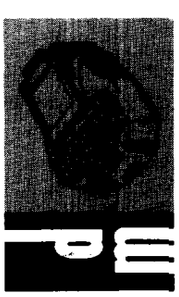

BEFORE THE
NEW MEXICO OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
February 26, 1969

EXAMINER HEARING

IN THE MATTER OF:

Application of Benson-Montin-Greer Drilling Corporation for special pool rules, San Juan County, New Mexico.) Case No. 4067

BEFORE: Elvis A. Utz, Examiner.

TRANSCRIPT OF HEARING

MR. UTZ: Case 4067.

MR. HATCH: Case 4067. Application of Benson-Montin-Greer Drilling Corporation for special pool rules, San Juan County, New Mexico.

The applicant has asked that the case be continued to March 5th, 1969.

MR. UTZ: Case 4067 will be continued to 3-5-69.

STATE OF NEW MEXICO)
)ss
COUNTY OF BERNALILLO)

I, GLENDA BURKS, Court Reporter in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Hearing before the New Mexico Oil Conservation Commission was reported by me; and that the same is a true and correct record of the said proceedings, to the best of my knowledge, skill and ability.

Witness my hand this 29th day of March, 1969.

Glenda Burks
Court Reporter

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 4067, heard by me on July 26, 1969.

Examiner
New Mexico Oil Conservation Commission

South line of Section 2, Township 22 South, Range 37 East, Lea County, New Mexico, reclassified as an oil well for the production of oil an undesignated San Andres Oil Pool and authority to produce same as an oil well.

CASE 4066: Application of Humble Oil & Refining Company for the consolidation of two non-standard gas proration units, Lea County, New Mexico. Applicant, in the above-styled cause, seeks the consolidation of two existing non-standard 320-acre gas proration units into one standard 640-acre unit comprising all of Section 26, Township 21 South, Range 36 East, Eumont Gas Pool, Lea County, New Mexico, to be dedicated to its New Mexico State "G" Wells Nos. 2 and 4 located in Units P and G, respectively, of said Section 26. Applicant further seeks authority to produce the allowable assigned to said unit from either of said wells in any proportion.

CASE 4067: Application of Benson-Montin-Greer Drilling Corporation for special pool rules, San Juan County, New Mexico. Applicant, in the above-styled cause, seeks the promulgation of special pool rules for the La Plata-Gallup Pool, San Juan County, New Mexico, including a provision for 160-acre spacing and proration units. Applicant further requests that said special rules provide that the unit allowable for a 160-acre unit in said pool be allocated on the basis of four times the normal unit allowable for Northwest New Mexico, and that no credit be given for depth factors. Applicant further requests that said special rules be limited in their application to the exterior boundaries of the La Plata-Mancos Unit Area.

CASE 4068: Application of Martin Yates III for salt water disposal, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks authority to dispose of produced salt water into the Delaware formation in its Yates & Hanson McCord Well No. 1 located in Unit E of Section 22, Township 23 South, Range 26 East, Dark Canyon Field, Eddy County, New Mexico. Applicant further seeks a procedure whereby its Cordie King Well No. 2 located in Unit K of said Section 22 may be approved for the disposal of salt water without the requirement of notice and hearing.

(Case 4060 continued)

Range 36 East, Jalmat Yates-Seven Rivers Pool, Lea County, New Mexico.

CASE 4061: Application of Millard Deck Oil Company for salt water disposal, Lea County, New Mexico. Applicant, in the above-styled cause, seeks authority to dispose of produced salt water into the Seven Rivers and Queen formations in the open-hole interval from approximately 3752 feet to 3872 feet in its Atha Well No. 1 located in Unit M of Section 31, Township 21 South, Range 36 East, South Eunice Pool, Lea County, New Mexico.

CASE 4062: Application of Kersey & Company for salt water disposal, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks authority to dispose of produced salt water into the Queen formation in the perforated interval from approximately 1835 feet to 1870 feet in the Bass Well No. 3 located in Unit F of Section 12, Township 19 South, Range 28 East, East Millman Queen-Grayburg Pool, Eddy County, New Mexico.

CASE 4063: Application of Kerr-McGee Corporation for the creation of a new gas pool and special pool rules, Eddy County, New Mexico. Applicant, in the above-styled cause, seeks the creation of a new pool for the production of gas from the Morrow formation by its Nix Well No. 1 located in Unit L of Section 11, Township 19 South, Range 26 East, Eddy County, New Mexico, and for the promulgation of special pool rules therefor, including a provision for 640-acre spacing.

CASE 4064: Application of Atlantic Richfield Company for salt water disposal, Roosevelt County, New Mexico. Applicant, in the above-styled cause, seeks authority to dispose of produced salt water into the San Andres formation in the perforated interval from approximaely 4207 feet to 4286 feet in its Tucker Well No. 4 located in Unit O of Section 23, Township 7 South, Range 32 East, Chaveroo-San Andres Pool, Roosevelt County, New Mexico.

CASE 4065: Application of Humble Oil & Refining Company for an unorthodox oil well location and reclassification of a water well to an oil well, Lea County, New Mexico. Applicant, in the above-styled cause, seeks to have its New Mexico State "S" Water Source Well No. 4 (CP-427), located at an unorthodox oil well location 650 feet from the West line and 175 feet from the

BURR & COOLEY
ATTORNEYS AND COUNSELORS AT LAW
SUITE 152 PETROLEUM CENTER BUILDING
FARMINGTON, NEW MEXICO
87401

JOEL B. BURR, JR.
WM. J. COOLEY

TELEPHONE 325-1702
AREA CODE 505

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4067
Case ~~4057~~

January 10, 1969

Mr. A. L. Porter
New Mexico Oil Conservation Commission
P. O. Box 2088
Santa Fe, New Mexico

Dear Pete:

Forwarded herewith is the Application of Benson-Montin-Greer Drilling Corporation for 160-acre spacing in the La Plata-Gallup Oil Pool. If it is at all possible, we would appreciate your setting this case for the last week in January. If this is not possible, please set the case in February, bearing in mind that Mr. Greer will not be available for the period from February 1-8, 1969.

Very truly yours,

BURR & COOLEY

By William J. Cooley jjh
William J. Cooley

WJC:jjh
Enclosures

Do please note

DOCKET MAILED
Date 2-13-69
2-20 thru 2-26

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
March 5, 1969
EXAMINER HEARING

IN THE MATTER OF:	
Application of Benson-Montin-Greer Drilling Corporation for special pool rules, San Juan County, New Mexico.	Case No. 4067
Application of Benson-Montin-Greer Drilling Corporation for a pressure maintenance project, San Juan County, New Mexico.	Case No. 4074
Application of Benson-Montin-Greer Drilling Corporation for amendment of the La Plata Mancos Unit Agreement, San Juan County, New Mexico.	Case No. 4075

BEFORE: Daniel S. Nutter, Examiner.

TRANSCRIPT OF HEARING

MR. NUTTER: We will go back and call Case No. 4067.

MR. HATCH: Case 4067. (Continued from the February 26, 1969 Examiner Hearing) Application of Benson-Montin-Greer Drilling Corporation for special pool rules, San Juan County, New Mexico.

MR. COOLEY: William J. Cooley, firm of Burr and Cooley, Farmington, New Mexico, appearing on behalf of the Applicants. We have one witness we wish to be sworn, Mr. Albert Greer.

(Witness sworn.)

MR. NUTTER: Mr. Cooley, are this and the following cases closely enough related that you might want to call them all and consolidate them?

MR. COOLEY: They all deal with the same pool and basically nothing incompatible. I will request that they be consolidated for purposes of hearing.

MR. NUTTER: We will call Case 4074.

MR. HATCH: Case 4074. Application of Benson-Montin-Greer Drilling Corporation for a pressure maintenance project, San Juan County, New Mexico.

MR. NUTTER: And Case 4075.

MR. HATCH: Case 4075. Application of Benson-Montin-Greer Drilling Corporation for amendment of the La Plata Mancos

Unit Agreement, San Juan County, New Mexico.

MR. NUTTER: Case 4067, 4074 and Case No. 4075 will be consolidated for purposes of testimony.

(Whereupon, Applicant's Exhibits 1 through 3 were marked for identification.)

ALBERT GREER

called as a witness, having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. COOLEY:

Q State your full name for the record, please.

A Albert R. Greer.

Q By whom are you employed, Mr. Greer?

A Benson-Montin-Greer Drilling Corporation.

Q Do you appear today on behalf of Benson-Montin-Greer Drilling Corporation?

A Yes, sir.

Q What role does Benson-Montin-Greer Drilling Corporation play in this application with respect to the La Plata-Gallup Oil Pool?

A Our company has a substantial part of the oil and gas leases in this area and we're operator of the La Plata-Mancos Unit which covers this.

Q Mr. Greer, I hand you what has been marked for purposes of identification, Applicant's Exhibit Number 1 and ask you first when that exhibit was prepared.

A The material in Exhibit 1 was prepared approximately one year ago.

Q For what purpose was it prepared?

A For the purpose of providing geological engineering and other information to the operators in the area to consider unitizing the area.

Q Would you briefly outline the content of that exhibit?

A Yes, sir. Under the index, about the second page in the exhibit, the contents are pretty well described and the different subjects are under different sections. Under Section B is the geological basis for determining the area of exploration, that area of exploration for which this report was originally prepared is the same area which we now request be spaced for 160-acre spacing.

Section C has five parts, has to do with reservoir mechanics and possible oil recoveries. Section D, pressure production data wells completed as of that time, approximately one year ago. Section E has to do with drilling and completion methods and costs. Section F is economics, under competitive

operation, and Section G is a comparison of economics, the development of this area under a unitized operation.

Q I now hand you what has been marked as Applicant's Exhibit Number 2 and ask you when this was prepared and why.

A Exhibit 2 was just recently prepared and is for the purpose of adding supplemental information beyond which was available and is in Exhibit 1 to bring all information down to date. It has four parts. Section A is an up-to-date structural contour map. Section B is a cross section through some of the recently completed wells. Section C is a part of the fluid levels in Mr. Taylor's No. 1 Walker well, which shows evidence of communication with other wells in the area. Section D is the reservoir fluid study of an oil sample taken from Taylor No. 1 Walker.

Q Then, in essence, Exhibit 2 supplements and updates Exhibit No. 1 at the present time?

A Yes, sir.

Q I hand you what has been marked as Applicant's Exhibit Number 3 and ask you to briefly identify the contents of this exhibit.

A Exhibit 3 contains summaries of the core analyses of the four wells which have been drilled within the last year in this area. All four wells were cored through the interval of

interest, high percentage of recovery was obtained and a good part of the cores were analyzed. This is a complete record of the core analyses of the four wells.

Q I now call your attention to Section B of Exhibit 1 --

A Section B --

Q -- and ask you to discuss, please, the area which you propose to be spaced at this hearing, and why.

A The area is shown on Figure 2 which follows page 8 under Section B.

Q Is that also the same area as the La Plata-Mancos Unit area?

