Case No.

1308 Rehearing

Application, Transcript,
Small Exhibits, Etc.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
March 13, 1958

IN THE MATTER OF: Case No. 1308

PARTIAL TRANSCRIPT OF PROCEEDINGS

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ORAL ARGUMENT

MR. PORTER: Do we have statements in Case 1308?

MR. SETH: We would like to make a summation, if the Commission please.

MR. PORTER: You may proceed, Mr. Seth.

MR. SETH: If the Commission please, the application of Shell for rehearing in this case, as we appreciate, has a somewhat limited scope. The application for rehearing does raise five or six basic points, which I believe are primarily questions of law, and mixed questions of law and fact.

The first of these points to be considered is the matter of vested rights, the application in the case that Shell, by virtue of its action taken under Statewide rules, acquired a vested right. The second point relates to estoppel. This is a proposition of when the person acts in reliance on the position taken by others and the person in whom reliance has been placed later changes his position, the Court will estop him from so doing to prevent injury to the party who has taken this action. The next point is the failure of the order to indicate any drainage areas. The next point relates to the impairment of the obligation

of contracts. The contract, of course, is the Carson Unit Agreement and the plans of development submitted under it. We feel that the change in position by the Commission impairs the obligations of contract which arose under the unit and the plans of development. And last, relates to the matter of the retroactive effect of the order here complained of.

Now, considering this matter of estoppel first. This is a fundamental point, I believe, in this rehearing. All of the points urged are independently urged, and we believe each one is sufficient ground to change the order; but as to estoppel, how is the doctrine of estoppel applicable here? As we have seen from the testimony this morning, Shell Oil Company, in reliance on the Statewide rule, proceeded with its drilling program. We're speaking about Statewide rules, all through this hearing, because that's all that we have. The original situation was obviously on a 40-acre basis; after the first hearing the Statewide rule was still in effect. The Commission had refused to change it, that was the only rule in existence. Shell, in reliance on these rules, as we have seen, proceeded with its drilling program. We have also seen that the Commission had knowledge that Shell was so proceeding with its drilling program and was drilling the wells which have been described in the hearing this morning. This notice was, of course, received through official channels by Form C-101, 128, and as we all know, at that time, at the time all of these wells were drilled, they could only be drilled on 40-acre tracts. That

was the rule of the Commission in force at the time. We have a typical situation, then, of someone acting in reliance on the Commission's rules. The Commission then changes the rules to the detriment of the person who has acted in reliance; and under the doctrine of estoppel, the Commission would be prevented now from so changing its mind to work a hardship on the operators who so acted in compliance.

As I said, it is a well-known doctrine and is applied frequently between individuals, but it is likewise applied against governmental agencies. The New Mexico courts have held that it does apply against a governmental agency. Now it has also been applied against governmental agencies, obviously, in other States, California, Colorado, and elsewhere. Its application against governmental agencies is a relatively recent development, but is well established. It is well-established in New Mexico.

I don't wish to burden the Commission with a long series of quotations, but I would like to read what one text writer has said about the application of this rule for governmental agencies. This appears in Book 1 A. L. R. (2d) at Page 346. The writer has this to say, this is a quotation.

"Assuming, however, the presence of all the prerequisites for the application of the doctrine of estoppel as between individuals, under some circumstances the public or the United States or the state may be held estopped if an individual would have been held estopped; as when acting in a proprietary or contractual

capacity; or when the acts of its public officials alleged to constitute the ground of estoppel are done in the exercise of powers expressly conferred by law, and when acting within the scope of their authority."

That's the end of the quotation. We believe that sets out pretty much the basic rule that we have in this situation and should be applied to the facts in the situation that we observed ourselves here. As I said before, this has been considered in other states, in California in a number of cases, and also has been considered in Colorado. Now these situations where the courts have considered it, there are a variety of factual situations and a variety of agencies. They relate to dedication of streets, to sales tax, to matters of service and to authorities of various governmental bodies.

In this case in Colorado, the Supreme Court of Colorado had this to say, this is a quotation --

MR. WHITE: (Interrupting) Give us the citation.

MR. SETH: I will give it at the end of the quote. "It was suggested by the trial court that estoppel against a governmental agency should be permitted only in extreme cases. Whether the Housing Authority is a governmental agency we need not decide. We have in this state ample authority for the proposition that estoppel against such an agency may be applied in the proper case. Estoppel was applied against the City of Denver in an eminent domain proceeding."-- and they cite the case. "If estoppel applies

to the City and County of Denver, it surely applies to the Housing Authority."

That quotation is The Supreme Court of Colorado, appears in the case of Piz vs. Housing Authority, 289 Pacific (2d) 905. There again it's the factual situation, is a little different but the same principle applies. Estoppel applies against a governmental agency. We feel it applies in this case.

Shell was relying on the Statewide orders and is entitled to be protected against the consequences of the Commission changing its mind. We note that the Commission has apparently considered this matter before in its rules. Some of the early rules were adopted, recognition was made that wells that pre-existed those rules might not come in under the rules later adopted. They were expressly provided for. An example of this is Rule 104 (k). 104 is, of course, the basic well spacing rule. "Nothing herein contained shall affect in any manner any well completed prior to the effective date of this rule and no adjustments shall be made in the allowable production for any such wells by reason of these rules." There's an express saving clause for wells that were drilled before the adoption of that rule.

That's a typical provision in rules of all administrative bodies. It is a typical provision in Statutes. It is typical to install a grandfather clause. Everybody in that position before the Statute or rule was adopted was protected by it. There was no such rule or protection in 1069-B. Thus anyone can find

themselves in a situation that Shell finds themselves in in this case. Any Statewide rule, if the Commission's present position is correct, any Statewide rule can be later changed to the detriment of anybody, and they have no recourse, although what they might have done in the past year is entirely proper and legal and done under the requirements of this Commission.

We are not talking here just about this particular spacing situation. This matter goes to all the rules that you adopt, Statewide rules, and all the special rules, too.

Now on this matter of vested property rights, that proposition has not received the attention of the courts in very many cases. It is a relatively new proposition. Our position is that Shell acquired a vested property right by the location of these wells, by the drilling of wells under the requirements of the Commission at that time. These locations on 40-acre tracts were required by the Commission at the time. We acquired a vested property right. Now, as I mentioned before this has not received very much attention in the courts. I would like to mention, however, one or two cases where it has been considered. First, just on the proposition of what is a vested property right, the State Supreme Court has considered this in New Mexico. This factual situation in this case, which is Rubalcava vs. Garst, 53 NM 295, this factual situation was where one of the parties had a claim against the estate of a deceased person. The claim was based on an oral agreement, that's all they had. At that time, at the

time that the oral agreement was made, such an agreement could be enforced against the estate of the decedent. After that, in 1947, the legislature passed an act that only written agreements would be so enforced, so where was this person who had the oral agreement that was in effect before the Statute was in force? The court said that this person had a vested property right created thereby and would be protected against the legislature's change in the law. That's what we have in this case here.

Now the court in this Garst case said this: "A 'vested right' is power to do certain actions or possess certain things lawfully, is substantially a property right, may be created by common law, statute, or contract, and after becoming absolute is protected from invasion of Legislature by constitutional provisions, and failure to exercise vested right before passage of subsequent statute seeking to divest does not affect or lessen such right."

The court later in the opinion stated this: "Every statute, which takes away or impairs vested rights acquired under existing laws or creates new obligation, imposes new duty, or attaches new disability respecting transactions or considerations already past must be deemed 'retrospective'".

That is the situation, I say again, here. The Commission changed its mind and attempted to apply the new rule retroactively to take away the vested property rights that Shell had. What is the vested right that Shell has in this case? Shell has a vested

property right to a full allowable for these wells that it acquired by drilling them. I don't know, no one here contends that they have a vested right to any particular allowable. That's absolutely an untenable position. We just have a vested right to a top allowable, that's all we have. We're entitled to have it protected. This matter has been considered in Texas at some considerable length. Perhaps the best-known case is Chenoweth vs. Railroad Commission, 184 SW 2d 711. This case concerned a case under their spacing rule 37, and I would like to quote just briefly from the opinion.

The Court held that an operator who had expended money in reliance on the rules of the Commission had a vested property right and was entitled to have it protected. The Court said, this is Civil Appeals of Texas: "It is settled law that when an owner or operator invests his money and drills a well in keeping with an existing valid order of the Commission he acquires property rights which he is entitled to have protected. The most common instance in such cases is where an owner has drilled his tract to a density authorized by the old oil spacing provisions of 150-300 feet. Change of the spacings to 330-660 feet cannot operate to destroy his property rights legally acquired in the wells already drilled under the former spacing provisions."

This case before the Civil Appeals of Texas is very close to the situation we have here. They protected the property rights acquired by the operator to drill pursuant to the Commission rules in this case. There are other cases in Texas, perhaps the next

best-known case is Humble Oil and Refining Co. v. Railroad Commission, 94 SW 2d 1197. This case is a very similar one to the Chenoweth case. I would like, if the Commission please, to read another quotation from this case. This is at page 1198.

"It requires no departure from the rules laid down in those cases to sustain the action of the commission in the instant case. It is true that when the permit here attacked was granted, it required an exception to rule 37 as that rule existed when said permit was granted. At that time the spacing provisions required were 466-933 feet. But at the time the 2.5 acres were segregated, spacings under said rule of only 150-300 feet were required. A subsequent amendment to such spacing rule should not, however, be permitted to destroy a property right duly acquired in keeping with the provisions of such rule as they existed at the time such property was so acquired. And the right to develop said 2.5 acre tract should be determined, we think by the provisions of rule 37 as they applied at the time the tract in question was segregated. Otherwise, an amendment to such rule, by increasing such spacings between wells, would in effect work a confiscation of vested property rights legally acquired in good faith and in keeping with such rule."

I think those two cases are very persuasive on this matter that we are discussing here of vested property rights. As I mentioned, there are other cases, but I don't think it's necessary to discuss them at any great length. I think we are entitled to

the same protection in this case that we have here. We, as I said before, do not argue that we have a right to any particular proration. We have a right, however, to a full allowable well. We had that when it was drilled and it cannot be taken away from us. Now it's no answer to say that we still have that, it has not been taken away from us, because everybody has gotten twice as much as we have. That's something taken away from us, certainly. If you have your neighbor getting twice as much as we did, perhaps we don't have anything taken away from us, but we still are twice as far behind as before the action was taken. It's sort of like at a football game, we get six points and we make a touchdown, they get twelve. Nothing has been taken away, we still get six points, but I think the comparison is applicable.

Now on this drainage proposition, I'm not going to discuss that at any great length. The order does not make any finding about drainage area. I don't know whether it's implied in the order or not. I think before an 80-acre proration unit can be established, there has to be a finding on the fact that it can economically and efficiently drain that one well. In our application we mentioned Rule 505 which relates to the depth factor. That rule, by this order that we complain of, was amended, and we do not believe that that amendment was within the scope of the hearing, as it was originally contemplated. There has been a substantial change in Rule 505 as a result of the issuance of this rule, and the factor here applied is not in keeping with the factors

as they have been set out in Rule 505 over the years.

Now on the matter of obligation of contracts, as I mentioned before, this just concerns the Carson Unit Area; consequently it just concerns what we call three 40-acre wells. The contract, as I mentioned before, is the Carson Unit Agreement; that is a contract among the parties, a good many of the parties here in opposition to Shell, also the State and the Federal Government. It was a contract, it contemplated that plans of development be submitted from time to time. Those plans became a part of the original contract and we consequently have situation here where we have an approved plan of development, as the witness in the case, supplement number three, for a 53-well program, which was approved and which has been changed by this order.

Now this order, as I'll indicate later, probably has the force and effect of law; and consequently is a statutory change which is prohibited by constitution. You cannot have a statutory change that impairs the obligation of contract. That is a fundamental proposition of law.

In the same New Mexico case which we have considered before, which was the Garst case, the Court said, this is New Mexico Supreme Court, it quotes from 1 Cooley's Constitutional Limitations, 8th Ed, p 583, as follows:

"'The obligation of a contract,' it is said, 'consists in its binding force on the party who makes it. This depends on the laws in existence when it is made; these are necessarily referred

to in all contracts, and forming a part of them as the measure of the obligation to perform them by the one party and the right acquired by the other. There can be no other standard by which to ascertain the extent of either, than that which the terms of the contract indicate, according to the settled legal meaning; when it becomes consummated, the law defines the duty and the right, compels one party to perform the thing contracted for, and gives the other a right to enforce the performance by the remedies then in force. If any subsequent law affect to diminish the duty or to impair the right, it necessarily bears on the obligation of the contract, in favor of one party, to the injury of the other; hence any law which in its operation amounts to a denial or obstruction of the rights accruing by a contract, though professing to act only on the remedy, is directly obnoxious to the prohibition of the Constitution.'"

We think it's quite apparent that 1069 impairs the obligation of the contracts which arose under the Carson Unit Agreement.

Now, on the final point, which relates to the retroactive effect of this Order 1069. This again is a fundamental proposition in this case and involves well-established doctrines of law. We, of course, do not believe that this order can have a retroactive effect, and we believe this because this Commission acts under delegated authority from the Legislature. You are exercising delegated legislative authority. The Legislature sets out the general framework in which the Commission shall operate. The Commission

is then given express authority and direction to adopt rules, regulations. These rules and regulations are an exercise of this delegated legislative power. You have the express right to make rules. These rules have the force and effect of law. There are penalties for violation of these rules. You are filling out by legislation the general framework that the State Legislature has set up. Other Commissions in the State do the same thing, of course, the Corporation Commission, with considerable Constitutional authority, but it again is exercising legislative authority. This is a very significant distinction that we must make all through this consideration. You are not exercising judicial authority. You are not adjudicating rights between individuals. You are not interpreting the Statutes. You are exercising legislative authority. This distinction is made in any discussion of administrative law, and the consequences are very fundamental. You cannot be exercising judicial functions and still be acting constitutionally.

That was clearly decided in a recent New Mexico case of a concrete products company against Governor Mechem here. That case, page 5250, clearly held that an administrative body could not be created in New Mexico with judicial power. That case has concerned, of course, a determination of whether or not the workmens' compensation law was constitutional. The Supreme Court held that it was not constitutional, by reason of the fact the Legislature had given this agency that was created by the Act

judicial authority. The Court held under our Constitution it cannot be given judicial authority, so obviously you are exercising legislative authority; so again you are acting respectively, you are under the same prohibition that the Legislature is as to retroactive Statutes. This goes back to the laws and all that goes with them. This again, of course, has received considerable attention by the courts.

The United States Supreme Court considered it in the case of Helvering vs. R. J. Reynolds Tobacco Company, 83 L. Ed. 536. That case involved the retroactive regulation by the Treasury Department affecting tax liability of the Reynolds Tobacco Company. The Supreme Court said that the regulation could not be applied retroactively; it changed the legal consequences of an act by a taxpayer before the regulation had been changed. That is again our position here. This order attempts retroactively to change the consequence of what Shell did under the previous regulation.

I would like to read a discussion, just a short paragraph on this Reynolds case because it's very, very significant. This discussion of the Reynolds case appears in Columbia Law Review, 40 P. 252. It is a summary of the opinion. The writer says:

"The power to change legislative regulations offers no serious difficulties. So long as the delegated legislative power is in effect, there should be no doubt that authority exists to amend prospectively, subject, of course, to the limitation that the amended regulation shall be reasonable, and within the granted

power. Reenactment of the section containing such a power, moreover, constitutes a new grant of the power to make regulations, and should be conclusive of the issue. New problems and constantly changing conditions require prospective amendments. A retroactive amendment of legislative regulations, however, stands on a different footing. The retroactive application of an amendment of a legislative regulation, precisely as in the case of the retroactive application of a statute, should be avoided; and, as in the case of a statute, an amendment of a legislative regulation should be construed if at all possible to have prospective application only. As a matter of policy, an administrative official should not have power to amend retroactively a legislative regulation adverse to the individual. As a matter of law, it would seem sound to require specific statutory authority. In any event, any attempt by Congress to delegate such a power to an administrative official would necessarily be subject to the same rigid limitations which the due process clause imposes upon retroactive legislation by Congress. Axiomatically, Congress can delegate no greater power than it itself possesses."

Again here the Commission can have no greater power than the Legislature from which the authority is derived. The Legislature cannot enact retroactive statutes; such would be a violation of due process. Here again you are exercising legislative authority, and you again cannot apply them retroactively.

This is applied again in a variety of circumstances. The

one case that I referred to was a tax case. They have been applied to C.A.A. regulations. They have been applied to excise taxes. They have been applied to contributions to unemployment compensation funds. They have been applied to railroad rates; and under a variety of circumstances they have been applied also to boards admitting persons to practice, dentistry, all manner of situations. It is obvious that the question would arise under a variety of circumstances, but the principle of the thing goes through, is the same to all of them; and it applies just as well in this case as it did in the C.A.A. regulation case, that case or any other case.

As I said before, there is a fundamental distinction in the activities of administration boards between judicial and legislative. There are many cases on boards that have judicial functions; obviously that is a different situation entirely. There are many, many cases on interpretation of regulations; that obviously is a different situation. That is judicial, quasi-judicial, whatever you choose to call it. Here we have a Statewide rule, it has a general effect, prospective effect; and that is changed.

I'll not read from any further cases, other than this one case that is called the Arizona Grocery Company vs. A.T.S.F. Railroad. This was before the Supreme Court of the United States, 284 U.S. 370 76 Law Ed. 348. The Supreme Court said, Page 356, it said:

"The Commission's error arose from a failure to recognize" --

this is referring to the Interstate Commerce Commission. "The Commission's error arose from a failure to recognize that when it prescribed a maximum reasonable rate for the future it was performing a legislative function, and that when it was sitting to award reparation it was sitting for a purpose judicial in its nature. In the second capacity, while not bound by the rule of res judicata, it was bound to recognize the validity of the rule of conduct prescribed by it and not to repeal its own enactment with retroactive effect. It could repeal the order as it affected future action, and substitute a new rule of conduct as often as occasion might require, but this was obviously the limit of its power, as of that of the legislature itself."

Now, on these several points, the matter of estoppel that we considered first, that is a fundamental proposition well recognized in law; the matter of protecting vested rights, pursuant to action taken by this Commission, is again a well recognized rule. The matter of impairment of contract and drainage area and the retroactive complication of the rule, they are all fundamental, and I think independently would justify a change in this proposed rule.

Now it is apparent that in the situation Shell here was certainly one of the few proponents of 40-acre spacing. They felt it was necessary for the proper development and still do. Now it's obviously a lot of people objecting to it. Most every action taken in business nowadays, somebody is going to object to

it. But in view of the questions that were put to the witness by the contestants here this morning, there is apparently some belief that they had to wait until there were no objections or that they should be guided by the objections from others. I don't think they seriously can contend that. Shell can go its own way, if it wants to. If it thinks it is right, doing the right thing, it can drill wells where it wants to, so long as it conforms to what the Commission says it can do or showed that is what it did. It doesn't have to wait until all the objections have died down. Now if it did, of course, in any situation, nobody can get any business done. It chose to rely on the orders of the Commission. After the initial hearing, of course, the Statewide, and after the initial order, the Statewide rule was still in effect. The Commission had refused to change it. The Shell, fully aware of the consequences of drilling during all these various periods, chose to proceed with its program of development considered the right thing to do, which it still considers the right thing to do. It was fully aware of the fact that anybody can come in to the Commission at any time and ask for any change that they want to ask for. This is no different from anybody making an argument that we should stop a certain development because somebody is going to or does introduce a bill in the Legislature. No one can stop us just because people are objecting or people are applying for some legislative relief, or that they are applying to the Commission for relief. Anybody can come in, as I said before, with

any sort of a proposal to the Commission, and the Commission sets it down and hears everybody and hears it, but that doesn't mean that everybody in the meantime has to pull up to a screaming halt to find out whether there is any merit to it or not.

Shell was fully aware of the fact that a rehearing might be granted, that it was granted, but it chose to rely on the Statewide rules and it chose to proceed with its announced course of action in the planned development. The orders are all final, that are issued by this Commission; there is no half-way ground. The original order before the application for rehearing was filed was a final order; every order is final. The Commission, of course, if a rehearing is granted, the Commission changes it mind, it can change an order. The order is final until an order entered after rehearing is entered by the Commission. So Shell has always been acting under final orders of this Commission and they have all been Statewide orders.

The order issued, as I mentioned before, after the first hearing that was on October 9, 1957, R-1069, that was the final order, but it didn't affect the Statewide order; so the Statewide order was clearly in effect after that order. The order granting the rehearing was issued, that didn't affect the Statewide order, it didn't effect any previous order of the Commission; and expressly recited that the previous order would remain in effect. Shell proceeded on that recitation again, and on the Statewide orders.

Likewise, all through this proceeding, as I mentioned

before, Shell has proceeded on the orders; it has been fully aware of all of the right of rehearing and that sort of thing, but it chose to proceed with its announced course of action.

If the Commission please, this has been discussed to some extent among counsel, but if the Commission would permit it, we would like to file a list, a memorandum on the cases that I have mentioned here and some other cases, and to relate those cases to the facts in this particular case, and to present a limited brief to the Commission on these various points, if that is agreeable; and we thought it would be advisable, perhaps, and expedite the matter if both parties were given a certain number of days to file memorandum briefs so that you have the full picture. Any period of time in that connection that the Commission feels reasonable is satisfactory with us.

Thank you.

MR. PORTER: We will take a very short recess.

(Recess.)

MR. PORTER: The meeting will come to order, please. We have further statements in this case. Mr. White.

MR. WHITE: If the Commission please, before I proceed, I would like to state that my argument will be on behalf of Magnolia, Humble, British-American, Skelly, Amerada, and Phillips, as a joint presentation on their behalf, and I wish to state that the atterneys for these companies have been very, very helpful in assisting in working up the argument; and at my conclusion, it is

very possible that they might want to add some statements.

I think at the start it might be well to mention that Mr. Seth mentioned the case of Governor Mechem's in 63 New Mexico, where it states that the Commission is strictly an administrative tribunal, but at the same time and in the same breath by the petition they're asking for judicial relief of an accountable nature. In their petition they went to great length in setting out certain allegations of good faith, I believe the first four paragraphs reiterate the good faith with which we were acting. However, little at this rehearing has been said about their good faith, except Mr. Robinson stated that he relied on Order 1069 throughout, and I might state he says that the Commission never advised him to the contrary and that they gave various notices and by your failure to do so, why, you mislead them. How can that be true, in view of the wording of Section 65-3-14, wherein it states that the Commission shall set up a uniform spacing plan or proration unit, and says: "...provided, that the owner of any tract that is smaller than the drilling unit established for the field, shall not be deprived of the right to drill on and produce from such tract, if same can be done without waste; but in such case, the allowable production from such tract, as compared with the allowable production therefrom if such tract were a full unit, shall be in ratio of the area of such tract to the area of a full unit."

Under this rule, the Commission could not deny them the

right to drill; and under this same statute, how can the Commission grant them what they're asking, a double allowable for their 40? So we submit that surely they didn't rely entirely on the order of 1069, and we submit even if they did, they have no vested right and we question the good faith of so relying.

It's been brought out that they were aware of the statutory right of appeal 30 days within notice of rehearing. They also knew that the case can be appealed to the Court for final determination. They knew that there was a possibility of the order being reconsidered and changed to an 80-acre spacing, and the probabilities of that fact were strengthened then and resulted in 1069-B and amended to allow 80 acres.

We submit that, why did Shell change their plans and go into a very rapid acceleration of the drilling of 40-acre wells when none had been drilled in the Bisti area prior to the filing of our application? Their correspondence that's in evidence shows that there was a question among the operators long before we filed our application as to whether it should be on a 40 or 80. They, it appears to us -- I won't say it appears to us, but it does suggest that either they acted under poor judgment or else they wanted to create the very situation which they now have presented to the Commission.

Now as to their rights as a result of the drilling. There's a case of Rieckhoff vs. Consolidated Montana Gas, 217 Pacific 2d, 1067. In this instance the gas company acquired the

rights of a lessor, and the gas company figured that the lessee had violated their covenants in their lease and brought a quiet title suit to cancel out the rights of the lessee. The District Court quieted title and cancelled out the rights of the lessee. He appealed it to the Supreme Court and the Supreme Court reversed the Lower Court. In the meantime the gas company had drilled a well on this land, so that the lessee filed an accounting suit, an injunction against the gas company; and the gas company, as does the petitioner here, claimed that they did it in good faith, they acted in accordance with the order of the District Court and therefore they should be treated with equity. The Court had this to say:

"The company says it was not a wilful trespasser for it entered under the District Court's decree, assuming to annul the lease and to quiet title in it. However, it knew the law gave to Rieckhoff the right of appeal and that on such appeal the decree might be either reversed, modified, affirmed, or the case be sent back for the taking of further evidence or a new trial. It knew Rieckhoff" -- that is the lessee -- "had vigorously fought the suit and that he was likely to appeal from the judgment entered against him. In misjudging the law and Rieckhoff the gas company acted at its peril. It assumed the attendant risk of drilling the well on the lands leased to Rieckhoff and of having the trial court's judgment reversed on appeal, but it took the chance and lost."

There are other cases that I can cite, but I believe I'll cite just maybe one. That was the case of Liles vs Thompson, 85 Southwestern 2d 784, which is a Texas case. The Court here said:

"It seems to us a serious impeachment of the good faith of the lessees when they persisted in developing the land for oil over the vigorous protest of an adverse claimant who was then suing; of which adverse claim and suit such lessees had full notice. It would seem in such a case the lessees should be held to have expended their money at their own risk and cannot be justly considered as innocent trespassers."

We submit the same applies in this case, in view of all the testimony and of the correspondence that was directed to Shell for them to go ahead at their own risk, why, they did so. As to the first correspondence which we think has some relevancy as to the question of good faith and also as to the impairment of any contractual obligation in regard to the Carson Unit plan which has been brought out, no 80-acre wells were included in the first plan, second plan, nor the third plan. Shell went on and developed their own acreage on a 40, and then they tried to get the working interest in the Carson Unit to go along with them.

I think it's relevant to review just a little of the testimony. Shell Oil Company in a letter addressed to the United States Geological Survey under date of August 8th enclosed the third unit plan of 53 wells. In their application for rehearing,

the petitioners claim that they were obligated to drill this on a 40-acre unit, but in the very letter it says "We intend to develop the areas of undefined sand development on 80-acre well spacing while exploring for commercial limits of the Unit." Now how they can allege that they were obligated to drill on 40, we don't know; and in that regard, the Carson Unit has never been introduced in evidence. They requested this 53-well program and the operators would not go along with it.

On August 9, here is a wire sent to Skelly: "Request your approval to drill 80-acre locations including our most recent plan of development involving 53 wells within the Carson Unit." They objected, the operators objected, the lease interest or working interest objected to the drilling of 40-acre wells under this third plan, and then they adopted an interim plan so they were under no obligation to drill on a 40.

It is also noteworthy that Shell Oil Company, after they had received the approval from Skelly, El Paso, and Humble to carry out this interim plan on 80-acre spacing, they hadn't received this consent from Phillips, and in their letter of August 22nd, they set out this telegram asking their approval to drill on 80-acre location. Then these favorable replies were received from Skelly, El Paso, and Humble,"but to date we have received no response from Phillips. Meanwhile, as we are close to concluding the drilling of the last approved plan, and pending approval of our 53-well program, we found it necessary to submit an interim

plan to continue efficient and economical operations on the unit." Now if they can develop that unit during the pendency of a final decision in this case, as they say, in the efficient and economical operation, why couldn't they do the same on their adjoining properties? There's nothing in the testimony or in the transcript to show that they were required to drill in order to save any of their acreage, either. They stated in the petition that they had the unqualified approval of the United States Geological Survey. That also is open to interpretation. The United States Geological Survey witheld giving any approval until after the issuance of Order 1069, and in their letter of October 15, wherein they gave their approval, they said: "Apparently the objections to 40-acre spacing have now been resolved, and you request our further consideration of your plan." I believe it can be very logically argued that the United States Geological Survey consent was upon the false assumption that the 40-acre spacing program or argument had been resolved.

There are other letters of correspondence in here, where the various operators and working interests plead again and again with Shell to withhold their development. For example, in Mr. Selinger's letter of October 31, he says: "This is to advise that as of this morning we have received the following telegram from A. L. Porter, "wherein you granted the rehearing. He says, "This means that Order 1069 in Case 1308 has been held up due to the granting of a rehearing by the Oil Conservation Commission. On

the basis of approval by the United States Geological Survey on the assumption that 40-acre spacing objections have been resolved is no longer true, we respectfully request that you continue operation on the interim plan of 80 acres until such time as the New Mexico Oil Conservation Commission has issued a final order. You can well appreciate our desire to avoid hasty action, that should the Carson Unit be developed on 40 and should the New Mexico Oil Conservation Commission issue an 80-acre order, the wells therein would each secure a half-well allowable; and we therefore feel it behooves the interested parties to await the final outcome of the rehearing before the Oil Conservation Commission."

There is other correspondence to the same effect. It might be well to mention Shell's letter of December 6, 1957, wherein they set out their proposition of drilling eight 80-acre wells, and four 40, which was finally withheld as to the 40, and they say this: "As you know, we have developed our acreage outside the Carson Unit on 40-acre spacing in accordance with the New Mexico Oil Conservation Commission Order 1069, including their latest order of November 4, 1957, and we intend to drill our unit area on 40-acre spacing. Specifically, we intend to drill these various wells to which they objected in the immediate future." So it cannot be said that they went into their program without their eyes being fully opened and realizing what they were getting into. We question the good faith.

Now as to the vested right proposition that's set forth in Paragraph 7. They claim that by drilling these wells after the application of Sunray was filed, that they acquired certain vested rights. We contend that under the wholesale litigation involving these cases there is no question but what the Commission had the authority to act as it did, and that there is no vested right involved in this case.

In the case of Texas Trading Company, et al., vs. Stanolind, 161 S.W. 2d 1046, the Texas Trading Company appealed from an order of the Commission which cancelled the appellant's permit to drill an additional well within a drilling unit. The Plaintiff contended as a matter of law that it was entitled to drill the additional well because under the then spacing rules and regulations in existence at the time the area was segregated and at the time it acquired its lease, that it had the right to drill this additional well. To this contention, the Texas Court of Appeals had this to say:

"The contention is overruled. Spacing rules must be subject to change from time to time to permit fair and equitable adjustment of the machinery of oil pro-ration to meet changing conditions. If a lease owner could acquire a 'vested right' in the spacing rules existing at any particular time, then the power of the Railroad Commission to make new rules for regulating drilling and oil production equitably and fairly among lease owners, and properly to conserve the oil resources of the State, would be greatly hindered.

In the very nature of the police powers from which the State derives its right to regulate the production of oil and gas, the oil operators can acquire no 'vested right' in the mere rules by which the power is exercised from time to time."

Now Mr. Seth cited a case in Texas, I think it was 84 S.W. 2nd, that is a right to drill a well; under our law they have a right to drill a well; that does not mean that they get a double allowable because they drilled a well still according to their acreage.

They also cited the Railroad Commission vs. Rowan and Nichols Oil Company, 310 U.S. 573, and other cases. In the case of Patterson vs. Stanolind Oil and Gas Co., 77 P. 2d 83, Oklahoma case, certain royalty owners contested the constitutionality of the Oklahoma Well Spacing Act with regard to their interests in a well which was completed prior to the spacing order of the Commission. Among the issues raised were the due process clause, impairment of contractual obligations, and the retroactive effect of the well spacing order. The Statute in question provided, among other things, that the different royalty owners within a drilling unit shall share in the production in proportion that their acreage bears to the entire drilling unit, which is very applicable to the case at hand.

The Oklahoma Supreme Court in overruling the Plaintiff's contention said:

"The decision of the United States Supreme Court in the

case of Ohio Oil Company vs. State of Indiana, 177 U. S. 190, 44 L. Ed. 729, was based upon the theory that the right of the owner of land to the oil and gas thereunder is not exclusive but is common to and merely co-equal with the rights of other land owners to take from the common source of supply, and therefore that his property rights to said oil and gas are subject to the legislative power to prevent the destruction of the common source of supply. It has already been decided that this police power of the State to prevent the destruction of the common source of supply may be exercised by regulation of production therefrom."

They further cited the case of Champlin Refining Company vs. Corporation Commission, 286 U.S. 210, 76 L. Ed. 1062, wherein the Court says:

"Every person has the right to drill wells on his own land and take from the pools below all the gas and oil that he may be able to reduce to possession including that coming from land belonging to others, but the right to take and thus acquire ownership is subject to the reasonable exertion of the power of the state to prevent unnecessary loss, destruction, or waste. And that power extends to the taker's unreasonable and wasteful use of natural gas pressure available for lifting the oil to the surface, and the unreasonable and wasteful depletion of a common supply of gas and oil to the injury of others entitled to resort to and take from the same pool."...."The restriction of drilling by the spacing of wells seems to be a much more feasible and effective method of

securing a just distribution for such owners than restrictions upon production after same has already commenced, for it tends to eliminate many distinct faults apparent in such regulations."

Continuing, the Court said: "Such regulation of spacing and your proration according to the acreage is valid, and this would be true even though the plaintiff were able to prove a distinct loss to himself through the operation of the statutes putting said police power into force and effect." . . . "All property is held subject to the valid exercise of the police power; nor are regulations unconstitutional merely because they operate as a restraint upon private rights of person or property or will result in loss to individuals."

I believe that sufficiently answers any question as to whether or not they have any vested rights in their having drilled on 40 acres.

As the Commission knows, there are no Supreme Court decisions in New Mexico defining the powers of the Commission. However, I think it's well to refer to the text of Summers Oil and Gas, wherein they define and explain the well spacing law for New Mexico as follows:

"The New Mexico oil and gas conservation statute authorizes the conservation agency of that state to make regulations governing the spacing of wells and issue orders creating proration units for each pool."

They go on and say that you have a right to amend your

rules from time to time, and expressly contained in your existing rules. The author further says:

"The oil and gas conservation statutes of twenty-two states authorize their conservation agencies to regulate the spacing of wells, to establish drilling units, to permit agreements for the pooling of separately owned tracts within a drilling unit."

I think clearly the Commission had the power to act as it did in the premises.

Now, the petitioner also claims that the order is a retrospective regulation and retroactive, in that it confiscates and violates their vested property rights. Now, Mr. Seth referred to a New Mexico case, I believe that was Rubalcava vs. Garst, 53 N.M. 295.

Our New Mexico Supreme Court said as to the definition of a "vested right", that it was the power to do certain actions or possess certain things lawfully, and this right may be created by common law, by statute or by contract, and upon principle every statute which takes away or impairs vested rights acquired under existing laws,creates a new obligation, is retrospective in nature, but we submit, in what way or manner does the Order complained of take away or impair any right which the petitioner acquired under any prior rule or regulation of this Commission? Under the existing rule it's permissive rather than mandatory they can drill on a 40, they can drill on an 80. In what respect does this order create any new obligation in respect to the petitioner? Now, as

before the adoption of the Order, cannot the petitioner and all other operators similarly situate develop any or all their acreage upon a 40-acre spacing program, as though the Order did not exist? Now, as before, is not the proration formula on an acreage basis and the same full allowable given to the 40 acres of which they complained as it would be given to any other 40 acres if you didn't have the rule? We submit, in what way are they harmed? How can they claim a vested property right, in view of the decision to which they refer and to which I refer, and can you say that the Order is retrospective when the rights exercised by the petitioner when they drilled were also subject to Rule 104-L of the Commission, which reads as follows:

"In order to prevent waste the Commission may after notice and hearing fix different spacing requirements and require greater acreage for drilling tracts in any defined oil pool or in any defined gas pool."

When they exercised their right to drill, they were doing it subject to this rule. Further, they were doing it subject to Rule 501 (b), which reads:

"After notice and hearing, the Commission, in order to prevent waste and protect correlative rights, may promulgate special rules, regulations or orders pertaining to any pool."

That's what you did in this instance. Is not the petitioner, we submit, afforded the same opportunity to recover his just and equitable share of the oil in the pool now as he was before the

order? I believe in actual truth and in fact, the petitioner is really saying: "We have spent twice as much money in this pool as any other operator, although unnecessarily, but having done so we now want to receive twice as much oil as the other operators." I question whether or not the Commission can give such relief under the circumstances.

As to the next point they raised, as to the failure of the Commission to set forth the findings of fact that one well will economically and efficiently drain 80 acres, we submit that there is nothing in our conservation law that requires such a finding, and the general rule of law is that where a finding cannot work to the benefit of either party, it's not error to omit the finding. Supposing you had the finding that they requested, would it benefit you, would it benefit anybody? If the case is appealed to the District Court, the Court is going to look at the transcript and read the transcript to determine whether or not your order is reasonable. The fact that you had that statement of fact in there neither adds or subtracts from the order itself. Moreover, under our Ferguson-Steere case that was the case of Ferguson-Steere vs. State, 288 Pacific 2d, 440, the order of the Commission was challenged upon the ground that when they issued a certificate of convenience and necessity, the Commission failed to set forth the conclusion of ultimate fact that the public convenience and necessity required the issuance of the certificate. Our Supreme Court had this to say:

"We think the recent decisions hold an absence of specific findings does not render void an order granting a certificate such as that here involved. More especially is this true when there was no request made on the board or commission whose acts were challenged in making specific findings. If findings, more adequate findings by the administrative board or commission is desired, the duty rests on the party complaining of their absence to have made a request for them."

If the petition for rehearing should be considered as a request for further findings, the Commission, as they may see fit, may include the finding or not. I don't think it adds or subtracts from the order. Moreover, I think the general order that the Commission made encompasses any inferior findings.

Now as to Rule 505, we submit that it's apparent from the reading of Rule 505 that it was never intended nor does it now provide for 80-acre proportional factor in the depth range from zero to 5,000 feet, and 505 is a general rule and it does not give way to any specific rule or regulation for any specific pool or field.

As to the obligation of the contract, we submit that no contractual obligations were impaired under the Carson Unit Agreement, the first plan and the second plan as they have been completed didn't involve any 80-acre spacing. They are now operating under their third interim plan, wherein it is agreed that they are only going to develop on 80 acres; and the third

plan in regard to the drilling of the 53 wells has never been approved as yet by the working interests to my knowledge.

Now, does the Commission have the right to change their proration or spacing orders, in view of a unit agreement such as the Carson? There's abundant authority to the effect that making such an agreement is subject to alteration by the police powers of the State, and any existing rules and regulations. In fact, pages 9 and 10, I believe, of the Carson Unit Agreement specifically provide that the agreement as entered into is subject to the rules and regulations of the Commission being altered from time to time. However, be that as it may, in the case of Alston v. Southern Production Co., 21 So. 2d 383, the Court passed upon the power of the Conservation Department to increase the size of drilling units theretofore prescribed as 320 acres. Under the Department's ruling they increased the drilling units to 640 acres. The parties came in and claimed that that violated their contractual obligations, impaired the obligations of the contract; it was therefore unconstitutional. The Court in upholding the power of the Commission to act said this:

"Order 28-C, increasing the drilling units to 640 acres in the Logansport Field, and the unitization Orders 28-C-6 and 28-C-8 are valid orders. Act 157 of 1940 authorizes the Commissioner to change the established units if conditions require it. In Paragraph 3 of Section 3 of the act it is provided that 'the Commissioner shall have authority to make, after hearing and notic

as hereinafter provided, such reasonable rules, regulations and orders as may be necessary from time to time.' The only restriction on the authority of the Commissioner to establish drilling units is that such an order must be reasonable and the unit prescribed must not exceed the maximum area which one well can efficiently and economically drain." -- the same as our law. "In the absence of a showing to the contrary, we assume that the Commissioner's finding, in this instance, which was preceded by the notice and hearings required by the statute, determined correctly that one well could efficiently and economically drain 640 acres.". . . "An order of the Department of Conservation increasing the size of the drilling units therefofore established by an order of the department, in a given oil or gas field, may supersede contracts made between landowners or leaseholders in the oil or gas field under authority of the previous order of the department, without being subject to the objection that the later order is unconstitutional for impairing the obligations of such contracts.. Citing numerous cases."

Now as to this doctrine of estoppel, Mr. Seth referred to the Garst case in 53 N.M., but he didn't refer at all as to what the Court said in that case, which I believe has a bearing and should be mentioned. Under Paragraph 10 and 11 of their petition, they claim that you should be estopped from preventing them from receiving a double allowable. Now one of the elements of estoppel is the conduct; namely, the conduct of the Commission. At this

time I want to take that back, that was not, the elements of estoppel was not contained in the case cited by Mr. Seth, but cited in New Mexico case, Chambers vs. State, 17 N.M. 487. In defining the conduct necessary to bring about estoppel, our Court says it must consist of acts or language or conduct amounting to a representation or concealment of material facts. Now, are they claiming that the Commission in granting the order in the original instance was concealing a material fact that the Commission, if a rehearing were requested, was going to change it to an 80-acre program? Another element of estoppel is that the truth concerning the facts were known to one party and unknown to the other party. Now what true facts were known to the Commission at the time they entered either order? Can it be said that in order for estoppel to work in this instance, that you mislead the other party, Shell Oil Company, and that you withhold the truth concerning the true facts; namely, that you were in the final analysis, were going to issue an 80-acre program? I hardly think so.

Now Mr. Seth states in many New Mexico cases upholding estoppel against the State there are such cases, but they do not pertain to any case where estoppel can be asserted against the State, when it's in the exercise of its police power. I know in the case of Sganzini vs. Kirk where a County Treasurer mis-stated the true fact as to whether or not there's an outstanding tax certificate against his property, and the County Treasurer said, "No, there's no outstanding tax certificate," and the man lost

his land because in fact there was an outstanding tax certificate, our Supreme Court said, yes, and in that the treasurer is estopped to deny it, because he had a vested right to redeem his property within a certain length of time had he known the true facts. Now that doesn't come within the exercise of the police power. That's an administrative duty performed by a State agent, accountant, or official.

As to whether or not our Supreme Court permits estoppel to be applied against the State when it's in the exercise of its police power, I cite the case of First Thrift & Loan Assn. v. State ex rel, Robinson, 62 N.M. 61, and just reading the excerpt, our Supreme Court states that"a State cannot estop itself by grant or contract from the exercise of its police power."

The case of Erickson v. McLean, 62 N.M. 264, our Court said, "Public policy forbids the application of the doctrine of estoppel to a sovereign state where public waters are involved." I think the same would apply where oil is involved.

As to the cases cited by Mr. Seth as to the vested rights, that is true where there are vested rights, but we submit there are no vested rights involved in this case and that the Commission acted under authority, under the powers that they have, and we submit that the petitioner is not damaged in any way except through its own acts and doings which it voluntarily undertook and to which they are not entitled to relief.

Thank you.

MR. PORTER: Anyone else have a statement?

MR. SANCHEZ: Southern Union Gas Company joins in Sunray and Midcontinent's position that they take, and desire that the 80-acre spacing unit be retained.

MR. PORTER: Mr. Selinger.

MR. SELINGER: If the Commission please, and the staff, most of the points have been brought out, so I won't belabor the points. There are two corrections I wish to make in Mr. White's presentation: one is that under Shell's stipulation of exhibits this morning, the Carson Unit Agreement was made a part of the record; and secondly, that the 53 well, which is known as the third plan of development for the Carson Unit, did propose 40-acre wells, and I believe that Mr. White was attempting to explain to the Commission that none of the working interest in any of the participating areas approved any location within the Carson Unit under that third plan, except on an 80-acre basis. There is a statute, a section of the statute in the New Mexico law with respect to the matter which Mr. Seth very graciously indicated that Shell on its own interpretation drilled 40-acre wells to the number of 14, on reliance of existing order of the Commission, and drilled them at their own risk. The section provides, 65-3-5, wordage of Commission's Powers and Duties, was lifted wholly from the Oklahoma section which has exactly designated Commission's powers and duties. This is very brief, but it states: "The Commission shall have, and it is hereby given, jurisdiction and

authority over all matters relating to the conservation of oil and gas in this State, and of the enforcement of all the provisions of this Act and of any other law of this State relating to the conservation of oil or gas. It shall have jurisdiction and control of and over all persons or things necessary or proper to enforce effectively the provisions of this Act or of any other law of this State relating to the conservation of oil or gas."

Perhaps fortunately in some instances and unfortunately in other instances, as we are meeting today there's a great lack of what I call, of conservation oil and gas law in this State, but there are plenty of other states that have had a long varied history in conservation; and I might add without revealing my age that since '31, the year 1931, I have been actively engaged in practically,most of those litigations. What did the Supreme Court of the State of Oklahoma have to say specifically as to that section? The State of Oklahoma vs. Bond, 45 Pacific 2d, 712, it states:

"The foregoing is the section of the Act" -- which I have just read -- "which empowers the Commission to make, change or modify its orders applicable to each common source of supply. It was inserted in the Act for a purpose. The Legislature realized, no doubt, the conditions surrounding production of oil from a common source of supply would change from time to time. To meet the exigencies of such changed condition, the Commission was empowered by this quoted section of the Act to exercise a discretion

judicial in nature, and to make and modify its orders, to accomplish the purposes of the Act, that is, the prevention of waste and the permission to each producer to take his ratable part of the oil from the common source of supply."

That's the interpretation that one State gives to the exact wordage of your Section 65-3-5. Apparently it must have been in the minds of the Legislature of this State to insert that Act for some purpose, and this is what one other State says the reason for the insertion of that particular provision is.

Now Mr. White has indicated the vast amount of correspondence within the Carson Unit. The reason for its importance at this particular hearing is that a portion of it lies in the heart of the field, of the trend going from southeast to northwest, and Shell was the unit operator. Despite all of the warnings of the other working interest, including myself in my letter of October the 31st, in which I specifically pointed out that should any hasty action be taken by Shell to develop the Carson Unit on 40 acres, they did so under the jeopardy of some allowable adjustment. Now this hearing does not concern location of wells, it has absolutely nothing to do with the matter that is presented in the petition for rehearing here. The matter is confined solely to one of allowable. Did the Commission act equitably in establishing the allowable differentiation between wells as they found them to exist at the time of the date of the issuance of the January 17th order? So this is confined solely to allowables.

It's the question of whether or not the Commission acted equitably in adjustment of allowables. Your statute, your rules are full of your authority to protect correlative rights. I think the Commission acted wisely in protecting correlative rights. I might admit that in my letter of October 31st I indicated that in that allowable differentiation between 40 and 80-acre, I referred to the allowable for 40-acre well as a half a well allowable. I think, and I stand corrected, I think the Commission action was wiser than my own interpretation, because your Order 1069-B provides, and you recognize the right of an operator to drill on any size tract under the statute; you recognize those operators that had drilled on tracts smaller than the 80-acre standard unit. You made provisions for them to have the exceptions. You made provisions for them to have their allowable according to the statutory authority given to you. You made provisions for the allowable, for the 80-acre well. I think you acted far more wisely than I even interpreted by the issuance of your Order 1069-B.

It is well known by the stipulation that all of the 14 wells that Shell complains here were spudded after the filing of the August 5th application of Sunray-Midcontinent, et al. Following my letter of October 31st, what was Shell's action in reply to pointing out the adjustment of allowable that might result from a correction of the order? Why, they went ahead and drilled eight additional wells of the fourteen, eight of the fourteen wells

additionally since that time. That was their answer.

Mr. White read you the letter of December 6th of Shell to Phillips and Skelly with respect to a development program in which they asked for eight 80-acre wells and four 40-acre wells. In the stipulation for the Sunray-Midcontinent exhibits, telegrams in which we requested Shell to withdraw their proposal for 40-acre wells and expressly gave them permission to drill the 80-acre wells; and those telegrams indicated that Shell did so, they withdrew their request for approval of the 40-acre wells. That is as of December 6th, and the part that Mr. White read you and which he indicated, the seven orders that are indicated in that paragraph that he read you are the three wells, the only three wells that are drilled on 40-acre in the Carson Unit not on participating area in which we would have a voice, but on Shell's own acreage in which they themselves would have the voice. We had nothing to say about it, but mind you, as late as December 6th, three, the only three 40-acre wells in the entire Carson Unit were drilled as a result of their statement saying that "We intend to drill our acreage in the unit outside the participating area on 40-acre spacing", and they specifically named the three wells that are on 40-acres inside the unit.

Now if you take, if you gentlemen accept Shell's interpretation of estoppel and vested rights and each order is a final order as it comes out from the mouths of the Commission and is issued, hark you what would result in administration from a

practical standpoint, you would have no authority at no time; once you initiate a spacing order under their theory, you would have no time to ever increase the size of the drilling unit because obviously wells were drilled on the existing order; and they could come in under their theory and say, "Well, you granted a 640-acre allowable, we drilled our wells on 160 acres, we are entitled to a 640-acre allowable."

How can the Commission proceed in its proper administration of the proration conservation matters if you accept Shell's argument about the matter of allowables in which they asked for 80-acre allowable given to 40-acre wells, based on existing orders, and no time can you ever change the allocation formula for any field, once you issue that, because it's those wells that were drilled under existing rules, were entitled under their theory to the top allowable forever. Now that is silly on its face, because we know that the Legislature intended this Commission to act from day to day as oil and gas conditions change from time to time. You would have no right, for example, in the Jalmat, to change the allocation formula, to introduce deliverability. I recognize your right to do that, as much as I dislike it, but I recognize your right to do it.

So that if Shell's theory is permitted to be adopted by this Commission, you no longer have the right to change either the spacing or the allocation formula, once you establish it in the field. I say that's going far beyond any law, any Court

decision that they may quote you. That might be applied to dentistry or to public service or to labor or anything else of that nature, because you see all the authorities that they have quoted this morning, you notice that they constantly said "under certain conditions". The administration of oil and gas is set aside from all other administrative regulations throughout the entire country. It has been set up by a special set of rules and regulations and Court decisions. As a matter of fact, in the administration of oil and gas in some states, the administrative bodies is the only exception to the United States Constitution after delegation of separation of powers, it was established way back in 17--,at the beginning of the birth of this nation, and just the Public Service Commission or a Railroad Commission or a Corporation Commission or an Oil Conservation Commission has a combination of rights which is separate and apart from the separation of powers in both the Constitutions of the respective States and the United States Constitution. So that why he may argue you don't have, this is not a judicial body, you do have to make decisions of a judicial nature. As a matter of fact, when someone comes in for an exception that is an exhibition of your judicial function under the statute here. So that we say that under the facts presented in which Mr. Seth admits that Shell went ahead on its 40-acre location at its own risk, that they cannot now say that they acted in good faith, they cannot say that they had vested rights, because the very fact of vested rights would prevent you from ever changing

any order of a particular field, no matter how it was warranted, and your delegation under your statutory authority permits you to change it from time to time.

Therefore, since this rehearing is confined to the matter of adjustment of allowable as between 40 and 80 acres, that all of the argument outside of that particular point is wholly irrelevant, such as spacing, or Rule 37 in Texas, which is nothing more than drilling, which is nothing more than in the absence of a unit as indicated in most other States, which Texas does not have, they have the theory of the Rule 37, that every tract, no matter how small, is entitled to a well. So that the only problem here is the adjustment of allowable between 40 and 80 acres, I submit that under the overwhelming legal authorities, your statutes, your own rules and regulations, and the very conduct of Shell in the entire proceedings indicates that you should deny their rehearing.

MR. KELL: I have a brief rebuttal. I think I can handle it in 10 or 15 minutes at the most.

MR. PORTER: Mr. Kell, there possibly will be other statements, just one moment. Will all of those who made appearances this morning have statements to make? I think we had best recess the hearing until 1:30.

(Recess.)

AFTERNOON SESSION

MR. PORTER: The hearing will come to order, please. At this time we will hear any further statements in Case 1308.

MR. KELLAHIN: If the Commission please, Jason Kellahin of Kellahin and Fox, appearing for Phillips Petroleum Company. I would like to make about a half a minute statement.

As I see it, the issue narrows down simply to the question prayed for in the prayer for relief in Shell's petition; it merely asks for the same allowable for 40-acre unit as that granted to an 80-acre unit. That's their prayer for relief. Now that's the argument that has been presented by Shell. I would like to point out that if the Commission would grant such relief as that, it would simply violate the statute which requires that acreage be given consideration in setting the allowable, and it would violate the statute for the protection of correlative rights.

I don't believe that anything further needs to be said. Thank you.

MR. PORTER: Mr. Ballou.

MR. BALLOU: A. F. Ballou, representing Sun Oil Company. Sun Oil Company is an operator in the Bisti Field. We feel that Mr. Kellahin's statement for Phillips Petroleum Company is accurate and we concur in the statements made by Mr. White and Mr. Selinger in opposition to Shell's request for relief.

MR. VERITY: If the Commission please, George Verity for Rex Moore. I would like to emphasize and underscore the portion of the argument that was made by the Skelly's attorney and point out to this Commission that this Commission is not just strictly a legislative body, but that they are judicial in nature as well,

as the cases he cited pointed out, and that Shell Oil Company in this hearing has had a judicial hearing and that they have a judicial appeal, a portion of which is taking place today; and therefore there are cases which are recited to the Commission which have to do with purely a legislative enactment which do not apply. They had full notice of the hearing, and when they drilled the wells in question and they knew that this order was exactly the one that might come out and they would be bound by the allowables that would come therefrom.

MR. PORTER: Mr. Bratton.

MR. BRATTON: If the Commission please, Howard Bratton, appearing for Monsanto Chemical Company. We would like to support the arguments which have been made by Mr. White, and we particularly concur in the analysis made by Mr. Kellahin. We believe that there are two facts which have been clearly demonstrated; one, that Shell has not demonstrated that it is entitled to any relief; and, two, that even if the Commission were so inclined, it could not under the statute grant the relief which Shell is asking.

MR. PORTER: Mr. Hinkle. Mr. Buell.

MR. BUELL: Guy Buell, for Pan American Corporation. Pan American recommends to the Commission that the application of Shell be denied in its entirety. We feel that the record of this case is crystal clear that the proper sized unit is an 80-acre unit. With respect to the allowable, it is our recommendation that 80-acre well receive double the allowable of a 40-acre well. We would

sincerely regret to see the Commission set a precedent of rewarding an operator who has drilled unnecessary wells by giving him the bonus allowable, which if Shell's request is granted, that's the effect of it.

MR. PORTER: Mr. Hinkle.

MR. HINKLE: Clarence Hinkle, representing Humble Oil and Refining Company. The Humble feels that the application of Shell should be denied. We concur in the position taken by Sunray, Skelly, and others, as stated here.

MR. PORTER: Mr. Sperling.

MR. SPERLING: J. E. Sperling, representing Magnolia Petroleum Company. Magnolia would like to add its concurrence to the position taken by Sunray, Phillips, and the others who have spoken in opposition to the relief sought by Shell.

MR. PORTER: Mr. Bushnell.

MR. BUSHNELL: H. D. Bushnell, attorney for Amerada. I would like to make a statement that I came here prepared to give what I believe the law ought to be in New Mexico, but after hearing Mr. Seth talk and give his argument, I have tossed that brief aside. Instead, I want to maybe sound so presumptious, as being a lawyer from out of state not certified to practice in this State, to take the liberty to disagree with the premise that Mr. Seth has used to support all of the issues he argued this morning. I do that because I feel that the State of New Mexico at this time is in a unique position of having no Judge-made law on the powers

of the Commission, and in construing the Act that empowers that Commission, those of us here today, lawyers from out of state, other states such as Oklahoma and Texas, are working under a handicap that you gentlemen, that you here who practice law operating under this State are not involved in. That predicament we find ourselves in stems from the fact that the Courts,not only in the States of Oklahoma and Texas, but also the United States Supreme Court, has often reasoned and reached its conclusions on the premise that Mr. Seth has used here, that you gentlemen are acting in a legislative capacity. As a result of that premise, they then reason that the particular issue should be applied to the function that the Commission is performing at that particular time. The authorities, the experts, the writers, many of them criticize this as not being any reasoning whatsoever. Instead, it is merely a justification for a conclusion already reached. I will show you some examples of the inconsistency of some of Mr. Seth's argument this morning. For example, he said, as I understand it, that you gentlemen are acting in a legislative capacity. To give support to one of his issues, he cites a case from Texas, which happens to be Rule 37.

In that particular case, it was a hearing on an exception to Rule 37 location. It so happens in the State of Texas the Court has used the same reasoning that Mr. Seth would like to have used here, that Court saying that when the Commission acts in that capacity, it acts in a judicial capacity but note that Mr.

Seth, who has already concluded that you are acting in a legislative capacity, cites a case from Texas where that Court has hold that they are acting in a judicial capacity. You can see the confusion that can arise if you will take cases from various jurisdictions and take the rule out without considering one of the facts in the case, the statute that they are construing. If you do, and I speak this as figuratively speaking for every rule, and I think all the lawyers will agree with me, for every rule that could be cited on either case today, other lawyers could find you five rules to contradict it. You cannot take rules from just a group of cases and apply it to this one. There is one good fundamental reason why you can't. Historically, the problem has evolved as a result of the Courts attempting to apply judicial rules to administrative functions; as a result, this unique argument that you will classify the function and then apply the rule.

Another example of the inconsistency of such an argument is reflected in Mr. Seth's argument this morning. He says you are acting in a legislative capacity, but orders are final, but you must have a finding supported, in that order. They are inconsistent arguments, if you are acting legislatively instead of judicially; and I say this for the benefit of this Commission, for the benefit of the Courts of this State, the lawyers of this State, especially the counsel who are advising this Commission. I urge you to look to the purposes, the reasons, use logic in applying those reasons to the statute that now exists today, either

as it is expressed or as it is implied. Use your judge-made law that you have available in this State, and if you use any cases from out of State, look to the facts, look to the purposes, and by all means look at the Statute under which that Commission operates. For authorities I would refer you, and I will be glad to give you the page numbers, but I refer you to 48 Law Review, 49 Columbia, 7 Rutgers, 25 Texas Law Review, articles written on the function of administrative agencies, and their authority, either in what the Courts have developed as quasi-legislative, quasi-judicial. These comments that I make, I merely am paraphrasing the comments of these experts. It is not original with me.

Thank you.

MR. PORTER: Does anyone else have a statement before Shell's rebuttal?

MR. WHITE: The Texas Company is an operator in the Bisti and they concur in the position taken by Sunray-Midcontinent and urge upon the Commission to deny Shell's application.

MR. ERREBO: Burns Errebo, Sinclair Oil and Gas Company has authorized me to state in their behalf that they support the Sunray position and urge that the Shell application be denied.

MR. PORTER: Mr. Sullivan.

MR. SULLIVAN: Mr. White, at the commencement of his remarks this morning, represented that he was speaking on behalf of me and my client in this matter, the British-American Oil Producing Company. I wish to corroborate that and point out that

our position is opposed to the granting of the relief requested by Shell in its application for rehearing.

MR. PORTER: Mr. Kell.

MR. KELL: If the Commission please, I don't want to belabor the point, but I just want to correct a few statements that were made concerning the summation by the proponents of 80-acre spacing. First, with regard to finality of the orders of the Commission, it has been suggested that because these orders made from time to time be subject to change or amendment, that they aren't final. That simply isn't the case. Any order of the Commission can be amended subject to the constitutional revision and limitation. By the same line of argument you would argue that a legislative enactment is not.

Then on this good faith issue which relates to the three unit wells that have been drilled, there has been a lot of comments and suggestions to the effect that Shell wasn't acting in good faith because some of the operators didn't like the spacing pattern they proposed. Those objections which are quite common in unit operations, I have never known a group to be unanimous on that type yet. Those objections are dealing with the differences among the operators, as such it appeared to me that what is material in terms of reliance is the orders of this Commission, as well as the orders and approval of the United States Geological Survey. In other words, we were relying on the orders of the State agencies and the United States Geological Survey, which had the ultimate

authority to grant the permission, and particularly as far as the United States Geological Survey, because the bulk of the lands involved were Federal lands or allotted Indian lands within their jurisdiction and they approved the notice of intention to drill the 40-acre wells involved.

With regard to the applicability of some of the Texas spacing cases which Mr. Seth referred to, there has been some suggestion that since they're spacing matters and since this is a proration matter, they have no bearing. Well, that simply is not true. It overlooks the relationship between the spacing and proration which at least in New Mexico, so far as oil is concerned, is governed by the same standard; namely, the area that can be economically and efficiently drained by one well. I think that the Texas spacing cases are particularly applicable to this situation. Then there has been some further suggestion that Shell is in no wise injured or damaged by the order in question because they got a factor of one originally, and they still have the factor of one under 40-acre wells; but this overlooks the fact that it destroys the relative position with regard to the allowable granted wells. When these wells were drilled they were entitled to a full unit allowable. 80-acre wells received the same allowable. When the New Mexico Oil Conservation Commission set proration for the Carson Bisti Field in September and January, they set them on the basis of 40-acre wells, 40-acre allowable basis. Now that order as revised, Shell's 40-acre will be given half the allowable that

the 80-acre locations will receive. Now it's been suggested, although I have doubts as to how serious it was, I can't believe that anyone would suggest that if Shell's position is adopted the Commission can't change the spacing or proration rules. That simply isn't the case. All we suggested is that when you drill wells in accordance with existing rules, that when they are changed-- and no one denies the right of the Commission to change them -- that they make adequate provision to protect the parties who have drilled wells in accordance with existing rules, either by exception or such other means of protection that are equitable.

As for the United States Geological Survey's approval of this third supplemental plan of development, and as for whether or not there is any question as to the final approval, I will leave that to the correspondence that we will submit in connection with that plan. I think that will resolve any doubts as to the finality of the approval.

One other factor I would like to mention, and that's in connection with some of the authorities Mr. White cited with regard to a lessor operator proceeding while there was a pending judicial action. Those cases involved, well, it appeared to involve largely a lessee-lessor situation, and a situation where there was a legal proceedings pending; and under which there has been an attack upon the lease. In other words, all the basic rights the party had was subject to question. Well, that simply isn't the case. The Statewide 40-acre proration rules were never attacked.

There was just merely a request for an exception, and until such request was granted, the Statewide orders remained in full force and effect at all times. That was evidenced by Order 1069 and 1069-A. If the position of the proponent of 40-acre spacing is correct, the mere fact that someone files a request for exception, that you stop drilling or drill at your peril, it would be a simple matter for people to successfully file various applications and force you to drill at your peril.

I am not suggesting, of course, that wasn't done in this instance; it shows the situation that can develop if you follow that line of reasoning and if you take the position that any time an application for exception or qualification to a rule is made by some party, that the operator has to hold up drilling. You can see how that will deter the further drilling operations.

So for these reasons, I respectfully request that the application be granted.

MR. PORTER: Does anyone have anything further to offer in this case? There was some discussion of the matter of filing briefs. The Commission will expect one brief from each side, to be filed within fifteen days of this date.

The case will be taken under advisement.

* * * * * * * * *

C E R T I F I C A T E

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this 2nd day of June, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley
NOTARY PUBLIC

My commission expires:

June 19, 1959.

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
March 14, 1958

IN THE MATTER OF: Case No. 1308

TRANSCRIPT OF PROCEEDINGS

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

BEFORE THE
OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
March 14, 1958

IN THE MATTER OF:

The rehearing requested by Shell Oil Company for reconsideration by the Commission of certain portions of Case 1308 - application of Sunray Mid-Continent Oil Company for the temporary establishment of a uniform 80-acre well spacing and Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.

Case 1308

BEFORE:

Mr. A. L. Porter, Jr.
Mr. Murray Morgan
Governor Edwin L. Mechem

TRANSCRIPT OF PROCEEDINGS

MR. PORTER: The meeting will come to order, please. The matter to be considered this morning is the rehearing on Case 1308.

MR. COOLEY: Case 1308: In the matter of the rehearing requested by Shell Oil Company for reconsideration by the Commission of certain portions of Case 1308 - application of Sunray Mid-Continent Oil Company for the temporary establishment of a uniform 80-acre well spacing and Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.

MR. KELL: Appearances on behalf of Shell will be Oliver Seth and Leslie Kell. We only have one witness to offer evidence at this time. In order to expedite this hearing, the parties got

together and stipulated to a lot of facts not in controversy. I would like to briefly mention the stipulations.

First, that the Carson Unit Agreement under which Shell is unit operator was approved by the United States Geological Survey, the Commissioner of Public Lands, and the New Mexico Oil Conservation Commission.

Second, that Shell's map which will be designated as Rehearing Exhibit 1, contains a description of the location of the wells which was drilled by Shell in the Carson-Bisti area at the time referred to in the application for rehearing; that Shell's chart designated as Rehearing Exhibit 2 contains an accurate description of the wells drilled by Shell in the Carson-Bisti area during the period before Order R-1069, between Order R-1069 and R-1069-A, and between Order R-1069-A and 1069-B.

The parties have also stipulated that the date of Sunray's original application was August 5th, 1957, in this matter.

The parties have also stipulated that Shell's Exhibits 3-A through N, inclusive, consist of photo-print copies of notices of intention to drill filed with the United States Geological Survey and also the New Mexico Oil Conservation Commission, in connection with the fourteen 40-acre wells referred to in Shell's application for rehearing.

A further stipulation is that the correspondence contained in Shell's Rehearing Exhibits 4-A through F, inclusive, relate to approvals of the third supplemental plan of development under the

Carson unit by the United States Geological Survey, Commissioner of Public Lands, and the Oil Conservation Commission.

Further stipulated that there was a lack of unanimity among the working interest owners and Shell as unit operator under the Carson Unit as to whether forty or eighty acre spacing was proper, and was further evidenced by such parties in Shell's participation in Case 1308; it was stipulated that Skelly introduce as exhibits copies of correspondence between the other working interest owners and Shell, indicating the differences over spacing which arose in connection with this third supplemental plan of development; and that Shell will have ten days from the date of conclusion of the hearing to introduce additional correspondence which it has between it and the other working interest owners and between the United States Geological Survey or the State Oil Conservation Commission relating to this third supplemental plan.

It is further stipulated that 40-acre proration was in existence during December of 1957 and January of 1958; and finally, that the cost of the fourteen wells referred to in Shell's application for rehearing was the amount alleged in the petition, $565,600.00. The only witness we have --

MR. CAMPBELL: (Interrupting) Just a minute. I didn't hear that stipulation with regard to the date of the filing of the application by Sunray.

MR. KELL: I mentioned that, August 5th.

MR. CAMPBELL: Is that all you said?

MR. KELL: Yes.

MR. CAMPBELL: We also stipulated, did we not, that all the 40-acre locations referred to in this petition, all the wells were spudded subsequent to that date?

MR. KELL: That will be shown by the exhibit that we plan to introduce in evidence.

MR. CAMPBELL: I would like to have that included in that stipulation, if that is the fact.

MR. KELL: That is a fact, no question about it.

MR. SELINGER: In connection with the stipulation, the matter that Mr. Kell referred to, the correspondence that Skelly was going to introduce, unfortunately we have only one copy of the attachments; however, we have summarized them and indicated them to be Sunray Mid-Continental, et al, second rehearing exhibits, March 13, and designated as Rehearing Exhibits from 1 to 20.

In addition to that, at the bottom of the summary sheet the following request is made for Shell to submit letter dated July 24, 1957, from Shell to the United States Geological Survey; also letter dated July 23, 1957, from the Oil Conservation Commission to Shell; and the letter dated August 23, 1957, from the United States Geological Survey to Shell. Also attached to this summary is the statement that Shell can also furnish copies of all instruments in their files of any correspondence regarding the third plan of development, and that is in connection with their stipulation.

MR. KELL: Our only witness will be Mr. R. R. Robison.

MR. WHITE: I think it might be proper to enter the other appearances at this time. Burns H. Errebo, Tulsa, Oklahoma; Jack M. Campbell of Roswell, New Mexico; and Charles White of Santa Fe, New Mexico, appearing on behalf of Sunray and others.

MR. SELINGER: George W. Selinger for Skelly Oil Company.

MR. SULLIVAN: R. W. Sullivan for British American Oil Producing Company, Denver, Colorado.

MR. BUSHNELL: H. D. Bushnell, appearing for Amerada Petroleum Corporation.

MR. VERITY: George L. Verity for Rex Moore.

MR. SANCHEZ: Manuel Sanchez for Southern Union Gas Company.

MR. KELLAHIN: Jason Kellahin for Phillips Petroleum Company.

MR. BUELL: For Pan American Petroleum Corporation, Guy Buell.

MR. BALLOU: For Sun Oil Company, A. R. Ballou.

MR. WADE: For the Texas Company, H. N. Wade.

MR. SPERLING: J. E. Sperling, Magnolia.

MR. HINKLE: Clarence Hinkle, Howard Bratton, Humble Oil and Refining Company.

MR. COOLEY: Will that be all the appearances in the case?

MR. PORTER: Mr. Cooley, will you swear the witness?

(Witness sworn.)

R. R. ROBISON

called as a witness, having been first duly sworn, on oath, testified as follows:

DIRECT EXAMINATION

By MR. KELL:

Q Would you state your name, employer, and the capacity in which you are employed?

A My name is R. R. Robison, Production Manager of Shell's Farmington Division, located in Farmington.

Q In your capacity as Production Manager, are you familiar with the drilling activities which Shell has conducted in the Carson-Bisti Area?

A I am.

Q Now in connection with exhibits, Shell's Rehearing Exhibits 1 and 2, would you refer to them and briefly explain what they purport to show?

A I think it might be a little more clear if we look at Exhibit 2 first. Exhibit 2 shows graphically the wells that have been drilled by Shell in the Bisti Field during the last eleven months or so, beginning April of 1957, and up to the end of February. The upper row shows the wells drilled with one string of tools, which was the first string of tools employed by Shell in the Bisti Field; and the second or lower row of wells indicated by number and by the solid blocks are those drilled with the second string of tools beginning the latter part of May, 1957.

MR. PORTER: Will you speak up a little, Mr. Robison?

A I'll begin with the second row, I think that is clear. The wells are numbered and the spud date is the initial date there

of the well, like 2515, the first well in the second row was spudded on May the 25th, and the rig was released on June the 4th, and so on.

That second string of tools was released near the end of January of 1958. The wells indicated in the blue --

MR. PORTER: Mr. Robison, just a minute. I believe a little better seating arrangement could improve this.

A The wells indicated in the solid blue color, you will note, are referred to as 80-acre wells and are so indicated in accordance with the present dedication of acreage; namely, one well on an 80-acre parcel, or no more than two wells in a quarter section. The wells indicated in red are those wells representing the third or fourth wells in a quarter section, or to which two wells are located in an 80-acre tract. The 80-acre wells, excuse me, the 40-acre wells indicated in red are shown to represent a total of fourteen wells, meaning that there are fourteen 80-acre tracts on which there are two wells. The wells indicated in red are the second to be drilled in the several 80-acre tracts.

The dates are shown on the chart, that is, the wells drilled are shown and the three dates, rather, pertinent dates are shown on the bottom here as October 9, 1957, which was the date of the Commission's order, original Order No. R-1069; November 4th is shown as the date of the second Order R-1069-A; and similarly, January 17th, the date of issuance of Order R-1069-B.

Prior to October 9, 1957, you will note that there are two

40-acre wells having been spudded and drilled; between October 9th and November 4th two wells had been drilled and two spudded for a total of four; and between November 4th and January 17th, eight wells were spudded, for the total of fourteen.

Then if you will refer to Exhibit No. 1, the locationsof the various wells are shown. The two wells drilled prior to October 9th are shown in Sections 15 and 10 of 25-12, over here in the lefthand portion of the map, locations being 31,-15 and 44,-10, circled in green or blue, it looks pretty close there. Then the four wells in between the dates of October 9th and November 4th are shown circled in blue; namely, 13-10, 33-10, and 22-9, and 42-9. The eight wells drilled after November and prior to January 17, 1958, are circled in red. You will note that three of the wells, only three of the wells were drilled, the 40-acre wells were drilled within the Carson Unit, the Carson Unit being indicated by the 24 section tract with the dashed lines representing the boundary.

Q Now these numbers that appear, for clarification, the numbers that appear on the chart 2 and correspond with the same numbers that appear on the map Exhibit No. 1, the well designation numbers?

A That's right.

Q According to the chart here, there were actually two wells that were drilled between the date of filing of Sunray's application on August 5th and the date of the Order R-1069, is that correct, two wells were drilled in that period?

A Correct.

Q Isn't it also true that of the two wells, one of the wells could have been dedicated 80-acres in accordance with the plan proposed by Sunray in its application?

A I believe that was correct, although there was some, I don't have the exact, I would have to look up here the order in which we drilled those wells, but 31-15 was at that time the seventh well on that section, so in my opinion that could have been classed as an 80, depending on how the acreage was dedicated.

Q As we stipulated, there was disagreement among the working interest owners in connection with the third supplemental plan of development under the Carson Unit. There was quite a bit of correspondence pertaining to this disagreement, was there not?

A That is correct.

Q Isn't it true that as a result of this disagreement among the parties that Shell proceeded to drill some of the 80-acre locations first?

A Within the Carson Unit?

Q Yes.

A Yes.

Q If I am correct, are three of the fourteen wells in question located within the Carson Unit itself?

A That's right.

Q Are you generally familiar with these various orders, 1069, A and B of the Commission?

A I think so.

Q Did 1069 expressly provide for continuation of the statewide proration rules, 40-acre?

A Yes.

Q Did 1069-A also contain a similar provision?

A Yes, and even just as forceful as 1069.

Q How about 1069-B?

A 1069-B as I interpret --

Q (Interrupting) Excuse me, 1069-A, did it contain a provision to the effect that the 40-acre statewide rule would remain in effect pending further order of the Commission?

A Spelled out carefully, that 1069 shall remain in full force and effect, and 1069-A, which granted the rehearing.

Q In connection, going back again to the unit wells, in connection with the unit wells, as you indicated, some of the 80's were drilled before the 40's due to the disagreement among the working interest owners, insofar as the United States Geological Survey was concerned, after the letter of October 15th which is Shell's Exhibit 4, did you have any request or suggestion from them that you not continue drilling 40's?

A No, sir, none whatsoever. In fact, we have complied with the regulations completely to my knowledge, in that we filed the notices of intention to drill, copies of which, after approval by the United States Geological Survey, are forwarded to the Commission's office in Aztec.

Q Well, now, insofar as the Oil Conservation Commission and the Commissioner of Public Lands are concerned, did you at any time between the time Sunray filed its application on August 5th and the date of Order 1069-B on January 17, 1958, have any request from any of the state agencies that you not drill any 40-acre wells?

MR. SELINGER: We object to the question. It is not within the province of this Commission to indicate to an operator when he shall drill a well on what basis. That is entirely within the business process of the applicant.

Q Did you receive any objection --

MR. SELINGER: (Interrupting) Let the Commission rule.

MR. SELINGER: Alright, if he withdraws his question.

Q Did you receive any request from the Commission not to drill these wells?

A None whatsoever.

Q As to all of these wells drilled subsequent to October 9th which is all but two, these wells were at all times drilled without objection from any state or Federal Governmental agencies?

A That is correct.

Q In drilling these 40-acre locations, did you do so in reliance upon the orders and upon the lack of objection received from any of these agencies?

A That is also correct.

MR. KELL: I think that's all the questions I have.

CROSS EXAMINATION

By MR. CAMPBELL:

Q You are not telling the Commission here, Mr. Robison, that Shell was unaware that a considerable number of the operators in this pool were pursuing a course of seeking an order for 80-acre units in the Bisti Field during all this period? You are not telling the Commission that you were unaware of that?

A No, I'm not.

Q None of these wells, the fourteen wells shown on your Exhibit No. 2, were drilled prior to the time that the applications of Sunray for 80-acre units in this field were filed, were they?

A That is correct.

Q At the time of the hearing in this case on September 20th, 1957, I asked you some questions with regard to Shell's plans at that time in relation to your testimony that Shell had these rigs which they needed to keep operating on some sort of a continuous program. At page 282 of the transcript of testimony on September 20, 1957, I asked you the question: "Have you estimated the number of wells you would be drilling if the 80-acre density were maintained during the next year?" You answered: "Yes, I have." Then I asked the question: "How many would that be?" Your answer to that: "To what we consider proven now, there would be enough 80-acre wells for the remainder of 1957, there would be twenty-nine wells to keep us going through the balance of the year, the same as the 40, but next year there would be eleven wells." Question:

"But you could maintain a continuous program for the balance of this year, at least, with the present operations that you contemplate?" Answer: "That's right."

Your Exhibit No. 2 indicates that on October 15th, less than one month after the hearing of September 20th, you commenced a series of 40-acre locations which are part of the complaint in this rehearing application. What changed the position of Shell during that period, between September 20th at the time you gave that testimony and the time that you started these 40-acre locations?

A I don't know that I follow you exactly on that transcript.

Q You stated at that time that Shell was, would be able to drill 80-acre locations for the balance of the year without any interruption of their drilling program, but you chose to drill 40-acre locations commencing less than thirty days after that testimony, isn't that correct?

A After Order R-1069?

Q Yes, but after this testimony that you gave that you could continue on 80-acre units.

A Yes, it was after that date.

Q Were you aware of the fact or advised of the fact that other operators had opportunity for rehearings in these cases?

A Yes.

Q Were you advised of that immediately after Order 1069 was issued?

A That you were going to request a rehearing?

Q That we were entitled to seek a rehearing.

A Yes.

By MR. WHITE:

Q Mr. Robison, at the hearing, on page 285 of the transcript of the prior hearing, Mr. Cooley asked you: "You stated that Shell has not commenced any 40-acre wells since filing this application. Would you be in a position to state whether they anticipate commencing any until there is a final decision in this case?" You replied: "I think that is right, that we will defer, we would like to and probably will defer drilling until there's a decision in this case."

In view of your testimony that you knew that we were entitled to a rehearing and that the order issued October 9th was not a final order, what brought about your change of position to cause you to proceed and drill on 40's?

A Order R-1069 and my, as I interpret it, was a complete denial of everything that the proponents of 80-acre spacing had asked for. We were in favor of 40 acres, still are, and on the strength of that order, proceeded to drill in accordance with statewide rules.

Q Knowing --

A (Interrupting) Order R-1069-A was even more emphatic in that the last paragraph of that order, I believe the last paragraph says that Order R-1069 in the meantime shall remain in full force and effect.

Q And in view of the fact that we had filed our application for rehearing, you continued to drill on 40's?

A Right.

Q Knowing that there possibly could be a change in the Commission's view?

A Could be, but on the strength of drilling them in accordance with the then existing rules, we certainly couldn't foresee a retroactive feature of any subsequent order.

Q Under the Carson Unit plan No. 1, there were no 40-acre units drilled, is that correct?

A Under what?

Q Under your Carson Unit plan No. 1.

MR. SELINGER: The first plan of development.

A I believe that is correct. I say that, because as far as I know the only ones drilled were the three wells shown on Exhibit 1, which were part of the third supplemental plan of development, the fifty-three well program.

Q Would you give us the days that those three wells were drilled in the Carson Unit, that is, the 40's? This is the spudding dates.

A 11-14 in the northeast corner of Section 14 was --

MR. SELINGER: (Interrupting) That is the northeast of northwest.

A Early January, 1958.

MR. SELINGER: Northeast --

A Northwest of the northwest.

MR. SELINGER: Northwest of the northwest.

A That was early January, 1958.

MR. SELINGER: That was a completion date?

A Spudded, it looks like, on January 1st, or December 31st, right there at the end of the year, and the rig released on the 7th of January, 1958. 33-14 was just a few days behind it, having been spudded, it looks like, on the 2nd of January, 1958, the drill rig released on January 9th, 1958. 44-14 was spudded on the 25th of December, 1957, and completed January, or rig released January 1, 1958.

Q (By Mr. White) At any time did the working interests in the Carson Unit agree to the drilling of any 40-acre wells?

A They did not.

Q And you did that as an operator?

A Those wells were not included in the participating area under the Carson Unit Agreement. We therefore had a right to drill those wells.

MR. WHITE: That's all I have.

By MR. SELINGER:

Q Mr. Robison, you were asked with respect to your reliance on the Commission order in drilling 40-acre locations, do you recall that, on direct examination?

A I recall something about it.

Q That Mr. Kell asked you that you relied on the orders of

the Commission in drilling your 40-acre locations?

A Say that again.

Q Do you recall on direct examination from Mr. Kell stating that in your opinion --

A (Interrupting) Today?

Q Just now, just a little while ago, that you relied on the order of the Commission in drilling these fourteen 40-acre locations?

A Oh, yes.

Q I believe you stated that you also are familiar with all of the orders of the Commission, that is, the orders 1069, 1069-A, 1069-B, and 1069-C?

A I don't recall offhand what 1069-C is.

Q That's granting your rehearing this morning.

A Okay, yes.

Q You are familiar with all those orders?

A Yes.

Q Tell this Commission what order of the Commission prevents you from drilling 40-acre locations?

A I consider that there are no objections to drilling 40-acre locations.

Q And there's no prohibition by this Commission for you to drill 40-acre location at this time, is there?

A That is right.

Q The only complaint Shell has is not the 40-acre locations but the allowable feature, is that correct?

A That is our strongest objection to the proration order.

Q That's your only objection, is that not correct?

A I believe that is the essential one, the essential complaint filed in our application.

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

MR. KELL: I have some redirect.

MR. COOLEY: I have one question.

By MR. COOLEY:

Q Was the production department, which is responsible for the drilling of these wells, aware that any party that might be aggrieved by Order R-1069 might within twenty days apply for rehearing?

A Yes, they're aware of that.

Q Were they advised of the fact that Sunray Mid-Continent Oil Company did make such an application?

A We were aware of that.

Q Were you aware that in the event an application for rehearing is filed, that an order of the Commission is not final? It does not become final unless there is a failure to apply for rehearing within the prescribed period, the case remains open and subject to reconsideration?

A Yes, we understand that.

Q Isn't this somewhat inconsistent with your statement that it was Shell's policy not to commence any other 40-acre locations until such time as the final order was entered in this case?

A No, but the first two orders, R-1069 authorized, first they denied everything that applicants had asked for, and I believe spelled out that 40-acre spacing was fitting and proper and should be continued.

Q You realized that this order was not final?

A That's right.

Q Due to the fact there was an application for rehearing?

A We proceeded because we consi'red that if there was a final order that it could not be made retroactive.

Q You proceeded even though there was no final order applying on the questions, or finding that the Commission would stay on 40-acre spacing?

A I don't know if we would call it a guess or not. After Order R-1069 or R-1069-A seemed to be so conclusive, there could only be room for doubt.

Q You do understand, your department understood that in the event that a rehearing is granted that any order could be entered as a result of that rehearing, that 80-acre spacing could have been granted, as it was, that it was a possibility?

A In the hands of the jury, you never know what will happen.

Q You realized that it was still pending?

A Yes, the case was still pending.

MR. SELINGER: I have one more question before redirect, if I may.

By MR. SELINGER:

Q Do you know whether or not you or anyone in the Shell organization was advised specifically on the matter of allowables of 40-acre and 80-acre wells prior to January 17, 1958?

A Advised of 40-acre allowables and 80-acre allowables?

Q The matter of which you are complaining before this Commission today as to the allowables between 40-acre wells and 80-acre wells. Was anyone in the Shell organization advised of that fact by anybody?

A To my knowledge, no.

MR. SELINGER: Thank you. No.

REDIRECT EXAMINATION

By MR. KELL:

Q Getting back to the allowables question that Mr. Selinger has raised on cross, at the time that these 40-acre wells were drilled, they received the full unit allowable, did they not?

A Correct.

Q The allowable was on a 40-acre basis. Now, under R-1069-B where you have two, two 40's, where you drilled two 40-acres in close proximity, they will be in effect receiving just half the allowable, is that not correct?

MR. SELINGER: We object to that question. That is interpreting the present existing Order 1069-B. I don't think this witness is qualified to interpret that. We will let Mr. Seth and Mr. Kell interpret that, but the matter of the 40-acre allowable as it existed prior to January the 17th and as it exists as of today is the same, all the 40-acre allowable wells get the same.

The effect of your order is to increase the allowable for only the 80-acre wells, but in no way is the 40-acre allowable wells affected.

MR. SETH: Are you objecting or arguing the case?

MR. COOLEY: The order speaks for itself. It needs no interpretation. If they wish to,argue it on legal argument.

MR. PORTER: Well, the order will speak for itself as far as the allowable case is concerned.

MR. KELL: I guess that's all I have, then.

MR. PORTER: Does anyone else have a question of the witness? He may be excused.

(Witness excused.)

MR. KELL: At this time we would like to offer in evidence Shell's Exhibits 1 through 4, inclusive, and we would also like to --

MR. WHITE: (Interrupting) What's 3 and 4?

MR. SELINGER: They haven't been introduced yet.

MR. KELL: 3 was the notice of intention to drill filed in connection with these wells, and 4 consisted of correspondence pertaining to third supplemental development.

MR. PORTER: And have been explained by the witness? They will be admitted.

MR. COOLEY: How did you specify these were to be marked?

MR. PORTER: Shell's Rehearing Exhibits 1 through 4.

MR. SELINGER: You had better make it Second Rehearing.

MR. COOLEY: You had better say Second.

MR. KELL: All right. I think we would also like to ask that the prior transcripts and the exhibits in the previous aspect of this case be incorporated in the record.

MR. COOLEY: They're already a part of this case. This is the same case. Mr. Kell, how many different wells of two forms does Exhibit 3 comprise?

MR. KELL: A through N, one for each of the fourteen wells.

MR. COOLEY: A through N as in Nancy?

MR. KELL: Yes, one for each of the fourteen wells. That's all the testimony that we have to offer in this application for rehearing at this time.

MR. CAMPBELL: We have no further testimony. We understand that the exhibits offered by Mr. Selinger on behalf of Sunray and et al have been received?

MR. COOLEY: They have not been offered.

MR. SELINGER: They were made part of the stipulation, but to clarify it we now wish to offer Sunray Mid-Continent et al Exhibits 1 through 20, also noting the paragraph on the bottom which permits Shell to introduce whatever correspondence is necessary with respect to the third plan of development to the Carson Unit.

MR. PORTER: Any objection to the introduction of these exhibits?

MR. COOLEY: That is Exhibits 1 through 20?

MR. SELINGER: They are indicated on the summary sheet,

Exhibits RX 1 through 20.

MR. PORTER: Does anyone have testimony to present in the case? Do we have statements?

(Oral argument by counsel.)

MR. PORTER: Does anyone have anything further to offer in this case? There was some discussion of the matter of filing briefs. The Commission will expect one brief from each side to be filed within fifteen days of this date. The case will be taken under advisement.

* * * * * * * * *

C E R T I F I C A T E

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this 31st day of March, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley
NOTARY PUBLIC

My commission expires:

June 19, 1959.

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

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

September 19 and 20, 1957

TRANSCRIPT OF HEARING

Case 1308

VOLUME 1

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

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

September 19 and 20, 1957

IN THE MATTER OF: Case 1308

Application of Sunray Mid-Continent Oil Company for an Order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, and temporarily establishing uniform 80-acre well spacing and promulgating special rules and regulations for said pool. Applicant, in the above-styled cause, seeks an order extending the Bisti-Lower Gallup Oil Pool to include:

TOWNSHIP 24 NORTH, RANGE 10 WEST
All Sections 2 & 3
Section 4: S/2

TOWNSHIP 25 NORTH, RANGE 10 WEST
All Sections 19, 26, 27, & 28
Section 31: S/2
All Section 35

TOWNSHIP 25 NORTH, RANGE 11 WEST
All Sections 7, 13, 14, & 15
Section 16: N/2
All Section 24
Section 27: SW/4
All Sections 28, 29, 30, 35, & 36

TOWNSHIP 25 NORTH, RANGE 12 WEST
All Section 3
Section 4: N/2
Section 5: NE/4
Section 7: SW/4
Section 10: E/2
All Sections 11 & 12
Section 17: SW/4
All Section 18
Section 25: S/2

TOWNSHIP 25, NORTH, RANGE 13 WEST
Section 1: SW/4
All Section 2
Section 3: S/2 & NE/4
All Sections 4 & 11
Section 12: S/2 & NW/4

TOWNSHIP 26 NORTH, RANGE 12 WEST
Section 31: N/2
All Section 32

TOWNSHIP 26 NORTH, RANGE 13 WEST
Section 26: N/2
Section 29: S/2, NW/4 & W/2 NE/4
All Sections 30, 31, & 32
Section 36: NE/4

The applicant further seeks the establishment of temporary 80-acre well spacing in the Bisti-Lower Gallup Oil Pool with units to run either North and South or East and West and with well locations on diagonal quarter-quarter sections within a governmental quarter section; and further, for the promulgation of special rules and regulations for the said Bisti-Lower Gallup Oil Pool, including but not limited to, the taking and reporting of gas-oil ratio and bottom hole pressure tests.

BEFORE:

Mr. A. L. Porter
Mr. Murray Morgan
Honorable Edwin L. Mechem

TRANSCRIPT OF HEARING

MR. PORTER: The hearing will come to order. The Commission will consider next Case 1308.

MR. COOLEY: Application of Sunray Mid-Continent Oil Company for an order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, and temporarily establishing uniform 80-acre well spacing and promulgating

special rules and regulations for said pool.

MR. CAMPBELL: If the Commission please, I am J. M. Campbell, Campbell and Russell, Roswell, New Mexico, appearing on behalf of the applicant. I would like to enter an appearance also for L. C. White; Gilbert, White and Gilbert, and for Mr. Burns Errebo, Tulsa, Oklahoma, attorneys for the applicant.

With the permission of the Commission, I would like to make a brief statement of the position of the applicant in this particular case. Most of the spacing cases of this nature which this Commission has heard in the past have involved deep reservoirs with effective water drive mechanism. The testimony here will show that in this particular reservoir, which is approximately 5,000 feet, there is a solution gas drive. There is another element present in this case, which to my knowledge, has not been present in any other spacing case before this Commission. A few weeks ago, months ago, this Commission entered its order authorizing a pilot pressure maintenance program in the Bisti-Lower Gallup Pool. This project, of which the applicant is operator, is now in operation. It is the primary position of the applicant here that in order to effectively develop that program of pressure maintenance and obtain the greatest ultimate recovery of oil from this reservoir, that the spacing which has been developed to date on a general 80-acre density should not at this time, at least, be disturbed, and to disturb might injuriously affect the operation of this effort

at pressure maintenance, which applicant's information indicates, and as will be presented in the evidence, is the only method by which a reasonable recovery of investment can be obtained from this reservoir.

We have two witnesses which we would like to have sworn at this time, and Mr. Errebo will interrogate these witnesses on behalf of the applicant.

MR. PORTER: Mr. Cooley, will you swear the witnesses?

MR. COOLEY: Are there any other witnesses in this case? Any other testimony to be presented?

MR. SETH: If you would like to swear the witness, we would enter an appearance on behalf of Shell, Mr. Oliver Hill and Mr. Oliver Seth, , Seth and Montgomery. We do have some witnesses.

MR. MALONE: Ross Malone for Gulf Oil Corporation. We would like to enter Gulf's appearance in opposition to the application and to enter the appearance of Mr. Booth Kellough, Division Attorney from Denver, in addition to Ross Malone. Both of us expect to participate in the hearing, and Mr. Willard Bauman is our witness.

MR. SULLIVAN: Just one moment. The reason I didn't rise earlier is I didn't want to interrupt. My name is R. W. Sullivan. I am a lawyer from Denver representing the British American Oil Company, and I will have two witnesses, Mr. Thomas Hogan and Mr. Stein that I ask to be sworn with the group.

MR. SELINGER: I would like the record to show that George Selinger appears for Skelly Oil Company.

MR. PORTER: No witnesses?

MR. SELINGER: Perhaps a witness.

MR. COOLEY: Would you have your witnesses stand up and be sworn.

(Witnesses sworn.)

MR. BUSHNELL: Bushnell, attorney for Amerada. I would like to enter an appearance, no witness.

MR. KELLAHIN: Jason Kellahin, appearing on behalf of the Phillips Petroleum Company. At the present time we do not contemplate having a witness.

MR. HINKLE: Clarence Hinkle of Hervey, Dow and Hinkle, and I would like to enter an appearance on behalf of Humble, although we don't expect to put on any testimony.

MR. WADE: H. N. Wade, Texas Company.

MR. LEWERS: Robert Lewers, attorney for Sun Oil. I would like to enter an appearance for Sun here. I don't believe we have any witnesses at this time.

MR. KEELER:: E. P. Keeler;, Magnolia Petroleum Company. I would like to enter an appearance. We will have no witnesses.

MR. WOODS:: A. W. Woods, Monsanto Chemical Company. I want to enter an appearance. We have no witness.

MR. TOMLINSON: Tomlinson for Atlantic. We will have no

witnesses but would like to enter an appearance.

MR. PORTER: Anybody here who isn't appearing in the case? Mr. Errebo, you may proceed with your witness.

MR. ERREBO: As the applicant's first witness, I would like to call Mr. L. G. Finfrock.

If it please the Commission, we have passed out to the members of the Commission and to your Staff all of the exhibits which will be offered in testimony and in evidence by our first witness. These exhibits are copies of the exhibits which you see on the wall and which will be used by the witness in his testimony. The only difference being that they are on a smaller scale. We would like to make one set of these exhibits on the smaller scale, the official exhibits for the Commission.

L. J. FINFROCK

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

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, occupation and by whom are you employed?

A L. J. Finfrock, Staff Geologist, Sunray Mid-Continent Oil Company in Tulsa, Oklahoma.

Q Will you please state briefly your background of education and experience?

A Graduated from the University of Illinois in 1940 with Bachelor of Science degree in geology and received my Masters of Science degree in geology from University of Illinois in '48. I worked for the Carter Oil Company for a period of seven and one-half years as a subsurface geologist, and have been with Sunray Mid-Continent for a period of seven years, at which time I served six years as a District Geologist and the past year as a Staff Geologist in the Tulsa Office.

Q Mr. Finfrock, are you familiar with the geology of the Bisti-Lower Gallup Oil Pool? A Yes. I am.

Q Have you ever previously testified before this Commission?

A I have.

MR. PORTER: His qualifications are acceptable.

Q What is the geographic location of the Bisti-Lower Gallup Oil Pool?

A The Bisti-Lower Gallup Oil Pool is located twenty miles south and slightly east of the City of Farmington in San Juan County, New Mexico.

Q A map which has been marked Exhibit No. 1 has been placed on the wall. Will you please go to this map and identify and explain it?

A Exhibit No. 1 is an area map of the Bisti-Lower Gallup Oil Pool located in portions of Township 24, 25, 26 North, Ranges 10, 11, 12, 13 West of San Juan County, New Mexico. We have shown

on this exhibit in the heavy red border, the outline of our proposed area for 80-acre spacing. We have shown here in the green border at the common corners of Township 25 and 27 North, Ranges 12 and 13 West, the area of our pilot injection program which has previously been okayed by this Commission. We have shown also on this map in colors the various types of leases in this area. Shown in red are the Federal leases. Shown in green are the State leases, and in orange are the Federally administered Indian leases in this area.

Now, we do not find any patented land within the area of this proposed application. Within this area there is 46,720 acres, approximately, of which 4200 acres belong to the State, which is approximately 9% of the total. The Federally administrated leases, approximately 23.3% of the total within this area, and the Federal leases, 67.7% of the area within this proposed 80-acre spacing program.

Q What was the discovery well for this pool, Mr. Finfrock?

A The discovery well for this pool was the El Paso No. 1 Kelly State, located in Section 16, Township 25 North, Range 12 West, San Juan County, New Mexico, which was initially completed on October 7, 1955 with an initial production of 180 barrels of oil flowing after fract treatment.

Q Are all of the completed wells shown on this map completed in the Lower Gallup?

A Yes, all of the wells shown on this map are completed from the Lower Gallup formation. We have, according to the best information available to us, as of September 4, 1957, 134 wells drilled within this area, of which a total of approximately 120 were oil wells, 5 shutin gas wells, and 9 dry holes.

Q Is present development on an 80 acre lease density?

A Yes, the present development of the pool is on an 80 acre density. However, we have a few areas within the outline of this map of which locations have been established for 40 acre locations, and should these locations be drilled, they would violate the 80 acre density pattern that has so far been adhered to by the operators in the Bisti-Lower Gallup Oil Pool.

Q What companies have established those locations?

A To my knowledge, these locations were established by the Shell Oil Company in and around the Carson Unit area.

Q How was the proposed spaced area determined, Mr. Finfrock?

A The proposed spaced area, which is outlined here in red, was determined from the following conditions: As a result of engineer's studies of the Bisti, Engineering Committee results of geologic study, results of sand studies, and also the results of the drilling of the exploratory and development wells within this area to roughly define this pool.

Q Will this pool probably extend southeastward from its present limits?

A I feel that this pool will very likely extend further in a southeasterly direction inasmuch as it has not been definitely defined by the drill.

Q Will you please refer to Applicant's Exhibit No. 2 and identify and explain it?

A Exhibit No. 2 is a reproduction of a portion of electric log of the Shell Oil Company No. 1 Carson Well, a wildcat, located in Section 24, 25 North, 12 West. This well was chosen as our type well inasmuch as it penetrated completely through the Lower Gallup formation. We have shown here, or indicated in yellow, the extent of the Lower Gallup formation, the top of which we have shown here at 4860 feet, and the base of the Lower Gallup formation at 5143 feet. The Lower Gallup formation in this area of the Bisti-Lower Gallup Oil Pool has an approximate average thickness of 380 feet. The sands in the Lower Gallup formation are composed of fine, light grain, fine to medium sands, with clean, well sorted sands in the central portion or core of the bar deposit. These sands grade laterally from the core of the bar into finer grained sands, silt stones and shaly sands.

Q Mr. Finfrock, have you read the application in this matter?

A Yes, I have.

Q The Shell No. 1 Carson is one of the wells in which the top of the Lower Gallup was identified in that application, is it not?

A That is correct.

Q Will you please refer to Exhibit No. 3 and identify and explain it?

A Exhibit No. 3 is an isopack of the upper sand of the Lower Gallup formation, contoured with a contour interval of two feet, based on the microlog separation as seen in the Schlumberger wells that were available to us. We have shown here also the outline of the proposed spaced area. As can be seen from this exhibit, the attitude of this upper sand in a northwesterly, southeasterly direction is that of a bar type deposit with the thicker sequence of beds going through the central portion or core of this deposit, of which a maximum of 22 feet of separation had been noted.

As you can also see from this exhibit, they grade laterally down to the zero isopack line, which is shown here to the northeast and to the southwest, by a dashed line. We find in these Lower Gallup sands, particularly in the uppermost sand of the Lower Gallup, that the permeabilities and porosities of the sand are better developed in the central portion or core of this bar, and in the subsidiary sands in this formation, and as we approach the outward limit of the bar, the sands become less permeable and less porous.

Q In other words, what we have here then is simply a buried sand bar, is that correct? A That is correct.

Q Do you find any interruption in the sand development from one end of this pool to the other?

A On the basis of our geologic study of the sand in the

Lower Gallup formation, we have found no evidence of a break in this deposit throughout this entire area of approximately 30 miles.

Q Will you please refer to Exhibit No. 4 and identify and explain it?

A Exhibit No. 4 is an isopack map of the second sand in the Lower Gallup formation, also contoured on a two foot contour interval and based on microlog separation. This sand, as can be seen on this exhibit, also reflects the same general strike pattern of that, of the upper sand, although this sand is not as well developed as the upper sand, nor does it continue completely across the area as does the upper sand.

Q This sand does appear to be continuous throughout the entire area to the best of your knowledge, which you now have available to you, is that correct?

A We have seen in our study no definite evidence that this sand is terminated in the core part of this deposit.

Q Will you please refer to Exhibit No. 5, which I believe is the structural map, and identify and explain it?

A Exhibit No. 5 is an aerial structure map of the Bisti-Lower Gallup Oil Pool with the datum on the top of the Lower Gallup formation on which these structural contours were made. The contour interval of this map is 20 feet. We have also shown hereon by the red border, the proposed area for 80 acre spacing, and by the yellow border here we show the area presently classified by the Commission

as the Bisti-Lower Gallup Oil Pool.

We also refer to the outline of our LPG gas injection at the location of the common corners of 25, 26 North, Range 12 and 13 West. Also shown on this map in the longitudinal direction is the blue line A, A_1, which represents the trace of our cross section, Exhibit 6-A. The transverse line on this map, B, B_1, C, C_1, D, D_1, E, E_1, and F, F_1, represent the traces of the transverse cross sections labeled Exhibit B, C, E, D, and F.

As can be seen from the structural map, we see an anticlinal dip into the basin in a northeasterly direction. We show no evidence of structural closure within this entire recommended area.

We believe that the trap for the Lower Gallup oil was afforded by nature of a stratigraphic trap rather than that of structural closure, with the buried sand bar being the reservoir and the bounding impermeable silts and shales affording the impermeable barrier needed to make this trap. We also show here in the southeastern portion of this map by a dashed red line and a dashed green line, the area which we label here and zone of oil and gas production, within this bounds we would find wells drilled should encounter both gas and oil, with wells drilled to the northeasterly direction from the dashed green line encountering only oil and wells drilling to the updip or southwest direction from the red line to its limitations would encounter gas.

Q Mr. Finfrock, will you please refer now to Exhibits 6-A

through 6-F inclusive, and identify and explain them.

A Exhibit 6-A, which Mr. Devlin will point out to you on our structural map, is the longitudinal cross section A, A_1, as shown here. This is a northwest, southeast electrical log cross section of the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico. We have shown here by this heavy dark line the top of the upper Gallup formation, and by this second heavy dark line the top of the Lower Gallup formation. We have shown hereon in a dark yellow color the upper sand in the Lower Gallup formation, which is the predominant reserve of this Lower Gallup reservoir.

We have shown in a pale yellow color the subsidiary sands in the Lower Gallup formation as they occur throughout this area. As can be seen from this exhibit, you will note that in each and every well on this cross section you will find that this upper sand of the Lower Gallup formation is present and well developed, and this sand has a very near uniform thickness throughout the area represented by this cross section.

Those who are closer will be able to see that within each of the well bores we have shown here the zones that have been perforated or tested for completion, and each of the sands that we have indicated in a yellow color have had perforations or tests made in them. This section is only to show those sands within the Lower Gallup formation of which perforations or tests had been made, and is not a straight stratigraphic section of the entire

Lower Gallup formation.

This section, as you can see here, has a difference of approximately 300 feet between its low portion and its high portion, which is in the area of the gas cap. Exhibit 6-B shown there by Mr. Devlin on our structural map, is the first of our transverse sections, and we show here the same features that we did on cross section A, A_1, with the deep yellow being the upper sand member. You can see here from this section that we do have the northeast dip into the basin. Cross Section C, C_1, also reflects the same information of the previous two exhibits, with the upper sand being shown in dark yellow. This cross section occurs in Sections 12 and 6 in Township 25 North, Range 26 West, San Juan County, New Mexico.

Exhibit D, D_1, third of our transverse sections, located in Sections 13 and 7 of Township 25 North, Range 11 and 12 West also show the same sequence of beds in the Lower Gallup formation, and this also shows the northeast dip into the basin as well as thinning of the Lower Gallup sand section as we go further away from the central portions of this bar.

Also shown here in this exhibit is one of the situations of which we feel there are probably many in the Bisti area, of which we have sands that are separated at the core of the bar in the Shell 14, 13 Carson, correlating and intermingling with the Shell 11-13 Carson, showing we do have direct communication of sand to sand in some areas within the Bisti Pool, or the Bisti-Lower Gallup Pool.

Cross Section E, E_1, is the essential north-south cross section through Section 20, and 17 of township 25 North, Range 11 West, San Juan County, and this exhibit also shows the northeasterly dip into the basin and the thinning of the sand sequence section as we leave the central portion of the bar proper.

You will note here on this exhibit that this is one of the instances where we find the uppermost sand member shaling out on the flank of the bar, and this occurs on this cross section between the Shell 23, 17 Carson and the Magnolia No. 1 sand wall test.

Exhibit F, F_1, is the essential southwest-northeast section through sections 27, 22, 25 and 14, San Juan County, New Mexico. This cross section shows a gentle dip and then a more abrupt dip into the basin as we go in a southeasterly direction. We also show here the evident thinning of the Lower Gallup sands as we go in a northeasterly direction. We also show on this exhibit the shaling out of this upper sand member at the outer fringe of the bar deposit between the Texas Company M-1 Navajo Well and the Benson, Montin and Greer No. 1 Harvey at the extreme north end of this section.

Q Is it your opinion then, Mr. Finfrock, that these cross sections show a continuous sand development of the Lower Gallup formation throughout this entire area?

A It is my opinion that this cross section shows that we have in the longitudinal direction, continuity of sand deposits

throughout the entire area with, as I pointed out in Exhibit 6-E and F, we do show the lateral gradiation as we leave the bar proper of some of the sand bars which is to be expected in this type of deposit; as you leave the core of the deposit and move out you will find the sands disappear on the flanks. That is to be expected.

Q Will you please refer now to Exhibit No. 7, the three dimensional drawing, and identify it?

A Exhibit No. 7 is a three dimensional drawing of the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico. This drawing was made up of all of the available Schlumberger logs that we could get ahold of to prepare this drawing.

Q Actually, Mr. Finfrock, that represents a large number of cross sections, doesn't it, on one exhibit there?

A Actually this map, as you can see here, shows innumerable areas of cross section within this dimensional map connecting the individual wells.

Q Will you please tell us how that three dimensional drawing was prepared?

A In looking at this drawing, I would like to orient you that on a map these heavy dark lines are the township lines in the north direction, with these being the east-west lines. You will be looking at this plane in a northeasterly direction. This plane surface we have depicted here is as if we had cut a slice out of the earth and an elevation of plus 1660 feet in elevation.

On this plain surface we have located on there surface location the individual wells that have been drilled within this Bisti Pool. After these wells have been spudded, we took their true subsea depth and plotted each individual well in its actual subsea location, and as you can see from these exhibits in the northeasterly or back portion of this map, we have much greater area shown by the dashed line between the actual location of the test and the top of the sand, whereas you move updip into the southwest you find that these locations actually approach into the top of the sand, showing that the beds have a dip here which we are attempting to show in this three dimensional view, dipping back to the north and northeast.

After these individual Schlumberger logs were traced upon this map in their new location, we then correlated from the top of the upper Gallup sand, which is the dark yellow sand in our cross section, we correlated each individual well to show the structural attitude on the top of the upper sand in the Lower Gallup formation. We then connected the base of the sand sequence where penetrated by another line, by a green line, this giving the aspects of individual cross sections. We then colored in green that portion of the Bisti-Lower Gallup Oil Pool which is oil productive.

We have shown in red that portion of the reservoir that is gas, and we have shown on this exhibit the gas-oil contact approximately plus 1530 feet, and have been able to show from this designation of

colors the projected outer limits of this gas cap.

All of this has been put on this plane map at this elevation of approximately 1660 feet to give you a picture, as we see it, of the structure of the Lower Gallup formation, the existence and the continuity of the sands as shown in each and every individual log, as well as to show the attitude of the contact between the oil and gas columns.

Q Mr. Finfrock, what would you say then is the significance of this exhibit?

A I feel that the significance of this exhibit is that it shows to us in one drawing the structural aspects of this field as well as showing us the continual type of deposition that we have within the Lower Gallup formation with our sand sequence gradually building up in each and every well into the uppermost sand, or predominant sand, in this bar deposit. And we can show from this exhibit that these sands are continuously developed, and we feel that a well drilled on 80 acre spacing in any position through this field would encounter the same sand conditions as a well drilled on closer spacing.

Q Will you please refer to Exhibits 8A through 8F and explain and identify them?

A Exhibit 8A is a distribution map of the upper sand member of the Lower Gallup formation. This is the same sand member we have referred to in our cross sections as the deeper colored yellow sand

in the upper portion of the Lower Gallup formation.

We have also shown hereon the outline of our proposed area for 80 acre spacing.

Q When you call that a distribution map, you mean that is a map that simply shows in orange where the sand is found, is that correct?

