CASE 3665: Application of WM. A. & EDWARD R. HUDSON for an exception to ORDER R-3221 [illegible]

CASE No. 3665

Application,
Transcripts,
Small Exhibits
ETC.

EXHIBITS 11, 12 & 13
CASES 3664 & 3665
OCTOBER 18, 1967 HEARING

BEFORE THE OIL CONSERVATION COMMISSION
OF THE STATE OF NEW MEXICO

IN THE MATTER OF THE HEARING
CALLED BY THE OIL CONSERVATION
COMMISSION OF NEW MEXICO FOR
THE PURPOSE OF CONSIDERING:

CASE No. 3665
Order No. R-3333

APPLICATION OF WILLIAM A. AND EDWARD
R. HUDSON FOR AN EXCEPTION TO ORDER
NO. R-3221, EDDY COUNTY, NEW MEXICO.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 a.m. on October 18, 1967, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW, on this 31st day of October, 1967, the Commission, a quorum being present, having considered the testimony presented and the exhibits received at said hearing, and being fully advised in the premises,

FINDS:

(1) That due public notice having been given as required by law, the Commission has jurisdiction of this cause and the subject matter thereof.

(2) That the applicants, William A. and Edward R. Hudson, operate a waterflood project on their Puckett "A" and Puckett "B" Leases in Sections 13, 24, and 25, Township 17 South, Range 31 East, NMPM, Maljamar Pool, Eddy County, New Mexico.

(3) That large amounts of water are produced in conjunction with the production of oil from the aforementioned waterflood project.

(4) That effective January 1, 1968, Order (2) of Commission Order No. R-3221, dated May 1, 1967, prohibits in that area encompassed by Lea, Eddy, Chaves, and Roosevelt Counties, New Mexico, the disposal of water produced in conjunction with the production of oil from any waterflood project or water pressure maintenance project on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed, or arroyo, or in any

watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies.

(5) That the applicants seek an exception to the provisions of the aforesaid Order (2) to permit the continued surface disposal of water produced in conjunction with the production of oil from the aforesaid waterflood project for a period of one year beginning January 1, 1968.

(6) That the applicants have not established that fresh water supplies as designated by the state engineer do not exist in the area immediately surrounding the aforementioned waterflood project or that if such fresh water supplies do exist the surface disposal of produced water does not constitute a hazard to said fresh water supplies.

(7) That it is in the interest of good conservation practices, including the conservation of fresh water, to recycle water produced or used in connection with the producing of oil or gas, or both, in water injection projects, whenever recycling is feasible and performed in a manner that will afford reasonable protection against contamination of fresh water supplies designated by the state engineer.

(8) That the subject application should be denied.

IT IS THEREFORE ORDERED:

(1) That the subject application is hereby denied.

(2) That jurisdiction of this cause is retained for the entry of such further orders as the Commission may deem necessary.

DONE at Santa Fe, New Mexico, on the day and year hereinabove designated.

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

DAVID F. CARGO, Chairman

GUYTON B. HAYS, Member

A. L. PORTER, Jr., Member & Secretary

esr/

cima CAPITAN incorporated
(N.S.L.)
312 BOOKER BUILDING
POST OFFICE DRAWER 1343
ARTESIA, NEW MEXICO
AREA CODE 505
TELEPHONE 746-1125

October 17, 1967

Oil Conservation Commission
Santa Fe, New Mexico

Re: Application of Hudson and Hudson
for an exception to Order No. R-3221

Gentlemen:

With reference to the subject application, Cima Capitan, Inc., an oil operator in Eddy County, supports the application of Hudson and Hudson.

It has been the experience of the oil operators in Eddy County, who have drilled wells throughout the area from the escarpment at Maljamar to the Pecos River, that no significant potable water exists in this area. Therefore there is no fresh water to contaminate.

Oil operators have drilled throughout the area in search of water of any nature to be used as a source of water for water flooding. Only in the vicinity of Red Lake has any substantial water been found and this water is very saline and mineralized. For this reason, practically all the water for flooding is piped at a considerable cost, from the Ogallala formation found east of Maljamar.

It seems utterly ridiculous that produced oilfield brines could in any way contaminate something that does not exist in any significant quantities, and where it does exist in limited quantities, is already of a quality which is unpotable and unfit for any beneficial use.

The oil industry in New Mexico was among the first to practice the conservation of natural resources. Certainly no one in the industry would hesitate to go to any cost to prevent an actual damage to fresh water resources. However, in the area west of Maljamar to the Pecos River, it is obvious that no contamination is occurring. A great economic hardship will be placed on many operators if the order stands as written; and many wells will be prematurely abandoned--resulting in economic losses to the area and to the state in taxes and royalties.

Very truly yours,

CIMA CAPITAN, INC.

Hal C. Porter

Hal C. Porter,
Vice-President

HCP:ms

MAIL ROOM
OCT 19 AM 8 55

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
P. O. Drawer U
Artesia, New Mexico 88210

October 13, 1967

CERTIFIED MAIL

RETURN RECEIPT REQUESTED

Mr. William A. & Edward R. Hudson
Post Office Box 198
Artesia, New Mexico 88210

Re: Leases LC 029415(a) & (b)

Gentlemen:

This office has received a copy of New Mexico Oil Conservation Commission Docket No. 32-67 listing cases to be heard before the Commission on October 18, 1967. Reference is made to your application to continue using surface pits to dispose of waste waters produced in conjunction with the production of oil from the waterflood projects on your Puckett "A" and "B" leases in secs. 24 and 25, T. 17 S., R. 31 E., for a period of one year after January 1, 1968.

The lands in your Puckett "A" and "B" leases in secs. 24 and 25, T. 17 S., R. 31 E., are Federal lands covered by the subject leases. [illegible] inspected, and it has been [illegible] the leases are subject to surface pollution and damage by improper disposal of salt water.

Federal Oil and Gas Operating Regulations require the disposal of waste water in such a manner that will prevent damage to the surface or pollution of streams or underground waters of the leases or other lands (see 30 CFR 221.32).

We feel that the eight-month deadline prohibiting surface disposal pits in waterflood operations as provided by New Mexico Conservation Commission order No. R-3221 dated May 1, 1967, is reasonable, and should be upheld.

Therefore, you are requested to properly dispose of the produced water on subject leases and cease using all surface pits after January 1, 1968.

Sincerely yours,

/s/ James A. Knauf

James A. Knauf
District Engineer

Copy to: R. L. Gray (delivered by hand)
N.M.O.C.C. ✓
U.S.G.S., Roswell

Docket No. 32-67

DOCKET: REGULAR HEARING - WEDNESDAY - OCTOBER 18, 1967

OIL CONSERVATION COMMISSION - 9 A.M., MORGAN HALL, STATE LAND OFFICE BUILDING, SANTA FE, NEW MEXICO

ALLOWABLE: (1) Consideration of the oil allowable for November, 1967;

(2) Consideration of the allowable production of gas for November, 1967, from thirteen prorated pools in Lea, Eddy and Roosevelt Counties, New Mexico. Consideration of the allowable production of gas from nine prorated pools in San Juan, Rio Arriba and Sandoval Counties, New Mexico, for November, 1967.

CASE 3664: Application of William A. and Edward R. Hudson for salt water disposal, Eddy County, New Mexico. Applicants, in the above-styled cause, seek authority to dispose of produced salt water into the Lower San Andres formation in the interval from 4125 feet to 4905 feet in their Puckett "A" Well No. 16 located 2180 feet from the North line and 660 feet from the East line of Section 24, Township 17 South, Range 31 East, Maljamar Pool, Eddy County, New Mexico.

CASE 3665: Application of William A. and Edward R. Hudson for an exception to Order No. R-3221, Eddy County, New Mexico. Applicants, in the above-styled cause, seek an exception for a temporary period of one year to the provisions of Order No. (2) of Commission Order No. R-3221, which, effective January 1, 1968, prohibits the surface disposal of water produced in conjunction with the production of oil from any waterflood or pressure maintenance project. The exception sought would be for applicants' waterflood project operated on their Puckett "A" and Puckett "B" leases in Sections 24 and 25, Township 17 South, Range 31 East, Maljamar Pool, Eddy County, New Mexico. Disposal pits affected are in Unit B of said Section 24 and Unit F of said Section 25.

CASE 3666: Application of Kennedy Oil Company and Newmont Oil Company for an exception to Order No. R-3221, Eddy County, New Mexico. Applicants, in the above-styled cause, seek an exception to the provisions of Order No. (2) of the Commission Order No. R-3221 which, effective January 1, 1968, prohibits the surface disposal of water produced in conjunction with the production of oil from any waterflood or pressure maintenance project. The exception sought would be for applicants' lands which are or which will be covered by waterflood operations in the Square Lake Pool, Eddy County, New Mexico, said lands being included in the following described area:

Sections 32 through 36, Township 16 South, Range 30 East;
Sections 19 through 22 and 27 through 34, Township 16 South, Range 31 East, and
Sections 2 and 4, Township 17 South, Range 30 East.

CASE 3667: Southeastern New Mexico nomenclature case calling for an order for the creation of four new oil pools and the assignment of oil discovery allowables therein, and for the extension of certain other pools in Lea and Chaves Counties, New Mexico.

(a) Create a new pool in Lea County, New Mexico classified as an oil pool for Middle Pennsylvanian production and designated as the Vacuum-Middle Pennsylvanian Pool, comprising the following-described acreage:

TOWNSHIP 17 SOUTH, RANGE 34 EAST, NMPM
SECTION 13: SW/4

Further, for the assignment of approximately 1,255 barrels of oil discovery allowable to the discovery well, Mobil Oil Corporation's Bridges State Well No. 121, located in Unit L of said Section 13.

(b) Create a new pool in Lea County, New Mexico, classified as an oil pool for Ellenburger production and designated as the East Brunson-Ellenburger Pool, comprising the following-described acreage:

TOWNSHIP 22 SOUTH, RANGE 37 EAST, NMPM
SECTION 25: NW/4

Further, for the assignment of approximately 38,915 barrels of oil discovery allowable to the discovery well, Texas Pacific Oil Company's Ella Drinkard Well No. 2, located in Unit E of said Section 25.

(c) Create a new pool in Lea County, New Mexico, classified as an oil pool for Granite Wash production and designated as the East Brunson-Granite Wash Pool, comprising the following described acreage:

TOWNSHIP 22 SOUTH, RANGE 37 EAST, NMPM
SECTION 25: NW/4

Further, for the assignment of approximately 210 barrels of oil discovery allowable to the discovery well, Texas Pacific Oil Company's Ella Drinkard Well No. 2, located in Unit E of said Section 25.

(d) Create a new pool in Chaves County, New Mexico, classified as an oil pool for San Andres production and designated as the South Cato San Andres Pool, comprising the following described acreage:

TOWNSHIP 8 SOUTH, RANGE 30 EAST, NMPM
SECTION 27: SW/4

Further, for the assignment of approximately 17,380 barrels of oil discovery allowable to the discovery well, Shell Oil Company's

Hodges Federal "A" Well No. 2, located in Unit M of said Section 27.

(e) Extend the Cary-Montoya Pool to include therein:

TOWNSHIP 22 SOUTH, RANGE 37 EAST, NMPM
SECTION 16: S/2
SECTION 21: NE/4

(f) Extend the Cato-San Andres Pool to include therein:

TOWNSHIP 7 SOUTH, RANGE 30 EAST, NMPM
SECTION 36: SW/4

TOWNSHIP 8 SOUTH, RANGE 30 EAST, NMPM
SECTION 1: W/2
SECTION 20: NE/4
SECTION 22: NW/4 and SE/4
SECTION 26: W/2
SECTION 27: S/2

(g) Extend the Chaveroo-San Andres Pool to include therein:

TOWNSHIP 8 SOUTH, RANGE 33 EAST, NMPM
SECTION 8: SE/4
SECTION 9: SW/4
SECTION 16: NW/4

(h) Extend the Flying "M" San Andres Pool to include therein:

TOWNSHIP 9 SOUTH, RANGE 33 EAST, NMPM
SECTION 29: SW/4
SECTION 30: NE/4

(i) Extend the East Hightower-Lower Pennsylvanian Pool to include therein:

TOWNSHIP 12 SOUTH, RANGE 33 EAST, NMPM
SECTION 25: NE/4

(j) Extend the Middle Lane-Permo Pennsylvanian Pool to include therein:

TOWNSHIP 10 SOUTH, RANGE 33 EAST, NMPM
SECTION 11: N/2
SECTION 13: SW/4
SECTION 15: E/2 NW/4

(k) Extend the Moore-Wolfcamp Gas Pool to include therein:

TOWNSHIP 11 SOUTH, RANGE 32 EAST, NMPM
SECTION 23: E/2

(l) Extend the Morton-Wolfcamp Pool to include therein:

TOWNSHIP 15 SOUTH, RANGE 34 EAST, NMPM
SECTION 12: SW/4

(m) Extend the North Vacuum-Abo Pool to include therein:

TOWNSHIP 17 SOUTH, RANGE 34 EAST, NMPM
SECTION 13: SW/4

67 SEP 8 PM 1 23

Case 3665

BEFORE THE

OIL CONSERVATION COMMISSION OF NEW MEXICO

IN THE MATTER OF THE APPLICATION OF WILLIAM A. AND EDWARD R. HUDSON FOR AN EXCEPTION TO THE PROVISIONS OF ORDER NO. R-3221 FOR A TEMPORARY PERIOD OF ONE YEAR

A P P L I C A T I O N

Come now WILLIAM A. and EDWARD R. HUDSON, and apply to the Oil Conservation Commission of New Mexico for an exception for a temporary period of one year to the provisions of Order No. 2 of Commission Order No. R-3221, which, effective January 1, 1968, prohibits the disposal of water produced in conjunction with the production of oil from any waterflood project or water pressure maintenance project on the surface of the ground, or in any pit, pond, lake, depression, draw, streambed or arroyo, or in any watercourse, or in any other place or in any manner which will constitute a hazard to any fresh water supplies, and in support thereof would show the Commission:

1. Applicant is the operator of a waterflood project on the Puckett "A" and Puckett "B" leases, Eddy County, New Mexico, from which small volumes of water are presently being produced.

