EXAMINER HEARING

OIL CONSERVATION COMMISSION

Santa Fe, New Mexico
January 7, 1958

IN THE MATTER OF: Case No. 1356

TRANSCRIPT OF PROCEEDINGS

DEARNLEY - MEIER & ASSOCIATES
INCORPORATED
GENERAL LAW REPORTERS
ALBUQUERQUE, NEW MEXICO
3-6691 5-9546

NEW MEXICO OIL CONSERVATION COMMISSION

Examiner Hearing (D.S. Nutter)

Santa Fe, , NEW MEXICO

REGISTER

HEARING DATE JANUARY 7, 1958 TIME: 9 A.M.

NAME:	REPRESENTING:	LOCATION:
F. Norman Woodruff	El Paso Natural Gas Co	El Paso Tex.
Dave Rainey	"	"
Garrett Whitworth	"	Jal, N.M.
J. W. Bardch. Jr		
E W NESTOR	SHELL OIL COMPANY	MIDLAND. TEX
DAN CURRENS	PAN AMERICAN	ROSWELL, N.M.
E A Chávez	State Engr Office	Santa Fé
Lowrie D	Texas Co	Santa Fe
H.N. Wade	The Texas Co.	Ft. Worth
R. V. Shoemaker	The Texas Co.	Ft Worth
J.W. Bardch, Jr.	SPNG. Co.	Jal, N. M.
G. L. Tribble	Permian Basin Pipeline	Omaha, Neb
Pat McCarthy	" " "	" "
W. J. BROWN	" " "	HOBBS. N.M.
[illegible] Johnston	Northwest Production	Albuquerque
Ray Phillips	✓ ✓	✓
W. V. Kastler	Gulf Oil Corp	Roswell
J. Don Walker	"	Fort Worth
John H. Hoover	"	Roswell
John L Sanders	Magnolia	Hobbs

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HEARING DATE January 7, 1958 TIME: 9 a.m.

NAME:	REPRESENTING:	LOCATION:
J. H. Moore	Shermerhorn Oil Corp	Hobbs
Beaman	Self	Salt Lake City Ut.
R.G. Hanagan	Signal "	Midland
[illegible]	" "	Ft. Worth
[illegible]	Hervey Dow & Hinkle	Roswell
Joe M Daniel Jr.	Cabot Carbon Co	Pampa, Texas
Pam C. Quinn	Cabot	Midland, Tex.
A.B. Cockburn	Cabot Carbon Co	Midland, Texas
L O Thompson	Delmar Oil Corp	Midland Tex
Mac C Watkins	Fluid Packed Pump Co.	Hobbs New Mex
Jewell Campbell	Campbell & Russell	Roswell NM

EXAMINER HEARING
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
January 7, 1958

IN THE MATTER OF:

Application of Cities Service Oil Company for permission to institute a pilot water flood project in Township 14 South, Range 31 East, Caprock-Queen Pool, Chaves County, New Mexico. Applicant, in the above-styled cause, seeks permission to institute a pilot water flood project in the Caprock-Queen Pool, Chaves County, New Mexico, by injecting water into the Queen formation through the following intake wells:

Government "B" No. 5, NW/4 NE/4 Section 10;
Government "B" No. 6, SE/4 SE/4 Section 3;
Government "B" No. 10, NW/4 SE/4 Section 3;
Government "B" No. 14, SE/4 SW/4 Section 3;

all in Township 14 South, Range 31 East.

Case 1356

BEFORE:

Mr. Daniel S. Nutter, Examiner

TRANSCRIPT OF PROCEEDINGS

MR. NUTTER: The meeting will come to order. Let the record show that due to construction work being done in Mabry Hall and the impracticability of holding the hearing here today, the meeting will be adjourned and resumed in the State Highway Building on Cerillos Road at 9:30 A.M.

(Whereupon the hearing was adjourned until 9:30 A.M. in the State Highway Building).

MR. NUTTER: The hearing will come to order, please. The

first case on the docket this morning will be Case No. 1356.

MR. COOLEY: Case 1356: Application of Cities Service Oil Company for permission to institute a pilot water flood project in Township 14 South, Range 31 East, Caprock-Queen Pool, Chaves County, New Mexico.

MR. HOLL: Appearances for the applicant, Alfred O. Holl, Bartlesville, Oklahoma. We have one witness in this case, Mr. Motter.

E. F. MOTTER,

a witness, of lawful age, having been first duly sworn on oath, testified as follows:

DIRECT EXAMINATION

By MR. HOLL:

Q Would you state your name and address, please?

A E. F. Motter, Hobbs, New Mexico.

Q By whom are you employed and in what capacity?

A Cities Service Oil Company as District Petroleum Engineer.

Q Have you previously testified before this Commission as an expert in cases such as this?

A Yes.

MR. HOLL: If there are no objections, we ask that his qualifications be waived.

MR. NUTTER: The witness is qualified.

Q Mr. Motter, are you familiar with the application filed in this matter?

A Yes, sir.

Q Is the area which is the subject of this application under your direct supervision?

A Yes, it is.

Q Our Exhibit No. 1 is a plat of the area showing all of the wells in the proposed water flood. Would you explain this exhibit, please?

(Cities Service Exhibit No. 1 marked for identification.)

A This plat shows the proposed area of the water injection, all the offset operators, offset producing wells. The proposed injection wells are Government "B" No. 5, it's in the Northwest, Northeast Quarter of Section 10; Government "B" No. 6, the Southeast Southeast of Section 3; Government "B" No. 10, the Northwest Southeast of Section 3; and Government "B" No. 14 in the Southeast Southwest, Section 3. They are all in Township 14 South, Range 31 East.

Q For benefit of the Examiner, Mr. Motter, will you give a brief history of the Drickey Queen Pool?

