STATE OF NEW MEXICO
ENERGY, MINERALS AND NATURAL RESOURCES DEPARTMENT
OIL CONSERVATION DIVISION
CASE 10339

EXAMINER HEARING

IN THE MATTER OF:

Application of Conoco, Inc., for a High Angle/Horizontal Directional Drilling Pilot Project and an Unorthodox Oil Well Location, Eddy County, New Mexico

TRANSCRIPT OF PROCEEDINGS

BEFORE: MICHAEL E. STOGNER, EXAMINER

STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO
June 27, 1991

ORIGINAL

A P P E A R A N C E S

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I N D E X

E X H I B I T S

APPLICANT'S EXHIBITS:

EXAMINER STOGNER: Call next case, No. 10399.

MR. STOVALL: Application of Conoco, Inc., for a high angle/horizontal directional drilling pilot project and an unorthodox oil well location, Eddy County, New Mexico.

EXAMINER STOGNER: Call for appearances.

MR. KELLAHIN: Mr. Examiner, I'm Tom Kellahin of the Santa Fe law firm of Kellahin, Kellahin and Aubrey, appearing on behalf of the Applicant, and I have three witnesses to be sworn.

EXAMINER STOGNER: Are there any other appearances?

MR. CROSS: Mr. Examiner, I'm Dean Cross, from the law firm of Losee, Carson, Haas & Carroll. I'm appearing on behalf of Yates Petroleum. We have no witnesses or exhibits at this time, however we would like to obtain copies of the exhibits submitted today.

MR. KELLAHIN: Here's a set.

MR. CROSS: All right. Thank you.

EXAMINER STOGNER: Are there any other appearances?

Okay. Will the witnesses please stand to be sworn.

MR. KELLAHIN: Mr. Examiner, I would like to call our geologic witness first, Mr. Bill Hardie. We'll commence Mr. Hardie's testimony, Mr. Examiner, with Exhibit No. 6 in the exhibit book.

WILLIAM E. HARDIE

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

EXAMINATION

BY MR. KELLAHIN:

Q. Mr. Hardie, would you please state your name and occupation?

A. I'm William E. Hardie. I'm associate geologist with Conoco.

Q. Mr. Hardie, where do you reside?

A. I reside in Midland, Texas.

Q. On prior occasions have you testified as a petroleum geologist before the Division?

A. I have not.

Q. Would you summarize for us your educational experience?

A. I have a Bachelor of Science degree in geology from Baylor University.

Q. In what year did you graduate?

A. In 1986. And I have a Master of Science degree in petroleum geology from Baylor University in

1990.

Q. Summarize for us your employment experience as a petroleum geologist, Mr. Hardie?

A. I have been employed with Conoco for a little over a year as a petroleum geologist assigned to the Southeast New Mexico area. In the past eight months I've worked almost exclusively on the Dagger Draw field.

Q. The request today is for a high angle/horizontal well in this North Dagger Draw Pool?

A. Yes, it is.

Q. Have you provided geologic work, including geologic interpretations and conclusions, about this proposed project by your company?

A. Yes, I have.

MR. KELLAHIN: Mr. Examiner, we tender Mr. Hardie as an expert petroleum geologist.

EXAMINER STOGNER: Mr. Hardie is so qualified.

Q. Mr. Hardie, let me direct your attention, sir, to Exhibit No. 6. Before we talk about the specific details, take a moment and identify the display for us and tell us the basic information that is shown on that exhibit.

A. Exhibit No. 6 is a map of the North Dagger

Draw Pool. The yellow areas are the acreage operated by Conoco. The proposed horizontal well location is near the top of the map, in the northwest quarter of Section 17.

This map is actually a combination of two contour maps; first of all a structural map, shown with the red contours on the top of what we call the Cisco C horizon. This is a geological marker near the top of the pay zone. Those contours show that the reservoir dips gently to the east, across the North Dagger Draw Pool.

The blue contours are isopachs of the dolomite within that same C horizon, and they show that the thickest part of that dolomite occurs in the northeast portion of the map, and that it thins away from that on either side. The dolomite within North Dagger Draw is what the reservoir is developed in.

Q. Can you approximate, Mr. Hardie, where the North Dagger Draw southern boundary is, adjacent to the area identified by the Division as the South Dagger Draw Pool?

A. I'm sorry, could you rephrase that?

Q. Yeah. Do you know where the pool limits are for the pool itself, when we move to the south?

A. I'm not positive, but I believe it's at the bottom of this map, which would be the northern part of Township 20 South.

Q. When we look, then, at your display, we're looking at the area being developed under the North Dagger Draw Pool Rules?

A. That is correct.

Q. Are you familiar with what the spacing requirement is for development of the North Dagger Draw Pool?

A. Yes, I am. We are allowed to produce up to 700 barrels a day for each 160-acre proration unit. We can do that with any combination of wells as long as they lie within the legal boundaries of that 160-acre proration unit.

Q. Give us a quick summary of the basic geologic characteristics you find in the North Dagger Draw.

A. The reservoir itself, since it is developed within the dolomite, has a western extent which coincides with the zero contour line on the map. As we move to the east, the reservoir gets deeper and deeper so that its eastern limit is controlled by excessive water production. And that eastern limit occurs somewhere between the -4200 foot contour and the -4300 foot contour, shown in red.

Q. Are you able to identify a specific oil/water contact in the North Dagger Draw at this point?

A. The reservoir itself is highly transitional, and it produces mostly oil at the upper portion of the reservoir and mostly water at the lower portion. There is no water-free production anywhere in the field.

Q. Describe the reservoir and how the hydrocarbons are trapped or placed in the reservoir?

A. The reservoir itself is a preferentially dolomitized carbonate margin build-up. It is encased in limestone so that it's trapped updip by a transition to impermeable limestone. The downdip limit of the reservoir, again is controlled by excessive water production.

Q. Within this dolomite, do you find that the hydrocarbons are uniformly placed throughout that interval?

A. They are not. The hydrocarbons or the nature of the reservoir is very heterogeneous. We find areas of the field that have higher oil/water transitions than other areas.

Q. Can you, from well to well, on wells that are 40 acres apart, identify the same productive interval for each of these wells?