2. In connection with the operation of said waterflood project applicant has constructed, maintained and utilized unlined surface pits located on the Puckett "A" lease in Unit B of Section 24, Township 17 South, Range 31 East, and on the Puckett "B" lease in Unit F of Section 25, Township 17 South, Range 31 East, all in Eddy County, New Mexico.

DOCKET MAILED

Date 10-5-67

3. Applicant seeks approval for the continued utilization of the above-described unlined surface pits until January 1, 1969.

4. The Ogallala fresh water-bearing formation is not present in the area under consideration and no fresh water is present under the Hudson Puckett "A" or "B" leases.

5. The continuation of present disposal methods for an additional year can cause no contamination of a fresh water reservoir.

6. Granting of an additional year will allow the applicant time to gather additional information which will be beneficial in finally adopting a disposal method that will most likely permit a better flood efficiency which will amount to a conservation of crude oil reserves, and the production of oil which would not otherwise be recovered.

WHEREFORE, applicant prays that this application be set for hearing before the Commission or its duly appointed examiner, and that after notice and hearing as required by law, the Commission enter its order approving the continued use of surface disposal pits for an additional period of one year, as requested.

Respectfully submitted,

WILLIAM A. and EDWARD R. HUDSON

BY: Jason W. Kellahin

Kellahin & Fox
Post Office Box 1769
Santa Fe, New Mexico

ATTORNEYS FOR APPLICANT

BEFORE THE
NEW MEXICO OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
October 18, 1967

REGULAR HEARING

IN THE MATTER OF:

Application of William A. and Edward R. Hudson for salt water disposal, Eddy County, New Mexico.

Denied
Case No. 3664

and

Application of William A and Edward R. Hudson for an exception to Order No. R-3221, Eddy County, New Mexico.

Case No. 3665

BEFORE:

A. L. (Pete) Porter - Secretary Director
David F. Cargo - Governor
Guyton Hays - Commissioner
George Hatch - General Counsel

TRANSCRIPT OF PROCEEDINGS

MR. PORTER: We will take up Case 3664.

MR. HATCH: Case 3664, application of William A. and Edward R. Hudson for salt water disposal, Eddy County, New Mexico.

MR. KELLAHIN: Jason Kellahin, Kellahin and Fox, Santa Fe, appearing for the applicant in connection with the presentation of Case 3664. We also have on the docket application of Case 3665. These two cases are companion cases involved in the same identical area, to a large extent the same testimony and same exhibits. So, for that reason I would like at this time to move that Cases 3664 and 3665 be consolidated for the purposes of the record.

MR. PORTER: If there are no objections to the counsel's motions for consolidation of these cases for the purpose of taking testimony the cases will be consolidated.

MR. KELLAHIN: I have one witness I would like to have sworn, please.

(Witness sworn)

(Whereupon, applicant's Exhibits 1 through 13 were marked for identification.)

R A L P H L. G R A Y, called as a witness on behalf of the applicant having first been duly sworn was examined and testified as follows:

DIRECT EXAMINATION

BY MR. KELLAHIN:

Q Would you state your name, please?

A Ralph L. Gray.

Q Mr. Gray, what business are you engaged in?

A Consulting engineer.

Q Where are you located?

A Artesia, New Mexico.

Q In connection with your work as a consulting engineer, do you handle any work for William A. and Edward R. Hundson, the applicant in Cases 3664 and 3665?

A Yes, sir, I do.

Q Do you supervise those properties?

A Yes.

Q Have you ever testified before the Oil Conservation Commission and made your qualifications a matter of record?

A Yes, sir.

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

MR. PORTER: They are.

Q (By Mr. Kellahin) Mr. Gray, are you familiar with the applications of William A. and Edward R. Hudson in Case 3664 and 3665?

A Yes, sir.

Q Briefly, would you state the purpose of these two applications?

A The purpose of the first application is to obtain authority to use the Hudson Puckett"A" No. 16-P Well as a water disposal well. If later deemed advisable, water would be injected within the interval of 4130 feet to 4895 feet.

The purpose of the second application is to authorize a one year extension on provisions on paragraph No. 2 of Commission Order R-3221, which, effective January 1st 1968, prohibits the surface disposal of water produced in conjunction with the production of oil from a waterflood project. Exceptions sought would pertain to the applicants' Puckett "A" and Puckett "B" leases in the Maljamar Pool.

Q Now, a waterflood project has been approved by this Commission for the Puckett "A" and Puckett "B" leases, is that correct?

A Yes, sir, that's correct.

Q They are operated as leases rather than as a unit project, is that correct?

A Yes.

Q Now, referring to what has been marked as Exhibit

No. 1, Mr. Gray, would you identify that exhibit and discuss it?

A Exhibit No. 1 is a map that shows the general area of the Hudson waterflood project and the surrounding area. The boundary of this waterflood project is shown on the map by the cross hatched portion. The blue circled wells in the northern portion of the Puckett property or the Puckett "A" lease, indicates the water injection wells that have been used up to the present time.

The wells that have the red circles in the southern portion of the project area are wells located on the Puckett "B" lease which are to be converted from producing to water injection wells. This expanded portion of the project was recently approved by the Oil Commission and we are presently engaged in expanding this portion of the flood.

Also you will note a red arrow on the map which shows the location of the Puckett "A" No. 16 Well which is presently temporarily abandoned. This well was drilled as a Paddock test and this is the well in which we request authorization to use as a disposal well if the applicant deems it advisable at a later date.

Q Have you started injection in the Puckett "B" lease as yet?

A Yes. Within the last few days we have started injection into two wells. One is the Puckett "B" No. 7 Well which is located in the northwest quarter of the northeast quarter of Section 25 and the Puckett "B" No. 12 which is located in the northwest quarter of the southeast quarter of Section 25. Water has been going into those wells just for a short period of time.

Q What formations are you flooding in those two waterfloods?

A We are injecting water into the San Andres-Dolmite.

Q In the upper zones of the San Andres, is this correct?

A Yes.

Q What is your source of water?

A The source of water, water is being purchased from the Double Eagle Water Company. The source of the water is the Ogallala formation, it is fresh water from this commercial water company.

Q Mr. Gray, did you testify before the Commission's Examiner in connection with the approval of the waterflooding of the Puckett "A" and the Puckett "B" lease?

A Yes, sir.

Q At that time, did you testify that produced water

would be reinjected?

A At the time that we had these hearings I can't recall the exact working that I used, but it was our thought at the time that it was rather indefinite as to the exact time that we would make use of produced water. We indicated that ultimately there would be a time in which we would use produced water.

Q You were aware at that time, were you not, Mr. Gray, that certain problems existed which might prevent the use of produced water?

A Yes. We are hesitant to try to use this water in the early stages if we can do so.

Q Now, referring to what has been marked as Exhibit No. 2, would you identify that exhibit, please?

A Exhibit No. 2 is a data sheet which shows pertinent information on the Puckett "A" No. 16-P Well. The "P" is a designation for Paddock Zone which was the zone in which the well was drilled for. This well is located 2180 feet from the north and 660 feet from the east lines of Section 24, Township 17 South, Range 31 East.

The well was drilled to a total depth of 5322 feet, five and a half casing was cemented at 5313 feet, with fifty sacks of cement and later an additional squeeze job was performed

at 4300 to 01 and 300 sacks of cement were squeezed at this location.

The well was tested through perforations at 524€ to 58 and the well produced salt water from the Paddock Zone. Subsequently, the well was plugged and has been temporarily abandoned since September, 1950.

Q Now, referring to what has been marked as Exhibit No. 3, would you identify that exhibit.

A Exhibit No. 3 is a portion of the gamma ray neutron log that was run on the Hudson Puckett "A" No. 16-P Well. You will note that there is a green line drawn on this log from a depth of zpproximately 3640 feet to approximately 4000 feet, which is the upper portion of the Sand Andres formation. This green line indicates the interval in the San Andres that is presently being waterflooded on the Puckett "A" and Puckett "B" leases.

Q Now, lower you will note a red line which extends from a depth of approximately 4125 feet to a depth of approximately 4900 feet, which is the lower portion of the San Andres formation and which is water bearing in all of the zones of porosity. The interval marked by this red line is the interval that we consider as a good place to inject this produced water.

Q Within that red area what zone would you propose

to inject the water into, Mr. Gray?

A Well, the log indicates a very coarse interval from a depth of 4850 to 4890' and I think it is most likely that we would perforate this interval and inject into this zone as an initial step.

Q Then is the water in the formation a salt water?

A Yes. Within a close proximity of this well there have been numerous tests drilled to greater depths than this and there has been coring and drill stem testing within these intervals and we are certain that the formation is water bearing.

Q And is there any oil production within one mile of this well from that zone?

A No, sir.

Q How would you propose to complete the well for water disposal?

A Well, we would drill out the present cement plugs in the casing, in the five and a half casing, and perforate one of these porous intervals and we would run plastic-coated tubing with a packer and the packer would be set just above the perforations. Then, we would inject produced water down the tubing.

Q That is the type of completion that has been ap-

proved by this Commission, has it not?

A Yes, sir. I might further explain that although we are requesting authority to use this well as a water injection well, we really are not certain at this time whether we, we want to do that or not. We have been considering two methods for disposing of the produced water. One method, of course, would be to reinject the produced water into the present injection system and secondly, we might prefer to hold off using this produced water in our present flood for a period of time and inject the produced water into a separate disposal well which would be separate from our present waterflood formation. So, though we haven't definitely made up our mind at this time to which method we would like to use, we would like to request this authority be granted so the method can be used if it is deemed advisable.

Q Would there be any saving to you in pumping equipment or in any other manner if your application in Case 3665, that is the extension of time under Order R-3221, is granted?

A Well, the applicant is presently conducting two waterflood projects in Winkler County, Texas. These projects are in the last stages of operation. They have been essentially flooded and the applicant has pumps and equipment which can be made available from one of these floods within this year

of extension period and, of course, we would like to save all of the money that we could. If we had to do this right at the present time, well, it would be necessary to purchase this equipment and, whereas, if we can delay this thing for a period of time, well, changes can be made in this waterflood project and the equipment can be released and can be used in this project.

Q Could that be accomplished within one year?

A Yes, sir.

Q Now referring to what has been marked as Exhibit No. 4 would you identify that exhibit, please.

A Exhibit No. 4 is a data sheet which shows annual water production figures for the Puckett "A" lease and also the Puckett "B" lease. You will note that we have shown no records available for the water being produced from the initial production which was in 1936 up through 1960. This is a period of 24 years.

Some of these wells were originally drilled in the water and there has been some rather substantial water production on both of these leases from the very initial drilling of the wells. But prior to 1960, unfortunately we don't have good records of the volume of water that was produced on these two leases. I have done my best to come up with what I think

is a reasonable estimate based on what I know about the reported completion tests on the wells and I think it is likely that during this 24 year period that perhaps the Puckett "A" lease might have produced somewhere in the neighborhood of 100,000 barrels of water and the Puckett "B" lease probably in the neighborhood of 200,000 barrels of water.

From 1961 through an eight month period, the first eight months of 1967, we show the annual water production for each of these leases. The total amount of water that has been produced and pitted on the Puckett "A" lease from 1961 to 1967 amounts to 203,537 barrels. On the Puckett "B" lease during the same period 181,454 barrels of water have been produced and pitted.

At the present time the Puckett "A" lease is producing approximately 240 barrels of water per day and the Puckett "B" lease is producing approximately 148 barrels of water per day. Now a part of this water is water that is not associated with the flood. As I previously mentioned, some of these wells made water from the initial completion and there is approximately 103 barrels of water per day out of the 148 on the Puckett "B" lease that is being produced from wells that are outside of the waterflood area.

Q That would be the same as water produced from a primary recovery operation, would it not?

A Yes, it would be the same thing.

Q Now, I note from Exhibit 4 that there was a substantial increase in the volume of water produced in 1966 over 1965. Are your present pits of sufficient capacity to take care of that volume of water?

A Yes, sir.

Q They require no enlargement of the present situation?

A No, sir.

Q And do you anticipate that the present pits will continue to be adequate in the event this extension is granted?

A Yes, sir, we think so.

Q You don't contemplate any enlargement of your pits?

A No, sir.

Q I note the exhibit also says you changed location of the Puckett "A" and "B" batteries and pits. Does this mean you had some pits that were in use prior to 1961 which are no longer in use?

A Yes, up until the first part of 1961 al of the oil and water production was going into one location on the

Puckett "A" lease and one location on the Puckett "B" lease which we will indicate later on our map.

Q Oh, that shows on another exhibit, does it not?

A Yes, but in the early part of 1961 the tank battery on each of these leases was moved to a more central location and, of course, new pits were dug at that time in the vicinity of these new battery locations.

Q And they are pits you are presently using?

A Yes, sir.

Q And those pits have been used since 1961?