A I made a detailed study of each log that was available to me to study, and see what sands were present in each well. I then plotted this information on a work map and compiled from that work map these six individual distribution maps which we have here as Exhibit 8. We have only attempted to show on this map by this method the areas where we have encountered this sand developed in the individual wells. We have not tried to define the quality of the sand. We have wanted to show where the sand was developed, and as you will note on this exhibit in the area of Section 30 of 26 North, Range 12 West, we have a solid line shown which defines the northeasterly limit of this sand at that point inasmuch as it was not present in the El Paso No. 1-B Well in Section 30, also in Section 16 of 25 North.

We show a solid black line to indicate that in the Skelly State Well No. 8 this sand was not present, defining in that position a portion of the southwesterly limits of the bar deposit. Also in Section 25 North, Range 11 West, we find a portion of this area defined by a black line indicating the sand was not present in this

area. Also in Section 14 of 25 North, 11 West, we find that same area where the sand was not defined, but in the rest of the entirety of this exhibit we find the sand present as shown by the shaded orange area.

Exhibit No. 8-B is the sand distribution map of the second sand member or bench in this Lower Gallup formation. We have also shown here the outline of our proposed unit, and show here in orange the distribution as proven in the individual well logs of this second sand member. In the northwestern portion of this field you will note that we have a solid black line extending from Section 29 in 26 North, 13 West through in a southeasterly direction into Section 5 of 25 North, Range 12 West, at which point we were able to define the outer limit of this sand.

Exhibit 8-C is a distribution map of the third sand member in the Lower Gallup formation, also showing the outline of the proposed area, and in orange showing our known distribution of this sand. We have here two instances where the outer limits of this sand was defined in Township 25 North, Range 12 West on the north flank of the bar and in 25 North, 11 West in Section 25 on the south flank of this bar deposit.

Exhibit 8-D is the distribution map of the fourth sand member of the Lower Gallup formation showing also the outline of our proposed area for spacing. This map also shows in orange the distribution of this member of the Lower Gallup. In the extreme northwest

portion again we show by a solid black line Section 29, 28 and 27, the northern limit of the sand in that portion, and at Section 30 of 26 North, 12 West, the northeastern limit of the sand at that area.

Exhibit 8-E is the distribution map of the fifth sand member of this Lower Gallup formation; also shown on this exhibit is the outline of our proposed area for spacing with the area known occurrence of the sand shown by orange. We have shown here Section 29, 28 and 33 of Township 26 North, 13 West, a portion of which on the southwest flank this sand was not identified.

Exhibit 8-F is the distribution map of the sixth sand member of the Lower Gallup formation, and like the other maps, in this exhibit, shows the area of our proposed spacing and shows the area of known sand by orange, with the solid black line extending from Section 3, Township 25 North, Range 12 West in a southerly direction into Section 20 of 25 North, Range 11 West, where this sand is defined on the northeast flank.

As you can note from observance of this Exhibit 8, you can find that these sands all lay in approximately the same position along this bar deposit in a northwest-southeasterly direction, and that these sands are present in approximately the same positions, but by some varying degree on each member they are not exactly stacked on each other. There is some variation as can be seen from the discussion of these exhibits.

Q I take it then, Mr. Finfrock, from these various exhibits that you have presented here today, that you have examined the logs of all the wells in this field, is that correct?

A I have examined 134 electric logs of wells in this field.

Q Actually there are other logs of some of the more completed wells which you haven't had an opportunity to examine?

A That's correct. There are some wells that have been completed in this field which the logs have not come to us as yet. It takes awhile between the completion of the well and the time that you are able to get a Schlumberger log for study. We do not have logs of every well in the field.

Q Have any of these sands been found to be absent in any well in this field?

A In a longitudinal direction we have found no evidence of these sands being present, but as I pointed out in the discussion of this exhibit, we find that in a lateral direction we have found instances where these sands do shale out as we approach the outward limit of this deposit.

Q To correct the record, you said you found no evidence of these sands being present, you mean absent?

A Absent, yes, sir.

Q Have you found any faults in this general area?

A I have seen no evidence of faulting in my study.

Q Is it your opinion then that the main sand body and each

of the other subsidiary sands are present and probably present or probably present throughout the entire area covered by this application? A That is my opinion.

Q Is it your opinion that these sands are continuous and form a common source of supply? A Yes, it is.

Q Would you call the Lower Gallup reservoir a lenticular reservoir?

A No, I would not call the Lower Gallup reservoir a lenticular reservoir inasmuch as we have been able to define its presence over an area of approximately 20 miles in length. I do not consider that a lenticular type of deposit inasmuch as in a lenticular type deposit you do not anticipate the sand in the lenticular nature in offset locations, and this is not the case here in this study.

Q You believe that the 80 acre proration unit and plan of well location, as proposed by Sunray Mid-Continent in this application, is reasonable? A Yes, I do.

Q Were all of the exhibits which have been offered as a part of your testimony here today prepared by you or under your supervision? A They were.

MR. ERREBO: We will at this time like to offer these exhibits, I believe 1 through 8, in evidence.

MR. PORTER: Any objection to the admission of these exhibits? They will be admitted.

MR. ERREBO: That's all the direct examination we have

of this witness.

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

MR. SETH: I would like to ask several questions, please.

CROSS EXAMINATION

BY MR. SETH:

Q Mr. Finfrock, you indicated at the outset that the field had been developed so far on an 80 acre density --

A Density.

Q What do you mean by that I'm not familiar with that term?

A By that term we mean that this field has been developed in a manner such that any well drilled at this time in this field can be assigned an 80 acre unit.

Q Then by so arranging the 40's you can assign acreage to any well?

A To any well that has now been drilled.

Q That, if I understand it correctly, is what you wish to accomplish by your application here, is to continue that same method throughout the life of the field, is that right?

A That 80 acres be assigned to each well?

Q Yes, just as you testified has been done heretofore.

A Well, before it's, as I understand, it has been on a voluntary basis and these wells have been drilled at a density at which 80 acres can be assigned to them, and under our application we would define 80 acre units which they have not been defined as

such to this point.

Q Now, had you made any examination to see how many wells are off pattern if a regular 80 acre spacing program had been put into effect?

A As if --

Q (Interrupting) When I say 80 acre, I mean limited to the northwest, southeast quarter or northeast, southwest.

A I do not have a figure at hand, but there are several locations I know that are not drilled on a stated location as you suggested there.

Q Would you say half of them, half of the wells in that field?

MR. ERREBO: If I could, Mr. Seth, I would like to state at this time Sunray has made a count of the wells which would be located off pattern, which are located off pattern according to our best information, and that would be 15 wells.

MR. SETH: Off what pattern?

MR. ERREBO: Well, that would be wells which would be located, for instance two wells located in the same half of a quarter section.

MR. SETH: But you have made no study, if I understand it correctly, on a strict northeast, southwest, northwest, southeast basis?

MR. ERREBO: Yes.

MR. SETH: Fine, that was the question.

Q As to the nature of these particular sands, would it be

your opinion that they are relatively undisturbed sands that have been layed down under quiet conditions, or how would you characterize them?

A I would say these sands have been layed down in what we would call a near shore position which they have been reworked and sorted with the better sorting and larger grain size near the central portion of the sand bar and with these sands as they go in a lateral direction from the core, decreasing in size to a finer grain sand, and finally to silt stones that we have separation of the sands by water action.

Q Then there was a certain amount of wave action which disturbs the sands from time to time, is that correct?

A Very probably.

Q Were they disturbed by marine organisms of any sort, do you know?

A Well, now, not to the extent that we were just discussing as disturbed by deposition. Now marine organisms, minute microscopic marine organisms are known to be present in the Gallup formation. Personally, I can't see that there would be much in the way of disturbance from this presence other than being there in the reservoir itself.

Q I see. Have you examined the actual cores that have been taken?

A Personally, I have not examined the actual cores.

Q Then you wouldn't know whether there was evidence of disturbance of any character?

A I have not made that examination myself.

Q I believe that Sunray has testified in previous hearings that there is a wide range in the well bore of porosity and permeability, is that correct? A That is correct.

Q Now, in presenting the Exhibits, I believe it's 6-A, this longitudinal cross section? A Yes.

Q You have colored in yellow there the entire upper Gallup sand, is that correct, based upon an electric log?

A Electrical log correlations.

Q In doing that you have not taken into consideration any variations vertically in the character of the sand, is that right?

A If you were closer to the cross section you could see that we have shown by indentations and also by little zones of white within the yellow where you do have change in the overall thickness of the formation. In other words, where it varies from well to well we have shown that variance.

Q I wasn't thinking of the thickness of the formation. I was considering more the character of the sand. You have drawn a fairly continuous yellow band across there, which if I understand it correctly, is the upper Gallup? A That is correct.

Q That is as far as you have gone in coloring the exhibit?

A That is right.

Q Likewise on your exhibit which you called a distribution map of the sands, you have approached it similarly, is that right?

A Yes, that is not a quality analysis.

Q What would you say the ranges are of permeability and porosity, or will another witness consider that?

A Well, our Engineering witness will testify on permeability and porosities in this reservoir.

Q Generally such structure as the dips to the northeast, did you say? A Yes.

Q Would you point out, I don't recall where the gas wells are, would you point those out?

A Yes, sir. In the southeast quarter of section 21, in the southwest quarter of Section 22, in the southeast quarter of 22, in the southwest quarter of 25 in Township 25 North, Range 11 West, in the southwest quarter of 30, Township 25 North, 10 West, five gas wells.

Q Now, are there any, considering those gas wells, are there any upstructure oil wells in that vicinity?

A To my knowledge, no.

Q There are not.

A Upstructure, you mean in a southwesterly direction updip?

Q Yes.

A On the map it is different.

Q I mean upstructure as far as the dip upstructure is concerned.

A No, that is correct.

Q You are aware of no oil wells upstructure then, is that correct?

A No, we have no knowledge of any oil wells above this area which we have defined as the zone of oil and gas production.

Q Now, referring again to your eight service there, your distribution, you have cut off the lateral extent of those sands by your finding that they did not occur in the offset well, is that correct? A That is right.

Q Does that necessarily mean that they might not again re-occur as we get further north?

A No, it does not mean that. This study just means that in this bar which we have defined here in the Bisti Pool does shale out in these areas we have shown, and as it is disappearing in a basinward direction, we would not expect them logically to appear again, but that does not rule out the possibility that there may be some sand deposits in that direction.

Q You conclude, I believe, or it was your opinion, that the sand was not lenticular because you found it throughout a considerable area here. Now in that testimony you are again referring merely to the occurrence of the upper Gallup sand or whatever member concerned, and not with perhaps the lenticular character of the permeability and porosity, is that right?

A We are defining these maps on sand continuity in these

exhibits here, and on the Exhibit No. 3 which was an isopack of this upper member, the isopack was made on a microlog separation which shows permeability, and we found that by microlog interpretation we found that the upper deep yellow zone was present and permeable throughout this entire area as we showed on Exhibit 3.

Q It was present throughout. Would you turn back to 3 please?

A Exhibit 3, yes, sir.

Q Now, if you'll just select one isopack near the center of the field there and trace it out, if you would, for the Commission.

A A certain thickness?

Q Yes.

A Contour. Well now, we have here our 20, this is our 20 foot contour at this position, and at this position, at this position and now, that is not going into the record so good.

Q Well now, when, you are referring to Exhibit 3, are you not?

A Exhibit 3 which I am defining --

Q (Interrupting) You are pointing now to the isopack, what is the number or the contour?

A The 20 foot contour, which is --

Q (Interrupting) What township?

A We have the 20 foot contour shown in Township 26 North, Range 13 West, also in 25 North, 12 West and in 25 North, 10 and 11 West, we do not show the 20 foot contour. The sand is beginning to thin in the southeastern direction. We do not show the 20 foot

contour in Township 25 North, Range 10 and 11 West.

Q Now, in tracing those out you have indicated that they cover relatively small areas, especially in the northwest part of the field. Doesn't that indicate there are considerable local variations throughout the field as shown by your Exhibit 3?

A There are variations in the thickness of this bar sand which you would expect to find due to the fact that it is a shallow water type deposit, and you have sorting and the affect of current action, and you would not expect in my estimation to find this sand to be exactly a 20 foot thickness over a period of 20 miles; geologically we wouldn't expect it to be that consistent over that great an area.

Q That is not a continuous sand. You, I believe, testified that it was a continuous --

A (Interrupting) Well, yes.

Q (Continuing). -- sand deposit?

A It is a continuous sand.

Q The sand is continuous, but its character varies locally, is that a correct statement?

A The character varies as you leave this central portion as you go towards the outer edges of the bar.

Q It varies from east to west? A Laterally.

Q East to west also. You traced out the particular contour up there?

A It varies in thickness, yes, sir, from northwest to southeast.

Q You are not testifying now as to whether the quality permeability, porosity likewise varies laterally?

A No, this exhibit is not based on porosity and permeability figures.

Q Now, on the character of the sands, again, would you say they're uniformly cemented or what about the cementing?

A I would say about the character of the sands themselves that in this central portion of this deposit these sands are fairly clean, fairly well sorted with better permeability and porosities, and as you approach the flanks of this deposit you find increasing amounts of silt stones and exclusion of gray shales which would impair or lower the permeability factor.

Q Then again your exhibits, as 6-A over here, you again make no differentiation as here on the quality of the sand. You are showing the Commission here the occurrence of the Gallup sand and you are testifying that it is fairly continuous throughout this particular area. Now, it does not, or I might ask you, does the sand likewise occur outside the limits of your structural map over there, which is Exhibit No. 5?

A Outside the limits?

Q Of the red border.

A We haven't defined the outer limits of the Lower Gallup formation, but as you know, the Lower Gallup formation outcrops on the surface and it is present in the subsurface in New Mexico

Q Then its being a relatively common formation, we would expect if you trace just the formation or just the sand itself it would recur over a considerable area, is that correct?

A That is correct.

MR. SETH: I believe that's all.

MR. PORTER: Anyone else have a question of the witness?

By MR. MALONE:

Q Mr. Finfrock, when did you first have occasion to begin a study of the Lower Gallup sand in the Bisti Field?

A In the earlier part of June of this year.

Q When did Sunray drill its first well in the pool?

A In 1956.

Q And you have, since June of 1957, devoted yourself to a study of the conditions as to which you have testified?

A That is correct.

Q I believe you said that you are familiar with the application which Sunray has filed? A I have read the application.

Q Have you given any consideration to the effect of that application as it relates to the protection of correlative rights or the prevention of waste? A Yes.

Q Do you recommend the application as made to the Commission as protecting the correlative rights of the various owners of sands in this field?

MR. ERREBO: Excuse me. Isn't that asking the geological

witness a legal question?

MR. MALONE: The question of the occurrence of saturation in the sand formation and its distribution with relation to an 80 acre development pattern would seem to be a geologic rather than a legal question. I agree with you the question of what will protect correlative rights may be a legal question, but whether a well on 80 acres is going to let a man get all the oil that he is entitled to as layed down geologically, would seem to be a geological question.

Q Is it your opinion that development on the proposed spacing pattern will protect the correlative rights of the operators in this pool?

MR. ERREBO: Mr. Malone, I fail to see, I think you could ask this question a little better. This witness does not know about correlative rights from the legal standpoint.

MR. MALONE: All right, I will be glad to.

Q First I might ask the witness if he knows the meaning of correlative rights.

A I am not an attorney, but I understand that the correlative rights means the protection of the individual where there is a royalty owner or working interest of his portion of the pool or his reserves or what he should get out of it. I couldn't give you a correct definition.

Q I didn't expect a legal definition. You have testified before this and other commission on previous occasions, have you not?

A Yes, I have.

MR. SELINGER: I would like to make a formal objection to the Commission that this witness is incompetent, irrelevant to testify on matters of correlative rights. He is presented purely as a geological witness and we would like to make a formal objection to this line of questioning from this witness.

MR. MALONE: I have no intention or desire to ask this witness to testify as to anything that he does not purport to be qualified to testify to. He stated in answer to my question that he recommended to the Commission 80 acre spacing. I was asking him whether or not on the basis of the geological information to which he has testified, that spacing would recover, would protect the correlative rights by permitting each owner to recover his equitable share of the oil.

MR. SELINGER: We renew our objection.

MR. MALONE: If the witness states he is not in a position to answer tho question, I will save it for another witness.

A I believe that is getting into the field of engineering more than pure geology.

Q Perhaps we can get at it from another point of view then. May I invite your attention to your Exhibit E, E_1 that you testified to over there. If I recall your testimony correctly, that that upper and thick yellow band was the principal and most prolific sand member in the Lower Gallup, is that correct?

A That is correct.

Q And that the lower band was additional sand members which are saturated and from which production has been obtained?

A Yes.

Q I believe you also testified -- may I inquire what the last well to the extreme right, your right, of that is?

A The Magnolia No. 1 Sanda Wall I believe.

Q Now, if you would indicate the well which you are now indicating, what is the designation of that well?

A The Magnolia No. 1 Sanda Wall, located in Township 18, 25, Range 11 West, San Juan County, New Mexico.

Q I believe you testified in that well the upper sand member had pinched out between the Shell No. --

A (Interrupting) 23-17.

Q (Continuing) -- 23-17 Carson and the Magnolia well, is that correct?

A That was my testimony.

Q The lower member was continuous over to the Magnolia westward?

A That is correct.

Q Now you mean that the upper member extends on to the 80 acre location on which the Magnolia well has been drilled, but that it does not extend to the location of that well, the Magnolia well will not obtain any portion of the oil that is in that upper member will it?

A This location of this well here in relation to the location

of this well, you asked me to state if this well would be able to get any, I mean this well, being the Magnolia well, would be able to get any of the oil that was present in the upper zone?

Q That is correct, and which might exist on the 80 acre spacing unit on which the Magnolia well is drilled.

A Now, we have, I don't know whether it would be my position to state or not, but we have in additional exhibits to come forward in this hearing, some exhibits on porosities and permeabilities in which we show that there is vertical permeability through this entire section, and I don't know whether that should be in the realm of me to answer the question about drainage.

Q I'll be glad to direct that question to a later witness. Can you testify whether or not in your opinion the Magnolia well would recover the oil from the upper sand member?

A I would say in primary operations it would not likely be, but under secondary recovery operations you would expect a program with vertical permeability there to sweep through the field and recover the oil that was not recoverable under the primary operation. That is as far as I can go into that.

Q You are not prepared to testify as to any barriers that may exist vertically to communication? A No.

Q That will come from another witness?

A Yes.

Q But insofar as your testimony goes, I just want to be sure

that I understand it, it is through primary operations the Magnolia well will recover none of the oil that may be in the upper member of the Gallup sand? A As far as I can see.

Q Now, with reference to the several sand members that you have testified to, what is the relative thickness of those sand members as you have found them?

A I would say the average thickness of the upper sand throughout this field average would approximate 15 feet, and of the secondary sands, these individual zones or benches would probably average four to six feet.

Q Is it --

A (Interrupting) I haven't made a study to get an average. That is just an estimate.

Q I'm not sure that I understood the delineation of those members. Now, is the first member that was shown on your Exhibit 8-A, that is the 15 or 20 foot principal member?

A That's right.

Q From which the best production will be obtained?

A That is correct.

Q The additional five members compose the lower yellow band that you have showed on your A, A_1 longitudinal cross section?

A That is correct.

Q Are the lateral limits of those various segments uniform or are they stacked on top of each other with various lateral

limits or aerial limits?

A Using your term they are stacked on top of each other, but their vertical limits are not precisely at the same point above each other. There is a variation.

Q There is a variance. So a well drilled at a given location might encounter one of those members but not encounter the next member even though an offset location would encounter both of them?

A In speaking of these reservoirs, we're dealing with marginal reservoirs here, and if you were looking for say one of these reservoirs or say two of these reservoirs, you very probably would not be looking at a commercial reservoir.

Q My question was whether the lateral edges of the sand barriers are so irregular that a well which penetrated one might not penetrate the same ones which were penetrated on an offset well.

A I do not have a definite figure, but based on my study of the logs and the preparation of the distribution maps, my estimation would be that out of the 134 wells that I studied that very probably, I don't know, maybe 90% of them encounter all the sands. That is just an estimate and it may be more than that.

Q Of the wells that have been drilled to date?

A The wells drilled to date. Those would be the wells on the marginal limits of this bar deposit.

Q If I may invite your attention to the Exhibit 3, the pinch out of the sands or the sand members which occur, occur as you proceed

away from the center of the sand bar, do they not?

A That is correct.

Q So that as we get out on the north and south flanks we find that one or more of those six members may have pinched out a little sooner or a little later than the next one, and they would not be coexistent in a given location as we come along the edge of the zone of saturation?

A That is correct. I would not be a precise point at which all members would shale out.

Q That lack of uniformity in those various oil-bearing members would exist along the flank of this entire field both north and south, would it not?

A Yes, that would exist on the marginal flank of the field.

Q So that wells drilled along the marginal flank of the field have no assurance of encountering all of the sand members which an offset well might encounter?

A Would not get all of the sands that an offset well near the central portion.

Q Near the central portion --

A Of the bar?

Q Yes. Did you testify as to the range of permeability which you found to exist in these sands?

A No, I did not.

Q Are you prepared to testify on that?

A We have exhibits. I could give some estimates. We have exhibits prepared and a witness who is to testify on that phase of the reservoir.

Q You have not studied permeabilities yourself?

A Not personally. I have read figures.

Q So you couldn't testify as to the range of permeability or porosity that may exist?

A No, other than figures that I have read, that would be all.

Q Your entire testimony is based on figures that you have read and logs that you have studied, is it not?

A Well, it has been my personal interpretation. I haven't measured permeability, I'm not an engineer. I have not measured any permeability.

Q All right. We will address that question to a later witness, thank you. In connection with your study of the Schlumberger logs, have you studied micrologs as well on these wells?

A I did not personally study the micrologs inasmuch -- I studied a few, I will say about fifteen, to familiarize myself with the picks that have been made by our geologist in our district office, of which the Bisti Field is under their guidance.

Q So that the testimony which you have given is not based upon an examination of micrologs of these wells to any extent?

A That is correct.

Q Do you have any opinion as to the relative value of

micrologs and electric logs?

A Yes. I would be lost without it.

Q Do you think that the information which might be disclosed by microlog study would be of value in the questions which the Commission is here considering?

A Yes, I think that microlog information as well as electric log information is a great help to the Commission and to anybody who does make a study of it.

Q Referring again now to the six members which compose the Lower Gallup Sands, you said that you had not examined any cores, I believe. A That is correct.

Q Are you in a position to testify what, if any, barrier or division exists between those members?

A We find that in this section, as I mentioned in my testimony, that the Lower Gallup formation is composed of sand, sandy shales and silt stones throughout its entirety, and we have endeavored to show here the sand members which are the members which we are interested in inasmuch as they do show the greater permeability and porosities, although it has been found by engineers, and based upon core analysis studies and microlog studies, that we do have a vertical permeability range through this section.

Q But the fact that you have divided the lower segment into six members and the upper segment in a single member indicates that there are barriers between those lower members which do not exist

in the upper member, is that correct?

A We have divided the Lower Gallup, for the purpose of this display, into the upper member, the five. There is a total of six, the five subsidiary members which we feel are part of one and the same formation. We have only done this to show the outline of the better developed portions of this sand.

Q Why, then, did you not divide the upper member likewise into a group of members?

A Because we did not see a continuity in the change that was in the formation there, whereas you can see from our cross sections that you will find that these silt stone and shaly sand breaks, as we call them, are consistently present in their position in the section throughout this.

Q It is true, I think we are in agreement, but I can't get you to say so, that the reason you recognize several members in the lower segment is because of shales and silts which separate the sands which are the zones of saturation from which you do produce.

A These do stand out on our electric log in our means of correlation.

Q And because there is a separation of some type between them, can it mean a loss of porosity or permeability shale or silt?

A Yes, because there is a facies change.

Q There is a facies change. That change does exist in the lower segment made up of the five members?

A That is correct.

Q You find them, call them barriers, call them separations, call them facies, they still exist in a tier of a five-layer cake down there, is that correct?

A These facies changes exist and are correlative, but we do not define them as barriers.

Q Well, I believe you said that you were not prepared to testify on that? A That is true.

Q And since you cannot testify as to communication that would exist there, you would not be able to say whether they were barriers or not?

A Not from the electrical log basis alone, no, I wouldn't.

Q Would you like to withdraw that answer then?

A Well --

Q (Interrupting) That's all right.

MR. CAMPBELL: If the Commission please, I believe counsel has to take the bitter with the sweet.

MR. MALONE: I might suggest that the witness answered a question he wasn't qualified to answer.

Q Can you testify whether or not in your study of the relationship betweenthe gas well and the oil wells producing from this reservoir, whether or not there may be oil wells producing from perforations, at a higher level than gas wells on adjoining land?

A I am not in a position to answer that question.

Q You have not made a study of the logs of any of the gas wells down in Section 20 and 22?

A Yes, I have studied the logs.

Q Have you found that condition to exist?

A I think what you mean, have we found wells in which sands have been perforated lower in the column to complete as oil wells?

Q No, that wells which have been perforated and completed lower that adjoining wells are producing gas from a lower level than the lower wells producing oil.

A Oh, I have seen nothing of that.

Q You have seen no example of that?

A To my knowledge, no.

Q Would that have any significance to you if you did find that situation to exist?

A Well, it depends on if it were the same reservoir.

Q Well, you testified this is all one reservoir, have you not?

A Yes. The Lower Gallup Reservoir, that is correct.

Q If you found that condition to exist in this reservoir, would it have any significance to you?

A Well, it would show that we do not completely understand the mechanics of oil and gas migration, and if one did find gas production below the oil production, that it could be a result of the test or something like that, I'm not familiar with what type

of equipment was used and what testing was made or how these tests might have been conducted.

Q Would you agree with me that a condition of that kind might indicate either a lack of continuity or a lack of communication as between those wells?

A Well, I think that it would more likely be a result of a fract treatment going from one zone into another in opening up another area into the bore of the well to get your --

Q (Interrupting) It could have been caused by that, but it likewise could have been caused by a lack of communication, could it not?

A By lack of communication, I don't quite get your question.

Q Well, I understood you to testify that communication in your opinion existed throughout this reservoir?

A That's right.

Q That is was one common sand bar and that communication existed throughout it? A That is correct.

Q Now, if communication does exist, could the situation I asked you about likewise exist?

A It doesn't sould plausible, but geology is not an exact science. I've seen strange things in my career as a geologist.

Q That would have some bearing on it if the situation existed?

A If the situation existed you would be aware of it and wonder what caused such.

Q You are not prepared to testify it doesn't exist in this reservoir?

A To my knowledge, no.

Q You don't have any knowledge of wells of that?

A I have no knowledge of that.

Q Have you had an occasion to study other sand reservoirs in New Mexico?

A In New Mexico this is the only field that I have studied.

Q So you would not be able to testify whether there is any particular characteristic of this sand bar that does not exist in the numerous other sand horizons from which we are producing in New Mexico?

A I have spent a lot of my life studying cretaceous sands of which these are, and I feel that the type of deposit and the age is just as importa-t as the geographic location, I mean, from the geological standpoint. Geographically I haven't studied any other field in this state.

Q How does this pool compare with the sands in the pool with which you are familiar?

A This is much longer reservoir than I have been able to study before, a larger reservoir, but it is also a reservoir which the permeabilities, as reported, are not as high as I've seen in other portions of the country, but as far as the geology of the deposit is concerned geologically, it is the same type deposit that we find

in this type of --

Q (Interrupting) You find nothing particularly out of the ordinary about this?

A No, it has fallen in every well with our concept of the geology of the field.

MR. PORTER: We will take a ten minute break.

(Recess.)

MR. PORTER: The hearing will come to order. Mr. Malone, will you proceed?

A I have one further question, if the Commission please. With reference to your distribution maps, Exhibits 8-A through F, am I correct in understanding that the area which you have delineated in orange as indicating the existence of a sand deposit, does not take into consideration in any respect the character of the sand or the porosity or the permeability of the sand?

A That is correct.

Q And the same thing is true of the three dimensional drawing up here?

A That is correct.

MR. PORTER: Anyone else have a question? Mr. Utz.

By MR. UTZ:

Q Mr. Finfrock, referring to your Exhibit No. 1, the red outline designates your proposed pool limits?

A That is correct, for the 80 acre spacing.

Q Are you aware of the fact that your proposed outline is

substantially larger than the pool outlined as defined by the Oil Conservation Commission? A That is correct.

Q I note that in some instances your outline as you propose is substantially over a mile from the nearest producing oil well, is that correct? A It is correct.

Q On what basis do you believe that it would justify a pool limit that far away from a producing well?

A This border was arrived at because of the fact that as of now at this stage of the development of the field we do not know the definite limits this field will take, and based upon the studies of the sands which we have made, we feel that the sands are present over most of this area and would very likely, under field development, would include most of this area within the Bisti-Lower Gallup Oil Pool at a later date by further development.

Q But you are not sure that that whole entire area is productive, are you? A No, sir.

Q Would it not be better then to extend the pool as completions would justify on the basis of say 150 acres at that time?

A This outline is not definitely submitted as the finalized outline to be arrived at by the Commission, but it was a line that we thought would be reasonable in lieu of future development, but your suggestion would very likely be a good one to follow in enlargement of this field.

Q If we go too far in we might have a lot of dry acres inside

the pool? A That's possible.

Q Are you prepared to discuss this gas cap which I believe you've --

A (Interrupting) Well, that will be discussed under engineering testimony in the latter part of this hearing.

Q As to the means of producing those gas wells?

A That is correct.

Q Referring to your Exhibit 6-F, referring in particular to your cross section on your Shell 5 Carson in 27, 25 North, 11 West, is that a completed well?

A We show it as a location here although I don't believe the well has been officially completed, although it was tested, we do not show it as a completed well officially. According to the records we have available, 27, 25, 11, yes, that is correct, we show an initial production on this well, but we were never able to find an official completion for the . 11 and did not show it as a completed symbol.

Q Is that an oil or gas well?

A I. P. 33 barrels of oil per day. It is listed here on our data. The gas-oil ratio is 17,000 to 1.

Q What was your answer?

A This Shell No. 5 Carson in Section 27 of 25 North, Range 11 West which we do not show as a completed well, has initial

production of 33 barrels of oil per day and a gas-oil ratio of 17,000 to 1.

Q Referring to the Es-Ka-Nel-E-Wood, Section 22, 25 North, 11 West, that was a gas well, was it not?

A Which one, we have Es-Ka-Nel-E-Wood No. 1 and 2.

Q It is the No. 2.

A The No. 2 is a gas well.

Q Do you know what the gas-oil ratio was on that well?

A 1020 to 1.

Q 1020 --

A (Interrupting) No, wait, that's that 1020 to 1 is the ratio for the No. 1 Es-Ka-Nel-E-Wood. I do not have a figure for the No. 2 on my exhibit here, for the No. 2 Es-Ka-Nel-E-Wood.

Q Do you know if it produced any oil or not?

A 4500 MCF of gas per day initial production.

Q No oil reported? A No oil reported.

Q That is undoubtedly a gas well, is that correct?

A Yes.

Q We have a well which is structurally higher than the well we have just discussed, the Es-Ka-Nel-E-Wood No. 2, which produces oil, how do you explain that? This is a gas cap.

A The perforations in the Es-Ka-Nel-E-Wood No. 2 were at plus 1572 to plus 1568, plus 1566 to 1562, plus 1542 to plus 1535, these perforations were throughout considerable amount of section.

In the Carson well we show perforations here plus 1577 to plus 1613, and I don't know, I don't know where those are in the section on the log.

Q Doesn't your Exhibit 6-F show the structural position of your known completion?

A In the Shell 5 Carson we show these perforations, 9112 to 30 and from 5141 to 48. And the No. 2 Es-Ka-Nel-E-Wood we show the perforations 4923 to 29 and 4929 to 33, 4953 to 60, which according to this information, these two are in the same zones of the Lower Gallup formation.

Q Which well is structurally higher?

A This well is structurally higher, that is the No. 5 Carson.

Q No. 5 Carson is structurally higher and that is the one that you reported as producing oil from the 17,000 to 1 ratio?

A This is the report we got through the scout service.

Q If the Es-Ka-Nel-E-Wood No. 2 is a dry gas well and is structurally lower than Shell No. 5 Carson, then does that indicate a gas cap?

A I couldn't give you a definition of a gas cap. I don't know if I am qualified to define what actually constitutes gas cap. We have gas production in this well.

Q Do you have any explanation as to why a well structurally higher would produce oil?

A Based on this exhibit here, both sands were perforated

at the same position within the section I can't answer, give a definite answer as to the reason why there would be that difference. I don't know.

Q But nevertheless that is a fact?

A That is the facts as reported to us, that is correct.

Q In your opinion could there be communication between those two wells?

A Based upon the location of the No. 2 Es-Ka-Nel-E-Wood Well is in the southeast quarter of 22, 25, 11, and the Shell No. 5 Carson in the southeast quarter of Section 27, these wells are almost directly, the Carson well is almost directly north of the Es-Ka-Nel-E-Wood Well, coming away from the bar deposit in going into the marginal area of the bar.

Now, we have found in our studies that, as I mentioned before, that in the core of the bar we have the sand as a coherent body and as it goes out towards the limits of the bar we have found inerfingering of the sand into the shale near the limits, and we feel there is communication, but as you approach the outer limits of the bar you may find this interfingering affect will be shown somewhat, but I don't know. That's the only position that I'm able to take on that is that we're approaching the outer limits of this bar here and possibly in the geology there with the differences in what you would suppose to be the permeability between these two wells, it might lead to the fact of encountering some oil in lows out here

which we have shown as would be in a gas area.

Q Then your answer is that you are not sure?

A I am not sure, no.

Q Do you believe that both those wells are in the same common source of supply?

A Well, that's our belief.

MR. ERREBO: Mr. Utz, if I could interrupt to make that determination seems to me like it would take some engineering evidence and information which I believe this witness here has not had any disposal of, and he is not qualified to give it. We have an engineering witness who perhaps can give you better satisfaction on those questions.

MR. UTZ: All right. That's all the questions I have.

MR. PORTER: Anyone else have a question?

MR. SELINGER: I would like to ask the witness a few questions.

By MR. SELINGER:

Q I believe you stated on direct examination that you felt that the area was approximately 43,000 acres more or less?

A I think that was about 47,625, 46,720.

Q Approximately 47,000 acres, and it had approximately 134 wells or thereabouts? A To date.

Q So that the vast majority of the area is yet to be developed, is that correct? A That is correct.

Q And I believe you stated on cross examination that with reference to the upper pay that it averaged approximately 15 feet in thickness if you had to use an average figure?

A That is correct.

Q And that as to the secondary sands, it averaged if you had to use an average figure, in thickness, of four to six feet?

A Four to six feet.

Q Now, referring to Exhibit 3, on cross examination you were asked on the isopack map to trace one of the isopack lines, and you picked at random a 20 foot pay thickness. Can you likewise at random say, pick a 10 foot pay thickness and trace that across the field? A Yes.

Q Laterally from the northwest to the southeast. Will you do so indicating on that exhibit, for the benefit of the Commission. the 10 foot? A Indicating by sections?

Q No, just a continuous line with your pointer.

A The 10 foot contour line is this heavy line here on the north flank of the structure extending in a southeasterly direction as I am showing here, following all along across Township 25 North, 12 West, coming on across Township 25, 11 West, down to Section 29 which it turns and comes back up.

Q Where does that point stop?

A The point here of the furthermost southeasterly direction of this 10 foot contour point stops in the southeast corner of

Section 29, 25 North, 10 West, and we have shown here isolated 10 foot contour closures to the southeast with this original 10 foot contour line coming back up on the southwest flank of this bar on up to the extreme northwest limits of the field as defined by the drill.

Q So that your 10 foot contour line or isopack line can be traced practically across the entire northwest-southeast with the exception of the extreme southeast corner?

A That is correct.

Q Can you at random pick either the 12 or 14 foot isopack line and similarly trace it for the benefit of the Commission?

A The 14 foot contour line is the second contour line above the 10 foot line. I will start at this position and trace it around here and then start at this point and take the 14 foot contour line, trace it back through this large area here, then continue with the 14 foot contour line on across Township 25, 12 West, on through until we get into the southeast quarter of Section 18 of 25 North, 11 West, which we can turn this contour back, come back up in a northeasterly direction, then back to our point of beginning. And also we are able to trace the 14 foot contour point on beyond the break we show in 18 so that it will pick up here and go down in a southeasterly direction on across to this point here in Section 26, which contour line comes back upon itself again, and in Township 25 North, 10 West we do not show any 14 foot contour interval, and

this area here to the southeast is also the area of the less densely drilled portion of the field, and I'm certain, and I certainly would not want to say what the maximum development of the sand would be in this portion of the field.

Q Now, in between your points of control on your isopack map there are areas, you have undrilled area, is that correct?

A Yes, that are areas within this outline which have not been drilled or which we do not have information available to complete a map.

Q If subsequent development takes place and permits the drilling of additional wells in these areas and you have undevelopment, you will have additional information upon which to draw your isopack lines throughout the area, is that correct?

A That is correct.

MR. SELINGER: I believe that's all.

MR. PORTER: Any further questions of this witness? Mr. Errebo.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q Now, Mr. Finfrock, the question of lenticularity has come up this morning. You discussed that briefly in your direct testimony. I would like for you to discuss that a little more thoroughly as to what you mean by lenticularity. I would like to ask you this question, would you say that a lens is a very small local

deposit of sand, would you say that?

A A sand lens?

Q A sand lens.

A Yes, I would.

Q That is different from the surrounding sand, is that correct?

A Well, now, different in character or --

Q (Interrupting) Different in sand character, it may or may not be, is that right?

A A sand lens itself doesn't necessarily have to exhibit different characteristics. It may or may not, depending on the deposit.

Q Will you describe in more detail then what you mean by a sand lens?

A A sand lens or a lenticular sand in my opinion is a sand that in its deposition was not deposited over a wide area. It is normally a thin sand associated in a section which is predominantly sand and shale. Its lateral and longitudinal distances are very severely curtailed. It is, I would say, a local deposit not of a regional nature whatsoever.

Q Then sand extended throughout the entire area of that proposed spaced area, would you call that a lens?

A No, I would not.

Q Would you call it a lens if it just extended over half the area?

A No, not as a sand lens as we are thinking today.

Q That is also generally recognized by geologists and engineers?

A That is correct.

Q What if you had say six sections, would you call that a lens as it is generally regarded? A Not in my opinion.

Q How about one section, do you think that then you might be getting close to what you call a lens?

A We are getting down to the sands that I have dealt with as leaning sands, say where in a section area you drilled numerable wells and found this sand was present in a portion of these wells but not distributed evenly throughout, and that you would find that this sand is present in one well and not necessarily in an offset.

It is erratic in nature.

Q It doesn't necessarily mean it is lenticular, does it, just simply because a sand is erratic doesn't mean it is lenticular, does it?

A In order to have body to a sand you have to define a border of the sand as well as the main portion of the body, and it would, I would say, assume a lens shape.

Q Well, let me ask you one other question then. If this is an engineering question I wish you would state that you don't know. Do you generally conceive that the area contained within a sand lens or that the pressure within a sand lens is connected to that part of the reservoir outside the sand lens?

A Would you repeat the question, please?

Q Do you believe that a sand lens is pressure connected with the surrounding reservoir?

A I don't think I can answer that question.

Q Then now it is not surprising actually in any reservoir, is it, to find somewhat of a wide range of permeabilities and porosities? A That is correct.

Q You can find that in any reservoir in any part of the country? A I believe so.

Q You would be surprised if you didn't find it?

A I would certainly be surprised to find a field developed with the same permeability and porosity throughout.

Q As you approach the outer limits of this field, you were asked in cross examination whether or not you knew whether or not once the sand lensed out or shaled out that it reoccurred again.

A The sand that shales out here to the northeast does not reoccur again in this immediate vicinity. It is present several miles off, but in this immediate vicinity as far as our studies shows this sand is completely shaled out for quite some area.

Q Then once it shales out, you have no evidence here that in the immediate vicinity it does reoccur again?

A That is correct.

Q If it does reoccur, it is a number of miles off?

A That is correct.

Q This may seem like an obvious question, but it seems

to have been brought into question this morning. All reservoirs have to end somewhere, don't they? A That is correct.

Q They just don't keep on going. That is the reason you drill dry holes? A That is one reason.

Q You can't always tell where they end?

A No, you can't.

Q The extent of reservoirs is no respecter of property lines, is it? A That is correct.

Q If that is a case then a little bit of a reservoir may be a surface acreage of five acres could extend over across a property line, couldn't it? A Yes.

Q Now then, if that were the case, it might even extend further, might it? A That is true.

Q Depending on how much you had extending across a property line would depend on how many wells you had to drill in order to adequately recover that oil, wouldn't it?

A That is right.

Q Or at least to penetrate that sand body?

A Penetrate that sand.

Q It is possible that you may have to drill on a five acre spacing to penetrate a sand body which existed below a lease, is that correct? A That is true.

Q And even 40 acre spacing might miss?

A That is true.

Q Now then, you stated that you had studied, I believe, 15 micrologs out of the wells in this field?

A Yes.

Q That is a little less than 15%, 10 or 15%?

A Yes.

Q You consider those micrologs are representative of the sand conditions in the other micrologs that are in existence and available for the field? A Yes, I did.

Q I believe counsel asked you if this might not be like a five layer cake, this reservoir? A Yes.

Q Don't you think in this reservoir the icing on top is really the best part of this cake? A Yes, I do.

Q It's really not very good icing though, even at that, is it?

A That is correct.

Q Now, do you know of any other Lower Gallup oil fields in this area, do you know of any others in New Mexico?

A According to the best information that I can recall off hand, I think there is a small one-well pool in the Gallup formation approximately several miles to the north. I don't know the Section, 18.

Q In other words, there might be another one, but there are not very many, are there? A No, that is correct.

MR. ERREBO: That's all I have.

MR. PORTER: Anyone else have a question of Mr. Finfrock?

The witness may be excused.

(Witness excused.)

The hearing will recess until 1:15.

(Recess.)

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. Mr. Errebo, will you call your next witness?

MR. ERREBO: For our next witness, we would like to call at this time, Mr. T. W. Brinkley.

T. W. BRINKLEY

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

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, your occupation, and by whom you are employed?

A My name is T. W. Brinkley, Chief Reservoir Engineer, Sunray, located in Tulsa, Oklahoma.

Q Would you give us a brief background of your education and experience as a reservoir engineer?

A 1940 I received a Bachelor of Science degree in petroleum engineering at the University of Tulsa. During the last twelve years I have been a reservoir engineer. Ten of those years was with Carter Oil Company, five being Division Reservoir Engineer, three

being Laison Reservoir Engineer with Carter Research the production field operations and management, two years engineering in charge of Secondary Recovery Group where we evaluated secondary recovery possibilities, and the last year and a half I have been with Sunray, currently as Chief Reservoir Engineer.

Q Have you made an engineering study of the Bisti-Lower Gallup Oil Pool?

A Yes, I have.

MR. ERREBO: Are his qualifications acceptable?

MR. PORTER: Yes, sir.

Q Now, Mr. Finfrock, has stated that this pool was discovered in December of 1955. What development has taken place since that time?

A As Mr. Finfrock stated, the pool was discovered in December, 1955, with the El Paso Kelly No. 1. Since then we have drilled. I say we, the operators have drilled 134 wells throughout this area, being bounded by the red line which represents our spacing area. Out of those total 134 wells, 120 of them are completed as oil wells as shown on our exhibit as solid circles. We have identified five completed gas wells down in the southeastern portion of the field. Also there have been nine wells completed as dry holes within the boundary as we have shown here in red.

Hence, we have a pool approximately 20, 25 miles long, contains oil, it contains a gas cap down the southeastern portion, and to date it is not completely defined, but we feel that the future

development necessary in order to completely define this field will be accomplished within the red outline.

Q What development pattern have the operators been following?

A To date the operators have followed a voluntary 80 acre lease density. This means that every well drilled so far can be assigned 80 acres from its own lease. Most wells drilled have been located in the center of diagonal quarter, quarter sections within each Governmental quarter section. On the basis of 80 acres assigned to each of the wells completed to date, would indicate that we have approximately 10,000 acres developed.

Q Mr. Brinkley, do you have any information that this voluntary 80 acre density will not be continued?

A Yes. Section 22, Township 25 North, Range 11 West, northwest quarter, Shell has publicly announced four locations on the 160 acre tract which is 40 acre spacing. Likewise in Section 9, Township 25 North, Range 12 West, the north half, Shell has publicly announced four additional locations in the north half of the section, putting that on 40 acre spacing. In addition, Section 10, same township, Shell has publicly announced at least three additional locations in the southwest quarter, which puts that quarter on a 40 acre spacing.

Q Does this constitute a serious threat then to our present voluntary 80 acre density that the other operators have been following in this field?

A Yes, it constitutes a threat to the lease owners adjoining this closer spacing by requiring offset development.

Q Mr. Brinkley, at what point are we now in the life of this pool?

A We are in the early stage of development in this reservoir not only by incomplete development, incomplete defining of the reservoir, but also the accumulated oil to date represents a probable less than one percent of the oil in place.

Q I refer you to Exhibits 9 and 10 and will ask that you identify and explain them.

A Exhibit 9 is a tabulation of production statistics for the Bisti-Lower Gallup reservoir, San Juan, New Mexico. The data was gained from the New Mexico Oil and Gas Engineering Committee monthly engineering reports. The data shown on Exhibit 9 consists of seven columns which are identified as follows: First one on your left is the year and month, the second column the number of wells produced during the month, the third column is the oil production in barrels per month, the next column is the cumulative oil produced to the end of that month, the next column is the gas production in MCF per month, the next column is the accumulated gas produced in MCF, and the last column is the average gas-oil ratio for that month. The table lists the discovery month, which is December, 1955, when one well produced; immediately below that we have the months for the year 1956, and below that the months

through July, 1957.

Now, if you would look in the fourth column at the bottom, you will see where the Lower Gallup reservoir has accumulated 903,689 barrels of stock tank oil. The next to the last column on the right-hand side, 543,260 MCF. That is an average ratio of approximately 600 cubic feet per barrel. This again demonstrates that the accumulated oil to date is a small percent of the original oil in place, again meaning that we are in the early stage of development.

Exhibit No. 10 is a graphical representation of some of the data carried on Exhibit No. 9. You will notice the graph is in two parts, an upper part and a lower part. The upper part represents the monthly gas-oil ratio, the dates of course are on the bottom of the graph, and the scale on the left side on the vertical side for the upper portion shows produced gas-oil ratio in cubic feet per barrel.

An inspection of the upper part of the graph indicates that the average ratio to date has been roughly 600 cubic feet per barrel. Also it indicates that for the last month that we have on this graph, being July, 1957, has indicated an advancing trend of the produced gas-oil ratio. The lower portion of the graph contains the produced oil and the produced gas, the former is shown as a heavy line, a bar graph, if you will, and the later the produced gas is in a hashered area, the produced gas is shown as a hashered area.

This is only a graph showing the same data presented in Exhibit 9, but some people prefer a graph, some prefer a table. Hence we have included both.

Q The allowables in this field are pretty low now, aren't they?

A Yes, the allowables have been low.

Q Do you know what they are for this month, Mr. Brinkley?

A I'm not sure, but I think they are seven barrels per well a day.

Q Have all operators been requested to furnish their information?

A Yes, the Engineering Committee for the Lower Gallup reservoir, Bisti, of which Sunray is the Chairman, have agreed, all the operator members of this Engineering Committee have agreed to furnish all available test information to permit an engineering evaluation of the Lower Gallup reservoir. I might mention the members of this committee, the following operators are members: British American, Phillips, Amerada, Gulf, Lyon, Shell, El Paso, and Sunray.

Q In other words, the operators have agreed to exchange information, is that correct? A That is correct.

Q Then your testimony today is based on such information as has been made available to you by the operators?

A That is correct.

Q What information do you have on the characteristics or the fluids which are contained in the Lower Gallup?

A We have the results of two bottomhole samples. The first sample was taken on Sunray Mid-Continent C-21, located in Section 8, 25 North, 12 West. The second sample is the British American Mayre No. 1 located in Section 1, 25 North, 13 West. Both of these bottomhole samples have been analyzed in the laboratory. The significant results of these laboratory tests are summarized as follows: The bubble point pressure, 1207 pounds per square inch absolute. Solution gas-oil ratio, 405 cubic feet per barrel. Reservoir volume factor, 1.26, reservoir barrels per stock tank barrel. Viscosity of the reservoir oil, 0.83 centipose.

Q Based on the engineering information now available, and the studies which you have made, what spacing do you recommend that this Commission adopt?

A It is my opinion, based on present information, that 80 acre spacing is proper for this pool. I feel we have sufficient data to justify that a permanent order would be proper and fitting, but no objection to a temporary order since we believe any additional data would confirm our present conclusions.

Q Do you recommend that this Commission, in its issuance of an order, extend the present area defined as the Bisti-Lower Gallup Oil Pool to include the area which is contained within the red outline on the various exhibits which Mr. Finfrock presented this morning?

A Yes, as Mr. Finfrock presented this morning, the yellow boundary represents the present known, or the presently defined boundary of the Lower Gallup reservoir. We have enlarged the area as shown by our red spaced outline. It is my recommendation that the Conservation Commission enlarge the presently known or identified yellow boundary to include the boundary as we have defined it here in the heavy red line.

Q Do you concur in Mr. Finfrock's testimony that the Lower Gallup formation is continuous throughout this area?

A Yes, I do.

Q Do you have any engineering information showing the quality of the sand which is covered by this application?

A Yes, I do.

Q Will you please refer to Exhibit No. 11 and identify and explain its significance?

A Before we open Exhibit No. 11, I would like to make some opening remarks. Exhibit 11 is the bound booklet of core analyses. This exhibit contains the results of cores taken on 26 wells. Bearing in mind now we have drilled and completed 134 wells, yet we have core analyses on only 26 wells. I believe that is enough information to permit a reasonable interpretation of the sand quality and sand characteristics for the Lower Gallup reservoir.

The first eleven pages in Exhibit 11 contain the results of core analyses for wells located along the longitudinal axis of this

reservoir. Now, that part of the reservoir contains the best quality rock in the entire reservoir. Also, as we will show later, not only is it better quality rock contained in the wells located along the longitudinal axis, but also it is more or less confined to only the upper portion of the reservoir. In addition to that, these cores which we have shown on the exhibit, represent the rock that has been taken as we drilled down through these wells, and we have taken the cores and had them analyzed and many many instances in our core analyses we find and can identify permeability throughout the entire section.

Furthermore, we find that as we move from the center, better-developed sand in the upper portion of the reservoir, to the northeast edge, we grade into inferior rock characteristics. Likewise, as we move a long way from the longitudinal axis to the south portion of the reservoir, we again grade into inferior rock characteristics. Which means if you take a transverse section across the reservoirs, you will go from inferior to the best you have got back to inferior rock characteristics.

Let us turn to page one of Exhibit 11. This sheet represents the electric log with the core analysis superimposed for the Phillips Petroleum Company Benally No. 2 located in Section 5, 25 North, 12 West. Mr. Devline will point to the location of the well. Bearing in mind again that the first eleven pages that we talk about, these wells represent the best wells that we have. They will all be

contained along the longitudinal axis of the reservoir. Page one shows the electrical log. In the center we have, we might say, the well bore and the depth. Also we have identified the upper sand with a one, and then the subsequently lower sands with numerical numbers, on the left we show the porosity graph. It is a bar graph plotted with depth according to the electrical log. The base line, which is on the right-hand side of the bar graph, represents zero percent porosity. As we move to the left, each division represents ten percent of porosity. You can see from this porosity graph that we have identified porosity throughout the entire cored interval.

On the right-hand side we have the permeability plotted as a bar graph. The base line representing zero millidarcies permeability, the next line to our right, one millidarcy, the next line ten millidarcies, the next 100 and the next 200 and the next 300 millidarcies. As you can see there looking up and down the permeability graph throughout the vertical section, we have identified permeability.

I direct your attention also opposite the sand which we identify as one being the upper member of this reservoir, the porosity is greater, also the permeability is greater.

Let's turn to page two. Here again we identified similar characteristics. This well is the Amerada Petroleum Joan White No. 2 located in Section 9, 25 North, 12 West. Again the porosity graph illustrates higher porosity opposite sand No. 1, yet we have

porosity throughout the vertical section. On the permeability graph we have identified greater permeability opposite sand No. 1, and also we have identified permeability throughout the vertical section.

I might mention possibly the average permeability for this upper member is of the order of 100 millidarcies. You will notice that the permeability in the lower portions of the reservoir is inferior to this 100 millidarcy sand.

Page three is the British American Douthit No. 11 located in Section 29, 26 North, 13 West. Again we display the same rock characteristics, better porosity and better permeability opposite the better sand, the uppermost sand. In this well the complete section was not cored. Sometimes we don't always core in the entire section, but what is there does show porosity and permeability.

Page four shows the similar thing, that is the British American Douthit B-2, located in 28, 26 North, 13 West. Without taking too much time, it is obvious that the upper portion of this reservoir identified as sand 1, is better developed in porosity as well as in permeability, and the relative values of each of these wells are consistent with one another.

Page five, the British American Mayre B-5, located in Section 35, 26 North, 13 West. Again we have a duplication of the similarity that we have been through.

Page six, the British American Mayre B-1 located in Section 35, 26 North, 13 West. Again a repetition of the preceding

information, namely that the upper sand is better developed both in porosity and permeability, and we have porosity and permeability in the vertical section.

Q Could I interrupt you for a moment, Mr. Brinkley?

A Yes.

Q On page five, on Mayre B-5, that shows an interval in approximately the center of the section shown with no porosity and no permeability. That means that no core was taken there?

A There was no core taken in that interval. We sometimes take what we can get and we try to do the best we can, but that's all we got.

Page 7, British American Producing Company, Mayre No. 1, located Section 1, 25 North, 13 West, again the upper sand shows better development. The lower portions show porosity where we have taken cores and we show permeability in some of those sections. Now, it's expecting too much from nature to have permeability every place. We take the reservoir as we get it, and in this section we found no permeability, very normal.

Page eight, Sunray Mid-Continent Oil Company Federal C-1, located in Section 6, 25 North, 12 West. Only the upper portion was cored, but again we have better-developed porosity and better-developed permeability, and those values are consistent with the previous illustration.

Page nine, again the same thing, which is the Sunray

Mid-Continent Federal C-10, located in Section 6, 25 North, 12 West.

Page 10, Sunray Mid-Continent Federal C-14, Section 8, 25 North, 12 West. Again the upper sand is better developed in porosity and permeability than the lower sections.

Page eleven, which is the last well now along this longitudinal axis that we have cores on that permit us to compare and conclude that that is the better-developed sand and that the relative values of the porosity and permeability throughout the longitudinal section where we have these cores shows consistency in values. So that at page eleven is Shell Oil Company Carson No. 1 located Section 24, 25 North, 12 West. Here we have better-developed porosity and permeability opposite the main body of the sand and below.

Now, pages twelve through twenty-four represent wells in the southwest flank. We have 13 wells that are between the longitudinal axis where the better sand is, and the southwest edge of the field, so these 13 wells in this inferior rock area will be studied next. Again we will attempt to show that although all these 13 wells show inferior rock characteristics when compared to the center of the pool, when we take them one at a time there is a great similarity as we go from northwest down to southeast.

Page twelve is El Paso Natural Gas Products Company Kelly State No. 1, the discovery well, located Section 16, 25 North,

12 West. Opposite Sand 1 we have a porosity about equivalent to the remaining porosity throughout the vertical section. On the permeability we have a permeability opposite the upper portion of the sand, which is also consistent in value with the lower portions of the reservoir. I should like to remind you that the previous examples we had average permeabilities of 100, 200 millidarcy range. Here we are talking about one millidarcy range. Again we show permeability in the vertical section.

Page thirteen, Anderson Prichard Begay No. 1, Section 25, 25 North, 11 West. This is an interesting well. The upper sand, you will notice, has inferior porisity and it also has inferior permeability. In fact, there are three sections in here, three intervals that the permeability hardly shows, the field has kind of slipped off, but there are three samples that did show this permeability. But this well is completed in the section immediately below the No. 1 sand. The No. 1 sand, you will recall, is the heavily colored yellow section shown onthe cross section. This is the only well, to my knowledge, that is completed in the second sand which is the sand immediately below this better-developed upper sand, but even so, the second sand has inferior rock characteristics, namely down to the order of ten millidarcies. That is only one tenth of the average permeability in the upper sand. The porosity still remains inferior to the center located wells.

Section CM and W Drilling Company Elliott located 30, 26 North,

13 West. Here we find inferior porosity throughout the vertical section and inferior permeability throughout the vertical section.

Page fifteen, CM and W Drilling Company Elliott No. 1, Section 30, 26 North, 13 West. Again we find inferior porosity with zero permeability. According to the core analysis, actually they made a well.

Page sixteen, British American Oil Producing Company Salge B-5, 33, 26 North, 13 West. Here we find poor sand development, although it is better than the lower sections, it is still inferior for the upper sand member. The same is true with the permeability, yet throughout the vertical section that was cored, we have permeability, also porosity.

Page seventeen, El Paso Natural Gas Products Company Kelly State No. 11, located in Section 22, 25 North, 13 West. Here opposite Sand No. 1 we find permeability and porosity, yet of inferior quality, but consistent with the previous values for the wells along the southwest portion of the field. Sunray Mid-Continent Federal C-18, a similar condition exists.

Page nineteen, the El Paso Natural Gas Kelly State No. 2, Section 16, 25 North, 12 West. A similar condition exists here, also. The same for page twenty, which is the El Paso Kelly State No. 3 located in Section 16, 25 North and 12 West. Here possibly the upper sand is better developed than the lower portions, but yet inferior to the wells located along the longitudinal axis.

Page twenty-one, El Paso Kelly State No. 4, Section 16, 25 North, 12 West. Again we have inferior rock characteristics and consistent with the other wells along the southwest portion of the field.

Page twenty-two, El Paso Kelly State No. 6, the same condition exists there. Page 23, El Paso Kelly State No. 7 located in 16, 25 North, 12 West. Here we find porosity and zero permeability. F R Anderson Petroleum Federal 21, 29, Section 29, 25 North, 12 West. This is the last well of the 13 that I explained that we have core analysis for along the southwest portion of the field. The same condition exists in this well, namely the rock characteristics for all wells completed in the southwest portion of the reservoir are, contain sand characteristics inferior to the wells along the longitudinal axis, yet when we examine wells along that trend, that they are generally similar to one another. We have two wells remaining which are the two wells along the northeast portion of the reservoir. Amerada Petroleum Gle-Na-Nup-Nah No. 2, Section 5, 25, 12 West. Here we find that the porosity and permeability are inferior to the wells located along the longitudinal axis, yet they resemble a similarity to those wells located along the southwest flank of the pool.

And the last well is the El Paso Natural Gas Sullivan No. 1-B, Section 30, 26 North and 12 West. Here we find better development in the No. 2 sand as far as porosity is concerned, yet it is of

inferior quality and we find, you might say, very little permeability in either the first or second sand.

In summary, we find that the better sand development occurs along the longitudinal axis. We find that there is great similarity in the values of the better quality sand as we proceed along the longitudinal axis, as we go to the southwest part of the field we find we get into inferior sand characteristics, yet have a similar quality from well to well. Also in the northeast part of the pool where we have the data, we find a similar condition, namely inferior sand characteristics, yet similarity between the wells.

So, in summary, it is my conclusion that the Lower Gallup reservoir consists of a thick sand section and the entire section contains permeability with the better development in the upper sand, and the upper development further confined only to the longitudinal axis. Although the better quality of the sand is contained in the upper sand, we do find an inferior gradiation as we proceed to the southwest, and an inferior gradiation as we go further to the east.

It is further my opinion, it is my opinion predominantly the reserves in the Lower Gallup reservoir will be contained in the upper sand and further the recoverable reserves will be regained predominantly out of the upper sand.

Q Mr. Brinkley, do you find evidence of well interference?

A Yes. Exhibit No. 12 has four wells circled, and the wells are located roughly along a transverse section at Section 6, Township

25 North, 12 West. The wells circled, starting from the top, are the Sunray 2-C located in Section 31, Section 6, No. 4, No. 6 and down in Section 7, C-18. These wells have been shutin for about a year. I would like to direct your attention to one little statement here that two of the wells intermittently produced a small amount of oil during that one-year period. They are the two wells, No. 4 and No. 6, but they are the only wells that we know of that we can estimate interference. I should like to direct your attention also that No. 18, located in Section 7, is in the inferior rock character area. Also Well No. 2-C is located in the northeastern portion of the field, again where the rock characteristics are inferior. Wells 4 and 6 are located in the area where the rock characteristics are good.

Briefly, we have observed pressure interference in all four of these wells across this transverse section, indicating that the pressure reduction occurs equally as good in the inferior rock characteristics as well as in the good rock characteristics, and the magnitude of the interference is sufficient to warrant us to conclude that interference will extend over a large area.

Let's take some detailed data. The insert on Exhibit 12, you will notice the insert on Exhibit No. 12, the first well C-18 which is the southerly-most well. Again it is located in the inferior sand characteristic area. I think we had six feet of sand, something like that. Five or six feet, perhaps one millidarcy of sand. The

table states that on October 22, 1956, over in the fourth column we measured a bottomhole pressure, 1535 pounds after the well was shut in thirty-three days. Approximately a year later, September 5, 1957, we measured the bottomhole pressure and it was 1430 pounds. That's a drop of 105 pounds per square inch throughout this period, the accumulated oil was 640 barrels, namely it did not produce during that eleven-month period. So we have experienced a draw-down of 105 pounds per square inch, and that draw-down is due to the production of offset wells only.

Now, if we consider that pressure draw-down as a result of producing the offset wells and taking the nearest offset well that produced and use that distance as a radius and circumscribe a circle around that well, that would give us an effective area. Now, that effective area is 250 acres in the inferior rock characteristics area. Let's take the last well, Sunray Mid-Continent Federal C No. 2. That well, on October 24, 1956, we measured a bottomhole pressure of 1512 pounds. On August 15, 1957 we measured 1207 pounds, a drop of 105 pounds per square inch.

I shall direct your attention again that this well is in inferior sand characteristics area. The interference, the drop in pressure being due to production, this well being shut in, hence the interference was due to the production in areas surrounding that well.

Again taking the radius of an area of drainage equal to the

closest well that produced during this period, we got an effective drainage area of 126 acres, the same condition exists for No. 4 and No. 6 where on the table in similar fashion we have identified drop of 82 pounds and 97 pounds. That's in the good quality sand. So in my opinion we have evidence that drainage occurs even in the inferior sand characteristics areas for a minimum of 126 acres. That's considerably in excess of 80 acres.

Q Then, based on this information, Mr. Brinkley, is it your opinion that one well will drain 80 acres economically and effectively?

A It is my opinion that it will with what information we have, and even in the inferior rock characteristics area will effectively drain an area in excess of 80 acres.

Q Then, Mr. Brinkley, if wells are drilled on a 40 acre density, will unnecessary wells be drilled?

A Yes.

Q How many?

A Approximately 300. Now, that is only an approximate figure, we don't know precisely what the definition of the boundary of this reservoir is, but it will be conservatively estimated that we will drill at least 300 unnecessary wells if we go to 40 acre spacing.

Q How much would it cost the operators to drill these unnecessary wells?

A We are looking at a minimum of twenty million dollars.

Q Will economic waste result if unnecessary wells are drilled?

A Yes. If we have to drill these unnecessary wells, this minimum of twenty million dollars could be more prudently spent in exploring for new oil finds or in purchasing equipment or materials for pressure maintenance and secondary recovery operations.

Q Have you made a study of the economics of drilling this pool to an 80 acre density as compared to a 40 acre density?

A Yes, I have.

Q Please refer to Exhibit No. 13 and identify and explain it.

A Exhibit 13 is an economic comparison of 40 acre development versus 80 acre development for the Lower Gallup reservoir. On the right-hand side we have two columns, one for 40 acre values and one for 80 acre values. The first number is the original oil in place, 40 acre wells and 80 acre wells. Now, the original oil in place at Footnote 1 means that we determine the oil in place volumetrically from the isopacks that you have seen this morning, core analysis, which I have presented, the fluid analysis that I also presented. The ultimate recovery which is Item 2 under Footnote 2, we have calculated a probable recovery. I would like to emphasize that probable. Now, in my opinion it is a probable number. A 40 acre well, 44,000 and 80 acre well, 88,000 barrels. The value of the recoverable oil, $111,000 for the 40 and $222,000 for the 80 acre well.

Investments to drill and complete a flowing well, based on an

average of nineteen wells, that we have drilled where we have the closed out accounting records, have averaged $55,000 each. The surface equipment, Footnote 5, consists of artificial lift, $10,000, miscellaneous surface equipment flow lines, proportionate share of tank battery, roads, water wells and various and sundry things, $11,000 per well. A total cost for the nineteen wells that we had adequate records to analyze, was $76,000 per well.

Operating expense, lease and well costs and taxes, we have estimated at $37,000 for a 40 acre well and $75,000, roughly, for an 80 acre well. Now, when we take the total revenue from the production and subtract out the investment and the operating expense, it indicates that a 40 acre well is a bread-even proposition. In fact, with our figures we show a loss. An 80 acre well shows a profit of some $70,000. That profit is a non-discounted profit, based on future earnings; in order to get an economic comparison of your present investment and your future earnings, we convert the future earnings back to the present condition. Hence, using a present worth compound interest factor of six percent, we show a material loss of 40-acre development and a very modest profit on an 80-acre well. Let me point out also that these economics do not include the cost of acquiring the leases. Also may I point out that there is differences of opinions among operators as to investment values, operating costs, various things like that which are inherent to the operation of different companies. This represents our

interpretation as a, may we say as a preliminary economics based on only what we know today. I don't think our economics would be materially affected with any reasonable differences in operating techniques and things like that, or even with additional information.

Q In view of the economic picture which you have presented, is it economic waste to drill on 40 acre spacing in this field?

A Yes.

Q What has been the industries success ratio of wells drilled compared to discoveries made?

A That success ratio is commonly referred to as demanding industry to drill ten wildcat wells in order to achieve a new discovery oil well.

Q Actually, your economics show a rather low profit even on 80 acre spacing, don't they, is that correct?

A That is correct.

Q In your opinion then, is the profit which can be made on 80 acre drilling commensurate with the risks which an operator must take to find oil and stay in business?

A No, it is not.

Q In other words, will the expected profit from this pool on 80 acres be sufficient to support exploratory drilling in New Mexico and elsewhere? A No, it will not.

Q Is there anything that can be done to increase the expected recoveries from this pool and improve this situation?

A Yes. By the application of secondary recovery operations with pressure maintenance at as early a date as possible.

Q What are the operators now doing to determine if secondary recovery will be feasible?

A At the present time Sunray, Phillips and British American are conducting a missible phase displacement test. That test is located at the intersection of Township 25 and 26 North, Range 12 West, 12 and 13 West. We went in and drilled a well in the center of four closely located oil wells. We have injected approximately 30,000 barrels of LPG. It is our plan to follow that LPG with injected gas. The gas will drive the LPG slug through the reservoir, displacing the reservoir oil and improve the recovery.

To date, in fact, today we will complete the injection of the 30,000 barrels of LPG a few days ahead of schedule. We have equipment arriving and will start gas injection in a very few days. This program, this test will continue so that we can evaluate and see if this reservoir is susceptible to this improved recovery method.

In addition to Sunray, Phillips and British American physically participating in this test, three other companies are contributing money to this test. They are namely the Shell, Amerada and El Paso.

Q Mr. Brinkley, if this is successful, how much do you expect this process to increase recoveries?

A My opinion, we can reasonably expect more than twice the recovery with this process than by natural depletion. That, in

effect, is just like picking up approximately two more oil finds with the wells already drilled.

Q Has Sunray had any experience in other types of secondary recovery that lead you to believe that LPG injection will be successful?

A Yes. This missible phase displacement is not a mysterious thing. It has appeared in magazines, papers and whatnot as a new recovery method. Missible phase displacement can be applied in several forms. Sunray has practiced missible phase displacement for several years. Several other companies have too, but they don't realize it. Our gas cycling pressure maintenance operations are nothing but a missible phase displacement operation where we have a reservoir field with wet gas and we inject dry gas to displace the wet gas, that very simply is a missible phase displacement. You are using a dry gas to displace something of more value, wet gas, and missibility means that they mix that is all it means. You can effectively displace the wet gas with the dry gas. Something that we have done for a number of years.

This LPG test that we have is a little bit different than that because not only are we pushing the slug forward by wet gas driven by dry gas, but in addition to that we have the extraction process ahead of it where the LPG extracts or washes out, if you will, the oil ahead of it. So we have no apprehension as to the applicability of this process, but it does require a field test to see if the

reservoir is susceptible to it and see if the reservoir fluids will react like we think they will.

Q You expect this program to be successful, don't you, Mr. Brinkley?

A The evidence we have to date, there is nothing available yet that would indicate that it will fail. Now we are in the early stage of this test and we don't have all the information we intend to get to fully evaluate the test, but to date there is no evidence to the contrary.

Q Now, in the event it should not be successful, you are not fully relying on this program of LPG gas injection to recover additional oil, are you?

A No, we are not relying entirely on the missible phase displacement program. It's customary to evaluate several recovery methods and pick the optimum one for prudent operation. So we have investigated the possibility of injecting the produced gas and the results of that engineering study indicates that if we should go that route, that we can improve the recovery by fifty percent as compared to primary methods which economically is better than the present competitive methods.

Q In other words then, gas, just straight gas injection is a proven method, is that correct?

A It is a proven method and people have become educated to it and have accepted it.

Q You are of the opinion it would work here?

A Yes.

Q Now, Mr. Brinkley, what effect does close spacing have on the success of an LPG gas or just a regular gas injection program?

A In my opinion close spacing would offer a hazzard to the effectiveness of achieving the maximum possible recovery. In other words, 80 acre spacing would be advantageous because the greater the distance between your injection well and your oil well the greater will be your overall flushing efficiency, because it minimizes the channel, the channeling nature of your driving fluid. I have observed that in many water floods. I have observed it in our cycling projects, and other experts who have published their opinions, recognized experts if you will, have made the same statement.

In checking the overall flushing efficiencies of several gas cycling projects, we have defined overall flushing efficiencies within the swept portion as high as 80 percent. So in my opinion it behooves us to follow as wide a spacing for secondary application whether it be gas drive or whether it be LPG injection, or water flooding or what you may want to use, it would behoove us to use as great a distance between the injection wells and the producers as possible.

In addition to that, the Sacroc Engineering Committee have also observed in their flooding operations quick break through on

first row offset and prolonged displacement flushing efficiencies at a high value on the second row offsets, and they have gone to shutting in near wells in order to achieve the higher flushing efficiency.

Q Can you name any of these experts that agree with this theory of yours, Mr. Brinkley, that the wider spacing is conducive to a higher ultimate recovery?

A The theory is not unique with me. I have learned from the other people, but I have observed that the statement that these recognized authorities have released, and my association with the research people as well as the practical operators leads me to believe that the wide spacing is the prudent thing to follow. Now, specifically, one recognized expert that I can mention who has made this statement is Morris Muscat in his book Physical Principles of Oil Recovery. I believe that is about the name of it, but he makes that statement.

Q Who is Mr. Muscat employed by or affiliated with?

A Dr. Muscat is connected with the Gulf Oil Corporation in their research facility.

Q Then would 80 acre spacing increase the oil recovery which could be obtained under secondary recovery programs which the operators are now considering?

A In my opinion it would assure a maximum flushing efficiency, whereas a closer spacing would hinder it.

Q Mr. Brinkley, what other rules do you have at this time to offer to the Commission for the regulation of this field?

A The location of the wells to be in diagonal 40 within a Governmental 160 acre tract, no closer than 330 feet from lease lines. The location in diagonal 40's will encourage uniform spacing, 330 foot formations will permit flexibility of well location where needed, especially near the edges of the field or at the gas cap. Most of the wells drilled to date are in the center of 40's. In addition I would recommend that we have original bottomhole pressures, better state it this way, originally completed bottomhole pressures and gas-oil ratio tests and semi-annual gas-oil ratio and production tests fitting a schedule consistent with what the Commission would desire. Also a limiting statewide gas-oil ratio of two thousand to one.

Q Then, based on your testimony today, Mr. Brinkley, is it your opinion that the granting of this application is necessary to prevent waste and secure the greatest ultimate recovery of oil from this pool? A It is.

Q Were all exhibits offered by you today as a part of your testimony prepared by you or under your supervision?

A Most of them were prepared personally by myself. Some of them were delegated and I supervised them.

MR. ERREBO: If it please the Commission, at this time we would like to offer Exhibits 9 through 13 in evidence.

MR. PORTER: Are there any objections to the admittance of these exhibits? They will be admitted to the record.

MR. ERREBO: That's all we have.

MR. PORTER: Anyone have a question of Mr. Brinkley? Mr. Seth.

CROSS EXAMINATION

BY MR. SETH:

Q I would like to ask just a very few questions. First, on the secondary recovery test you referred to Sacroc. Would you compare the permeability existing there with this pool here?

A That is a very dangerous statement to make because of the heterogenity of rock characteristics. Now here we have very good permeability, here we have very poor, we have observed in Sacroc we have very good permeability, we have very poor.

Q Can you compare the two, the good there and the good here?

A No.

Q The bad here? A No.

Q Do you have any figures on that at all?

A No, I don't.

Q Well, how can you compare with the Sacroc for your secondary recovery to this pool then if you have no basis of comparison as far as permeability is concerned?

A I can answer you best this way, that fluids follow a freedom path, that is they will follow a path of least resistance.

Now their path of freedom would be affected by pressure differential and distance. Now, that physical condition has been observed in many, many reservoirs with many kinds of rock characteristics. I'm afraid that I would mislead people if I got down to a minute rock characteristic because to me it is irrelevant.

Q It is just pressure and distance are the only factors as far as you are concerned? A That is the important thing.

Q You are assuming, in your testimony, about the sweep efficiency and so forth that this is entirely a homogenous reservoir?

A No reservoir is entirely homogenous.

Q Are you assuming it or are you not?

A I beg your pardon.

Q Can you answer the question first and then explain your answer?

A I am not assuming that the reservoir is homogenous.

Q You are not? A No, sir.

Q Go ahead and explain.

A Since we recognize that fluids follow a freedom path, then it is up to the engineers to direct the flow of the fluids and encourage them to follow a definite path, which is what we try to do.

Q How do you try to do that?

A By the proper location of our wells and withdrawal rates and injection rates.

Q But your initial wells where you pilot flood are for all practical purposes on the 20 acre spacing, is that right?

A Yes, the oil wells are located in centers of 40, but the injection well --

Q The injection well is a five spot?

A That is correct, yes.

Q Why didn't you begin it on a wider spacing if you are going to direct the course of this LPG as you stated?

A That is a very interesting question. Don't misunderstand me, we can explain it. We searched around for an area where the wells were closely located.

Q Why did you do that?

A We wanted our results quickly. We were experiencing rapid reservoir pressure drop and we had to get our rules soon enough so that we could apply this method, if it can be proven applicable, before sufficient pressure drop had occurred that would prevent the application of this method. That is the reason we did it.

Q Then does time of the recovery of the LPG, is that a factor in a project of this character?

A I don't understand what you mean about time of recovery.

Q This LPG I assume costs considerable amount of money. If you inject it you are interested in getting it back, I assume, in reasonable time.

A Economics are not only based on recovering the LPG, but

recovering more oil.

Q Can you answer the question directly?

A What is your question?

REPORTER: Reading: This LPG I assume costs considerable amount of money. If you inject it you are interested in getting it back, I assume, in reasonable time.

A Yes, we are interested in getting it back in a reasonable time, and LPG does cost money.

Q Then isn't that the case the closer the spacing the quicker you will get back the slug and the recovery of oil?

A So that I don't confuse the Commission --

Q (Interrupting) I don't believe the question will be confused if I may say so, they have a lot of witnesses. Just go ahead and tell us the story.

A All right. We are interested in making money. Now, there is an economic optimum spacing which would keep our investments at a minimum yet provide a maximum recovery in revenue that would permit us then to define the spacing so that we could get the maximum amount of oil, make the maximum amount of money with the minimum amount of investment. We can't always achieve precisely the optimum condition, but we have to assure ourselves of the best chance of getting the most oil out within a reasonable period of time, and the 80 acre spacing qualifies for that decision.

Q Would you testify, or would you state that you would get it

back sooner if it were on 40 acre spacing, or would you not?

A You might get it back quicker on 40's than you would on 80's. It is also a function of how fast you inject it and how fast you withdraw. It is a complex thing. I don't want to be evasive with you.

Q The reason I asked the question was you testified that you pick the four close wells because you wanted a quick answer?

A Yes.

Q From that I assume the closer the wells the quicker you get an answer, so consequently the closer the ultimate spacing the quicker you get back the secondary recovery oil?

A No.

Q The quicker you get back the LPG?

A No, I misled you.

Q I'm easily misled.

A One thing we are interested in is channeling, we want to know when the LPG breaks through to the oil wells, by knowing how much we have injected and the time at which it broke through, then that will give us some idea of the flushing efficiency. Another thing we wanted to know, and know fast, was the pressure. We have to maintain roughly 1250 pounds pressure before this method will work. Another thing we wanted to check and learn quickly would be the injection capacity of these wells. If we can't get the LPG in we want to know it now. If we can get it in, we want to know it now.

So for the reasons we picked the wells that were closely spaced, so we can find the answer in six-month's time rather than wait a year and a half or two years when the pressure is down so far we couldn't apply the method.

Q Well, Shell is participating in the program?

A Yes.

Q You are using some of their money at least?

A Yes.

Q Now, I want to refer to your Exhibit 13. Do you have one handy there? That's the well cost. Do you have that there?

A Yes.

Q Now, would you please state the factors that you use in making these computations? A Yes, I'll be glad to.

Q Will you start with the oil in place?

A Start with the first one, oil in place?

Q Yes.

A We find that the better quality sand is along the center part of the reservoir, so we took the isopack and said that the sand contained within the 20 foot isopack line was better quality than the sand contained between the 10 and 20 contour line, the inferior rock then would be along the edges of the field where the isopack thicknesses were less than 10 feet. Now that is a means of dividing the reservoir up into three parts where we studied the inferior rock, we studied the best rock and then the rock in between. So we

determined the oil in place in the best quality rock, the oil in place in the poorest quality rock, and then the oil in place in between and added them together, which would define the oil in place.

Once we defined that, then we followed the solution gas drive performance equations.

Q Excuse me, give me a little detail on how you determined the oil in place between the bad and the good section, what thickness did you use and all the factors?

A Between the zero and 10 foot line that would be the poor quality sand, we found or measured 14,203 acres which had 17,016 acre feet. The rock properties were 10.6% porosity, 6.2 millidarcies permeability, 43% connate water, and it contained 26,600,000 barrels of stock tank oil in place. Between 10 and 20 foot contours on the isopack, we had 9,736 acres, 146,045 acre feet, a porosity of 12.7%, permeability of 43.6 millidarcies, connate water of 23% with 83,200,000 barrels of oil in place. For the best sand where we had 20 or more feet or in that area we had 732 acres, 15,376 acre feet, a porosity of 14%, a permeability of 100 millidarcies, connate water of 10% with 12,000,000 barrels of oil in place.

Now then, out of that reservoir volume I had to subtract the gas cap volume. Now, the gas cap covered 3,906 acres approximately, or 24,390 acre feet, or roughly 16,400,000 reservoir barrels.

Q Now, on your first point zero to ten foot contour, how

did you arrive at this 10.6%?

A I took all of the core analyses that were on wells located between the zero and ten foot isopack line, of which there were thirteen. I added them up for the porosity and permeability and divided by thirteen and got arithmetic average porosity and permeability.

Q It is not a weighted average?

A No, sir, just an arithmetic average.

Q The same on your permeability?

A Precisely.

Q Do you feel that a more accurate analysis could have been made if you had used the weighted average? What were the maximum and the minimum porosity within that area?

A The maximum value between the zero and ten foot isopack line was 18% porosity and 70 millidarcies permeability, the minimum value on a producing well was 6% porosity, and zero millidarcies permeability.

Q Then your average of zero and 70 is your arithmetical average, is that a very true picture of the situation?

A Well --

Q (Interrupting) How much of the interval was 70 and how much was zero, is that a factor or not?

A Well, that is only one of the thirteen samples. The other twelve average one millidarcies.

Q You are using just bare averages and you disregard entirely, if I understand you, the thickness of the particular formation for which that factor is given, is that right?

A I don't understand you.

Q You are just using a maximum and minimum, you disregard how much of the interval is the maximum and how much is the minimum, is that right?

A No, I'm afraid I haven't made myself clear.

Q Tell me how you arrived at your average again.

A I got the average porosity for each of thirteen wells, I got the average.

Q How did you get the average?

A By reading the core graphs we have here.

Q What figures did you use, the maximum and the minimum?

A Well, the maximum -- let me check here -- I'm sorry, I misled you. This is 7 millidarcies instead of 70. What I did was just by inspection, take the sand interval, the average value from the bar graph, just by inspection, I didn't try to refine it, and I did that for each of the thirteen wells completed within the zero isopack line. And I take the averages for each well and add them up and divided by thirteen.

Q The selection and the manner of getting the average would have quite an influence on your final figure, would it not?

A No, it would not.

Q It wouldn't have any influence?

A Oh, one percent maybe. It's a nebulous thing.

Q If the same is true for both porosity and permeability, wouldn't it have an effect on your figures in a substantial amount?

A With the data we have, no. Now, if every well were cored we could construct iso-permeability maps, iso-porosity maps, and set up a grid network and run it through the electronic computer, which we do in many cases. But I have observed where we have, I'll put it this way, usually by arithmetic averaging, if you have enough samples that you are still representing, shall we say, the average rock properties, I hold no apprehension as to the average values I have used.

Q Does that hold true where there is a great spread between the maximum and minimum which we have here in which you say the spread is great here?

A We have minimized the spread that you are referring to by breaking the reservoir up into three smaller segments, so we have eliminated that hazzard.

Q Do you have any figure on the per acre oil in place within the zero line or within any other particular area?

A The stock tank oil in place?

A Yes, the corrected stock tank.

A I would say that the in place oil on an acre basis, assuming an average acre would be someplace in the neighborhood of

5,000 barrels.

Q We're talking about per acre feet, per acre foot.

A Per acre foot?

Q Yes.

A Yes, I can give that. In the neighborhood of 520 barrels per acre foot. That would be for an average acre foot.

Q Now, would you say that since it is an average it would hold true pretty well throughout the area that you have defined here?

A No. No, no, not at all.

Q That's perhaps, I might state it this way, in the testimony of Sunray at the LPG hearing, you had a slightly different figure I believe. Would you explain the difference?

A Do you have an exhibit?

Q Is that a different area?

A I would have to refer to the previous exhibit.

MR. ERREBO: If it please the Commission, I think the record will show that a different witness testified.

Q I believe a Mr. Brooks testified. Are you acquainted with Mr. Brooks?

A Yes.

Q He testified, I am reading from page sixteen of the record in Case No. 1280, now this is the case on the LPG understand. We will assume that it is limited to that general area, although it doesn't express it as so. You say that other witnesses have said it is pretty much the same all throughout the reservoir, we can

use this figure. He testified that there are 670 barrels per acre foot of original oil in place.

A Yes, I certainly appreciate that statement. The pilot area is in the better quality sand. Now, if you take the better quality sand of 670 per acre foot and add to it the poorer quality sand which has less than 100, the overall average is still consistent with the figures that were presented at the previous hearing.

Q Sunray, in a letter to the various operators dated July 8, 1957, indicated that the original stock tank oil, this is a sentence, recovery by primary depletion is calculated to be 20.9% and recovery by LPG is estimated to be 50% of the original stock tank oil, or 234,000 barrels. Original stock tank oil would be 468,000 barrels according to this letter. This letter was written by Mr. Penn. Would you like to look at the letter?

A I'll be glad to look at the letter.

Q Do you have any comment on it?

A I don't know.

Q Do you have any comment on figures used there as compared to your figures?

A No, they are consistent with my figure.

Q You feel they are. Now, referring still to Exhibit No. 13, ultimate recovery, could you give us a time factor on that? How long it is going to take to recover 44,000 barrels?

A For the 40 acre well, thirteen years.

Q How long for the 80 acre? A Twenty years.

Q Twenty, did you say? A Yes.

Q Now, I hate to burden the Commission with this, but our figures are on a little different basis, but I would like to have the witness compute the stock tank oil within the isopack, the zero to 10, the 10 to 20. Would you do that for us?

A You want the oil in place between the contour lines?

Q Separately on a per acre foot basis.

A All right.

MR. PORTER: Let's take a short recess.

(Recess.)

MR. PORTER: The meeting will come to order. Do you have your answer computed, Mr. Brinkley?

A Yes. The original barrels of stock tank oil in place for the zero to 10 foot isopack interval will average 370 barrels per acre foot. For the 10 to 20 foot interval they will average 570 barrels per acre foot. For 20 feet or more, 780 barrels per acre foot, an average for the entire reservoir, 520 barrels an acre foot.

Q Thank you for the calculations. That gives us a little better basis to compare our figures. Now, in making these computations did you use your isopack map that was introduced in evidence --

A Yes.

Q (Continuing) -- earlier in the hearing?

A Yes.

Q On that isopack map those thickness figures, are they based on the net microlog?

A They were based on the net, they're based on the spread in the microlog, logs.

Q It purports then to be the total of the microlog pay?

A Yes.

Q At the point through which the line is drawn, is that correct? A That is correct.

Q Just a few more questions. We have divided this up in the hope of saving time. I have about two more questions. How many wells would you say that you have listed that are in the inferior rock area, as you call it? A Thirteen.

Q How many of these would you regard as being profitable wells? A None of them.

Q None of them?

Well, if a substantial portion of this reservoir and the data that you have used is in areas that are not profitable, do you think that should influence the rate of development of the better portion?

A I'll state this, that they are non economic on 40 acre development. I didn't make myself clear to you.

Q Were you testifying on an 80 acre basis then on the economic?

A That is a good question.

Q Well, you are a good witness, can you give us an answer?

A On primary recovery I would judge that they would be non economic under competitive type operation.

Q Then in our data, though we have used those wells and we have used the area inwhich they're located, though, to arrive at an overall figure. A Exactly.

Q Just one more question. On the electric log data, I believe that was Exhibit 11, do you have that?

A Yes.

Q You have been referring to several of the pages there. I believe on page twelve, for example, page two also, I understood your testimony to be that there was permeability throughout the Gallup sands as shown by that exhibit, is that right?

A We have identified permeability throughout the vertical section on page two of Exhibit 11.

Q Let's stay with page two a moment.

A All right.

Q What do you mean by the statement that you have identified permeability?

A Anything greater than zero millidarcies.

Q Is the permeability of zero millidarcies, is that significant for your purposes here? A Yes.

Q It is? A Yes.

Q Then you would also testify that there is and can be

vertical migration through the sections since you have identified permeability throughout the sections?

A I would state that there is communication throughout the entire reservoir by virtue of the inherent permeability of the reservoir rock.

Q Will you also state that since you have identified permeability on page two of Exhibit 11, that there will be and can be vertical migration adjacent to that well bore?

A I hate to use specifically vertical migration. Fluids are freed to travel a freedom path. It might be vertical, it might be horizontal, it could be anything in between. There is freedom of travel when we have permeability.

Q Then there is freedom of travel, if you prefer to use that term, vertically adjacent to the well bore?

A There could be.

Q Although the permeability in the area may vary from zero to 50 or 100, is that right? A Exactly.

Q Do you disagree then with Mr. Finfrock on his, as I understood his testimony, that there were barriers existing between the lower five sands, the lower four sands?

A I don't recall exactly what Mr. Finfrock said.

Q Let's put it this way, if he did so testify, I'm not saying that he did or he didn't, if he does you would disagree with that?

A I am not saying I would disagree. I would state my opinion

on what I think the reservoir rock contains. I would rather restrict my testimony to my belief rather than me make a comparison with what he said.

Q If there is silt stone or some other formation between these sands of zero permeability, or a little more permeability than that, you say that is not a barrier, is that correct?

A A barrier is a matter of degree. Now, in any reservoir rock we find a normal hetorogenity in reservoirs we say are homogenous, we still find portions that have zero permeability, it is acceptable. We are just thankful to have what we have got. I don't consider zero permeability in some place in a section like this as a barrier.

Q You don't consider it a vertical barrier?

A No, fluids are still free to flow horizontally to some other place than vertically.

Q Then let us assume that they are some distance from the well bore, there is an area they could rise vertically and get back up to the upper sand or the lower sand as the case may be?

A The fluids follow a freedom path.

Q Is my statement correct? A It could be.

Q Is it or isn't it? Can you answer the question? If you can answer it -- A I don't know.

Q But you feel throughout the reservoir this will occur, you have so testified to that?

A I feel that we can consider this reservoir as possessing permeability in the vertical section as displayed from the core analyses that we have.

Q But if the oil has to move laterally before it can move vertically, why that would assume that there is some sort of a barrier there, would it not be of a lenticular nature or shape, and if there are discontinuities within the reservoir, that is what you are testifying, are you not?

A I don't want to seem vague, actually we don't know what is in the reservoir between our wells. We do know that fluids do follow a circuitous path in the freedom path in reaching an outlet, you might have a barrier right here, but no barrier there. I don't know.

Q Since we don't know, the more wells that are drilled into the reservoir, the more likely we are to encounter these permeability areas, are we not?

A Not necessarily, no, sir.

Q Aren't the chances better the more you drill?

A The more chance you would have of not experiencing them too.

Q Don't you think the odds are better at all?

A No, I don't.

Q To drill twice as many wells?

A No, I don't.

MR. SETH: That's all.

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q I would like to establish the identity of some of the names that have been used in the examination. Mr. M. B. Penn, what is his capacity with Sunray Mid-Continent?

A I should like to ask my counsel to correct me if I am wrong, or perhaps maybe he would be better qualified to give you his complete title.

MR. ERREBO: His complete title is Chief Unitization Engineer.

Q Chief Unitization Engineer. Both you and he are in the Engineering Department of Sunray then?

A I would prefer counsel to answer.

MR. ERREBO: No, sir. As a matter of fact, he is in a separate section from Mr. Brinkley's section.

MR. MALONE: He does have authority to speak for Sunray?

MR. ERREBO: Yes.

Q Mr. Brooks, who testified here in the former hearing?

A Yes.

Q What is his capacity?

A He is in my section as a Senior Reservoir Engineer.

Q Are you his superior or he is your superior?

A I am his supervisor.

Q Were you present when he testified here in the hearing

on the LPG project? A Yes, sir.

Q You heard his testimony at that time?

A Yes, sir.

Q Referring to page sixteen of the transcript, I invite your attention to the following question and answer that appears there. "Q Please refer to Exhibit No. 7 and identify and explain it." "A Exhibit No. 7 is a summary of the average reservoir and fluid characteristics of the Bisti-Lower Gallup Oil Pool. Some of the pertinent information on this exhibit is that 20 wells have been cored and we have shown the average rock properties, the bubble point pressure of fluid analysis was 1207 pounds per square inch, and the bottomhole pressure in April 1957 was 1319 pounds. We have shown that there are 760 barrels per acre foot of original oil in place." You heard him so testify? A Yes.

Q And he stated that he had taken into consideration the average reservoir and fluid characteristics of the Bisti-Lower Gallup Oil Pool, did he not? A That's right.

Q And the core analysis that he considered are the same core analysis that you have based your testimony on here today, are they not? A That is correct.

Q Would you then take 670 barrels per acre foot and compute the oil in place under a typical 40 acre location?

A Yes.

Q Let's assume, for the purposes of the question, a 20 foot

thickness, which I believe you testified was approximately average.

A No, I did not.

Q You did not? A No, I did not.

Q Did Mr. Finfrock, I believe it was Mr. Finfrock who testified to 20, use 20 feet.

MR. SELINGER: He averaged 15 for the upper and 4 to 6 on the lower.

Q For the purposes of the question, would you compute it at 20 feet, please?

A Would you like the original oil in place?

Q Original oil in place.

MR. CAMPBELL: If we are going to have some calculations to establish the case for the protestants, I think they should be based upon what the witnesses have testified as to the average rather than the highest thickness of the pay.

MR. MALONE: I will be glad to state what I had in mind, the economic comparison offered in evidence is based on average oil in place figure on some 210,000 barrels on the 40 acre location. The computation on the basis of the 670 figure used in the former hearing by another representative of the same company gives us a figure of some 536,000 barrels, based upon a 20 foot thickness, which we believe the evidence testified to will support. The question of whether a 40 acre location is profitable or not profitable depends on how much oil there is under it, the difference between

536,000 barrels and 210,000 barrels is very substantial, and we felt that under those circumstances since the testimony from representatives of the same company showed that big an apparent disparity, it would not be unreasonable to ask the witness to verify the fact.

Q Can you give me an answer to that?

A I'm confused what you are asking for now.

Q I'm asking if you would agree with me that assuming a figure of 670 barrels of oil in place per acre foot on a 40 acre location with a 20 foot thickness of the oil sand, whether you would agree that 536,000 barrels would be the oil in place.

A In answer to your questions, I would say, no. In the first place I do not agree with the 20 foot sand thickness.

Q I asked if you would assume that for the purposes of the question.

A It's dangerous to take hypothetical cases. I would prefer limiting my testimony to the facts of the case.

MR. MALONE: If the Commission please, I believe I'm entitled to ask the witness to make the computation or to agree or disagree with the figure given. I don't want to be unreasonable. If the Commission has any question about it, I'll leave it.

MR. PORTER: Mr. Brinkley, go ahead and compute the figures using a 20 foot thickness.

Q What figure do you get?

A Using 640 barrels per acre foot, is that the figure?

Q 670.

A I beg your pardon. I have used 640. 670 barrels of stock tank oil in place, and assuming a hypothetical thickness of 20 feet, and assuming that would be representative for an average 40 acre well, you would have assumed oil in place, calculated on that data, of 536,000 barrels.

Q And that would compare with the figure of 210,000 on Exhibit 13, would it not?

A It depends on how you use the word compare. It would be used in lieu of this, but we are not on the same basis.

Q But both figures relate to stock tank oil in place, do they not? A Yes.

Q Yes, sir. Now, would you compute the recoverable oil that would underlie a 40 acre location on that basis?

A Using my same recovery figures?

Q Using the oil in place figure which you have just obtained. I believe it was 21% that you used in your calculation.

A Yes, 21%. That would give 113,000 barrels of recoverable stock tank oil for that condition.

Q And assuming that condition to be correct, that would compare to a figure of 44,000 barrels which you have shown on Exhibit 13, would it not? A That is correct.

Q And now, would you compute this figure of value of net 7-8

oil recovered for the figure that you have just obtained?

A 280,000 dollars.

Q That would compare with the figure of $111,000 which you have used on Exhibit 13, would it not? A Correct.

Q If that figure was used in lieu of $111,000, the economics of drilling on 40 acres would be apparent, would it not?

A That is correct.

MR. MALONE: Will counsel for Sunray stipulate for me that their geological witness. Mr. Finfrock, that he testified that there were 15 feet in the upper sand and 4 to 6 feet from the lower segment of sands?

MR. ERREBO: I think the record will show, of course.

MR. MALONE: I didn't want to search the record on it.

MR. ERREBO: Fifteen feet for the average for the upper sand.

MR. MALONE: And 4 to 6 feet to the lower?

MR. ERREBO: I think that would be all right.

MR. MALONE: And I am sure that we can stipulate that fifteen and four make nineteen and fifteen and six make twenty-one, and that twenty is halfway between them.

Q So that if we use as a figure for recoverable oil in place the figures which you have just computed, development on a 40 acre basis would be economic, would it not?

A Assuming this condition, correct.

Q Now, referring to the letter of Mr. Penn from your company,

which was heretofore referred to and which I would like to identify and offer in evidence.

(Marked Gulf's Exhibit No. 1, for identification.)

Q Will you examine the exhibit and see if you can identify the signature of Mr. Penn? A Yes, I do.

Q That is a letter that was sent out to the operators in the Bisti Field, is it not? A Yes.

Q I read you the paragraph beginning on the first page of that letter: "In the 40-acre area to be swept lying within the 160-acre pilot area, our engineers estimate the original oil in place to be 468,000 stock tank barrels." Am I correct in construing that is a statement that in 40 acres that lies between your four wells up there in the pilot -- A That's correct.

Q (Continuing)--That the original oil in place was 468,000 barrels? A That is correct.

Q That will compare to figure of 210,000 barrels used on Exhibit 13, will it not? A No, it will not.

Q Bearing in mind that this refers to a particular portion of the field? A Exactly.

Q And that you have used an average as to the remainder of the field? A Exactly.

Q But with that difference it has the same reference, does it not? A Exactly.

Q So the figures do relate to the same thing?

A No, they do not.

Q Well, I believe you will agree with me that your figure is your computation of the number of barrels of oil in place under an average 40 acre location in this field.

A That is correct.

Q And that the figures stated in this letter relate to the number of barrels of oil in place under a particular 40 acres?

A That is correct.

Q And as between the average that you arrived at and the particular 40 acres, there is a difference on your own statements of 210,000 as against 468,000 barrels of oil in place?

A That is exactly right.

Q You would agree that the 468,000 acre reserve would justify the drilling of this field on a 40 acre basis, would you not?

A At that particular location, yes.

Q Now, in arriving at your estimate and allocating the reserves throughout the field, how much of the field have you treated as being production? In other words, what was the area that you have used in dividing your oil in place over the field or the pool? How many acres? A 24,671.

Q How did you arrive at that figure of 24,000, by measuring the isopack?

A By measuring the isopack, yes.

Q Did you take into consideration the portion of the field that had the rich upper sand as well as the portion that had the less desireable lower segment?

A I took that into consideration, yes.

Q You have in effect allocated the production from the good sand out over the area which is not actually overlain by that good sand? A Would you restate that?

Q That is the effect of your allocation is to allocate it over the entire area whether the good sand exists there or not?

A We have allocated, we have computed the oil in place for the productive reservoir, yes.

Q And you have allocated it without reference to the boundaries of this upper segment of sand? You have allocated it over the whole 24,000 acres and not just a portion overlain by the --

A (Interrupting) That is correct.

Q (Continuing) -- by the good bar that you have testified to?

A That is correct.

Q This figure of 24,000 acres compares to what figure, that is the total for the entire proposed field which you have outlined?

A The area within the area we asked to be spaced represents 46,720 acres, or 73 Governmental sections.

Q You have treated 24,000 of that as being productive for the purpose of this allocation? A At the present time --

Q (Interrupting) Well, is that the figure that you did treat?

A Yes.

Q Thank you. Go ahead and explain your answer, I wanted to find out if that was going to be correct.

A The only thing I was going to say is that based on the information that we have, the productive boundary to date is the 24,671 acres, but I want to qualify that and state that before we could adequately define productive boundary, it is going to take more development, and it will be concentrated within the area we have asked to be spaced.

Q So your answer is that is true. Now, Mr. Brinkley, I believe you testified to a serious threat that occurred when Shell announced some 40 acre locations. You are aware of the fact that the rules of the Commission provide for 40 acre location in absence of other order by the Commission, are you not? A Yes.

Q So there was not a threat to do anything except what the rules provided, was there?

A There is a caution signal since our evaluation certainly spells caution to us to not drill on 40 acre spacing, and we consider it a threat.

Q Yes, well that subjectively you considered, but insofar as the rules of this Commission are concerned, Shell was perfectly entitled to do what they did do, were they not?

A Yes.

Q Now, with reference to the hearing on this 40 acre pilot

gas LPG injection system, you were present at the hearing, you testified? A That is correct.

Q And you now say that because of the possibility that a large part of the recovery will have to be secondary, it is your opinion that this field should be developed on 80 acre spacing?

A Exactly.

Q That ties into the repressuring project of Sunray's?

A Exactly.

Q Did you or any other Sunray witness at the time of the meeting in which you got the Commission to approve that project, testify that you expected if it worked it was going to require 80 acre spacing?

A I didn't testify. Now, the man, Mr. Brooks, who did testify, I don't recall what he said in that regard.

MR. MALONE: I believe the record in that case has been incorporated here?

MR. COOLEY: No, it has not.

MR. MALONE: We would like to ask that the record in that case be considered a part of the record in the case now before the Commission.

MR. CAMPBELL: For what purpose?

MR. MALONE: For the purpose of disclosing the fact that there was no statement of a proposed 80 acre spacing plan in connection with the LPG pilot.

MR. CAMPBELL: I wasn't within the call of the hearing. It wasn't suggested there we will stipulate that. Rather than encumber the record any further with the entire record of the other case.

MR. MALONE: If it can be stipulated the witness said he didn't know what had been testified to, if it be stipulated that there was no reference in that hearing. That is the thing we wanted to establish by the record.

MR. COOLEY: Does Sunray so stipulate?

MR. ERREBO: So stipulate.

MR. CAMPBELL: Yes.

Q Would you agree, Mr. Brinkley, that the results which you will get from your pilot test as it is now set up, will be more applicable to the results you would obtain on 40 acre development than on 80 acre development?

A You speak of results. Would you like to ask me specifically what results?

Q Well, the results which you felt you must get in a hurry, and hence you had proceeded on that basis. My question is will the information that you obtained be more applicable to 40 acre or to 80 acre spacing when you receive it?

A Yes. Without the results --

Q (Interrupting) It will be more applicable to the 40 acre development?

A No, it would be more applicable to the 80 acre.

Q Now the density of those wells is one to each 40 acres, isn't it?

A Yes.

Q You have an injection well in the center of the four wells?

A Exactly.

Q It is your testimony the results you obtain from that pilot project will be less applicable to 40 than it would be to 80 acre?

A I will state it this way, that as an example, a specific example, we will need to know the injectivity capacity of the injection well before we can go to 80 acre spacing, and hence we have to qualify the well. Now then, if we were unable to get insufficient volume of LPG into the injection well, it would automatically throw out the 80 acre spacing. We know from our experience that 80 acre spacing is desireable and warranted, fitting and proper, but we were waiting on the injection well to qualify itself to show and display sufficient injection capacity in order to completely achieve that.

Q My question was when you do know that, it will be more applicable to 40 acre development because those wells are on 40 acre?

A No.

Q You do not agree to that?

A I do not agree.

Q Can you tell me whether or not you feel that the information which you obtained from this pilot project will be a sound basis for you to recommend to your management development if the field is developed on an 80 acre basis?

A Yes.

Q You feel the information will be adequate?

A Yes.

Q I believe you testified that it's your opinion that any well or any pool can better be subjected to secondary recovery and LPG flood or recirculating if it is developed on 80 acre locations than on 40 acre locations?

A If I said any pool, let me rephrase my statement that we would confine that to a reservoir.

Q Then any --

A (Interrupting) Then with --

Q Excuse me.

A Then within the reservoir, which by definition would imply continuity, then you would achieve greater overall flushing efficiency as you increased the distance between the injection and the producing wells.

Q So that it is your testimony that you favor 80 acre spacing in all fields where a single reservoir is involved in order that secondary recovery may be more sufficient?

A Yes.

Q Now, you are aware of the fact that the policy of this Commission is to develop the field on 40 acre location, are you not?

A I think that is a legal decision, and I am not a lawyer.

Q Do you have knowledge of any sandstone fields in New Mexico which are developed on an 80 acre basis?

A I'm not acquainted with all the pools or fields in New Mexico. I feel unqualified to answer the question.

Q You do not know of any yourself, though?

A No, I do not.

Q The testimony you have given then as to why you feel that the Commission should adopt 80 acre spacing, would be equally applicable to any other single reservoir pool in New Mexico, would it not?

A Let me answer it this way, each reservoir possesses its own inherent problems, and each reservoir has to be evaluated with its own characteristics. It would be dangerous to make a blanket statement for promiscuous use. I would be hesitant to make a statement like that.

Q You did state on direct examination that 80 acres would make for a more efficient second recovery program than 40?

A In the Lower Gallup, yes.

Q You quoted an authority, that was Mr. Muscat from Gulf. He was not referring to this particular reservoir, I assume?

A It was Dr. Muscat, and he was not referring to this pool.

Q Do you or do you not feel that as a general proposition 80 acre spacing is desireable in order to make secondary recovery more efficient?

A Generally, but let me make a qualifying statement on this. The spacing problem in industry as well as with Commissions is an educational problem. Years ago we had close spacing, no conservation,

the spacing has grown wider and wider as we have become better acquainted with the recovery mechanism in the recovery of oil. We have all become educated along these lines, both from a recovery, conservation and economic standpoint. It's been a tough battle, but I think you will have to agree that the trend toward wider spacing has prevailed and we will experience wider and wider spacing even in the future.

Q I appreciate your statement. I'm not sure it answers my question. But I won't repeat the question. May I ask you how many fields that were developed on 80 acre spacing you have had experience with in secondary recovery projects?

A The McKenny patent field in Louisiana is on possibly 160 or 640 acres the way it is being operated. I completely evaluated that on it.

Q That is not an 80 acre field?

A It is greater than 80 acres.

Q It is greater? A Yes, sir.

Q Have you had experience with any spaced on 80 acres?

A We have ....

MR. CAMPBELL: May I ask that he be permitted to continue his answer to the question.

MR. MALONE: It wasn't responsive, but I'll be glad for him to answer.

A Maybe it would be better if I summarize it that in most gas

condensate reservoirs in liquifying operation, which is a missible phase operation, spacing is considerably in excess of 80 acres, the flushing efficiencies are upward of 80%.

Q This is not a gas condensate reservoir?

A No, it is not.

Q Have you ever had an experience with a reservoir of this type? A Yes.

Q Which is spaced 80 acres and which you have had a secondary flood project? A Yes.

Q Now, that is my question.

MR. CAMPBELL: What is that field?

A Of course I have had a few years experience, but I kind of forget the names of the pools. But I might cite that I have investigated several pools where part of the pool would be developed on 40 acres, part of it on 80 acres, in water flood operations, and the recovery within practical limits have been identical. When I was with Carter --

MR. PORTER: Excuse me.

A When I was with Carter, we evaluated one like that where the pool was separated, they were separate, but the rock properties, the reservoir properties, the structural conditions, pressured, things like that very similar, again we found that the recoveries was independent displacement.

Q So that is the basis of the testimony which you have given?

A Yes.

Q You have testified with reference to some interference tests on four wells. Will you refer to Sunray's Exhibit 12? The copy of that exhibit, which I had, did not have the wells marked on it and I may not have gotten them correctly.

A I am sorry.

Q No, that's all right, I am just leaving myself a way out if I need it. If you will refer to Well 2-3, which I believe was one of them on which you based your testimony.

A Yes, sir.

Q In Section 31? A Yes.

Q Well, now, that well is offset by two direct 40 acre offset and one diagonal 40 acre offset, is it not?

A That is correct.

Q Would or would not the interference to which you testified have resulted from those 40 acre offset wells?

A That is precisely what I used.

Q So that your testimony merely established that there is communication between 40 acre locations?

A No. No.

Q The wells which were the basis of your testimony are spaced on 40 acre locations, are they not? A Exactly.

Q And the interference which resulted was between those wells, was it not? A That is correct.

Q Would you give us then your interpretation of that interference?

A Certainly. Take the south offset well, if it would drain 40 acres, the radius of effective drainage would not reach beyond the 40 acre tract, but this radius of drainage extended beyond that and engulfed the next well which is not 660 feet apart, but 1320 feet apart. It's a common misconception.

Q You have not used, well, let's refer, what were the other wells that you used here?

A The No. 18 which is in Section 7.

Q And how is it offset?

A It is offset to the northeast and it's offset to the southeast.

Q Those are on 80 acres, what would be the equivalent of 80 acres or 40 acres?

A They would be the normal 80 acre locations.

Q Are any of the other wells that you used in the interference tests besides 2-C the equivalent of 40 acre locations?

