STATE OF NEW MEXICO

ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION

IN THE MATTER OF THE HEARING CALLED BY THE OIL CONSERVATION DIVISION FOR THE PURPOSE OF CONSIDERING:	CASE NO. 11,650
APPLICATION OF TEXACO EXPLORATION AND PRODUCTION, INC., FOR AMENDMENT OF DIVISION ORDER NUMBER R-5530, AS AMENDED, TO INCREASE INJECTION PRESSURES IN ITS CENTRAL VACUUM UNIT PRESSURE MAINTENANCE PROJECT AREA, AUTHORIZE A TERTIARY RECOVERY PROJECT BY THE INJECTION OF CARBON DIOXIDE AND TO QUALIFY THIS PROJECT FOR THE RECOVERED OIL TAX RATE PURSUANT TO THE ENHANCED OIL RECOVERY ACT, LEA COUNTY, NEW MEXICO	ORIGINAL

REPORTER'S TRANSCRIPT OF PROCEEDINGS
EXAMINER HEARING

BEFORE: DAVID R. CATANACH, Hearing Examiner

December 19th, 1996
Santa Fe, New Mexico

This matter came on for hearing before the New Mexico Oil Conservation Division, DAVID R. CATANACH, Hearing Examiner, on Thursday, December 19th, 1996, at the New Mexico Energy, Minerals and Natural Resources Department, Porter Hall, 2040 South Pacheco, Santa Fe, New Mexico, Steven T. Brenner, Certified Court Reporter No. 7 for the State of New Mexico.

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I N D E X

December 19th, 1996
Examiner Hearing
CASE NO. 11,650

* * *

E X H I B I T S

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* * *

A P P E A R A N C E S

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By: WILLIAM F. CARR

* * *

WHEREUPON, the following proceedings were had at 10:48 a.m.:

EXAMINER CATANACH: At this time we'll call Case 11,650.

MR. CARROLL: Application of Texaco Exploration and Production, Inc., for amendment of Division Order Number R-5530, as amended, to increase injection pressures in its Central Vacuum Unit Pressure Maintenance Project Area, authorize a tertiary recovery project by the injection of carbon dioxide and to qualify this project for the recovered oil tax rate pursuant to the Enhanced Oil Recovery act, Lea County, New Mexico.

EXAMINER CATANACH: Are there any appearances in this case?

MR. CARR: May it please the Examiner, my name is William F. Carr with the Santa Fe law firm Campbell, Carr, Berge and Sheridan.

We represent Texaco Exploration and Production, Inc., and I have four witnesses.

EXAMINER CATANACH: Any additional appearances?

Will the witnesses please stand to be sworn in?

(Thereupon, the witnesses were sworn.)

MR. CARR: At this time we would call Mr. Lanning.

RONALD W. LANNING,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Would you state your name for the record, please?

A. Ronald W. Lanning.

Q. Where do you reside?

A. Midland, Texas.

Q. By whom are you employed?

A. Texaco Exploration and Production, Inc.

Q. Mr. Lanning, what's your position with Texaco?

A. I'm a landman on the North Hobbs Asset Team.

Q. Have you previously testified before this Division?

A. I have.

Q. At the time of that testimony were your credentials as a petroleum landman accepted and made a matter of record?

A. They were.

Q. Are you familiar with the Application filed on behalf of Texaco in this matter?

A. Yes, sir.

Q. Are you familiar with the status of the lands in the area surrounding the Central Vacuum Unit?

A. I am.

Q. Have you prepared exhibits for presentation here today?

A. Yes, sir.

MR. CARR: Are Mr. Lanning's qualifications acceptable?

EXAMINER CATANACH: They are.

Q. (By Mr. Carr) Would you initially summarize for Mr. Catanach what it is Texaco seeks with this Application?

A. We seek amendment of Division Order Number R-5530, as amended, dated September 20th, 1977, which approved the Central Vacuum Unit Pressure Maintenance Project for the injection of water into the Vacuum-Grayburg-San Andres Pool to:

Number one, increase the maximum surface injection for water in certain injection wells to 1500 pounds, provided there is no break in the step-rate tests.

Number two, to authorize the implementation of tertiary recovery operations in this project area by including the injection of carbon dioxide and produced gases with water into the Grayburg and San Andres formations.

And, three, to provide for the differences in density of CO_2 by permitting CO_2 injection to be conducted at maximum of 350 p.s.i.g. above the allowed surface water

injection pressure, not to exceed 1850 p.s.i.g., which is lower than the pressure requested in our Application.

Q. The Application actually requested 1900 as a limit, did it not?

A. I believe it did.

Q. We also will be asking that this project be qualified as a tertiary recovery project for the recovered oil tax rate; is that correct?

A. Yes, sir, it is.

Q. Could you identify what has been marked as Texaco Exhibit Number 1?

A. Exhibit Number 1 is our Application filed with the Division seeking qualification for the recovered tax rate.

Q. Attached to that exhibit are attachments A through D. Will they be referred to periodically throughout the presentation of other witnesses in this case?

A. They will.

Q. Mr. Lanning, when was the Central Vacuum Unit formed?

A. It was formed August 9th, 1977, pursuant to the Statutory Unitization Act in 1977, under Order Number R-5496.

Q. Does the unit agreement authorize CO_2 flooding?

A. Yes, it can be conducted under the agreement, because the agreement provides for the use of advanced technologies.

Q. And Texaco is the operator of the unit?

A. Yes.

Q. When did waterflood operations commence in the unit area?

A. In 1978, pursuant to Division Order Number R-5530.

Q. Let's go to Texaco Exhibit Number 2. Will you identify that for Mr. Catanach and then review what it shows?

A. Exhibit Number 2 is just a pretty simple base map of the area. You'll note that the Central Vacuum Unit is highlighted in yellow and outlined in red, and the various offsetting units are also designated and named in different colors.

I'll point out that Phillips' East Vacuum-Grayburg-San Andres Unit to the east and also Phillips' State 35 Unit, which is in the middle part of the western boundary of the Central Vacuum Unit, are identified, and both of those units inject CO_2.

Q. Are the pressures that we're seeking here today compatible or consistent with the pressures being utilized by Phillips for CO_2 injection in its offsetting units?

A. I believe they are.

Q. Let's go back to Exhibit Number 1 and look at attachment A to that exhibit. Can you identify this plat and explain to Mr. Catanach what it shows?

A. This is a map which specifically identifies the project target area within the Central Vacuum Unit, and it also designates our Vacuum-Grayburg-San Andres Unit, which is the offsetting unit to the southwest of the Central Vacuum Unit.

Q. All right. We've got the Central Vacuum Unit outlined in what? Black?

A. The entire unit is outlined in black. The project area is outlined in red.

Q. How many acres are there in the Central Vacuum Unit?

A. The unit itself is approximately 3080 acres. The project area is approximately 1550 acres, which is just slightly over half.

Q. This shows all wells in the unit area and the --

A. Yeah, the --

Q. -- current status?

A. Yes, all the wells are designated as either producers or injectors.

Q. Are there current plans to add injection wells to what is covered by this Application?

A. There are not.

Q. What is the character of the land in the unit area?

A. It's essentially all State of New Mexico lands. There is one fee tract within the unit.

Q. Is Exhibit Number 3 an affidavit confirming that notice of this Application has been provided?

A. It is.

Q. And to whom was notice given?

A. We sent notice to all of the offset operators within a half mile of any proposed injection well in the field and also to the surface owners on which each injector is located.

Q. Will Texaco be calling engineering witnesses to review the technical portions of this case?

A. Yes.

Q. Were Exhibits 1 through 3 either prepared by you or compiled at your direction?

A. They were.

MR. CARR: At this time, Mr. Catanach, we would move the admission into evidence of Texaco Exhibits 1 through 3.

EXAMINER CATANACH: Exhibits 1 through 3 will be admitted as evidence.

MR. CARR: And that concludes my direct

examination of Mr. Lanning.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Lanning, is it Texaco's intent to only inject CO_2 within the project target area?

A. That's my understanding.

Q. Okay. Your unit agreement and -- unit operating agreement have provisions for allocation under a tertiary-recovery flood?

A. Well, it has provision for the -- It doesn't specify CO_2, but it provides for advanced technologies, and we plan to use the existing tract participation factors.

Q. Who are Texaco's working interest partners in this unit?

A. I don't have that with me. Marathon is the second largest with, I believe, about 25 percent. We currently have 58 percent.

EXAMINER CATANACH: Maybe I'd better just --

MR. CARR: I think Mr. Wehner probably can respond to that, because he can tell you the status of the voluntary joinder of the other owners in the proposed CO_2 project.

EXAMINER CATANACH: Okay, let's just --

MR. CARR: And he will be our next witness.

Q. (By Examiner Catanach) Mr. Lanning, under the

unit agreement, was there any provision where you had to get approval by the Commissioner of Public Lands for conducting the tertiary operations?