A The Drickey Queen Pool was discovered in June of 1953 by Penrose, the discovery well was the Zimmerman No. 1, located in the Northwest of the Northwest of Section 15, Township 14 South, Range 31 East. The development proceeded in all directions from this well until it reached the old Caprock Queen Pool to the north and the wells encountered water to the east and they found a gas

cap to the west. Development to the south never did quite tie in with what they call the South Drickey Queen Pool. It appears that this pool lies in the northeast southwest trend along an old shore line. The producing formation is the Queen Sand of the Permian system, and the pay section in this area consists of from eight to ten feet of unconsolidated sand. The accumulation of oil is found along the flank of a local high extending northeast southwest; the reservoir is a stratigraphic trap with some evidence of local closure. On Cities Service acreage there were seventeen cores and sixteen Gamma Ray-Neutron logs run. Very poor recovery of the cores occurred because of the unconsolidated nature of the pay section. From all the available information, the porosity is estimated to be twenty-three percent, permeability five hundred twenty md and connate water 28.5 percent. A bottom hole fluid sample obtained from the Government "B" No. 20 shows a saturation pressure of 934 psig at a reservoir temperature of ninety degrees. The gravity to produce oil is 36.5 degrees at 60 degrees F. At present it appears that the main driving mechanism is a solution gas; however, as I stated previously, a gas cap exists to the west and water has been encountered along the eastern edge of the field, but because of low initial pressure in the field, it is anticipated that this water is essentially dormant and will not act as a water drive.

Q Now, Mr. Motter, I hand you our Exhibit No. 2. Would you, when the Examiner has a copy, explain it and identify it, please?

(Cities Service Exhibit No. 2
marked for identification.)

A Exhibit No. 2 is a structure map of the area of interest. This map is contoured on the top of the Queen Sand. Due to the completion methods used in this portion of the pool, we were unable to obtain true sand thickness so we were unable to make an isopach. The reason for this is that most wells were drilled with rotary tools to within a few feet of the pay, and after the oil string was set, the well was drilled with cable tools. It is not certain whether the sub sand section below the main pay was drilled in all the wells and for this reason, no attempt was made to prepare an isopach. However, as I stated before, we believe there is from six to eight feet of pay throughout this area.

Q Now, Mr. Motter, you have prepared what we call our Exhibits No. 3 and 4. I will ask you to identify those when the Examiner has a copy.

(Cities Service Exhibits No. 3 & 4
marked for identification.)

A Exhibit No. 3 is a radio-active log on the Government "B" No. 5, and I might say right now that this is the only log we have available on the four proposed injection wells. Exhibit No. 4 is a schematic drawing of the proposed method for completing the input wells.

Q I notice from the Exhibit 4 that there is a liner in this proposed input well. Will liners be run in all of your input wells?

A No, sir. Our plan is to log each input well and if the

five and a half inch casing is set into the anhydrite streak immediately above the pay, liners will not be run. We have roughly tried to duplicate the Gamma Ray-Neutron curve on this, and the base of the liner is the anhydrite streak which we have referred to. If we have cased down that far, we will not run liners in those wells. If you refer to Exhibit 3, the log on the Government "B" 5, you note several stringers above the anhydrite streak. We have enough cores in this area to find that this is rather unconsolidated and contains some salt.

Q Then what is the purpose of the liners?

A Well, as I have just stated, there are some core analyses. From core analysis we know that free salt exists in the formation above the anhydrite streak. Since we are going to use fresh water to kick off the flood, we feel we should protect this free salt from flushing.

Q You have mentioned fresh water for the flood. Where do you plan to obtain the water?

A We have purchased two commercial water wells in Section 24, Township 14 South, Range 31 East. It is not on the map, but it is right down there about a mile. We have both water lease and water rights assigned from the State Land Commissioner and the State Engineer. We have been authorized to use 465 acre feet of water per annum from four wells in Section 24. The file number on the change of ownership of water rights is L-2661. We have a copy of Commercial Water Lease No. W-119 assigned to Cities Service Oil

Company. These are all presented in Exhibit No. 5 and No. 5-A.

(Cities Service Exhibits No. 5 & 5-A marked for identification.)

Q What is the source of this water?

A The water will come from the Ogallala formation at approximately three hundred foot depths.

Q Have you tested these wells for capacity?

A They have been tested for a daily capacity of 3700 barrels. These wells have not been produced at capacity for quite some time, and have not been cleaned recently, and we feel that if we cleaned out the wells, the producing capacity could be quite some better than what it is right now.

Q How much water will be used for this pilot water flood per day?

A We had planned to inject approximately four hundred barrels per day in each of the four injection wells, so that will take sixteen hundred barrels per day.

Q Have you made any effort to determine if another source of water other than the fresh water you propose to use is available?

A Yes, we have looked at logs in the area of numerous wells drilled, and talked to operators who have cable tooled wells to the producing zone in this area, and they report no evidence of water down to that depth. Water has been found in a drill stem test in the Devonian formation to the east, but inadequate information is available as to the quantity.

Q Do you know of any other operators who have been able to find another source of water other than fresh water in this area?

A It is my understanding that Grest Western has just re-entered a dry hole drilled to the Devonian and tested for water. The results of the test have been reported. I do not know how lengthy the test was, so I don't know how reliable the water source would be. We have considered picking up salt water from several other producing fields in the area, but the pipelines to transport the water would cost too much and prohibit this consideration of this water as a source for water flooding.

Q Have you performed any tests to determine if fresh water will perform successfully in this flood?