A The other 40 acre location would be at well location 2-C.

Q That was the well you listed as the fourth well on the interference measure? A That is correct.

Q Thank you. Do you know whether or not under-saturated oil has been encountered in any of the wells which have been drilled in this pool? A Yes.

Q Where has that been encountered?

A The two wells that I mentioned where we had bottomhole samples each displaced under saturated conditions.

Q There is a gas cap in other portions of the field, is there not? A Correct.

Q Do you have any difficulty in reconciling the existence of a gas cap in one portion of the field with under-saturated oil in the other portion if there is good communication?

A Not at all, it is very common.

Q How do you reconcile the two?

A We have observed it.

Q It is not an unusual phenomenoa in your experience?

A None whatsoever.

Q In connection with the question which was asked by your counsel as to whether or not you considered the 80 acre locations would prevent waste, you answered that in your opinion they would. You were not asked whether or not in your opinion the granting of this application would protect correlative rights. Have you given any consideration to that question?

A I think you would have to define correlative rights. Maybe it's a legal question, I don't know. Now under certain conditions it might be important.

Q I will ask you then, if you are not in a position to answer the question, please merely say so, whether or not in your opinion, if the application is granted, each of the owners in this

field will recover his just and equitable share of the oil underlying the property?

A I would like to decline that question at this time.

Q All right. Now, in your Exhibit 11, let's refer to page number four, I notice in the center portion of the exhibit the numbers one, two, three, four, five and six. To what do those refer?

A One would be the upper sand, two would be the second sand, the one immediately below the one, three would be the third sand from the top, four, five and six would be the successive lower and lower sands consistent with the cross sections as we have previously presented.

Q So that regardless of whether the frosting or the cake is the best part, you will agree we have layers here?

A That's a matter of degree.

Q Do we have some layers, isn't that what is indicated when you can make one, two, three, four, five and six here?

A In a way. I am not apprehensive in referring to them as layers, that is all right.

Q I just want to get your opinion as an expert as to whether in fact those are separate sands, and if they are, whether communication vertically exists between them throughout the area included in this application.

A I don't know -- now this is my view, I'm not a geologist. I'm not going to get into geological work.

Q I wouldn't want you to.

A But from a reservoir standpoint, flow of fluids, permeability measurements, core analyses, things like that, I am hesitant in thinking of this thing as a layer type sand. You got a sand body, period. It displays permeability through the vertical section, that's it. That's the way I look at it.

Q You don't look at it as your geologist, Mr. Pinfrock, in any event you prefer not to adopt his description of these several sand members?

A I neither refute them nor accept them. I have my personal views and I would like to think of a reservoir as a whole, I have to in my business.

Q Now, in thinking of this reservoir as a whole, have you been able to establish to your complete satisfaction that communication exists between these several members throughout the reservoir?

A I think the core analysis substantiates that statement.

Q Does the core analysis show a marked uniformity or non-uniformity of permeability and porosity?

A Now which way are you directing the uniformity?

Q I'm directing it to the way that you have testified it exists.

A Yes. When we consider one condition similar to the next condition, in other words, we compare similar conditions, we get evidence of similar rock properties. But when we cross similar

conditions or have conditions that are dissimilar, why then we are not making a fair comparison.

Q Is it your opinion that on the basis of these 15, or was it 21 cores? A Twenty-six cores.

Q Twenty-six cores that you have examined, that you can testify with certainty that there is communication between these various members so that if a particular well failed to penetrate one of the members, the other members would nonetheless be drained by that well?

A Let me direct your attention that core analysis themselves do not define interference or continuity. You have to establish that from pressure interference.

Q You have not made a pressure interference study except upon the four wells as to which you testified?

A That is all the available information, yes.

Q In that case you would not be able to testify with certainty that communication does exist so that various members might be drained, whether they were penetrated or not?

A The best information we have, I would say they would be drained.

Q It is your opinion they will? A That is correct

Q That is your opinion as to the entire area in the proposed pool?

A Based on my experience, I find that would be a reasonable

opinion.

Q I want to be sure we have clear the basis and not be repetitious, it is the interference test on the four wells that you have testified to plus the 26 cores that you have examined?

A Let's take about one thing at a time. Are we talking about interference or core analysis?

Q I am talking about the basis of the opinion you just expressed. I want to be sure it's clear what you reached that conclusion on. Would you state the basis on which you reached the conclusion that vertical communication exists and that a single member would be drained by a well penetrating another member, whether or not all members were penetrated?

A That's a pretty big order. Let me answer it this way: We have defined from the core analysis that predominantly the bulk of the reserves and the bulk of the recoverable oil will be gained out of the sand we call No. 1. We have defined interference from our interference tests, which shows that a well can drain an area in excess of 80 acres. So based on that data I say that we can effectively deplete the reservoir on spacing of 80 acres.

Q You say that each well will effectively drain the 80 acres that is allocated to it as a unit?

A Yes.

Q And that is your opinion? A Yes.

Q There is a rather broad variation in the permeability

which you found in this sand section, is there not?

A Yes.

Q From one-tenth of one millidarcy up to one hundred millicarcies?

A Or greater than a hundred.

Q Or greater than one hundred?

A Yes.

Q There is no uniformity in the relationship between the areas where those variations occur? That was a bad question. I think we agree on the answer. You heard some testimony this morning as to the existence in this reservoir of oil wells which were up structure from gas wells? A Precisely.

Q Are you aware of that condition existing in the reservoir?

A I'm assuming that you are referring to the Carson No. 5 Shell Well located in Section 27?

Q Well, refer to the well that was used this morning by Mr. Nutter.

A I would like to have the well defined, so I know precisely what we are talking about.

Q I'm not going to ask you with reference to the particular well. Are you aware that condition does exist?

A No, I'm not.

Q You have not taken into consideration the possibility that it may exist, in your testimony? You are not aware it does exist?

A No, I am not. I am confused, are you talking about a well located structurally higher than the five defined gas wells?

Q Yes, which is producing oil from a point structurally higher than gas wells in the immediate vicinity.

A Let me state this, with the data we have being of a conflicting nature and without any source of additional test information that we cannot, I cannot say if it's an oil well or a gas well, and I would prefer having some complete test information. Once I get that I will be happy to make you my interpretation of what that well is.

Q Do you feel that if that situation exists, it would have some effect on your testimony as to the reservoir?

A I can't give an opinion until I check that specific well with its test data.

Q Have you in any other hearing before this or another commission, ever recommended that any field be spaced on 40 acres?

A State that again.

Q Have you ever in any hearing before this commission or any other commission recommended that a well be developed on 40 acre spacing? A Yes.

Q Where was that?

A Well, it might be any one of several states. I don't have my list handy.

Q All right. Thank you very much.

MR. PORTER: Does anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Brinkley, referring to your Exhibit No. 13, with special attention to the ultimate recovery column, I note that you have stated there that the recovery on 80 acres is exactly twice the recovery on 40 acres? A That is correct.

Q I would assume that your recovery factor is identical for both spacings? A That is correct.

Q 40 acre radius, drainage radius, is somewhat smaller than an 80 acre drainage radius, is it not?

A That is correct.

Q Is it not true that it is the pressure differential between the reservoir and the well bore that causes the oil to flow to the well bore? A That is correct.

Q Then it would follow that your testimony here would be that the pressure and the depletion at the 80 acre radius would be the same as the pressure at the 40 acre radius?

A Appreciably so.

Q Would you care to elaborate why you feel that would be true, that depletion stage?

A I'll be glad to. As I stated earlier, the problem of well spacing is one of the industry's unsolved problems. Many of the experts have done considerable research in comparing recoveries on 40 acres versus 80 acres. They find no evidence of any

appreciable difference in ultimate recoveries when they can define the rock and fluid properties. Also it might ease people's minds if I state that an 80 acre well draining a circular area, would have contained twice the energy as a circular area containing 40 acres. Yet, the radius of the 80 acre well is only 41% greater than that for a 40 acre well. Also flow is not only affected by a pressure differential, but by friction, and of course that is affected by velocity. When one computes the velocity of the liquid flowing, we find that we are advancing just few inches a day until we get very close to the producing oil well.

Hence, with low velocity you would normally assume that you would be in the streamlined flow, and your friction would be approaching zero. Those values have been computed both for an 80 acre spaced well and 40 acre spaced well with good characteristics here. We find that to be the case. Again, may I state that it is one of the unsolved problems of industry, and I have some quotations in my bag that if you would like for me to quote from I would be glad to do that, but it is one that we will be faced with for some time. It's an educational problem. But our experience, so forth, leads us to conclude that there is no appreciable difference in ultimate recovery on a 40 and an 80 acre, I mean two 40's or one 80 acre tract.

Q Thank you. I believe that you have stated in your testimony that it is your belief that we have a gas cap in the Bisti Field?

A That is correct.

Q Would you have any recommendation as to how those gas cap wells should be produced?

A Yes. I think they should be permitted to produce at a rate commensurate with the oil voidage for an oil well, incorporating the limiting gas-oil ratio.

Q Would it be your thought that 40 or even 80 acre gas well in this area would not be a commercial well?

A Are you talking about a gas well?

Q Yes.

A It would be non-commercial.

Q Do you think that more acreage should be dedicated to the gas well in this gas cap than an oil well?

A I do.

Q Let's dwell a moment on the 80 acre unit which I believe you have requested. Am I correct in my understanding that you have requested 80 acre units to run north and south the long ways, to run north and south? A No, sir.

Q You have not requested that? A No.

Q Do you have any opinion?

A I would prefer that the counsel make a statement on that. I believe he is more acquainted with the details of the content of our application than I.

Q You have made no recommendations as to where the well

should be located?

A Yes, we have made a recommendation. I think I misunderstood your question. Yes, I have made a recommendation. I stated that the location of wells to be in diagonal 40's within a Governmental 160 acre tract and no closer than 330 feet from the lease lines. There is no statement whether the tracts would run north and south or east and west, but they can be fitted in like a puzzle, like little squares or little rectangles; the way some of the wells are spaced, we will have to go north and south, and other ways east and west. We have tried to leave it flexible to the discretion of the operator for more flexible operation.

Q It is your testimony that you could run them either way?

A Yes.

Q According to the situation? A Yes.

MR. PORTER: Anyone else have a question of the witness? Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, you testified that you feel that the ultimate recovery will be substantially the same on the 80 acre spacing, as it would be with the two 40 acre wells?

A Correct.

Q Under what specific conditions did you recommend 40 acre spacing?

A I did not recommend 40 acre spacing.

Q I believe you, in answer to counsel's question, stated on several occasions in the past you have recommended 40 acre spacing.

A I beg your pardon. That was on another field. As I further stated that each reservoir has to stand on its own merits, and the spacing and various other things are dependent on the peculiarities of that reservoir.

Q That's what I am getting at, what are the specific conditions that make it possible or impossible, advisable or inadvisable to space 40 or 80, in your opinion?

A Well, we had more sand.

Q Thicker sand?

A Yes. One hundred feet of sand possibly.

Q That has no bearing on drainage, but economics?

A Exactly.

Q What is another one?

A That would be the important thing, the oil in place. The whole thing could be summed up as to the oil in place and recoverable oil, if we had sufficient oil to justify a reasonable profit return to carry on exploitation and things like that, why then of course we do that.

Q Then the simple underlying factor for the recommendation of 80 acres rather than 40 is the economic factor?

A Yes, that is right.

Q You feel it is not economical to drill 40 acre wells throughout the field?

A Under a competitive situation it is hardly economical on the 80, on the average conditions.

Q Would it be so, I think you continued to use the term throughout this hearing, competitive conditions?

A Yes.

Q That does not take into consideration fieldwide unitization and secondary recovery project, does it?

A That is correct.

Q And is it not contemplated by your company and the major companies and possibly all the people in this pool, for this pool to be operated effectively, there will have to be secondary recovery?

A That is right. The salvation of the pool will be through the secondary means, pressure maintenance with unitization.

Q Assuming we achieve this salvation, would it then be economical to develop the wells on 40 acre spacing?

A No, sir. It might be economical, but --

Q (Interrupting) You wouldn't make as much money?

A You wouldn't make as much money and it wouldn't be prudent operations to spend twice as much money to gain the profit. What I am getting at is unnecessary wells are a waste. We can accomplish the same thing on wider spacing.

Q Now, when a well is drilled into a reservoir like this,

isn't there immediately a low pressure area created which causes the oil to drain toward the well bore and get your production?

A When it is produced, that is correct.

Q Is not this pressure a gradiation back off into the reservoir back off into a point where the pressure is that of the original reservoir pressure?

A The gradiation phenomenon?

Q It is not a sharp drop, it is gradiation throughout on the reservoir?

A That is correct.

Q While you might have a thousand pounds, what was the initial pressure of this reservoir?

A Probably of the order of 1500.

Q When a well is immediately drilled, what does it drop to?

A As it is produced, the pressure will drop.

Q What does it drop, say within a week, to make it produce?

A I can't give you the precise answer.

Q Just a rough estimation, that is to point out the gradiation factor.

A I would just guess, produce a week might get five pounds drop, ten pounds drop, just a guess.

Q This drop will be a gradiation down through the reservoir?

A Correct.

Q As you go ahead producing, what do you think that differential would be between the pressure right at the well head and out

away from the well, you don't know, you don't believe one well will drain this entire pool?

A Given enough time, yes.

Q If you drill a well right up in the middle of the 25 mile lateral area, you think the pressure of this well would ultimately drop even though that is the only well the pressure would drop to abandonment pressure?

A Yes, it would ultimately drop to abandonment pressure.

Q Do you feel that the well, when it reaches the abandonment pressure, do you feel you can go out to the other ends of the pool and still drill a producing oil well?

A We are getting into a hypothetical condition.

Q Well, let's answer it then.

A Given sufficient time, it might take a century, the well would drain the reservoir.

Q But this pressure gradiation goes off to practically original reservoir pressure, would it not?

A The gradiation?

Q From abandonment at the well head to original well head pressure at the extreme ends of the pool.

A No, I can't say that. You do get a pressure gradiation at the well bore. It is not a sharp drop.

Q When you abandoned your 80 acre well, don't you feel that the pressures out at the periphery at the edge will be something

in excess of abandonment pressure? A No.

Q At what point in the development of this well does the pressure level off instead of grade off?

A You are kind of losing me.

Q You drilled a well and you had the pressure gradiation?

A Yes.

Q Low at the well head and high away from it?

A Yes.

Q At some place in your test, instead of grading off to a higher pressure, somewhere away from the well, it levels off it is abandonment pressure through the pool?

A No, you always have that, you just don't have sufficient pressure differential to produce the production of oil in economic quantities.

Q At the outer perimeter of your drainage area of your 80 acre well, you will have somewhat higher pressure than your --

A (Interrupting) That is correct.

Q Would there not be a larger perimeter of this well if it were drilled on 40 instead of 80 since you have a shorter radius on your 40 acre drainage, it would just be half would it not?

A No, on the contrary, you could have less oil remaining on 80 acre spacing than on 40.

Q Let me ask my question again, see if you still want to answer it the same way. This is still a gradiation?

A Yes.

Q It is lower and it's going out away from the well?

A Yes.

Q If it has to drain roughly 2,000 feet or more?

A A thousand some.

Q Twenty-two hundred feet? A For an 80 acre?

Q Yes. A 1,070 feet.

Q Draining to the other end. If it drains 1,070 feet at the 1,070 foot the pressure would be higher than it would at the 500 foot? A Yes.

Q With 40 acre wells, the outermost boundary of the drainage areawould be the 500 foot?

A No, it would be 750 feet.

Q 750 feet? A Yes.

Q Nonetheless, it would be higher?

A Yes.

Q On the 80 than the 40?

A Yes.

Q You would get more recovery on 40 acres than 80?

A No.

Q Would you care to explain in reference to your Exhibit No. 12, it seems to be another enigma, maybe you can solve this one for me. I believe you testified that the No. 4 and No. 6 wells, these are referred to as wells outlined in red, and you referred to

them as your interference wells? A Yes.

Q Your 6 and 4 wells are in what you referred to as in the superior sand? A Yes.

Q The 4 and 6 were produced intermittently or just once?

A Each of them produced roughly a thousand barrels some time during that year period.

Q And neither the C-18 nor the C-2 was produced at any time?

A That is correct.

Q Can you tell me why the C-18 and C-2, which are in the inferior sand, I believe you testified?

A That's right.

Q Were less permeable and less porous, why did they get more pressure drop than the 4?

A They had more interference.

Q Was it a time period?

A No, they had more interference.

Q Isn't that another enigma that an area with less permeability and less porosity would show more interference than it would in an area of high permeability and high porosity?

A Interference can be any magnitude, it's a matter of degree. All I can say is that they suffered more interference.

Q Wouldn't it logically be the other way, that in the good permeability and good porosity you would get a bigger draw down?

A Not at all. No. Not at all, just the reverse of what you are

thinking.

Q Well, I could be very well mistaken, it would seem to me that the draw down would be greater in this high permeability area.

A No. For the same quantity of oil it would be opposite to what you say.

(Discussion off the record.)

MR. PORTER: Let's go back on the record. Mr. Cooley.

Q I believe you testified in answer to a question on cross examination a short while ago, that your recommendation, or the advisability of 80 acre spacing in this pool, would be directly dependent on the injectivity of your injection wells in this pool?

A Yes, the injection well would have to qualify for the wider spacing.

Q Are you prepared to state unqualifiedly at this time that the injectivity of the wells in the Bisti-Lower Gallup Oil Pool are adaptable to 80 acre spacing? A Yes, they are.

MR. COOLEY: That's all.

MR. SULLIVAN: Mr. Chairman, my name is Sullivan, representing British American Oil Producing Company.

By MR. SULLIVAN:

Q Mr. Cooley was questioning you a moment ago with regard to the reasons why the two wells in what you have referred to as the inferior sand area, did not have as great a pressure drop as the two wells in the superior sand area?

A You have them reversed.

Q Very well. Would a simple explanation of that be the fact that the wells in the area of the inferior sand simply had lesser area from which to rebuild the pressure while shutin?

A You can't give, in my opinion, you can't give a simple explanation like that because what we measure is the compounding effects of not only reservoir depletion, but interference from offset wells which we cannot precisely define. All we measure is the composite effect.

Q I thought perhaps there might be a simple or elementary answer to this enigma. I was puzzled also during Mr. Seth's cross examination of you, Mr. Brinkley, about this factor. With regard to the quantity of LPG products necessary to carry out a successful flood program -- A Yes.

Q Assume that your pilot program there proves to be successful to a practicable degree. A Yes.

Q Assume that the well spacing in the field stays on an 80 acre basis, would you not be able to carry out your missible slug program with about the same quantity of LPG products on an 80 acre spacing that would be required if the field were developed on 40 acre spacing?

A Comparing an 80 tract with two 40 acre tracts?

Q Yes. A Correct.

Q Then, in other words, with an 80 acre spacing as compared

with 40 acre spacing, at least you would make a greater or more efficient use of your LPG products in sweeping through the field?

A Precisely.

MR. PORTER: Anyone else have a question of the witness? The witness may be excused.

(Witness excused.)

I believe it's apparent that this case will not be concluded today at least during daylight hours. There are some parties who entered an appearance this morning who have indicated that they cannot be here beyond today and would like to make a statement, so we will entertain those statements at this time, and if you have a copy of the statement written out, I would appreciate it if you would leave it with the reporter.

MR. MALONE: I thought maybe in view of the time, if we might not be able to file written statements, say within a ten-day period.

MR. PORTER: In lieu of the oral statements, the written statements from the interested parties will be acceptable within a period of ten days.

MR. MALONE: May I be certain that Gulf's Exhibit 1 is admitted in evidence? It was identified but not offered.

MR. PORTER: Without objection, Gulf's Exhibit No. 1 will be received.

(Discussion off the record.)

MR. PORTER: Will the next witness come forward, whoever that may be? Is that all of your witnesses?

MR. ERREBO: That concludes the applicant's case.

MR. BUSHNELL: Did I understand correctly the conclusion of this discussion that statements may be mailed in and that those statements will be incorporated in this record?

MR. PORTER: They will be put in the record, yes, sir, within ten days.

MR. SETH: We are prepared to proceed, if the Commission would like. I was just hesitating, I thought some of the other people would like to put on some other witnesses.

MR. PORTER: Before proceeding with any further testimony, I would like to make a brief announcement. This hearing will not continue in this auditorium in the morning. We have arranged to meet in the Highway Commission Building on Cerrillos Road. We will take about a five minute break.

(Recess.)

MR. PORTER: The meeting will come to order. Mr. Seth, will you proceed with your first witness, please?

DONALD R. LINDSAY

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please?

A Donald R. Lindsay.

Q Were you sworn earlier during the course of this hearing?

A Yes, I was.

Q Would you state briefly your educational qualifications, your experience?

A I received the degree of Bachelor of Science and Mechanical Engineer from Stanford University in 1948, and degree of Master of Arts in Geology from the University of California at Los Angeles in 1952.

Q What has been your experience and by whom have you been employeed?

A I have been employed by Shell Oil Company for the past six years in the capacity of exploitation engineer.

Q Have you made a study and are you familiar with the geology in the Bisti Pool? A Yes, I am.

MR. SETH: May he testify as a geologist?

MR. PORTER: He may. His qualifications are accepted.

Q Now, have you made a structure contour map of the Bisti Field?

A I have. That is Exhibit No. 1.

Q Would you point it out, please?

A Yes.

Q Would you please state to the Commission what it shows,

Mr. Lindsay?

A This is a structure contour map on the top of the Gallup formation. The map includes the western two-thirds of Range 11 West, Township 25 North, and the eastern five-sixths of Range 12 West, Township 25 North, San Juan County, New Mexico. This is a portion of the Bisti Field and is located about in the central part of the field. The map shows the property lines within this area and the locations of the wells which have been drilled within the boundaries of the map.

Contours which have been drawn with respect to sea level at a contour interval of twenty foot show a northerly dip of about eighty feet to the mile. This map has been submitted at this time primarily to show the geographical locations of some forthcoming exhibits. We have indicated with red arrows Shell Carson No. 1 an Shell Carson 33-24, which are located in Section 24, Range 12 West, Township 25 North. Thes~ wells were cored through the productive portion of the Gallup formation, and on this map we also show the lines of Section A-B, C-D and E-F which will be referred to later in the testimony.

Q Now, would you proceed to your next exhibit, you have a stratigraphic section, do you not? A Yes.

Q We'll refer to this as Exhibit No. 2.

A Yes.

Q Was this prepared under your supervision and direction?

A Yes, it was.

Q Would you please describe what it shows?

A This section illustrates the subsurface data which we obtained from Shell Carson No. 1 and Shell Carson 33-24, which were cored through the Gallup formation. The wells are located about 2950 feet apart, slightly more than a half mile, and are shown at a vertical scale of four feet to the inch. They are hung on a datum of electric log marker GC which occurs at the top of the uppermost oil productive sand in the field.

Q The following information is provided for each well: The self potential and resistivity curves have been traced from the electric log. We show with heavy black lines the interval in each well which exhibits microlog separation. Porosity values are shown with open circles and have been connected with lines to show a porosity profile for each well. The porosity scale on the chart is zero to fifteen percent, and those values which are more than ten percent have been shaded with green.

We show permeability values with solid circles, which have also been connected in this case to show a permeability profile for each well, and the scale for permeability is a logarithmic scale from one-tenth of a millidarcy or less to a hundred millidarcies, and we have shaded each portion of each well showing more than one millidarcy in red.

The chart shows correlation lines between the wells which

connect correlative electric log markers in the two wells. These markers are identified as used by Shell, from top to bottom, GC, GD, GE, GF and GG. Two intervals contain the majority of permeable sands which supply most of the production from the field. The upper one is between marker GC and GD, and I'll refer to that as the GC sand. This is the same interval as was discussed by Sunray witnesses as the best sand, the one that was referred to as essentially a sand bar deposit.

The lower sands are between marker GD and GE and I will refer to this interval as the GD sands. This chart represents the differences in the location of permeable sands in various wells in the field. For example, in Shell Carson Unit No. 1, the GC sands exhibit very favorable reservoir characteristics. There is considerable microlog pay permeables ranging up to one hundred millidarcies, and the porosities are generally of ten to fifteen range. In the GD interval there is virtually no sand, the section appears to be almost entirely at this time impermeable silt zone.

Carson 33-24, the converse is true. The GC interval has almost entirely silted out, there is only a short interval showing microlog separation. On the other hand, the GD sands in this well porsess favorable reservoir characteristics inasmuch as they have permeability characteristics which range up to over a hundred millidarcies, and have about ten feet of net microlog pay. This section, I think, illustrates the fact that sands in the Gallup

formation are not continuous and that permeability sands within the Gallup occur at different stratigraphic positions in different wells in the field.

Q Now, would you tell the Commission the source of the data that appears on this Exhibit No. 2?

A This chart contains data which were obtained from electric logs, micrologs and core information, core analysis.

Q Now, would you say that the variation in permeability in each of those sections is great or is in small or how would you care to describe it?

A I would say that these sands in the Gallup formation in Bisti Field are characterized by a very wide range of porosity and permeability values.

Q You would say then that they were greater than you would ordinarily expect in a sand reservoir or that are usually encountered in a sand reservoir?

A They are greater than any I have seen in sand reservoirs prior to this.

Q Now, does this section also represent the wide variation from well to well? What is the distance between those two wells?

A The distance is a little over a half a mile.

Q What other conclusion do you draw from Exhibit No. 2, if any?

A I would say that the petrophysical data and the core

analysis data that we have from these wells indicates a considerable amount of discontinuity in the permeable sands between those wells. The sands which show microlog pay are separated by intervals of very dense silt stone and tightly cemented sandstone, which I would say would be impermeable to the passage of oil.

Q This section, would you say this is consistent with or confirms the microlog surveys which you have used and will use in the subsequent exhibits?

A I think that this section illustrates a remarkable correspondence between microlog pay and porosity and permeability values. This is in each case where we have core data available where we have microlog separation, we also have correspondingly high values of porosity and permeability, and where we do not have microlog separation in other portions of the well, we have fairly consistently low values of porosity and permeability.

Q Would you explain, please, what is microlog separation and how useful is the data obtained?

A Well, the microlog is an instrument for detecting the presence of mud cake in the well bore and that is produced when the liquid portions, the liquid phase of the drilling fluid filters into the formation and deposits a mud cake. It is thus an indication of permeable sand and also a porous sand.

Q Do you consider it a good or reliable indication?

A I think it is a very reliable source of information in the

Bisti Field, and I believe that most of the operators in the Bisti Field evaluate it because virtually all the operators in the Bisti Field run micrologs in their wells.

Q Could you say whether or not these two wells are pretty much typical of what you find in the field as far as a unit?

A I would say that no one well is typical of what you find in the Bisti Field because there are such extreme variations from well to well. However, I think that these wells are fairly representative of what you would find in an average well.

Q Now, have you prepared an isopach map from the data you collected? Would you point out again on your contour map the location of the stratigraphic section again?

A The stratigraphic section shows these two wells, Carson No. 1 and 33-24.

Q Go ahead with the isopach.

A Exhibit No. 3 is an isopach map of the net microlog pay in the Bisti Field. That is the portion of the Bisti Field which is included by the map, and the Exhibit 3 includes the same area as is covered by Exhibit No. 1. The map illustrates the distribution of net microlog pay in the Gallup sands by the use of isopach lines drawn to an isopach interval of five feet.

Q What do you mean by that, what is an isopach interval of five feet?

A Isopach line connects points of equal thickness of net

microlog pay. For example, a closed curved line labelled 20 feet situated in Section 20 of Range 11 West, Township 25 North, means that every point on that line represents a location where approximately twenty feet of net microlog pay would be encountered in a well, and since the values decreased away from that, this implies that a well within the closed line would probably encounter more than twenty feet of net pay.

Q When you say twenty feet, referring back to Exhibit 2, would that be the total of the black, what you labeled there in black?

A Yes, it would.

Q Regardless of where it occurs vertically?

A The map does not represent one large continuous sand body, but it is actually a composite map of the sum totals of many streaks of thinner pay.

For example, in Carson 33-24, there are intervals of 5 feet, 3 feet and 1 foot and half a foot, another half a foot, which adds up to 10 feet of net microlog pay, and those several intervals are combined, that gives you the 10 foot isopach value on the map.

Q That means just the total at that point, there could be a large number of stringers, is that correct?

A That's right. Actually the map illustrates that there are considerable variations in net microlog pay thickness through the field. For example, in the upper portion of Section 16 in Range 12 West, 25 North, there is a region of twenty feet of net microlog

pay and less than half a mile there is a region of five feet which to me illustrates a very rapid change in the sedimentary characteristics from one region to the other.

Q Do you have any further comments on the Isopach Exhibit 1?

A Not now.

Q Would you go ahead to your cross sections, please?

A We have constructed two sections which were selected in a relatively densely drilled area, Section AB, which is Exhibit No. 4, which is located in Sections 10, 15, and 16, Range 12 West and Township 25 North. The well shown on this section are from southwest to northeast El Paso Kelley State 8. State 3, Shell Government 12-15, Shell Government 21-15, Shell Government 34-10 and Shell Government 43-10: The wells are ranged vertically with respect to sea level as a datum and are shown at proper relative horizontal positions according to the scale of the section, and the wells are an average of about 1800 feet apart.

Again we have shown with correlation lines, the correlative electric markers from well to well as we did on Exhibit No. 2. We have made schematic and interpretive correlations of net microlog pay from well to well.

We have indicated these intervals in green on each section. These correlations indicate the changes from well to well in the stratigraphic location of the interval, showing microlog pay. In other words, they show that the permeability sands, the most

permeable sands in the Blatt Field are irregular and discontinuous. For example, in Shell Government 24-10 the GC sand has a considerable microlog pay thickness which rapidly pinches out to the southwest, and is gone by the time Shell Government 12-15 is reached. This well exhibits no microlog pay in the GC sand.

Continuing in a southwesterly direction, El Paso Kelley State 3 does have some microlog pay in it, and this I interpret as a discontinuity in the permeable sand in the GC interval in this portion of the field. The degree of discontinuity of these sands is fairly well controled, suggests to me that there is probably a much greater degree of discontinuity and lenticularity of sands and permeable sands than we can possible know about.

These correlations have been made in as simple and continuous a manner as possible, and probably denser well control would reveal a much greater degree of discontinuity and lenticularity that can now be demonstrated.

Q You consider that a reasonable interpretation of the data?

A I would consider it a reasonable interpretation of the data available.

Q Of course, between wells, where it is noncontinuous, those could be terminated, but you don't know where they terminate?

A We don't know exactly where they terminate. No one knows that.

Q There could be certainly some variation from what you have

shown there?

A Yes, there could be, but I think that it is correct in principle. This also, I think, is suggestive of the fact there may be other permeable sand streaks existing between the wells which are on this particular section, which are not penetrated by any well. For example, in the GE sands in Shell Government 12-15, there is good microlog development in the GE sands which is not present in either El Paso Skelley State C or Shell Government 2315 to the southwest and northeast. It seems to me very likely that had by chance these wells been spaced at the alternate positions at which they are, this sand may have been missed completely, or it may just have been penetrated on the edge. At least it may have been inadequately penetrated by these wells.

Q Then it's possible then for wells on relatively wide spacing to miss these stringers entirely, is that correct?

A I believe that is true.

Q Are the chances of encountering them greater by reason of a number of wells than are drilled?

A Yes, they are greater. Incidently, I would like to say also that it is not to be inferred from these sections that we believe that the only production from the field is from these permeable streaks of sand and, contrary, we know that we obtain some production from the remainder of the sands where they are oil saturated, but that the permeability is so low in these sands that we feel that

wells completed in those sands without microlog pay alone would be very poor producers. In attempting to define the limits of the field, we completed Shell Carson No. 2 in Section 25, which did not exhibit any microlog pay at all. Although it did have, according to the electric log, some SP development, and therefore it did contain a sandy interval that well was completed for only an allowable of 21 barrels a day and has declined from that.

Q On your Exhibit No. 4 you have shown perforations, have you not, in addition to the microlog?

A Yes, I did. That illustrates, I think, the perforated interval does not show microlog pay because we have obtained enough oil from the intervals.

Q Now, Exhibit 4 is the cross section across the narrow dimension of the field, is that right?

A Exhibit 4 is a southwest northeast cross section which is across the main trend of the Gallup sand.

Q Do you have another cross section longitudinally?

A Yes, Exhibit No. 5.

MR. PORTER: The hearing will be recessed until tomorrow morning at nine o'clock when we will reconvene in the Auditorium of the State Highway Commission Building on Cerrillos Road.

Mr. Seth, could you have your exhibits posted there at nine o'clock?

MR. SETH: Yes.

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

October 17, 1957

VOLUME II

TRANSCRIPT OF HEARING

Case 1308

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

(Whereupon, the hearing was recessed until 9:00 A. M., on Friday, September 20, 1957.)

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(Whereupon, on Friday, September 20, 1957, the hearing was continued in the Auditorium of the State Highway Commission Building on Cerrillos Road in Santa Fe, New Mexico.

MR. PORTER: The meeting will come to order, please. I would like to announce that the Governor has said he will be a little late on account of some previous commitments. He will be here later in the morning. We will resume Case 1308. Mr. Seth, would you continue with your witness, please?

DONALD R. LINDSAY

called as a witness, testified further as follows:

DIRECT EXAMINATION (Continued)

By MR. SETH:

Q Mr. Lindsay, when we concluded yesterday, you had testified concerning the cross section Exhibit 4, I believe. Would you mind going up to the exhibits, please, and indicate again where Exhibit 4 is located, the cross section Exhibit 4 on your contour map there?

A Exhibit No. 4 is cross section AB which is located in portions of Section 10, 15, 16 in Range 12 West and Township 25 North. It has been drawn in a southwest, northeast direction, and therefore is across the trend of the sands.

Q Now, do you have a [illegible] longitudinal section through a

portion of the field?

A Yes. Exhibit No. 5 is a longitudinal section CD which is located in portions of Sections 9, 15 and 16 in Range 12 West, Township 25 North.

Q Would you point it out on there so we can see where it is?

A (Indicating.)

Q Okay.

A This longitudinal section includes the following wells, Amerada Joan White 2, Amerada Joan White 1, Phillips Mayre B-5, El Paso Kelly State 1, Shell Government 12-15 and Shell Government 23-15. This section has been constructed similarly to the cross section AB. The following information is provided for each well, a tracing of the SP and resistivity curves on the electric log, the interval showing microlog pay has been shown with a heavy black line and perforations and completion data are shown where applicable. Similarly to section AB, I have made correlations of microlog pay intervals from well to well. Again, we find that the permeable sands as indicated by the microlog occur at different stratigraphic positions in different wells. In comparing the longitudinal section with the cross section we can see that the sands are somewhat more persistent down the Gallup sand as compared with across it, but again we find that the sands occur in discontinuous streaks.

That is the permeable sands, for example, in the left four wells the sands are well developed, the GG sands are well developed, and

pinch out toward the southeast and are not present in Shell Government 12-15 in sufficient permeability to exhibit microlog separation, and that they again resume to the southeast appearing in Government 23-15. The GD sands indicate an opposite trend in that they are well developed as a series of permeable sands in the southeastern part of the section and gradually pinch out, grading laterally into silt stones and tightly cemented sand stones toward the northwest and apparently begin to resume development at the northwestern end of the section in Amerada Jean White, 2.

Q You colored this Exhibit 5 in green on the basis of the microlog separation, is that correct?

A That is correct. I have shown in green only those portions of the section which I interpret to be permeable sands, permeable enough to exhibit microlog separation, and again this section is not meant to imply that the remainder of the Gallup sands are not oil-bearing, and it does not imply that they are not productive of oil. Certainly we have seen that we do get some production from them, and therefore we perforate the Gallup sands wherever they are oil-bearing and wherever they show SP development on the electric log.

I think that we can expect these tighter sands to contribute production throughout the life of the field mainly through migration of oil films, these sands into the adjacent permeable sands and thence through those more permeable paths to the well bore.

Therefore I would conclude from this that the efficient

drainage of this field will depend on the adequate penetration and development of the more permeable sands.

Q Which then, in your opinion, more wells would be preferable rather than fewer?

A I would say that the more wells we drill in this field the more of these discontinuous sands we will drain. I feel quite certain in my opinion wells on 80 acre spacing will miss a good deal of the permeable sands in the field, and that wells on which closer spacing, I would say that wells on one acre spacing or eve ten wells to an acre would still probably miss some of the smaller sand stringers.

Q Now, Exhibit 5, as Exhibit 4, you have colored it on the basis of a reasonable interpretation, have you not, that's generally accepted by geologists?

A As I mentioned earlier, I think that the microlog is a very effective tool for detecting permeable sands in these wells where we don't have core data. I think if you will run your little eye up and down these wells shown on Exhibit 2, that at least you can't help but be impressed by the general core of microlog pay with intervals showing high porosity and high permeability.

Q Now, I was thinking takin this first microlog section in Shell Government 23-15, you colored that and it is finally pinched out before reaching 12-15? A That is correct.

Q In your opinion is that a reasonable delineation of that

condition there?

A I think so, to be consistent I was not able to show microlog pay going through Shell Government 12-15 in the GC sand because there is no microlog separation there.

Q But it was in 23-15, not in 12-15, so we assume that it stopped somewhere in between. Now, exactly where we don't know, do we?

A No, that is an interpretive problem.

Q You saw the applicant's exhibits as far as the cross section concerned the lower sands, do those exhibits actually show some discontinuity also?

A Yes. On examination of the longitudinal section, I noticed that in the lower sands which we referred to as the GD sands, there were discontinuities apparent on that section which I did not hear brought out in testimony.

Q Now, would you expect in this longitudinal section for these stringers to be longer than you would in Exhibit No. 4, which is across the section, and if that is the case, would you explain why that occurs?

A I would expect the permeable sands to be more continuous and longer in the longitudinal section than I would in the cross section since the longitudinal section is drawn parallel with the depositional grain of the Gallup sand in the Bisti Field.

I would agree with many of the points that were brought out

in the geological testimony of a previous witness, that the Gallup sand is a sand bar type deposit which was deposited in fairly shallow water, and that the sands are best developed in the vicinity of the core of the central part of the bar, and that they pinch out away from the bar in both directions.

Q Tell us a little bit more about this deposition, was it at a beach or how?

A We believe that the Gallup sands were deposited as an off-shore sand bar, probably in very shallow water very possibly, in fact, very probably during most of its deposition, I would say that the sand bar was within wave base and therefore suffered considerable disturbance by the action of waves while the sediments were being deposited, and that it was probably deposited on a fairly flat sea bottom with very low slope.

Q Do you have any other comments concerning Exhibits 4 or 5?

A I think that for the moment I have said what I wanted to about them.

Q Do you have some further data on the detailed situation in the well bores? A Yes, I do.

Q Would you tell us first a little about the coring and how you handled the cores?

A We have cored to date three wells through the Gallup sand. We attempted to core continuously through the productive portion of the Gallup sand and to keep examine these cores as and then

down the middle and photograph them.

Exhibit 6 is a photograph of a portion of the continuous core taken in Carson 33-24, and in the exhibit the core extends from the depth of 4893 to 4911, and this portion of the Gallup sand is within the productive OD zone in this well.

Q Could you point the well out on the map and on the stratigraphic section?

A The well is located in Section 24, Range 12 West in Township 35 North. The portions which are shown on the photograph is in 4893 to 4911, about in there.

Q That is the entire photograph covers that portion, does it?

A That is correct.

Q Do you consider that fairly representative section of a core and of the wells that were cored?

A Yes, I do. I have examined the cores from Carson No. 1 and Carson 33-24 and in both of these cores I find conditions similar to this throughout the Gallup in both wells. The cores I think exhibit very typically the absence of smooth, even bedding planes and exhibit the disturbed sedimentary structure which are characteristic of these sands. To augment this photograph I would like to produce core samples from this interval.

Q Yes, do you have them there?

A I regret that I don't have several copies of these. Exhibits 7 and 8 are respectively core samples from depths of

4894 and 4909 in Carson 33-24, and their positions are indicated by the left red arrows on the photograph respectively. These particular examples show that we interpret to be a result of reworking of the sediments by marine organisms, resulting in very irregular pods and tube lenses of permeable sand, which are closely associated with very tight, tightly sedimented sand stones, and I think exemplify the limited continuity of the permeability in these sands on a microscopic scale.

Exhibits 9 and 10 are core samples from Carson Unit No. 1 for which I do not have a photograph present. Exhibit 9 is from the GC zone in this well. It was taken from the interval 4878 to 94 and Exhibit 10 is from 4964. Exhibit No. 9 is from the GC sand in this well and it also exhibits very irregular and disturbed bedding, and Exhibit 10 is from the lower portion of the Gallup sand below the GD sand, and this is an example of a core which exhibits SP development on the electric log, but no discrete permeation. Again I believe that the evidence of disturbance of bedding planes is extreme.

I would conclude from examination of cores and the cores that I have seen in the Bisti Field, that the permeable paths in these sands are very irregular, very torturous and very, very limited continuity.

Q Now, there was some testimony yesterday concerning some gas wells in the area. Do you have anything further on the cores

before we can discuss that matter?

A Nothing at the present.

Q Do you have an exhibit prepared showing the relative location of the gas wells to the oil wells?

A Yes. Exhibit No. 11 is a presentation chart showing the wells in the southeastern part of the field, the portion of the field that we have studied. It is referred to as Penetration Chart EF and extends from the eastern portion of Range 12 West, Township 25 North, to the eastern portion of Range 11 West, Township 25 North, and includes the following wells: Shell Carson No. 2, Shell Carson 33-24, Shell Carson No. 1. Let me start this order over again. Shell Carson No. 2, Shell Carson 33-24, Shell Carson 1, Shell Carson 4, Gulf Gle-Ka-Nup-Nah No. 1, Sunray Es-Ka-Nel-E-Wood 2, Sunray of Anderson Prichard To Sah 1, and Anderson Prichard Harold Begay 1. These wells are not spaced at their respective relative distances, but the total distance from the left well to the right well is six miles, approximately. They are, however, ranged vertically with respect to sea level. On the section we have colored with red opposite the perforation intervals, those wells which produce gas, and with green those wells which produce oil. The significance of this is that gas wells have been completed in the field at comparable and even lower structural positions to oil wells in the Gallup formation.

As an example, Gulf Gle-Ka-Nup-Nah No. 1 was completed with an

initial production of 1515 MCF a day dry gas and no oil. Shell Carson 33-24 to the west is 21 feet structurally higher than the other well, and completed for an initial flowing production of 470 barrels a day of oil, the GOR of 620, which is about in the average range for the field. The westernmost well, Shell Carson 2, was completed at a structural elevation 64 feet higher than Cle-Na-Hup-Nah No. 1 and as pointed out previously in the testimony, this well does not have microlog pay, but does have SP development, and was completed for an initial production 21 barrels a day of oil with a very small amount of gas.

I would conclude from this situation that the existence of gas wells down structure from oil wells in the reservoir of this type and an unfaulted reservoir, that there must be some sort of discontinuity in the sediments themselves. I can arrive at no other conclusion at the present.

Q You agree, do you not, generally with the dip of the field as testified to by the proponents? A I do.

Q Was this existence of the gas referred to by the proponents as a gas cap, is this the same matter you are referring to now?

A I believe these gas wells were referred to by the proponents of 80 acre spacing as being in a gas cap.

Q Do you have any further conclusions or statements you would like to make, Mr. Lindsay?

A Yes. I would like to briefly summarize the results of my investigation of the Gallup sand stone reservoir of the Rusti Field

as follows: Isopach maps of the net microlog pay in the field reveal that the permeable sands are irregularly distributed and of variable thickness throughout the field. Cross section and longitudinal sections, both which show detailed correlation of microlog pay intervals, reveal that the permeable sands are located in different stratigraphic positions from well to well, and that they are discontinuous and grade laterally into tight silt stone and tightly cemented sand stones.

Correlation of core data between continuously cored wells also reveal with core analysis data that the permeable sands are variable in their stratigraphic position and that there is a very wide range of porosity and permeability within the Gallup sand stone.

Examination of cores indicates that the Gallup sands are not evenly bedded, but that they exhibit evidence of severe disturbance during deposition, with the result that permeability paths are very irregular on a small scale as wells on a large scale. Production anomalies occur in the southeastern part of the field where gas wells have been completed down structure from oil wells, which to me is virtually positive evidence of discontinuity in the sediments. Inasmuch as every avenue of investigation has indicated that the Gallup is a very heterogeneous reservoir, the possibility that the field can be efficiently drained on a spacing as wide as 80 acres appears to me to be very unlikely. And that if drilling is not carried out on a denser spacing pattern, that it is probable that

much of the primary recoverable oil will remain in the ground.

Q Now if I may just make a statement, and the data you have presented concerns a large segment of the field, but is it, in your opinion, fairly representative of the entire area?

A I think that it was brought out by the proponents of 80 acre spacing that the field is fairly, conditions in the field are fairly continuous from one end to the other, and I feel that our approach of sampling about a third of the field is what we have done; on a very detailed examination has revealed a good deal more than a very broad view of the field as a whole. I do feel that our sampling is adequate and representative of the field as a whole.

MR. SETH: That's all the direct we have. We would like to move the admission of exhibits, Shell Exhibits 1 through 11 at this time, if the Commission please.

MR. PORTER: If no objections, the exhibits will be admitted in the record. Does anyone have a question of Mr. Lindsay? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Lindsay, I believe you stated that you had been employed by Shell Oil Company for six years?

A Correct.

Q As exploitation engineer? A Correct.

Q That is not exploration, is it?

A No.

Q Where has most of your work been done?

A Most of it has been in California in sand stone reservoirs. About fifteen months of that were in the Rocky Mountains in oil fields in Utah, I have to qualify that, it was a dry hole.

Q (Interrupting) I consider that experience -- Beg your pardon.

A All right, I'm through.

Q Do you feel that the sands that are encountered in this particular reservoir are reasonably comparable with those that you have encountered and studied generally in the State of California?

A I would say that these are not typical of the sand stone reservoirs in California. Although I believe that our method of geological investigation would apply in either case.

Q Isn't it not generally true that the sands encountered in the area in which you have worked have contained considerably greater pay and net pay than these sands? A That's true.

Q Does that not, in your opinion, have some bearing upon the density with which you develop these reservoirs, or recommend to your management that they be developed? A Yes, it does.

Q Now, Mr. Lindsey, you have stated that you have taken your information as to these wells from a certain area of the reservoir which you agree is of approximately the lateral extent that the proponents have testified here. Is that area generally in the

vicinity of the Carson Unit that you operate?

A Yes.

Q How many wells have you actually studied in that area?

A I would say approx --

MR. SETH: (Interrupting) What do you mean studied?

A Excuse me.

Q I mean which one have you conducted detailed geological studies on all of them in the area, all of them in the field, or how many?

A I would say approximately twenty-five to thirty.

Q How many wells have been drilled in this reservoir so far?

A I don't have the count.

Q If you have studied only the wells, twenty-five or thirty wells in this area, how can you make the statement that they are fairly representative of all the wells in the area in the reservoir?

A I believe that portion of the testimony which was brought out by the proponents of 80 acre spacing in which it was stated that the reservoir conditions are, and geological conditions are fairly uniform throughout the field.

Q Do you believe that it is an adequate study of a reservoir twenty to twenty-five miles in length with 134 wells, to geologically study twenty-four or twenty-five of the wells?

A I think it is an adequate sampling of the field. If you are worried about how representative this is, then you must be

concerned about the possibility of discontinuities in the field?

Q I'm asking you to satisfy me at least that your conclusions with regard to this entire reservoir which we are studying here, your conclusions are predicated upon an adequate sampling of the reservoir. Now, you have indicated that you base your conclusions as to the lack of uniformity in this reservoir principally upon the study of microlog seperation?

A I think that is one of our most powerful tools.

Q Am I correct that is what you are using principally?

A No, we have used the electric log, microlog and core data and production characteristics of the wells.

Q These Exhibits 4 and 5 are predicated on microlog separations, are they not?

A The manner in which the shaded green portions are drawn are predicated upon the microlog.

Q You have admitted, as I understand you, that you will concede there is some continuity of sand, but you will not concede there is a uniformity of sand, is that correct, uniform condition of sand characteristics, permeability?

A I will concede there is a certain amount of continuity, yes.

Q So then it becomes a matter of the degree of movement rather than the movement itself, is that not true?

A Not necessarily, I don't believe. I think that a considerable portion of this reservoir is so impermeable that oil will not

move through it.

Q And you base that upon the absence of microlog separation principally, do you not?

A No, there's no need to compare microlog with an interval which the electric log shows obviously is a silt stone or shale.

Q Well, this green differential is based on microlog separation?

A That is based primarily on microlog separation.

Q Now, Shell has completed some of its wells in zones that you show that don't have any microlog separation, haven't they?

A Yes

Q How have they done that? A How?

Q Yes.

A By perforating the sands as shown by the SP curve of the electric log.

Q They have obtained production in that manner?

A Non-commercial production.

Q Have they fracted any of those wells?

A I think they have.

Q Well, now, Mr. Lindsay, this may be a production question, but it has a bearing upon your conclusion of lack of permeability, isn't it true that it is not uncommon in a reservoir of this nature where you do not show absence of microlog separation, that by perforating and fracting you may induce sufficient permeability to

create a rather satisfactory production situation, isn't that the purpose of fracturing?

A The purpose of fracturing is to increase the permeability around the well bore of the formation you are attempting to produce, but I'm not sure just how far these fractures extend into the reservoir, and I would like to refer to cross section AB where there is considerable distance as I have interpreted it from, for example, Government 12-15 in the 80 sands to where I believe the permeability sands pinch out, and I would state that I doubt that fractures would reach that far.

Q Of course, you have admitted, Mr. Lindsay, that you are just guessing after you leave the well bore in any of those situations where that pinches out?

A As has been testified, geology is an inexact science.

Q I become more aware of that constantly.

A So do I.

Q As a matter of fact, if you carry your argument to its logical conclusion, which apparently is done in California, you might have some of these streaks of permeability extending immediately adjacent to the well bore, mightn't you?

A I would say that is very unlikely.

Q And the only way that you could actually be assured on primary methods of recovering the oil, all of the oil in the reservoir, would be to mine it out, wouldn't it?

A I don't think any operator ever will make the claim that he will get all the oil out of a reservoir.

Q The greatest ultimate recovery of oil, I'll put it that way.

A I think that the amount of oil that you will recover from any reservoir will increase with the density of the development and that, well oil has been mined as a matter of fact.

Q Your company recommends that in this instance, would it?

A No, because it would be a very non-commercial enterprise.

Q Exactly. So it becomes a question of where you reach the point of no return, does it not, as far as economics is concerned?

A That is true, yes.

Q Have you made your analysis and your conclusion that you stated at the end of your testimony with reference that primarily recoverable oil may be lost by 80 acre spacing with any consideration of the possibility of pressure maintenance in this reservoir during the stages of primary recovery?

A I am not an expert by any means on secondary recovery or pressure maintenance, or for that matter reservoir engineering.

Q Then you have not made that statement in consideration of the possibilities of any such approach?

A As I was about to say, however, I would say that no matter how continuously you attempted to maintain the pressure in this reservoir throughout its productive life, there are sufficient discontinuities that you will never efficiently flush this well as a

wide acre, or flush this field on a wide spacing.

Q Of course you are making that in the light of your previous statement that you don't have any understanding of pressure maintenance or secondary recovery?

A I didn't say I had no understanding of it. I said I was not an expert.

Q With regard to the photograph of the core that you presented in evidence here, which is Exhibit 6, that core is taken from one of the lower zones in this sand formation, is it not?

A Correct.

Q Do you agree with the witnesses for the proponents that the most likely producing zone in an economic sense in this reservoir lies at the top of the sand formation?

A I agree that there are probably more reserves in the upper portion of the reservoir, that is what we call the CC sand, than there are in the lower.

Q Then the photograph of the core which you have taken represents a portion of the formation which is in what we would consider a poorer sand?

A In this particular well this sand is better developed on the electric log as regards microlog pay and as regards core data, than is the upper sand.

Q Do you think that this Exhibit No. 6 represents a poorer sand zone?

A No, I would say it is a fairly good sand zone.

Q What is the point of this, what are you trying to establish that the colors aren't the same, or would you explain it a little further to me?

A I was attempting primarily to illustrate the very irregular bedding planes and the evidence that we have of disturbance during deposition of the sands to point out that we are not dealing with long, continuously even bedded sands, but sands which are disturbed and irregular on a very small scale as well as on a large scale. I think this supplements, on a microscopic scale, what we show with our cross sections on a microscopic scale.

Q Did this reflect any unusual condition in this sand reservoir that is not present in other sand reservoirs in this area that you have studied?

A I have not studied other sand reservoirs in this area.

Q Now, with regard to your Exhibit No. 11, as I understand it, none of the gas wells which have been completed in this pool have ever been produced, is that right?

A I don't know of the production history of those gas wells.

Q And it is also true, is it not, that there has been limited production history with regard to the oil wells because of lack of market, isn't that also true?

A I have heard that that is true.

Q Do you know how much oil those wells on your exhibit have

produced? A No, I don't.

MR. SETH: This is a geological witness. We'll have other witnesses who are production people.

Q Have you had experience in examining the geological characteristics of a sand reservoir containing a possible gas cap?

A Yes.

Q Where was that? What reservoir?

A That was in the Ventura Field in California.

Q Does that definitely contain a gas cap?

A We believe that it did not contain a primary gas cap, but that at its present stage of depletion some of the zones have increased. Again, I'm not a reservoir engineer, but they have been depleted to the stage where considerable gas has come out of solution and that the high structural wells have extremely high gas-oil ratios, and we feel that this is evidence that a gas cap is probably forming in the stage of development of those pools.

Q You have recognized, I believe, that the rock characteristics in this particular reservoir are in some instances rather poor and variable, have you not? A Yes, I have.

Q Well, Mr., as a geologist, can't you say that it is true that it is not uncommon in a reservoir with non-uniform rock characteristics, to have a transition zone between oil and the gas cap that may establish anomalies over vertical distances of considerably more than 25 feet and still not eliminate the

possibilit[illegible] gas cap?

A I would say that under the geological conditions of this field that there has almost certainly been enough geologic time for equilibrium to be attained in the reservoir, and that if this were one continuous reservoir I would expect the gas cap to occur only at a higher structural position than at relatively down-structure position to oil-bearing sands.

Q Do you mean to say that in a reservoir of this type that there should be a positive distinguishing cleavage between the oil reservoir and the gas reservoir in order for you to consider there is a gas cap?

A I would not consider myself qualified to say just how sharp that cleavage would be.

MR. CAMPBELL: I believe that's all.

MR. PORTER: Anyone else have a question of the witness?

MR. SULLIVAN: Just a minute, please.

By MR. SULLIVAN:

Q Mr. Lindsey, unfortunately I was sitting down here today and yesterday I wasn't furnished with copies of your exhibits, but I believe they're all marked so that I can see them up here now. I was going to ask you to read, refresh my memory on a number of them, but I see it wouldn't be necessary.

A All right.

Q Now, have you ever appeared, Mr. Lindsey, as an expert

witness for Shell or any other company before in a hearing of this type? A No.

Q I thought I detected a nervousness or, I want to explain something very briefly. The role of the lawyer in a thing of this kind, and I consider it my role, is to elucidate, we are not here to spar with you. My client, the British American Oil Producing Company, is as eager to make known the facts in this case as is Shell. So that I don't want to approach this now, Mr. Lindsay, in the spirit of sparring with you. A Suits me.

Q Good. But I want to start off, let's reduce this thing to elementals and we will take a hypothetical question. Let's assume that this was your oil field, or that these interests in this field were yours individually and not Shell's or British American's or Sunray's or some other relatively large company. Now, if that were the case, how would you classify the oil field as to quality, just generally let's say three general classifications, real good, fair, below fair? A On what basis?

Q Just generally overall, is it a really good oil field, is it a fair oil field, or is it a below fair oil field?

A Are you referring to the amount of oil that I might expect to recover from this field?

Q Yes, on that basis, real good, fair or less than fair.

A I would put it some in the middle.

Q It's either fair or less than fair?

A I would call it fair. Better than some and not as good as some others.

Q Now, we have picked out some standard, it's in the middle here. It's kind of an average oil field. Look at it again from your personal viewpoint, your overall satisfaction with the performance of this field is going to be governed by how much money you make on it, off it, isn't it? A Oh, definitely.

Q And secondly on the basis of whether or not you have in effect recovered all of the oil that is recoverable within practical economic limits, is that correct?

A Yes.

Q Now, I think we now have established what your aim, what probably your employer's aim, and what the other people involved in this hearing, their general aim is with regard to this field, if we can consider that their attitude would be much the same as yours, is that probably a correct deduction?

A I think we have.

Q Now, I believe that you testified in effect that from the viewpoint of establishing, tapping, let's put it —

A What is that?

Q From the viewpoint of tapping each of these individual sands, the best method of making certain that you recovered all of the recoverable oil in each of these sands would be to mine it, but of course, that is preposterous, isn't it?

A Yes.

Q We depart fromthat degree of preposterousness. You wouldn't drill it on one acre spacing would you?

A No.

Q You would drill it on 40's I infer. I don't believe you ever made that recommendation directly, but I infer that you suggest that the field should be developed on 40 acre spacing?

A That seems to me to be a reasonable spacing for this field.

Q Do you think that at some time in the future you might recommend 20 acres, if 40 is proved to be less satisfactory than you now think they would be?

A I'm not prepared to say. I think that would depend entirely on what we found on 40 acre spacing. I am not in a position to recommend what we do in the future.

Q I am not asking that you recommend. I am asking if it may be shown that if you develop it on 40 that subsequently in order to tap each one of the disconnected sand bodies, it might be necessary to drill it on 20's?

A I would say that it is very improbable. This is only an opinion that I think that is improbable that we would want to drill 20 acre wells to attempt to recover more of the primarily recoverable oil in this field.

Q Is there any condition attached to that?

A No.

Q If it were profitable to do so?

A There would have to be a very thorough profitability investigation made of that. I am not, that is not my particular specialty.

Q Now, one point in your direct testimony, or either upon cross examination by Mr. Campbell, I'm not sure which, but I'm certain that you said something to this effect, that you felt that the type of sampling that you have done here with minute study was of a better grade than a general sample taken throughout the field?

A I think that information gained this way is more pertinent for a spacing study, that is for a general ruling for an entire field, than would a more superficial examination.

Q Well, but do I understand correctly that your study was confined to a relatively, I won't say relatively, absolutely, this series of diagrams here represents these two lines, does it not?

A It does.

Q And what is the distance of each of those lines?

A Oh, about two miles each.

Q You were present in the hearing room yesterday all day, were you not? A Definitely.

Q You heard Mr. Finfrock testify, did you not, the first witness yesterday morning? A I did.

Q Did you see the charts that he exhibited to the Commission

which were his Exhibits, I recall 6, with sublettars down through F?

A Yes.

MR. SETH: We'll stipulate that the proponents Exhibits were longer than ours and covered more territory.

MR. SULLIVAN: Mr. Seth, I don't want to spar with you either.

MR. SETH: We just want to get to the point here.

MR. SULLIVAN: The point is, this young man testified Exhibit 6, this young man testified that he thought his examples were better than general examples. I assume that he referred to Mr. Finfrocks exhibits. I'm not going to refer to the length.

MR. SETH: I don't believe he characterized the proponent's exhibits at all.

A No.

MR. SETH: I don't think it is fair to put him in that position.

A You are putting words in my mouth. I did not say mine are better than his. I think his are admirable.

Q Let's go at it another way. All I want to establish was, would a study of logs extending the entire longitudinal length of the field, or as nearly along its entire axis as those logs are available, give a good picture of the entire sand bar?

A It would depend on what information is shown, what geologic tool we employ in interpreting these wells. I would say

that --

Q (Interrupting) Suppose that we employ a good geologist, an experienced geologist, to examine these logs. That's an important tool, isn't it, an experienced, competent examiner of the data? A Yes.

Q And then in addition to that examination he also makes studies of cross sections, the entire longitudinal length of that field comparable in length to your AB line, and he does five of them, would that give a more complete picture of conditions in the field than taking that same study in an isolated area?

A Only if he used all the tools which were available to him, including the micrologs.

Q Let's assume that he does use all of those tools, core analysis, Microlog, anything else that has been made available to him, then we get a more truly representative picture of the entire structure, would we not? A Yes, you would.

Q Let's get around to this problem of whether or not there is any other possible set of physical circumstances which could lead to the discovery in this structure of oil above gas. That is simply stated, but a good deal of your testimony was directed to that situation, was it not?

A A very small part of it.

Q Are there any other conditions other than the non-connection of the oil and the gas bearing sands that could possibly occur in this

particular instance for production of oil above the production of gas in two fairly adjacent wells?

A There is nothing that I can think of for a reservoir of this type.

Q Now, you are down here close, or on the gas cap of this structure, are you not, in this situation where the two wells, the two wells that you have referred to and which were fairly adjacent wells in which gas is produced at one in a lower elevation than the oil is produced in the adjacent well, is that on or near what has been referred to in this hearing as the gas cap?

A Yes.

Q Let's find out, one, is it not possible, let's start out this way: I believe that you stated that assuming equilibrium of the fluids in this reservoir, that that was the only conclusion that you could arrive at was the lack of connection between the sands?

A That is correct.

Q Assuming equilibrium. Well, now, if those fluids in the reservoir were not in equilibrium, would your conclusion necessarily be, would it be an inescapable conclusion?

A No.

Q Is it possible that the fluids in this reservoir are not in equilibrium?

MR. SETH: I think he should answer the question first. Were you going to answer the first question there?

MR. SULLIVAN: I'm sorry if I interrupted. Would you read back one question, please?

REPORTER: Reading: Assuming equilibrium. Well, now, if those fluids in the reservoir were not in equilibrium, would your conclusion necessarily be, would it be an inexhor ble conclusion?

A May I answer your first question?

MR. SULLIVAN: Yes, go ahead.

MR. SETH: Yes, do.

A I think that that is a question pertaining to reservoir engineering and I think that one of the subsequent witnesses will be better qualified to testify upon that than I am.

Q Would a tilted gas, the general tilt result here in a possibility of a gas cap?

A I don't think there would be a tilted gas cap in this case if the testimony of the geological witness yesterday were correct, because as I remember on this big three-dimensional illustration there was shown a definite line, a horizontal line, showing the base of the gas cap.

Q But if the gas cap were tilted, if the gas cap were tilted, we could state this as a hypothetical question if you like, but if the gas cap were tilted, then it is possible to produce gas at a lower level than oil is produced, is it not, even with inter-communicating sands?

A Again I would like to remind you that these questions involve the field of reservoir engineering, which I think one of our subsequent witnesses would be better qualified to testify.

MR. SULLIVAN: I will take it up with him, Mr. Lindsay.

Q Are you prepared to qualify as to whether or not you believe there's any vertical permeability? I think it was referred to as vertical permeability by Mr. Brinkley.

A Is there any?

Q Yes, any. A Yes, there is some.

Q To what degree, in your opinion, does it have any substance or importance in this reservoir?

A I would say it has an importance in that I believe that vertical migration of oil may take place from the very low permeability oil-bearing sands into the very permeable streaks of sand in a vertical direction where they are adjacent to them, and then I would expect them to travel more or less horizontally there to the well bore.

Q Do we have any modern method other than in your cores, of determining the extent of vertical permeability? Is there any method of determining vertical permeability except from the study of the cores? A I don't know.

Q Did your cores there show any signs of vertical permeability in any of those sands? A Yes.

Q Of which they were illustrative?

A As a matter of fact, the core sample No. 7 shows some vertically distributed sand streaks which I would assume to have some vertical permeability.

Q I had one other thought too, Mr. Lindsay, which maybe we shouldn't pass by in connection with this gas above the oil, or oil above the gas situation. Are you familiar with the term relative permeability? A Yes.

Q In a tight sand, does the relative permeability of the sand to gas as compared to oil make it possible that an oil-bearing sand will produce gas when it does not produce oil?

A I believe that is possible.

MR. SULLIVAN: I think that's all, Mr. Chairman.

MR. PORTER: Anyone else have a question of the witness?

MR. SELINGER: I have a few questions to ask. Would you care to have a short intermission before I embark on my series?

By MR. SELINGER:

Q Mr. Lindsay, I represent Skelly Oil Company, so you may know who I am. I want to direct your attention to the exhibits that you yourself have made and presented to the Commission, and in order to avoid any misunderstanding of questions and answers to be forthcoming, I want to get it clear as to the extent of your study. Is your study confined to the one-third of the area of the field, or do you have any knowledge at all of the entire field?

A My study has been concentrated in the approximately

one-third of the field which I have described in my exhibits.

Q Do I take that answer to mean that you know nothing about the entire field as a whole? A No.

Q Then to what extent is your knowledge for the entire field? Do you have knowledge, for example, as to the aerial extent of the field? A Not precisely.

Q Do you have any idea then as to the approximate amount of productive acreage as disclosed by presently drilled wells?

A I cannot give you a figure.

Q Do you have any knowledge of that? I didn't ask for any specific figure.

MR. SETH: I think that is a reservoir question.

MR. SELINGER: I am not asking him about any reservoir data whatsoever. I am asking geologically, the productive limits of the field, if he knows.

A All right. I would say that the presently proven productive limits are a little more than twenty miles long and a little more than two miles wide.

Q Does it extend beyond Ranges 11 and 12 West?

A Yes.

Q And by your answer then, I assume that you have made detailed study of the area in Ranges 11 and 12 West, but a study of a great deal minor detail in Ranges 10 and 14 West, is that correct?

A That is correct.

Q Now, within the area that you have made a detailed study, particularly Ranges 11 and 12 West, are there any areas of undeveloped acreage lying in those ranges?

A Yes.

Q Would you mind pointing it out to the Commission as well as indicating for the record the approximate four or five, six, sections that have little or no producing wells?

A I would say that portions of Sections 11, possibly 12, 13, 14, 23 and 24, 15, you say little or no? I'm pointing to the ones for which there are remaining locations to be drilled.

Q Thank you. That is what I had in mind.

A These are in Range 12 West, in Range 11 West. I would consider remaining locations to be drilled in Section 16, little or no you say, 18, 19, 20, 21, 16, we're getting into the gas area. I have no idea how densely that will ever be.

Q That is sufficient, you have answered my question. In answering that question, you have referred to Exhibit No. 3?

A Yes.

Q Now, on that exhibit, have you determined geologically the limits of production in that particular area?

A We have defined the approximate limits of production in that area.

Q Both on the northeast and southwest along its entire line?

A Yes. You said along its entire line?

Q Along its entire line northeast and southeast.

A I think from the drilling that has been carried out in that area that we have a pretty good idea of where the productive limits are in the northeast and southwesterly direction.

Q So that as a geologist, you can say to the Commission that you have determined for all practical purposes the productive limits of the Gallup zones in Ranges 11 and 12 West?

A I think we have.

Q Now, on that Exhibit 3, which is an isopach map of the net microlog, is that correct? A Correct.

Q Can you trace, for example, across the entire area delineated on that particular exhibit for example, a line ten feet along the south line and then along the north line?

A Shall I describe where it is?

Q No, I ask you first can you do so?

A Yes.

Q Will you do so by merely pointing and we'll let the record be silent in that respect, but the Commission can get it from your pointing? A All right.

Q Now, along the north line can you similarly do so?

A I think I can. I thought I could.

Q Thank you, Mr. Lindsay. Would you be able to continue the tracing of the ten foot line, which is not exhibited on Exhibit 3 in Ranges 11 and 12 West, but could you similarly trace that, a

continuation on through Ranges 14, to the northwest and Ranges 10 to the southeast?

A I think I could if I were to draw one.

Q Thank you. I want to refer your attention particularly to your Exhibit 2 which is styled stratigraphic section in which you have depicted there on two wells, the Shell Carson No. 1 and the Shell Carson 33-24, and you have indicated on this exhibit the distance between these two wells as being 2950 feet?

A Correct.

Q You have indicated on your Carson No. 1 your permeability, which is depicted in millidarcies in red, is that correct?

A Correct.

Q Do you have any of whatever nature on your Carson 33-24?

A Any what?

Q Any permeability in the so-called CC sand which the proponents have indicated as the upper, do you have any permeability of whatever nature on that well? A Yes.

Q How many feet? A Of permeability?

Q Yes.

A Permeability of what magnitude?

Q Of any kind. Do you have any, I said, and you said, yes, and I'm asking you how much. A How many feet?

Q Yes. A Or magnitude?

Q Any magnitude, I said.

A I cannot give you a figure at the moment because on this chart, since we have a logrithmatic scale for permeability, there is no zero in a logrithmatic scale, so I do not know how many of those marked one-tenth of a millidarcies include the zero or less, which may include some intervals of zero permeability.

Q Do you have any coloring of red on that?

A No, I do not.

Q Will you kindly step to the exhibit and see whether or not there is any red appearing on that?

A In the GC sand you say?

Q In the GC sand.

A I'm sorry, I am mistaken, there is a small amount.

Q Would you care to correct your answer? We started out by saying, and you agreed, there was some degree of permeability, you didn't know how much. Now will you kindly, since you have stepped to the board and looked at Exhibit 2 closely, indicate whether or not there is any degree of permeability in that well, referring to the Gurean 33-24.

MR. SETH: He already testified there was.

A There is some degree of permeability in that sand.

Q Do you know how much, to what degree?

A Do I know what is the magnitude of the permeability?

Q Yes.

A I know of over the portion of the zone, but unfortunately

when we corad the well there is no recovery over the interval which shows the microlog pay.

Q Can you give us any figures as to the rod color that you have there?

A Yes, I have a small interval which shows slightly more than a millidarcy.

Q Is it possible to correlate the permeability from the Carson No. 1 to the Carson No. 33-24 in the SC sand or upper sand from this exhibit?

A I can only say that those intervals of permeability may or may not be connected.

Q If there is additional permeability which is not shown on this exhibit because of what reason —

A There was no core recovery in that interval.

Q Because of the lack of core recovery, then would it be possible to show your correlation through there?

A That would depend upon what well control you had in between those two wells.

Q Are there any other wells in between those two wells?

A No.

Q So that it's a matter of speculation as to the extent of the permeability and the correlation between those two wells, is that correct? A I believe it is.

Q That speculation is due primarily to the lack of additional

walls between those two walls? A That is correct.

Q And if there were additional walls between these two particular walls depicted on Exhibit 2, you would be in a better position to give a more clarified answer?

A I think you would be in a better position.

Q Thank you. Now, I want to ask you about this Exhibit 4 in this well known as the Shell 12-15, you have depicted on this Exhibit 4 as four green lines, is that correct?

A Green intervals.

Q Green intervals? A Yes.

Q Do you show these three green intervals separated from each other? A I do.

Q Do you show these three green intervals separated from the respective wells on each side? A I do.

Q Is it your view as a geologist only that these three green intervals are separated from each other and that they each bear oil or gas?

A I think that they are separated with either no, or very little permeability between them.

Q Is it your view as a geologist that they are not connected, that they are separated? A It is.

Q Is that well perforated in all three of these separate leases?

A It has perforations in all three of them.

Q From that, then, you would assume that the well is

producing from all three of those intervals?

A I would.

Q Now, I might ask you in the interval between the Shell, what is that, 21-15 and 12-15, how far apart are those wells?

A Those are about 1800 feet apart.

Q Would you have any opinion as a geologist if a well was drilled in between those two wells we have mentioned, and which I am pointing to, whether or not that well would find production in the zone of production in Well 21-15 and in the zone, one of the zones of Shell 12-15?

A I think that I can only say that it may or may not do so.

Q And your answer is given on the basis of lack of additional drilling in between those two wells, is that correct?

A That is correct.

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

MR. PORTER: Anyone else have a question of the witness? Mr. Bushnell.

MR. BUSHNELL: I just have one or two quick questions.

By MR. BUSHNELL:

Q Mr. Lindsey, as a geologist, is it your opinion that the oil in this Bisti Field originally originated these sands, or would you say in your opinion that it migrated to these sands?

A I would say that probably the oil was supplied from both sources.

Q From both sources? A Yes.

Q Did I understand you to say from both sources?

A You did, yes.

Q So that part of it could have been formed elsewhere and then migrated into the sands now known here as the Bisti Field?

A I'm not prepared to say how far.

Q No, I wasn't asking how far. I was trying to repeat what you had said that in your opinion, am I correct, you just said that in your opinion part of the oil here now migrated from some other source, is that correct? A That's correct.

Q If that is true, then, Mr. Lindsay, would it not follow that the oil in the Bisti Field would be all one common source as to that portion that migrated at least?

A I can't say at the present whether that's true or not.

Q Does that sound logical?

A I would say it's not impossible.

Q Does that mean the same as it sounds logical? Let me ask you one other question, then, you have used the word discontinuity several times here. A Yes.

Q Were you using that to mean that you are denying communication? A No, I am not.

Q In other words, you can have discontinuity and still have communication, is that correct?

A You can have all degrees of communication.

Q So that you could have discontinuity and still have communication, is that correct?

A Not where you had discontinuity, no. I would say what I'm referring to is the Gallup sand as a whole, I would say that there is a limited amount of continuity in it, but where there is discontinuity there is just discontinuity.

Q You are not denying that there could not be communication by use of that word, are you?

A Communication from where?

Q To these terms that have been used between these intervals of the Bisti sand. A Up and down?

Q Yes.

A I don't believe there is communication up and down between these two intervals, these two main groups of sands that I have referred to, since there appears to be fairly persistent silt and shale bodies existing between them, which I would say is impermeable to migration of oil.

Q I thought I had you saying what I wanted you to say, but I lost you. Let me repeat once more, Mr. Lindsay. You have used the word several times here this morning, discontinuity, is that correct? A That's right.

Q Are you using that word to mean that when you have that condition you cannot have communication? You are not using one opposite the other, are you? A One what?

Q Opposite of the other. One is not to the exclusion of the other, is it?

A I would say in some places discontinuity.

Q This is a general principle. I'm not a geologist. I am a lawyer with Amerada, I forgot to introduce myself.

A How do you do. Could you restate the question, please?

Q The word you are using, the word discontinuity, is not to the exclusion of communication is it? I'm not referring to any particular piece of testimony, I'm just using it to define in my mind the word discontinuity.

A I used discontinuity to refer to a portion of the reservoir where I think oil will not migrate. I use communication to refer to a portion of the reservoir where I think oil can pass through, to a certain degree.

Q Let me put it this way, in an oil pool that is a common source, you could have parts of it where there exists what you used the term discontinuity, but in other parts of that field there could be communication? A Yes.

MR. MORRILL: That is all the questions I have.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsey, does your general geologic picture here look more favorable or less favorable from the standpoint of recovery of oil than Mr. Pinkerton? A On what spacing?

Q Any spacing. It doesn't make any difference. Does it look like there is more oil to you in the reservoir from the pictures you have drawn than it did from the pictures that Mr. Finfrock drew?

A His pictures, no. I would say that his look better than mine.

Q That's what I thought. Then yesterday the argument developed between the proponents and protestants as to how much oil there was in the reservoir. In that argument, Shell was on the other side. Now I can't understand how there can be more oil by Mr. Finfrock's picture, which is put in terms of barrels at 210 foot per 40 acre tract, I don't see how this is consistent with the geologic picture you drew.

A What I meant by better, that is that Mr. Finfrock's pictures looked better, was that they showed more continuity than mine do.

Q Didn't they also show more oil?

A I don't think he specifically showed where the oil existed in his pictures.

Q No, but if the conditions that he portrayed exist, there would be more oil than if the conditions you portrayed existed, would there not?

A Not entirely, because he had an isopach map of net mineralog pay which would compare pretty much with ours. If they have their volumes on how much oil there is in the field on that

net isopach map, then our pictures I think would be quite comparable.

Q Thank you.

MR. PORTER: Mr. Utz, did you have a question?

MR. UTZ: Yes, sir.

By MR. UTZ:

Q Mr. Lindsay, through all of this gas well discussion here, I still haven't determined in my own mind as to whether or not you have an opinion as to whether there is a gas cap in this pool or not.

A I don't know whether there is a gas cap or not. There certainly is some gas production, and I would, in my opinion, those gas wells produce from sands which are not connected with sands which produce oil in upstructure positions. Whether or not you would call that a gas cap, I don't know.

Q Is there a possibility that it could be a local gas cap condition?

A I think there is a possibility, but I don't know how continuous that gas cap would be from gas well to gas well.

Q I see. On these four different cores that you have submitted here as exhibits, would you have any permeability information as to those individual cores? Would you be in a position to say what the permeability was in each core?

A You are including these?

Q Yes, I'm referring specifically to these rock cores that you have brought in.

A Well, the situation is that permeabilities within these cores, Exhibits 7 and 8, would probably range from zero to some considerable number of millidarcies of permeability, depending upon which part of the core I sampled.

Q By considerable, you mean what, hundred millidarcies?

A These streaks may or may not contain a hundred millidarcies. I think they could.

Q I'm trying to establish in my mind what the relationship between flow of oil and permeability would be, referring specifically to the type of oil we have in the Bisti Pool. How low a permeability can we have, if this is an engineering question please say so. How low a permeability can we have and still have a movement of oil through it?

A It is an engineering question, however, I would estimate that the range of permeabilities through which oil would flow might be on the order of a tenth of a millidarcy to a millidarcy. Actually I would say that it might be actually less than that through which oil could flow at all. I would certainly say that sand showing zero permeability oil would not certainly flow with any ease through that type of sand, but as to the break-off point, as to where oil will flow and oil will not flow, I am not prepared to say.

Q But you don't think that at a tenth of a millidarcy oil would flow through it?

A I can only give an opinion on that, and I would say that oil would probably flow through a tenth of the millidarcy sand, but probably very, very slowly.

Q It would flow better through one millidarcy?

A Certainly.

MR. UTZ: That's all I have.

MR. PORTER: Does anyone else have a question? Mr. Kellahin.

By MR. KELLAHIN:

Q Mr. Lindsay, I'm representing Phillips Petroleum Company. I just wanted to ask you, you just have the two cores, is that correct? A Pardon me.

Q Two cores which you brought here?

A Four.

Q About what are the sizes of the cores, about three inches?

A Yes.

Q Then you are taking about a twelve-inch section of the pool to relate the twelve miles, is that right?

A Twelve inches?

Q Well, you have four cores three inches across, that is about twelve inches.

A No, these are not the extent of our reservoir information about the reservoir rock.

Q These are the only ones that you have presented to the Commission? A That's right.

Q You are relating that, and by inference saying it covers twelve miles.

A I am prepared to testify that these cores are representative of the Gallup sand, the entire Gallup sand, which was cored in these two wells.

Q These four cores are from two wells?

A That's correct.

MR. KELLAHIN: That's all.

MR. PORTER: Anyone else have a question? Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsay, you are familiar with the term common source of supply?

A I have heard it, but I have never used it, and I do not know its definition.

Q Do you feel that questions concerning common source of supply should be better directed to an engineering witness rather than a geological witness? A Yes.

MR. COOLEY: No further questions.

MR. COOLEY: Mr. Nutter.

By MR. NUTTER:

Q Mr. Lindsay, I believe it has been stated at this hearing that the length of this pool is some twenty miles, is that correct?

A I think I heard that figure, twenty or perhaps a little more.

Q What is the overall length of the entire study which you have made as depicted on Exhibits 1 and 2 by the red lines, the general overall length of your study?

A About, I would say, between nine and ten miles. I would say nine miles as a figure.

Q And that lengthwise study has been made, or that nine or ten mile study has been made along the longitudinal axis of the pool, is that correct?

A No, both along the longitudinal and across the axis of the trend.

Q How many miles of study have you made along the longitudinal axis of the pool?

A You are right, about nine.

Q In other words, that nine or ten miles of study that you have made along the longitudinal axis of the pool represents a study of some half of the length of the pool?

A Approximately. Slightly less, I would say.

Q And I think that you stated, correct me if I am not correct, you stated that you believe that the general reservoir conditions along the longitudinal axis of the pool are similar from one end to the other?

A I would say that I have stated many times that this is a very heterogeneous reservoir, and I think that the heterogenity that we would find in these nine miles would probably exist throughout the

entire reservoir.

Q Did you hear the testimony yesterday, Mr. Lindsay?

A Yes.

Q Was the general tone of the testimony yesterday such that would indicate that the general conditions of the reservoir would prevail from the northeast to the southeast end of the reservoir?

A Yes, they do.

Q Do you feel that your nine or ten mile study therefore, along the longitudinal axis of the pool is typical of the entire length of the pool?

A I believe that it is.

Q What length are the crossewise studies that you have made across the pool? A About two miles.

Q What is the general width of the pool throughout the length of the pool?

A I would say about two and a half miles.

Q So you have pretty adequately studied the cross section of the pool, do you feel that is true?

A I feel that I have.

Q Mr. Lindsay, in response to a question by Mr. Selinger, you pointed out certain areas where the acreage had not been completely developed? A Yes, I did.

Q Has Section 5 of Township 25, 12, been fully developed in your opinion?

A It has been fully developed on 80 acre spacing.

Q Has Section 8 been fully developed?

A On 80 acre spacing, yes.

Q Are there several other sections there that haven't been developed on 40 acre but they have been fully developed on 80 acre spacing? A Yes, there are others.

Q So that no part of the pool has been fully developed insofar as 40 acre spacing is concerned? A That is correct.

Q In response to another question by Mr. Selinger, he was mentioning a hypothetical well that could be drilled between, referring to your exhibit of cross section AB, a hypothetical well which could be drilled between the third well and the fourth well on that exhibit reading from the left?

A Yes.

Q Where would that well be located on your red line on the exhibit showing the plat of the area? A Here.

Q Would that be a standard location for a 40 acre well?

A No.

Q So that even on 40 acre spacing it would be impossible to know what would prevail between these two wells as depicted on cross section AB? A Correct.

Q In response to another question, Mr. Lindsay, I believe this question was directed by Mr. Bushnell, he asked the origin of the oil which is in Eight-Seven Eddy pool?

A Yes.

Q Whether the oil had occurred somewhere else and migrated into the pool, or whether it occurred in the pool, you stated that you believed it could possibly have occurred in both places?

A Yes.

Q If the oil had occurred somewhere else, would it have been possible for the oil to have found its way through geological time into any zones which may be permeable but are surrounded by relatively impermeable sections?

A That would depend partly on when the oil was formed and what the geological conditions were when oil migration took place. Have I evaded your question?

Q No, I think you have answered it. Do you think that the oil, if the oil was formed someplace else throughout geological time, would it have a better chance of getting into the, now you say, I believe that there are isolated permeable sections, isolated sections of permeability and porosity? A Right.

Q Would the oil have a better opportunity or lesser opportunity of getting into that isolated section of permeability and porosity in geological time or of getting out of the isolated section of permeability and porosity during the normal life of an oil well?

A I would say the oil would have a much better chance of getting in than getting out.

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

A Unless we drilled enough wells.

MR. PORTER: Are there any further questions? The witness may be excused. We will take a short recess.

(Witness excused.)

(Recess.)

MR. PORTER: The hearing will come to order. Mr. Seth, will you call your next witness?

MR. SETH: I want to call Mr. Norbert E. Methven.

NORBERT E. METHVEN

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

DIRECT EXAMINATION

By MR. SETH:

Q Mr. Methven, were you sworn during the course of this hearing? A I was.

Q Will you state your name and position with Shell and your educational experience, please?

A My name is Norbert E. Methven. I was granted a Bachelor of Science degree in electrical engineering from Oregon State College in 1953. I have been with Shell four years, specializing in reservoir engineering.

Q Where do you live at the present time?

A I'm living in Farmington, New Mexico.

Q Have you made a study of the Bisti Field in this connection?

A I have.

Q Are you generally familiar with the reservoir characteristics in that field? A Yes, I am.

MR. SETH: May he testify as an engineer?

MR. PORTER: Yes, sir, his qualifications are acceptable.

Q Mr. Methven, will you please proceed and describe the reservoir characteristics and the source of your data and how you arrived at your various figures and computations?

A Yes, I will.

I'm employing the geologic interpretations as presented by our previous witness, also employing the petriphysical analysis and the study of the reservoir data. We find in general that wells spaced in accordance with the rules and regulations of the New Mexico Oil Conservation Commission, firstly will recover more oil than wider spaced wells, secondly will run a sufficient profit, and thirdly will pay out the cost of this development within a reasonable length of time. These findings are based on calculations of the total oil in place and an estimate of the amount of recoverable oil. These calculations involve the use of the average reservoir porosity, in the region we are discussing this value is 15%, we are using an average water saturation of 25% as determined by electric log interpretation, core analysis, mercury capillary pressure curves, we are using a shrinkage factor of .78 as determined

by PET analysis and permeables with ranges as previously testified to in this hearing of one to two hundred, and averages of ten and thereabouts millidarcies.

We also are basing this on a drive mechanism of solution gas drive receded by gas expansion while the reservoir is above the bubble pressure. Using these data, the total oil in place as calculated, is 680 barrels per acre foot.

I want to point out that this is in the microlog pay interval. Now, we think that the primary recovery efficiency, or I think, that the primary recovery efficiency will be about 20% of the oil in the microlog pay regions as described in its Exhibit 3 as previously mentioned. Now, this 20% would be of the 680 which is 135 barrels per acre foot. We also want to point out that I believe that this value is applicable only to wells spaced at 40 acre intervals and it will not hold 80 acre spaced wells due to these previously testified to discontinuities. These have been exemplified by Exhibits 2 through 11. I would like to present an Exhibit No. 12.

(Marked Shell's Exhibit No. 12, for identification.)

This Exhibit No. 12 constitutes well data in the Bisti Field of properties operated by Shell Oil Company, and generally in the region as depicted by the Exhibits 2 through 11.

Column 1 are the well numbers as we have them on our exhibits.

Column 2 is the location of that well. Column 3 are the perforated intervals. Column 4 is the microlog pay pick or thickness, and we also have tabulated what we term poor pay in that same column. The next column, 5, are the amounts of fluid used in fract treatment wherever applicable. The sixth column is the total depth of the well. The seventh column is the elevation in feet measured from the Kelly Burk, the next column is the initial rate and barrels per day of these wells where applicable. The next column is the initial pressures of these respective wells. The next column is the most recent pressure data of these wells, and the eleventh column is the cumulative oil in barrels. These numbers are up to 8157 unless otherwise noted.

I want to qualify especially Column 10 which are the recent pressure data, and these data were obtained by Amerada type RPG pressure bomb which was hung in the perforated interval of the respective well and these data in Column 10 represent shutin pressure of wells, these wells having been shut in for periods of 19 to over 180 days.

These, therefore, represent average reservoir pressures in the region of the particular well.

I would like to point out some of these wells on one of our exhibits. I would like to make the general statement that in the interior region of the Shell operated properties, in the region of the central portion of the Shell operated properties, and I might

qualify that by giving some specific wells, Carson Unit No. 1 which is in Section 24.

Q Mr. Bethven, why don't you stand over on this side, and I think everybody can see.

A Carson No. 1 in Section 24, 12 West is this well right here. This well as of 9-2-57 had a pressure, static pressure of 1546. Another well in that region would be Carson 4 of Section 20, which is right here. This well had a pressure of 1580, 1,504 on PSI. Another one is Carson 14-13 in Section 13, which would be right here, had a pressure value of 1539, which as I said the evidence is very near original pressures in that region, primarily because of the lack of withdrawals in there. To the west in Sections 10 and 15 significant withdrawals have been made. I think the discontinuities become evident from these data.

Now, specifically 14, 15 in Section 15, which would be this well right here, had a value of 1177 PSI after withdrawals of 6,555 barrels. Now, Well No. 12-15 had a pressure of 1154 PSI, which is the next well up here, after withdrawals of 22,309 barrels. Now, the next well to the north, 14-10, this one right here, had a reservoir pressure or average static pressure of 1454 PSI after withdrawals of 15,152 barrels.

I would like to qualify this data as I neglected to do before, the pressure data, these have been corrected to a common elevation of 1900 feet, common datum. My point here is that this well 14-15,

12-17 and 11-20, these are in Township 25 North and Range 12 West, have values of only in the region of a little over 1100 PSI, while the well to the north has 1454 PSI. In accordance with the testimony the other day, I do not have the specific example, but they had a similar situation where the pressures were the same in general on locations like that, but here it does not occur. But there is a significant difference and yet withdrawals have been appreciable here. I think it's a kind of a comparable example, and yet it points to or suggests a different conclusion. It suggests another discontinuity, or at least a heterogenous type of reservoir in view of the fact these wells have been static for quite some time, or shut in.

Now, based on the previous reservoir perimiters that I have listed, and based on the isopach map of the microlog pay which is Exhibit 3, and based on an average microlog pay of 12 feet, based on 40 acre spaced wells and the previous recovery factor of 20% and the 135 barrels per acre foot recovery average, I have calculated that there would be 65,000 barrels per well from this sand. This I went to repeat again is the isopach, from the isopach of the net microlog pay. Now, in addition to that we have what we term poor pay. These are sands that are within these major microlog pay intervals and others, and we think that there will be some oil from there, in fact this is based on the fact that we have wells that have been complified that. My estimate of that oil per well

will be on the order of 10,000 barrels. Thus there should be about 75,000 barrels per 40 acre well. This figure of 75,000, of course, disagrees with the previous testimony. Economics of this recovery of 75,000 barrels and an estimated drilling and development and completion cost of $48,000 will render adequate profit, the pay-out on the basis of this cost and this recovery will be less than two years, assuming existing New Mexico allowables.

Now, in conclusion, I feel that 40 acre spaced wells will recover a greater percentage of the oil in place. I also feel that 40 acre spaced wells will be profitable and will have favorable and acceptable pay-outs. Therefore, I think it's imperative for us to recover this additional oil in the interest of all concerned and in accordance with the rules and regulations of the New Mexico Oil Conservation Commission.

MR. [illegible]: I believe that's all the direct. We would like to have the exhibit introduced into evidence.

MR. PORTER: Exhibit No. 12?

MR. SETH: No. 12, yes, sir.

MR. PORTER: Without objection it will be admitted in the record.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. [illegible], Shell, up-to-date at least, has generally confined its operation to its area to the Eumont Gas area, has it

not?

A With the exceptions to the west of one or more sections.

Q Has Shell followed a practice in this area of drilling wells and delaying the actual completion of these wells, in other words, not actually been producing them? Have you done that?

A That is true. Exhibit 12 exemplifies that some of these wells have not been completed.

Q Just how much production history do you have from the wells you have drilled in this reservoir?

A I do not have the cumulative number, but it is only a matter of several thousand barrels. You may be able to add that up if you would care to be more specific.

Q I have noted that a number of the wells in the Carson Unit with which your company has been principally concerned, contain a number of blanks in your well data exhibit.

A Yes, sir.

Q I assume that is due to the fact that you have not completed those wells? A Yes, sir.

Q Do you think that you have enough data upon the basis of Shell's experience in this pool, to reach a firm conclusion that permanent 40 acre spacing is justified in this whole reservoir?

A In my opinion it was sufficient to recommend this spacing.

Q Do you feel that there would be any disadvantage of retaining the present 40 acre well density in this pool for a period of

one year to obtain additional production data upon which you could base firmer conclusions?

A As will be brought out in subsequent testimony, it will be disadvantageous in some respects to delay the more dense spacing program.

Q You have stated that in your opinion wells should be drilled now in this reservoir upon a 40 acre spacing pattern. Do you make that recommendation with regard to all of the areas in this reservoir or just to the more prolific areas in the center strip that you, I believe, or the other witness have referred to?

A I believe I testified to this, was on the average of the microlog pay region as depicted by Exhibit 3.

Q Yes. My question now is when you leave the areas of thicker microlog pay and move to the boundaries of the reservoir on the exterior edges of it, would you recommend to your company drilling wells on 40 acre spacing in those areas?

A No, I wouldn't and, because these are unprofitable ventures as testified by one of Sunray's witnesses.

Q All right. Then assuming that you are correct in your analysis that this reservoir lacks uniformity and that there are areas on the edge that are not as prolific of oil or profitable financially, would not your proposal result in the loss of oil from those areas if you drilled your best areas on 40 acre spacing and recognize that you cannot drill the other areas on 40 acre spacing?

A There will be some of that oil left behind, of course. In fact, there might be quite a bit of it. However, I don't think any industrial organization would want to go, would want to go there and drill these wells because they are uneconomical.

Q Your recommendation is based on the belief that you can, by 40 acre drilling at the apex of this reservoir --

A (Interrupting) Would you repeat?

Q Your conclusion on 40 acre spacing, as I understand you, is based upon your belief that because of the thickness of the sands in the better areas of this reservoir, you can recover more oil than if you drill on 80 acre spacing throughout the entire reservoir, am I right in that? Do you believe that you can do that?

A I want to be sure I understand the question.

Q Perhaps it was vague. Do you believe that if this reservoir is developed by drilling on 40 acre spacing in the areas of the reservoir, that contain the thickness of the sand which you say will pay these wells out rather than drilling 80 acre wells throughout the entire reservoir, in which system would you get the most ultimate recovery of oil?

A As stated, I don't believe that I could give an opinion because as stated, the question infers that if you develop on an 80 acre spacing pattern that you will drill wells out in the non-profitable region.

Q Well, don't you believe as a matter of practical economics

and mathematics that you are more likely to do it under those circumstances than if you are called upon to drill it on 40 acres where it is only half the investment?

A If it's a loss, I don't think that anybody would care to put their money into a losing venture.

Q That would depend too upon the rate of withdrawal, would it not? A Excuse me.

Q That too would depend to some extent upon the rate of withdrawal permitted from the 80 acre well just as your --

A (Interrupting) I said a loss. I mean if it constitutes a loss in dollars.

Q Is your conclusion as to the advisability of 40 acre spacing from an economic point of view for your company, predicated to any degree upon the desire of your company to acquire oil from this reservoir for its pipeline and refining and marketing purposes?

A Sir, I'm in the Production Department, and as you know, our job is to produce and develop those fields. I am not qualified to speak as far as the other phases of the company are concerned.

Q Have you made any study of the proposed effort to establish a pressure maintenance program in this reservoir?

A Yes, I have.

Q Have you in connection with your studies of proposed spacing in this reservoir at this time taken into consideration the possibilities of that effort? A Yes, we have.

Q Is it your opinion that if wells are immediately drilled on a 40 acre basis and withdrawals take place at the assumed rate that you used of the present allowable, that there will be a pressure decline in the entire field somewhat equivalent to the pressure declines you pointed out in Sections 10 and 9?

A I believe that you have stated that if wells are drilled immediately. I don't think that's a practical consideration. I don't think it's a practical question.

Q All right. If wells are not to be drilled immediately upon that basis, what objection can you have to an order of 80 acre spacing for one year?

A I just testified previously that that would be brought out in future testimony.

Q You don't have any views or ideas on that at all?

A Would you state a question?

Q If you do not believe it is feasible, and it obviously isn't, to drill wells on a 40 acre basis in the next year, what objection do you have to continuing the field on the 80 acre basis until at least the pressure maintenance program is tested?

MR. SETH: I don't believe the witness so testified. He didn't testify it was not practical to drill wells on a 40 acre spacing during the next year.

Q Do you think that you can drill enough wells in the next year to develop the Carson Unit on a 40 acre basis?

A That is quite probable.

Q How many wells would that take?

A Oh, estimating in the next year?

Q Yes.

A Probably -- Carson Unit?

Q Well, on your acreage.

A Well, something like fifty wells, I believe.

Q And how many do you believe it would take to develop this field on a 40 acre basis entirely during the next year?

A Are you speaking of the same area now?

Q I'm speaking of the entire Bisti-Lower Gallup Oil Pool as we presently know it.

A The entire Bisti Pool. I believe that's brought out in the testimony the other day of a very great number of wells.

Q Approximately 300 wells, was it not?

A Something like that.

Q Now, do you think it's practical to drill that many wells in a year?

A I think I already said that it wasn't.

Q That it wasn't? A No.

Q What do you consider to be the bubble point pressure in this reservoir?

A My figure is very close to that figure as testified to yesterday.

Q That I believe was 12 — A 1207.

Q 1207.

A 1207 I believe it was, yes.

Q I notice that with the limited production that has taken place in the field, that two of the wells to which you referred as having some production in Section 13, that the recent pressures are already below the bubble point, am I correct?

A That is correct.

Q As a reservoir engineer, does that have any significance to you insofar as ultimate recovery from this reservoir is concerned?

A Significant of this pressure?

Q Pressure decline to below the bubble point with the amount of oil that has been produced.

A Would you restate the question?

Q Does that have any significance to you, the decline of reservoir pressure in the short production history of these wells below the bubble point have any significance?

A Very definitely. It's a very normal reaction.

Q Doesn't it indicate to you that this is a reservoir that requires a rather conservative approach as far as spacing and withdrawal is concerned?

A That's why we have given it a very thorough study.

Q Do you think that the overall production history is

sufficient to justify the risk that you think must exist, the caution that must be used in the development of this reservoir?

A Yes, I do. I think that it justifies the risk in my recommendation I wouldn't have recommended it.

MR. CAMPBELL: That's all.

MR. PORTER: The hearing will recess until one-fifteen.

AFTERNOON SESSION

September 20, 1957.

MR. PORTER: The meeting will come to order, please. Anyone have any further questions of Mr. Methven?

MR. SETH: We have a few more exhibits we would like to offer at this time. They only relate to the general study that Shell has made of the field and we wanted a complete picture. We would like to offer Exhibits 14, 15, 16, 17 and 18 at this time.

MR. PORTER: Are these studies by Mr. Methven?

MR. SETH: No, they are by other personnel in the company who occupy similar capacities to Mr. Methven.

MR. CAMPBELL: I would like to take a look at these.

MR. PORTER: Surely.

MR. SELINGER: While Mr. Campbell looks these over, may I interrogate the witness?

MR. SETH: I might explain these are copies of letters that have been sent out to the people interested in the Carson Unit and the United States Geological Survey. I think most

everybody here has copies. Excuse me, Mr. Selinger.

MR. CAMPBELL: What are the marks appearing on them? There are some red marks.

MR. SETH: No particular significance.

MR. CAMPBELL: Are any of those people going to be present to testify? Is Mr. MacAlister going to testify?

MR. SETH: Yes.

MR. CAMPBELL: Mr. Robison, I assume, is not?

MR. SETH: Mr. Robison is here. Mr. MacAlister will be prepared to discuss the letters, Mr. Campbell.

MR. CAMPBELL: Mr. Pickell?

MR. SETH: No, he is not here.

MR. CAMPBELL: I won't offer any objection. If you desire, as far as I'm concerned, offer them at this time. Is that all of the letters that have been sent to the participants in the Carson Unit by Shell as operator?

MR. SETH: I doubt that very much. These are the regular geological reports. There have been innumerable letters written on the Carson Unit, I'm sure.

MR. CAMPBELL: Are these all the geological reports?

MR. SETH: Mr. MacAlister can answer that. Is that right?

MR. MacALISTER: Yes, that's right.

MR. CAMPBELL: Do you have extra copies of these?

MR. SETH: No, we don't.

MR. CAMPBELL: I don't mean to be arbitrary, if the Commission please, but this is quite a number of geological conclusions, without even an opportunity to read the letters I hate to accept them in evidence, particularly in view of the fact that the witness is not here to testify. I don't mean to be arbitrary. If I could have a little time while the cross examination is going on to look them over, perhaps I can accept them.

MR. SETH: We are not in any hurry.

MR. PORTER: Then it would be agreeable to you to wait until the other witnesses have been accepted before you offer these exhibits?

MR. SETH: Yes, certainly.

MR. SULLIVAN: Could you lay your foundation for the introduction of those through a subsequent witness like Mr. MacAlister?

MR. SETH: Perhaps we could if that would be --

MR. SULLIVAN: (Interrupting) Then you can identify them and they would come in in a more regular fashion, would that be preferable, Mr. Campbell, from your viewpoint?

MR. CAMPBELL: It would be acceptable.

MR. SETH: That's right, I would like the record to show that we offered them, but we will defer urging their admission until Mr. MacAlister has had an opportunity to testify and to further identify them.

MR. PORTER: Well, the Commission will delay the acceptance or any consideration of acceptance of these exhibits until after your other witnesses have appeared. Mr. Selinger.

CROSS EXAMINATION

By MR. SELINGER:

Q Mr. Methven, as an engineer do you likewise have the opinion that the previous geological witness had that, particularly with reference to Exhibit 11, that there are some oil wells producing structurally higher than gas wells?

A If that's as the exhibit presents, yes, I believe it.

Q Is your testimony, is your opinion based on that Exhibit 11?

A Well, it's based on Sunray's exhibit as presented yesterday also. It shows the same structural relationship.

Q And referring to Exhibit 11, are you familiar with Shell's completion methods of your wells in this field?

A Somewhat, yes.

Q You are somewhat? A Yes.

Q Which of the oil wells produce structurally higher than the gas wells? Just name them.

A Could I refer --

Q (Interrupting) Surely. If you want to refer to the exhibit. It's all right to.

A Yes. Would you repeat the question again?

Q Which of the oil wells produce structurally higher than the

gas wells on that exhibit, or any other information that you may have?

A Which of the oil wells produce structurally higher than the gas wells?

Q Yes.

A It appears that most of these oil wells on this exhibit produce structurally lower than the gas wells. I believe there's an exception here. Yes, Shell Carson 2 produces higher structurally, I believe.

Q Then that's the only well on this exhibit that produces oil structurally higher than the gas well, is that correct, on this exhibit? A On the exhibit.

Q Do you know whether or not Shell individually tested the various perforations to determine whether or not those particular perforations were productive of oil?

A I do not know if they tested those individually.

Q In the event that the well was tested through all of the perforations simultaneously, how can you ascertain whether or not the particular, the uppermost perforations produced oil?

A We can't testify to.

Q Now, look at the log, are you familiar in reading logs?

A Somewhat.

Q Does that indicate that it might be productive of oil itself?

A The log doesn't tell you whether it's gas or oil.

Q Does the indenture lines on the left-hand column, the left-hand side of the well bore column indicate, what does that indicate?

A You mean this line over here?

Q Yes, on the left-hand side.

A I believe that our geologist said that depicted sand development.

Q Then I'll ask you does the sand development, as indicated by this particular log, indicate the ability of the well to produce oil from that particular perforation?

A Certainly not. Just a minute. Your question was does this --

Q (Interrupting) Yes. A Does this what?

Q Then I'll ask you does the sand development, as indicated by this particular log, indicate the ability of the well to produce oil from that particular perforation? You will have to speak so the Court Reporter can hear your answer also.

A Okay.

Q My question is whether or not this Exhibit 11 indicates that the sand development on the Carson No. 2 shows the ability of a well to produce oil? A No, it doesn't.

Q Do you have an explanation, I didn't mean to cut you off, Mr. Witness, do you have an explanation?

A No, that will be all.

Q Now, I want to call your attention to Exhibit 12, this morning you referred to your Exhibit 12 and in pencil indicated on Exhibit 1 in red, three wells, two of which are located in Section 15, Township 25 North, Range 12 West, and one located in Section 10, Township 25 North, Range 12 West.

Do you recall your testimony on direct and cross examination in which you put those figures in red?

A Yes.

Q Do you have your Exhibit 12 in front of you?

A I have.

Q I note that a number of wells were fracted and a number of wells were not fracted, is that correct?

A That is.

Q A number of those wells were fracted with 30,000 gallons of acid, is that right, or treatment?

A Oil and --

Q Treatment? A Treatment.

Q You indicated on this morning's session that the two wells in Section 15 had quite a rapid drop or decline in bottomhole pressure as compared to the well in Section 10, did you not?

A The wells are specifically --

Q (Interrupting) The wells are specifically 12-15 and 14-15?

A Yes.

Q Are those two wells at the present time from your exhibit

the lowest pressures in the field that you have measured?

A In accordance with the exhibit I believe they are.

Q Are they both below the bubble point?

A We have established that they were.

Q Your answer is yes? A Yes.

Q How many gallons of treatment was used in fracting the well in Section 10, Well 14-10?

A That well has not been fracted.

Q How many gallons of treatment were used in fracting the Well 12-15?

A That was 117,450 gallons.

Q How many gallons of treatment were used in fracting Well 14-15? A 115,280 gallons.

Q Did you, in any completion of your wells, use that fracting in any of the other wells from your Exhibit 12?

A No, those are the largest ones.

Q From an eyeball survey of Exhibit 12, would you say that the average gallonage used in fracting the wells in this field were approximately from thirty to fifty thousand gallons?

A That may be, yes, the most of them are in the thirty to fifty thousand gallon region, yes.

Q As an engineer, would you likely expect a more rapid decline in pressure after an unusually large fracting?

A If you had two completely similar wells the objective,

of course, of fracting is to improve their productivity, and therefore the larger fract may not decline as rapidly as the other.

Q Have you had experience in fracting in the completion of oil wells generally in your career?

A I've been involved in a few cases.

Q In those few cases do you generally find it true the heavier the fracting the more of a pressure decline in those few cases that you are familiar with?

A I don't recall the answer.

Q Very well, would you have an answer then for the explanation of the rapid decline of these two wells in Section 15, 25 North, 12 West, being due to the extremely high gallonage of treatment used for fracting, would that be an explanation for that decline?

A No, I think the reason that these wells have had an abnormally great decline is due to the fact that their drainage area is not large. They have a relatively small drainage area.

Q By a relatively small drainage area, you take into consideration for your answer the thinness of the pay compared to the well in Section 10?

A Of course, the amount of initial oil in place that this well drains very definitely has a definite effect.

Q Does pay thickness have an effect on the original oil in place?

A By all means.

Q Then your answer is that you did take into consideration the

thinness of the pay of these two wells in explaining the rapid decline in pressure for those two wells?

A I didn't mention it specifically.

Q You may not have mentioned it directly, but you did after three questions. You said that would depend on the small drainage area, and by the small drainage area you meant the oil in place.

A The drainage volume.

Q Drainage volume, which was in turn controled by your thickness of pay? A Yes.

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

MR. PORTER: Does anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Methven, I'm still trying to arrive at some conclusion as to whether or not there is a gas cap in the Bisti Pool or not. Do you have an opinion on that subject?

A Yes, I have. I don't think I have the answer to it. In the last cross examination the inference was that we didn't know in the case of the oil wells, where the oil was coming from. Now, in the case of the gas wells, the same will hold. However, there were pressure measurements made in these gas wells while producing, and the drawdown was several hundred PSI. I cannot recall the exact number, I don't have the data with me, but it was several hundred PSI, and assuming the pays in the field which are

relatively general, let us assume they are one-tenth MD for FSI, then there should have been a considerable amount of oil with that gas, assuming this rapid drawdown.

Now, then, I believe the figures and the initial production of those wells do not show any oil. Therefore, I can only conclude that gas is coming from all those sands and that oil is not coming from them. Further, to further the explanation, I might go back and say that, let's see, I believe in yesterday's testimony Mr. Brinkley stated that you can have gas occurring, you can have a gas cap, I don't remember his exact words, but this was the thought, that you could have a gas cap in the presence of undersaturated oil. Well, he not only said you can, but he says, I believe his words, that it happens all the time. There are, of course, many cases where it does not happen. Therefore, that is not true.

Also I don't see how it's possible to have a gas cap in conjunction with undersaturated oil just based on the theory of fluid mechanics. So, assuming that you cannot have those two in the presence of one or another, then there has to be some other explanation. I think that in view of the discontinuities that have been placed or are pointed out in our previous testimony, I think you could draw a very logical conclusion that there is another discontinuity in that area which could account for it, but a gas cap existing where you have undersaturated oil, I can't explain that any other way.

Q Then I take it from your explanation that you would gather, or your opinion is, that these gas wells are in a common source of supply of their own and gas only? In other words, a gas reservoir?

A I'm not completely familiar with the exact definition of common source of supply.

Q Well, gas only and no oil?