A. No.

Q. They were notified, though?

A. No, I don't believe they were, Mr. Catanach, because we're proceeding under the existing approvals.

EXAMINER CATANACH: Okay, I do have them on this notice list for the hearing.

MR. CARR: Yeah, and they were -- and they were notified because they were the owner of the surface of the land, but they were notified.

EXAMINER CATANACH: Okay, I think that's all I have for now.

MR. CARR: At this time we would like to call Mr. Wehner.

SCOTT C. WEHNER,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Would you state your name for the record, please?

A. Scott Wehner.

Q. How do you spell your last name?

A. W-e-h-n-e-r.

Q. Where do you reside?
A. Midland, Texas.
Q. By whom are you employed?
A. Texaco Exploration and Production, Inc.
Q. What is your current position with Texaco?
A. I'm a project engineer, licensed to practice petroleum engineering.
Q. Have you previously testified before the New Mexico Oil Conservation Division?
A. I have.
Q. At the time of that testimony, were your credentials as an expert accepted and made a matter of record?
A. Yes, they were.
Q. And at that time were you qualified as an engineer?
A. I was.
Q. And in what did you actually receive your degree?
A. Geological engineering.
Q. Are you familiar with the Application filed in this case on behalf of Texaco?
A. I am.
Q. And are you familiar with the Central Vacuum Unit and Texaco's plans to implement a CO_2 flood in that unit?
A. Yes, sir.

Q. Have you made a technical study of the unit based on your work, and are you prepared to make recommendations to the Examiner concerning the need to implement tertiary-recovery applications at this time?

A. I am.

MR. CARR: Are the witness's qualifications acceptable?

EXAMINER CATANACH: They are.

Q. (By Mr. Carr) Mr. Wehner, what is the current status of Texaco's efforts to implement this project?

A. Significant man-years have been put into reservoir characterization of this field, and specifically this reservoir. Those studies have been completed over the last couple of years. Geological interpretations have been made, as has also been included into reservoir compositional simulation. Facilities designs have been completed for the project. We have received corporate approval for the investments through Texaco's senior management.

We have balloted all of the working interest owners in the Central Vacuum Unit. To date, we have received 17 of the 22 working interest owners' approval for the project, yielding 62.8 percent of the 65 percent required for approval of the project. We've been in verbal communication with those other operators, and we expect

well over 90-percent approval very shortly for the project. We do not and have not received any disapprovals to date.

Q. Are related contracts being negotiated to go forward with this project?

A. They are. We are negotiating a CO_2 commodity purchase contract. We are likewise contracting for the transportation of that same CO_2. We are negotiating a gas-processing contract and also lease-line agreements with offset units.

Q. How soon does Texaco hope to commence operations of the CO_2 project?

A. We anticipate to begin injection of CO_2 injection within the project area around -- on or about April 1st, 1997.

Q. Mr. Wehner, let's go back to the base map, Exhibit 2. In referring to that, could you review the current status of this unit?

A. Okay, first of all on Exhibit 2, which represents basically the limits of the entire Vacuum field, other than a few small tracts, it is all under some form of secondary recovery or tertiary recovery. And of course, as you can see in the bright yellow, Central Vacuum Unit gets its name from its relative position in the field.

I'd like to first point out what's most notable here is that immediately to the east of the Central Vacuum

Unit is Phillips' operated East Vacuum-Grayburg-San Andres Unit. That unit has been under -- or a portion outlined in blue has been under CO_2 active operation since late 1985, so we have a very large amount of data available to analyze from that. It's been going for 11 years now.

As of November 26th of this year, Phillips also initiated CO_2 operations in the State 35 unit, immediately offset to the west of the Central Vacuum Unit.

Waterflood operations in the Central Vacuum Unit itself began in early 1978 with Division Order R-5530. There are currently a total of 86 active injection wells in the unit. Cumulative volumes that have been injected through October of this year is approximately 326 million barrels of water. We are currently injecting at approximately 63,000 barrels of water per day, which on average is around 732 barrels of water per day per well.

There are 88 active producers within the unit. We are currently drilling three additional producers, the first of which was spud Monday of this week.

There's been a total cumulative oil production to date of 72 million stock tank barrels of oil. Since commencement of waterflooding, we have recovered 42 million barrels of that total. We are estimating ultimate recovery, inclusive of primary and secondary, to reach 44 to 45 percent of the original oil in place within the unit

boundaries.

The project area, although not shown on this map -- we have it shown on some other maps that you'll be seeing in later exhibits -- represents only approximately 50 percent of this acreage, more or less.

Q. Could you explain to Mr. Catanach how Texaco proposes to implement this CO_2 flood?

A. Recovery within the targeted area or the project area is to be enhanced with the introduction of CO_2. Typical of CO_2 projects within the industry, produced gases will be recycled or reinjected as warranted, water will continue to be reinjected outside of the project area and also in the target area with alternating slugs of CO_2 in what is known as water alternating gas injection scenario.

Within that targeted area or the project area for the CO_2 operations there are 68 existing producing wells and 51 injection wells which will be utilized in the project. Three additional wells, as I said, are currently drilling. That's the only drilling we have planned at this time. There are currently no other plans to drill except on the lease lines, and those negotiations, as I mentioned earlier, are ongoing with offset operators.

We plan to purchase 95 billion standard cubic feet of CO_2 for the project. Produced gases will be recycled back into the reservoir, resulting in an ultimate

injection of 259 billion standard cubic feet of gas over the next 25-year period.

The recycled gas would consist of CO_2, certain hydrocarbons that can not be economically marketed and associated nonhydrocarbon gases.

Q. Mr. Wehner, how were the boundaries of the project or target area determined?

A. Well, the target area is driven, really, by two factors, the two factors which are most influential on the miscible CO_2 process itself.

The first factor is, well, where is the location of the hydrocarbon pore volume that you can contact with the CO_2? In other words, the oil available to contact with the process.

And then secondly is injectivity or a time component, and how fast can you contact that hydrocarbon pore volume and process the reservoir?

Q. Before we actually look at the reservoir, could you refer to the Phillips East Vacuum-Grayburg-San Andres Unit and just briefly review the status of the tertiary-recovery operations in the unit to the east of the Central Vacuum?

A. Okay, as you said, it's immediately east and borders the Central Vacuum unit. That project, the CO_2 project, that is -- Let me back up.

Its waterflood operations started about a year and a half after waterflood operations started at Central Vacuum Unit. However, very shortly thereafter, they got an order, R-6856, to commence -- to start a CO_2 project. They ultimately began injecting in late 1985 and over the course of an 18-month period phased in the blue area on Exhibit 2.

They've had 11 years of a very successful CO_2 flood, and although not the largest in volume, East Vacuum is one of the most efficient CO_2 floods out of the 40 Permian Basin CO_2 floods that now exist.

The current authorized bottomhole injection pressure at East Vacuum is 3150 p.s.i.g. for CO_2. That equates to a surface injection pressure of approximately 1850 p.s.i.g.

Q. And that's what we're seeking in this case; is that right?

A. Yes, it is.

Q. What about the status of the tertiary-recovery operations in the Phillips State 35 unit?

A. Phillips' State 35 Unit is New Mexico's most recent CO_2 flood. It's the third CO_2 flood of any major size that's been started in the state. It actually started injection November 26th of this year, so it's relatively new. That was approved with Order Number R-10,599-B on September 27th of this year.

It's currently authorized to inject CO_2 with a surface injection pressure of 1850 p.s.i., which is equivalent to that 3150-p.s.i. approved pressure for CO_2 at the East Vacuum.

Q. And again, it's consistent with what we're asking for here today?

A. Yes, it is. We're asking for a maximum of 1850 p.s.i.g. on CO_2 injection.

Q. Let's go back to Exhibit 1 and to attachment C to that exhibit, and I'd ask you to identify that and review it for Mr. Catanach.

A. Well, this exhibit C to attachment 1 [*sic*] is the Central Vacuum Unit type log from the original unitization. It includes portions of the Grayburg-San Andres formations, which are identified in that unit agreement. The unitized interval is from 3858 feet to 4858 feet on this particular log.

This is a Welex acoustic velocity log. It was run in November of 1963 in Texaco's State of New Mexico "O" NCT-1 Well Number 23, located in the southwest quarter of the southeast quarter of Section 36, Township 17 South, Range 34 East, Lea County, New Mexico.

On here, travel time is shown on the right scale of the type log as a general measure of porosity. As that curve moved to the left, there's increased porosity.

The log trace in the left column is the gamma-ray, and as that moves to the left, that represents a cleaner carbonate sequence. Both curves moving to the left are targeted dolomite zones for the flooding operations.

On here we've shown the Grayburg marker at about 4107 feet. That marker is simply just a -- as it states, a marker. It exists throughout the entire Vacuum area and is a good reference for mapping purposes and stratigraphic cross-sections.