A Yes, sir, the unit area is shown by the boundary which is a cross-hatched boundary, which is the area of the La Plata-Mancos Unit and the area which we are now requesting be spaced on 160 acres. There's another boundary shown, north-south boundary, with single sliding lines which is on the range line between Ranges 13 and 14. This separates the Indian lands which lie to the west from the other lands which lie to the east. East of this boundary are fee lands, Federal lands and State lands.

Q Was the area which you propose to be spaced at this hearing arrived at by geologic inference?

A Yes, sir. It was determined from geologic inference.

Q Would you please discuss the method of arriving at this area?

A Yes, sir. First, I would like to point out the structure. We're concerned in this hearing with the Niobrara member of the Mancos formation. It sometimes in this area is called the Gallup formation. The Mancos is contoured on an electric log marker within this Niobrara member close to the base of it, which we will see on later cross section exactly where this point is.

The heavy contour lines are a thousand-foot contours. The light contour lines are 100-foot contours. I would like to point out that in the vicinity of Sections 5 and 6, 31 and 32, there's a very high angle of dip of the beds, approximates as much as 4,000 feet per mile. Then there's a sharp break at approximately the zero contour, where the formation flattens out into the basin and the dip then is only on the order of a hundred to maybe two hundred feet per mile.

In our determination of the area with which we are concerned, we consider an area in which there is adequate development of a zone within the Niobrara and where this particular zone is, drapes over or is closely connected with this steeply-dipping part of the hogback.

I think first it would be best to look at the zone,

which we feel is adequately developed to have production in this part of the Niobrara, and that is shown on Figure 3. That's following Figure 2 in this Section B.

This cross section shows eight wells, in a southwest, northeast line which crosses the area of interest, as shown on the plat on the right-hand side of the cross section. The zone which we believe is productive in this area is the one colored in brown and we can see from this cross section that the zone deteriorates to the southwest, just about disappears in the two wells on the left-hand side of the cross section. It thickens in the middle of the cross section and it appears to possibly thin and perhaps deteriorate to the northeast, the last well on the cross section on the right.

Q I call your attention, Mr. Greer, to Section B of Exhibit 2 and ask you if it also bears out the analysis that you have just made.

A Yes, sir.

Q This is the cross section, is it not, of the wells completed since preparation of Exhibit 1?

A Yes, sir. And we find the same zone, the same continuity in these additional wells. The left-hand well on this cross section under B of Exhibit 2 was drilled a year ago, that's Mr. Taylor's Number 1 Walker, but it had not been

logged through this producing zone. It has since been logged and the other two wells since been drilled and we find the same productive zone in these wells.

I would like to point out at this time that when this cross section was prepared, and I am looking now at Figure 3 of Exhibit 1, at that time we simply postulated that the productive zone in this area was the one colored in brown. Of all these wells on the cross section, only one well was producing, that was the fifth well from the left-hand side of the cross section identified as Benson-Montin-Greer Drilling Corporation Well No. M-5 Standard of Texas. It was drilled about ten years ago by the Standard of Texas.

We purchased this well a little less than a year ago, after we had done this work,and after we purchased the well we obtained the logs to our reports which showed how the well was drilled and the depth at which oil was encountered. The well was drilled through this area, this zone shown on this cross section, with air, and they stopped occasionally to test for shows of oil. The last stop which they made to test for oil and did not have any oil was at 5925. That's about in the littl marker colored green on the cross section.

By the time they reached 5970, which is about ten feet below the area colored in brown, they had a substantial

show of oil and had shut down at that time to test the oil show. So we now know that the zone which produces in that particular well is the one colored in brown.

Now, the rest of the wells do not produce. Some of them have, completions were attempted in this Gallup formation but they have not found commercial production. The two wells on the left, completion attempts were made. I think one produced two or three thousand barrels of oil and was plugged. No commercial quantities of oil obtained from it.

The third well from the left, I believe, was drilled through the Gallup to the Dakota, made a Dakota well, and I believe a completion attempt was not made in that. The fourth well shown as Standard of Texas 12-8, a completion attempt was made in it but they had mechanical difficulty, I think lost a string of tools in the hole, and the well was plugged without knowing for sure whether it would produce.

The third well from the right on the cross section, BMG No. J-5, was drilled through this zone into the Dakota, completed as a Dakota producer. We're currently making, preparing to recomplete this well in the Gallup zone in this area colored in brown.

The second well from the right was drilled through this interval with air, they found no show and the well was

plugged without fracking it. The last well on the right, I believe a completion attempt was made on it. It was unsuccessful.

Q Have you prepared a structural map which shows a planned view of the area of best development of the Niobrara member?

A Yes. I think first we should briefly look at Figures 4 and 5. I would like to look at Figure 4 next. It is another cross section displaced from the first cross section we looked at to the east, approximately one to two miles. Shows about the same type of development deterioration of the brown zone to the south, a thickening to the north, possible deterioration in the furthest north well.

Figure 5, then, is another cross section, an east-west cross section, showing development of the brown zone. On the right-hand side of the cross section, it appears to be entirely missing in the furthest west well, Pan American Tribal "H" No. 1. The second well from the left, at the time this cross section was prepared, had not been logged. It has, however, since been logged and is shown in Exhibit 2 under Section B, and has the zone of interest at just about the same point as we anticipated it.

This cross section shows that we have no development of the zone in which we're interested on the west part of the

plat shown on the cross section, which is the edge of the area which we request to be spaced. It would appear from this cross section that the zone does have development to the east of there that has to be spaced.

Q Now, proceeding to the structural contour map, Figure 6 --

A Figure 6 is the same structure contour map which we looked at in Figure 2, except it has superimposed on it our interpretation of the area of best development of this particular zone in the Niobrara. We believe the zone deteriorates north, south and west, probably continues to the east.

Q What is the significance of Figure 7?

A Figure 7 shows in our interpretation the area which would be of interest if we were considering structure alone. That is the area within approximately one mile downdip from the base inflecture and slightly updip from the point of updip flecture. The basin flecture is approximately on the zero contour line, the maximum change in dip of the beds on the updip side is at about the 4,000-foot contour, so if we were considering structure alone, this is where we would look for production in this fractured shale formation.

Q Have we then combined the features of both structure

and development of the Niobrara member?

A Yes, sir. That is shown on Figure 8. The area colored in yellow on Figure 8 shows that area which we believe to be most prospective for production in this particular zone of the Niobrara.

MR. NUTTER: Mr. Greer, let me interrupt you just a minute there. Going back to Figure 7, --

THE WITNESS: Yes, sir.

MR. NUTTER: -- you have got this dashed line which cuts across the middle of Sections 20, 21 and 22, and then diagonally across, down here in the southwest corner across through Section 12, that's the corresponding boundary of the brown area on Figure 8. Now, would you explain what that dashed line represents, please?

THE WITNESS: Yes, sir. The dashed line represents, in our opinion, the probable limits of commercial production. It's very difficult for us to tell where commercial production begins and ends. We think it would be somewhere within the brown area.

MR. NUTTER: So if you come back to Exhibit 7, and you are going on structure alone, you would have between the left-hand side of the pink area and the right-hand side of the pink area, --

THE WITNESS: Yes, sir.

MR. NUTTER: -- but then your commercial production would end at the dashed line on the north and south ends of the pink area?

THE WITNESS: Yes, because of the course of development within Niobrara, --

MR. NUTTER: I see.

THE WITNESS: -- so here we have the primary area and perhaps the secondary area shown on Figure 8. We have attempted to enclose both of these areas with the unit area, and the area which we request to be spaced.

Q (By Mr. Cooley) What is the significance of Figure 9?

A Figure 9 shows a further interpretation of the reservoirs in this pool. We conclude from our study, or had a year ago, that there were at least two fault blocks in this pool. One would be the area colored in brown and the other the one colored in yellow. There could, of course, be more than these two fault blocks. We felt there were at least this many. They're really two separate reservoirs. We believe, however, that from a practical standpoint of administration by the Oil Commission that it should be considered one pool, of one spacing and one proration standard, and accordingly we have requested that it be considered this way. Although we

believe it actually has at least two fault blocks. We have indicated here that we believe one zone or area of separation would be the little green-shaded area which shows the locus of what we believe to be the ceiling fault. This is at the point of the maximum change in dip of the beds. It changes from about 40 to 45 degrees to almost flat. We felt that there is probably at least one fault there. Could be a series of faults.

Q Skipping, now, through Exhibit 1 to Figure 10, which follows immediately after page 22 of Section C.

A Figure 10 --

Q Part 1, excuse me for interrupting, Part 1 of Section C of Exhibit 1 deals with comparisons with other pools in the area. However, first, would you explain, make a comparison of the reserves between sandstone and shale reservoirs with equal permeabilities?

A Yes, sir. I would like to refer to Case 3455, in which we went into this in a little more detail. This is one of the exhibits from that case and it shows a comparison of pore space which one might anticipate for a fractured reservoir as compared to the pore space in a sandstone reservoir for the same permeability.

For instance, sandstone of 100 millidarcies, we can

see from the brown-shaded area of this Figure 10, one would anticipate a porosity on the order of 12 per cent to perhaps 25 per cent. On the other hand, a fractured system which has that same permeability would probably have a porosity on the order of 200 to perhaps four-tenths of one percent. In other words, we might expect a tenth to a hundredth as much oil in place from a fractured shale oil well which has the same productivity as an oil well producing from sand.

Q In Case Number 3455, you presented a working model, the purpose of which was to portray these same characteristics that you have just discussed, did you not?

A Yes, sir. At that time our working model showed a more rapid rate of depletion on the fractured system as compared to a sandstone system.

Q Have you attempted to estimate the oil in place in the La Plata-Gallup Oil Pool based upon comparison of the characteristics of this pool, with other fractured shale reservoirs in the San Juan Basin?

A Yes, sir.

Q Is that discussed in detail on pages 1 through 7 of Section C?

A Yes, sir.

Q Would you briefly summarize that discussion, please?

A Yes, sir. The other comparative pools are the Verde-Gallup, the Boulder-Mancos Pool, the East and West Porto-Chiquita Pool. In Case 2881 we went into detail showing the recoveries from the Verde-Gallup Pool and those recoveries are 500 to 1,000 barrels per acre.

Q Let me interrupt, please.

MR. COOLEY: Mr. Examiner, in order to shorten the discussion with respect to the Verde-Gallup, could we move that that portion of the transcript in Case 2881 with respect to the oil in place in the Verde-Gallup Oil Pool be incorporated in this case?

MR. NUTTER: What case was that?

MR. COOLEY: This was the first spacing hearing with respect to the Porto-Chiquita Pool.

MR. NUTTER: Was that the Pubco case?

MR. COOLEY: No, sir. It was the first 160-acre spacing in the Porto-Chiquita Pool where the same approach was made in the comparison with other fractured shale reservoirs.

MR. NUTTER: Yes, sir, that portion of the testimony or the record in Case 2881 will be incorporated by reference.

MR. COOLEY: Thank you.

MR. NUTTER: Also, if you desire that portion of Case 3455 that relates to this sand and shale drainage can be

incorporated.

