 15 and 16 and Day 19, that those actually should show zero rather than 51, is that what you're saying?

A That's correct.

Q Does that change your conclusions that you would reach from this exhibit in terms of whether or not there is production from the C zone or --

A No, no, just -- just a lot less and due to the packer, trying to pump the well through the packer it creates difficulty in itself and it's very difficult to determine just exactly how much is coming from the C, but I

I would say that based on this data, it looks like less than 10 barrels of oil a day.

Q Are there any other exhibits which demonstrate actual production from the C zone?

A Yes. Exhibit Number Eleven, which is the -- the, excuse me, the Amoco Schmitz -- the Federal Schmitz Anticline No. 1 Well; also the Amoco State CC Well, Exhibit Number Twelve; also Exhibit Number Fourteen, the Amoco Hill Trust Federal No. 1 Well; and Exhibit Thirteen, which is Nassua Resources Wishing Well 35 No. 7; the Amoco Bear Canyon Unit No. 1, Exhibit Number Fifteen; the Amoco Bear Canyon Unit No. 2, which is Exhibit Number Sixteen; Amoco Bear Canyon No. 3, which is Exhibit Number Seventeen; and finally the Mobil Federal No. 1, Exhibit Number Eighteen.

Q And each of these wells can be located using your key on Exhibit Number Two?

A That's correct.

Q And just briefly describe, these exhibits are all similar in content, is that correct?

A That's right, with some minor variations.

Q And would you describe the common features of the exhibits, please?

A Yes. Yes, all the exhibits have

completion reports as the first page and logs as the second page.

Some of the exhibits have -- have GOR reports; others have production information, actual production information from the well.

Q And what do these exhibits show? I mean do they -- how do they help you determine whether or not there is in fact production from the C zone?

A Well, these wells were initially completed in the C zone, all except for the Wishing Well 35 No. 7, and the Mobil Federal No. 1 was a B and C completion and never was independently completed in the C, as far as I know.

Q And what, what information contained herein, actually in the exhibits, tells you whether or not there was production from the C zone?

Let's take Exhibit Number, say, the first one, the Schmitz Anticline, can you go to that Exhibit --

A Yes.

Q -- Eleven and just demonstrate to the Commission how this exhibit shows whether or not there is production from the C zone?

A You bet. Exhibit -- the second page of the exhibit shows a well log, shows the perforated interval,

which is clearly the C zone.

The -- since completion the well produced at a GOR between 2-to-300 cubic feet per barrel. The latest GOR test on file in the Aztec Office shows a GOR of 200-to-1 (sic).

Amoco is not reporting gas production on this well and the volume we're using is an estimate from their staff.

Q Is there a better exhibit that would give more --

A Yes.

Q -- accurate information and better able to depict the --

A Yes. If we examine the State CC.

Q That's Exhibit Number Twelve?

A Exhibit Number Twelve. Made an average of 236 barrels of oil per day. The well was making just enough gas to operate the well site on March 9th. A test meter was installed to measure what little gas was vented. From that point the well averaged 265 barrels of oil a day and 41 MCF a day for a GOR of 155 cubic foot per barrel.

The latest C zone GOR test in our office, and that's -- it shows a GOR of 233-to-1.

The well was recently completed in the A and B zones and GOR tested. Those zones only show 626

barrels of oil and 100 MCF for a GOR of 160-to-1.

Q So you would there -- do I understand what you're saying, therefore, is by looking at the separate C zone production you've got independent C zone production and then when you look at the combined A, B and C zone production it still would indicate the C zone contribution? Is that correct?

A Yes. That's correct.

Q And can you make a similar analysis of each of these exhibits?

A Yes.

Q And you come up with a similar conclusion for each of the wells which you've looked at?

A That's right. We've got one, the Hill Trust Federal No. 1, the Exhibit Number Fourteen, that shows the C zone only on the first -- first set of columns there.

One thing, one thing that really disturbs us, if you'll -- if you'll notice on the gas being reported, that anomalous looking 20, it's very difficult to interpret exactly what that means.

So you have to keep in mind that the data is not -- is not satisfactory.

Q Based upon all of the information which you have gathered and looked at, do you have an opinion as to whether or not there is C zone contribution to the oil

being produced in the wells throughout the two pools?

A Yes, I do have an opinion on that. We'll refer back to Exhibit Number Two.

The amount that's being contributed from the C zone in the Gavilan area below the Bear Canyon Unit seems to be -- seems to be a lot less and also the low GOR's seem to be -- seem to exhibit themselves.

There are some prolific C producers. The Bear Canyon Unit wells are apparently some prolific C producers.

The Schmitz Anticline, the State CC Well, Amoco State CC Well, is a prolific producer. The Canada Ojitos B-32 and the F-30 are significant contributors.

Q So it is your opinion that there is a significant contribution from the C zone? Would that be a fair statement?

A Well --

Q Not consistent, necessarily, but --

A It's difficult to say what this is telling us, you know, there are a couple of things that you could -- that you could draw conclusions on. It means that the C zone is a separate source of supply, separate pool, or that the operator, in the event that it is a prolific producer, may have drilled into a nice little fracture

system; if it's not, may have missed the fracture, something of this nature.

Q But the fact that it's not consistent throughout the reservoir, doesn't make you think that it's not a producing zone in all places, is that correct?

A That's right. I believe that it is -- that it is a producing zone in -- in all places.

Q Is there anything else that you'd like to add to your testimony today?

A There is more information available on the Bear Canyon and State CC Wells.

In communicating and talking with Amoco, they have conducted some PVT tests, or they do have some PVT information on the Bear Canyon Unit Area. They've also got some pressure, some pressure tests, and some other tests indicating -- well, talking about the A, B and C communication problem -- or question, and I'm sure that Amoco, at the request of the Commission, would be happy to come forth and present whatever -- whatever information they do have in addition.

I do have the information but I --

Q Is it -- it's in the form of oral statements to you --

A That's correct.

Q -- would that be correct? Yes, sir.

All right, so you have nothing further to present on that issue.

Q All right.

MR. STOVALL: I have no further questions, Mr. Chairman.

MR. LEMAY: Thank you. Questions of the witness?

MR. DOUGLASS: Yes.

CROSS EXAMINATION

BY MR. DOUGLASS:

Q Mr. Busch, are the -- are there a number of Mancos Pools that have a fractured type reservoir?

A Yes, Mr. Douglass, there are.

Q Is the -- is secondary recovery something that in your experience the Commission has tried to encourage the operators to look at with reference to the various pools?

A Yes.

Q Can you tell me how many of the fractured Mancos pools that that you're aware of where a pressure maintenance project by gas injection have been conducted?

A I'm aware of the Canada Ojitos Unit Pressure Maintenance Project.

Q Any others?

A I'm not aware of any others.

Q Mr. Busch, have you seen any report from -- strike that.

It's my understanding that you may have attended some of the meetings that involved the Gavilan operators, is that correct?

A That's correct.

Q Have you seen any report that any operator or working interest owner in that field has presented from the standpoint of a reservoir study that showed that any kind of secondary recovery program would increase the recovery from Gavilan and how much that increase would be?

A No, no reports. A statement made by Mr. Al Greer at the first meeting relating to approximately 12 percent based on gas injection in the Gavilan.

Q When you say 12 percent, you mean 12 percent above primary, 12 percent more than primary would be recovered?

A Yes.

Q That's not a very -- very much additional recovery over primary, is it?

A Well, that's -- I guess that's relative.

Q Well, if I understand it, in other words

primary, 100 percent of primary would be X barrels.

A Yes, sir.

Q And if you recovered 12 percent more of that through a secondary recovery project, that would be 12 percent of X, is that right?

A That's right.

Q Have you seen any reports or documented data that shows what the primary recovery would have been in what we've been calling the West Puerto Chiquito Pressure Maintenance Area, what the primary in there would be versus what the secondary would be?

A Yes, but I don't recall any, any figures, Mr. Douglass.

Q But you've actually seen a report that showed primary for the West Puerto Chiquito injection project and the additional recovery from secondary for the West Puerto Chiquito injection project?

A Oh, for the West Puerto Chiquito, I'm sorry, I misunderstood your question.

No, no, I haven't.

Q To you what is the significance of whether there's any contribution from the C zone or not with reference to the issues we have in this hearing?

A Well. as I stated, the operator may -- it may be an indication as to -- as to what -- what type of

area he's drilling in. It may be something the Commission might want to look at as far as separating the C zone.

Q Do I see that a number of the wells that you've looked at, L, N and O, are outside the Gavilan Mancos Pool?

A Let me get my exhibit, Mr. Douglass.

Q That's 2.

A Thank you. Yes, that -- well, if you look at Bear Canyon, Bear Canyon wells, that's an extension of the Gavilan Mancos; at the Hill Federal Trust Well, that's an extension of the Gavilan Mancos; and then, of course, you have the Regina Gavilan wells down in Section 36 of 24, 1, which is not in the West Puerto Chiquito Pool.

Q In the Gavilan Mancos Area that you show in your Exhibit Two there, from your study of those wells within the Gavilan Mancos Area that you show there, would it be fair to say that you -- it didn't appear that there was much contribution, if any, from the C zone in that area?

A Well, it would be fair to say that there wasn't much contribution but it wouldn't be fair to say that there wasn't any.

MR. DOUGLASS: Pass the witness..

MR. STOVALL: Excuse me, Mr.

Chairman, if I may first, I'd like to offer the exhibits. I neglected to do that, Exhibits One through Eighteen.

MR. LEMAY: Fine. Without objection Exhibits One through Eighteen will be admitted into evidence.

Any questions, Mr. Kellahin?

CROSS EXAMINATION

BY MR. KELLAHIN:

Q Mr. Busch, when you've examined the production surveys in this area of West Puerto Chiquito and the Gavilan Mancos Pools, what you have shown us on Exhibit Number Two is all the available production data from the wells in those areas?

A That data that I have, Mr. Kellahin. There may be other data that I'm not aware of.

Q And in your analysis, if I understand it correctly, when you look at the spinner side of the production log, when the rates fell below 120 barrels a day, that fell below the rate at which the spinner was going to register.

A That's according to Welex Logging Company. That's an are --

Q So when we attempt to quantify the magnitude of oil contribution from the C zone in any of

these wells, all we can tell is that it's something less than 120 barrels a day.

A Well, that's right, based on what you have.

Q Mr. Douglass asked you awhile ago whether or not there were any written reports on the potential for secondary recovery in Gavilan Mancos and I believe your response was that you had not seen any written reports.

A That's correct.

Q It was your recollection, however, that there was an opinion attributable to Mr. Greer that there would be a benefit of secondary recovery for Gavilan Mancos.

A Yes, that's correct.

Q And that percentage was 12 percent?

A It -- it seems to me that it was along that -- yes.

Q Now are we talking approximately 12 percent of the original oil in place being recovered by secondary recovery operations or are we talking about an additional 12 percent above primary?

A An additional 12 percent above primary.

Q That was your recollection?

A Yes. When we look at the area that you

have surveyed on Exhibit Number Two, the current boundary line between West Puerto Chiquito Mancos and the Gavilan Mancos Pool is what you've depicted on this display?

A That's correct.

Q And when we look at the expansion area, that area we've called the expansion area, that would be the two rows of sections immediately to the east of that dark black line?

A Yes.

Q Separates the two pools?

A Yes.

Q Based upon your studies, Mr. Busch, do you think it is reasonable to attribute the difference in production to simply the quality of the fractures in the areas of the pool, rather than characterizing it as separate sources of supply?

Did I make myself clear?

A Yes, you did, Mr. Kellahin. As I've indicated, the quality of fracturing may be the reason an operator gets a better well. If the fractures are not there he may not -- he may not get the kind of well he would have otherwise.

Q We have had an issue or a point of discussion in prior Gavilan hearings, Mr. Busch, I'm sure you're aware, of whether or not it is reasonable and

probable to try to separate the Gavilan production from the West Puerto Chiquito Mancos production by saying that A and B zones produce in Gavilan and the C zones produce in the Unit.

You've shown us here, I think, that in the Bear Canyon Amoco Unit we've got significant C zone production.

A That's correct, Mr. Kellahin.

Q So there is an area, then, west of the West Puerto Chiquito line that's got significant C zone production.

A Yes.

Q How comfortable would you be to try to separate production in this reservoir between the two pools based upon A and B in the one side and C in the other?

A I wouldn't be comfortable at all.

Q Why not, sir?

A Because of -- because of what we see indicated, the Bear Canyon being a prolific C producer and we don't know why and we can't quantify what -- what is going on down at the Gavilan as far as what may be coming from the C. There's a lot at stake and to say that they were two separate sources of supply, I -- all I'm saying is that the C could be looked at as possibly being separate from the A and B. I don't have any information as to

whether the A and B and the C are in communication.

Q There's so much at stake, Mr. Busch, that you're not comfortable as an expert to separate the two pools based upon A, B and C zone production.

A That's right.

Q That's not going to be the magic parachute or the safety net that solves the problem between operators in the pool.

A It may not be.

MR. PEARCE: Mr. Chairman, if I may get back in?

MR. LEMAY: Mr. Pearce.

CROSS EXAMINATION

BY MR. PEARCE:

Q Mr. Busch, let's look real briefly at Exhibit Two, again, please, sir?

All right.

Q I find the wells that you labeled A, B, C and D.

A Okay.

Q Do I understand that we do not have a spinner reading on any of those wells which reflected a flow out of the C zone? A, B, C or D wells on --

A Mr. Pearce, you'll have to let me take a

minute here and just review, but I think that's correct. I want to make sure that that is the case.

There is nothing from the Homestead Ranch; nothing from the Mobil B-37; and the Howard Federal 1 No. 8. That would cover it, wouldn't it?

That's correct, Mr. Pearce.

Q Okay, and as I understand your discussion earlier, I believe it was Exhibit Five, showed the daily production from the C zone in the Mallon Fisher Federal Well?

A Exhibit Number Six, Perry?

Q Yes, I'm sorry, it is Six.

A Okay, would you repeat the question, please?

Q That is one of the wells on which we do not have a spinner reading and your testimony was that that well's average production during the time that only the C was open was something less than 10 barrels a day?

A That's correct, Mr. Pearce.

Q Mr. Busch, do you have any information about a well called the Davis Federal in Section 3 of 25 North, 2 West?

A No, I do not today.

Q Mr. Busch, you've indicated that you believe there is some C zone contribution both in the

Gavilan and West Puerto Chiquito Mancos Pools, is that correct?

A Yes, with the exception of the L-27.

Q Do you therefore conclude that the C zones in those two pools are in communication?

A Yes, I would say that they are.

Q On what do you base that conclusion?

A That just looking at the overall picture it's apparent that -- and looking at the logs, that the C zone is a continuous body.

Q And therefore, since the zone is continuous your conclusion is that those formations -- are in communication between those pools?

A Yes, sir.

Q Do you conclude that the Boulder Mancos Pool is in communication?

A No, I have not -- I have not done any study to the -- to the effect looking at the Boulder Mancos.

Q Have you examined logs between the West Puerto Chiquito Mancos Pool and the East Puerto Chiquito Mancos Pool?

A No, no, I have not, Mr. Pearce.

Q If those logs reflected the same geological interval would you conclude that they were in communication?

A Yes. Well, based on -- based on what I previously said, yes.

Q Nothing further. Thank you.

MR. LEMAY: Additional questions of the witness? Any redirect?

MR. LUND: Mr. Chairman.

MR. LEMAY: Yes, sir.

CROSS EXAMINATION

BY MR. LUND:

Q Mr. Busch, my name is Kent Lund with Amco and because of your discussion about the Bear Canyon, I would like to follow up with a few questions, if I may.

A You bet.

Q First of all, who did you speak to at Amoco to get this Bear Canyon information?

A Richard Jones.

Q Now, talking about Bear Canyon, there are some differences in the Bear Canyon Unit from either West Puerto Chiquito or Gavilan, isn't that true, and I'll follow up with some specific questions?

A Yeah, maybe you could qualify them.

Q All right. First of all, Bear Canyon produces from the A, B and C zones, doesn't it?

A I'm sorry, the --

Q Bear Canyon unit, the wells that you were discussing produce the --

A They -- they do. They do now, I believe, some of them, Bear Canyon 1 and 2.

Q Right, but they produce from the three zones, isn't that true?

A Yes.

Q And I realize you're a little reluctant to discuss pressures, but the pressures are different in Bear Canyon from -- as opposed to Canada Ojitos, isn't that true?

A Yes.

Q Substantially so. I mean isn't the average pressure in the Bear Canyon Unit about 900 pounds psig?

A Mr. Lund, let me -- let me refer back to my -- back to my notes, if I may.

Q Sure.

A Do you want me to get into specific pressures?

Q I'm just talking about a general pressure in the Bear Canyon Unit. My question was, isn't it true that the approximate average pressure in the Bear Canyon Unit is 900 pounds psig?

A No, it looks to be a little more, to

me in looking at the Bear Canyon 1 on the -- now this is a calculated bottom hole pressure using surface pressures.

Q All right, when you say a little bit more than 900, what's your estimate?

A A couple of hundred pounds higher.

Q Well -- and in comparison the average pressure, or maybe the high end pressure in Canada Ojitos is around 400 pound, isn't that true?

A Yes.

Q There's some variability there but if you need to look at something, please do.

A I'd like to get Mr. Greer's rainbow map, if I may.

All I've seen is some pressures of 800 to 1100, going from west to east in the Unit, Mr. Lund.

Q You don't see it as high as 1400 in the Canada Ojitos Unit?

A Well, yes, there -- there are pressures that -- that high to the extreme east, over next to the East Puerto Chiquito Pool, of 16-1700 pound figures.

Q All right, and the pressure you're talking about, about the Bear Canyon No. 1, you indicated that you thought it was a couple hundred pounds initially over the 900 that I asked you about? Is that what your testimony was?

A Yes. If I -- if I could just talk a minute about a bottom hole pressure test that was calculated by your -- your people? After 115 -- 15 hours of shut-in using surface pressures and fluid levels, the pressure was calculated to be 1228 psia at 7442, corrected to 1100 psia at 7038. Now --

Q Now that's the Bear Canyon No. 1?

A Yes, sir.

Q And the original pressure conditions?

A Yes, sir. Now, on 12-21-87 a bottom hole pressure bomb was run and measured 951 psig at 7050 and 1082 psig at 7040.

Q So the initial pressure in the Bear Canyon Unit was around 1000 of record and then it has been reduced by virtue of depletion, is that fair to say?

A Yes, it very well may have been.

Q Did you examine the fluid properties in Bear Canyon?

A No, no, I didn't, Mr. Lund. I received a few numbers and PVT data and decided that it would be better for Amoco to present this.

Q Okay, and you didn't look at bubble points?

A Yes. The bubble point, as I recall from

that PVT data, was -- I want to say 928 pounds, is that it?

Q Yes, sir, but I want you to confirm that independently.

A All right, Amoco's PVT data study indicated that the bubble point pressure was 928 pounds psig.

Q In the Bear Canyon Unit.

A In the Bear Canyon No. 1.

Q All right, how about comparing that to some of the nearby areas. The Gavilan is around 1600, isn't that true?

A Yes.

Q And in Northeast Ojito it's approximately 1400, isn't it

A It seems to me that Gavilan was something in the neighborhood of 1550, 1480 to 1550, and West Puerto Chiquito, I can't bring that to mind right now.

Q How about approximately 1400 to 1500 in the Canada Ojitos Unit?

A Okay, I'll accept that.

Q Well, is that a fair statement to your recollection? I don't want to put words in your mouth.

A No, no, I'm -- no --

Q Mr. Chairman, I'm going to object. I

think the witness is far beyond his -- far beyond his area of expertise and Mr. Lund is doing what we --

MR. LEMAY: What I said earlier. Will Amoco have any witnesses, Mr. Lund, concerning the Bear Canyon Unit?

MR. LUND: Well, we are certainly hoping to clear that up by these questions. We certainly can produce a witness on the Bear Canyon Unit.

MR. KELLAHIN: Mr. Chairman, it's better cleared up with reservoir engineers and we've got gobs of them in this room to talk about all these pressures.

MR. LEMAY: Well, thank you, Mr. Kellahin.

I just want to -- how long do you want to pursue this cross examination?

MR. LUND: Not very long, Mr. Chairman. The point we want to make is that there are substantial differences in Bear Canyon as opposed to West Puerto Chiquito and I think --

MR. LEMAY: Well, I don't know if the witness actually was -- was getting on the point of -- of similarities between Bear Canyon and West Puerto Chiquito. He used some logs n there to show some C Zone production. Beyond that, I don't think he's qualified to

give the kind of information that you're trying to delve into here.

MR. LUND: Well, he testified that he examined this very information for purposes of his testimony.

MR. LEMAY: The bubble point? I didn't hear any bubble point testimony?

A No, no, I didn't. I didn't use bubble point information.

Q How about pressure information?

A No pressure information, either. I used production information.

Q All right, then I'll ask one more question.

MR. LEMAY: That's fine, you may ask your question or any others if they're pertinent.

Q Was it your testimony that there was substantially less C zone production south of the Bear Canyon Unit?

A Yes, sir.

MR. LUND: Thank you.

MR. LEMAY: Thank you, Mr. Lund.

Additional questions of the witness?

Yes, sir, Mr. Lopez.

MR. LOPEZ: Mr. Chairman, just one brief question, I think, in order to clarify my understanding following Mr. Pearce's questions.

CROSS EXAMINATION

BY MR. LOPEZ:

Q Is it your testimony that there exist stratigraphic similarities in the logs or that when there exist stratigraphic similarities in the logs of different wells in this approximately 7-township area, that those wells are in communication?

A No. Based on that, coupled with the testimony of the C zone producing.

Q But you are talking about pressure communication between these wells.

A I'm talking about the C zone being, again, a continuous interval running from Gavilan to the West Puerto Chiquito and that type thing.

Q So if I understand your testimony correctly, then, if in several townships even farther to the west there existed C zone, your same conclusions would hold, that these various reservoirs could be in communication since the C zone -- the C zone was present in the wells.

A At least the C zone.

MR. LEMAY: Additional questions of the witness?

Mr. Chavez.

QUESTIONS BY MR. CHAVEZ:

Q Mr. Busch, just to clear up an item. On the Bear Canyon Unit wells is the information you supplied, except where it's differentiated as including A and B, exclusively C zone pressure and production?

A Yes, Mr. Chavez, that's correct.

MR. LEMAY: Additional questions of the witness.

He may be excused.

(Thereupon a recess was taken.)

MR. LEMAY: Please be seated. We'll resume.

Mr. Stovall, you may call your next witness.