The Grayburg dolomite is shown below that, and then the upper San Andres dolomite. The lower San Andres dolomite is separated from the upper with the Lovington sand.

Q. Into what portion of this formation do you propose to inject?

A. Well, basically we plan to inject the same as the ongoing waterflood operations, that is, any porosity with sufficient permeability to process the unitized hydrocarbon interval.

From a practical basis what that means is, based on our core analysis, the sandstone members that we find out here are very tight, They have some porosity, but permeability is never developed. They're considered nonpay.

Our completions are to approximately 4700 foot.

That's fairly consistent within the Central Vacuum Unit. It's well above the unitized base that's shown on here. 47 foot is approximately where the oil-free column existed at discovery, and that's where our completions are to also. And our evaluations of our significant core database that we have suggests that the carbonates are productive above a 7-percent porosity cutoff.

Q. Is it fair to say that what we're doing is seeking authority to inject into essentially the same intervals that are being used for CO_2 injection in the offsetting units located both east and west of the Central Vacuum Unit?

A. Yes, with the exception of the thin Grayburg dolomite zone that exists. The Grayburg dolomite, sufficient porosity and permeability never developed off the structural high of this acreage, and the structural high exists pretty much on our acreage, as shown on later maps.

Q. Mr. Wehner, could you describe the general characteristics of the Grayburg-San Andres formation?

A. Well, the Grayburg dolomite is a minor carbonate sequence near the base of the formation. It's usually separated from the San Andres itself by a sand. We call it the Grayburg sandstone. Again, it's nonproductive and it comes and goes. It exists in some locations; it does not

exist where this particular type log is.

The San Andres is two major carbonate sequences with multiple shoaling upward cyclic depositions. The Lovington sand, as I mentioned, is between those two. It's a minor sand -- Well, there's some minor sands found in the Upper San Andres. They are very limited in areal extent. Again, none of them have been found to be productive.

And when I say sands, from core analysis, even in the literature, they're called sands, but they're actually a silty dolomite, is probably the reason why the permeability is as bad is it is.

The thickness of the producing horizon, if you'll look at the Exhibit C, that type log, in this location the Grayburg dolomite is approximately 30 feet thick. It comes and goes, as I said. It's nonexistent in some places or does not have sufficient porosity or permeability developed.

The upper San Andres is 150 feet thick. It's rather consistent across the entire Vacuum area.

The Lovington sandstone is 35 feet, and it comes and goes, although it's fairly consistent.

The lower San Andres dolomite is very massive. It continues all the way on to the Glorieta formation. However, we consider our gross pay only down to approximately 4700 feet in this location, which is about

minus 700 feet. That's the free oil column, at initial discovery. And it's 280 feet thick in this location. It's very dependent on the structural position within the unit and the oil-water contact.

We consider -- Actually, the gross pay on the top of the structure in the field gets up to as much as 600 feet thick, and approximately 40 percent of that can be considered net pay.

Q. Let's go to the structure map, and that is Exhibit -- or attachment A to Exhibit 1. And I'd ask you to refer to this, Mr. Wehner, and review the information on this map for David Catanach.

A. Okay, this map is a contour map on top of the Grayburg dolomite structure. That's our shallowest productive interval, as you saw on the type log.

One thing that's very apparent on this structure is the tightening of the contours as you move to the south and southwest, and that's an indication of the development of this reservoir, the shallow shelf carbonate, which was right on the margin of the Delaware Basin in the northwest shelf.

In here, shown in black outline, is the Central Vacuum Unit acreage, the producing wells shown in solid dots, the injectors in open circles, with a small arrow through those.

The Vacuum-Grayburg-San Andres Unit is shown in green, an offsetting piece of acreage that Texaco operates.

The project target area is shown in red, again, and it is basically representing the better structural position where more oil is in place to target the CO_2 process.

Q. At this time, I'd like to have you turn to Exhibits 4, 5 and 6, your index map and your two cross-sections, and I would ask you to -- working with those together, review them --

A. Okay.

Q. -- for the Examiner.

A. Well, Exhibit 4 is simply an index map. Again, it shows the project target area in relationship to the outline of the Central Vacuum Unit and the Vacuum-Grayburg-San Andres Unit.

We have a north-south and an east-west cross-section through the target area. The north-south cross-section is Exhibit 6, and the east-west is Exhibit 7 -- I'm sorry, 5 and 6, respectively.

If you'll look at Exhibit 5 -- If you have room there, you can open both of those up. What we're trying to show here is just simply the continuity within the acreage that we operate, and particularly the targeted area. These cross-sections are stratigraphic, they're hung on that

Grayburg marker that was on the type log. It helps in correlation from the geological-sequence standpoint.

The curves that you see in blue -- I know these are awfully small, but really what we're wanting to show is just the blue curves represent normalized porosity curves, based on our studies of the logs that we have, porosity logs that we have, and our core database.

The left curve shown, or the trace in red, is the gamma ray again. The things that stand out mostly is, the Lovington sandstone is very apparent, as you see that high gamma-ray in the middle of the San Andres showing up. The upper and lower San Andres on the gamma rays to the left are a very clean section. You can see the areal distribution of the porosity and the vertical distribution of that. These macrozones of the Grayburg dolomite, the upper San Andres dolomite, the lower San Andres dolomite, are very consistent throughout the entire area.

Also shown in the center trace with the footage of these cross-sections is our completion intervals. A number of these that you see with just a solid red trace down the middle or a solid blue trace represent an open-hole section below casing point, and where you see the red or green coming and going, those are intervals of perforations. That kind of is an indication of that vertical porosity distribution, and you can see as -- it

varies areally as we move north-south or east-west.

We plan similar CO_2 operations as the two offset operators, as we mentioned, in these same zones that are correlated with the State 35 and the East Vacuum. They are not injecting into the Grayburg dolomite, however. They do not have any porosity or permeability development to inject in.

Q. Why does Texaco propose to institute this CO_2 project at this time?

A. Well, one of the more obvious reasons is the fact that we are now sandwiched between two offset CO_2 offset operations, although that's not the main reason.

As I say, we have the East Vacuum-Grayburg-San Andres Unit and then the State 35 unit. I would refer you to Exhibit 7 here, briefly, to talk about that East Vacuum-Grayburg-San Andres unit. That is a plot of production versus time of both the target area within the Central Vacuum Unit that we're planning, versus the East Vacuum-Grayburg-San Andres Unit project area. It's not the entire unit; it's just simply the targeted CO_2 unit area that they're processing.

Now, I'm not going to spend a lot of time on this, because it's rather confusing, other than just to say the solid lines represent the Central Unit, the dashed lines represent the East Vacuum Unit.

This same data is plotted on Exhibit 8, and I would refer you to that, because what we have taken from Exhibit 7 and normalized for the facts that East Vacuum-Grayburg-San Andres Unit started its waterflood a year and a half behind Central Vacuum Unit, when you move these all together, you get somewhat of a feel for the similarity between these projects.

And you can see that we had a very similar ramping up of injection volumes shown in the pink curves. The oil production, very textbook response to waterflood, peaked out and went on its traditional decline. The solid line, being Central Vacuum Unit, it is turned upwards somewhat here in the last couple years due to some aggressive 10-acre infill drilling programs, some very successful fracturing campaigns, but that is back on its decline.

You can see the difference between -- on the oil curves here with what's occurred with introduction of CO_2 at East Vacuum. You can see that when they introduced CO_2 they mitigated the decline of their oil curve, and it's been at a very low decline for many, many years.

Also, you can see after the gas collapsed back into solution under waterflooding in -- I think it was completely -- it collapsed back in 1981 -- it's really rather constant, and you can see how East Vacuum's has

deviated with the CO_2 response in there.

The conclusion really is, you know, with that type of information available to us, it's been a very successful flood immediately offset to our acreage, and now is the time to start CO_2 operations.

Q. Do economics also dictate going forward with the CO_2 flood at this time?

A. They do. Oil prices are up over the last year. Our forecasts are much more attractive than they have been in past years. That's led us to more aggressively design and get this project under way.

Water cuts within the CO_2 project area are already at 96 percent. The unit as a whole, as a reference, is up to 92-percent water cut. Continued increases in that water cut are pushing operations towards their economic limits. As a rule of thumb, industry uses for waterfloods approximately a 98-percent water cut as an abandonment point. The -- We'll be pumping cement if we wait too much longer, rather than CO_2.

Also, the earlier the CO_2-flood operations are commenced, the shorter the time during which operators will have a negative cash flow period in their operations. That impacts the economic viability of the project. Some of the smaller operators may not have the resources that a larger company may have. They may not be able to withstand, if we

delay too long, the impact of that.