A. In a general sense, we have the same productive interval, although no two wells are completed in the exact same stratigraphic interval.

Q. What tools do you utilize as a geologist to help you identify the zones that may be productive?

A. We use a standard set of open-hole logs, porosity logs, resistivity logs, but more importantly we use an acoustic imaging log which shows us where the gross vuggular development occurs. The production in the field for each well can be directly related to the number of these vuggular zones that a well encounters.

Q. When we look at the northeast quarter of Section 17, that would be the spacing unit in which you desire to drill the horizontal well?

A. That is correct.

Q. What is the status of the development of that 160 acres at this point, with North Dagger Draw wells?

A. At this point there's one producing well in that proration unit, the Jenny Com #1. It currently produces between 40 and 50 barrels of oil per day.

Q. What about the other well?

A. The other well is abandoned. It was

produced and depleted and plugged.

Q. What is your geologic reason for selecting this 160 acres to test the horizontal concept in this reservoir?

A. There isn't any real specific geological reason for this location. The concept of drilling a horizontal well in Dagger Draw applies to the entire field. This particular location was selected because it has within it two adjacent 40-acre blocks available for drilling, and that's one of the requisites for a horizontal well. You have to have two adjacent blocks so you can achieve the necessary lateral length.

The other requirement is that the proration unit not be making its 700 a day allowable, in fact it needs to be making much less than that, and this one currently makes approximately 50 barrels a day from the Jenny Com, leaving 650 barrels a day of uncaptured allowable.

Q. Let's turn to Exhibit 7.

A. Exhibit 7 is a cross-section that's located back on Exhibit 6. If you look back in Section 17, the green-dashed line labeled A - A', is the location of the cross-section in Exhibit 7.

The cross-section itself runs parallel to the proposed horizontal well. I've placed the proposed horizontal well on this cross-section, but we need to keep in mind that it doesn't exactly exist in this same plain. It's located a thousand feet to the north of this cross-section.

I've included this cross-section for the primary purpose of showing which part of the Cisco reservoir we intend to penetrate with a horizontal well. At Conoco, we've broken the Cisco down into four units, and these are shown on the cross-section.

The Cisco A is actually just the top of the Cisco formation. The primary producing horizon is the Cisco C zone, which labeled on the cross-section. The proposed horizontal well will penetrate the upper portion of the Cisco C zone in Section 17.

Q. Why have you not chosen to penetrate, with the horizontal portion of the well, the entire Cisco C interval?

A. At this location, we are in the downdip portion of the reservoir, and the lower portion of the C and the downdip portions of the reservoir has very high water cuts, and we are seeking to avoid those high water cuts in order to more efficiently produce from the reservoir.

Q. Is there any significance to this particular orientation and angle of the well?

A. The orientation that we've chosen is to drill the well in an updip direction. Our goal is to traverse the upper portion of the Cisco C, and by drilling in an updip direction, we can maintain the borehole in the better part of the oil column.

If, for example, we chose to go the other direction and drill downdip and our goal was to traverse the upper section, then we would start high in the Cisco C, but by the time we got to the bottom of the target zone, we would be well within the high water cut part of the reservoir.

Q. Let's turn now, Mr. Hardie, to Exhibit No. 8.

A. Exhibit No. 8 is an acoustic imaging log from one of the wells in the North Dagger Draw Pool recently drilled by Conoco. It's the Lodewick "A" Com #3.

Q. Where is that well located?

A. If I could refer you back to Exhibit 6, this well is located, it is the northwesternmost well in Section 19.

Back to Exhibit No. 8. An acoustic imaging log is made up of three tracts. The tract on the left includes the gamma ray curve and four calipers, each of those calipers 90 degrees opposed. On the right are two imaging tracts, one of them derived from acoustic amplitude, the other from acoustic travel time. They basically just reinforce each other.

Each of these tracts provide us with an image of the borehole. It's as if you had split the borehole open and laid it flat, so that you're looking at all 360 degrees of the borehole.

The dark areas on this log indicate gross vuggular development. The reservoir itself is composed of an intercrystalline porosity developed in the dolomite. It's fairly tight in the matrix and anywhere from zero to six percent porosity. So, in order to produce from the Cisco reservoir, you have to have the gross vuggular dolomite developed in order to add to that porosity. It adds up to six percent to the matrix porosity.

This log shows two vuggular zones, approximately 25 feet in thickness. These zones are not correlatable to adjacent wells indicating that they occur randomly throughout the dolomite reservoir.

Q. For what purpose have you used this log?

A. We use this log to identify those coarse vuggular zones, so that we can know where to perforate each of the wells.

Q. How does this help you in any way in the horizontal well concept?

A. Looking at the various acoustic imaging logs that we've run, it's very apparent that these vuggular zones are randomly developed. Therefore, it's a matter of luck as to how many of these zones you encounter with a vertical wellbore. By increasing the amount of exposure to the reservoir with a horizontal well, we statistically improve our chances of encountering more of these vuggular zones and therefore can more efficiently produce from the reservoir.

Q. I would direct your attention to Exhibit 9. Would you identify and describe that display for us?

A. Exhibit 9 is more or less a summary of the concept of drilling a horizontal well in the North Dagger Draw Pool. It's a conceptual cross-section, and in it I show the Cisco Dolomite reservoir.

The upper portion of it is shaded green, and then it grades downward to a blue shading. This is representative of the very transitional nature of the oil-to-water transition, producing mostly oil at the top, mostly water at the bottom.

The irregularly shaped cross-hatched areas conceptually illustrate the vuggular zones that are randomly distributed through the reservoir.

The three wells I've shown on there are hypothetical completions in the reservoir. The one on the left would be a typical good producer from Dagger Draw. It encounters two, possibly three of these vug systems spread throughout the reservoir. It would produce, perhaps, 300,000 barrels of oil over its life, and a large amount of water.

The well in the middle is an example of a poorer producer. It encountered one vug system in the lower part of the reservoir, would have a cum of about 150- to 190,000 barrels of oil, and a very large amount of water, perhaps a million barrels of water.

The horizontal well shown on the right, conceptually illustrates that by extending the length of the exposure of the wellbore to the reservoir, we statistically increase our chances of encountering more of these vug zones and therefore can more effectively and efficiently produce from the reservoir.