MR. COOLEY: Yes, sir.

A In the Boulder Pool we have determined that 750 barrels per acre will be recovered. This pool is nearly completed and there is very little doubt as to the ultimate recovery. This also was reviewed in Case Number 3455. In West Porto-Chiquita an elaborate interference test was run and from that interference test we determined minimum values of oil in place of 1,000 barrels an acre, maximum of 2500, with an average estimated of approximately 1700 barrels in place.

From this information, and comparison with the transmissibility of these pools, we can make an estimate of oil in place for the La Plata-Mancos Pool. In Boulder, we calculated 2200 barrels per acre in place; it has, Boulder has transmissibility on the order of ten darcy feet in its main fracture system. West Porto-Chiquita with 1700 barrels in place has a transmissibility on the order of five to six darcy feet.

We have determined from the La Plata-Mancos, the wells on which we have information in this pool, the transmissibility of the main fracture systems will probably not exceed one and a half darcy feet. We can then compare the amount of oil in place to be expected in the La Plata Pool

to be something less than we found in Boulder, something less than was found in West Porto-Chiquita, and if we make the assumption that the relation is as that shown by the trend of porosity to permeability shown on Figure 10 for that type of fracture system, then we arrive at about 1200 barrels per acre in place, is about all we can expect in La Plata.

This calculation is set out in detail in the discussion on pages 1 to 7.

MR. NUTTER: Do you hazard a guess as to recoverable?

THE WITNESS: Yes, sir. The recoverable oil will depend partly on the method of exploitation, whether the gravity drainage mechanism can be utilized or if the recovery will be essentially solution gas drive. In Boulder, we believe that the producing mechanism was primarily solution gas drive with some help from gravity drainage, and we believe the recovery approximated thirty to thirty-five per cent of the oil in place. We think we have a fairly accurate calculation of oil in place of 2200 barrels an acre and recovery of 750 --

MR. NUTTER: Mr. Greer, I don't see an estimate of recoverable in East or West Porto-Chiquita; do you have an estimate of recoverable on either of those with your known transmissibilities?

THE WITNESS: Now, in East Porto-Chiquita we did not

obtain transmissibility data. In West Porto-Chiquita we did obtain a lot of transmissibility data. For that pool, for the part of it that we can utilize the gravity drainage mechanism and we hope that that will be for a substantial part of it, we are hoping to have recoveries as high as 60 per cent of the oil in place.

MR. NUTTER: Which was 1700 barrels?

THE WITNESS: 60 per cent of 1700 barrels. We know we cannot realize the gravity drainage mechanism throughout all of West Porto-Chiquita. Here in La Plata it will depend, in my opinion, on which mechanism contributes the greater part of the production, if it has to be solution gas drive, and, of course, it will be solution gas drive if the field is developed on close spacing, then we're looking at a recovery on the order of 30 per cent. 25 per cent under the particular circumstances here.

MR. NUTTER: You have enough dip to help the gravity drainage?

THE WITNESS: Yes.

MR. NUTTER: 45 degrees?

THE WITNESS: Yes. If we can utilize the drainage mechanism, I would expect us to get 60 or 70 per cent recovery.

MR. NUTTER: I think we will take a fifteen-minute

recess at this point.

(Whereupon, a recess was taken.)

MR. NUTTER: The hearing will come to order, please. Mr. Cooley, will you proceed?

Q (By Mr. Cooley) Mr. Greer, have you had core samples taken from any of the wells in the La Plata-Gallup Oil Pool?

A Yes, sir, we cored four wells last year.

Q Do you have any of those cores here present?

A Yes, sir.

Q Or portions of them?

A Yes, sir.

Q Would you identify them, please?

A Here are some core samples, this first one is from the N-31 well, that's in Unit N of Section 31. That's a depth of 2279 feet. I would like to show by this core sample the type of vertical fracturing that we have found in some of the zones, and which we believe forms a reservoir. This instance we could see at least one vertical fracture, down approximately the center of the core. There's always a question, when you find a vertical fracture in a core, as to whether the fracture was induced by coring or if it was truly a fracture in the formation before it penetrated the formation.

In this instance, we feel that the fracture was in

place in the formation and a little additional evidence that we have is the fact that after we fracked this particular well and cleaned it out, we found some pieces of formation which fell into the hole.

Here is another sample. Incidentally, I would like to have these samples back, these little pieces. You can see where the core, bit cored down through the formation, and then after fracturing, sand fracture treatment, the formation parted along its natural fracture planes and the piece fell into the hole.

MR. NUTTER: How was that recovered?

THE WITNESS: In a sand pump. It was a large hole, we have a large sand pump and naturally we recovered large pieces. Here are a few more.

MR. NUTTER: This is where the side of the hole has sloughed off and fell in after the core had been cut?

THE WITNESS: You can sort of see some little erosion channels, which I believe helped the fractured pieces to part from the formation and fall into the hole as a result of the frack. All those samples we just looked at are from the N-31 well.

A I would like to look at this one next. This next core sample, we can see the steep dip of the formation; this is

from the I-6 well at a depth of 4165 feet. It shows some of the streaks of silty limey material which gives a higher reading on the electric log than some of the pure shale. You can actually measure the dip of the beds from, by measuring the angle of those streaks and that well in that --

MR. NUTTER: This is approximately 45 degrees at least?

THE WITNESS: Yes, sir. and there was at that depth. In that well, I believe the hole was deviated a few degrees and, of course, it deviates toward the bed, toward a perpendicular to the bed, which means, then, that the dip of the formation is slightly greater than what we actually cored --

MR. NUTTER: I might point out here to some of you fellows that might be interested, one of the wells that Al mentioned earlier in his testimony, the Standard well, was located right in the center of the Southeast of the Southwest, right on these very steeply-dipping beds and when the well was bottomed they ran a survey on it and found that the bottom of the hole was almost in the middle of the Southwest of the Southwest. It had traveled updip and into the next 40 and bottomed almost into the next 40.

THE WITNESS: Almost off the list.

A This next core sample shows something which we believe

causes a separation perhaps of one reservoir from another, in that there are little faults, and we believe they are probably large faults in the vicinity of this well. But you can see from the little streaks in this core, little offsets in the lines. They are tiny faults and we have an idea that they are probably larger faults in the vicinity of this well.

Now, this core is also from the I-6. And it's in an area which is essentially non-productive. It has the, approximately the same electrical log characteristics, the same core analyses as the other wells, but when we fracked this well, the pressure built up after we had injected just a couple thousand barrels of oil, just as though we had reached the end of the reservoir and we feel that probably that's what happened, that we were in a little fault block perhaps no larger than one or two acres.

Q (By Mr. Cooley) In order to identify the core samples that you have just discussed for the record, the one showing the vertical fracturing that you discussed first is identified as Exhibit D-1, is that correct?

A Yes, sir.

Q And the second one that you discussed, showing the dip of the formation, is identified as D-3?

A Yes, sir.

Q And the third one that you discussed, being the non-productive area, is identified as D-2, is that correct?

A Yes, sir, that's correct.

(Whereupon, Exhibits D-1, D-2 & D-3 were marked for identification.)

Q Have you had laboratory analysis made of the cores that you have taken from the wells recently drilled in the La Plata-Gallup Pool?

A Yes, sir.

Q Referring to Exhibit 3, are these the analyses to which you refer?

A Yes, sir.

Q Would you briefly discuss the characteristics shown?

A Yes, sir. The most important characteristic, I believe, which we found as a result of this coring program, we can see if we'll look under Section C of this Exhibit 3, there are two pages of core analyses and then a graph or a plat which shows the core analyses plotted on the same scale as a copy of the electric log.

The significant thing to me is that where we find low resistivity and resistivity curve is the right-hand curve of the electric log section, which has the coloring yellow, green and brown. The scale is ten ohmmeters per division and

the oil and water saturation are shown on the graph that has the red coloration and you can almost see a direct correlation between resistivity and oil saturation and, of course, the inverse of water saturation, which is shown with the solid line and the oil with the dashed line. Now, what this means to us in areas which have not been cored, I mean zones which have not been cored, if we have a resistivity, a low resistivity, say ten to twenty ohmmeters, or perhaps even thirty ohmmeters, that we cannot expect to have a high oil saturation. It's simply, the shale is simply saturated with water.

For instance, in the interval from about 5160 to 5200, the water saturation is between 70 and 80 per cent. There just is no oil saturation.

Q Mr. Greer -- Excuse me, was there other discussion?

A Yes, we think this is significant because a part of the Niobrara which has been produced in the San Juan Basin covers several hundred feet and there has been some thought on the part of some people that perhaps the entire several hundred feet of section is oil saturated and possibly could be oil productive if fractured. We are convinced from this coring program that we can anticipate oil production only in those zones that have high resistivity and, of course, there is high resistivity on the electric log and, of course, we know

that we can have high resistivity without having high oil saturation, so again, we draw the conclusion that although high resistivity is necessary for oil saturation, it is not in itself an indication that it is only oil-productive, but under any circumstances we must have high resistivity, and by high, in this particular field it appears something in excess of 20 to 30 ohmmeters and, of course, we can go back to the other cross sections and by inspection we can see that only the zones that we have colored are zones which we can reasonably anticipate to produce.

Now, we might look just a little, reviewing in detail some of the analyses that we have. We find that the porosity, total porosity determined in the laboratory, runs on the order of five to eight per cent. And oil saturation in the productive interval from, oh, 40 to 50, possibly 60 per cent. But the significant thing here is that when we add the oil saturation, which is still in the core when we recover it, and bring it up on the ground and it's had an opportunity for whatever oil is in it to produce in a sense, to come out of the core, if we add the oil saturation to the water saturation, we find that these two saturations will total from 80 to 95 per cent of the total pore space. This means, then, that only five to perhaps fifteen or twenty per cent of the

total pore space is all that's available for productive, for oil to produce. And, too, we have found a good part of this porosity is tiny fractures, little hairline fractures, that exist and probably exist in the core samples here, but you can't see with your naked eye until you treat the core in some fashion to bring those fractures out. And, of course, the cores now are not under pressure and these fractures have expanded and so it's difficult to tell what the true oil volume of these cores would be without putting them back under the same reservoir pressure. We can only tell the maximum --

MR. NUTTER: Mr. Greer, just to interrupt you here -- How are you able to determine what the oil saturation is in a core? When your drilling fluid is crude oil, I notice here on all your core analyses, how much of that residual oil that's in that core came from the drilling fluid?

THE WITNESS: The answer to that, I think, is, although it's an odd thing, we have found very little invasion of oil into a core and the way we can, of course, demonstrate that there has been very little oil invasion is by looking at the core analyses, for instance, the graph we were looking at under Section C, the oil saturation in the interval from, say, 5180 to 5200 runs from four per cent to fifteen per cent. Yet the permeabilities and porosities are similar to the cores

of the hole. This means, of course, that in this instance there was no oil invasion, because there's no oil left when the core was analyzed and yet the characteristics of the core are the same.