A significant delay in implementing the project could result in the permanent loss of our ability to economically conduct a CO_2 flood in this area, actually. As we start to lose wellbores, we've found economics -- you cannot go into a project and redrill or recomplete wells at the cost that's required for a CO_2 project.

And then lastly, more recently our CO_2 supplies have become very tight, and we already have a firm bid on that, so we want to lock that in before there is no CO_2 left in the near term.

Q. Mr. Wehner, let's go to Texaco Exhibit Number 9. Referring to this exhibit, would you explain to the Examiner what is required for an effective CO_2 flood?

A. Okay. Well, as I previously mentioned, there's two driving factors in a CO_2 flood, and that's the need for a hydrocarbon pore volume to contact with the miscible process, and injectivity, and injectivity is a strong function of pressure.

This exhibit shows the pressure required throughout the reservoir in order to maintain a miscible flood. It's a generalized recovery efficiency response to pressure, on the Y scale, zero through 1, 1 being 100-percent recovery of a contacted volume of oil, and on the X scale is the relative miscibility pressure. What you can

think of that as is, 1 is one would be an equivalent to a reservoir's minimum miscibility pressure.

There's an obvious difference between miscible injection and immiscible injection. Waterflooding is an immiscible process; the two fluids do not mix. Miscibility is where all molecules within the system mix and you have one phase flowing.

In the miscible range, we get as much as 95-percent recovery of the oil contacted by the CO_2 at those elevated pressures. And there's a very narrow window of -- that -- where the recovery drops significantly from this 95 percent down to the immiscible range. From the miscibility pressure, you can go plus or minus 25 to 30 percent and go all the way from 95-percent recovery of the contacted oil down to only 25-percent of the contacted oil.

And what is shown on this plot within the yellow region is what we call near miscible, where that slope increases or is rather steep between the two process recoveries.

Minimum miscibility at Vacuum field is approximately 1250 p.s.i.g., with pure CO_2. With recycling operations through the life of the project, we will have approximately a 300-p.s.i.g. addition to that miscibility pressure with the contaminants that we're recycling. So really we're looking at something in the 1550 p.s.i.g.

range.

The Central Vacuum Unit itself, average reservoir pressures average anywhere from 1500 to 1700 p.s.i.g. So approximately half our injection patterns are right at the miscible range or just in that near miscible range already.

The closer you get to the producing wells, we lose the miscibility in the reservoir. That's where the drawdown or the pressure sink exists in our patterns. We have less mobility due to the breakout of CO_2 as a compounded issue, you have reduced sweep efficiency, which is the mobility component. You have reduced displacement efficiency, which is the shape -- this S-shaped curve that I'm showing you here.

We anticipate significant response to the CO_2 injection, if we are allowed to keep the entire reservoir pressure near or above that minimum miscibility pressure, as best that we can.

We will need sufficient injection pressures to maintain the reservoir pressure near the minimum miscibility pressure in the near-wellbore region of the producing wells, and this is partly -- part of our reason for our request for some pressure changes on a few specific wells that you'll hear about later.

Q. What is the source of the carbon dioxide you propose to inject?

A. We've bid that supply out and we are currently negotiating with a supply out of southwest Colorado. It will be delivered through the Cortez pipeline and a lateral 33-mile line from that, that serves the Vacuum Field area. Delivery pressures on that line range from -- have been fluctuating between 1820 to 1850 pounds per square inch, gauge.

This is the same source and delivery that's used for the East Vacuum Phillips project and also for the State 35 project.

Q. What volumes is Texaco planning to inject, total volume?

A. Total, we plan to inject 259 billion standard cubic foot of CO_2 and other gases, in addition to another 148 million barrels of water.

Q. And what will be the maximum daily injection rates?

A. The maximum will be approximately 7 million cubic foot of CO_2 per day.

Q. And what is the pressure you're proposing to utilize?

A. Sufficient pressure to maintain bottomhole pressures equivalent to that of the water injection, not to exceed the 1850 p.s.i.g., which is similar to the two offset CO_2 floods.

Q. Let me ask you several questions concerning the Application for the Enhanced Oil Recovery Tax Act qualification. Let's go back to Exhibit Number 1, and I'd ask you to just refer back to that and identify it again for the Examiner.

A. Yes, Exhibit 1 is our actual Application for the Enhanced Recovery Act, the recovery project qualification for the recovered oil tax rate. It meets all the requirements, the Division rules.

Q. Is it a complete Application, providing all the data that is required by those rules?

A. Everything is attached to that, except it discusses the two volumes sitting in front of Mr. Catanach there.

Q. Okay, and references those?

A. Yes, it does.

Q. What are the estimated additional capital costs to be incurred with this project?

A. Approximately $35 million will go towards facilities and well work, about $8 million will go towards field installation and upgrades, another $25 million will go towards separation and compression facilities, and the well work, downhole work, actually amounts to about $1.5 million.

Q. And the total project cost?

A. Total project cost, inclusive of the injectant costs, is $346 million.

Q. And how much additional production does Texaco expect to obtain from this CO_2 project?

A. We are looking for recovery of approximately 20 million stock tank barrels of oil and an additional 23 billion standard cubic foot of hydrocarbon gas.

Q. And what is the total value of this additional production?

A. Based on a $19.62-per-barrel for the oil and an equivalent barrel basis of 6 MCF per stock tank barrel of the oil, that adds up to about $474 million.

Q. If this project, in fact, is commercially successful, does Texaco plan to expand the project?

A. Most certainly. Within the unit, as I mentioned earlier, we're only targeting approximately 50 percent of the unit acreage. We can expand accordingly as warranted and also into the offset Vacuum-Grayburg-San Andres unit.

Q. Mr. Wehner, does Texaco Exhibit 1, attachment D, set out the production history and production forecast for oil, gas and water from the project area which are required by Division Rules in an application for certification for the incentive tax break?

A. It does, and real briefly, that exhibit is a rate-time plot, and the data from 1978 through current date

is the historical operations.

You can see that we started in early 1978 with injection, and it ramped up rather rapidly into 1980 as we got the lease lines and all on line. Textbook waterflood response. The oil bank hit, it climbed up to 16,000 barrels a day and went on its precipitous decline. It's been mitigated in the near term with some infill drilling on 10-acre spacing, some fracture programs. We're currently at about 4100 barrels of oil a day.

Injection has been -- on average, has been fairly consistent. Water production has shown itself, following the peak waterflood response. The gas-oil ratio collapsed around 1982 or 1983, and plotted on here is gas in red. It follows the oil curve pretty consistently after fill up.

We are forecasting in the dashed lines -- Well, the dotted line represents the forecast of the continued oil decline, as our modeling suggests, following the 4100 peak that we saw earlier this year.

The dashed lines, longer dashed lines, represent our forecast. You can see that at the peak, up towards the top, we will be injecting about 65 million cubic feet of CO_2 a day. Our water injection drops off, as does our -- I'm sorry, our water production drops off as we are introducing CO_2 into the reservoir, and it ultimately begins to climb as our water alternating gas process gets

wetter and more water is injected. In other words, you see the water coming back up in later years, and you see that water injection in blue, light blue, climbing through there.

The gas also increases significantly. This includes hydrocarbons and CO_2 in this plot. Our oil will increase from the current 4000-barrel-a-day range to about 6500 barrels of oil per day. That's -- and these are -- All these numbers on the forecast are annual averages. It looks to be approximately 4000 barrels incremental at the peak here, but it's actually -- when you look at it on a daily rate, it's closer to 5000 barrels a day increase due to CO_2 operations.

Q. Will Texaco call additional witnesses to review the status of the wells in the area of the proposed project and also to review step-rate test information and support the requested increases in pressure?

A. Yes, we have two more witnesses.

Q. In your opinion, will approval of this Application and the implementation of the proposed CO_2 flood in this portion of the Central Vacuum Unit be in the best interests of conservation, the prevention of waste, and the protection of correlative rights?

A. Yes, it will.

Q. Were Exhibits 4 through 9 either prepared by your

or compiled under your direction?

A. Yes, they were.

MR. CARR: At this time, Mr. Catanach, we would move the admission into evidence of Texaco Exhibits 4 through 9.

EXAMINER CATANACH: Exhibits 4 through 9 will be admitted as evidence.

MR. CARR: And that concludes my direct examination of Mr. Wehner.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Wehner, why do you limit the target area to 50 percent of the unit? Why don't you do the whole unit entirely at this point?

A. Texaco is part owner in about a dozen CO_2 floods within the Permian Basin and elsewhere within the United States. As we have found and other operators within industry have found, that blanket development of acreage is not profitable. You have to have a minimal amount of hydrocarbon pore volume to process in a timely fashion with the CO_2 process.

We cannot go out and, say, as an example, process a 10-foot zone when you're injecting an injectant that is significantly more expensive than water. Our study has shown that the area targeted is what we can afford to

address with our forecasts at this time.