MR. STOVALL: Bill Weiss, please.

WILLIAM W. WEISS,

being called as a witness and being duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. STOVALL:

Q Mr. Weiss, would you state your name and place of residence, please?

A Bill Weiss, Socorro, New Mexico.

Q Have you ever testified before the Commission and had your qualifications accepted?

A No.

Q Would you please tell the Commission about your educational background?

A I have a degree in chemistry from Western State College. I've attended a number of industry courses and -- 19 total, 4 of them in reservoir engineering, 3 in pressure transient testing, 3 in computer programming, and other courses in logging and fracturing,-- fracturing, et cetera; also been invited to attend 4 SPE forums.

Q Okay, would you -- would you describe for the Commission your work experience, please?

A Yes. 13 years with a service company; 5 years using a Phillips Model for reservoir simulation; 5

years in the Abilene District doing reservoir work for Texas Pacific Oil Company and Sun Oil Company; 2 years with Sun in their research center doing EUR type research work; and 3 years at the New Mexico Petroleum Recovery Research Center.

Q And all this work has basically been in the field of petroleum and reservoir engineering, is that correct?

A That's correct.

Q Are you a member of any professional organizations?

A Yes, the Society of Petroleum Engineers.

Q Have you authored or published any written works?

A Yes, several. One that might be of interest here. It has to do with a polymer flood that was done in north central Texas but it was peer-reviewed and presented in Tulsa, then it was peer-reviewed and published in JPT; later published in Transactions; and most recently peer-reviewed again and published in the SPE Reprint Series, No. 23.

Q Would describe more fully your present employment, please?

A Well, I serve as liaison between the scientists and the oil operators in the State of New Mexico

employment, please?

A Well, I serve as liaison between the scientists and the oil operators in the State of New Mexico for the scientists working at the Petroleum Recovery Research Center and the oil operators.

I've currently been investigating fractured reservoirs, including the Mancos and the -- another is the Bone Springs down in the southeastern part of the state.

Q Let me just stop you for a moment there. Would you -- would you explain to the Commission, please, what -- what is the Petroleum Recovery Research Center?

A The Petroleum Recovery Research Center is a division of the New Mexico Institute -- the college -- Tech, New Mexico Tech.

The charter of the Center includes on-going application, as well as theoretical EUR research, technology transfer, and we're also chartered to assist others in their efforts to recover oil and to cooperate with State and Federal agencies.

Q Now you say that your specific function is liaison between the industry and the scientific types at the center, is that correct?

A Yes.

Q And in that capacity are you directly

engaged in conveying and analyzing information regarding oil and gas reservoirs?

A Yes.

Q And you've indicated that you have done some analysis of some fracture oil reservoirs?

A Yes.

Q Will you go into a little more detail? You say you have done work in the Gavilan Mancos and the West Puerto Chiquito Mancos formations, is that correct?

A That's correct. I've also looked at the Mancos formation down there at Cuba operated by Gary Williams. The reservoir there, the name of it, the pool, slips my mind right now.

The -- I've also looking into this Bone Springs, which is a fractured carbonate some places and sand in others down in the southeastern part of the state.

Q And have you, and in specifically doing the work in the Gavilan Mancos and west Puerto Chiquito Pools, have you prepared some exhibits and done the specific research in preparation of this case?

A Yes, I have.

Q At whose request and in what capacity have you done so?

A We did this, again, under our charter to assist to Federal and State agencies, and the Commission

asked that we -- we review the information collected during the period from June 30th through February 23rd, the pressure and production information that was collected.

We've also looked at the exhibits that have been presented at previous hearings here; matter of fact, read every word; unlikely to have retained too much of it, though.

Q Were you asked to make any specific analysis or were you told to confirm any specific information or were you more -- told to just --

A No, no, we were not; just to, I think the words went something to the effect, we'd appreciate your evaluation of the data that's been acquired.

Q And are you or the center receiving any specific compensation from anybody for this, other than your normal budgetary salaries compensation?

A No.

MR. STOVALL: Mr. Chairman, I'd like to offer Mr. Weiss as an expert in petroleum engineering.

MR. LEMAY: Mr. Weiss' qualifications are acceptable.

Q Now, before we get into the content of your exhibit again, I'd like to inquire a little bit about the background and preparation work which you have done in

preparation of this exhibit.

Will you describe the process somewhat for the Commission?

A Well, yes. I've attended, early on, one of the Engineering Committee meetings in Denver and listened to discussions there.

I've attended one of the meetings there in Farmington where -- where all of the operators were invited to -- to suggest and comment on the technique used to gather the pressure information, specifically, whether the wells should be shut-in 72 hours or 24, et cetera.

And as I said, I have reviewed the -- the exhibits presented.

Q And where did you acquire specific data or information which you've used in doing your analysis and preparing your exhibit?

A I acquired the data from the Aztec OCD Office and the exhibits that have been presented here; the single exception being one -- one interference test that has not been presented and I don't believe it went through the Aztec Office.

That was given to me by BMG.

Q And so all of the data has been either supplied to you by the parties or through the Commission or the Division, and you have not actually gone out

independently and acquired any data from --

A That's correct.

Q Have you -- has your analysis or report been made available to the parties prior to this date?

A Yes. I had a preliminary report that I gave to all parties who requested one back in May; the purpose of that being to get their comments and invited everyone who wished to comment to -- to visit with us in Socorro, and both sides did, and contributed greatly to this more recent work here.

Q And when you say you've invited their comments, what -- what was the nature of that? Is it just for clarification or --

A Well, there are differences of opinion in how you analyze data and so I requested that both sides review it, if they had any serious objections I wanted to know about them, and then I might, I think -- or if they had an alternate technique, that I'd consider it, and, in fact, I did do that.

Q And, in fact, their input has resulted in some modifications to your exhibit.

A To the preliminary exhibit, yes, that's right.

Q To the preliminary exhibit, which has resulted in this final document about which you're about to

testify.

A Yes, sir.

Q Now, would you take your exhibit, and for the record, this has been marked New Mexico Petroleum Recovery Research Center Exhibits in cases -- Case Numbers 7980, 8946, 8950 and 9111 before the Oil Conservation Commission, A Review of the Gavilan - West Puerto Chiquito Mancos Reservoir Performance During the Period of July, 1987, through February, 1988, is that correct?

A That's correct.

Q Would you take that exhibit and just review the format for a moment to explain to the Commission how this booklet was put together?

A Well, there are five sections. One is a bit of background material; one section that includes the static pressures; and then the method used to arrive at those is in the Appendix and all the worksheets, and they're after the first yellow section.

The third group, or third section, includes the build-up tests and their analysis; again, that is in the Appendix.

The interference tests, sometimes called frac pulse test data, is also included as Section 4, and that is in the Appendix.

And then I looked at the rate

sensitivity question and the work that was done with the production data is summarized in Section 5 and is also included in the Appendix.

Q All right, so if I understand you correctly, you're saying that the first twelve pages, approximately, fourteen pages, are a narrative report, followed by tables and figures which support that report?

A Yes, sir.

Q Followed by, behind the yellow tab, your actual calculations that went into coming up to the conclusions you've reached?

A Yes.

Q Is that correct?

A Yes.

Q Now, let's just for efficiency, let's look at this report and would you just start out with the section entitled Background and describe briefly for the Commission the gist of that portion of your report?

A In the Background section I think the only thing that might be of interest to -- to the groups here, would be the production history of the Boulder Mancos Field, which is on Figure One.

We cam see from this figure that the field will produce about 1.8-million barrels of oil. It's -- it's about done right now. It contains 25 wells on 4000

acres, maybe a little less, the average transmissibility of three wells in this field was 97 darcy feet based on build-ups run by Chevron, I believe, back some years ago.

This -- this transmissibility is five times better than anything calculated at Gavilan or the Canada Ojitos Unit.

I might add the dip in the Boulder Field is about 2000 feet per mile and roughly 10 times that at Gavilan or the west side of Puerto Chiquito.

This is all primary production, this 1.8-million barrels from Boulder Mancos Field, and I notice that -- that the COU Well E-10 has produced 2.2-million barrels of oil, more than the entire Boulder Field. I think that is evidence that -- that gas injection, secondary recovery by gas injection works.

Q All right, would you now describe briefly the results of your analysis of static pressure evaluation?

A Yes. Briefly, bottom pressures were corrected to the top of the B zone using wellbore gradient, usually, unless it is obvious that the well had been killed with oil, these gradients are constant.

It was then corrected to the +370-foot datum with a reservoir gradient based on a volume weighted fluid density, and again the PVT data is that of the Loddy

No. 1.

The static pressures are mapped on Figures 2 through 4, that's pages 23 through 25, and if we'll look at those, look at page 23, with this data we can see that pressures are generally higher to the east with a gradient across the field until we get over to the west side of Gavilan. This outline here is the West Puerto Chiquito and Gavilan at the time that these tests were done.

So that's the data on June 30th, 1987.

On Figure 3 we see the static pressures at -- on November 19th, 1987, and again the gradient from -- from east to west is evident.

And finally, on page 25, Figure 4, the pressures on February 23rd, and again this pressure gradient from east to west, with some -- with the exception being the far west side of Gavilan.

Now these type of pressure gradients that the lines are not drawn in, you have to -- not being a very good line drawer, I just put the pressures in -- but on the next figure, Figure 5, here are some pressure gradients on a CO^2 flood in north Texas. This project is approximately -- the capacity of the rock is about one darcy foot and the pressure gradient is about 200 psi per 1000 feet, and we can see that response is evident on

Figure 6. That reservoir was indeed connected.

On Figure 7 is a gas injection project. This is really old data out of Muscat's book, but here the flow capacity was 13 darcy feet based on core analyses, and if you look across there until you find the pressure gradient of 75 psi per 1000 feet.

On Figure 9, or Figure 8, I have a waterflood taken from the Judy -- Judy Creek Waterflood. Here the capacity varies from 5 to 10 darcy feet and the pressure gradients according to the contours there are about 25 psi per 1000 foot; the point being on Figure 9 we see the pressure gradients from a single injection well to others in West Puerto Chiquito and pressure gradients there are comparable to those seen in this CO_2 flood, waterflood, gas injection pressure gradient, pressure gradient, and my point was that they're not unusual, those that -- those that are evident on Figure 9.

Q And you're saying, then, they are not unusual for what, for a secondary recovery project?

A For a secondary recovery project, yes.

Q Is there anything further you'd like to add with respect to the static pressure?

A Yes. I think on Figure 9 there you can also see that there's a north/south trend to the permeability, it being much greater north/south than east/west,

perhaps by a factor of 10.

Q Turn now, then, to the pressure build-up test portion of your report and describe that for the Commission.

A All right, a number of wells had pressure build-up tests conducted. At the meeting in Farmington we stressed the point to get early time data and the operators were -- did indeed do that.

The analytical technique used to analyze the data was to convert the gas and oil flow rates to reservoir barrels, then identify the proper straight line on a semilog plot and this was done by constructing a logarithmic plot of the change in pressure versus change in time and then using accepted rules to identify the proper straight line.

The time was mapped in "Agarwal" time to correct for any short time problems and once this proper straight line was identified, transmissibility was calculated from the semilog plot. This information is tabulated on Table 1 and mapped on Figure 10, page 31. That might be the easiest to look at.

But here we see the transmissibility expressed as darcy feet per centipoise of these key wells; two wells in West Puerto Chiquito and the rest in Gavilan. As you can see, that varies from about a 1 to 20 darcy feet

per centipoise with the better wells having the higher transmissibilities, as one would expect.

That was our look at most of the wells.

One well, Mobil's B-37, exhibited a double slope in the area where the -- where the proper straight line should be. This -- this indicates several things. It can -- one, it can be a boundary effect, or it can be a dual porosity reservoir, or a change in mobility, et cetera, but since the bulk of the testimony that I'm aware of, is this has always been called a naturally fractured reservoir, we should have dual porosity characteristics, we analyzed this well in terms of -- or using a dual porosity model and the results are shown on page 5, two different sets of results.

Initially I used 233 feet as the thickness of this well. Mobil suggested that perhaps based on their analysis of the production log, that it should only be 50 feet. Now I've heard conflicting stories this morning as to whether it's 50 or 233, so I'm glad that I had them both in here.

The only thing that changes between the analyses of significance is the matrix capacity. It varies -- when I use the 50 foot analysis I use the porosity from the B-38 core analysis, which is -- offsets the B-37. The matrix capacity is 30 millidarcy feet, first 9, then I used

233 feet, and also the transfer coefficient, which might be quite important, increases roughly the effect of roughly 4.

Q Okay, and what is the significance of that analysis, then?

A Well, this -- this would tend to support the -- the contention that this is a dual porosity reservoir.

Q And if that is the case, do you have any ability to determine what rate the matrix contributes to -- to the production in this reservoir?

A I did attempt to do that and I was unable to do it. This is dependent on transfer coefficient, or oil flux rate, or whatever you call it, and I could not find a simple analytic expression to calculate that, and so, no, I can't comment on it.

Q Okay, is there anything further you'd like to add with respect to the pressure build-up portion of your report?

A I might add that I think both sides agreed with the -- generally, with the report -- with the transmissibility reported on Figure 10, at least during their visits.

Q Would you turn now, then, to the interference test portion of your report and describe your analysis there?

A Yes. That's on page 6.

I think one of the key -- key points on this analysis, and there's been a of contention as to how there could be so much variation in transmissibility from an interference test and from a build-up.

Well, and this caused consternation, my first attempt at analyzing this data was by something that was easy and quick and analytical, and I liked it but nobody else did, so I quit it, and I went back to using the exponential integral superposition -- EI function.

But before I did this, I talked to -- to the men who have developed these techniques and they all suggested that, but they also pointed out that in an interference test in a naturally fractured reservoir, that the response from a pulse is going to run down the cracks before it runs through the matrix, as a whole, or before it runs through the whole reservoir interval.

So this makes sense; therefore, if you see any, any response to a pressure pulse in a naturally fractured reservoir, it's going to be higher than what you observe in a build-up, which measures the entire interval.

Now this can be seen on Figure 11. Reviewing the data I see that Mallon/Mesa Grande presented this earlier, and I'm sorry I didn't see it right off the bat, but this explains how this happens. There's

dimensionless time, that's the bottom axis, and dimensionless pressure is on the Y axis. I've taken and calculated dimensionless time from an equation which I won't bother you with, and used the build-up, or the transmissibility data that's on Figure 10 or on Table 1 or 2, whatever it was, yeah, Table 1, and I calculated dimensionless time, t_D. At no time did it ever exceed 1 $x10^1$ based on these build-ups. Well, you can see, that's not even included on this -- on this curve here.

So the only -- and if you got a response, it would be from the fractures and you wouldn't see a response from the homogeneous or -- or the entire matrix plus fractures wouldn't respond until you got up to a dimensionless time of t_D greater than 10^5 power.

Okay, let's see, so it's not unusual that -- that the response at observation wells from the frac pulses is difficult to see and there were great questions as to whether there was really fracture response. The fact that there was not is not unusual. It must means that the fracture system in that area was not as extensive as it is in others, and that's explained on Figure 11.

I then used the -- the build-up transmissibility obtained from Well B-32, the map on Figure 10, page 31, with 21.7 darcy feet per centipoise, and I plugged

that into a linear flow equation and I cannot illustrate it on Figure 10 but it has been documented before that the pressure at Well C-34 was in the neighborhood of 1400 pounds at the time these tests were run; that's -- I believe B-32 was on November 19th, the build-up was run.

Then I calculated the distance from C-34 and B-32, and then one mile north of B-32 is a Well B-29, and it's not on the map, but B-32 is two miles east of -- or C-34 is two miles east.

Q Mr. Weiss, would Figure 12 relate that information on page 33. is that --

A I'm sorry, C-34 is not on there, either, but B-29 is, but C -- C-34 would be two miles east of -- of B-32, about 10,000 feet.

I drew a rectangle 10,000 feet by one mile and concluded that that pressure drop with the transmissibility obtained from B-32 could result in -- in about -- in about half of the production from B-29 to B-32 at the time B-29 and B-32 were producing approximately 10,000 barrels of reservoir fluid a day and half of that was probably due to -- to the pressure difference across C-34 to B-29.

Q And what -- what does that indicate, then, in plain terms? That there is in fact communication across there?

A Yes, the reservoir is continuous across that area.

Q Is there anything further you would like to add with respect to the interference tests?

A Yes. I did find five -- five frac jobs that I thought in my judgment resulted in pressure response at the observation wells. Transmissibility was calculated in those and they are reported on Table 11, page 17, and mapped on Figure 12, page 33.

Q And again would you -- would you just briefly summarize the significance of that information?

A I believe that the -- that these frac tests, frac pulse tests, do indeed represent the transmissibility of the fracture system; not of the reservoir as a whole.

Q Now, in -- I believe I heard you say earlier, however, that if there was not a communication which was evidenced in this test, that would not necessarily mean that there was no communication between a pair of wells, is that correct?

A Exactly. For instance, C-34 was fraced and whether there was a response at B-32 and B-29 was controversial. That was pointed out to me and I accept that. It is controversial, and I deleted it. But that does not all mean that the wells are not connected.

Q So it is possible based upon this information that there -- or rather let me rephrase that question.

This data, would you consider it conclusive or not as to whether there is a geological boundary in this area which would separate the two reservoirs?

A I'd say it conclusively demonstrates there is not a geological boundary.

Q Is there anything further you'd like to add with respect to the interference tests?

A No.

Q Will you turn now, then, to the section entitled Rate Sensitivity and go through an analysis of that information?

A The way we handled this problem was to collect the production GOR data, and this was submitted to us by, again, the Aztec OCD Office, and submitted by the operators.

We took this data and we entered it in -- by month, the monthly production data, except where the data was sparse and there was only less than a month's data or less than two month's data, and there we entered the data by hand and we sorted this data based on rate, highest rate at the top and its associated GOR.

And we plotted that information on a logarithmic plot, and you can see these in the Appendix, it's the last Appendix. For instance, the last Appendix, just -- the sheet right after the first yellow sheet, we see all the wells that were analyzed, the data from all the wells, and that line in there is (not clearly understood.)

So then we did the same thing for each individual well.

Now the next well happens to be Amoco Bear Canyon Unit No. 2. There wasn't a lot of data here. It's plotted in barrels of oil per day rather than barrels of oil per month, and down in the lower lefthand corner you'll see the correlation coefficient. This indicates the goodness of fit to a straight line. The correlation coefficient in this particular well is .31. That means there is no fit to a straight line.

However, just the opposite is the Amoco State CC on the -- about one, one page over, and there the correlation coefficient is 1. It's perfect. That's 100 percent fit, and as you can see, the straight line falls on every point that was plotted.

Then the rest of the wells are -- were done in a similar manner and these are tabulated on Table III.

Now, of the 80-some wells analyzed about

half of them exhibited the correlation coefficient of .85. or greater, and I might add, in the lab that we use .95, but for field data my judgment was .85 was a good correlation.

I've noted there that three of the wells, the data appeared in chronological order so that could well have been just a depletion type response.

One of the wells had a positive slope, indicating poor efficiency.

I should back up a moment and explain that the -- as a GOR, gas/oil ratio decreases with -- as the oil rate increases. That indicates improved recovery efficiency.

In an attempt to explain how this could happen we looked at several different methods.

A material balance equation doesn't do it. It doesn't include rate calculations.

But displacement equations do include rate and (unclear), so I used the fractional flow equation on page -- page 9, the bottom of page 9, and I assume that the data from the build-up tests was sufficient to describe the vertical as well as horizontal transmissibility.

Substituted it into this equation and then plotted the results from this theoretical equation against the actual on several wells where I had the build-

up data, and these are illustrated on page 34, Figure 13.

So we can see on Figure 13 there Mobil's B-37, kind of a general correlation; certainly no history match.

BMG's E-6, not much correlation there. Here we see the slope is pretty much the same as the Mallon Johnson Federal 12 No. 5. and no correlation, but theoretically does not match Mesa Grande's Bear Trap well No. 1.

But I again picked the Mobil Well and changed the parameters in that equation; namely, the kA, the permeability area, and when I did that I was able to obtain this fit. This suggests to me that -- that gravity segregation and counter-current gas flow may well be the reason for this -- this GOR oil rate correlation that we've seen.

Q So in summary, what conclusions do you reach, if any, with respect to the rate sensitivity? You've indicated that approximately half the wells had a correlation coefficient that you found acceptable?

A Uh-huh.

Q And what -- are you able to draw any conclusions with respect to rate sensitivity from that?

A Well, I -- it's my opinion that -- that there's a high probability that there is gas saturation, gas segregation. It's going up and pushing the oil down

and that's the reason for the rate sensitivity in about, maybe, half the wells.

This is not a -- that's my opinion.

But then, when I look at the recovery efficiency as a function of pressure drop, I had conflicting information, and what I did here, and this is summarized best, I think, on Table 4 on page 20, and all we have here is a change in pressure between 6-30 and 11-19, 1987, and that's a change of pressure, dP in the first column on the top half, a group of wells; the oil produced by that group of wells, and then that cumulative oil produced divided by the pressure drop, and we can see they're all negative there and that the average is 98 barrels per psi pressure drop.

Next we did the same thing with the -- during the low rate period, which was from November 19th through February 23rd. This is when the wells' production rates were restricted. And we see the negative pressure decrease in all but two wells, the E-10 and Meridian's Hill Federal No. 1. There the pressure increased during this period of low rate production.

Here we have the oil produced and then again excluding the two wells where the pressure increased, the static pressure increased during this time period, we see that the -- that the recovery efficiency is 550 barrels

psi, quite a change. It could be that that change is due to the denominator in the barrels per psi equation being held up by pressure support from outside the pool.

I might add that the -- I see no other way for pressure to increase, such as it did in the E-10 and the Hill Federal No. 1 other than pressure support from the gas injection project.

Q Anything further you'd like to add with respect to the rate sensitivity analysis that you have done?

A No.

Q Now, looking at all this data, it appears that you have some conflicting, or possibly inconsistent, at least, conclusions, or multiple conclusions from the individual analyses, is that correct?

A Yes, you could say that. You see things and different parts of the data indicate different -- different things.

Q And if you look at the -- all of the data together as a group, and as a single report, which this is, do you reach any significant conclusions?

A Yes. Yes, I do.

Q Would you summarize those, please?

A You bet. Those are on page 11. It appears to me that the Gavilan - West Puerto Chiquito Mancos

Pool are a common reservoir and that it's probable that the reservoir transmissibility is sufficient to allow fluid migration across the pool boundaries.

About half of the wells studied exhibited more efficient, rate sensitive characteristics with the GOR declining during the period of high oil production rates and the rate-sensitive producing mechanism is not clearly understood by -- myself.