MR. KELLAHIN: That concludes my examination of Mr. Hardie, Mr. Stogner. We move the introduction of his Exhibits 6 through 9.

EXAMINER STOGNER: Exhibits 6 through 9 will be admitted into evidence.

I've got some general questions to ask once we hear from everybody, but the questions I'm going to ask of Mr. Hardie at this time are somewhat general.

EXAMINATION

BY EXAMINER STOGNER:

Q. Let's go with Exhibit 9. Do you see a coning effect in this Cisco Dolomite producing interval when I look at this Exhibit No. 9 and how it's artistically put together?

A. We have one well that we think may have a coning effect in it, although, as a general rule, we don't see a coning effect. One of the ideas of this project is to avoid the traditional high-water cuts, that you have in Dagger Draw, by keeping the wellbore in the upper part of the zone. So, if you did have a coning effect, that would serve to alleviate that.

Q. You have more of a water encroachment as opposed to--

A. Exactly.

Q. --somewhat more uniform?

A. Yes.

Q. Your well in Exhibit 8, that is not on your cross-section, is it?

A. It is not, no. The wells on the cross-section were too old, and we did not run acoustic imaging logs on those wells.

Q. You may or may not have covered this. When I look at Exhibit No. 8, can I correlate the top of the Cisco A, the Cisco B and the Cisco C on this cross-section?

A. On Exhibit 8, which is the acoustic imaging log, we're looking at just a very small portion of the Cisco C zone. The scale on this is such that you're looking at one-foot increments. The entire exhibit covers approximately 90 feet.

Q. Then even the top of the Cisco C is not represented on here?

A. No, it's not.

Q. Would you call this Exhibit 8 the upper portion of the Cisco C, the oil-bearing zone or the transitional zone in the middle, or the lower zone in the water?

A. This is from an updip well. It includes the lower part of the upper Cisco C. It's right in the middle.

EXAMINER STOGNER: Okay. I have no other questions right now of Mr. Hardie, but maybe later, Mr. Kellahin.

MR. KELLAHIN: All right.

MR. STOVALL: I just have one question more for curiosity.

EXAMINATION

BY MR. STOVALL:

Q. Why did you pick the orientation, the horizontal direction, this particular one as opposed to another? Is there a geologic reason?

A. There is not. That orientation was selected because it's one of the few adjacent 40-acre blocks that are open that is not currently in a proration unit that exceeds its allowable or at least makes its allowable.

At a later date, when some of these other proration units begin to decline, we will have more open locations available. The east-west, north-south orientation is--

Q. It's geologically insignificant, is what you're saying?

A. Exactly.

MR. STOVALL: Okay. That's all I have.

MR. KELLAHIN: Mr. Examiner, I call Mr. Gary Faul. He spells his last name F-A-U-L.

Mr. Faul is a drilling engineer with Conoco.

GARY FAUL

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

EXAMINATION

BY MR. KELLAHIN:

Q. Mr. Faul, for the record, would you please state your name and occupation?
A. Gary Faul. I'm a senior drilling engineer for Conoco in its Midland Division.
Q. That's where you reside now, sir?
A. Yes, sir.
Q. Have you, on prior occasions, testified as a drilling engineer before the Division?
A. No, I have not.
Q. Summarize for us your educational background, please?
A. I obtained a B.S. degree in mechanical engineering from McNeese State University in Lake Charles, Louisiana, and graduated in 1978.
Q. Do you hold any other degrees in engineering?
A. No, I do not. I am a registered professional engineer.
Q. In what state, sir?
A. In the states of Louisiana and Texas.
Q. Summarize for us your employment

experience, and place particular emphasis on your experience as a drilling engineer.

A. First two and a half years of working for Conoco in Lake Charles I worked as a production engineer, and since that time, since 1980, I've worked as a drilling engineer, both onshore and offshore, last two years being spent in Midland, Texas.

Q. Do you have personal experience in drilling high-angle or deviated wells?

A. Yes, sir. When I worked in the offshore division, we directionally drilled wells from platforms and obtained angles up to 70 degrees.

Q. Are you familiar with the drilling and completion program proposed for this well?

A. Yes, sir, I am.

MR. KELLAHIN: We tender Mr. Faul as an expert drilling engineer.

EXAMINER STOGNER: Mr. Faul is so qualified.

Q. Mr. Faul, let me take you through some of these preliminary exhibits, starting with Exhibit No. 1, and then we'll get down to the more specific questions with regards to the drilling program for the well.

If you'll simply take a moment, though,

let's go through these earlier exhibits and have you identify, first of all, Exhibit No. 1?

A. Okay. Exhibit No. 1 is a location and acreage dedication plat for the Barbara Federal #13. What it shows is the surface location for our proposed well to be directionally drilled, with that surface location being at 760 feet from the north line and 2,630 feet from the west line of Section 13, Township 19 South, Range 25 East, Eddy County, New Mexico.

Q. Do you have an opinion as to why it is necessary to move to the southern side of the 160-acre spacing unit at which to commence the drilling of this well?

A. We are trying to stay within a block area, keeping 660 feet from lease line boundaries.

Q. With the lateral portion of the wellbore, then, in the reservoir?

A. Yes, sir. The actual part of the lateral that's going to be in the reservoir is going to maintain a spacing of 660 feet from that.

Q. In order to maximize the opportunity to expose in the formation the maximum lateral distance, is it necessary, in your opinion, then, to start at this unorthodox surface location?

A. The reasoning behind the unorthodox surface location being 10 foot offset from the lease line, is that the vertical and angle built section of our hole will take us to a point that's 660 feet from the east side. So we need this area to build up around.

Q. Can you yet determine the specific angle and azimuth at which you will drill the lateral for this well?

A. At this point we have plans to head due west, of course, and the angle build that we're planning is 10 degrees per hundred foot, and we're planning on building up to an angle of between 85 and 88 degrees. This is not cast in stone, but it's our current best estimate of what we'll have to do to encounter the formation.

Q. That plan is subject to change based upon what you find when you drill the first portion of this well, is it not?

A. Yes, sir.

Q. Do you desire that the Examiner provide you the flexibility to make those operational decisions in the field at the time that you're drilling the well?