Q. But you can, at a later time, expand into the remainder of the unit?

A. We certainly can. The process itself is technically successful, it's been proved. It's the economics that drives the target area at this point.

Q. So once you start to, say, recover some more oil from the target area, that makes it more attractive to go --

A. That's right --

Q. -- into the other area?

A. -- that's right.

Q. Okay. The CO_2 will basically be injected into the same intervals that are being waterflooded at this time?

A. Right.

Q. Okay. So you're not going to be squeezing off perforations in injection wells or producing wells or anything like that?

A. No, we are not.

Q. Okay. And both the Grayburg and San Andres portions will be CO_2-flooded?

A. Yes.

Q. Okay. I just want to go over some of the figures you gave me before.

17 out of 22 working interest owners have committed for a total of 62.8 percent, and you said you needed 65 percent. Is that in the unit agreement?

A. Yes, it is.

Q. Okay And you anticipate over 90 percent of the working interest owners will approve this operation?

A. Right.

Q. Okay.

A. You had asked Mr. Lanning who the other operators were.

Q. Right.

A. The principal owners are Texaco at approximately 60-percent ownership, Marathon Oil Company at approximately 25 percent, Phillips Petroleum Company at approximately 8 percent, Mobil Oil Company at approximately 4 percent, and the rest are -- add up to the remaining percentages.

Q. Okay. Lease-line agreements will be required to be obtained from Phillips. Is that the only operator, Phillips?

A. And Texaco as operator of the Vacuum-Grayburg-San Andres Unit.

Q. Okay.

A. Those agreements are not necessarily required to do a CO_2 project, but Phillips is very desirous to implement those lease lines. As you recall the structural

map, their best acreage is our lease line, which is somewhat our lower quality reservoir, due to structural position of our acreage.

Q. Are you basically going to have injection wells on the lease lines?

A. No, we're -- Well, the existing injection wells will remain. We will ultimately try to negotiate into our language to include -- for the inclusion of drilling some producing sites. We do not believe we will need any additional injection sites on the lease lines --

Q. Okay.

A. -- at this time.

Q. So the lease-line agreements will cover the allocation of production from the producing wells?

A. Right, and the intent is to develop these lease-line agreements for CO_2 similar to the existing lease-line agreements for the waterflood.

Q. Okay. Within the target area you, I believe, testified you had 68 producing wells? 51 injection wells?

A. Let me verify that. That sounds right. I believe that is correct. I'm not finding my notes that I had on those, but that sounds correct.

Q. Okay, and you're currently drilling three wells within the target area?

A. Yes, they are within the target area.

Q. Okay.

A. And that will complete our 10-acre development, as we envision it currently, except for any 10-acre locations that might appear on the lease lines that we negotiate with the offset operator.

Q. Okay. 42 to 44 percent of original oil in place, is that your estimate of primary plus secondary?

A. Primary plus secondary. Ultimate recovery, we are forecasting 44.5 percent of the original oil in place.

Q. 44.5 percent.

A. I didn't mention it, but we are forecasting approximately 11.8 percent of the original oil in place for the CO_2 project.

Q. That's over and above the 44?

A. Yes, in the targeted area.

Q. 11.8 And that is a total of 20 million barrels?

A. 20.3 million stock tank barrels. And an additional 23 billion cubic feet of hydrocarbon gas.

EXAMINER CATANACH: Okay. This is a whole lot to digest.

MR. CARR: Wait till we review our well data sheets.

EXAMINER CATANACH: I can't wait.

Q. (By Examiner Catanach) Okay, you're asking for 1850 maximum surface pressure for CO_2?

A. Yes.

Q. What would be your maximum water surface pressure?

A. We would maintain the same operations as we currently have, and that varies across the unit. Mr. James Anderson will be talking about that in detail here later.

Q. Okay.

A. Our intentions are to maintain an equivalent bottomhole pressure as the existing waterflood operations with CO_2.

Q. Why was the Phillips East Vacuum -- Why did they start so early on CO_2 on that flood?

A. I suspect as a lot of -- some of the original CO_2 floods that were initiated in the early 1980s, most operators, the industry as a whole, the financial community was forecasting oil prices by this time to be in the $50-per-barrel range. There were some significant tax benefits through the federal systems on windfall profits tax, benefits to initiate projects. The industry did not foresee a collapse of the market, so a lot of those projects, the biggest projects that were able to handle the more expensive CO_2 were implemented in the early 1980s, before the 1986 collapse in oil prices.

With that collapse in oil prices went the expenses of CO_2, which were tied to that. So CO_2 has

gotten cheaper. We've learned a lot from the original projects, and we're able to learn from their mistakes and go forward.

Q. How far are you guys away from CO_2-flooding Vacuum-Grayburg-San Andres?

A. That's our next study area, as soon as we can get this going and implemented, immediately initiate our investigation into the acreage. It has a few concerns to us as far as injection abilities there. As you move south you get much more heterogeneously into the reservoir, as it dips down towards the oil-water contact.

Again, as I mentioned earlier, we need the injectivity. The time component has to be right as a factor in our economics, and our initial review of that is that there's not enough injectivity, and we will just have to investigate that in a lot more detail before we can put some capital towards that project.

The operations in the Central Vacuum Unit, of course, will help us in that forecast as we investigate the offset patterns.

Q. Okay. The capital investment, I believe you testified the total investment was $346 million?

A. Yes.

Q. That includes the CO_2?

A. That includes the injecting costs, which includes

the purchase of the first 95 billion standard cubic feet of CO_2. It also includes the cost of recycling the produced gases.

I include that in that cost, as that is a component of the federal EUR tax credit reduction. It's actually an expense item, but it's included there. We look at it as a large investment decision.

Q. Is that the total amount of CO_2 that's going to be needed, is 95 BCF?

A. That is a volume -- That 95 BCF represents about a 50-percent hydrocarbon pore volume of CO_2 injected. We will let the reservoir dictate to us as to whether or not we need more CO_2 in the future. Some of the older projects are finding that they are able to get more oil than they forecasted by going to higher slugs of CO_2. We will wait and let the reservoir dictate to us whether we can do that, and that will be a separate economic decision down the road.

Q. Okay, the actual injection operation, do you know what cycle you'll be using as far as water, CO_2?

A. Again, we'll let the reservoir dictate, but we had to make a forecast, obviously, and our modeling -- we looked at a number of options there and analyzed that.

And what we've concluded, which is similar to what a lot of the practices have become in the industry, is

that we will inject a rather large volume up front in a slug of approximately 10 percent of the hydrocarbon pore volume CO_2. That will then be followed by the WAG operations.

In other words, we're getting the -- more water into the reservoir with the CO_2. We'll go to a quarter-to-one injection scenario, quarter of CO_2 to -- I'm sorry, a quarter volume of water to a volume of CO_2. The next 10 percent of CO_2 will be injected as a .5-to-1 WAG ratio. And it will progressively get wetter with time as we eventually just have recycled product and no purchase to add to it. And we will recycle through the life of the project.

Q. You've estimated this to be a 25-year process?

A. That's where we've forecast to, and that's really a limitation of our economic model. We still show a positive cash flow at year 25, and depending on the oil markets over that period of time, I suspect we will -- as world supplies get tighter, I suspect we'll see a longer life to this reservoir than what is apparent with that forecast.

Q. Okay. The value of the recovered hydrocarbons you estimated as $474 million. Did that include oil and gas?

A. Yes, it did. And that's based on that $19.62.

That's an average of the posted prices for the three-week period immediately prior to November 13th, when we made that calculation.

Q. How long before you guys think you'll see a response to CO_2?

A. About a year before we see the main oil bank, I suspect -- and that is somewhat a limitation in our forecasting ability with compositional simulation. There's a tradeoff in time in developing that simulation, and you cannot mimic every single 10-foot layer in a reservoir. There are some high-perm zones that I suspect we'll see flooded more efficiently -- more rapidly, and we will see an oil response in 1997 from some of those. But it's basically 12 months before we see the whole property starting to really turn upwards.

EXAMINER CATANACH: I think that's all I have at this point.

MR. CARR: At this time, then, we would call Robert McNaughton.

ROBERT McNAUGHTON,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Would you state your name for the record, please?

A. Robert McNaughton.
Q. Where do you reside?
A. Hobbs, New Mexico.
Q. By whom are you employed?
A. Texaco Exploration and Production, Incorporated.
Q. Mr. McNaughton, what is your current position with Texaco?
A. Production engineer.
Q. Have you previously testified before this Division?
A. No.
Q. Could you summarize your educational background for Mr. Catanach?
A. BS in geology, 1984, BS petroleum engineering, 1987, master's petroleum engineering, 1992, from Texas Tech.
Q. And since graduation from Texas Tech, for whom have you worked?
A. Two years with two independents in Texas, one year with Welex in Hobbs, six years with Texaco.
Q. And you've been in Hobbs all that time?
A. Yes.
Q. Are you familiar with the Application filed in this case on behalf of Texaco?
A. Yes.