From this we assume that we have not had much oil invasion. But to analyze the porosity, which is left after you take oil saturation and water saturation and the fluids that are left in the core, after it's brought to the surface, then we find we are looking at a really small part of the total bulk of the core, something from two or three-tenths of a per cent to maybe a half a per cent. And this is roughly the amount of pore space that it would take to contain the amounts of oil which have been indicated in the other pools to be present; namely, from a thousand to two to three thousand barrels in place.

Q (By Mr. Cooley) Now, Mr. Greer, the data that you have just been discussing reveals that the total oil contained in the core itself, as they were analyzed, was much greater than the amount of oil that you have estimated to be "in place", is that correct?

A Yes, sir. Of course, the total oil in the core is a very large amount of oil, locked into shale that can never be moved.

Q And for purposes of clarification, although it might not be entirely accurate, is it true that the oil that you have calculated to be in place is oil that in the main fracture system that has capability of movement?

A Yes, sir.

Q And that the vast quantity of the oil, percentage of it, is locked in these hairline fractures and has no connection with the main fracture system?

A Yes, sir.

MR. NUTTER: In other words, your oil in place is oil that's in the fractures only and not in the matrix?

THE WITNESS: Yes, sir, the matrix in this instance is, well, for instance, the oil is still in these cores although they have been on the surface of the ground for months, if they were to be analyzed right now they would show the same oil saturation which you have in these core analyses.

Q (By Mr. Cooley) Did you have prepared, Mr. Greer, a photograph of the entire core of one of your wells?

A Yes, sir. On the P-31.

(Whereupon, Applicant's Exhibit E was marked for identification.)

Q I hand you what has been marked as Exhibit E for purposes of identification and ask you if this is the

photograph to which you refer?

A Yes, sir, this is a photograph of every bit of the core, which was taken from the P-31 well and, of course, the purpose of this is to give visual evidence or evidence which can be seen visually at this hearing, of the fact that there is no substantial change in the type of formation or the lithology for the entire interval cored, although there is a substantial difference in the amount of oil in the cores from the different depths.

Q Is it your desire, Mr. Greer, to withdraw this exhibit after the case has become final and the Commission has had an opportunity to review it?

A Yes, sir, we would like to have the film, or the picture returned within a matter of months, unless the Commission feels they need them.

MR. COOLEY: Does the Examiner have any objection to the withdrawal of the exhibit?

MR. NUTTER: We have no objection to the withdrawal of the exhibit after the time for the appeal of this case is over.

Q (By Mr. Cooley) Mr. Greer, have you conducted any communication tests in the La Plata-Gallup Pool?

A Yes, sir.

Q Referring to Exhibit 2-C, is this a graphical

demonstration of communication within the pool?

A Yes, sir. Perhaps we should look at Exhibit 2-A first, to locate the wells we'll be discussing. On 2-A we can see the well which was shut in and the fluid levels measured in it. It's the Taylor No. 1 Walker in the Northwest Quarter of Section 6.

The two new wells which have been drilled, which communication is evidenced with the Taylor No. 1 Walker, are the P-31 well and the N-31 well, both in Section 31. The first evidence of communication was observed between the No. 1 Walker and the P-31 well.

We might now look at Exhibit 2-C. The vertical scale is fluid level in terms of feet from the surface of the ground. This particular well was completed in February of 1968. And this graph is all for the year 1968. It was produced about twenty days and then shut in. The fluid level started raising as shown in March, and by about the 20th of April was up to approximately 1400 feet.

And as noted on the graph, the scale change, we picked up, down at the bottom of the graph, in April, fluid level continued to rise until in May, for a period of a few days, tubing was run in the well and it was swabbed at the rate of about ten barrels a day, in order to condition it to

take a bottom hole sample, a bottom hole sample was taken and at that time the well shut in again and the rise in fluid level continued and it was observed as shown and recorded on this graph.

And then in August, about the 9th of August, the P-31 was given a sand frack treatment and there was an abrupt increase in the rate of rise of the fluid level in Taylor's well, which was shut in all this time. Which we believe was a result of the sand frack treatment.

And then in early September, as shown on the graph, the P-31 was put to production. It started pumping the load oil back and there appears to have been a leveling off in the fluid level rise in the Taylor well at that time.

And then in early November, I believe that's the first of November, the N-31 well was given a sand frack treatment. And the fluid level then showed an abrupt increase, pressure wave more or less went through the Taylor well and then the fluid level started declining for the next few days.

Incidentally, we checked the fluid level rate of increase in the Taylor well within about thirty minutes after fracking the N-31, and we actually measured the fluid level rising while we were there on location, it was rising I believe at the rate of about 20 or 30 feet an hour.

MR. NUTTER: Now, you had a rather abrupt increase in fluid levels in the middle of October there on that well, Mr. Greer. What do you attribute that to?

THE WITNESS: I don't know what caused that. We have postulated that that might be a reflection of the pressure wave created back in August.

MR. NUTTER: Was the N-31 drilling at the time?

THE WITNESS: The N-31 was drilling, and we went back to check our records to see if it was possible that we had oil circulation and perhaps interference from that standpoint and the well was drilling at too high a point clear above the matrix formation, so we felt that was not it. So we really just don't know; of course, it's a small increase of about four feet, about a pound and a half.

A Then in about the 10th of November the N-31 was started to pumping and again a very marked decrease in fluid level was noticed in the Taylor well. It went clear off the scale in three or four days, and by November 23rd the fluid level was down to 1490. At that time, I believe we put the Taylor well to producing and shut the N-31 well in.

The N-31 had started making gas and we felt it would dissipate the reservoir, so we have a marked increase, or increase in fluid level and evidence of communication between the

N-31 and Taylor's well. And not quite such a sharp increase, but a definite increase in fluid level resulting from frack treatment of the P-31.

Now, we have concluded, although we have not shown it on this graph, that the reservoir has a pressure production coefficient on the order of 1500 barrels per pound and that results from the fact when we introduced about 5,000 barrels of oil in the P-31 we had an increase in the fluid level equivalent to about three pounds. By the same token, when the N-31 well was fracked, the fluid level, although there was a pressure wave went through Taylor's well, it was declining at a rate which would appear to us would give the same stabilized increase in reservoir pressure. So we can draw, really, two conclusions from this. One is the pressure production coefficient, 1500 barrels per pound; and the other is, although there is quite a difference in the type of reaction from the frack treatments, the end result is going to be roughly the same. The two wells which had high permeability, namely Taylor's well and the N-31, showed the sharp change in pressure immediately following the frack treatment. But it's pretty evident, it is evident to us, that after two or three weeks the pressure increase will be comparable to that which resulted from fracturing the P-31; so we feel that all three

wells then are not only in communication, they are in communication with the same reservoir. It's unlikely that one of them is producing from two zones and another from only one.

Q (By Mr. Cooley) Well, from this study, Mr. Greer, do you draw any conclusions as to the effective area of drainage of the well in this pool, in this portion of the pool?

A The N-31, or the P-31 and Taylor's well, approximately half a mile apart. This would be one-half mile drainage radius or approximately 600 acres, would be the equivalent of 600-acre drainage. The N-31 and Taylor's well are approximately 1500 feet apart, would be roughly equivalent to 160-acre drainage.

Q And is there any doubt in your mind and in your opinion with respect to the effectiveness of this drainage, any economic time?

A No.

Q Moving now, Mr. Greer, to the drainage mechanism of the reservoir drive that is present in the La Plata-Gallup Oil Pool, would you direct your attention to Figure 11, following immediately after Figure 10?

A The Figure 11 shows our calculation of --

Q Excuse me, this is in Exhibit 1. Immediately after page 22 of Section C.

A This shows the rate of drainage which we believe might result in this area if the oil can be maintained in its under saturated condition. Refer to this in the rim block which is in the west part of the pool, the fault block that's along the steeply dipping part of the area.

Q You have just mentioned the under saturated condition of the oil in the La Plata-Gallup Oil Pool, Mr. Greer. What evidence do you have of this fact?

A The under saturated oil to which I refer, we found from a sample in Mr. Taylor's well. And that fluid analysis is in --

Q Section D of Exhibit 2?

A Exhibit 2, Section D.

Q Section D as in "dog" of Exhibit 2.

A It shows a bubble point of approximately 185 pounds at a time the pressure was on the order of 300 pounds in the well. We have carefully conditioned the well such that the pressure in the well bore during the conditioning period, in bringing new oil into the well bore, would have had to have been at least 275 pounds, so the sample was at least 100 pounds under saturated below the lowest pressure which existed in the well bore at the time the well was being conditioned. So we believe this was a very good sample and accurate information.

Now, if we can keep the oil under saturated, and, of course, we keep it under saturated by maintaining pressure on it as the field is produced, we can expect gravity drainage rates as shown on Figure 11, but at different depths. For instance, in the upper part of the reservoir where the depth or the rate of dip is about a thousand feet per mile, for transmissibility of a thousand millidarcy feet, which would be one darcy feet, we have about 200 barrels per day per linear mile on stride. If we have as much as one and a half darcy feet, 2,000 feet per mile, we get up to about 500 barrels per day, per mile, on a stride. This, these gravity drainage rates are discussed under --

Q 14 to 17 --

A -- Section 2, pages 8 to 13. Section C, Part 2. I think we need not go into them now.

Q What would happen, Mr. Greer, if the reservoir is produced at a rate in excess of the gravity, efficient gravity movement?

A In that event, the pressures will drop below the bubble point, gas comes out of solution, you have, in a sense, primarily solution gas drive, and the recoveries then would be solution gas drive recoveries and, of course, this will result if the well is, if the field is drilled on a close spacing, and

high rates of production field-wide are realized. The only way that we can expect to have the gravity drainage mechanism work is to restrict rates of production to that comparable to those shown on this graph in Figure 11.

Now, the drastic things that happen when the solution gas drive mechanism takes place, is that the viscosity drops, the permeability to oil drops, and within a short time after the pressures have dropped below the bubble point, then these rates, as shown on Figure 11, will drop by a factor of ten to one hundred; in other words, where initially we have 200 barrels per day per linear mile in the area we can expect an area around the Taylor well, it would soon be down to 20 barrels per day per linear mile or even two barrels per day per linear mile, if we deplete the field by solution gas drive.

Q From this information, Mr. Greer, what conclusion do you draw with respect to the most desirable density of development?

A Well, the density should be, well, first, we need, of course, in each fault block to have enough wells to produce the oil in a reasonable length of time. And it appears from these gravity drainage rates that this can be realized producing the reservoir in a reasonable length of time with just a few wells. Certainly nothing like a 40 or 80-acre

pattern would give.

Q Mr. Greer, on page 16 of Section C, you have some estimated recoveries from the various blocks which you refer to as the rim block and the basin block. Recalling once again that this exhibit was prepared over a year ago, prior to drilling of the three most recent wells, do you have any revision to make with respect to your reserves stated there?