A. Yes, sir. At the time we drill the well, we plan on drilling a vertical pilot hole into the formation and logging it at that time. And we'll identify the exact top of the formation then, and we'll need some flexibility at this time to adjust the directional program.

Q. Would it satisfy your desires for flexibility if the Examiner provides you a drilling window in the reservoir that is no closer than 660 feet from the outer boundaries of this 160-acre spacing unit?

A. Yes, it would.

Q. And that would conform to the setback requirements for a vertical well under these pool rules, would it not?

A. Yes, it would.

Q. Let's turn now to Exhibit No. 2. What's shown here, Mr. Faul?

A. Okay. This is a location map showing the trajectory of the Barbara Federal #13, in the northwest quarter of Section 17. The surface location is shown as a square dot. The angle build section is shown as the dotted section. The actual horizontal in the target formation is shown as the solid portion betwen the two surfaces.

Q. All right, sir. Let's go on to Exhibit No. 3 and have you identify and describe that for us, please.

A. Okay. Exhibit No. 3 is the plat of the

160-acre proration unit, and what it shows is the surface location as the large solid dot being at 10-foot offset from the east line, the angle build section at 10 degrees per hundred foot as the dashed line, and then our lateral section commencing at a point no further than 1,980 feet from the west line and continuing to a point no closer than 660 feet from the west line.

The solid portion is the actual, what we're calling the horizontal, which would be in the target producing formation.

Q. Let me have you turn to Exhibit No. 4. Let's use Exhibit No. 4, Mr. Faul, to have you go through and give us the details, then, of the drilling program. You're going to start with a surface location and you're going to do what?

A. Okay. Exhibit No. 4 is a vertical section, a little bit more detail of what our drilling plan would be. We would start at the surface and drill vertically to set surface casing at 1,200 feet. From this point we would drill vertically through the target formation, being the Cisco, at approximately 7,775, and at that point we would log--excuse me, 7,875.

Q. You have a straight hole, then, from

surface to what would be close to the bottom or the base of the Cisco target?

A. Base of the Cisco target, yes.

Q. Why are you doing that?

A. Okay. We do this mainly for two reasons. Number one, we would want to log this section and identify the reservoir at this point. Number two, and most related to the directional drilling part of it, would be to more accurately identify the top of this formation. We have it estimated right now, but it's real important to get the top of that formation, in that once we build angle and we're at an angle of 88 degrees, every little bit of error in vertical distance will make a large difference in horizontal distance. So we want to pin down the top of that formation as close as we can.

Q. Once you've done that, what then do you do?

A. Once we've done that, we plan to plug the well back to approximately 7,100 feet. That's what we're using for all of our planning right now, 7,100 feet to plug back to that depth and kick the well off, build angle at 10 degrees per hundred foot, until we reach our terminal angle at approximately 85 to 88 degrees, and that would put us into the top of the target formation, the Cisco, at approximately 7,775.

Q. Once you get to that point, then, what do you do?

A. At this point, we would plan on setting our string of 9-5/8" casing into the top of the target formation that would isolate our build section and our vertical hole section, and set us up to be able to drill the horizontal section without any effects from this section as a whole.

Q. When we look at the vertical portion of the wellbore, that initial stage, when this well is completed for production, is that portion isolated?

A. Completely.

Q. What's the drilling fluids used during the various stages of drilling?

A. Okay. We plan on using fresh water in the surface hole section, a brine starch system in the vertical and angle-build section, and once we set this string of 9-5/8 intermediate casing and isolate the build section and the vertical section, then we would go to our fresh water type as simple a system as we could.

Q. When you have drilled the lateral portion of the wellbore, how do you prepare that for a completion and production?

A. At this point we're planning to do an open-hole completion. We feel like the confidence of the formation is there and, as a completion technique, we do a light acid treatment to the formation. That would be our initial completion plans.

As a contingency, we've allowed ourselves, by going with the 9-5/8 intermediate string, to set 7-inch as a contingency string to be able to set a liner and selectively complete the formation, if we need to.

Q. Describe the basic equipment for us that you'll use to control where you are in the reservoir and how you'll complete that drilling.

A. Okay. Of course, from the vertical hole we're going to get control in that way. While we're drilling the kick-off section and the lateral itself, in the horizontal, we'll be using directional MWD and a down-hole mud motor. The directional MWD will give us instantaneous readings at the surface of what our angle and direction heading are, so that we can control where we're at physically as we're drilling the lateral.

Q. Are there any other high angle/horizontal wells in North Dagger Draw at this point?

A. Not that I'm aware of.

Q. This is the first pilot project of this type for this pool?

A. Yes.

Q. Turn now to Exhibit No. 5. Would you identify that for us?

A. Okay. Exhibit No. 5 is a calculation, you might say, based on our 7,100 foot kick-off point, of the angle and direction that we're going to be encountering as we drill the build-up section and our horizontal section. It's based on inclination, direction, true vertical depth. At this point it all hinges around that 7,100 foot kick-off point and it hinges around what our estimated top of the target formation is going to be.

This is where we would really need the flexibility. When we identify the top of that formation, we may have to make some minor adjustments, you know, plus or minus feet, to nail down this program.

MR. KELLAHIN: That concludes my examination of Mr. Faul. We move the introduction of Exhibits 1 through 5.

EXAMINER STOGNER: Exhibits 1 through 5 will be admitted into evidence.

EXAMINATION

BY EXAMINER STOGNER:

Q. Mr. Faul, let's refer to Exhibit 4.

A. Yes, sir.

Q. Starting at the top of the hole you use 13-3/8" casing down to 1,200. Is this in an area that's in a water basin as declared by the State Engineer, that you know of?

A. I know for a fact that in the development we've done out in this area, it's customary for us to set the surface casing at approximately 1,200 feet. We don't always use 13-3/8" casing. Generally it's something smaller, but we do generally set the casing at 1,200 feet.

Q. Is that cemented all the way back to the surface?

A. Yes, sir, it is. We go through a lot of extra pains to ensure that we do get cement returns to the surface. And if we don't, we'll do a top job to get cement to the surface.