Q. Are you familiar with the status of the wells in the area of the proposed CO_2 injection project?

A. Yes.

Q. Have you reviewed the status of each of the wells in the area of review for each injection wells in the proposed project area?

A. Yes.

Q. And are you prepared to share the results of that review of each of these wells in these areas of review with the Examiner?

A. Yes.

MR. CARR: Are the witness's qualifications acceptable?

EXAMINER CATANACH: They are.

Q. (By Mr. Carr) Mr. McNaughton, let's go to what has been marked for identification as Texaco Exhibit 10. Can you identify that and then explain to Mr. Catanach what this is designed to show?

THE WITNESS: This map here --

EXAMINER CATANACH: Got you.

THE WITNESS: -- with all the circles on it.

Q. (By Mr. Carr) All right, what does this exhibit show?

A. Okay, this is a composite map, covering all the different C-108 applications involved in this area. The

broad pink outlines the CVU project CO_2 area. The red circles and dashed lines are prior C-108s from the last five years for Grayburg-San Andres wells. The blue and green and black circles are deeper well applications within the last five years. The yellow area is Grayburg-San Andres wells within the project area or the area of review that have not been covered by prior applications.

Q. And this plat shows all injection wells within the area, and it shows all wells within two miles of each of these injection wells; is that correct?

A. Yes.

Q. And the lease ownership in the area is also depicted on this exhibit?

A. Yes.

Q. All right. Are the two volumes in front of Mr. Catanach what has been marked as Texaco Exhibit Number 11?

A. Yes.

MR. CARR: Now, Mr. Catanach, we could review these individually for you if you desire, or we can give you --

EXAMINER CATANACH: We could be here till Christmas.

MR. CARR: -- an overview if you like.

EXAMINER CATANACH: An overview would be fine.

Q. (By Mr. Carr) Mr. McNaughton, could you explain

how this exhibit is organized and what information is contained therein?

A. Okay, this is compiled in sections. This is the wellbore drawings for the area of review. The first is CVU. The second part is the new well completions. The updates are next with the new P-and-A's for P-and-A'd wells, and then the East Vacuum offset completions, and then the older C-108s, and this includes all the wells in the area, so we would have to go back between find different applications. You'll find that some wells have been covered as many as five times, and all the wellbore drawings that are in there.

Q. They are organized by each of the prior projects, as indicated on Exhibit Number 10; is that not correct?

A. Yes, in Exhibit 10 it has the PMX or order numbers on the map for cross-referencing.

Q. So what we have here are all wells in the Central Vacuum Unit?

A. Yes.

Q. We have all wells within half a mile of each of the proposed injection wells in the CO_2 project?

A. Yes.

Q. We have all plugged and abandoned wells in the area of the CO_2 project?

A. Yes.

Q. And the data in this volume has been revised and is current as it relates to all wells within the Central Vacuum Unit's CO_2 project?

A. Yes.

Q. This Exhibit contains for these wells all of the information in the areas of review for all wells which penetrate the injection zone as would be required on a full CO_2 review; isn't that -- or a --

A. Yes.

Q. -- C-108 review?

A. Yes.

Q. Have all of the wells been included, all the wells we're talking about, been included in applications for injection into the reservoir within the last five years, or are there new wells which have been added?

A. There are some new CE wells, the new completions, and some new deeper wells added in there. That's in the update section. And for this Application we, of course, cover the entire CVU, just the complete -- all the wells in there.

Q. And in the update section you've brought everything current?

A. Yes, it should all be current.

Q. Have you reviewed data available on the wells within these areas of review, for this proposed CO_2-

injection project, and satisfied yourself that there is no remedial work required on any of these wells to enable Texaco and others to safely operate these wells in close proximity to the proposed CO_2 flood?

A. Yes, I've reviewed the wells and I find no work that needs to be done.

Q. What is the present status of the wells that Texaco is proposing to utilize for injection in the CO_2 project?

A. These are all currently active water injection wells.

Q. And how do you monitor those wells to assure yourself that the integrity of the wellbores is sound?

A. Okay, automation, we've got -- It records the rate pressures daily. There's flags in automation for any rates that are particularly high or low. Of course, if they're low, we check -- well, either way, we check out what it is. We have a team that records that information, looks at it every day. Also, they do Bradenhead surveys every month, manually checking the casing with pressure meters, manually.

Q. In your opinion, will the injection of carbon dioxide in these wells pose a threat to any underground source of drinking water?

A. No.

Q. What are the water zones in this area? Ogallala?
A. Ogallala.
Q. And at approximately what depths are they found?
A. I believe 180 feet to 300 feet.
Q. And are there freshwater wells in the area?
A. Yes, there are 82 within the Vacuum area.
Q. And how many within the project or target area?
A. Within the project area there are 14 active water wells and six inactive water wells.
Q. Are the wells in this project area and within a half mile of injection wells properly completed and cased so as to prevent any problems with these water wells?
A. Yes, they're properly completed.
Q. Are you the individual who's responsible for the preparation and filing with this Division of the Vacuum quarterly water flow reports?
A. Yes.
Q. And do you stay aware of the status of all wells in this area and the potential for crossflow therefrom in the Vacuum CO_2 project area?
A. Yes, I do that.
Q. In your opinion, will the injection of carbon dioxide, as proposed by Texaco, pose a threat to any freshwater supplies in the area?
A. No.

Q. Have you examined the available geologic and engineering data on this reservoir, and as a result of that examination have you found any evidence of open faults or other hydrologic connections between an injection interval and any underground source of drinking water?

A. There is no evidence.

Q. Were Exhibits 10 and 11 prepared by you?

A. Yes.

MR. CARR: At this time, Mr. Catanach, I would move the admission into evidence of Texaco Exhibits 10 and 11.

EXAMINER CATANACH: Exhibits 10 and 11 will be admitted as evidence.

MR. CARR: And that concludes my direct examination of Mr. McNaughton.

EXAMINATION

BY EXAMINER CATANACH:

Q. How long did it take you to review all these wellbores?

A. A long time.

(Laughter)

THE WITNESS: To summarize, I've been in Buckeye now for two years, in this area. I've worked ten different waterfloods. One of the first things I did was start compiling wellbore data for the team members, because I

knew that sooner or later this was going to come up, and it's a continuous -- When we start new projects, when wells are plugged, I always make sure and get wellbore drawings and check these things out. And I've kept everything pretty current.

Q. (By Examiner Catanach) Okay. This is -- Are the wells duplicated in this?

A. Yes, some of them as many as five times.

Q. Okay.

A. We wanted to make sure that we had everything covered so you wouldn't have to go back and forth between different Applications. That's one reason it's so thick.

Q. Okay.

A. It looks like a lot, but I think you'll find it's easy to go through, the way it's laid out.

EXAMINER CATANACH: Yeah.

(Laughter)

Q. (By Examiner Catanach) Okay, a lot of these wellbore schematics, did you actually calculate cement tops on the majority of these, or --

A. Yes. For the CV wells I went through every well file at length, and for those wells that we didn't have all -- incomplete data, I went to the Commission and copied all the original completion reports. I went through drilling records, and even for offset partners I called them and

badgered them until I got the information I needed.

Q. Okay. Mr. McNaughton, what is the status, the current status of the water-flow problem in the Vacuum?

A. The current status, we occasionally have small water flows when we drill wells, but nothing significant. I haven't seen any records from the offset partners out there that recorded anything in the last ten years.

Q. Now, you say you do encounter some small water flows. That's in the salt section?

A. Yes.

Q. Is the problem, in your opinion -- is it diminishing?

A. Based on past records, yes, there is a very small area we have found some. The largest was 300 barrels an hour, and within four hours it was completely gone. Most of them are in the nature of 20 to 30 barrels an hour for a couple hours, and that's it.

Q. And then it just depletes itself?

A. Yes.

Q. Stops flowing?

A. Yes, we have -- I have found no records in the last ten years that I could -- in all the records from ours, from offsets, where any of this interfered with drilling operations. And in fact, I don't think I can find any records in the last five years we've actually squeezed

a well with a casing link.

Q. Was the original water flow area -- wasn't it pretty much in the area of the CVU or --

A. Well, the last map I've seen, it covered almost the entire Vacuum Pool, what -- where Bradenhead flows recorded. Yes, we are atop structure. I would expect the accumulation to be there at the top of the structure in the salt.

But like I say, you know, I looked at the records, and it's obvious that they discovered the waterflow that -- the big, big mass of waterflows, drilling CV injection wells, when this was first done back in 1978. So obviously CV wasn't the problem. It came from off-lease somewhere. I don't know where.

Q. In your opinion, do you believe that the CO_2 injected will remain in the Grayburg-San Andres formation?

A. Yes, sir, under the operating conditions we're looking at, it will be just like water, same pressure. There are a few minor increases in pressure we're asking for, but we know from step rates we're well below fracture gradient.