A Oh, well, the wells have exhibited no oil in their production history, several have exhibited that, so if there was not a discontinuity and, as brought out by the geologist, if there was not a discontinuity, this thing couldn't occur because over the millions of years that this thing took to get there, it will have to be separated some way. There haven't been appreciable withdrawals here so there hasn't been much movement there in many years, according to the geologist.

Q Then, do you feel that if these gas wells were allowed to produce unrestrictedly, it would have no effect on the reservoir energy in the Bisti Oil Pool?

A If it was a separate pool, why then it wouldn't, but I do not know what the answer is to their occurrence.

Q You don't know at this time whether it is a separate gas pool? A No, I do not.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question of the witness? Mr. Kellahin.

By MR. KELLAHIN:

Q Mr. Methven, I understand that the initial reservoir pressure in this pool were on the order of 1590 pounds?

A Yes.

Q Is that correct? A In that region, yes.

Q I notice on your Exhibit No. 12 you have the Government 12-15 and the Government 14-15 wells, on the first you show an initial pressure of 1330 pounds, and on the second, 1314 pounds, is that correct? A Yes, it is.

Q Does that not indicate that those wells, prior to the taking of initial pressure tests, had suffered some drainage then?

A Yes, and this drainage, I believe, was pointed out by our geologist. He did not make the contention that you had specific 40 acre blocks of oil that you will have some communication, and therefore I should think that that pressure drop would be caused by some communication from other wells.

Q From other wells in that area? A I should think so.

Q I notice too on the Government 14-15 that shows no microlog pay? A That is correct.

Q And yet it was completed for the production of oil?

A That is correct.

Q And it also suffered this drainage?

A It infers that, yes.

MR. KELLAHIN: Thank you very much.

MR. PORTER: Mr. Sullivan.

By MR. SULLIVAN:

Q Mr. Methven, has Shell conducted, in any of the gas wells, any bottomhole pressure surveys?

A Yes, I just reiterated one, but I do not have the data with me.

Q How did the bottomhole pressures in the gas wells compare with the bottomhole pressures that you discovered in the adjacent oil wells on bottomhole pressure survey?

A I don't remember the specific values, however, if there was an appreciable difference there I may have read it, but I don't remember what those values were.

Q Now, if there had been an appreciable difference, you think you would have remembered that there was an appreciable difference?

A Pardon me.

MR. SULLIVAN: Well, would you go back and read his last answer?

REPORTER: Reading: I don't remember the specific values, however, if there was an appreciable difference there I may have remembered it, but I don't remember what those values were.

Q So I take that answer to mean that if there had been an appreciable difference in the bottomhole pressures between the gas wells and the oil wells adjacent, that you would have remembered that there was an appreciable difference?

A I said I may have. I also said that I do not remember those values.

Q Well, if the pressures shown in the gas wells and in the oil wells were about the same, certainly upon initial completion, would that be indicative that the gas-producing stratum was a separate stratum from the oil-producing strata in the vicinity?

A It would not tell you that it was or wasn't.

Q Is it likely that if they are one continuous stratum through there between the gas and the oil-producing sands, that the pressures will be identical or substantially so?

A They should be, but if they are of the higher values, we have just previously stated that this case should not exist in view of the laws of fluid mechanics.

Q Do I remember correctly that your testimony was that you anticipated that you could drill and complete the remaining wells on the Shell property in the field at about an average cost of $45,000?

A [illegible] —

Q (Interrupting) Feel free to correct me.

A Will you state it over again?

Q Do I remember correctly that your testimony was that it would cost about an average of $45,000 for Shell to drill and complete each well that remains to be drilled on your property?

A That is correct. That would be the cost for each additional well.

Q Would a cost of $48,000 include a figure for a sand fract job?

A They did. However --

Q (Interrupting) A sand fract job of the magnitude of the two that Mr. Selinger asked you about in one case, you used 115,000 gallons of treatment and in the other case I think it was 117,000 gallons of treatment. Now, if you conduct a fract job of that magnitude, can you do it and complete the well for $48,000?

A We have a subsequent witness that is going to testify to the specific values, and therefore, I would rather not.

Q Well, Mr. Mathven, I assumed that when you testified that the cost of a well was $48,000, that you knew the component parts that went into making up that total cost.

MR. SETH: That is not the correct understanding, it has been furnished, that cost, by Mr. Robison, who will be the later witness.

Q You did not testify --

MR. SETH: He is prepared to discuss the cost in full.

Q You did not testify to the $48,000 then, of your own knowledge?

A I base my profitabilities on that $48,000.

Q But you did not derive at that figure of your own knowledge or your own figure as to what the wells will cost?

A I did not make that calculation.

MR. SULLIVAN: That is all, Mr. Chairman.

MR. PORTER: Does anyone else have a question of the witness? Mr. Cooley, did you have a question.

MR. COOLEY: Yes.

By MR. COOLEY:

Q Mr. Methven, you testified under cross examination a short while ago, I believe, that you would not advise your company to drill wells out on 40 acre spacing outside the profitable area shown here on Exhibit 3 or Exhibit 1 I believe it is.

A It would be Exhibit 3, which is the microlog.

Q Exhibit 3, that's right.

A Any wells drilled out there would be of an exploratory nature.

Q What area was it that you testified to in answer to Mr. Campbell, that you would not advise your company to drill?

A In the region of only a very few feet of micro pay and there out beyond the zero line. And I also contend that you would not drill 80 acre wells out there as admitted in other testimony.

Q That's my next question. Does it make any difference what spacing it is, the purpose for not drilling the well is the fact it wouldn't produce oil? A That's right.

Q If it had a thousand barrel allowable it wouldn't be any different than if it had a ten barrel? A No, it wouldn't.

MR. COOLEY: That's all.

MR. PORTER: Any further questions?

MR. SELINGER: I want to ask the witness one more question that Mr. Cooley brought out.

By MR. SELINGER:

Q You said a few feet of micrelog. What do you mean by a few feet, five, six, seven, eight?

A Certainly not beyond the zero line or the five foot.

Q Would you drill any wells between five and ten feet?

A Yes, you would.

Q Where in between those two points would you have your line of demarkation?

A I couldn't say because this well assumed you place it, let's assume that you place it on the five foot line, will drain some towards the zero and some toward the thicker pay.

Q Having in mind the exhibit that Mr. Seth was attempting to introduce before and which he graciously withheld, would you say that you would recommend the drilling of a well on ten feet on 40 acre basis? A Yes, I believe I would.

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

MR. PORTER: Any further questions? Mr. Utz.

By MR. UTZ:

Q Mr. Mathews, can you tell me from your personal knowledge whether or not Shell has completed any gas wells in this trend or not?

A I do not have data on any specific gas wells, with me that is.

Q Then in your opinion you haven't completed any gas wells?

A I don't know.

Q You're not sure? A That's right.

Q Do you have another witness who could answer this question?

A Possibly, I don't know.

MR. UTZ: That's all I have.

MR. PORTER: Are there any further questions of Mr. Methven?

MR. COOLEY: Did you have something to say in answer to Mr. Utz' question, Mr. Methven?

A I just ran across one of the numbers I have here. It is Shell Carson Unit No. 32-26, that it did produce on an initial test of 1250 MCF per day of gas. Therefore, I believe that one would be it.

MR. UTZ: Did it produce any oil?

A We have a figure of something like three barrels.

MR. PORTER: Was that a twenty-four hour test?

A I'm not sure what it is. I cannot attest to the fact that this is oil or what type of fluid it is.

by MR. UTZ:

Q Do you know what Shell's policy is going to be in regard to producing that well?

A No, I do not. I should think that it would be in agreement with the New Mexico Oil Conservation Commission Rules and Regulations.

Q In the absence of any regulations, do you think they would produce it for whatever it would produce or whatever the market was?

A If under the state regulations they were permitted to produce that.

MR. UTZ: That's all.

MR. PORTER: Mr. Cooley, did you have any more questions?

By MR. COOLEY:

Q Mr. Methven, is there a line or point of demarkation from which you can tell from your engineering experience what is dry gas and what is casinghead gas as those terms are commonly understood?

A There's not a fine line, that I'm aware of.

Q But ordinarily your casinghead gas would contain much more liquids, would it not?

A Yes, yes. The fact is, it is generally referred to as wet gas.

Q Would a gas cap be wet gas? A A gas cap?

Q That is in commonly understood sense a true gas cap, would it be wet gas or dry gas?

A It should have some liquid constituents, I believe.

Q To your knowledge has there been any gas analysis on the gas being produced from the Bisti-Lower Gallup Oil Field?

A There have been gas samples taken, but I do not know which wells these were taken from.

Q Are you aware of the results of these tests?

A No, I'm not and I don't have them with me.

Q I wonder if anyone with your company does.

MR. SETH: We can furnish it to the Commission, I'm sure, if you would like to have it.

Q In your opinion would the properties of this gas, and particularly the amount of liquids contained therein, have any bearing on whether or not this is a gas cap or is not a gas cap?

A It could, yes.

MR. COOLEY: In view of that answer I would like to have the results of those analyses if possible.

MR. SETH: Be glad to get them.

MR. PORTER: Anyone else have a question of Mr. Methven? The witness may be excused.

(Witness excused.)

ROBERT S. MacALISTER, JR.

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

DIRECT EXAMINATION

By MR. SETH:

Q Have you been sworn previously during the course of this hearing?

A Yes, I have.

Q Would you state your name please, and your position with Shell?

A Robert S. MacAlister, Jr., Division Exploitation Engineer.

located in Farmington, New Mexico.

Q How long have you been with Shell?

A Ten years.

Q What have been your duties during that time?

A I have been an Exploitation Engineer with the company during that entire time. Three years was spent as a specialist in secondary recovery operations.

Q What are your educational qualifications?

A I graduated from the California Institute of Technology in 1947 with a Bachelor of Science degree in mechanical engineering.

Q Have you made a study and become familiar with the Bisti Field in New Mexico?

A I would say that I was familiar with the field. I haven't studied it myself as a full-time project, but I have had a number of people working under me who have studied it, and I'm familiar with their work.

MR. SETH: Are his qualifications acceptable?

MR. PORTER: Yes, they are.

Q Would you proceed, Mr. MacAlister, please, and give us a brief statement, perhaps, of Shell's position with regard to this LPG pilot program?

A I would like to state at the outset that Shell is very much interested in secondary recovery in any field where it can be done profitably, and we can improve the recovery of reserves and, in

particular at Hobbs, we're very hopeful that some sort of secondary recovery in one form or another will be found applicable there and it has been testified that we are actively supporting the present LPG injection test.

I would also like to state that I believe that wells drilled on closer than 80 acre spacing will be required for secondary recovery operations in this field, and I see no reason why 40 acre drilling needs to be postponed on account of the secondary recovery prospects. I would like to mention four reasons why I make this statement. First, is that I believe it would be impossible to fit any efficient injection well production well pattern to the present random spacing of wells in the field on 80 acre density. The second reason, I believe that while the current, the form of the current pilot injection test is the best that could have been devised considering all the conditions with which we had to contend, I could not recommend to my management that we extrapolate the hurried results which we must obtain from this pilot project to a project that would be based on 160 acre five spots in that field, and if only 80 acre wells were drilled, then 160 acre five spots would necessarily obtain, if we went to such a pattern. I might say that a five spot is a five-well arrangement in the form of a square, with four wells at the corners, one well in the center, and this is the arrangement that is being used in the pilot injection project at Hobbs. In that particular project the injection well is at the

center and the producing wells are at the corners.

The third reason, I believe why 40 acre spacing will be necessary, is that in view of the demonstrated discontinuities and irregularities in this reservoir, an efficient sweep out of the reservoir cannot be done on wide spacing. I might interject here that during the testimony yesterday I heard it said that in one field the recovery efficiency was the same on 40's and on 80's. I found that a little difficult to reconcile with another statement that said if you went from close spacing to wide spacing at Bisti you would get better efficiency. I think it was also mentioned that at Smeroe they found that wide spacing was better than close spacing, and while I'm not familiar with all the details of Smeroe, I do know that is a reef limestone field with over something in the neighborhood of 200 pay, of pay at a depth of 7,000 feet, and I don't believe that anything that happened there could be said to be relevant to the Bisti situation.

The fourth reason that I believe that closer spacing would be desireable is that the pay-out of a secondary recovery project would be unattractively long with wide spacing. One of the more unattractive features of secondary recovery operations is that you have to make a considerable investment, and your pay-out on your investment doesn't begin for one or more years, doesn't begin for one or more years after you make that investment. I believe that in an LPG injection project, which we all hope will be found

feasible here, that that situation will be even more critical because of the large investment that will have to be made in LPG. Perhaps as much as fifteen to twenty million dollars alone for LPG in this field. Therefore, I believe that spacing on closer than 80 acres would be required to gain an acceptable pay-out in this field. The pay-out time varies roughly with the spacing in secondary recovery operation. It seems to me I had something more to say, but maybe we had better get on with it.

Q What is the arrangement of the initial injection project here, what spacing would that be?

A The four producing wells are on 40 acre spacing, and the injection well is drilled between them would be called a 40 acre five spot, but the actual spacing between injector and producer is 20 acres.

Q You mentioned the importance of the time factor in secondary recovery. Do you mean that once you inject this large investment in LPG gas, it could be a year or several years before you even get the injected gas LPG back, is that what your testimony is?

A Well, the injected LPG in gas would be the last thing you would expect to come out. What I meant to convey was that in order to get additional recovery over and above what you would get by primary operations sufficient to pay out the investment, it takes a number of, well, it takes a year or more for that to begin in most secondary recovery projects.

Q There has been some testimony about pressure changes that have resulted from drilling in the pool. Are those pressure changes a function or related to spacing, or is the pressure change more a function of withdrawals?

A I think pressure drop is related both to withdrawals and the drainage volume from which you are taking those withdrawals. A well with small volume of reservoir attached or being drained by the well would have a relatively higher pressure drop with a small withdrawal.

Q But the overall field pressure would be controlled more by the overall field withdrawals than any other factor, is that correct?

A Yes.

Q Do you have any other comments you would like to make relative to this secondary recovery matter?

A I don't believe so at the moment.

Q Have you written a number of letters to the parties participating in the Carson Unit relative to the geology and engineering in the area?

A We have. As one of our obligations as operator of the Carson Unit, we have to present plans of development for the unit and recommendations as to participating area within the unit. To accompany our recommendation, we have from time to time presented our tentative engineering interpretations.

Q I hand you what has been marked for identification as

Exhibits 15, 16 and 17. Would you describe please, to the Commission what those are?

A These are entitled "Geologic and Engineering Report, Gallup (Upper Cretaceous) Pool - Carson Unit, San Juan County, New Mexico", and the first one is to accompany the proposed first revision of the participating area. That's Exhibit 15.

Exhibit 16 was to accompany the proposed second revision of the participating area. Exhibit 17 to accompany the proposed third revision of the participating area.

Q Now, do these three exhibits represent the opinions and the thinking of Shell at the time that they were written?

A They do.

Q I will also hand you No. 14 that is signed by Mr. Pickell.

A J. J. Pickell.

Q Who is he?

A He was an Exploitation Engineer who was for a time in charge of the Exploitation Engineering Section in this area.

Q Would you examine 14 and can you state whether or not that is a report similar to 15, 16 and 17?

A It is. It has the same title as the previous reports except that this one is to accompany the proposed initial participating area.

Q Now, do these reports also reflect the development of the study and the thinking of Shell over this period of time?

A Yes, they do.

Q Could you tell the Commission whether or not that shows any slight change in Shell's thinking and approach to this problem during this period?

A I don't believe these letters or reports show the present thinking of Shell. The last one.

Q I meant do they show the position as of the time they were written, each one individually? A Yes.

Q Does that show any change in position?

A Yes, there is some change.

Q Would you describe that to the Commission, just in general terms is sufficient?

A At the time that the first report was written I believe we made statements as to our belief of the general continuity of the sands in this field, especially true along the central portion of the productive test where a good pay development has been observed. I think as we go along in these reports will indicate that we become less and less convinced of the continuity of the sands.

MR. SETH: We would like to offer these in evidence at this time.

MR. CAMPBELL: I have no objection as far as we're concerned.

MR. PORTER: Any objection to the admission of the exhibits?

MR. SULLIVAN: In regard to that, may I ask one

question which may establish whether I want to object to their admission?

CROSS EXAMINATION

By MR. SULLIVAN:

Q What has happened to Mr. Pickell? You have testified that he was in such and such a position. Where is he now?

A Mr. Pickell is in Denver.

Q Still in the employ of the Shell Oil Company?

A Yes, he is.

MR. SULLIVAN: Thank you. I have no objection.

MR. SETH: If the Commission please, I might perhaps make an explanation in order for offering these. We wanted to show the trend in the study and thinking of Shell in this connection over this period of time. We thought the letters, we're a little disappointed, we thought they would be more interesting to the proponents than they are. We think they are a part of the story and the Commission has a picture on them.

MR. CAMPBELL: We haven't had an opportunity to view them yet.

A I believe the Commission has obtained copies of these. They were sent to the Commission as well as the other parties in the unit, and the United States Geological Survey.

MR. PORTER: The Commission rules that Exhibits 14, 15, 16 and 17, Shell Exhibits, will be admitted to the record.

MR. SETH: That's all the direct we have.

MR. PORTER: Anyone have a question of Mr. MacAlister?

By MR. CAMPBELL:

Q First a few questions with regard to your position on the pressure maintenance program in this area. Have you had an experience with a pressure maintenance program of this nature?

A No, sir, I have not.

Q Then the reasons that you give for disagreeing with Mr. Brinkley's conclusion on the effectiveness of the program under 40 acre or 80 acre spacing, are based upon what assumptions or general knowledge of secondary recovery, or what?

A Based on some general knowledge of secondary recovery plus the fact that it will be a fluid drive project, and as are all secondary recovery operations, I think it differs by degree only from any water flood project in that the physics of controlling the drive are not greatly different from one project to another.

Q You will agree, will you not, Mr. MacAlister, that in any fluid pressure maintenance or secondary recovery program, that the determination of the pattern of injection has to be determined by experimentation, does it not?

A I would say that that could be part of the answer, it's also based on experience I believe.

Q Well, isn't it conceivable here that continuing study of this pilot program and initial phases of the program itself could,

for example, result in flooding this reservoir from one end to the other or from the gas area toward one end or the other.

I mean isn't that a matter to be determined as the program progresses?

A I believe that a line drive project might be possible, but I think it is probably even more dangerous to try and extrapolate a five spot plug on close spacing to a line drive on wide spacing.

Q But in any event, that is a matter of disagreement of approach between you and Mr. Brinkley, isn't it?

A Yes.

Q And either one of you may be wrong, is that right?

A In my opinion he is more likely to be wrong than I am.

Q I'm sure if he had an opportunity to testify he would express the same views. Now, since that is true, and assuming that he may be right, since there's an honest difference of opinion between you in this engineering matter, what objection can you have to delaying this thing at least a year until that difference at least has a chance to be reconciled?

A I believe that the discontinuity and irregularity within the reservoir is going to require closer spacing for both primary and secondary recovery operations no matter what form the secondary recovery operation takes.

Q That matter can be determined within the early stages, I assume, of the program, can it not, say during the next year?

A In my own mind, why I believe that we have already shown that it has to be. You can't drive oil out of these dead end things.

Q Now, with regard to your statements concerning the pay-out of the secondary recovery or pressure maintenance program, you were referring to the pay-out of the program, it's not the pay-out of the entire investment of the operators in the field, were you not?

A It's the pay-out of the secondary recovery investment.

Q Of course, if wells are drilled on 80 acres instead of 40, and assuming the effectiveness of the LPG program, you will have twice the cost to work against, will you not, on the pay-out for the entire investment?

A The cost would be not twice, but it would be considerably more than on 40, but you have to inject for twice as long to get your oil out.

Q Mr. MacAlister, with regard to the reports of your company as operator of the Carson Unit to the other operators in the unit, and the U.S.G.S. and the Oil Commission, I would like to ask you whether in addition to these, indicating your continuing belief, that there is what I prefer to call a lack of uniformity in this reservoir that these do not also indicate your continuing belief that you cannot determine the pressure declines and other information in the reservoir due to the lack of production history?

A Certainly we're missing some important information by not having some production information. However, we've made these

detailed studies which have been presented here today by previous witnesses since the last of those reports was written. Our ideas are considerably different now than they were at the time that the last of those reports was written as regards the continuity of the sands and the ability to drain on wide spacing.

Q Throughout these letters you refer to wells which Shell has drilled but not completed, is that correct?

A That's correct.

Q How many such wells are there now?

A Oh, there are probably half a dozen, maybe as many as ten now. We have recently embarked on a large completion program in which we perforated some sixteen to twenty wells, I believe, and these wells are undergoing production tests at the present time.

Q I want to ask you one final question which hasn't yet seemed to me to be answered. What disadvantage is there to Shell Oil Company in the light of the circumstances that you present forgetting our testimony, what disadvantage is there to you to space this field on an 80 acre program for a period of one year?

A I think it will be brought out in subsequent testimony. It's going to cost more money to do it that way. That consideration aside, my feeling is that from the standpoint of engineering work we would be better able to concentrate on this development program in a single continuous program rather than an interrupted one. I believe that from the standpoint of efficient utilization of the

primary reservoir energy, it's better to complete your wells on a uniform spacing pattern to begin with rather than get oil going in one direction at one time and then go in and drill more wells and start it going in another direction. I believe that from the standpoint of efficient completion work, the earlier you drill and complete your wells, the better off you are.

Q The better off you are? A Yes.

Q Is that irrespective of the reservoir condition?

A No, that's not irrespective of the reservoir condition.

Q That will depend on each reservoir, will it not?

A In general I think it can be said to be true of almost any reservoir.

Q One last question. I know you don't like to do this, but you pointed out, and I have too, there is a difference of opinion between you and Mr. Brinkley about the effectiveness of this pressure maintenance program. If Mr. Brinkley is right, would you then still feel that this field should be developed at this stage on 40 acre spacing?

A I can't agree that Mr. Brinkley is right.

Q All right.

MR. CAMPBELL: That's all I have.

MR. PORTER: Anyone else have a question of Mr. MacAlister? Mr. Sullivan.

MR. SULLIVAN: Is this the witness that will be able to

testify as to well costs?

MR. SETH: You have to wait one more witness.

MR. SELINGER: May I ask Mr. MacAlister a few questions?

By MR. SELINGER:

Q You talk about the Carson Unit, and your counsel in having you identify Exhibits 15, 16 and 17 and the explanation that it would tell the entire picture of your consistency of your views as operator of the unit, will you kindly tell the Commission the size of the Carson Unit in acreage and who are the owners of the Carson Unit, if you know?

A The Carson Unit is four sections wide by six sections north and south, that is twenty-four sections, 150,000 acres plus or minus, not all, am I wrong, that's too big, 15,000 acres, excuse me. Not all of the leases within that area are participants in the unit, but substantially all of them are, I believe.

Q Will you kindly tell the Commission the owners of the, or the participants of the unit, and if you have it available, the percentage owned by each?

A I can't tell you the exact percentage, but Shell is the largest participant with something in the neighborhood of eight, oh, eighty-five percent of the acreage. Phillips Oil Company and Shelly Oil Company each have in the neighborhood of --

Q (Interrupting) Seven and a half percent?

A Seven and a half percent. El Paso and Humble each have

minor interests.

Q Now, in furtherance of your counsel's explanation for Exhibit 15, 16 and 17, and in order to coincide with his wishes to give the Commission the complete picture, do you have correspondence between you and the U.S.G.S. and you and the other participants or owners of the Carson Unit with respect to bringing Exhibits 15, 16 and 17 up-to-date?

A I'm not sure I understand.

Q Did you have any further correspondence outside of Exhibits 15, 16 and 17 with any other operator in the Carson Unit?

A Oh, yes.

Q Do you have that available here?

A Not all of it, no.

Q Did you get any correspondence from Phillips about the unit?

A Yes, sir.

Q Did you get any correspondence from Skelly about the unit?

A Yes, sir.

Q Did you get any correspondence from any of the others, and if so, from whom? A From Humble and El Paso.

Q Now, can you, since you are familiar with that, can you indicate to the Commission the desires of the other participants in the Carson Unit since you have gone into great detail as to the desires of Shell with respect to this matter?

MR. SETH: I believe the letters would be the best evidence.

Perhaps you have them, Mr. Selinger.

MR. SELINGER: No, I haven't. You are putting in the testimony and the exhibits, I would like for you to put the rest of the exhibits in.

MR. SETH: If you have them we will be glad to put them in if the Commission would like to receive them.

MR. SELINGER: I don't have the correspondence from Humble or Phillips.

MR. SETH: I am thinking that you object to the spacing in the —

MR. SELINGER: (Interrupting) Let the exhibits speak for them.

MR. SETH: There is a lot of correspondence.

MR. SELINGER: Let the exhibits speak for them. This witness said he has the correspondence here.

A No, sir, I do not.

MR. SETH: He does not.

A I do not have all of them.

MR. SETH: If you will identify them more particularly, we will be glad to get copies and submit them to the Commission.

Q On examination you stated that you had correspondence fr— these various companies. Tell the Commission the correspondence you had with Shully with respect to the Carson Unit.

A We have had more than one series of letters with Shully.

When we first suggested a plan for spacing in this area, I believe Skelly indicated that they might, that they would be happy to drill some, to have some 40 acre wells drilled on their lease. Subsequently we have had letters from them that indica they have changed their mind on that subject.

Q Did they say why they changed their mind?

MR. SETH: If the Commission please, I think the letters are the best evidence. You must have your letter. You are asking about what you wrote.

MR. SELINGER: I am going to ask about Humble and the rest which Skelly has no possession of.

MR. SETH: Do you have your letter with you?

MR. SELINGER: No.

MR. SETH: We would like for you to produce it.

MR. SELINGER: We would like to have Shell furnish the Commission with the correspondence from the other interested parties in the Carper Unit which will indicate likewise the desires of those other participants as well as Shell in their Exhibits 15, 16 and 17 so that the Commission can get the complete picture. They have presented only one, Shell's position. Now my purpose in asking for the additional information to be supplied, is to show all the participants.

MR. SETH: I believe we told you we got them once and we must distinguish between these exhibits, these are reports by the

operators to the participants in that capacity. This other is just extraneous correspondence, but we'll be glad to furnish it to the Commission, of course, if they would like them.

MR. COOLEY: Mr. Selinger, for what purpose is the correspondence sought?

MR. SELINGER: The same purpose that Exhibits 15, 16 and 17 as explained by Mr. Seth, to show the full picture, it's for the same purpose.

MR. COOLEY: As I understand it, it could not be for the same purpose because I believe the purpose of 14, 15, 16 and 17 was to show the change in policy of Shell Oil Company, and I can see how no correspondence from any other company could indicate that change.

MR. SELINGER: Well, we have no --

MR. COOLEY: (Interrupting) Is that the purpose of 14, 15, 16 and 17?

MR. SETH: That's right.

MR. SELINGER: We have no control over Shell's viewpoint, but they are speaking now on behalf of the Carson Unit. I want the Commission to understand that the consistency or inconsistency of their view in operating the Carson Unit can likewise be indicated by the inconsistency of the views of the other participants.

MR. SETH: I think the record, we speak for Shell Oil Company as Shell Oil Company, we are not speaking for the Carson

Unit. It is not involved in this hearing.

MR. PORTER: In the interest of time, Mr. Seth, the counsel for Shell, has agreed to supply the Commission with copies of this correspondence, which the Commission will accept.

MR. MECHEM: You can include that too in your statements to the Commission.

MR. SELINGER: Yes, sir, we shall.

Q Mr. MacAlister, you said that you had sent copies of Exhibit 15, 16 and 17 to the U.S.G.S.?

A Yes.

Q What was your latest correspondence with relation to those exhibits, Exhibits 15, 16 and 17 to the U.S.G.S. with respect to the development plan?

A We sent them a plan of development suggesting development of the Carson Unit on 40 acre spacing, and we recommended the drilling of 53 wells.

Q Was that subsequent to those exhibits?

A Yes, it was.

Q Was that your latest word to the U.S.G.S., was there any later correspondence you had with the U.S.G.S. with respect to the plan of development? A Yes, there was.

Q What was the date of that later correspondence, in effect, the gist of it, to the U.S.G.S. as to the plan of development in the Carson Unit?

MR. SETH: If the Commission please, I believe the Commission has copies of that correspondence, do they not, Mr. MacAlister?

A I'm not certain.

MR. SETH: Or the Commissioner of Public Lands, in any event. We will get copies of that.

A Ordinarily the correspondence is handled by our Land Department. I'm not familiar with the dates of the correspondence.

Q You mean it will be covered by a subsequent witness?

A No, I'm afraid we don't have one here.

Q You said you were familiar with the later correspondence of the U.S.G.S. as to the latest plan of development as submitted by Shell. Will you tell this Commission in gist form what was that later plan of development?

A We requested the U.S.G.S. to approve certain wells within their plan of development in order to continue our operations in the field while this discussion of spacing in the field was being settled.

Q And that basis was 80 acres for the present, is that correct?

A No. We didn't say that, anything as to spacing as I recall it.

Q You did not say it would be on 80 acre density?

A No, I don't believe so.

MR. SELINGER: That's all I have.

MR. PORTER: Mr. Utz, did you have a question?

By MR. UTZ:

Q Mr. MacAlister, are you familiar with the economics of the Sunray pilot flood which they are beginning to operate now?

A Generally.

Q Do you know what the estimated cost per barrel of oil recovered by secondary means is to be?

A No, I don't believe I can answer your question directly.

Q Do you have that information available that you can furnish the Commission with it?

A Let me try and answer it. Maybe I can satisfy you and maybe I can't. The cost of the project is going to be, I believe, somewhere in the neighborhood of one hundred fifty to two hundred thousand dollars, including the cost of LPG and gas. That's the capital investment, of which I think we can reasonably expect to recover substantially a large part of the LPG and gas eventually, so maybe the total investment would boil down to one hundred thousand, one hundred twenty-five thousand dollars. If the project works as well as they have predicted it will, they will recover something like 136,000 barrels of secondary oil.

Q Did your one hundred twenty-five thousand include the cost of drilling the injection well?

A Yes, but it doesn't include operating costs. I'm not familiar with what the operating costs might be.

Q Roughly it would be about a dollar a barrel?

A I would think that would be reasonable.

MR. UTZ: That is all.

By MR. CAMPBELL:

Q You and Mr. Utz are only referring to the pilot phase of this project, are you not?

MR. UTZ: I am, yes, sir.

Q I wasn't sure he was, I wanted to be clear.

A Of course they won't recover 136,000 barrels in time necessary to recover the pilot and extrapolate it to a full scale flood, if that becomes desireable it comes over the life of the injection project.

MR. PORTER: Anyone else have a question? Mr. Kellahin.

By MR. KELLAHIN:

Q Mr. Kellahin, as I understand it, Exhibits 11 through 17 have been offered for purposes of showing the change of position on the part of Shell, is that correct?

A Yes, sir.

Q Yet, based solely on these exhibits, they reflect no change in Shell's opinion that there is a continuity of the sands in the northwest, southeast direction, is that not right?

A I think you'll have to say that that statement was rather qualified in the letter.

Q Well, I would assume that Exhibit 17 is the last report,

is that right? A Yes.

Q I believe on Page 2 of Page 2 of Exhibit 17 your statement is to the effect that "In previous proposals for participating areas (see Geological and Engineering Reports supporting the proposals of Initial Participating Area and First Revision of the Participating Area, January 18, 1957 and April 26, 1957 respectively) data were presented suggesting fair continuity of sand development along the northwest-southeast pay trend, and poor continuity in the transverse direction." Is that the qualification you refer to? A Yes, I believe that was.

Q Yet you support that by a reference to the two preceding reports which do not in anywise qualify your statement.

A Can I elaborate on the content of that?

Q I am referring to the contents of the exhibit, if your attorney wants to bring out the explanation.

MR. SETH: You can explain your answer. Go ahead and explain your answer.

A That was written to explain why we had extended the participating area in the direction and meetings that we had, and it was an extension along the grain of deposition of the sands, and it was meant to convey that we felt that we could extend the participating area in that direction with more confidence than we could across the grain, simply because the general deposition indicates that commercial production can be obtained laterally along the

grain, I mean from commercial wells more readily than you can predict a transverse extension of commercial production.

Q But on the basis of these exhibits alone, you request no change in your opinion as to the continuity of the sands aside from the qualification which you state?

A I don't think it reflects a change in our ideas as to the gross picture of the sand deposition.

MR. KELLAHIN: Thank you.

MR. PORTER: Are there any further questions of Mr. MacAlister? Mr. Cooley.

By MR. COOLEY:

Q One of the major factors, Mr. MacAlister, you said in secondary recovery, was to get a quicker pay-out and make it attractive to the company since there was such a large expenditure of monies? A Yes.

Q You felt that you would get this quicker pay-out on 40 acre spacing, you would get a quicker pay-out on 40 than you would on 80?

A Yes, sir.

Q My only question is was that based on well potentials, you can just produce more out of twice as many wells, or was this based on greater allowables assigned?

A Usually the life of a secondary recovery project depends on the average injection rate that you can maintain in the injection wells. The more injection wells you have, the faster you can inject

and flood out the reservoir.

Q Then it's actual potential of the well and not the allowable? The statewide allowable has nothing to do with your discussion on that point? A No, injectivity.

MR. PORTER: Anyone else have a question? The witness may be excused. We will take a short recess.

(Witness excused.)

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Seth, will you call your next witness?

MR. SETH: We would like to call our subsequent witness now.

R. E. ROBISON

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Robison?

A My name is R. E. Robison.

Q By whom are you employed?

A I'm employed by the Shell Oil Company as Division Production Manager, Farmington.

Q How long have you been employed by the Shell Oil Company?

A Going on thirty-four years.

Q During that time what experience have you had, Mr. Robison?

A Well, back up to the beginning, I graduated from Stanford University in 1924 and majored in mechanical engineering. I went to work first in our Gas Department for a year or two, and then in mechanical engineering as mechanical engineering work, and later as Division Mechanical Engineer, and then Engineer of the Drilling Department, later Drilling Foreman, Division Superintendent, and since 1953, Production Manager. That is a hurried rundown.

Q At the present time you are in Farmington, is that correct?

A Yes, I came to Farmington when the so-called Farmington Division was organized, April 1st, of this year.

Q Have you, during your work in Farmington, had occasion to become familiar with the costs of wells in the Bisti Area?

A I have.

MR. SETH: Are his qualifications acceptable?

MR. PORTER: They are.

Q Would you please state, Mr. Robison, the experience of Shell with well costs in the Bisti Pool?

A Yes, in that connection I have two tabulations here of costs, one labeled Exhibit 13-A, the other Exhibit 13-B. I might pass these out. Referring to the tabulation labeled Exhibit 13-A, you will note that it includes six wells which were completed this year during the month of July. These costs are not down to the dollar, but serve as representative costs, days drilling cost of Shell's in the Bisti Field. These costs range from $40,800 to a low of

$35,200. The average being $38,000. This $38,000 includes a well completed as a flowing producer including everything from the roads, the drill site, the actual drilling, testing, the casing, casing services, cementing, perforating, the tubing, the wellhead, the flow line as well as the cost of the formation fracturing that we commonly do. Then if you will refer to the tabulation shown as Exhibit 13-B, we go back to the first well that we drilled in the Bisti Field, after a tabulation of total cost for the 37 wells that had been completed the middle of August. You will note that there is a wide variance there in cost, our first wells being, first well being $88,000, that well was drilled in the early part of 1956. The average cost of the, on a per well basis for the 37 listed, is $46,500. The logical question would be why such a marked reduction.

There is nothing in my opinion that's mysterious about it. It is largely due to concentrated efforts, what we now know how to drill, but even more important the cost began to come down mainly because of a development program. This reduction from $46,500 to $38,000 in current cost is rather sizeable, I doubt that we can do as well in the next year and a half, but the downward trend is still with us. Again largely by means of the continued development program in the field.

We, as I said earlier, started the, organized the Farmington Division the first of April. Since that time we've in addition

to the two strings that we are now running here, we get up to a maximum of thirteen currently drilling eleven, with eleven strings of tools, two of which are Bisti. The cost of moving the outfits into the Bisti Field is quite sizeable, but that has been, has paid off, so-to-speak, amortized over the wells that have been drilled and are being drilled.

The next group of wells which we have contracted for will be two bits a foot less than we are presently paying, that means roughly a saving of $1250 a well. Again that downward trend is with us. I might right here clear up the figure of $48,000 that a previous witness used. That has been arrived at from these figures, taking into account the reduction that we contemplated in the next group of wells, namely $37,000 complete with fracture treatment, completed as a flowing producer, add $6,000 as being the future cost of pumping equipment, plus $3,000 as each well's share of the field facilities from here on out.

Q What are these field facilities, Mr. Robison?

A Share of the gas and oil separators, the manifolds, and main roads.

Q Now, how, what effect does it have on the cost of field facilities if you initially plan for an 80 acre spacing and then have to go back to a 40 acre spacing?

A Unless the program were continuous, it would add materially to the cost. It is, as I tried to explain, a reduction in our

drilling costs is largely because of the continuity of operation and we get that for several reasons, we have been able to maintain the same contractor in the field, and I might add too that we had a string of tools of our own, our own crew in there to drill six wells, but mainly it's been contract work. The crews become familiar with the operation and that is quite important in this country, you find it necessary not only, the contractors find it not only necessary to tell us to weed out the crews to get good help, and secondly if we were to have a shutdown in operations, someone has to pay to move this equipment out and move it back in. That pay comes to us or any operator in the field. That runs into rather sizeable figures, and the two together, well, it depends on the number of wells, the amounts to, I had better just say a sizeable figure, several thousand dollars per well.

Q The well costs, you expect that, they would be less ultimately, if you can maintain a continuous program, and they would be less too if you did not have to start on an 80 acre spacing and then go back to a 40, is that right? A Correct.

Q Now, what is your drilling program for the balance of this year?

A The balance of this year we have planned, and our budget approved and calls for the drilling of 29 additional wells in addition to the 37 listed on the exhibit shown as 13-B. For next year under 40 acre spacing, we have tentatively planned in our budget,

and incidentally, our budget is on a calendar year basis, so we are right in the preparation of it now, but we are planning on 58 wells in the Bisti Field for next year. We would like to drill them.

Q Are you prepared to drill them?

A We are prepared to drill them.

Q Is the money budgeted to drill them?

A Only tentatively, but we have had a preliminary budget hearing and top management appears to be in agreement. That was, I might mention this number of wells was originally included in our tentative budget when the Farmington Division was organized. So I look for no problem as far as obtaining the funds.

Q Then Shell is prepared, if the Commission permits it, to go ahead on a 40 acre basis, is that correct?

A Correct.

Q And would you have a rough approximation of the acreage of Shell leases within the proposed pool, just roughly?

A Yes, roughly 25% of the area that's been discussed here previously.

Q As by the other witnesses? A Yes.

MR. SETH: We would like to offer these two Exhibits, if the Commission please, 13-A and B, at this time.

MR. PORTER: Any objection to the admission of these exhibits? They will be admitted.

Q Do you have any further statements you would like to make,

Mr. Robison? A No, I believe not.

MR. SETH: That's all the direct we have then.

MR. PORTER: Does anyone have a question of Mr. Robison? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Robison, just a few questions about your exhibits relating to well costs. The reason, as I understand you, that you have been able to reduce your well costs from your first wells to your latest wells is by virtue of the size of your drilling operations, am I correct in that, and the information you have obtained?

A Not so much the size because we are not conducting a large operation now, you might say we only run two strings of tools, but by size I would interpret that to mean, I would rather say it as to continuity of operation. First we went in as sort of an exploratory operation, we drilled a few wells and then there would be a period when there was no development, we would have to go back in again and in turn pay for getting the contractor's equipment into the field.

Q Have you estimated the number of wells that you would be drilling if the 80 acre density were maintained during the next year?

A Yes, I have.

Q How many would that be?

A To what we consider proven now, there would be enough 80

acre wells, for the remainder of 1957 there would be 29 wells to keep us going through the balance of the year the same as the 40, but next year there would be 11 wells.

Q But you could maintain a continuous program for the balance of this year at least with the present operation that you contemplate?

A That's right.

Q Are there, to your knowledge, operators in this field who do not have the amount of undeveloped acreage that you do?

A I couldn't speak with very much authority on that, but I would say that there are probably some that do not have the acreage because I just mentioned that we have 25%.

Q Your plans with relation to the development of your acreage in this field have assumed that you would be permitted to drill it immediately upon 40 acre basis?

A We have gone on the assumption all the time up until the filing of this petition, that we would have 40 acre spacing.

Q That is the sole disadvantage to the delay of 40 acres, assuming that it were later put into operation, that your company sees in this application?

A No, I can't say that is the only objection. I'm merely citing one part of the objection. One objection.

Q What others, that you know of?

A Well, I was listening to a previous witness who thought there might be some inefficient use of reservoir energy through postponing

of drilling of all the wells.

Q Do you feel that the economic loss to your company that you say that would exist for the balance, for 1948 if this were drilled on 80 acres to that time justifies the drilling of additional wells by other operators is a sole reason?

A I don't quite follow you how the other --

Q You mean that your economic loss -

A (Interrupting) Because we would force other operators to drill unwanted 40 acre wells?

Q Yes, sir.

A Well, basically we are sold on the 40 acre spacing, so we don't think that even the other operators would suffer.

Q Well, that of course, is the essence of this discussion, for the last two days, but my reference was whether you thought that was a sufficient sole basis for your feeling you shouldn't go along on a one-year 80 acre spacing program?

A Well, again, I'll just have to say we would like to abide by the present regulation, one well to 40.

Q Would you, if that remained in effect, be able to drill all your 40 acre locations in the next year?

A I'm not positive of that, but I'm sure that we would get the majority of them drilled.

MR. CAMPBELL: I believe that's all.

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

Robison? Mr. Cooley.

By MR. COOLEY:

Q Mr. Robison, has Shell completed as of this date, or commenced, rather, as of this date, any well which could not have 80 acres dedicated to it? Plain words, have you started any 40 acre locations?

A We have not started, or did not start, any 40 acre well after the date of the filing of the petition, but we have, I believe, one well, maybe two, that are on a 40 acre basis, at least I would call them that. Now, I don't know whether we can add another 40 to them. They're not uniformly spaced 80, put it that way.

Q I'm aware of that that there would be several exceptions to the attempted uniform spacing plan in here, but you do have an additional 40 acres that you could dedicate to any existing well?

A That I'm not sure of. If there is any, there's only one or two. If I can leave it as general as that.

Q You stated that Shell has not commenced any 40 acre wells since filing this application. Would you be in a position to state whether they anticipate commencing any until there is a final decision in this case?

A I think that is right, that we will defer, we will like to and probably will defer drilling until there is a decision in this case.

Q You cannot state as an absolute fact that you will not drill any?

A Well, we would advise you people, we would have to get your concurrence to do so and would like to, in preference to discontinuing our present operations. We will attempt to, but we will not do it on our own.

By MR. PORTER:

Q Mr. Robison, I believe you stated that you hadn't started any wells since the application was filed. Do you know whether or not you had completed any prior to that time on 40 acres?

A Yes, that was the one that I was referring to. We did not spud a well on a 40 acre location, at least to which it couldn't be called an 80, we did not spud any 40 acre locations after the petition was filed, but just prior to that we were ready to go and were drilling on one well, the name of which I think was -- was this 44-10.

MR. MacALISTER: I believe Government 31-15 is the well which could not have 80 acres dedicated to it.

A There appears to be one.

MR. MacALISTER: I also believe that Government 44-10 probably could not have 80 acres dedicated to it either because subsequent to the completion of that well we've drilled 14-15, I believe it is, Carson Unit.

A Yes. 44-10 is right in the corner.

Q What section?

MR. MacALISTER: We have drilled this one. I was mistaken in the number. 14-11 has been drilled also.

Q What is the location of the section and township?

MR. MacALISTER: It is in the southwest of the southwest of Section 11, Township 25 North, Range 12 West.

MR. COOLEY: Just a minute, that is not the location of the well which could not have 80 dedicated to it?

A No. That is Government 44-10 in the southeast of the southeast of Section 10, the same township and range that could not have 80 dedicated to it.

Q The other well?

MR. MacALISTER: Government 31-15, which is in the northeast of the northeast of Section 15, Township 25 North, Range 12 West.

Q Those are the only two wells that you know of?

MR. MacALISTER: Yes.

A Yes.

MR. PORTER: Does anyone else have a question of Mr. Robison? Mr. Sullivan.

By MR. SULLIVAN:

Q Mr. Robison, I have before me Shell's Exhibit 13-B from which you have been testifying. I notice that in your tabulation of all of the 37 wells that Shell has drilled in this field, you have two there with double asterisks.

A Yes. I neglected to mention that.

Q The explanation for the double asterisk that I read is "costs include above single asterisks plus artificial lift equipment".

A Yes.

Q Do I take it that these are the only two wells then in your entire 37 on which you had to set pumping equipment?

A Correct.

Q Are there any of those wells which will necessitate the installation of pumping equipment to put them on production?

A Quite likely.

Q You have several wells over there which have never actually been completed as producers? A Correct.

Q Now, out of those you expect that there will be some that will require pumping equipment? A It's possible.

Q Have you installed flow lines on those wells that are in that situation?

A We are in the process now of dividing our oil gathering system as part of the automatic custody transfer system that was approved a few months ago, and flow lines are in part of that and we are even putting them in for other locations that we expect to drill and feel assured of getting production, and until we put the field under production we will use a gathering system as a water system. We will economize.

Q What I'm asking is are there some of these figures in the

right-hand column on your Exhibit 1)-B which do not include, one, the cost of pumping equipment?

A The two wells are the only ones that include pumping equipment.

Q Are some of these wells the figures in the right-hand column, do not include the cost of flow lines?

A Right.

Q As they exist on this page?

A I think you are probably right, probably the flow lines are not in.

Q Are you in a position to make an estimate as to the per well cost —

A (Interrupting) Of a flow line?

Q No, sir, of the installation of your automatic lease —

A (Interrupting) Automatic custody transfer? A.T.C.?

Q Automatic custody transfer equipment. Can you estimate what that will cost per well? Just average it out, you know, take a total figure and divide it by the total number of wells.

A Oh, $3,000.

Q Well, now, that figure is not included in any of this, is it?

A That's right. This figure —

MR. SETH: Just let the witness answer.

Q Excuse me.

A This is not a complete analysis by any means, and the first

that two wells here have included that cost of pumping equipment, the average of $46,500 is slightly distorted, possibly if you take out $16,000 I doubt if you could read your slide rule, however, to find it, but it does illustrate, I compared that to today's figures in the tabulation marked Exhibit 13-A. Those figures are comparable generally.

Q Mr. Robison, I'm not questioning the accuracy nor the propriety, but we are concerned about the fact that we believe that drilling of a well is completion and the entire works will cost considerably more than the figures that you have testified to here as to Shell's cost, and what we're trying to establish is one, where the discrepancy arises between what we anticipate and what you anticipate, and we think that in view of the fact that these figures have become important in the discussion with regard to the economics of drilling wells on a closer or wider spacing, that it should be brought forth that there may be additional costs other than those which eventually will be added into your well cost in the Bisti Field. Now, let's put it this way, are these the final costs that you anticipate? A To date.

Q And which you will allocate to each of those wells as of the date they start pulling oil into the new pipeline?

A Well, our well costs do not include as such, we have a completed well cost statement that does not include anything in the way of lease facilities, only for profitability of the well do we

include that.

Q Do you cut that off short after say tankage, lease tankage?

A Flow line is where we quit. That is part of the well.

Q So if your accounting methods call for the inclusion of lease tanks as part of well costs, these figures in turn would be increased? A Would be higher, yes.

MR. SULLIVAN: Thank you. That's all I have.

By MR. COOLEY:

Q Mr. Robison, did you say that the figure of $46,000 was your average well cost when you put in the cost of a pump for each well and some other items you enumerated?

A And future share of lease facilities.

Q Which was the same facilities that Mr. Sullivan was referring to?

A Yes, and which was referred to by our previous witness when Mr. Methven used $46,000.

Q The $46,000 that has been used by Mr. Methven and explained by you, all the way through includes all the facilities?

A That is the average expenditure that we expect to incur in the Risti Field in the way of capital, put it on a per well basis, but in any of our completed well cost statements that will not show the forty-eight.

Q But your total cost allocated to all the wells in the field averages out $46,000? A From here on out.

MR. COOLEY: Thank you.

A We hope maybe to get a slight reduction. That is right.

MR. PORTER: Any further questions of Mr. Robison? The witness may be excused.

(Witness excused.)

MR. SETH: That's all the witnesses we have, if the Commission please.

MR. PORTER: Mr. Kellough.

MR. KELLOUGH: Booth Kellough. I am a lawyer for Gulf Oil Corporation, and we have a witness we would like to present to the Commission.

MR. COOLEY: Is this the gentleman I swore the other day?

MR. KELLOUGH: Yes. You have been sworn, have you not?

MR. BARMAN: Yes.

WILLARD BARMAN

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

DIRECT EXAMINATION

By MR. KELLOUGH:

Q Will you please state your name to the Commission, and will you please spell it for the reporter?

A Willard B-a-r-m-a-n.

Q Where do you live, Mr. Barman? A Denver, Colorado.

Q By whom are you employed? A Gulf Oil Corporation.

Q In what capacity?

A Zone Petroleum Engineer.

Q Are you employed by the Denver Division which has within its jurisdiction the northwest part of New Mexico?

A I am.

Q How long have you been engaged in duties as a petroleum engineer for the Gulf Oil Corporation? A Since March, 1946.

Q Do you have an engineering degree, and if so, will you please state from what college?

A I have a degree in mechanical engineering from Texas Technological College in 1941.

Q Has all of your work since that time been in connection with petroleum engineering?

A I spent approximately a year and a half on an engineering training program with Gulf upon graduation, and except for the time I served in the military service, why I have been working in petroleum engineering.

Q Have you made a study of the Gulf wells in the Bisti-Lower Gallup Pool and that portion of the pool upon which they are located? A I have.

MR. KELLOUGH: Are the qualifications of this witness acceptable?

MR. PORTER: They are, Mr. Kellough.

Q Will you please state to the Commission, Mr. Bauman,

the number of acres that Gulf has under lease in the area covered by this application?

A Well, if these are regular Governmental quarter sections, it would be 960 acres.

Q It is approximately 960 acres? A Yes.

Q Would you state for the information of the Commission the number of wells that Gulf has?

A Gulf has completed five wells and is drilling the sixth.

Q In other words, as far as this pool is concerned, Gulf is a small operator? A That is correct.

Q Have you made a study of the economics of drilling wells upon 40 acre spacing as authorized by the statewide rules?

A I have.

Q From that study is it your opinion that it is economical to drill a well under the existing statewide rules without any special 40 acre order? A It is possible.

Q Do you have an opinion as to the amount of profit to be expected to be made from the wells based upon the study of the Gulf wells?

A I would estimate the profit to be in excess of $49,000 per well for a 40 acre tract.

Q Have you prepared an exhibit that will reflect your views in that regard? A I have.

MR. KELLAHIN: Miss Reporter, will you please mark this

as Gulf Exhibit No. 2?

(Marked Gulf Oil Company's Exhibit No. 2, for identification.)

MR. KELLOUGH: Yesterday there was an exhibit identified as Gulf's Exhibit 1, and I thought to keep the record straight this could be Gulf's Exhibit 2.

Q Now, Mr. Dawson, will you please state briefly for the Commission what this exhibit shows?

A This Exhibit No. 2 shows an economic analysis of drilling a typical well on Gulf's leases in the lower flanks of the field. It shows that an estimated ultimate recovery of 60,000 barrels, gross barrels, and on the basis of two dollars and ninety cents per barrel net for the oil, the net revenue would be in excess of $152,000, which does not include any value for the casinghead gas that would be produced and sold. The total outlay to recover this oil would be 90¢ per net barrel for production expense, amounting to $36,000, production tax, a little over $8,000, and development ~~cost including producing equipment~~ and a proportionate amount for tankage, of $72,000. And after allowing for a small credit for salvage, the total outlay would amount to $103,000, which subtracted from the net revenue from the oil, would yield a profit of $49,000.

Q $49,230, is that the figure there?

A That is correct.

Q Was this exhibit prepared by you?

A It was.

Q Is it based on a solution drive type reservoir?

A It is based on a solution drive recovery.

Q That determines your recovery factor?

A That is correct.

MR. KELLOUGH: We offer in evidence Gulf's Exhibit No. 2.

MR. PORTER: Without objection this exhibit will be admitted.

Q Now, Mr. Bauman, are you familiar with the proposed arrangement for proration units which has been proposed by the applicants here in this case, which is that the units may run either north and south or east or west? A I am.

Q And are you also familiar with the proposed well location pattern which provides that the well may be located in either 40 acres of the 80 acre unit provided that they are diagonal with any one Governmental quarter section?

A Yes, I am.

Q That is a statement, as you understand, the proposal for this floating or flexible well location pattern proposed, is that right?

A That's the way I understand it.

Q Have you made a study of the Gulf leases with respect to whether such a proposal will protect the correlative rights of the Gulf in that case? A I have.

Q I refer you now to what will be identified as Gulf Exhibit No. 3, and ask you to please state what that is.

(Marked Gulf's Exhibit No. 3, for identification.)

A This is a plat of portions of Township 25 North and Range 10 and 11 West, and shows the acreage located within the proposed spaced area, the blue acreage shaded in blue is identified as Gulf leases.

Q Does this exhibit show the location of the presently existing wells by the solid circle, is that right?

A It does.

Q Does it show the authorized location of wells under the proposed well location pattern by crosses?

A It does.

Q Now, referring to the southwest of Section 24, what is that?

A 25 North?

Q 25 North, 11 West. How many wells are located on the Gulf lease?

A Two producing wells.

Q Under the proposed 80 acre pattern, well location pattern, could any more wells be located there?

A They could not.

Q How many wells could be located under the proposed pattern offsetting Gulf lease?

A There could be six wells, six, seven wells on offsetting

Gulf acreage that would not be owned by Gulf.

Q That would be on the authorized pattern?

A That would be on the authorized pattern.

Q And the ratio of seven to two as to that particular 160 acre tract?

A That is correct.

Q Will you please explain to the Commission what the blue circles represent?

A The blue circles merely represent an area of 80 acres at the same scale that this map is drawn.

Q That is drawn on the assumption that a well would drain 80 acres as contended for here in this case, is that correct?

A That is correct.

Q And that is prepared also on the assumption that the Commission will grant the application as it is now asked for?

A That is correct.

Q What does the area between the blue circles represent?

A The area between the blue circles merely represents the area in which there is the highest pressure or the highest oil saturation between the four permitted locations.

Q Is it not an elementary rule of petroleum engineering that oil will migrate from areas of high pressure to areas of low?

A That is generally accepted.

Q Now, in that connection then, what is the significance of your blue circles?

A Well, the blue arrows merely indicate that from some point in the center of this area the oil under a uniform spacing pattern will move equally to the four wells that are draining that area.

Q That would be the direction of the flow of the direction of the drainage under a uniform 80 acre pattern?

A That is correct.

Q Now, Mr. Pauman, what do the red circles represent?

A The red circles represent an area of equal magnitude of a well, another well that could be drilled under the flexible pattern.

Q Will you please demonstrate to the Commission the effect of the drainage of oil if you add the two other wells which would be permitted wells under the proposed application?

A The effect of adding the other two wells would mean that in the 160 acres that those three wells would be located, you would be taking out three barrels of oil and three barrels of oil here as compared to two barrels of oil from the tract upon which the completed wells are located, and that in effect, would create a pressure somewhere in the vicinity of the three wells that would not be created under a uniform pattern, and in effect, would create additional force that would cause the oil to move toward those additional wells and would result in more oil moving to these three wells from this area right here, and this area here then would be the case under a uniform pattern, and the correlative rights of each would not be protected.

Q In other words, the arrows represent the pull of the oil, and by the addition of that well, is authorized the pull of the oil would be off of the Gulf lease?

A That is correct.

Q Would that result in uncompensated drainage?

A It would.

Q And in your opinion then will the application as proposed, protect the correlative rights of Gulf Oil Corporation?

A It will not.

MR. KELLOGG: That's all.

MR. PORTER: Does anyone have a question of Mr. Bauman? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Bauman, I believe you stated that Gulf owns 960 acres in this area? A That is correct.

Q It's approximately two percent of the present productive proven limits of the field?

A I haven't made the calculation so I presume though that you have stated it correctly.

Q Is it true that Gulf owns 20 percent of the proposed four corners pipeline?

MR. KELLOGG: I am going to have to object to that line of questioning. It is quite apparent that the question of methods

or market demand or matters of that nature are not germane to an application for a well spacing. That's a proper and appropriate question as to the question of the allowable production for the pool, but certainly the question of what market may exist over the life of this pool should not be an issue in this case to determine the proper location of wells. Therefore, I think it's an improper cross examination to try to delve out of this witness any information with respect to the company's ownership, if it has any, in any proposed pipeline.

MR. PORTER: Mr. Kellough, your objection is sustained.

Q Mr. Bauman, I understood you to say that Gulf has completed six wells to date on their acreage?

A I believe I stated five.

Q What was the figure? Are you completing one now or drilling?

A The sixth one is drilling.

Q According to the information that was presented yesterday, three of these wells are gas wells, is that correct?

A No, sir, there's only two of these wells that are gas wells.

Q I show a well, or this exhibit shows a well in the southeast quarter of Section 21 which is a gas well, that is 25 North, 11 West.

A That is correct.

Q And it shows a well in the, that's southeast quarter of Section 21, the southwest quarter of Section 30.

A In southwest of Section 30 there is what?

Q A gas well according to this map.

A There is one gas well.

Q And the southwest -- wait a minute. The well in the additional well in the southwest quarter of Section 30, has that been drilled to total depth yet?

A Which well are you referring to?

Q The one that is now drilling apparently in the southwest of the southwest of 30.

A That is a completed well. That is a gas well that I was referring to.

Q What about the one in the northeast of the southwest of 30?

A That's an oil well.

Q Are you producing it as an oil well now?

A It is.

Q What is --

A (Interrupting) To the best of my knowledge it is being produced.

Q What is the gas-oil ratio?

A The gas-oil ratio of that well at completion was determined as 2300 cubic feet per barrel.

Q How much oil has it produced?

A I don't know how much it has recovered to date. It was only completed in July.

Q How much oil treatment was it given in fracturing, if you have

that information?

A The well was perforated from 5,085 to 92, and 5110 to 20 feet, and flowed naturally 168 barrels of oil per day through 2664 inch choke.

Q With no fracture? A No fracture treatment.

Q Do you have the cumulative amount of oil that Gulf has produced from this reservoir?

A I don't have it available.

Q Is Gulf prepared to drill wells on their acreage in Section 24 on a 40 acre pattern?

A Yes, sir. At least I would recommend it to the management.

MR. CAMPBELL: I think that's all.

MR. PORTER: Anyone else have a question of Mr. Bauman?

MR. SELINGER: I would like to ask one question.

By MR. SELINGER:

Q I couldn't quite hear your answer, what was the cost of drilling and completing a well of your five wells in the Bisti Field? I didn't get that total figure.

A The cost to drill and complete?

Q Yes, everything, complete cost.

A $72,000.00.

Q That's what I thought. Thank you.

MR. PORTER: Mr. Sullivan.

MR. SULLIVAN: I think I can confine myself to one question.

By MR. SULLIVAN:

Q Mr. Bauman, if 40 acres becomes, it stays or becomes the spacing pattern for the field, how many locations will you have offsetting this 160 acres that you were describing in your testimony, that's set forth on your Exhibit 3?

A How many --

Q How many offset locations will there be surrounding your 160 acre lease on a 40 acre pattern?

A Well, there would be, I presume you are referring to these locations off of Gulf acreage?

Q Yes.

A Well, there would be one, two, three, four, five, six, seven, eight, nine, ten, eleven.

Q As compared to how many possible offset locations under the application as submitted by Sunray Mid-Continent?

A I believe this shows one, two, three, four, five, six, seven.

Q So that your correlative rights will be better protected with eleven offset locations than with seven?

A That's correct.

MR. PORTER: Anyone else have a question of the witness?

MR. KELLOGG: I would like to ask a question on redirect examination if there are no other questions.

MR. PORTER: Mr. Pho has some questions.

By MR. UTZ:

Q Mr. Bauman, would a rigid 80 acre spacing pattern tend to correct this situation which you state will exist under the conditions there?

A In my opinion it would not. I presume you're referring to a uniform 80 acre pattern?

Q That is correct.

A With the wells located in the same Governmental --

Q (Interrupting) Same quarter, quarter section on the 160. Your answer was that you don't think it will?

A I don't believe it will.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Bauman, would you state the rate of flow at which the well which you testified the GOR was 2300 to 1. would you state the rate of flow on that test please?

A 166 barrels of oil per day.

MR. NUTTER: Thank you.

MR. PORTER: Are there any further questions? Mr. Cooley.

By MR. COOLEY:

Q There's been testimony throughout this case that the heart of this pool is highly productive, much better than the fringe areas. Does Gulf own a characteristic proportion of each or do they own more good acreage than not, or what will be your opinion on that

matter?

A I think we are represented for the area of the southeast portion of the pools insofar as the wells that have been drilled so far.

Q You think you have your representative share of the good acreage and your representative share of the bad acreage?

A Yes, sir.

Q Did you say it would be your recommendation to your company to drill all 24 possible locations under 40 acre spacing? I believe there are twenty-four nine hundred sixty divided by forty nets twenty-four, if my arithmetic hasn't failed me.

A I would recommend that we would drill the 40 acre locations on that tract in the southwest of Section 24 at the present time, and depending upon the results of the well now drilling, that could be extended.

Q You wouldn't care to estimate how many wells Gulf will eventually end up with on the acreage shown on Exhibit 3 on 40 acre spacing?

A That is pretty hard to say without knowing the results of the well now drilling.

MR. COOLEY: That's all.

MR. PORTER: Are there any more questions on cross examination? Mr. Kellough.

[redacted]

By MR. KELLAHIN:

Q I would just like to ask one question, Mr. Bauman, in the event that this application is denied and the drilling is upon the statewide rules of 40 acre spacing, and if Gulf completed the drilling of wells in the southwest of 24, then in connection with Mr. Sullivan's question, would there be an offset to each of the wells on the adjoining tracts?

A There would be an offset, yes, sir.

Q Did you wish to convey the impression to this Commission that in your opinion the correlative rights of Gulf would be better protected under the proposed application than they would under the statewide rules?

A I'm not sure that I understand you. They would not be protected the way they are now, but we would be able to protect them if that tract was offset by 40 acre drilling.

Q Then, perhaps you misunderstood Mr. Sullivan's question as I understood your answer, Mr. Sullivan asked you if it was not a fact that the correlative rights of Gulf would be better protected under the proposed application than under the statewide rules and your answer, I believe, was that it would. Is that what you intended to testify?

A To the extent that there would be no drainage from our property.

Q Well, I'm trying to get you to express your opinion to this

Commission, Mr. Lauman, as to whether in your opinion, based upon your exhibit, the correlative rights of the company, Gulf Oil Corporation, would be protected under the proposed 80 acre floating well spacing pattern.

A I don't think they would be.

Q Would they under the statewide rules?

A They would.

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

MR. PORTER: Does anyone else have a question of Mr. Bauman. The witness may be excused.

(Witness excused.)

You just had the one witness?

MR. KELLOUGH: That's all we have.

MR. PORTER: Does anyone else have any witness?

MR. SULLIVAN: I would like to call Mr. Thomas Hogan in this case.

MR. PORTER: He has previously been sworn?

MR. SULLIVAN: Yes, sir.

MR. KELLOUGH: I am a little late, but I would like to offer in evidence Gulf Exhibit No. 3, the map. I believe I neglected to do that.

MR. PORTER: Without objection, Gulf Exhibit No. 3 will be admitted to the record.

THOMAS HOGAN

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

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Will you please state your name, your employer, your position with that employer?

A My name is Thomas Hogan, I am employed by British American Oil Producing Company, and what was the other one?

Q What is your position with that employer?

A District Superintendent for the Northwestern District.

Q Where are you located? A Denver, Colorado.

Q You say that you are District Superintendent. Would you explain to the Commission in your company what that district encompasses?

A It encompasses the producing active, the producing and drilling activities in Montana, Wyoming, Colorado, Utah, Nebraska and New Mexico, North and South Dakotas.

Q In those states, Mr. Hogan, just approximately how many oil fields do you have under your jurisdiction as far as drilling and producing is concerned?

A Quite a few, I don't know. We have four field offices with Field Superintendents over them.

Q In other words, in your organization a district is considerably

vaster area than we have heard described as being divisions in other organizations? A It is.

Q Briefly, and be as brief as possible, Tom, in this, state your professional experience.

A I received a B. S. degree in mining engineering from the University of Oklahoma in 1933. Since that time I have been employed by The Texas Company in various engineering capacities, with the Iranian-American Oil Company as Superintendent of the Abquiq District and as Chief Development Engineer, and now for the last five years with British American Oil Producing Company as District Superintendent.

Q Mr. Hogan, you have read and are familiar with the application of Sunray Mid-Continent in this case?

A I have.

Q Is the position of your employer, the British American Oil Producing Company, in support of that application?

A Yes, we are strongly in support of the application, but I would like to point out that we would like to stress the temporary nature of the order that we wish issued.

Q Now, there are two, let us say three, distinguishing parts to the application. One, they ask for 80 acre spacing, two on a temporary basis, three for the expansion of the definition of the pool. So I take it that you are saying that your company is in support of all three facets of that application?

A It is.

Q But that you believe that there is particular emphasis to the temporary part, what do you mean by the emphasis that your company puts on the temporary feature asked for?

A We do not believe that there has been sufficient production and pressure history from the Bisti Field to enable us to determine that 40 acre spacing is economically feasible.

Q But you, on the other hand, are willing in effect to consider it when you get sufficient information?

A We are.

Q One further question, how many producing wells does British American operate in the Bisti Field? A Thirty.

Q That's approximately what percentage of the total in the field? A Twenty-five.

Q Do you recall how many of those wells, off-hand, you have cored? A Approximately twelve.

Q Do you recall the first witness put on, in Mr. Finfrock's testimony, how many core analyses of wells were involved in the diagrams which he presented, was it twenty-six?

A It was in the twenties I believe. I'm not sure.

Q With all of the producing information that you have from thirty wells, and with the core analyses from twelve wells with the additional information that you have obtained from producing those wells, I take it then that your position is that you still do not

have enough information to determine that you can successfully and economically drill on a 40 acre basis?

A No, we feel that we don't, principally because the production of the field has been restricted so drastically throughout most of its life, and as testified by Mr. Brinkley, it is still in the early stages of the producing life of the field.

MR. SULLIVAN: That's all, Mr. Hogan.

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

By MR. SETH:

Q Just one question. How long have your wells been producing, Mr. Hogan?

A The first well was completed in January of 1956.

Q Been producing over a year? A Yes.

MR. SETH: That's all.

By MR. PORTER:

Q Mr. Hogan, do you recall about what the gas-oil ratios are on your wells?

A Oh, they are in the neighborhood of I would say 450 feet to the barrel. I wouldn't guarantee it, but that is my best recollection.

MR. PORTER: Does anyone else have a question? The witness may be excused.

(Witness excused.)

MR. SULLIVAN: I would like also to ask Mr. John Stein

to testify, Mr. Chairman.

MR. PORTER: All right. Will you take the stand, please?

MR. SULLIVAN: He was sworn yesterday.

JOHN STEIN

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

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Mr. Stein, will you briefly state your name, your professional education and professional experience?

A My name is John Stein. I am a graduate of the Missouri School of Mines with a degree in mining engineering, petroleum engineer. I have been with the British American for eight years, and during the past two years have served in the capacity of District Engineer for the entire Northwestern District.

Q In your capacity as District Engineer, Mr. Stein, are you familiar with the Bisti Field? A Yes, I am.

Q Part of your duties are to study and make recommendations, generally supervise, in effect, the engineering of the Bisti Field?

A Our portion of it, that is correct.

Q You have been present during the last two days of testimony on this cause? A I have.

Q Are you generally in agreement with the conclusions reached by the witnesses for the proponent of this application?

A Yes, I am.

Q Would you like to comment upon the opinion that you have reached with regard to the economics of drilling this field according to the present stage of your knowledge on a 40 acre basis?

A Well, at the present time I don't feel that we have sufficient knowledge of how much reserves we can attribute to nine 40 acre wells. We have made some special core studies in which we have come up with a representative figure, we think, of recovery per acre foot. Now, we base most of our profitabilities on one well to 80 acres. Now, in the very heart of the field where we have the good production, we expect to obtain on 80 acre spacing roughly a hundred to ten thousand barrels of oil, which deduct royalty and lifting costs and so forth, would amount to a gross profit, or a gross revenue in the neighborhood of $190,000.

Now, it costs us around $70,000 to drill a well. So that means that on one well to 80 we could get $120,000 gross profit. That is assuming that our recovery estimates are pretty good. Now, if we drill two wells on that 80, that's going to require $140,000 expenditure, and that just cuts the gross profit right down the middle, which would leave somewhere in the neighborhood of $50,000 for that particular 80, which we are not sure we can even get, because there hasn't been enough production decline history, nor bottomhole pressure history to substantiate these initial estimates of recovery of oil per acre foot.

Q Now, I understand that these estimates were based, did you state that these estimates were based upon an average cross section or thickness of pay?

A No, this would only apply in the very best portion of the field. Now, we have some wells that have already been completed and actually indicate that they'll never pay out, and they are on 80 acres.

Q They are completed in the upper bench?

A Yes.

Q As producers. Are they also completed in the lower benches of the sand?

A They certainly are.

Q So there are wells even in your end of the field completed in the upper bench and lower benches which you do not consider economic wells at this time?

A That's right. Actually our core studies indicated that in the poorer sections of the reservoir we might expect from five to fifteen barrels of oil per acre foot. That is pretty low. We have already had a couple of wells which had considerable drop in pressure for only a small amount of oil produced. If we would just take the pressure decline that we have had on those two wells, we can only expect to get roughly 15,000 barrels of oil out of them ultimately, and that will never pay for a $70,000 well, yet they are on 80 acres.

Q Can you corroborate the gas-oil ratio that Mr. Hogan testified to with regard to your average or individual gas-oil ratios

in the section of the field which you are producing?

A Yes, they are running in the neighborhood of 400 to 450. There may be a few in the 500 range, but very few.

Q In connection with your special core studies, did you direct your attention in any respect to the possibility of communication between the upper and the lower benches, and if you did, with what purpose?

A Not particularly with core studies. However, we did note that on our core analyses that there was some minute amount of permeability even in the shalely, silty zones between the better-developed sand benches, so we conducted some communication tests.

Q Other than your core studies?

A Yes. We perforated the third bench of the Gallup sand and fractured it, and swab tested it, and then we went up and perforated the first bench of the Gallup sand, fractured it and swab tested the two together. Of course, established a rate, then we ran a packer on the tubing and set it in the blank interval between these two perforated zones and pump tested the well for, oh, I don't know, about two months, a man ran fluid level surveys on the fluid in the annulus, and the results of that test did indicate that there was communication between these two zones to some degree.

Q You were pumping it from which bench at that point?

A We were pumping from the third bench, the bottom bench, and checking the fluid level in the annulus, which is supposed to be

in the first bench if no communication existed, however, as we pumped from our third bench from the packer, our fluid level in the annulus went down the hole and finally stabilized when we shut the well in for a week to a month at a time, the fluid level in the annulus would build back up. Those are definite evidence of communication between those sand benches in that well.

Q I won't ask you whether or not you have made a deduction from that test. I would like to ask you whether or not you have a suspicion as to what this proves between the relationship as what you refer to as the upper and the third bench?

MR. KELLOUGH: We have had a lot of opinions, but I don't believe we should have a suspicion.

Q Would you state your opinion as to what may be your deduction from the test you have run?

A Actually that is only on one well. Of course both zones were fractured. Now, any time you fracture a well, a fracture is going to go in all directions, we may have caused that communication by fracturing, and again we may not. It may be due to the natural permeability in the reservoir. I don't think we can quite conclude on this test. We do wish to make more tests.

Q That is why I didn't ask you for a conclusion. I just wondered if you had a suspicion. One further question, did you earlier testify in connection with the economics of 40 as versus 80 acre spacing as to what you estimate your completed well cost will be

in that field from here through the foreseeable future?

A I don't know if I made that statement exactly, but our costs, I expect --

Q Would you make it now?

A (Continuing) -- to be between sixty-five and seventy thousand dollars per completed well.

Q Generally what will that include?

A That will include everything pertaining to a well from drilling it, setting the pipe, perforating, logging, perforating fracturing, all of the pumping, lifting facilities and lease facilities. Everything that is necessary to get this well to produce into tank battery.

MR. SULLIVAN: That's all, Mr. Chairman, that I have.

MR. PORTER: Does anyone have a question of Mr. Stein? Mr. Cooley.

CROSS EXAMINATION

By MR. COOLEY:

Q Mr. Stein, you said your company had already completed some wells that in your opinion would not pay out?

A Yes.

Q You stated that that was on 80 acre spacing with the inference at least, I thought, that possibly the payout would be less if they were on 40 acre spacing?

A Certainly we couldn't even expect to offset these wells and

got any more additional oil. I mean we have, already they are on 80.

Q Offsetting is not required where the well is not economic, Mr. Stein? I want to know, if anything, an uneconomic well is drilled, the dedication of no amount of acres to that well will make it economic, will it?

A I don't quite understand.

Q If you dedicate 20 acres to that well, or 1000, it is still an uneconomic well, is it not? A I'm afraid it is.

MR. COOLEY: Thank you.

MR. PORTER: Mr. Utz, do you have a question?

MR. UTZ: Yes.

By MR. UTZ:

Q Mr. Stein, in answer to one of Mr. Sullivan's questions, I understood you to say that you were generally in favor of Sunray's application. Would that indicate that you are not wholly in favor of it, some portion of it that you don't agree with it?

A I am in favor of a temporary 80 acre spacing order, I'll put it that way. I would not be in favor, for instance, of making this a permanent spacing order. Of course, they have not asked for a permanent spacing order. I am in favor of the one well to 80 acre spacing on a temporary one year basis.

Q Are you in agreement with their so-called floating spacing pattern?

A Well, yes, I would be in agreement with that.

Q That would allow you to cluster four wells around a quarter quarter section, or quarter section?

A Yes, it would allow that in certain specific cases. However, there are some wells in the field already that are off spacing and therefore, there is going to have to be an exception made for those particular wells. You have to either give them an east-west 80 or north-south 80. There is also a possibility that a fellow sitting off out here that is maybe only got 70 acres within the zero contour, so I think if you had a little leeway as to where he could drill that well, he would still only have one well to the 80. I think there should be some leeway to that.

Q You are in favor of flexible spacing pattern then?

A To some degree.

Q Even though it would be clustering the wells?

A I think it should be either east to west or north to south. I wouldn't want to throw them on a diagonal.

MR. UTZ: That's all I have.

MR. PORTER: Any more questions? If no further questions, the witness may be excused. (Witness excused.)

MR. COOLEY: I would like to direct a question to either Mr. Errebo or Mr. Campbell. As you gentlemen know, this state as a general rule interpreted its spacing orders to permit the drilling of more than one well on a standard proration unit, whatever size it may be. As Mr. Campbell knows, there are many areas of this state

where there are two, three and four wells on 140 acre proration units. In view of the fact that this is somewhat peculiar, since an 80 acre unit will probably get just twice what a 40 acre unit will get, that anyone who desired could drill on a 40 acre spacing pattern even though the established and recognized 80 acre proration unit were established.

MR. PORTER: There is a limitation there, Mr. Cooley, in that regardless of the number of wells that the unit received the same allowable even though one well?

MR. COOLEY: That's correct, but since on a 5,000 foot well there is no depth factor, then a 40 acre well would get just exactly half of what an 80 would and vice versa, which would not occur in any other depth range.

MR. PORTER: Not under your existing rules.

MR. CAMPBELL: What is your question?

MR. COOLEY: The question being does the applicant by this application propose to prohibit the drilling of more than one well on an 80 acre?

MR. CAMPBELL: We would like to have the order so provide, if the Commission issues any order. The interpretation of the statutes we would leave up to the Courts. The section that permits drilling on one unit, if you want to, with one allowable.

MR. COOLEY: Yes. We have not ordinarily interpreted our rules, in any 80 acre pool, to prohibit the drilling of an

additional well on the 40.

MR. CAMPBELL: You have occasionally permitted after application.

MR. COOLEY: No application, they just drill them.

MR. CAMPBELL: We would like to have the order so provide, if the order is issued, for temporary 80 acre spacing.

MR. SELINGER: May I attempt to answer that likewise? I have here a suggested order, both the findings and the order, which I would like to introduce and merely for the suggestion on the part of Skelly in which it incidentally coincides with Mr. Campbell's suggestion, but it is very short. I might read it, I would like to suggest this:

Findings: That the geological and engineering evidence presented to the Commission bearing on the matter of well spacing indicates that the Bisti Field as classified and defined in this order, should, for a period not to exceed one year from the date of this order, be developed on a pattern of one well to eighty (80) acres in order to drain efficiently the recoverable oil from said pool, assure orderly development, and prevent waste in a manner to protect correlative rights.

That temporary 80-acre spacing in this field will result in a earlier determination of the geologic and engineering characteristic of the pool, avoid the drilling of a number of unnecessary wells should a wider spacing prove to be proper after additional evidence

is obtained as will protect correlative rights.

In the order we suggest that: That effective this day temporary 80-acre spacing is hereby established for the Bisti Field.

That this order shall continue in force for a period not to exceed one year from the date hereof.

It was merely a suggestion and I might add that it is based on practice and procedure that we have in the State of North Dakota which issues temporary spacing orders for the express purpose of securing information upon which to predicate a permanent order.

MR. PORTER: Mr. Cooley, before we conclude this matter we would like to know if there are any other companies who desire to present testimony in this case.

MR. BUSHNELL: At the opening of the hearing Amerada intended to put in a four and one-half page statement at the end of the hearing, but during the course of the hearing the last several days we conclude that we would like to put that statement in in the form of testimony since it was prepared by a witness who is here. However, since it appears that this hearing may run on through the lunch hour today, I contacted Mr. Seth and we have stipulated that I may enter this statement of Amerada's, prepared by Mr. Christie, into the record as if it were given by Mr. Christie, and if there is no objections I would like to offer this into the record as Amerada's Exhibit No. 1.

MR. SETH: We have so stipulated. I don't know what

Gulf's position will be on it. We had stipulated that if Mr. Christie were called, he would testify as this statement reads.

MR. KELLOUGH: We have no objection to the admissibility of the statement.

MR. COOLEY: Do both you gentlemen waive the right to examine him?

(Marked Amerada's Exhibit No. 1, for identification.)

MR. PORTER: Under these stipulations, the statement will be accepted as testimony. Does anyone else desire to present testimony in this case?

MR. KELLOUGH: I just want to make one comment, whereas I have no objection to Mr. Christie's statement, on the other hand and quite to the contrary, I do object to any admission of Mr. Salinger's order in the record in this case. If he wishes to present it as argument on his behalf, I think that is very well and good. I certainly don't think, I think it would be a little presumptious to submit to this Commission a finding based upon all of the evidence which has been presented here for the last two days.

Now, I'm sure that Mr. Salinger intended that to be only argument, if that is the case, very well and good, but if it is intended to be admissible in some manner in this case, then I would like to object to it.

MR. SALINGER: I merely intended to give Mr. Kellough

advanced notice that I'm going to attach that to my statement to be filed within the next few days. That's why I had it read.

MR. COOLEY: It has been the practice on occasion, of this Commission and other Commissions, to accept proposed orders, but they have no evidentiary weight whatsoever.

MR. KELLOUGH: Very well.

MR. PORTER: Was this question of number of wells to the unit settled to your satisfaction?

MR. COOLEY: What, the application section? Yes.

MR. PORTER: If there are no further witnesses to appear, no further testimony to be presented, the Commission will entertain statements that you may have. However, as you remember, yesterday we indicated that written statements might be submitted within ten days, ten days from yesterday. However, you still have the privilege of presenting the statement orally if you so desire.

MR. HINKLE: If the Commission please, Clarence Hinkle of Hervey, Dow and Hinkle, Roswell, representing Humble Oil and Refining Company. I would like to present a brief statement on behalf of the Humble. The Humble Oil and Refining Company has a 4.722% interest in the Carson Unit area which covers a part of the Bisti-Lower Gallup Oil Pool and owns additional acreage within the proposed horizontal limit of the pool. The Humble desires to go on record in this case as supporting the application of the Sunray Mid-Continent Oil Company for a temporary order of one year establishing orderly de-

acre spacing in the Bisti-Lower Gallup Oil Pool.

Due to the fact that production from the Bisti-Lower Gallup Oil Pool has been relatively small because of the market outlet, the information accumulated to date with respect to well performance and bottomhole pressure data has been rather limited, and although the production data thus far accumulated indicates that one well will effectively, efficiently and economically drain more than 80 acres, a temporary order entered for a year would permit further development on an orderly 80 acre spacing pattern during such period so that additional well performance and pressure data can be accumulated to enable the Commission to more definitely determine the characteristics of the pool and as to whether at the end of the year development should properly proceed on an 80 acre or 40 acre spacing.

It is also possible after a field has been on a definite 80 acre spacing pattern, to drill the additional wells so as to complete the development on 40 acre pattern if essential to obtain the greatest ultimate recovery. But once development has started to any considerable extent on 40 acre pattern, for all practical purposes it can never be changed, and it would then be too late to prevent economic waste caused by the drilling of unnecessary wells and the unnecessary use of steel and other industry equipment.

We, therefore, urge the Commission to give favorable consideration to the Sunray Mid-Continent application.

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MR. PORTER: Anyone else have a statement? Mr. Kellahin.

MR. KELLAHIN: Jason Kellahin appearing for Phillips Petroleum Company. Phillips Petroleum Company owns acreage in the Bisti-Lower Gallup Pool, participates in the Carson Unit area, and is likewise participating in the pilot LPG injection program now under way in this pool. Phillips is of the opinion that the reservoir information which has been presented in this case and is now under consideration shows that one well on 80 acres will efficiently and economically drain and develop the 80 acre unit.

In that connection we would like to call the attention of the Commission to the testimony offered by Sunray Mid-Continent as to four wells which showed an initial pressure below the original reservoir pressures, and also Exhibit 12 offered by Shell which shows on at least two of the wells the same situation, which on the testimony from both the proponents and the opponents of this application, show effective drainage over an 80 acre area. For that reason, Phillips Petroleum Company supports the application and urges the adoption by this Commission of the temporary 80 acre spacing order for a period of one year.

Also in connection with it, we would like to urge the Commission to give serious consideration to the testimony which has been offered in regard to the pilot injection program, the testimony of some of the witnesses indicates that the development of the area on closer spacing could well endanger that program and result in reduced recoveries. The money which would be spent, according to the

testimony of the witnesses, on developing this acreage on 40 acres could more profitably be used to institute this secondary or this pressure maintenance and secondary recovery program with a resulting recovery in excess of that which could be achieved by any multiple program which has been offered.

For that reason Phillips endorses the application and urges the approval by the Commission. I am also authorized to state that El Paso Natural Gas Products supports the application and urges a temporary 80 acre spacing and drilling unit program for the Bisti-Lower Gallup Pool. I am likewise authorized on behalf of Benson-Montin and Greer to state that they likewise support the program. They have an interest in this field as does El Paso Natural Gas Products Company, and urge the approval of the temporary 80 acre spacing order.

MR. SELINGER: If the Commission please, Skelly Oil Company concurs in the application for a temporary 80 acre spacing order for one year. We will file a detailed written statement later.

MR. BUSHNELL: Bushnell for Amerada. I would like the record to show that Amerada is in support of this application subject to the single qualification that Amerada would be agreeable to and would favor an order which provided for uniform spacing.

MR. JUSTICE: My name is P. S. Justice. I am Manager of the Rocky Mountain Division for the Sun Oil Company, Denver, Colorado, with jurisdiction over and responsibility for Sun's

operations in the area of the Bisti-Lower Gallup Oil Pool. I would like your permission to make a statement on behalf of Sun. I would like to make this and have it understood it is a comparatively brief and non-technical statement. Since this is the first time I have had the privilege and opportunity of attending a hearing before the New Mexico Oil and Gas Commission, I wish to express my personal and official appreciation of the impartial, patient, and efficient manner in which this hearing has been conducted by the Commission and its Staff. If at first blush this appears to be apple polishing, I can assure you that you can consider yourself unanimously polished by this attendance here.

Sun Oil Company concurs fully in the application of Sunray Mid-Continent Oil Company for an order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico and temporarily establishing uniform 80 acre spacing in accordance with the details of said application.

Furthermore, in Sun's considered opinion, the evidence so lucidly, ably and intelligently presented by Sunray Mid-Continent Oil Company as applicants in this case unmistakably demonstrates the desirability, urgency and practical necessity for prompt establishment of such temporary 80 acre spacing. We believe that this is necessary in order to prevent waste, that it will aid in promoting the ultimate efficient maximum economic recovery of oil from said pool with due regard for the legal, moral, and just or relative

rights of all interested parties.

Finally, we wish respectively to state to the Commission and to the parties opposing this application, that in our opinion the adoption or the establishment of such a temporary 80 acre spacing order would not necessarily be permanently harmful to the premises or position of the opposition even if the same later should be proven to be correct or advisable. On the other hand, if lesser well spacing regulations remain in force and development on 40 acres is permitted, no later action or order could effectively prevent the waste or other inequities that have clearly been shown to result therefrom. Thank you.

MR. PORTER: Thank you, Mr. Justice. Any more statements?

MR. ERREDO: Sinclair Oil and Gas Company entered an appearance in the matter after the first day, and they have authorized me to state in their behalf that they strongly support Sunray's application for 80 acre spacing, that they equally strongly oppose 40 acre spacing, and they support our application with the exception that they would favor a permanent order and that their second choice would be a temporary order, and that they will file a written statement subsequent to this hearing.

MR. PORTER: Mr. Sullivan, did you have a statement?

MR. SULLIVAN: I think it behooves me to say one additional word in view of Mr. Cooley's question to Mr. Campbell with regard to the well locations and the way the 80 acre spacing units

would lie. I don't think the position of British American Company should be based on Mr. Stein's position, because in discussing it with him, I don't believe you were on common ground in this discussion with Mr. Utz.

Let me say we are in agreement with the position that Mr. Campbell takes, we feel there should be one authorized well to the 80 acre unit, and the Commission should establish the direction in which the units should lie, and that they should be uniform. Is that essentially correct, Mr. Campbell?

MR. CAMPBELL: The only thing I discussed with Mr. Cooley, that we did question, that if an order is entered that it provide that not more than one well be drilled upon any 80 acre unit. The present application as it stands, permits flexibility in the location of the well on the unit. And there has been some testimony or indication here that some people feel it should be a fixed pattern rather than a flexible one, but our application is for a flexible pattern.

MR. SULLIVAN: So it is within 330 feet of any place within the acre boundary?

MR. CAMPBELL: I believe that is 3330 feet from the boundary track which is a part of the 80 acre unit.

MR. COOLEY: Which could put it 330 feet anywhere around.

MR. SULLIVAN: I would go one step further and say we would like to see the present spacing pattern as it exists in the

British American portion of the field maintained.

MR. CAMPBELL: We have no objection to a fixed pattern spacing insofar as it is feasible under the present circumstances.

MR. SETH: Do you modify your application to that extent?

MR. CAMPBELL: We'll let the application stay like it is.

MR. SETH: The same thing that troubled Mr. Cooley has troubled me. Ever since the application first came to us, it's an application for prorationing units in an area where there is no prorationing. It is not really a spacing case when you get right down to it. Under the terms of the application it will be perfectly proper for anybody to drill any number of wells within the 80 acre tracts if they wish to do so. I think the application and publication and so would permit. This is not an application for spacing, it is an application for proration units.

MR. CAMPBELL: I disagree. I think it is broad enough that the Commission could deem it advisable to limit the drilling in this area of one well per 80 acres.

MR. SETH: We have treated this and tried this as a spacing case. We are prepared to go along with any spacing rule that the Commission has. I don't think the application is for spacing at all.

MR. PORTER: Anyone else have a statement? Mr. Cooley, do you have some letters?

MR. COOLEY: Yes. From Honolulu Oil Corporation:

"Honolulu Oil Corporation owns and operates one well in this field in the area included in the notice of hearing. This well is our State of New Mexico "D", Well No. 1, located 660 feet from the North and West lines of Section 36, T 26N, R 13W, NMPM.

Because of our minor percentage of production and reserves in this field, we do not plan to be represented at the hearing. However, it is our belief that the proposed temporary 80-acre well spacing is proper for this field at this time.

Honolulu Oil Corporation respectfully requests that the Commission adopt the special rules and regulations for the Bisti-Lower Gallup Oil Pool as proposed by Sunray Mid-Continent Oil Company."

From The El Dorado Refining Company: "Notice has been received in the matter of Sunray Mid-Continent Oil Company's application for the purpose of establishing spacing and special rules for the Bisti lower Gallup oil pool, San Juan County, New Mexico. It is our understanding that this matter has been scheduled for Wednesday, September 18, 1957, in Santa Fe, New Mexico.

This is to advise that as an operator in this area The El Dorado Refining Company supports Sunray Mid-Continent Oil Company in their request for 80 acre proration units and well spacing plus special rules and regulations for the subject pool."

From Anderson-Prichard Oil Corporation: "Anderson-Prichard Oil Corporation recommends that the Commission approve the

application of Sunray Mid-Continent Oil Company for an order which will (1) extend the horizontal limits of the Bisti Lower Gallup Oil Pool, (2) temporarily establish uniform 80-acre spacing for oil wells, and (3) require semiannual gas-oil ratio and bottom hole pressure tests.

Anderson-Prichard Oil Corporation further recommends that the Commission include in the field rules a volumetric withdrawal formula for computing allowables for gas wells which are completed in the gas cap portion of the Lower Gallup oil reservoir. The equities of all parties can best be preserved by permitting the operators of such wells to attribute up to 320 acres to each well for allowable purposes provided that said acreage is proven productive of gas."

From Shiprock Industries, Inc.: "It is our understanding that you are having a meeting on 9-18-57 to consider oil well spacing in the San Juan Basin, New Mexico.

We are the holders of thousands of acres, both proved and unproved, in this area and it is our studied opinion, after advice from our geologists, that it is quite improbable that more than forty acres of oil land can be drained by a well thereon. We therefore violently oppose changing of the laws of the State of New Mexico to allow for spacing greater than forty acres per oil well."

From Laurence C. Kelly Trust: "I have been notified that a meeting of your Commission will be held in Mabry Hall on September 18th, at 9 A.M. to consider among other things Case #1308,

the Application of Sunray Mid-Continent Oil Company for an order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, and temporarily establishing uniform 80-acre well spacing and promulgating special rules and regulations for said pool.

The Laurence C. Kelly Trust, of which I am Trustee, holds State of New Mexico Oil and Gas Leases Nos. E-6597, E-6644, and E-7698, aggregating a total of 4,118.59 acres. All of this acreage is in Township 25 North, Ranges 12 and 13 West, and covers all of the State owned acreage in this Township and Ranges, with the exception of 1,000 acres.

You will remember no doubt that the discovery well of the Bisti Pool was on Section 16, Township 25 North, Range 12 West, which is part of our State Lease.

As Trustee for the above Trust, I would like to make formal protest against changing from the present established 40-acre spacing to 80-acre spacing, as requested by Sunray Mid-Continent Oil Company, for the following reasons:

1. The Oil Conservation Commission of the State of New Mexico has never before found it necessary to change the spacing from 40 to 80 acres as it has no doubt found 40-acre spacing satisfactory from every angle.

2. It is the considered opinion among a great many well qualified geologists that one well cannot possibly drain in excess of 40 acres, because of the nature of the Gallup Sandstone which has been established as a very tight formation with low porosity and permeability.

3. The only sound reason in the opinion of the writer that have been advanced to date, namely, lack of market for the oil, will be completely eliminated before the end of the year when the Four Corners Oil Pipeline to California will be in operation and the Refinery of the El Paso Natural Gas Products Company will be on stream.

4. It would appear to be short-sighted policy to restrict the production of oil from the Bisti Pool at a time when there is a very strong demand for it and the Refineries of California are clamoring for it. This condition might not prevail for too long and should be taken advantage of while it does.

5. A change in the established 40-acre spacing could be very detrimental to the revenue obtained from oil by the State, which undoubtedly, like nearly every other State, needs more and more revenue every year for school purposes. It is more than likely to bring about requests for wider spacing than the present 40 acres.

In view of the above facts I cannot urge you too strongly to allow the present established spacing of 40 acres to remain in effect."

MR. PORTER: Let the record show that these letters are entered in evidence.

MR. ERREBO: I have a copy of a letter from Honolulu. Did you read that?

MR. COOLEY: Yes, supporting.

MR. CAMPBELL: Are you going to make a statement, Mr. Seth?

MR. SETH: Mr. Carroll will make the summation. You go ahead, you are the applicant.

MR. CAMPBELL: Normally they close. I don't want to be contentious about it.

MR. CARROLL: I appreciate this has been a long hearing. I do not want to labor the evidence, but I would like to summarize

the principal issues that have been brought out in this case. In particular to review very generally the nature of the spacing order that has been requested, the economic consideration involved, the relationship of the spacing to secondary recovery, and the effect of the spacing on correlative rights. Insofar as the nature of this spacing order itself is concerned, as I am sure the Commission is well aware, this represents what is an unprecedented request for 80 acre fieldwide spacing at 500 foot depth. Previous spacing orders have been eight to nine thousand feet or greater depth.

The Commission would have every reason to believe and expect that where applicants come forth requesting exceptions from statewide rules which have been established and followed, they would present evidence of some unusual circumstances or conditions existent in this reservoir which would justify a variation from the rules.

However, the applicants have utterly failed to do this, and as a matter of fact, as I think their evidence has shown, they have testified that the conditions in this reservoir do not vary materially in any other respect from other reservoirs in the state.

The next point I would like to present, the correspondence in connection with the application itself, is in regard to the so-called density pattern. It is obvious from examination of the petition itself as well as from a review of the testimony, they avoided the use of the word spacing pattern. This is easy to understand

because this so-called strategy of arbitrarily dedicating acreage to a well to achieve an 80 acre unit is contrary to the practices of the Commission and contrary to the ordinary spacing pattern.

Furthermore as has been emphasized by some of the early discussion, what has been requested is a floating pattern with diagonal 80 east-south or north. It is to produce an indefinite spacing pattern rather than a fixed orderly pattern which is normally fixed by the Commission. Other considerations in connection with the order, and one in which the applicant has placed great emphasis, that a temporary order cannot possibly hurt anyone or do damage to present development in the field. We firmly believe this is not true. If, in fact, an 80 acre order is given and 80 acre wells are actually drilled, although we are firmly convinced they will not by any means effectively or adequately drain an 80 acre area, they may yet take enough oil out of the area so that later on it will be uneconomical to drill the area on 40 acre basis.

Furthermore, we have demonstrated if you drill on 80 and try to drill on 40 again, you will have waste and dissipation of reservoir energy. Next, having briefly considered the petition, I would like to go into economic conditions involved. In this connection I think it quite significant that if you take the figures with regard to potential reserves, figures that have been established in the prior LPG hearing by the applicant, figures that have been established by

virtue of correspondence which the applicant wrote to various operators trying to interest them in LPG operation, and finally evidence of reserves as presented by their testimony in this case, I think it can be firmly established that drilling on a 40 acre basis is economically practical and feasible.

Furthermore, there are other considerations in this case that I feel that perhaps hasn't been too adequately emphasized, I think for obvious reasons, that is namely in addition to the interest of the State of New Mexico in the lands affected by the petition, which are substantial, there are also some very substantial interests of the United States of America of various Indian wards. In my opinion these interests should have the effect of the maximum development that can be obtained and are entitled to, and I think they should not be penalized in terms of development of the reservoir by the higher drilling cost of some of the operators.

Then the next factor I would like to consider is the emphasis that has been placed on secondary recovery operations. Now, it is true and has been emphasized by a lot of testimony, that Shell did participate in Sunray's LPG project, it is Shell's project to participate in any experimental secondary recovery project. I might add that we are hopeful of its success. However, it is necessary to view this project realistically in terms of what it actually is, namely an experimental project for the injection of LPG as has been admitted by the testimony of the applicants.

They have just now completed injecting the gas into their pipeline.

Therefore, it would seem somewhat premature at this time during the early phases of primary recovery, to regard a project of this nature as a substantial factor in establishing fieldwide spacing in a 47,000 acre area.

Furthermore, insofar as this secondary recovery through the use of LPG is concerned, we consider it quite significant that they did not use an 80 acre pattern as they suggested would have to be followed, but they used instead what was in essence a 20 acre pattern consisting of four 40 acre locations with the injection well in the center.

Now, if the applicant contends that it seriously believes that some jeopardy might be done to future secondary recovery operations by having wells drilled on a 40 acre basis, as a matter of fact, they said anything less than 80 acre basis, and if they have conceded this is a continuous reservoir and if this LPG is in what they regard as in a better paying location, it is difficult for me to understand why they would jeopardize this project themselves starting on a 20 acre basis.

I think Shell's testimony has established with regard to secondary recovery operations, that the ultimate pattern will have to be, at least will be, on a nature of 40 acre rather than 80 acre pattern.

Finally, I would like to point out that insofar as the doctrine

of correlative rights is concerned, it has been quite convincingly illustrated by the exhibits and by the testimony of the Gulf Oil Corporation that many inequities may develop by virtue of the use of the floating spacing pattern proposed by the applicants, particularly where wells are drilled along lease boundary lines. Such inequities violate the principal of correlative rights as set forth in the New Mexico Statutory provision and this Commission's regulation. Thank you.

MR. KELLOUGH: May I very briefly summarize. In a case of this kind there are three basic issues. First your reservoir performance, that is your reservoir characteristics and performance, second the economics and third the correlative r'ghts. Now, referring only to the high points of these three issues, if you are looking at, considering as this Commission must do, the question of the reservoir characteristics and performance, I'm sure we will all agree that this oil pool is not one big solid porous mass that ties this room in four miles wide and four miles wide, or square. You remember the longitudinal exhibit that ran clear across the room, looks like 66, the applicants themselves did not rely on that interpretation as to what is productive. When they figure reserves they go over to the exhibit based on the microlog which showed numerous variations, and showed a much smaller area. There has been in this case, I think, two clinchers.

You have heard two entirely diametrically opposed

theories.

The applicants on one hand have stated in their opinion that there is continuous porosity and continuous permeability throughout. On the other hand the witnesses for the Shell have presented to you their opinion that this pool consists of lenses of permeability overlapping and massing throughout this pool. The clinchers that would appear to tip the scale, the balance in the scale, is number one, the evidence that you have gas lower than oil, oil higher than gas in this reservoir. Now, no real explanation has ever been given for that, no satisfactory explanation, the only inference I submit that can be inferred is that because of the lenticularity of the nature of this pool, you must have local traps that will cause that condition. It would seem that it would be impossible if you had a continuous permeability, continuous porosity, this pool has been layed down over millions of years, that you would have gas below the oil.

Second, unassailable point, is that you have in this pool in certain parts of it undersaturated oil. In other words, the oil in that part of the pool has less gas than it could absorb, and on the other part of the same reservoir you have either a gas cap or certainly you have a very high gas-oil ratio well. So if there is a great continuity and continuation of porosity and permeability, then it would seem most unlikely that in part of the reservoir you would have the oil which had not absorbed the gas.

Now then, as to the question of economics, you have first the testimony of the applicants in their pilot area several months ago where it was unquestionably economical to drill a well on 40, and you have the evidence of Gulf in its own wells, and you have heard the testimony of Shell and as to applicant's testimony, you'll recall that the engineer testified in basing his calculations on recovery where he concluded that a well would not be off on 40 acres, he did not give any average porosity, but he took certain areas of this field aggregating about half of the total area to be included. He used only a small portion of acreage in the pool and upon that basis calculated reserves which were way under those which had been calculated by his associates in the former hearing.

And furthermore, when you consider testimony of the geologist for the applicants, where he stated the upper sand averaged 15 feet and the lower sands from 4 to 6, making an average pay thickness of about 20 feet, if you compute that on the same figures that were used by the applicants other witness, then according to that computation a well would be profitable on 40 acres.

Issue No. 3, is the question of correlative rights, and though we submit that this floating well spacing pattern will undoubtedly result in a cluster of wells through the streak of the field, they have testified that the heart of the pull is down the middle. The opportunity to cluster the wells anywhere you want, you are bound to have clustering of the wells on the center of the field,

and you wouldn't have 80 acre spacing in anybody's book. It is no answer to say this will be temporary for only one year. It's no answer to say that you are only going to be hurting for a little while. It's the duty of the Commission to protect the correlative rights of the parties now and not let them suffer for a temporary period however short or however long it may be.

Now then, if you pass on that consideration to the proposal that this should be temporary because you don't have enough information to know the performance of the pool, it all ought to be built on 80 acres. I submit how that argument goes to a challenge on the statewide rules. If that is true, you should have 80 acres for statewide rules in any pool. If you don't get enough information, I don't know how to space the pool. If the argument is valid, the lack of information to justify 80 acre spacing, that is a challenge to the statewide rules and not any specific valid argument in this particular case. For these reasons we ask that the application be denied.

MR. PORTER: Mr. Campbell.

MR. CAMPBELL: If the Commission please, I would be less than honest if I didn't admit that some of the statements just made on behalf of Shell Oil Corporation and Gulf Oil Corporation give me a slightlift, even at this hour of the evening after some of the spacing cases that I have been in in which they have been participants. I quite agree with the gentleman with Shell that in order

for the Commission to justify even a temporary 80 acre spacing order in a reservoir at 5,000 foot depth, it must be an unusual reservoir. It is my opinion that perhaps the only time such an order is justified is when you have either a very poor or a very good reservoir. So far as I am concerned, from the testimony of the witnesses of Shell themselves, this has been established at best as a poor reservoir, and it seems to me that what little information is available at this time clearly indicates that the reservoir condition due to rapid pressure declines below the bubble point, and this is also from Shell's own witnesses, indicates that there are conditions in this reservoir which require careful study.

That was recognized by practically all the operators in this pool when they participated in the installation of a pilot pressure maintenance program at a stage of development in this field where it had only been one percent depleted; to me that is a very unusual situation. At least in the spacing cases with which I am acquainted, such a condition has never been present. It seems to me that the crux of this thing boils down to whether there is sufficient basis for the arguments by the protestants to justify to the Commission the risk that obviously exists so far as our people are concerned, and I think they are just as honest in their opinions as the witnesses for the protestants so long as there is a risk, that to develop this field at this stage on a narrow spacing program might adversely affect the ultimate recovery of the oil.

It seems to me that is the basic question of conservation a part of all these controversies about how much it cost this company or that company to drill a well or how quick they get their money back. It seems to me the responsibility of the Commission would be if they feel there is some risk involved, to see that that risk is not taken unless there is a serious disadvantage to somebody if the risk must be taken. The only disadvantage that has been testified to here that I have heard, and I have tried to get it from a number of witnesses, is that they have assumed and made arrangements on the basis that they were going to drill on 40 acre spacing. I don't think that the inconvenience or even loss of revenue to an individual operator in the field justifies the risk which we believe exists that you may not get the greatest ultimate recovery from this reservoir, to me that is the crux of the matter, and I don't think any of the evidence that has been introduced here today or yesterday even can get around that basic proposition.

If the Commission should permit the drilling of these additional wells, and if it should result in the pressure maintenance program not having the effectiveness that it would under the other basis, it not only would risk a tremendous amount of capital which could be used to find oil fields somewhere else in the San Juan Basin, but it would run the risk of loss of oil, a natural resource which this Commission has the obligation to protect.

MR. PORTER: Does anyone else have anything in this case?

The Commission will take the case under advisement.

C E R T I F I C A T E

STATE OF NEW MEXICO)
: SS
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Court Reporter, do hereby certify that the foregoing and attached transcript of proceedings before the New Mexico Oil Conservation Commission 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 25th day of October, 1957.

Ada Dearnley
Notary Public-Court Reporter

My commission expires:

June 19, 1959.

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

December 19, 1957

DEC 11 AM 8:22
OIL CONSERVATION COMM.

TRANSCRIPT OF HEARING

Case 1308

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3-6691 2-2211

I N D E X

	PAGE
L. J. FINFROCK	
Direct Examination by Mr. Errebo	4
Cross Examination by Mr. Seth	17
Redirect Examination by Mr. Errebo	30
T. W. BRINKLEY	
Direct Examination by Mr. Errebo	32
Cross Examination by Mr. Seth	48
Redirect Examination by Mr. Errebo	65
Re-Cross Examination by Mr. Grenier	66
Statement by Mr. Verity	85
C. D. GAINES	
Direct Examination by Mr. McGowan	86
Cross Examination by Mr. Seth	100
Redirect Examination by Mr. McGowan	116
Recross Examination by Mr. Seth	119
Redirect Examination by Mr. McGowan	121
Recross Examination by Mr. Cooley	121
Redirect Examination by Mr. McGowan	123
Recross Examination by Mr. Cooley	123
JOHN STEIN	
Direct Examination by Mr. Sullivan	127
Cross Examination by Mr. Cooley	133
E. F. LEWIS	
Direct Examination by Mr. Kellahin	137
Cross Examination by Mr. Seth	153
Redirect Examination by Mr. Kellahin	163
Recross Examination by Mr. Cooley	164
R. S. CHRISTIE	
Direct Examination by Mr. Bushnell	166
DONALD R. LINDSAY	
Direct Examination by Mr. Seth	174
Cross Examination by Mr. Campbell	202
Statement by Mr. Grenier	243
Redirect Examination by Mr. Seth	245

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ALBUQUERQUE, NEW MEXICO
3-6691 5-9546

I N D E X

	PAGE
NORBERT METHVEN	
Direct Examination by Mr. Seth	245
Cross Examination by Mr. Campbell	261
Redirect Examination by Mr. Seth	284
Recross Examination by Mr. Utz	286
STATEMENTS	290

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

December 19, 1957

IN THE MATTER OF:	
(Rehearing) In the matter of the rehearing requested by Sunray Mid-Continent Oil Company, et al, for reconsideration by the Commission of certain portions of the application in Case 1308 for the temporary establishment of uniform 80-acre well spacing and promulgating Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.	Case 1308

BEFORE:

Mr. Murray Morgan
Mr. A. L. Porter

TRANSCRIPT OF HEARING

MR. PORTER: The meeting will come to order, please. The Commission will consider this morning Case 1308.

MR. COOLEY: Case 1308. (Rehearing.) In the matter of the rehearing requested by Sunray Mid-Continent Oil Company, et al, for reconsideration by the Commission of certain portions of the application in Case 1308 for the temporary establishment of uniform 80-acre well spacing and promulgating Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.

With your permission, Mr. Commissioner, I would like to outline the conditions under which this hearing will be heard.

MR. PORTER: You may proceed.

MR. COOLEY: In Order 1069-A wherein this rehearing was granted, it was ordered, one, that the above-styled cause be reopened and a rehearing be held at nine o'clock A.M. on December 18, 1957, Mabry Hall, Santa Fe, New Mexico, at which time and place all interested parties may appear. That order goes on to say, "It is further ordered that testimony on rehearing shall be limited to, one, new evidence on the issues raised in the petition for rehearing." It is the intention of the Commission to strictly enforce the provisions of this order in this hearing today. With that understanding, you may proceed unless there is some misunderstanding.

MR. PORTER: Any questions of Mr. Cooley's statement? Mr. Errebo.

MR. ERREBO: If it please the Commission, Burns Errebo from Tulsa appearing for Sunray Mid-Continent Oil Company, in addition L. C. White for Sunray Mid-Continent from Santa Fe, and Mr. Jack Campbell, Campbell and Russell of Roswell. We will have two witnesses.