A Well, of course, we know that there are two floods to the north in the old position of the Drickey Queen Pool now operating on fresh water, and we have had laboratory tests run on cores taken from the lease and the water which we plan to use for flooding. X-ray diffraction analysis indicates that no water sensitive clays are present. Laboratory tests indicate that filtering of the water will be necessary to overcome plugging difficulties. After filtering the samples of water, there was very little change in permeability of the cores after injecting water through them for ten days.

Q What rates do you plan to inject the water into each well?

A As I stated before, approximately four hundred barrels per day per well. Since the wells will be on an eighty acre five-spot

and have approximately six to eight feet of pay, that would be nearly one barrel per day per acre foot.

Q Would you say this rate is high or low?

A I would say that is about average.

Q Do you have an estimated pressure at which the water will be injected?

A Well, while fill-up is taking place, we expect the intake wells to take water on gravity. After fill-up has occurred and as we start pushing oil, we will probably expect pressures of one thousand pounds, or perhaps in excess of a thousand pounds.

Q At this rate, you propose, how long do you predict it will be before fill-up occurs and producing wells will be affected?

A We should get some response before fill-up occurs. We estimate that it will take approximately six months before we get any effect of the water flood.

Q Do you have any information relative to the past performance and present reservoir conditions?

A Yes, we have prepared a data sheet marked, I believe it is Exhibit 6, and we have decline curves on the Government "B" lease and also several wells around this proposed pilot that are marked Exhibit 7.

(Cities Service Exhibits No. 6 & 7 marked for identification.)

Q Will you please explain this data sheet, or Exhibit No. 6, to the Commission?

A This data sheet gives information on all wells on the Government "B" lease, including date of completion, the original potential, and the most recent production tests, cumulative production to December 1st, 1957, and the most recent bottom hole pressures, and this has the bottom hole pressure in December of 1954, I believe I stated previously that was '53, it should have been corrected to '54. I might add that there is one inked-in pressure that we got after I got in yesterday. It was called up to me.

Q That was taken on the 5th day of January, 1958?

A Yes, it was taken Saturday or Sunday.

Q What do you believe the significance of the decline curve for Exhibit No. 7 to be?

A Well, the main thing, if we just look at the Government "B" lease as a whole, these curves show that the production has been falling below allowable more and more each month. The last month that the allowable was produced was January, 1956. If you will notice, we have added two small red marks there for the months of August and September. Those two months we asked for a reduced allowable, which are indicated by the two small circles; the red lines would have been what our allowable would have been, top allowable for all wells on the lease.

Q What are the reservoir conditions as they exist today?

A We estimate that we have recovered sixteen and a half percent of the oil in place, and according to our calculations, we believe that we will recover perhaps another five and a half

percent by primary means. We also estimate that we will recover an additional 25.6 percent by secondary means.

MR. NUTTER: How much was that?

A 25.6 percent.

Q Then if water flooding is not employed, there will be some loss of oil to Cities Service Oil Company and a loss of revenue to the royalty owners, who are the State of New Mexico and the Federal Government, is that correct?

A Yes, that is correct. If secondary operations are not inaugurated, we estimate that we will leave in place an estimated seventeen hundred forty barrels per acre foot.

Q Then that would result in waste if this application were not granted?

A Yes, we believe it would.

Q Now, do you have any plans relative to the increasing of the size of this pilot water flood?

A Well, naturally if this pilot is successful, we would like to increase the flood to ultimately cover our entire leases in that area. We would like to, if the Commission would approve that this be done by administrative approval rather than have to come back before this Commission each time we want to add a few more wells to our water flood.

Q Then you want the Commission to understand that we would notify all offset operators and keep them advised of any increases in this project?

A Yes, we would naturally do that on our application for administrative approval. I might add that all offset operators, of course, were notified of this application by registered mail, and as far as I'm concerned, we have had no objection. We have had several meetings in the past several months, and nearly all operators seem to be in approval of flooding for this area.

Q This proposal that we are making is the same that has been approved by the Commission in several other projects, is that correct?

A Mr. Holl, if I understand you right, this pattern agrees in line with the two pilots that are now in operation to the north of this area.

Q Were Exhibits numbered 1 through 7 prepared by you and under your supervision?

A Yes, they were.

MR. HOLL: We ask that Exhibits 1 through 7 be admitted to the record.

MR. NUTTER: Is there objection to the entrance of Cities Service Exhibits 1 through 7? If not, they will be admitted.

MR. HOLL: That's all we have.

MR. NUTTER: Does anyone have any questions of the witness?

MR. IRBY: I have a question.

MR. NUTTER: Mr. Irby.

MR. IRBY: Frank Irby from the State Engineer's office.

CROSS EXAMINATION

By MR. IRBY:

Q Did you testify that the water for this project is coming from Section 24, 14, 31, 32?

A Section 24, let me see here. I'm sure that's right. It's in the same township and range as the proposed water flood. It is about three miles south of our acreage.

Q The applications that I have on file in the State Engineer's office for this project are all in Sections 19, 29, and 30, for the withdrawal of water?

A Yes, sir, we made application in those sections; that is in the township immediately to the east of our proposed flood. After we made those applications, this commercial water well or wells became available, so we purchased those wells, and we have a transfer of ownership which I have introduced as evidence. I think that your Roswell office has all those copies, also. It was purchased from Mr. J. J. Kirby. That is what we propose to use, that water to kick off this flood, since those two wells are drilled and producing and have all the equipment in them right now.

Q Do you plan to abandon your rights under these applications L-3643 through 3649?

A Well, that's a little hard for me to say right now. If this flood would expand in the future, I'm sure that we would probably need more than this four hundred sixty-five acre feet. We might have to go over and pick up some of that water in that

other township. I believe that those leases or water rights are good for two years. We hope by that time to know whether this will be adequate or not.