Q. Are you concerned at all about any microannuluses in any of the producing wells or anything of that nature?

A. It doesn't appear to be a problem.

Q. Well, you haven't injected CO_2 yet. You don't

think it's going to be a problem?

A. I don't think under the conditions it will be much more mobile than water will be.

Q. Have you looked at Phillips' operation, and do they have any problems as far as keeping the CO_2 in zone?

A. Not that I've seen. Their efficiency seems to be pretty like what they had expected it to be.

Q. Have you looked at Phillips' operation with regards to the increased danger of corrosion by the injection of CO_2?

A. Yes, they have run a number of case-inspection logs wells in their wells. I'm not sure if that's prior to CO_2 or after. I know that in a lot of their wells, their corrosion wall loss in their injectors seems to be a lot more than ours.

We just ran 17 logs during the current workover operation, and on those wells the corrosion wall lost was like 10- to 15-, 20-percent range. And these are much newer wells in there. They're actually in very -- in excellent shape, compared to theirs.

In any case, it doesn't matter, because this whole unitized interval below the packer, if the casing is completely gone it doesn't matter because it's all good pay for CO_2.

Conformance, I don't see a problem anywhere.

Q. Are your injection wells going to be equipped about the same as Phillips'?

A. Yes, we'll have meters on the back side, pressures and temperature.

Q. What kind of tubing do you use? Is it --

A. It will be Rice dual lined, fiberglass. We'll switch out all the tubing strings.

Q. Fiberglass lined?

A. Yes, with new packer -- CO_2 injection packers.

Q. Have they found out that that works about the best with CO_2, the fiberglass lined?

A. Yes.

Q. Have they had packer problems?

A. Not that I've heard of. As operations go, comparing this, the Vacuum field, to other areas, they seem to have a lot fewer problems.

Bear in mind that the chemical man that does their operation is the same as ours, so we get to share a lot of information.

Q. Do you have to take any other precautions in your producing wells to account for any additional corrosion?

A. Yes, most of our -- Well, there's approximately 40 -- or is it 51? -- subpumps now in the producing area. Most of them are in the target area. Those usually have about 100 pounds of back pressure on those. We will bump

up the back pressure a little bit and change out to high-pressure wellheads and go to a high pressure separator.

Other than the higher operating pressures in that target area, shouldn't be any other problems.

Corrosion, we've been able to keep a handle on. I know from Phillips that the corrosion they estimated prior to the flood, they never saw it.

There are conditions where water in CO_2 is corrosive, but under WAG system in the injectors, you go to dry CO_2, it's not a problem. In fact, a lot of their flow lines are carbon steel, bare carbon steel.

We've had a number of floods we can look at to design this from. We've been able to learn a lot of things that they learned the hard way.

EXAMINER CATANACH: Mr. Carr, who's your last witness?

MR. CARR: Last witness is James Anderson, who will talk about just the increases in pressure we're seeking, explain why.

Q. (By Examiner Catanach) Okay. Do we have schematics of the injection wells and how those will be completed, or you didn't include that?

A. No, they're in there. We're not changing -- other than -- the injection wells that are in there that are current, it will be the same completions. We'll just

be changing at the packers, basically, the same setting depths, same completions.

So from the standpoint of operations right now, changing fluids is not going to change anything on the completions. All the reperforating and cleanouts have already been done.

Q. 2-7/8-inch tubing?

A. 2 3/8 --

Q. 2 3/8.

A. -- for most of the wells. There will be a few down in the southern areas we'll try to put 2 7/8 in, to facilitate cleanouts to cold tubing.

Q. Do you -- So you don't anywhere have a list of the -- Is it 51 injection wells?

MR. CARR: Yes, it is 51.

THE WITNESS: No, we --

Q. (By Examiner Catanach) You don't have a list of those?

A. Not broken out specifically, no.

EXAMINER CATANACH: Okay, it would probably --

MR. CARR: James does, and that will be part of the last witness's presentation. We have a list that shows each of them.

EXAMINER CATANACH: All right, I think that's all I have of this witness.

MR. CARR: I just have one follow-up question.

FURTHER EXAMINATION

BY MR. CARR:

Q. In this reservoir you're producing sour gas; is that right?

A. Yes, there is some hydrogen sulfide.

Q. When you look at the hydrogen sulfide in terms of its corrosive nature, how does that compare to CO_2? Is CO_2 comparable or do you have --

A. It's about the same.

Q. So you don't -- you're not going to be changing in essence --

A. No.

Q. -- anything in terms of the corrosive nature of what you're --

A. Operationally, nothing will change.

MR. CARR: Okay, that's all I have.

And at this time I would call James Anderson.

JAMES ANDERSON,

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

DIRECT EXAMINATION

BY MR. CARR:

Q. Would you state your name for the record please?

A. James Anderson.

Q. Where do you reside?

A. Hobbs, New Mexico.

Q. By whom are you employed?

A. Texaco Exploration and Production, Incorporated.

Q. Mr. Anderson, have you previously testified before this Division?

A. No, I have not.

Q. Could you summarize your educational background for Mr. Catanach?

A. Graduate, BS in petroleum engineering from Texas Tech University in 1986.

Q. And since graduation for whom have you worked?

A. I worked for a minor producing company, Republic Mineral Corporation in Big Spring, as a general field operations, and I've worked for Texaco since 1988, in Texas until April of this year when I came over to New Mexico to look after the development and started with the CO_2 project.

Q. Are you familiar with the Application filed in this case on behalf of Texaco?

A. Yes, I am.

Q. And are you familiar with Texaco's plans to implement a carbon dioxide tertiary-recovery project in the Central Vacuum Unit?

A. Yes, I am.

Q. Have you made an engineering study of this unit and in particular focused your study on pressures that are necessary to implement an effective CO_2 flood?

A. Yes.

Q. Are you prepared to share the results of that work with Mr. Catanach?

A. Yes.

MR. CARR: We tender Mr. Anderson as an expert witness in petroleum engineering.

EXAMINER CATANACH: He is so qualified.

Q. (By Mr. Carr) Would you initially tell us what it is specifically you have studied in preparation for this hearing?

A. What I did was go through each of the Central Vacuum Unit injection wells and review all the step-rate tests that were available, and I've compiled a listing of what the New Mexico OCD injection pressure limits are for those wells, along with the date of increase and, you know, just determining what the parting pressure of the reservoir is.

Q. And the purpose of this review was what?

A. To basically see that we could establish a minimum miscibility pressure through the reservoir and, you know, what the injection wells could withstand with the CO_2 injection.

Q. Let's go to Exhibit Texaco Number 12. Would you identify that and review it for Mr. Catanach?

A. Okay, what this is is a table of Central Vacuum Unit -- it's titled "Central Vacuum Unit - New Mexico OCD Pressure Limits". And the "well number" column is each injection well out on Central Vacuum Unit.

You'll note a shaded area just to the right of the well numbers that indicates which wells will be CO_2 injection wells.

The next column on there would be the New Mexico OCD injection pressure limit. The green dashes on there are wells that we were not able to establish a parting pressure with the step-rate tests that we conducted.

The following column would be the pressure increases, and then the information from the step-rate tests, where they parted or at what pressure we went to where there was no break established on the step-rate test.

Q. All right. If you were able to get no break in your step-rate test, what pressure limitation applies to that well?

A. Right now, each well is permitted based on the .2 p.s.i. per foot of depth to the top of the injection interval.

Q. And what kind of ranges do you have in permitted pressures at this time within this...

A. The range right now is 872 pounds to 2775 pounds, the average being, for the Central Vacuum Unit, 1585 pounds surface pressure. And the average bottomhole pressure, based on the step-rate tests and permits there would be equivalent to 3417 pounds.

Q. If we look at, for example, the CV Unit Number 74 well on Exhibit 12 --

A. Yes.

Q. -- and we see going across the exhibit that, one, it is going to be a proposed CO_2 injection well --

A. Yes.

Q. -- and that the current New Mexico OCD injection pressure limit is 890 pounds, right? --

A. That's correct.

Q. -- and the green indicates there's no break on the step-rate test, if we go farther across that exhibit we can see that you went up to 4000 p.s.i. and could not get a break; is that right?

A. That is correct, we did not note any break on there. You'll note that the surface pressure went to 4000 pounds, but the bottomhole pressure only went to 3425.

Q. And why, in your opinion, can you go that high and not experience a pressure break?

A. This is such a high-quality area, the field there that -- the rates that we're talking about is in excess of

6000 barrels a day that we were trying to inject, you know, equivalent, during the step-rate tests.

So the friction pressures became the dominant factor where the fluid was flowing through the formation where we couldn't actually get a bottomhole pressure high enough to establish a part.