(Witnesses sworn.)

MR. ERREBO: The first witness I would like to call, Mr. L. J. Finfrock.

L. J. FINFROCK

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

DIRECT EXAMINATION

By MR. ERREBO:

Q You are Mr. L. J. Finfrock?

A That is correct.

Q And you are located in Tulsa, Oklahoma as a staff geologist for the Sunray Mid-Continent Oil Company?

A I am.

Q You testified as a geologist in the previous hearing in this matter, is that correct? A That is correct.

Q Mr. Frinfrock, since the original hearing in this matter in September, have you made or caused to be made additional studies of this area, and as a result do you know of additional information concerning this reservoir and its adaptability to the spacing which Sunray has requested? A Yes, I have.

Q Will you please refer to an aerial map which has been placed on the board and marked Sunray Exhibit 1-R and identify and explain it?

MR. ERREBO: Incidently, at this point I would like to explain that our exhibits have been identified by the letter R after the number to indicate rehearing exhibits.

(Marked Sunray's Exhibit 1-R, for identification.)

A Exhibit 1-R is an aerial map of the Bisti-Lower Gallup Oil Pool situated in portions of Township 25, 24, 25 and 26 North,

Ranges 10, 11, 12 and 13 West, in the San Juan County, New Mexico. As can be seen from this exhibit, we have brought it up-to-date as near as possible at the time we left for this hearing. There have been several wells drilled within the area of the Bisti-Lower Gallup Pool since the last hearing. These wells have been posted and added to this field.

You can also see that the boundary indicated in red which we outline as our proposed area for 80 acre spacing has been reduced in area, and this boundary reflects the orders of this Commission outlining the Bisti-Lower Gallup Oil Pool.

We have shown here that the green line, the traces of the micro-log cross sections which will follow as additional exhibits in this rehearing, and these are as follows, A A_1, from the Britis American No. 1 Marye in Section 1 of 25 North, 13 West, to the Shell 3220 in Section 20, 25 North, 11 West. Section B B_1 starts with the Shell 3220, continues in a southeasterly direction to the Monsanto No. 1 Blanch located in Section 34 of 25 North, Range 10 West.

Microlog section C C_1 through the pilot area extends from the BA No. 5 Marye in Section 1 of 25 North, 13 West in a north-easterly direction, terminating with the Sunray C-7 Federal in Section 31, 26 North, 12 West.

The fourth and final microlog, D D_1 starts, a north-south section, starts with the Shell No. 5 Carson in Section 27, 25 North,

11 West, terminates with the Sunray Mid-Continent No. 1 Platero in Section 15 of 25 North, 11 West.

Q Then as I understand your answer, Mr. Finfrock, the area which Sunray now proposes to space in this application has been reduced since the original hearing in this matter and is now confined to that area which has been heretofore recognized by this Commission as being a part of the Bisti-Lower Gallup Oil Pool, and certain one other 160 acre tracts upon which there have been drilled and completed certain oil wells, is that correct?

A That is correct.

Q Now, Mr. Finfrock, since the original hearing have you obtained micrologs of wells in this field which were not available to you at the time of the original hearing?

A I have.

Q And have those micrologs been used in constructing certain cross sections and have they formed the basis for a new study which you have made in this field? A Yes.

Q Mr. Finfrock, will you please refer to Exhibit 2-R which is a cross section and identify and explain it?

(Marked Sunray's Exhibit 2-R, for identification.)

A Exhibit 2-R is a northwest-southeast microlog cross section along the central part of the section. It is a microlog cross section of the main pay sections in the Bisti-Lower Gallup

Oil Pool. Starting with the British American No. 1 Marye in Section 1 of 25 North, 13 West, and terminating with the Shell 3220, this section is composed of portions of the micrologs of the wells that compose this cross section. On these micrologs we have defined the positive microlog separation by the dark red shading, which you will see in each of these logs. We have connected this positive separation by the solid lines and have connected between these wells with a lighter shading to indicate the continuity of this porous and permeable sand body. As you will note in the northwestern portion of this cross section, we have only the positive separation on the upper of these two main sand bodies. Whereas in the last four wells of this cross section, namely the Shell 34-13 Carson in Section 13, 25, 12 South, the Shell 34-18 in Section 18, 25, 11, The Shell No. 4 Carson in 20, 25, 11, and the Shell No. 32-20 in Section 20, Township 25, Range 11, both evidenced by positive microlog separation in the two main pay sands.

Q In the original hearing, Mr. Finfrock reference was made to microlog separation and there were certain exhibits offered showing microlog separation. This Exhibit and some of your subsequent exhibits are exhibits showing microlog separation. Will you please explain what you mean by microlog separation and to what extent it is significant in determining sand continuity and permeability?

A In referring to microlog separation, we are here referring

to positive microlog separation as shown by these electrical characteristics which I have just described.

In a bore hole the fluid will leave a thin veil of filtrate on the bore of the hole, and this is common throughout the hole except at those positions in the hole where a porous and permeable body is encountered and at these positions in the bore hole a filter cake will be built up as we have lost fluid into this porous media.

The micrologging tool, the pad that is pressed against the wall of this bore hole, when it is reading the filter cake, it will read a positive separation at that point where the filter cake is built up opposite a porous and permeability formation, and thereby resulting in the positive separation that is shown on micrologs.

Q Mr. Finfrock, how many wells are there in this field, to the best of your knowledge?

A To the best of my knowledge at the time we prepared these exhibits, there were 187 wells.

Q And you have studied micrologs on how many of these wells?

A I have obtained and studied micrologs on a total of 164 of these wells.

Q You have studied micrologs on 164 of 187 wells in this field, is that correct?

A That is correct.

Q Now, Mr. Finfrock, will you please refer to Exhibit 3-R and identify and explain it?

(Marked Sunray's Exhibit No. 3-R, for identification.)

A Microlog cross section 3-R is a continuation of 2-R from the 3220 Carson down to the Monsanto No. 1 Blanch in Section 34, 25 North, 10 West. This microlog section as the previous, has been built from portions of the micrologs of the individual wells that have been drilled in the field, and we have shown here by the same symbols that we had on the previous section, the positive microlog separation by the solid red color.

In these sections you can see both the main producing sand bodies have been found in each of these wells, though in varying degrees of thickness. We have found that in this study we have the opportunity to use wells that were not available at the previous hearing, which have given us closer spacing in order to get a better correlation between wells than we had before, and we feel as a result of these studies that our opinion about the continuity of these pay zones in the Bisti-Lower Gallup Oil Pool has not been changed as evidenced by these exhibits.

Q In fact, would you say that your opinion has been strengthened as a result of these new studies?

A Yes, I would.

Q Will you please refer now to Exhibits 4-R and 5-R and identify and explain them?

(Marked Sunray's Exhibits No. 4-R and 5-R, for identification.)

A Exhibit No. 4-R, microlog section C C_1, which is essentially a north-south, I mean a north-south cross section through the microlog section through the Bisti gas injection area. This cross section, as previous, has been built in the same manner as before and we have shown here the positive separation and the continuity of the permeability between these wells.

As can be seen from this exhibit, which is a transverse exhibit to the lengthwise of the field, that we do have a definite thinning of the porous and permeable zones on the flank with a definite thickening in the central well, indicating that these sands do thin as they approach the flanks of the field, and do lose some of their porosity and permeability.

Section D D_1 is a north-south section in the gas cap area from the Carson No. 5 to the Sunray No. 1 Platero.

Q That is actually down toward the southeast part of the field, is it not?

A Yes, it is. We have shown here by the same symbols we had in the other exhibits, this exhibit shows one thing, two things that we didn't have in the other. It shows the absence of the upper sand in the No. 1 Platero and the absence of the second sand in the Shell No. 5 Carson.

I would also like to point out to you the difference in the stratographic position of these two sands in the wells in which they are present. The upper sand, you'll see the belt of porosity

and permeability assumes an arc which I feel represents more or less the relief of the sand bar, while the second sand stratographically climbs the section as we move northward, becoming a little higher in the section as we move northward. Although the dip is to the northeast, the lower sand does not drop in the same relation that the upper sand, because it is structurally higher sand as we move north.

Q Of the 164 micrologs which you studied, how many had microlog separation in the upper sand?

A Of the 164 wells that I studied, I found a total of 138 which showed microlog separation in the upper sand.

Q Then microlog section indicates a continuity of porous and permeable sand, is that correct?

A That is correct.

Q How many, if any, showed no microlog separation?

A I found a total of 26 wells which did not show positive microlog separation.

Q Were the micrologs which you studied well distributed throughout the field, or were they bunched up, leaving large areas or substantial areas which had no micrologs available?

A No, the 164 wells were very well distributed throughout the length and breadth of the field.

Q Did you find any micrologs in the better portion of the field which has been referred to as the fairway, which showed no

separation? A No, I did not.

Q In other words then, is it true that the micrologs which showed no separation were taken from wells located on the flanks of the field where the Lower Gallup thins out, is that correct?

A Yes, that is correct.

Q Now, does your testimony and your exhibits which you have presented down to this point, do they further confirm the continuity which was shown by the electric log cross sections offered by Sunray at the first hearing?

A Yes, I feel that they do.

Q One more question with regard to these wells on the flanks which have no microlog separation, are all or a part of those wells producing even though they have no microlog separation?

A To my knowledge the wells that are on the flanks of the field, they are productive of oil and have been perforated.

Q To be productive of oil, they have to have some permeability in them, don't they?

A They would have to evidence some.

Q Throughout the main portion or the fairway of this field, have you found the main body of the Lower Gallup to be continuous and permeable and porous without interruption?

A Yes, I have.

Q Then is it therefore your conclusion that the main body of the Lower Gallup formation is a sand body of continuous porosity

and permeability which may thicken and thin throughout some parts of the fairway, is that correct?

A Yes, I think that is evidenced by our cross section, that it isn't continually the same thickness throughout, it does vary.

Q Is it also your conclusion that the lateral edges of the other subsidiary reservoir do not always line up vertically with each other so that wells drilled on the edge of the sand bar can be expected to find erratic sands of fairly low permeability?

A That is correct.

Q Mr. Finfrock, has Sunray Mid-Continent Oil Company recently drilled and tested a well known as the No. 1 Platero, located in the southwest quarter of Section 15, 25 North, 11 West?

A Yes, it has.

Q Did that well produce gas on its initial test?

A Yes, that well produced dry gas at the rate of 566 MCF per day on an 1864 inch choke with a tubing pressure of 840 pounds.

Q On the first test was that a dry gas?

A Yes, it was.

Q Is there anything unusual which might be considered unusual at first blush in this situation?

A Yes, it was at first appearance.

Q Have you prepared a structural map which explains this situation?

A Yes, I have.

Q That map has been identified as Sunray Exhibit 6-R. Will you please proceed to explain it?

(Marked Sunray's Exhibit 6-R, for identification.)

A Sunray Mid-Continent Exhibit 6-R is a structural map on the top of the second sand member in the Lower Gallup formation of the Bisti-Lower Gallup Oil Pool. This map is contoured on an interval of ten feet. We have shown hereon the various wells in the area, near the Platero well, so that we could reconstruct geologically the reason to explain the dry gas test that we had in our Platero well.

As can be seen from these contours, this structure dips into the north and northeast and across the central portion of this map, we find a very definite nosing, on this nosing in a downdip position we find a structural closure within which structure closure we find two wells, the Sunray Mid-Continent No. 1 Platero in the southwest quarter of Section 15 and the Shell 2122 A in the northwest quarter of Section 22.

As can be seen from this interpretation, it is my opinion that when the hydrocarbons were moving into the Lower Gallup sand in this Bisti Field, that this anomaly, this closed anomaly was filled with gas and oil, but there were more hydrocarbons present than could be accounted for by this small structure and it spilled over from this small structure and moved on updip to the updip limit or

shaleout of the sands which afforded the updip trap of this stratographic type field.

We find updip from this Platero area the gas cap area, and we also find updip from the Platero area that there have been completions in these same Lower Gallup sands for oil.

It is our conclusion that with this structural picture that we have here, we can explain the position that although it appears that the Platero well was downdip structurally, that actually it is on a closed high which is higher than many of the producing oil wells in that area.

Q Have you prepared a schematic cross sectional diagram which further explains this situation? A I have.

(Marked Sunray's Exhibit No. 7-R, for identification.)

Q Will you please refer to that schematic diagram which has been marked Sunray Exhibit 7-R, and explain it?

A Sunray Exhibit 7-R is a schematic diagram in the gas cap area of the Bisti-Lower Gallup Oil Pool. Shown hereon in a schematic fashion is an interpretation of the structural map which we have just looked at.

On this diagram we have spotted the Sunray Mid-Continent No. 1 Platero in the small anomaly which is downdip from the major portion of the Bisti Field. In an updip position we have spotted the Sunray Mid-Continent No. 1 Es-Ka-Nel-E-Wood well which was completed as an oil well, which is actually fifteen feet higher

structurally than the No. 1 Platero well, but we feel that this interpretation shows why we would find some gas accumulated though in small volumes below updip oil.

Q Then is it your opinion that the gas which is being produced lower on the structure than oil is being produced from a local pimple or bump on this structure as it dips to the northeast?

A Yes, it is my opinion that this gas was trapped in a local anomaly on this large stratographic feature.

Q Is it further your opinion that this gas that has beer so entrapped can not move on upstructure to the main gas body?

A Yes, there's a certain amount of gas that was trapped in this structure that was not able to move on updip, although the major portion did.

Q Then, based upon your studies of this area, Mr. Finfrock, is it your opinion that a gas cap exists, a major gas cap, which is in communication with the oil which is found in the other portions of the reservoir? A That is correct.

Q Now, Mr. Finfrock, have you changed your opinion from the previous hearing, or has it been further confirmed by the additional studies based on this new information, the drilling of new wells and the passage of three months' time?

A Well, my original position has not been changed.

MR. ERREBO: I believe that's all we have from this witness.

MR. PORTER: Anyone have a question of Mr. Finfrock?

Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q Mr. Finfrock, I would just like to ask you a couple of questions about your exhibits. On your cross sections there you apparently have no horizontal scale, is that correct? They're just arbitrarily placed?

A No, they are placed at the same intervals throughout the length of the field. The scale is shown, well, here is the scale shown here in these sections, and then up here we have shown where the wells are located across the sections of the field. They vary from quarter of a mile up to about a three-quarters of a mile.

Q But you have not represented on the cross section other than the diagram, is that right?

A Well, we show the scales as such here with a vertical scale of fifty feet to the inch and there's no scale on the horizontal, they are equally spaced.

Q Likewise you have no vertical control of down either, do you?

A Yes, we have hung these from a correlation point at the top for the Lower Gallup Formation here. They are all hung from the same correlation point electrically. It is an electrical location point.

Q The diagrams don't indicate that, do they?

A Well, we have this same characteristic across here, and we

come to the same position above it to the tie.

Q You have done that regardless of the depth below --

A (Interrupting) These aren't hung from a subsea datum. They are hung from the Upper Gallup here. These are not subsea.

Q Then you have not attempted to show the relative positions --

A (Interrupting) Structurally.

Q (Continuing) -- structurally at all?

A No.

Q It's more or less an arbitrary arrangement then of these various long pictures both vertically and horizontally?

A We have picked a correlation point to hang each log from regardless of its structural position.

Q Well, your C C_1 would show quite a dip, would it not?

A Yes, it would show a dip in this direction from south to north if we had hung it from a subsea datum, we would take these lines here and they would assume an angle like that.

Q Then your points of microlog separation would not be opposite each other necessarily, would they?

A Opposite each other?

Q From one well to the next they would not be on the same horizontal line?

A No, because we would be connecting the same porous sand in here. If we hung them from a subsea datum the line would be tilted in this manner with the updip sand in a higher position than the

downdip sand, and these correlations would drop as we move northward. It would be the same correlation though.

Q You have arranged them so the lines appear --

A (Interrupting) They are not straight, no, but we have just correlated between the sands as has been shown.

Q Have you shown all the microlog separations in each well? Take for example, on B B_1, Skelly No. 2 Longhart, is there some separation that you haven't shown there, for example?

A Yes, there is. There is separation right at this position here that we have not shown.

Q And the Monsanto No. 1 Frank, is that likewise true?

A I don't believe that I can read from this print whether that is microlog separation or not, but there are, I would say out of the 43 wells that are on these cross sections, I think I counted 6 wells of which we had a position like this in the Skelly Longhart, of which there was a small amount of microlog separation, and we did not attempt to show those microlog separations in these inferior sands.

We are attempting to show that in the main pay sands of the Bisti-Lower Gallup Oil Pool we had this continuity of porosity and permeability.

Q Then there are other productive sands, or at least sands showing microlog separation that you have not attempted to show? You haven't shown them all?

A That is the inferior sands. That is correct.

Q You have testified, I believe, that there was continuous porosity and permeability throughout, but you do not testify on any variations in either one of those factors, do you?

A I believe I stated that we had variable thicknesses of the porous zones within the sands, as can be seen from these sections, that they do vary.

Q You certainly recognize that there is varying porosity and permeability throughout the general sands that you speak of?

A It does vary, yes.

Q The information with reference to the existence of the gas wells, I believe you mentioned that the sands shale out?

A Yes, we have an updip shaleout of the lower sand, I mean of the sands of the Lower Gallup Formation, which afford the updip trap for the sole stratographic feature known in the Lower Gallup Pool.

Q Would you expect to encounter similar shaleout in other portions of the pool?

A It is continuous from one end of the pool to the other. The sands do shale out.

Q Why did you, on 6-R, Mr. Finfrock, why did you prepare that on the top of the second sand member?

A Because that was the sand that was encountered in our No. 1 Platero well, and was the sand that came in for a dry gas test to begin with, and I wanted to find an explanation for it, and I had to

map on the productive horizon to do so.

MR. PORTER: Anyone else have a question of Mr. Finfrock? Mr. Malone.

MR. MALONE: Ross Malone, Atwood and Malone of Roswell, New Mexico for Gulf Oil Corporation. I would like to enter the appearance of Booth Kellough of Denver, Colorado for Gulf Oil Corporation.

By MR. MALONE:

Q At the time that you testified in the case previously, Mr. Finfrock, was there any doubt in your mind as to the conclusions to be drawn from the evidence which you presented?

A No, I thought from the evidence, you mean presented geological testimony?

Q Yes, geological evidence.

A As far as I could see from the geologic standpoint, and not taking in the other aspects of the case, I thought that we had shown the continuity of the Lower Gallup Formation through the field.

Q The further study which you have made since that hearing has merely further strengthened your conclusion in that regard?

A It has my personal conclusion, yes.

Q Your conclusions now are actually identical with those to which you testified here on the original hearing, are they not?

A I would say not exactly identical, no.

Q Would you say substantially the same?

A Substantially the same, yes.

Q You have limited your study of the microlog separation shown by these logs to the two principal members as you define them in this Bisti-Lower Gallup Pool, have you not?

A I studied the entire area of the Lower Gallup Formation. We have limited our exhibits to the main productive zones of the Bisti-Lower Gallup.

Q So that for instance on a number of those logs where perforations are shown opposite which you have not indicated microlog separation, there are other areas of permeability and porosity?

A As I mentioned, I think there were six wells out of the forty-three on these sections that we were able to see a positive microlog separation, and in those same zones in the other wells there was no evidence of microlog separation.

Q Your exhibits do not indicate any continuity or communication as between those zones and the members which you have portrayed?

A No, as can be seen from these exhibits, you are not able to show from the positive microlog separation a vertical connection, is that your question?

Q Yes. Are there other areas in the pool in which this condition exists in which oil wells were found apparently upstructure from gas wells in addition to the area to which you testified?

A To my knowledge this area in 25 North, 11 West is the only area that has come to my attention that this does exist.

Q If there are other areas, would you account for them in the same way you have accounted for this one?

A If there are such areas I would want to make a geologic study of them before I would attempt an answer. I had to do that in this case.

Q You wouldn't account for them necessarily in the same way?

A No, but I would say this, that where it exists in one place it's possible that the same situation could exist again.

Q If I may invite your attention for just a minute to Exhibit 5-R and to the Shell No. 21-22 Government A shown on there.

A Yes. That is this well here.

Q In the upper member that is shown there I notice that you show what appears to be a separation of that member into an upper and lower segment by a loss of permeability, I assume?

A That is correct.

Q Now, as you proceed toward D, you show that loss of porosity or permeability? A To the right?

Q No, that is D_1.

A Towards D, I see.

Q As you proceed towards D you show that loss of permeability to terminate and the two segments to again become one, so that the lower segment would have complete communication with the upper members shown in the Magnolia well? A That's right.

Q How do you reach the conclusion that there is a continuous

area of porosity and permeability there rather than that there is a pinchout of it between the Shell and Magnolia well?

A I find that in the Shell well, as we have shown, there is about a one and a half feet, it looks like, of known positive microlog separation, and we find in the Magnolia well, we have no such separation, and this point is an arbitrary point, I have picked it halfway between, it could be here, it could be there, we don't know where the point, the juncture is. It is a common geologic practice when you are dealing with an unknown, to put it at a point halfway between the two knowns.

Q Would it be an equally acceptable conclusion, in your opinion, that the lower segment pinched out between those two wells so that there would be no communication between it and the separation in the Magnolia well?

A I would have no information to state what actually did happen to that lower portion of that sand.

Q So that it is --

A (Interrupting) This is my interpretation, my geologic interpretation of the facts as we have them.

Q But you don't have information by which you can actually substantiate the way that is portrayed on your exhibit, do you?

A Well, looking at it in its plain diagram, we do not. Possibly taking other wells in the vicinity and studying the whole picture, it might be able to prove another thing, I don't know.

Q It would also be possible though, would it not, that that, if there is a pinchout in that lower segment, that that would be one of the erratic sands that would not have communication with the rest of the member?

A The sand itself is present electrically all the way through there. We're dealing here with measured positive microlog separation, but the sand itself I have no doubt that it is not present between the well.

Q And you would not be able to say with certainty that communication would exist through that, would you?

A Well, the microlog tool I would say is one of the more accurate electrical tools in the industry, but it does not measure down to zero permeability, and it's possible that though we do show here a zero permeability from reading, not zero permeability, but non permeable streak there, that if we had core analysis through the section we would possibly show low order permeability.

Q So that the conclusion which you have portrayed with reference to the continuous nature of that lower segment, is the conclusion that you draw from it, but one which there would be a difference of opinion on?

A Yes, that is geology.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question of the witness?

MR. BUSHNELL: H. D. Bushnell, attorney with Amerada.

By MR. BUSHNELL:

Q Mr. Finfrock, I believe you stated this morning that the hydrocarbons in the Lower Gallup sand migrated into the sand, is that correct?

A Yes. There will be some migration and some inside too, hydrocarbons.

Q If that's true, would it not necessarily follow that this reservoir would be one common source in your opinion?

A I think it is.

MR. BUSHNELL: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Finfrock, I'm not sure that I understood for sure whether or not you interpreted the gas wells in the upstructure from your Platero No. 1 to be a gas cap.

A Yes, it is our opinion it is a gas cap.

Q Then, referring to your Exhibit D D_1 --

A Which exhibit?

Q D D_1. A D D_1, yes.

Q Between the Magnolia No. 1 Ah-Nus-Bah and the Shell No. 21-22 Government A, would you say that there was a low trough in there which separated the Platero and your Shell 21-22 from the Magnolia Ah-Nus-Bah?

A Yes, that is my interpretation.

Q Is it your opinion that some volumetric limitations should be put on those gas wells in the gas cap?

A I'm not sure I understand your question.

Q Well, something --

A (Interrupting) You mean volumetric is --

MR. ERREBO: (Interrupting) If the Commission please, this gentleman is a geologist. We will have an engineer on the stand who will discuss the gas cap and make the recommendation, I believe, you are seeking.

MR. PORTER: Would you refer your question to that witness?

MR. UTZ: Yes, sir, I will. That's all I have.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Finfrock, was the Sunray No. 1 Platero well originally a gas well and is now an oil well?

A Yes. I will be glad to read here a short dissertation on that well. This well was perforated December 5, 1957, in the Lower Gallup sand from 4852 to 4903, on the twenty-four hour test with a 1864 inch choke the well flowed at a rate of 566 MCF gas per day, with a tubing pressure of 840 pounds.

After that test the well was shut in for a period of nine days. On a test of the same perforation on December 14, 1957, the No. 1 Platero flowed oil at a rate of 73.24 barrels in twenty-four hours

on a three-quarters inch choke. Tubing pressure had dropped to 280 pounds, casing pressure was 500 pounds, and the gas-oil ratio 34,000 to 1.

Q What has happened there, has the gas in that nose or that little pimple been depleted and the oil is moved upstructure?

A I think that that would answer a major portion of the question, that we have a small gas cap in this area and when we initially tested it we tested the dry gas and when it was, the well was perforated through the entire sand and which was through the gas in the oil column, when the well was opened back up again we got our liquid hydrocarbons.

Q Which had moved up the structure while the well was shut in?

A No, I believe they had been there to begin with, and we had as I might say it, I might be getting into reservoir engineering over my head, as I see it we had a little gas cap above this oil and in our initial test we got the dry gas.

Q You don't think that the perforations penetrated oil that was in place originally?

MR. ERREBO: If I might interrupt you, Mr. Nutter. We will have an engineering witness later on that I think can give you quicker answers.

MR. NUTTER: That is fine. We will defer that line of questioning. No further questions.

MR. PORTER: Anyone else have a question.

MR. McGOWAN: I have one question. James McGowan, Sinclair Oil and Gas Company.

By MR. McGOWAN:

Q Mr. Finfrock, the Definition 46 of the Commission Rules and Regulations read in part as follows: I quote: "Pool means any underground reservoir containing a common accumulation of crude petroleum oil or natural gas or both". Is it your opinion that the Bisti-Lower Gallup Pool constitutes such a common accumulation as is referred to here in this definition?

A Yes, I do.

MR. McGOWAN: Thank you.

MR. GRENIER: A. S. Grenier, representing Southern Union Gas Company.

By MR. GRENIER:

Q Mr. Frinfrock, in response to a question by Mr. Seth, I believe you stated that although this was in your opinion a continuous reservoir, at least as to these two main members there, there were some variations as to porosity and permeability within the pool area? A Yes.

Q Are you familiar with any producing pool or field which does have completely homogenous porosity and permeability?

A No, I am not.

Q In other words, this variant characteristic of porosity and permeability is typical of any continuous formation, and they're

never exactly the same all the way through?

A I would say that would be the natural result, yes.

MR. GRENIER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. ERREBO: I have several questions on redirect examination.

MR. PORTER: Go ahead.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q With regard to the lower zones which you did not show, Mr. Finfrock, on your cross sectional exhibits, those actually from your study, are those not rather negligible insofar as the major part of the oil accumulation in this reservoir is concerned?

A Yes, I think they are.

Q That is the reason you did not show them?

A Yes.

Q With regard to the way in which you ranged the logs for correlation and interpretation, is that not the generally accepted way among geologists of ranging logs on cross sections for interpretation?

A There are two ways, you can range them this way and hanging from subsurface to get a structural picture. I am not trying to define structure here. It is an accepted way of making cross

sections.

Q I believe you previously testified, have you not, that the porosity and permeability varies from the center to the edge of the field? A Yes.

Q So that therefore our cross section D to D_1 in going from the Shell No. 21-22 Government A to the Magnolia No. 1 Ah-Nus-Bah, you would not expect the formation to thin or to pinch out, would you?

A I wouldn't normally.

Q That would be contrary to the trend which has been observed throughout the entire field? A That is true.

Q In further regard to that point, have you found any well in the main portion of this field that has not had either, have you found any well in which either the upper or the lower sand pinched out once that sands continuity has been established?

A Would you repeat the question, please?

Q In the northwest portion of the field, the upper sand is shown to be continuous throughout? A That is correct.

Q In that portion of the field have you found any well in which the upper sands pinched out?

A Not except on the flanks.

Q Except on the flanks? A That is correct.

Q And in the southeast part of the field have you found any well in which either the first or the second sand is pinched out?

A I think the situation is the same.

MR. ERREBO: I believe that's all.

MR. PORTER: Anyone else have a question?

MR. ERREBO: If it please the Commission, at this time --

Q Mr. Finfrock, the exhibits were prepared by you, were they not?

A Yes, sir, they were.

Q Or under your supervision.

MR. ERREBO: If it please the Commission, we would like to offer in evidence Exhibits 1-R through 7-R.

MR. PORTER: Without objection these exhibits will be admitted to the record. The witness may be excused.

(Witness excused.)

We will take a short recess.

(Recess.)

MR. PORTER: The hearing will come to order, please. Mr. Errebo, will you proceed with your next witness?

MR. ERREBO: If the Commission please, we would like at this time to call Mr. Brinkley as our next witness.

(Witness sworn.)

T. W. BRINKLEY

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

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, please?

A My name is T. W. Brinkley.

Q By whom are you employed and where, Mr. Brinkley?

A I'm employed by Sunray Mid-Continent Oil Company in Tulsa.

Q And you are Chief Reservoir Engineer for Sunray?

A That is correct.

Q And you testified as a Reservoir Engineer at the original hearing in this matter, did you not? A That is correct.

Q Since this original hearing have you made additional studies of this pool, taking into consideration new information which you obtained? A Yes, I have.

Q Does this new information that you have obtained consist primarily of bottomhole pressure data in the area surrounding the pilot area of the experimental LPG project in this field?

A Yes. Considerable additional information is now available in the pilot area that was not available at the last hearing.

Q Have you prepared a plat showing this data which has been accumulated since the last hearing? A Yes, I have.

(Marked Sunray's Exhibit 8-R, for identification.)

Q That plat has been identified as Exhibit 8-R. Will you please go to that plat on the wall and explain what is shown on it?

A Exhibit 8-R, which we have a large copy of, I believe you will want to mark your exhibit. Exhibit 8-R is a pilot area map,

the pilot area is shown with heavy dashed lines at the intersection of Township 25, 26 North and Range 12 and 13 West. This pilot area, for your convenience, is located in a previous exhibit in the northwest portion of the field where I am pointing. The pilot area consists of four oil wells, Sunray Federal 2-C located in the southwest of Section 31, Phillips Hospah No. 1-A located in the southeast portion of Section 36, British American Marye No. 1 located in the northeast portion of Section 1 and Sunray Federal No. 1 located in the northwest portion of Section 6.

In the center of these four oil wells we have an injection well. We have shown in the four sections, Section 31, 36, 1 and 6, all of the wells that have been drilled in those sections. In addition to showing the wells we have listed measured bottom hole pressures, also the date when the pressures were run and the type of instrument we used to measure the pressure.

As an example, British American Marye No. 1, located in the northeast portion of Section 1, we showed five pressure measurements. The first pressure measurement was taken in October 23, 1956. The B indicates a bomb measurement, the 1252 represents the reservoir pressure at an elevation of plus 1300 feet.

The next pressure was August 15, 1957, S standing for sonolog. That is an echo device which we used to estimate the reservoir pressure and the pressure on that date was 1203 pounds. The next pressure was in September, the 4th, 1957. Again a sonolog pressure

and the value at plus 1300 feet was 1298 pounds.

October 1, 1957 is the next pressure, again with a sonolog, and the measured bottom hole pressure was 1292 pounds. On November the 6th, 1957, sonolog method indicated a pressure of 1386 pounds. It is quite significant with this information that all notice between the first and second pressures that there is a decrease in reservoir pressure over the period of roughly ten months. The drease in pressure is 49 pounds. That means that the natural decline in reservoir pressure for the ten-month period prior to the injection of LPG and gas amounted to 49 pounds.

It is significant too that the third pressure on September 4, 1957 had shown an increase of 95 pounds over the preceding pressure. Further, the October 1, 1957 pressure further substantiates the higher pressure than the reservoir pressure immediately prior to the injection of LPG. Also, the last pressure, November 6, 1957, shows the pressure to be 1386, still greater than the pressure immediately prior to injection of LPG.

This is a pressure reversal from the normal decline experienced by this well as a result of injecting LPG and gas.

Q Mr. Brinkley, could I ask you one question at that point? How long was it between the second and third pressure maintenance, that was roughly three weeks there, was it not?

A Slightly less than three weeks.

Q Was that not a significant increase in such a short period

of time? A That is correct.

Q And you also have quite a large increase between the first of October and the sixth of November, do you not?

A That is correct.

Q And was the decrease in pressure that occurred from October the 23rd of 1956 to August the 15th, 1957, a significantly large decrease considering the amount of oil which had been withdrawn from that reservoir and from that well over that period of time?

A That is correct.

Q Thank you.

A Let's consider another well. Sunray Mid-Continent No. 5 Federal which is almost a mile south of the gas injection well. Again we find the same characteristics on October 22, 1957, as you were, 1956 with a bomb measurement, we measured the reservoir pressure of 1446 pounds. On April the 5th, 1957 again with a bomb we measured the reservoir pressure to be 1343. The third pressure taken in October 7, 1957, again with a bomb, we found the pressure to be 1412 pounds.

Again we find the normal decline in pressure during the period prior to LPG and gas injection and the characteristic pressure reversal, after the injection of fluids, that same characteristic is observed in other wells in this area.

Generally we expect a higher pressure reversal or pressure benefit in the wells nearer the injection well, and they occur

earlier than outlying wells. In any event, we can construct possibly a line around the injection well in a radial fashion, indicating that fluids have moved away from the injecting well, and the reason we know the fluids have moved is because of this pressure reversal effect that we have noted.

Now, this fluid movement confirms sand continuity in this immediate area consistent with the previous exhibit presented by Mr. Finfrock. I believe that's all.

Q Will you please refer to your Exhibit No. 9-R, Mr. Brinkley, and identify and explain what it shows?

(Marked Sunray's Exhibit 9-R, for identification.)

A Again I would suggest that you number your exhibit; Exhibit 9-R illustrates the basic information that was presented on Exhibit 8-R, only we show it in a chronological fashion. As an example, the red line as shown on our exhibit according to the date of August 21, 1957 which corresponds to the scale at the bottom, represents the date at which we started the injection of LPG. At that time you will notice that the reservoir pressure in the pilot area based on the factual data presented on Exhibit 8-R was in the range of 1100 pounds to roughly 1350 pounds.

I invite your attention also to the date of October, 1956, when the reservoir pressure was the range of 1200 pounds to 1400 pounds. The trend shown by the data for those two periods indicates

the normal decline experienced in the pilot area prior to the injection of LPG. That decline averages approximately a hundred pounds per square inch for the ten-month period. This trend is defined or illustrated by two heavy lines, the extrapolation of that defined trend to periods past the injection of our LPG indicates that at the present time we would have suffered additional pressure decline as substantiated by later pressures in outlying wells.

The portion of the curve to the right of this red line and above the probable extension of the pressure decline indicates the pressure restoration or the pressure reversal that we have experienced in the pilot area by the injection of LPG and gas.

It is significant that the pressure has remained stable since the start of gas injection. Moreover, it has been restored to the value that we observed ten months before the pilot. In addition to that we have withdrawn high oil rates out of the four oil wells.

You will notice Phillips Hospah 1-B and 2-A, 1-B, 2-A on Exhibit 8-R have shown the pressure increase, but at a later date as we would expect.

Further, every well in this area with the exception of No. 9, an outlying well, has experienced a pressure reversal due to the movement of fluids through the sand, supporting continuity.

Finally, the benefit that we have gained in the pilot area by pressure buildup has amounted to approximately 200 pounds, had we not started the project, and that benefit will continue the longer

the pilot project is in operation. I believe that pretty well covers the significant items.

Q The results of these tests then show, do they not, that wells almost a mile away from injection well have already shown pressure increases as a result of the injection of LPG and gas into the injection well, is that not correct? A That is correct.

Q Mr. Brinkley, have you calculated the amount of acreage which has been affected by this injection well, and will you state how much it is?

A The circle that we have drawn or indicated in the pilot area as being affected by fluid movement through a continuous sand, taking that radius of 4500 feet, the distance from the injection well to the No. 5 would circumscribe an area approximating 1500 acres.

Q Then is it your opinion, based on this information, that one well will drain some 1500 acres in this field?

A The evidence that we have here indicates that it will drain an area approximating 1500 acres.

Q Your Exhibit 9-R then shows a decrease in pressure which you say is normal for this reservoir up to the point at which injection was commenced in the pilot well, is that right?

A That is correct.

Q You say this is normal. You mean it is normal for a reservoir of this low oil in place originally?

A The pressure decline on withdrawals is normal in a solution drive type mechanism. But the rate of pressure decline with the small volumes that have been removed here is abnormally high.

Q Then actually the second portion of your curve shows a rather sharp increase over a short period of time after the commencement of injection of LPG and gas into this well?

A This shows a rapid increase in pressure occurring shortly after the injection of our LPG, and that same characteristic is repeated and will repeat itself as we go further and further away from the injection well.

Q Would you then say that this LPG injection program would be just as effective on 80 acre spacing as on 40 acre spacing?

A Absolutely.

Q That being the case, are 40 acre wells needless wells insofar as secondary recovery by LPG injection and gas injection into this field are concerned?

A Forty acres are a waste. They are not needed in this process.

Q Now, Mr. Brinkley, in order that we may have a little closer look at this matter of efficient and economical drainage, will you please state what in your opinion is one of the prime requisites for such drainage?

A The first requisite for efficient and economical drainage is pressure interference.

Q What would you say would be a second requisite for an efficient and economical drainage?

A The second requisite would be proper permeability and viscosity of the oil.

Q And what would be another requisite for an efficient and economical drainage?

A Finally, sand continuity.

Q Pressure differentials which you have stated are the first requisite for drainage have been found to exist as far as one mile from the injection well, have they not?

A That is correct.

Q As to your next requisite for efficient and economical drainage, is the ability of fluids to flow, which requires fluids of proper viscosity and reservoir rocks of sufficient permeability to permit such flow important?

A I should like to invite your attention to the fact that Well 2-C is in a thin sand section, it is not shown here, but as previously testified to, also of inferior rock characteristics. The main body of the pool lies in here, and of course, this would represent one of the edge wells where you encounter thin sand and poor permeability, yet we detected pressure interference due to the fluid movement.

Moreover, Well No. 5, a mile away approximately, also represents a south flank well where the rock properties are inferior and thin.

Yet again we detect the pressure reversal due to fluid movement from the injection of our LPG and gas clear through this area and being felt down here.

Q Then, as for your third requisite of sand continuity, that has also been established then by the pressure tests, has it not?

A Obviously since we have detected pressure reversals it has been a result of fluid movement, and that movement has had to move from the injection well past these wells through the intervening space where we had no control or where it was questionable on our cross sections to get to these outlying wells. So we have to accept the fact that the fluid has moved through those areas in order to detect this pressure reversal.

Q Then I believe you state, Mr. Brinkley, that throughout the general pilot area that you have shown, there is some variation of permeability, but that variation of permeability then in your opinion will not prevent adequate drainage and proper and efficient drainage of this area because of the pressure differentials you observed?

A That is correct.

Q And the influence of the other requisites that you stated as being necessary for efficient and economical drainage?

A That is correct.

Q Does this further confirm the position which you took with regard to drainage in the original hearing?

A That is correct.

Q In your work as a reservoir engineer, Mr. Brinkley, do you have frequent occasion to make use of micrologs?

A That is correct.

Q Microlog separation indicates a permeability of rock formation which is capable of allowing the passage of fluids and transmitting pressures? A Yes.

Q You heard Mr. Finfrock testify, did you not, that microlog separation, indicating the presence of permeability, has been found in approximately 164 of 187 wells? A That is correct.

Q That have been drilled? A That is correct.

Q Are you in agreement with previous testimony in these two hearings that this reservoir is similar in its general characteristic throughout the area of this field?

A That is correct.

Q That being the case, is it your opinion that the results obtained in the pilot area could be obtained throughout the rest of this field? A That is correct.

Q Is it your opinion that one well located in any part of this field where sand is developed will drain it in excess of 80 acres efficiently and economically? A That is my opinion.

Q Are you in agreement with Mr. Finfrock's testimony that gas is found in this, found in structurally higher locations?

A That is correct.

Q Are you also in agreement with his explanation of the

occurrence of gas at a lower structural level than oil?

A Yes, I am. I might elaborate on that a little bit. I am satisfied that there is no question among we people that gas is found in structurally high positions. Furthermore, the structural configuration forming, if you will, an apex as you go down the flanks, you can encounter irregular highs, you might call secondary highs, which they themselves can trap gas in the high locations.

I have observed this thing in a number of stratographic traps, solution gas drive type reservoirs, and they are secondary gas accumulations along the flanks of a typical gas cap. It is not at all unusual as far as I am concerned.

Q Then is it your opinion that the gas cap in this reservoir is in communication with the down structure of oil?

A It is my opinion.

Q At the last hearing there was some question raised as to the status of the Shell Carson No. 5 located in Section 27 inasmuch as there was a report that this well had produced highly and it is the highest well structurally in the field at least at that time. Have you had opportunity to give some study to this matter and to obtain some additional information on this well which will enable you to explain this situation?

A Yes. The records will reflect that Shell Carson Unit No. 5, located in the southeast quarter of Section 27, 25 North, 11 West, and structurally in the gas cap, is a gas well. The records show

that the well was fractured with 80,430 gallons of oil, and the only oil produced has been a part of this fract oil.

Q In other words then, this well has produced no reservoir oil?

A That is correct.

Q Then would you say that any inferences previously drawn with regard to the apparent production of reservoir oil from this well are at this time not valid in view of this information?

A I believe they were presented by misinformation and are not valid.

Q Mr. Brinkley, have you made a study of the Pedigrew-Tocito Pool, located in the State of New Mexico?

A Yes, I have.

Q How do the reservoir conditions and the structure of this pool compare with those found in the Bisti Field?

A Both Bisti and the Pedigrew-Tocito Pool are quite similar. Both are stratographic traps. The core analyses are very similar, the electric logs when layed side by side are very similar, the reservoir fluids are similar with one exception, the Tocito Pool has a little better quality fluid characteristic.

The reservoir pressures at Tocito are only approximately 600 pounds greater than at Bisti, and that is due to an additional 1600 feet of depth. Both reservoirs are solution gas drive type mechanisms, both reservoirs have identified a gas cap. I believe those are the significant points, high lights at this time.

Q Do you know what spacing the Commission has adopted for that field?

A The order as issued, approved 80 acre spacing. However, out of the 18 wells drilled, 16 of them are on 160 acre allocations.

Q This field has been produced for a period of approximately five years since this spacing order was adopted. Do you have any information as to what has been the drainage efficiency which has been observed in this field under this pattern of 80 acre spacing or greater which has been adopted?

A We have two observations regarding drainage. The first observation is that of the first nine wells, as of the first ten wells drilled, the first well completed indicated an initial reservoir pressure of 2197 pounds on the date of July 26, 1951. The following nine completions each identified a completion reservoir pressure lower than the original completion reservoir pressure by [illegible] to as much as 193 pounds per square inch, bearing in mind that these nine later completions were on spacing considerably greater than 80 acres.

This is the first indication of interference and drainage. The second observation of drainage efficiency is revealed in the ultimate recovery from the reservoir. The estimated primary recovery for the period before the pressure maintenance went into effect permits the conclusion as to the natural depletion recovery on this wide spacing. That recovery is of the order of approximately 100 barrels

per acre foot consistent with what was predicted there as well as Bisti. Therefore I concluded that the spacing at Tocito, being considerably greater than 80 acres, permits me to conclude along with the similarity of the two reservoirs and their fluids, that we can efficiently and effectively deplete and drain on 80 acre spacing.

Q It is your statement then, based on the efficiency of drainage that has occurred in the Tocito and the similarity of conditions in this pool, the Bisti, that you can consider that a well on 80 acres can efficiently, economically drain 80 acres in this pool, the Bisti Pool?

A That is correct.

Q Then with the testimony that you have given here this morning, does it or does it not confirm the testimony and opinions which you held at the previous hearing before the additional studies were made?

A This additional work that we have done, using additional reservoir pressures et cetera, confirms my original conclusion, and that conclusion was that we can efficiently and effectively drain the Bisti-Lower Gallup reservoir on 80 acre spacing.

Q Do you believe that waste will occur if this application is not granted? A Yes.

Q Do you recommend that the rules which you presented at the original hearing be adopted by this Commission?

A My recommendation is consistent with the recommendation presented at the previous hearing, namely that wells will be located in diagonal 40's in 160 acre tracts, forming 80 acre proration units.

Two, wells will be located a minimum of 330 feet from the 40 acre lines. Three, allowable to be based on 80 acre proration unit. Four, limiting gas-oil ratio of 2,000 cubic feet per barrel.

Five, semi-annual survey for gas-oil ratio and reservoir pressures.

Q Were Exhibits 8-R and 9-R which you presented here this morning, prepared by you or under your supervision?

A They were prepared by me or under my supervision.

MR. ERREBO: We would like at this time to offer them in evidence.

MR. PORTER: Any objection to the admission of the Exhibits 8-R and 9-R? They will be admitted. Does anyone have a question of Mr. Brinkley?

MR. SETH: If I may, I would like to ask Mr. Brinkley three or four questions.

CROSS EXAMINATION

By MR. SETH:

Q Referring to 8-R, Mr. Brinkley, doesn't the data on that map show some considerable pressure differentials between adjacent wells, referring to some of the more recent tests, does it or does it not show that? A Yes.

Q It does? A Yes.

Q For example, on the SDX wells 5 and 6, does that show a considerable pressure between those two wells from time to time?

A Yes.

Q Have you prepared any isobaric map showing this situation?

A No, I have not.

Q If one were prepared, it would show a highly irregular picture, would it not? A That is correct.

Q Now, how would you explain that in view of the testimony of this freedom of pressure communication? Why is it different, why is it irregular?

A Well, we expect this sort of thing like you mentioned, irregular pressure among wells, and it's as I say, what we expect due to the variance in sand quality. The quality varies in this well and the fluid, of course, will follow the path of least resistance.

Q Well, we are speaking just about pressure communication?

A Yes.

Q That shows an irregular pattern, does it not?

A That is correct.

Q How did it happen that this particular area was picked for the pilot project in the first instance?

A We were interested in getting our results of evaluation of this new recovery method as soon as possible. We also wanted to

share with other operators. We searched around for an area where the wells were clustered so that we could get our results quickly rather than selfishly going to our own lease where we had a pattern on wide spacing, yet sacrifice a year or two's time for the results.

We searched and we found the one area in this part of the field where three operators could cooperatively join, pool, their talent, experience and so forth and drill an input well and share and share alike on this new venture.

We all recognized at that time that the salvation for this poor type field would depend on some type of secondary method.

Q You don't need to sell us on the program. We are for it. I just wondered why you picked this area. You certainly didn't pick one where you expected to find poor communication or poor sands, did you?

A Frankly, we were after the close spacing wells on this pilot test to get our results quickly. We realized at the time that this was an inferior well, and might offer problems, but we didn't know enough about the method to know what kind of problems we would get into. We know much more about it now by having that poor quality sand in our pilot area, and I think it is to our advantage that we have looked into this situation.

Q Well, you have certainly picked an area where you expected to encounter good or better communication in the sands certainly?

A Correct.

Q Because you wanted the quick result?

A That is correct.

Q Your testimony as to the facts and the testimony today has been confined to this particular area, and from that you have expressed your opinions as to the entire field?

A Yes.

Q Do you feel confident that from this localized area in the better part of the field you can extrapolate the results over the entire field? A Yes, sir.

Q You have no misgivings on that point at all, is that right?

A We have learned a lot in this past four or five months, and we are quite confident that we can apply these results to the other developed portions of the reservoir.

Q And you would testify that one well in any reasonably good part of the field would drain 1500 acres, is that correct?

A No, I didn't mean to infer that at all. I said the evidence we have here indicates that I have testified that one well drilled on 80 acres would efficiently and effectively drain that 80 acre tract.

Q I thought you testified that one well would drain 1500 acres, that is what I understood. If that is not correct, I was mistaken.

A I will erase my statement, I did say that. I think I prefaced that based on this information that one well will drain 1500 acres. I stand corrected.

Q In view of what you have now testified that one well in any reasonably good part of the developed area would drain 1500 acres --

A Yes, sir.

Q You are basing that testimony primarily on the pressure communication which you have found in this area that you have these pressure interference tests, is that correct?

A That is correct.

Q In this area are the pressures above or below the bubble point?

A In the pilot area right now 1350 pounds are above the bubble point.

Q What were the compressibility factors, what did you use or what would you use here? A For the oil?

Q Yes.

A I don't recall precisely what the number is, but it is probably one times ten minus five volumes per delta PSI reservoir conditions.

Q The compressibility would be less in these fluids where the pressures, we haven't reached the bubble point in areas where you have, is that correct? A I didn't follow you.

Q Does your compressibility vary whether it is above or below the bubble point? A Yes.

Q Well, then, are there other portions of the field where it is below the bubble point?

A I believe it would be best if I answer this way --

Q (Interrupting) Perhaps you could answer yes or no and then explain the answer.

A Well, I can't give just a one answer because of the variance.

Q Well, go ahead then.

A I will state this, the Bisti-Lower Gallup reservoir contains oil and gas, at the gas-oil interface the reservoir oil is saturated as we proceed down structural elevations lower than gas-oil contact, we get into more and more under saturated oil to the point where the lowest elevation or the lowest structural elevation would be the most undersaturated oil.

Q Your data and your conclusions based on this data would make a difference whether you have taken it in an area that is below or above the bubble point, would it not, Mr. Brinkley?

A What are you referring to?

MR. SETH: Would you read the question to him?

REPORTER: Reading: Your data and your conclusions based on this data would make a difference whether you have taken it in an area that is below or above the bubble point, would it not, Mr. Brinkley?

A I take it that you are referring to the pressure interference?

Q Yes.

A Yes, if you moved toward the gas cap, then the effect of pressure interference will become minimized due to the difference in

compressibility of your fluid.

Q That would be true in any area where the pressures are below the bubble point, is that not right, not only gas cap areas, but any other?

A That would be true if you have sufficient gas. The effect on your pressure interference is directly proportional to the amount of gas that you have, hence they would be more felt in a gas cap area than in the undersaturated area.

Q That is what I was wondering. You have wells of your own with pressure on the order of three or four hundred pounds, do you not?

A I don't believe they are that low. We have some 700 pounds.

Q Then there are, certainly are wells that you know of within the area that are below the bubble point?

A Yes. Yes, in fact the pilot area is below the bubble point, or would have been --

Q (Interrupting) It is not now?

A These surrounding areas down here may be.

Q You say may be. Are they or are they not?

A Yes, this well is low.

Q Now, the cumulative withdrawals have not been large from the area that you have discussed here, have they? Do you have the information on that?

A They vary from well to well. I do have the data if you would

like to go through them well by well.

Q No, I wouldn't like to do that. Can you characterize them as being either large or small or medium, give us the high and the low? That will give us an idea.

A They vary from possibly the order of 2,000 barrels to possibly the order of 30,000 barrels.

Q That would be an estimate on the spread?

A That would be the spread, yes.

Q Just one more question. We note you don't have any pressures on your 2-C well which is within the pilot flood. Why is that? Recent pressures?

A Original pressures.

Q Recent pressures?

A Yes. We ran one just before we came out here and I got the data just in the last few hours. I have it right here. C-2 on forty-eight hour shutin has a casing pressure of 850 pounds and the reservoir pressure was 1389 pounds. 1389 would put it some place in here.

Q Is that a bomb test?

A No, that is an echometer test.

Q How about the British American Marye No. 1? Do you have a December pressure on that?

A No, the last data I had was December 6.

MR. PORTER: Anyone else have a question of Mr. Brinkley?

Mr. Malone.

MR. MALONE: Ross Malone, with Gulf.

By MR. MALONE:

Q Mr. Brinkley, do you have any recent pressures on the Federal 5 and 6 in Section 6?

A No, sir, that's the last data I have.

Q The October pressures are the last ones that you have?

A Yes, sir, that is the last ones I had, yes.

Q The last two pressures on those two wells indicated that the pressure was going up, did they not?

A That is correct.

Q And on the No. 4 well which is an offset, the pressure is going down in the last two, would it not?

A That is correct.

Q You don't know what the December pressures would show on 5 and 6?

A No, sir. We would have to measure it.

Q Your cross section indicates that the injection of gas is being made into a single sand member in the injection well, does it not?

A That is correct.

Q That single sand member condition is not uniform all over the pool, is it?

A No, it is not.

MR. MALONE: That is all.

MR. PORTER: Anyone else have a question of Mr. Brinkley? Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, I believe in answer to Mr. Malone's question you said that the pressure information reflected a single sand member?

A I don't believe he asked that.

Q Well, I'm asking you that then now. Could not this same pressure information, this communication be shown if a single sand member is common to all these wells? A Yes.

Q Then it would not necessarily follow that all of these wells would have every sand member present in the Bisti-Lower Gallup Oil Pool?

A I don't know whether I understand your full statement there.

Q Does the fact that there is communication indicated as a result of your pressures also indicate that the various sand members of the stringer of sands that have been testified to that are contained in the Bisti-Lower Gallup trend would necessarily be present in all the wells shown on your Exhibit 8-R?

A We are injecting into the upper member, and that is the member that is being pressured up, and that is what we have detected in these adjacent wells, and the movement of fluid through the upper member and going over to the adjacent wells, I mean that movement has caused the pressure reversal.

Q This pressure reversal is no indication whatsoever that every stringer in the Lower Bisti Gallup trend is present in every well on your Exhibit 8-R, is it? A No.

Q I believe you testified that it was your opinion, as a result of this information, that one well would adequately and efficiently drain 80 acres? A Yes.

Q Now, tell me, Mr. Brinkley, if a well, any one of the wells on Exhibit 8-R failed to penetrate one of the lesser members, or failed to penetrate any trend or any stringer in the Lower Bisti trend, it would not be possible for that well to drain that particular trend, would it?

A You are speaking of the lower member?

Q Of any member if it failed to penetrate it, it couldn't drain it, could it?

A It is my opinion that the bulk of the reserves is contained in the upper member.

Q Mr. Brinkley, would you please answer my question? If the well --

A (Interrupting) I would like to have it repeated again.

Q If the well does not penetrate a given sand member, it cannot drain that member, can it?

A If the sand member is penetrated?

Q I say, if it does not penetrate it, it cannot drain it?

A Not that well.

Q Maybe the question is so ridiculous you refuse to answer?

A Not that well. That is correct.

Q Then this information does not conclusively show that a well drilled on 80-acre spacing pattern would drain all of the sand members in the Lower Bisti trend, whether they are important or unimportant, in their opinion it doesn't prove that it would drain all of them?

A That is correct.

Q On primary recovery, Mr. Brinkley, what is the effect on the pressure decline, the normal pressure decline when a well is shut in?

A The pressure decline permits a buildup in gas saturation.

Q I don't believe you understood my question. What is the effect on the pressure decline, the normal pressure decline without any type of secondary recovery measures, what is the effect on the pressure decline when the producing well is shut in?

A I'm sorry, I don't understand you.

Q You get a pressure decline on a well in primary recovery?

A Yes.

Q It is declining at a steady rate?

A Yes.

Q Then the well is shut in, what is the effect on that curve?

A Well, it would continue to decline if the other wells in the field continued to produce.

Q Assume they do not in the area around this well.

A They would maintain the same value.

Q Would there be any possibility of a buildup?

A Not in a solution gas drive reservoir. Once it has built up due to its normal rock properties, then it would remain stable.

Q Are you aware of what production has been taken from the wells shown on Exhibit 8-R other than the four test wells?

A Yes.

Q What production has been taken from those wells during the months of September and October, 1957?

A I don't have it just in that form. I have the accumulated values for the pressure measurements on each well, but I have in my book here the monthly production by each well.

Q Are you aware that none of the wells according to your statistical report on Exhibit 8-R has any production whatsoever for the months of September and October with the exception of the Sunray Federal C-5 in Section 6, Township 25, North, Range 12 West.

A Let me present what I have here on Section 6, 25 North, 12 West.

Q That is the Sunray Federal 5-C?

A Five.

Q C-5? A For what months?

Q September and October. Substantially the period of time since the institution of the LPG injection program that was

commenced on August 21, 1957, is that correct?

A September, my book shows for Federal C-5 to have produced no oil. For October I have 689 barrels.

Q Now, do you have any production whatsoever for any other wells shown on Exhibit 8-R with the exception of the four test wells?

A No, sir.

Q What effect do you think the failure to produce these wells would have on these pressures shown on Exhibit 8-R?

A It would reduce the pressures further.

Q Had they been produced?

A Had they been produced, that is correct.

Q In your direct testimony I believe you referred to a comparison between what you called the Pedigrew-Tocito Pool?

A Yes.

Q I believe that is the pool that the Commission designates the South Blanco-Tocito Pool? A Exactly.

Q On primary production prior to injection of water in the South Blanco-Tocito Pool, the records indicate that they were able to produce 3,152 barrels per PSI decline?

A Yes.

Q Will you state whether you think the Bisti-Lower Gallup Oil Pool could produce a similar quantity of oil without injection?

A No, it would produce less.

Q How much less? It doesn't need to be precise. In the

order of a thousand less or two thousand less.

A It will be the same order of magnitude as observed in the Tocito Pool.

Q It would produce? A Roughly three thousand

Q Three thousand barrels per PSI?

A That was what we have observed to date. I believe I had better qualify that statement, however, that is in the undersaturated region where we are operating.

Q What would be the importance of that qualification? What would be the effect in a saturated region?

A In a saturated region the barrels produced per delta PSI would be less than the three thousand.

Q Did you explain in answer to Mr. Seth's cross examination, I believe, the apparent anomaly of undersaturated oil and gas cap?

A I don't know.

Q Isn't it anomalous to have a gas cap in undersaturated oil?

A The oil in contact with the gas cap has to be saturated, but the oil that is downstructure at elevations lower than the gas-oil contact can be undersaturated like we have here at Bisti.

Q This is not an unusual situation?

A This is not unusual, no, sir.

Q You don't feel that this might possibly indicate a lack of communication between the gas cap and the oil?

A No.

Q I believe you testified that if this pool were developed on 40 acre spacing, that waste would occur? Would you please tell me how?

A Waste would occur by the drilling of unnecessary wells requiring investment by the operators.

Q The drilling of unnecessary wells rather than waste as defined by the New Mexico Statutes? A Exactly.

Q The definitions of waste are underground waste and --

A (Interrupting) Yes.

Q (Continuing) -- surface waste through evaporation or burning?

A Yes.

Q Economic waste through production of oil in excess of market demand? A Yes.

Q Waste as related to violation of ratable take. None of these would occur as a result of 40 acre spacing, would it? It would be merely by the drilling of unnecessary wells?

A The drilling of unnecessary wells.

Q Mr. Brinkley, would you direct your attention, please, to Exhibit 8-R please? More specifically to the British American Marye No. 3 well. On October 23, 1956, the pressure reading was taken of 1190 pounds, is that correct?

A That is correct.

Q And on August 15, 1957, the pressure reading was taken showing 1234 pounds? A Yes, sir.

Q This was prior to the injection of any LPG or gas into the Lower Gallup Oil Pool? A That is correct.

Q Would you please explain what in your opinion caused this increase in pressure?

A Let me check my records first.

Q The increase is also indicated on your Exhibit 9?

A Yes. That increase in pressure of 1234 pounds taken August 15, 1957 as compared to October 23, 1956, some 14 pounds.

Q Forty-four pounds, I believe.

A Some 44 pounds. Probably is explainable by the shutin times. The August pressure was shutin quite a few hours longer than the earlier pressure.

Q Are there any other variations in shutin times on the pressures indicated on Exhibit 8-R which might account for some of the variations shown thereon?

A There may be. I didn't try to list all of that information.

Q These tests were not taken under identical conditions for each well? A No, they were not.

Q Can you furnish the Commission with the shutin times for each of the wells for each of the tests?

A Yes.

Q Would you please do so? A Yes.

MR. COOLEY: Thank you very much, Mr. Brinkley. I have no further questions.

MR. PORTER: Mr. Brinkley, I believe you testified that you, in your opinion, this pool could be efficiently drained on an 80 acre spacing pattern? A Yes, sir.

Q Does that mean that you think you would recover as much oil on an 80 acre spacing pattern drilling one well to the 80 acres, as you would two wells to an 80?

A As far as we can be practical about it and honest with ourselves, yes, sir.

Q Then, you would have to assume that these various zones of pay are identical on horizontal limits, wouldn't you?

A We would have to assume that they extended sufficient distance to be penetrated by the wells.

Q All of the wells? A Yes.

MR. PORTER: Anyone else have a question? Mr. Errebo.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q With regard to Sunray Federal No. 4 well, do you have any explanation at this time for the decrease in pressure from the November 6, 1957 pressure of 1314 pounds to the December 4, 1957 pressure of 1294 pounds?

A Both tests were shut in in the same length of time, namely forty-eight hours. However, the likely reason why we have a variance there between those two dates is probably due to the irregular injection rates that we have experienced, and the reservoir had not

stabilized in that area.

Q Mr. Brinkley, have you calculated the recoverable reserves in this field? A Yes.

Q What percent of these reserves are found in the two upper main sands?

A I would say essentially 95% of the total producable oil out of this reservoir would be contained in the two uppermost sands.

MR. ERREBO: Thank you. That's all I have.

MR. PORTER: Mr. Grenier.

RE-CROSS EXAMINATION

By MR. GRENIER:

Q Are you familiar with the definition of waste, Mr. Brinkley, as contained in the New Mexico Statute?

A No.

Q Let me then refer you to this portion of Section 65-3-3 of the New Mexico Statutes where it states as used in this Act, "The term waste, in addition to its ordinary meaning, shall include various other things", then it lists underground waste and surface waste. As I understood, in response to your answers given to Mr. Cooley, you indicated that perhaps the waste that you were talking about in the drilling of excess wells here that weren't needed, would not be either underground or surface waste. But when you drill twice as many wells as might be needed, would you mean that

would be wasteful in the ordinary meaning of the word?

A In my opinion it would.

Q Approximately how many wells, or Mr. Finfrock indicated had been drilled in this pool?

A I think 187.

Q Have those been drilled to date substantially on 80 acre spacing?

A All with but a few exceptions.

Q Do you have any indication as to how many additional wells it would require to drill this up to 40 acre spacing?

A It would be over 200 wells.

Q What would the approximate range of cost of those wells be, would you have any concept of that? I mean per well.

A What a per well would cost?

Q Yes.

A Someplace in the order of $70,000.

Q So that multiplying seventy thousand by two hundred would indicate additional investment of about how much?

A About a million and a half dollars. Close to fifteen million.

Q So that using waste in the ordinary meaning of the word, you would think then there might be waste approaching fifteen million dollars? A That is correct.

Q If your conclusion is correct that 80 acre spacing will adequately drain all but the inferior flank portion possibly

of this pool, is that correct? A That is correct.

Q Now, what is the position of an operator who has drilled his tract on 80 acre spacing and finds that other operators around him have, as permitted by regulation, drilled up to 40, can he adequately protect his position by producing from his 80 acre tracts?

A With the 80 acre unit allowable, I feel that he can.

Q Could he with a 40 acre allowable?

A If he had two wells on the 80 acre unit he could.

Q But if he is only going to drill up his tract to an 80 acre density rather than to a 40 acre density, can he adequately protect himself from drainage in that situation without drilling up his wells also?

A You kind of lost me in there with so many wells.

Q Assuming a situation where 40 acre spacing pattern is permitted by Commission order as at the present moment, assuming an operator has drilled up his tract originally on an 80 acre spacing pattern. His offset acreage around him is now drilled up to 40 acre density by the offsetting operators. Will he be adequately able to protect himself in that situation without drilling his own acreage? A I think so.

Q He will be able to do so even under those circumstances?

A If I understand your question properly, you are wanting to know if you can protect yourself whether you are on 40 acre drilling

or on 80 acre drilling, is that correct?

Q No, I'm saying here he sits still. He doesn't drill up his particular tract to 40 acre density. He just stays put with 80 acre spacing in his particular tract of land, but all around him are 40 acre spaced wells. Will he in a 40 acre spacing pattern established by the Commission be able to protect himself without himself drilling up to a 40 acre density also?

A I'm sorry, I must be dense this morning. I just don't follow the entire question that you are asking.

Q Well, I'm assuming that each of these wells is now going to be getting the same allowable that he is going to have, each of these wells that he has drilled, one every 80 acres, but because he is only given 40 acres for prorationing purposes as his producing unit, he is only going to be getting one allowable for each of his wells. Now, under that circumstance, will he be able adequately to protect himself from drainage by these surrounding wells that are drilled to double the density on his tract?

A I'm still not clear. May I get this clear? Are the 80 acres on 40 acre allowable?

Q Yes. A No, sir, you will not.

Q He will not be able to protect himself?

A No, sir.

Q Without drilling the additional wells necessary to put him too on 40 acre spacing? A No, sir.

Q So, in effect, once people do start drilling on 40 acres, each operator offsetting that 40 acre drilled area is going to have to drill up to the 40 acre level himself in order to prevent being drained, is that correct? A That is correct.

MR. GRENIER: I think that's all.

By MR. VERITY:

Q Mr. Brinkley, George Verity for Rex Moore. If I understood you, you said there was only approximately five percent of the reservoir in these minor stringers?

A That is correct.

Q That is other than the two that you have graphed?

A That is correct.

Q Or Mr. Finfrock graphed. Assuming for the moment that you wouldn't recover any of it on 80 acres, which we realize is an assumption, and if you recovered all of it on 40 acres, would it pay for the cost of drilling the additional double amount of wells?

A No, sir.

By MR. MALONE:

Q Mr. Brinkley, you were asked a question by counsel for Southern Union as to the effect of developing on 40 as against 80 acre locations. Would you refer to your Exhibit No. 1-R, and in particular to the northwest quarter of Section 10 in Township 25 North, Range 12 West. Tell us how Southern Union developed those locations, drilled those locations, whether it was on 40 or 80 acres?

A You are referring to the northwest quarter of Section 10, Township 25 North, 12 West?

Q Right.

A Those are on 80 acre locations.

Q They are 40 acre offsetting wells, are they not?

A We have 160 acres, and considering 80 acre tracts running vertically, you would have one well on 80 acres. Hence it is consistent with the 80 acre spacing.

Q It does not conform to the pattern which you have recommended to the Commission, however, does it?

A No, sir.

Q Now, with reference to your statement that 95% of the total recoverable oil is in the two uppermost sands, have you computed the recoverable oil in place in this pool?

A Yes.

Q Could you give us that figure, please?

A It would be the same figure you presented in the previous case and it is not new information.

Q I think it relates to some new testimony.

A All right. Will you restate your question, please?

Q I asked you if you had computed the recoverable oil in place in the pool. You said yes, and I asked you what figure you had obtained.

A It would be roughly twenty-two million barrels.

Q Have you allocated that as between the two principal members which are shown on your cross section?

A Yes, sir.

Q Can you give us that allocation?

A You mean split between the two sections?

Q Yes.

A No, I have not done that.

Q Have you allocated it as between those two sections and the lower sections which are perforated in a large number of these wells?

A I don't have that precise number. However, we have arrived at this five percent additional oil out of the lower members by using the rock characteristics and the high water saturation in all of those to show there is very little oil in place and using a small recovery efficiency consistent even with other operators, that the amount of oil recovered is negligible and the five percent is basically an order of magnitude number.

Q Is Mid-Continent perforating in those lower zones in the wells they are drilling?

A We perforate in the lower zones as well as in the upper zones.

Q Would you say then that your figure of 95% was an estimation rather than a computation?

A It is an estimation.

MR. MALONE: Thank you.

By MR. GRENIER:

Q Mr. Brinkley, are you familiar, referring again to this group of Southern Union wells which was just mentioned in Mr. Malone's cross examination? A Yes.

Q Are you familiar with the zones in which those wells are respectively completed?

A No, I would have to refer to cross sections and maps.

MR. GRENIER: If we may make a statement at this time, Mr. Porter.

MR. MALONE: A sworn statement.

MR. GRENIER: I thought it would expedite matters and give you the answer in which you appear to be interested. If you would like to have Mr. Wiedekehr on and sworn, we will be glad to do so.

MR. MALONE: I am willing to accept your statement. I was kidding.

MR. GRENIER: There are, as indicated by Mr. Malone's questions, two wells upon this 160 acre quarter section. There are two completions in the upper zone, there are two completions --

MR. WIEDEKEHR: (Interrupting) If I may make the statement for him. There are two wells completed on 160 offset on 40 acres, one well completed in the upper zone and the other in the 200 feet separating the two; so actually there are the two wells completed on one 160 acre spacing, one well in each zone.

MR. PORTER: Thank you.

MR. SELINGER: May I ask the witness a few questions?

MR. PORTER: Are you going to direct your question to Mr. Brinkley?

~~MR. SELINGER: Mr. Brinkley.~~

By MR. SELINGER:

Q Mr. Brinkley, you testified that in your opinion the drilling of more than one well to 80 acres is an unnecessary well, is that correct? A That is correct.

Q You indicated that at the present development that there is some, there would be some 200 wells drilled as unnecessary wells?

A That is correct.

Q Now, every time you drill a well in this reservoir you utilize some of the reservoir energy in drilling that well, is that correct? A That is correct.

Q Now, if the drilling of an unnecessary well utilizes some of the reservoir energy, then that unnecessary well is utilizing reservoir energy unnecessarily, is that correct?

A That is correct.

Q Now, I want to read you the definition of underground waste as being the inefficient, excessive or improper use or dissipation of the reservoir energy, including gas energy. Now, would you have that situation in the drilling of the great many unnecessary wells in this field? A That is correct.

MR. SELINGER: That's all.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, just one more point on this definition of waste, 65-3-3 of the New Mexico Statutes Annotated. It says,

Waste-Definitions, This definition is the definition of the waste of hydrocarbon, not the waste of money. Now, under the defined sense of A, B and C, or under the ordinary meaning of the word waste, will there be any wasting of hydrocarbon as the result of drilling on 40 acre spacing?

A Yes, under item A, the dissipation of reservoir energy, gas energy, spacing, drilling, operating, producing.

Q Will there be less hydrocarbon recovered on 40 acre than on 80 acre spacing, Mr. Brinkley? A No.

Q Then there wouldn't be any waste of hydrocarbons?

A There's always a waste in producing.

Q As compared between 80 and 40 acre spacing. You stated that 40 acre spacing would cause waste in this pool. I asked you what you meant by that. I think I know what you meant, you meant the economic loss? A Yes.

Q Of drilling wells? A Yes.

Q But you don't mean you mean to say there is going to be less oil recovered on 40 acre spacing than on 80 acre spacing?

A No.

MR. SELINGER: I believe you were conversing with Mr. Nutter at the time I was interrogating this witness. We are talking about the dissipation of reservoir energy, not the recovery of hydrocarbon, we are talking about the reservoir energy itself in the reservoir. He testified there would be a dissipation, an excessive

inefficient dissipation of the reservoir energy in the drilling of unnecessary wells. That is defined as part of underground waste.

MR. COOLEY: I also asked him if there would be more oil recovered on 80 than 40.

A No.

MR. SELINGER: You are talking about a recoverable factor. I'm using the term of underground waste in the use of reservoir energy.

MR. COOLEY: If oil is not recovered it is wasted.

MR. SELINGER: If you drill unnecessary wells and dissipate reservoir energy regardless of your recoverable factor, that is underground waste.

MR. PORTER: Mr. Seth has a question.

MR. SETH: I don't know whether to direct this question to Mr. Selinger or the witness.

By MR. SETH:

Q Mr. Brinkley, you testified in response to Mr. Selinger's question, that there would be reservoir energy lost by the drilling of wells?

A That is correct.

Q Now, would you explain how that comes about?

A Well, the fuel that is required in order to drill those wells is fluid that is used to do unnecessary work, and in my opinion that would be waste.

Q Using gas to complete the wells?

A Yes.

Q That is the extent of your point on that particular question?

A That is one example.

Q Well, what else is there, it takes reservoir energy to produce these wells too, is that what you are testifying to?

A Well, now, I'm not an expert on waste and legal matters.

Q I'm not talking to you at all about legal matters. The question was reservoir energy. You are an expert on reservoir energy?

A That's right.

Q How is that expended by drilling these 40 acre wells?

A Because you are using fuel to drill unnecessary wells, and the fuel could be diverted to repressuring operations to further the recovery in this reservoir.

I might carry that a little bit further, that we know that we can get additional oil recovery by the injection of gas, and one of our studies right now considered the injection of gas to improve the recovery, and if the gas is wasted and can't be injected, it would be waste.

Q Your testimony now is that it takes gas to power the equipment to drill the wells and for gas depletion, is that right?

A Yes.

Q What is being done with that gas now if it were not used for that?

A Part of it, I'm sure, is being used for fuel, but right now

we are making a study to utilize that gas.

Q Well, then, the extent of your testimony was that you use some fuel to drill wells and the fuel is procured locally?

A Yes.

Q Is that about the extent of it?

A Yes.

MR. GRENIER: May I ask one question?

By MR. GRENIER:

Q In response to Mr. Seth's questioning, I gathered that you were indicating that exclusive of the fuel use, things happening on the surface, that approximately the same amount of reservoir energy would be required to produce the same amount of oil whether on 40 or 80 acre spacing, is that correct?

A I believe it would be the same amount of energy.

Q Now, having used the same amount of energy to produce the same volume of oil on either spacing, which would be the more efficient way of using that reservoir energy, through a program that cost X dollars or through a program through having double the wells, two X dollars?

A The former X dollars.

Q So, it would be the more efficient use of reservoir energy to recover this same amount of oil and make use of this same amount of reservoir energy on an 80 acre spacing pattern than on 40?

A That is correct.

Q So that relatively the 40 acre spacing pattern utilization of reservoir energy would be inefficient, is that correct?

A That is correct.

Q And therefore that would be within the definition as we have it here in this section referred to where it defines underground waste as being a number of things embracing the inefficient use or dissipation of the reservoir energy, which you characterize it, then the use of reservoir energy by 80 acre as being such an inefficient use of reservoir energy?

A That is correct.

Q So that it would be wasteful then to that extent?

A That is correct.

MR. PORTER: Mr. Cooley.

By MR. COOLEY: Mr. Brinkley, are you familiar with the way the two Southern Union wells, which were mentioned in the testimony a few moments ago, were completed?

A Only from what I have heard here.

Q These wells are on offsetting 40 acre tracts, are they not?

A That is correct.

Q And since you do not know of your own information that these wells are completed in different zones, let us assume that these wells are completed in two different zones.

A Yes.

Q One is completed in an upper zone and one completed in the

lower zone? A Yes.

Q Then, Mr. Brinkley, my question is this, had the Southern Union wells been drilled in accordance with your recommendations, one of the wells would have been to the northeast corner, I believe was your recommendation? A That is correct.

Q Is there not a good possibility that the zone penetrated by the well in the southeast where it is actually located, might not even have penetrated that zone? A That is correct.

MR. COOLEY: Thank you.

MR. PORTER: I have a question in mind, but I think I will defer it for awhile. Mr. Sullivan.

MR. SULLIVAN: Mr. Sullivan, British American.

By MR. SULLIVAN:

Q There has been a good deal of testimony here, Mr. Brinkley, with regard to the terms of the New Mexico Statute. I would like to read a provision to you and ask you whether or not that this provision existed in the law. You may answer this either yes or no.. Are you aware of the fact that Section 65-3-14(b) of the New Mexico Conservation Act reads as follows: "The Commission may establish a proration unit for each pool, such being the area that can be efficiently and economically drained and developed by one well, and in so doing the Commission shall consider the economic loss caused by the drilling of unnecessary wells, the protection of correlative rights, including those of royalty owners, the prevention of waste, the

avoidance of the augmentation of risks arising from the drilling of an excessive number of wells, and the prevention of reduced recovery which might result from the drilling of too few wells." Are you aware that that was in the statute?

A I have never read this.

Q Just the answer no then?

A But through conversation --

Q Just the answer no then? A No.

MR. PORTER: The hearing will recess until one-thirty.

(Recess.)

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. I don't recall who was questioning Mr. Brinkley at the recess. Mr. Grenier, were you questioning the witness?

MR. GRENIER: No, but it has been called to my attention during the recess by one of the other lawyers in the case, that apparently I misstated one question and the witness misheard and we got a rather strange question and answer. This relates to the point where I was inquiring of Mr. Brinkley as to whether 40 or 80 acre development of the field would represent the more efficient utilization of reservoir energy. I think I asked, isn't 80 acre spacing less efficient, and he said yes.

My question, I'm sure, was asking him wouldn't 40 acres be more inefficient, and I would ask him what his answer to that would be.

A Yes, a 40 acre spacing would be less efficient.

MR. GRENIER: Thank you.

MR. PORTER: Anyone else have a question of Mr. Brinkley at this time?

MR. UTZ: I have a question.

MR. PORTER: Mr. Utz. I didn't see you.

By MR. UTZ:

Q Mr. Brinkley, how long do you think that it takes to stabilize the shutin pressure in the Bisti Pool?

A We have observed in some of the wells along the longitudinal axis they would completely build up in pressure in less than forty-eight hours. Also the fringe wells have been, required a longer period of time than forty-eight hours to stabilize.

Q That would be due to lower permeability?

A Due to poor rock characteristics.

Q In taking shutin pressures in the pool, what would you recommend as the shutin pressure time for the period of stabilization?

A For the wells in the fairway I would recommend forty-eight hours, and in the fringe areas I would recommend a minimum of seventy-two hours.

Q It would be a little bit difficult to have two different times?

A Yes, it would.

Q In reference to your Exhibit 9-R, with particular

reference to the Sunray C-2, I note over in the first part of April a shutin pressure in the vicinity of 1270, and apparently there was not any more shutin pressures taken until somewhere about the middle of September? A Yes, sir.

Q Do you attribute that increase to your injection of LPG and gas?

A This is an abnormally high pressure, and I cannot explain it. It could be an error in measurement or instrument or something else, but it is obviously too high. I did put it on here because it was a data I received and I did not try to edit the data.

Q It also shows quite a fast decrease in pressure on the pressure taken the latter part of September, does it not?

A Yes, sir, this point here. I first would like to say that I questioned that point, and since I had this point here I drew a line to connect the two data points and the decline carries no significance as far as I'm concerned.

MR. UTZ: That answers my question.

MR. PORTER: Anyone else have a question of the witness? Mr. Nutter.

By MR. NUTTER:

Q Mr. Brinkley, you stated there would be a difference in the efficiency in the use of the reservoir energy in 40 acre against 80 acre spacing? A Yes, sir.

Q How would this be measured, what would be the ultimate

outcome of the difference in the efficiency in the use of the reservoir energy?

A For one thing, you would have half as many pressure sinks in the reservoir, which of course, a pressure sink causes increase in gas saturation and it is that that I am referring to.

Q The ultimate answer to the use of reservoir energy is the barrels of oil produced, is it not?

A Yes.

Q And then the question could be resolved as to the matter of time in which the oil is produced?

A Yes.

Q The economic limits of the time that it takes to produce a given amount of oil, that is important?

A That's right.

Q Would it be fair to say that one of the criteria here that the Commission must consider, would be how long it would take to produce a given amount of oil in this reservoir?

A That might be one criteria.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

The Commission has had a request from counsel for Rex Moore, Mr. Verity, for permission to make a short statement in order to

leave here to make a plane connection. Is there any objection to Mr. Verity making this statement at this time?

MR. VERITY: Your Honor, in behalf of Rex Moore, we don't have any evidence to produce at this hearing, but I would like for the record to show that Mr. Rex Moore, who owns the 1,040 acres of leases within the area that is here under consideration, finds himself in a very embarrassing position. If the Commission establishes a 40 acre spacing as his lease is at the present time, or in the past when it was being developed under a voluntary 80 acre spacing, he, as an independent operator, could develop his lease. I'm sure this Commission is aware of the fact that the average independent must borrow money in order to develop his lease properties under normal circumstances, and certainly Mr. Moore is in that position, and I believe the bulk of the independents in this Bisti Pool. He is in the position that whereas he can borrow money and develop his thousand and forty acres on 80 acre spacing, he as yet has been unable to find any lending agency that will finance him to develop his pool on 40 acres. That leaves him in the position, if this Commission allows its order to stand that it promulgated recently, establishing the 40 acre, he is going to have to sell his lease or else farm it out on whatever kind of a basis can come around.

He feels that that is inequitable and that is unfair, and therefore he joins in the application for 80 acre spacing. He finds that his engineers and bankers concur with the

engineering that recommends the 80 acres to this Commission.

MR. PORTER: Mr. McGowan, did you have testimony to present at this time?

MR. McGOWAN: If the Commission please, we will have three exhibits. I suggest that we continue to number them 10, 11, 12-R so there will be continuity in the record. They are in support of the application for rehearing and in support of the application.

MR. PORTER: We have no objection.

(Marked Applicant's Exhibits 11-R, 10-R and 12-R, for identification.)

C. D. GAINES

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

DIRECT EXAMINATION

By MR. McGOWAN:

Will you state your name and by whom you are employed and what capacity, please?

A The name is C. D. Gaines. I am Division Production Engineer for Sinclair Oil and Gas Company in their Denver Division.

Q You do have a degree in engineering and have had about nine years' experience as a working engineer for Sinclair?

A That is correct.

Q You have not previously testified in this hearing?

A No, sir, I have not.

Q You have previously, however, testified as an expert before this Commission? A Yes, sir, I have.

MR. McGOWAN: Are his qualifications acceptable?

MR. PORTER: Yes.

Q In your capacity, Mr. Gaines, as Division Engineer for the Denver Division, do you have under your jurisdiction what is being referred to here as Bisti Pool? A Yes.

Q Does Sinclair Oil and Gas Company own interests and leases in wells in that pool? A Yes, we do.

Q Are they more or less concentrated in a particular portion of the pool?

A Yes, they are concentrated in Township 25 North, Range 11 West, approximately in this area in here.

Q Now, Mr. Gaines, have you, although you did not testify in it, have you read and are you aware of the testimony that was given at the previous hearing in this matter?

A Yes, sir, I am.

Q You have the information that was contained then in the testimony given at that time, it has been available to you in your studies, has it not? A Yes, sir, it has.

Q Have you also made an independent study of the pool yourself with particular attention to the area you just made reference to?

A Yes, sir. In fact, the study was concentrated on this hearing.

Q Is that the reason that you had more information in that area than other areas?

A It was partially due to the fact that our interests are in this area of the pool and we were interested in evaluating Sinclair Oil and Gas Company's interest, and also that is the data that we had available to work with.

Q Now, you were aware in your study, were you not, that the Commission had under consideration here the proper sized spacing or proration units to develop this pool on, together with the field rules that would be necessary to prevent waste in this pool, were you not? A Yes, sir, I was.

Q Did you make a study of this reservoir to enable you to make what in your opinion would be a recommendation to the Commission which would be in your opinion the best method of so doing?

A Yes, sir, the concentrated study, as I said before, was in Township 25 North, Range 11 West, but I did review other data that was presented at the last hearing.

Q In making such study you were aware, were you not, that the Commission is concerned with the prevention of waste as defined in the statutes, and those definitions you were aware of?

A Yes, sir.

Q You were aware that the Commission has a duty of protecting correlative rights, and you were aware of that in your study?

A Yes, sir.

Q May I ask you, in considering the effect upon correlative rights, were you considering the statutory definition of such, which is essentially to give to each operator the opportunity so far as practical, to recover the hydrocarbons under his lands?

A Yes, sir.

Q Now, Mr. Gaines, evaluating a pool and coming to a conclusion concerning the size of spacing of proration units that would be necessary, do you feel that there is a minimum below which you cannot go? A Yes, sir, certainly.

Q Is that minimum actually based upon economics?

A Yes,sir, it is.

Q In other words, then, any unit that does not contain sufficient recoverable hydrocarbons under it to pay for the cost of drilling and operating a well to depletion plus profit would be uneconomical and therefore below that limit, would it not?

A Yes, sir, it would.

Q Would it be fair to state that you start with that minimum and then see how large an area in your opinion can be drained by one well in order to establish the maximum?

A Yes, sir.

Q Then within those two limits, you decide what you feel is the best proration or spacing unit for that field?

A Yes, sir.

Q Now, in constructing and coming to the recommendation that you are going to make to the Commission, did you consider all these factors and proceed essentially on the matter that has heretofore been outlined? A Yes, sir.

Q Then on that basis, will you advise what your recommendation is concerning this pool?

A We feel that the greatest ultimate recovery could be obtained from the Bisti-Lower Gallup Field by a fixed 80 acre spacing pattern. However, we feel that the establishing of 80 acre prorationing units would essentially accomplish the purpose with respect to preventing waste. We concur in the recommendation of Sunray Mid-Continent that the limiting gas-oil ratio for oil wells be set at 2,000 cubic feet per barrel.

We would further recommend that for the present at least, that a well which is producing with a gas-oil ratio in excess of 15,000 cubic feet per barrel be classified as a gas well.

We would further recommend for allowable purposes that a gas well be permitted to assign up to four 80 acre units, and that the allowable be based upon the volumetric formula.

Q Now, Mr. Gaines, when you used the word spacing unit, you were thinking in terms, were you not, of prescribed 80 acre units with a prescribed well location thereon and prohibition against drilling additional units on this 80 acre unit?

A Yes, sir.

Q When you mentioned the word proration units, you were talking about a proration unit for allowable purposes without any restriction as to whether one or two wells could be drilled thereon?

A Yes, sir.

Q You mentioned a gas cap, Mr. Gaines. With particular attention to the area in which Sinclair has leases and in which you have, in your opinion, sufficient information to evaluate the reservoir, do you feel that you have come to a valid conclusion concerning the approximate location of the gas cap in this reservoir?

A Yes, sir, as to the approximate location.

Q In discussing the gas cap as you envision it in this field, will you refer to Exhibit 10-R? Would you please advise the Commission what that exhibit shows?

A Exhibit 10-R is a structure map in the area that we were speaking of, which is based upon a marker which is approximately ten feet above the top of the first sand in the Lower Gallup. We have indicated two cross sections, A, A_1 and B, B_1 which are shown on Exhibits 11-R and 12-R. The area that is colored in yellow represents our interpretation of the area in which some free gas could be expected.

Q That would be what would normally be referred to then as the gas cap area?

A Yes, I think so. Certainly you would have to move inside this yellow band to get a gas well without making any oil because

there would be marginal areas through there where you would have both oil and gas, and thus high gas-oil ratio wells.

Q Do you feel then that the gas in this area is pretty well concentrated, or the gas in this pool is pretty well concentrated in a gas cap along the southwestern flank except for such free gas as might be found in isolated anomalies as was discussed by a previous witness this morning?

A Sir, we did not go past the town line, rather the range line, between 11 and, Range 11 and 12 West, and our interpretation of the gas area in Sections 19 and 20 in Township 25 North, Range 11 West is based purely on interpretation. We had no gas volumes to use from these wells, but using the same criteria that we did use down in this area where we did have control, we extended this gas cap area across here. We have no proof that it does go there.

Q Do you feel that you have been able at least in that area to define the gas cap to the southwest?

A We have --

Q (Interrupting) Let's say the southwestern edge of the gas cap.

A We have a distance of approximately five miles in lateral extent that we can very definitely define the gas cap.

Q You feel the southwesterly edge of it would be the edge of the pool? A Yes, sir.

Q The northeasterly edge of it would be the gas-oil contact?

A Yes, sir.

Q And the southeasterly and northwesterly limits of it cannot at this time, in your opinion, be defined or at least on the information that you have?

A Based on the information I have, I cannot define them. It might be possible they could be defined.

Q I gather that you are of the opinion there is a significant gas cap area in this pool?

A We are looking at the gas cap area that certainly represents approximately a fourth of the length of the pool.

Q Will you refer to your Exhibits 11-R and 12-R and advise the Commission what they are and the significance of those exhibits? One moment, Mr. Gaines, before you go to the latter two exhibits. It has been called to my attention that on the map there is an error in one or two lease owner names. Would you like to correct that at this time?

A Yes, sir, on this plat we did not catch this until we had them prepared, but the Sunray Mid-Continent Sinclair lease in the southwest quarter of Section 15, Township 25, all of these are in Township 25 North, Range 11 West, the name of that lease should be the Platero. The lease in the northeast quarter of Section 23 should be Bittony NEZ, and the lease in the northwest quarter of Section 25 should be Es-Ka-By-E.

A Would you mind spelling those lease names?

A Es-Ka-By-E, E-s-k-a-b-y-e, Platero, and B-i-t-t-o-n-y N-E-Z.

Q Now, will you refer to Exhibits 11-R and 12-R and state what they are and their significance?

A Exhibits 11-R and 12-R are cross sections, as I stated before. No. 11-R being more or less perpendicular to the field with the exception of the red going over to the Shell Carson Well and the other well diagonally across the breadth of the field. We were concerned about the Shell Carson No. 5 due to the past tests, but we had to report that it was a 33 barrel oil well, and we felt like that certainly it should be a gas well.

I don't believe it is proven that it isn't a gas well as yet. In Es-Ka-Nel-E-Wood No. 2, Sunray Mid-Continent Well afforded us some very valuable information with regard to this gas cap, in that the well was tested separately in both the first and second zones and produced gas from both zones, which meant that our gas-oil contact must lie below the bottom perforations in the second zone, but there is no fluid reported.

Then Sunray Mid-Continent Es-Ka-Nel-E-Wood No. 1 was completed with a gas-oil ratio of 1,020 to 1. That would certainly mean that essentially all of the perforations in Es-Ka-Nel-E-Wood No. 1 must be in the oil zone. Therefore I think certainly in this area here we would expect that the gas-oil contacts in the two zones must be slightly different.

I might add, in talking about these gas-oil ratios, that

p[illegible]cally all of them are potential tests or completion tests on the wells. After short periods of significant fluid withdrawals, I think the gas-oil ratios could change considerably.

Q They would change to a higher rate, would they not, in your opinion?

A Certainly I think in this gas cap area. Yes. We had the Texas Company No. 1 Navajo also, and then the No. 1 Harvey which was a dry hole. We attempted with our other cross section to apply these same gas-oil contacts to the wells that we have in this cross section.

I might add that we did have core data on the Anderson-Pritchard or Sun Oil's No. 1 H Begay, Sun Oil Heirs of Ko-Sa No. 2, the Heirs of Ko-Sa No. 1, the Sun Oil No. Heirs of Ka-Na-Pah and No. 1 and No. 2.

Using the same gas-oil contacts which were a plus 1550 in the first zone, and I believe plus 1530 in the second, we used this same data to apply to this cross section. This was a gas well in the second zone perforated only in the second zone. Magnolia's No. 1 Ken-Nu-To had a gas-oil ratio I believe of about 11,550 cubic feet per barrel. It produced 45 barrels of oil on a 1664 inch choke. We found that to explain a low gas-oil ratio of, and by low I mean approximately a thousand to one in Sun Oil's No. 1 Heirs of Ko-Sa, that we had to tilt the gas cap approximately ten feet, going down structure.

It could be that with more production we would find a higher gas-oil ratio in this well. Then as we go on down structure, we have ratios of a thousand or less, and then we do have included the No. 1 Platero which was discussed this morning, and we also independently put a little gas cap in this area independently, I would say, of Sunray's approach to the gas that is found down structure in the second zone, and the first zone, or rather the second zone which is the producing zone in the Platero No. 1 is found at plus 1510, while the second zone in Sun Oil's No. 2 Heirs of Ka-Na-Pah is down at a plus 1500. In other words, it is higher structurally.

Q You then agree with the conclusions that were expressed concerning that well this morning?

A Yes, sir, I do.

Q One other question on two exhibits. Those two cross sections, I believe, are constructed to scale both horizontally and vertically, are they not? A Yes, sir, they are.

Q Now, Mr. Gaines, you recommend to the Commission 80 acre proration units? A Yes, sir.

Q Did you evaluate this reservoir from an economic standpoint?

A Yes, sir, I did.

Q Is it your opinion, without going into detail very much, the record is full, that 40 acre units in a major portion of this reservoir would be uneconomical? A Yes, sir.

Q They would not produce enough oil for drilling and

operating the well to depletion? A Yes, sir.

Q In making such calculations, and the calculations in the previous testimony are on the same basis, you were assuming a depletion of the wells based upon an allowable at least in line with other allowables in the State of New Mexico?

A We used a ten year life for 40 acre spacing, which I think would be a reasonable life with the allowables in southeastern New Mexico.

Q If that allowable in northwestern New Mexico, and particularly in this pool, remains substantially lower than in southeastern New Mexico as it presently is, that would extend the life of the wells? A Yes.

Q It would also substantially increase the operating costs?

A Yes, sir.

Q It would make wells that might now seem economic, uneconomical? A Yes, sir.

Q You recommended 80 acre proration units, is it your opinion that one well will economically and efficiently drain the recoverable oil from under an area in excess of 80 acres in the oil portion of this reservoir?

A From the data that we have worked with and the data that we have had the opportunity to look at that other people have worked with, I do.

Q Without repeating the testimony to any extent, I gather

then that you feel that the permeabilities in this pool are sufficient to allow drainage in excess of 80 acres in the oil zone?

A Yes, sir.

Q And it is your opinion that the interference test and the information in the text that has been given here before conclusively proves that?

A Yes, sir.

Q Is it your opinion that one well will economically and efficiently drain in excess of 320 acres in the gas cap area?

A Yes, sir.

Q It is the basis of your recommendation of assigning a maximum of four proration units to a gas well?

A Yes, sir, and also on the basis that a lesser spacing would be very uneconomical and in fact 320 acres would be a slightly less than break even proposition to the gas wells located in that area.

Q Do you feel that the method of controlling this field and setting up proration units that you have recommended to the Commission will result in the greatest ultimate recovery of hydrocarbon from the entire pool?

A Yes, sir, I certainly think there is that possibility.

Q Now, Mr. Gaines, without leaving any inference that you feel that one well on 80 will produce more oil than two wells would, is it nevertheless your opinion that the 80 acre spacing will actually produce more oil from this pool than 40 acre would?

A If we make certain assumptions.

Q And that assumption would be that the fringe areas should not be and would not be developed on 40 acres?

A Together with the assumptions and data that has been previously presented to the Commission.

Q Insofar as each area of this pool could not be economically developed on 40 acres, the oil underlying that land would not be productive except by drainage into the center of the pool?

A Yes, sir.

Q In your study of this reservoir, have you found leases that in your opinion could not be economically developed on 40 acres?

A Yes, sir.

Q Does Sinclair own one? A Yes,sir.

Q Would you recommend to your management that they drill 40 acre wells on that lease if the Commission orders 40 acres?

A No, sir, I would not recommend they drill wells on that lease.

Q It would be to the economic advantage of Sinclair to abandon the lease rather than drill 40 acre wells on it?

A That would be my recommendation.

Q I assume that you feel that in order to prevent waste and protect correlative rights of the parties to the greatest extent possible, 80 acre proration units should be established for the Bisti-Lower Gallup Pool?

A Yes, sir.

Q Do you feel that unnecessary wells would be drilled if such

a program is not adopted by the Commission?

Yes,sir.

MR. McGOWAN: I believe that's all.

MR. PORTER: Anyone have a question of Mr. Gaines?

MR. SETH: I have a few questions.

MR. PORTER: Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q If I understand your testimony, Mr. Gaines, the issue here is if the Commission continues with the 40 acre spacing, you'll either have to drill that lease up on 40 acre tracts or abandon it, is that right?

A That is not the issue with us, no, sir.

Q I mean is that what you think you are faced with? Is that your choice?

A If we are talking about one lease. I think it is broader than one lease, but there will be leases that we feel would be uneconomical to drill.

Q Let's take the one lease that you spoke of. You feel that if they continue the 40 acre spacing, that you'll either have to drill it up or abandon it, is that correct?

A That is correct.

MR. SETH: That's all.

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q Mr. Gaines, as I understood your study was limited entirely to the area east of the range line, which is depicted on your Exhibit 10-R?

A Yes,sir, it was, other than reviewing also the results of other people's studies, also.

Q Was your study also limited entirely to the two sand members that are shown on the two cross sections which you have introduced?

A Essentially, we looked at some 30, 31 or 32 wells in this area. We found cases where we would have as much as two or three feet of microlog separation below that.

Q And that was perforated in a number of those wells, was it not?

A There was a very few of the wells that it was perforated in. In fact, I think they were in Township 25 North, 11 West, there were four wells which were perforated in zones other than the first and second zone.

Q Did you make any study of that sand member?

A Not independently, no, sir.

Q So its existence is not taken into consideration in the recommendations that you made to the Commission?

A Other than we feel it will contain very small reserves.

Q You feel that it can be disregarded and you have disregarded it?

A Yes, sir.

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MR. MALONE: That's all.

MR. DUTTON: Granville Dutton, Sun Oil in Dallas.

MR. PORTER: Mr. Dutton.

By MR. DUTTON:

Q I have heard two references to I believe it's Shell Carson 5. Am I correct in understanding that this well was represented at the last hearing as being an oil well?

A I believe that's the conclusion that I drew from reading the testimony.

Q And it is your testimony now, and I believe if I understood Mr. Brinkley this morning, that the well has produced only 33 barrels of oil?

A No, sir, I believe it has recovered, I believe he used 80,000 gallons as a fract treatment, and it has yet not recovered the 80,000 gallons of oil.

Q Is it your testimony now that in your opinion this well is a gas well?

A No, sir, we do not have any data as to whether that well tested a gas well or whether it didn't.

Q Well, it is your testimony that a gas cap does currently exist in the southeastern portion of the Bisti-Lower Gallup Oil Pool?

A Yes, sir, I think very definitely.

Q You testified that you have made an economic evaluation

of the leased portions of this field?

A Yes,sir.

Q In so doing did you arrive at an average figure for a cost of a well in this area? A Yes, sir, we did.

Q Would you give us that figure?

A The average figure for an oil well, including the averaging out, the lease equipment and the artificial lift equipment, we used a figure of $70,000. For the well itself we had a figure of $54,800.

Q Mr. Gaines, would it be your opinion that it would be economically feasible to drill a $54,800 development well if the reasonable expectation was to receive a producing allowable of only ten barrels per day?

A Certainly not.

MR. DUTTON: Thank you.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Gaines, in making your study of this pool, did you attempt to determine how much of the oil was in the various independent pays that comprised the Gallup formation?

A No, sir. We did not split them up by zones. However, it would be purely an estimate on my part. I would say that probably in excess of 95% would be in the first and second zones in the areas that we have looked at.

Q In these two main zones that you have shown us?

A Yes, sir.

Q Mr. Gaines, in drilling a pool up on 80 acre spacing, on a northeast-southwest basis in each 160 acres or northwest-southeast, does it not follow that the wells would of necessity, to be on a perfectly uniform pattern, have to be 660, 1980 locations?

A Yes, sir. To be perfect.

Q And if a pool is drilled up on 40 acre spacing with completely uniform spacing throughout the pool, it follows that the locations must of necessity be 660, 660 locations, is that correct?

A Well, I believe it would be 1320, if they were in the center of the 40.

Q I mean 660, 660 out of each 40 acre tract in the center of each 40. A Yes, sir.

Q If you drill wells on ten acre spacing, the normal spacing pattern would be 330 feet out of each ten acre tract in order to be in the center, would it not? A That is correct.

Q How many wells does Sinclair have in this area that you have depicted in your exhibit?

A We have a half interest in nine wells that are completed, and I believe at the present time there are two drilling.

Q How many of those wells have been located in such a manner that the minimum distance from the lease line, or minimum distance from the 40 acre tract in which the wells are located, is at least 660 feet?

A It would be an estimate on my part since I don't think right here I have the exact location of the individual wells.

Q These wells are located on your map with respect to the actual distance from the lines, aren't they?

A That's correct.

Q The Platero No. 1, how far does it appear to be from the section line?

A I would guess that to be a 330 location.

Q Sinclair Sunray's Es-Ka-Nel-E-Wood No. 2 is what type of location?

A Could I correct myself on that last statement there, it would be, do you want the distance to the closest lease line?

Q That's right.

A Then it would be, it appears to be approximately 330.

Q How about Sinclair Sunray Es-Ka-Nel-E-Wood No. 2 in Section 22 there?

A It looks like it is 660.

Q It is a 660, 660 location?

A Yes, sir, No. 2 is also.

Q The No. 1 and No. 2 on that lease?

A Yes.

Q How about up here, Sunray Sinclair A-Se-Des-Pah?

A Yes, that was the Bittony NE¼ and that would be 660 also, I believe.

Q How about Sinclair Sunray's, about this well over here in Section 24?

A I believe that is a 330 location.

Q Sinclair's Margalita No. 1 is a 660, isn't it?

A Yes, sir.

Q How about down here in Section 25, the Es-Ka-By-E No. 2?

A Well, that looks like it could be between 330 and 660 from my plat here.

Q It doesn't appear to be a 660?

A No, it appears to be between 330 and 660.

Q How about the Kas-Na-Des-Pah in Section 25?

A That appears to be 330 from the north line.

Q How about in Section 30, SDX 9 Eton No. 2?

A The No. 2 appears to be 330 from the north line of the lease. The No. 1 appears to be 660 from the east line and greater distance from the south line.

Q So that probably would be close to 330 from the north line of that tract, would it not?

A The No. 2 would, the No. 1 --

Q (Interrupting) The No. 1 from the 40 acre tract?

A From the 40 acre tract, yes, sir.

Q Is there any significance in this location of these wells, Mr. Gaines? I count six wells that are 330 locations from the 40 acre tracts and four wells that are 660. Is there any significance

in the location of those wells?

A I think there might be one significance in the area in that high gas-oil ratios have been experienced down in this area and it's recognized that there is a gas cap here, and I think certainly that any operator would try to stay away from the gas cap.

Q In a field where it becomes necessary to drill more than half the wells on 330 locations, is that any reflection on the ability of the wells to produce an 80 acre tract?

A I don't think it is. As to the reason for it becoming necessary to drill on 330 from the edge of 40 acre tracts, it certainly would have some bearing upon the drainage. However, in the core analysis that we did examine in this area, we found very good permeabilities in the first and second zone. I think certainly I would concur with the opinion that one well could drain in excess of 80 acres.

Q In other words, the location on 330 feet from a line was not necessitated by any lack of permeability whatsoever?

A Having part interest in this property, the recommendations for drilling are submitted to Sinclair and approved by us. As to the exact reasons, we don't know, we do approve them if we agree with them.

MR. NUTTER: Thank you.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Gaines, I believe you stated that you felt that something in excess of 95% of the reserves in the Bisti-Lower Gallup Oil Pool are in the first two zones?

A Yes,sir, based upon the area that we have looked at here.

Q And then limiting yourself to the area that you have studied, to what degree are these first two zones coextensive through this area? A The first two zones?

Q Yes.

A I think that you can trace them completely through the area, as indicated by the two cross sections we have there, until you do get out on the flanks of the field, and then it appears that in this area, as you get to the north edge of the field, that the first zone shales out before the second zone does. To the south it appears that the first zone, the second zone possibly shales out a little before the first does.

Q Could you give a rough estimate in percentage as to what percent of this area you feel these two zones are coextensive, 75% or better or 50% or better?

A Well, what we would have to do to come up with that volume I think is to plot the limits of where the zones would shale out along the flanks of the field and then perimeter that area under that and apply it to the number of feet that we would think would be an average.

I think when we talk about total reservoir volume, that we are

speaking about, probably a significant percent due to the perimeter of the field. Assuming that these conditions do exist all the way around the field, I think that there is a possibility that it would be a significant volume.

Q A significant area over which they are not coextensive?

A By coextensive --

Q (Interrupting) One well drilled at any given point would not penetrate both zones?

A Yes, sir, I think it would be a significant area because of the perimeter of this field. I think you are looking at quite an area if you just drew a circle around the field if it were only one location wide.

Q Of course, this perimeter, I believe, as all the testimony indicates, all the way around are the poorer locations?

A Yes, sir.

Q Mr. Gaines, I am not sure I understand all of your recommendations concerning the proration of the gas wells completed within the gas cap in the Bisti. Would these wells be assigned 320 acres as a standard unit, I believe you testified you are up to four proration units? A Yes, sir.

Q Would a standard, would there be such a thing as a standard unit and would that unit be 320 acres?

A No, sir, I believe that would be the maximum unit size.

Q What would determine whether a 160 or 320 or any figure

would be assigned to a given well?

A I think it would be determined by the area that would be productive of gas, and by that I do mean gas cap gas.

Q Would this area dedicated to a gas well, would it be the possibility under your proposed plan of dedicating certain of that acreage to an oil well also? A No, sir.

Q There would be no simultaneous, it would either be dedicated to a gas well or oil well? A Yes,sir.

Q Did you include a volumetric withdrawal computation into this?

A I mentioned one.

Q I thought you just mentioned, and in passing I wondered if you would expand on that just a little.

A Well, there are several ways that you could approach it, it would be a matter of how exact you wanted to get, and of course, the more exact that you get I think the more data that it would require to regulate these gas allowables. The simplest would be to apply the solution, the limiting gas-oil ratio for oil wells, times the number of 80 acre units assigned to a gas well to come up with a limiting gas volume.

Q If an 80 acre oil well got X, the amount of gas that an 80 acre unit could produce along with its oil would be X?

A That's correct.

Q Then a 320 would produce 4X?

A That is correct, that would be the simplest and then you could go to more or other formulas that would be more complicated and require bottom hole pressure data in that.

Q Do you think there is a danger in the possibility that gas might be withdrawn from this gas cap at higher rates than the corresponding oil production and cause a wetting of sands?

A If it isn't regulated I do.

Q But would this gas-oil ratio type of formula be any insurance whatsoever against that sort of occurrence? Your system would seem to give everyone a fair share of reservoir energy.

A Yes, sir.

Q But would it prevent the wetting of sands?

A It has been my experience that if a gas cap is produced, or if high gas-oil ratio wells themselves were causing some wetting of the gas sand by oil, and likewise the gas will move down structure and you will have oil wells going to high gas-oil ratio wells. About the only way that if you are going to produce from this area of high gas saturation that you can prevent some wetting would be from some type of secondary recovery, gas cap injection to hold that injection above the pressures that would exist in the oil section.

Q I don't believe I understand you. You would advocate the injection of gas and the production of gas in the same area?

A I am not advocating.

Q Is that the essence of what you just stated?

A I think there will be some wetting of the gas cap sand by oil, if wells in the area of high gas saturation are produced.

Q Theoretically it is possible to produce them at a balanced state, is it not, where there would be no wetting if you can determine what that rate would be?

A Theoretically it is; practically, it is very hard to do.

Q And to be on the safe side, you could underproduce the gas and be assured of avoiding the wetting of sands?

A Well, of course, I don't think that you would necessarily be giving the people in the gas cap area --

Q (Interrupting) I mean discounting the possible violation of correlative rights.

A Yes, sir, it would improve, a gas expansion drive would certainly give you a higher recovery.

Q Mr. Gaines, I believe you said that you had certain leases, that Sinclair has certain leases, which you would advise your company not to develop in the event this Commission decides upon 40 acre spacing for the Bisti? A Yes, sir.

Q Do you likewise have some leases that you would advise them not to develop on 80? A Yes,sir.

Q Now, can you tell me what the difference is?

A Yes, sir.

Q I mean in terms of percentage or numbers, how much of the

pool are we talking about that wouldn't get developed at all if we go to 40 as compared to 80, obviously some of it wouldn't warrant development at any type of spacing?

A Yes, sir. Well, for instance, let's take one lease where we happen, well, let's just take the northeast quarter of Section 23, the Bittony NEZ lease there. One well had 16 feet of pay in it. This well that was over in the northwest quarter of Section 24 had six feet of pay in it. I don't think that we would be too pessimistic to say that the average pay over that 160 acre tract, that quarter section, would not exceed ten feet.

We did have control by the dry hole up in the southeast quarter of Section 14 on 80 acre spacing, you could drill a well that probably the well itself would never pay out, it might, you would be taking a risk on that, but at least if you average up the volume of recoverable oil that you could estimate under that tract with two wells I think we could make a reasonable profit. If we drill four wells, I don't think that we would recover our drilling costs.