I thought that the anistropic nature of the reservoir should be further investigated in order to look into a secondary recovery process at Gavilan. The production rates, of course, in a secondary mode would be dependent on what you inject and what you produce, a balance of the two, which would make it quite easy.

Q Is there anything further you'd like to add with respect to your exhibit or the report or analysis that you have done at this time?

A No, no, there's not.

MR. STOVALL: Mr. Chairman, I would like to at this time mark this exhibit as OCC Exhibit Nineteen. It has not been previously marked, and I would offer it into evidence.

MR. LEMAY: Without objection OCC Exhibit Nineteen will be admitted into evidence.

MR. STOVALL: I have no

further questions of the witness.

MR. STOVALL: I have no further questions of the witness.

MR. LEMAY: We can start the cross examination, I think, and go for about 25 minutes on it and then break it in the middle.

CROSS EXAMINATION

BY MR. DOUGLASS:

Q Mr. Weiss, I have to confess to you I haven't had an opportunity to read the twelve pages that you now have in the front of your report with reference to the nine pages that you had previously, although I think it appears to be the same type spacing, so, obviously, there's some more data there.

But let me ask you about the items that may be common to your report.

Go to your rate sensitivity area and let me ask you about -- in your opinion is the Gavilan Mancos Pool a solution gas drive reservoir?

A It was initially.

Q It was initially. Do you say that it has now a secondary gas cap that's assisting in the production?

A Most probable.

Q Did you locate through your study in this field the secondary gas cap?

A No.

Q Does it follow that in the Gavilan Mancos Pool if there is a secondary gas cap that it should be in the areas of high structure as opposed to the areas of low structure?

A I'm not at all sure. It could be -- it could be more a function of localized structure.

Q What do you mean by localized?

A Well, in between wells; you know, the wells are one mile spacing. I could see a gas cap in between two wells and not -- not extending to either well.

Q A gas cap in between two wells --

A Perhaps.

Q -- not extending to either well --

A This is all speculation.

Q You consider that speculation about whether it's a secondary gas cap?

A Yes.

Q What kind of information would tell you whether there's a secondary gas cap in an oil reservoir of this sort?

A Escalating GOR's and the production logs, I should think would be interesting, but again,

those are the only -- identifying what's happening in the vicinity of the producing wells.

Q Now escalating GOR's you have in a solution gas drive reservoir.

A That's true. That's true. That's true.

Q And the production logs are just going to tell you what's coming out of that particular well.

A That's correct.

Q Do you -- is it your experience that solution gas drive reservoirs generally are not rate sensitive?

A Generally, not only my experience, but in the literature, yes.

Q The literature is pretty clear on it, isn't it? Is that right?

A Yes.

Q And when we say rate sensitivity, what you're talking about in a solution gas drive reservoir is if you produce the reservoir at X rate you will get Y recovery from the reservoir. That would be the first calculation you made, right?

A Well, no, I don't think so. I think that you'd look at just -- you see, if it's not sensitive, GOR would not vary greatly.

Q Well, I'm not talking about GOR. I'm

just saying that if you produce the reservoir at X rate, you get Y recovery, that's --

A Oh, yes, yes, a material balance equation, exactly.

Q And then the second calculation you'd make is if you produced it at 2X you should still get Y recovery.

A Uh-huh.

Q Is that right?

A Yes.

Q Produce it at 10X and you still get Y recovery.

A That's correct.

Q Same recovery no matter what the producing rate is.

A In the solution gas drive.--

Q Right.

A -- yes.

Q Yeah. Now, I believe you said this in your direct testimony, that if you have -- if you produce at high oil rates with lower gas/oil ratios, that is a more efficient production method, is that correct?

A Yes.

Q Now, in your report you -- I don't know that it's clear, but you say 50 percent of the wells that

here that we're dealing with we ought to be able to calculate how much efficiency has been obtained by higher oil rates versus lower oil rates.

A Well, to comment on that I'd have to do it, and I've not done it.

Q But it is something that can be done?

A I've not done it.

Q Okay. Well, there are standard engineering techniques and formulas to do that.

A In a gas displacement process, yes.

Q In a gas displacement. Are you telling me that solution gas -- solution gas drive reservoir that -- that you cannot calculate the recovery efficiency based on GOR?

A GOR versus cum.

Q Yes.

A Yes. I thought you were referring to the rate sensitive --

Q Now, your study also has indicated that you think that this is what you -- would it be fair to say a dual porosity system?

A One well indicates that, yes.

Q One well. Well, also the -- as I recall, wouldn't that phenomena in this reservoir that we've seen of high oil rates, lower gas/oil ratios, wouldn't that

indicate a dual porosity system where you have fractures and oil in the matrix?

A No.

Q You don't think so.

A I shouldn't say no. I don't know.

Q You don't know. Well, --

A Let me think on that a little. I'm not sure that it would make any difference what the nature of the reservoir is to see that phenomenon. It could be all matrix or all fractures or a combination.

Q Well, one of -- on page -- let's see if I can find it here.

A What -- what is it you're looking for? Maybe I can help.

Q I'm looking for the explanation of the favorable rate sensitivity.

A Oh, yeah, I have three of them listed. That's page 8.

Q In the Item 2 there it says, "Formation of a large pressure difference between the fractures --" that's at the top of page 9 --

A Yes.

Q "Formation of a large pressure difference between the fractures and the matrix enhancing transfer of the oil to the fracture system."

Isn't that a logical explanation of what's happening in this reservoir when you have high rate -- higher rates versus lower rates and the gas/oil ratio is going down?

A Well, only if you can identify what that matrix system is, and what -- at what rate the oil will come out of it, and I was not able to do that, as I mentioned earlier.

Q If that is occurring, you would expect the reservoir to perform as the production tests and the gas/oil ratios have indicated during the low rate production and the normal rate production.

A I don't know because I wasn't able to do it. I couldn't do it.

Q Do you -- do you recognize as a standard engineering text that's used The Fundamentals of Fractured Reservoir Engineering by T. D. Van Goff-Rocht?

A I've not seen that text.

Q You're not familiar with it then.

The -- in your earlier report you mentioned the Spraberry Trend Area a number of times.

A Yes, it's not in this final report?

Q And why is that?

A I didn't think the analogy was strong enough. That was brought up by the Mallon - Mesa Grande folks as not being relevant and I agree with them.

Q Do you still agree that there are some characteristics of the Mancos reservoir that are similar to the larger Spraberry Trend Area field?

A There could be. I'm not at all positive.

Q I think now you've replaced that example with the Boulder Mancos Pool, is that correct?

A Yes. Well, the primary from the Boulder Mancos.

Q The primary.

A Yes.

Q Well, have you determined any -- have you seen any figures that show you the primary from the Gavilan Mancos Field -- Pool?

A No.

Q Have you seen any figures that show you the primary recovery from the West Puerto Chiquito Pressure Maintenance Area?

A No.

Q If you were going to see how efficient or whether secondary recovery is -- well, strike that.

Has it been your experience that all reservoirs that you put in as secondary recovery projects, you'll get an economically attributable enhanced recovery?

A No, that's not my experience, no.

Q There are failures.

A Yes, there are.

Q And what operators and this Commission, of course, will be doing with reference to any reservoir, is trying to study it and determine what the reservoir is and whether it is a candidate for secondary recovery. Is that correct?

A I would assume.

Q Well, that's what you would do as a reservoir engineer.

A Yes, I would; I certainly would; particularly when I see one well made more oil than the whole field, yeah.

Q Well --

A To me that's night and day.

Q You think that's -- you think that's real significant, then?

A It certainly is. That would warrant a study.

Q All right, and who told you about the Boulder Field?

A Well, as a matter of fact, I looked up the Boulder Field back when I was looking at this -- this Mancos Field for Gary Williams, the Rio Puerco, I believe is the name of that pool, but I did get the tramsmissibi-

lities from Mr. Greer. He sent them to me. They were in the case, in the Commission's case history.

Q What -- did it appear to you -- you gave me some -- or gave us some differences on your direct about the slope of the reservoir, as I recall.

A Yes.

Q You said there was 2000 feet of structural difference in what distance?

A A mile or a mile and a half; something like that; about a mile.

Q 2000 feet in a mile.

A Yeah, that's in the -- the reference for that would be the Four Corners Geological Society publications.

Q Now, the -- are you aware what the dip of the formation is over in the pressure maintenance area in the West Puerto Chiquito?

A It varies.

Q Let me see, just in order to help us here, if you all have the -- use the same nomenclature. We used this in the March '88 hearing and I show you a copy of a map that looks very similar to the one introduced, and it may be identical as far as the color -- the coloring scheme is concerned; may not be the same colors but the brown on this exhibit I'm showing you, which Mr. Hueni's going to

introduce later, is the West Puerto Chiquito injection area.

A Uh-huh.

Q The stripes, green and white, the two-section tier there generally, is what was called in that hearing the pressure -- excuse me, the expansion area, or the pressure maintenance expansion area.

Are you familiar with those terms from reading a transcript or the --

A Yes, yes.

Q And then the boundary between the Gavilan and West Puerto Chiquito is the area where you begin the green area to the -- to the west, and that's the Gavilan Mancos Pool as currently designated as far as the boundary is concerned. Are you familiar with those areas?

A Yeah, Gavilan, the expansion area, and West Puerto Chiquito? Is that your --

Q Yes.

A -- is that what you want me to remember?

A Yes. Now -- well, I just wanted in order that I could communicate with you about -- when you say there's communication between Gavilan and West Puerto Chiquito. I don't believe there's any dispute that across the boundary between those two pools that there is communication.

Do you understand there's any dispute in that area?

A I don't know.

Q Well, when you were studying it, was that the area that you were trying to determine whether there was communication across -- across the pool boundary?

A Well, when I looked at it, it was my opinion that the pressure gradients had existed without any boundaries. If you'll notice, when I drew those maps I didn't put any boundaries in. It was typical of a secondary recovery project.

Q You say it was typical of a secondary recovery project.

A Uh-huh.

Q That's typical of a secondary recovery where there is communication throughout is what you say.

A Typical of secondary recovery. I don't think there's recovery throughout any secondary recovery projects. There's always local areas where you have -- you might not even have any sand.

Q Let me ask you about Boulder and West Puerto Chiquito, if I could. According to geological maps that Sun and BMG have put on, there's about 450 feet of structural difference per mile in the West Puerto Chiquito. Now you say there's 2000 feet per mile in the Boulder?

A Yeah, something like that.

Q That would be about five times greater than --

A Uh-huh.

Q Are you aware that over in the Gavilan Mancos, the green area over here, there's a structural difference; there's only about 100 feet per mile?

A Yes.

Q And that -- so up in Boulder, that would be 20 times greater, wouldn't it?

A Yes.

Q Are you saying that structural position should have an affect on recovery?

A On the primary recovery in Boulder it certainly did, because there you had plenty, plenty action. You had plenty gravity segregation taking place; lots of room for it.

Q And so the 5-to-1 ratio would be -- be very beneficial to Boulder versus West Puerto Chiquito?

A Yes.

Q Likewise, if the West Puerto Chiquito and the Gavilan were separate reservoirs, then the recovery in West Puerto Chiquito, with 400-to-450 feet of structural advantage, versus 100 over here in the Gavilan, ought to be about 4 to 4-1/2-to-1 as far as that relationship.

A No, I don't think so. You're -- you're talking in degrees of dip there, practically nothing, and I doubt that the structure -- maybe somewhat, but I couldn't quantify it.

Q Well, are you saying that if a 4-to-1 between Boulder and West Puerto Chiquito is something that's beneficial, that a 4-to-1 from--or it's 5-to-1, I believe --

A Uh-huh.

Q -- that 4-to-1 from West Puerto Chiquito to the Gavilan Mancos is not beneficial, as far as --

A I can't -- I can't quantify it. I'd say 1000 feet, or 2000 feet, whatever it was per mile dip, is lots, and a few hundred feet per mile is not lots.

Q You don't consider the 400 - 450 in West Puerto Chiquito feet lots?

A It's not lots.

Q Versus 100.

A No, I don't.

Q But you do consider 2000 versus 450 between Boulder and West Puerto Chiquito to be lots.

A Yes.

Q Now, in your study did you assume approximately the same amount of oil in place throughout West Puerto Chiquito, the expansion area, and the Gavilan

Mancos?

A I didn't attempt to measure the amount of oil in place.

Q Do you find anything that indicates that there is not approximately the same amount of oil under each of those areas per section?

A I find -- I find -- no, I would say that it varies per section.

Q But you're not able to quantify it.

A No.

Q Would you say that -- did you make such a determination in the Boulder Field?

A No, I did not.

Q What are the -- what are the tests that a reservoir engineer would use to see how efficient production is with reference to a particular area? Would he find out how much oil was in place?

A Typically.

Q If you can't do that, then you're --

A You're right, the transmissibilities in Boulder Field that were reported are quite high and if there's a relationship between transmissibility and, say, porosity, that would indicate there was more oil in place there.

But I'm not sure there is a relationship.

MR. DOUGLASS: Mr. Chairman, did you want to go -- I've got -- I would like an opportunity to look at the latest report because I think he may have changed some of the areas I'm going to cover next and it may shorten -- cut down my cross examination as far as --

MR. LEMAY: Fine, we'll reconvene at 1:15 after lunch.

MR. DOUGLASS: Thank you.

(Thereupon the noon recess was taken.)

MR. LEMAY: Reconvene and continue with cross examination of the witness.

Bill, do you want to go back on the stand? You're still sworn in.

Mr. Douglass, you may continue.

CROSS EXAMINATION CONTINUED

BY MR. DOUGLASS:

Q Mr. Weiss, before the recess we were visiting about the Boulder Pool.

Have you made a comparison before with reference to primary recovery between fields based on the

recovery per acre?

A No.

Q You never have done that? Do I understand that from your report here the only conclusion that you have with reference to whether a secondary recovery process is successful in the fractured Mancos is to point out that one well recovered 2.2-million barrels versus that one field recovered 1.8-million?

A Yes.

Q You analyzed a number of pressure build-up tests in this field, is that correct? Is that correct?

A Yes.

Q All right. Let me show you a pressure build-up over the B-37 Well and let's call that Mallon Exhibit One, if we might. This is a pressure build-up measured on the B-37 Well from June the 27th to June the 30th, 1987. Have you seen that pressure? Are you familiar with that as part of the data that you looked at?

A Go ahead.

Q All right, sir. Does it appear that the pressure at that time in the B-37 Well had built up?

A It's difficult to say from this plot. This is a (not understood) plot and you normally see this on a semilog scale where you can see it a bit better, but

yes, it does appear to on this plot, certainly does.

Q That was measured at the end of June of 80 -- it says June of '86, I believe that's June of '87, it should be, and if everyone would correct their exhibit, I believe that should be June of '87; I'm a draftsman, what you call a draftsman here.

Now then, pressure build-up measured at end of initial restricted rate period, June, 1987, 41 barrels of oil a day, 334 MCF per day. It looks like it's essentially built up, is that correct?

A It certainly does.

Q All right. Now, do you have that same B-37 Well on your table, on one of your tables back here for, I believe, Table 4?

A Table 1 has the B-37.

Q Table 1 has the B-37?

A That's the transient results, if that's what you're talking about.

Q All right, and then on Table 4 do you have that well?

A Yes. sir.

Q And it's in the -- the -- you have it appearing again in June 30 of '87 at the end of this pressure test, is that correct?

A Yes.

Q To the -- November the 19th, when the pressure was measured after the normal rates had been restored for a month, I believe, July, August, September, October, and about half of November?

A That's right.

Q All right, so that -- some of the less informed call that the high rate period; I call it the normal rate period, we know what it's --

A I'm amongst the less informed.

Q Okay. It's -- it's only high versus the restricted rates, is that correct?

A That's correct.

Q All right, sir. Then you use a pressure there that, as you say, it's lost 270 pounds, producing 26.385 barrels of oil, or a 98-pound deltaP per barrel of oil produced, is that correct?

A That's correct.

Q Let me show you now what's been marked -- what I have marked as Mallon Exhibit Two. Now is this the pressure that you used to determine the 237-pound pressure drop with the -- I'm sorry, 270-pound pressure drop with the production of the 26,385 barrels of oil?

A I've looked at these closely here and I -- my delta P's are based on the static pressures, which was agreed upon by all the operators at their meeting in

Farmington, and that was the pressure calculated at the end of 72 hours.

Q 72 hours, all right, but it was the pressure at the end of the 72-hour period?

A Yes. Right.

Q I don't know whether they're exactly the same, but it looks to me like at the end --

A No, they're not exactly the same. They're quite different.

Q Well --

A I see the -- my pressure of June 30th, static pressure, at the top of the B rather than 370 feet above sea level, is 1036 pounds, and this one here is about 1060 pounds.

Q All right, sir. All right, 1060 pounds and then the pressure at the -- on Mallon 1 is 1060; on Mallon 2 it's what, about 810, or so?

A Yeah, 809.

Q 809?

A Uh-huh.

Q And so that difference would be 251 pounds --

A Okay.

Q -- instead of your 206.

A Okay.

Q Close enough for government work?

A You bet.

Q Okay, and -- well now tell me what's happening to the pressure in that B-37 Well at the end of 72 hours.

A I don't know.

Q Is it going down?

A Somebody's drawn a line showing it going up.

Q And what would you say was happening to it looking at zero to 70 hours?

A The trend was up.

Q Yet you used the pressure at the end of the 72 hours after the normal rate of what you call high rate of production to determine how much pressure drop had occurred --

A I had a reason for doing that, as I mentioned. There was a meeting amongst all of the operators in Farmington at which time it was agreed that the 72 hours was satisfactory to measure the static pressure.

Q Well, on this well -- my question is on this well the pressure was still building up at the end of 72 hours.

A Looks like it; yes.

Q Isn't the proper way to determine how efficient a reservoir is producing as far as pressure is concerned, is to determine the reservoir pressure at one rate of production and the reservoir pressure at another rate of production?

A No, I don't think so.

Q All right, let me restate it. Isn't -- if you're going to determine, if you're going to try to use pressure as for the efficiency, then you need to determine how much was produced with one pressure drop versus how much was produced with another.

A Yes.

Q And isn't the way to do that is to determine what the reservoir pressure is at each of those times?

A Yes, and that's what was agreed upon as being taken in 72 hours, is my recollection.

Q I see, that's what you understood was what they were agreeing to here.

A Yes.

Q Now, did I also understand you to say -- well, first of all, does pressure determine when a reservoir is abandoned?

A Rate determines when a reservoir is abandoned.

Q In other words, whether you can economically produce a well -- if you can't economically produce a well at 1000 pound (unclear) pressure, then you can't economically produce it at 200 pound pressure and the well doesn't know what pressure it has, it just knows that -- the operator knows that he can't operate it under those conditions, is that correct?

A Yes.

Q Did I also understand you to testify that the -- that the only way the pressure could increase between the two surveys that you've look at here would be by gas injection -- from the gas injection project?

A No, no, that's not entirely correct. Pressure support could come from anywhere with -- outside the pool boundaries. It wouldn't necessarily have to come from West Puerto Chiquita.

Q Well, couldn't the pressure support that we're looking at here, I believe of 4 pounds in the Gavilan side, couldn't that come from the matrix feed in and --

A I don't understand your 4 pounds. What's the 4 pounds?

Q Well, isn't there a 4 pound difference in the two pressures that you list as having increased? One of them is 12 pounds and one of them is pounds on your -- on your exhibit Figure 4, isn't it?

A Yes, the Meridian Hill Federal No. 1?

Q Right, that's 4 pounds and the other one you have listed as E-10 is 12 pounds.

A Correct.

Q Are those the two wells you're referring to that had some outside pressure support?

A Yes. Those two went up. All of the wells could well have had outside pressure support.

Q And this, the pressure that you're looking at here, or we're looking at here, is after what -- after the low rate production.

A Yes.

Q Let me look at those just to see. First of all, the E-10, I believe, is on the same side as the injection wells as far as the West Puerto Chiquito is concerned, and the boundary that Mallon and other working interest owners in the Gavilan Field say exists there, is that correct? In other words, E-10 could have been affected by pressures from the injection in that --

A Yes.

Q -- in that well.

Now the other well you talk about is the Hill Federal and I don't know exactly where it is.

A Right about where your hand is --

Q Right there, I believe, is the Hill Fed-

eral Well, is that correct?

A Well, I can't see it.

Q That's the Hill Federal according to this and I believe it's correct. Now that's going to be, oh, five or six miles from any injection well, isn't it?

A That's right.

Q Is it -- and the pressure went up 4 pounds in that well --

A Yes.

Q -- according to the survey.

A Yes.

Q That's pretty close to the accuracy of the gauges, isn't it?

A No, I don't think so. It could be. I'm not an expert in gauges, so I won't even venture a comment on that.

Q One percent would be a 9 pound difference, wouldn't it, on the gauges?

A I'm thinking that a lot of gauges are generally rated to a 10th of a -- of a -- but I don't know.

Q I understand. I was just trying to get the magnitude.

One percent would be 9 pounds; a half of one percent would be 5 pounds; and one percent would be

A Well, I guess it could have been a 10

pounds pressure increase.

Q Well, yeah, if you want to analyze the thing that way, it sure could, couldn't it?

Now, would also another explanation for an increase of 4 pounds in the Hill Federal 1 be feed in from the matrix?

A I don't know. I attempted to analyze that very problem but I was unable to.

Q Are you saying that could not be an explanation?

A I'm not saying that at all. I'm saying I don't know. You'd need an expert.

Q Let me look at your figures that you have here.

Figure 2 is the, if you'll go back a couple of pages, Figure 2 is -- did you analyze these pressures that you have on Figure 2, 3 and 4 to determine whether there was -- appeared to be reservoir separation between the West Puerto Chiquito injection project and the expansion area and Gavilan?

A No, these are merely static pressures.

Q Did you conclude that there could be pressure communication across there because in the gas injection project you see at lest 300 pounds pressure difference?

A Yes.

Q Do you think that you could analyze these pressures and come up with any conclusions that might -- that might show that there is separation between the West Puerto Chiquito and the areas west of the barrier?

A No, I don't know how to do that.

Q Well, let me ask you on Figure 2, do I -- have I placed that red line approximately where the barrier is between the West Puerto Chiquito -- I'm not trying to do it to scale, or anything --

A Sure.

Q All right. You've got, on Figure Two, then you've got one pressure at 1504, the rest of pressures in June of '87 were around, at least near that barrier, around 1150 to 1200. In other words, there's about a 300 pound pressure difference across here, is that correct?

A Yes.