A Well, yes, sir, first I think we should explain the figures that show here. The basin block is the block which we show colored in brown on Figure 9. And the rim block is the area we show colored in yellow on Figure 9 of this Exhibit 1. We have some pressure production data for the basin block which allows us to arrive at an estimate of oil in place and recoverable oil in addition to what we would have postulated from our geological work. This is shown on the line opposite the one titled "Basin Block", under both competitive operations and unitized operations.

MR. NUTTER: Mr. Greer, may I interrupt one more time?

THE WITNESS: Yes, sir.

MR. NUTTER: That 300,000 produced oil, that would have come primarily from that Standard --

THE WITNESS: M-5.

MR. NUTTER: -- M-5, right?

THE WITNESS: Yes, sir, all of it came from that.

MR. NUTTER: From the one well?

THE WITNESS: Yes, sir.

A Then in the rim block, if it covered an area shown in Figure 9, with other characteristics as shown, we would estimate for competitive operations nearly three million barrels in place and approximately 870,000 recoverable. Under unitized operations, and we have used this comparison, because under unitized operations we can control gas-oil ratios, control production, perhaps inject water or gas and maintain pressure, we would anticipate a higher recovery, nearly two and a half times as much.

Now, the figures for the basin block, of course, we must qualify to the extent that we, although we have some pressure production data for the basin block reservoir, we don't know how much gas, free gas was originally in place there. With this unknown factor, it's difficult to put an exact number on the remaining reserves.

For the rim block, of course, we had no pressure production data and all we can go on is the size of the area, and if it has these chracteristics; we now know that the rim block contains a substantial gas cap and, of course, as a result

there will not be as much oil in place. It also has a broader area of separation between the rim block and the basin block and so the rim block is not quite as large as we estimated a year ago. Nevertheless, the relative recoverable reserves for the rim block will be about the same as we have shown here, which is roughly, we think, 25 to 30 per cent under competitive operations up to perhaps 70 per cent on wide spacing and under unitized operations.

MR. NUTTER: Mr. Greer, how did you establish that there is a gas cap on the rim block?

THE WITNESS: By drilling a well into it, and it's the N-31, it penetrated the gas cap --

MR. NUTTER: The N-31 did --

THE WITNESS: The N-31.

MR. NUTTER: But it was completed as an oil well, wasn't it?

THE WITNESS: Actually we haven't completed it yet, we just produced part of the load oil back and the gas reached such a high point that we shut the well in rather than continuing producing it.

MR. NUTTER: Structurally, it's about what, a hundred feet higher than the Taylor well?

THE WITNESS: Yes, only about a hundred feet higher,

and if I might add to that, I don't have the figures with me, but we determined the bottom hole pressure in the N-31 at the time we finished the sand frack treatment and from that pressure it was, I believe, about 20 pounds higher than we felt it should be. And, of course, this gave us concern, because one reason for that would be that the oil column extended only half-way between the Taylor well and the N-31 and, of course, in producing the well we did find the high gas-oil ratio and it's in the gas cap. And from those pressures, then, we would estimate that the gas-oil contact is about half-way between those two wells.

MR. NUTTER: I see. Which would probably be at about, well, one is 3836 and the other is 3718?

THE WITNESS: Yes, sir.

MR. NUTTER: So that's 118 feet difference between about half of that difference you would expect to be the location of the gas-oil contact?

THE WITNESS: Yes, sir, which would be roughly 60 feet above the Taylor well.

Q (By Mr. Cooley) Mr. Greer, does there occur any vertical separation within the productive member of the Niobrara?

A Yes, sir. I would like to refer back to Figure 3, if you might, for just a moment.

Q This is under Section B?

A Under Section B of Exhibit 1. We anticipate from this field most of the production will come from the zones between the D and E marker, primarily the zone colored in brown, although we believe that there might be production possible from the zone colored in yellow, particularly if it could be connected with vertical fractures to the zone colored in brown.

Now, there are some other zones which show continuity across this area. And there are three zones between the B and C markers, which one can follow. We have not colored them in but it's apparent that they are rather continuous. Our experience, however, in the Porto-Chiquita Pools with zones in about that part of the Niobrara, they have had high gas-oil ratios, they have not been good reservoirs and even where the gas-oil ratio was good, they did not have as much horizontal communication as other zones, and a well completed in one of them would produce just a short while and then be depleted.

We have not, however, found vertical communication all the way from, say, the B-C interval down to the D-E interval, which is a separation of maybe a hundred to 200 feet. The shales between those intervals are perhaps more plastic and if they were fractured at the time that the other

zones were fractured, well, the fractures have since healed, and we have found no vertical communication between those zones. And this means, then, a number of things; we cannot determine communication, for instance, from a well completed in the B-C interval with one in the D-E interval, but primarily it means we have an expensive completion in that we have to isolate these zones which are not good producers, in order to confine our sand fracture treatment to the productive interval. If we attempt to fracture several hundred feet of open hole, we believe it's possible, if not probable, that the fracture, the sand frack treatment will not enter the right zone. And if it doesn't enter the right zone, and not being in vertical communication, then we have not, we do not have a commercial well.

Q Looking now, Mr. Greer, to Section D of Exhibit 1.

A Yes, sir.

Q This has to do with the pressure production data. As you pointed out in your earlier discussion, this deals only with the basin block, is this correct? The pressure, actual pressure production history deals largely with the basin block, does it not?

A Yes, sir. We do have a pressure buildup on the one well, on the Taylor well in the rim block, which is covered

in here, but no production data to work with.

Q I'm interested in shortening this hearing as much as possible. Could we turn to Figure 12 and try to summarize the information that's contained in Section D of Exhibit 1?

A Yes, sir.

Q That appears immediately after page 9 of that section.

A Pages 1 to 9 contain primarily the statistical data which goes into the figures which follow. On Figure 12 is shown the bottom hole pressure buildup on the N-5 well taken in April of 1968. From this we have determined two things, primarily, an estimate of permeability in the area of this well. And what its pressure might be at the time or this day it was taken in April.

The Figure 12 shows on one scale most of the information which was taken up to about two days after the oil was shut in. The details of the information from that point on is shown in Figure 13. And primarily what we determined from this is that the permeability at some distance from the well bore is substantially better than that near the well bore.

On Figure 12, for the first part of the buildup curve we determined the permeability to be something like four to five hundredths of a darcy foot. As shown on Figure 13, a permeability of ten times that amount is indicated at some

distance from the well bore. Now, we believe that at this time, of course, the pressure was substantially less than it had been originally, and the permeability to oil is less than it originally was. And I would estimate that the initial permeability, then, when the oil was at a pressure in the reservoir, that it was substantially oil and very little free gas, would probably have been about three times that amount.

If so, the main fracture system within the area of this M-5 well would have a transmissibility on the order of one and a half darcy feet.

Figure 14 is a plot of pressures taken in the M-5 well, plotted against a cumulative production. By April of '68 the well produced approximately 300,000 barrels of oil, and as can be seen on the graph, shut in 48 hours and shut in twelve days, the pressure was still increasing. And our interpretation of the maximum pressure at which this well might build up, which would reflect the true reservoir pressure at this time, would be something between 1100 and 1200 pounds. If the pressure, stabilized pressure in the reservoir were size 1200 pounds last April, it would indicate a pressure production coefficient of 1,050 barrels per pound. We know that it was at least 1100 pounds, which would be a pressure production coefficient of 800 barrels per pound.

Using those two coefficients, we can calculate that the oil in place, that there were no free gas in the reservoir, would originally have been on the order of two to three million barrels of oil. Now, at this point I estimated two and a half million barrels of oil. Now, this means, then, that if this well is in communication, or was at the time it was first drilled for two and a half million barrels of oil, and we have, as we believe, something like 1200 barrels per acre in place, the well then must be draining an area on the order of 2,000 acres. It is only happenstance that that is approximately the size of the area shown in brown on Figure 9, which from our geologic interpretations would be the size of the basin block reservoir which geologically we would expect to have.

Now, the fact that we determined 2,000 acres from our pressure production data, of course, does not necessarily confirm that that is the area, but it would be an area of about that size. It may not be located as shown on Figure 9, but it would be an area of about that size.

Now, of course, if there were substantial, if there were a substantial gas cap in this reservoir, then the amount of oil would be less and the area would be less. We think that there is very little room for substantial gas cap here, because it is so close to the point which we believe separates

the basin block from the rim block. The bottom hole location of the well is indicated on Figure 9, is very close to the zero contour and we feel that there can be very little productive acreage updip from that point. Even so, if there were a substantial gas cap or free gas in this reservoir, which tended to hold the pressure up, we still have the fact that the well has actually produced 300,000 barrels of oil, and if the recovery in this instance, almost has to be solution gas drive, there's hardly enough dip here for gravity drainage. We must be looking at only 400 to 500 barrels per acre, so this means, then, that the well has actually produced amount of oil equivalent to complete depletion of six to seven hundred acres.

MR. NUTTER: Whatever dip there is, is down from the well anyway?

THE WITNESS: Yes, sir. So this, then, gives us additional evidence, we believe, of widespread drainage possibilities in this pool.

Q (By Mr. Cooley) Moving now, hurriedly, Mr. Greer, to Figure 15, for a brief summary of the pressure buildup survey on the Lloyd B. Taylor No. 1 Walker --

A We determined, again, two things from the pressure buildup of this well; as shown on Figure 15, this is a plot

which is often used for a well, a new well in a reservoir, the familiar Delta "T" divided by "T" plus Delta "T", time ratios against either pressure or fluid level. And, of course, from this we can tell permeability in the vicinity of the well, which is indicated to be two and a half darcy feet. And also an extrapolation which would indicate a minimum height of fluid level to which the well might build up.

The important thing we gather from that is that it is apparent that the fluid level will raise at least to a point 1300 acre feet from the surface, and, as a matter of fact, it actually rates higher than that. But that gives us a minimum pressure in Mr. Taylor's well, the E marker datum, of around 330 pounds. And when we convert that back to a datum comparable to that of which the M-5 well was completed, or which the pressures were measured in the M-5 well, we find a comparable pressure, then, of 1500 pounds, which is about the pressure the M-5 had originally.

This means to me that we are dealing, then, with virgin pressure in the rim block reservoir. And that the M-5 well has not depleted this reservoir.

MR. NUTTER: The rim block?

THE WITNESS: The rim block, yes, sir.

A So we have, then, pressure difference data which

then adds to our belief that there are two, at least two fault blocks.

Q (By Mr. Cooley) Section E, Mr. Greer, deals with drilling and completion methods and costs. It is self-explanatory, and I suggest that we move on to Section F, which deals with the economics under competitive operations.

A All right, sir. I suggest we look --

Q On page 3 of that section you have a tabulation which I think best explains it; would you direct your attention to that?

A Yes, sir. On page 3 of Section F of Exhibit 1, we have a schedule which shows my estimate of drilling costs based upon the depth wells will be drilled and also on the spacing, and the reason it varies in this instance with spacing is that it would be my thought that on close spacings, say, 40 acres or 80 acres, that operators would not take the, go to the expense of large sand frack treatments, they would hope by drilling enough wells that they could get into the fracture system with the additional number of wells, and perhaps could drill them somewhat cheaper than on wide spacing. On wide spacing we feel we have to go to large frack treatments to be sure we get into the fracture system. And, of course, on the close spacing, if care is not taken to drill a well with air,

if they are drilled with mud, of course, they will ruin some of the wells.