Q. Is the Captan Reef present in this area?

A. I'm not sure.

Q. Not sure?

A. Not sure.

Q. Okay. Let's talk about the vertical portion. You'll be coming out from underneath a

13-3/8, and drilling approximately 7,800 feet?
A. Yes, sir.
Q. That will then be logged, then?
A. Yes, sir, it will.
Q. What kind of problems do you expect in this area? Are there any loss circulation zones out there?
A. Well, as of recent we have encountered some loss circulation in our producing formations, in our target formations, the Cisco. It's not prolific, it's not something that we haven't been able to control with minor loss circulation material, but we do see some loss circulation in our target interval. Other than that, none.
Q. And when we talk about loss circulation down in your target interval, is it corrected by your brine starch solution, or by pumping a loss circulation material?
A. We'll generally have a loss circulation material mixed into a pill and premixed, and have it ready, so that when we see the loss circulation, we can spot it at that time and minimize how much losses loss we have to the formation.
Q. What kind of time interval are we talking about, from the time you come from underneath the surface casing and drill your pilot hole, log it, and

plug that interval off?
A. Well--
Q. Or back, I should say.
A. Yeah. I'm going from memory, of course, but it seems like about 20 days that we're talking about to do that. And by drilling vertically through the formation, and logging that section of hole, it's going to add about five days or so to our drilling program--four or five days.
At this point we feel like it's important enough, number one, to identify the reservoir at that location, since it is sort of a step out in a pilot program. And, number two, if you would imagine or look at this 88-degree wellbore laid out, if you make just a few feet of error in your TVD direction, it throws you off by several hundred feet in a horizontal direction. So we think it's important enough that we've got to identify the top of the target formation.
Q. That's unusual to have that kind of a zone open-hole before running casing. That's going to give you some additional worries, I would assume?
A. Well, of course at that point, you know, at the point that we plug back, we'll set cement plugs to isolate the old wellbore.
Q. Then you'll be setting a whipstock, I would

assume, at 7,100?

A. We'll set a cement plug that will be capable of kicking off of with a steering tool. Once we get kicked off, then we'll be drilling with a directional drilling assembly, with a motor and MWD, so that we can control our build section.

Q. Once the 9-5/8" casing is set, what are your plans for the cementing of that string? Will that be tied back into the surface?

A. Yes, sir. As a minimum, I think we would tie that back into the surface casing. We would, of course, not have any other open hole below us whenever we set that casing string, and we wouldn't drill the lateral until after we've set and cemented that intermediate string.

Q. And I'm sorry, I missed it. Once you get your 9-5/8" casing set, you'll be using the mud motor, and what fluid will you be utilizing in your last stage?

A. Right now we're planning on fresh water and really as simple a system as we can go with. We may see, in the process of drilling it, that we need to use some gel or some other additives to give us some adequate hole cleaning, but at this time we think we'll be able to get by with fresh water.

Q. What do you anticipate your drilling rate to be in that horizontal section?

A. Generally what we figured is about half-rate for the horizontal, versus if you were drilling it at vertical. And from memory, I'm saying generally we get about 16 to 20 foot, so that would mean we're planning on about 8 to 10 foot rate of penetration.

Knowing that this is a pilot project and this is our initial project out here, we generally plan things conservatively, you know. In other words, time and how we're setting up our casing program, there was quite a bit of interest in scaling down the size of our casing program, but it being the pilot well out there, we figured that we would be conservative and more or less give ourselves some insurance to make sure we could get the wellbore down.

Q. You mentioned earlier that you have experienced loss circulation in this area, even if you have to drill without returns. Do you anticipate that happening, or would there be any problems in the horizontal section?

A. Yes. Drilling the horizontal section with the idea of possible loss returns, we're opening up a lot more formations. I can see what you're leading to. If we're able to go with fresh water, of course that would be a situation where we're not dealing with a fluid that would harm anything, you know, formation-wise, and would not be real expensive. So we could do some dry drilling. And at that point we'll just have to try some loss circulation pills and see how they react. If not, then, we would do some dry drilling.

Q. Are these vuggular structures noticeable when they're drilled into them? The rate of penetration, of course, will go up, but are they also recordable?

A. I think on not the last well that we drilled but the one before that, they had a real noticeable instance that happened to them where the bit actually fell a couple of feet whenever they encountered one of them. I think that's maybe an extreme. I think in general they're not real noticeable, but in some cases you'll see the torque and in that case, an extreme, we actually saw the drill string fall a couple of feet whenever they encountered that.

MR. STOVALL: Let me ask an additional question to follow-up on that, if I might.

EXAMINATION

BY MR. STOVALL:

Q. I assume when you're talking that, you're talking a vertical hole and the string just dropped vertically through the vug, is that right?

A. Yes, sir.

Q. Does that cause a problem if you're going horizontally and you hit one of these large holes? Do you have a problem losing your ability to control the direction of that hole?

A. It may give us some effect for a short distance, but being as we're going to be using a steerable system, and it will be stabilized, you know, back up from the bit it will be stabilized, I believe you would be able to correct for it without a lot of problem. It's something that getting the surveys up to the surface on a continuous basis, we'll be able to correct for that.

EXAMINER STOGNER: Any other questions of Mr. Faul?

MR. STOVALL: I just have a couple of real quick questions, thinking in terms of the future of establishing horizontal drilling rules, so that each one is not an exception.

Q. (BY MR. STOVALL) Do you have an opinion, with respect to the identification of a surface hole location for a well such as this, or identifying this as being unorthodox because, in fact, the surface location is 10 feet from the proration unit boundary? Do you have a recommendation in terms of the future, as far as identification of the well location, orthodox or unorthodox, or anything?

A. I have an opinion, for what it's worth.

Q. That's all I want is an opinion, because it really has no bearing on your case. We're trying to build some information on that.

A. We, at Conoco, for the last two years, have been trying to identify prospects, and this is probably the closest we've actually gotten to drilling one. It's something that is definitely a problem in West Texas, and I'm sure it is in Southeast New Mexico, but just being able to physically go in and identify a large enough area to lay a lateral out, you've almost got to have special considerations in being able to back up your surface location so that your vertical and your build section, which would not be in a producing formation, may be in an unorthodox position.

If you don't, if you've only got so much area and you use that up with your build section, well, then, what it does is limit the length of your lateral which, in this case I think we've identified as plus or minus a thousand feet, before it even becomes economic, well, then, you would kill a lot of projects, of course. A lot of projects wouldn't be able to survive economically.