Q That's the 300 pounds right there, 300 pounds from that injection well over to -- across what we say is the barrier, is that right?

A Yes, sir.

Q Then on Figure 3 -- Figure 2 represents the pressures that were measured at the beginning of the normal rate, dash, high rate according to Mr. Weiss, production period, is that correct?

A Yes, sir.

Q And then Figure 3 are pressures that there measured that were measured after that period of time in November of '87, is that right?

A Yes, sir.

Q And if I put a red line separating the wells that we say are west of the barrier and the ones that we say are east of the barrier, we now have two wells to the east instead of one, is that correct?

A That's correct.

Q And the pressure in one well that we have the (not understood) on is within 4 pounds of what it was; it went up slightly, is that correct?

A No. No, it went down from the previous period.

Q Well, let's see, K-13 --

A Oh, I'm sorry. I thought you were referring to Hill Federal No. 1.

Q No, I said east, I'm sorry, the one well we had -- we only had one well east of the barrier in both pressure periods, is that right?

A Okay, yes, yes, I see it --

Q It went up about 4 pounds, didn't it?

A Yes, uh-huh.

Q About like what the Hill Federal went

went up.

A Uh-huh, uh-huh.

Q All right, and you've got another pressure now on the E-10 east of the barrier, is that correct?

A Yes.

Q And that pressure differential between those two wells east of the barrier is now 100 pounds, is that right?

A That's right.

Q And the pressure differential between those two wells and the wells west of the barrier is 4-to-500 pounds difference.

A That's right.

Q All right, and the last pressures that you had on Figure 4 are the ones taken at the end of the -- of the low rate period, is that correct?

A Yes.

Q And now we have -- have I drawn that line in approximately correct between the --

A Yes, you have.

Q -- wells. Now I've got three wells on the east side of the -- of the barrier and I had two on the pressure survey before and one on the beginning pressure survey, is that right?

A That's right.

Q And does it appear that -- now that there is about a 500 pound, roughly, 450 to 500 pound pressure differential across there, is that correct?

A That's correct.

Q So during the period of low rate production, you've had just as high a pressure differential across the barrier as you did before.

A The delta P?

Q Yes, sir.

A Uh-huh. Well, let's see, we have about -- very roughly, yes.

Q You said 300, I don't see -- you've got 400 minimum across the boundary, that barrier, don't you?

A No, I was referring to the June.

Q Okay, I'm sorry. Doesn't that pressure differential across that barrier indicate to you the existence of a barrier?

A No.

Q That's just normal gradient.

A In my opinion that's the gradient that's associated with many secondary type projects.

Q Let me give you what I'll have identified as Mallon Exhibit Three, and I may have to construct all the others, but I'll just give one to the reporter right

now. Does that look about like the one you've got?

A Yeah, that's pretty good.

Q Okay. Make that Mallon 3, if we might, and that's the February 23rd pressure survey comparison and I want to ask you about the wells on the east side of the barrier.

How much pressure differential between the K-13 and E-10?

MR. KELLAHIN: I'm sorry, Mr. Douglass, what are you referring to? Is this one of Mr. Weiss' --

MR. DOUGLASS: No, that's --

MR KELLAHIN: -- displays?

MR. DOUGLASS: Yes, it's Figure 4, I'm sorry.

A Approximately 40 pounds.

Q 40 pounds, and would you accept subject to measurement on the map over here that that's about 13,500 feet between those two wells? If you won't accept it, I've got a scale and you --

A Well, it looks like -- are they two sections apart or one section apart?

Q Let me get the map over here so you can satisfy yourself. E-10 and K-13.

A Yes.

Q Okay. And the other well on the east side of the barrier in that area is the L-27, is that right?

A Yes, sir.

Q What's the pressure differential on that side of the barrier on February the 23rd, 1988, between those two wells?

A Well, I'm sure you've calculated it. What is it?

Q It looks to me like 80 pounds.

A Yeah, that looks pretty close.

Q All right, sir, and subject to check, my folks have measured it's 24,000 feet between those two.

A Okay.

Q So in wells ranging from 13,500 feet to 14 -- 40 -- 24,000 feet, there's only a pressure differential of 40 to 80 pounds, is that right?

A Yes.

Q All right, and if you measure from the K-13 over to the 950 well -- the A-20 Well, that's a -- there's a 500 pound pressure differential there, is that right? K-13 to the 950.

A Okay, yes.

Q To the A-20.

A Uh-huh. Uh-huh.

Q And we're going across the barrier now,

according to -- to the proponents position in this matter, is that right?

A If you'd point out A-20.

Q A-20, right there.

A All right.

Q K-13, right here. Subject to check would you accept that that distance is 18,000 feet?

A Yes.

Q Less than the distance to the L-27 (unclear).

A Yes.

Q All right, and the next well to the south across the barrier would be the B-29, that would be the next closest well to the K-13 across the barrier, wouldn't it?

A Yes, sir.

Q And there is a pressure differential of 500 pounds there.

A Yes, sir.

Q And subject to check, would you accept 22,000 as that measurement?

A Yes.

Q And the next closest well, I think, I'm not sure whether it's the well to the south or -- the D-17, there's the B-32 and D-17, but if you go to the B-32, that

pressure difference again is about 480 pounds.

A Oh, it's about 500, I guess, 480, unless you're calculating.

Q 970 versus 1466. It lacks 4 pounds of being 500 pounds.

A Yes, sir.

Q And subject to check, 24,000 feet between those two wells.

A Yes.

Q Same distance from the well, the L-27, to the well to the north where you had only an 80 pound pressure differential.

A Yes, sir.

Q And the L-27 is northwest of the K=13 and the B-32 is southwest.

A Yes.

Q Is that correct? Doesn't that indicate to you that there is a barrier between the K-13 and the A-20, B-29, and B-32 wells with that much pressure difference?

A Yes, if you read the text, that's why I pointed out the directional permeability, I thought, was about, oh, several -- it was quite a bit greater in the north/south direction than in the east/west, and that's why I attributed that. As a matter of fact, I suspect that's

that's why the secondary recovery has worked as well as it has.

Q Well, when you say north/south versus east/west, the L-27 is east/west of the K-13 in addition to being north/south.

A Yes.

Q Just like the B-32.

A Yes, sir.

Q Your table -- did you -- let me ask you, did you find any frac responses across the barrier area?

A I don't have the barrier area drawn in here but we can look at this Figure 12 on page 33 and perhaps you can tell it. I don't have it on here, no.

Is A-20 and A-29, is that across the barrier? That would be the only ones.

Q All on the west of the barrier. You asked me A-20 and which one? I'm sorry, page 33, Figure 12?

A Yeah. A-20 and B-29, those would be the only ones I can see.

Q All right, and those are west of the barrier as shown on the previous exhibit.

Are you saying that those two wells are the only two that you saw the frac response in?

A Yes, sir, that that I judged and readily

identified and it would seem to be agreement between all parties that indeed it was.

MR. STOVALL: Page29 would be in the Appendix of this -- is that what you're looking for?

MR. DOUGLASS: Well, no, I was really looking for -- for the F-7 and the J-6, and there's some wells that are on -- I can't identify the pages because they're not numbered --

A Yeah, I'm sorry they're not -- they're not numbered but --

Q -- but it's in Appendix 3, which -- you can find Appendix 3 if you go to the gold page, is that right?

A Yes, sir.

Q And it's 1, 2, 3, 4, 5, 6 wells in, 6 pages in, I'm sorry. Do you have the page I'm looking at? It says COU Frac Pressure Response Signals from F-7 to J-6?

A Yes.

Q Let's see if I can locate those two wells. Maybe you can help me, I know the area where they are but --

F-7 to the J-6, is that right?

A Yes.

Q Okay, and that would be west of the barrier area as we describe it.

A As you describe it.

Q And are you saying that that data there does not indicate a frac response?

A No, I'm saying it does.

Q Okay, I misunderstood you. I thought you said the only wells that you saw a frac response in were the B-29 and --

A Oh, no. The map on page --

Q I'm sorry, I just misunderstood you.

Would you agree with me while we're at that point that that's the -- F-7 and J-6, when you have a spike up like that, that's what you'd call a typical frac response, is that right?

A No, I wouldn't agree with that.

Q You don't think that the F-7 to the J-6 is a typical frac response?

A No.

Q How would you describe for me the pressure indication of a typical frac response?

A An increase from the pressure print, not just increase, and it could be gradual. It depends on the transmissibility.

Q You're saying, then, that you really can't identify a frac response, then, from, say, a pressure change that indicates a barrier.

A Oh, why, certainly you can.

Q How do you do that?

A A barrier doesn't create a pressure change.

Q A barrier doesn't create a pressure change?

A No, sir.

Q If I'm taking a --

A It takes a rate change to cause a pressure change.

Q I see. Well, if I've got a build-up occurring for a well and there's a change in the slope of the build-up, then that's always a frac response?

A No, no, not at all.

Q Well, maybe I don't understand how you tell whether there's a frac response. Do you say there's -- tell me how you tell if there's a frac response in one of these pressure differences.

A Okay. An offset well is fraced at a high rate. That high rate generates a pressure pulse. If that pressure pulse is obviously present in the observation well, I interpreted that as a frac response.

Q But that particular type of response does not have a typical curve that's recognized in the industry, then.

A No, not to my knowledge.

Q All right, I just wanted to establish it. Is that type of response in the receiving well different from one, different from the response that that -- the well that's shut-in building up received from encountering a barrier?

A Yes.

Q And how do they differ in characteristics?

A Well, in that one there that you have there, there's no -- there's no doubling of the slope.

Q Well, what does the doubling of the slope have to do with it?

A That's a characteristic of a -- of a boundary.

Q So if you've got a pressure build-up that gets sort of a --

A On a semilog plot.

Q On a semilog plot, doubling of the slope

-- A Can be interpreted as a boundary.

Q As a what?

A As a boundary.

Q Boundary. It could be a fault?

A Yes.

Q A barrier as we show it here, permeabil-

lity barrier?

A Yes.

Q Gas/oil contact?

A Yes.

Q Water/oil contact?

A Yes. Dual porosity system.

Q Dual porosity system. Now, --

A It takes geologic support.

Q How do you tell the difference if -- if a frac response does not have a characteristic slope, how do you tell the difference between a frac response and one that has encountered pressure?

A The doubling of the slope on a pressure build-up curve and that would -- that could include many things.

Q Well, I think you've told me that -- I don't know that you answered my question, Mr. Weiss.

A I guess I don't understand what you asked.

Q My question is if a frac response does not have a characteristic response, then how do you tell it -- how do you tell it as being different from a response to a barrier or a boundary?

A The deviation from the established pressure trend is greater than a 2-to-1 slope, or it's not a

2-to-1 slope, let's put it that way. and it's a -- and it's an obvious deviation.

Q You wouldn't consider the F-7 to the J-6 an obvious deviation?

A Yeah, I do consider that.

Q And can we consider F-7 to J-6 a frac response?

A Yes.

Q With reference to the -- I guess my question now is do you have any frac response across the barrier that you've analyzed and that you say, those are frac responses across the barrier?

A No. I did analyze some and they're in the Appendix but they're debatable.

Q All right.

A And therefore, no.

Q Have you analyzed any of the slopes to see if there's about a 2-to-1 slope on any of those pressure build-ups during frac treatments across the barrier?

A The only test that I analyzed that had an obvious 2-to-1 slope was the Mobil Lindrith B-37.

Q Did you analyze all of them to see what their slope was?

A Well, I looked at the slopes, yes, not

on these frac tests; only on the pressure build-ups where I knew the rate and I had -- and they were conducted as pressure build-ups.

Q Let me show you Figure 9, page 30 out of your book and I'll ask that to be identified as Mallon Four.

Have you calculated here the pressure gradients at the end of the low rate production in February of '88?

A No, I don't think I did that. I just looked at the February data -- well, yes, that's February '88? Yeah.

Q And that says psi per 1000, what does that mean?

A 1000 feet.

Q Per 1000 feet?

A Uh-huh.

Q Well, have I again on that, at least my copy of that exhibit, put a red line through -- between or in the barrier area between the wells to the east and the west, as we've talked about them.

A Yes, you have a red line there.

Q All right, and it would be where the barrier, not exactly, but where the barrier is between those wells, is that correct, if it exists?

A If it exists.

Q If -- if -- you don't think it exists.

A No, I don't think so.

Q All right, and do I detect in reading the pressure gradient per 1000 feet here that on the east side of the barrier as we show it, they only range from 2.22 to 3.61 per 1000 feet?

A Yes.

Q And when you get -- if you go across the barrier, you're going to have to get up in the 17 to 27 range.

A Yes.

Q 8 -- 6 to 8 times greater.

A Yes.

Q And, again, that didn't indicate to you that there was a barrier.

A No.

Q Let me -- let me ask you, when you get on the west side of that barrier, I don't see many between the wells on the west side, but you have one from the B-17 to the E-6, is that right?

A Yes, sir.

Q About in the same relation directionally as from the K-13 to the L-27?

A Yes.

Q And the pressure there is .775.

A Yes, sir.

Q Could you -- and down below down there you have it between the B-29 and the B-32, I believe.

A Yes, sir.

Q 1.30.

A Uh-huh.

Q You say there is a directional permeability?

A I suspect that.

Q In your earlier paper you -- I believe it was an indication to a directional porosity.

A No. No, no.

Q You don't believe that's directional a porosity figure?

A No, no. I don't believe so.

Q Directional permeability.

A Yes, I suspect there's directional permeability.

Q In fact, that's what a barrier would be in this reservoir, is that you'd have very good permeability north and south and across that barrier you would none, if it was an effective barrier.

A If -- if it were an effective barrier you would have none, zero permeabilty?

Q Yes.

A Zero permeability? Yeah, that's right, that would be a barrier; no question about that.

Q And that's directional permeability, isn't it?

A No, no, not at all. No. Directional permeability you could have permeability running, maybe 10, maybe even 100, and I've seen published reports of 1000 times greater one direction than the other, but no barrier.

Q Well, let me ask you. Is it inconsistent to have a barrier when you -- I understand you have directional permeability north and south, and it's less east and west.

A Yes, much less.

Q Okay, it could get so much less as to be zero.

A I've never seen that reported.

Q You've never seen a reservoir that had permeability barriers within the same geological formation?

A Never seen one reported as having directional permeability of zero.

Q Well, have you seen barriers within the same geological formation, permeability barriers, where -- where there was no effective communication across the barrier?

A I've seen limited communication.

Q In other words, you've never seen an example of where there is actually a barrier within a geological formation where there's two producing fields on either side of that barrier, not connected with each other.

A That's my experience.

Q Do you have any San Andres production in New Mexico?

A Yes.

Q What we call San Andres. Isn't essentially all of those fields separated by permeability barriers in the same geological formation?

A I don't know.

Q What's your opinion on what separates the San Andres?

A Lack of reservoir.

Q When you say lack of reservoir, you mean no permeability?

A No production, no permeability, yeah.

Q I think I've got just one additional question for you. I want to look at one of these -- I want to look at one of these build-ups between the F-17 and the D-17.

A That's not a build-up.

Q I'm sorry. This pressure is not a

build-up; not looking at a build-up?

A Perhaps you're right. I'm sorry, I shouldn't have said that. You may have been.

Q You know, sometimes, Mr. Weiss, I don't know what I'm looking at.

A No, that's an interference test, see.

Q Okay. I see what it says up there, but I want to look at the build-up. Is the build-up this -- is that the pressure build-up that I see that's the heavy line? Is that a pressure build-up?

MR. LEMAY: What page are you referring to, Mr. Douglass?

MR. DOUGLASS: The F-17 and the D=17, and I'm sorry I can't give you a page number but I'll start at the end and count and in Appendix 111, the 1, 2, 3, 4, 5, 6, 7. 8, 9, 10, 11, 12, 13, 14, 15, 16. It's a signal from the F-17 to the D-17.

Q Is the D-17, is there a pressure measurement being taken in the D-17?

A It appears that the D-17 was shut in at some time and building and a frac was conducted.

Q I've sometimes heard that called a pressure build-up. Is that a --

A No, that's it, I guess. I don't have the data to say what -- what conditions were.

Q Well, I see some little events in that pressure build-up there.

A Uh-huh.

Q My folks tell me that's the tide doing that; the tide is doing that. Does that --

A Tidal effects normally run 1 to 2 tenths of a pound, but there's no ocean over Gavilan, so I don't see it being the tide.

Q You don't think that's the effect of the moon or of the tide that's occurring.

A Usually it's the weight of the water that causes these pressure fluctuations; the change in the water, not gravitational forces.

Q The -- can you tell on your graph there what -- how much of a change in psi that is?

A No. If you'll notice, I didn't interpret that one.

Q You can't tell from just looking at it if it's in the range of .2 of a pound, or less?

A I -- that was one of the questionable tests that was -- I discarded.

Q The final question I have would be back on Table 2.

Did you find frac pulse test results in those wells?

A Yes.

Q And are all of those wells you list there west of the barrier?

A I see an error right now. I don't think --

Q Well, it's J-61; that's really just J-6.

A 6, I'm sorry about that.

Q Mr. Weiss, if that's --

A Yes.

Q -- the biggest error you and I make today, we're both going to be in good shape.

A Gosh, I hope that's all.

Q It was so small I wasn't even going to mention it.

A Well, thank you. But you're right, those are all to the west of -- the western side of West Puerto Chiquito.

MR. DOUGLASS: Pass the witness.

MR. PEARCE: Mr. Chairman, I've got a couple of questions which I hope are non-repetitive.

CROSS EXAMINATION

BY MR. PEARCE:

Q Let's begin, if we can, Mr. Weiss, on page 6 of your report. I'm looking at the bottom of the page, the last couple of lines, as a matter of fact, the last line, last two lines.

"... Table II reflect the transmissibility and storage capacity of the fracture system rather than the total system properties obtained from a single well test."

Could you come up with another phrase to describe what you call a single well test?

A Well, when there's only one well involved it's a single well test; that's a build-up test.

Q That's a build -- that's -- that's what I wanted. Okay, and -- and when you speak of the total system, could you tell me what you're talking about?

A Measuring the average properties of the reservoir around that well.

Q I'm looking back, sir, at Figure 5 on page 26 of the report. You indicated that you had seen pressure gradients in other reservoirs which led you to believe that the pressure gradients you saw in the area we're worrying about today were to unusual, is that correct?

A That's correct.

Q And looking at Figure 5 on page 26, that

is the Isobaric map of one of those examples.

A Yes, sir.

Q What can you -- it says that the CO_2 flood, what can you tell me about that reservoir, sir?

A It's described in the literature as a heterogeneous carbonate. Is that what you're interested in?

Q Do you know if it's fractured, sir?

A No, I don't. Many carbonates are.

Q It is my understanding that it is not unusual in CO_2 flood projects for the CO_2 to be injected with slugs of water. Do you know if that was done in this reservoir?

A This happened to be a continuous CO_2 injection.

Q Thank you.

Looking, sir, at Figure 7 on page 28, the Shuler Field.

A Yes, sir.

Q What can you tell me about that reservoir?

A That's a sandstone.

Q Is it fractured?

A I don't believe so.

Q Do you know --

A But I don't know for sure, so I shouldn't say.

Q Was this water injection at the time these questions were taken?

A Gas.

Q Gas injection?

A Yes, sir.

Q Okay. Looking at Figure 8, page 29, the Judy Creek Field. If I understand the legend at the bottom of that, that was during water injection, is that correct?

A That's correct.

Q All right, thank you, sir. Now, sir, if you'd turn with me, please, to page number 7.

There is an equation at the top of that page and I'd like for you to try to explain to me, and I'm not an engineer, what that equation does for you.

What's "q"?

A Rate.

Q The rate --

A Oil in barrels per day.

Q Barrels per day of flow?

A Of reservoir fluids.

Q Could -- could you tell me the parameters that you used? I assume 1.127 is a constant --

A That's correct.

Q -- in the equation.

A Uh-huh.

Q Can you tell me what the other things used in your equation were?

A Yes. "k" is (unclear), "k" over mu times would be -- that's permeability divided by viscosity.

Q And what value did you use in that equation?

A That would be about 5 darcy feet centi-poise, but the feet would be included in the area there with the -- yes, in the area. centipoise.

Q Okay, what about A into L?

A L is the distance between these wells, C-34 and B-32.

Q L, I'm sorry, L is the distance between those?

A Yes.

Q And what was that distance?

A Oh, about 10,400 feet. Let's see, I think that might be in the Appendix. Pardon me? Let me look. I tried to include all these worksheets in there.

Yeah, here we are on the 1, 2, 3rd yellow tab, first sheet after identifying it, the first sheet after Appendix III, after giving the Interference Test Analyses.

Q Okay, L, as I read this, is 10,411 feet?

A That's right.

Q And the A factor in that equation is --

A One mile, 5,280 feet times transmissibility of 21.696 darcy feet per centipoise.

Q Okay, and in the calculation that you did on page 7 you used a delta P of 440 pounds?

A Yes, sir.

Q Could I get you, sir, to run that calculation as a delta P of 350 pounds and tell me what that would be?

A No, I can't multiply sitting up here.

Q If I provide you with a calculator, could you?

A What -- what is your result?

Q I -- I have not done it. I would be willing to ask you subject to check if I had the answer. I do not.

A 4340.

Q 4340 --

A Reservoir barrels per day.

Q -- reservoir barrels per day, and that is, using that calculation, the amount of flow between the E-32 and the C-34 wells.

A And a mile north of the C-34.

Q That would be along a one mile section of what we interpret to be as a barrier?

A Yes, sir, I think it would.

Q Do you know how much -- how long is the boundary between the Gavilan and the West Puerto Chiquito?

A How -- I don't understand you.

Q Well, you've told me that that is the rate of flow over one mile of that boundary and I'm asking you how long that boundary is.

A I estimated from the B-29, which is another high capacity well where the transmissibility may, indeed, be much higher than I estimated at the B-32. I -- I don't know how far north it is. I just used that as a means of showing that there is, indeed, the capacity for fluid to flow across the hatch marks on that --

Q And -- and in -- I'm sorry. And do you believe that that capacity for fluid to flow across that boundary line exists all up and down that -- the boundary between those pools?

A I don't have an answer to that.

Q There might be a barrier over the other sections of boundary.

A We can make similar calculations based on the build-up but I did not do that.

Q I don't think I have anything further.

Thank you, sir.

MR. LEMAY: Additional questions of the witness?

Mr. Lopez.

CROSS EXAMINATION

BY MR. LOPEZ:

Q Mr. Weiss, on page 2 of your report, in discussing the first paragraph, your Boulder Mancos Pool comparison, I notice that you state that the pool encompasses about 4000 acres and will produce abut 1.8-million cumulative barrels of oil.