Q Could you give me the numbers of these wells from which you presently propose to withdraw the water for this project, the State Engineer's file numbers? I think you gave them before.

A Well, actually I don't know whether the two wells are numbered; the transfer of ownership to us just shows four hundred sixty-five acre feet per annum to be taken from four wells, and two wells are drilled right now and producing. I can give you the location of those, they are in the northwest quarter of the northwest of Section 24.

Q Northwest, northwest, and the township and range on that?

A That is 14 South, 31 East.

MR. IRBY: Thank you. That is all.

MR. NUTTER: Anyone else have any questions?

By MR. COOLEY:

Q Mr. Motter, I believe you testified on direct that you are now seeking administrative approval, or provision in the order authorizing administrative approval for extensions to this project?

A We would like -- maybe I should explain that a little more. We would like to get something worked out so that if this flood is successful, it wouldn't be necessary to come before the Commission with a hearing to add additional wells to the flood. We thought perhaps administrative approval with offset operators' approval, or

something like that might be worked out.

Q Was this particular facet of the case mentioned in your application?

MR. HOLL: If I might interpose, Mr. Cooley, the main purpose of the application is to obtain Commission approval of the present and proposed water flood as set out in the application. Now the thought we had relative to enlarging it, if it should prove to be successful, was merely to aid, if possible, the Commission and ourselves in maybe removing the need for a hearing at a later date. If the Commission feels and the legal staff feels such is required under the New Mexico Statutes, why we'll certainly be happy to come back in on each case.

MR. COOLEY: Thank you.

Q Do you intend to continue to seek a source of salt water in this area, or do you expect to use fresh water?

A Yes, of course, we don't like to use the potable water any more than anybody else. I think we would like to see how this well of Great Western would stand up before we would attempt to test to the Devonian. I think a test to the Devonian would probably run in the neighborhood of $225,000.00 or some such matter.

Q There are no dry holes on your acreage to the Devonian?

A Yes, sir. I might add that the one commercial well we had was originally drilled to furnish fresh water to the rig on the test to the Devonian should that test be --

Q (Interrupting) You are referring to the Great Western test?

A I am referring to Great Western's test. As I understand, the well has only been tested for a short period. I don't know what the P.I. is or should that bear up, should that prove successful, we would have a dry hole drilled by the Union Water Company. We could possibly enter that hole and move our water through the pipeline up to our proposed injection wells.

Q That is in Section 14?

A No, it is in Section 24. I have a map of that.

Q Earlier in your direct examination, to clear the record, you referred to the Drickey Queen Pool, this was the original name and it is now being designated as the Caprock Queen?

A Caprock Queen.

Q It was the Drickey Queen when the wells were originally drilled?

A That's right. I have a large map of the area showing those which sections our water wells lie in. I have only one copy, so I wouldn't like to introduce it. I only brought one.

MR. COOLEY: I don't think it would be necessary to introduce it as an exhibit.

MR. HOLL: We would be happy to furnish you with a copy if you think it would be of benefit to you.

MR. NUTTER: I don't think that additional map would be necessary, Mr. Holl.

Q Mr. Motter, has your company made any study to determine

what the breakthrough pressure would be in this area? I see you intend to inject with a thousand pounds?

A We don't want to inject at such pressures until we lift the overburden, or we will fracture the formation. We probably would not want to go over a thousand pounds in this area.

Q You do not think the thousand pounds would cause a breakthrough?

A No, I don't believe it will.

Q What is the production from your four proposed injection wells?

A If you refer to Exhibit 6, those injection wells are No. 5, that was tested 7-16-57 for twenty-four barrels per day. No. 6 was tested 7-9-57 for twenty-seven barrels per day. No. 10, 7-12-57 for thirty barrels per day; and 14 was tested 7-18-57 for thirty barrels per day.

Q Would you in your opinion as an expert in these matters consider these wells listed on your Exhibit 6 as being in the stripper stage?

A No, but they are approaching that stage quite fast. I think we can bear that out by the bottom hole pressures here, which don't look like they will be with us too much longer; and also this No. 7 shows how our decline on this lease has been for the last few months.

Q Where in your opinion would the line be drawn in this area between pressure maintenance project and water flood?

A Well, that's a pretty good question. We could probably say it is either water flood or pressure maintenance right now. I

might add that one reason we would like to start this flood is that these wells are getting to the stage now that if we didn't inaugurate water flooding, we would probably go in and frack all the wells. In our opinion that is a waste of expense, if we are planning on doing any water flooding anyway.

Q You feel that you could make most of the wells top allowable by fracking them?

A Yes, sir. We fracked one well several months ago in this area and helped it considerably. I think it produced potentially eighty-some barrels per day after frack.

Q Isn't it more common to refer to water flood as the injection of water into a pool where the wells are in the stripper stage, rather than in a relatively high productive stage as are these?

A That might be true. Our experience has been if we can start injecting water at a stage more like this, we have better recovery than waiting until the wells get to a stripper stage.

Q But the earlier you commence injection of water, the more it falls in the category of pressure maintenance?

A Well, that's true, yes.

Q What area of effect do you expect -- refer to your Exhibit 1, please, and tell me what wells you expected to be affected by the injection of water in the four proposed wells.

A I would say the well in the center, the Government "B" 8. I would say, well, if you allow me, Mr. Cooley, the wells that we have on Exhibit 7, those wells listed in the back are those

wells we expect to be affected by the pilot.

Q Listed in the back?

A There are some twelve or thirteen of them there. I'll read those if you like, for the record.

Q All wells listed in 7?

A Yes, the front page is the entire lease, but the wells attached to that are the wells we expect to be affected by the four well pilot.

Q You expect seventeen wells to be affected. What is the furthermost well?

A Let me read them off.

Q I would rather see how far you expect it.