A Yes, sir.

Q Referring to what has been marked as Exhibit No. 5, would you identify that exhibit, please.

A Exhibit No. 5 is a large scale map of the Puckett "A" and Puckett "B" leases. The purpose of this large map is to show in more detail some of these facilities that we will discuss. I would like to point out the old water disposal pits on the Puckett "A" and Puckett "B" leases. These are indicated by the blue colored squares in the approximate center and near the left edge of the map and these are so designated old disposal pits.

The present disposal pits are indicated on the map by red colored squares. The Puckett "A" lease pit is located

in the approximate center of the north half of Section 24 and this is also just due east of the injection well No. 21.

The yellow colored square just east of this disposal pit is the location of the water injection plant which is presently being used.

On the Puckett "B" lease the present water disposal pit indicated by the red squares is located just north of the Puckett "B" No. 16 well. This well is located in the southeast quarter of the northwest quarter of Section 25.

This map also shows some dashed lines which you will note and these lines represent the present water injection lines.

I might also point out that all of the producing wells are indicated on the map by the solid circles and the present injection wells are indicated by the plain circled wells.

Q Now, in Section 25 there appears some colored circles and it indicates water and gives a depth. Do those relate to the wells to which they are adjacent?

A Yes. These colored circles --

Q They are not separate wells?

A No. The coloring in these circles relates to the

location of the waters that were encountered in drilling these wells and this color symbol fits in with an identical color symbol which we will show you later on some cross sections just to identify the location of these waters.

Q Now, Mr. Gray, have you actually supervised the development of these two leases yourself for the most part?

A Yes, the recent development. You will note that on the Puckett "A" lease there are -- well, I won't say on the Puckett "A" lease because I think there are three wells on the Puckett "B" lease just on the line, but you will note fourteen water injection wells which are located in Section 24. These are recent, fairly recent wells, which have been drilled on a five spot pattern for purposes of injecting water, and during the drilling of all fourteen of these wells, I have been performing work for the Hudsons and I have actually witnessed the drilling of all of these wells. Thirteen of the wells were cable tool holes in which we are able to determine if we penetrate any fluids at all, that is readily detectable in these cable tool holes and only one of the wells was a rotary well which, of course, is difficult to establish the fluids.

Q On the Puckett "A" lease did you encounter any fluids at all? Fresh water is what I am talking about.

A No, sir. None of these wells showed any water whatever in these shallow sands or any water above the salt section.

Q All of the water you encountered was below the salt section --

A Yes.

Q -- is this correct? Were any wells drilled in the vicinity of the old disposal pits that had been used for some 26 years?

A Yes. I can call your attention to the Puckett "B" No. 14 which is located in the northwest quarter of the northwest quarter of Section 25. This wells was completed in 1960 which was a short time before the old disposal pit just north of this location was abandoned.

This No. 14 well is approximately 1100 feet from the old disposal pit.

Q You did not encounter any fluids in the shallow sands in that well?

A No, sir. In drilling this well, no water at all was encountered above the salt section.

Q Now, are you familiar with the various formations encountered in these wells?

A Yes, sir.

Q Is the Ogallala fresh water bearing formation present in this area at all?

A No. The Ogallala fresh water formation extends in an easterly direction and I think about the closest point that the Ogallala exists to this area is approximately five or six miles to the northeast of this area.

The Ogallala formation extends in an easterly direction and as we go westward to this area and then further westward well, the Ogallala is not present.

Q Are there any fresh water sands of any kind present in this area?

A No, sir. We haven't found any evidence of any.

Q You have been on the lease many times, have you not?

A Yes, sir.

Q Are there any windmills or stock water sources in the area at all?

A There are no shallow water wells or windmills. Cattle is being grazed on the surface of these leases. The Ranchers have tapped a commercial waterline in this vicinity and they have connections coming off this waterline into their troughs and this is the method that the Ranchers use for watering their cows.

MR. PORTER: Is this one of the commercial lines --

A Yes, sir.

Q --that supplies water for floods?

THE WITNESS: Yes, sir.

Q (By Mr. Kellahin) How far away is the source of that water?

A Well, the source of that water is the Ogallala formation. There are several supply wells that this company uses and I would guess that the closest one might be in the neighborhood of ten miles, something like that, and then further from this location.

Q Now, in connection with Exhibit No. 5, you show that some waters were encountered in the Puckett "B" lease. Referring to what has been marked as Exhibit No. 6 would you identify that exhibit, please.

A Although no waters at all were penetrated on the Puckett "A" lease we do have a record of some waters having been drilled to the south on the Puckett "B" lease. The first well that reported any show of water is the Puckett "B" No. 6 well which is located in Unit A of Section 25. This well reported a show of water at 575' to 618'. The next well reporting water was the Puckett "B" No. 9 which is located in Unit H of Section 25 and this well reported a

show of water and a deeper zone at 819 to 830 feet.

The Puckett "B" 11, located in Unit P of Section 25, tested two barrels of water per hour from 540 feet to 550 feet. All three of these wells are the early wells that were drilled quite a long time ago and more recently some additional development occurred and one of these recent wells was teh Puckett "B" No. 13. This well is located in Unit O of Section 25. The Puckett "B" No. 13 tested three barrels of water per hour, 538 feet to 550 feet. Also the well encountered a prolific salt water at 882 feet to 892 feet, and this water couldn't be bailed down within a short period of time.

The Puckett"B" No. 18 located in Unit L Section 25 encountered salt water at 845 feet to 858 feet. Also this couldn't be bailed down.

The Puckett "B" No. 20 located in Unit M of Section 25 encountered a show of water at 530 feet to 540 feet.

MR. PORTER: What kind of water was that?

THE WITNESS: Mr. Porter, we have an analysis of the water and we will describe that for you.

MR. PORTER: All right, fine.

Q (By Mr. Kellahin) Mr. Gray, it would appear from the depths you have shown on Exhibit No. 6 that there are two horizons of water which have been encountered on the

Puckett "B" lease. Is there any indication that either one of these horizons is extensive over the entire area or a substantial part of it?

A No, these are little, apparently, isolated spots that occur mainly in the south portion of the Puckett "B" lease and actually there are several wells that have been drilled between all of these wells and the old pits are the present pits on both of these leases in which no water was encountered at all in these particular zones so they appear to be isolated instances of entrapped water in these particular cases.

Q Do you find any evidence of any -- that this water or any part of it could have come from the pits that are existing on the lease now or that existed there in the past?

A No, sir, we don't think so. I think Exhibit 7 will help me to explain best. Exhibit 7 is a portion of the Gamma ray neutron log on the Puckett "B" No. 13 well. You will note that the top water, or in this case the water which was encountered at a depth of 538 to 558 -- 550 feet. This is indicated on this log by the purple coloring which also conforms with these colored circles that we have shown on Exhibit 5 just to identify the waters. This top water is located in a formation which we would judge to be the Santa

Rosa. There is a very predominant shale streak present at a depth of approximately 470 feet to approximately 478 feet in this well.

We consider these shale streaks to be impervious barriers to any movement of water vertically and in addition to this, there are other shale streaks present above this, between there and the surface. So, we find it pretty hard to visualize any water being able to penetrate these barriers from the surface down to these lower, deeper water zones.

You will note that in the very bottom of the log of Exhibit 7, we have shown the location of the deeper zone which is indicated by the green coloring from a depth of 82 feet to 892 feet. This water actually occurs in the top part of the salt section and it is highly saturated with salt. Also it seems to be a rather isolated thing,we find it in a few places. It can't be traced over any large area and we don't know why it is there, but it is there, but we don't think there is any connection between that and any possible source from the surface.

Q On the basis of the information you have available to you, in your opinion is there any movement of either one of these water zones, a movement of water through it?

A Well, we haven't been able to find any evidence of

any movement of water. There has been drilling conducted over both of these leases over a long period of time beginning back in 1936 and extending up to, within just a few years of the present time and these wells have been scattered all over both properties, some of them have been drilled close to the old disposal pits. We haven't been able to find any indication at all of any movement that we can determine.

Q Now, referring to what has been marked as Exhibit No. 8, would you identify that exhibit, please?

A Exhibit No. 8 is a portion of the Gamma ray neutron log on the Puckett "B" No. 18. You will note that this predominant shaled area we referred to in the previous exhibit also is present in this well at a depth of approximately 455' to 560' and that is indicated by the red coloring on the exhibit.

In this case, the only water that was encountered was the salt water or the deep water which was found at 845 to 858'. This is shown by the green coloring.

Q And that was below the top of the salt section, is that correct?

A Well, below or possibly right in --

Q Right at it?

A --close to the top of the salt section.

Q Now, to sum up your testimony to this point, Mr. Gray, there is no fresh water zones within the entire area of the Puckett "A" and "B" leases or in that vicinity, is this your testimony?

A That's correct.

Q And the only water that was encountered was highly mineralized and salt water?

A Yes, sir.

Q Now, you have an analysis of that, is that Exhibit No. 9?

A Yes. Exhibit No. 9 is a copy of a water analysis which was made by Dowl Incorporated on water that was recovered on the interval of 538' to 550' in Puckett "B" No. 13. This analysis shows that the water has 2,820 parts per million calcium. I will just state some of these properties, we won't list them all. Sodium has 5890 parts per million, the cloride content is 13,100 parts per million, and the sulfate content is 4,850 parts per million. The water has a total solids of 27,655 parts per million which we don't believe is useful for any purpose.

Q Now, you do have an active waterflood project going at the present time. Is there any particular reason

you do not feel that is proper to use your produced water in this injection system?

A Yes, sir. Problems do exist in reinjecting produced water into waterflood projects. Some of the problems that are experienced are plugging of the formation near the well bore as well as away from the well bore, also, ecceleration of corrosion in an injection system and equipment which can be very costly and the formation of scales in the formation and in producing well bore holes. All of these problems are costly and can adversely effect the efficiency in recovery of oil from these secondary oil projects.

Q Have you had an analysis on the produced water which indicates that you would have these problems?

A Yes, sir. We have had Martin Laboratories of Monahans, Texas obtain samples of various produced waters on both of these leases as well as the fresh water that is being purchased for injection and Martin Laboratories have performed the analysis and conducted compatibility tests and have made studies in line with their experience in produced waters and waterflood projects and these people have recommended to us that if we make use of this produced water that they strongly recommend that the produced waters be

kept separate from the fresh water supply in that we have separate pumps and separate injection lines and separate facilities so that we won't have to mix these two waters.

Q In addition to the fact you would have to set up separate injection systems, does the use of your produced water create any other problems?

A Yes. Of course, the problem that we have is all of these solids in the injection waters. There are various types of solids in these produced waters including iron sulfides and scale materials, in some cases presulfur, parafin and even droplets of oil, oil emulsion can cause plugging problems in these injection wells and this is a problem that concerns us very much because it can greatly reduce the amount of oil that can be recovered from these waterfloods. If we use this bad water and it plugs the formation, well it can certainly have an adverse effect on the project.

Q That results in a reduced recovery from the flood project?

A Yes, sir.

Q And that would constitute waste as defined by the statute, is that your opinion?

A Yes, sir.

Q The fact that you would have to have two separate injection systems, would that create any problem as to the volumes of water available, say, from produced water, for example, in operating your flood?

A Yes. In the early stages it causes some operational problems which people who aren't actually engaged in waterflooding probably never realized but in the early stages of waterflooding when your volumes are small, for example, you might be producing 200 barrels of produced water per day and you might be putting it into an injection well, for example, that might need to take 300 barrels of water per day to efficiently flood, so you lack 100 barrels of water per day having enough volume in this case to flood this well. So this causes you to have to use what we term make-up water or some of this fresh water to make-up the volume, and then it is further complicated by the fact that our injection of volumes are constantly changing throughout the flood. Also, our produced waters are constantly changing throughout the flood so it is very difficult to exactly use up the amount of produced water that you have on hand without actually having to either pit a portion of it or use some of the fresh water to make-up the volume that is required.

Q Then if you do determine to use the produced water

in the injection system by a separate system, you would still need some disposal method for that portion that you are not able to inject, is this correct, either put it in a pit or put it down the disposal well?

A That is going to be a problem that we know is going to face us, however, we are hoping that we can solve it in some manner and actually we are not asking for relief in this particular application for that particular problem, but I would like for the Commission to realize that we do have some problems that are perhaps hidden that exist and we have to determine some method to be able to handle these conditions.

Q Now, have other operators in the area reinjected produced water in the San Andres formation?

A Yes. Continental Oil Company is injecting -- I'm sorry, I think I misinterpreted your question. There are waterflood projects that join this which are injecting water into this formation. However, we have made a study of various operators in different areas who are injecting produced water into their waterflood projects and we have found that actually there is quite a variation in the methods that these operators use.

Q Would you outline those methods?

A Well, some of the floods, the operators are mixing the fresh water with their produced water, they are maintaining open systems that is to, allowing the atmosphere to be present in the system and they are not even using chemical for treatment. That is one extreme.

We also find that some projects are mixing fresh water and produced water, however, they are maintaining a closed system, they are excluding the oxygen from the system and they are using chemicals to treat or remove the oxygen from the system and also to treat for corrosion and for scale form.

Then, thirdly, we find some operators who are keeping these two systems separate, they keep their produced water separate from their fresh water, maintain complete separate facilities throughout. The waters aren't ever mixed, they maintain closed systems, keep out the atmosphere, then they treat with various types of chemical treatment to combat corrosion and scale and oxygen in the water. So it is apparent that there is quite a difference of opinion even among the operators as to actually what is necessary or what is the best way to inject this water and, frankly, I don't consider myself enough of an expert to really state at this time which method is the best and which

method will give us the most recoverable oil.