Q. Once again I would ask for your opinion, and I recognize you're speaking mostly for yourself, possibly for Conoco, but would you recommend, perhaps, that the orthodox location be defined as the producing interval of a high-angle deviated well?

A. Yes, sir, I would, you know, because really thinking of what affects offset production and what affects everybody else, really is what's in the producing interval. Everything else is kind of just rented space, you might say.

MR. STOVALL: I appreciate your comments. We're, as I say, moving towards the direction of trying to define some rules for this, but we're trying to do it with experience; so your input is helpful. Thank you. Nothing further.

EXAMINER STOGNER: Any other questions of Mr. Faul?

MR. KELLAHIN: No, sir.

EXAMINER STOGNER: I may later have some more questions.

Mr. Kellahin?

MR. KELLAHIN: I would like to call Mr. Mark McClelland.

MARK McCLELLAND

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

EXAMINATION

BY MR. KELLAHIN:

Q. Mr. McClelland, would you please state your name and occupation?

A. My name is Mark McClelland. I work with Conoco as a senior reservoir engineer.

Q. Mr. McClelland, on prior occasions have you testified before the Division as a reservoir engineer?

A. No, I have not.

Q. Summarize for us your education.

A. I received a B.S. in petroleum and natural gas engineering from Pennsylvania State University in 1983. In 1989 I received a Master's in engineering management from the University of Southwestern Louisiana, and also in 1989 I was registered, by exam, as a professional engineer in the State of Louisiana.

Q. Summarize for us your employment experience.

A. My first five years I worked in the Gulf

Coast with Conoco as an area engineer. My assignments were primarily as a production and also reservoir engineer for one of our onshore fields.

Since then I've worked in mainly lease evaluation, reservoir studies, acquisitions, dispositions, and in the last year and a half I've worked in Southeast New Mexico performing reservoir studies.

Q. Summarize for us your experience in the North Dagger Draw Pool.

A. My experience in North Dagger Draw has involved a reservoir study to determine recovery efficiencies, rates, reserves of development, and also to identify the horizontal drilling prospects.

Q. As part of that study, have you reached certain conclusions and opinions about the feasibility of the high angle/horizontal well that Conoco is seeking to have approved today?

A. Yes, sir, I have.

MR. KELLAHIN: We tender Mr. McClelland as an expert reservoir engineer.

EXAMINER STOGNER: Mr. McClelland is so qualified.

Q. Mr. McClelland, let me ask you about how you went about organizing the information upon which then to study and ultimately reach conclusions about the feasibility of this project?

A. Trying to predict rates and reserves for a horizontal well in a vuggular dolomite is a very difficult task. To help in this analysis, I've spent almost a month and a half primarily studying the vertical well performance, and from that data I gathered, I was able to go ahead and predict rates and reserves for the horizontal well, based on the vertical well performance.

Q. What methodology did you apply, as a reservoir engineer, to determine recoveries and performance of vertical wells in this type of reservoir?

A. I analyzed the production of all of the Conoco-operated vertical wells in the North Dagger Draw field. From this analysis, I was able to determine typical type recoveries and also to determine reservoir parameters from the production performance history of those wells.

Q. What methodology did you apply in order to come up with recoveries for the wells?

A. The methodology for the recovery was based on volumetrics, calculations, and also it was verified by the production performance.

Q. Do you have a case example of a vertical well in the North Dagger Draw from which, then, you have determined that it was a typical well, in terms of vertical performance and reserve potential?

A. Yes, I do, and that is shown in Exhibit 10.

Q. Let's turn to Exhibit 10 and before you explain your conclusions, tell us how to read the display?

A. Exhibit 10 is just a fluid production history of the Barbara Federal No. 6, from 1976 until 1985.

Q. Why did you choose the Barbara Federal No. 6 well?

A. Barbara Federal No. 6 shows what we feel is a typical type profile in the North Dagger Draw area, and it shows a dual porosity type production history. Dual porosity means we have a high initial decline rate on the oil production in the first two years, and after that time the well stabilizes with less decline, 10 to 15 percent.

Q. Having selected a typical producing vertical well in North Dagger Draw, what then did you do with this information?

A. With this information, I was able to nail down some of the reservoir parameters that we did not have data for, those being primarily the effective permeability and also the amount of porosity and thickness in the reservoir.

Q. From the information plotted on Exhibit No. 10, were you able to extrapolate a decline for the oil rate on this well?

A. Yes, I did, and that decline is noted in the solid back line. The green line is the oil production on the Barbara Federal No. 6. The blue plus symbols is the water production, the red squares on top is the GOR for the life of the well.

Q. Having done that, what then did you do?

A. Having determined the decline in production history, and also the vertical well parameters in the North Dagger Draw field, I was able to analyze or predict the horizontal well performance.

Q. Let's turn now to Exhibit No. 11. Identify and describe that display.

A. Exhibit 11 shows the oil production curve from Exhibit 10, again for the Barbara Federal No. 6, in the heavy green line. The blue connected squares is a type-curve match that I constructed using various reservoir properties.

Q. What conclusion do you reach about the match of your typical profile versus actual performance of the No. 6 well?

A. As you can see, the match is fairly representative of the actual performance of the Barbara Federal No. 6. Therefore, we conclude that the reservoir parameters that I've based the match on, are reasonable.

Q. Let's turn now to Exhibit No. 12, Mr. McClelland. Would you identify that display for us?

A. Exhibit 12 is a summary of the reservoir parameters that I determined are affecting the North Dagger Draw field.

On the top of Exhibit 12 are the reservoir parameters for the vertical type curve match, and on the bottom are the reservoir parameters I used in predicting the horizontal well performance.

Q. Without reading each of the parameters, give us a general sense of the key components, in terms of comparing the parameters and the values for each of those parameters, as we move from a vertical well to a horizontal well.

A. The key components, as Mr. Hardie discussed, is the amount of reservoir that is in contact with the wellbore.

As you can see in the vertical well case, we're showing 100 feet of pay. In the horizontal well case, we're showing 1,320 feet of wellbore.

The other key component that affects oil production is your effective permeability in the reservoir, and from the type curve match, we were able to determine that at two millidarcies.