This is not a material thing from the standpoint of recovery because on 40-acre spacing they would probably only need a fraction of the total number of wells drilled to recover the oil, so that's not the fact that they would ruin some of the wells doesn't mean they wouldn't recover all of the oil; and by "all of the oil", I mean all the oil that is recoverable by solution gas drive methods and under competitive operations it probably would make very little difference in recoverable oil on the various spacings other than we might recover a little more on wide spacing than on close spacing.

The reason for that is that competitively the wells, the reservoir would be produced so fast, depleted so fast there would be very little gravity drainage.

Now, with these figures of costs of wells, we can then determine the economics under the various spacing patterns that might exist under competitive operations.

Q Would you proceed, then, to the 40-acre spacing pattern and discuss the economics under that?

A This is shown under the tab numbered 40 and here we have just taken a sample reservoir of the sizes indicated earlier, postulated a few dry holes and calculated the total

cost depending upon the depth and for the 40-acre spacing column as we reviewed on the previous schedule.

In this instance we would anticipate a recovery of a million one hundred and seventy thousand barrels of oil at a cost of seven dollars a barrel, which, of course, would be uneconomic.

Q Would you proceed to the 80-acre spacing postulation?

A With the same principles on 80-acre spacing, we come up with a cost of five dollars and eight cents per barrel.

Q And for 160-acre spacing?

A 160-acre spacing we get down to a cost of three dollars and eighty-three cents per barrel for the over-all average.

Q And for 320-acre spacing?

A 320-acre spacing we have gone to a little bit more detail, broken the cost down as to the different blocks, the basin block and the rim block, but primarily what we would like to show here under the colored plat, under the 320-acre tab, is the fact that on any spacing pattern it is difficult to realize the full spacing recovery for any -- on an over-all average, and that is because that somewhere under the spacing unit of the outside or edge wells the reservoir will probably cease to be productive or you'll reach the edge of the reservoir, and for the example shown on this plat, although the

spacing is 320 acres per well, the true average area of drainage, which each well would result in having, is only 200 to 220 acres. So even under wide spacing we find that we really could not anticipate a full drainage tract for each well equal to the spacing unit.

Now, these costs are shown, figuring costs in terms of dollars per barrel recovered, is shown, too, for the basin block, which is still quite high, $6.50 a barrel. The rim block, however, begins to reach economic proportions, $1.72 per barrel on 320-acre spacing.

Q Mr. Greer, from your testimony with respect to the various possible spacing patterns, it would appear that in your opinion that none of the spacing patterns, either 40, 80, 160 or 320 would be an economical method by which to develop this pool.

A This is true.

Q Then, as far as, in fact, development, in view of the unitization of this pool, would you proceed to Section G and demonstrate to the Examiner how you would propose to actually develop this pool?

A Yes, sir. It is our thought that this pool can only be economically developed under unitized operation and, of course, concurrently with that, to have some type of wider

spacing pattern than the 40 acres. One type of development pattern is shown under Section G of Exhibit 1, which would probably recover the maximum amount of oil for the minimum cost. And the reason for this is that the gravity drainage mechanism could be realized in the rim block and additional oil recovered in that fashion. And it would take only a few wells to do it.

The basin block, it makes no difference, I believe, what spacing is drilled on, it's recovery will be about the same, being solution gas drive.

Q Well, Mr. Greer, in view of this fact, why have you proposed that the Oil Conservation Commission space this pool on 160-acre spacing?

A Well, sir, it's very difficult, of course, to get 100 per cent commitment of the working interest owners to a unit agreement and if some of the operators have not joined the unit agreement, then they, of course, must be permitted to develop their own properties in their own way. And so it's necessary that we have some type of spacing pattern. And it certainly needs to be wider than 40 acres.

We believe, in this instance, that with the commitments we have to the unit agreement, although part of the acreage is still not committed, that the unitized lands

could be properly protected with the 160-acre spacing pattern. I believe we could meet any offsets which would be drilled by any of the non-unitized parties, and protect the lands without a dense drilling program being resulting.

Q Would this be true in the case of either 80-acre spacing or 40-acre spacing?

A If we get down to 80-acre spacing and 40-acre spacing I feel we could not protect the unitized lands without drilling too many wells.

Q Would this, in your opinion, result in the drilling of useless and unnecessary wells in the pool?

A Yes, sir.

Q Would failure to drill on a closer pattern result in any less recovery from the pool?

A No, sir. In fact, I anticipate higher recovery on the wider pattern.

Q And this, again, is because of the efficient utilization of the gravity drainage mechanism?

A Yes, sir.

Q Now, so that we have no misunderstanding with respect to the particular type of spacing order that the Applicant is here requesting, it is true, is it not, that you propose that the order prohibit the drilling of more than one well on 160-acre

quarter section?

A Yes, sir, we are concerned with not only proration units but actual spacing units.

Q In your opinion, is this particular provision absolutely essential in order to prevent waste in this pool?

A Yes, sir, it's absolutely essential.

Q In your opinion, will the pools, or pool or pools, the area requested here to be spaced, be efficiently and economically drained under the patterns which you propose?

A Yes, sir.

Q In your opinion will the correlative rights of any operator in the pool be adversely affected thereby?

A No, sir.

MR. COOLEY: Mr. Examiner, this concludes the direct testimony that we have with respect to the spacing facets of our case and we would move admission of Exhibits A through E at this time.

THE WITNESS: Could we have a word?

MR. NUTTER: Sure.

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

MR. COOLEY: I would like to move the admission of these exhibits and then inquire of the Examiner his pleasure with respect to procedure. Do you want to cross examine with

respect to this?

MR. NUTTER: We have got Exhibits A through E?

MR. COOLEY: Yes, sir. We have Exhibits A, B and C in the form of the booklets.

MR. NUTTER: Those are 1, 2 and 3.

MR. COOLEY: Excuse me, Exhibits 1, 2, 3, 4, 5.

THE WITNESS: We have got some misnumbered here.

MR. COOLEY: I will redesignate the exhibits, but they are 1, 2, 3, 4, 5.

MR. NUTTER: Now we have three books here, that's 1, 2 and 3, and you have got three rocks there?

MR. COOLEY: No, they are all marked as 4.

MR. NUTTER: 4-A, 4-B and 4-C?

MR. COOLEY: Correct.

MR. NUTTER: And you have got Exhibit 5 here, which is the film that you want withdrawn later?

MR. COOLEY: Correct.

MR. NUTTER: Applicant's Exhibits 1, 2, 3, 4-A, 4-B, 4-C and Exhibit 5 will be admitted in evidence provided that Exhibit 5 may be withdrawn at a later date.

(Whereupon, Applicant's Exhibits 1 - 5 were offered and admitted in evidence.)

MR. NUTTER: How much longer will your direct

examination last, Mr. Cooley?

MR. COOLEY: I would think possibly another fifteen minutes with respect to the pressure maintenance and the amendment of the unit rules.

MR. NUTTER: I think we'll recess the hearing at this time until 1:30, then.

MR. COOLEY: In order to clarify the record with respect to Applicant's Exhibits, that portion of the record which refers to Exhibits D-1, D-2 and D-3 should be changed to read 4-A, 4-B and 4-C respectively. And the exhibit identified as Exhibit E should now be identified as Exhibit 5.

(Whereupon, the noon recess was taken.)

MR. NUTTER: The hearing will come to order.

Mr. Cooley, I believe just prior to lunch you had finished your direct testimony on Case 4067, is that correct?

MR. COOLEY: I said I was, but I have one more question with respect to that case.

DIRECT EXAMINATION (CONTINUED)

BY MR. COOLEY:

Q With respect to Case 4067, Mr. Greer, due to the extreme angle of dipping in the La Plata-Gallup Pool, is there a possibility that within the same fault block, wells could be completed that were in different depth factors as established by the Commission's rules and regulations?

A Yes, sir.

Q As a result of this possibility, do you have any recommendation with respect to what allowables should be assigned 160-acre spacing and proration units in that pool?

A Yes, sir, would suggest four times the normal unit allowable for all wells, all depths throughout this spaced area.

MR. COOLEY: With that, we have no further direct testimony to present in connection with Case 4067.

CROSS EXAMINATION

BY MR. NUTTER:

Q Mr. Greer, in your direct testimony you mentioned that the rules that you would propose for this pool would prohibit the drilling of a second well on a 160-acre tract if such unit were approved by the Commission. Now, I presume then that you would also object to the formation of a nonstandard unit comprising less than 160 acres?

A Yes, sir, unless, of course, it was the result of a partial section. You know, there are some lots, as I recall, along the township line; some are larger than standard, and some are smaller. But with that exception, we would oppose it.

Q Now, you also mentioned that there were some tracts in this unit area that had not been committed to the unit agreement?

A Yes, sir.

Q For the purpose of protecting the unitized line by drainage from those tracts outside of the participation, you felt that 160-acre spacing would be adequate. Now, what tracts are not committed to the unit, could you tell me, and what is the size and shape of those tracts?

A I believe somewhere in the Commission's records, you have a copy of Exhibits A and B to the unit agreement. If I had that, I could probably identify them more quickly and simply. Do

you suppose we could have someone look that up in the unit files? I don't have a copy of Exhibit A or B with me.

Q Yes, I think we probably can. Has the status changed since the unit agreement was signed, or do you know offhand which tracts are not committed, so if you had a copy of the Exhibit A--

A I would have to look at Exhibit A or B in order to tell which tracts we feel will not come in. In general, though, they are tracts, if you might refer back to--

Q Refer to figure 2, that shows all of the tracts, and you can probably identify them.

A You are looking at figure 2?

Q Exhibit 1.

A They are primarily in Sections 27, 28, 34, I believe a 40-acre tract in Section 8, the northeast of the southeast. That would be most of it.

Q Now, up here in Section 27, which would the acreage be which was not committed?

A In the south part of Section 27.

Q That little narrow strip that runs across the south part there?

A I believe it is either the narrow strip or the small tracts, the north halves of those 40-acre tracts.

Q And then in Section 28, which is the acreage that is not committed?

A I believe it is the acreage shown through the center of the--

Q Is that the odd-shaped configuration?

A The odd-shaped configuration, yes.

Q And did you mention Section 29?

A I didn't mention Section 29, and I certainly can't tell.

Q And in Section 34, that would be--

A Probably the little tract, 80 acres in the west half of the northwest quarter.

Q Mr. Greer, in the event we adopted 180-acre spacing rules, and you don't approve of nonstandard units, what opportunity is given to the owners of this acreage to develop their property?

A Well--

Q Without coming into the unit.

A They can drill in on 160-acre tracts and, of course, if they don't have a full 160, then, of course, they can communitize with unit lands in the 160. Of course, if we refuse to join, they could force pool the unit lands. This is our interpretation of the forced pooling law or rule.