That is one reason that we would like to have a year extension on this thing, because we are presently trying to get all the information that we can on the different methods and try to determine a means that will give us the most oil recovery in our flood operation and that, we feel, the data that will probably be available in another years period will be most helpful in perhaps eliminating some of these methods and pointing a finger to the best means to do this, to get the most oil from the ground.

Q Plugging of the formation is your chief concern in using this produced water, is it not?

A It is one of the chief concerns, corrosion is a serious problem.

Q You have an article by Waylan Martin that you want to put in the record, Mr. Gray?

A Yes. We would like to call the Commission's attention to a technical paper that was prepared by Mr. Waylan C. Martin who is the owner of Martin Water Laboratories in Monahans and who is a recognized authority on the chemistry of waters and waters used in waterflood projects. Mr. Martin has been in this business for a long period of time and he is familiar with projects all over the Permian Basin and New

Mexico. He has had a great deal of experience in using, in the floods where they are using produced water for injection.

Mr. Martin recently prepared this technical paper which he has entitled, "Applying Water Chemistry To Recovery" and this paper was presented in 1967 at a meeting of the Society of Petroleum Engineers of AIME. The paper is quite lengthy and I won't begin to read the thing but there are some --

Q Can you leave a copy with the Commission?

A Yes, I would be glad to.

Q Were there parts of it that you wanted to read into the record?

A There are portions that I would like to read. I think they are pertinent to the argument that we are trying to get across here. Mr. Martin states in the paper, I might say that here he is referring to solids, the various types of solids which exist in these produced waters that are being used for water injection and he states, "Though the efforts to identify these filterable solids at the producing well are plagued with many complications, there have been several instances in which it is considered conclusive that these particles do not reach the producing well in anywhere

near the amount that is injected, if at all." Now, what he means there is that there have been instances where they have measured the amount of solids that are actually entering the well bore in an injection well and they have measured the amount of solids that are produced from the offset producing wells, and what they have found is that these solids are not transmitted to the producing wells in anywhere near the quantity that is being injected and therefore they are being deposited somehwere out in the formation and, of course, the deposition of solid out there tend to block off the passage ways and tend to reduce the flood efficiency and the amount of oil that can be recovered. Mr. Martin poses two questions. He says first, "Does this in-siturestriction of interstices by the filterable solids significantly influence the ability of the injection water to sweep a maximum amount of oil from the producing interval?" Secondly "If there is a detrimental influence on the sweep efficiency, then are we crediting this condition in its proper proportion when a reservoir does not appear to be responding as anticipated just because the evidence of direct plugging of the formation face in the injection well does not appear?" There what he is stating is that he doesn't think that it is necessary to have complete plugging of an injection well in

the near vicinity of the well bore to demonstrate that plugging is occuring. Even though an operator may be able to inject quantities of water into an injection well doesn't necessarily mean that everything is going well because these solids can get out there a distance away and then can start being deposited in these permeable channels and effect a block.

And then, finally, Mr. Martin makes this statement, "It is our opinion that the presence of excessive filterable solids does significantly influence the sweep efficiency, whether or not there is definite injection well bore plugging."

Further in the paper Mr. Martin gives some date that was developed in his laboratory in regard to the ability of these injection waters to carry gypsum or calcium sulfate which is one of the most troublesome factors that we have in some of the producing wells in some of these projects. Mr. Martin has demonstrated that the amount of calcium sulfate that these waters can carry or can dissolve and carry is roughly proportionate to the pressure,so therefore the higher injection pressures that are used the more calcium sulfate material can be carried in suspension and then later dropped out of suspension as it comes in to the well bore of the producing wells. And this is a very troublesome factor that

tends to plug off the formation in the vicinity of the producing wells. So, it certainly is important to, from this point of view, to keep these injection pressures as low as possible.

Q You say it is important to keep the injection pressures as low as possible because of the plugging factor. Do the injection pressures cause any other problem in this particular reservoir?

A Yes, aside from the gypsum problem which we just mentioned, all of you, I'm quite certain, are familiar or have heard of our problem of premature water channeling or premature water breakthrough.

Q Have you experienced that in this project?

A We have experienced some of this and fortunately, we have been able to overcome part of it. We do have a very clear case of what can happen because of this premature water breakthrough, and this is demonstrated in what we call Exhibit No. 10. Exhibit No. 10 is a graph which shows a plot of monthly oil and monthly water production for the Puckett "A" No. 6 well. The solid portion of the curve is, represents oil production and is so identified on the exhibit. The water production is indicated on this curve by the dashed lines.

You will note on this graph that during the latter part of 1963, there was a very abrupt change in producing characteristics. We started producing large volumes of water at that time and produced those volumes over a period of approximately one year. During this time there was very little if any significance increase in oil production and this is a good case of what we mean by premature water breakthrough, which in this case was caused by excessive injection pressure.

You will note that at the end of 1964 this problem was corrected in this well and then later during the latter part of 1965 the oil production starts climbing and we start getting a normal response to waterflooding, so I think it is perfectly clear that it is very important that we keep our injection pressures down below these fracture or breakthrough pressures in order to get the oil that is present.

MR. PORTER: We will take a short recess

(Whereupon, a short recess was taken)

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

Q (By Mr. Kellahin) Mr. Gray, in the event William A. and Edward Hudson decide to reinject water, what plan

will be followed?

A Well, in our discussion up to the present time, it is the applicant's belief that we should inject this produced water into the expanded portion of our waterflood project or the Puckett "B" portion.

Q What is your reason for this?

A Well, the Puckett "A" lease is substantially better. There has been a substantially greater amount of oil recovered from the "A" lease. The flood is aggressing very satisfactorily, we are pleased with the results we have had up to this time and the applicant hesitates to, at this stage atleast, to change the operation and take a chance that some of these unfavorable factors might hurt this portion of the flood. The Puckett "B" lease, the wells that are drilled on this portion are much tighter and thinner pays and if we do any harm,it is not going to hurt as much as --

Q The loss to the operator will be smaller, is this what you are saying?

A That's correct, yes sir.

Q Now, in the event you decide to flood the Puckett "B" lease with the produced water, would it be necessary to use fresh water first?

A We would like to have the first part of the injection be conducted with fresh water. We would like to build up at least a partial fresh water-front, so that we can at least get a good start on this portion of the thing before we start using the produced water.

First of all, of course the further away from a well bore we get with the fresh water-front, well, the more larger radius we have to work with and the larger area exposed to the water push. So, if there is any plugging, well, the further out we could get from the well bore before this starts happening, well, the more chance we have that we can continue through some other portions of the permeability that will be effective.

Secondly, when water is injected through the formation it has a tendency to remove some of the chemical components or solids that are naturally present in the formation of water, and as the water injection progresses you tend to wash some of these components from the formation. And if we can build up this fresh water-front, then we think we have a better chance with following it with water that isn't quite so good and not do so much damage.

Q Now, Mr. Gray, what are the reasons you have for desiring to continue to surface disposal of the water as

opposed to putting it, for example, in your Puckett "A" Well No. 16?

A Well, of course, if we inject into a separate water disposal well such as the Puckett "A" No. 16, we have to have facilities that are in addition to the facilities that are required to inject water into the waterflood area. This would cause us to have more facilities than we would normally have, which would cost money and also it would be fairly expensive to inject water into the disposal well from the operating cost standpoint. We have to have power, electric power for example, so that there would be a certain amount of the cost for this type of handling which would be in excess of what would normally be used in waterflooding. Of course, we look on this disposal well as a temporary thing. We don't anticipate that we would continue throughout the life of the flood. If we did use a disposal well, we would do it for a period of time to get us through this period when we are not producing large quantities of formation water and then later on, of course, this means would be stopped and then we would start using produced water in our regular waterflood operation.

Q Now, have you any idea what it would cost to

recomplete the "A" No. 16 and use it for injection purposes?

A Well, the cost would be somewhere between twelve thousand and fifteen thousand dollars and then in addition we would need a connecting line between our "A" and "B" batteries, which possibly would add another five thousand, so, we are talking seventeen thousand to twenty thousand dollars.

Q Would that be an unnecessary expense in your opinion in the event you do reinject the water?

A Yes, if, in other words the possibility is this, if we were given more time to work this thing out to our satisfaction, we may decide that the best means for disposing of produced water is to handle it in our injection system and, of course, if we arrived at this decision, if in the meantime we have been forced into another method of handling the water without sufficient time to justify this method well, then that portion of the cost would be in excess of what would be necessary.

Q Now, you will have to put in additional facilities to use the water for injection, will you not?

A We have sufficient pump capacity, I think, in our present plant to handle injection water into the, into our injection system. I think the only place that we would

need additional facilities would be that if we decide to use the disposal well, why then we would need those additional facilities. If we maintain a separate system, of course, and we decide to keep the waters separate and not mix them, what we would have to do at the plant would be to take one of the present pumps out of service on the fresh water system and convert it to a salt water system, but there are other parts of the system, of course, that we would have to add to. So, if we maintain a separate system, well, there are portions of the system that would have to be constructed new.

Q Now, will a one year extension of time be adequate for you to determine just what you are going to do?

A Well, we feel that we do need more time to make our determination on what is the best approach to this thing. It is a question that we don't think we can take lightly, because we can do something that will make us recover less oil in this project and can adversely effect the economics of it, so, we would like to have sufficient time to take all these factors and make our determination and come to some conclusion that we think would be reasonable. And in addition, these other companies are conduction their floods and injecting produced water and they are actually

developing data for us in a way. They are finding out new things that should or should not be done and these factors also will benefit us, so, we feel that if we can be given another year that we can certainly come to a mcuh better decision on how this thing should be done so that we can get the most oil out of this project.

Let me say that we are not turning our backs on the contamination of surface waters or shallow sands. It is our opinion that any place that a fresh water reservoir is present that the disposal of waters into the surface can be harmful to those shallow deposits of water. And we certainly agree that water disposals should not be permitted indiscriminately; but we do feel that in areas where it can be shown that these waters are not present and that there are other natural conditions present which are also harmful to any later deposition of water such as the caliche pits for example. Any rain water percolating through the Calicag will cause a water that is not suitable for domestic purposes. So, we have all these natural factors that we can't control as well as our produced water situation so we would not want to continue this water disposal into the surface pits if we thought there was any chance in the world that we were contaminating any water supply anywhere. We just feel that by

continuing this for this period of time that we have requested that we will just add slightly to the amount of salt water that has already been put into the ground and certainly there won't be any additional harmful effects from that additional amount.

Q Now, in connection with this there is one type of damage we haven't discussed. You are on this lease regularly, are you not?

A Yes, sir.

Q Do you go by these pits frequently?

A Yes, sir.

Q Have you ever seen any sign of any surface leakage from these pits that damaged the vegetation in the area?

A No, there is no indication of it. These leases are in sandy terrain and are not noted for their abundance of vegetation, but there is mesquite and various types of desert plants that are in the area and these plants are present around both of these pits in close proximity and there is no indication at all that any of the plant life has been affected at all.

Q Did you visit the pits within the last day or two?

A Yes, sir.

Q Did you take some pictures at that time?

A Yes, sir.

Q Do you have the pictures of the two pits involved?

A Yes, sir.

Q Would you have them marked as exhibits, please?

(Whereupon, applicant's Exhibit's 11 through 13 were marked for identification.)

Q (By Mr. Kellahin) Mr. Gray, I hand you what has been marked as Exhibit 11 and ask you to identify that exhibit.

A Exhibit No. 11 is a photograph taken from the top of the tank battery serving the Puckett "B" lease and the picture is pointing in a westerly direction and shows the disposal pit in the background.

Q I hand you what has been marked as Exhibit No. 12 and ask you to identify that.

A Exhibit No. 12 is also a picture of the Puckett "B" battery and a portion of the disposal pit. This picture was taken from the southern edge of the pit and is looking in a northeasterly direction and it shows the abundance of plant life in near vicinity of the pit.

Q And I hand you what has been marked as Exhibit No. 13 and ask you to identify that exhibit.

A Exhibit No. 13 is a photograph showing a portion

of the pit which serves the Puckett "A" battery. This picture is looking in an easterly direction and shows the waterflood plant in the background. Also this photograph shows that there is an abundance of green plant life near this pit.

Q When were those pictures taken?

A These were taken October the 16th, 1967.

Q And did you take them yourself?

A Yes, sir.

Q Were Exhibits 1 through 13 prepared by you or under your supervision?

A Yes, sir.

MR. KELLAHIN: At this time I would like to offer into evidence Exhibits 1 through 13 inclusive.

MR. PORTER: If there are no objections, the exhibits will be admitted.

(Whereupon, applicant's Exhibit's 1 through 13 were admitted into evidence.)

Q (By Mr. Kellahin) Mr. Gray, were copies of the applications of William A. and Edward R. Hudson in Cases 3664 and 3665 furnished to the office of the State Engineer?

A Yes, sir.

Q And did you discuss the applications with Mr. Frank Irby of the State Engineers Office?

A Yes, we did.

MR. KELLAHIN: That concludes our presentation on direct examination, Mr. Porter.

MR. PORTER: Does anyone have a question of Mr. Gray? Mr. Nutter?

CROSS EXAMINATION

BY MR. NUTTER:

Q Mr. Gray, referring to Exhibit No. 2 wherein you state that these two squeeze jobs were performed on this well.

A Yes, sir.