Q. What is the underlying data upon which you have made the engineering assessment of the permeability?

A. The permeability, the effective well permeability that comes from a type curve match, we made an initial estimate of it and then, by adjusting this figure, we were able to match the initial rate of the Barbara Federal No. 6.

Q. Any other key parameters and values you want to direct the Examiner's attention to?

A. The first line on the seconds section. The vertical perm to horizontal perm ratio is a key component in predicting horizontal well performance. The .3 ratio we've shown here is based on core data from the Barbara Federal No. 1.

Q. What does that mean? 0.3 is a ratio to what?

A. 0.3 is a ratio of the vertical perm divided by the horizontal perm. Normally your vertical perm is less than your horizontal perm. In this case we're saying, if we have 100 millidarcies of horizontal perm, we would have 30 millidarcies of vertical perm.

Q. From analysis of the core, the data from the core will give you both a value for a vertical permeability as well as a horizontal permeability value?

A. Yes. It's characteristic to measure permeabilities from hole core in both the X and Y directions, both vertical and horizontal directions.

Q. Anything else about the parameters you want to direct the Examiner's attention to?

A. Just using these parameters in the horizontal well bank, the initial rate will be calculated at 1,700 barrels of oil per day, and cumulative recovery is calculated at 790,000 barrels of oil.

Q. Based on your experience and engineering judgment and your opinion, are these reservoir parameters reasonable?

A. Yes, they are.

Q. Let's turn to see what conclusions you reach when you take these parameters and apply them to forecasting production in the North Dagger Draw with a vertical well and with a horizontal well. First of all, let's go to Exhibit 13.

A. Exhibit 13 is a prediction of production for two cases. The first case is the horizontal well case shown in the dark green line. The second case would be the other development scenario, and that would involve drilling two vertical wells on the 80-acre tract that's open for development.

Q. The assumption of spacing, then, is an 80-acre spacing?

A. That's correct.

Q. You're dealing with two vertical wells, one on each 40?

A. That's correct.

Q. And comparing that to what would happen with a vertical well, with the assumption of 80 acres?

A. A horizontal well.

Q. I'm sorry, a horizontal well with the assumption of 80 acres?

A. That's right.

Q. Take us through, before we start the horizontal, take us through the sequence with the first vertical well and the second vertical well, in terms of forecasting production.

A. The first vertical well decline profile is based on the typical decline profile we saw earlier in Exhibit 6. Its initial rate is 500 barrels of oil per day. The well would decline out every nine years and produce 300,000 barrels of oil.

Under this development scenario, we would drill a second well approximately one year later, and that's shown as the footnote number two. This well will be drilled in a down-structure location and would probably encounter a higher water cut. For that reason we've risked the initial rate and have a calculated rate of 340 barrels of oil per day.

In summary, the rate profile shown is for a vertical well development of this 80-acre tract.

Q. Contrast that now to the results you may achieve with a horizontal well.

A. The horizontal well, as I said previously, estimated an initial rate of 1,700 barrels of oil per day. However, our proration unit allowable is 700 barrels of oil per day, so we'll be rate-restricted on that. We have a 50 barrel of oil per day currently on that proration unit, so the uncaptured amount is 650 barrels of oil per day.

We should be able to maintain a constant production of 650 barrels of oil per day for approximately one and a half years, and there on out we'll go on a decline that is similar to the vertical well performance decline.

Q. Have you also plotted what would be the results of cumulative oil recovery, when you compare vertical to the horizontal well?

A. Yes, I have, and that information is shown in Exhibit 14.

Q. All right, let's turn to that.

A. Exhibit 14 shows the cumulative production profile for both cases again. The dark green line is for the horizontal well and the blue line is for the two-vertical-well-development scenario.

In summary, the horizontal well cum'd 790,000 barrels of oil after nine years. The two vertical wells would cum 300,000 and 190,000 barrels of oil, respectively, for a total of 490,000 barrels of oil.

By drilling horizontally and in turn by contacting more of the reservoir with the wellbore, we would make an additional 300,000 barrels of oil over a nine-year period.

Q. Can you give us a general range of the cost of the vertical well versus the horizontal well?

A. It's roughly two-to-one. Vertical wells are running $800,000 to drill and complete, and we're projecting the horizontal well at $1.65 million.

Q. Under this reservoir analysis, is it

economically feasible for your company to undertake this horizontal pilot project?

A. Yes, it is, mainly in part due to the uncaptured proration unit allowable that exists in this location.

Q. Are you familiar with the operators that have joined the spacing unit, Mr. McClelland?

A. Yes. To the north, Yates Petroleum operates--

Q. Let's go back to one of the first exhibits. Let's look at Exhibit No. 2. Do you have that before you?

A. Yes, I do.

Q. Explain to the Examiner the operators of the spacing units surrounding this 160 acres?

A. The only other operator besides Conoco is Yates, to the north. They operate in Section 7 and 8. Conoco operates Section 17 and 18.

Q. They've been contacted about your application?

A. Yes, they have.

Q. In fact, they're present in the hearing room today, are they not?

A. Yes, they are.

Q. Have you received any objections from any of the offsetting operators or any interest owner involved in this prospect?

A. No, we have not.

Q. In your opinion, Mr. McClelland, would you request that the Examiner approve this application?

A. Yes, I do.

Q. In your opinion, will it afford the opportunity to Conoco to explore the feasibility of recovering hydrocarbons from this pool, that might not otherwise be recovered?

A. It definitely will do so. This pilot project allows us to evaluate the rate and recovery of the horizontal well. We're predicting that we should be able to recover more oil than we can in vertical wells, so it will maximize the efficiency of the recovery from the reservoir.

Q. You're proposing that the producing oil rate for this horizontal well be controlled by the proration unit allowable for this spacing unit, which is the maximum, 700 barrels of oil per day?

A. Yes, sir.

MR. KELLAHIN: That concludes my examination of Mr. McClelland. We would move the introduction of Exhibits 10 through 16.

EXAMINER STOGNER: Exhibits 10 through 16 will be admitted into evidence at this time.

EXAMINATION

BY EXAMINER STOGNER:

Q. Mr. McClelland, when you were doing your study, were you able to actually research similar horizontal wells and their performance in a formation such as this?