Q But you would still object to the formation of a

nonstandard unit and suggest--

A Well, I'm sorry, sir, I thought you were talking about standard 160-acre tracts in which they didn't have the full 160 acres.

Q Well, you would object to either the formation of a nonstandard 160, excluding the unitized lands, and you would suggest they would force pool?

A Oh, yes, sir.

Q Take the southwest quarter of Section 28 there, 40 acres presumably is unitized, and 120 acres is not committed to the unit?

A Yes, sir.

Q So you would suggest if they wanted to develop that quarter section, that they would have to force pool the 40 acres that belongs to the unit in with their 120?

A Yes, sir, they would always have that right. I doubt that we would refuse to join. We would probably work out some kind of agreement where they could have our 40 acres and drill it. But certainly, we would not prevent them from drilling their 120 acres and force pooling our 40.

Q Now, what is your primary objection to the establishment of nonstandard units, say two 80-acre units in a quarter section, assuming that each of those wells would receive half of an

allowable? The withdrawals from those two wells would be limited to one single allowable, and wouldn't result in dropping the reservoir pressure below the bubble point with an increase in viscosity, would it?

A I have no particular objection to two 80-acre tracts forming a 160. The nonstandard units that I would oppose would be, say, two 40-acre tracts and, say, two lots of five acres each. That would really give you only 90 acres. In this instance, we would suggest that they go to 240 acres.

Q You would rather see an oversized unit than an undersized unit?

A Then they could have the unitized allowable with it.

Q Along the west side of this township, there are some undersized sections which, I presume, do have some small lots under them?

A Yes, sir, you can see it is dotted out, I believe in Section 7. In the south part of the plat, you can see the size of those small lots.

Q Referring to your Exhibit Number--or Figure No. 8 in Exhibit 1 in which you have--correction, we will make that Figure 9, in which we have the rim block and the basin block. Now, this is probably the limits of the development as far as commercial production is concerned, as you know it now, is that

correct?

A It could extend into the area a little bit north of that, as shown on Figure 8, colored--the areas colored on Figure 9 would be the area primary possibility. Figure 8 there colored in brown, in my opinion, might offer production or might permit production, but I really doubt that it would be commercial. Somewhere in the brown shaded area, I think we will find the end of the commercial production.

Q Now, actually, what you have done, if you take the colored area on Figure 9 which is bounded by the dotted line, you have extended that on the north with the dashed line by just about a belt, a belt of just about a mile width, is that correct?

A Yes, sir, that's correct.

Q And then down on the southwest side of the colored area, you have extended that area by a belt exactly one mile wide around on the southwest side?

A Yes, sir. If I might continue on that, we shorten it on a due south side because of the poor development shown in the No. 1 Elliott, the southernmost well on the plat along the range line between 13 and 14 west.

Q What are the pool boundaries as established by the Commission at the present time?

A The present designated La Plata-Gallup Pool, I believe,

covers the south half of Section 5, and then, of course, as I understand it, the rules applying to this pool then would also cover wells drilled within one mile of that boundary, which just about fits this southern boundary. Of course, it would be slightly east of this boundary.

Q The pool has never been extended over to the Taylor Walker Well yet?

A I think that the Taylor Walker Well has just been operated under the same rules, since it is within about a mile of the present designation.

Q And then you have two wells in Section 31 which aren't shown on this exhibit, and the pool hasn't been extended to take them in either, also?

A No, sir.

Q Now, your request here for the 160-acre spacing is that these rules would be applicable to the entire area of the La Plata-Mancos Unit, the way I understand it?

A Yes, sir.

Q Which would be beyond the commercial productive limits, as you estimated them, they would be well beyond the present pool boundaries, and they would even be past the commercial limits? Take up in the north end there of the unit, you have a belt there that is beyond the one mile belt, which is at least a

half a mile wide, so you would be making these rules applicable for beyond the present pool boundaries and beyond the expected boundaries of commercial production?

A Yes, sir. The reason for that is it is so difficult to tell for sure where the production will start and where it will end.

Q I realize when you have a fracture system this way, it could extend a good distance.

A Yes, sir. And we felt it is absolutely necessary to cover the area, and we feel that on one will be harmed if we have a little larger area than actually covers these pools.

And, of course, as we understand it, there is nothing at some future date to prevent an operator from asking a hearing to shrink the pool boundaries, if through development of additional information they have found a separate reservoir which requires different treatment, as for instance a sand bar.

Q Is it your present contemplation to drill any additional wells?

A Yes, sir, there is a well in Section 32 of Unit G, which is currently being drilled; and further drilling to the north of that would probably depend on the outcome of that well.

Q And there is nothing going on at the present time in the brown area?

A Yes, sir, we are preparing to work over the well in the southeast quarter of Section 5, indicated on Figure 9 as the J-5.

Q That is shown with the gas well symbol?

A Yes, sir, that well was originally completed in the Dakota. We have just recently plugged the Dakota off and are preparing to treat the Gallup formation.

Q Is that the Hoss well that we had considerable correspondence on last year?

A No, sir, the Hoss well is the old Standard of Texas 5-1 well which Hoss purchased from Standard of Texas, and we purchased then from Hoss, and it is designated on here as the M-5.

MR. NUTTER: I believe that is all the questions I have. Are there any other questions that anyone wants to ask of Mr. Greer? Go ahead, proceed with your next direct testimony.

(Whereupon, Applicant's Exhibits Numbers 1, 2, 3, 4, 5, inclusive, Case No. 4074, were marked for identification.)

DIRECT EXAMINATION

BY MR. COOLEY:

Q Mr. Greer, Benson-Montin-Greer has made application to the Commission in Case No. 4074, for the institution of a pressure maintenance project in the La Plata-Gallup Oil Pool, and the

surrounding area, the area covered by the La Plata-Mancos Unit Agreement. Have you prepared a plat which shows thereon the proposed injection water wells?

A Yes, sir.

Q I hand you what has been marked as Exhibit 1 in Case 4074, and ask you if that is the plat to which you refer?

A Yes, sir.

Q Does Exhibit 1 show thereon the proposed water injection well?

A Yes, sir.

Q Would you identify that, please?

A It is in Unit B of Section 31, and is identified on the plat.

Q For what purpose do you propose, what specific purpose do you propose to inject water into this pool at this time, Mr. Greer?

A In order to maintain pressure and keep the characteristics of the reservoir oil as favorable as possible. We believe by this sort of flotation water flooding process, we can realize the same ultimate recovery, high ultimate recovery as we can by gravity drainage. It is just a reverse process of moving the oil uphill rather than downhill. The important thing is to keep the gas in solution, and prevent a deterioration of

the relative permeability characteristics.

Q Does the success of this water injection pressure maintenance concept depend upon the concept that the water will, because of its weight, sink to the bottom of the reservoir or below the oil, at least?

A Yes, sir, the area right around the proposed injection well is fairly tight, low permeability. We believe the water will course in all directions as we inject the water into this well, but when it reaches the permeability indicated for the reservoir found in the No. 1 Walker and in the N-31, this will be high enough permeability to allow the water and oil to separate by gravity segregation. We feel then that the oil will float to the top, in a sense, the water will tend to move to the bottom; and if we can keep the oil undersaturated, we think we should have a high recovery of oil in place.

Q Do you have any evidence through the producing history of this pool of the amenability of the pool to gravity segregation? Have you had occasion to observe gravity segregation in the pool?

A All we can do is calculate on the basis of transmissibility the rates of gravity segregation, gravity drainage, which we have done, and we think would be adequate for a successful flood. Our only problem here is that the reservoir appears to be

quite small.

Q Have you prepared a diagrammatic sketch of the proposed water injection well?

A Yes, sir.

Q I hand you what has been marked as Exhibit Number 2 in Case No. 4074, and ask you if that is the diagrammatic sketch to which you refer?

A Yes, sir.

Q Will you explain to the Examiner the information set forth thereon?

A Well, this plat simply shows the casing in the well, the proposed setting point of the packer. It was our intention to load the annulus with oil behind the packer, and we will then inject water into the perforations through which the well now produces.

Q Do you also propose to simultaneously inject gas into the reservoir at a different point.

A Yes, sir. In Exhibit 1, we show the location of the proposed gas injection well. It is in Unit N of Section 31, and is marked on the plat.

Q What is the purpose of injecting gas, what would be your purpose of injecting gas into this reservoir?

A Our purpose in injecting gas is again to help maintain

reservoir pressure high enough to keep the oil at a pressure above the bubble point. We have anticipated by the time we can get water started into the ground that the pressure will have dropped somewhat in the reservoir, and it will be necessary then to raise the pressure in order to keep the oil pressure above the bubble point.

We can do it two ways. One would be to inject an excess amount of water and compress the gas cap, but if we do we are apt to lose oil into the dry gas cap. So our plan is to inject enough water to raise the level around the No. 1 Walker. At that time, we will inject enough gas to raise the pressure in the reservoir to a point that we can plug the well and a draw down in the well bore, while leaving the working pressure at or near the bubble point. In this fashion, we can produce with a minimum draw down any given volume of oil, and with a minimum draw down in pressure we will have a maximum potential for successful water flood.

Q Has the gas oil ratio in the Taylor Walker well shown any increase since its completion?

A It produced from about three months from the end of November to the end of February at about solution gas oil ratio, and at this point it started--it has recently started a slight increase in gas oil ratio, which is just about the same we

calculated would happen.

Q Isn't it also further evidence of the amenability of the reservoir to gravity segregation?

A I believe it indicates that some gravity segregation was taking place in the production of this well, inasmuch as the gas oil contact is only 60 feet above the datum at which this well produces. And horizontally from the well bore, it would have to be within 200 or 300 feet, and there is enough oil being produced that had we had complete gravity segregation, the gas would have been approximately to the well bore now. So this means there has been very little coning, and with very little coning we can only assume that we have had good gravity segregation.

Q Have you prepared a diagrammatic sketch of the proposed gas injection well, N-31?

A Yes, sir.

Q I hand you what has been marked as Exhibit Number 3 in Case 4074, and I ask you if this is that diagrammatic sketch?

A Yes, sir.

Q Would you please point out the significant features of this?

A This also shows the strings of casing in the hole where they were cemented, and how much cement. This is an open hole

completion, approximately 80 feet of open hole below the casing.

It is our intention to inject gas in this well in the casing without either tubing or packer. I understand this is an unusual procedure, but in this instance we feel that it is a completely safe operation.

The casing is seven and five-eighths inch N-80 casing, will stand several thousand pounds pressure, and we anticipate our highest injection pressure to be on the order of 300 or 400 pounds.

Q Mr. Greer, what will be the respective sources of the injected water and injected gas in the event this application is approved?

A As to water, one of the local ranchers has a water well within a few hundred feet of the proposed water injection well. We have an agreement with the rancher to purchase water from him.

As to the source of gas, Southern Union Gas Company has a pipeline within a few hundred feet of the well, and the line carries pressures ranging from 300 to 500 pounds. It is our plan to purchase gas from Southern Union and inject it into the well without compressor, just simply use line pressure. The injection rates will be quite small. We anticipate injecting probably not more than 100,000 feet a day, and probably injection

would be required for a period of time less than a year in order to raise the reservoir pressure to the point desired.