Q Were those during the drilling operation or were those squeezed while the well was being plugged and abandoned?

A That was during the testing of the well.

Q So, while that five and a half inch casing is cemented with only fifty sacks around the shoe, there should be approximately one hundred and fifty sacks then in the interval piped down through the pay then.

A Yes, sir.

Q I see. Then you have got another three hundred

sacks squeezed in at 4300 feet.

A Yes, sir, that's right.

Q So, you feel, if you should inject into the San Andres through your proposed interval of 4125 to 4905, then there wouldn't be any danger of any possible harm to the Paddock Zone?

A Yes, sir, that's right.

Q Now, you stated that you would use plastic coated tubing in a packer, the packer would be set just above the perforations. I presume your perforations would be from 4125 to 4905, is this correct?

A Well --

Q Or would you selectively perforate in that gross interval?

A Well, here is the situation. We haven't really come to a definite discussion in our own company as to exactly what interval that would be perforated first in this disposal well if it is used for such. We were asking for authority to inject water within this interval which we indicated by the red line on the log. Now, I am not real certain whether Mr. Hudson, for example, would prefer to start, for example, at the top part of this interval and, say, inject into a portion of that and then progressively

go down if necessary or whether he would prefer to start at the bottom of this well and perforate the very bottom part of it and then later if additional perforations were needed, come up the hole.

I would state this, however, that before we perforated any interval, of course we would get the approval of the Commission and the U.S.G.S. on the exact interval that we would perforate.

Q Well, at any rate the perforated interval or the zone of injection, would be somewhere in the vicinity, within the area from 4125 to 4905 --

Q Yes, sir.

Q -- at all times.

A Yes, sir.

Q Now, what I am trying to do is arrive at some kind of a stipulation that the Commission could put into the order with relation to where the packer should be set also. Would a stipulation that the packer be set no higher than 4100 feet be satisfactory with Hudson and Hudson which would be somewhere, 25 feet above the --

A Yes, that would be --

Q -- the uppermost injection zone?

A No higher than 4100 did you say?

Q Yes, sir.

A Yes, that would be satisfactory.

Q You could find room for your packer in there?

A Yes, sir.

Q Now, would it be agreeable also of the requirement that the casing tubing anulus be left open or equiped with a pressure gage in order that a packer or tubing leak would be detected?

A Yes, we would want it that way.

Q Now, how much water did you say you are producing on these two leases at the present time, Mr. Gray?

A We are producing approximately 240 barrels a day on the Puckett "A" lease and approximately 148 barrels a day on the "B" lease.

Q And what is your average rate of injection per well for your sixteen injection wells?

A Approximately 250 barrels of water per day per well.

Q So at the present time you are producing enough water to satisfy the need of at least one injection well if you didn't mix the water?

A Yes, if we select the right injection well, yes sir.

Q Now, when was the date of the issue of that order, not so terribly long ago, Mr. Gray, which authorized the additional injection wells on the Puckett "B" lease?

A I am sorry, but I don't have that order with me.

Q That was along about May or June someplace in that neighborhood, wasn't it?

A I think so, in the spring sometime.

Q Well, now, you stated, Mr. Gray, if you injected this produced water, you would probably do it down here in this south end on the Puckett "B" lease?

A Yes.

Q And you also stated that you would like to have time to build up a fresh water bank --

A Yes, sir.

Q --prior to following through with the produced water. Now, if the order was issued in May or June you have had time to build up a fresh water bank, if the wells would have been put on injection at that time, you would have had time to build up a fresh water bank in front of produced water by January the 1st, 1968, wouldn't you?

A Well, we haven't been able to develop this that quick. We have had other problems in connection with starting this expansion program. For example, we have had

to make a line agreement with Continental Oil Company on the east line of this flood and we are in the process of negotiating a contract with Skelly Oil Company on wells along the west line of the lease, so that, we have been delayed in starting these operations because of some of these factors and also because of the time required in getting material and actually getting the project installed.

Q Well, you already had a Continental line agreement, didn't you, when you put your No. 23 and your 29 on up in Section 24?

A No, sir. No, sir, we just hoped that we could get some kind of a reasonable agreement with them. We didn't want to delay injection on the line, we wanted to go ahead and get our injection wells in, so we actually drilled two wells on the line without any actual agreement with the Continental at that time.

Q They recently had a modification for the location of one of the wells on their property --

A Yes, sir.

Q --in which Hudson and Hudson furnished us with a waiver. I presume that that location was in accordance with the line agreement?

A Yes, sir.

Q How about this No. 39 of yours out here in Section 24 which is on the Skelly line, have you ever drilled that well yet?

A No, that well hasn't been drilled. It seems that some of these things take an awfully long time to do, like to get a line agreement with people and to put in these projects, but I will assure you that where you are busy and have a lot of other things to do sometimes it just takes a lot of time to get a lot of these things done and of course when you are ready well, maybe the other company is not quite ready and you both have to be ready to really decide on the thing at the same time which never happens, so it does take a long time to get some of these things done.

Q How long do you think it is going to take before you get these additional wells on injection in Section 25?

A We have two of the inside locations that are taking water now. They have been converted within the last week, I would say. We have a third well, Puckett "B" No. 9 which we are presently working on and which we hope to have completed as an injection well within a few days time on that one so that will give us three immediate wells. Then, see, the conversion of the wells along this line has been

delayed. I don't think I am hurting Continental by saying that we have been waiting on Continental but that is the case. They ran into a problem where their water supply line was not sufficient to take care of all their water requirements so they had an unexpected delay in their program in converting their wells so we have delayed the conversion of our line wells along the eastern edge of the Puckett "B" lease until Continental completed their work and started converting their line wells so that both of them would mesh together and that we would be able to start injection approximately the same time. Well, Continental has started. Approximately two weeks ago they started converting the well offsetting our Puckett "B" No. 6 Well and they may be working on that yet or they may have completed it.

Q Is that Section 30 in that Continental MCA used?

A That would be the section directly to the east of Section 25. Yes that would be --

Q It is labled as the Carper Lease, that would be under operation?

A You are looking at Exhibit 1 aren't you?

Q Yes, sir.

A The map that we have used here really isn't up to

date, in that the well numbers that are shown on the Continental Wells don't correspond to their unit number wells, so the map is not correct in that respect. The well Continental is or was working on is a well located in the northwest quarter of the northwest quarter of Section 30.

Q Being that 3-A there?

A What we show as 3-R, I believe it is.

Q 3-R?

A Of course it has a unit number now.

Q This acreage in Section 30 is operated by Continental then?

A Yes, sir, that's right.

Q What does the agreement call for, does it call for that 3-R--

A Let me give you the correct unit number.

Q --and No. 3-B go on injection?

A Pardon?

Q Does the line agreement call for their 3-R in Unit D and the 3-B in Unit L to go on injection?

A Yes, that's right and let me give you the unit numbers. The 3-R has a unit well number of 104 and the 3-B which will be converted also is their number 164 unit

well.

Then in addition they recently started on their unit well number 17, which is located in the southwest quarter of the southwest quarter of Section 18, Township 17 South, Range 32 East. I think they are working on that well at the present time.

Q Oh, I see.

A So, although, we could have been ready three months ago to convert these line wells. We didn't wish to do so at that time because of the delay that the Continental had in making their conversions.

Q Does Continental have wells on active injection up here in Sections 19 and 20?

A I really don't know, I can't answer that. This is in the area that they are expanding and I haven't kept up with their expansion program to that extent. I really can't say whether they have or have not.

Q Do you know in their secondary recovery area whether they are recycling the produced water or not?

A I know that they planned to use their produced water and I'm not certain whether they are actually using it at this time or not.

Q How about Skelly to the west, are they recycling

their produced water?

A As far as I know, they are not.

Q Now, you mentioned when these fourteen injection wells were drilled up here in Section 24 that thirteen of them were drilled with cable tools and one with a rotary.

A Yes, sir.

Q Which one was the one that was drilled with a rotary?

A Well No. 26 was drilled with a rotary. This well was carried down to test the **Paddock** Zone in this area.

Q The No. 23 down here southeast of the old disposal pit was drilled with cable tools then?

A Yes, sir.

Q And no show of water was encountered in it?

A No, sir.

Q When was the flood started on the Puckett "A" lease, Mr. Gray?

A It was started October the 1st, 1962.

Q That is when the water started going into the ground?

A Yes, sir.

Q Now, I noticed during your direct testimony several times you stated that if you decide to recycle you would do

this and that and the other and if plans were consummated for the reinjection of water. Is there some doubt that you might not reinject your produced water at all?

A Oh, no, not on a final basis. Of course, what we are hoping is that we will be able to delay for one year the time that we do have to start using the produced water. Now, we don't anticipate that we won't use the produced water but we just need more time we feel to, we are just not ready to do it yet. We think that we could do something that would very definitely hurt our flood efficiency by being rushed into this thing.

Q Well, Mr. Gray, I have a hard time understanding, if the flood started in October of 1962, that is five years back.

A Yes, sir.

Q How long does it take to decide these things?

A Well, we haven't been faced with the decision until very recently. You see, we didn't begin to think about these things until your order came out which is going to effect our operations.

Q That was in April?

A Yes, sir.

Q So you have got to make the decision now --

A As a matter of fact, at the very start of this thing when the order first came out, well, we didn't visualize too much, too many problems at that time, really, through innocence on our part and the more we got into this and the more we thought about certain aspects of the thing, well, the more complicated it became. So it has kind of developed along to the point that the closer we get to it, well, the more complicated it becomes and we see more problems involved than we were able to see at first.

Q So what it boils down to is the fact that you have got five years experience in the flood,you still only had eight months in which to decide what to do with the water.

A Yes, sir.

Q Now, Mr. Martin, in his paper, suggests that one of the causes for breakthrough would be the use of water containing contaminates which would plug portions of the reservoir thereby letting the water break through. You weren't using contaminated water when you had your premature breakthrough on your Puckett "A" No. 6 Well, were you?

A Oh, no. The cause of that breakthrough wasn't due to the deposition of plugging material, we don't feel.

We just feel that we got too high on our injection pressure and it caused a fracture in the formation.

Q So that the regulation of the pressure is just as important as having pure water.

A Yes, sir.

Q Now, you also suggested, Mr. Gray, that waste would occur in that oil wouldn't be recovered if contaminated water was used. It is possible to treat water, is it not?

A Yes, it is possible to treat water.

Q What is the price of the water that you buy from this water company per barrel?

A May I continue on this thing we just said just a minute ? When I say that we can treat water, that is kind of a comparative thing. We can treat it up to a point. In other words, we can take bad water and we can go through certain processes of treatment and we can come out with a water that is greatly improved over the water that we had to start with. That doesn't mean that our final water is completely free of all of these objectionable things, so it is kind of a comparative thing. We never are able to really treat a water to a degree that we are completely satisfied with the quality that we actually end up with.

Q Well, even if you were using, in some cases, even when you are using pure drinking water you have to treat it --

A That's right.

Q -- so it won't plug up your formation, but essentially it is possible to treat water, it is just a matter --

A You can improve the characteristics.

Q It is just a matter of comparing the economics of treating that water with the economics of buying fresh water.

A Yes, and then, of course, you do have this problem of a certain amount of these solids getting into the formation and doing some damage.

Q In your knowledge, are there any waterflood projects, which have been carried to depletion, which haven't used any recycled water?

A Well, most of our projects are comparatively new in New Mexico, and I can't site a single instance that -- I don't know of any instance where a waterflood project has reached the end of its life in New Mexico.

Q I don't think there are any in New Mexico, but do you know of any anywhere that haven't used recycled water?

A Well, let's see. I have been in New Mexico most

of my days in the engineering business and I would say that nearly all of my experience is limited to New Mexico.

Q Let me put it this way, Mr. Gray. Do you know of many projects in New Mexico which haven't been taken to depletion yet but which are using recycled water?

A Oh, yes. There are several projects which are using produced water.

Q How many injection pumps do you have at the station now?

A Well, we have four at the present time.

Q Are those pumps all operating at capacity?

A No, the fourth one is the one that we just recently installed and, of course, the purpose of that one was to take care of this expansion program we are getting into. We don't have all of the wells on and we are not up to capacity at this time.

Q Are the three pumps which were originally set required to operate at capacity to take care of the original fourteen injection wells?

A Well, originally we installed two pumps which were designed to take care of the pilot portion of the flood. Originally we only had six injection wells in the pilot program. Then, as we progressed and further, ex-

paneded further and drilled more injection wells, well, we added a third pump to take care of the conditions, up to, you might say up to this time.

Q What I was wondering, Mr. Gray, would it be possible that you would have capacity there in your pumping station to use three of those pumps for injection of the fresh water that you are putting in now and the fourth pump to recycle the produced water? Do you have ample capacity to do that?

A Well, we would be limping along. You see, one of these pumps is capable of handling, say, fifteen hundred barrels a day. Well, we are only producing two hundred and forty barrels from the "A" and one hundred and forty from the "B", so we only have a partially loaded pump.

Q What you want to do is you want to wait until this additional equipment is available from Texas so you can use it here.

A Well, the additional equipment from Texas would only be used if we use this Puckett "A" 16 as a disposal well. Now, if we use a disposal well, then we will need equipment in addition to that that we have at the present time simply because that water is not being directed into the waterflood portion.

Q In other words, if you should recycle the water, you are going to have to have equipment any way.

A You mean if we don't use a disposal well?

Q That's right, if you recycle your produced water. The equipment in Texas would be used for disposing of water. The equipment that you have got here in New Mexico now would be limping along if you recycled your produced water, so it is going to take some new equipment if you use produced water.