According to my calculations this results in about 450 barrels recovered per acre in that pool. Do you agree with that?

A Well, I haven't done that, but I'm sure you have.

Q Well, subject to check, right?

A Yes.

Q Now referring to the Canada Ojitos Unit Well E-10, I note that you've indicated that it's produced over 2.2-million barrels of oil.

Have you -- can you tell me how many surface acres have contributed to that well's production or how much -- how many surface acres that well has drained?

A No.

Q Have you calculated how much of that production is primary and how much is secondary?

A No.

MR. LEMAY: Additional questions of the witness?

Mr. Lund.

MR. LUND: Three quick ones and I hope they're not (unclear) of hearsay.

CROSS EXAMINATION

BY MR. LUND:

Q I just want to make sure that I understand.

First, is it my understanding that you made no calculations of oil in place for Gavilan and/or West Puerto Chiquito?

A That's correct.

Q And is it also correct that you made no calculations of the percent of oil and gas to be recovered under primary operations in either Gavilan or West Puerto Chiquito?

A That's correct.

Q And finally, is it -- is it fair to say that one of the simplest ways to gauge the effectiveness of

a secondary recovery operation is to compare the percentage of oil and gas recovered under the primary versus under the secondary?

A Certainly is.

Q Thank you.

MR. LEMAY: Additional questions of the witness?

Mr. Kellahin.

CROSS EXAMINATION

BY MR. KELLAHIN:

Q Mr. Weiss, do you need a break for a drink of water, or something?

A Fire away.

Q All right. Mr. Weiss, I'd like for you to turn to page 11 of your report, if you will, sir.

The conclusion in this final draft is the same conclusion you had in the preliminary draft about the Gavilan/West Puerto Chiquito Pools being one, single, common source of supply?

A That's correct.

Q With that conclusion, Mr. Weiss, I'd like to see what your recommendation is to the Commission as to what impact that conclusion has on a number of issues that the Commission must resolve.

So that we're using the same shorthand definitions, I'll refer to Gavilan as being the Gavilan Pool; the expansion area to be the two rows of sections immediately to the east of the boundary between Gavilan and West Puerto Chiquito Mancos; and then the project are is that part of the Canada Ojitos Unit that is depicted starting with the two rows of sections to the east of the boundary and moving eastward.

One of the issues to be decided by the Commission for which they seek your recommendation is the issue of whether or not the Gavilan/West Puerto Chiquito Mancos current pool boundary where it is now should be moved two rows of sections to the east and thereby create a boundary between the two areas of this reservoir that allows those two different areas to be operated independently of each other.

What is your recommendation?

A I don't think the two areas can be operated independently of each other.

Q One of the issues involved with regards to the Commission's decision is whether or not this expansion area ought to be included and approved as part of the project area for pressure maintenance.

What is your recommendation?

A That's a very difficult question and it

pertains, as I see it, to correlative rights. You don't want anybody stealing anybody's oil.

I don't have any recommendation other than it should be operated as a single reservoir.

Q When we talk about the barrier that Mr. Douglass has had placed on this base map, and for which various of his witnesses have referred, do you have any confidence that this barrier is an effective pressure separation between the expansion area and the project area?

A No.

Q When we determine, or try to determine, what is the most efficient rate at which to increase ultimate recovery for the reservoir, the Gavilan side and the West Puerto Chiquito side, rate is an issue the Commission must decide, and I note in your report that you have studied that issue, and when we look on pages 10 and 11, you make reference to Figures 18 and 19.

When we look at Figure 18 we are looking at the high production rate period and at the high rate the recovery efficiency in barrels of oil per pound of pressure loss in the reservoir are averaged out to be 98 barrels?

A Yes.

Q Are you comfortable as an engineer that that is a sound, reliable way upon which to judge the reservoir efficiency in terms of improving ultimate

recovery?

A No.

Q If we could have your choice about how to judge reservoir efficiency, how would we do it?

A With the tools I had to work with, this is it. It would take a great deal more effort and study amongst the various operators. That's all I can say.

Q With the tools and the data we have available to us now.

A That's the best I could do.

Q Are you comfortable in making recommendations to the Commission based upon that analysis of the relationship between barrels of oil per pound of pressure loss in the reservoir?

A Making what recommendation?

Q As to what rate the reservoir ought to be produced at.

A I've not made that recommendation.

Q No, sir and I haven't seen it here and I was going to ask you whether or not you were comfortable in making that recommendation.

A No, I'm not comfortable making a rate recommendation, other than it has to be (not clearly understood) based on correlative rights.

Q And everybody, obviously, is seeking the

the maximum amount of recommendations from the various experts and you're obviously one on which everyone will rely, and I was curious as to whether you had a rate recommendation.

A I have no rate recommendation.

Q When we look at the information you have studied, the study shows you that at the higher rate we're recovering significantly less barrels of oil per pound of pressure loss.

A That's correct.

Q That's the hard data.

A That's correct.

Q When we look at the low test rate period on Figure 19, that's the low producing rate, the average of recovery efficiency is now up to 543 barrels per pound of pressure loss in the reservoir.

A Yes.

Q I'd like to play the pressure gradient game with you that Mr. Douglass was playing awhile ago.

A Sure.

Q Let's identify --

MR. DOUGLASS: I'm sure Mr. Kellahin wasn't accusing me of playing. It seems to me that that type of remark is only trying to delay the hearing because when he puts the bait out there, I'm going

to rise to it.

MR. LEMAY: We won't consider this a game, Mr. Douglass.

MR. DOUGLASS: Like I said before, I'll play it round or flat, Mr. Chairman.

MR. LEMAY: Well, we'll play it straight.

Q If we'll look at the pressure gradients that you discussed --

MR. DOUGLASS: I am, Mr. Chairman.

MR. KELLAHIN: I apologize. I didn't mean to infer that we were playing a game, John.

Q The pressure gradients that I'd like to discuss with you, some of which are highlighted in your book, Mr. Weiss, I believe we could find the first set on Figure Number 2, I think it's on page --

A Page 23.

Q -- 23. I'm sorry, it's going to be Figure 3 on page 24. This is the low rate figures.

When we look at the Howard Federal 43-15 Well, you see the Howard Federal 43-15 in Section 15, when we look now to the Hill Federal Well in Section 24, you have a pressure gradient between those two wells, do you not, sir?

A Yes, sir.

Q And that approximate distance is about a mile and a half, is it not?

A I suspect that you've measured it. I haven't.

Q I get a pressure difference in that mile and a half of about 160 pounds.

A So do I.

Q That will give us an average pressure gradient of about 100 pounds over that mile and a half.

A Uh-huh.

Q When you look at the Bear Trap No. 1 Well, has the 769 pressure?

A Yes, sir.

Q Then you look back again at the Hill Federal No. 1 --

A Yes, sir.

Q -- approximate distance there, I believe, is about a mile and three-quarters, and there we have about 179 pounds of pressure?

A Let me subtract it. I can't subtract; I'll have to take your word for it.

Q I believe it's about 179 pounds.

A All right.

Q We -- we see a pressure gradient between

between those wells within Gavilan itself of about 100 pounds a mile.

A In that area, certainly do.

Q In your opinion as an engineer is that a large enough pressure differential to keep those wells from being within the same reservoir and in pressure communication?

A Those wells I would definitely say are in pressure communication and in the same reservoir.

Q When we move on to certain portions of where the calculations have been between the B-32 and the C-34 Wells, across the -- the inferred permeability restriction area that we discuss so much --

A Uh-huh.

Q -- that pressure differential is about 350 - 400 pounds between those two wells?

A Yes. I believe we figured it about that, yes.

Q And we're dealing in that range of about two miles between those two wells?

A That's correct.

Q So we get a pressure gradient across that area of about 200 pounds a mile.

A Yes.

Q At what point, Mr. Weiss, does the

pressure gradient per mile become so large that you would not be comfortable with having those two areas in the same reservoir?

A Well, I'd not thought about that but it would be in the order of ten times more than that, and that might not be meaningful in some of these reservoirs, the anisotropic reservoirs. That's why I say it's difficult to try to quantify the magnitude of these numbers.

Q I'd like to turn to the displays that you have utilized to show pressure support from wells being produced in the expansion area, which you have concluded are receiving outside pressure support, and I believe one of the first wells is the A-20 Well?

Yes, sir, if we'll turn to page 11, in the second paragraph you begin by saying, "However, wells E-6, A-20 and B-32 show improvement during the period of low production rates when gas injection was able to support withdrawals."

A Yes, that's right. It's referring to the barrels produced per psi pressure drop, psi pressure change.

Q What table shows us the E-6, the A-20 and the B-32 that document that conclusion?

A Table 4.

Q That's on page 20?

A Yes. E-6 and Hill Federal 1 actually had a pressure increase, where A-20, when we go from -- oh, yes, we went from -- an order of magnitude increase there, from 11 to 126 barrels per psi pressure drop.

Q When we look at the A-20 well, that well is right on the eastern edge of the expansion area, still in the expansion area immediately adjacent to the project area -- do you see where I found the well?

A Yes.

Q And it is in close proximity to the current project area.

A Yes.

Q Do you see as an engineer any other source by which pressure could support the production in that well, other than the gas injection that's taking place in the project area?

A The gas injection in the project area is the obvious answer.

Q When we look at the E-6 Well, the E-6 Well is closer to the western edge of the expansion area in close proximity to Gavilan. There is a well there that you have said receives pressure support from the gas injection.

A That's my opinion.

Q Do you see any other logical place that that pressure support cam come from other than the project

area?

A The most -- the obvious source of the pressure support is the project area.

Q When we go from the E-6 in the northern portion of the expansion area to A-20 in the central portion of the expansion area, we finally go south to the B-32 in the southern end of the expansion area and that is also a well that you attribute pressure support to from the project area?

A That's correct.

Q If you'll turn to page 8 with me, Mr. Weiss, when you looked at 87 wells, there included some of the wells in the Canada Ojitos Unit?

A Yes.

Q There -- I've been told there are 74 wells in Gavilan. Is that approximately right?

A I -- we can count them.

Q No, sir, what I'm saying is the 87 wells will include the Gavilan wells and some of the unit wells in the pressure maintenance unit?

A Yes. Yes, it does.

Q And it has some of those wells in the expansion area.

A Yes.

Q Just before the high rate test period,

if we have a well that is already producing at its capacity and has a certain gas/oil ratio, and during the high allowable period, if that well is at capacity, it's not going to produce any more even if the allowables increase.

A No, that's the definition of capacity.

Q The wells that you have tabulated as being a total of 46 wells, --

A Yes, sir.

Q -- are there any of those wells in the 46 that fall within the description I have just given you of wells that were at capacity before the high allowable period?

A I don't know.

Q I'm sorry, the page is not numbered, Mr. Weiss, I'm going to have the same kind of difficulty that Mr. Douglass had.

I'd like to direct your attention to the Merrion Krystina No. 1 Well.

MR. DOUGLASS: Which appendix is it?

A It would be the last appendix.

Q It's in the last appendix --

MR. DOUGLASS: Appendix III?

A And it's about in the center -- well, in the first third of that appendix, and it's --

A I believe these are alphabetical.

Q All right.

MR. DOUGLASS: Which well is it?

A It's the Merrion Krystina No. 1 Well and it's abbreviated Merrion KRY No. 1.

MR. DOUGLASS: Okay, I found it.

Q This is a well that is included among the 46 wells in your summary?

A Yeah, it should be.

Q Okay. When we have a CC that says 0.96, what does that number tell you?

A Very good correlation.

Q Correlation between what, sir?

A Rate and GOR.

Q When we look at the barrels of oil per day rate on the well, I think that's in a different portion of the book. Can you tell me whether or not this well is a well that would benefit by an increased allowable?

A I think this well is about a dry hole.

Q And yet it is included among the 46 in the calculation of wells that appear to have a benefit.

A Yes.

Q Is it possible to go through the data

and separate out from the 46 wells those wells that will have a higher capacity to produce at a lower gas/oil ratio and produce more oil from those like the Krystina Well that are really not going to be affected by the higher allowable?

A Yes, I should think you could do that. I have not done it.

Q I'm not going to ask you to do it.

A No.

Q The question is that we can separate out from the 46 those wells that are truly going to be able to have the capacity to benefit from the higher allowable.

A Oh, yes.

Q And you don't mean to represent that these 46 wells in the table are all those kind of wells.

A No. These are merely 46 wells that have correlation between -- .85 or better, between GOR and rate.

Q On page 5, Mr. Weiss, you have gave us some information with regards to the core information and the calculation of matrix porosity --

A Yes, sir.

Q -- that I'd like to review with you. You gave us some discussion which I have failed to write down.

I see the two calculations wherein the

top results, the matrix capacity is changed because you have used 233 feet --

A As the thickness of the producing zone versus 50 feet in the bottom.

Q In the bottom calculation you're using 50 feet of thickness.

A Yes. And also I used 1.9 percent porosity in the bottom zone versus .1 in my initial calculations in the top (unclear.)

Q It is the 1.9 that I'd like to discuss with you.

A Fine.

Q The Mobil core information showed that the core porosity at ambient conditions on the surface is the 1.9 percent?

A I don't know the conditions, frankly. It is a Core Lab report and I merely averaged the -- the porosity over this interval that was presented to me as being the producing interval.

I don't know the -- it's in the Mobil exhibit. I believe it -- the Mobil core analysis, I believe, is an exhibit.

Q Is it a correct way to make the calculation for the engineer to take that matrix porosity boundary and either have the Core Lab or someone reduce it to the

reservoir conditions, subsurface?

A That's occasionally done; many times it's not, and in my case if it was not already reduced, I did not -- did not reduce it. I took it as is.

Q If we reduce that factor to reservoir conditions, do you know what that number is?

A No. I don't know that it's not reduced.

Q You just took the number that as given to you?

A Yes. But I suspect it was not. It seems to me they're just routine core analyses.

Q A routine core analysis would give you a matrix porosity, then, at ambient conditions?

A That's correct; so I took that amount. But if they were corrected, I don't know.

Q If that number is corrected to reservoir conditions, it will significantly reduce the permeability in the matrix.

A There's been articles in the literature that suggest that.

Q It may be a simplistic question, Mr. Weiss, but when are we going to know when the matrix has gotten to the point where it's going to produce?

A When it's homogeneous.

Q Is it a reasonable engineering assump-

tion from the data that that matrix, if it's contributing at all, will have contributed from the first production?

A I would think that it would have contributed initially. Now, normally when you look at your production trends in fractured reservoirs, fractures empty first, that could be a short-lived period, you might even miss it, and then you'd have the contribution of the matrix and the fractures.

And then you get, yes, where only the matrix produces. Many times a well can become uneconomic at that time.

Q When we look at the Bearcat No. 1 and the Howard Federal 43-15, here's the Bearcat 1 in Section 22 in Gavilan, and here's the Howard Federal 43-15 --

A Yes, sir.

Q -- you concluded in your report that those wells are too far away to receive external pressure support?

A Yes.

Q From the unit.

A Outside of the Gavilan. I felt those were -- those did not have pressure support from outside Gavilan.

Q The numbers you gave us this morning, if you recall, with regards to the steepness of slope in the

Boulder reservoir.

A Let me look, I jotted those down. About 2000 feet per month.

Q What approximately is the areal extent of the Boulder Pool?

A About 4000 acres, maybe a little less. I didn't planimeter it.

Q When we look at the Canada Ojitos Unit, we're dealing with a unit and a reservoir that is significantly longer north and south than the Boulder Pool.

A Significantly larger, yes.

Q And the degree of slope in the Canada Ojitos Unit is less than the slope in Boulder?

A The slope in Boulder was 2000 feet. The Canada Ojitos, depending on where you are in the unit.

Q When we move over to the center portion of the Unit?

A I -- there are no -- this is not a structure map but I've been told that it's on the order of 200 feet or perhaps more and about 100 in Gavilan per mile.

And down in the buffer area, I don't know. I don't have that, but I'm sure someone does.

Q When we look on page 7 in the second paragraph, you talk about the B-32 and the B-29 wells.

A Yes, sir.

Q Those are both wells in the expansion area?

A Yes, sir.

Q Here's -- here's the B-32 in Section 32. Immediately north of that, about a mile north, is the B-29 Well?

A That's correct.

Q When you were doing the pressure build-up calculations and analysis for that well --

A For the B-32?

Q Yes, sir. You said that the drainage from those wells was apparently being replaced from the gas injection area?

A That's my feeling.

Q And I'm not sure I heard you and please tell me again, the calculation of the build-up assumes a rectangular shape?

A A rectangle about two miles by one mile with three wells on the corners, the C-34, B-32 and B-29.

Q So when we take that rectangle and superimpose it on the display, we would have the B-29 up in the northeast corner of the rectangle.

A Yes, sir.

Q And in the southeast corner of the rectangle we have the B-32.

A That's correct.

Q And then we have the C-34 over on the other side of the --

A That would be the southeast corner, yes.

Q Southeast corner of the rectangle?

A That's correct.

Q And the assumption and the calculation is that you're going halfway distance between the B-29 and the B-32, approximately half a mile?

A No, I assumed that it was uniform for one mile across. I assumed -- I took the transmissibility of the B-32 and used to describe the flow characteristics in that -- in that rectangle.

Q The calculation of the 50 percent number of the production --

A Yes.

Q -- that does not take into consideration the additional factor of the one-half mile to the north, then, of the B-29, or the one-half mile south of the B-32?

A No, no, it does not. It is purely based on the transmissibility obtained from the B-32 build-up.

Q And if you add in the half mile on each side -- the other -- opposite side of those two wells, then you would have 100 percent.

A Well, you'd have a bigger rectangle.

Q You don't mean that the conclusion from this analysis to be drawn that only 50 percent of the gas injected in the project area is supporting the expansion wells.

A Oh, no, no, no. I didn't mean that at all.

My point was that it's obvious that the gas injection is supporting the production from those two wells, in my opinion. Now whether it's all of it or 50 percent or 32 percent, I don't know.

Q When we talk about the information on the Mobil well, Lindrith B-37 --

A Yes, sir.

Q -- help me find that in the report that you prepared.

A That's the build-up?

Q Yes, sir.

A I think you're talking about the dual porosity?

Q Right.

A That would be on page 5.

Q Okay. When we talk about the build-up slope on that Mobil well, we're looking at the Mobil Lindrith 37 -- Well B-37.

A Right there.

Q Down here in the southwest corner of Gavilan?

A Yes, sir.

Q There are a number of choices that you as an engineer can make to interpret the character of that slope on the build-up.

A Yes, there are.

Q Would you refresh my memory and tell me what are the possible reasonable choices for identifying that slope?

A All right. A barrier, a change in mobility, an oil bank, for instance, a gas/oil, water/oil contact.

Q Would -- would a stratified reservoir give you that look?

A Perhaps. It was my opinion that this reservoir has been referred to as a fractured shale for some time, and therefore, it ought to be analyzed in that manner.

Q Do you see any other, other than the Mobil build-up, shape of that build-up, do you see any other pressure build-ups in Gavilan that have that same shape?

A No. I didn't see another one.

MR. KELLAHIN: Nothing further.

MR. LEMAY: I'm sorry, Mr. Kellahin, did you say that was it?

MR. KELLAHIN: Yes, sir, thank you.

MR. LEMAY: Additional questions of the witness?

Mr. Chavez.

QUESTIONS BY MR. CHAVEZ:

Q Mr. Weiss, could we turn in your Appendix IV to the graph of the Amoco State CC Well? I believe it's the fourth sheet.

A State CC, yes, I have it.

Q Just calculating the figures that we have, it appears that if you calculate the rate in barrels of oil per day times the GOR you will be able to get the amount of gas produced during that day on -- for that production rate, is that correct?

A That's correct.

Q The calculations that I did indicate that on each day for this graph this well produced 20 MCF of gas, is that correct?

A I can't answer that. The information was submitted to us and I'm afraid I didn't put this in the computer, so -- so perhaps it's in the table back here, I

don't know.

Q Well, don't look. I already looked and it's not there.

A It's not there? Okay. That was the information supplied to us.

Q Okay. In looking at a production rate of 20 MCF a day consistently regardless of the oil production, did that give you any different prospective on the rate sensitivity of the well?

A Well, a correlation coefficient of one certainly gives one suspicion of -- of the quality of the data. That doesn't happen, at least in the real world.

Q Okay, if you'll turn to -- further in there to the graph on the Benson-Montin-Greer D-17.

A Yes, sir.

Q Within that graph there toward the center there are five points that appear to line up in a straight line from the top left to the bottom right.

A Yes, sir.

Q The calculations under that indicated that on each day of production for those oil rates that results were the same volume of gas, approximately 10 MCF of gas.

Did you check those out?

A No.

Q How were these scales selected for these graphs?

A The scales were selected just merely to get all the data on the scale.

Q Would you turn to the graph on the Benson-Montin-Greer J-6.

A Is that -- that's behind the D-17, isn't it?

Q Yes, it is.

A J-6, here it is.

Q It appears that there is something else on this graph than is on the others. For example, the actual gas rate, MCF per day, is that correct?

A One of those we had that; let me look at the next one. Yes, this is one and we also have the times on this.

Q Okay, it appears that November, January and December this well produced approximately the same amount of gas.

A Yes, but the GOR varied.

Q Because only of the oil production rate, is that right?

A Apparently.

Q Would you turn further in the exhibit to the Dugan Lindrith No. 1?

A I think that's -- okay. The Dugan Lindrith No. 1?

Q Yes.

A Yes, I have it.

Q It appears that during this production period there were several times that the well averaged four barrels of oil per day; however, the GOR was significantly different on each day.

A Yes, sir, it appears that way.

Q Is that significant in your analysis?

A Well, let's see, this has a correlation coefficient of .75, therefore there is no correlation in my opinion. This would not be included in the group of wells (not clearly understood.)

Q When you check further on a few more pages to the Mesa Grande No. 2 Well, February '88.

A Okay, I'll find it. Mesa Grande, Mesa Grande, 2?

Q Yes.

A I have it.

MR. DOUGLASS: PRO-2?

Q Yes. It appears that this graph also shows a correlation of 1.0 --

A Perfect.

Q -- and the multiplication of the rate in

in barrels of oil per day times the GOR indicates exactly the same amount of oil -- of gas reported for each day's production.

A Quite a coincidence.

Q Is that significant in your -- would that be significant in looking at a different perspective on how the oil production rates may affect the GOR or the total well production rates affect the GOR in your recommendation?

A Yes, certainly.

Q That's all I have.

A And I have not done it.

Q That's all I have.