Q Now, would you advise your company to drill a well anywhere in the north half of the northeast quarter of Section 23?

A Section 23?

Q It is the same area that we have been talking about, could you drill a well in the north half of that section at all under either type spacing?

A Well, I believe, are you speaking of the north half of the

southeast?

Q The north half of the northeast quarter of the section. You have one well in the southwest quarter of the northeast quarter?

A Well, that is the tract that I was speaking of.

Q Yes. Now, would you advise your company to drill a well in the north half of that northeast quarter of Section 23?

A Yes, sir, I would advise them to drill a well there if 80 acre proration units were established for the field.

Q How about the north half of the northwest quarter of Section 23, moving on to the east?

A No, sir, I would not on 80 or 40 acre spacing.

Q Now, would you drill a well in the southeast quarter of the northwest quarter of Section 24? An immediate offset to your, I guess that's a drilling well, isn't it, in the southwest quarter of the northwest quarter?

A Yes, sir. You did say the southeast quarter of the northeast quarter?

Q Yes, it would be an immediate east offset.

A No, sir, I wouldn't recommend a location to be drilled there.

Q Then there wouldn't be too much difference as to the undrillable leases as far as Sinclair is concerned, whether 40 or 80 go into effect?

A In one instance there was and in the other one there wasn't a difference.

Q I missed the one where you were going to drill, that is the northeast quarter of 23? A Yes,sir.

Q You would drill it in the northeast quarter of the northeast quarter?

A Yes, sir, if we knew that we were going to be committed to two wells for that quarter section, I think we could justify drilling a well there.

Q Couldn't you expect a great deal more recovery drilling a well in the southeast quarter of the northeast quarter?

A From that particular well, yes, sir, comparing the two wells I think you would expect a greater recovery.

Q The point I'm trying to make here, Mr. Gaines, is that it seems to me in a practical operation that all of these fringe wells would be drilled as near the better part of the field as you can and dedicate the acreage on out in the poorer sections away from the trend to the west unless a complete strict type of spacing is enforced there. You could expect, as I believe you testified, considerably more recovery if you drilled your second well in the northeast quarter of 23 in the southeast quarter of the northeast quarter rather than the northeast quarter of the northeast quarter.

A That is considering only the comparison of the two wells that we are considering there.

Q What you can expect by comparison, it would be a better well?

A Yes.

Q You would have every expectation it would be a better well?

A Yes, sir.

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

MR. PORTER: Anyone else have a question?

MR. McGOWAN: I would like to ask a few on re-direct examination.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q In discussing the two well locations with Mr. Cooley in the northeast quarter of 23, you stated that a well on the south 40 acres would be a better well than a well on the north?

A That is correct.

Q Would you expect to recover any more oil from under that 160?

A I would think that the recoverable oil from beneath the 160 would be less than it would be, would be less if both wells were drilled in the 80 to the south than if one well was drilled in the south half of the northeast quarter and the other well were drilled in the north half of the northeast quarter, yes, sir.

Q In evaluating the lease, you are looking at how you can get the most oil out of it with the least number of wells?

A That is correct.

Q When you talk about recommending wells or well locations to your management, you are talking about it from the purely economic

standpoint as calculated by you as an engineer? In other words, will it make a profit or not?

A Yes, sir.

Q Now, then, looking at the fringe areas again, obviously some of it, whatever portion it might be, would be developed on 80 that could not be developed on 40 from an economic standpoint, is that correct?

A I think that is correct.

Q Would you not also be justified in taking a gamble if you could hope to get all the oil out from under 80 acres on a well that you wouldn't be justified in taking if you had it restricted to 40 acres?

A Yes, sir, I think you would.

Q So what might not be a worthwhile gamble on 40 would be on 80? A Yes, sir.

Q Now, in talking about the wells that Sunray and Sinclair have drilled that they jointly own, all of those wells were at least 330 feet from the lease lines, were they not?

A Yes, sir.

Q That is what is presently and at that time were the requirements of the Commission? A Yes, sir.

Q I believe you stated that at least one of the reasons for so locating them was to avoid the gas cap area?

A I would imagine that that was one reason.

Q That is good conservation practice, is it not?

A Yes, sir.

Q Had the rules that you have advocated here today been in effect allowing us to attribute additional acreage to a gas well, it would not have been so important to do so, would it?

A No, it wouldn't. Assuming that the gas cap were being produced, however, there is very little gas being taken from the gas cap.

Now, just high ratio wells are the only ones that are producing the gas.

Q As to your recommendation for proration units in particular attention to the gas cap area, as I understood your recommendation, it was that the Commission establish 80 acre proration units for the entire Bisti-Lower Gallup Pool? A Yes, sir.

Q And that where a well produced at a gas-oil ratio of higher than 15,000 to 1, it be classified as a gas well?

A Yes, sir.

Q And that to such gas well there may be attributed up to four proration units, assuming those units were underlain by gas for allowable purposes? A Yes.

Q And that the allowable for the gas well would be calculated on the volumetric formula with a 2,000 to 1 limit gas-oil ratio?

A That is correct.

Q These three exhibits were prepared by you or under your

supervision, were they not? A Yes,sir.

Q To reemphasize, the two cross sections are to scale both vertically and horizontally? A Yes, sir, they are.

Q So they show the true dip and variation within the reservoir itself?

A Yes, sir, the horizontal and vertical scales are different, however they are scaled. They are both to scale, both horizontally and vertically.

MR. McGOWAN: I offer these three exhibits in evidence.

MR. PORTER: Without objection to the admission of the three exhibits, they will be admitted.

MR. McGOWAN: That's all.

MR. PORTER: Does anyone else have a question?

MR. SETH: I have a question that was brought up by reason of the re-direct examination.

RE-CROSS EXAMINATION

By MR. SETH:

Q I don't follow you, Mr. Gaines, on the reason why you would get more oil out of the northeast quarter of Section 23 by a well located in the northeast of the northeast?

A Yes.

Q Why do you say that, if you would maintain at the same time that one well will drain 80 acres?

A Well, I maintain that as you get to the flanks, towards the

flanks of this structure, you are going to get into tight sand and that certainly as you get into lower permeabilities your drainage radius is going to become less, and with two wells located on the south half of this 160 acre tract, your drainage radius would be considerably greater than it would be on 80 acre spacing actually to drain the whole 160 acre tract.

Q Your drainage area for your northernmost well would be less than the southern well, is that right? You say they are in tighter sands?

A Yes, sir, it would. It would have less drainage radius.

Q But you feel it would be a better well because it would have more acreage, is that right? Does that improve the well, Mr. Gaines, to have more acreage?

A I said the recovery.

Q Assigned to it.

A I believe I stated that the recovery from that 160 acre tract, and that is disregarding any drainage into that tract, any drainage situation that might occur, but the recovery would be greater with the location of a well in the northeast quarter of the northeast quarter.

Q Well, assuming, as you apparently did, that would be a mediocre well -- A Yes, sir.

Q -- you don't testify it becomes any better because it is on an 80 acre than on 40, or that it is more profitable on 80 than 40?

A I testified that a recovery would be greater if two wells, only two wells were drilled on the south half of the quarter section.

Q You would still, although it is in an obviously poor area, you would still attribute 80 acres to this well, is that right? You would assign 80 acres to it? A Yes, sir.

MR. SETH: That's all.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q Mr. Gaines, I think it's obvious that the assigning of more acres to a well will not make it any better well?

A No, sir, it will not.

Q If through one well you are allowed to recover the oil out from 80 acres, it is going to be more economical than if you can only recover the oil out from under it under 40 acres, would it not? A That is correct.

MR. PORTER: Mr. Cooley.

RE-CROSS EXAMINATION

By MR. COOLEY:

Q I'm confused, Mr. Gaines, I believe in answer to my question awhile ago you said a well drilled in the southeast quarter of the northeast quarter would be a better well than one drilled in the northeast, northeast quarter?

A Yes, sir, if you put the well on the pump or started producing it, it would be a higher capacity well then certainly,

assuming that something unusual doesn't occur, than your well in the northeast quarter would.

Q Is the reason that your total production from the two wells would be, I think you testified that the total production from the two wells if they were located both in the south half of the northeast quarter, would be less than the total production from the two wells if one is located in the northeast quarter of the northeast quarter, is that your testimony? If one well is located in the northeast of the northeast quarter, will the combined production of the existing well and this new well we are talking about, northeast quarter of the northeast quarter be greater than the combined production from the two wells located in the south half of the northeast quarter?

A Yes, sir, it would be. We are not talking about rates. We are talking about ultimate recovery.

Q When I said better well, I was really referring to ultimate recovery. I possibly should have qualified my question.

A The ultimate recovery of the 160 acre tract should be greater if one well were located in the southwest quarter of the northeast quarter, another well located in the northeast quarter of the northeast quarter, than it would be if one well were located in the southwest quarter of the northeast quarter and the other well in the southeast quarter of the northeast quarter.

Q Is the reason for that that your well in the southeast

quarter of the northeast quarter will interfere or will drain some oil that the well in the southwest, northeast quarter would not have drained?

A Would not have drained you mean?

Q Would the well in the southeast quarter of the northeast quarter cut down the production that you could expect from the well in the southwest quarter of the northeast quarter?

A No.

Q It wouldn't, I don't understand that.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q If you drilled two wells on the extreme southern edge of the 160, they would produce more oil than two wells drilled anywhere else on the 160, disregarding where the oil might come from, is that correct? A That is correct.

Q If you are attempting to recover the oil in place from under that 160 acres, then a well in the southwest 40 acres and the northeast 40 acres would come more nearly doing it?

A That is correct.

RE-CROSS EXAMINATION

By MR. COOLEY:

Q Did you mean anybody kicking back any oil that came from his well bore because it came from anybody else?

MR. VERITY: I take exception to that. We are trying to

establish a formula that will establish the greatest ultimate recovery from that pool.

A It would recover possibly more, less uneconomically.

MR. NUTTER: It is a matter of economics?

A Yes, sir.

MR. NUTTER: I think that four wells would probably drain more oil in that quarter section. However, we must take the matter of the economics of the thing into consideration.

MR. COOLEY: That concludes my questions.

MR. PORTER: Anyone else have a question? Mr. Utz.

By MR. UTZ:

Q Mr. Gaines, I believe you recommended a gas well over 15,000 GOR and up to 320 acres be dedicated to a well?

A Yes, sir.

Q Did you make any recommendation as to how the units would be dedicated to the well? In other words, by hearing of the Commission or by just purely a request of the operators as to whether you wanted to dedicate 80 or 320?

MR. McGOWAN: I think that is getting into a procedural question that our engineers should not attempt to answer. We feel that is a matter for the Commission's discretion as to whether they are going to have a hearing on each well or whether they want to do it administratively.

MR. UTZ: I will ask him another question to satisfy me.

Q Do you think, Mr. Gaines, it would be good practice to dedicate oil acreage to a gas well? A No, sir, I do not.

Q Then the dedication of acreage to the gas well should be

controlled quite closely? A Yes, sir.

Q Did you make any recommendation in your fixed spacing as to what part of the 160 acres the wells should be drilled in?

A No, sir.

Q Would you want to?

A Yes, sir. I think it would be certainly to the best advantage if each well were located in diagonal 40's within the 160 acre tract, it wouldn't make an awful lot of difference which way they ran.

Q The pattern is pretty well set up now, is it not?

A Yes, sir, I think so.

Q And to follow that pattern would be in accordance with your thinking? A I think so.

Q And did you make any recommendation, Mr. Gaines, as to what part of the 160 acres would be dedicated to each well, that is, the north-south, or east or west half?

A I have given that some thought. I don't know that I'm prepared to make a recommendation in that respect. However, I think certainly one thing that should be considered in the assigning of this acreage is the condition, or better, I might say the composition of the field, which is rather a long, thin field as far as the length and breadth goes. Also the gas cap possibly should have some influence on that too.

Q Do you agree that it would not be good practice to dedicate

dry acreage to an oil well? A Yes,sir.

Q Then the field being more east and west than it is north and south, would you say that there would be less danger of that if you dedicated the units to the south and north half?

A I think that that would certainly be a point in that dedication.

Q But you wouldn't recommend it?

A I think personally, I'm not speaking for my company, I can say personally that I would recommend it.

MR. UTZ: That's all.

MR. PORTER: Anyone else have a question of Mr. Gaines?

MR. McGOWAN: I might correct one statement for Mr. Gaines. He was speaking for the company.

MR. PORTER: Were you, Mr. Gaines?

A Yes, sir, I am.

MR. PORTER: I believe this is all the witnesses you have. The witness may be excused. We'll take a fifteen minute recess.

(Witness excused.)

MR. SULLIVAN: This is just in the matter of information. I don't think it needs to go in the record.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Sullivan, I believe you have one witness for British American. Would you have the witness stand and be sworn?

(Witness sworn.)

JOHN STEIN

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

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Would you state your name, please?

A I am John Stein.

Q Are you a petroleum engineer?

A Yes, I am.

Q Have you previously appeared before this Commission in this cause?

A Yes, I have.

Q Was that at the hearing held on the application of Sunray Mid-Continent on September 18, 1957?

A Yes, it was.

MR. SULLIVAN: May this man's qualifications be accepted as an expert witness?

MR. PORTER: Yes.

Q Mr. Stein, since the hearing held in this matter in September, has the British American Producing Company conducted any tests and studies to determine whether or not 80 acre spacing is the proper spacing for the Bisti-Gallup Pool?

A Yes, we have.

Q Will you describe the nature of those tests and your

conclusions? A Yes, I will.

I have here on Exhibit No. 1 the results of some bottom-hole pressure drawdown tests run by the British American Oil Company of two of our wells in the Bisti-Gallup Field, namely the Douthit B No. 5, located in the southwest of the northeast of Section 28, 26, I believe that is 12, 26 North, 13 West, and on the Douthit B No. 8, which is located in the northeast of the southwest of Section 27, 26 North, 13 West.

At the time we started these drawdown tests, all the wells had been shut in from seven to ten days prior to commencement of the drawdown tests. In particular, the Douthit B No. 5 had been shut in ten and a half days prior to commencing the drawdown tests, the Douthit B-8 had been shut in seven and a half days prior to the drawdown test.

We then initially took a bottomhole pressure on each of the wells, and approximately a day and a half later started producing the wells surrounding the Douthit B-5 and Douthit B-8 wells. Of course the Douthit 5 and 8 wells were left shut in during this time, and twice a day a pressure survey was taken on each of the wells.

The results of these pressures are shown graphically on Exhibit 1. The Douthit B-5 commencement of the test, the bottomhole pressure was 1078 PSI. Approximately a day, roughly two days later it was 1139½, a day later 1150, about four o'clock on the 12th, 1192, and it reached a stable peak at midnight and was 1195, then dropped

rather rapidly, at noon the next day, it was 1061, stayed fairly stable until the next day and a half and then dropped to 1031 PSI on noon of December 15 at which time we ran out of tank room.

The Douthit B-8 at the commencement of the test, the bottomhole pressure was 1036, then over two days it had built up to 1193, and then started a gradual drop 1173, slight build up 1178, very slight drop 1177, a fairly good drop to 1153, and then fairly stable pressure at 1162 to the end of the test at which time we ran out of tank and were unable to produce the wells any longer.

These drawdown tests, as I stated before, were conducted with these two wells shut in and the other wells producing.

Q Mr. Stein, have you indicated on this exhibit, this aerial exhibit on the right here, the wells to which you are referring in the exhibit to which we'll refer as British American No. 1. Have you indicated these wells on this aerial map?

A Yes, I have a circle drawn around them. I also described them in the testimony.

Q Thank you. Proceed, please.

A Now, as a result of these drawdown tests we can certainly see that interference exists between these wells, between the wells shut down and producing wells, otherwise there would have been no pressure drawdown in these two particular wells. That certainly indicates to me that one well can drain substantially more than 80 acres.

Q In your opinion, Mr. Stein, what is the area, the demonstrative area of interference as indicated by these tests that you have just described?

A Well, I would take the minimum area which would be between the nearest offset wells, these wells being about 1980 feet from the center of each of the shutdown wells, would calculate out something about 280 drainage as the minimum.

Q What do you mean by minimum?

A Of course, there are other wells out here producing. I can't definitely say that the drawdown was caused in B-5, say, from B-13, it was a combining of all the wells, but let's take the very minimum conditions which is the direct offsetting of the wells. That would indicate 280 acres.

Q Then the minimum area of demonstrable interference is, as you have just indicated, at least in the immediate offset well?

A That is true. Of course, the maximum could be this large area here.

Q You need not volunteer that. Let's just confine ourselves to the minimum that we have shown. Mr. Stein, you have across the top of the room a long series of cross sections. Incidently, let us refer to Mr. Stein's Exhibit there, the first one he used as British American Exhibit No. 1. I believe it is the first exhibit we have introduced in this cause. Let us refer to your next exhibit then as Exhibit No. 2, and will you describe to the Commission what

it is, please?

A Exhibit No. 2 is a cross section of certain wells across the field that were cored or on which core analysis were available to me, and of course --

Q (Interrupting) At what time now, you say were available to you, when do you mean?

A Well, during the time I was making this study.

Q Is that since the hearing held in September on this matter?

A Yes, it is.

Q Thank you.

A This cross section was prepared to illustrate the continuity of the sand clear across the field, and this is done by plotting actual measured values of permeability from core analysis opposite each of these wells. It extends from the British American Douthit 11, which is in the northeast, northeast of 29 on across the field and ends up about at the extreme southern edge of the field in the Lion No. 1 Atlas, I believe it is called.

As you can see, we can trace permeability, measured permeability, through core analysis clear across this reservoir on every well that was cored, and at the first bench some measurable amount of permeability was found. To me this indicates that the permeability distribution across this reservoir is continuous.

Q To anticipate a question which I'm certain Mr. Seth will ask, these are all hung from some common marker and do not, on the

cores, and do not represent any tilt or angle to the strata, do they?

A No, these do not attempt to show structure.

Q I do that in the interest of time.

A It's an accepted method of determining or illustrating the continuity of sands across the reservoir.

Q Were you present when Mr. Brinkley testified this morning?

A Yes, I was.

Q Do you recall his Exhibit 8-R?

A Yes, I do.

Q Do you remember what the substance of that exhibit was, Mr. Stein, what did it represent?

A It represented that the pressures in the vicinity of the pilot project had built up considerably and thereby indicated a maximum area of drainage, I believe, in the neighborhood of 1500 acres.

Q Are you a member of the Engineering Committee which was formed to supervise and study the pilot injection program?

A Yes, I am.

Q Do you agree with the conclusions that Mr. Brinkley drew, based upon his Exhibit 8-R this morning?

A Yes, I do agree with him.

Q Do you recall generally, and would you so state if you do recall what the conclusions were? Be as brief as possible.

A He concluded that the gas injection here had caused the pressures to build up in all the wells in the vicinity here and that a maximum drainage area around this particular injection well could be in the neighborhood of 1500 acres.

Q And those are the conclusions with which you agree?

A Yes, I agree.

Q You testified, I believe, at the earlier hearing, that you were in concurrence with the recommendations made by Sunray Mid-Continent in support of their application for 80 acre spacing in this field, is that correct? A Yes, that is correct.

Q Have you changed your opinion with regard to that concurrence since the last hearing? A No, I have not.

MR. SULLIVAN: That's all, Mr. Chairman.

MR. PORTER: Anyone have a question of Mr. Stein? Mr. Cooley.

CROSS EXAMINATION

By MR. COOLEY:

Q Mr. Stein, how many pounds pressure buildup did you get from shutin in the two wells shown on your exhibit, what is the number? A Exhibit No. 1.

Q Exhibit No. 1.

A Yes. Well, it built during the time that the pressure survey was being conducted, pressure in the No. B-5 well had built up from 1078 to a maximum of 1192, and then leveled off at 1195,

1195 was the maximum.

Q And what was it, something over a hundred pounds, I didn't catch the figures.

A Yes, from 1078 to 1195 would be 113 pounds.

Q What did you get on your other well?

A It built up from 1036 to 1193 maximum.

Q What is the difference there?

A About 167.

Q Now, are these wells affected in any manner, in your opinion, by LPG injection project?

A No, they would not be affected, I don't believe, they are too far away.

Q I believe you stated you were present when Mr. Brinkley was testifying this morning? A Yes.

Q And in response to my question, I had asked him when a well was shut in, what happened to the pressure on that well.

A Yes.

Q He said it would stabilize. I asked him if it would build up and his answer was, I believe, in the negative. Have you found that to be true in your experiments in this field?

A Well, if a well has been produced for any length of time, of course it has a bottomhole operating pressure which is somewhat lower than the static pressure would be. Certainly when you shut that well in that well will try to reach its static pressure.

Q Then do you think --

A (Interrupting) It will be something higher than the bottom-hole operating pressure, of course.

Q Do you think that there might be a possibility that the shut in of the wells around the LPG project might account for the appearance of the pressure buildup?

A I do not, I don't think so in that case.

Q Why?

A It has been a long time since those wells were shut in, oh, 120 days at least, and any additional pressure they have gained has been due to the pressure built up in the pilot project. Perhaps in the first three or four days that they were shut in they probably got some pressure buildup and reached a static, and then from there on any pressure that was added in those wells had to come from the pilot injection project.

MR. COOLEY: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Malone.

By MR. MALONE:

Q Mr, Stein, referring to your cross section up there, did I understand you to say those were all based on core analyses?

A Yes, sir.

Q Not electrical logs?

A No, the electric logs were merely put on there so we could

show the sands themselves. It would be rather difficult to show sands in relation to each other just from a permeability profile.

Q You had how many core analyses to work from?

A Oh, I would have to count them across there. Well, there is nineteen represented here.

Q They extended the entire length of the Bisti-Lower Gallup Pool, did they?

A Well, I would say fairly well over the entire length, yes.

Q So far as I can tell from this distance, as you have colored that area of permeability that you have traced through there, you have found it to be a single area that is coextensive throughout, is that correct?

A I have only attempted to show the permeability continuity in the No. 1 bench of the sand. I did not attempt to show it in the other benches.

Q This is then a single bench?

A Yes, sir, that is correct.

Q You do recognize the existence of other benches that are not portrayed by this exhibit?

A Yes, that is true. There are other benches, you can spot them on here as you go along.

Q The continuity that you found to exist in this bench doesn't necessarily exist in the other, does it?

A It wouldn't be so indicated by this.

Q So your testimony with reference to the communication that would result, is limited to the single bench as to which this exhibit is prepared?

A Yes, sir, that is correct.

MR. MALONE: That's all.

MR. PORTER: Anyone else have a question? Did you wish to offer your exhibits in evidence?

MR. SULLIVAN: Yes, sir, if everybody is through. I submit British American Exhibits 1, 2 and 3 in evidence in this cause.

MR. PORTER: Without objection the exhibits will be admitted. The witness may be excused.

(Witness excused.)

Is there anyone else wishes to present testimony?

MR. KELLAHIN: If the Commission please.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: If the Commission please, Jason Kellahin of Kellahin and Fox, appearing on behalf of Phillips Petroleum Company. We will have one witness, Mr. Lewis.

(Witness sworn.)

E. F. LEWIS

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

DIRECT EXAMINATION

By MR. KELLAHIN:

Q Would you state your name, please?

A My name is E. F. Lewis.

Q By whom are you employed and in what position?

A I'm employed by Phillips Petroleum Company as a supervising area petroleum engineer.

Q How do you spell the last name?

A L-e-w-i-s.

Q Mr. Lewis, does the area under your supervision include the pool under consideration here, the Bisti-Lower Gallup Oil Pool? A Yes, sir, it does.

Q Have you previously testified before this Commission and had your qualifications as an expert accepted by the Commission?

A Yes, sir.

MR. KELLAHIN: If the Commission, please, Mr. Lewis has appeared in examiner hearings. If it is the desire of the Commission we will go through them.

MR. PORTER: If he has previously qualified before an examiner it wouldn't be necessary.

Q In connection with your duties, Mr. Lewis, as supervising area petroleum engineer, have you made a study of the Bisti-Lower Gallup Pool? A Yes, sir, I have.

Q What was the nature of that study?

A Well, the nature of the study was to examine the economics

of 40 acre spacing versus 80 acre spacing in an entirely new approach and specifically to apply to the question raised by the Commission Staff with regard to saturation gradients and pressure gradients as to the recovery under the two types of spacing.

Q In making this study, would you describe the methods which you used?

A Well, in very brief, the method is an application of a material balance method presented by Luper and Calhoun in their technical papers 25, 92 as published in the Volume 186 of the AIME transactions. This study further was modified by the use of Bisti crude properties.

Q Now, in connection with the use of these Bisti crude properties, have you prepared an exhibit showing what those are?

A Yes, sir, I have.

(Marked Phillips' Exhibit 1-R, for identification.)

Q Referring to the exhibit which has been marked as Phillips' Exhibit 1-R, would you state what that is?

A These properties shown in Exhibit No. 1-R are simply the variation in formation of volume factors, solubility, oil and gas viscosity and gas conversion factor as taken, being the average of two bottomhole samples, one taken on Sunray Mid-Continent Federal C-21 and the other was British American Marye B No. 1 well.

Q Now, Mr. Lewis, in making your calculations, what results

did you find in applying this method to the Bisti Pool?

A I found that, essentially, that the result of this calculation was that there was no effective difference between the ability of the well to drain 40 acres as compared to 160 acres, which was the spacing that I used for a particular purpose in this examination.

Q Now, referring to Phillips' Exhibit 2-R, would you state what that is?

(Marked Phillips' Exhibit 2-R, for identification.)

A Exhibit No. 2-R is a graphical portrayal of the saturation distribution as it would be in various stages of depletion in a 40 acre developed area as compared to 160 acre developed area.

I might, if I may, refer to the larger scale copy of that exhibit and briefly explain that this represents the saturation distribution, the heavy line represents the saturation distribution as it would be around a well drilled here, and the second well drilled at this position.

Q You say at this position, what do you mean by the two relative positions, Mr. Lewis?

A Where the two wells would appear they would be on 40 acre spacing. The dashed line represents the saturation distribution around the well bore on a single well drilled on 160 acre spacing at this common location here.

These three curves represent the saturation distribution at

three separate stages of depletion. The bottommost one being the distribution in effect at the abandonment pressure.

Q Which you show as 137 pounds per square inch, is that correct?

A Yes, sir, that is correct.

Q Is that exhibit in proportion, Mr. Lewis, in regard to its size?

A No, sir, of course the significant element in this saturation distribution in the exhibit is the shaded area here which represents the saturation sink which occurs by the drilling of this additional well as against a single well at this point, and of course at this final stage of depletion this relatively pressure sink or saturation sink represents then the difference in recovery which would occur as between the 160 acre well drilled at this point and the infill well drilled at this point.

Q The infill well being on a 40 acre pattern?

A The infill well being drilled on 40 acre pattern. This roughly two feet in height here represents something on the order of 27½% of the total pore space in the reservoir. If we were to represent all of the pore space occupied by oil in this reservoir by a graph, it would be approximately eight feet in height, which is a little bit impractical, it is easy to string them out, but you can't get them up quite that high.

Than with an exhibit eight feet in height, this shaded area

represents the difference in recovery that you would achieve with an infill well on 40 acre spacing.

Q Now, what percentage of the oil in place does the shaded area represent then, Mr. Lewis?

A According to my calculation it represents four hundredths of one percent of the total stock tank oil originally in place.

Q In making this calculation, did you take into consideration any pressure maintenance or secondary recovery process that might be effected?

A No, sir. To have considered that would result in, rather secondary recovery operation or pressure maintenance operation would nullify even that difference in ultimate recovery.

Q Now, have you made a calculation on a material balance method, Mr. Lewis?

A Yes, sir. I have made the calculation material balance performance on this field by the specialized method which I originally referred to, and that method, by its nature, permits one to compare the relative performance on 160 acre spacing versus 40 acre spacing or any other interval that one might wish to do.

In other words, this special adaptation of the material balance equation of Luper and Calhoun considers a bounded area and therefore you can evaluate the performance of whatever area you chose or, in fact, whatever rate of pressure drawdown that you might wish to impose on the reservoir.

Q Now, is that information reflected on Exhibit No. 3-R?

(Marked Phillips' Exhibit No. 3-R, for identification.)

A Yes, sir, Exhibit No. 3-R is a plot of the gas-oil ratio and pressure performance, using the Bisti crude as applied to this Luper and Calhoun method, the gas-oil ratio is demonstrated by the curve beginning in the lower left-hand portion of the exhibit, and the pressure performance is that curve which begins in the upper left-hand portion of the exhibit.

Now, the several points, the different methods of indicating points at essentially the same spots on this thing represents the performance with the open circle on 160 spacing and the cross on 40 acre spacing. I think that the significant element here is that these points are in effect superimposed on one another and it would be impossible to draw or indicate a separate performance characteristic which would be attributed to the 160 as compared to 40 acre spacing.

Q Are we to understand this is a modified application of the material balance method? A Yes, it is.

Q Have you tested this calculation against the conventional method of arriving at a material balance curve?

A No, sir, I didn't personally make that comparison, but the authors in their paper made a comparison and I have taken a material balance calculation which was made in a completely independent

manner, and which predates both of these hearings and incorporated that as our Exhibit No. 3-R-A I believe. That is a transparent overlay which when superimposed on this curve will show the agreement in the two methods.

Q Now, does this support then the validity, in your opinion, of your calculations?

A Yes, sir, it is my belief that it does.

Q Do you have anything you want to add to that, Mr. Lewis?

A No,sir.

(Marked Phillips' Exhibit 4-R, for identification.)

Q Now, referring to Exhibit 4-R, would you state what that is?

A That is a tabulation of the same data which is on this Exhibit 3-A on which the 3-R is based.

Q What are the significant factors that appear on that exhibit?

A Here again is the only point or the only manner in which we can see really the difference between 160 acre and 40 acre spacing and that is in the final point here at pressure decrement No. 7 we find the difference in recovery of four hundredths of one percent of the oil in place.

Q Have you calculated what that would represent in terms of barrels of oil?

A Yes, based on an oil in place figure of 220,000 barrels,

this would represent approximately 390 barrels.

Q Would that represent an increase in the cost of recovery as against the spacing on the 40 acres as against 160?

A Well, to express it in terms of development cost, this would require that we spend approximately $180.00 per barrel to develop this additional oil. That cost figure is based on a well cost of $54,000 conservative estimate of well cost, incidently.

Q Were you present at the previous hearing in this case?

A Yes, sir.

Q Was that approximately the well cost represented by the testimony of Shell's witnesses?

A As I recall, that was their estimate of the well cost including pumping equipment and a share of the lease facilities I believe they referred to.

Q Again, Mr. Lewis, does this calculation that you have made as to the amount of oil to be recovered, and the other testimony you have given on these exhibits, take into consideration the effect of pressure maintenance or secondary recovery?

A No, sir, it does not.

Q Does the calculation take into consideration the economic limits of oil production?

A No, it does not consider the effect of economic limits on oil recovery.

Q Now what effect would a pressure maintenance program have

on this?

A It would tend to further minimize the difference in recovery between the 40 acre and 160 acre spacing patterns.

Q In your testimony so far you have referred to wells spaced on 160 acre spacing as opposed to 40 acre spacing. For what reason did you do this?

A Well, the purpose was to emphasize the lack of difference between recovery on the 40 acre spacing as opposed to some wider spacing, and also to highlight the fact that the distance that oil must travel from the limit of a drainage radius to a well bore is immaterial as to the amount of recovery that may be attained at a well, and also it follows that no matter how tortuous the path the oil must follow in a low spacing to get to the well bore it will get there with no loss of ultimate recovery, or certainly very little loss.

Q Your answer to that question then, and the calculations which you have made, assume a continuous reservoir, do they not?

A Yes, sir. This material balance method, as in all other methods of evaluation in which gross reservoir properties are used, does require the assumption of continuity within the reservoir.

Q Now, have you made a study and have you had experience with sands of similar characteristics to the sands found in the Bisti Field in that connection?

A Yes, sir. In my personal experience I have observed a

number of reservoirs in which sands are of generally similar characteristic.

Q Now, you have heard the testimony in this case. In your opinion is it a practical thing to attempt to correlate sand continuity on the basis of the presence or absence of the showing of continuity on core data and electric logs?

A No, sir. In my opinion unless you have pressure interference data or some similar type of data, it is extremely hazardous to assume that you have either continuity or lack of continuity.

Q In other words, you would have to have some performance information to consider in connection with that?

A Yes, sir, with the one exception in considering that historically these fields in which we have variation in permeability and variation in an apparent lack of continuity that the reservoirs do perform as a homogeneous mass.

Q Now, what experience have you had that shows that?

A Well, the best example of that arose in the evaluation of a secondary recovery project in which Phillips was the operator in the North Burbank Unit of northeastern Oklahoma.

Now, this reservoir, as in Bisti, is a solution gas drive reservoir. The reservoir is an offshore bar deposit having generally similar sand and fluid characteristics to the Bisti Field.

In that study a series of injectivity profiles were run in injection or input wells and compared with permeability profiles

in the same wells, and in the course of these studies it was observed that there was little or no correlation between the injectivity profile and the permeability profile within the same well.

Q Is that shown on Exhibit No. 5-R?

(Marked Phillips' Exhibit 5-R, for identification.)

A Yes, it is. This is one of the number of permeability profiles that were run on wells in which there was core data available. This illustrates the lack of continuity of injection and the lack of correlation between input rate in a given foot of sand as compared to the permeability in that foot.

Q Well, did you have any experience in connection with this particular pool which supported your contention that it was a homogeneous reservoir?

A Yes, sir, I was employed as a reservoir engineer in this North Burbank District of Phillips for a period of a year and a half. I did not, however, participate in the actual running of these injectivity profiles.

Q What facts,then, supported your contention in that pool that it was the homogeneous reservoir, Mr. Lewis?

A Well, I would like to back off here just a minute, if I may, and further explain something about this peculiar performance that was observed here in this lack of correlation between injectivity profile and the permeability profile and state that in

view of this peculiar performance, our research department took a sample of a core from this well and drilled horizontally through this four and a half inch core sample and divided that cylinder into three separate permeability plugs and tested the permeability on those three small pieces and found that within that four and a half inch section that the permeability varied in the order of 300%, so that naturally disturbed them very much and led to a further investigation to see if this was a peculiarity of that particular four inch sample that they ran or whether it was more nearly characteristic of the nature of permeability itself. And they took then six inch by four and a half inch core section and divided that into forty-eight separate permeability plugs and tested the permeability on each of those forty-eight samples. The results of that detailed, more or less detailed, examination of this one small core sample is shown, I believe, in Exhibit 6-R.

(Marked Phillips' Exhibit 6-R, for identification.)

Q What is the significance of the figures shown on Exhibit 6-R, Mr. Lewis?

A Well, this exhibit, as I see it, illustrates that to take a single core sample from a foot of formation is rather grossly misleading and here we have within six inches a variation in permeability from nine-tenths of a millidarcy to twenty-eight millidarcies, I believe is the highest one shown in this series of

forty-eight samples.

The conclusion then, from this, is that it's somewhat presumptuous to assign permeability value to not simply the one foot vertical distance that is commonly done, but to also assign that same value to a length of 600 or 1300 feet or however far the distance may be between several wells.

So that a fallacy can arise from the use of the very small sample that is given a reservoir by the one sample per foot method.

Q Yet in spite of this wide variation in permeability, you found in this particular reservoir, did you find that it operated as a homogeneous reservoir?

A Yes, sir, this reservoir was a remarkable example of homogeneity despite the lack of continuity in this projectivity profile.

High permeability, the fact that it did behave as a homogeneous unit, was illustrated by the fact that in the area of which these wells are a part, approximately ninety-nine and three-tenths percent of the calculated fillup volume was required to be injected before any increase in oil was observed in the offset oil producing wells.

Now, that fillup volume, incidently, was calculated on the basis of all of the measureable permeable sand in the core sample.

Q Now, in your opinion is this situation similar to the situation that you have found in the Bisti Pool?

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A Yes, sir, It is.

Q Are we to infer from what you have said that you do not agree that there is a continuous sand body across the reservoir?

A That I do not agree there is a continuous sand body.

Q The fact that you have shown there may be a discontinuity of permeability, are we to infer it is not a continuous reservoir then?

A No, sir, I would not infer it is not a continuous reservoir because of the lack of continuity of permeability illustrated in the several core samples or core information that has been presented here and because of the fact that you can't correlate specific elements within the gross sand interval, it's my belief that as a result of this work that it is all you have to prove to establish that the reservoir will behave in a homogeneous manner, is that you do have continuity of the gross interval.

I think I might add that the gross, the existence of a gross interval of continuity has been proven here, and certainly it was our intention to prove that and further that continuity has been indicated by the interference tests introduced in evidence here despite this apparent lack of homogeneity and despite the fact that you can't take individual elements of the sand and correlate them from well to well.

Q Now, on the basis of your study of the Bisti and on your experience in other areas, what are your conclusions then, Mr. Lewis?

A Well, it is my conclusion that the effective continuity does exist within this reservoir and that one well therefore will economically and efficiently drain 80 acres.

Q And is that your recommendation to the Commission then?

A Yes,sir, it is.

Q Do you have anything further you want to add to this?

A Well, I believe that my thoughts in the matter are rather well summed up by a report on well spacing by the Research and Coordinating Committee of the Interstate Oil Compact Commission, made September 10, 1951 at a meeting of the Commission. I would like to, if I may, quote several of the conclusions of that Committee which I believe fairly represents my thoughts on the matter.

The first of these is that, and I quote, "While porosity and permeability in most fields are known to be irregular and to lack apparent continuity, fluid flow performances are much the same as if discontinuities did not exist. In either solution gas-water drive or combination drive reservoirs,the production of oil is independent within reasonable limits of well density. Where land lease controls permit, new oil fields could be first developed on wide spacing patterns, final well density and other development and production practices could then be determined in the light of geologic engineering and economic information development."

Q Mr. Lewis, to go back in your testimony a ways to a point I think we overlooked, you stated I believe that you did not take

into consideration the economic time element in connection with your calculations, is that correct?

A The original statement as to the amount or the difference in recoverable oil as between 40 and 160 acre spacing did not consider the economic time of depletion. I did, however, for the purpose of illustration, assume that we might be forced in consideration of economic rates of production, to abandon the reservoir at somewhat higher pressure than we would under 40 acre development, and in that example I used a depletion pressure of 175 pounds.

From Exhibit 3-R. The recovery at that point, as I remember, would have been 19.6% of the original oil in place, and the difference then in recoverable oil would have been 1800 barrels on 80 acre spacing versus 40 acres spacing under those conditions and the development cost of that oil, using the same well cost value would be approximately $30.00 per barrel.

MR. KELLAHIN: That's all the questions we have. Thank you, Mr. Lewis.

MR. PORTER: Anyone else have a question of Mr. Lewis? Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q Mr. Lewis, in your calculations, they were of course made on the assumption that it was a homogeneous reservoir?

A Yes, sir.

Q I conclude from your subsequent statements that it doesn't make any difference in these calculations whether it is homogeneous or not?

A No, sir, I don't believe, it certainly wasn't my intention to convey that.

Q I thought you testified that the performance would be, you would expect the same performance where it was homogeneous or heterogeneous.

A No, sir, my intention was to make it clear that reservoirs behave as a homogeneous unit whether they appear to be heterogeneous of discontinuous or not.

Q Then you speak of the performance then as the same whether it is heterogeneous or homogeneous?

A In that sense, yes, sir.

Q Then you would in this particular case, I had a little difficulty in following when you were testifying about the Oklahoma field, and in this field, in this particular field you would ignore the facts if they be established that there are isolated areas in the pool that would be productive of oil, in arriving at these calculations?

A Well, sir, I don't know that we have gotten into the question of isolated areas within the pool as yet.

Q Well, that was part of the heterogeneous nature of it, perhaps I am mistaken in my terms, if there are wide variations in

permeability which result in isolated sand members, would you ignore that situation in these calculations that you have made?

A Well, it is my contention that the wide permeability variations do not result in isolated --

Q (Interrupting) Then you haven't considered that, is that your answer?

A (Continuing) -- areas.

Q So I understand since you do not believe they occur, you have not considered them?

A My experience leads me to ignore them, yes.

Q Then you have ignored them, have you or haven't you?

A Well, fundamentally this method -- this method dictates that you must ignore isolated elements in the reservoir if these isolated elements, in fact, exist. My experience, however, dictates that there are no such things, generally there are no isolated elements in the reservoir.

Q Your answer is that you have ignored them as far as the Bisti Pool is concerned?

MR. KELLAHIN: I submit he has answered the question.

A I don't believe, if I understand all this thing correctly, I don't believe that I want to say that.

Q I'm not trying to lead you into anything. You said your experiences lead you to ignore it, but you would never answer my question. If your experience would lead you to ignore it, did you

or didn't you ignore it?

A Might I say that I don't recognize there are separate elements in this field.

Q They don't make any difference as far as the calculations are concerned? A No, sir.

Q You have also ignored the time factor too, is that correct? I believe in response to Mr. Kellahin's question that the time of recovery does not enter into this picture as far as your calculations are concerned.

A No, sir, it does not. However, the last question that Mr. Kellahin asked brought out that we did make a separate calculation considering to some extent the difference in recovery that would result from economic timing.

Q Yes. Are you in the economics department of Shell Oil Company? A No, sir.

Q I didn't get your qualifications.

A I am not with Shell. I might listen to an offer. I am in the production department.

Q You are in the production department?

A Yes.

Q You would precede your statement that you made an approach to the economics of it, what is the new approach, is that the proposition whether it is heterogeneous or homogeneous doesn't make any difference?

A No, the approach is something that I don't believe was brought forth in the last hearing, that I have attempted to show mathematically that there is no practical difference between the recovery on whatever spacing you might choose to institute here.

Q And your study data took you into the core analysis and that type of data? A I didn't hear you.

Q Did your study of the field take you into the matter of core analysis, core data, or wasn't that necessary for, did you ignore that also?

A It is not necessary to the method that I go into detailed examination of the core data, no, sir.

Q You didn't do it then, is that right, if it is not necessary?

A I didn't do it in respect to this particular calculation I made.

Q It doesn't enter into the material you presented to the Commission today?

A It doesn't enter into the material balance method of calculating oil in place.

Q Does Phillips follow a method of sampling cores every foot or every two feet, what is the practice?

A Every foot. One sample per foot generally.

Q Do you still follow that practice although you are inclined to cast some doubt on it, is that correct?

A Yes, sir.

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

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q Mr. Lewis, with reference to this North Burbank Pool in Oklahoma, I understand that you find a marked similarity between that pool and the pool under consideration here?

A A general similarity, yes.

Q On what spacing pattern is that pool developed?

A Ten acre.

Q With reference to the experiments that were conducted by your company on the core samples, that resulted from your having encountered quite an unusual condition, did it not?

A Yes, sir.

Q And because that condition was so unusual, you performed a number of experiments which you would not normally have performed in the course of the operation you were conducting?

A Yes, sir.

Q You concluded from those experiments, conducted in this unusual situation, that to all intents and purposes the Commission in this case would be justified in disregarding permeability entirely in the treatment of this reservoir, is that a correct conclusion?

A Well, I wouldn't want to go quite that far, not entirely certainly, since we must have some permeability in order to be able

to produce oil.

Q And in determining the characteristics of the reservoir and the manner in which the greatest ultimate recovery can be obtained, it will be appropriate for the Commission to give some consideration to the permeability situation found to exist, will it not?

A Yes, sir.

Q In suggesting that a wide variation in permeability and a great reduction in permeability may be ignored, is there any limit to that? In other words, if we have a, let's say a fifty foot section of extremely low permeabilities, do you mean that its effect on the performance of the reservoir would be different than if it was only ten feet?

A I don't know that I understand exactly what the meaning of your question is. Certainly a well with fifty feet of permeability, one-tenth millidarcy is going to have some difference in flow charadteristics than one having ten feet of permeability of the same permeability in forty feet as some other permeability.

Q It is true that we spent quite a bit of money fracting wells to improve the permeability even though it may be disregarded, isn't it?

A I don't know whether I want to go all the way along with you or not. We did spend a lot of money fracting wells, that is true.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Nutter.

By MR. NUTTER:

Q Mr. Lewis, this Exhibit 5-R, is this a portrayal of the input rate and the permeability of this North Burbank Unit Well No. 127W8 or it is a North Burbank Unit Well, isn't it?

A These wells are in the same, they may not be the same well. I failed to check that particular point when I got these exhibits together. They are in the same, I believe 90 to 120 acre area, however.

Q Well, whether it is the same well or not, it is immaterial. This is the North Burbank Unit Well?

A Yes, sir.

Q First of all, how did you determine the input rate per foot in this well?

A We used a device, an instrument that has been developed by Phillips' Research Department. I don't know whether I can explain exactly how that works or not or whether my research people would want me to explain how it works, since I think that some features of it are patentable, but it was, part of this study was intended to give this injectivity profile instrument a marketable quality and that's part of what generated our interest in why the injectivity profile didn't agree with the permeability profile.

Q Did you ever solve the reason why the bulk of the water

that finds its way in the reservoir is opposite the zones of low permeability?

A We believe we found the answer to it in the detailed core study which is Exhibit 6-A which indicates that you don't have the same permeability across four inch increment, that you can't presuppose that because the sample that you have at hand has a permeability that it's applicable to the next inch or the next foot or the next 600 feet of formation away from this thing.

Q But a zone of measureable permeability such as from 2980 feet to 2985 which has reasonably high permeability and yet a low injectivity, does this detailed analysis of small cores account for something like that?

A It's our thought that it does, yes, sir.

Q Did you attempt to measure the permeability in a well before you perforate that well?

A Do we attempt to?

Q Yes, sir. By logs or any such means.

A I don't believe we do ordinarily, no, sir. The permeability data is not available until after the fact, so to speak.

Q Well, isn't a microlog an indication of permeability in some cases?

A In a general sort of way.

Q You attempt to determine permeability where you have one according to the law? A Yes.

Q So if where you can have high permeability or high injectivity and conversely a high rate of output on a producing well in a zone with low permeability, you probably attempt to perforate where high permeability is indicated, don't you?

A We're just delighted to get any permeability, and we perforate anything, generally anything that looks good either on these micrologs or the other log characteristics which are not quite as definitive as the microlog is.

Q I see. Was any section of this well on this exhibit stimulated in any way to affect the injectivity?

A No, the only treatment that was given the well, to the best of my knowledge, was a small slack period with perhaps a small acid treatment to relieve any mud effects on the well bore itself.

Q None of this stimulation could have affected the reservoir opposite the well bore?

A Not to a material degree, no, sir.

Q What was that last document that you read from which summarized your thoughts on the subject?

A The report by the Research and Coordinating Committee of the IOC Commission, made at their meeting of September 10th, 1951.

Q The first paragraph that you read, would you read that again, please?

A "While porosity and permeability in most fields are known to be irregular and to lack apparent continuity fluid flow performances

are much the same as if discontinuities did not exist."

Q Did the Research and Coordinating Committee attempt to explain that phenomena?

A I don't know. I believe that there are several references throughout this thing to experiences in which heterogeneous reservoirs have performed as though they were homogeneous.

Q On your Exhibit 2-R where you show a very small difference in the production of oil from a hundred sixty acre spaced well to a forty acre spaced well, does that take into any account the time that these infill wells may be drilled or Exhibit 3-R, is the time in which the infilled wells are drilled considered at all?

A No, sir, I believe it would be immaterial.

Q It would be immaterial? A Yes, sir.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question of the witness?

MR. KELLAHIN: If nobody else does, I do.

RE-DIRECT EXAMINATION

By MR. KELLAHIN:

Q In response to the question by Mr. Malone as to whether you disregarded permeability in your calculation, actual performance as demonstrated by interference is of more importance in your opinion, is that correct?

A Yes, sir, I think that is the critical evaluation of that.

Q We are not to infer from your testimony that you would

greatly disregard the factor of permeability in connection with your testimony, are we?

A I don't believe that we can completely disregard it.

Q Would it be correct to say that your testimony goes to the effort to correlate permeability as between wells and across the field rather than a recommendation that permeability be ignored?

A Certainly I wouldn't recommend that permeability be ignored. I think it's my intention that it was to set forth that specific intervals of permeability need not be correlatable from well to well in order to show continuity from well to well.

Q Were the exhibits which you have used in this testimony prepared by you or under your directions and supervision?

A Yes, sir, they were.

MR. KELLAHIN: At this time we offer in evidence Phillips Petroleum Company's Exhibit 1-R through 6-R inclusive.

MR. PORTER: Without objection these exhibits will be admitted. Does anyone else have a question of the witness?

RE-CROSS EXAMINATION

By MR. COOLEY:

Q Your material balance calculations assume throughout that one well will drain 160 acres, do they not?

A They don't assume, they are intended to prove that they will develop or rather drain 160 acres.

Q They are intended to prove it? A Yes, sir.

Q By what manner? A Well --

Q Can you sit down with a pencil and prove it will drain 160 acres?

A That is what I have done, mathematically proved that one well will drain 160 acres.

Q I don't understand from your figures how you can assume that one well will drain 160 acres.

A It isn't an assumption any longer. As far as I'm concerned, it becomes a fact that according to the mathematics and the mechanical and physical principles involved, that one well will drain 160 acres.

MR. COOLEY: That's all.

MR. PORTER: Does anyone else have a question of Mr. Lewis? The witness may be excused.

(Witness excused.)

MR. KELLAHIN: That's all we have, Mr. Porter. Thank you.

MR. PORTER: Is there any other Applicant in this case that has testimony to present?

MR. BUSHNELL: H. D. Bushnell, attorney, representing Amerada, co-Applicant. We have one witness and four exhibits which we don't have enough copies to pass out to all those who might like a copy, and therefore, we would like to take a couple of minutes to post them on the bulletin board.

MR. PORTER: Take a couple of minutes, we will take a

five minute recess.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Bushnell, will you proceed.

MR. BUSHNELL: Amerada has one witness to be sworn in.

(Witness sworn.)

R. S. CHRISTIE,

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

DIRECT EXAMINATION

By MR. BUSHNELL:

Q Would you state your name and the company by whom you are employed?

A R. S. Christie, Amerada Petroleum Corporation.

Q And in what capacity are you employed?

A Petroleum engineer.

Q And you have testified before this Commission on prior hearings, is that right? A Yes, I have.

Q Mr. Christie, will you go up to the blackboard and point out Amerada's Exhibit 1-R and state what it purports to show.

A Exhibit 1-R is drawn to represent the development of a 640-acre section based on the statewide field rule, or statewide rules. To be specific, that is 104-C. The dots represent the wells 330 feet from the corner of each quarter quarter section, if we assumed that one well will drain only 40 acres. The stippled

area represents that area which will not be drained by this sort of development.

Q Now, how many acres is represented by the stippled area showing undistributed area or acreage area?

A The undistributed area, assuming that one well will drain only 40 acres, represent 280 acres.

Q So that means that 280 acres would be undeveloped or undisturbed? A Yes, sir.

Q Now, this plat, or Exhibit No. 1-R, does not purport to represent the development of any particular field, is that right?

A No, sir.

Q Now, refer, Mr. Christie, to Amerada's Exhibit 2-R. Would you state what that represents?

A Exhibit 2-R indicates the same thing except that the wells indicate that they are draining ratably as we would expect, of course, in any well, so that in this case, we also have a stippled area that represents essentially the same thing as in Exhibit 1-R. I think actually it is about nine acres less.

Q Approximately nine acres less of the undisturbed area than that represented in Exhibit 1, is that correct?

A Yes, sir.

Q Now, Mr. Christie, do you conclude from these two exhibits that any well pattern that locates the wells as close as 330 feet from the outside boundary line prevents the full development of the pool unless each well drains in excess of 40 acres?

A Yes, sir, I do.

Q Now, would you refer to Amerada's Exhibit 3-R and state what that purports to show?

A Exhibit 3-R is intended to show the drainage area of uniformly spaced wells on 80 acre spacing.

Q And that is on the assumption that those wells are located on the center of each alternate 40-acre tract, is that correct?

A Yes, sir.

Q Now, how many acres is represented in the stippled area which purports to be the undisturbed area?

A The total undisturbed area? On Exhibit 3-R it is 57.9 acres.

Q And how does the size of that undisturbed area of 57.9 acres, as shown on Amerada's exhibit, compare with the size of the undisturbed area assuming a 40-acre well development pattern, and that such 40-acre wells were located in the center of each 40 acre drilling unit?

A It would be exactly the same. In other words, if you drilled the section up on a 40-acre basis with the wells located in the center of the 40's, you would have an undisturbed area of 57.9 acres.

Q Now, Mr. Christie, refer to Amerada's Exhibit 4-R and point it out and explain what that purports to show.

A Exhibit 4-R simply shows the development of a section with the wells located similarly as in Exhibit 3-R and showing the

units running north and south.

Q And such wells are located in the center of the alternate 40-acre tract?

A Yes, sir. And in this case we would have no undisturbed area.

Q Now, is it your conclusion from these four exhibits that if a well will drain 80 acres, the infill wells are unnecessary to develop such a pool?

A It is my conclusion, yes, sir.

Q Were these four exhibits prepared by you or by some one under your supervision? A Yes, sir.

Q Now, Mr. Christie, if you will return to your chair, please. Are you acquainted with the provisions of this Commission's Order R 106, dated October 9, 1957?

A Yes, sir.

Q Is it your understanding that the effect of this order is to authorize the location of wells in the Bisti Pool as close as 330 feet from the boundary line of each 40-acre drilling unit?

A The order would permit that, yes,sir.

Q Is there any findings in this particular order that a well completed in this Pool will effectively and efficiently drain any number of acres? A No, I believe not.

Q Assuming that a well completed in this Pool will effectively and efficiently and economically drain 80 acres or more, in your opinion, will development on an 80-acre well spacing pattern

drain this pool just as adequately as development on the basis of a 40-acre well pattern development?

A Yes, I do.

Q You have heard the testimony and reviewed the exhibits presented at this hearing by the applicant today, is that correct?

A Yes, sir.

Q Based on that evidence and testimony, in your opinion, can the Bisti Pool be adequately developed on the basis of an 80-acre well pattern? A Yes, sir.

Q Do you wish to state anything else or make any other conclusions, Mr. Christie?

A Well, it is not my intention to suggest that the statewide rules be changed. I think they are perfectly adequate to develop any oil field we have, and I think the spacing is probably immaterial since one well will drain, as has been testified, as much as 160 acres, so that the spacing is not material, and the advantage of having the flexibility of a 330, I think is proper also. What I probably intend to show here is that the Commission itself apparently realizes or recognizes the fact that, by their own order, one well will drain more than 40 acres in this field, or any other field for that matter.

Q Now, is it your opinion that one well will drain a minimum of 80 acres in the Bisti Pool? A Yes.

Q And is that the opinion upon which you have now reached the conclusion that this Bisti Pool can be adequately developed on

the basis of an 80-acre pattern development?

A Yes, sir. There has been quite a bit, if I may add -- There has been quite a bit of discussion on how much one well, or what area one well will drain, and I have a report here that I would like to submit to the Commission, if they would like to have it. I would like to read from that report the following exerpt which is very short. This is a report by W. O. Keller and F. H. Calloway. It is titled, "Critical Analysis of the Effect of Well Density on the Recovery Efficiency," and they have found by their experiments and by their work that a hundred and sixty acre spacing, the recovery based on the percent of original oil removed would be only 16.2 percent or would be only 16.2 percent. Now, on an 80-acre basis, the recovery of the percent of the original oil in place would be 16.3 percent. In other words, they found that there is only one-tenth of a percent difference between recovery on an 80-acre and 160-acre tract, and they have continued that on to two and a half acres where they get only 16.93 percent recovery on a two and a half acre basis, and if the Commission would like to have a copy of that, I will submit it for the record.

MR. BUSHNELL: I suppose that should be shown as Amerada's Exhibit 5-R, then. I believe that is all I have.

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

MR. SETH: On your Exhibit 2, if the Commission should require that the well be drilled in the center of a 40-acre tract, would you have any estimate as to --

A I gave that, Mr. Seth, I believe. It would be exactly the same as an 80-acre basis or 57.9 acres.

MR. PORTER: Does anyone else have a question? The witness may be excused.

(Witness excused.)

MR. PORTER: Mr. Bushnell, would you like to move the admission of your exhibits?

MR. BUSHNELL: Yes, I move that Amerada's Exhibits 1-R through 5-R be a part of this record.

MR. PORTER: Is there objection to Amerada's Exhibits? They will be admitted.

Are there any other of the applicants in the case that would like to present testimony?

MR. WHITE: At this time Sunray would like to incorporate by reference the statement made by John Woodward in the consideration of the oil allowable for the Month of December as the statement was given November 14, 1957.

MR. CAMPBELL: Would you mind restating that, Mr. White, incorporate by reference the statement of John Woodward in consideration of the oil allowable for the month of December?

MR. MALONE: Was he under oath?

MR. WHITE: He was under oath.

MR. COOLEY: What is the significance?

MR. MALONE: I object to it, if the Commission please.

I don't know what the statute says, but apparently it has no relation to this hearing. I am sure there are parties who are interested in this hearing who were not present at the time he testified. If there is anything Mr. Woodward could testify to that would be pertinent to this case, he should be presented as a witness so that he would be cross examined by the interested parties.

MR. WHITE: If the Commission please, we think it is very significant as to the economics involved in this hearing, the question of a person being required to go through the cost and expense of drilling on a 40-acre tract in consideration of the probable market demand that might be available to him. Mr. Woodward brought out very clearly that the filling of the pipeline will take until about the middle of February. It is an artificial false market, and also he further stated that it would take more than a crystal ball to even estimate what the market demand on the West Coast might be for New Mexico crude oil. He also brought out that --

MR. SETH: If the Commission please, I believe counsel is virtually stating the contents of the statement, and I think it should be in or out.

MR. WHITE: Mr. Cooley asked what the significance was. I would like to state what material parts of the statement might be --

MR. PORTER: Just one moment, Mr. White.

MR. WHITE: And I might state that as far as Mr. Malone's objection is concerned, there were some twelve representatives of Shell and about four or five representatives of Gulf present at this hearing. It certainly has material bearing on economics in this case. Mr. Malone was present and also Mr. Seth.

MR. MALONE: Can you assure me that I was in the room when the testimony occurred?

MR. PORTER: The Commission rules that the counsel's motion for the incorporation of Mr. Woodward's testimony and statement into the record is overruled and denied.

MR. CAMPBELL: May I inquire the basis for that? Is it because it is immaterial?

MR. MURRAY: Mr. Campbell, I think we have considered some of the testimony Mr. Woodward gave as pertinent to this case, but his entire statement is not to be considered in this case, and if counsel wants to develop similar information insofar as being pertinent in this case, that's his opinion.

MR. WHITE: Can I renew my request to incorporate the record as it appears on Page 39 through 42.

MR. SETH: If the Commission please, we know it is clearly hearsay, because he is not here to be cross examined, but it is simply that, instead of incorporating these statements in other cases, where some of the parties were present and some weren't, and considering them as part of the record in this case as if

given under oath here, there is no opportunity for cross examination, and it is hearsay.

MR. WHITE: Mr. Seth representing Gulf and Ross Malone representing Shell or vice versa are in a position to raise the point, but it is inadequate, that they weren't present, but they were in fact present at the hearing, and I believe the rules permit the admission of statements. They have been read all the time in these hearings, telegrams, and otherwise.

MR. MALONE: We would renew our objection to this further offer, and we would like to point out in connection with it, that counsel says that he wants to put in Mr. Woodward's evaluations of the California market situation. Now, if we had had any idea that that was going to become pertinent in this case, we certainly would have cross examined Mr. Woodward to see if he is an expert and able to testify in the California market situation. We were sitting out in the audience waiting for another hearing to come up, and having no interest on his testimony at that time, we, of course, did not cross examine him at that time.

To permit testimony to be introduced when the witness is not available for cross examination is contrary to any principal of either administrative or judicial hearings that I know of.

MR. PORTER: The Commission's ruling denying your motion extends to all of his statement.

MR. WHITE: In view of the Commission's ruling, I will

request that the Commission take administrative notice of its records and particularly the statement made by Mr. Woodward on Page 39 through 42. That's the testimony in consideration of allowables for December, 1957.

MR. PORTER: The Commission will do so.

MR. WHITE: Thank you.

MR. MALONE: What was the ruling, please?

MR. PORTER: The Commission will take notice --

MR. COOLEY: Take administrative notice of its own records.

MR. MALONE: I don't want to labor this point, but the Supreme Court of New Mexico has held that for a Commission to take into consideration, in deciding a case, material which was not presented in the hearing and to which no opportunity was afforded for cross examination, is reversible error, and I hate to see the Commission put in the record the fact that it is going to do something that the Supreme Court of New Mexico has held improper.

MR. SETH: If the Commission please, this might simplify the question. We have no objection if Mr. Woodward would like to write the Commission a statement, a letter, and the Commission give the letter consideration and give consideration to the statement given in this matter. Our objection is considering it as part of the testimony. The Commission as you all know received statements, and we have no objection to that. If Mr. Woodward wants to write a statement with the same material, that's all

right with us.

MR. MURRAY: That is the light in which we were going to consider it.

MR. SETH: Mr. White is asking it be include as part of the testimony and as part of the sworn testimony.

MR. WHITE: As a mere statement of Mr. Woodward, that's all we care about it.

MR. SETH: I don't think there is any probability it can, as far as I can see. We don't know whether Mr. Woodward wants this in or not. Maybe he doesn't, but if he is prepared to write a letter on it, we have no objection.

MR. McGOWAN: If the Commission please, in taking administrative notice of your records, and you are not making it a part of the record in this case, the only way there is any objection, or any objection can be made, is if you made a decision on taking administrative notice on facts clearly outside the case. You have to take administrative notice of your own regulations and records, and that's all it amounts to.

MR. PORTER: The Commission will stand on the ruling. I believe that I requested the other applicants in this case to come forward with testimony, if they had some to present at this hearing, and nobody took advantage of it.

If there is nothing else at this time, the hearing will recess until nine o'clock tomorrow.

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MORNING SESSION

Friday, December 20, 1957

MR. PORTER: The meeting will come to order, please. At this time we will continue with Case 1308.

MR. WHITE: May the record show that I'm also appearing on behalf of The Texas Company at this time?

MR. PORTER: Mr. L. C. White, appearing on behalf of The Texas Company.

MR. COOLEY: Mr. Commissioner, at this time I would like to move the Commission to reconsider its ruling of yesterday on the question of whether the Commission will take administrative notice or judicial notice of previous separate cases heard by this Commission. I believe I found the rule of law to be that the Commission can not take judicial notice of records in another and different case.

MR. PORTER: Mr. Cooley, you refer to the Commission's action of yesterday in taking administrative notice of Mr. Woodward's statement in the previous case?

MR. COOLEY: Yes, sir.

MR. PORTER: The Commission hereby reverses that ruling. We will not take administrative notice of Mr. Woodward's statement. Mr. Seth.

MR. SETH: If the Commission please, we would like to start Shell's case in opposition to Sunray's application for the

change in the statewide rules. I would like to enter the appearance of Mr. Leslie Kell with Shell Oil Company, and Oliver Seth as attorneys. We would like to call as our two witnesses Mr. Methven and Mr. Lindsay who have both previously testified before the Commission.

MR. PORTER: Will the witnesses stand, please, to be sworn.

(Witnesses sworn.)

MR. SETH: Would you take the stand, Mr. Lindsay?

DONALD R. LINDSAY

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Lindsay, and your position with Shell Oil Company?

A Donald R. Lindsay, I'm an exploitation engineer with the Shell Oil Company. I would like to mention that my specialty in that classification has been production geology. I think I failed to say that at the first hearing.

Q You are the same Mr. Lindsay who testified at the original hearing in this case? A I am.

Q Would you please go to Shell's Exhibit 1-R and make your preliminary observations?

(Marked Shell's Exhibit 1-R, for identification.)

A Shell's Exhibit 1-R is a structure contour map of the Bisti Field, and it is a different one than we presented at the first hearing in that it covers the entire field instead of just a portion of it, and it has been contoured on Marker GC which is the highest producing oil productive sand in the field rather than on Marker GA as the previous map.

On this map we have in red lines section lines for new sections which we have constructed for this hearing. In the northwest part of the field are sections GH and IJ, in the central portion of the field are sections KL, MN, and OP. Farther to the southeast is Section QR and in the southeastern portion of the field are sections ST and UV.

We have left on this map, or have shown on this map, section lines AB, CD and EF, which were presented at the first hearing, and we have left them on this map so their locations can be noted. As in the previous case we still maintain that this is a stratigraphic type trap and that structure is not the most critical factor as far as oil accumulation goes, but it does seem to be a factor in the southeastern part of the field in the upstructure portion of the field where there is gas produced.

We have not changed our views on the fact that there have been gas wells completed downstructure from oil wells with no structural explanation for this. I refer to Shell Government 21-22A in Section 22, 25 North, 11 West which was completed as a gas well

at a structural elevation at Marker GC of 1565 feet above sea level.

There are a number of oil wells to the west and upstructure from this well which are completed in the same zone and which are oil wells. I won't take the time now to enumerate all of them, but will do so if requested. I refer also to Shell Carson 32-20 in Section 20, 25 North, 11 West which has also been completed down-structure in the same sands and with no structural reason for this well to be down structure from oil wells. To summarize our views on this, we think these wells which have been completed since the last hearing tend to strengthen our belief that this field does not contain one simple gas cap but a number of gas producing sands which are isolated from upstructure oil-bearing sands.

Q Have you constructed a petrophysical chart based on additional data?

(Marked Shell's Exhibit 2-R, for identification.)

A Yes, Shell Exhibit 2-R is a petrophysical chart of data from Shell Government 24-16A located in Section 26, 25 North, 11 West.

Q Would you point that out on the map, please?

A On the map I have circled that location in red.

This well has been drilled and cored since the last hearing, and I present here data from this well. On it we have traced the

electric log, the SP and resistivity curves, we show the well depths every fifty feet, and we show again with a solid bar the interval I have interpreted as supposing positive microlog separation.

As in the other charts prepared for the last hearing, we have traced on this chart a porosity profile with all values greater than ten percent porosity shaded in green and a permeability profile with all values greater than one millidarcy shaded in red. We also show on this chart several well depths indicated which will point out the positions of core samples which will be presented forthcoming.

The permeability scale, as on the previous charts, is a logarithmic scale and has no zero point, and as on the other chart, the point one or one-tenth millidarcy column includes all values which were one-tenth millidarcy or less. A number of these measured zero permeability core analysis in the lap, and to indicate those which do I have written a zero beside each value in the oh point one column which is actually a zero value.

Q Why is this chart significant? Would you summarize, please?

A It is significant, in the first place it confirms our previous evidence that there is good correlation between microlog separation and core analysis values.

Q Would you point out that correlation between the permeability and the microlog separation in several examples?

A There are several intervals of microlog separation in the

GC sands, and opposite those are generally concentrated the highest values of permeability and porosity. The GC has the best reservoir characteristics, in this particular well it has permeables up to forty-four millidarcies and porosities up to sixteen percent.

The GC has a short microlog pay interval, GD corrected, and that shows high porosity, but the permeabilities here are all less than one millidarcy, but they are higher than intervening intervals.

I want to mention, in addition to these intervening intervals, that approximately sixty percent of the gross interval core here measured zero permeability. In this well, the GE sands in the lowest part of the section are not productive at this location, but they are elsewhere in the field.

Q Are there areas of zero permeability lying between sections showing microlog separation there?

A Yes, there are. There are several intervals of zero permeability between the two microlog pay intervals in the GC sand, and I think particularly significant is the fact that they are a couple of feet within the GC microlog interval showing zero permeability. In other words, we have an interval which shows microlog separation and does not show correspondingly high permeability.

But this occurs in each case opposite a deflection in the SP curve on the electric log, and I think that these deflections are significant in their correlation with core analysis, and I believe

that from this chart and from cores which we will see in a moment, that they represent interbedded shales and silt stones that are nonproductive and are nonpermeable and are effective barriers to intercommunication between the underlying and overlying sands.

Q And you have an effective horizontal separation between these microlog areas there, is that right?

A I believe so.

Q Are there any further comments on Exhibit 2-R?

A I think those are the main points I wish to mention.

Q Do you have photos of the core from this well?

A Yes, Shell's Exhibit 3-R is a set of photographs of the cores from Government 24-16-A.

(Marked Shell's Exhibit 3-R, for identification.)

MR. CAMPBELL: What was that well again, the same well?

A The same well.

Q Would you describe the preparation of these cores, how these cores were handled?

A Yes, the photographs of the cores from 24-16-A were prepared in the same manner as the core graph of an interval from 33-24-A which we presented in the first hearing. The core was cut down the middle through its entire length, and one-half of that core was mounted and photographed and the other half was sampled every foot for core analysis and for exhibits for this hearing. So

that the exhibits which we will have will not actually be the photographed piece, but its other half, it's better half. In this photograph the top of the photograph down to a depth of 4943.

Q Which way does it run on the photographs?

A Well, the top is in the upper left, the well was commenced coring at 4914 to total depth and the upper left of the first photograph is the top of the core and it runs down and then across each page as this comes in order in this exhibit.

The uppermost portion of the core from the top to a depth of 4943 which is near the bottom of the second photograph, includes the interval in the GC to GD group of interbedded sand stones, silt stones and shales.

Q Can you refer to Exhibit 2-R and show us where that is, please?

A From the top to the portion of the petrophysical chart labeled GD. The GD group extends from 4943 to a depth of 4992, and the GE.

Q Show us the top of that again.

A (Witness complies.)

Q From that point to --

A (Indicating.)

Q Thank you.

A Below that are the GE and lower sands and shales, they are not very sandy in this well. Mostly shales and silt stone. This

well is located about two and a half miles east and slightly north of Shell Carson Unit No. 1 which is the nearest cored well by the Shell Oil Company for which evidence was presented at the last hearing.

It lies about a mile north of the depositional trend of the Gallup sands from Carson Unit 1. So it therefore represents a more northerly sampling of the field than the previous two cores presented as exhibits.

Q Would you point out any significant portions of this exhibit?

A Well, viewing as a whole, it appears to be, to have the same, the same general characteristics of sedimentation as the previous examples. It has extremely irregular bedding, the sands in this core are very intricately bedded with shales and silt stones, and you can see countless discontinuities on a very small scale, generally for a sand reservoir I would say it is remarkably heterogeneous. The porosity and permeability on the petrophysical chart were samples measured every foot, but I think that if you measure them every fraction of an inch you would get great differences, so these can only be used as general average values throughout a particular interval.

I think that this set of photographs tends to confirm that the cores which we presented at the last hearing from Carson Unit 1 in 33-24 were representative and characteristic of this formation.

On these photographs there are red arrows which indicate the core samples or the intervals of core samples which will be presented as exhibits.

Q Anything further on those photos?

A I think not at the moment.

Q Do you have the core samples? A Yes.

Q Mr. Lindsay, you have presented the core samples which are Exhibits 4-R A through H? A Yes.

(Marked Shell's Exhibits 4-R A through H, for identification.)

Q Would you proceed with these and indicate their significance and their general location and depth? What well are these from?

A These cores are from Shell Government 24-16A, the same well for which the petrophysical characteristics are shown on Exhibit 2-R. I would like to refer to this chart as I describe just briefly the appearance of each of the cores.

The uppermost core sample is from a depth of 4917 feet, I will give these to the nearest foot. That is in the uppermost microlog interval of the GC sands. It's a fine grain calcareous silty sand stone and this foot of core measured 1.3 millidarcies, but again I think you would have wide variation within that foot.

Referring both to the core sample and the photograph, we again have these little irregular streaks, pods of more friable sand, which I think were caused by marine organism, some of a burrowing

nature which probably left burrows and borings in the sediments and which were later filled with other sand. These generally are of a more permeable nature than the surrounding rock, but I don't think they are very effective as far as communication because generally the walls of each of these little borings are lined with silt, probably deposited during, while the organisms were in action. The second core at a depth of 4925 is from --

Q (Interrupting) That is Exhibit 4-R-B?

A 4-R-B is from an interval between, two intervals of micro-log pay in the GC sand group. This is a silt stone of zero permeability, and it also shows extensive reworking by marine organism and contains many isolated little sand streaks which are apparently not effective to communication because of the fact that we were not able to obtain any permeability in this core in lab measurements at all.

The next sample, 4-R-C, from the depth of 4933 feet, and that is in the longest microlog pay interval in this well in the GC sands, and this consists of very closely interbedded sands, silt stones and shales. This sample measured 10.7 millidarcies, but I think that if you were to get an independent core analysis permeability measurement of a streak of sand by itself, if you could do so, you would probably get a much higher permeability. The permeabilities are in this interval extended up to 44 millidarcies.

The next sample, 4-R-D from a depth of 4939 isn't this same

microlog interval, but from a lower sand which is separated from the previous one by a number of shale breaks, this is from a six inch sand body from which particularly on the photographs the evidence of these borings by marine organisms is particularly in evidence. This particular sample measured 6.2 millidarcies, but it is adjacent to more permeable sands.

The fifth sample, 4-R-E from a depth of 4952 is from a very irregularly bedded shale and silt stone interval which lies between the microlog permeability intervals in the GC and the GD sand groups, and this also measured zero permeability, and I think that this is from an extensive section that separates and isolates the GC and GD sands in this well.

The next samples, 4-R-F, from a depth of 4974 is from the microlog pay interval in the lower part of the GD interval. It is very fine-grined silty calcareous sand which showed a permeability in this foot of 0.3 millidarcies, and again if evidence of reworking is present and on the top of the core where the core was broken is a fossil.

Q Will you point it out, please?

A Yes. Which is a fragment of some mollusk which I think might very well be a bottom dwelling organism and may possibly have been one of the organisms which caused, of the species which caused all this reworking.

The next sample, 4-R-G, the depth of 4991 occurs just above

Marker GE in this well and is a shale with streaks of silt stone and non-interconnecting very fine grain sand streaks of zero permeability, and the lowest sample 4-R-H from a depth of five thousand and three is a slightly more sandy sample, but it is also a predominantly silt stone and shale, and also measured zero permeability.

Q Do you have any comments now on any relationship of the chart to these cores? Before that, I believe you testified that location of these particular samples is shown on the core photographs by some red markers, is that correct?

A Correct.

Q So we can relate the other half of these particular samples to particular points in the photograph?

A Yes, the arrows in each case point to the top of the interval from which the sample is taken. I would summarize from this that inasmuch as we have cored a well some distance away from previously cored wells and found the same nature of sedimentation, that this core has not changed our ideas regarding the nature of the Gallup sands in the Bisti Field, that it is very heterogeneous reservoir, and that I don't think that any further development will modify our ideas regarding the reservoir.

Q Have you prepared some cross sections as indicated on Exhibit 1-R? Would you go to those, please?

A Quite a few. I have already indicated the locations of these sections. In the previous hearing we didn't have any sections

through the southeastern portion of the field, and so I have prepared two cross sections in that area, cross section ST which is Shell Exhibit 5-R, which is along the trend of the sands.

(Marked Shell's Exhibit 5-R, for identification.)

Q Would you point it out to its full extent, please?

A It starts in Section 24, or 25 North, 11 West and extends southeast to Section 34 in 25 North, 10 West. In Section UV which is Shell Exhibit 6-R, is constructed across that section in a southwest-northeast direction. That is entirely within Sections 33 and 34 of 25 North, 10 West.

(Marked Shell's Exhibit 6-R, for identification.)

Q Would you discuss those two sections and point them out, please? ST is Exhibit 5-R and UV is 6-R?

A That is correct. ST is this long section which goes through a number of wells, to save time I won't name them all, but the most northwesterly well is Gulf Carson 4 and at the southeastern end is Monsanto Blanch 1. I have used a similar approach in interpreting pay intervals in these wells and in interpreting their communication or lack of communication.

I have shown on each well a black bar which represents the interval of positive microlog separation. Now, as I pointed out on the petrophysical chart, there may be areas of positive microlog separation which include very thin interbedded shales of zero

permeability and break these intervals into thinly interbedded sands and shales, so I have used the SP curve in conjunction with the microlog in interpreting the position of the pay sands.

As before, we don't maintain that all production comes from only these pay intervals as indicated sections, but these are the best sands, the sands of considerably higher permeability than any of the sands which do not show microlog separation. I have indicated these best sands with this tippled pattern on each cross section. In this Section ST there is pay in both the GC and upper GE sand intervals almost all the way along the section. This, of course, would show the most continuity inasmuch as it is constructed along the depositional grain of the sands.

This does not necessarily mean, though, that where two wells are shown as connected with pay that there is actually effective communication between these wells. I mention that now, but I will show more evidence for it a little later. The most striking situation on this well I think is the Skelly Lockhart No. 2 which is the third from the right on the section. This well was drilled or completed in September, 1957, it is a 40 acre lease line offset to Monsanto Frank 1 which was completed in July, '57.

The well to the northwest of Lockhart 3 is Skelly Lockhart 2 which was completed in October, '57, and I want to point out the greatly increased pay interval picked up in this well, Lockhart 2, of which three sands do not reach either of the other wells.

This, to me, is a very surprising thing, particularly for a longitudinal section. There are two sand intervals in the GC and one in the GD which do not show microlog pay in either of the adjacent wells on this section.

This Skelly Lockhart 2 is the tiein well for our southwest-northeast cross section UV. The wells on this section are Skelly Lockhart 1, Skelly Lockhart 2 and Monsanto Atlas 2. In the middle well, Lockhart 2 again penetrates a much greater pay interval than either of the adjacent wells. I guess Skelly has real good geologists because I would not have been able to predict from the adjacent wells what we would find in this well, and I think it is very surprising that we find a much thicker pay interval than in either of the adjacent wells.

On this section you have, we can see that the uppermost microlog pay sand interval in Lockhart 2.

Q Would you point it out, 2?

A Which was not penetrated by Skelly Lockhart 3 or Monsanto Frank 1 was penetrated by Skelly Lockhart 1 and Monsanto Atlas 2, but the lowest pay interval in the GC group is not penetrated by an adjacent well on either section, including one 40 acre offset.

To me this is strong evidence that that sand would not have been drained had not this well been drilled in this particular location. Again, the lowest GD sand for which there is microlog separation in Skelly Lockhart 2 does not show microlog separation in

either of the surrounding four Wells. I reach the same conclusion for that sand.

I would like to show next, in conjunction with these sections, Shell Exhibit 7-R, which is a true scale section of a portion of cross section ST. The wells on this true scale section are from left to right, Skelly Lockhart 3 and Skelly Lockhart 2 and Monsanto Frank 1. The first sections that I referred to, Exhibits 5-R and 6-R are constructed with a ten-fold vertical exaggeration, in order to show the data it is necessary to show, and not have the section unduly large. The scale on the full-sized exhibit is to a horizontal scale of one inch to two hundred feet and a vertical scale of one inch to twenty feet.

(Marked Shell's Exhibit 7-R, for identification.)

Exhibit 7-R, the portion of cross section ST is to both a horizontal and vertical scale of one inch to twenty feet. I constructed this merely to point out that these other sections give a rather distorted view as far as distance between wells go. They look like they are real close together, but this Exhibit 7-R shows their true relationship in distance. So you can see on this section the distance between a 40 acre location from its offsetting well, Skelly Lockhart 2 and Monsanto Frank 1, and the distance between Lockhart 3 and Lockhart 2 represents the distance between two diagonal 80 acre wells.

I think this gives us a better idea of the distances over

which we are correlating these very thin stringers of sand.

Q You have an additional cross section, Mr. Lindsay?

(Marked Shell's Exhibit 8-R, for identification.)

A Yes, cross section QR is Shell Exhibit 8-R. Section QR is the next cross section to the north we have of Sections ST and UV, and it runs in a southwest-northeast direction through this portion of the field.

In this section we can again see evidence of very rapid sedimentary variations in all intervals, the uppermost GC sands, GD sands, and also down in the lower sand group, the GF sands on this section.

This section extends from Shell Carson Unit 34-19 on the left to Shell Government 23-16 A on the right. Shell Carson Unit 32-20 picked up the best sand development in the GC sand group. And of these, the uppermost three pinches out before it reaches either adjacent well, and the lowermost, well, all the interval thins out before it gets to either adjacent well, and even more striking is the upper GD sand which shows no microlog separation in either of the adjacent wells.

Between Shell Carson Unit 41-20 and Shell Government 24-16 A there are very rapid sedimentary changes. It may appear that the wells are not in communication with each other at all.

I would like to amend this section at this time to indicate that the lowest portion of the upper GC sand in Shell Carson Unit

41-20 may connect with the uppermost portion of the upper GC sand in Government 24-16 A. That may be a more preferable interpretation. But even if they do, they are not in exactly the same stratigraphic interval, and it is my opinion there might be very poor communication between those sands.

Q Is there a gas well on this section?

A Yes. Shell Carson Unit 32-20, the third from the left, was completed as a gas well, the initial production on October, '57 was three barrels of load oil and 1250 MCF per day gas. Production since then has indicated that it is a dry gas well. This well is situated downstructure from Shell Carson Unit 23-20 and Shell Carson Unit 34-19. These are oil wells, I believe that 23-20 has a higher than average gas-oil ratio. I don't believe that 34-19 does. These are in communication as shown on this section through the GC sand.

Now, that's an enigma that we would have oil wells upstructure in communication with gas wells, and this is very significant to me in that even where I can show communication there may be discontinuities between those wells that we know nothing about until we drill there. I think this is a genuine anomaly and I can't explain it structurally.

One final thing, I would like to point out, is the lowest GD sand in Shell Government 24-16 A which was not penetrated by the, I believe in the adjacent 40 acre well, Shell Government 26-13 A.

Giving additional evidence there is discontinuities between 40 acre wells. I show pay in the lower GD sands, they should not be considered as pay inasmuch as they are water bearing.

Q Would you go to KL, Exhibit 9, and point out where KL is on the structure map?

(Marked Shell's Exhibit 9-R, for identification.)

A I would like to refer next to Section KL, MN and OP which are situated close to each other and near our previous Section AB and CD. Section KL, which is a Shell Exhibit 9-R, is a west to east section extending from Section 7 to Section 10, 25 North, 12 West. Section MN is a south to north section within Sections 15 and 10 in the same township and range, and Section OP is another east-west section, cross section, extending from Section 9 to 11 in the same township and range.

On Section KL, the west-east section, there are three Sunray Mid-Continent wells on the left side, Federal C-18, C-16 and C-14 which are spaced at 80 acre locations, and on the right side are five Shell wells extending from Shell Government 12-9, sorry, correction, four Shell wells and a Southern Union well which are at 40 acre locations in the line of the section.

The best sand development is found in the GC sand group, fortunately, on the right side of the section. In Shell Government 32-9 and 42-9 there appear to be as many as five separate inter-bedded sands which pinch out in both directions, thinning down to the

west to three sands, two and then one, which is getting quite thin. The GC sands on the left side of the section there appear to be at least two separate sand stringers which are not at the same stratigraphic position, and therefore, in my opinion they are not in communication with each other, and the GE and GF sands on this section, the lowermost sands are present in most of these wells, showing microlog separation.

They have very erratic distribution up and down the section as well as exhibiting very rapid lateral variations. Probably the thickest GE sand was penetrated in Shell Government 32-9 that pinches out completely to the left in Shell Government 22-9, and thins down to practically the vanishing point in Shell Government 42-9. The lower portion of Shell 42-9, there are two GC sand stringers that doesn't show any microlog pay interval in the adjacent well.

The Shell 22-9 is a GE sand. That does not. Shell Government 12-9 are three GE sands in which neither the upper or the lowest appear to reach either of the adjacent wells, and Sunray picked up one in Federal C-18 which appears to not reach 16 in that it appears there is no microlog separation.

Some of the sands are perforated and do not produce oil, particularly after having been fracted even. Again, I believe that the best developed sands are where they do exhibit microlog separation and where they don't I believe the sands to be very tight and to not communicate over any considerable horizontal distance.

Q Exhibit 9-R, you have instances where there are sand members showing microlog separation that don't even extend from one 40 acre location to another, is that correct?

A That is correct. Several of these wells were drilled since the last hearing as 40 acre location wells, and several of them have picked up new sands.

(Marked Shell's Exhibits 9-R and 10-R, for identification.)

Q Now, Exhibit 10-R. A Excuse me.

Q Well, proceed.

A I have a few more things on this one. I want to point out another drafting error in Sunray Mid-Continent Federal C-14, the lowest GF sand or the GF sand which shows microlog separation was located ten feet too low on this exhibit and should be ten feet higher.

The interval should be 4858 to 60 and that would place it opposite the interval which Sunray wisely perforated, it would probably then communicate with the upper GF sand in Government Shell 12-9 rather than the middle one.

I have one further thing that Southern Union made a very good well out of this Ka-Gee-Tah 1. They perforated it only down to the GE sand as I believe was explained yesterday, and the initial rate, according to our records, was 480 barrels a day from the lower sands alone, even where they don't exhibit microlog separation.

This would appear to me to indicate that it's possible to make a fairly good well out of just the lower sands, and they have been referred to as inferior sands and they aren't the best sands in the field, but I think here is evidence that they are very important in the development of this field.

Now, Section MN is Shell Exhibit 10-R. This is the north-south section in the central portion of the field.

MR. SETH: Mr. Nestor, would you point that out again, please?

MR. NESTOR: Yes.

A I would like to refer to this section in conjunction with Section OP since these two sections cross MN, being the vertical and OP I should say, the north-south and this, the OP, the west to east section. The tiein well on these two sections is Shell Government 34-10. In other words, both sections pass through Shell Government 34-10, and show the same pay intervals.

This well was also shown on Section AB at the previous hearing. If you'll compare them, which I'm sure you will, you will notice that in this section we show four separate sand intervals in the GC, whereas in the previous one we showed only one continuous sand interval. I have reexamined many of these logs and I found a slight streak in the micrólog pay in the upper portion in the GE sand in this well which I think actually is not continuous microlog separation, and the reexamination of the SP curve shows there are

many shale breaks which we have seen from the petrophysical chart, and the core samples and photographs do represent interbedded shales which are not pay and which separate the sands into interbedded layers.

I think the explanation for this microlog pay, where we don't really think it is, is that where there is a gross sand interval with many interbedded shale beds, that undoubtedly the microlog zone dragged some mud cake across the face of the shale, gives you a reading where there really isn't enough permeability to really be indicated by the microlog.

I have taken that into account in constructing my section, and that's my explanation for this reinterpretation in 34-10. On other of these sections the GC sands are very well developed. They occur in most wells as many layers of sand rather than one continuous one. The thickest GC interval was penetrated in Shell Carson Unit 11, the far right well on Section OP. There appear to be eight separate sands, and the uppermost and the lowest GC sands in Carson Unit 11 have pinched out by the time, pinched out in Shell Government 44-10 and do not show microlog pay intervals.

Again I think this is evidence of the pinch of permeable sands between two 40 acre wells and that if 14-11 had not been drilled we might not have penetrated these sands in any well. Their easterly extension is undetermined because development hasn't continued that way to date.

On Section OP, the second well from the left, Phillips I-Tah-Nip 2 penetrated three intervals of GD sand as indicated by the microlog. This well was also on Shell's cross section CD in the previous hearing. If you check this against that you'll find that the upper two GD sands were penetrated by El Paso Kelly State 1, but the lower one was not. So there are wells on three sides of I-Tah-Nip 2 which do not penetrate a GD sand which was penetrated by I-Tah-Nip 2. On Section MN, Shell Exhibit 10-R, the well second from the right penetrated several sands in the GE and GF group, and on this section they have all pinched out in Shell Government 31-10, that is they don't extend that far.

The middle one of these three sands pinches out before it reaches Shell Government 34-10 with microlog separation, and the top and bottom sands have thinned down to a very small interval.

I think those are the points I want to make on these sections.

Q Do you have any general observations to make to the Commission as a result of this study?

A There are two more sections. These are the last two.

Q All right.

A Sections GH and IJ were located in the northwesternmost extremity of the field. GH is a section northwest-southeast section longitudinal with the sand trend. It extends from Section 29 to Section 34, in 26 North, 13 West, it extends from British American Douthit B-11 to British American Salge B-3. Section IJ is a

southwest, northeast section which crosses GH at Douthit B-14, it extends from Section 33 to Section 22, the same township and range. It extends from British American Salge B-2 to Benson, Montin, Greer Foster 2.

On Section GH, which is the section longitudinal through the deposition, grain appears to have fairly good, relatively good continuity as indicated by the microlog. But there are again reasons to believe that this does not necessarily mean completely good communication.

The GC interval shows good sand development in British American Salge B-1, and in Salge B-3 there were two microlog intervals in the same sand, and I would have interpreted these as pay except that British American ran a drillstem test including both of these intervals in one test and they recovered 65 feet of drill mud on a one-hour test, so it would appear to me that these sands are quite tight and perhaps just porous enough and barely just permeable enough to exhibit microlog pay.

They are not productive, the well was abandoned. British American Salge B-1, according to our records, was completed for an initial production of 743 barrels a day, and the next well to the northwest, Douthit B-14 which shows even more GC pay but no GD pay although it was perforated there, had an initial production of 185 barrels a day. This, to me, reflects the changes in the quality of this reservoir rock which you cannot pick up merely by

plotting the microlog and suggests to me that the most prolific portions of this field are not very predictable and that many of them may be missed or just grazed if spacing is carried on too wide a pattern in this field.

I have to explain another drafting mistake. It is not important to the discussion, British American Douthit B-15 is mislocated laterally between Douthit B-11 and B-14. The correct distance should be from Douthit B-11 to B-15, the horizontal distance is 1880 feet and from 15 to Salge B-1 the distance should be 47, 10, 1. That would move B-14 farther left on this section, but there do not seem to be significant discontinuities which I will dwell on which this change would affect in any way.

Section IJ, which crosses GH at British American Douthit B-14, shows much more evidently rapid sedimentary variations. British American Douthit B-5 penetrated a fairly thick sand in the GC interval. That is the most, lowermost one which's not penetrated, Douthit B-14, and has practically thinned down to nothing in B-16. In a situation like this, if B-5 were here and B-6 were here, this sand would not be adequately drained, and therefore in the similar situations between 40 acre wells where there is a thick section penetrated in one well and thinned down to a very thin interval in another well, I think the drainage would not be adequate even though it was penetrated in this thin interval, that the drainage of the greater portion of the sand would not be adequate unless it is penetrated in its thickest, best

value portion.

Of course, I say we are more likely to do that on 40 acre spacing than on 80 acre spacing. Other discontinuities on this section are found, British American Douthit B-13 is the lowermost GC sand, I see appears to pinch out before it reaches either of the adjacent wells.

Q Do you believe that these lower sand members are a matter that should be considered and perhaps a significant part of the reservoir after all, based on your study and the presentation of these cross sections and also the completion by Southern Union of a well in the lower pay?

A Yes, I think they have proven to be a significant portion of this reservoir.

Q Do they show a greater or lesser discontinuity, could you generalize on that?

A Yes, the lowermost sands, the ones, the GE and lowerare much more irregularly distributed in this reservoir. They don't occur in every place that the overlying sands do, and if you drill, my opinion for only the overlying sands, you may miss many portions of the lower sands. They are generally thinner as a group, but they seem to occur in discontinuous intervals, and they don't seem to extent over as wide areas as the individual stringers, streaks of sand in the upper sands.

Q Is it also the case where you have production from sections where there is no microlog separation too?

A Yes, it is.

Q Do you have any further comments, Mr. Lindsay?

A I think that is all I have to say with reference to the exhibit.

Q Do you have any general conclusions you would like to draw?

A I don't think my conclusions would be different from what they were after the first hearing.

Q Would you restate them just briefly?

A Just very briefly, that my geologic investigation of the Bisti Field has shown it to be an extremely heterogeneous sand reservoir, that it shows frequent numerous discontinuities from well to well, and that examined both on a large scale with maps and sections and also on a very, very small scale with core samples, that I would not expect this sand to have characteristics which would permit it to drain over wide areas, and that I think therefore a spacing as wide as 80 acres is certainly going to miss many sand intervals which would be penetrated by 40 acre wells. I think that that now has been proven.

MR. SETH: I believe that's all the direct we have, if the Commission please.

MR. PORTER: We are going to take a fifteen minute recess.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Seth, you were through with your direct examination?

MR. SETH: Yes.

MR. PORTER: Would you take the stand, Mr. Lindsay? I'm reasonably sure that somebody has a question.

Anyone have a question of Mr. Lindsay? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Lindsay, first I want to assure you that if you hadn't confessed I wouldn't have found those errors.

A I thought Mr. Selinger would be here this morning.

Q You may have stated at the last hearing, but I'm not sure, would you please tell me the extent of your experience in sand reservoirs of this nature in the Mid-Continent or Rocky Mountain area?

A My experience with sand reservoirs of this nature in the Mid-Continent or Rocky Mountain area consists exclusively of the Bisti Field. I became familiar with the development at Bisti during the latter part of 1956, and since last July I have been Shell's production geologist responsible for the production geology of the Bisti Field.

Q Have you had experience in other areas with fields that you considered to be comparable with regard to the deposition and so forth as the Bisti Field?

A I have not had experience in other fields which are quite like the Bisti Field.

Q How can you then state as a conclusion that this field is, as I understood you, more heterogeneous than other fields of similar nature?

A By other fields of a similar nature, I was referring to sand reservoirs in general. I have never seen so heterogeneous a sand reservoir.

Q It's quite true, is it not, that the Bisti Field, based upon your study, is considerably different in a great many respects than in the sand reservoirs, say on the West Coast?

A Yes, it is.

Q That is true with regard to the characteristics of the rock as well as the pay thickness and so on?

A That is correct.

Q Would you say that this Bisti Field, considering the general pay thickness, is of an inferior quality to many of the sand reservoirs on the West Coast?

A There are many on the West Coast that are much better and there are some I would say of generally comparable quality as a reservoir.

Q Are there reservoirs that you have studied that you have as in this reservoir, various stringers of possible productive sand such as you have described here this morning?

A There are reservoirs of that type, but I have not thoroughly studied this type of reservoir before.

Q Do you believe that it is feasible to drill a sufficient number of wells in this reservoir to penetrate each and every one of the possible productive sand stringers to which you have referred?

A You mean economically feasible?

Q Yes. A No, I don't.

Q So that it is a matter of degree as to the feasibility or advisability of drilling additional wells in this reservoir?

A I think that's a sound basis to go on.

Q Our basic difference then lies in what that degree may be, as I understand, whether it's necessary or feasible to do it on 40 acres or 80 acres?

A That seems to be the controversy.

Q This may be an engineering question, if it is, of course you should defer it to the engineering witness. I would like to refer you to your Exhibit 9-R which I believe is the long exhibit at the top of the main board there. A Yes.

Q As I understand that, you have three wells of Sunray on the left spaced at 80 acres, correct?

A I believe that's correct.

Q Are those wells essentially toward the flank of this sand bar?

A They are near the southernmost extremity of the Bisti-Lower Gallup sands.

Q Would you expect at that point the GC and the GD and all the rest of the sands there would probably thin out due to the

nature of the deposition?

A Thin out in which direction?

Q Thin out towards the flanks. A I believe that they do.

Q Now, then, referring to the four wells of Shell's there, I would like for you to tell me how much additional oil sand you penetrated by the drilling of those inside wells there that you did not penetrate with the 80 acre location. Considering those two that you just pointed to as your normal 80 acres, it appears to me that you got more sand with those than you got with the 40 acre ones.

A It appears that we got the most in the normal 80 acre well 32-9 and we have just about as much of the 42-9, including two sands in the GE and GF groups that were not present in 32-9, and we appear to have encountered a GE sand in 22-9 which is not at the same stratigraphic position as the GE sand in 32-9.

Q Now, assuming that you have approximately the same amount of sand in your upper zones which I believe is your GC and possibly part of the GD there, in all four of those wells do you consider that you obtained enough additional oil sand or potential production from the lower zones of the infill wells to justify the cost of their drilling?

A You talking about additional oil?

Q Yes. A From the new wells?

Q Yes. That you would not have recovered from the 80 acre wells.

A The mechanics of production and volumes of recovery do merge on the present of our engineering site and I have not made a cost estimate or a volumetric estimate of the type you mentioned. But apparently this is considered by Shell's Engineering Department as a profitable enterprise, so that's the way we are conducting it.

Q I'm sure that is true. Could that be a matter of the rate at which you are able to obtain the oil rather than whether you obtain the oil?

A No. Of course, we'll obtain it faster, now we are getting into supply and demand and I don't want to go into rate and all that, but I conclude that there is a significant amount of additional oil which you would not get at all on 80 acre spacing.

Q Well, now, are you concluding that as a geologist, or do you want me to ask the engineer about the amount of oil?

A Well, from a geological standpoint.

Q Explain that to me, that is what I want to find out.

A Not only on these particular wells.

Q I want you to talk about these particular wells. Those are the ones that are demonstrated there as indicative of the conditions in this field.

MR. SETH: I think the witness can answer the question and explain it further by referring to other exhibits.

A I will explain it here. I will refer to Shell Government 22-9 and 42-9, those wells penetrated sands in the GE and GF groups

which were not penetrated by the other wells, and I believe that that is new oil which will be produced that would not have been produced on the 80 acre wells.

There appears to be a pretty fair correlation of pay zones up in the more prolific pay. Now I mentioned earlier the qualification I placed on these correlations I make. That I am convinced by now that merely because you can correlate a microlog pay from one well to another does not mean that they are necessarily in complete communication. I have attempted to stress the lateral variations in porosity and permeability development in these wells, and their apparent lateral variations in productivity as shown particularly on GH where you can correlate microlog pay zones in one well it is very productive and in this well it is dry.

Q Let's talk about the lateral variations in, or the vertical variation in permeability, do you consider there are inpenetrable barriers between the zones that you have classified in your geophysical chart and as you showed them on your cross sections?

A I lost you.

Q Do you consider there are inpenetrable barriers between your GD and GC or GE there?

A I think that at the location of this well we have direct evidence that there are layers of inpenetrable rock through which oil will not migrate in any practical time.

Q Do you consider that exists throughout this reservoir?

A It is my opinion that it does.

Q Do you think there is more than one oil reservoir involved here?

A It's difficult to define, I would say, an individual reservoir in a field like this. We look at the whole thing as one oil field, but it's my belief that it really consists of many isolated sands which are completely separated from each other, I mean a great many and each of those I think if you wish to cut it very finely you might call a separate reservoir.

Q Would you recommend that any of these particular sands be produced separately? A No, I don't.

Q Do you consider that that situation at this stage of development creates some uncertainty with regard to the nature of this particular reservoir?

A I think that at this date we have an even greater sampling of the reservoir and a portion of it on closer spacing than we had at the previous hearing. At that time I had drawn certain conclusions regarding the nature of the reservoir, and I think that the development since then has only strengthened those and has not really changed them.

Q Let's go to another point which appeared to me to be a matter of considerable uncertainty in your mind. You have referred to a number of what you classify as gas wells being downstructure from oil wells in this reservoir, is that correct?

A Yes.

Q You say that you are unable to find any geological or structural explanation for that situation?

A For the ones that I mentioned, yes.

Q Doesn't that create some degree of uncertainty about the nature of the reservoir and the manner by which it should be developed and produced?

A I draw the conclusion, what sort of explanation was I unable to find?

Q Well, I understood you, you said it was an anomaly and that's it. It's one of those things apparently you are indicating it was another indication of heterogenity in this reservoir.

A What I think I said, and what I meant to say, I find anomalies which I cannot explain on these structural bases, and therefore I conclude it is a stratigraphic reason, the stratigraphic reason being the discontinuity of the sands.

Q Well, as long as that situation exists, an unexplainable situation so far as you are concerned, do you not feel that it creates some degree of uncertainty as to the manner of development and production from this particular reservoir?

A I believe I just explained it.

Q How do you produce your gas wells, do you know?

A No.

Q Do you know how you produce your high gas-oil ratio wells?

MR. SETH: What do you mean how?

Q In what manner. Are you producing them as gas wells or oil wells?

A Some wells we, you mean our wells which produce both oil and gas?

Q Yes.

A I had better not qualify myself as an expert to answer that question.

Q One other question, again, with regard to your Exhibit 9-R. I believe you indicated that in your wells there were some areas that were perforated across that microlog separation which actually didn't produce in one well, it might produce in another. Are those distances sufficiently small that communication could be established by fracturing?

A You mean horizontal distances?

Q Vertical distances.

A Vertical distances.

Q In the upper zone there?

A Oh, (indicating).

Q Yes.

A Of course the purpose of fracturing is to increase the permeability of the reservoir immediately adjacent to the well bore and as to how far those fractures extend in the reservoir and as to whether they form effective vertical communication I think is something that certainly I don't know, and I don't believe that we could rely on fractures to do anything further than increasing the permeability of the pay, and we hope of the tighter pay right adjacent to the --

well bore, but as to establishing an effective vertical system of communication between the various pay zones any distance away from the well bore, I don't think that we can rely on them to do that.

Q One general question. Are you acquainted with the number of wells that have been drilled by Shell, since the original hearing, on a 40 acre spacing pattern?

A I don't have a figure with me, no.

MR. CAMPBELL: That's all.

MR. PORTER: Anyone else have a question of Mr. Lindsay? Mr. Grenier.

MR. GRENIER: I have never been a real good geological lawyer and I'm afraid much of this testimony is just completely beyond my individual depth. With the Commission's permission, I would like to have them permit Mr. Wiedekehr, our reservoir engineer and head of the Production Department, to conduct a portion of our company's cross examination.

MR. PORTER: Yes.

MR. GRENIER: Thank you.

By MR. WIEDEKEHR:

I would like to start back with Southern Union Gas Company's Ka-Gee-Tah, please. I think we will do better if I can go with you so we can see what we are talking about. Referring to your Exhibit 9-R, Southern Union Ka-Gee-Tah No. 1, would you state first approximately where the perforations on that well are?

A They seem to extend from about 4845 to 4865.

Q 4845 to 70 be all right? A Yes.

Q How much microlog separation did you find on that particular well? A I didn't find any.

Q No microlog separation?

A No positive microlog separation.

Q Did you have available to you core analysis from that well by any chance?

A I did not prepare that with core analysis available.

Q In your cross sections that you have used this morning you have been correlating, I believe, potential pay zones using microlog separation, right? In other words, you have shown that these sands pinch out, disappear, come back in, and the basis that you used for that has been microlog separation?

A Not entirely. I have used the data available to me, and as far as drawing my sections, I have used both microlog and SP development.

Now, I do want to make it clear that I did not consider a sand interval as shown by the electrolog without microlog separation as not being a pay zone, but as being very tight.

Q You have, I believe, on your Exhibit 9-R the reported high pay from that well?

A My records show 480 barrels a day.

Q 480 barrels a day flowing? A Yes.

Q Let me assure you that is correct. Then I wish you would explain to me, with no microlog separation, I happen to have the core analysis available, only two feet of it had any permeability, how a well of that category could produce that much oil. I mean geologically how can you get 480 barrels flowing out of a well with no apparent permeability? That's what your microlog is supposed to show.

A It is supposed to show the better permeability. There is permeability there or we would be unable to produce the oil.

Q Right. Wouldn't it require relatively good permeability somewhere adjacent to the well bore to have produced that volume of oil?

A That rate is certainly more than I would expect from the appearance of that well.

Q Well, assuming that we are correct then that that particular zone, no microlog separation, no apparent permeability, matter of fact very poor SP, wouldn't you say?

A Mediocre.

Q Mediocre. All right. Assuming that it produced oil from that type of formation, would it not be possible that say Shell's Government 44-10 in Exhibit 11-R in an interval from 4830 to 4840 or so, showing no microlog separation but having equivalent or better SP, might be productive?

A We have perforated that interval. We have not yet completed

the well at least to my latest knowledge. We have perforated that interval without microlog separation for the purpose we believe it will produce some oil down there.

Q In other words then, we might say that since Shell has perforated in their Carson Unit 14-11 zone with no microlog separation, and this one, the 44-10 and the Government 24-10 and the Phillips 1 I-Tah-Nip, apparently they have perforated that same zone, it is apparently the feeling of both Shell and other companies that these zones will produce, at least if they didn't they wasted a lot of money on perforation even though there is no microlog separation, isn't it considerable that all these zones could be tied together even though you can't correlate them with microlog separation?

A Where there is no microlog separation I infer from that information that the permeabilities are very low. Therefore, I would say that sands of that character would have a much smaller drainage radius than sands of higher permeability.

Q We just got through discussing a well with no permeability made 480 barrels a day flowing.

A It had permeability.

Q But what type of permeability would it have to have, as a geologist would you say it had to have good or poor or fair, or how would you describe the type of permeability required for that kind of a volume?

A From a rate alone, if I had no other information, it would sound to me like you had some pretty fair permeability.

Q Let me ask you, were you in the hearing room yesterday when Mr. Lewis testified for Phillips? A Yes, I was.

Q You heard his testimony about the variation in permeability even within an inch of core?

A Yes, sir, I agree with him on that.

Q You agree with him. Then you would also agree that if we took any one of these wells and moved out three inches further from the well bore that there might be a good change in permeability and there might be good permeability there?

A In the sands in this interval which I have examined in cores are of heterogeneous nature and you certainly will get rapid changes good to bad, good to bad permeability in that very irregular distribution, and you may move out three inches and get better permeability, but in sands of this type, from the appearance of them from cores and from their log characteristics, I wouldn't expect you would go out three inches and encounter a real permeable bed that would go on and on.

Q You wouldn't expect that, yet apparently something on that order happened in this particular well?

A It may have happened in this particular well.

Q Let's look at Exhibit 12-R. I believe you discussed the capacity of a couple of wells. The British American Douthit B-12,

B-1 produced at one rate.

A Our records show 743 barrels a day initial.

Q How about the B-14?

A Pumping 185 barrels a day.

Q You based, I believe now on direct examination you based that on the fact that the sands were, you said that even though sand in the B-14 appeared much better, that the Salge B-1 was the better well. Would it not be entirely possible that that was strictly a matter of completion? In other words, does the method of completion have a lot to do with the IP of these wells in the Bisti Field?

A I think the method of completion does have a lot to do with it. I had better admit right now that I don't know exactly the method of completion in these wells beyond perforating the sands.

Q I believe on direct you did infer that it was a difference in sand that caused it rather than completion practice. I just want to point out and ask you as a geologist if you didn't think that the completion practice might have had a lot to do with it?

A Yes, I am sure it would. I also referred to Salge B-3 which also has sand and microlog development, but which is tight.

Q Was pipe set on that well?

A I can't say for sure, but apparently not.

Q In other words, apparently British American relied on a drill stem test in that area to decide not to set pipe?

A Apparently they did.

Q Is it not true that there have been a number of wells in the San Juan Basin on which pipe was not set because of poor drill stem test and yet future development has proved that area to be productive?

A I'm not familiar with development away from the Bisti Field itself, but the statement that you make as regards in general is true.

Q I was referring particularly to another Gallup field, the Verde Gallup. You are not familiar with it at all?

A No, I am not.

Q For your information, two wells were drilled and plugged and abandoned as dry holes due to poor drill stem test before the first producer was found. What I am trying to point out, that with that well with pipe set on it might have made a little oil well.

A Yes, it might.

Q I'm sure you are familiar with other fields other than Bisti. Do you know of any field in which the sand condition, both the type of sand and the thickness of the sand, does not vary from one portion of the field to another? Let me reverse that. Do you know of any field in which the sand is constant throughout in thickness and characteristics?

A Constant is a relative word.

Q I said thickness. A Oh, in thickness.

Q Yes.

A The constancy of the thickness of the sand certainly depends on the manner in which the sand was laid down, on all manner of geologic events which would govern the thickness of that sand and the extents laterally.

Q You would expect sands in any field to vary in thickness for two miles away or three miles away? It is not unusual for sands to vary just as they do in Bisti?