A If we used produced water in our present injection system?

Q Yes, sir. That will take some new equipment.

A Well, I'm not sure. We may have adequate capacity in our plant at this time.

Q I see.

A It is not absolutely certain, I mean we haven't got into this thing far enough yet.

Now, of course, here is another thing. We are restricting the maximum injection pressure that we are operating under to approximately eighteen hundred and fifty pounds which we hope to continue for some time yet. We hope we can, but there will be a time later on when we will have to raise the injection pressures in order to

flood out some of these tighter zones. So at the time that we raise the injection pressures, well, then there is going to be a decidly greater increase in the capacity of these wells to take water, so we really don't know what is going to happen at that stage of the thing. It is possible that we will need some additional capacity in that stage of the flood.

Q Now, Mr. Gray, when you got that water analysis on that No. 13 Well, that well was drilled evidently to a depth of eight hundred fifty-five feet.

A Yes, sir. That was the total depth at the time that the sample was taken.

Q Well, now, in looking at the log of that well, which is Exhibit No. 7, it would appear that the total depth of the well was right down at the top of the salt at the time the water sample was taken.

A Not quite. See this rustler anhydrite, the base of it is probably about --

Q Eight, sixty-five?

A Yes, I would say that is probably pretty close to it. So we weren't quite through the rustler enhydrite. You see, in this stage of the thing these holes, they make a hole in a hurry. They drill a lot of formations real

quick through this portion of the formation. It is soft and there was a certain amount of time that passed after we actually encountered the water until we were aware of it and could shut them down and get the water samples. So the actual depth of the well at the time we obtained the water sample was eight hundred fifty-five feet, but it was in this anhydrite section before we actually got into the lower water zone.

Q Well, if you had eight hundred and fifty-five feet of hole open there, how do you know the water came from that interval five, thirty-eight to five - fifty?

A Well, that is the interval where the water started entering the hole and, of course, they have to bail that water out. Well, we took a bailer test and the well was making three bails of water per hour. Well, as the hole progressed down the hole it continued making that same amount of water.

Q But you never did get a sample when you were up there at that depth, five hundred thirty-eight to five, fifty.

A Not until we got to eight hundred and fifty-five feet.

Q The only samples you got was when you were within

ten feet of the salt.

A Yes, sir.

Q Do you know of any water analysis in the Santa Rosa out in this general area which would be comparable to this water?

A Yes. I think most of the Santa Rosa water that I have seen has sufficient solids in it that it is not suitable for domestic purposes. I don't know of any case where the Santa Rosa formation is being used for domestic use. Some of it is being used for cattle, that is true and some of it is better than others. It varies.

Q I think it is over in Lea County, Mr. Gray.

A Well, possibly it is. I am not familiar with that.

Q But in Eddy County, you don't know of any place where it is not brackish?

A Every place that I am aware of the water is jiffy and brackish. It is not suitable for any domestic purposes.

MR. NUTTER: I believe that's all. Thank you.

MR. PORTER: Does anyone else have a question of Mr. Gray? Mr. Ramey?

CROSS EXAMINATION

BY MR. RAMEY:

Q Mr. Gray, you mentioned that before you started using produced water, that you wanted to build up a fresh water bank in the formation, is that correct?

A Yes, sir.

Q How much of a bank do you want to build up? Do you have any idea of how much you want inject?

A Well, no. It is kind of a relative thing. In other words, how much time can we have? I mean the more the better.

Q Well, it appears to me --

A I will say this. If we can inject water over a year's time, well, certainly we are in much better shape than if we have to start injecting that produced water after the very start.

Q Well, it appears to me on your Puckett "A" lease that you have several years of injection and you should have a fresh water bank there, so I can't understand why you couldn't inject produced water on your Puckett "A" lease.

A Well, it is a relative question. In other words, we can probably get by with it but how much damage are we going to do and --

Q I thought that was the idea of putting a fresh water bank in, was to possibly sweep --

A That is only helping your problem, you are not eliminating your problem, you are just helping it. So, if you are going to have any decrease at all in the water-flood efficiency, well, certainly you would rather have it on the portion of your property where you don't have so much oil there to begin with.

Q It appears that you might have more oil to recover off, at this time, more oil to recover off of your Puckett "B" lease than you would off of your Puckett "A".

A No, sir, we still won't. There is too much difference in the amount of oil on the two leases. We still, even from this point on, we will still get substantially more oil off of the " A" lease than we will off the "B" lease.

MR. RAMEY: Thank you.

CROSS EXAMINATION

BY MR. PORTER:

Q Mr. Gray, you now have two pits you are using. According to your figures, you are disposing of close to four hundred barrels a day in the two pits.

A Yes, sir.

Q Do you have any idea how much of this water evaporates, what percentage of it evaporates and what percentage goes into the ground?

A No, sir. I have no way of knowing that, I can't answer that at all.

Q I see, but some of it would no doubt evaporate.

A Yes, sir.

MR. PORTER: Does anyone else have a question?

MR. HATCH: I have a communication. It is a copy of a letter addressed to Mr. William A. and Edward R. Hudson sent to the Commission. I think it should be read into the record at this time.

MR. PORTER: Well, Mr. Hatch, we will have you read that letter. If there are no further questions of the witness here, why, I would like to dismiss the witness. You may be dismissed.

(Witness excused)

MR. PORTER: Off the record, please.

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

MR. PORTER: Back on the record.

MR. KELLAHIN: The witness has been excused, has he not?

MR. PORTER: Yes, the witness has been excused.

MR. KELLAHIN: That completes the presentation on the part of direct examination.

MR. PORTER: Does anyone else have anything further to offer for the record in this case? Mr. Kennedy?

MR. KENNEDY: I am Robert Kennedy with Kennedy Oil Company and I do have a statement to make. We have listened to the testimony in evidence in Case No. 3665 of William A. and Edward R. Hudson for exception of Order R-3221. As operator of a waterflood project in Eddy County, New Mexico, we feel that there will be no damage to fresh water supplies in the area and we support the application of the Hudsons.

MR. PORTER: Mr. Ledbetter?

MR. LEDBETTER: I am Herman Ledbetter, Division Superintendent for Newmont Oil Company in Artesia and I would like to make a statement, the exact statement that Mr. Kennedy made.

MR. PORTER: Does anyone else have anything to offer? Mr. Knauf, I believe you had something.

MR. KNAUF: I wanted to make a statement in regard to Case 3664. The survey offers no objection to the case, in fact, we recommend that the Commission approve

the disposal.

MR. PORTER: Anything further?

MR. KELLAHIN: I would like to make a brief closing statement if I can. I know the Commission has been quite patient to listen to us at considerable length, but we felt because of the nature of this case and the fact that we are dealing with an order that is new to the Commission, that we had to make a full presentation and at the same time, I feel some obligation to my client in making a closing statement, to point out some things that I think are quite significant in this particular case.

I think we are probably inclined to lose sight of the purpose for which Order No. R-3221 was originally adopted. As the Commission well knows, over a period of years there has been some concern over the contamination of fresh water supplies, primarily over in Lea County and this really is what prompted the adoption of Order R-3221.

Now, there is a lot of testimony in the record as to the reasons we don't want to make underground disposal at this time, that we may or may not be able to use this water for the secondary recovery project and we do ask for a delay.

This may lead to some little bit of confusion and say, well, they could have done this or they could have done

that, this is true. If you have foresight and know all of the things that are going to occur to you, why, you can prepare for them, but as Mr. Gray stated, they hadn't considered these problems until this order was adopted.

So, I think the Commission, in considering this application should look to the reason the Order R-3221 was adopted. It was adopted to prevent damage both to fresh water supplies and possible surface damage.

Now, the testimony is pretty clear here that there isn't any fresh water supplies in this area or anywhere near this area which could possibly be damaged. The only water which has been encountered, as shown by our testimony, is not only not fit for domestic use, it is not fit for livestock use. With a content of in excess of twenty-seven thousand parts per million, you are talking practically about sea water. It is of no value to anybody, and if these little pockets of water, as the testimony shows they only occur in pockets and not a blanket water zone, if they are contaminated, it hasn't done any harm to anybody.

The testimony also shows, and I think the pictures which were introduced into evidence, show that these

pits, which have been in operation there since 1961, don't have any leakage and they haven't damaged any of the vegetation, such as it is, in this area. The vegetation couldn't amount to a great deal, but even what is there, I assume is of value to the person that is using it for grazing purposes, but we haven't damaged it and these pictures clearly show this.

So, what we are really talking about then is a continuation of a practice which has done no harm and according to the testimony can do no harm and we are only asking for a period of one year. Now, we could have come in and asked for a larger exception and said we want an exception to the provisions of Order R-3221. That isn't the approach we elected to take. We want an opportunity to make a decision as to the best means of disposing of this water either in the "A" 16 Well or in connection with the secondary recovery project. Both of these are going to take some little time. Of course, by gearing up into high gear we could complete the disposal well and start putting it underground by January 1st, but the witness's testimony shows that in the event this water is used for secondary recovery, that would be a waste of something in excess of twenty thousand dollars or in that vicinity.

We submit then that we have presented the case showing a clear-cut need and a justified need for an exception to the provisions of Order R-3221, and we ask for the exception for a period of one year.

MR. PORTER: Is there anything further to be offered in this case?

MR. HATCH: In light of what Mr. Knauf said, I would like to withdraw the suggestion that the letter be read into the record.

MR. PORTER: The record will so show.

MR. KELLAHIN: If the Commission please, we didn't offer this paper by Mr. Martin as an exhibit, but --

MR. PORTER: That will be fine, Mr. Kellahin.

MR. KELLAHIN: That completes our case.

MR. PORTER: Is there anything further in this case? The Commission will take the case under advisement and the hearing is adjourned.

(Whereupon, the hearing was concluded.)

STATE OF NEW MEXICO)
)
COUNTY OF BERNALILLO)

I, JERRY M. POTTS, Court Reporter, do hereby certify that the foregoing and attached transcript of proceedings before the New Mexico Oil Conservation Commission Examiner at Santa Fe, New Mexico, is a true and correct record to the best of my knowledge, skill and ability.

IN WITNESS WHEREOF: I have affixed my hand and notarial seal this 16th day of November, 1967.

Notary Public - Court Reporter

My Commission Expires:

July 10, 1970

SOCIETY OF PETROLEUM ENGINEERS OF AIME
6200 North Central Expressway
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Cases 3664 & 3665

PAPER NUMBER SPE 1789

Applying Water Chemistry to Recovery

By

Waylan C. Martin, Member AIME, Martin Water Laboratories, Monahans, Tex.

ABSTRACT

This paper presents the established and theoretical influence of the chemical and physical properties of water on ultimate recovery of crude oil. Establishment of useful data and their consequent evaluation in regard to the effect of filterable solids and potential precipitates on recovery are covered. A review of experiences and current research on pressured water effects on the reservoir are presented, with special concentration on calcium sulfate.

INTRODUCTION

The primary objective in the presentation of this paper is to review field experiences and laboratory results of the chemical and physical studies involving secondary oil recovery by water repressuring. There has not been adequate opportunity to effectively correlate these conditions with the existing literature that reports data both directly and indirectly related to the subject matter.

The remoteness of the producing interval and the use of comparatively small core samples for studies have left us with the inability to accurately duplicate formations and their natural conditions. There particularly seems to be a limitation on the data of producing intervals in regard to the natural connate water [hereafter used as a reference to the total original interstitial water in the reservoir], the chemical characteristics of the matrix, and the sensitivity of the matrix to the foreign water introduced in an injection program and the changes that result therefrom. This paper makes a meager effort to reveal some of the conditions encountered and the interpretation of their implications.

FILTERABLE SOLIDS IN INJECTION WATER

A factor that is frequently puzzling in a waterflood project is the significance of the

References and illustrations at end of paper.

filterable solids. The author suggests the use of this term "filterable solids" as describing that material suspended in the water that has particle sizes in excess of 0.5μ [one micron equals 0.001 mm] in diameter. This generally differentiates the significant suspended solids from smaller suspended particles such as colloids, which are not filtered out by normal millipore filter tests and are not considered of significance in a flood water. This also separates these filterable solids from suspended liquids such as oil.

The interpretation of the significance of filterable solids in injection waters is relatively complex and involves a multitude of factors. The nature of the solid is considered the primary factor in such an evaluation. It becomes necessary to include consideration of the particle sizes, the relative number of the different sizes, and the physical characteristics of the particles. Another factor of considerable concern in regard to these particles is the permeability of the combination at higher pressures. Also to be considered in this regard are the interstices in the formation through which these particles must pass. This in itself involves considerable complexity in view of the different sizes of interstices in a single zone and the relative distribution of these sizes. This is further complicated by the variation in interstices from one zone to another in the same producing interval. It is immediately apparent that this subject is entirely too broad to allow detailed coverage in the paper; therefore, it will be covered more generally by relating actual conditions and the implications.