MR. NUTTER: Go ahead and read them off.

A Government "B" 2, south offset to No. 5; "B" 3; "B" 5 -- now I should take that back, we also have the producing curves on the injection wells in this list. "B" 6, which will be an injection well; Government "B" 8 will be affected; "B" 9; "B" 10, that will be an injection well; "B" 11; "B" 12; "B" 14, which will be an injection well; "B" 15; "B" 19; and the State"AN" No. 1.

MR. COOLEY: That's all. Thank you, Mr. Motter.

MR. NUTTER: Anyone have any further questions of the witness?

MR. UTZ: I have a question.

MR. NUTTER: Mr. Utz.

By MR. UTZ:

Q Mr. Motter, you spoke of primary recovery being somewhere

in the neighborhood of twenty-one and a half percent, is that right?

A That is what our reservoir department has made as an estimate on this pool.

Q Can you put that in barrels? Do you have a figure for oil in place?

A I believe that is 250 barrels per acre foot.

Q That's total oil in place, 250?

A No, that is not total oil in place. That is recoverable to the primary. Yes, that is 250 barrels per acre foot by primary means.

Q Do you have a figure there for total oil in place?

A Just a minute. Oil in place, barrels per acre foot, we estimate at 1,133 barrels.

Q That's per acre foot?

A Yes, sir.

MR. UTZ: That's all I have.

MR. NUTTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Motter, by this application you are not, at this time at least, seeking any allowable relief with regard to this project whatsoever, are you?

A No, sir.

Q And do you understand that if the application is granted, that the quarter sections on which the injection wells are located will not be assigned an allowable?

A Yes, we understand that.

MR. COOLEY: That's all. Thank you.

MR. NUTTER: Any further questions? Mr. Motter, I'm having a little difficulty reconciling this injection of water into four wells here of a total production of some two thousand barrels per month, and calling this a water flood. I wonder if you would elaborate on what a water flood is and what a pressure maintenance program is.

A Like I stated before, we, at this stage of the field, we could probably call it pressure maintenance; we refer to it as water flood. Our experience in other areas has been if we can start flooding along about this stage, that we will be in better position or have more ultimate recovery of water flood oil than if we wait until the field gets to a stripper stage.

MR. NUTTER: Aren't these wells here relatively high yet on a production decline curve?

A I believe if you refer to this Exhibit 7 that you could see that since about, oh, April of '57 that we're going downhill pretty fast. Right on the front page there, Mr. Nutter, the "B" lease as a whole. Then one thing we are quite concerned about is the fact that the pressures have dropped from 934 pounds when we drilled this area until right now I think we can say it is somewhere between, right here we have 213 - 319 pounds.

MR. NUTTER: Mr. Motter, isn't part of the reason for the decline the fact that the allowables have been lower since April of

'57, or has that not had any effect on the wells here?

A Those small circles are the allowables.

MR. NUTTER: They represent top allowable?

A Top allowable up until the point where the small red dashed line is in there. That is when we asked that the wells be reduced in allowable. I might add if you want more about the pressure maintenance or water flooding, we have the gentleman who is head of our secondary recovery department here.

MR. HOLL: I was going to interpose that. Mr. E. E. Funke, who has spent a great number of years on secondary recovery and water flood exclusively, is here, and we would be happy to put him on the witness stand and let him elaborate on his theories and success with those theories.

MR. NUTTER: We would be happy to hear Mr. Funke testify.

MR. HOLL: The questions you have been bringing out are for an expert secondary recovery engineer. I think you will receive more information from Mr. Funke.

MR. NUTTER: Let's excuse Mr. Motter for the time being.

MR. UTZ: I have one more question.

MR. NUTTER: Mr. Utz.

By MR. UTZ:

Q I would like to know what you calculate your average net pay in this area.

A Six feet is what we have used throughout the area.

MR. NUTTER: Mr. Motter is excused from the stand, subject

to recall.

(Witness sworn.)

E. E. FUNKE

a witness, of lawful age, having been first duly sworn on oath, testified as follows:

DIRECT EXAMINATION

By MR. HOLL:

Q Would you state your name and address, please?

A E. E. Funke, Bartlesville, Oklahoma.

Q By whom are you employed and in what capacity?

A Cities Service Oil Company, Secondary Recovery Engineer.

Q Mr. Funke, would you briefly elaborate on your educational qualifications?

A My formal education is a B.S. in Chemical Engineering from Kansas State College.

Q Now when did you obtain that degree?

A That was 1935. I have been working in the field of secondary recovery almost constantly since about 1936.

Q In such work have you studied and made recommendations with any number of secondary recovery projects?

A Yes, any number. I would hate to try to recall right off-hand how many. Currently Cities Service Oil Company is interested in some fifty, I would say, secondary recovery projects, and that oil represents roughly twenty percent of the Cities Service production.

Q And you have been primarily responsible for initiating all of these projects, is that correct?

A Well, primarily responsible; in some cases we are not the operator, other companies have taken the lead, but I would say in all those that Cities Service is the operator, I have been responsible, yes.

Q Have you served on any committees, industry committees relating to secondary recovery?

A Yes, I have served on several committees for the American Petroleum Institute.

Q For how long a period, has that been for fifteen years?

A I would say off and on for the past twelve years, anyway.

Q Have you written any papers and given any papers relative to this subject?

A I have written papers that have been published, and given papers at various A.P.I. meetings. I think the most recent one discussed the matter of proration and control of water flood projects, which was given at the Wichita District meeting of the A.P.I. in 1956.

Q Do you recall the title of that particular paper?

A "The Effect of Proration on Water Floods."

Q You have been listening to the questions propounded to Mr. Motter relative to water flood and pressure maintenance, is that correct?

A Yes, sir.