A No. Sands may vary in constancy over a long area, but others will do it much more rapidly.

Q I was never quite satisfied with the answer you gave Mr. Campbell about the additional oil that you expected to recover by the drilling of the Shell 22-9 and the 42-9. Would you tell me roughly how many feet, assuming microlog is correct entirely, how many feet of microlog difference you have from the Shell 42-9 to the 32-9 in the bottom sands only on Exhibit 9-R?

A You referring to the individual sands or the whole group?

Q The bottom sands, that is from your GD down.

A They are approximately the same in total thickness.

Q How about in 42-9, how many feet of sand do you show on microlog below the GD sand? A About four feet.

Q As a geologist, are you familiar with the estimated recovery per acre foot from the Bisti Field?

A I used to know the figure, but I can't recall it.

Q As a geologist, would you recommend that your company drill a well in the Bisti Field for four feet of pay?

A Four feet only, no.

Q But if we assume, and let's make an assumption right now, if we assume that the GC sand could be drained across an 80 acre spacing, then in an appreciable period of time then actually the drilling of the Government 42-9 was drilled for only four feet of sand, was it not?

A If we make your assumption I can't say yes to that because we didn't know how much GC sand we would find. We drilled it for the productive sand that we would find in that location.

Q But you drilled it for four feet now in the lower members. In the lower members now.

A We found an additional four feet of microlog pay.

Q So as I said before, I believe then assuming the upper member could have been drained on 80 acre spacing, you actually then did drill that well and would expect the economics to show that the four feet of pay there would pay for the drilling of the well?

A Based on your assumption that the 32-9 would drain completely and efficiently, that we would get no additional oil from here. Actually I have to subtract about a foot from that four, three feet.

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

MR. GRENIER: Just one or two more questions, Mr. Lindsay, on behalf of Southern Union.

Q How many wells of the, I believe it was the 187 it was testified yesterday, have been drilled to date, have you examined logs on or informed yourself about, substantially all or just a small percentage?

A I should count these before I come in here because I always get asked this.

Q Would it be about half?

A Well, I would say that it is somewhat less than half.

Q Approximately 80 to 90 then would be something in the range that you looked at in some degree of detail?

A Yes.

Q Were most of those wells along the so-called fairway or were they along the flanks or were they spread in a fairly representative fashion?

A The greater part of them would be in the, would be along the fairway, it's been called Route 66, although there is a fair scattering across the entire trend.

Q What proportion of those wells which you have examined logs on exhibited sand, pay sand in the upper member? I believe that's the one you referred to here generally as the GC sand, is that correct?

A That is correct. A good majority of them exhibited pay in the GC interval.

Q In the fairway area would it be correct to state that

substantially all exhibited this?

A Not entirely. Many of them even in the fairway were better developed in the lower, what we call the GD sand group than in the GC, but certainly most of them along the central part of the trend did exhibit better GC qualities than GD.

Q Approximately what proportion or percentage, if you can give it to us that way, of these wells that you have examined did exhibit some microlog separation in the lower sands?

A By lower, do you mean --

Q I'm referring to the GD on down.

A It would be a horseback guess, roughly three-quarters, possibly a little more.

Q Would you have any figure that you can give us as to approximately what the development was there? Was it about the same, three or four feet, that we were discussing in your just preceding cross examination by Mr. Wiedekehr, would that be fairly typical?

A It varies from several feet of sand, perhaps ten or more, to nothing.

Q So that any given well which was drilled here and taken on down to these lower sands would have approximately 75% chance then I gather, based on the wells that you have seen, of hitting something which might vary from zero to ten, is that correct?

A You're referring to sands exhibiting microlog separation?

Q Yes.

A That would depend on which part of the field you are in, in some portions of the field you might have a greater percentage than in the other, but if you are including the GD sand, I probably should have raised my estimate to more than 75, but that might be a fair figure.

Q Now, then, going below the GD, what would the percentage of wells be that exhibited anything below the GD level?

A Well, if the sands exhibit microlog separation they're less than 50%.

Q So that whenever a well was taken down below that either on 80 or 40 acre spacing, you would have somewhat less than a 50% chance of hitting anything there, is that correct?

A I think you would. Well, anything, you may hit sands which might produce a considerable amount of oil on being fractured, but for hitting sands which you would run a microlog and find separation down there, I would say you would have less than a 50% chance.

Q You would have a less than 50% chance if you based it only on microlog separation, but you might have more than that if you based it on what actual production history is shown in the absence of microlog separation, as for example in the Southern Union well which you were discussing a few moments ago?

A Yes, I think that is correct.

Q So that whenever you go down below the GD level, you are

having about a 50% chance of hitting anything at all, if I understand your testimony.

A I think you would have more than 50% chance of hitting sands which are capable of production but less than 50% chance of finding sands which show microlog separation.

Q In your opinion would the additional sands that you would find down there, disregarding the upper strata, be of sufficient likely productivity to justify the drilling of a well?

A I think that the lower sands by themselves probably in most parts of the field would not justify drilling a well just for that alone.

Q Would you have any estimate that you could give us, or have you formed any opinion about this as to what portion of the total reserves in the field are to be found in the area below the GD level?

A I have not formulated an opinion to the point where I could give you any figure.

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

MR. PORTER: Mr. White.

MR. WHITE: Mr. Wade has one question. All of mine have been pretty well covered.

MR. PORTER: Mr. Wade.

By MR. WADE:

Q I would like to discuss nomenclature with you a little bit.

I believe on one exhibit, I believe it was your cross section GP, you referred to eight sands I believe, is that right?

A Yes.

Q Actually you were referring to eight indications of micrologseparation, were you not?

A Well, the microlog is in fair agreement with the SP, and I would say that both the microlog and the SP suggest that there are eight sands.

Q Eight separate sands?

A By that I mean that eight sand layers showing microlog pay were penetrated in that well which are separated by interbedded shales, silt stone.

Q You referred to your black bars which are an indication of microlog separation almost uniformly in your testimony as sands. Do you consider that those, each of those black bars is an indication of a separate sand on each of these exhibits?

A Actually my black bars tend to generalize on the real number of discrete sand layers within any microlog separation interval. I have attempted to stress that I consider them to be very thinly interbedded sands for the most part as seen on the cores and as evidenced by the SP in many wells and as evidenced by the very, very irregular permeability profile.

Q Well, in your references to sands and the black bars, again using that nomenclature in this Southern Union well that has been

discussed here, there are no sands in that portion that were opened, is that right?

A The SP shows there are sands.

Q Well, then, the nomenclature that you were using as regards microlog separation does not necessarily mean that when you call them sands that they are sands as such?

A I was perhaps abbreviating somewhat when I referred to them as sands.

Q I didn't want to leave any confusion with the Commission that you were indicating that all of these cross sections and the lack of continuity shown thereon was the basis of sands, but rather that they were drawn to show that there was lack of continuity between microlog correlations only?

A Yes, the sands I referred to in my discussion of my sections, I meant to refer to the portions of the interval which show the stippled pattern as being the sands which do show microlog separation.

Now, there are other sands over sections which do not show microlog separation, and they are sands and I say they are very low permeability.

Q If you eliminated this nomenclature calling the bar sands and correlated on actual sands, the SP curves, this discontinuity or apparent discontinuity that is shown by correlation of micrologs would disappear to a certain extent?

A I have seen quite a few exhibits at this hearing which did show that is true.

Q Showing a continuity of sand, but a discontinuity apparently of microlog separation?

A A discontinuity of the very permeable sands.

MR. WADE: Thank you.

MR. PORTER: Anyone else have a question?

MR. DUTTON: Granville Dutton, Sun Oil, Dallas.

By MR. DUTTON:

Q Mr. Lindsay, to return for a minute to the heterogeneous variations of permeability in sands, would you say that your examination reveals any systematic distribution of those heterogeneous?

A Examination of cores?

Q Of all information available to you.

A A systematic distribution?

Q Systematic distribution.

A Yes, there are in this field certain trends that can be seen if you add up in each well the sum total of all the various microlog pay intervals and plot them as isopacks; as a matter of fact I presented one at the last hearing which do show areas of this field which have more net pay than other areas, and if you can draw isopacks on it and get a trend, the trend does follow generally the trend of the field itself. But I also wish to make clear at that time, and say again, that merely because you can draw isopacks

showing a trend does not mean that all those separate thin layers are all connected.

Q Then within a given core sample, those that you have introduced in evidence here, would you say there is any systematic variation in the heterogenity in those cores?

A In these cores alone?

Q Yes.

A I would say it is quite irregular, some of these sands in this core are massive for perhaps a few inches up and down and others are very small streaks of sand completely encased in shale material, and in these very irregularly distributed, finely interbedded sands in many of those intervals why we were unable to establish communication in our core analysis. That is core analysis showing zero probability, or permeability, showed that they were not interconnected and showing they are radically distributed.

Q The systematic distribution that you have described is primarily one of weighing the permeability in one and the porosity in one and lumping that together and then you find with that weighted average some systematic distribution, is that correct?

A I think that there is some systematic, well systematic, there are trends of more pay in this field, yes.

Q But within the individual core would it be correct to describe the parameter as being randomly distributed?

A Not entirely randomly since this is a bedded formation it is

certainly, certain qualities of sand follow very specific bedding planes, are contained within specific stratigraphic intervals, and perhaps within a certain stratigraphic interval you will find a particular type of sand interbedded a particular way and above and below you may find a dense shale and above that a massive sand, so above that you may say there is some systematic distribution within a core.

Q With respect to Shell Carson No. 5, could you tell me if that is an oil well or a gas well in your estimation?

A I have been informed that is a gas well and that the oil production that I think was referred to in the last hearing was load oil. We have no indication it was an oil well.

Q Would that explain one of these anomalies that you thought was present in the original hearing where you had oil production above gas production or thought you had?

A The anomaly that I referred to and attempted to stress was the anomaly between Gulf To-Nah-Bah Navajo 1, which is a gas well according to my information, and Shell Carson Unit 33-24 and Shell Carson Unit 2, both of which are oil wells and upstructure from that Gulf well.

Q And Carson No. 5 does not indicate any anomaly at this time, is that correct?

A No, there is no anomaly there.

Q You have testified that in your opinion, or perhaps I should

ask this as a question. Is it your opinion that it is economically feasible to develop on 40 acre spacing at this time?

A Well, I have not made those calculations myself, but I'm informed by fellow workers at Shell that it is their opinion that is profitable development.

Q Are these fellow workers under your supervision?

A No.

Q Or do they just give you the advice?

A We give each other advice. They are not workers under my supervision.

Q Your classification is exploitation engineer, do you ever indulge in economic analysis?

A I have from time to time at Shell, but generally the economics are in the province of the Reservoir Engineering Department, and, let me clear something up. Shell's Production Department, there is the Mechanical Engineering Department and the Exploitation Engineering Department. Within Exploitation Engineering there are three specialties, being Reservoir Engineering, Petrophysics and Production Geology, and we all try to familiarize ourselves pretty much with all three fields, but we have one specialty and mine is production geology, so it is therefore not my responsibility to make economic calculations.

Q Then your testimony relative to the desirability of 40 acre spacing is based entirely on the geology of the field and not upon

economics.

A I try to limit my opinions to what the geology alone shows. I don't try to calculate in terms of dollars what we are going to get here or there or even in barrels of oil. But merely I try to the best of my efforts to determine the nature of the geology of this field and then as for the economics, that is a matter of the company policy.

Q In answer to one of Mr. Campbell's questions, I believe you indicated that you did not consider it economically feasible to drill on less than 40 acre spacing, was I correct in your statement?

A You are referring to the first hearing?

Q No, I'm talking about the cross examination by Mr. Campbell today.

A I cannot recall that question.

Q Then I will ask it. Is it your opinion that if this field were developed on 20 acres it would recover more oil than if developed on 40?

A It is my opinion that you would recover more oil.

Q Then would it be your recommendation to develop it on 20?

A Not until our reservoir engineers had made an economic analysis of that situation.

MR. DUTTON: Thank you.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q I have just a couple of questions here. Mr. Lindsay, has any analysis been made of any cores or in any other manner to determine whether any vertical communication exists between these various sand bodies, or within these various sand bodies, for that matter?

A Our core analysis has been limited to one sample per foot, and we have not, to my knowledge, in the lab made any effort to establish vertical communication between individual sands as far as permeability measurements go.

Q Well, now,have you made laboratory analysis, or has a laboratory analysis been made, I should say, of these silt stones and shales to determine whether they are permeable either horizontally or vertically?

A The analyses, for example, in Shell 24-16 A are shown on the petrophysical chart and we have therefore made numerous measurements of the silt stones and shales which do show zero permeability.

Q Laterally? A Laterally.

Q But no analysis has been made on vertical permeability?

A Not to my knowledge.

Q Mr. Lindsay, I can understand why a company might perforate where no microlog separation was evident. These cross sections indicate a lot of perforations in many wells, but I can't understand why a company wouldn't perforate where the separation did exist. What's the reason for that? I note that it has occurred in several

instances.

A Were it my job to recommend perforations in any particular well that we might drill, I would recommend perforating all of the microlog pay intervals, all of them including and in addition the better developed sands from the SP that didn't show microlog. Right off-hand I can't think of a reason why one would not want to perforate microlog pay zones, assuming that those sands were not water bearing.

Q I note on your Exhibit OP, Carson Unit 14-11 has some microlog separation which hasn't been perforated. I just wonder about that.

A I don't know the reason for that. I would have recommended that we perforate the whole thing, I mean the whole microlog pay. There may be a discrepancy in depth measurement which was not corrected when this section was drawn, but I don't know if there is.

Q Mr. Lindsay, you corrected several of the exhibits while you were testifying. Are there any other errors in these exhibits or have they been checked to see if there are errors?

A They have been checked. I have corrected those errors that I have been able to find.

Q This process of checking, have you determined in your own mind that you feel that these exhibits are correct as they are now with the corrections that you made on them?

A They are to the best of my knowledge correct now.

MR. MUTTER: That's all.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsay, are the CC sands and the CD sands, as you identify them, the same sands which the Applicants refer to as the top two and the most prolific sands?

A I think that they are. They have a different nomenclature.

Q You were present at the hearing yesterday, of course?

A Yes.

Q You heard continuous reference to the top two sands which were referred to as the most prolific sands?

A Yes.

Q From which two witnesses testified that they felt either 95% or something in excess of 95% of all the oil in the Bisti-Lower Gallup oil pool lies? A Yes.

Q Now I would like to know if you agree with this estimate as to the distribution of the reserves through the various sands?

A Well, I believe that this is weighting the upper sands rather heavily. I think that the 95% figure is probably lower than 95%. I would say that there is apparently, in my opinion there is more oil in the lower sands compared to the upper sands than in other opinions.

Q If you were asked to make an estimate to correct this figure, what would you think would make a closer approximation of the

distribution of the oil?

A I would be pretty hard pressed to give a figure, but I should think that I believe that our reservoir engineer has made an estimate and I would hate to give one different from his.

Q I would like to know from your geological examination what you feel the distribution is. I understand there are many factors from the engineer standpoint that come to bear upon these and modify them; strictly from the geological standpoint where do you feel this figure would be more properly placed?

A Well, I would say that as an opinion it would be more on the order of 75 to 80%.

Q Thank you, Mr. Lindsay. Yesterday Mr. Lewis testified that he felt that correlation between microlog pay was an extremely hazardous way of attempting to establish either the presence or the absence of communication between wells due to many factors, one of which you core a very, very small area compared to the distance between the two wells and the wide variations of permeability of which you have no knowledge in between. Do you agree with this statement?

A This approach certainly has limitations. It's an interpretive problem, has a lot of geology, it's the best method that I know of doing that of geologically looking for communication or discontinuity, I make every effort to correlate microlog pay though where they lie in the same stratigraphic position.

I think where they lie in different stratigraphic position, where one exists in one well and does not exist in the next well, I think it is a reasonable interpretation that somewhere between those two wells this sand which is confined between certain bedding planes must decrease sufficiently in permeability that it does not reach the other well, and therefore there is not communication, effective communication between those two wells in that sand interval. That's the best way I know how to do it.

Q You would agree that actual communication tests conducted between the wells would be more conclusive proof of the existence or non-existence of communication rather than an interpretive correlation of microlog pays?

A I think really the two approaches in conjunction might give you more of an answer, but I think that you have to, or that it is more informative if you conduct your pressure tests in individual sands rather than as in the entire interval open to the well. I think in many cases some sands may go through and communicate and show you pressure communication where many others do not go through, but the effect of those as I understand from our reservoir experts, is that where there is even a slight amount of communication you would see a pressure drop or a pressure interference between two wells which does not mean that all the sands are communicated between those two wells.

Q I'm not referring now to any communication test or tests

that have been conducted with reference to this pool, but in general if they are conducted under ideal conditions and as you say we will assume they are conducted for each interval.

A Yes.

Q This would be considerably more conclusive method of determining communication between the wells than would correlation of microlog pays, wouldn't it? A I think it would be,--

Q (Interrupting) Thank you.

A (Continuing) -- conclusive.

Q If you have further explanation I didn't mean to cut you off.

A That's all right. I think that the two really together would probably give you more information if you do test isolated sands, but of course I have confined my investigation to purely the geological approach.

MR. COOLEY: Thank you.

MR. PORTER: Mr. Utz.

By MR. UTZ:

Q Mr. Lindsay, I'm sure by now that you are aware that there are a number of perforations shown on your cross section exhibits which are borne out by microlog separation. Is my understanding correct that those perforations were made on the basis of the SP curve alone? A They were.

Q Then, let's refer to your cross section OP, Exhibit 11-R, for a minute. The perforations below your GD sands on Government

44-10 which do not show microlog separation, can you state whether or not those perforations are still in that well?

A To the best of my knowledge they are.

Q Let's enlarge it to all of your exhibits. Are all of the perforations shown on your exhibits still open in the well bore as far as you know?

A As far as I know they are unless there are any cases that I am not aware of where it has been indicated that the well has been plugged back above those; otherwise, I would assume they are open.

Q Getting back to your Shell 44-10, can you state whether or not the lower perforations below your GD sands produce oil in that well?

A I can't say conclusively that they do because I don't think they have been tested separately.

Q Can you state that any of these perforations shown on your exhibits, which do not show microlog separations, produce oil?

A On one of my cross sections at the previous hearing we showed Shell Carson Unit 2 which showed perforations in an interval of no microlog separation, and that is an oil well, it is not a very good oil well, but it does produce oil from only perforations opposite no microlog pay, and then this Southern Union well on Section KL appears to have perforations only opposite a sand interval without microlog separation. Apparently the sand intervals

which do show microlog separation have not been perforated.

Q That turned out to be a pretty good well then, didn't it?

A Sure.

Q So microlog separation alone is not indicative of whether a well will produce or not, is it?

A No, it is not.

Q I believe that it is your contention that there are quite a number of isolated sand lenses in this reservoir which are completely separated from other sand lenses. Am I correct in your analysis?

A It is again the problem of nomenclature. The sands in, I would say, probably most of these cases do go through to other wells, but those adjacent wells don't show microlog separation and therefore I think that the communication between those wells would be very poor inasmuch as the more permeable sands lose their permeability going between the wells until somewhere between this well and that well the permeability has dropped to so low a figure, probably in the tenth of a millidarcy or less range.

Therefore, I conclude that there is poor communication, if any, between those wells.

Q Have you, or do you know of any pressure tests, gravity tests that have been made as between these individual sand lenses?

A I don't know of any between individual sand lenses.

Q Would that not be a pretty fair way of indicating that they

had complete separation?

A I think that would be a good approach.

Q But you don't know that that has ever been done?

A Not to my knowledge.

Q Just one other question. Mainly out of curiosity, if these sand lenses are completely separated, how do you account for the oil being there in the first place?

A Well, we are getting back to this problem of geologic time. I was asked that question at the last hearing and I stated that I thought some part of the oil was indigenous, but that most of it migrated in the Gallup sands from an outside source, and I would say that the vast majority of it has migrated into the Gallup sands.

The Gallup sands, if you look at them in their environment, are a series of relatively thin sands interbedded with and entirely encased in a vast section of shale, the mancous shale, which I believe is considered to be a good reservoir rock. And I would say that in my opinion the mancous shale is probably the source of virtually all the Bisti oil, and of course when these sands were laid down why they were not tightly cemented like they are now. They had streaks of fairly relatively clean sand which had very little clay in them, and other portions which did have a good deal of clay which would account, would be represented by the shaleout of the sands in lateral directions, and the mancous shale at that time as it was

laid down before and after these Gallup sands, consisted of mud and clay which was gradually compacted, and in that mud and clay I would say from the large concentration of organic remains, that the oil was generated and more or less squeezed out of the shales into the sands.

In other words, as oil is generated in shales and shales are compacted, they become tighter and the oil tries to escape and we find some escapes into the sands and becomes concentrated into the sands. Then, of course, the sediments are buried rather deeply and at some time, at some geologic time, other changes take place, circulation of ground waters which deposit cementing material, much of it probably a result of the calcareous remains of the various fossils which are right in the sands themselves, and that changes the quality of the sands, it changes the nature of the sand, they become differentially cemented and the oil which remains in these streaks and stringers of permeable sand becomes trapped. That is my concept of how the oil got into these sands and why it can't get out until you penetrate it with a well.

MR. PORTER: Mr. Grenier.

By MR. GRENIER:

Q Just a couple of questions that have come to mind in the course of the cross examination by other parties. Referring to your Exhibit 11-R, I believe it was indicated in your Shell Carson Unit 14-11 well there were some eight different microlog separation

intervals there where positive separation was shown, is that correct?

A That's correct.

Q Going over to the next one on the left, and the Shell Government 44-10, is that bar correctly shown there as being a continuous positive microlog separation throughout that interval which you have stippled in that well?

A Yes, it is. I can't recall the log itself. I looked at quite a few, but I would assume that the microlog did indicate a solid interval of separation.

Q Now, running through that solid interval I see that you have some four non-permeable streaks which appear to pass right through it, two of them at least going on a couple of wells on further to the left of the exhibit, isn't that correct?

A Yes.

Q What was your basis for determining that those were still impermeable lenses, or whatever, when you had positive microlog separation throughout the full interval?

A The basis for the shale beds separating the sands was the SP curve of electric log.

Q The microlog separation did not indicate that discontinuity?

A Not in this well.

Q I gather that you think that these, taking again the eight separate sands over there in 14-11, that some of them pinch out before they get over to offsetting wells. Wouldn't it be just as

likely to assure that some or all of the non-permeable intervals would pinch out before they got over to the next wells?

A A reasonable question, and I think in many cases the non-permeable streaks do pinch out as I show some here which do, Shell Government 14-10, and toward the center of the same section has a solid sand interval, and on the other side of it is a shale which is approaching that, but which pinches out before it gets to it.

The reason why I interpret it that way is because in that particular well that sand appears from the electric log to be fairly continuous sand and the shale is a very thin body and therefore the sand is in the majority. Looking at the field as a whole, the sands are in the minority and I find it easier to visualize thin sands pinching out into shale rather than the shales pinching out into sands.

Q But within these areas, not taking the entire depth of the well, you do have certain intervals which are predominantly sand?

A Yes.

Q With minor stringers within them?

A Yes.

Q With the same line of reasoning, those would be more apt to pinch out? A Yes, they would.

Q Thank you.

A I wasn't quite through. I attempt to correlate all the sands in the same stratigraphic, but if they are not in the same

interval, then I interpret those sands as not being communicated.

MR. PORTER: My watch shows it is noontime.

MR. GRENIER: We are going to have to leave to catch one of the planes. May I say that Southern Union supports the Applicants in this case for 80 acre spacing. It does so primarily on the ground, even after the testimony it is solidly confusing and irreconciliable, the most you can get to from that situation is a condition where we don't know yet, we cannot prove conclusively what the conditions are in this reservoir, that you cannot undrill a well once it is drilled.

It's always easier to drill one that you haven't drilled before, but you can never undrill one, and particularly in the light of the low takes which have been adverted to in the testimony in this case of oil from this pool, at this time this is hardly the time to be pushing people, as it was indicated in Mr. Brinkley's testimony yesterday, into a 40 acre development pattern as opposed to the 80 on which most of the field has been developed to date.

MR SETH: Is Mr. Wiedekehr going to leave too?

MR. GRENIER: Yes.

MR. SETH: We were going to call Mr. Wiedekehr as a witness since he has given statements from the floor. The only thing we wanted was the cumulative production from the well that is under production. If he would give that.

MR. WIEDEKEHR: I don't have that available. We will be

glad to furnish it. It has been very small. It has been 200 barrels a day.

MR. SETH: How did you measure?

MR. WIEDEKEHR: After swab test, after load oil has recovered.

MR. SETH: What about your practice on core samples?

MR. WIEDEKEHR: Yes, every foot, and you can have that too if you would like to have it. If you will drop me a little note I'll send you all the information I can on it.

MR. SETH: I think that will do it.

MR. PORTER: I realize that these plane connections are difficult to make, so if someone else would like to make a statement.

MR. WOOD: A. W. Wood, from Monsanto Chemical Company. Monsanto wants to express concurrence with the proponents of 80 acre spacing and reiterate its requests made at the original hearing, that the Commission grant temporary 80 acre spacing in the Bisti-Lower Gallup Pool.

MR. PORTER: The meeting will recess until one-thirty.

(Recess.)

MR. PORTER: The meeting will come to order, please. Does anyone else have a question of Mr. Lindsay? The witness may be excused.

(Witness excused.)

Mr. Seth, did you offer your exhibits?

MR. SETH: No, I had one redirect, if I may.

MR. PORTER: I see.

RE-DIRECT EXAMINATION

By MR. SETH:

Q Would you expect that the drainage radius in areas that showed no microlog separation would be smaller than in areas that did indicate a microlog separation?

A Yes, I would expect them to be smaller.

MR. SETH: I believe that's all.

Q Now, referring to the exhibits, were these exhibits prepared under your direction or supervision? A They were.

MR. SETH: We would like to offer at this time Shell's Exhibits 1-R through 13-R, including letters A through H under 4-R.

MR. PORTER: Is there any objection to the admission of these exhibits? They will be admitted.

MR. SETH: I call Mr. Methven.

NORBERT METHVEN

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Methven, and your

position with Shell Oil Company?

A My name is Norbert E. Methven. I'm a reservoir engineer with Shell Oil Company, stationed in Farmington, New Mexico.

MR. PORTER: Just a minute, Mr. Cooley. Mr. Cooley says that the witness was not sworn.

A I was sworn with Mr. Lindsay.

MR. COOLEY: You were both sworn at the same time?

A Yes, sir.

MR. SETH: He was sworn with Mr. Lindsay.

Q What type of work are you doing in Farmington?

A I am a reservoir engineer, doing engineering work primarily in the Bisti Field.

Q During the course of that work you have become familiar with the reservoir characteristics of the Bisti Field, have you?

A Yes, I have.

Q What reservoir engineering data do you have that relates to the geological information that Mr. Lindsay has presented this morning?

A Well, there is considerable reservoir data which supports this geologic concept of irregularities and discontinuities. One of these is the apparent absence of vertical communication, and I think most, at least Shell uses, for instance in their completions they use a method of fracting --

Q (Interrupting) Well, in your fract methods do you recognize

and take into consideration the fact that there is no vertical permeability, there is no effective vertical permeability?

A That's right.

Q If so, how do you do that?

A Well, we take that into account, and in order to assure ourselves of fracting each individual sand, remembering that there are various permeabilities of these sands, or the permeability varies, we use a method wherein you use rubber balls in the fracting process. What you do is commence your fract job and in essence you will then fract the higher permeable zones, and then you use the rubber balls, you float the rubber balls and those go into the holes where the velocity of the fracting fluid is greatest and plug those off and the fluid is diverted to the zone of lesser permeability.

Not only does Shell do it, but I have been informed that other operators do likewise. Now, if you felt that you had vertical permeability, you wouldn't be concerned about something like that. You wouldn't need it.

Q What other reservoir characteristics relate to the discontinuity?

A Well, the presence of gas in a lower zone which is structurally lower than the presence of oil in an upper sand would indicate lack of vertical communication. Now, in view of the fact, as our geologist testified, that the oil was put in there in geologic time, surely this separation or migration would have occurred, but

in any event this was depicted in Sinclair's Exhibits 11-R and 12-R as presented yesterday where they showed oil occurring above the gas. Now if they had vertical communication or permeability, surely that gas would have migrated up and the oil down.

Q Now, have you in your reservoir studies, have you made a survey or paid special attention to the pressure picture in the field? Could you give us any over-all analysis or estimate on the pressure picture?

A Yes. There are large differences, large pressure differences, at adjacent well locations. Now, this occurs especially below bubble point.

Q Can you point out or do you have an example?

A Yes, I have some. One of these examples is in the British American properties in Section 28, Township 26 North, Range 13 West. The well that I am going to refer to first is Douthit B-2 in this case. In the month of October, 1956, this well had a static pressure of 760 PSI. Here is a case of a very low pressure, and it is British American Douthit B-4 in Section 27, Township 26 North, Range 13 West had a pressure of 924 during the same month.

Another one in this same area was taken as of a later date, this same British American Douthit B-4 had a value of 601 in April of 1957, while Douthit B-5 had a pressure in the same month of 1326.

Q Does this pressure show a pretty irregular arrangement throughout the field, or is there any sort of pattern to it?

A There is no apparent pattern. I think there's some other examples down here in for instance Amerada No--Des--Pah No. 1 in Section 8 of Township 25 North, Range 12 West.

Now, in April of 1957 that well had a static pressure of 1292, while the well immediately south of that which is in Section 17, Township 25 North, Range 12 West, Sunray Federal B-1 had a pressure of 441 during the same month. Pressure data in general throughout the field exhibits those irregularities. Upon attempting to say make an isobaric map of the field, Why you run into those differences, very, very great differences in pressure. Just in general the pressure data is scrambled up and certainly highly indicative of poor communication.

Q That shows irregularity would more or less confirm the geological data that was put in by Mr. Lindsay?

A Yes, sir, it would be.

Q I believe you were here, or did you hear the testimony concerning interference tests conducted in the vicinity of the pilot test area? What does an interference test of that character show?

A Well, an interference test as such shows pressure communication only, and it does not necessarily show the amount, or does not give you a measure of drainage efficiency.

Q Why isn't pressure communication alone a measure of drainage efficiency?

A Well, one thing is where you have isolated sands, why you would not be measuring, for instance if you measured a well here and a well there, and if you had an isolated sand why you wouldn't necessarily measure the pressure or the interference.

Q Does the degree of pressure at the particular time have any significance?

A It has a very definite significance.

Q What is that?

A Well, pressure communication early in the life of a field that is undersaturated, is a function of the time and the compressibility of the fluid at that time. Now, when you are above the bubble point, the compressibility, I mean above the bubble point means you have undersaturated fluids, it means fluid and the compressibility of a fluid is very small. So when you have a certain pressure in say a vessel filled with fluid and you take a drop out, the pressure changes very greatly, but if you have a case where you have this vessel filled with some gas and you take a drop of gas out, then the pressure effect is very slight because the pressure of the fluid, or rather the compressibility of the fluid, is very slight as compared to gas.

Therefore, when you take an interference test when you are above the bubble point in the undersaturated region, then you have a, quite a pressure effect, but not very much or not necessarily very much fluid communication.

Q Well, then, it would be relatively easy to show pressure communication in an area where the pressures are above the bubble point?

A Yes, it is.

Q That would hold whether the pressures were obtained artificially or were naturally occurring, is that true?

A Yes. And the difference of say the pressure communication from say above the bubble point to some place below the bubble point can amount to say a hundred times as much as the same amount of, that the time to detect that pressure difference would be say one hundred times.

Q Are there areas in the field that are presently below the bubble point?

A There are, yes. I just cited a few pressure cases that were.

Q I don't believe you told us what the bubble point was, what is it?

A It's in the region of, well, in the original hearing it was stated as 1207 PSI.

Q Now, you have indicated that there can be instances of pressure communication, but that will not show drainage efficiency and will not show the complete drainage picture. Can you refer to any of the exhibits that are presently posted and show us an example where there may be pressure communication through a particular zone while others there is no communication indicated?

Q There are, of course, quite a few of them. I think on our

Exhibit 13-R, British American Douthit B-13, you can see that as you check the communication between this well and this well, you could very well have it or you could possibly have it any way through there, but it doesn't tell you what's happening to this sand in here, this separate sand in here.

Q Then if interference tests were conducted, using those two wells, it could possibly show pressure communication and it would be much easier to show it if it were above the bubble point, but still we wouldn't have a very good picture on the drainage situation?

A No, it certainly wouldn't tell you anything about what the drainage situation was of that sand. There's a lot of examples like that. Oh, we can pick say this well right here, this is Government 22-9 as depicted on KL or our Exhibit 9-R, there's a stringer here that you couldn't tell what the effect was by measuring the pressures in here or here as far as drainage is concerned. You could very well have pressure communication there, but you couldn't tell what is happening there.

Q The pressures taken in the well bore generally are not selective of any particular sand, they just measure the total over-all pressure?

A That is the conventional way of measuring pressures, and it is only very occasionally does somebody try to isolate the sand and try to measure the communication.

Q What are the two methods used to try to determine drainage efficiency?

A Of course, interference is good, assuming you have homogeneous sands and you are measuring those sands in particular. However, say a material balance calculation can give you an idea of what the drainage efficiency might be or an extrapolation of pressure and or production decline trends.

Q Considering where we are in the life of the Bisti Field, do you believe that it is, you could apply either one of those two methods?

A Certainly not now. For one thing, say the material balance is based on pressure performance and we have already stated that the pressure performance is very erratic and as a consequence the reliability of any material balance at this stage would be very, very poor.

Q You heard Mr. Lewis testify, and if I understand it correctly, you recognized that method of computation as being a method used generally, is that correct? A Oh, yes. It's --

Q (Interrupting) But you would not feel that it should be applied to the Bisti Pool at the present time, is that right?

A No, his was based on purely a text book example, and a perfect reservoir, and I'm sure this is anything but that, plus the fact that your pressures indicate the same.

Q Would you express an opinion as to when in the life of this

field that you think that you could apply the material balance calculation in order to extrapolate from your production data?

A Well, in order to give you any measure of workable accuracy, you should be say a third of the life or later of the reservoir.

Q Now, from what you know about the Bisti Field, do you think that can happen in the next five years, say, or three years or what, do you have any basis for estimating that?

A I think it could happen, certainly not within three years, and possibly not until five years.

Q Then it's going to be down the line a ways before you start using those partic lar methods for their drainage efficiency?

A Yes, it will.

Q Now, consider just a delay of say a year on the drilling of 40 acre locations, how will that affect completions, assuming that you had to drill on 80 acre locations now and waited a year to drill on 40's, what effect, if any, will they have on the drilling of these infill wells, a year or some such order from now?

A Well, in view of a certain degree of pressure communication, why these sands that may occur from one well to the next would be, at least their pressure would be lower and thus that would be in some of the sands. However, other sands would have initial reservoir pressures, so in the process of drilling wells through partially depleted sands as compared to virgin sands, why you have a lot of completion difficulties. Some of these are say mudding up of the

lower pressure sand.

Q Does that complication arise by reason of the fact that there are areas of different pressure within the same well bore? Do you get more mud in some sections than others?

A By all means, yes.

Q Explain.

A Well, during the process of drilling the well, you of course carry a certain mud weight to hold back the formation. In this case you would have to carry enough to hold back the pressure of the higher zones. The lower pressure zones would be highly susceptible to taking the filtrate out of the mud itself.

Q That would complicate the efficiency of your completion, is that correct?

A By all means. Not only mudding up, but the fracturing considerations are quite complicated there that, if assuming then that you didn't have mudding up, then if you were to fract the well, then this same lower pressured sand would be the one that would be most receptive to the fract fluid, then you have the problem of fracting the virgin sands to get the additional recovery.

Q Again, on this proposition of delaying the drilling of the infill wells and assuming, as the proponents do, that there is drainage, what effect will it have on changing the direction and movement of this oil? We assume it starts toward the 80 acre location if the proponents would, and that you drill the 40 acre

wells, does the oil have to change its path?

A That's right. You can envision the oil moving toward that well bore and then you drill another well here and it reverses itself.

Q Is that of any significance?

A Well, one thing, based on those assumptions then for one thing, say the gas saturation will be higher and as a result the mobility ratio or the ability of the oil to move back again will be reduced.

Q Does this show that the drilling of these so-called infill wells at a later date would be less attractive to any person to fully develop the field?

A By all means.

Q What other factors are involved, cost factors?

A Well, of course, you will incur higher drilling costs because of say a noncontinuous development program. Your completion costs, as we have already stated, would be higher. The lease facilities that you would have to replan those costs would be higher at a later date.

Q On the pressure aspect of it too, would you expect to encounter in some of the sands at least, lower pressures, and will that affect your payout situation?

A Yes. At a later date some of the pressures will be lower, and the consequent payout of the well will undoubtedly be much longer than they are today.

Q During the course of the hearing there has been a considerable discussion about the importance of the production from the lower members of this sand. Is it your opinion that the expected production from these areas is important, is going to be important in the over-all production from the Bisti Field, or is it of no consequence as the Applicants have indicated?

A No, I think it's quite important that any well you recover there that you should do so, and it is very difficult to calculate how much this will be, but it will be quite a bit, and in the difference of say a 40 to 80 will be even more in view of the discontinuities as indicated in the upper sands too.

Q Well, in drilling the 40 acre locations, you not only get the oil that is in discontinuities that don't extend over the 80 acre distance, but does that have any effect on the efficiency and the drainage in the upper sands?

A I think it will have an appreciable effect on the drainage efficiency of the upper sands.

Q And in these 40 acre wells we have to consider not only the production in the lower areas, but it is a complete well in itself and we should look at the entire well, should we not?

A Certainly.

Q Would you care to express any, or indicate to the Commission any percentage that you would expect, making a division between the upper and lower sands? A Well, --

Q Just considering oil in place in the first instance.

A Well, in the case of the lower sands, let's refer to what we call the GE, GG, which are the lower members as depicted by the cross sections, there is probably some 20% of the t[illegible]l oil in place in those sands.

Q Now, Shell's testimony shows too that these lower sands you probably wouldn't get the same production efficiency that you would from the upper sands. Is that a fair statement?

A I think it is. They're poorer sands in general.

Q Then that should be considered by the Commission also, should it not? Your figures relate to oil in place?

A Yes, they do.

Q But you would feel that it was important to consider also that the production be less efficient from the lower?

A Yes.

Q Are there some examples of each well in the field that have shown some rather high initial production but have dropped off?

A Yes, there are some wells on the edge that appear, that apparently don't have much pay in them, and as a result their pressures have declined and the wells are approaching the economic limit, and I wouldn't think that they would recover, but say several thousand barrels, and those wells are generally where there's small if no microlog pay in them.

Q Do you have any other comments that you would like to make

to the Commission on the reservoir situation?

A Well, I think that one thing, wells completed say in this, in these lower sands that apparently don't show any microlog pay, there has been some brought out today that actually produced oil, produced quite a bit of oil, however I think they'll have rapid declines, especially on a wide spacing program, and I think that's quite applicable to say the sands in the interior where you have poor pay but there's certainly oil there, certainly recoverable and we certainly would like to recover it.

Q This production, you heard testimony about the Southern Union well where there was no microlog pay indicated, and there was production, would you expect the radius of drainage there to be less than in areas where there is a microlog separation?

A Yes. It would be a very logical conclusion, that is a wide-spaced well would not recover a very great percentage of the oil where a closer-spaced well would recover a greater percentage of that oil.

Q This oil that is apparently in the areas where there is no microlog separation, that has a place in the picture, does it not?

A Yes.

Q And our spacing should be geared with that situation in mind, very small drainage radius? A Yes.

Q Is there a considerable development in the field to date on patterns other than any requested by the Applicants? Do you have

an exhibit showing that? A Yes.

(Marked Shell's Exhibit 14-R, for identification.)

Q Would you refer to Exhibit 14-R?

A Yes. This is Exhibit 14-R, which is a contour map of the Bisti-Lower Gallup Pool, and what we have done is colored in the Governmental quarter sections, for instance the ones in red are the Governmental quarter sections on which there have been two wells, which there have been more than two wells drilled. There's eight red ones, I believe.

Now, in the case of the green ones, those are Governmental quarter sections on which two non-diagonal wells have been drilled. So you can see these are spaced throughout the field.

Q In this diagram you have not taken into consideration direct 40 acre offsets, have you? A No.

Q You are just considering quarter sections alone?

A Yes, there are a lot of other wells that are misplaced.

Q There are a lot of forty acre direct offsets?

A There are, yes.

Q Is Shell Oil Company prepared to proceed on the 40 acre development as testified at the previous hearing?

A Yes, as far as I know.

MR. SETH: That's all the direct questions we have.

MR. PORTER: Does anyone else have a question of the witness?

Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Bethven, will you stand up and refer to this exhibit again, please, your Exhibit 14-R? Do you have the dates on which the wells in this area were completed by Shell since the first hearing?

A The dates of completion?

Q Yes.

A I could probably get some of them. I think I have some of those dates with me.

Q I'm going to point to various of these red marked quarter sections in the approximate center of the exhibit and ask you to tell me who appears to be the owner of the acreage underlying those red marked quarter sections. Let's take this one right here. Is this Shell acreage?

A Yes, it is.

Q Is this one?

A That is Shell's acreage.

Q Is this one?

A Yes.

Q Is this one?

A Yes.

Q Is this one?

A No.

Q Who owns this acreage?

A El Paso is the oil company.

Q Out of the six quarter sections marked in red in that area, Shell is the owner of five, is that correct?

A It i

Q Can you tell me how many of the wells that are shown in those five quarter sections have been drilled by Shell since the last hearing?

A I don't know exactly, but I think most of them were. There are, I believe a few that were drilled prior to the other hearing.

Q Do you know the number of wells that Shell has drilled on a 40 acre pattern since the last hearing, the total number?

A I don't remember the number, no.

Q As a reservoir engineer, would you say that it is a correct statement to say that in a situation of this type with a cluster of wells as these are clustered in what has been testified to as the fairway or Highway 66, might result in a drainage situation to the advantage of the owner of these properties with the clustered well ownership?

A You mean under the present condition wherein the other people do not have 40 acre wells?

Q Yes.

A Well, I think there might be some room for say some drainage out there based on limited amount of apparent interference.

Q Do you have any data with you on the production history of the wells situated in that area to which we have been referring on the Shell acreage? A Yes, I have some.

Q Can you tell me what the production was from those wells

during the month of November?

A I don't think I have the November figures. I think the book is only up to October, the October figures.

Q Do you know whether Shell has the November figures here available?

A I don't think they are.

MR. SETH: We can get them for you if you want them.

A The November figures, of course, come out in December and we apparently didn't have them available.

MR. CAMPBELL: I would like to request that the production figures on the Shell wells in Township 25 North, Range 12 West be furnished to the Commission together with the dates of the commencement of drilling on each of the wells.

MR. SETH: We will be glad to furnish that.

Q Is there any other acreage shown on that exhibit that is owned by Shell than that to which we have referred, your Exhibit 14-R, that is marked in green or red?

A Which ones did you point to?

Q That group in the center of some eight, are there any others marked that are Shell acreage?

A This is Shell here.

Q Have any wells been drilled on that tract since the first hearing?

A Yes, sir.

MR. CAMPBELL: I would also like to have the information on that tract, the commencement date on each of the wells, and

the production data.

MR. COOLEY: Mr. Rathven, will you identify the last quarter section?

A This last one, Section 16 in Township 25 North, Range 11 West, and this is the southwest quarter of that section.

MR. SETH: We will like the same information on Sunray's offsetting wells.

MR. ERREBO: If you will identify in some general terms, we will know what you want.

MR. PORTER: Is that the November production figures that you have requested?

MR. CAMPBELL: Yes, sir. I understand the October are available to the Commission.

MR. SETH: That is Sunray Mid-Continent C-14 and C-21, those two seem to be the only ones.

MR. PORTER: I believe those reports usually reach the Commission about the 25th of the month.

MR. COOLEY: Will you be willing to furnish the information requested, Mr. Errebo?

MR. ERREBO: Yes, I so stated.

Q During the course of your testimony, you, as I recall it, made the general statement that at the present time because of the inadequate production history, as I understood you, you could not determine the situation in this reservoir by an examination of the

production usually and the pressure decline, is that correct?

A I believe I made that statement.

Q And what was your reason that you could not determine the movement of fluids by interference tests?

A Interference tests showing only pressure communication above the bubble point.

Q Do you consider that pressure communication is not any measurement of communication or drainage?

A It's an indication of movement and drainage, but it gives you no qualitative or quantitative amount.

Q And at this stage of develolment and production or completion of this reservoir, there is no quantitative basis on which you can determine that, is there? A Determine what.

Q The drainage, the movement of fluid, the amount of fluid moving that you referred to. If you can't use interference tests and you can't use material balance method, then there is no basis at the present time upon which you can calculate that, is there?

A You have to base your estimates on the geologic picture.

Q And as you said, the indication of pressure changes, is that correct? A Yes.

Q But you do believe that with additional production history in this reservoir some of the factors necessary to make those calculations will appear, will they not?

A I think they might, given sufficient time. However,

say the pressure, the erratic nature of the pressures to date suggest it would be a long time, and matter of years of course.

Q If you are unable to make any of these calculations, are you unable for your company at this time to calculate or estimate ultimate recovery or possible performance of your wells in this reservoir? How would you do that?

A How would I, would you rephrase that?

Q How do you calculate for your company in their economic calculation of drilling, any basis for ultimate recovery from the lease?

A You base that on the geologic picture and the total oil in place.

Q You base it entirely on your geologic picture?

A And your calculation of the total oil in place.

Q How do you calculate that? A By volumes.

Q Do you have enough information in this reservoir to do that?

A I think so. There's quite a few exhibits here that give you a very good means of calculating the oil in place.

Q Is that the method that you used in calculating the 20% of the oil in place in the lower sand zones?

A Yes, volumetric.

Q Do you have your calculations as to the amount of sand you estimate?

A I have some calculations here.

Q Did you consider the reservoir characteristics in the lower sands to be the same as in the upper sands in your calculation? A No.

Q Did you consider the porosity to be the same, the average porosity? A No.

Q Did you consider what you stated was the possiblity of rapid decline of production in the lower zone?

A Pardon me.

Q Did you consider what you stated during the course of your testimony was your prediction of a rapid decline in production in the lower zones?

A You are asking me about the total oil in place calculations?

Q Recoverable oil, yes.

A I believe I understood you to be talking about total oil in place, at least I was.

Q Well, were you talking about recoverable oil in place when you were referring to 20%?

A Total oil in place?

Q Total oil in place. A Yes.

Q Do you have any calculations or estimates considering reservoir characteristics and the performance possibilities of the lower sands to indicate recoverable oil as related to the upper sands?

A Well, you have, as you mentioned, the porosities and saturations of those sands.

Q Do you think that the estimates that have been made here by their engineering witness as to the approximately 95% of the recoverable oil being in the upper sands are out of line?

A I think so, yes. I think that would leave only five percent of the recoverable in the lower sands. I think there's more than that.

Q How much more recoverable?

A I couldn't give, you can't calculate it, so I can't give a definite number.

Q In other words, there is no way in which you can calculate it, is there?

A No, not the recovery efficiency.

MR. CAMPBELL: I believe that's all.

MR. PORTER: Anyone else?

MR. WHITE: I have one question.

MR. PORTER: Mr. White.

By MR. WHITE:

Q In your testimony as to the delays and the resultant difficulties that would arise by development on 80 acre spacing program such as mudding up due to low pressures, you are wholly disregarding, are you not, the possible success of the LPG program?

A Could you read that back to me.

REPORTER: Reading: In your testimony as to the delays and the resultant difficulties that would arise by development on 80 acre

spacing program such as mudding up due to low pressures, you are wholly disregarding, are you not, the possible success of the LPG program?

A I think you will have these same troubles a year from now whether you flood or not.

Q To the same degree or lesser degree in view of the LPG, assuming it to be a success?

A In order to answer that, you have to make a lot of assumptions, now, for instance who you would propose to flood.

Q Well, you were here yesterday, were you not?

A I was indeed.

Q Let's assume that the LPG program continues to be successful as it is pointed out to be, what would your conclusions then be on that assumption?

MR. SETH: What area are you referring to?

MR. WHITE: Well, wherever the LPG program initiated, where the results of it would be felt.

Q Well, getting back to the original question, did you or did you not give any consideration to the LPG program?

A Well, we're actively considering it, of course.

Q Do you take that into consideration when you state your conclusions as to what difficulties might be encountered by delay caused by drilling on an 80 acre spacing program?

A Well, let's go on to the next question.

MR. SETH: Maybe if you would make them a little more specific as to areas they would be capable --

MR. WHITE: (Interrupting) I merely asked him if in stating his conclusions he took into consideration the LPG program.

Q You stated that Shell was ready to proceed on a 40 acre spacing program, is that true? A I did, yes.

Q Do you intend to drill the outer edges on a 40 acre spacing program?

A We don't intend to drill any non-economical wells. If a well out there is uneconomical, we have no intention of drilling it. We obviously will drill out as far as a well is economical.

Q Then your statement definitely has limitations to Shell's readiness to proceed on a 40 acre spacing program?

A Well, it would if it was any spacing.

MR. WHITE: That's all.

MR. PORTER: Mr. Wade.

MR. WADE: I have just a couple.

By MR. WADE:

Q Mr. Methven, back to this delay business, what will happen on 80 acres, if you were to have to go back in later? I think your first difficulty that you were discussing in completion was this mudding up of the low pressure sands?

A Yes.

Q Do you think that that mudding up situation would be of

such magnitude that the normal fract job wouldn't bring it back in good shape?

A I think there's quite a possibility, yes, that if not mudding up, you could say have some sort of blocking of the formation back into the formation.

Q You are assuming then that the filtrate will penetrate a pretty far distance back from the well bore if a fract job wouldn't eliminate that block, aren't you? A That's right.

Q Has it been your experience, or do you think that that occurs, that you have a filtrate invasion to a considerable degree in this thing?

A We have already experienced some troubles along that line.

Q And a fract job would not bring them back?

A They did in this case, but I suspect that if the sands have been depleted, that the trouble would have been exaggerated over and above what they have been recently, and I think you would encounter considerable difficulty.

Q I think you also indicated that fracturing would be more complicated?

A If not mudding up, then fracturing would be more complicated just, if you didn't have mudding up then you would have the case of the oil going into that depleted sand and possibly not fracting the lower sand.

Q That is just what I was going to get at, what is wrong

with your rubber balls that you are using now?

A In this case it's questionable about the effectiveness at that date, that time.

Q What do you mean effectiveness?

A The effectiveness of the rubber ball fract jobs.

Q Well, that rubber ball fract job is just a physical principle of the rubber balls going to the zone of highest permeability, is it not? A Yes, it is.

Q Wouldn't that physical principle still hold?

A In general it might be complicated.

Q I think you also said that you would experience a higher drilling cost the second time around for drilling the infill wells, is that right? A That is, yes.

Q What do you base that on?

A That's based on the previous testimony at the previous hearing.

Q Did you testify to that? A I did not.

Q You really don't know then whether or not it would be more expensive the second time around?

A I would expect it to be.

Q You would base it on your experience?

A Well, I'd base it on the previous testimony, the previous accepted testimony.

Q I think you also indicated payout on the second time around

would be longer?

A It could very well be.

Q That would be based on your assumption that the drilling cost would be higher the second time around to a great extent, would it not?

A That plus the wells capabilities at that time might not be as they are today.

MR. WADE: That's all.

MR. PORTER: Mr. Dutton.

By MR. DUTTON:

Q Mr. Methven, are you one of the members of Shell Oil Company that gets to deal in dollars, respecting economic evaluation?

A I don't handle many dollars.

Q Do you make economic evaluations?

A I do, yes.

Q Have you made one in this field?

A Yes.

Q In making such an economic evaluation, say with particular reference to the drilling of the development well, do you think that payout time should be considered?

A Payout time should be considered. I think so, I think it always does.

Q Do you have any idea of your own, as a reservoir engineer, as to what might be a reasonable payout period for the development

of well costs?

A A reasonable payout time is dependent upon what the company is willing to accept, and I have no, I mean I don't control that.

Q In the original hearing, did you testify that you thought that a 40 acre spacing would pay out in a reasonable length of time?

A I did.

Q At that time were you speaking for Shell Oil Company on your own position as a reservoir engineer and professional man?

A Speaking for Shell Oil, yes.

Q At that time what did Shell consider to be a reasonable payout period?

A I think it's about two years.

Q About two years? A And it varies.

Q Are you familiar with the Bisti Unit allowable that has been recommended for the month of January, 1958, for the standard 40 acre unit? A I believe I heard.

Q What figure do you recall hearing?

A For what period was this?

Q January.

A For the month of January?

Q Yes, expressed in barrels per day.

A I don't think it was definitely decided, but it was something to the effect of ten barrels per day for the month of January.

Q Mr. Methven, what is your idea of the approximate cost of

drilling a well in the Bisti area?

A Previously a witness -- could you define the cost now, what does the cost that you are talking about include?

Q First to define it, I would define it as the total cost of drilling, completing and equipping. I would accept any one of the categories that you would define.

A Which one would you prefer?

Q The sum would be fine.

A The testimony at that time was to the effect of $48,000.

Q On the basis of ten barrels of oil per day production, can you give us an estimate of what the payout time would be for the --

A (Interrupting) Ten barrels per day per month. Are you making an assumption that you can produce the well only at ten barrels a day --

Q (Interrupting) I'm assuming --

A -- forever?

Q I'm assuming that the well will produce ten barrels a day, yes, sir, approximately what time would the payout be on that?

A It is certainly a hypothetical question, and I don't have a handy figure, but there is no question about it, it would be a long time.

Q It would exceed two years by a substantial margin of time, would it not?

A Assuming this hypothetical production rate?

Q Assuming this hypothetical type of an example, would you object to stating that the net income would be roughly to the operator two dollars a barrel after all expenses of lifting the oil?

A Would you rephrase that?

Q Considering all expenses involved to the operator, would you say that his net income per barrel of two dollars would be too far out of the ball park just to talk about years?

A No.

Q At ten barrels per day then, the operator would have essentially a twenty dollar a day income?

A That is right.

Q In $48,000 expenditure, how many days would that involve just roughly?

A Forty-eight divided by twenty?

Q Yes.

A That goes in about thousand --

Q (Interrupting) Would twenty-four hundred be all right?

A Yes.

Q Then twenty-four hundred days would be approximately seven years.

A I presume.

Q Mr. Methven, do you have any information that you would like to submit to the Commission at this time that would indicate that the allowable situation in the Bisti Pool is likely to change

in the immediate future?

MR. SETH: If the Commission please, I don't believe that is within the scope of the direct examination. I don't think it is pertinent. I don't think it is within the scope of the hearing at all.

MR. DUTTON: If the Commission will hear discussion, the purpose of the question was that Mr. Methven's hypothetical term given to this particular example might have left, or did to me insinuate that ten barrels a day would not last very long, and I just wondered if he had any information that would indicate that to be a fact.

A Could I --

MR. SETH: Just a minute.

A Oh.

MR. PORTER: The objection to the question is sustained.

MR. DUTTON: Thank you. That's all I have.

MR. KELLAHIN: Jason Kellahin for Phillips Petroleum Company.

By MR. KELLAHIN:

Q Mr. Methven, you, as a reservoir engineer, recognize the use of the material balance calculation in predicting reservoir performance in terms of oil originally in place, do you not?

A He interrupted my ability to concentrate on the mispronunciation of my name.

Q I apologize. A It's Methven.

Q Shall I repeat the question?

A I wish you would, yes.

Q Mr. Methven. A Thank you.

Q As a reservoir engineer, you do recognize the use of the material balance calculation to predict reservoir performance in terms of oil originally in place, do you not?

A Yes.

Q And do you make that prediction after the pool has been one-third depleted?

A You can make these predictions all along the line, but the accuracy of these predictions on a pool are very poor because the material balance equation is based on a homogeneous reservoir, so they're very poor until you get very, very good data, and that data comes only after a period of years.

Q In that event, then, you wouldn't say that the material balance calculation is useless at the initial stages of reservoir development, would you?

A Well, it gives the reservoir engineer something to do, but I for one couldn't sell it to management in the early stages of development.

Q Have you, yourself, used it for that purpose?

A Like I said -- I have used a material balance equation.

Q In your use of that, did you have the perfect reservoir

to which you referred?

A No, I didn't. And my results showed it.

Q Actually the only assumption in that connection is an assumption of continuity, is it not? A Pardon me.

Q I say the only assumption you make in reservoir characteristic on that point is an assumption that it is a continuous reservoir, is that correct?

A Oh, yes, you have to know all of the factors of the reservoir.

Q I mean in regard to a homogeneous reservoir, you have to assume continuity, is that correct, in a material balance formula?

A Oh, surely.

Q Now, you made some reference to difficulty or impossibility of reversing the flow of the fluids in the reservoir by the drilling of later infill wells. Just what was your testimony on that, Mr. Methven?

A I said that you can -- by drilling wide spaced wells you can have oil moving towards that well and then when you drill a well in between and you, say you draw the pressure down here, would prefer to go to this well then, after having moved possibly beyond that point.

Q Actually it would move to the new well, would it not?

A Pardon me.

Q It would tend to move toward the infill well?

A Some of the oil, yes.

Q The relative permeability at that point being less than at the point of the old well?

A The relative permeability being less at this time and therefore the movement of that oil at this time is impaired as compared to drilling the well initially.

Q Then what is the difficulty in the movement of that oil toward the new well? I don't follow your reasoning on that.

A I just said that you have already moved it away from the new well and now you are going to move it back into the well. Why didn't you drill the well, I mean you should drill the well first and take it out there.

Q But the fact is that it will move, is that correct?

A Yes.

Q To the new well? A Oh, yes.

Q Then there's no loss?

A Oh, on the contrary, the ability for it to move it at a later date then is impaired as compared to initially.

Q In connection with your testimony on the drilling of these infill wells, you expressed some concern about the mudding up of low pressure zones. I believe you also had some testimony to the effect that the pressure communication did not necessarily indicate the ability of the fluids to move through the reservoir in regard to drainage. In that connection, how would pressures be reduced

at the point of these infill wells if there was no effective drainage at that point?

A I did not say there wasn't any drainage. I said that the drainage efficiency could not be measured by pressure interference tests. I did not deny --

Q (Interrupting) There would be drainage?

A I wouldn't deny that if you have communication. The degree, of course, is very important.

MR. KELLAHIN: Thank you, sir.

MR. PORTER: Anyone else have a question of Mr. Methven? Mr. Cooley.

By MR. COOLEY:

Q Mr. Methven, have you, yourself, made any calculation as to the drainage efficiency of one well or an average well in the Bisti-Lower Gallup Oil Pool?

A The drainage efficiency of one well?

Q I don't mean any particular well, but I mean what you feel the drainage efficiency is in this pool over all.

A In certain sands, yes, certain members, the prime members I believe we testified would be something like 20% at the previous hearing.

Q And have you made any calculation as to the area which one well will drain?

A Well, you can't do that, you can't calculate how much one well

will drain. Given enough time, why a well could in this field, could drain over long distances, but I don't think it would drain many of the sands and the efficiency would be very, very poor.

Q Well, I believe you answered that you felt that one well would drain 40 acres, didn't you? A Pardon me.

Q Haven't you testified in this case that one well will drain 40 acres? A Yes.

Q Now, this is what I'm getting at, how did you determine that it would drain 40 acres? What method of calculation did you use?

A Well, you of course use the geologic picture, and from that it appears that you can drain a certain amount of that oil out of that region, and so you estimate what the efficiency would be.

Q It's based primarily on the geologic picture?

A Primarily, plus experience from what you might experience from a field like this.

Q This geologic picture is obtained through the interpretation of micrologs and electric logs and core data?

A All data available, yes.

Q All of this is localized in the area of one well bore and you are interpolating or interpreting what the intervening area will hold? A Oh, sure.

Q You feel that this type of calculation is more reliable than pressure interference information?

A I think it is at this stage, yes. I think that's the method.

I don't mean that pressure interference tests are not applicable, but they don't give you a measure of the degree.

Q Wouldn't the amount of drawdown give you some indication of the qualitative drainage effect? You have stated repeatedly that you can't ascertain the quality of your drainage through communication tests. Wouldn't the degree of drainage pressure variation give you some indication at least of that quality?

A Yes, yes. But you don't have anything to relate that degree to.

Q You are not prepared to state what percentage of recoverable oil you feel lies below the GC and GD sands as you define them?

A Percent of recoverable. I don't know what that would be, but I said that it would probably be less than the upper sands which are better. It's very difficult to estimate what it is. It's something less than that.

Q I believe you also stated that you felt the density of the drilling affects the recovery. Is this only in extremely heterogeneous types of reservoirs? I mean we have had testimony and extractions from papers by various bodies, Interstate Oil Commission Committees and various other agencies, to the effect that density of drilling was pretty much, made very little difference in the ultimate.

Q They said that it made some difference and that amount of difference was calculated on the basis of purely textbook example

of a very homogeneous reservoir, so there is, even they admit to some in the case, I mean a small amount in the case of the homogeneous reservoir, and then when you differ from the homogenity that the figure goes up.

Q It is your feeling that the homogenity increase is due to the increased density?

A Yes, I think as the homogenity increases, then your efficiency increases with the denser spacing.

MR. PORTER: Does anyone else have a question of the witness?

MR. SETH: I have a little re-direct.

MR. PORTER: Let's take a five minute recess.

(Recess.)

MR. PORTER: The hearing will come to order, please. Mr. Seth, I believe you have some re-direct.

MR. SETH: Yes.

RE-DIRECT EXAMINATION

By MR. SETH:

Q Mr. Methven, in your calculations on your reservoir here, did you use the methods that are ordinarily used in the industry?

A Yes, volumetric calculations, those are the general and accepted methods.

Q Generally accepted throughout the industry, are they?

A Yes, they are.

Q Your other calculations likewise?

A Very much so, yes.

Q In those calculations you used established permeability, porosity, water data that had been furnished to you, is that correct? A That's right.

Q And using all of that data you made your calculations as testified to in the original hearing?

A Yes.

Q You were asked about efficiency on 40 and 80 acre tracts. What would your opinion be as a comparative efficiency on the 40 as compared to 80 acre locations, ordinary drainage efficiency?

A Well,related to this pool there would be quite a bit of difference in addition to this lower interval which we've stated has about 20% of the total oil in place. It's difficult to say how much of that you'll get, but you might get, well, half the recovery efficiency there as you would with the upper sand, or say 10% of that, and that plus the additional segregated or discontinuous members that you would get in the upper sands, plus the improved recovery efficiency in general, would amount to a considerable percentage of the oil in place.

Q And you would recommend to the company, as you did before, that they would proceed on such a drilling program?

A Yes, I think so. There's a lot of oil there, and I think

they can recover it, and I think the fact is I advise that they do recover it, and in any event these wells are going to be economical.

MR. SETH: I believe that's all. We would like to ask that our Exhibit 14-R be admitted in evidence. That is the map.

MR. PORTER: This completes all your exhibits? Without objection Exhibit 14-R will be admitted.

Anyone else have a question of Mr. Methven? Mr. Utz.

MR. UTZ: Yes, I would like to ask a question or two.

RE-CROSS EXAMINATION

By MR. UTZ:

Q Mr. Methven, it is your contention, I believe, that you can recover more oil on 40 acres than 80 acre spacing?

A In a non-homogeneous reservoir it quite frequently --

Q (Interrupting) Well, with particular reference to Bisti.

A Yes.

Q Can you state how much more oil you can recover by drilling two wells on an 80 than one well?

A Well, as an estimate I should think it would be at least 20% more.

Q Could you put that in barrels?

A Well now, you mean in barrels for an 80 acre tract?

Q Well, in barrels, you said 20% more oil recovered on 40 acre spacing than 80 acre spacing. A Yes.

Q If you can, I would like to know about how much that is in

barrels.

A Well, it would probably be in the neighborhood of twenty to thirty thousand barrels.

Q It's my understanding that Shell is drilling their wells, or developing their acreage, on somewhat of a mass production, a production line plan, whatever you would like to call it. How much money do you save per well by drilling them in that manner?

A This manner, it means not so much mass production as continuous production. I guess you can interpret that as mass. The amount of saving is, I don't know what it is, but it is several thousand dollars per well.

Q Do you have any idea what your first, second or third well costs?

A I'm not familiar with the cost, no.

Q Would it be $10,000 a well, $20,000 a well, do you think?

A The question is the second and third costs?

Q Well, what I'm really wanting to know is how much money are you saving per well by drilling on a continuous basis as you call it, rather than drilling and contracting one well at a time.

A Well, the move in costs out there, I think they vary quite a bit, oh, something like five thousand, seven thousand dollars or something like that.

Q You stated that your drilling cost was $48,000?

A Yes, it is.

Q Would you say that a figure of $65,000 would be unreasonable for drilling individual wells?

A Oh, I wouldn't think it would be that high, no.

Q $60,000?

A Somewhere between fifty and sixty.

Q Now, is it your opinion that by drilling on 40 acre spacing that you will recover the oil from your acreage in a lesser time than if you drilled on 80 acre spacing, is that a consideration, I will ask this?

A Oh, yes, yes, you normally would expect that you would recover the oil faster with the denser spacing program, and that is not predicting what allowables would be. I don't know what that would come to.

Q Then in your decision to recommend 40 acre spacing to your company, the length of time to recover the oil was a factor?

A By all means, the rate of return is always a very important factor to a development program in the field.

Q The fact that you could recover, as you just stated, twenty to thirty thousand more barrels per acre tract, was that a factor?

A Yes.

Q And likewise the fact that you can save fifteen, or well, we'll say for the purpose of a figure, $15,000 a well by the fact that you can use your continuous development plan, was that also a factor? A Yes.

Q Which one of those factors was the most important?

A Well, I think they all make each other important.

Q If your wells cost you $60,000 a well to drill as it would say an independent operator with 80 or 160 acres, would you still recommend 40 acre spacing?

A As long as it's an economical venture why I certainly would.

Q Well, you have made those economic calculations, haven't you? A Yes.

Q I'm asking you from your standpoint and what you know from your study, would it be an economical venture?

A Well, of course, it depends where it is located in the field, if the oil isn't there, then no spacing would be economical and so here is the case where you would be incurring additional $10,000, it in that case would detract from the profitability, but I don't have a ready figure to say how much it would amount to.

Q You can't say whether it would detract enough to where you would not recommend 40 acre spacing?

A No, I think you would have to make an individual analysis of it in the specific case. I'm sure in some cases it would be quite economical.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. PORTER: Anyone else desire to present testimony in this case? Any statements at this time?

MR. HINKLE: If the Commission please. Clarence Hinkle, representing the Humble Oil, and I have a brief statement on behalf of Humble.

Under our statute authorizing the Oil Conservation Commission to establish proration units, a unit must be established that can be efficiently and economically drained and developed by one well. In establishing proration units, it is mandatory that the Commission consider first the economic loss caused by the drilling of unnecessary wells, two, the protection of correlative rights, three, the prevention of waste, four, the avoidance of risks arising from the drilling of an excessive number of wells, and fifth, reduced recovery which might result from the drilling of too few wells.

We believe that the testimony in this case clearly shows that one well will effectively, efficiently and economically drain more than 80 acres in the Bisti-Gallup area, that economic loss will result in loss on 40 acre spacing, and that substantially the same amount of oil will be recovered by development on 80 acre spacing as by development on 40 acre spacing.

In this case we have a pool which covers a relatively large area, and roughly the operators owning less than 50% of the productive area are seeking development on 40 acre spacing and the other

operators want development on 80 acre spacing. The undisputed evidence shows that development on 40 acre spacing will require the drilling of approximately two hundred additional wells, of which the owners of more than half of the acreage in the field would be required to drill more than one hundred additional wells, and to risk in excess of five million dollars in drilling equipment.

The proponents of 80 acre spacing are only requesting a temporary order for one year. As we pointed out in the original hearing, a field which has been developed on an 80 acre pattern can always be further developed on a 40 acre basis, but if an error is made in requiring the field to be developed on 40 acre basis, resulting economic loss can never be recovered. In our opinion it would not, under all the facts and circumstances of this case, be in the interest of good administrative practices under the Oil Conservation Act to require the majority of the operators in this field to develop on 40 acre spacing pattern until it has been demonstrated beyond a reasonable doubt by additional production history that waste will be committed by development on 80 acre spacing.

If there is any doubt about the matter in the minds of the Commission, that doubt should at this time be certainly dissolved in favor of the temporary order. We urge that the Commission grant the temporary 80 acre spacing.

MR. PORTER: Mr. Errebo.

MR. ERREBO: If it please the Commission, Magnolia

Petroleum Company was joined in the application of Sunray and others for rehearing. Its representative H. J. Ramsey appeared at this hearing but has had to leave and has authorized me to make this statement in their behalf. The Magnolia Petroleum Company is an operator within the productive limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, operating six oil wells and one gas well with 800 acres under lease.

At the previous hearing of Case 1308, Magnolia supported Sunray Mid-Continent in their application for 80 acre spacing. Magnolia's position has not changed and we again concur with Sunray Mid-Continent for 80 acre spacing.

It is believed that waste of hydrocarbons will not occur with 80 acre spacing. Infill drilling can be accomplished at a greater rate and the productive limits of the field determined sooner on 80 acre spacing. It should be kept in mind that spacing on 40 acres can be accomplished at any time, while initial 40 acre spacing may result in economic waste with little or no ultimate hydrocarbon recovery being realized.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: Jason Kellahin, representing Phillips Petroleum Company. Phillips Petroleum Company feels that the testimony which has been offered in this case clearly demonstrates that one well will adequately and economically drain and develop 80 acres; as it was pointed out by Mr. Hinkle in behalf of Humble, if

there is any doubt in the mind of the Commission, certainly that question should on a temporary basis be resolved in favor of a temporary order for 80 acres, and particularly in view of two important factors, one, the present market situation, the other being the pressure maintenance program which is being presently operated on a pilot basis.

Now, the development of this pool on temporary 80 acre proration units, we frequently hear the statement that you can go back and infill. I would rather compare that somewhat to the nature of an exploratory operation as against an autopsy. If we ever are going to find out anything, we can find it out on the basis of 80 acres and then we will know where we are going. If we drill it on 40 acres we have performed an autopsy over a dead body, there is nothing more we can do about it. The development of this field, as has been pointed out, on 40 acre spacing, will result in expenditure of a tremendous sum of money, and if as present indications certainly point out, the fact will be this pressure maintenance program is successful, that money could far more adequately be used in secondary recovery than in development on a 40 acre pattern, and Phillips Petroleum Company urges the Commission to adopt the temporary order.

MR. PORTER: Mr. Malone.

MR. MALONE: May it please the Commission, Ross Malone for Gulf. There are two things that I would like to point out at the

outset that it seems to me should be borne in mind in consideration of the problem that here faces the Commission.

The first is that we are here on a rehearing of the order of the Commission which made applicable the statewide 40 acre spacing rules under which substantially all the oil of New Mexico has been developed. Now, this problem of spacing and large spacing units and small spacing units is one that has been troublesome ever since the industry started and will always be troublesome, and some companies are referred to as wide spacers and some as narrow spacers. Gulf has been before this Commission many times urging 80 acre spacing, it has and undoubtedly will be before the Commission again urging it, but the function of the Commission as we view it is to apply the standards to the particular pools under consideration and see whether as regards that pool the most efficient development and the least waste will result from 80 acre or 40 acre spacing.

Now, if we start out with this homogeneous pool that has been discussed here, that has perfect communication, one well for the entire pool as we all know would ultimately drain and would most efficiently and most economically drain that pool. As we move away from that ideal condition, the spacing unit must inevitably get smaller and smaller. It can be assumed then that when the operators come before the Commission as in this pool and say that the spacing unit should be larger than the one on which 95% of the oil in New Mexico has been developed, that they would have a pool

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in which conditions were much better than average and hence you would be entitled to assume that you would get better performance under a wider spacing pattern, but the evidence that has been presented by both sides shows exactly the contrary to that. It shows a pool which in its rock characteristics, in the heterogeneous character of the sands, in the pinchouts of permeability, all of those things make this a less desirable and not a more desirable pool for wide spacing.

Now, under thosecircumstances, with 95% of the oil of New Mexico having been developed on 40 acre spacing, it's a little difficult to understand other than on the theory of wide spacing for the sake of wide spacing, a recommendation that the pool be developed on 40 acres.

Gulf has a relatively small amount of acreage in this pool. We don't have and won't have any production line drilling operation going on out there, but our experience and the experience of our engineers fully supports the case which has been presented by Shell, which is that we have here a deposit of oil in sands which if not developed on a pretty dense spacing pattern is going to result in a lot of that oil being left in the ground, and that basically as we understand it, is the question that the Commission has before it, the question of how this reservoir can be developed so that it will be efficiently and economically depleted. We believe that the evidence which has been presented here today, as does the

evidence presented in opposition to the Commission order, adds little, if anything, to the testimony that the Commission heard at the outset in this case. It shows again two main sand members in which communication is shown to exist, and nobody has argued about that, there is some communication in the most favorable parts of the sand members.

I don't think anybody would question it. That is not the question that makes the completion of this pool, as we feel indicates that it should be done on a 40 acre and not an 80 acre basis. If the Commission were dealing only with a single sand member such as exists up there in the pilot flood area which has the most favorable communication possible, or the most favorable communication that exists in this pool, it would be one situation. But the evidence shows that is not the situation that exists throughout the pool, and that unquestionably there are going to be not only stringers in these lower producing horizons, but because of the lack of continuous permeability in the upper horizons, there is going to be oil that would not be produced on an 80 acre pattern. We feel that the extent of the pool and the perimeter of it in which these two principal sand members are not coextensive, creates another tremendous area in which oil will be left in the ground on an 80 acre development pattern.

Under those circumstances, Gulf feels that the order of the Commission was proper, that no reason has been shown for it to be

vacated, and that the Bisti Pool should be developed on a 40 acre pattern as have been all other comparable pools in New Mexico.

I would like to add only this, that some reference has been made to gas-oil ratio and field rules in this hearing. As we view it, that was not an issue on this rehearing. Certainly it's a matter which when the Commission gets ready to consider it, should be the subject of a special hearing, that it could be gone into, because I don't believe any of the operators intended to go into it at this time. Thank you very much.

MR. HALL: Hall, representing Elliott and Hall. We are operators in the Bisti Field, southeastern part of the field. We wish to go on record as supporting Sunray Mid-Continent's application for temporary 80 acre spacing.

MR. BUSHNELL: Amerada would like to urge the Commission to consider granting of this application in light of the apparently numerous anomalies existing in the minds of the witnesses of the opposition, Shell Oil Company. Amerada feels that if there is any doubt, and there apparently is, as to certain information concerning the Bisti Pool, that the Commission should consider wider spacing until those apparent anomalies have been resolved. Thank you.

MR. PORTER: Mr. Seth.

MR. SETH: I don't think it is necessary to argue this thing, particularly, or rediscuss the evidence that we have all heard in the last several days. There is one point here I would like to

mention. It relates to, specifically to testimony of Mr. Gaines of Sinclair, I think it has more or less prevailed here in the thinking of a good many of the Applicants. Mr. Gaines testified that he felt that the company would have to drill every 40 acre location on the lease that was then under discussion, or abandon the lease. Again, in the statements this afternoon there was a figure of two hundred wells. That contemplates the drilling of a location regardless of whether it is economical or not. Nobody under any sort of spacing is going to drill these locations.

That was what the proponents have been arguing, that is what Sinclair argued, that they would have to drill every 40 acre location within their lease, within this pool. That is clearly not so. No one is going to have to drill uneconomical wells regardless of what the spacing is. This figure of two hundred wells multiplied by the cost of drilling each well, that figure is based on the same sort of reasoning. Again, perhaps the opponents in this case do not own a majority of the acreage in the field. I don't think we do. We would probably like to, but we certainly don't, but that again, I don't believe that is the basis for consideration. It is strictly a matter of drainage, a matter of waste that is the only consideration.

In examining the applications for rehearing in this case, I think it was apparent to all of us that there has been some confusion about the burden of proof in a situation like this, and in the

original case as far as that's concerned, and again referring to Sinclair, their counsel indicated that there were no rules as I understood him, for this situation, and it was time we got some.

Well, that's not the problem, it wasn't at the original hearing, we have statewide rules. The situation is covered by rules, it is operating properly. Shell has drilled its wells there in accordance with the rules all along, everybody has. We have rules, the situation is that the Applicants want to change the rules. They have the burden of proof.

In the applications for rehearing, the matter of the burden of proof in the original hearing was completely ignored. The applicants have the burden of persuading the Commission to change the statewide rules. Just because there is some doubt created, that doesn't mean the statewide rules should be changed. Several statements just awhile ago said if there is some doubt it should be in the other direction. That is certainly not the burden of proof rule that has always prevailed before this Commission. The Applicant has the burden of making his case. He has to make his case, it is not for the opponents to.

We feel they have failed to do that in this case. They are trying to offer proof in order to change an existing rule. No reason has been shown to change the spacing. The evidence, we believe, clearly shows that the most efficient development of the field as a whole will be on 40 acre basis. That is the efficient and economic way

to drain the field and to prevent waste.

The discussions concerning these lower sand members are very important. Mr. Finfrock testified that there was virtually nothing in the lower sands, it was negligible. We think that that should be considered, the content of the lower sands. We don't consider the oil in the lower sands alone as a factor. It is one, but you have to consider in addition the improved efficiency and drainage by drilling a 40 acre location, the improved efficiency in the upper sands. You add the increased efficiency in the upper sands with the oil in the very discontinuous lower sands and you clearly have efficient operation in the field.

The wells will be commercial, everybody wants to make money in a situation like this and to have commercial wells within the limits of conservation, and prevention of waste, and we think that the 40 acre program will clearly do that. We don't have any production line drilling program. I don't know quite now how that got into the picture. We operate our drilling program just like everybody else does, the other companies, we try to keep the contractors busy over an extended period of time. It is better for him and it is better for us. The independents do that, individuals do it, there is nothing unusual about it. I don't think we have any more rigs going than anybody else, it is just a matter of planning, and we do just like anybody else, there is nothing unique about keeping a drilling contractor busy for an extended period of time.

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

In that connection we don't have any production line system. We are no different than anybody else. Our costs are lower, but it is just by using ordinary business planning in that connection, and again, on this burden of proof on the temporary order matter, there seems to be the idea that you can get by with a temporary order when you don't have enough proof for a permanent order, that it is somewhere in between. If you can't make a case on a permanent order you ask for a temporary order. That again, I don't believe is the case. You have to make your proof for any change in the rules whether it is temporary or permanent. And to ask for just a temporary because you are not quite sure or you don't think the proof is strong enough, you are asking the Commission to make a change in the existing rules, you have to make a case to do it no matter what change you are asking for, and to fall back on a temporary argument because you don't have a strong case as you would like and don't think you have a strong case for a permanent order, I don't believe that is contemplated in the rules of the Commission or in ordinary or judicial or administrative rules.

We believe that not only that the Applicant has failed to meet the burden of proof, but that the proof is overwhelming that there should be 40 acre spacing for proper development of this pool, and to prevent a very real danger of waste if the spacing is on an any wider pattern. Thank you.

MR. PORTER: Mr. Campbell.

MR. CAMPBELL: If the Commission please, I shall not take the time to discuss with the Commission the question of burden of proof except to say that I do not agree with Mr. Seth's construction of the statewide rules, but I'm satisfied that the Commission here intends and will establish in this pool what it considers to be the most appropriate, most efficient, most economic, the least wasteful program that will adequately develop this field, both in the light of primary production and in the light of possible secondary production.

The Commission's order in the original case stated that there was not proof that one well would drain 80 acres. At this hearing the Applicant has undertaken, and I believe has by additional evidence from additional information, additional studies, additional engineers for different companies, undertaken to substantiate its position and to improve its position with regard to this particular point. At the first hearing it was implied by the witnesses for Shell that only a microlog study could really establish the question involved in this drainage. At this hearing the geologist for Sunray presented a fieldwide study of microlog separation in which he concluded as to these exhibits, that appear on the wall, it seems to me at least in general, that there is communication and continuity at least as to the upper two principal producing zones in this particular field.

That information was further substantiated by the witness for

British American who made the same sort of analysis across the entire length of the field from all the cores that he had available, and he correlated those into the same kind of picture that we believe exists in these principal producing sands.

The witness for British American also indicated by pressure drawdown tests, interference tests, that there was communication. These have been minimized by the witness for Shell today. Nonetheless, in the absence of additional production history which we cannot get without the passage of time, certainly that is the best information to establish this particular point whether you are dealing with 40 acre spacing or 80 acre. The testimony of the Phillips' witness used the application of the material balance formula in which he reached the conclusion that only an infinitesimal amount of additional oil would be recovered by 40 acre spacing than 80 acre spacing.

Finally we had the testimony of Mr. Brinkley in connection with the operation of what we considered to be a very important pressure maintenance LPG injection program, and so we think that the testimony at this rehearing has certainly established that one well will drain 80 acres upon the basis of the information now available.

The Applicants conceded in the original application that there has not been sufficient production history in this field perhaps to justify a permanent order. This rehearing has made it even more apparent, even when you consider it in the light of the evidence

offered here by Shell. Let's just look for a moment at some of the uncertainties that exist in this field. These are some of the things that I believe do differentiate this situation from 95% of the pools to which Mr Malone referred. I agree with him that each pool should be considered on its own. There have been varying estimates in the cost of wells by different companies, different methods of operation. The second place, there has been testimony regarding the lack of production history from these wells, testimony regarding the present limited production from these wells due to market conditions, and finally uncertainty as to what the production might be in the future.

Those things enter into the economic considerations that the statutes require in the establishment of proration units. Then there has been the question of the gas cap, the existence of gas wells at a structurally lower position than oil wells. This is a formation or pool condition which we feel needs to be approached with extreme caution. Then there has been the installation and the development of this pressure maintenance program, which up-to-date appears to be progressing satisfactorily, even on a wide area basis. We believe this should be given an opportunity to work to determine by all of the operators in the pool how they can best invest their money to get the most oil out of this reservoir, and perhaps have a little left over to invest in some other place.

The witness for Shell has testified that they have been unable

to make any determination of vertical permeability in this field to date. They have no pressure or gravity tests in the lower sand zones, apparently have not tested them separately. They have been unable to determine fluid movement because there has been a lack of production history.

All of these factors, when considered in the light of this very important economic factor, the possibility of economic loss from the drilling of unnecessary wells, we feel justifies a temporary order in this particular field. I have heard with some interest a remark of the Sinclair witness and the statement recently made by the Sun Oil Company, whether he is an attorney or engineer or both, Mr. Dutton, in any event in connection with the establishment of 80 acre proration units. I think that is a possibility that the Commission must consider, particularly in view, in the light of the fact that Shell has apparently, since the last hearing, and I would assume since there are some twenty wells drilled since the application for rehearing, continued to develop in their own areas upon a 40 acre basis. We believe that there isn't any evidence here which will run contrary to the issuance of a temporary 80 acre proration unit or spacing order in this field, as the Commission should see fit to apply.

MR. PORTER: Mr. Wade.

MR. WADE: The Texas Company is an Applicant in this rehearing. I would like to make a statement for The Texas Company on this matter.

I think that there are two issues involved essentially in this hearing. The first of which, does communication exist in this reservoir in sufficient nature to justify the drilling of one well on 80 acres, and would that one well efficiently drain that 80 acres.

The second point, I think that we need to consider, would that well more economically drain the acreage than would one well on 40. Texas Company believes that the proponents of 80 acres have presented data here that does justify the acceptance of both of these points, and we would urge the Commission to accept and grant the 80 acre spacing for this field.

MR. PORTER: Mr. Dutton.

MR. DUTTON: Sun is in the same position. If I may make a statement. Sun Oil Company, as an 80-acre operator in the Bisti Field, is seriously concerned with the Commission's action in this case. However, we realize that the Commission's action cannot be predicated upon the alleviation of Sun's concerns, but must embody an attempt to realize the dual proration goals of preventing waste and granting each operator a fair opportunity to recover the hydrocarbons under his property. Such an attempt must of course be within the statutory authority of the Commission.

The status upon which Sun bases its recommendation to the Commission is contained within Paragraph (b) of Chapter 65, Article 3, Section 14 of the New Mexico Statutes. It is requested that the Commission take administrative notice of this statute, particularly the language which parenthetically defines a proration unit to be "....the area that can be efficiently and economically drained and developed by one well....". It is significant that the definition does not read "most efficiently". It is also significant that it reads, "can be" and not "might be" or "will be if the market demand improves" economically drained and developed.

Ample testimony has been given that both 40-acre and 80-acre spacing will adequately and efficiently drain the pool. On the other hand testimony to date has been that it is not economically feasible to drill even the cheapest Bisti well for the January

indicated allowable of 10 BOPD. As the referenced statute is couched in the present tense, it is submitted that the statutory requirement that a proration unit be an area that can be economically developed by one well would not be met by a present designation of a 40-acre proration unit.

Sun Oil Company is on record as being in support for 80-acre well spacing and we do not now alter this position. However, Sun is not merely interested in maintaining a position -- or for that matter in merely enforcing the absolute letter of the law -- but is vitally interested in not only the prevention of waste, but also in the assurance that each operator has a fair opportunity to recover the hydrocarbons. Therefore, in the alternative, Sun would recommend that if the Commission sees fit to establish 40-acre well spacing, that they also adopt an optional 80-acre proration unit. By so doing, the Commission would be granting to those operators who believe they can eventually profit from a 40-acre development an opportunity to prove their point. At the same time, there would be no statutory violation to force such operator's poor domestic cousins into what is currently a patently uneconomical situation. In addition, such an order would overcome the objection that uniform 80-acre spacing would result in failure to drill certain choice locations. Both sides might well benefit from this feature. As to the possible complaint that such an order would result in irregular surface spacing, the evidence introduced by

both sides indicates that the Bisti has hardly been deposited in quarter-quarter sections.

MR. PORTER: Anyone else?

MR. BUELL: Guy Buell for Pan American Petroleum Corporation. In the interest of saving time, may we simply readopt our closing statement that we filed by letter after the September hearing. In that letter we supported 80-acre units. We feel that data are even more conclusive now that the only proper spacing in this field is 80-acre.

MR. PORTER: Anyone else have a statement to make?

MR. SELINGER: If the Commission please, Skelly Oil Company is one of the applicants for the rehearing. We regret that we have no affirmative factual data to present, mainly because we attempted to take some interference tests and unfortunately we are unable to complete them due to the lack of tank room. Likewise, we had no factual data to present as an applicant in view of the lack of production history from our wells, all of which are relatively and comparatively new wells.

At the time of the first hearing we had in the process of completion six producing wells. At this time we have twelve producing wells, and all of the twelve producing wells are on alternate 40-acres or 80-acre spacing as we know it. We have drilled three wells in the gas cap since the last hearing. The first well is 660 feet from the nearest lease lines, and our other two wells

are a minimum of 990 feet, these three wells being in the gas cap. We would like to recommend to this Commission to take consideration of the 80-acre spacing.

MR. McGOWAN: I would like to make this one point. There are no rules on this field. It is simply subject to the restrictions of the state general rules against drilling close to lease lines, and it has a proration unit for your proration purposes. It is a very substantial field; it has a number of wells in it, and it certainly is time the Commission took jurisdiction of it and issue such orders as they feel will come nearest to preventing waste possibly, and we feel it should be whatever program will do it, and not whether the 40-acre proration units should be changed, but an affirmative action on the part of the Commission. As stated by our engineer, we do feel that Sinclair would have been, and even now could recover a greater amount of oil, and in an effort to keep this field under control, and in view of the great development on it already, we are recommending 80-acre proration units as a means of controlling this field, at least on a temporary basis. Thank you.

MR. PORTER: Anyone else desire to make a statement at this time?

MR. STEWART: Standard Oil Company of Texas concurs with the application.

MR. PORTER: Are there any more statements? If there are

no other statements to be made at this time, the hearing will be adjourned.

****

STATE OF NEW MEXICO)
)
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this 17th day of February, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

ADA DEARNLEY, COURT REPORTER
NOTARY PUBLIC

My Commission Expires:

June 19, 1959

Memo

From

To 2-25-59

R-1069-E mailed to the attached list + D. V. Carter, Magnolia & R. R. Robison, Shell

BP

COPY OF ORDER R-1069-A, Case 1308, SENT TO THE FOLLOWING:

- L. C. WHITE, Santa Fe,
Oliver Seth, Santa Fe
George Selinger, Skelly Oil Co., Box 1650, Tulsa
Sun Oil Company, Denver Club Bldg., Denver 2, Colo.
James H. McGowan, Sinclair Oil & Gas Co., Box 521, Tulsa
Jason W. Kellahin, Santa Fe
L. W. Folmar, The Texas Co., Box 1720, Ft. Worth 1, Tex.
- H. D. Bushnell, Amerada Petr. Corp., Box 2040, Tulsa 2, Okla.
Thomas M. Hogan, British-American Oil Producing Co., Box 180 ., Denver 1,
Jack Vickrey, Magnolia Petr. Co., Box 900, Dallas 21, Tex.
C. T. McClure, Anderson-Prichard Oil Corp., Liberty Bank Bldg., Okla. City 2,
W. M. Wilson, Lion Oil Co., 602 W. Missouri St., Midland
Southern Union Gas Co., Burt Bldg., Dallas 1,
Alex Clarke, Jr., Pan American Petr. Corp., Box 1410, Ft. Worth
- Ross Malone, Box 867, Roswell
- R. W. Sullivan, 1109 Mile High Center, Denver 2, Colo.
Booth Kellough, Gulf, Box 2097, Denver
Clarence Hinkle, Box 547, Roswell
W. P. Tomlinson, Atlantic Refining Co., Box 6640, Roswell
C. L. Kelley, Pan American Petr. Corp., Box 899, Roswell
W. C. Smith, Delhi-Taylor Oil Corp., Corrigan Tower, Dallas 1,
Standard Oil Co. of Tex., Attn. C. M. Tilley, Box 1776, Albuquerque
F. W. Nantker, Shell Oil Co., 1901 Main St., Durango, Colo.
Leslie Kell, Shell, Los Angeles 54, 1008 W. 6th
John Anderson, USGS, Roswell,
Phil McGrath, USGS, Farmington,
George R. Hoy, Honolulu Oil Corp., P.O. Drawer 1391, Midland,
F. T. Anderson, The El Dorado Refining Co., El Dorado, Kans.
Shiprock Industries, Inc., Taylor Bldg., Farmington
Laurence C. Kelly, Trust, 309 Bank of America Bldg., Beverly Hills, Calif.

11-7-57
BP

ORDER R-1069-B was sent to the above list and the two names listed below:

Jack Sullivan, 3825 Willat Ave., Culver City, Calif.
The Atlantic Refining Co, Box 2819, Dallas 21, Texas, Attn. Bruce Vernor

1-20-58
BP

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION
TELEGRAM

(33). 01

W. P. MARSHALL, PRESIDENT

MAIN OFFICE OCC

SYMBOLS
DL=Day Letter
NL=Night Letter
LT=International Letter Telegram

The filing time shown in the date line on domestic telegrams is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

LA089 DB179 1959 JAN 12 PM 1:29 1229 JAN 12 AM 11 53

D MDA129 PD=MIDLAND TEX 12 1229PMC=
NEW MEXICO OIL CONSERVATION COMMISSION, ATTN MR
A L PORTER SECRETARY AND DIRECTOR= SANTA FE NMEX=

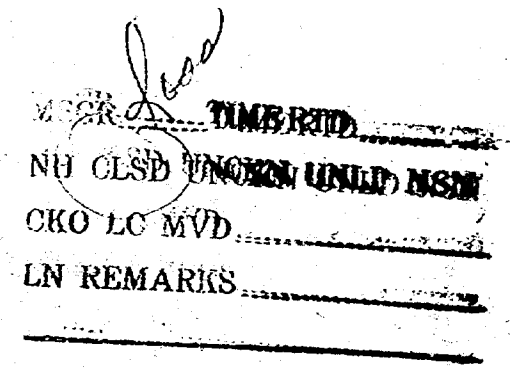
IN REGARD TO CASE NO. 1308 TO BE HEARD BEFORE THE COMMISSION JANUARY 14, 1959, IT IS THE POSITION OF HONOLULU OIL CORPORATION THAT ORDER R-1069-B BE CONTINUED AND MADE A PERMANENT ORDER. HONOLULU OIL CORPORATION HAS ONE WELL PRODUCING IN THE BISTI LOWER GALLUP OIL POOL AT THE PRESENT TIME=

GEORGE R HOY HONOLULU OIL CORP MIDLAND TEXAS=

Case 1308

1308 14 1959 R-1069-B=

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE


TIME RTD
UNKN UNLD NSM
NU CLSD
CKO LC MVD
LN REMARKS

WIRE

DALLAS, TEXAS JANUARY 12, 1959

Oil Conservation Commission, Mabry Hall, State Capitol, Santa Fe, New Mexico

RE Application of Cities Service Oil Company to dually complete its State "P" No. 3 well, by the installation of dual zone pump equipment, Terry Blinebry Oil Pool and an undesignated oil pool in the Glorieta Sand, Lea County, New Mexico. (Case No. 1557)

Magnolia Petroleum Company as an operator in the Terry Blinebry Field, hereby supports Cities Service Oil Company in its application for permit to install dual zone pumping equipment to effect a dual completion of its State "P" No. 3 well between the Terry Blinebry Oil Pool and an undesignated Glorieta oil pool, Lea County, New Mexico.

Original Signed By
D V CARTER

D. V. CARTER, MAGNOLIA PETROLEUM COMPANY

OJF:DW
CONFIRMATION COPY

CLASS OF SERVICE
This is a fast message unless its deferred character is indicated by the proper symbol.

WESTERN UNION
TELEGRAM

W. P. MARSHALL, PRESIDENT

1220 (R 11-54)

SYMBOLS
DL = Day Letter
NL = Night Letter
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The filing time shown in the date line on domestic telegrams is STANDARD TIME at point of origin. Time of receipt is STANDARD TIME at point of destination

LA080 DB137

D LLM 123 LONG PD=WUM DALLAS TEX 13 1123AMC=

OIL CONSERVATION COMMISSION =

MABRY HALL STATE CAPITOL SANTA FE NMEX=

=RE CONTINUATION OF RULES AND REGULATIONS SET FORTH IN ORDER NO. R-1069-B /CASE NO. 1308/ MAGNOLIA PETROLEUM COMPANY, AS A OPERATOR IN THE BISTI LOWER GALLUP OIL POOL, HEREBY SUPPORTS SUNRAY MID-CONTINENT OIL COMPANY IN ITS REQUEST FORA CONTINUATION OF 80 ACRE SPACING AND PRORATION UNITS FOR THIS POOL IN SAN JUAN COUNTY, NEW MEXICO. WE FEEL THAT THE PREPONDERANCE OF GEOLOGICAL AND ENGINEERING TESTIMONY SUPPORTS 80-ACRE SPACING FOR THIS RESERVOIR=

D V CARTER MAG PET CO==

NO R-1069-B 1308 80 80=

1308

1959 DEC 15 AM 11:10
OIL CONSERVATION COM.
SANTA FE, NEW MEXICO

THE COMPANY WILL APPRECIATE SUGGESTIONS FROM ITS PATRONS CONCERNING ITS SERVICE

SHELL OIL COMPANY

705 West Municipal Drive
Farmington, New Mexico

December 22, 1958

Subject: Bisti Lower Gallup Oil Pool
Orders R-1069-B and R-1069-D

New Mexico Oil Conservation
Commission
Post Office Box 871
Santa Fe, New Mexico

Attention: Mr. A. L. Porter, Jr.,
Secretary-Director

Gentlemen:

It is our understanding that at the monthly Commission hearing in January 1959 the matter of continuation of Orders R-1069-B and R-1069-D, relating to the Bisti Lower Gallup Oil Pool, will be considered. As we indicated in the course of the recent discussions with respect to dismissal of our appeal from such orders, we would now have no objection to their continuation or to the re-establishment of forty-acre proration under the statewide rules. However, we would be strongly opposed to any modification of these orders which would make them eighty-acre spacing orders or which would in anywise serve to preclude our drilling forty-acre wells in the Bisti Lower Gallup Oil Pool.

In the event the proponents of eighty-acre proration in this pool should attempt to modify Orders R-1069-B and R-1069-D in such a manner as to preclude our drilling forty-acre wells, we anticipate presenting additional evidence in support of our position in this matter at the January hearing.

Yours very truly,

R. R. Robison,
Division Production Manager

Docket Mailed
1-7-59 BF

FORM 446 4-58

PAN AMERICAN PETROLEUM CORPORATION

OIL AND GAS BUILDING

FORT WORTH, TEXAS

ALEX CLARKE, JR.
DIVISION ENGINEER

January 12, 1959

File: GWK-6120-986.510.1

Subject: Case 1308, Regular Hearing Docket, January 14, 1959 Establishment of Uniform 80 Acre Well Spacing and Promulgation of Special Rules and Regulations for Bisti Lower Gallup Field, San Juan County, New Mexico

New Mexico Oil Conservation Commission
Capitol Annex Building
Santa Fe, New Mexico

Attention: Mr. A. L. Porter, Jr.

Gentlemen:

Pursuant to the Commission's Order No. R-1069-B dated January 17, 1958 the subject case has been scheduled for the regular hearing docket of January 14, 1959.

Pan American Petroleum Corporation is an operator in this field and has participated in previous hearings concerned with the adoption of rules for this field, and generally supported the rules that are currently in effect on a temporary basis. It was our opinion at the time of these prior hearings that the proper size unit for this pool was 80 acres. All data which have been gathered in the interim period have confirmed our conclusion that one well will efficiently and effectively drain in excess of 80 acres. Therefore, we recommend that the present temporary rules, now in effect, be adopted as permanent rules for this pool.

It is requested that this statement of our position be read into the record of the January 14, 1959 hearing.

Very truly yours,

Alex Clarke, Jr.

Alex Clarke

REM:lj

SUNRAY MID-CONTINENT OIL COMPANY

P. O. Box 8367
Albuquerque, New Mexico

February 9, 1959

Mr. Murray Morgan
State Land Commissioner
New Mexico Oil Conservation Commission
State Capitol Building
Santa Fe, New Mexico

Dear Mr. Morgan:

If possible, I should like a copy of the Commission's order relating to oil-well spacing in the Bisti Pool Area. I believe the hearings on this order were held January 17th and 18th, 1959.

Thank you.

Yours very truly,

Frank J. Devlin

Frank J. Devlin
District Geologist

FJD-LP

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. 1308
Order No. R-1069-E

APPLICATION OF SUNRAY MID-CONTINENT OIL
COMPANY TO MAKE PERMANENT THE SPECIAL
RULES AND REGULATIONS FOR THE BISTI-
LOWER GALLUP OIL POOL, SAN JUAN COUNTY,
NEW MEXICO, AS SET FORTH IN ORDER NO.
R-1069-B.

ORDER OF THE COMMISSION

BY THE COMMISSION:

This cause came on for hearing at 9 o'clock a.m. on September 18, 1957, December 18, 1957, March 13, 1958, and again on January 14, 1959, at Santa Fe, New Mexico, before the Oil Conservation Commission of New Mexico, hereinafter referred to as the "Commission."

NOW on this 2nd day of February, 1959, the Commission, a quorum being present, having considered the application and the evidence adduced, 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 preponderance of the evidence presented in this case indicates that one well will efficiently and economically drain 80 acres in the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico.

(3) That the Special Rules and Regulations for the Bisti-Lower Gallup Oil Pool, as set forth in Order No. R-1069-B, should be continued in effect until further order of the Commission.

IT IS THEREFORE ORDERED:

(1) That the Special Rules and Regulations for the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico, as set forth in Order No. R-1069-B, be and the same are hereby continued in effect until further order of the Commission.

(2) That this order shall become effective March 1, 1959.

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

STATE OF NEW MEXICO
OIL CONSERVATION COMMISSION

JOHN BURROUGHS, Chairman

MURRAY E. MORGAN, Member

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

ir/

OIL CONSERVATION COMMISSION
P. O. BOX 871
SANTA FE, NEW MEXICO

February 2, 1959

COPY

Mr. Bill Loar
Sunray Mid-Continent Oil Co.
P.O. Box 2039
Tulsa 2, Oklahoma

Dear Mr. Loar:

We enclose a copy of Order R-1069-E issued February 2, 1959, by the Oil Conservation Commission in Case 1308, which was last heard on January 14, 1959.

Very truly yours,

A. L. Porter, Jr.
Secretary - Director

bp
Encls.

copy sent to Charlie Sparn & Oliver Seth
B.P.

No. 2-59

DOCKET: REGULAR HEARING JANUARY 14, 1959

Oil Conservation Commission 9 a.m., Mabry Hall, State Capitol, Santa Fe

ALLOWABLE: (1) Consideration of the oil allowable for February 1959

(2) Consideration of the allowable production of gas for February 1959 from six prorated pools in Lea County, New Mexico; also consideration of the allowable production of gas from seven prorated pools in San Juan and Rio Arriba Counties, New Mexico, for February 1959.

NEW CASES

CASE 728 Application of El Paso Natural Gas Company for an order revising and amending Order No. R-586. Applicant, in the above-styled cause, seeks an order amending Order No. R-586 to extend the vertical limits of the Justis Gas Pool in Lea County, New Mexico.

CASE 1308: In the matter of the hearing required to be held by Order R-1069-B to permit all interested parties to appear and show cause why the Special Rules and Regulations set forth in Order R-1069-B should be continued beyond February 28, 1959.

CASE 1557: Application of Cities Service Oil Company for a hearing de novo before the Commission on its application for a dual completion. Applicant, in the above-styled cause, seeks an order authorizing it to dually complete its State "P" No. 3 Well located 990 feet from the South and West lines of Section 32, Township 22 South, Range 38 East, Lea County, New Mexico, in such a manner as to permit the production of oil from the Blinebry Oil Pool and from an undesignated Glorieta oil pool through parallel strings of tubing.

CASE 1581: Southeastern New Mexico nomenclature case calling for an order for the creation of new pools and the extension of existing pools in Eddy and Lea Counties, New Mexico:

(a) Create a new oil pool for San Andres production, designated as the South Loco Hills-San Andres Pool, and described as:

TOWNSHIP 18 SOUTH, RANGE 30 EAST, NMPM
Section 32: NE/4

(b) Create a new oil pool for Seven Rivers production, designated as the West Pearl-Seven Rivers Pool, and described as:

TOWNSHIP 19 SOUTH, RANGE 34 EAST, NMPM
Section 25: SE/4

(c) Create a new oil pool for Queen production, designated as the North Red Lake-Queen Pool, and described as:

TOWNSHIP 16 SOUTH, RANGE 28 EAST, NMPM
Section 34: NE/4

(d) Create a new oil pool for Delaware production, designated as the Shugart Delaware Pool, and described as:

TOWNSHIP 18 SOUTH, RANGE 31 EAST, NMPM
Section 22: SW/4

(e) Extend the Allison-Pennsylvanian Pool to include:

TOWNSHIP 9 SOUTH, RANGE 36 EAST, NMPM
Section 10: NE/4

(f) Extend the South Carter-San Andres Pool to include:

TOWNSHIP 18 SOUTH, RANGE 39 EAST, NMPM
Section 7: NE/4

(g) Extend the Dos Hermanos Yates-Seven Rivers Pool to include:

TOWNSHIP 20 SOUTH, RANGE 30 EAST, NMPM
Section 28: N/2 SE/4

(h) Extend the High Lonesome Pool to include:

TOWNSHIP 16 SOUTH, RANGE 29 EAST, NMPM
Section 12: SW/4
Section 13: NW/4

(i) Extend the Justis-Blinebry Pool to include:

TOWNSHIP 25 SOUTH, RANGE 37 EAST, NMPM
Section 24: E/2
Section 25: E/2
Section 36: E/2 & SW/4

(j) Extend the Justis-McKee Pool to include:

TOWNSHIP 25 SOUTH, RANGE 37 EAST, NMPM
Section 24: SE/4

(k) Extend the Loco Hills Pool to include:

TOWNSHIP 18 SOUTH, RANGE 30 EAST, NMPM
Section 8: S/2

(l) Extend the Maljamar Pool to include:

TOWNSHIP 17 SOUTH, RANGE 33 EAST, NMPM
Section 18: SW/4

(m) Extend the vertical limits of the East Millman-Queen Pool in Eddy County, New Mexico, to include therein the Grayburg formation.

(n) Extend the East Millman Queen-Grayburg Pool to include:

TOWNSHIP 19 SOUTH, RANGE 28 EAST, NMPM
Section 13: N/2 & SW/4
Section 22: N/2
Section 23: NW/4

(o) Extend the Pearl Queen Pool to include:

TOWNSHIP 19 SOUTH, RANGE 35 EAST, NMPM
Section 21: N/2 SE/4 & SW/4 SE/4
Section 33: NW/4

(p) Extend the Ranger Lake Pennsylvanian Pool to include:

TOWNSHIP 12 SOUTH, RANGE 34 EAST, NMPM
Section 24: SW/4

(q) Extend the Shugart Siluro Devonian Gas Pool to include:

TOWNSHIP 18 SOUTH, RANGE 31 EAST, NMPM
Section 27: NE/4

(r) Extend the Skaggs-Glorieta Pool to include:

TOWNSHIP 20 SOUTH, RANGE 37 EAST, NMPM
Section 12: NW/4

(s) Extend the South Vacuum-Bone Springs Pool to include:

TOWNSHIP 18 SOUTH, RANGE 35 EAST, NMPM
Section 22: S/2
Section 27: W/2

CASE 1582: Northwestern New Mexico nomenclature case calling for an order for the extension of existing pools in San Juan and Rio Arriba Counties, New Mexico:

(a) Extend the South Blanco-Pictured Cliffs Pool to include:

TOWNSHIP 25 NORTH, RANGE 3 WEST, NMPM
Section 27: W/2

TOWNSHIP 26 NORTH, RANGE 5 WEST, NMPM
Section 13: NE/4

(b) Extend the Tapacito-Pictured Cliffs Pool to include:

TOWNSHIP 26 NORTH, RANGE 3 WEST, NMPM
Section 21: SW/4

(c) Extend the Blanco-Mesaverde Pool to include:

TOWNSHIP 27 NORTH, RANGE 8 WEST, NMPM
Section 30: E/2

TOWNSHIP 29 NORTH, RANGE 4 WEST, NMPM
Section 6: All

TOWNSHIP 30 NORTH, RANGE 4 WEST, NMPM
Section 31: All

(d) Extend the South Los Pinos-Dakota Pool to include:

TOWNSHIP 31 NORTH, RANGE 7 WEST, NMPM
Section 22: N/2
Section 34: N/2

(e) Extend the Verde-Gallup Oil Pool to include:

TOWNSHIP 31 NORTH, RANGE 14 WEST, NMPM
Section 8: SW/4 SE/4
Section 17: SW/4

ir/

BEFORE THE
NEW MEXICO OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

IN THE MATTER OF:

CASE NO. 1308

TRANSCRIPT OF HEARING

January 14, 1959

DEARNLEY - MEIER & ASSOCIATES
GENERAL LAW REPORTERS
ALBUQUERQUE, NEW MEXICO
Phone CHapel 3-6691

I N D E X

WITNESS		PAGE
L. J. Finfrock		
	Direct Examination by Mr. Loar	6
	Cross Examination by Mr. Nutter	18
	Questions by Mr. Utz	19
	Questions by Mr. Fischer	20
	Redirect Examination by Mr. Loar	21
	Recross Examination by Mr. Fischer	21
T. W. Brinkley		
	Direct Examination by Mr. Loar	22
	Cross Examination by Mr. Nutter	34
	Questions by Mr. Utz	35

BEFORE THE
NEW MEXICO OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

IN THE MATTER OF:	
The hearing required to be held by Order R-1069-B to permit all interested parties to appear and show cause why the Special Rules and Regulations set forth in Order R-1069-B should be continued beyond February 28, 1959.	CASE NO. 1308

BEFORE:

John Burroughs
Murray Morgan
A. L. Porter

T R A N S C R I P T O F P R O C E E D I N G S

MR. PORTER: Proceed next to Case 1308, and at this time I would like to ask for appearances in this case.