MR. LEMAY: Thank you, Mr. Chavez.

Additional questions of the witness?

MR. PEARCE: May I get back in --

MR. LEMAY: Mr. Pearce.

MR PEARCE: -- real quickly?

RECROSS EXAMINATION

BY MR. PEARCE:

Q Could I ask you to look at Mallon 2??

That's one of the --

A Yes, you bet.

Q -- plots on the B-37 Well?

A I have them both here.

Q If I may approach you and look over your shoulder, this is the one that I want to ask you about. That's Mallon --

A Mallon 2?

Q Yes. I understand you indicated before that you had used the 72-hour period because that's what you thought folks agreed to.

A Yes, that's my understanding.

Q As an expert in petroleum engineering and looking at the data represented on that exhibit, do you think that 72-hour period was adequate in this particular case?

A It -- it could well make a difference. Now, there's no -- nothing to say that that's going to continue on at 4.7 psi per day. That can be calculated, though, but I did not do it.

Q Thank you, sir.

A You're welcome.

MR. LEMAY: Mr. Humphries.

QUESTIONS BY MR. HUMPHRIES:

Q Initially do you think that the testing time was long enough?

A As I say, there seemed to be agreement amongst all the operators.

Q So you're in concurrence with them?

A Basically, yes.

Q You seem to have some apprehension.

A Well, this is a valid point that Mobil has pointed out: Was the well shut-in long enough and that's a calculation that can be made; perhaps someone's done that; I didn't.

Q But for the entire project over the entire two reservoirs -- well, entire two pools, would you -- well, do you feel that the shut-in times were long enough for the --

A Yes, I do. By and large I think the 72 hours were adequate and that any -- any further changes in pressure would be small.

Q Okay.

A What that is, I don't know; they'd be small.

Q Let me ask you, and I'm certainly not trying to rephrase the question, because I think it's been asked to you lots of times and I think I got the same

answer every time.

You made no rate recommendations.

A I made no rate recommendations.

Q However, you did believe that approximately half the wells had so-called reverse rate sensitivities. The GOR seemed to go down when the allowable went up.

A Yes. Subject to -- to the points that have been brought up. I did not examine each well to see if the data was reasonable and this type of thing.

But, yes, approximately half the wells exhibited a favorable rate sensitivity.

Q And the other half were not -- didn't respond in any kind of regular --

A Well, no, one well had an unfavorable, indicated coning.

Q The rest had sort of an erratic response.

A Had no response. They -- perhaps those are solution as drive wells.

Q Okay. And then I believe you responded to Mr. Kellahin's question in the following fashion: Again I'm not trying to trick you, I've got to make sure I understood what you answered.

A Sure.

Q You felt the higher the rate of recovery on some of the wells, and I'm not sure if you quantified that, on some of the wells, or if you just left it in a categorical statement, the less oil would be recovered per pressure loss, per pound of pressure loss?

A There's data that says that, yes.

Q Now is that generically across both pools?

A No, no, that's just on those wells that are on these maps; the only ones I have data for, Table Number 4.

Q The 87 wells?

A No, no, just on Table 4 is the only place we have the data.

Q Oh, okay. And then I think by inference, or perhaps by direct statement, you stated then that the lower rate of recovery, the lower the rate of recovery, the more oil that would be recovered per pound of pressure loss?

A Yes, on these --

Q Just on those four wells.

A That's correct.

Q Is there any way that you would hazard to expand over both pools, or is that going to be specific in those four wells?

A I -- I personally would keep it to these wells, yes. I think that's your problem.

Q I have no further questions.

MR. LEMAY: Okay, Commissioner Brostuen.

QUESTIONS BY MR. BROSTUEN:

Q Bill, in reviewing some of the exhibits that were presented in previous cases, it appears that there are some wells along what Mallon, et al, have -- contend to be a barrier, that are nonproductive or very poorly productive, perhaps uneconomic wells, and you have testified today that -- that you believe there's effective communication across this barrier whether or not it exists.

Have you taken those -- those low production wells, or non -- presently shut-in wells under consideration in your determination?

A Unless there were pressure or build-ups, something that was collected during this testing period, I have not looked at those.

Q I think the G-32 would have some production during that period of time but getting very low ratings, so you would not, perhaps, use it.

But at any rate, there were three other wells that -- one is an observation well, the Benson-Mon-

tin-Greer D-17, the --

A Now that one, I think, was included --

Q Was that included?

A No, in the interference testing that I don't believe we drew any conclusions from.

Q Okay. Thank you very much.

A You're welcome.

QUESTIONS BY MR. LEMAY:

Q Mr. Weiss, one quick question on pages 39 and 40 where you're plotting your barrels of oil produced per pound of pressure drop. Was there any accommodation for the gas produced either as reservoir voidage or converted to oil?

A No, there was not. That takes a -- you need to know the pressure history much -- to much more detail than I have available, but if I'd have known the pressure daily, I could easily have done it, and I could make a stab at it, you know, on averages, or something of that nature, but I did not do it.

Q Would it be fair to assume that the gas production was constant through that period of time?

A Well, I would guess in the low rate period, certainly, because I think that's the way the wells are produced. They produce their gas allowable and that's

it. But I (not clearly understood.)

MR. LEMAY: Additional questions of the witness? If not, he may be excused.

We'll take a recess, a 20-minute recess. When we return we'll start with the Proponents.

(Thereupon a recess was taken.)

MR. LEMAY: So that we can keep this thing relatively on track, we'll start at 8:30 tomorrow; hopefully be able to quit at 4:30; at least it gives us a little more flexibility; hate to break a witness off right in the middle, so we'll work it that way 8:30 in the morning we'll reconvene, when we quit today.

I guess we're ready for opening statements. Mr. Douglass.

MR. DOUGLASS: Thank you, Mr. Chairman.

First of all, Mr. Chairman, on our position paper and witness list, we had three columns advising parties who were lined up as Proponents and in one of those we've indicated -- in one of the columns we've indicated the Proponents that also had an interest in the COU Unit, and one of those we listed was Hooper, Kimball

and Williams, Inc.

They do not currently have an interest. They did and it's been sold so that's a correction that you should make on our position paper.

I apologize for the error but the party who gave us the information originally had not realized that that interest had been sold.

Mr. Chairman, this -- and Commissioners, this opening statement is made on behalf of Mallon Oil Company.

Mallon has been a participant in an on-going reservoir study with regard to the Gavilan Mancos Pool for approximately two years. The other participants in the independent engineering study by Mr. Greg -- done by Mr. Greg Hueni and his staff at Jerry R. Bergeson & Associates, Inc., have included American Penn Energy, Inc.; Amoco Production Company; Hooper, Kimball & Williams, Inc.; Koch Industries, Kodiak Petroleum, Inc.; Mesa Grande, Limited; Mesa Grande Resources, Inc.; Mobil Exploration & Producing, USA, Inc.; Reading & Bates Petroleum; and Tenneco Oil Company, are the parties who have participated in that study.

This study has determined that for the State of New Mexico -- has determined that the State of New Mexico has lost more than $4,000,000 in state revenue

from the loss of production taxes and royalty revenue because of the restricted allowables in the Gavilan Pool originally ordered by the previous Commission in September of 1986.

Most of the true Gavilan Pool production is from Federal lands. The Gavilan working interest owners and fee royalty interest owners have lost more than $22,000,000 in income, which could have been reinvested in New Mexico oil and gas drilling and the local economy.

During the past 22 months of restricted rates Gavilan has lost ultimate recovery of approximately 400,000 barrels of oil due to the low rates.

This is waste.

By restoring production levels and increasing gas production in the Gavilan Mancos Pool the State of New Mexico can recover a substantial portion of these lost revenues and can actually increase the ultimate recovery from the pool by approximately 600,000 to 700,000 barrels because the Gavilan produces with lower gas/oil rations and higher oil production rates. The gas energy is the drive mechanism in the Gavilan Pool. By restricted oil rates the gas rates increase, and this is a -- excuse me, by restricted oil rates the gas rates increase and this is an inefficent use of the drive mechanism for the Gavilan Pool.

This Commission has literally a golden opportunity to correct the past mistake made by the previous Commission by immediately restoring reasonable allowable rates, thereby permitting maximum production to the benefit of New Mexico, increasing tax revenues, increasing royalty payments, increasing drilling and increasing industry confidence that New Mexico truly has lived up to its State motto, Crescit Eundo (It grows as it goes) for oil and gas development.

One of the severe adverse effects of the restricted production which the previous Commission ordered in September of 1986 has been the shutdown of development in the Gavilan by the Proponents. The most active operators who have been developing in the area are the opponents, who have drilled 13 of the 17 wells added in the true Gavilan.

BMG production from these wells drilled in the 2-section tier eat of Gavilan has caused severe drainage in the original Gavilan Mancos Pool area, all in violation of correlative rights of the Gavilan owners.

This Commission, we believe, perceived the error that was made by the previous Commission and ordered new production tests at normal rates and pressure tests be run in order to determining the proper boundaries for the Gavilan and whether production from the true Gavilan Pool would adversely affect the injection project being

conducted by BMG in the West Puerto Chiquito Mancos Pool. These production and pressure tests were conducted from July, 1987, through February of 1988.

As a result of this Commission's ordered production and pressure tests, it has been conclusively established that Gavilan Pool boundaries should be extended to include the expansion area, or the 2-section tier that was referred to in the March, 1988, hearing.

In addition, the March, 1988, hearing evidence clearly showed that there was no effective communication between the true Gavilan Mancos Pool and the West Puerto Chiquito area operated by BMG under a gas injection project.

Evidence in this hearing will show that the BMG gas injection project is essentially completed and will be headed for blowdown in a short period of time.

The Commission ordered testing has shown without question that producing the Gavilan wells at normal oil allowable, or in excess of normal oil allowables causes lower gas/oil ratios; in other words, less gas is produced with more oil at increased rates and therefore reservoir energy is used more efficiently.

For example, the field gas/oil ratio in the Gavilan during the restricted rate production was 4683 (sic) for the month of January, 1988, with 2653 barrels of

oil, whereas in October of '87, at normal allowable rates of production, the oil production was 6204 barrels of oil and the gas/oil ratio was 3257. Oil production was 134 percent greater in October of 1987 versus January, 1988, and the GOR was 30 percent less in October of 1987 than in January of 1988.

This Commission has in the past been urged by Sun and BMG to consider the feasibility of secondary recovery in the Gavilan. Because of the highly fractured nature of Gavilan, gas injection is not economical or practical and is not a secondary recovery possibility.

It should be emphasized that the March 17-18, 1988, on the application of BMG to expand their injection authority, conclusively showed that there is no effective pressure communication between the West Puerto Chiquito current injection area and the proposed expansion area, which although carried in West Puerto Chiquito Pool, is more properly classified in the Gavilan, and would be what we call the true Gavilan or the true Gavilan Mancos Pool.

There currently exists approximately 400 to 450 psi pressure differential between Gavilan and the injection project being carried on by BMG.

The evidence is clear that the normal rate of production from the true Gavilan Mancos Pool has not

and will not in any way adversely affect the injection project being carried on by BMG.

After five years of production in the Gavilan, 78 barrels per acre have been recovered, whereas during the equal period of time in the West Puerto Chiquito only 22 barrels per acre have been recovered. Based on the best estimate of ultimate recovery, it appears that Gavilan will recover 199 barrels per acre where the West Puerto Chiquito will only recover 161 barrels per acre, even though the West Puerto Chiquito will have had a pressure maintenance project in effect most of its producing life.

It appears that Gavilan is going to be a better producer than West Puerto Chiquito and that the pressure maintenance project in West Puerto Chiquito has not effectively -- has not been effective to increase the ultimate recovery from that pool area.

We will show that reduced oil allowables and reduced gas limits have placed severe limitations on a number of wells in the Gavilan, thereby permitting the lower gas/oil ratio wells and higher capacity wells recently drilled by BMG in the expansion area, to drain the offset Gavilan and to adversely affect the correlative rights of the Gavilan Mancos Pool.

In summary, the Mallon supported evidence will show the following:

(1) State income will substantially be -- will be substantially enhanced with the restoration of allowables or production at higher oil rates.

(2) Production of restored oil allowables or higher with capacity gas allowables for the true Gavilan oil wells will result in significant, additional hydrocarbon recoveries, conservation of reservoir energy, and the prevention of drainage and thereby protecting correlative rights of the current Gavilan owners.

(3) Production from the Gavilan Mancos Pool at the above requested rates will not have any adverse effect on the West Puerto Chiquito injection project.

(4) Gavilan and West Puerto Chiquito are effectively separated between the expansion area and the West Puerto Chiquito injection area.

(5) Gas credit for the West Puerto Chiquito injection project should not be permitted to give net gas/oil ratio to the BMG wells in the expansion area which actually produce from the Gavilan reservoir. Such treatment as shown in Docket Number 9111, is unwarranted, will cause further and even more massive disruption of correlative rights.

Under the proposal of this hearing by Mallon and others, the oil wells in the expansion area will essentially not limited as far as gas/oil ratios are con-

and will not need any injection credit.

Mallon recommends that the gas/oil ratio and the oil allowable for each well in the revised Gavilan Pool should be made equal to the well's ability to produce.

The proposed testimony to be submitted on behalf of the above group will consist of:

(1) Mr. Greg Hueni testifying about the results of the Commission ordered tests, the enhancement of recoveries by restored production rates, the basis for pool separation and the lack of any adverse effect on the West Puerto Chiquito injection project by increased Gavilan production.

(2) Dr. Charles Kohlhaas will testify regarding the well test information and show no interference tests demonstrate communication between the pressure maintenance area and the expansion area but, on the contrary, confirm the presence of the barrier between the two areas.

These test data also show a double porosity system in which significant amounts of oil are in the matrix rock.

(3) Mr. Lincoln Elkins, distinguished petroleum engineer, adjunct professor at the Colorado School of Mines, and author of the paper cited and relied on by Dr. John Lee and Mr. Bill Weiss, will testify with regard to the bulk of the Gavilan oil in the matrix, injecting gas into a

fractured system -- excuse me, injecting gas into a fractured system will not recover oil from the matrix and the impracticability of pressure maintenance by gas injection in a fractured type reservoir such as the Gavilan Mancos Pool.

Mr. -- we may call Mr. Max Powell, whose testimony was mainly directed to the Spraberry Trend Area, but he is available to testify with reference to the failure of the gas injection project in that field, the effective communication as to what constitutes reservoir separation.

We agree with the Commission that this matter should be laid at rest once and for all. This can only be accomplished by establishing the proper boundary between Gavilan and West Puerto Chiquito as recommended by Mesa Grande and, secondly, restoring production rates to the highest level for gas production in order to achieve the greatest ultimate recovery with the lowest gas/oil ratio.

We also make another request. We request that you make your decision, if at all possible, at the conclusion of this hearing. We are convinced that you will know this case better at that time than you will any other time. You've expressed to us directly that you want to have this done once and for all and we really feel like

that is the time the decision needs to be made.

You will have your own staff to be able to communicate with you with reference to this particular area. You'll have an opportunity, I think, to see two cases, the reading of the position papers are obviously diametrically opposed to each other as far as what they believe the data and information shows, and I think that the field has been studied enough.

You have had four hearings, the Commission has, on this field, in the last fourteen months. This Commission itself needs to remember they have had three hearings in the last fifteen months. Of course, I've enjoyed the last two because I was able to attend, but I sense that perhaps you're not interested in having another one. So we would urge that the decision, if possible, be made as soon as possible after the conclusion of this hearing.

And another reason is that we believe that you will be convinced that waste is occurring daily in the Gavilan Pool at the restricted rates. It's been approximately 400,000 barrels in the past. It's going to be 600-to-700,000 barrels in the future. The only way we're going to cut off that waste is to turn this field loose and let it produce in accordance with the mechanism that is most efficient here.

Thank you.

MR. LEMAY: Thank you, Mr. Douglass.

Mr. Lopez.

MR. LOPEZ: Mr. Chairman, members of the Commission.

Mr. Douglass has discussed that our evidence will show that the Gavilan Field should be allowed to produce at capacity and that the wells located in the western two sections on the west side of Puerto Chiquito Pool are in direct communication with the Gavilan wells but are not in effective communication with the wells located to the east and that the two pools are indisputably separate as the Commission has already found in Finding Number Five of Order R-6469-D.

But my opening remarks, I would like to share with the Commission some historical perspective as to how we got to where we are today.

I first might mention that I began practicing before the Commission in 1970 and in reminiscing Mr. Chairman, I tried my first case with you helping me, and in all these eighteen years I have known of no controversy so deeply felt by both sides and which so much of the Commission's time and energy has been expended. I think we might make an exception for the potash cases, but those are

an on-going deal.

This is an amazing deal. I don't think any case has filled so many file drawers.

It is a remarkable case and one that will have far reaching ramifications but, hopefully, during the course of the hearing this week we will have reached the final bend in the road.

Whatever is decided at the conclusion of these hearings will have an irreparable effect on Gavilan's future, and that is why they are so important, and that's what Mr. Douglass just pointed out.

I, myself, personally became involved in these Gavilan cases as early as 1983 when hearings were held regarding initial spacing considerations for the Gavilan Pool. We have gone from 40 to 160 to 320 acre spacing and as a result of the March, 1987, hearings, to 640-acre spacing. So apparently we all seem to be learning something from our studies of this reservoir because both sides seem to agree that 640-acre spacing with the option to drill a second well is appropriate.

However, the real issues that the Commission must confront this week were put on the table for the first time at the week-long hearing that took place in August, 1986, before the previous Commission members.

Sometime prior to those August hearings,

at the request of Mr. Stamets an engineering committee had been formed consisting of all working interest owners who were then operating in the Gavilan Pool.

It should be noted that Mr. Greer attended all the Gavilan meetings but had no mineral interest in Gavilan whatsoever.

As early as March, 1986, Mr. McHugh stated in a letter to the Engineering Committee members that the purpose of the the Gavilan Pool Study Committee was, "To determine the feasibility of the unitization of the Gavilan Mancos and Gavilan Greenhorn Dakota Pools."

The response of the other operators was that such considerations were grossly premature because no one had a clear understanding of Gavilan's reservoir mechanics, what the spacing should be, or how the pool should ultimately be operated.

Then, without attempting to resolve these issues with the other members of the Engineering Committee, Mr. McHugh and Mr. Greer uncompromisingly filed applications before the Commission to restrict allowables because they perceived that an emergency condition existed.

Mr. Dugan joined the battle supporting both Mr. McHugh and Mr. Greer, as did Meridian. The rest of the operators and working interest owners held divergent opinions on what the temporary rules should be; however, no

one from our side believed that such severe restrictions were called for but we did agree that the Engineering Committee should continue its study and figure out exactly what makes this reservoir tick.

Naturally, in these early days of Gavilan there was a great deal of confusion and strong contrary opinions were expressed. But clearly the first shot was fired at the August, 1986, hearing and the battle lines were drawn.

The opponents camp proposed unitization, then study.

Our camp proposed more study, then to do what made good sense.

Our camp, today's proponents, have been cooperating in an attempt to study the reservoir ever since that August, 1986, hearing.

Greg Hueni was initially hired by Mallon and Mesa Grande to independently study the reservoir and discounting their biases was asked to reach an informed opinion.

I would like to mention at this point that the position put forth by Mobil at those August, 1986, hearings is essentially the position that all of us Proponents today now agree with.

I would personally like to congratulate

Luis Zambrano, Mobil's reservoir engineer and principal witness at those August hearings and who is present here in the audience today, on his foresight, now with our hindsight,and calling it right the first time, and that's pretty amazing, Luis.

During the course of the August hearings there wasn't much disagreement between the two camps that there existed a permeability barrier in the trough separating the two pools. That thing's been there since day one.

There was sharp disagreement, however, whether allowing the wells to continue to produce in accordance with the standard statewide rules would be harmful to the reservoir. After hearing the evidence, the previous Commission issued a ruling restricting production to the statewide allowable of 702 barrels of oil with a limiting gas/oil ratio of 2000 cubic feet per barrel of oil, to 400 barrels of oil per day with a limiting GOR of 600 cubic feet of gas per barrel.

Of course, this came as a shock to those of us opposing Mr. McHugh and Mr. Greer, based not only on the evidence presented, but because no other fractured reservoir in New Mexico had had its allowable so restricted.

After those August, 1986, hearings all

parties were ordered back to the drawing board and once again all the operators resumed deliberations.

The Engineering Committee held meetings, assembled and analyzed the available data from the wells within the area of interest. Initially, some people felt that progress was actually being made; however, unitization as a prerequisite for studying the reservoir continued to influence the deliberations and was not well received.

Communication between some of the parties again broke down in November, 1986, because little or no progress was being made in studying the reservoir because of the unitization issue. The committee dissolved and the parties prepared for the March '87 hearing at which you were all present and then at which you all presided.

Mr. Hueni's costs and the continued study efforts by this time were being shared by all the Proponents at those hearings and at the hearings being held here today and this week.

You all know what happened at that hearing. Each side presented their cases and the line up was pretty much the same as it was at the August, 1986, hearing. The Commission carefully considered the record and after thoughtful deliberation decided to continue the restrictions that were then in effect; however, the Commission also ordered that further testing be performed under

Commission guidance with Gavilan producing under normal allowables and under restricted allowables so that the Commission could decide once and for all whether the reservoir is rate sensitive.

Valuable data was also obtained concerning Mr. Greer's pressure maintenance project.

Mr. Douglass has stated that our witnesses are prepared to show you this week that all the Proponents agree on how the field should be operated to obtain maximum, ultimate recovery at maximum operating efficiency, thereby preventing waste and protecting correlative rights. Current restricted allowables, which cause waste, cannot continue unabated if continued irreparable harm to the reservoir is to be avoided.

As the Commission can appreciate, the talent on our side of the table in terms of geologic and engineering capability is not inconsiderable. Not only are all these engineers' reputations and careers on the line, their chief purpose is to maximize profits for their employers so that their jobs are on the line, as well.

More than anything else, they want to see maximum efficient recovery of the reservoir's hydrocarbons because it only makes good sense and it's self-serving.

I do not intend to repeat my closing

argument presented at the March '87 hearing, which was so well received, or again speculate as to Sun's ulterior motives for supporting severely restricted allowables; however, we are now faces with a situation where Mr. Greer and Sun, to some extent supported by Mr. Weiss and the Commission staff, but no longer supported by Meridian, conspicuous by their absence, believe that Gavilan and West Puerto Chiquito Mancos Pools are a common reservoir, contrary to hearing evidence presented in the March, 1988, hearing clearly showing that there is no effective communication between the true Gavilan, as referred to by Mr. Douglass, and the West Puerto Chiquito Pressure Maintenance Project, and if, of course, contrary to the previous findings of the Commission.