In making massive numbers of filtration tests at the injection wellhead pressure, it is immediately apparent that, if the producing interval were as tight as a millipore filter [0.45μ], then the injection well would plug almost immediately in many instances. In view of the fact that the formation does not plug with anywhere near the rate that is indicated on

the millipore filter, it is then apparent that at least partial penetration into the formation by these filterable solids does occur. It is further apparent that this penetration is not minor [that is, a few feet], as there would be relatively rapid plugging if they were held up in the immediate vicinity of the injection wellbore. Though the efforts to identify these filterable solids at the producing well are plagued with many complications, there have been several instances in which it is considered conclusive that these particles do not reach the producing well in anywhere near the amount that is injected, if at all. This evidence includes even bacterial cells in that the bacterial flora of the injection and return waters do not correlate in all instances. It should also be brought out that some constituents that are dissolved in the injection water, such as phosphate, do not appear at the producing well in the return water. It would than be concluded that the limited studies that have been directed toward this subject give at least preliminary indications that these filterable solids are typically stopped in situ at some point in which they attempt passage of an interstice that is of insufficient size to allow penetration.

The foregoing indications are sufficiently stable to allow careful consideration of the following two questions: [1] Does this in-situ restriction of interstices by the filterable solids significantly influence the ability of the injection water to sweep a maximum amount of oil from the producing interval? [2] If there is a detrimental influence on the sweep efficiency, then are we crediting this condition in its proper proportion when a reservoir does not appear to be responding as anticipated just because the evidence of direct plugging of the formation face in the injection well does not appear?

In answering the above questions, it is necessary to evaluate all the potentially influential conditions involved in any single project. Even though the evidence is slight and scattered, it is our opinion that the presence of excessive filterable solids does significantly influence the sweep efficiency, whether or not there is definite injection wellbore plugging. It is further considered likely that this is more frequently involved in lower permeable zones and therefore is inclined to have an undesirable influence on water channeling tendencies. It appears advisable to consider this factor in reservoir evaluations, and especially while a flood project is in progress.

The reader should be cautioned not to interpret this as indicating that an injection water needs to be perfectly free of filterable solids. It is becoming generally accepted in the oil industry that, in the absence of oil, an average filterable solids of less than 1.5 mg/liter is satisfactory. In the presence of oil, this material is usually coated; therefore, the tolerance is increased to approximately 2.5 mg/liter. This should not be confused with suspended oil, for we believe that in the absence of filterable solids the liquid suspensions do not result in an obstruction. As the average filterable solids begin to exceed these figures, the concern becomes directly proportional to the amount. There are exceptions to this as, for example, 1.5 mg/liter of bacterial cells is considered a prominently detrimental condition, whereas this quantity of large sand particles is of concern only in the abrasive effect.

FILTERABLE SOLIDS DEVELOPMENT IN SITU

The in-situ development of filterable solids becomes even more complex in its implications than filterable solids in the injection waters. Most common reference in this regard is to the compatibilities between the injection water and the reservoir and its natural connate water. In a great majority of instances, the chemical and physical characteristics of the natural connate water give at least a preliminary indication of the water sensitive characteristics [excluding swelling clay] of the reservoir. Studies have shown that in most cases satisfactory compatibilities between injection waters and natural connate waters will simultaneously suggest compatibility with the chemical properties of the reservoir. The exception to this is when the produced water is indicative of the possibility of the existence in the reservoir of an undissolved salt that is soluble to any extent in water. Studies have revealed that the matrix can be as much as 8 percent water soluble in formations in the Permian Basin.

Studies of incompatible conditions have revealed an extremely wide variation in the quantity of filterable solids that would be anticipated to precipitate in situ. These have shown quantities varying from 0.1 lb to 3,000 lb of solids precipitating per 1,000 bbl of water injected. It is immediately apparent that the former would be completely insignificant, whereas the latter would likely result in no response at the producing wells. Quantities between these two figures occasionally require decisions with consideration being given to reservoir characteristics, source and cost of different waters, etc. Of course, this is also clouded with the inevitable doubt of just how much of the predicted precipitation will actually occur in the footage between injection well and producing well.

In regard to this decision, there is the ever-present question of how much in-situ mixing

there is between the injection water and the natural connate water; if, in fact, there is any at all. It seems clearly evident that there is at least some mixing of natural connate water and injection water in situ. This is apparent in that, as the injection water reaches the producing well, there is not a completely abrupt change; but rather the returning injection water continues to carry produced water characteristics for a considerable length of time in practically all instances.

Efforts to identify the relationship between sandstone interstices and passage of filterable solids have not been conclusive. An example is a single sandstone that was examined in regard to sand particle sizes, with permeabilities in the range of 5 to 50 md, and that did not show any uniform variation in the proportion of sand particles of different sizes. The average sand particle size ranged near 100μ in each core sample in this permeability range. However, if interstice sizes could be effectively evaluated, there would still not be a definite indication of the potential particle size passage. This involves the fact that openings of certain sizes will filter out much smaller particle sizes.

CALCIUM SULFATE SOLUBILITY AND PRESSURE

The fact that the most common of all precipitates in the Permian Basin is calcium sulfate has prompted a concentrated study of this compound. Studies that have been in progress since 1956 have been reasonably reliable in estimating the solubility of calcium sulfate in the average oilfield waters in the Permian Basin. This study has applied only to natural waters, as there was a failure to obtain satisfactory correlation with artificially constructed waters. The dominating influences to consider in determining whether a water is supersaturated with calcium sulfate are the calcium-to-sulfate ratio and the chloride concentration [calculated as sodium chloride] as exemplified in Fig. 1. These studies have indicated that the factors which either have too limited effect to be considered or are very inconsistent in their involvement are the levels of temperature, magnesium, bicarbonate, or hydrogen sulfide. If any of these varies widely from the average, it is then taken into consideration. The magnesium and temperature have been previously reported as other influencing factors.[1,2]

A very common production problem in the Permian Basin area has always been the restriction of flow of fluid into the producing wellbore by depositions of calcium sulfate. Our experiences have been that pressures were involved in these depositions on the face of the formation.[3] One of the most prominent field indications of this involvement of pressure is that many fields that do not show this problem during primary have encountered it as a major problem when the producing interval is repressured. This has prompted the following concentrated study on the involvement of pressures and calcium sulfate solubility.

Method

The waters used for these experiments were all taken from various oil-producing or related intervals. The specific study reported herein was made on an equal combination of El Capitan Reef water and Yates water. This water had a chloride content of 38,000 mg/liter as sodium chloride. Theoretical combinations were utilized in reporting the results. This water was placed in a chamber with 2 percent anhydrous calcium sulfate powder and the pressure brought to 4,500 psi at 80F and held for 48 hours. A sample was then removed, filtered, and calcium and sulfate determined immediately. This sample was then divided, with one half being untreated and the other half being treated with 1 percent anhydrous calcium sulfate powder. Each of these was allowed to stand in the dark sealed at 80F at atmospheric pressure for a period of 24 hours. They were filtered, and calcium and sulfate determined on each. The pressure on this chamber was then dropped at 48-hour intervals to 3,500, 2,500, 1,500 and 500 psi. Identical procedures were then carried out on each of these samples with the exception that mild agitation was periodically given to the untreated aliquot that was taken at pressures of 3,500 and 500 psi.

Results

The results of the above tests are reported in Fig. 2. They reveal a definite increase in solubility to calcium sulfate with an increase in pressure. The average test indicated that this water would hold approximately 1,400 mg/liter [490 lb/1,000 bbl] more calcium sulfate at 4,500 psi than it would at atmosphere. They further show a gradual precipitation of calcium sulfate on reduction of pressure with a definite acceleration resulting from the presence of calcium sulfate powder or agitation. The presence of sand in other tests did not show an acceleration of precipitation as did the calcium sulfate powder.

Conclusions

It is concluded from this study that when any water enters a formation and is exposed to anhydrite, it then becomes saturated with calcium sulfate at that pressure at a rather rapid rate. As the pressure then declines, this calcium sulfate will in turn commence precipitation and if additional anhydrite is encountered, the rate of precipitation will be accelerated. Movement through the formation may produce

sufficient agitation to cause at least some acceleration of precipitation. If a continuous drive is sustained within the reservoir, then the more prominent drop in pressure and agitation will occur as the fluid enters the wellbore of the producing well. As the calcium sulfate deposit starts to build on the face of the formation, it when tends to accelerate the rate of additional depositions. If the fluid is gaseous, some additional agitation could be expected that would cause additional acceleration of precipitation. The author suggests that substantially more influence of fluid flow restriction by calcium sulfate results from this principle than results from the influence of temperature and evaporation.[4]

Some extreme field situations we have experienced tend to throw signigicant light on the foregoing. In one instance, a well receiving water at approximately 5,000-psi bottomhole pressure was backwashed, and three minutes out of the formation it was found to be severely supersaturated with calcium sulfate. This tends to reveal how rapidly the water becomes saturated with calcium sulfate at a given pressure after it has been injected. Another example was two immediately adjacent leases. One project had a single injection pump, was occasionally down for several days, eventually lost communication between injection wells and producing wells, and had no trouble with calcium sulfate at the producing well. The adjacent lease had continuous uninterrupted injection and did not lose communication between injection wells and producing wells, but had a prominent gypping problem at the formation face in the producing wells. This latter example tends to indicate that the first lease allowed pressure drop in situ and experienced essentially all of the precipitation there, whereas the second lease maintained more consistent pressure in situ and experienced more precipitation at the producing well.

SUMMARY

Current data on the significance of filterable solids in injection water are classified as incomplete, but the evidence available is indicative that these solids most frequently are involved in in-situ obstruction of interstices as opposed to the less common wellbore plugging at the injection well. The development of filterable solids in situ on the introduction of a foreign water, which is commonly referred to as incompatibility, is a potential detriment to sweep efficiency when it exists between two waters or between the injection water and water soluble salts in the matrix. The concentrated studies on the influence of pressure on calcium sulfate solubility give conclusive evidence of its involvement in restriction of production by scale in the producing wellbore. The studies further reveal a distinct probability of some calcium sulfate precipitation in situ by virtue of its becoming saturated at the pressure in and around the injection well and then precipitating as the flood water proceeds toward the producing well with a declining pressure.

ACKNOWLEDGMENT

The author wishes to acknowledge the assistance of W. Reagan White in the experimental procedures.

REFERENCES

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2. Tate, Jack F., Venable, Raymond L. and Nathan, Charles C.: "The Solubility of Gypsum in Oil Field Brines", Paper presented before the Division of Petroleum Chemistry, ACS, Chicago, Ill. [Aug. 30 - Sept. 4, 1964].
3. Marshal, D.: Heidelberger Boitr, Mineral u. Petrog. [1952] 3, 289-296 cf. C. A. 47 85941
4. Sloat, Ben: "Controlled Solubility Phosphates - A Versatile Solution to Oilfield Scale Problems", J. Pet. Tech. [Nov., 1960] 30-36.

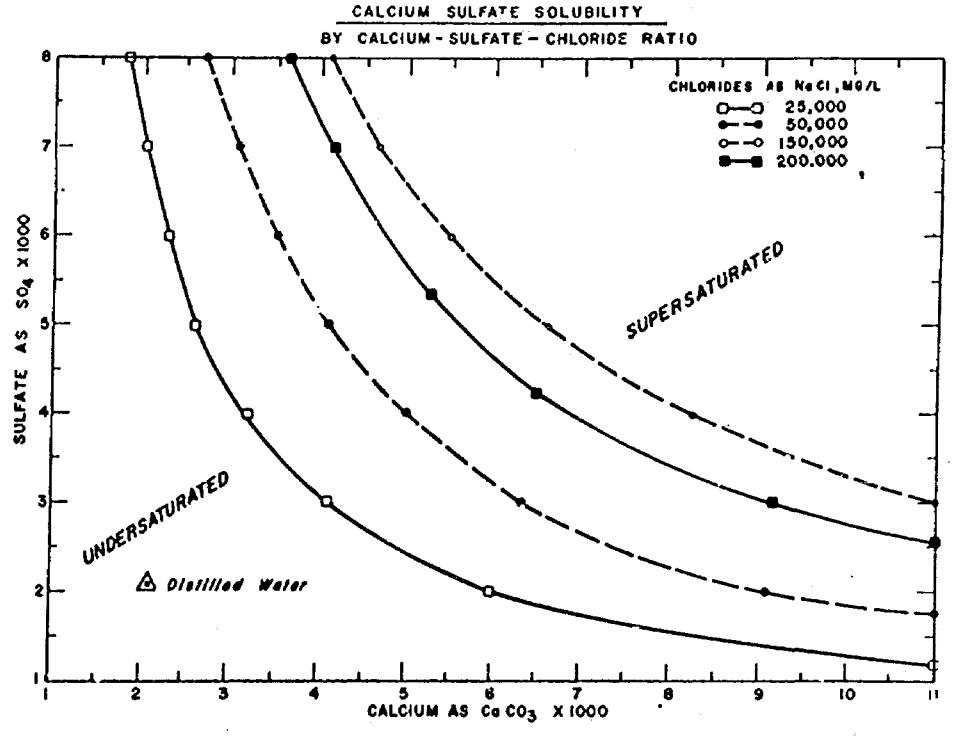

CALCIUM SULFATE SOLUBILITY
BY CALCIUM - SULFATE – CHLORIDE RATIO
CHLORIDES AS NaCl, MG/L
25,000
50,000
150,000
200,000
SUPERSATURATED
UNDERSATURATED
Distilled Water
SULFATE AS SO_4 X1000
CALCIUM AS $CaCO_3$ X1000
1
2
3
4
5
6
7
8
9
10
11