MR. HOLL: Why don't we just turn the witness over to you and you ask him the questions you are interested in? Do you feel that his qualifications are acceptable?

MR. NUTTER: The witness is qualified. Now in your summary of your background and experience, Mr. Funke, you mentioned this recent paper that you wrote?

A Yes.

MR. NUTTER: Relating to prorationing of water floods. Would you state briefly what the text of that paper was?

A You mean the conclusions?

MR. NUTTER: Abstract the thing very briefly.

A I hate to say the conclusions were rather indefinite in that, based on a number of water floods in which we had experience. We found any number of cases where interruption of production for one reason or another had caused what we considered irreparable damage or loss of oil because of that interruption. We also found some cases where interruption of production apparently caused no ultimate loss, of course, it caused an immediate loss. The conclusion was that it's risky to curtail the water flood once it is under way. There are cases where you are lucky and won't be hurt. As to why some cases won't be hurt and others would, I attempted to show that as being related to the variation in permeability within the section. There's probably many other reasons that floods might be hurt. The thing about a water flood is that usually you start your water injection with the pressure in the formation being rather

low, and incidentally, I would consider this rather low.

MR. NUTTER: This is low pressure?

A Yes. The injection of water cannot help but create a local increase in pressure, so that you have quite a difference of pressure between the input well and the producing wells. Under primary production or natural water drive, you have a rather even decline in reservoir pressure, but having this rather large differential in pressure between the input and producing well, you are inviting the water to find avenues to bypass oil and move from the input well to the oil well. Once it gets there, if the area immediately around the oil well is not uniformly increased in pressure, and I assume that it wouldn't be when you had a condition of bypass, curtailment of production will mean that water can head up in the oil well and actually reverse its flow and go back into some of the other parts of the formation.

MR. NUTTER: Now, Mr. Funke, is this bypassing of oil through the more permeable sections and the passage of water through the more permeable sections of the reservoir possible whether production is curtailed or not?

A It's possible; however, it will happen certainly, but whether it is curtailed or not, the damage in effect, though, is what we are concerned about. That is, if you are able to take out the oil and water that comes into that well, yes, damage of water backflooding into the formation should be eliminated.

MR. NUTTER: What I'm concerned with here. Now you have

stated that the bypassing of oil is possible by the injection of water and flooding out of certain sections, and leaving oil in place in other sections. Now isn't that possible whether you curtail production or not on one of these? If you inject water into a reservoir, is it not possible for the water to take off in one direction in the line of least resistance and follow the most permeable path it will find?

A I think it will always do that whether you curtail or not. Again I want to say the damage effect would be worse if you curtailed the production.

MR. NUTTER: We have got four wells here that at the present time are producing better than two thousand barrels of oil a month, and by injection of water into those wells, is it not possible for this water to bypass the oil and find its course of least resistance to well No. 8 and leave oil in the reservoir there that never will be recovered?

A I think it is possible. I'm not going to say it is going to happen. If we thought it were going to happen in a damaging amount, then we certainly wouldn't be wanting to start this water flood.

MR. NUTTER: Well, do you consider this primarily to be a water flood or pressure maintenance program here?

A I heard your question to Mr. Motter a while ago. I thought the answer to that might be determined by the situation of the reservoir fluid; that is, the pressure now is, oh, some 260 pounds,

isn't it?

MR. MOTTER: Something like that.

A Originally this reservoir was under a pressure in excess of 900 pounds, and I think the reservoir fluid analysis showed that the saturation pressure was just about the original pressure, in excess of 900 pounds. From that point on down we have had free gas occurring in the formation. Now pressure maintenance, to be strictly pressure maintenance, ought to be applied above the saturation pressure of the reservoir fluid.

MR. NUTTER: So, strictly speaking, you would not call this a pressure maintenance?

A No, this is way below the saturation pressure.

MR. NUTTER: Is this not relatively high in productivity to be water flooding?

A No, I don't think so. It's possibly higher than the average water flood, but our objective ought to be to eliminate secondary recovery as such. We ought to strive to maintain pressures on all reservoirs. There's two more points I might say there. I believe his testimony gave the most recent tests which were some six months ago. I believe that the lease production has continued to decline; therefore, the well production in the wells involved here certainly has declined also since then.

MR. NUTTER: Well, the lease production hasn't declined in an abnormal fashion, has it?

A No, but it has declined in six months' time. The two thousand

barrels per month might be a little high. Oh, I could go back and think about any number of projects that we are involved in, I know that -- well, in one case, the Langston Cliner Field in North Texas, we have commenced water flood there on a pattern basis when the individual well's production capacity was at least as much as these wells, I think a little bit greater. Another one I'm familiar with that we have an interest in is the Chitwood Simpson Sand Unit in Pratt County, Kansas. We commenced a water flood there, a number of the wells having capacities in excess of one hundred barrels per day.

MR. NUTTER: Those were water floods?

A We considered them water floods. Well, I'm getting clear off New Mexico, but in the State of Kansas they prorate until the pool average drops below twenty-five barrels per day, and this was still a prorated pool.

MR. NUTTER: Mr. Funke, you've testified ~~in~~ the your paper that you mentioned a while ago, reflected that in some cases these water floods can be curtailed and in other cases they can't be. Have you made a study of this particular reservoir here?

A Well, I've studied it, as to whether I have a conclusion as to whether this can be curtailed or not -- like I said, I would say in all cases that we would consider it risky. We have an idea on this problem which I think is somewhat straddle of the road position, I know they had a considerable hearing on the issue a month or so back.

MR. NUTTER: Where was this?

A Our position, I say.

MR. NUTTER: Where was this?