Today West Puerto Chiquito is approaching blowdown, producing only 243 barrels per day in the pressure maintenance project.

Gavilan at restricted allowables is suffering irreparably and severe economic hardship is being endured by its mineral owners.

I believe that the Commission will be persuaded by the evidence that we shall present by the astounding degree of consensus after an intensive study by the best engineers and geologists, Amoco, Mobil, Tenneco, Koch, Reading & Bates, Hooper, Kimball and Williams,

Kodiak, Mesa Grande, Mallon, and American Penn have to offer, not to mention the talents of all our independent consultants beginning with Greg Hueni and including the distinguished Lincoln Elkins, Charles Kohlhaas, and Max Powell.

I have much respect for the Commission and its staff and the merits the evidence we plan to present this week. The Commission again, with informed hindsight on our part, was right in March in 1987 to insist on further study of this relatively new, complex, and certainly controversial reservoir called Gavilan, which is just opposed to a pool operated by one of San Juan County's long established operators.

Mr. Greer has operated West Puerto Chiquito for 26 years. Gavilan has been in production for 6 years. The Commission has asked for and has obtained the necessary correct information to reach an informed decision. Consensus in its true meaning has been reached by the Proponents and I'm optimistic that the Commission will join in this consensus

I am also hopeful that the Commission will be courageous enough to permit Gavilan to produce at its capacity to obtain the greatest ultimate recovery from the pool, an unconventional move for New Mexico, no doubt, but not for other oil and gas producing states which

routinely permit capacity allowable production.

I would also hope that the Commission will establish the proper boundaries separating the Gavilan Mancos Pool and the West Puerto Chiquito Pressure Maintenance Project, as has been requested by Mesa Grande.

Thank you.

MR. LEMAY: Thank you, Mr. Lopez.

Yes, sir, Mr. Pearce.

MR. PEARCE: Thank you, Mr. Chairman.

May it please the Commission, I'm Perry Pearce and I'm appearing in this matter today on behalf of Mobil Producing Texas & New Mexico, Inc. Under the Commission's classification scheme we classify ourselves as very small Proponents in this matter. Based on reservoir -- reservoir performance, the Gavilan Mancos Oil Pool, resulting from restricted allowables, Mobil wishes to re-emphasis its earlier conclusions which it presented to an earlier set of commissioners in August of 1986. That conclusion is that in order to prevent waste of resources the Commission must remove all producing rate restrictions for oil and gas in the Gavilan Pool.

The evidence at this hearing will demonstrate that the most efficient way to produce the

Gavilan Pool is to set oil allowables and gas/oil ratio limitations equal to each well's ability to produce. Only by maximizing reservoir performance can the maximum amount of oil be removed from matrix.

In fact, evidence will show that if the reservoir continues to be artificially restricted the productive energy of the reservoir will be wasted.

Mobil believes that these are in fact two separate reservoirs. For more than 20 years vastly different pressures existed between these reservoirs. The barrier which allowed those pressure differences to continue for more than 20 years is still in place. The pressure histories of these two pools amount to a 20-year interference test and it is conclusive proof of the existence of that barrier.

Mobil believes that there is no reasonable possibility of secondary recovery in the Gavilan Pool. Evidence will show that primary production in the Gavilan will exceed production in the West Puerto Chiquito on a per acre basis, and that the West Puerto Chiquito Pressure Maintenance Project has not raised recovery in that pool.

The Gavilan is a fractured reservoir with a tight matrix rock. Evidence will show that gas injection projects will not aid recovery in such a reser-

voir and that in the absence of a geological structure to confine the injected gas and restrict the movement of that gas, that rapid breakthrough occurs and ends any benefit which might be received from gas injection.

In summary, Mobil believes that in order to prevent waste and protect correlative rights, the Commission must raise the producing rates and the gas/oil ratio limitation to allow each well to produce at its capacity.

The Commission must move the boundary between the Gavilan and the West Puerto Chiquito Pool two sections to the east so that that boundary conforms with the physical barrier and the Commission must recognize that restricted rates are threatening this reservoir's productive energy, and that there is no possibility of secondary recovery through gas injection in this reservoir.

Thank you, Mr. Chairman.

MR. LEMAY: Thank you, Mr. Pearce.

Mr. Lund.

MR. LUND: Mr. Chairman, I forgot my 10-page, typed opening statement.

Very briefly, I'm appearing on behalf of Amoco and we're off the fence. We got an incredible amount of criticism, I think, for a couple of

years ago saying to the Commission in a letter that if you're going to make a mistake, you've got to err on the side of preventing waste, and we think the Commission was correct in doing that and the study has taken place and we believe now that the restrictions in Gavilan need to be eliminated and that is why we're Proponents, and we believe the evidence will prove the matters set forth in our June 3 letter setting forth our position, which we submitted to the Commission.

Thank you.

MR. LEMAY: Thank you.

Any other opening statements for the Proponents?

Yes, sir.

MR. MOCK: Mr. Chairman, and members of this Commission, my name is Bob Mock. I'm an employee of Phelps Dodge Corporation and I thank you for the opportunity to present Phelps Dodge's point of view as a stake holder on the subject of allowable production rates in the Gavilan Mancos Pool and its horizontal boundaries.

Approximately fourteen months ago in a hearing held in March '87 I told you that Phelps Dodge Corporation is this country's largest producer of copper and it's New Mexico's largest consumer of utilities, New Mex-

ico's second largest employer in total payroll, and among the largest contributors to New Mexico's treasury in terms of taxes paid and among the largest consumer of New Mexico businesses -- sorry, consumer -- customer of New Mexico's businesses -- but we have consumed some businesses as well.

Those statements are still true today. Phelps Dodge has hundreds of millions of dollars invested in the New Mexico, more invested in producing facilities in New Mexico or in any other state or country. Phelps Dodge's operations in the southwest consume approximately 30-to-35 million cubic feet of gas each day. Obviously we are interested in obtaining a secure supply of natural gas to satisfy our needs.

In 1986 in pursuit of this objective, Phelps Dodge purchased the right to production from several wells producing in the Gavilan Mancos Pool, along with a small gas processing facility near Lindrith, New Mexico.

Because of lower than expected allowed production rates from these wells, we are failing to realize the benefits we anticipated from this investment. While we are not experts in the natural gas industry, we did understand that the biggest risk we were undertaking with our investment in New Mexico gas production was the imponderable of forecasting bulk production. We consulted with experts and did the things that anyone would do to un-

derstand and evaluate the inherent risks of well production forecasting.

Having done all of that it was decided to make the investment. What was not adequately understood was the risk of regulatory constraint on production, which has impeded production from the start.

Phelps Dodge understands that is this Commission's responsibility to use its best judgment after having reviewed all of the facts to decide how to optimize the use of this state's oil and gas resources and to protect the rights of the various interest holders.

We know that this responsibility is in competent and capable hands. You have already received a tremendous amount of information from both sides of this controversy concerning the production rates necessary to optimize the Gavilan Mancos Pool and the drawing of boundary, of its boundaries.

This week you will receive more data and experts opinions. Men of integrity will present divergent views based on their evaluation of similar data and recommend conflicting courses of action on your part.

I am indeed incompetent to help you find the truth or give you comfort that your decision will be the right one. To the extent uncertainty remains when you are required to make a decision, I would recommend that you

consider the following points:

First, in general a decision for low production rates will result in a more immediate, certain, measurable and extensive loss to all who own an economic interest in production from the Gavilan Mancos Pool. Higher production rates will minimize this known risk of loss and increase the risk that sometime in the future a loss may occur through under utilization of this resource.

We believe that under these circumstances it is best to minimize the certain loss and to bear the risk of the unknown .

Second, all parties in this dispute deserve an answer. With a final order from this Commission affected parties will have the basis upon which to make future decisions. For the past eighteen months uncertainty with respect to production rates has frustrated our ability to make enlightened business decisions.

Third, a ruling from this Commission subsequent to having made an investment which hampers the investor's ability to recover his investment along with a reasonable return will undoubtedly result in a diminished willingness to make additional investments for the development of the State's resources. New Mexico will have incurred a significant loss if, after your decision in this matter, the State is less able to attract capital for the

development of its oil and gas resources.

Finally, Phelps Dodge is an economic interest holder in the Gavilan Mancos Pool. If wells producing on the periphery of the Gavilan Pool but not subject to its operating rules are draining the pool, we must have this condition stopped. We rely on this Commission to protect our rights. Therefore, I urge you to weigh the evidence carefully and to write your final order in this matter in favor of restoring the production rates of the Gavilan Mancos Pool to, as a minimum, statewide depth bracket allowables of 702 barrels per day and a 2000-to-1 GOR for 320-acre proration units and twice that amount for 640-acre production units.

Those are the rates upon which we evaluated our investment. Thank you.

MR. LEMAY: Thank you, Mr. Mock.

Any additional opening statements for the Proponents?

We'll go to the Opponents and Mr. Kellahin.

MR. KELLAHIN: Thank you, Mr. Chairman.

I don't have a lot of rhetoric or dialogue for you. I'd like to share some facts.

We have prepared a written statement of position with Mr. Carr's client and circulated as required by the Commission with opposing counsel here some extra copies of that.

I have two clients, gentlemen, Sun Exploration and Production Company is in a unique position in this reservoir. We could be on either side of this table. We have 40 percent of the Canada Ojitos interest in that unit with Mr. Greer, but we are also the single largest operator of producing wells in the Gavilan. We have 28 of those wells and not all of those wells are going to be able to produce at higher gas/oil ratios at lower rates. We have some in Mr. Weiss' book that fall on both sides. We're going to have some of those high capacity gas wells that are going to produce at lower gas/oil ratios and get up a higher (unclear), and we have some of the other kind. We have some of those low capacity wells that do not benefit at higher rates.

And so we're really caught in both positions but our engineers have told us, and we think the facts prove conclusively that less is better for Gavilan.

The fundamental issue back in 1986 was what to do with the gas. The issues we had then are the same issues we have now and those issues were in place long before any of us were here. Mr. Greer was the only one out

there for twenty years operating in the Gavilan a very successful pressure maintenance project and was his one great hope that what has been identified as a permeability restriction was going to be an effective pressure barrier to keep the competitive operations in Gavilan from gutting the gas out of the pressure maintenance project.

The facts are the barrier leaks. It is not an effective barrier.

The other fact is we have one common source of supply and one reservoir and it becomes virtually impossible to graft onto that one common source of supply two pools. We think, however, where we've established the boundary between the two pools the evidence is that that becomes a boundary that has been utilized, money has been spent, and we can control the migration of gas and oil at the current boundary.

My other client is Dugan Production Corporation. I have the unique privilege of having to work with John Roe, who is one of those fine nuts and bolts engineers who testified back in '86, testified in '87, and will testify for you this week. He's had hands on experience with all these wells and he knows what these wells can do and cannot do. He knows what these test results mean and he's going to tell you some facts that you're going to have to deal with.

One of the facts that Mr. Roe tells me is that at the lower producing rate for the reservoir, not just for a few wells, for the reservoir, we have an average of 6,200 barrels of oil recovered for every pound of pressure loss; cold, hard fact.

At the higher rate we only get one-third that efficiency. The recovery in barrels of oil per pressure loss is reduced to 2,200 for the reservoir. To increase the rates, you reduce the ability of the wells to produce and I don't know how you resolve that; that's a fact you're going to have to deal with.

Higher is not better.

Another direct measurement of the efficiency of the reservoir, Mr. Roe tells me, and he will tell you, is that out of the 74 wells in Gavilan 52 of those wells do not benefit at the higher rate. Some 70.3 percent of the pool did not seek lower gas/oil ratios with increased oil rates. Another fact that Mr. Roe shares with me. There are some 23 wells in this pool that actually decrease in oil rates during the high rate test period. If you increase the rates I don't know what you're going to do with those wells.

Mr. Roe tells me that the tests at the high rate show him, and he will show you, that the high capacity gas wells, producing at higher rates, do in fact

produce more oil but they're going to do that at the expense of the adjoining wells, the gas injection project, and the reservoir itself.

He will tell us that the high rates do not increase ultimate recovery in Gavilan and that we're just acceding to the pressure from those operators with the high capacity wells that want to put us back on rules of capture and blow and go and leave us, but they're going to do it at the expense of what we think has been reasonable operations in the pressure maintenance project.

Mr. Roe tells me this, and he will tell you, that there are some 43 wells out of the 74 Gavilan wells that could not return to the level of productivity that they had before the high test rate. He tells me the high test rate was a mistake, damaged the reservoir, and he's got 43 wells in that pool that did not return to the productivity rate that they had before the test.

It's also interesting to note that at the high allowable rate there is not a single well in Gavilan that can produce the maximum top oil allowable. There's not one that can produce the maximum top gas/oil ratio allowable. Can't get the gas allowable, that doesn't have the top rate.

Mr. Roe tells me that despite the parties that have lined up as Proponents in the pool, he

finds that virtually no other operator but Mallon obtains the benefit, and that he obtains that benefit at the expense of not only Gavilan Mancos, but of the Unit. He tells me that at a high rate Mr. Mallon has 9.5 percent of the wells; he's got 7 out of the 74; that they have a reservoir share of 8.1 percent of the reservoir, but at the higher rate they get to capture 24 percent of the total Gavilan Pool reserves.

And that violates somebody's correlative rights.

Mr. McHugh and Mr. Greer did not dream up this problem. From 1982 to January, 1986, Gavilan was experiencing pressure decline of 15 to 20 pounds a month and in January and the early spring of 1986, at the request and the concern of the Aztec Office of this Division, they saw climbing gas/oil ratios that were approximating 30 pounds a month, and it scared them all. The gas has got to be controlled.

As a result of that the working interest owners did get together and we found that unfortunately the working interest owners could not agree and this matter came to the hearing before the Commission in August , 1986, and the Commission did what we thought was appropriate and they reduced the gas to the solution gas/oil ratio and thereby giving the operators a window of opportunity in

which to attempt to resolve the differences they among themselves about producing the Gavilan Pool.

That window is closing on us, gentlemen, and while the window is still open and we have some of that opportunity now, but my concern is we're going to deplete this reservoir and still can't agree on what to do with it.

The hardest fact is that we cannot agree and you must take action to tell us what we ought to do, and that action is structured within the rules of conservation and we characterize our position as being, one, a prudent operation where we are up against competitive operations in Gavilan, and we think the rates must be reduced.

We think the temporary reduction in the allowable rates affixed by the Commission in August of '86 were successful. Mr. Roe will plot that for you and he will demonstrate that the Commission action then was the right action.

We will show you that during the low rate test period the pressure loss per month was down then 7 or 8 pounds a month, and during the high test rate period jumped back up to 44 or 45 pounds a month.

We've got to conserves the gas in this reservoir to give the parties the opportunity to institute pressure maintenance. We think unitization is the only way

to do it. We've got to shut in the high capacity gas wells and have those owners share in the production on the unit basis.

We need a solution and we don't see any of the proposals given to you by the opposition to be the appropriate solution.

We will propose to you a solution. We have a solution with regards to what we can do in this common source of supply between Gavilan and between the pressure maintenance project in West Puerto Chiquito Mancos that will give you a solution, and we will present that to you.

MR. LEMAY: Thank you, Mr. Kellahin.

Mr. Carr.

MR. CARR: May it please the Commission, on the 13th day of the hearings on the Canada Ojitos Unit I don't think you need to know who I am and who I represent but I will tell you this. There have been comments made in some of these openings that require one point be addressed up front. As you know, Mr. Greer has been operating in this area for 26 years and I think it's important that everyone understands that it was not his intention 26 years ago and it is not our intention here today to deny anyone the opportunity to produce their just

and fair share of the reserves in this reservoir.

We do, however, believe we have a very valuable pressure maintenance project. It's of value to Mr. Greer; it's of value to the other interest owners; it's a value to the State of New Mexico. And we're here today, like we have been for 12 days prior to this time to defend that unit.

Now, we support Sun and Dugan in asking you to maintain the current producing rates. We think that is what must be done if you are to effectively and efficiently produce the reserves in this area.

I'm going to call Mr. Greer. We're not going to talk about the same things that Sun and Dugan are talking about. We're not going to talk about all the things we've talked about before.

Mr. Greer is going to address several, I think, important issues, things that have not been discussed before.

And that takes us to, I think, the first one and we will present testimony on the boundary question and I want to tell you right now, the boundary question does nothing but mislead and confuse what we're here trying to do. The boundary exists; it's a fact now, and it is a fact not because of geology, but because of development and we're going to present testimony that shows you what the

development is between the existing unit and the Gavilan off to the west, and I want you -- it's important for you also to recognize that the question before you isn't where you draw another arbitrary political line in this reservoir, the question is where is the boundary on this unit. It's a unit that's been approved with your involvement at the conservation level but it's a unit that exists as a result of private contract. It's a unit that has been approved by the Federal government, and the question remains, what do you do between the boundary on that unit and the production off to the west, and if you move the boundary the unit's going to stay and you're still going to have the same question that you have today. So the question is, what do we do along the boundary between this unit and the Gavilan production off to the west and how do we protect correlative rights along that boundary.

And then this takes us to the question of our pressure maintenance project and we've talked to you about the pressure maintenance project at great length, but we're going to show you that it is working. We're going to show you why, and we're going to take recent information which verifies our porosity and permeability figures and I'm not going to testify beyond that because I'm not competent to do that, but these figures and this recent data verify what we have shown you before and you will be able

to see how we've used them to show that gravity drainage is working in this reservoir, is in fact what's happening, and this gravity drainage, coupled with this pressure maintenance project and the careful spacing of wells is effectively and efficiently producing reserves in the area.

We're also going to demonstrate that oil is being produced through an extensive fracture system that may connect a number of separate reservoirs but the contribution is coming from the fracture system, not from matrix porosity.

We're going to show you that there is (unclear) transmissibility throughout the reservoir system, throughout the fracture system, and we will explain to you why the interference tests, why the frac pulse tests, show such diametrically -- so much higher results than the build-up tests that were offered before and we're going to show you that this is a result of improper analysis, and we're going to show you where the problems in that data actually were at the prior hearing.

That, coupled with, we believe, what will be clear to you, the absence of a barrier, at the end of this hearing, will bring you to the conclusion that if you're to carry out your duty to prevent waste of resources, you've got to approve the pressure maintenance project, and it has got to be done with pressure mainten-

ance injection credit as exists in the present approval for the project.

We're also going to look at correlative rights. We're going to look at recovery efficiencies and we're going to show you how at high rates some wells do produce a lot more than others, but when they do that, they're draining wells from the offsetting properties and correlative rights are therefore being impaired.

And finally, we're going to note that this is not a unique situation but is a pressure maintenance project in a portion of a single reservoir, and we're going to show you how you can address this situation, how you can improve the project, and how you can do so and at the same time protect the correlative rights of the interest owners off to the west.

One last point, every time I come to the Commission I hear how you've got to do something fast and quickly because you're going to discourage investment in our state. Well, I think what will discourage investment in New Mexico faster than anything is having decisions that were not made in a concerned and informed fashion as you've been trying to reach the decision in this case. We support you in that effort. We're here to quickly and we think efficiently address certain things that remain and need to be addressed, so hopefully we can finish quickly this week,

so that then you can take the case and make the informed decisions when you're ready to make them.

MR. LEMAY: Thank you, Mr. Carr.

Let's start it off and call Mr. Hueni to the witness stand at this time.

MR. DOUGLASS: Mr. Chairman, would you just tell me when you want to stop because I lose track of the time oftentimes.

MR. LEMAY: That's fine. I might leave it up to Greg if there's a point in there he prefers to or doesn't want to break it, just give me a high sign, and we can do that, or maybe -- I don't know how long it's going to go. Let's just see how we're doing.

MR. DOUGLASS: His testimony is probably going to last two to three hours.

MR. LEMAY: Well, let's -- that's why I said if he has a breaking point in there he can signal me and we can certainly stop it at that time.

MR. KELLAHIN: Mr. Chairman, what's your desire about going into the evening?

MR. LEMAY: I'd like to break it about 5:00 today.

MR. DOUGLASS: If you all will signal me we'll come to a point to stop at that time.

MR. LEMAY: Okay, if there's a logical break somewhere between five or ten minutes to five or five after, that's fine.

GREGORY B. HUENI,

being called as a witness and being duly sworn upon his oath, testified as follows, to-wit:

DIRECT EXAMINATION

BY MR. DOUGLASS:

Q Would you state your name for the record, please, sir?

A Yes. My name is Gregory B. Hueni.

Q And, Mr. Hueni, are you a registered professional engineer?

A Yes, I am.

Q State of Colorado?

A That's correct.

Q You're a reservoir petroleum engineer?

A Yes, that's correct.

Q And you've testified in the August of 1986 hearing, the March of 1987 hearing and the March of 1988 hearing, is that correct?

A Yes, I have.

MR. DOUGLASS: Mr. Chairman,

I will not go any farther into his qualifications since those records are a part of the case.

MR. LEMAY: His qualifications are a matter of record and they're acceptable to the Commission.

Q Mr. Hueni, have you brought up to date your study that you've made in those earlier hearings?

A Yes, sir, I have.

Q Let me ask you, what -- what group of individuals or operators or working interest owners in this field have been working with during this period of time?

A Since our involvement preparing for the March, 1987, hearing, we have represented a considerable number of companies. We refer to them as Gavilan Proponents. They include American Penn Energy, Amoco, Hooper, Kimball & Williams, Koch, Kodiak, Mallon, Mesa Grande Limited and Mesa Grande Resources, Mobil Producing, Reading & Bates, Tenneco. All of those companies have been active participants in our study.

In addition, Conoco has shared in the cost of our study but not been an active participant in it.

Q And those companies you named, have they actually had engineers or geologists, technical people that have been used to (unclear) information that you have been working on and the conclusions that you have been reaching

with reference to each of the steps that you've gone through the study in this field?

A Yes. We've had several technical review meetings. We've exchanged information and exchanged ideas and reviewed the study as it's progressed.

Q Have you had any indication that any of those parties did not agree with the engineering conclusions and the analysis that you've made of this reservoir?

A No, I believe all of these companies believe that our analysis is valid.

Q On the board and in your book, I hope in the order that's on the board, I believe you're up to Mallon Exhibit Five. I'd like to mark on the board the base map as Mallon Five.

I think in order to cut down or reduce the testimony, I think that up to this point in the hearing we know generally what we've been referring to as the West Puerto Chiquito injection area, the expansion area, and the Gavilan Mancos.

Let me ask you just generally what you have determined to be the acreages in those two areas as indicated by the data and information that you have studied?