Q. Isn't what we really see here is a situation where the wells in the best part of the reservoir that don't show a break at very high pressures are, in fact, being penalized by being limited simply to the .2-pound foot of depth injection pressure limit?

A. Correct.

Q. What pressure is Texaco seeking for water?

A. Basically what we're looking at in these wells that have not established a break point on the step-rate tests, we're looking for a 1500-pound surface injection pressure so that we can basically get us into that 3100-, 3200-pound bottomhole pressure range.

Q. And so if we go back to the CVU Number 74, you're currently limited to 890 pounds, you couldn't get a break at 4000 pounds, and what you're requesting is for that well a pressure limit of 1500 pounds?

A. That would be correct.

Q. And as to wells where you have been able to get a break on a step-rate test, you're seeking no change

whatsoever; isn't that right?

A. That is correct. If there was a break noted, we are honoring that parting point pressure and just accepting that till future step rates can be run to see if there is any higher rates available.

Q. In your opinion, is there any potential risk in terms of the injection fluid getting out of zone or damaging the formation if, for example, on the CV Unit 74, the pressures are increased from 890 pounds to 1500 pounds?

A. No.

Q. What pressures are being sought by Texaco for CO_2 operations?

A. Basically what we're looking at is an equivalent bottomhole pressure to what we're injecting for CO_2, and this is not to exceed 1850 pounds on the surface.

Q. Okay. Now, for water you're saying not to exceed 1500?

A. That's correct.

Q. For CO_2 you want to not exceed 1850?

A. 1850.

Q. Why is this pressure difference being sought in the surface injection pressure?

A. Basically, it's a difference in the density of the CO_2 phase that we'll be injecting and the water phase to get an equivalent bottomhole pressure. With the surface

pressure being 1500 pounds, it's roughly a 350-pound difference, just because of the density in the fluids.

Q. So basically we're talking about the same pressure in the reservoir, aren't we? We're just -- It's different fluids, and so you can increase the pressure and still be basically at the same point; is that right?

A. Yes, same bottomhole pressure.

Q. And is it your opinion that you can increase both water and CO_2 pressures as requested without damaging the formation?

A. Yes.

Q. Let's go to Exhibit Number 13. Can you identify and review that, please?

A. Okay, Exhibit 13 would be a table that lists the injection wells on there. There's a shaded area that shows wells that are below 1500 pounds on the New Mexico OCD injection pressure limit.

The next column over is pressure increases that we have submitted. On December 6th I submitted a letter to the OCD to ask for the pressures that are listed in there. The asterisk shows some of the wells that we are currently running step-rate tests on.

The next column over is what we're requesting for the CO_2 injection pressure. And basically what that shows is a 350-pound increase above the water permit, or 1850

pounds if it exceeded.

Q. Let's go to Exhibit 14. What is this?

A. Exhibit 14 is a map that -- What it shows is the well numbers on there and the step-rate parting pressure at the surface.

What can be noted on there are wells that did not -- or no parting pressure was established, there's an N in front of the pressure, so that you can actually get a feel for what the offsetting injection pressures are to those that could not -- or did not have a parting pressure established on them.

Q. So you can look at this if you've got a well that doesn't show a parting pressure, and you can look at the offsets and see what's been approved there; is that what the purpose of this is?

A. Yes.

Q. What is the authorized injection pressure for the East Vacuum-Grayburg-San Andres Unit, and also the State 35 Unit, the two units being operated by Phillips on either side of our proposed project?

A. East Vacuum-Grayburg-San Andres Unit has an authorized injection pressure, bottomhole average, 3150. State Unit 35 has a 1850-pound surface injection pressure limit. This would be pretty comparable.

If you calculate bottomhole pressure up to the

surface, the 3150 corresponds approximately to the 1850 surface pressure.

Q. So what we're seeking is the same thing that others have received on either side of us?

A. That is correct.

Q. Can review the conclusions you've reached from your study of the pressures in the CO_2 project area within Central Vacuum Unit?

A. Basically, there is no real correlation as to -- You know, from the map you could look and see that there are high pressures in some spots and low pressures in others, so there's no real correlation throughout the field.

And what we're looking for, you know, is, I guess, pretty much that, you know, we are not going to be creating any damage to the formation or anything, since all the pressures that we're asking for do not exceed any parting pressures established.

Q. In your opinion, will approval of this Application, the implementation of a CO_2 flood in the Central Vacuum Unit and the increase in pressure limits as requested be in the best interest of conservation, the prevention of waste and the protection of correlative rights?

A. Yes.

Q. Were Exhibits 12 through 14 prepared by you?

A. Yes, they were.

MR. CARR: At this time, Mr. Catanach, we would move the admission into evidence of Texaco Exhibits 12 through 14.

EXAMINER CATANACH: Exhibits 12 through 14 will be admitted as evidence.

MR. CARR: That concludes my direct examination of Mr. Anderson.

EXAMINATION

BY EXAMINER CATANACH:

Q. Mr. Anderson, I probably would -- it would probably be helpful if you submitted a list that shows exactly which wells you're seeking an increase for.

A. Okay, that is in the column there, on Exhibit 13, the pressure increases submitted.

Q. Okay, the ones that have pressure increases submitted, those are the wells that you're seeking an increase for?

A. Right, and those were addressed in a letter to your attention on December the 6th.

The ones with an asterisk on there, I have another letter that's to go out to you, asking for those increases also.

Q. Okay, so the wells with the asterisk, that's

going to be a subsequently filed letter?

A. That is correct.

Q. So within the order that I write for this project, I would only have to address at this time the wells -- Let's see, there's about 10 or so, or a little more than 10; 12 wells?

A. That would be correct.

Q. Okay. And on the CO_2 pressure, you're seeking -- in the far right-hand column, you're seeking that pressure to be assigned for CO_2?

A. That is correct.

Q. Okay. And some of those say that they've been submitted also. Those are part of the letter you've already submitted?

A. That is correct. I have that highlighted as which wells I had actually submitted on the letter and just in the column, submitted, put it in there that those were included in the letter that is already here.

And I guess what can be noted on there, even in this submitted area, if you looked at Well Number 43 on there, it was 878 pounds, was its permit. The step-rate test that was out there showed a break at 1500 pounds, and we were asking for a 1450 --

Q. Uh-huh.

A. -- on there, so the CO_2 corresponding pressure,

which adding just 350 pounds for the density differences, would give you an 1800-pound pressure that we're asking for on that well.

Q. Okay.

A. In the letter all I did was address the water side of it; I did not address any of the CO_2.

Q. What are you guys going to do with wells like the Number 60 that have only a --

A. We're going to go back and run step-rate tests on there. The test that was run there was run, I believe, in about 1984.

And since, you know, the injection has gone on there, the field is a little bit better developed and the pressures are up in that area, we're anticipating the parting pressure will probably be up higher than that.

Q. Okay. Will CO_2 injection ever be above 1850 p.s.i.?

A. Current plans right now are that it will not be.

Q. Do you know when you plan on submitting those additional step-rate tests for the wells with the asterisks?

A. I have the letter with me, and I didn't know if it would be better to give it to you now or drop it in the mail, so --

EXAMINER CATANACH: It would probably be better

if you incorporated that into this case so we could just deal with that in this Order.

MR. CARR: Mr. Catanach, if we can, we would submit that, then, as Texaco Exhibit 15.

EXAMINER CATANACH: Okay. Exhibit 15 will be admitted as evidence.

THE WITNESS: There is one well that is missing off there, which would be Well Number 136. We could not run a step-rate test on that well because it is shut in due to Marathon's drilling.

And when we get that step-rate test done, we will follow up as a following letter, so...

Q. (By Examiner Catanach) Okay. Mr. Anderson, do you believe that approval of these injection pressures will result in the injected fluid being confined to the injection interval?

A. Yes, like I say, this is below the parting pressures that were established by the step-rate tests, so I feel that we should be able to keep it all confined.

EXAMINER CATANACH: I have nothing further.

MR. CARR: That concludes our presentation in this case.

EXAMINER CATANACH: Okay. Mr. Carr, can I get a rough order from you in this case?

MR. CARR: Yes, sir.

EXAMINER CATANACH: Okay. There being nothing further in this case, Case 11,650 will be taken under advisement.

(Thereupon, these proceedings were concluded at 12:29 p.m.)

* * *

CERTIFICATE OF REPORTER

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

I, Steven T. Brenner, Certified Court Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Division was reported by me; that I transcribed my notes; and that the foregoing is a true and accurate record of the proceedings.

I FURTHER CERTIFY that I am not a relative or employee of any of the parties or attorneys involved in this matter and that I have no personal interest in the final disposition of this matter.

WITNESS MY HAND AND SEAL December 27th, 1996.

STEVEN T. BRENNER
CCR No. 7

My commission expires: October 14, 1998

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 11650, heard by me on December 19 1996.

David R. Catanach, Examiner
Oil Conservation Division