A On the Graridge application in the Caprock Queen water flood. I was not here at that hearing, but I have read about it. Our position is this, that water floods can be controlled in a fashion if the control is known and the plan is initiated -- I mean the control is initiated at the time the flood is initiated. The area to be flooded should be considered and prorated on a project basis with allowable being assigned to the project rather than to the individual wells.

MR. NUTTER: Now in this Graridge case, what was Cities Service position?

A Well, that's about what I'm stating now.

MR. NUTTER: Did they make a statement at that hearing?

A Yes, Mr. Motter made a statement at that particular hearing. In other words, if you know that you are going to be prorated, you can take your project and arrange your development so that you inject water in the area that's initially developed at the rate desired, which in this case we think should be somewhere around one barrel per day per acre foot, and have enough area involved in the project so that the allowable will be sufficient for the oil wells immediately adjacent to produce that capacity; and you expand your project then only as necessary to keep your project allowable up to the State regulation.

MR. NUTTER: Now in this case, what would you consider to be a project area?

A The entire group of leases involved there, which I think is, oh, I think --

MR. NUTTER: You mean the leases that are colored in yellow on the map?

A Yes, with the exception of the one eighty separated there.

MR. NUTTER: Do you feel that the impact of the water flood will be felt --

A (Interrupting) No, I don't mean that.

MR. NUTTER: -- up in the upper left-hand corner of the plat?

A No, I meant that the allowable should be assigned to the entire area shown in yellow, less the one isolated eighty; at present that is thirty-seven barrels. We have thirty-seven barrels per well for all the wells in that area with no individual well assignments. We can inject water in these four wells, and whatever other wells are necessary to bring our total project up to thirty-seven barrels a day. Yet the wells that are actually affected will be the only ones that, I mean will be produced to capacity, and they will be taking more than thirty-seven barrels a day at times, probably considerably more than that, but they will always be taking all their fluid out, that is, both oil and water. I don't know whether I have explained myself there or not.

MR. NUTTER: Actually this matter of allowable is beyond the scope of this hearing today. However, we are interested in

knowing the amount of water that is going to be injected and whether this water is going to affect the wells immediately adjacent to it or how far away the impact of the water will be felt. We also would like to know what will happen to well No. 8, which is directly in the center of the four injection wells. What do you think will be the future of well No. 8 after you start injecting water?

A Well, No. 8 might be produced for a short period of time at a rate as high as four hundred barrels a day oil. That, of course, is the direct relation between input and production.

MR. NUTTER: That is at the rate of four hundred barrels per day on these four offset wells?

A Yes.

MR. NUTTER: That well No. 8 could produce four hundred barrels of oil per day?

A That would be the maximum we would expect out of that well. That won't occur for very long, because water floods have a way of producing water instead of oil. There will always be some water show up.

MR. NUTTER: As I mentioned before, the matter of allowables is not a subject of this hearing. This is an application for a pilot water flood period, but you did testify a moment ago that you felt that the rate of injection could be controlled at the beginning of a water flood project, did you not?

A Yes, sir.

MR. NUTTER: And that the productivity could be thus con-

trolled by the rate of injection;if you started injecting water at four hundred barrels per day into these four injection wells, wouldn't you be a little bit presumptuous as far as expecting four hundred barrels per day out of well No. 8?

A There again I would like to make it on a project basis and that would allow us. I think the decline on the other wells would far more give us room to take up that increase.

MR. COOLEY: Mr. Funke, I'm interested in your comment about assigning allowables on the basis of a project rather than per well allowables, and your statement particularly that the allowables could be kept within what you would call a lease allowable or project allowable by adjustments in the rate of development or expansion of the flood?

A That's the point, yes.

MR. COOLEY: You said this can be done if the company or the operator of the project forsees this and proceeds on that basis. Are you aware of whether or not Cities Service anticipates development in such a manner?

A I would answer it in this fashion, that the pattern for Caprock has been somewhat established by the decision on the Graridge case. Therefore, we would assume that capacity production is to be expected all over the Caprock Pool.

MR. COOLEY: The question of rate of development has not yet come up with regard to the Graridge application, however, since there must be a hearing to expand any water flood project as it now

stands, we still have some control over the rate of development. As you pointed out, the total production can be more or less leveled off or maintained at a given level by controlling the rate of development?

A That's correct. Now each individual --

MR. COOLEY: (Interrupting) Do you feel --

A Excuse me.

MR. COOLEY: Do you feel that such a staged rate of development would be possible in this instance?

A Yes, I do. The exceptions would be the problems of what the offsets do. Now we have a fairly large area here. Graridge may be up against a different problem.

MR. COOLEY: You said, I believe, that you had read about this case. Have you read the record of the Graridge case?

A No, I haven't seen it.

MR. COOLEY: Are you aware of whether or not the pool conditions are similar in that area to those in the present area under consideration?

A About the only difference would be the Caprock area is at a more advanced state of depletion.

MR. COOLEY: That's what you might call the stripper stage?

A Yes, it is definitely stripper. I think they had an average of some one barrel or two barrels per well per day.

MR. COOLEY: That's all the questions I have.

MR. NUTTER: Mr. Funke, do you think that a water injection

program that would be classified as a pressure maintenance program can be curtailed in any manner? If so, why?

A Well, a strictly pressure maintenance where you do not allow the original reservoir pressure to decline and therefore don't bring the pressure up locally by injection could be more easily curtailed.

MR. NUTTER: Most pressure maintenance programs are instituted after the pressure has declined somewhat?

A After it has declined somewhat. Now that is the matter of degree. Had we started our injection in this field with the reservoir pressure about nine hundred pounds, I believe that we could have had less danger of loss of oil by curtailing production than we would at this time.

MR. NUTTER: Does anyone have any further questions of Mr. Funke?

MR. HOLL: I would like to ask a few more questions.