A The acreage associated with the brown area, which is the Canada Ojitos Unit, pressure maintenance

project area, contains approximately 50,000 acres. They actually contain a little bit more than that, but the 50,000 number has been quoted several times.

The remaining acreage, which is the acreage that's either green, colored a solid green, which is the Gavilan Mancos Pool, or shaded a green and white color, which is in the Canada Ojitos Unit proposed expansion area, those two groups of acreage together cover approximately 47,200 acres.

Q And this is essentially the same base map that you presented before and have you got the Gavilan Pool Proponents listed on it (unclear.)

A It is essentially the same base map. We've extended it further to the west to include all of the Gavilan Mancos Pool.

Q Anything else you want to add on the exhibit?

A We have shown on Exhibit Five the barrier which we have testified to previously in the March, 1988, hearing and which we still believe to exist separating the pressure maintenance area from the proposed expansion area in Canada Ojitos Unit.

MR. DOUGLASS: Mr. Chairman, I don't think I offered Exhibits One through Four, but at this time I'll offer One through Five.

MR. LEMAY: Without objection One through Five of Mallon's exhibits will be admitted into evidence.

Q Let me put this exhibit here because I may be referring to it some more later.

I'd like to have identified for the record as Proponents' Exhibit Six, a plot of oil production rates. Would you tell us what you've shown on this Exhibit Six, please?

A Exhibit Six is a plot for a period of time of 1984 through available data into 1988. Producing rate and gas/oil ratio performance for what is referred to -- what we referred to as Gavilan Mancos Area, and by the Gavilan Mancos Area we mean to include all of the wells that are included in the Gavilan Mancos Pool as well as those wells that are in the Canada Ojitos Unit Pressure -- or proposed expansion area, which on the preceding exhibit we had shown in the green and white striped area, which we find to be in communication with the Gavilan Mancos Pool.

The -- this particular -- this particular graph of the production history for the Gavilan Mancos Pool is actually production history for only those wells that were producing as of July, 1987, which is basically the start of the Commission ordered what we refer to as normal rate testing period and then followed by the re-

stricted rate testing period. Prior to that normal rate testing period there was also restricted rates in effect from September of 1986.

Q What's the scale? Why have we -- what scale have you used on here?

A The scale on the lefthand side, which is barrels of oil per producing day, or per calendar day, the bottom -- bottom scale is 10, then 10^2 is 100, and then we talked about 10^3, which is 1000 a day, and then we go up as high as, on the scale, which is 10^4, which is 10,000 barrels of oil per day.

On the gas/oil ratio scale we have on the bottom 100 standard cubic feet per barrel. The next line up is 1000. The next line up is 10,000, and then 100,000 at the very top.

We've indicated on this -- this chart those periods of restricted rate production, normal rate production, and then once again restricted rate production. We've included only the wells producing as of July, 1987, to show the very definite affect that the normal rate test period had on the field as a whole. The gas/oil ratios decreased. They were trending upward. The expected gas/oil ratio in the period, in the normal rate testing period might have been on the order of 4000 standard cubic feet per stock tank barrel had we maintained the restricted

rate basis, but on the other hand it was down closer to 3000 standard cubic feet per stock tank barrel during that period.

At the same time the oil production increased, obviously, very dramatically from about 3000 barrels a day up to in excess of 6000 barrels a day, so the restricted rates have obviously a very significant economic impact on the field, but it also implies that it has a physical waste implication inasmuch as when we produce at high rates we take less gas out in conjunction with a barrel of oil than we do at low rates, and I think it's one of the basic tenets of reservoir engineering that you try and avoid taking out unnecessary gas volumes and try to leave that gas energy in the reservoir itself.

So this is just one of several exhibits that we have that show that restricted oil rates are associated with higher gas/oil ratios and the implication is that this causes waste in both economic terms and in terms of reduced recovery -- reduced rates but also reduced recovery causing physical waste.

Q Let's see if I understand. The dashed line here represents the September '86 restricted rate order, is that correct?

A Yes, that's correct. It was followed, however, very soon after that by the bringing on of several

new wells, so the rate went down right in September itself and then rebounded as a significant number of new wells came back on production and then once that occurred, then in early 1987 the rates were down in the 3000 barrel a day range.

Q Then the next dashed line represents the testing period where the Commission ordered testing at normal rates and what some others have referred to as the high rates?

A Yes, that's correct.

Q And so that would be basically from the July, August, September, October, and a half of November, is that correct?

A Yes, that's correct.

Q Do you split November on this or do you --

A Well, no, we haven't really split November in that because it's a partial month and we have basically put the line in between October and November.

Q Then after November or the middle of November, the production was again produced because of restricted rates, is that correct?

A Yes, that's correct. Now the total field plot would be somewhat higher because there were several new wells that had been -- that were coming on in

this time frame so total field production was really about 3000 barrels a day by March of 1988 but the wells that were producing as of July, 1987, were somewhat less.

Q What happened when the oil production rate declined as far as the gas/oil ratio when the restricted oil rates were re-instituted versus the gas/oil ratio during that period of time of the re-institution of (unclear)?

A It -- it's a pretty sharp line.

Q And what range to approximately what range?

A Well, it went from -- it looks to be about 3,210 cubic feet per stock tank barrel to in excess of 4,010 cubic feet per stock tank barrel.

Q Do you have an opinion as to what -- whether waste occurs in the reservoir at the restricted rates as far as this Gavilan Mancos area is concerned?

A Yes. My opinion is that we -- when we produce at restricted rates, we take out unnecessary volumes of gas and therefore we don't use our gas efficiently and we have physical waste that will be occurring in the reservoir.

Q And do you so indicate that conclusion on this exhibit?

A Yes, that's correct.

MR. DOUGLASS: Offer Exhibit Six.

MR. LEMAY: Without objection it will be -- Exhibit Six will be admitted in evidence.

Q I'd like to identify for the record as Proponents Exhibit Seven a graph entitled a Comparison of Total Gavilan Area and COU Pressure Maintenance Area.

What have you shown on this exhibit?

A Yes. What we have shown on this exhibit is the relative producing capabilities of what is known as the pressure maintenance area of the Canada Ojitos Unit compared to the producing capabilities of Gavilan Mancos Area.

The plot here is once again a time plot from 1983 through 1988. It is a plot of production on the vertical axis. The dots that are -- the green line and the green dots represent Gavilan Mancos Area production, once again including the proposed expansion area in the Gavilan Mancos totals.

And then the red -- the red line with the X's showed the pressure maintenance area production from the Canada Ojitos Pressure Maintenance Unit area. The pressure maintenance area production has been on a decline since 1983. It was about 600 barrels a day at that point in time. It's down now to 243 barrels a day. It's fairly

easy to extrapolate the decline that's been occurring out in that particular area and that type of extrapolation will indicate that approximately 100,000 barrels of oil remain to be produced in this pressure maintenance area, based on decline curve analysis.

On the other hand, the Gavilan production has been building up and we have shown this in a linear scale on a scale of zero to 10,000 barrels a day. The Gavilan production built up to as high as 8000 barrels a day prior to the initiation of the restricted rates by the Commission. The rates during the restricted period fell as low as 3000 barrels a day, but then with the normal restoration of rates went up to as high as 6500 before once again being restricted to 3000 barrels a day.

So one of the -- one of the conclusions we have is that certainly that when we talk about the Gavilan Mancos area we're talking about substantially more production than we're talking about in the -- in the pressure maintenance area.

We will show later on that we believe that the remaining reserves in the Gavilan Mancos area are on the order of about 3.9-million barrels compared to the 100,000 barrels in the pressure maintenance area.

We would note one last point, that in spite of the fact that the pressure maintenance area

pressure being very high, 1400 psi, the pressure is -- or the production rate is very low, so high pressure doesn't necessarily go with high production rate.

Conversely, the Gavilan pressure is down in the range of 800 to 850 psi and yet it still has the capability to produce probably on the order of 6000 barrels a day.

Q Anything else you want to add with reference to Exhibit Seven?

A No.

MR. DOUGLASS: Offer Exhibit Seven.

MR. LEMAY: Admitted into evidence without objection.

Q Identified for the record as Proponents Exhibit Eight is a graph entitled Plot of Oil Production Rate Versus Gas/oil Ratio for All Wells Producing As Of July '87 to January of 1987 - March of 1988.

What have you shown on this exhibit?

A This is another exhibit plotted on a total field basis showing, once again, the inverse relationship between producing rate and gas/oil ratio. In this particular case we have plotted on a linear scale to better emphasis the trend that we observed.

We've also extended the time scale to

include the periods of time where we had restricted rates, normal rates, and the testing period, and then once again restricted rates.

I think it's very easy to see that we had a very significant increase in production under the normal rate testing period and at the same time we've had a very significant reduction in gas/oil ratio.

Once again we can take a pen and I'm sure draw a line through -- through the gas/oil ratio trend during the restricted rate period and show that we have a significant reduction in gas/oil ratio during the normal rate period.

Q Do you want to do that on the exhibit on the board here?

All right, sir, you've drawn a line on the one on the board across there and it showed a -- the reduction in gas/oil ratio that occurred just about at the peak of the oil production rate during the normal rate testing period, is that correct?

A Yes, that's correct. That's a reduction from approximately 4000 standard cubic feet per stock tank barrel that we anticipate would have occurred under the low rate testing compared to a gas/oil ratio in the order of 3100 standard cubic feet per stock tank barrel that actually did occur and later on we believe that this is, when

we quantify this, that this indicates that -- that this additional gas that has come out of the reservoir when we have restricted rates causes waste in the amount of 15 to about 19 percent of the oil recovered by taking out the additional gas with the oil.

Q What -- does it appear that the GOR trend has now gone back to its original trend during restricted rate production?

A Yes, it certainly does. It looks like it was -- has a very definite trend in the restricted rate periods that is certainly altered during the normal rate testing period.

Q Anything else you want to add on Exhibit Eight?

A No.

MR. DOUGLASS: Offer Exhibit Eight.

MR. LEMAY: Exhibit Eight accepted into the record without objection.

Q I'd like to identify for the record as Proponents Exhibit Nine a graph showing total production Gavilan Mancos Are, GOR versus Oil Rate, July, 1987 - March, 1988. What is shown on Exhibit Nine?

A Exhibit Nine is another graph that illustrates once again the very well defined relationship

between producing rate and gas/oil ratio trend.

In this case what we have done is taken from our production history at a given point in time the oil rate and the gas/oil ratio and we've plotted that oil rate versus the gas/oil ratio. The gas/oil ratio is on the -- the vertical axis; the oil rate is on the bottom axis.

Now this is for the Gavilan Mancos Area in total.

Q Let me ask you, on the oil scale if you have a dot above the 1000 that's 1000 barrels of oil per day, is that correct?

A That's correct.

Q And if you have one over here above 6000, then that means, the dot above it, you're producing 6000 barrels a day, is that right?

A That is correct.

Q So the farther you go from left to right on the exhibit, the higher the oil production rate per day.

A Yes, that's correct.

Q Now, on the gas/oil ratio rate on the -- is that the Y axis --

A Yeah.

Q -- that you engineers refer about, the scale on the left here? If you had a well or had a -- the

field was producing at 1000 cubic feet per barrel, then the -- it would be along the area where it says 1000 across the scale going from left to right, is that correct?

A Yes, that's correct.

Q And if you had the field producing at a gas/oil ration of 5000-to-1, then it would be across from left to right, crossing the 5000 along the Y axis here, is that correct?

A Yes, that's correct.

Q What are these two groupings that you have here?

A Well, the individual points represent individual months production test period, and the points that have been colored green represent those points during the normal rate testing period. Those points that are colored red represent the points during the restricted rates following the normal rate testing period, and that was the restricted rate period.

The -- it's, I think, fairly obvious that at normal rates, which are substantially higher, in the range of 5000 to 7000 barrels day, the gas/oil ratio has been reduced to in the range of 3-to-4000 standard cubic feet per stock barrel.

On the other hand, when we go to reduced rates, down between 2000 and 4000 barrels day, the gas/oil

ratio is up between 4000 and 5000 standard cubic feet per stock tank barrel. We just don't have as an efficient use of the gas energy when we produce at low rates.

Q And in your opinion does that cause waste in this reservoir?

A It most certainly does cause waste.

Q Offer -- anything else you want to add on Exhibit Nine?

A No.

MR. DOUGLASS: Offer Exhibit Nine.

MR. LEMAY: The record accepts Exhibit Nine without objection.

Q I'd like to identify for the record as Exhibit Ten three graphs entitled COU 29 and COU 32, EJ-6 -- oh, that's a location -- West Puerto Chiquito Mancos GOR versus oil rate.

What is shown here?

A Well, we've -- we've presented you information up to this point on total field basis to show that higher oil rates are associated with lower gas/oil ratios.

Mr. Weiss also presented considerable information showing that higher oil rates were associated with lower gas/oil ratios.

What this is, this is information on three wells that run across the main portion of the Gavilan Mancos Pool and into the Canada Ojitos Unit proposed expansion area. We have the graph on the far left is the Loddy No. 1 Well, which is on the far western side of Gavilan. The center well is the Rucker Lake No. 3.

Q Help me get that one.

A Which is Section 25.

Q That is right there?

A Well, the Rucker Lake No. 3, it should be down further to the south.

Q Here's No. 3.

A Right.

Q All right, the Loddy, Rucker Lake, okay.

A Yes, and then we go up to the north, up in Section 6, BMG's Canada Ojitos Unit No. 29, which is the E6 Well, also includes the J6.

Q Let me see if I understood. Loddy, Rucker Lake 3, and the E6 Well.

A Yes, that's correct. We wanted to show this kind of spread to show that this particular behavior is not localized. It's behavior that occurs across the pool area.

The information that we're presented in our packets, unfortunately we don't have combined plot of

the -- of the three wells, so we've presented the individual plots, but I think if we looked at each of the plots we would see that the lower axis represents oil rate.

Q Just like the previous exhibit?

A Yes, that's correct, although the scale on the lower axis is dependent on which well you're looking at because different wells are of different quality.

On the Y, or vertical, axis we have gas/oil ratio plotted and once again that has a different scale for each well because these different wells produce in different GOR ranges.

Once again, the green dots indicate what's occurred during normal rate production periods and the red dots indicate what's occurred during the restricted rate period, testing period, following the normal rate testing period.

This demonstrates the effect this restricted rate has had on several of the wells.

Looking first at the Loddy No. 1 Well on the far left of this, which is the first page of the exhibit in the book, we see that under normal rates this well was capable of producing 60 to 80 barrels a day and gas/oil ratios ranging from 4000 to 7000.

When we went to restricted rates, that particular well's production was cut from -- down to the

range of 35 to 50 barrels a day and its GOR jumped up to 7000 to 12,000.

Once again, this is an inefficient use of gas energy producing a well at a lower rate with a higher gas/oil ratio.

The Rucker Lake Well in the center is even more dramatic. When that well was allowed to produce at normal rates it could produce at35 -- well, 30, 30 to 45 barrels a day; had a gas/oil ratio in the range of 1-to-2000 standard cubic feet per day, but when we restricted that well, the rate went down to 3-to-15 barrels a day and the gas/oil ratios went up from 8000 to 44,000. The restricted rates are obviously getting down to the range in which these wells are marginal to operate in, or several of the wells are marginal to operate in. and this is one particular well that has in particular suffered some very detrimental effects due to the restricted rates.

The well on the far righthand side is the Canada Ojitos Unit Well 29 and 32, otherwise known as the E-6 J-6 Well.

That well during the normal rate period produce in the range of -- of 300 to 450 barrels of oil per day, gas/oil ratio, 2500 to 4300.

With the reduction in rate, or with the restricted rates, it went down to 160 to 270 barrels of oil

per day and the gas/oil ratio increased from 5200 up to 7800.

All three cases we have examples of the inefficient use of reservoir energy and we have indicated that the wells are basically spread throughout the Gavilan Mancos Are. This is a problem that is -- is common across the field.

Q Anything else you want to add on Exhibit Ten?

A No.

MR. DOUGLASS: We offer Exhibit Ten.

MR. LEMAY: Exhibit Ten accepted into the record without objection.

Q I'd like to identify for the record as Proponents Exhibit Eleven a -- two plots of the daily oil and gas production July 1, 1986, through May 19 -- May 15, 1988.

Will you tell us what you've shown on that exhibit, please?

A Yes. We (unclear) production history for two of the wells in which we had daily information and we plotted that production history versus days and it shows the dramatic effect that this restricted rate has had on individual well performance and the difficulties that it

has caused several of the operators.

The well that is shown on the top plot of this 2-plot exhibit is the Howard Federal 1-8. It's a Mallon well located in Section 1, Township 25 North, 2 West.

And then the bottom plot is a plot of Ribeyowids production shown -- well, that's in section -- I guess that's in Section 2.

What we've plotted here, we plotted time in days.

Q Shall we pull Exhibit Five out again and show where those two wells are?

A Yes, we --

Q Howard Federal 1-8?

A It's in the northeast quarter of Section 1 and the Ribeyowids is in the southeast quarter of Section 2, those two wells.

Q The scale is in time on the bottom axis. It's measured from the date of July 1st, 1987. It goes through -- we have data through May 15th, I believe, of this year.

On the vertical axis we have two quantities plotted. We have daily production. It's measured either in barrels of oil per day, which are the green dots, or it's measured in terms of MCF per day, which

are the red triangles. This is -- we differentiate from this because this is not a gas/oil ratio that we've plotted, we have plotted gas production here.

Q In other words, that's -- what's plotted here is the actual amount of gas in daily rates shown on the Y scale in MCF per day with the red triangles, is that right?

A Yes, that's correct.

Q All right, sir. For instance, looking at this, the way you would calculate the gas/oil ratio is to determine what the oil production was on that same day and divide it in order to find out what the gas/oil ratio is, is that correct?

A Yes. Yes, that's correct.

Q This gives you the basic rates that were produced on a daily basis from these two wells for gas and oil, is that right?

A Yes, that's correct. This is based on daily pumper gauge reports that we have received.

The, what we see looking first at the Howard Federal 1-8, which is the upper portion of the graph, we see a well that during its normal rate testing period produced 300 barrels a day, some days a little bit more, some days a little bit less. It produced gas initially at about 1.2-million a day declining down to

maybe 1-million a day, but basically fairly constant.

After about 140 days the end of the normal testing period caused this well to be -- be shut-in, first for the pressure build-up survey and then subsequently for allowable purposes.

Since --

Q Excuse me, is that -- is that arrow drawn at about the end of the normal rate?

A Yes, that's what the arrow is meant to represent.

Q End of normal rate testing, correct?

A That's correct.

Now, what's happened since that time on this particular well is that well has only been permitted to flow intermittently because of its restricted allowable situation. When that well was put on production now, we'll note that the rate is on the order of 100 barrels a day for those periods of time when it's on.

On the other hand the gas production is up where it was before. It's still up with 1-million a day. It hasn't gone down.

And what's happened and what's had to occur, then, is that in order to produce its allowable it had to be shut-in and it has been shut in approximately 90 percent of the time.

So what we've seen here now is a well that's a 300-barrel a day capability well that's been restricted down to an effective rate of about 20 barrels a day on a monthly average, shut-in 90 percent of the time, and, in fact, if we divide the gas by the oil, the gas is still as high as it was, the oil is just diminished and the gas/oil ratio is obviously increased.

So for each barrel of oil we're taking out, we're taking out the same amount or we're taking out fewer barrels of oil and the same amount of gas.

It's difficult to see on this particular plot just exactly when the shut-in periods are. It's far easier on the individual plots we've handed out. They are basically where the red triangles overlap on the green dots.

There are several green dots at the end of the -- at the end of this plot on Howard 1-8 which are not -- do not represent shut-in. These represent an effort by the operator to test the well, try to produce the well on a continual basis, see if by producing it on a continual basis instead of a short term basis if they can lower the gas/oil ratio and thereby produce a little bit more oil.

What the result of this effort has been is basically that in producing the amount of gas that they're allowed to produce on a daily basis, their oil

production rate has gone down to in the range of 2 to 3 barrels of oil per day.

And this is once again a 300-barrel a day capacity type well.

Q What conclusions do you draw from the study, then, on the 1-8 Well (unclear)?

A Well, I would draw several conclusions. First, that you experience the same level of gas production as you experience with normal -- normal rates under restricted oil rates.

Gas/oil rations have obviously been increased significantly with -- well, when you have restricted oil production. You have inefficient use of the gas energy and just as is demonstrated by the gas/oil ratio trends.

And you have inefficient economic utilization of this well in the fact that you've cut it back so severely and the fact that you have to shut it in approximately 90 percent of the time.

The lower well is much the same story. This is a well that during its normal rate testing period had the ability to produce 90 barrels a day and at that time it produced on -- in the range of about 230 to 240 MCF of gas per day, and that was fairly constant.

The restriction, restricted rate period

began after about 130 to 140 days and that well then was reduced in the amount of oil it was allowed to make. The gas diminished for just a very short period of time and then it went back up and actually went up above where it had been before, so we're taking out more gas and less oil from this reservoir on a daily basis.

Now, we have a period of time in -- for this particular well, where it looks like that well is almost shut-in, and it, in fact a part of the time it is shut-in because of allowable purposes and once again you can see that on your plots where you see the red triangles overlaying the green -- green data.

Q If you look at the handouts, they show more clearly. In blowing this up it -- it merges them together, but you can see the times when they're shut-in, those are the overlap or the darker areas on the handouts, is that correct?

A Yes, that's correct. That's correct. But in looking at that exhibit and noting, there are several periods of time when this well is not shut-in when it's only able to make two to three barrels of oil per day because of the restricted rates and the high gas/oil ratios that have gone with those restricted rates.

This is an example of a well that is now submarginal to produce and the operator is considering what

to do about this and there is certainly consideration being given at this point in time to recompleting this well in the Dakota formation which has a much higher producing capacity than is currently being allowed in the Gavilan Mancos.

MR. DOUGLASS: Mr. Chairman, this is just as convenient as any of the rest and we still have a number to go.

MR. LEMAY: Are we through with this exhibit?

MR. DOUGLASS: Yes.

MR. LEMAY: If it's okay with you, Greg, let's break it here and reconvene tomorrow at 8:30.

(Thereupon the evening recess was taken.)

C E R T I F I C A T E

I, SALLY W. BOYD, C.S.R., DO HEREBY CERTIFY the foregoing Transcript of Hearing before the Oil Conservation Commission was reported by me; that the said transcript, contained on pages 1 through 245, inclusive, is a full, true and correct record of this portion of the hearing, prepared by me to the best of my ability.

Sally W. Boyd CSR