Q Then with respect to the water sources, it would be fresh water that you would be injecting?

A Yes, sir.

Q Mr. Greer, in your opinion, will the approval of the proposed pressure maintenance project increase the ultimate recovery from the La Plata-Gallup Oil Pool?

A Yes, sir, in the circumstances which we have found, the wells which we have drilled in this area so far, it appears that we cannot utilize gravity drainage in the normal fashion, which we would have preferred in this particular fault block, for the simple reason that the highest productivity wells are updip, and the lower productivity wells are downdip. Accordingly in order to reduce the reservoir to a reasonable rate of production, it is more practical to inject water downdip than to produce the updip wells, rather than, say, inject gas updip and produce the downdip wells. Of course, we are going to inject gas, but only for the purpose of raising the pressure, and not for the purpose of moving the oil downdip.

Q In your opinion, can the correlative rights of any operator in the entire area of the pool be adversely effected by the approval of this proposed project?

A No, sir, all of the owners of working interest rights within the area of the proposed pressure maintenance project have committed their interests to the unit agreement, and we can see no difficulty with uncommitted owners.

Q It is your proposal, however, that the entire unit area be considered as the pressure maintenance project area?

A Well, sir, I believe the practice of the Commission has been, even inside a unit, to designate pressure maintenance projects which do not cover the entire land, and I should think we can be guided by the same principles that the Commission has used in the past for designating a pressure maintenance project.

Q Do you have any recommendations with respect to the area to be covered by the proposed pressure maintenance project?

A Well, I have not given thoughts to that, but I guess we can do it right now.

I would suggest all of Section 31, the east half of Section 36, the east half of Section 1, the north half and the southwest quarter of Section 6.

Q Does that include all of the presently completed wells in that particular fault block?

A Yes, sir, so far as we know at this time.

Q If any additional wells were completed within that particular fault block, would it be your recommendation that

the project area be enlarged to include them?

A Yes, sir.

MR. COOLEY: I have no further questions on direct.

CROSS EXAMINATION

BY MR. NUTTER:

Q Mr. Greer, referring to Exhibit Number 2 first, I note that your surface pipe is set at 276 feet. Is this adequate to protect the surface water in this area, the shallow fresh water?

A Yes, sir.

Q Do you know what the depth of the rancher's well is that you will be buying water from?

A I don't recall that. I believe it is from--I believe we checked into this one time, and decided it is producing from the Cliff House, and, of course, the formation dips in that area. The Cliff House is exposed on the west part of the unit, and it is several thousand feet deep on the east side of the unit. The surface or near surface water sands are not related, I don't believe, I believe are not related to any of the other formations.

Q Now, what volume of water do you anticipate you will be injecting into this well?

A It is my thought that we would inject just enough

water to maintain reservoir pressure, once we have raised the reservoir pressure by injecting gas in the N-31. It is my thought that we will shut the well in, use it as an observation well to measure reservoir pressure, and then we will adjust our injection, water injection volumes to maintain that pressure, neither increase or decrease it.

Q In other words, you would be putting in what you take out?

A Putting in what we take out. Nearly always there is a loss of water injected, and it varies from perhaps 10 to 30 per cent. I don't know whether it is absorbed in the shale, or what happens to it. But I would think that that would be something on the order of what we would inject, from 100 to 130 per cent of the oil produced.

Q Do you have any idea what the injection pressure will be for that water?

A No, sir, we have not run any calculation. I have just assumed we would have no difficulty in putting the water away. We have a tentative order for a pump which will go up to several thousand pounds, if we need it. And, of course, we are certain that we can put the water away if we have to go to fracking the pressure, which will be 1,500 to 2,000 pounds.

Q Now, the perforated interval in this P-31 is 2,943 to

2,975. Would that be with reference to the cross section that you have in this Exhibit Number 1 with the brown, the yellow, and the green? Would that be in the brown area?

A It is only in the brown area, yes, sir.

Q And then referring to Exhibit Number 3 on the gas well, you mentioned the source and the volume, and the pressure. It is this open hole interval from 2,219 to 2,234 in the brown only?

A No, it is in both. It is in both the yellow and the brown.

Q That is the well that we were discussing before lunch that is partially completed above the gas oil contact, isn't it?

A Yes, sir.

Q Is the surface casing here adequate to protect the shallow fresh water from being contaminated by gas in the event you should have a breakthrough somehow? You have 176 feet.

A Yes, sir. I believe at that point we don't really have fresh waters. That is usually characterized by water that is not fresh. I believe at this particular point, we don't have surface fresh water problems.

Q No shallow fresh waters here?

A No, sir.

Q Now, in your P-31 well, you will use plastic lined

tubing, and you are going to load the annulus with oil. Can that be equipped with a pressure gauge at the surface so you can detect a pressure leak?

A Yes, sir.

Q And you suggest for the project area that we include all of 31, the east half of 36, east half of 1, and the north half and southwest quarter of 6?

A Yes, sir.

Q Now, you mentioned that the G-32 is drilling in the northeast quarter of Section 32?

A Yes, sir.

Q Presumably upon completion of that well as a producer, you would extend the project area. And what is the status of this I-6 in the southeast quarter of Section 6?

A Sir, if I might make a comment on the possibility of adding the G-32. If, of course, we find that the G-32 on completion to be a commercial well, and in the same fault block as these others, we would ask for it to be extended.

Now, we are in the real steeply dipping part of the formation at that point, and it is our present thinking that this well, if it develops to be a commercial producer, will probably be in a different fault block than either of the others.

Q There is a transitional zone between the rim block and the basin block?

A Yes, sir. I believe this for the reason that as we examine the pressure coefficient of the wells in the rim block now, and the fact that we have found a substantial gas cap, we can then back up our calculations to a total volume of oil and total area, and that point I feel it unlikely the area will be large enough to include the G-32. We don't know this, but this is our thought.

Q What is the status of the I-6?

A I-6 is about to be plugged. We have drilled the well, set pipe, fracked it, and produced part of the fracked oil back. I doubt we will recover all of the fracked oil before we plug it. I-6 is definitely in the area of noncommunication with either the rim block or the basin block.

Q That is where those rocks are bent and very tight, I guess?

A Yes, sir, probably faulted.

MR. NUTTER: I believe that is all I have. Does anyone have any questions of Mr. Greer in this case?

MR. COOLEY: I have something additional.

REDIRECT EXAMINATION

BY MR. COOLEY:

Q Mr. Greer, you have submitted to the Commission logs on both proposed injection wells, have you not?

A Yes, sir.

Q I hand you what has been marked as Exhibit Number 4 in Case 4074, and ask you to identify this, please?

A Yes, sir, this is the well in which we propose to inject gas.

Q That being--

A The N-31.

Q I hand you what has been marked as Exhibit Number 5 in Case 4074, and ask you to identify it, please?

A It is a log of the P-31 well, which we propose to inject water in.

MR. COOLEY: Mr. Examiner, Applicant offers into evidence Exhibits 1 through 5, inclusive.

MR. NUTTER: Applicant's Exhibits 1 through 5,in Case No. 4074 will be admitted in evidence.

(Whereupon, Applicant's Exhibits Numbers 1, 2, 3, 4, 5, inclusive, Case 4074, were admitted in evidence.)

Does anyone have any further questions of Mr. Greer

in this case? Do you have anything further in this case, Mr. Cooley?

MR. COOLEY: No, sir.

MR. NUTTER: We will proceed with Case 4075.

DIRECT EXAMINATION

BY MR. COOLEY:

Q Mr. Greer, has the Oil Conservation Commission already approved as to form the La Plata-Mancos Unit Agreement?

A Yes, sir.

Q Has the operator of that unit been Benson-Montin-Greer?

A Yes, sir.

Q Have you had occasion, Mr. Greer, to consider minor changes as to the form of that agreement?

A Yes, sir.

Q What particular portions of the La Plata-Mancos Unit Agreement do you propose now to amend?

A We would like to amend pages 15, 16, 17, and 18 for the purpose of permitting lands to be added to a participating area which are necessary for unit operations, lands which not necessarily are established to be commercially productive.

Q For what reason would it be justifiable to include such lands within a participating area?

A For the reason, as we just reviewed in the preceding

case, we would like to add a gas well to the participating area in order to inject gas into it. As a gas well, it is a noncommercial well. It is also a noncommercial well as an oil producer. According to the terms of the unit agreement as originally approved, only lands which are commercially productive can be added to a participating area. This would permit lands to be added to a participating area which are necessary to unit operations.

Q For further production of that well as a gas well, it would have an extremely adverse effect on the oil recovery from the pool?

A Yes, sir. Wells producing from a structural position, the same as the N-31, would probably produce a little bit of oil, but the amount of gas to be produced with it would so deplete the reservoir pressure as to seriously affect the ultimate recovery, so these wells are wells in that category and should not be produced. Accordingly, lands of this category should not have wells drilled on them, but there are some gas and some oil that can be recovered from them from the downdip wells. Accordingly, they need to be added a participating area, given some fair equity, and handled in this fashion.

Q I hand you what has been marked as Exhibit Number 1 in this case, and ask you to explain the significance of this

exhibit?

A This exhibit shows pages 15, 16, 17, and 18 as they appeared in the original unit agreement which the Commission has already ruled on. Shown in red on these pages are the changes necessary to put the unit agreement in the form which we require in order that lands necessary for unit operations can be added to participating areas.

The United States Geological Survey has approved as to form these changes as shown here. The State Land Office has also approved them.

Q In your opinion, Mr. Greer, will the proposed changes in this unit agreement tend to prevent waste and protect correlative rights within the unit?

A Yes, sir.

MR. COOLEY: No further questions.

(Whereupon, Applicant's Exhibit Number 1, Case 4075, was marked for identification.)

MR. NUTTER: Does anyone have any questions regarding this case? Mr. Greer may be excused.

Mr. Cooley, do you have anything to say with respect to the three cases?

MR. COOLEY: Thank you for the offer, Mr. Examiner. I think we have taken quite enough time of the Commission, and the

transcript will speak for itself.

MR. NUTTER: Does anyone have anything they wish to offer in these three cases? We will take the cases under advisement, and call Case No. 4065.

I N D E X

STATE OF NEW MEXICO)
) ss.
COUNTY OF BERNALILLO)

We, ADA DEARNLEY and SAMUEL MORTELETTE, Court Reporters in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Hearing before the New Mexico Oil Conservation Commission was reported by us, and that the same is a true and correct record of the said proceedings, to the best of our knowledge, skill and ability.

Ada Dearnley
ADA DEARNLEY - COURT REPORTER

Samuel Mortelette
SAMUEL MORTELETTE - COURT REPORTER

I do hereby certify that the foregoing is
a complete record of the proceedings in
the Examiner hearing of Case No. 4067-74-75
heard by me on 3/5, 1969.

..., Examiner
New Mexico Oil Conservation Commission