MR. NUTTER: Mr. Holl.

By MR. HOLL:

Q Mr. Funke, we have talked some here about ultimate recovery. We have also talked some about permitting a field or pool to get down to what is commonly termed the stripper stage, down to a few barrels per well per day, as opposed to, on the other hand, pressure maintenance, or beginning a water flood when your production is at a higher level. What is your feeling with regard to ultimate recovery from a field or a lease in those situations?

A I would say that if a field is going to respond to any kind

of an injection program, the ultimate recovery will be better if that injection program is initiated early in the life of the property. That is, while the pressure is still high in the reservoir.

Q In other words, the higher the pressure is, the better you consider the ultimate production to be?

A That's correct.

Q In this situation, then, you feel that ultimate production -- which is the primary concern of most operators, isn't that correct?

A That's right.

Q -- would be greater by instituting water injection now or permitting these wells in this lease to go down to smaller production?

A I think we will recover more oil by initiating it as soon as possible.

MR. HOLL: That's all.

MR. NUTTER: Now to elaborate on that a little further, Mr. Funke, the sooner water injection is instituted, the more ultimate recovery you will have, is that your testimony?

A That is my testimony.

MR. NUTTER: If you started off immediately when you drilled a well and started re-pressuring the reservoir with the first production, you would have more ultimate recovery?

A Right.

MR. NUTTER: If you started a water flood when the wells are producing twenty-five to thirty barrels a day, you'll have more

recovery than if you wait until they are producing one or two or three barrels per day?

A More ultimate oil, yes.

MR. NUTTER: Does the amount of oil produced per day have any reflection on this ultimate recovery?

A I don't know whether I understand that question.

MR. NUTTER: Well, now, you state you will have more ultimate recovery by maintaining pressure from the beginning or instituting a water flood before the pool gets to a stripper state. Does the amount of oil produced per day have any bearing on this ultimate recovery? That is, will the ultimate recovery be increased by producing the oil at a faster rate, is what I'm driving at, on a pressure maintenance or on a water flood?

A Where the bottom hole pressure is somewhere near original, I don't believe that the rate will have very much effect on the ultimate recovery. Now when you get to discussing rate of production, you always have the matter of economics to bring in. I mean by that that you can be producing at a rate that is so low that you are not making money, and, of course, that is not going to continue very long and that oil would be lost.

MR. NUTTER: Do you feel that rate sensitivity of water floods or pressure maintenance programs is proportional or related in any way to the pressure of the reservoir at the time that this flooding is instituted?

A Yes, I think so.

MR. NUTTER: In what manner?

A I think that I tend to repeat what I have said already, that if the field is in a rather advanced state of depletion, the bottom hole pressure is low, that it is more likely to be rate sensitive. I don't know, I have probably gotten clear away from your original question.

MR. NUTTER: What I'm asking you is, in other words, do you feel that the project is more rate sensitive the lower the pressure?

A Yes, sir, I do.

MR. NUTTER: In other words, sensitivity is inversely proportional to pressure at the time of the injection of water?

A I don't know the relation, what it would be, but I feel there is a relation and it would be more rate sensitive at lower pressures.

MR. NUTTER: And we have a relatively high reservoir pressure here for water floods, do we not?

A I wouldn't consider this relatively high. It's under three hundred pounds, about two hundred sixty.

MR. NUTTER: Is it at all unusual to water flood a pool that is producing at the rate that this is?

A No, not any more. The early day water flood started, oh, way back in the 1920's, they didn't think of it, but this method of recovery has certainly grown in stature through the industry, and I think everyone wants to apply it quicker.

MR. NUTTER: There is more oil being produced by water floods all the time?

A Yes, sir.

MR. NUTTER: Anyone have any questions of Mr. Funke?

MR. CAMPBELL: Jack M. Campbell, Campbell and Russell, Roswell, New Mexico. I think I had better ask a question or two on behalf of Graridge Corporation, since it has come into this case.

MR. NUTTER: Mr. Campbell.

MR. CAMPBELL: Your testimony was, as I understood you, Mr. Funke, that you felt that the basis for determining where you depart from pressure maintenance and start into water flooding or secondary recovery would be based upon the pressure situation in each area in each reservoir?

A Yes, sir.

MR. CAMPBELL: Was it your statement that at such time as the pressure is below the saturation point, that then it becomes essentially a matter of secondary recovery?

A Trying to find a place to distinguish between one and the other, I would say that would be a point.

MR. CAMPBELL: Be started, as a general rule of thumb, would it?

A Yes.

MR. CAMPBELL: It is your testimony that up to the time that you reach the saturation pressure, there is not too much effect with rate sensitivity in a reservoir that you are injecting water,

is that right?

A That's right.

MR. CAMPBELL: Beyond that point the risk increases with the decline in pressure in the reservoir at the time that the project is instituted?

A That is my opinion.

MR. CAMPBELL: That's all.

MR. NUTTER: Anyone have any further questions of Mr. Funke? If not, he may be excused.

(Witness excused.)

MR. NUTTER: Does anyone have any further questions of Mr. Motter? If not, he may be excused.

(Witness excused.)

MR. NUTTER: Does anyone have anything further in this case? If not, we will take Case 1356 under advisement.

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C E R T I F I C A T E

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Proceedings before the New Mexico Oil Conservation Commission was reported by me in stenotype and reduced to typewritten transcript under my personal supervision, and that the same is a true and correct record to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this 20th day of January, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley
Notary Public

My commission expires:

June 19, 1959.

I do hereby certify that the foregoing is a complete record of the proceedings in the Examiner hearing of Case No. 1356 heard by me on 1-7, 1958.

Daniel S. Nutter, Examiner
New Mexico Oil Conservation Commission