A. Yes, sir, I did.

Q. And which formations or which areas did you look at?

A. Case histories in the vuggular dolomite are fairly rare currently. There are two--well, two good examples by Elf-Aquataine, one in the Rospo Mare field offshore Italy, very similar to North Dagger Draw. It's a vuggular quartz type reservoir, and from that literature I based my analysis on that literature and used that for an upper limit of production prediction. In some of their wells, they saw an increase of horizontal to vertical of over four-to-one. That is, their horizontal wells produced four times their vertical wells.

Q. And they drilled two wells up there? Or you said there was another one?

A. Actually, in the case history I'm referring to, in the Rospo Mare Field, the only way they could develop the field was through horizontal well technology. It was non-economical under vertical well technology.

Q. But there were two wells in that field that you were referring to in your case history?

A. No, that field had seven or eight wells that were developed.

Q. Were there any other case histories that you utilized?

A. There was one other case history, a small field in France, the name escapes me currently, but Elf-Aquataine actually developed some of their horizontal technology drilling onshore first, and then they used that technology to develop the Rospo Mare Field I'm referring to. I can supply the case history to you there.

Q. Any case histories in New Mexico that you know of--I'm sorry. No, of course not--in the United States?

A. In vuggular dolomites, now Conoco has drilled a horizontal well in a Pinnacle Reef type formation in Michigan, that's somewhat similar and we can draw an analogy to this case. We drilled approximately a thousand feet through a Pinnacle Reef to try to reduce the coning effects in that reef, and we were successful in doing so.

Q. Was that a gas bearing reservoir or oil?

A. It was both. It had a gas cap to it, with an underlying water lake.

EXAMINER STOGNER: I have no other questions of this witness. Any other questions of this witness?

EXAMINATION

BY MR. STOVALL:

Q. Again, looking towards a more long-term approach, in your opinion what is the difference, in terms of a draining lateral, that is not the length of the wellbore but perpendicular to the wellbore drainage effect of a horizontal well in this type of reservoir, as opposed to a vertical?

A. The extent of drainage would be no more than the current vertical well drainage. But the benefit of the horizontal well is that you contact more pay, have a more efficient drainage in that area.

Q. When you measure perpendicularly or circularly around the bore itself, you're saying there is no--

A. It's the same amount of lateral drainage that you have with the vertical well.

MR. STOVALL: That's the only question I've got.

EXAMINER STOGNER: If there are no other questions of Mr. McClelland, he may be excused.

MR. KELLAHIN: That concludes our presentation in this case, Mr. Examiner, unless you would like to recall any of the witnesses.

EXAMINER STOGNER: There are a couple of points I would like to cover. First I would like to recall Mr. Hardie.

WILLIAM E. HARDIE

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

FURTHER EXAMINATION

BY EXAMINER STOGNER:

Q. Could you go into a little more detail the vuggular structure, how it was formed, and maybe the orientations of the actual cavities themselves? Are they symmetrical, both vertically and horizontally, or are you expecting to see them larger crossways as opposed to high?

A. The reservoir itself was first deposited as a limestone, and then later preferentially dolomitized. And then, at some point, this dolomitized interval was leached and created the secondary porosity. At that point the reservoir was, essentially, created.

We have recently cored a well from the top of the reservoir to the bottom, the Barbara Federal No. 12. The initial results from that core indicate that there's no preferred orientation to these vugs. They're primarily controlled by the depositional fabric within the reservoir. It's even more random than we thought before.

The typical vug zone is about 25 feet in height. We don't know the exact horizontal limit of these vug zones, but we do know that they cannot be correlated in closely spaced wells, so they can't extend for very far laterally.

Q. The leaching process, was that a shallow type of an environment?

A. Probably a shallow fresh water influx which leached out the dolomite preferentially.

EXAMINER STOGNER: That's all the questions I have. The other question I'm going to through out--I hate to use this word--but plugging of such wells, could somebody answer me that question? How you plan to plug them, what's the operation and the procedure in plugging these wells?

MR. KELLAHIN: Why don't you step down,

Bill, and let's recall Mr. Faul.

GARY FAUL

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

FURTHER EXAMINATION

BY EXAMINER STOGNER:

A. Well, I guess from the cased-hole standpoint, if it were a wellbore that were cased, it would not be a lot different than conventional pluggings in that you would want to put a plug such that it would isolate this formation or the producing formations from any other formations up the hole.

In the case of a horizontal, where you have a large section of open hole, well, then I think the same thing applies. It would just be what method you use to isolate that section from anything else that you don't want to be contacted. With the way we have this well set up, we're setting an intermediate string that, of course, is going to isolate everything from our producing formation and above, and so we probably want to set some cement plugs at specific intervals coming up the hole, to isolate things such as fresh water zones or other than that.

Q. So, essentially, as far as filling the

Cisco formation up with cement, there's really no need? Just tack a plug up on top of the intermediate casing? Is that what I'm hearing?

A. I would think so, unless in the course of doing it you expose something that was totally different than what you expected; say you crossed a fault and got into something that was totally different, well, then, I would think within your horizontal unit, you would want to isolate between whatever your formation is and whatever you saw that was different.

EXAMINER STOGNER: That's all the questions and topics I have to cover.

Are there any questions of any of the witnesses at this time?

Mr. Cross, would you like to make a statement or anything at this time?

MR. CROSS: No, sir.

EXAMINER STOGNER: All right. Mr. Kellahin, do you have anything further?

MR. KELLAHIN: No, sir.

EXAMINER STOGNER: Does anybody else have anything further in Case No. 10339?

Well, it's been about 37 years since Conoco was in here proposing horizontal drilling. It took a while.

We'll take this case under advisement.

CERTIFICATE OF REPORTER

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

I, Carla Diane Rodriguez, Certified Shorthand Reporter and Notary Public, HEREBY CERTIFY that the foregoing transcript of proceedings before the Oil Conservation Division was reported by me; that I caused my notes to be transcribed under my personal supervision; 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 July 1, 1991.

Carla Diane Rodriguez

CARLA DIANE RODRIGUEZ
CSR No. 91

My commission expires: May 25, 1995

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 10339, heard by me on 27 June 1991.

Michael E. Stogner, Examiner
Oil Conservation Division