Fig. 1

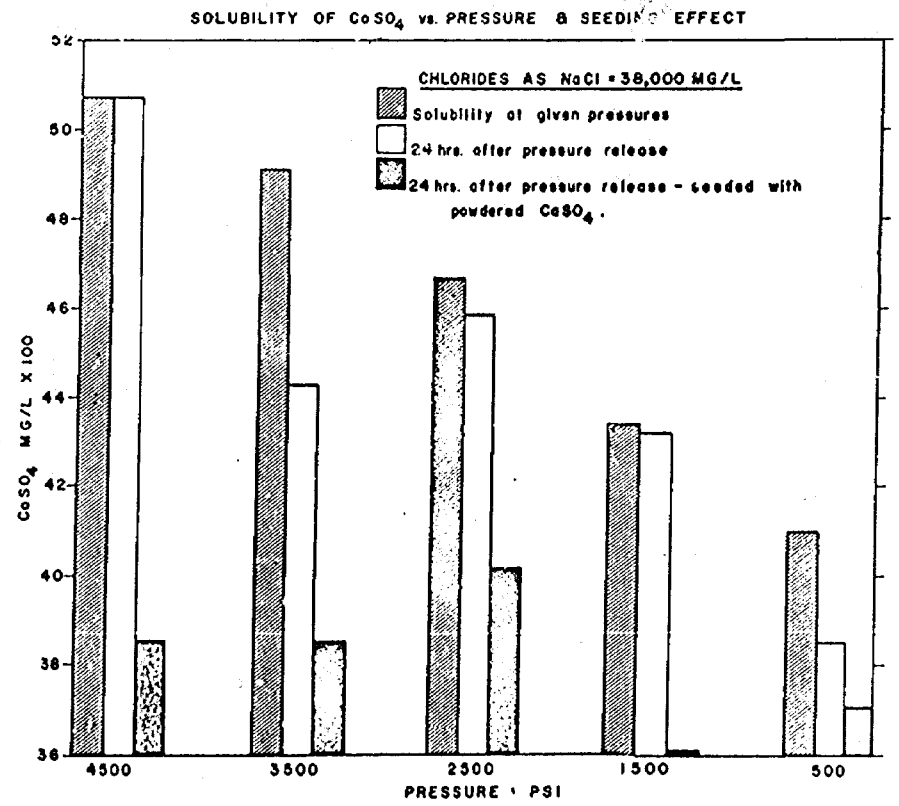

SOLUBILITY OF $CaSO_4$ vs. PRESSURE & SEEDING EFFECT
CHLORIDES AS NaCl = 38,000 MG/L
Solubility at given pressures
24 hrs. after pressure release
24 hrs. after pressure release - seeded with powdered $CaSO_4$.
$CaSO_4$ MG/L X 100
52
50
48
46
44
42
40
38
36
4500
3500
2500
1500
500
PRESSURE - PSI

Fig. 2

WILLIAM A. & EDWARD R. HUDSON - PUCKETT "A" #16-P

Location: 2180' from North and 660' from East lines of Section 24-17S-31E.

Total Depth: 5322'

Elevation: 3853 D.F.

8-5/8" casing cemented at 840'.

5½" casing cemented at 5313' with 50 sacks.

Perforations: 5246-58, produced salt water from Paddock Zone.

Cement Plugs at: 5246-52 w/150 sacks.

4300-01 with 300 sacks.

Both squeeze jobs.

Temporarily abandoned September 1950.

OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
Exhibit No. 2
Case No. 3664-3665

Exhibit #2.

RALPH L. GRAY
PETROLEUM ENGINEERING

WILLIAM A. & EDWARD R. HUDSON

WATER PRODUCTION

YEAR	PUCKETT "A" LEASE	PUCKETT "B" LEASE
1936 - 1960	No Record	No Record
1961*	15,440	26,411
1962	12,065	14,011
1963	22,792	13,485
1964	37,938	23,064
1965	27,619	31,058
1966	45,460	42,869
1967 (8 Mos.)	42,223	30,556
	203,537 bbls.	181,454 bbls.

* Changed location of Puckett "A" and "B" batteries and pits.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
Exhibit No. 4
Case No. 3661-65

Exhibit #4.

WILLIAM A. & EDWARD R. HUDSON

PUCKETT "A" & "B" LEASES

MALJAMAR POOL - EDDY COUNTY, NEW MEXICO

RECORD OF WELLS WHICH ENCOUNTERED WATER ABOVE SALT SECTION

PUCKETT "B" #6 - Unit A - Section 25

Reported show of water at 575' to 618'.
Top of Anhydrite - 618'.

PUCKETT "B" #9 - Unit H - Section 25.

Reported show of water at 819' to 830'.

PUCKETT "B" #11 - Unit P - Section 25

Tested 2 barrels per hour from 540' to 550'.

PUCKETT "B" #13 - Unit O - Section 25

Tested 3 barrels water per hour from 538' to 550'.
Encountered prolific salt water at 882' to 892'.
Couldn't bail down.

PUCKETT "B" #18 - Unit L - Section 25

Encountered salt water at 845' to 858'.
Couldn't bail down. Top of salt at 830'.

PUCKETT "B" #20 - Unit N - Section 25

Encountered show of water at 530' to 540'.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
Exhibit No. 6
Case No. 3664-65
Exhibit #6.

Wm A. & Ed. R. Hudson-
Puckett B #13

300
400
500
600
700
800

800 E.U.
500 E.U.
200 E.U./C.D.
125 E.U./C.D.
4800 E.U.
3000 E.U.

530
550

3 Bailers Water Per Hour 538-550

Top of Anhydrite

882
892

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
Exhibit No. 7
Case No. 3694-695

Exhibit #7

Wm A. & Ed. R. Hudson
Puckett B #18

300
400
500
600
700
800
900

Top of Anhydrite

Top of Salt

845
858

Encountered salt water at 845' to 858' Couldn't bail down.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
Exhibit No. 8
Case No. 3664-65

Exhibit #8

DOWELL DOWELL DIVISION OF THE DOW CHEMICAL COMPANY

FIELD LABORATORY REPORT

WATER ANALYSIS

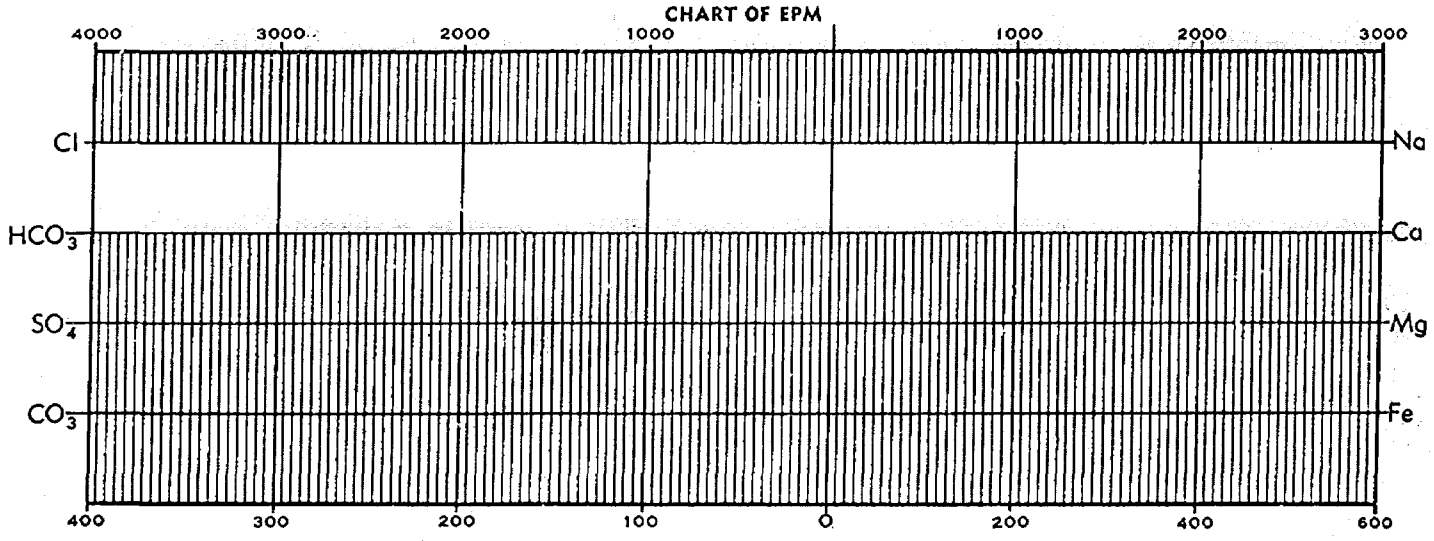
TO: Dowell
Box 1177
Artesia, New Mexico

LABORATORY LOCATION: Hobbs, N. Mex.	REPORT NUMBER: 1576
COMPANY: Hudson & Hudson	WELL: Puckett B #13
POOL:	LOCATION:
COUNTY: Eddy	STATE: New Mexico
DATE SAMPLE SUBMITTED: 7-6-60	FORMATION: Water Sand
SAMPLE SOURCE: Well Head	SUBMITTED BY: S. M. Tipton
	DEPTH: 855'
	TESTS DESIRED: Analysis

	PPM	EPM		PPM	EPM
5-7.2 CALCIUM	2820	141	1-4.9 CHLORIDE	13,100	366
5-11.0 MAGNESIUM	905	74	SULFATE	4850	101
SODIUM	5,890	253	10-.1 BICARBONATE	90	1
IRON			CARBONATE		
HYDROGEN SULFIDE			HYDROXIDE		

SPECIFIC GRAVITY: 1.020 AT 74 °F | pH 6.8 | $CaCl_2/MgCl_2$ 2.2 | % SALT SATURATION:

CHART OF EPM



REMARKS:

Total Solids - 27,655ppm.
Water is from interval 538'-550'.

CC: Hurst
Stewart
Rosene
G. O. File

Conf. Exhibit #9
Cs 3664-65

James P. Glasgow 7-6-60
CHEMIST James P. Glasgow DATE

DWL-451-B

PUCKETT A 6

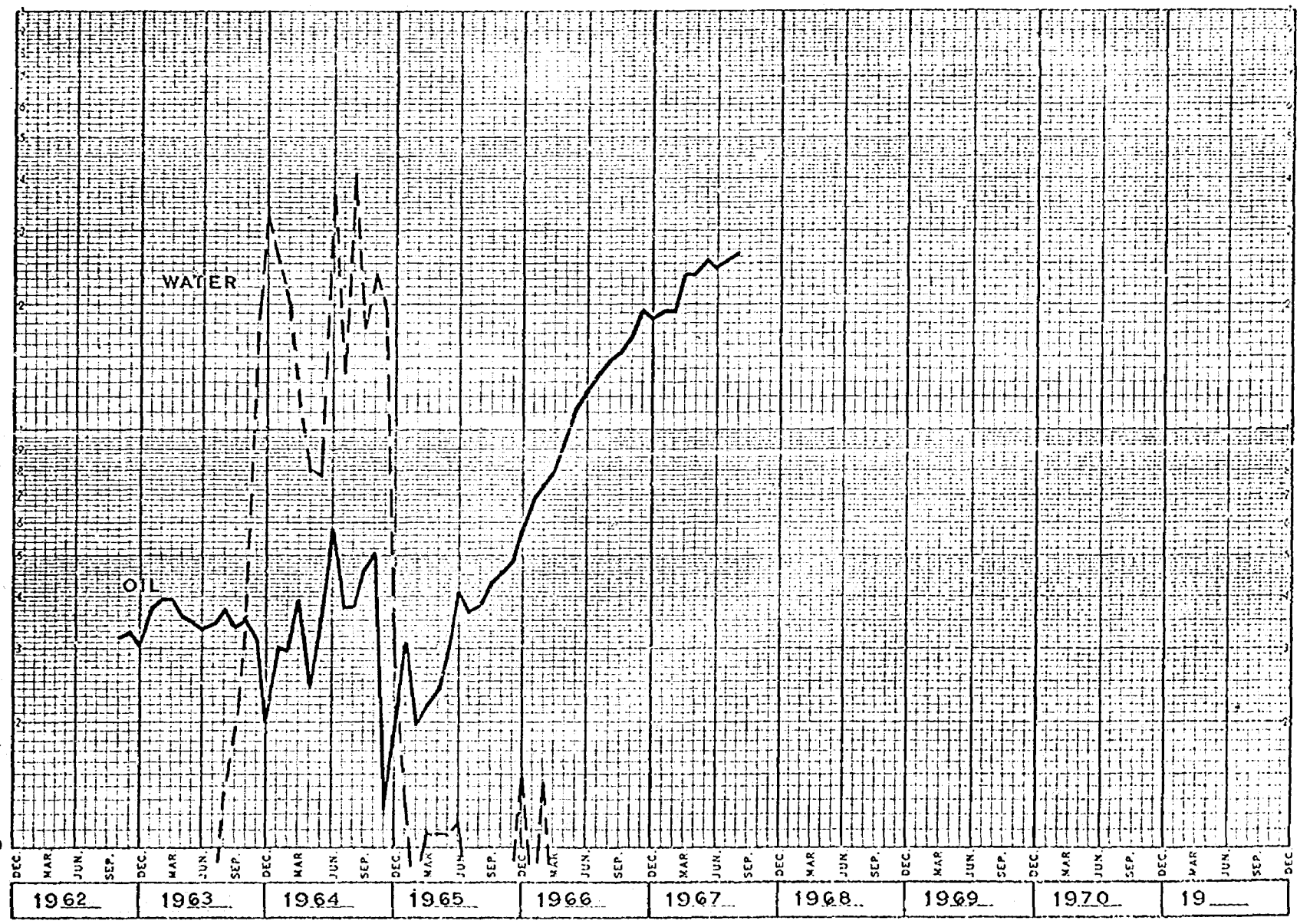


Exhibit #10