MR. PAYNE: Case 1308. In the matter of the hearing required to be held by Order R-1069-B to permit all interested parties to appear and show cause why the Special Rules and Regulations set forth in Order R-1069-B should be continued beyond February 28, 1959.

MR. WHITE: Charles White, of Gilbert, White, and Gilbert, Santa Fe, New Mexico, appearing as resident counsel for the following companies:

The Texas Company and Sinclair Oil and Gas Company, whose attorney, James H. McGowan of Tulsa, Oklahoma is associated in

the case; Skelly Oil Company, whose attorney, George Selinger, of Tulsa, is associated in the case; Sunray Mid-Continent, whose attorney, William R. Loar, of Tulsa, is associated in the case, and I also would like to enter the appearance of Jack M. Campbell of Campbell and Russell, Roswell, New Mexico, also appearing on behalf of Sunray.

MR. PORTER: Mr. White, The Texas Company, Sunray Mid-Continent, and what other company?

MR. WHITE: Sinclair.

MR. PORTER: Thank you.

MR. SPANN: Charles C. Spann, from Albuquerque, and Mr. Cecil Hamilton, from Oklahoma City, representing Phillips Petroleum Company.

MR. BRATTON: Howard Bratton, Hervey, Dow & Hinkle, Roswell, New Mexico, appearing for Humble Oil and Refining Company, appearing as resident counsel for Sun Oil Company. Associated with me for Sun Oil Company will be Mr. Granville Dutton, from Dallas, Texas.

MR. KELLAHIN: Jason Kellahin, of Kellahin and Fox from Santa Fe, New Mexico, appearing on behalf of Amerada Petroleum Corporation. I have associated with me Mr. H. D. Bushnell of the Oklahoma bar.

MR. NEWMAN: Kirk Newman, of Atwood & Malone, Roswell, New Mexico, appearing as resident counsel for Gulf Oil Corporation, and associated with me is Mr. Kellough of the Colorado bar.

MR. SPERLING: J. E. Sperling, appearing on behalf of British American Oil Producing Company.

MR. PORTER: Any other appearances in Case 1308?

MR. SETH: Oliver Seth, Santa Fe, and L. C. Kell, Los Angeles, appearing for Shell Oil Company.

If the Commission please, if I may ask a question. It is the understanding of Shell Oil Company that this hearing, the scope of the hearing is limited to the question as to whether or not the existing order will be continued in its present form, and we have proceeded on that assumption. Are we correct in our understanding?

MR. PORTER: Mr. Seth, you are correct, and the matter will be confined strictly to the advertisement. We will not get into relative merits of 80-acre proration units versus 80-acre spacing.

Mr. White, I believe you said that Sunray has testimony to present in this case?

MR. WHITE: Yes, we have.

MR. PORTER: I think we will proceed with the testimony for about twenty minutes, and the Commission will recess for lunch about 11:45.

MR. WHITE: If the Commission please, at this time I would like to make a brief opening statement.

The record in this case shows that in August of 1957, Sunray Mid-Continent filed this application requesting a temporary

order authorizing an 80-acre proration unit to be established in the Bisti Lower Gallup Oil Pool in San Juan County. The case was heard in September of 1957, and the Commission denied the application. Thereafter, a petition for re-hearing was filed, and the case was again heard, in December of 1957, at which time additional evidence of the pool characteristics was introduced. As a result of that hearing, the Commission issued its Order R-1069-B, and the order, among other things, made the following findings of fact, which I would like to quote. Namely, Finding No. 5:

> "That sufficient evidence was adduced by other Petitioners on re-hearing, in addition to the evidence adduced at the original hearing, to justify the establishment of 80-acre proration units in the Bisti Lower Gallup Oil Pool on a temporary basis."

Now, this order, by its expressed terms, is to become ineffective March 1st of this year. However, the Commission had an occasion to reaffirm Order R-1069-B as recently as last April, and in so doing, made the following finding of fact, and I quote:

> "That in deciding Case 1308, Order No. R-1069-B, the Commission determined that one well would efficiently and economically drain 80-acres in the Bisti Lower Gallup Oil Pool, and that such determination is inherent in Finding No. 5; and further, that in making such determination, the Commission took into consideration the economic loss caused by the drilling of unnecessary wells, the protection of correlative rights, including those of royalty owners, the prevention of waste, the avoidance of risk arising from the drilling of excessive number of wells, and prevention of reduced recovery which might result in the drilling of too few wells."

As I previously stated to the Commission, this pool was established in 1956. At the time of the hearing, original hearing, there were approximately 125 wells drilled in the pool upon which study could be made. Sunray Mid-Continent, and other operators in the pool then, as now, feel that the pool can be economically and efficiently drained by 80-acre proration units. However, because of the limited amount of factual information available, both geologically and field information, Sunray requested that the order be temporary in nature in order that additional studies could be made as to the pool characteristics, and that the matter could be later reconsidered by the Commission, and the Commission has called a hearing today to determine whether or not Order R-1069-B should continue to be in effect.

There now have been 304 wells drilled in the pool, and since the original hearing, Sunray Mid-Continent and the operators in the pool have been diligent and continued to carry on their extensive study of the characteristics of the pool.

The pool history now shows, and the results of their study show, that the testimony which has previously been offered has been confirmed; namely, that there is no communication and continuity of sand throughout the pool. The reservoir is of such porosity and permeability that the area can be drained economically and efficiently on 80-acre proration.

We hope to establish at this hearing, from the testimony that will be offered, that it will not only lend additional support to

Commission's findings that such a proration unit is justified in the area, but that Order R-1069-B, in its present terms, should be continued in effect.

Mr. Loar will proceed with the interrogation of the witness.

MR. VERITY: Your Honor, I would like to enter my appearance. George Verity, on behalf of Mr. Rex Moore, supporting this application for continuance of the order.

MR. PORTER: Thank you, Mr. Verity.

MR. VERNOR: I would like to put in an appearance for Atlantic Refining Company. Atlantic Refining Company is in support of this application.

MR. PORTER: Are there any other appearances to be made in this case?

Mr. Loar, would you have all of your witnesses stand up and be sworn, please.

MR. LOAR: We have two witnesses.

(Witnesses sworn.)

MR. LOAR: Mr. Finfrock, will you please take the stand.

MR. PORTER: Will you have Mr. Finfrock spell his name for the Reporter, please.

MR. FINFROCK: Initial L. J. F-I-N-F-R-O-C-K.

L. J. FINFROCK

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

DIRECT EXAMINATION

BY: MR. LOAR:

Q Mr. Finfrock, will you please, for the record, state your name and occupation?

A I am L. J. Finfrock, research geologist for Sunray Mid-Continent Oil Company, Tulsa, Oklahoma.

Q Will you very briefly--I believe you have testified here before--very briefly state your qualifications and familiarity with the Bisti Lower Gallup Oil Pool.

A I graduated from the University of Illinois in 1940 with a bachelor of science degree in geology, and in 1948 I received my master of science degree from, in geology, from the University of Illinois. I have been actively engaged in the study of the Bisti Field since June, 1956, and have been in attendance at numerous hearings, and worked on the Unit Committee of Geologists and Engineers.

Q Have you examined essentially all of the electric logs in this field?

A I believe I have.

Q I believe there are approximately three hundred.

A Approximately three hundred.

MR. LOAR: If his qualifications are acceptable, we will proceed.

MR. PORTER: They still are.

Q (By Mr. Loar) Will you please refer to what has been marked as Sunray's Exhibit No. 1 and discuss it briefly?

A Exhibit No. 1 is our area map of the Bisti Lower Gallup Oil Pool. The Bisti Pool is composed of portions of Township 24, 25, and 26 North, Range 9, 10, 11, 12, and 14 West. This pool is approximately thirty miles in width and averages from one and a half -- I mean, in length, and averages from one and a half to three miles in width.

We have shown hereon, by the appropriate symbols, the 289 oil wells and 13 gas wells in the lower Bisiti Gallup Oil Pool. This is an additional 115 wells since the hearing of last year.

We have also shown hereon, by the orange border, the pool limits as defined by the New Mexico Oil Conservation Commission in the December nomenclature hearing.

We have also shown hereon, the original LPG gas injection pilot area, forming a square of 160-acres around the common corner of Township 25 and 26 North, Range 12 and 13 West.

We have also shown here in yellow, the project area of the recently approved gas injection project, incorporating portions of our Federal C Lease in Township 25, 26 North, Range 12 West.

We also have indicated on this area map, by the red and green solid and dashed lines, the traces of various cross sections that have been made in preparation for this hearing.

Q Now. then, Mr. Finfrock, would you refer to Exhibits 2, 3, 4, and 5, and --

A Exhibit No. 2 is a copy of the portion of the electric log of the British American Oil Producing Company's Marye No. 1

located in the northeast northeast of Section 1, 25 North, Range 13 West. As can be seen from this Exhibit, we have depicted by the green color in the solid portion in the middle of the electric log, the lower Gallup formation, and have shown it by the appropriate name. The top of this formation is picked in this well at 4826 feet. At total depth of 5,003 feet, we are still in the lower Gallup formation.

Exhibit No. 3 is a copy of the portion of the Shell Oil Company's Carson No. 1 in Section 24, 25 North, 12 West, which likewise shows, by the green color, the lower Gallup formation in this well. The top of the lower Gallup is encountered at approximately 4860 feet, with the base at 5134 feet.

Exhibit No. 4 is a copy of a portion of the induction electrical log of Skelly Oil Company's Lockhart 1-A, located in Section 31, 25 North, 10 West. This location --

Q Mr. Finfrock, could I interrupt you at this point. I think the staff -- some of these Exhibits aren't numbered. Are you aware of the numbers on the exhibits?

MR. NUTTER: Yes.

Q (By Mr. Loar) Would you go through two, three, four and five, merely identify the wells so that they can mark on their exhibits the exhibit number.

A Exhibit No. 2 is a British American Well, No. 1 Marye.

Q Just a minute now, Mr. Finfrock. All right, Exhibit No. 3.

A Exhibit No. 3 is the Shell No. 1 Carson. Exhibit No. 4 is the Skelly No. 1-A Lockhart. Exhibit No. 5 is the L. E, Elliott C-1.

Q Now, then --

A Going back to Exhibit No. 4, which is the Skelly's Lockhart 1-A, the top of the lower Gallup is picked in this well at approximately 5146 feet, and at a total depth of 5295 feet approximately, We are still in the lower Gallup formation.

Exhibit No. 5 shows the portion of the induction electrical log of the L. E. Elliott Federal C-1, located in Section 34, 25 North, 10 West, and in this well, the top of the lower Gallup formation is picked at approximately 5345 feet, and in a total depth of 5450 feet, we are still in the lower Gallup formation.

As can be seen from these type logs which have been picked from various portions of the reservoir, one can see that the lower Gallup formation is present in each and every log, which are representative of the general area from which they have been picked.

MR. PORTER: Mr. Loar.

MR. LOAR: Yes, sir.

MR. PORTER: At this point it is 11:45, and the hearing will be recessed until 1:15.

(Recess)

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

Q (By Mr. Loar) Mr. Finfrock, had you finished your

discussion of Exhibit No. 2, 3, 4, and 5, which are the logs for the Bisti Lower Gallup Oil Pool?

A Yes, sir, I have.

Q I believe you testified that these logs are representative of the logs in the field, is that correct?

A That is correct.

Q Now, then, will you please refer to Exhibit No. 6 and discuss that briefly?

A Exhibit No. 6 is an electrical log cross section extending from the British American No. 1 Navajo, the northwest, northwest, 15, 26 North, 14 West, following the solid green line to the Lion No. 1 Atlas, Section 24, Township 25 North, Range 10 West. This exhibit is hung from a datum of plus 1750 feet, and shows the division of the upper and lower Gallup formation.

We have covered here in green the designation of the lower Gallup formation as approved in committee work for unitization in which we have shown the first section and third benches in the lower Gallup formation, as can be seen from this exhibit. The lower Gallup sands are present through out this longitudinal axis as shown here on this exhibit.

Q Is this essentially the same cross section that you presented in previous hearings?

A That is correct.

Q Now then, will you please refer to Exhibit No. 7?

A Exhibit No. 7 is cross section A prime, double A prime,

which starts on Lion's No. 1 Atlas, which was the last well in the previous section, continues on to a southeast direction to Gulf No. 1 Federal Well in Section 29 of 24 North, Range 9 West. This is the portion of the field that had not been developed at the time of the previous hearing, and we've continued this section on in a southeasterly direction to show that we have the same upper and lower Gallup formation present in these sands, present and continuing in an elongated direction through this bar-type deposit.

Q Does the additional drilling in this area and the cross sections that you prepared from the information obtained from these wells, confirm your previous testimony?

A They do.

Q Now, then, will you refer to Exhibit No. 8?

A Exhibit No. 8 is Cross Section CC Prime, which is shown here in the dashed green line, extending from the Sunray's G-1 Federal in Section 32 in a northeasterly direction, to the Benson-Montin-Greer No. 1 Foster in Section 21 of 26 North, 13 West. The previous two cross sections and this one are drawn from the same rate of plane, and as can be seen from this cross section, we show the attitude, or the dip, or bed of the lower Gallup formation to the northeast.

I would like to call you attention to the fact that as we produce, as we move down dip basinward, we will find that the shalely sand stone, represented as the uncolored sand between

the upper and the second bench, tends to thin as we go basinward, and that the second sand thins also. We have no evidence in it, in the last well, the Benson-Montin-Greer No. 1 Foster. We also show the same thinning characteristics as we move off the bar deposit in these other sands.

Q Now, will you likewise refer to Exhibit No. 10?

A Exhibit No. 10 is cross section DD prime, which is shown represented here by the dashed green line, extending from the El Paso Natural Gas Pilot No. 8 Kelly State in a northeasterly direction, on cross section 9, and terminating with Pan American's No. 2 In-ni-da-pah.

Q Excuse me, I referred to that as Exhibit No. 10, is that No. 9

A That is 9.

MR. PORTER: It corresponds with the one I have.

A And terminated with the Pan American No. 2 In-ni-da-pah in Section 4 of 25 North, Range 12 West. This, as in the previous exibit, is drawn from the same data plane, and you can see the characteristics of the dip best in a northeasterly basin direction. I would also like to point out that this shale separating the upper two benches, as the previous section, continues to move as we move off the bar deposit. Likewise the shale, the interval between the second and third benches, as we approach the northern or up dip portion, tend to dip to where it is possibly less than one half to two feet in thickness.

Q I believe you are ready for Exhibit No. 10?

A I am ready for Exhibit no. 10.

Q Will you discuss that, please?

A Exhibit No. 10 is cross section EE prime, which is a north-south section essentially extending from the Carson -- I mean, from the Shell Carson No. 5 in Section 27, terminating in the National Drilling Company's No. 1 Federal in Section 15 of 25 North, 11 West. This previous section is drawn from the same datum point, indicating the northeasterly dip into the basin, and the fact that this shalely sand stone, between the upper two benches, still shows this characteristic of thinning basinward, and we feel that between the Shell 21-22 Ah-nus-Bah, and the Sunray Platero, this goes into one sand, which in turns shales completely out north over to the Platero, between the Platero well and National Drilling Company's No. 1 Federal. In this instance we show very little thinning of the shale zone between the second and third interval. However, we do show an overall thinning in the lower Gallup section as we moved eastward off the bar.

Q Now then, I believe we are ready for FF prime, which is, I believe, No. 11.

A That is correct. Exhibit No. 11, FF prime, is the last of our transverse cross sections. This cross section is in the southeasterly portion of the field, and due to the lack of complete development, in this portion of the field, we are not in the same position as the other sections that we have, in that

we have not been able to complete it across the bar. However, you see, though, they are hung from the same datum point, and we show the same northeasterly dipping bed of the lower Gallup formation. We also show that the presence of the three previously mentioned sands are there, and in this instance, we do not see the evidence of thinning of the shalely sand interval between the sand benches.

Q At the previous hearing, microlog cross sections were introduced showing the more, representing the more porous and permeability portions of the lower Gallup formation. Have you prepared micorolog cross sections paralleling all of the SP cross sections that you've discussed here today?

A Yes, I have, and the microlog cross sections are indicated on this Exhibit No. 1 by the solid red or dashed red lines.

Q In preparing these, did you take into consideration the hundred and fifteen new wells that had been completed in the lower Gallup since the last hearing?

A Yes, I did.

Q Do they confirm your testimony here today and your previous testimony?

A They do.

Q Now then, Mr. Finfrock, I believe you prepared a sand distribution map of the upper portion of the lower Gallup formation, have you not?

A Yes, I have.

Q Will you please discuss that? I believe it has been marked Exhibit No. 12.

A Exhibit No. 12 is a distribution map of this upper sand member of the lower Gallup formation. This yellow, as shown here on this map, is not to represent quality of sand, it merely represents presence of sand by study of the electrical log characteristics, and as you can see, this sand is in the form of a barrier in the north, west, south, and easterly direction, extending at least thirty miles in length.

Q Would you proceed.

A I have since then made a study of the micrologsof the approximate three hundred wells in the Bisti Lower Gallup Oil Pool, and contoured an isopach map of this lower Gallup formation, and which we have superimposed over the distribution map. This shows the occurrence in that sand zone of the better developed portion of the upper bench of the lower Gallup, and as can be seen from this exhibit, we find that the fairway, as we mentioned before, is on the outer edge of this bar, which is the seaward side, where we would expect to get sorting in a better manner than we would back from the seaward side.

Q Now then, have you prepared a similar exhibit for the second sand of the lower Gallup formation?

A I have.

Q This has been marked Exhibit No. 13, has it not?

A Exhibit No. 13 is the distribution map of the second member of the lower Gallup formation, and the yellow, as indicated hereon, has been put there as a result of a study of electircal logs showing that the sand is present in these wells, as shown hereon, and the study of the microlog logs of these wells indicates the presence of that portion of this deposit, which is better sorted and shows more porosity and permeability, and as can be seen from this exhibit, this portion of the bar lies in approximately the same position in relation to the total sand body as did that in Exhibit No. 12.

Q Now then, do the sand distribution map and the isopach for both portions of the lower Gallup reflect a study of all of the wells in the Bisti Oil Pool?

A All of the wells that I was able to obtain, and that is practically every well that has been completed.

Q Do the hundred and fifteen wells drilled in the past thirteen months, and used in these exhibits, confirm your testimony in the last hearing?

A Yes, they do.

Q Do all of these exhibits that you have prepared today reflect that the sand is continuous and connected throughout the Bisti Lower Gallup Reservoir?

A That is my opinion.

Q Were Exhibits 1 through 13 prepared under your direction and supervision?

A They were.

MR. LOAR: We move at this time that these exhibits be admitted in evidence.

MR. PORTER: Is there any objection to the admission of Sunray Mid-Continent's Exhibits 1 through 13? They will be admitted into the record.

MR. LOAR: That's all the direct we have of this witness.

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

CROSS EXAMINATION

BY: MR. NUTTER:

Mr. Finfrock, in this additional study that you have made of the Bisti Lower Gallup Oil Pool, with the some one hundred and fifteen additional wells to study, has anything come to your attention that would indicate to you that the spacing of the pool, as it presently exists, is in error?

A No.

Q You still feel that it should be spaced or prorated--

A Prorated.

Q --on the basis of 80-acres per well?

A I feel that is adequate.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else?

MR. UTZ: Yes, sir.

MR. [illegible]ER: Mr. Utz.

QUESTIONS BY MR. UTZ:

Q Mr. Finfrock, referring to Exhibit No. 12, specifically to the Merchant 2 and 3 wells in Section -- at point 512, are those wells completed in the Gallup formation?

A Those are two wells that I have not been able to receive electrical logs on, so I did not attempt to show the presence of sand. However, due to the fact that they apparently are productive wells, there must be sand present, but I did not have those logs to study, and they are not represented in as belonging to anyone group or the other. I haven't been able to defind them because I didn't have the logs.

Q We would assume then that your isopach map is in error, particularly in that area?

A The isopach map would probably have to be corrected when those came in. If they do not evidence any microlog separation, I mean, if they did evidence microlog separation.

Q In your opinion, would your study in regard to the micrologs show that we have now some dry acreage in the boundaries of this pool?

A You mean based upon the study of the micrologs?

Q Based upon your study of the pool, if you want to cover the entire area.

A Well, there are several wells that have been drilled within the confinds of this pool that do not have been drilled

and have been completed that do not show evidence of microlog separation. That is not the only criteria, the positive microlog separation.

Q We do have quite a bit of pool outside of your zero microlog permeability?

A The orange boundary is outside of the zero line of the isopach in some instances, that is correct, sir.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question? Mr. Fischer.

QUESTIONS BY MR. FISCHER:

Q Mr. Finfrock, in Section 15 of Township 24 North, 9 West, --

A 24, 9?

Q Yes, sir.

A 15. Yes, sir.

Q That No. 8 Federal Gulf, that is dry in the lower Gallup, in any of the Gallup?

A Apparently it is. They did not complete it as an oil well.

Q And the No. 4 in Section 21 South, east quater, that's a Gulf well?

A Section 4, you say?

Q No, sir, Section 21, is that well No. 1?

A Yes, in the northeast, northeast, the Gulf Kenny

Beto, I guess. We show that as a completed well.

Q Is that completed in all three benches?

A In the lower Gallup.

Q All three?

A I do not have the perforations.

MR. FISCHER: Thank you, that's all.

MR. PORTER: Any further questions?

MR. LOAR: I have one additional question, Mr. Porter.

REDIRECT EXAMINATION

BY: MR. LOAR:

Q Mr. Finfrock, are there some wells, at least in the Bisti Lower Gallup Oil Pool, which are producing and do not show any microlog, positive microlog separation?

A I feel there are, yes. There would be the edge wells on either plane.

MR. LOAR: That's all.

MR. PORTER: Anyone else?

MR. FISCHER: Yes, Mr. Porter.

MR. PORTER: Mr. Fischer.

RECROSS EXAMINATION

BY: MR. FISCHER:

Q Your yellow section that you say shows that this sand is present, have you found any other evidence outside the limits of this Bisti Pool that there is any uniform permeability in this

sand where it is encountered that might show another bar type development outside the pool limits?

A No, sir, I have not.

MR. FISCHER: Thank you.

MR. PORTER: No further questions, the witness may be excused.

(Witness excused.)

T. W. BRINKLEY

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

DIRECT EXAMINATION

BY: MR. LOAR:

Q Mr. Brinkley, will you please state your name and occupation?

A My name is T. W. Brinkley, I am chief reservoir engineer for Sunray Mid-Continent located in Tulsa.

Q Will you please give a brief resume of your professional background?

A In 1940 I graduated from the University of Tulsa, Tulsa, Oklahoma, with a bachelor of science degree in petroleum engineering.. Since then I have been practicing as a reservoir engineer, as a petroleum engineer the last thirteen years specializing in reservoir engineering.

Q Have you been associated with the Bisti Field since

the earliest states of development?

A Yes, I have. I might state that since Sunray is chairman of the Engineering Committee, I have been associated with that group, also since Sunray is chairman of the Operators' Committee, I have been associated also with that group. In addition to that, I have made several independent studies of the Bisti Lower Gallup reservoir. I have in the past appeared as a witness and offered testimony in this spacing matter.

MR. LOAR: If his qualifications are acceptable, we will proceed.

MR. PORTER: Yes, sir.

Q (By Mr. Loar) Will you please briefly discuss the reservoir characteristics or history of the lower Gallup formation, Bisti Pool, San Juan County, New Mexico?

A To date, we have drilled approximately three hundred two oil wells in the Bisti Lower Gallup reservoir. This drilling has defined a pool approximately thirty miles in length, and width varying from one and a half miles to three miles. Out of these three hundred two wells that have been drilled, thirteen of them are gas wells, and these gas wells are located in the southeastern portion of the Bisti Field. The most easterly gas well, and I will circle the well here for your convenience, is the Humble State No. 2, located in Section 32, 25 North, 10 West. It is located in the southeast of the southeast.

The westerly most gas well is the Shell Carson Unit No.

32-20 located in Section 20, 25 North, 11 West. As you can see, this gets the eastern and the western boundary of the thirteen gas wells.

The New Mexico Oil Conservation Commission's boundary of this pool was identified earlier by Exhibit 1 as the orange boundary. That boundary contains thirty-three thousand eight hundred acres.

As described earlier by Mr. Finfrock, the drilling of these three hundred and two wells has defined the Bisti Lower Gallup sand as a long narrow deposit of sand. Further, we find that the drilling of these wells has characterized the reservoir as being thinner in the center. Also we find that the wells drilled on the northeast flank and the southwest flank up and down this trend, the sands are thinner.

Further, the electric log interpretation reveals that the thicker sands are of better quality, and the thinner sands on the flanks are of inferior quality. This characteristic is further substantiated by core analysis.

Q I believe you prepared exhibits reflecting the core analysis for three typical wells. These have been marked Exhibits 14, 15, and 16. Would you please refer to these, briefly?

A Exhibits 14, 15, and 16 represent, are exhibits showing the electric logs and laboratory analysis of cores taken from these three wells. The three wells are identified as follows:

Exhibit 14 is the Phillips Benally No. 2, located in the northeast, southwest of Section 5, 25 North, 12 West. This well represents a well in the fairway.

Exhibit 15 is the British American Salge B-5, and it is located in the northeast, northeast, Section 33, 26 North, 13 West. As you can see, it is an edge location.

Exhibit 16 is the El Paso Natural Gas Kelly State No. 1 located in the northeast, northeast of Section 16, 25 North, and 12 West. Again, this exhibit represents an edge well.

Since these three exhibits illustrate the same significant characteristics, I would like to concentrate my testimony on Exhibit 14. That is the Phillip's Benally No. 2, the fairway well. You will notice in the center of the exhibit that we have the electric log. We have identified the upper and second sand. You will notice also the electric log reflects better sand development in the upper sand, compared to the second or lower sand. On the right hand side we indicate the results of the laboratory determined permeability from cores taken through the entire vertical section.

As you notice, the better permeability occurs opposite the upper sand. Maximum permeabilities are detected at approximately two hundred milladarcies. You will notice too, that permeability is identified by the bar graph throughout the entire veritcal section.

On the left hand side you will notice the laboratory

determined porosity values for the entire cored interval. Again, you will notice better porosity development opposite the upper sand, compared to the second and lower sand. Again, I direct your attention to porosity development throughout the entire vertical section. The foregoing characteristics are reflected on Exhibit 15 and 16.

Q Mr. Brinkley, I believe there are some blank spaces on Exhibit 15 on your porosity scale and permeability scale.

A Exhibit 15. Yes, we have blank spaces circled in red. On Exhibit 16 there are several blank spaces. Those blank spaces represent sections that were not cored.

Q Now then, what is the significance of these three exhibits?

A These exhibits illustrate that permeability exists throughout the vertical sections, and also refect the better sand character in the fairway wells in the reservoir.

Q Mr. Brinkley, is pressure interference information one of the tools of the petroleum engineer or the reservoir engineer to defind drainage, or the area that one well will drain?

A Yes.

Q Have you seen evidence of pressure interference in the Bisti Field?

A Yes, sir, I have.

Q Would you please discuss some of these instances of pressure interference?

A We have several instances of positive well interference in the Bisti Lower Gallup reservoir. One instance occurs in the El Paso Natural Gas Kelly State No. 2, located in the southeast, northwest, Section 16, 25 North, 12 West. That well is located right here, which I have circled in red. In that well, on January 31, 1956, the bottom hole pressure was measured to be fourteen hundred and three pounds at the elevation, on datum of plus thirteen hundred feet. This pressure is two hundred and nine pounds less than the original reservoir pressure. Another instance --

Q Now, Mr. Brinkley, are there wells, were there wells offsetting this well which were producing prior to its completion?

A Yes, the nearest well that was producing at the time, or before the time that this well pressure was measured, was the discovery well, El Paso Natural Gas Kelly State No. 1, which was previously circled in black. The discovery well is located twenty-four hundred and twenty feet distance from the Kelly State 2. The well that we detected interference on. Using this information and constructing an arc around the producing well, with a radius of twenty-four hundred and twenty feet representing the interference that we have measured and detected, would encompass an area of four hundred twenty-five acres.

Q Mr. Brinkley, what was the pressure on this Kelly State No. 2 that you testified to?

A The bottom hole pressure on the Kelly State No. 2

measured on January 31, 1956, was fourteen hundred and three pounds per square inch.

Q That was completion pressure?

A That is completion pressure, before any production was taken from that well.

Q Now then, will you please discuss some of the other examples?

A Another example is the El Paso Natural Gas Kelly State No. 3. That well is located on the northeast, southeast, Section 6, 25 North, 12 West. Again, I will circle that well in red. On February 29th, 1956, this well measured a bottom hole pressure of thirteen hundred ninety-four pounds at the elevation of thirteen hundred feet. This pressure represents two hundred eighteen pounds less than the original reservoir pressure. Again, the nearest well producing, at this time, was the discovery well, El Paso Natural Gas Kelly State No. 1, and it is located twenty-three hundred feet north, twenty-three hundred and ten feet north of the subject well. Again, by circumscribing an arc around the discovery well with that radius, the well encompassed an area of three hundred and eighty-four acres.

Q Now, was this also a completion pressure on this Kelly State, which well was it, No. 7?

A No. 3. Yes, it is also a completion pressure, measured before any oil had been produced.

Q All right.

Another example is Shell-Phillips No. 23-10, located in the northeast, southwest of Section 10, 25 North, 12 West. Again, I have circled the well in red. On August 31, 1957, the bottom hole pressure was measured in this well, and the value was fifteen hundred and twelve pounds at an elevation of thirteen hundred feet.

Q Was that also a completion pressure, Mr. Brinkley?

A That also was a completion pressure. This completion pressure represents a hundred pounds per square inch, less than the original reservoir pressure. The nearest producing well is Southern Union's Ka-gee-tah. It is located in the southeast, northwest, Section 10, 25 North, 12 West. Again, I have circled that well. The nearest well that was producing is fourteen hundred feet from the Shell-Phillips No. 23-10. Similarily, by constructing an arc around the producing well with a radius of fourteen hundred feet, we circumscribed an area of fourteen hundred feet. We circumscribed an area of one hundred forty-one acres.

Q Now, then, do these examples reflect pressure interference and drainage of wide areas even in the portion of the field which has been described as perhaps inferior or with less peremeability?

A Yes.

Q As well as the more premeable portions.

A Yes, they do.

Q These pressure interference tests reflect migration of oil in the reservoir, do they not?

A Pressure interference tests reflect the movement of oil away from the newly completed well used in this example, and that oil flows from that area to the nearest producing well.

Q Now then, have you seen other instances of pressure interference in this pool?

A Yes. One example, the latter part of '56, continuously through the fall of '57, in the project area marked on Exhibit 1, colored in yellow, representing the Sunray Federal C Lease, we had four wells shut in for approximately one year, and measured the reservoir pressure from time to time. During that year we observed a pressure decrease in each of those four wells, and the range in value of this pressure decrease was between eighty-two pounds and one hundred and five pounds.

Bear in mind two of these four wells are located at the edge of the field where the inferior sand characteristics are, and two of the wells were located in the fairway. Again, using the distance between these shut in wells and the nearest producer to the well, and circumscribing an arc or circle around the producing well with that radius, and calculating the area within that circle, we find that we can calculate the radius of drainages for areas varying from a minimum of one hundred twenty-six acres to a maximum of nine hundred and ninety acres. There is another instance of interference and that instance is in the pilot area, as Mr. Finfrock mentioned

this morning. The pilot area is located on Exhibit 1, colored in green. The pilot area is located at the intersection of Township 25, 26 North, Range 13 West. This interference test was identified as a pressure build up in outlying wells, observed for a distance of little less than one mile from the injection well. This pressure build up was due to the injection of LPG and gas in our injection well. In other words, we identified the pressure build up in the wells within that circle, almost a circle. Using that radius and constructing a circle around the injection well, we can circumscribe an area in excess of a thousand acres.

Q Mr. Brinkley, have you made a study of the reservoir pressure the Bisti Lower Gallup Oil Pool?

A Yes.

Q Will you please refer to Exhibit No. 17, which is a pressure contour map reflecting a recent bottom hole pressure survey for this pool?

A Exhibit 17 represents an isobaric map of the lower Gallup reservoir.

Q Mr. Brinkley, will you please explain what an isobaric map is?

A It can be stated quite simply. An Isobaric map is a pressure contour map, that means that a contour represents lines of equal pressure in the reservoir.

Q Is an isobaric map, or pressure contour map, one of the recognized tools of the petroleum or reservoir engineer?

A Yes.

Q All right, sir, will you proceed with the discussion of Exhibit 17.

A Exhibit 17, being the pressure contour map, reflects basically the pressure distribution in the reservoir. This exhibit was constructed from a poolwide voluntary survey conducted by the operators in the pool. This survey was conducted in August 1958. At that time, representative wells, key wells, were picked throughout the length of this reservoir, and were measured for pressure so that we could use that data in constructing a pressure contour map that would reflect representative reservoir pressures. The result of all of this field work was then put on this map, which we now call Exhibit 17. You will notice that the highest pressures are detected on Exhibit 17 along the fairway for the entire length of the reservoir, and these higher pressures are detected where the thicker sand exists. You will notice also that the lower reservoir pressures are identified along the northeast flank and along the southwest flank of the reservoir where the thinner sand sections are. You will notice further, the smooth and continuous nature of the contour lines reflecting continuity of our sand up and down the longitudinal axis of our reservoir.

Q Does this map then reflect that we have widespread pressure or fluid communication over a broad area?

A In my opinion, Exhibit 17 is significant mainly

because of the continuous nature of the isobars in that they reflect fluid movment has occurred over large areas, otherwise the contour lines would displace a discontinuous character such as erratic type contouring and the erratic type contouring would include numerous isolated low pressure areas.

Q At the previous hearing on this field, did you testify that one well would efficiently and economically drain 80-acres?

A Yes, I did.

Q I believe that both you and Mr. Finfrock have testified that approximately one hundred fifteen wells have been drilled since the last hearing?

A That is correct.

Q Has the drilling of these one hundred fifteen wells changed your opinion of this reservoir or changed your testimony?

A No, sir, it has not.

Q Does the pressure interference information and this isobaric map support your testimony that one well will drain in excess of 80-acres?

A Yes, it does.

Q Does all of the evidence available confirm your testimony that one well will efficiently and effectively drain in excess of 80-acres?

A Yes, it does.

Q Were exhibits 14, 15, 16, and 17 prepared under your

direction and supervision?

A They were either prepared by myself or under my supervision.

MR. LOAR: We move that these exhibits be admitted into evidence.

MR. PORTER: Without objection, the exhibits will be admitted.

MR. LOAR: That's all the direct testimony we have from this witness.

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

CROSS EXAMINATION

BY: MR. NUTTER:

Q For how many wells did you have available bottom hole pressures in making this isobaric map, Mr. Brinkley?

A I didn't count them, but there are approximately a hundred.

Q And they are scattered throughout the length and breadth of the pool, I presume?

A Oh, yes, when we scheduled this bottom hole pressure survey, we requested that we get representative coverage, or each section or quarter section from each reservoir, so that we could be reasonably assured that the results we would gain would be representative of the reservoir pressure.

Q The little numbers opposite some of the well numbers

on the map indicate the well pressure that you had available on that well?

A I am very glad you brought that up. I forgot to mention that. Yes, we have shown, I think the draftman has been consistent, but immediately above the well and in fact, immediately above the well number, you'll find another number, and that number would be the pressure in that well. As a matter of fact, this isobaric map represents pressures corrected to the center of the completion interval.

Q These are not necessarily taken at a common datum?

A No, we feel that, since we are interested in reservoir pressure, that the pressure expressed at the center of perforations more nearly reflect what we want to know.

MR. NUTTER: Thank you.

MR. PORTER: Does that conclude your questioning?

MR. NUTTER: Yes.

MR. PORTER: Mr. Utz.

QUESTIONS BY MR. UTZ:

Q Mr. Brinkley, did you have more core data to study other than Exhibit 14, 15, and 16?

A Oh, yes, yes.

Q You made a study --

A Yes.

Q --of that core data?

A Yes, I made up Exhibits 14, 15, and 16, since they

were typical of the wells that would be included in all the wells cored.

Q Then there was other core data?

A Yes.

Q In your opinion, does this show communication between the sand in the Bisti Pool?

A It shows that permeability exists throughout the vertical section. However, the degree of communication vertically will not be as great as horizontally.

Q But you feel there is in the vertical limits?

A Yes, I do.

Q You have only shown two sands here. It is my understanding, or three, it is my understanding there are three sands. Did you show the three of them?

A I am not sure I understand you, but on Exhibit 14 we identified the upper and second sand.

Q Yes, sir.

A Are you referring to the lower sand?

Q Yes, is that shown on this exhibit?

A The lower sands are on Exhibit 14, 15, and 16, but they are not identified as such. They are identified upper sand, second sand, consistent with the isopach map that was presented earlier by Mr. Finfrock.

Q Well, then, all three sands are shown on this exhibit?

A Yes.

Q But they are not identified?

A The lower sand is not identified, that is correct.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question? The witness may be excused. Does this conclude Sunray's testimony?

MR. LOAR: Yes, sir.

MR. PORTER: Does anyone else desire to present testimony in this case? Any statements?

MR. CAMPBELL: Mr. Commissioner, I would like to make a brief statement on behalf of Sunray Mid-Continent, since they are the principal proponents for the continuation of this order.

I think it is apparent from the testimony that has been presented here, that all of the conclusions of these witnesses, who have appeared in prior hearings, have been confirmed, in their opinion, by the additional drilling that has taken place, and by the additional studies that have been made. I do not know whether the request was made to include the testimony and exhibits in the prior hearing in this hearing or whether they will automatically be included, but if it is necessary, I would like to request that all of the prior testimony involving the establishment of proration units in this pool be included as a part of the record in this case.

MR. PORTER: It is our understanding that the previous record is a part of the case.

MR. CAMPBELL: Then, as I say, with the previous record and the testimony here, based upon the most recent findings of the Commission, and their most recent order, it appears to us that there is a basis for a continuation of the present order, or for a new order at the time this one expires, upon the same terms as the present order.

Sunray Mid-Continent is requesting that the present arrangement of proration units in this pool be extended or continued, or that a new order be written with the same provisions, and that proration units of 80-acres be continued with the right of any party to drill more than one well on 80-acre proration units, should they so desire, with the proper adjustment in allowable.

With regard to the terms of any such order, it is our recommendation and our request to the Commission, that if it sees fit to write another order, that that order remain in effect for a period of one year from the expiration date of the present order, and that it include a provision that it shall continue in effect thereafter until any interested party or the Commission requests that it be brought up again for hearing.

I do not think that there is any question about the right of the Commission to bring it up again for hearing, but there has been some conversation recently that a party might be precluded from doing it at a later time. The reason for that request is that it will avoid the necessity, unless the Commission or an interested party request it, for another preparation of this type,

commencing ten or eleven months from now, and it will leave open, on the other hand, as the present order has, the full right of the Commission, at the expiration of the one year, or any other party at the expiration of that time, or at any later date, to request that the Commission bring the matter up again for hearing.

It is our understanding that the Commission has been advised by the company which originally appeared in this hearing in opposition to 80-acre spacing units, as distinguished from proration units, that they do not object to the continuation on the present basis, even though they have, I presume, been fully advised. They are not objecting to the continuation, so long as it is on a proration unit basis, and Sunray Mid-Continent is requesting that this order be extended upon the same terms as the present order.

MR. McGOWAN: James McGowan, Sinclair Oil and Gas Company. Our people have made a similar study, but not nearly as detailed as that shown here today by the Sunray people, and they arrive at essentially the same conclusion. If they testified today, their testimony would support and substantiate the testimony that has been given at the previous hearing by Sinclair's witnesses. We, therefore, recommend that the Commission make the present order permanent, or extend the order for such a period as they desire to, or write a new order consisting of the same terms.

MR. VERNOR: Russ Vernor, enginer for Atlantic

Refining Company.

Atlantic only has one well in the field. We haven't made a detailed study other operators have made, but I have reviewed the data and testimony of the other operators, and as a reservoir engineer, I agree with their conclusions, and I would like to recommend to the Commission that the Sunray application be adopted.

MR. BRATTON: Howard Bratton, appearing on behalf of Humble Oil and Refining Company and also on behalf of Manzano Chemical Company. I would like to make a statement for both companies, who concur in the recommendations of Sunray Mid-Continent. On the basis of the evidence previously presented, the Commission's findings, and the further evidence presented here today to substantiate those findings, it appears to us that the present order must be continued.

MR. VERITY: George Verity, for Rex Moore. I would like to urge the adoption of the proposal, and state to the Commission whereas Mr. Moore only had two wells at the time this was previously considered, he has since then drilled five more because it was 80-acre spacing, and all of his findings with regard to that has confirmed his opinion that it should be continued on that basis.

MR. BUSHNELL: H. D. Bushnell, appearing on behalf of Amerada. Amerada concurs in the recommendations made by Mr. Campbell, and feels that the evidence presented here today would

support that recommendation.

MR. SPERLING: J. E. Sperling, on behalf of British American Oil Producing Company. Independent studies made by British American with reference to this reservoir, leads to the same conclusions that may be deduced from the evidence presented today and at the previous hearing. Thereby, Amerada concurs in Mr. Campbell's recommendations to the Commission and recommends the order or a new order as suggested by Mr. Campbell.

MR. DUTTON: If it please the Commission, Sun Oil Company is in complete accord and actively supports the New Mexico Statutory mandate that the orders of the Commission shall so far as practicable afford each property owner in a pool the opportunity to produce his just share of the hydrocarbons to the extent such can be obtained without waste.

In our opinion, Order R-1069-B meets the statutory requirements in an admirable manner by providing for an optional 80-acre proration unit and acreage allocation. The order provides the best current practicable method of providing each owner in the Bisti Field the opportunity to recover economically the hydrocarbons under his property by permitting 40-acre drilling units. The order prohibits no operator from drilling additional wells if he deems it economically feasible to insure his opportunity to recover or to increase his own hydrocarbons. Most important, particularly in view of the domestic oil industry's attempt to maintain a competitive position. The order offers

no incentive to any operator to drill wells which will not substantially increase ultimate recovery merely for the purpose of securing an allowable advantage. Such advantage, which will permit an operator to drain his neighbor's property, inevitably leads to drilling unnecessary wells, which greatly increase the cost of domestic production.

A final point in favor of the rule is that the market demand for oil from this field is being met under the order.

For these reasons, we believe the Order R-1069-B ideally meets the dual proration goals of preventing waste and protecting correlative rights.

Sun Oil Company therefore respectfully requests that Order R-1069-B be continued in effect in the Bisti Field without a stated time limitation.

MR. KELLOUGH: Gulf Oil Corporation has no objection to the continuation of the present order for an additional period of time. We would like to concur in the recommendation made by Mr. Campbell that the order as now written be extended in all of its particulars for a period of one year and so long thereafter until upon application of any interested party or by the Commission on its own motion in the matter is brought up again. In that way, the ultimate proper spacing for the pool can be determined after additional producing history and at the proper time and without prejudice to any party with respect to any technical issues on the burden of proof.

MR. SETH: I would like to make a statement on behalf of Shell. Shell participated actively in the previous hearing as we all recall, and we advised the Commission by letter in December that we would not object to a continuation of this order, nor would we object to a termination. We have no objection, and we do not now object. We don't want anyone to misunderstand our inaction. We have not changed the position that we originally expressed in the very first hearing. We still feel that the development should be on the basis that we advocated at that time, and during the coming year Shell plans to proceed within the flexibility provided in the existent order and develop it in accordance with its beliefs, and we will struggle along for another year.

MR. WHITE: The Texas Company is one of the operators in the pool, and they concur in the recommendations by Sunray.

MR. SELINGER: If the Commission please, my name is George Selinger, and I represent Skelly Oil Company. We operate twenty-five wells in the field, in addition, we have an interest in the Carson Unit operated by Shell. We wish to concur in the Sunray Mid-Continent application and request that our concurrence should not in any way lead the Commission to feel that we have departed from our views that one well would adequately and efficiently drain 80-acres, and at this time we are willing to concur with the application and request of Sunray.

MR. PORTER: Anyone else have a statement to make?

MR. PAYNE: Mr. Commissioner, I have received communications here on behalf of Honolulu Oil Corporation and Magnolia Petroleum Corporation adopting the view of Sunray Mid-Continent Oil Company, and we will put these in the record.

MR. PORTER: Thank you, Mr. Payne. Any further statements? The Commission will take the case under advisement and we will have a short recess.

(Recess)

Oil Conservation Commission

Mabry Hall, State Capitol, Santa Fe, New Mexico.

Re: Continuation of Rules and Regulations set forth in Order No. R-1069-B, Case No. 1308. Magnolia Petroleum Company, as an operator in the Bisti Lower Gallup Oil Pool, hereby supports Sunray Mid-Continent Oil Company in its request for a continuation of 80-acre spacing and proration units for this pool in San Juan County, New Mexico. We feel that the preponderance of geological and engineering testimony supports 80-acre spacing for this reservoir.

D. V. Carter

Magnolia Petroleum Company.

New Mexico Oil Conservation Commission

Attention Mr. A. L. Porter, Secretary and Director

Santa Fe, New Mexico.

In regard to Case No. 1308 to be heard before the Commission January 14, 1959, it is the position of Honolulu Oil Corporation that Order R-1069-B be continued and made a permanent order. Honolulu Oil Corporation has one well producing in the Bisti Lower Gallup Oil Pool at the present time.

George R. Hoy

Honolulu Oil Corporation

Midland, Texas.

New Mexico Oil Conservation Commission

Capitol Annex Building

Santa Fe, New Mexico.

Attention: Mr. A. L. Porter, Jr.

Gentlemen:

Pursuant to the Commission's Order No. R-1069-B dated January 17, 1958 the subject case has been scheduled for the regular hearing docket of January 14, 1959.

Pan American Petroleum Corporation is an operator in this field and has participated in previous hearings concerned with the adoption of rules for this field, and generally supported the rules that are currently in effect on a temporary basis. It was our opinion at the time of these prior hearings that the proper size unit for this pool was 80-acres. All data which have been gathered in the interium period have confirmed our conclusion that one well will efficiently and effectively drain in excess of 80-acres. Therefore, we recommend that the present temporary rules, now in effect, be adopted as permanent rules for this pool.

It is requested that this statement of our position be read into the record of the January 14, 1959 hearing.

Very truly yours,

Alex Clarke, Jr.

STATE OF NEW MEXICO)
) ss
COUNTY OF BERNALILLO)

I, Joseph A. Trujillo, Notary Public in and for the County of Bernalillo, State of New Mexico, do hereby certify that the foregoing and attached Transcript of Hearing before the New Mexico Oil Conservation Commission was reported by me in Stenotype and reduced to typewritten transcript, and that the same is a true and correct record, to the best of my knowledge, skill and ability.

WITNESS my Hand and Seal this 22nd day of January, 1959, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Joseph A. Trujillo
NOTARY PUBLIC

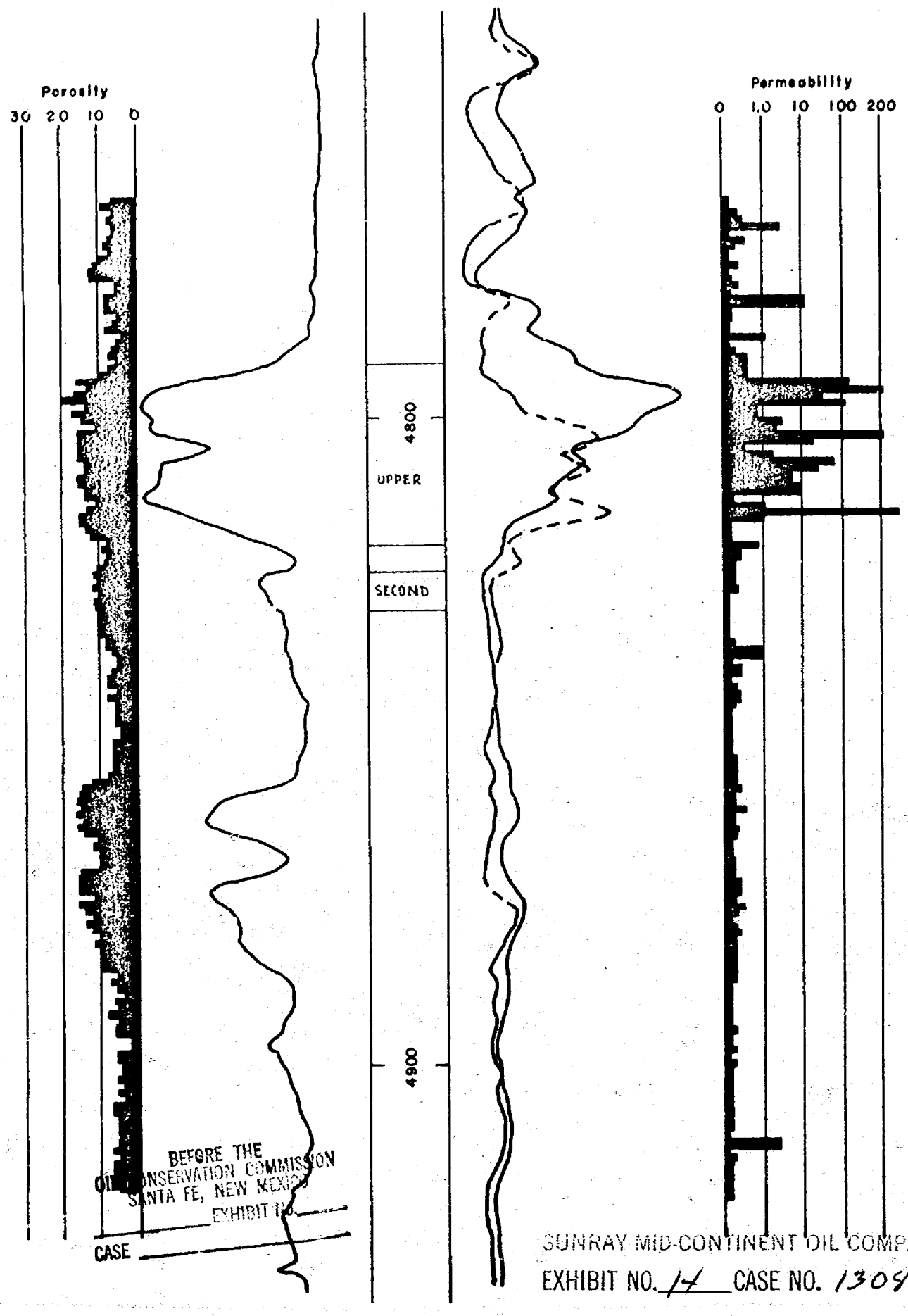
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October 5, 1960

PHILLIPS

Benolly #2

Sec. 5 25N – 12W



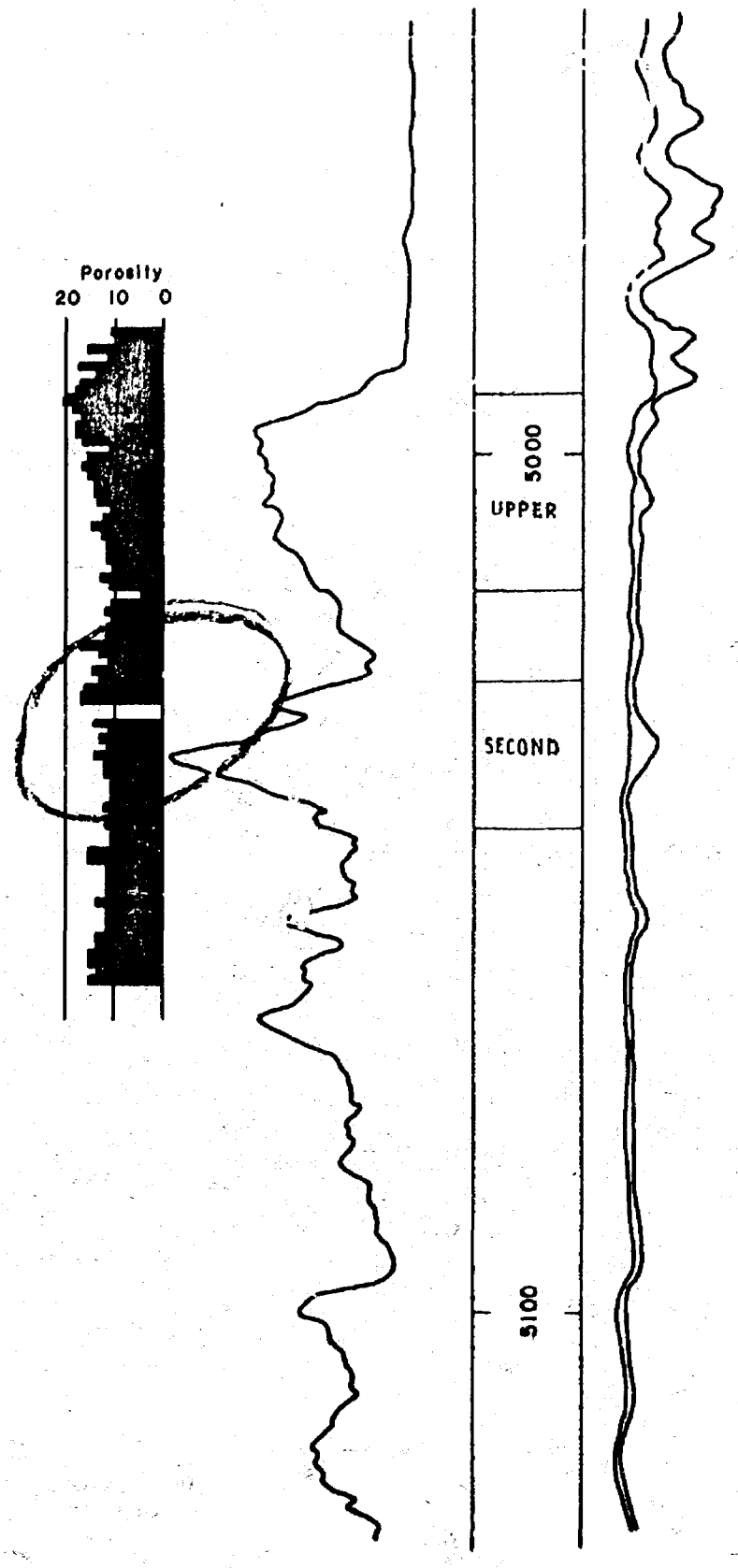
BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
EXHIBIT NO.
CASE

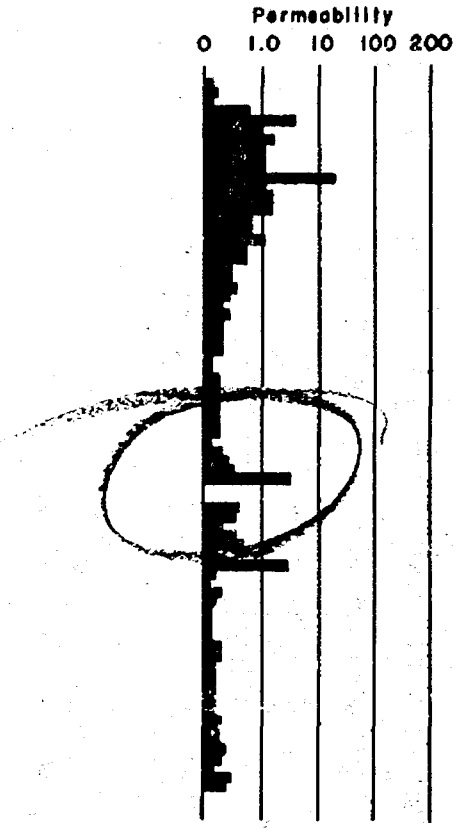
SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO. 14 CASE NO. 1304

BRITISH - AMERICAN

Solge # B-5

Sec. 33 — 26 N—13 W





BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO

EXHIBIT No. ____

CASE _____

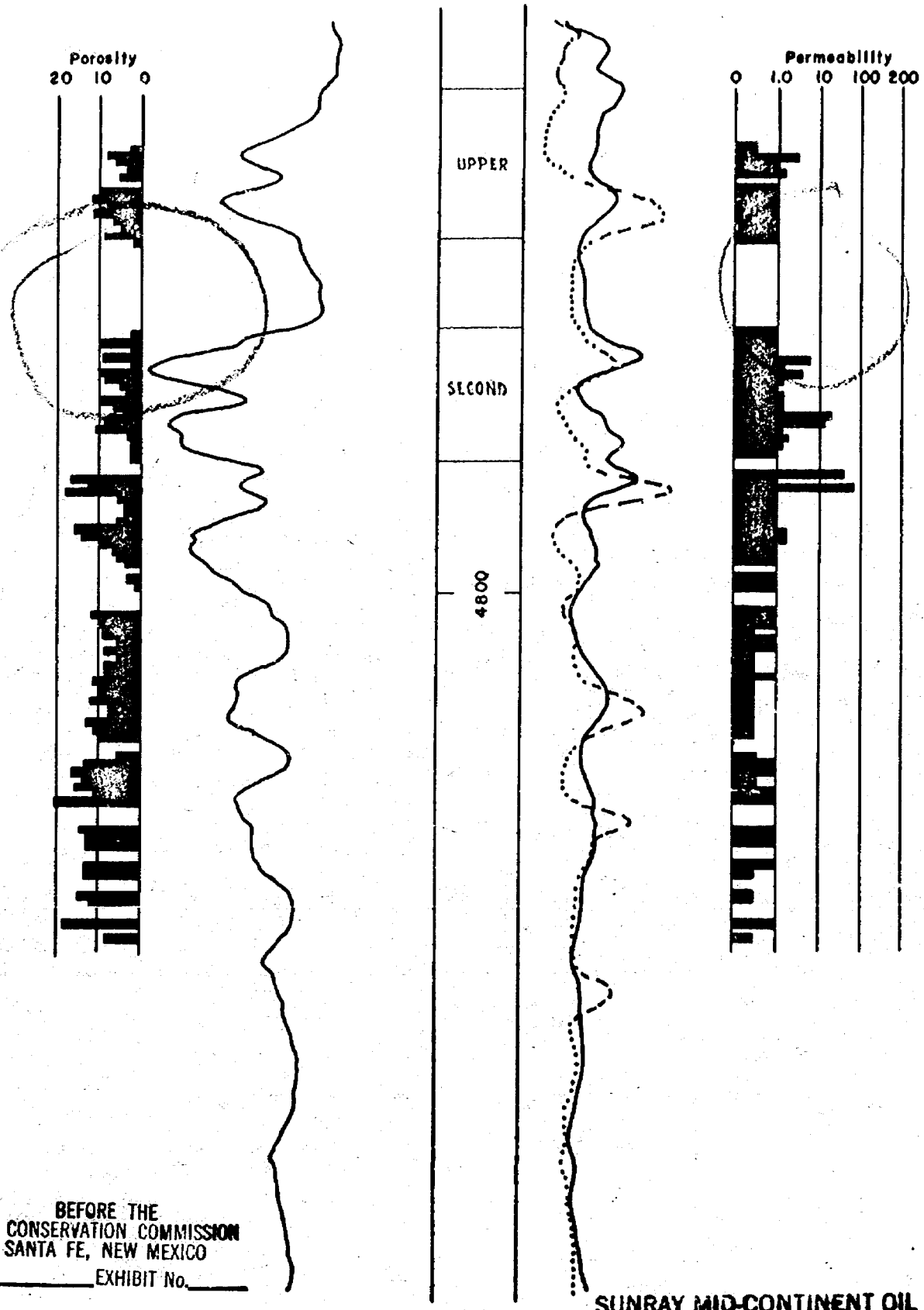
SUNRAY MID-CONTINENT OIL COMPANY

EXHIBIT NO. 15 CASE NO. 1308

E P N G

Kelly State #1

Sec.16 25 N - 12 W



BEFORE THE
OIL CONSERVATION COMMISSION
SANTA FE, NEW MEXICO
_____ EXHIBIT No. _____
CASE _____

SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO. 16 CASE NO. 1308

SUNRAY MID-CONTINENT OIL COMPANY
P. O. BOX 2039
TULSA 2, OKLAHOMA

MAIN OFFICE 066
1958 JUL 18 AM 8:33

R. E. FOSS, VICE PRESIDENT
R. W. GRIFFITH, ASST. TO THE VICE PRES.
M. S. PATTON, JR., MANAGER
ENGINEERING DIVISION

PRODUCTION DEPARTMENT

C. J. KERWIN, SUPERINTENDENT
OIL DIVISION
L. G. FODGERS, GENERAL MANAGER
GAS DIVISION
J. N. DOUMA, MANAGER
JOINT OPERATIONS DIVISION

July 15, 1958

New Mexico Oil Conservation Commission
P. O. Box 871
Santa Fe, New Mexico

Attention: Mr. W. J. Cooley

Gentlemen:

Under separate cover are the following three sets of exhibits in Case No. 1308 concerning the 80-acre spacing hearing on the Bisti (Lower Gallup) Oil Pool, San Juan County, New Mexico, which you requested:

1. Sinclair's Exhibits 1 - 3 in the rehearing held December 18, 1957
2. Sunray's Exhibits 1 - 13 in the original hearing held September 18, 1957
3. Sunray's Exhibits 1 - 9 in the rehearing held December 18, 1957.

Very truly yours,

SUNRAY MID-CONTINENT OIL COMPANY

William R. Loar

William R. Loar
Chief Proration Engineer

JWS/at
cc: Sinclair Oil and Gas Company
P. O. Box 521
Tulsa, Oklahoma
Attn: Mr. J. H. McGowan

ECONOMIC COMPARISON
40-ACRE VS. 80-ACRE SPACING
BISTI POOL, SAN JUAN, NEW MEXICO
LOWER GALLUP RESERVOIR

	Well Spacing Density	
	40-Acres	80-Acres
Original Oil in Place, (1)		
Gross Barrels Stock Tank Oil	210,000	420,000
Ultimate Recovery, (2)		
Gross Barrels Stock Tank Oil	44,000	88,000
Value of Net (7/8) Oil Recovered (3)	$111,000	$222,000
Investments		
Drill & Complete (4)	$ 55,000	$ 55,000
Surface Equipment (5)	21,000	21,000
Total	$ 76,000	$ 76,000
Operating Expense		
Lease & Well Costs (6)	$ 30,800	$ 61,600
Taxes (7)	6,830	13,660
Total	$ 37,630	$ 75,260
Non-Discounted Operating Profit (Loss)		
Before Salvage or Overhead	($ 2,630)	$ 70,740
Present Worth Operating Profit (Loss) (8)		
Before Salvage or Overhead	($ 16,920)	$ 33,050

(1) Volumetrically determined from isopach, core analysis, and fluid analysis.

(2) Calculated natural depletion; 21% of original stock tank oil in place.

(3) $2.85/barrel.

(4) Clear for location, drill & complete a flowing well.

(5) Surface equipment:

Artificial lift including rods, pump, prime mover, etc.	$10,000
Flow line, proportionate share of battery, roads, etc.	11,000
Total surface equipment	$21,000

(6) Estimated cost for life of property at 80¢/net barrel.

(7) New Mexico production tax:

Severence	2.50% value
Gross receipts	2.00%
Conservation	0.14%
Ad Valorem	1.50%
	6.14%

(8) Present worth compound interest factor @ 6%.

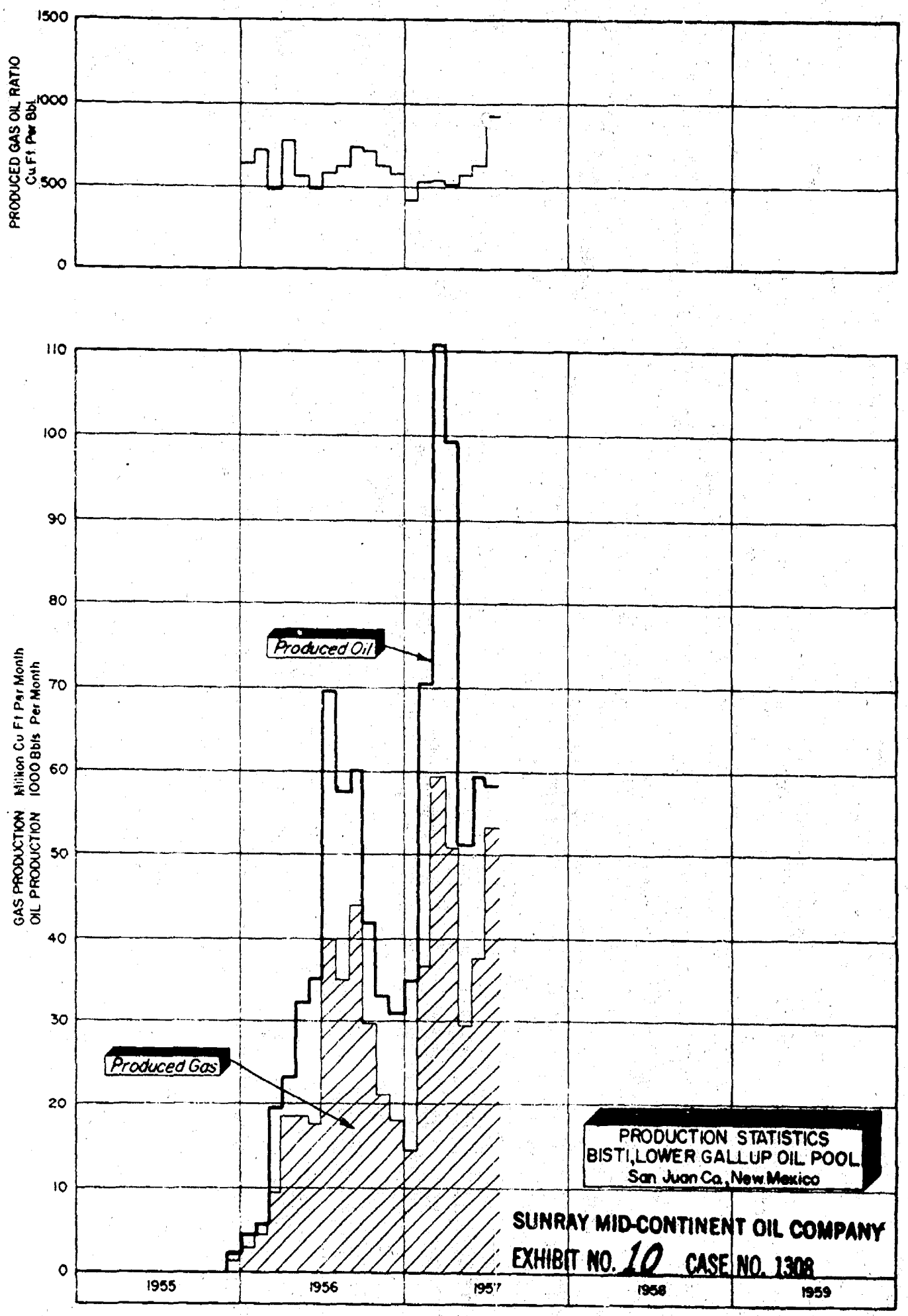
SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO. 15 CASE NO. 1308

PRODUCTION STATISTICS **
BISTI (LOWER GALLUP) NEW MEXICO

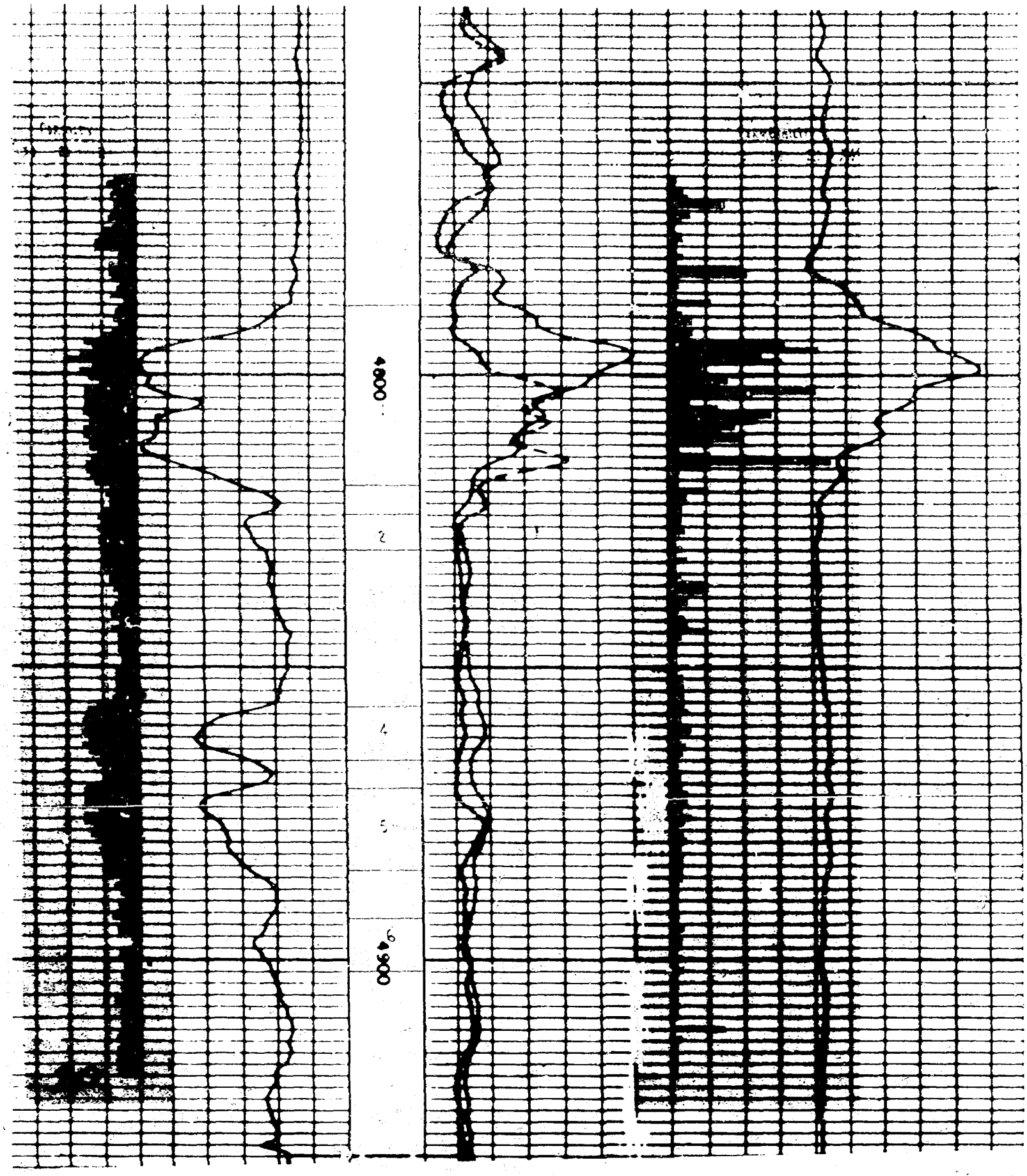
Year and Month	Number of Wells Produced	Oil Prod. Bbls./Mo.	Cum. Oil Prod. Bbls.	Gas Prod.* Mcf/Mo.	Cum. Gas Prod. Mcf	Avg. GOR Ft./Bbl.
1955						
Dec.	1	2,319	2,319	1,280	1,280	
1956						
Jan.	2	4,493	6,812	2,918	4,198	649
Feb.	4	5,755	12,567	4,104	8,302	715
Mar.	5	19,519	32,086	9,355	17,657	479
Apr.	12	23,580	55,666	18,370	36,027	779
May	16	32,269	87,935	18,319	54,346	567
June	26	35,220	123,155	17,265	71,611	490
July	39	69,921	193,076	40,657	112,268	582
Aug.	49	57,883	250,959	35,805	148,073	619
Sept.	47	60,278	311,237	44,662	192,735	741
Oct.	45	42,032	353,269	29,788	222,523	709
Nov.	49	33,351	386,620	21,042	243,565	631
Dec.	51	31,205	417,825	17,820	261,385	571
1957						
Jan.	44	35,005	452,830	14,339	275,724	410
Feb.	50	70,885	523,715	36,911	312,635	521
Mar.	58	111,079	634,794	59,801	372,436	538
Apr.	60	99,377	734,171	50,863	423,299	512
May	67	51,180	785,351	29,223	452,522	571
June	79	59,666	845,017	37,660	490,182	631
July	81	58,670	903,687	53,078	543,260	926

* Gas production was estimated for producing oil wells which did not show a gas volume in the report.
** New Mexico Oil and Gas Engineering Committee Monthly Engineering Reports.

SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO. 9 CASE NO. 1308

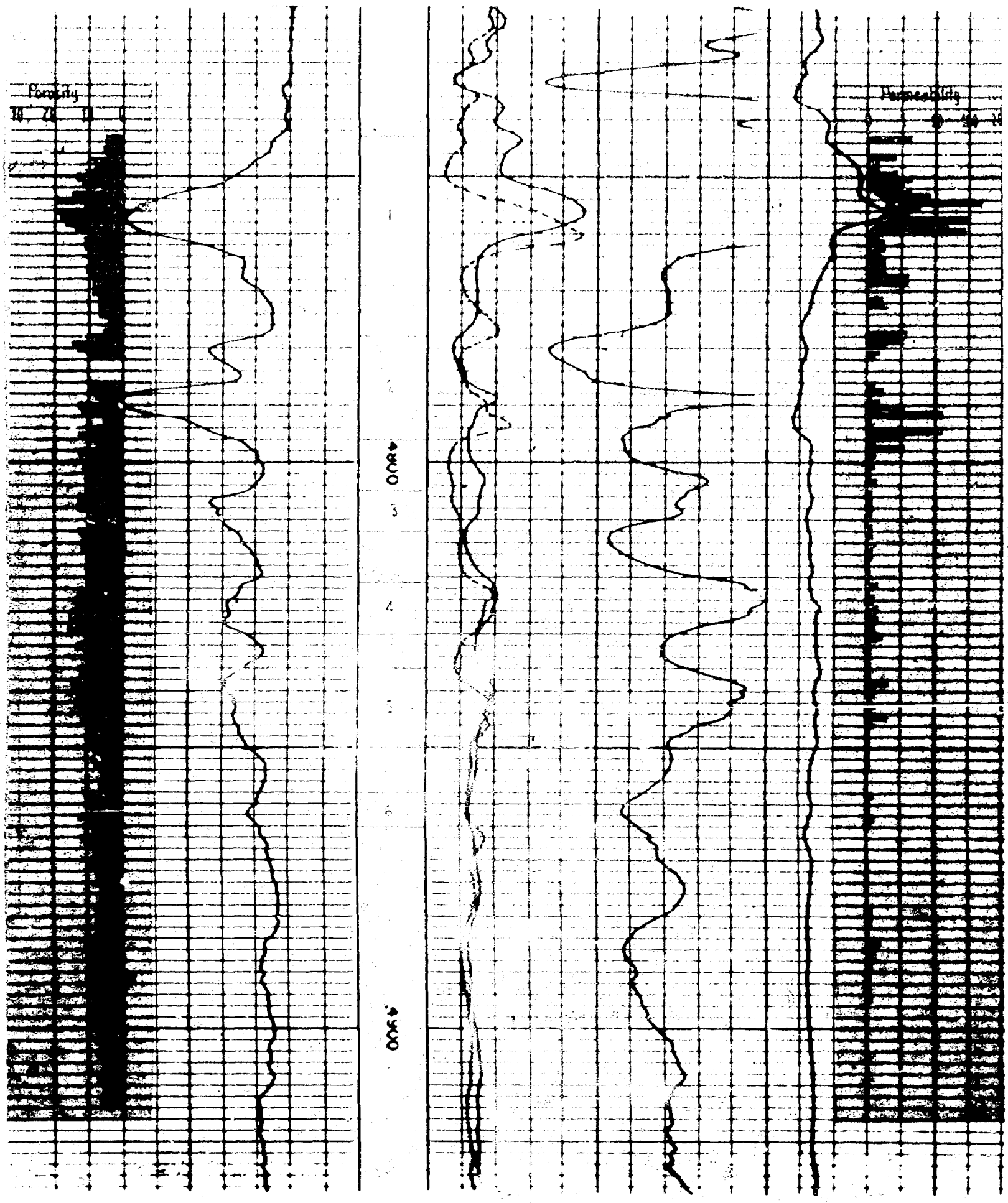

PRODUCED GAS OIL RATIO
Cu Ft Per Bbl
1500
1000
500
0
GAS PRODUCTION Million Cu Ft Per Month
OIL PRODUCTION 1000 Bbls Per Month
110
100
90
80
70
60
50
40
30
20
10
0
Produced Oil
Produced Gas
1955
1956
1957
1958
1959
PRODUCTION STATISTICS
BISTI, LOWER GALLUP OIL POOL
San Juan Co., New Mexico
SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO. 10 CASE NO. 1308

Phillips Petroleum Company
Benally #2
Section 5-25N-12W

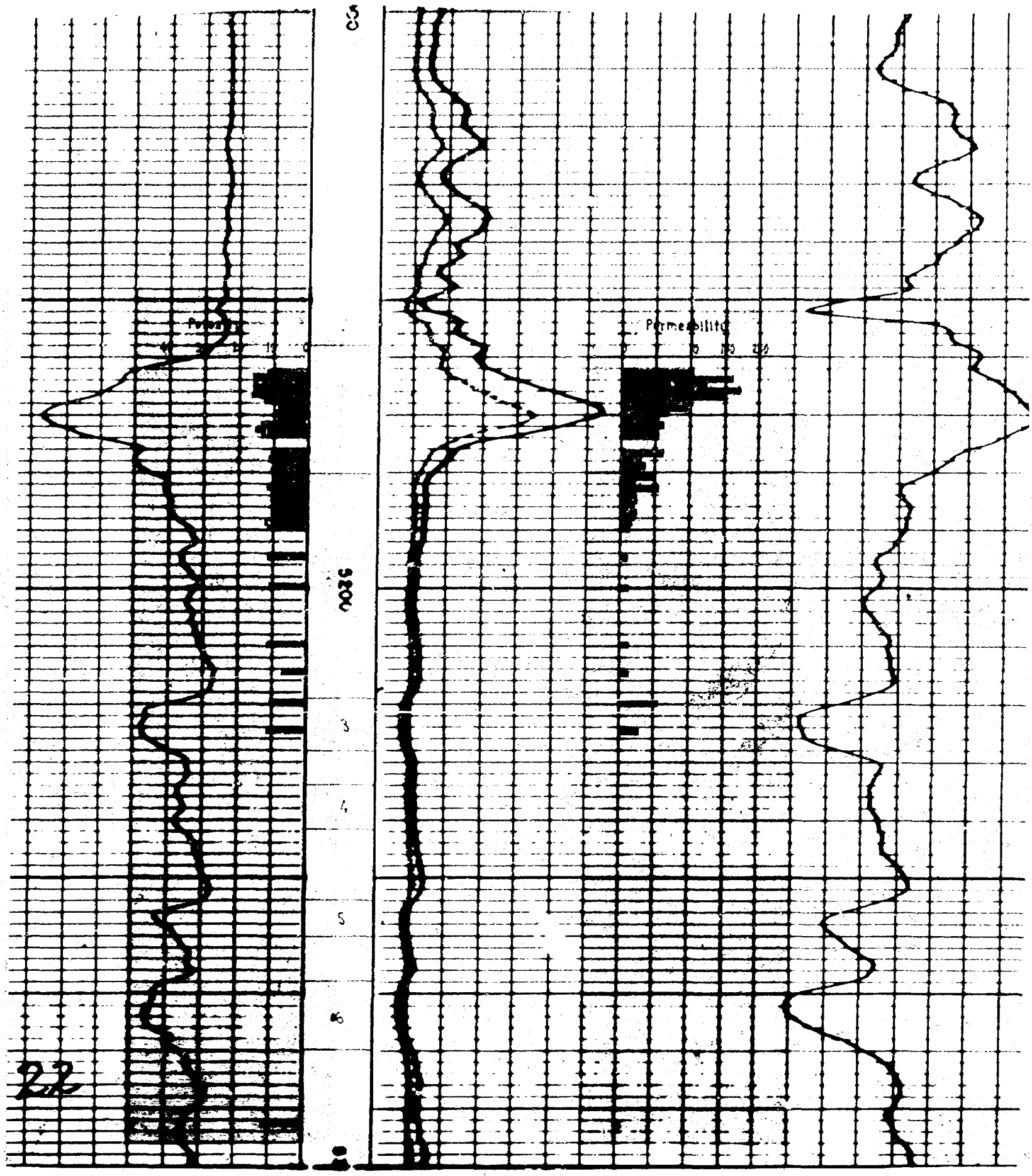


SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO. // CASE NO. 1308

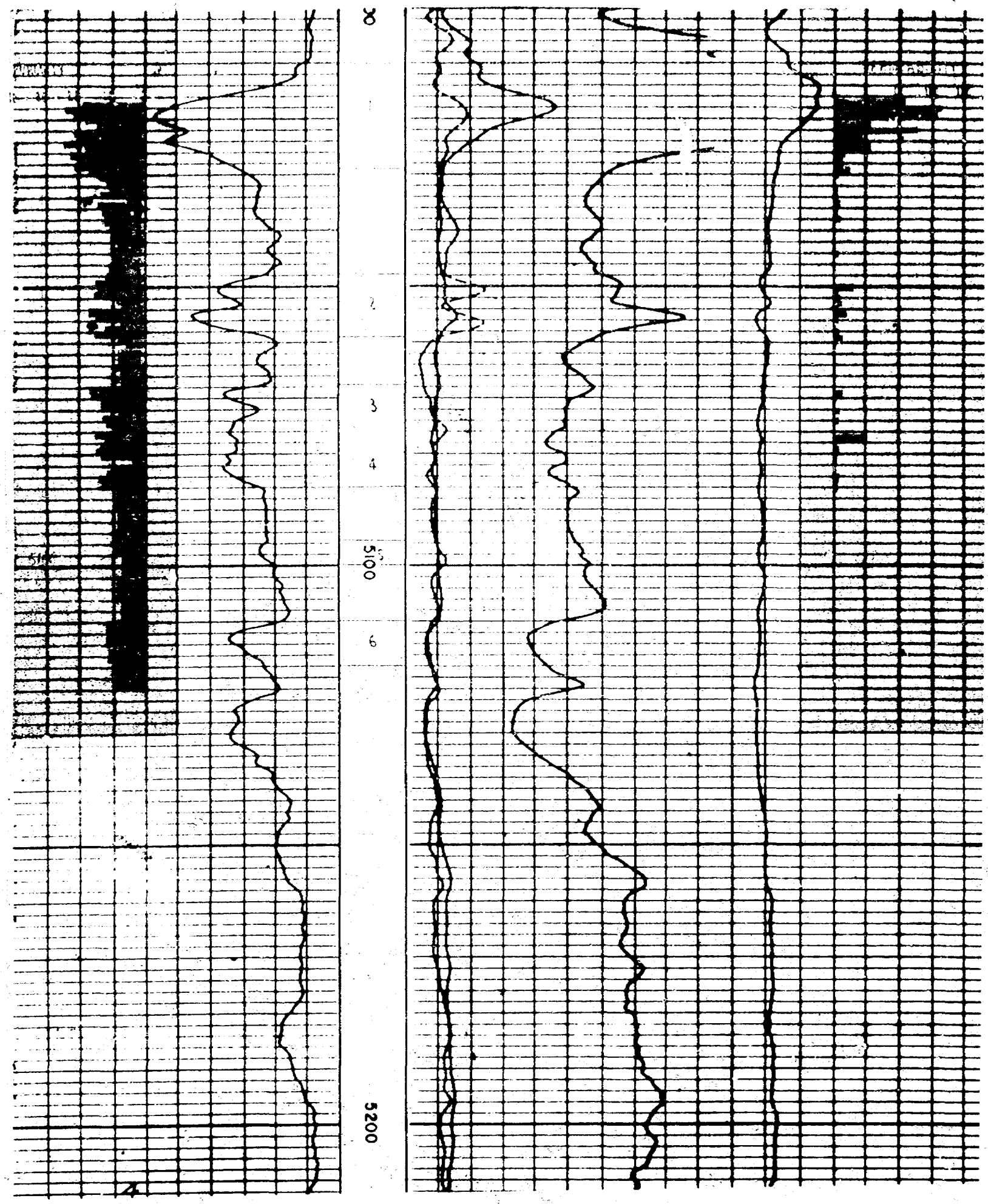
Amerada Petroleum Corporation
Joan White #2
Section 9-25N-12W



British-American Oil Prod. Co.
Douthit #11
Section 29-26N-13W

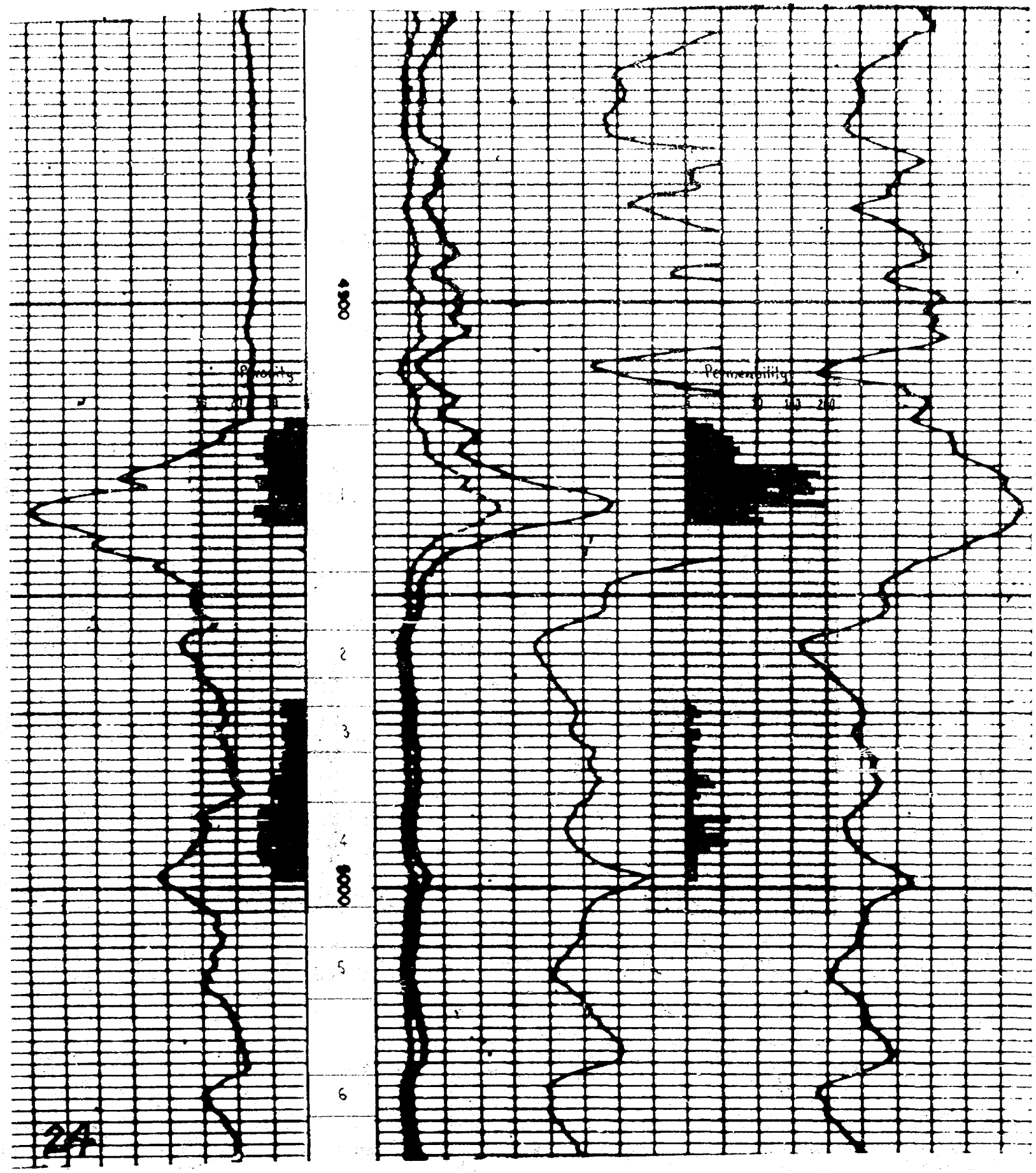


British-American Oil Prod. Co.
Douthit B-#2
Section 28-26N-13W

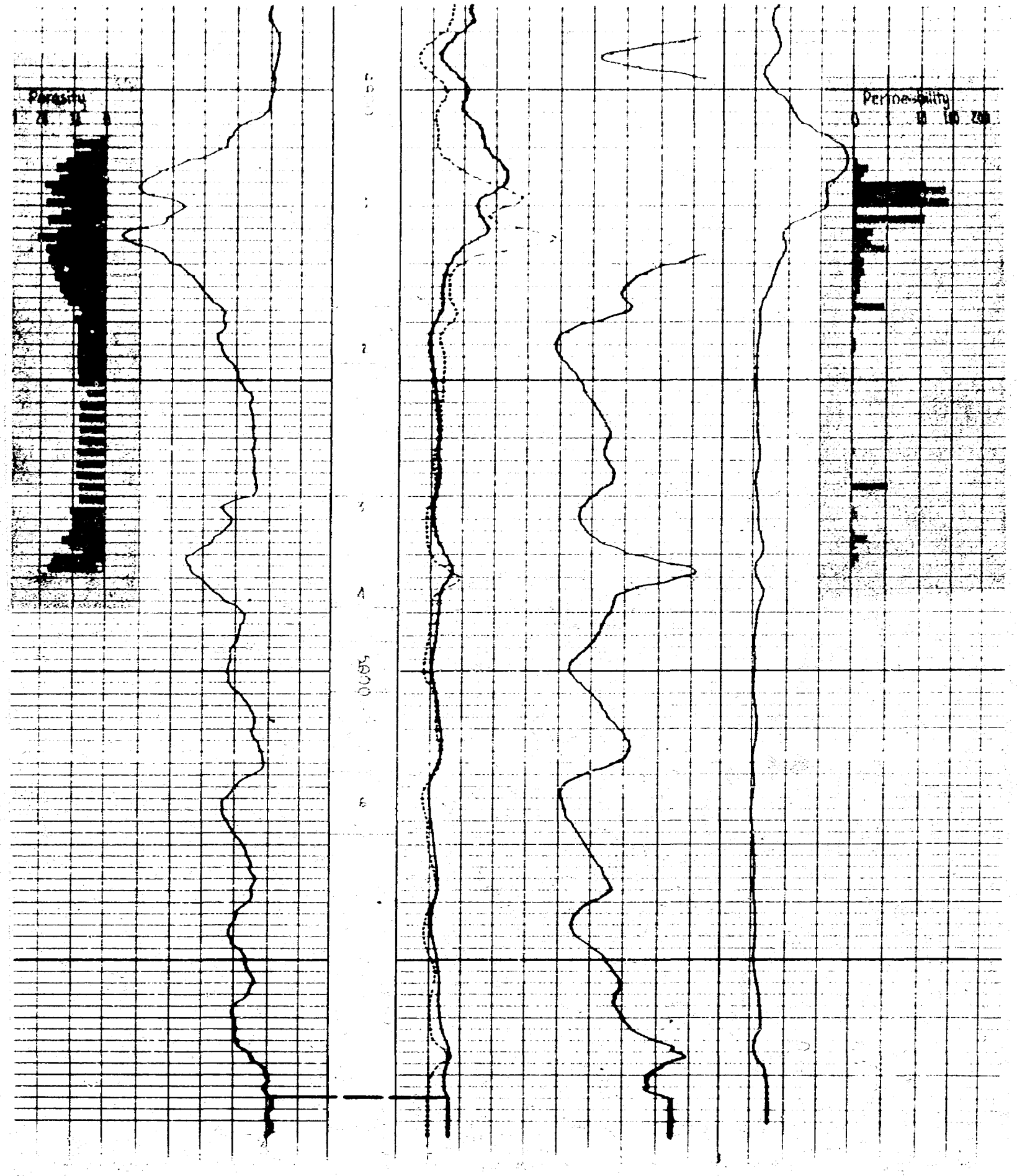


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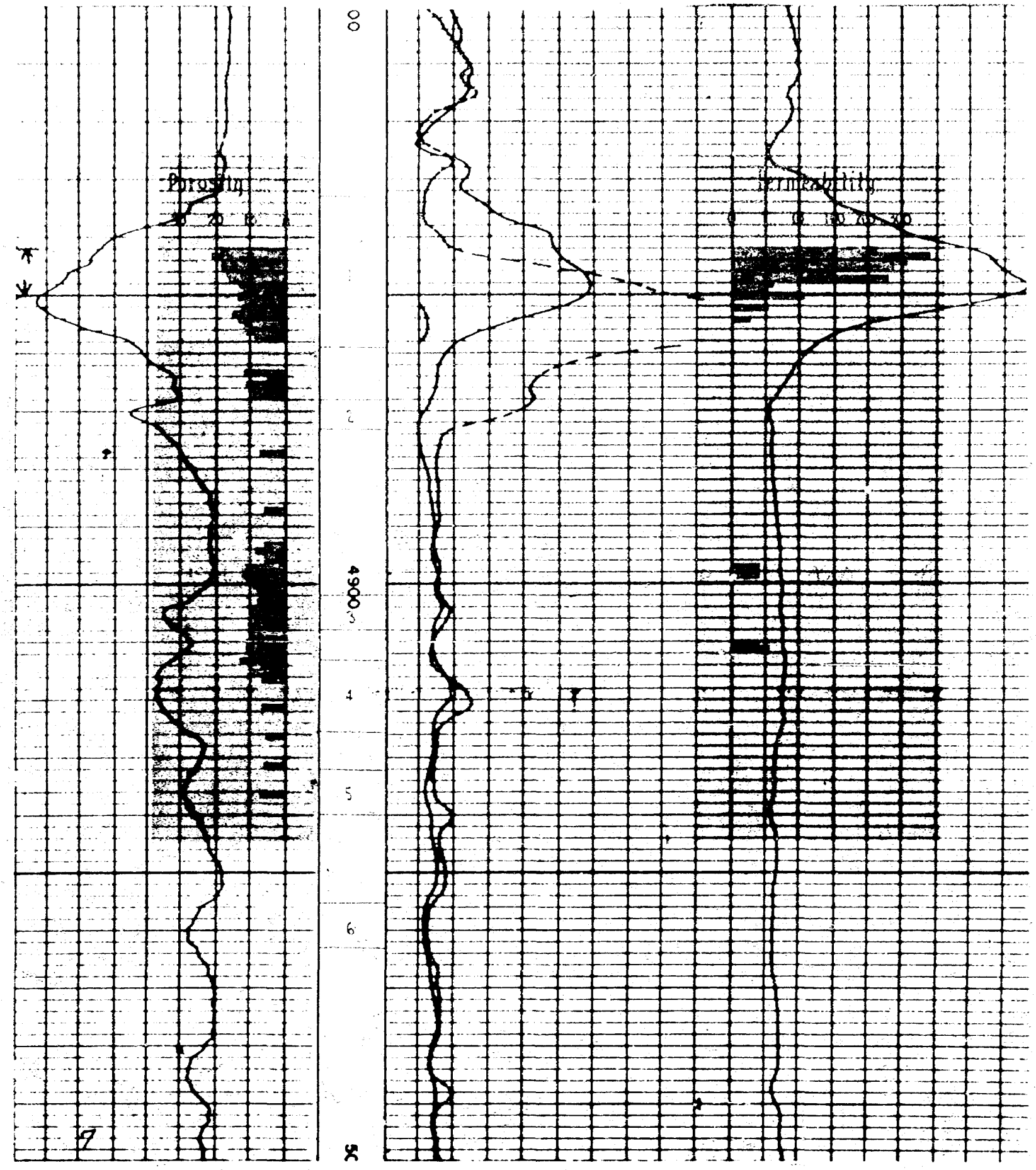
British-American Oil Producing Company
Mayre B-5
Section 35-26N-13W



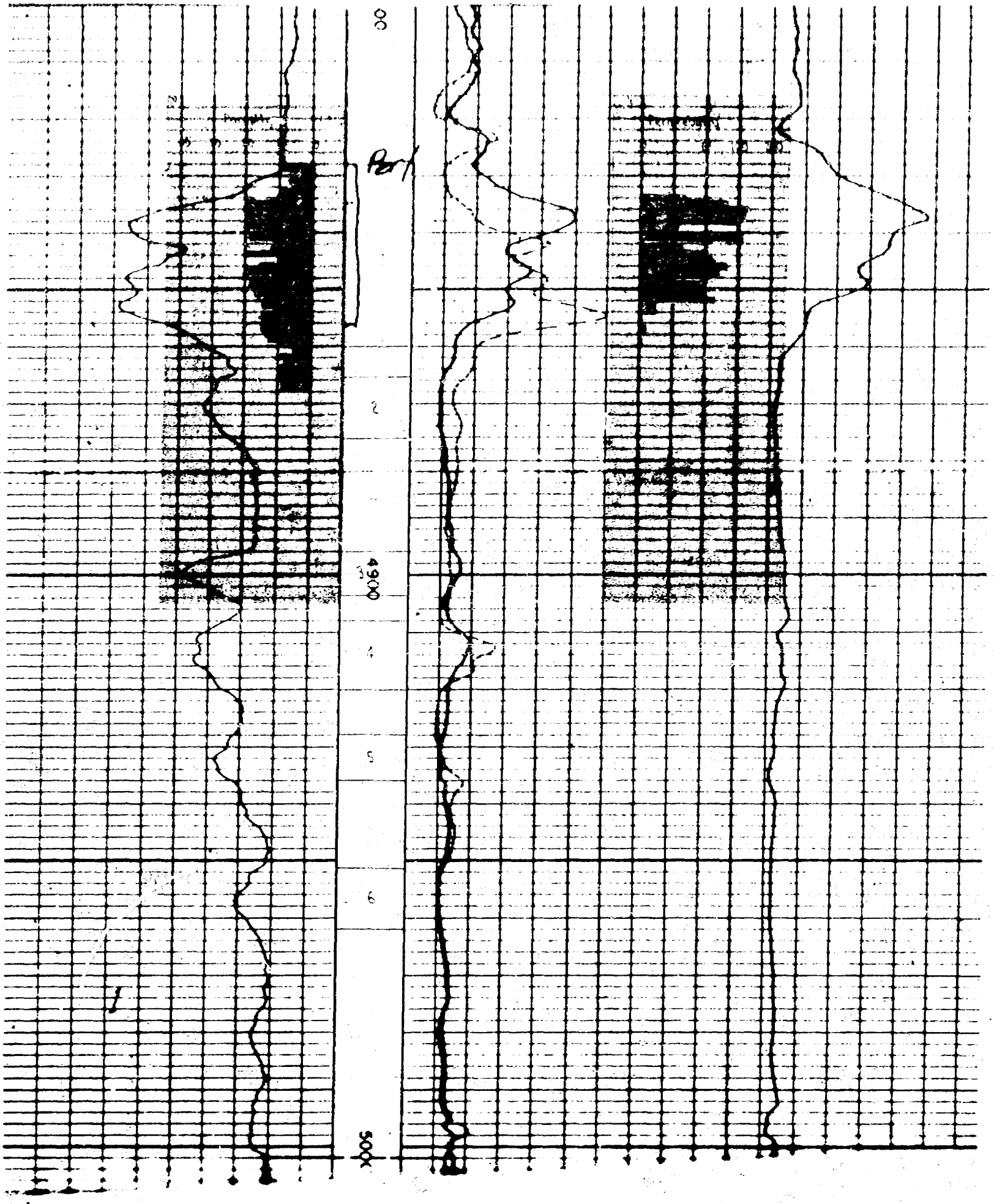
British American Oil Producing Company
Maryo B-1
Section 35-26N-13W



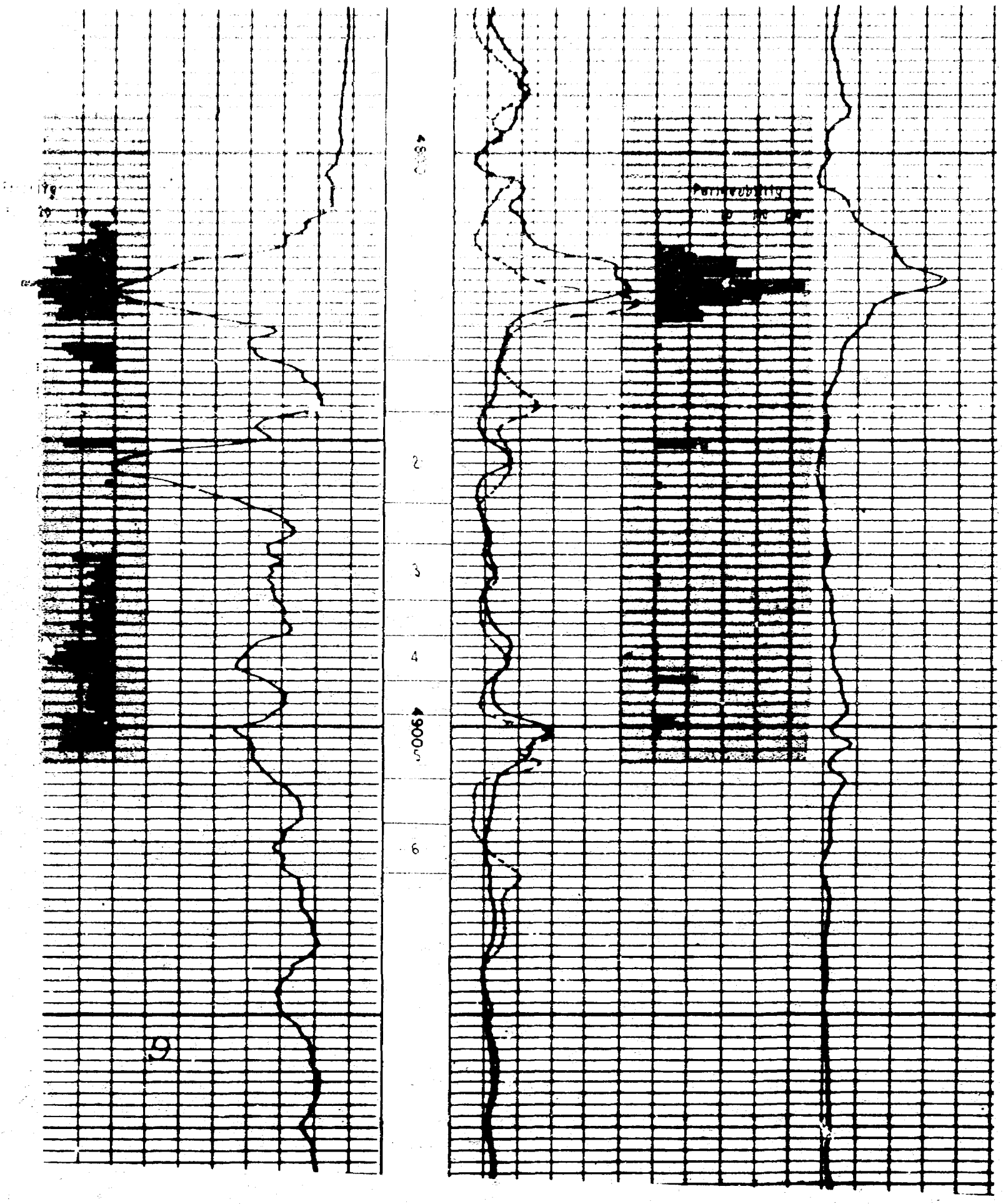
British-American Oil Producing Company
Mayre #1
Section 1-25N-13W



Sunray Mid-Continent Oil Company
Federal C-#1
Section 6-25N-12W

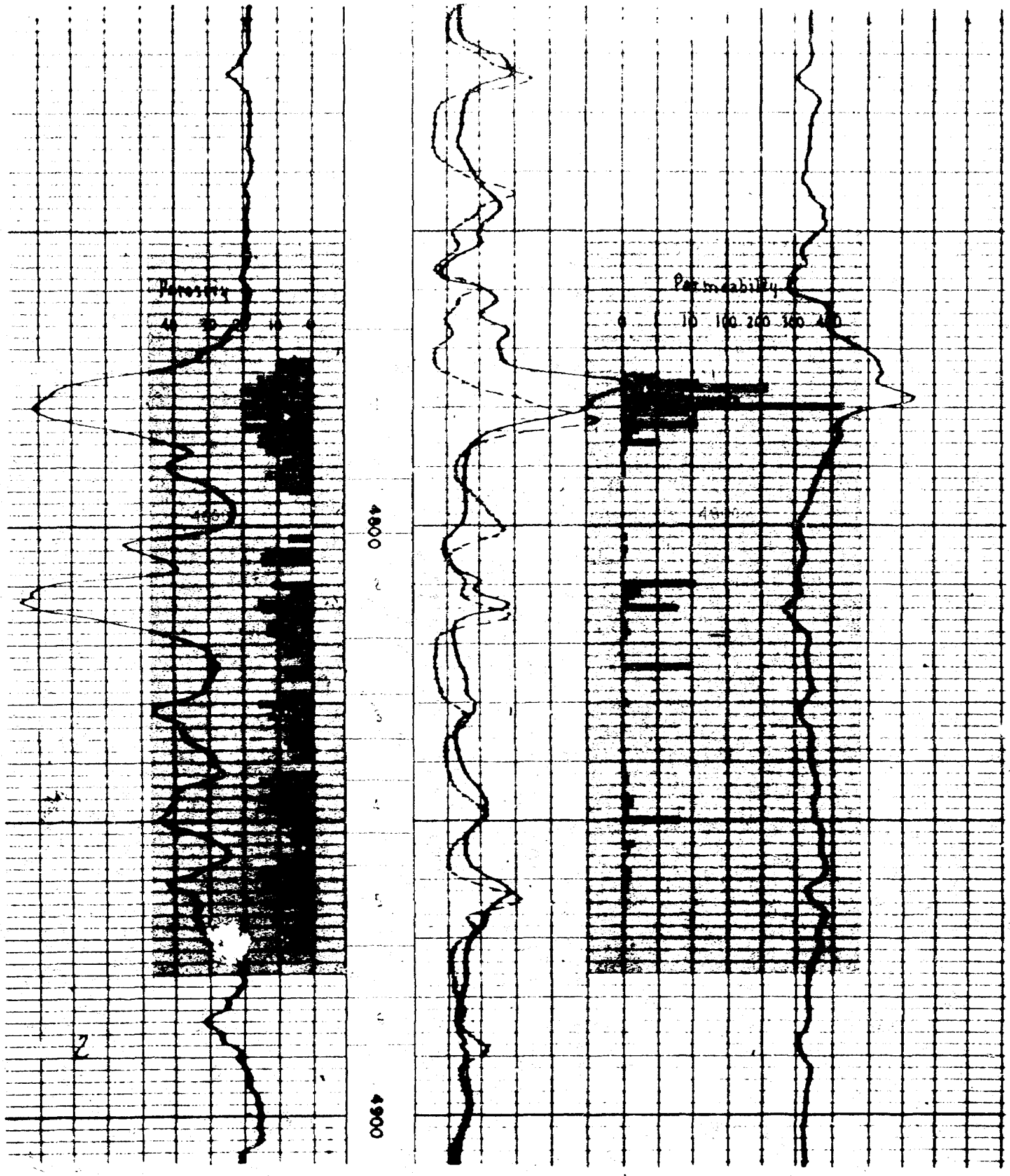


Sunray Mid-Continent Oil Company
Federal C-10
Section 6-25N-12W

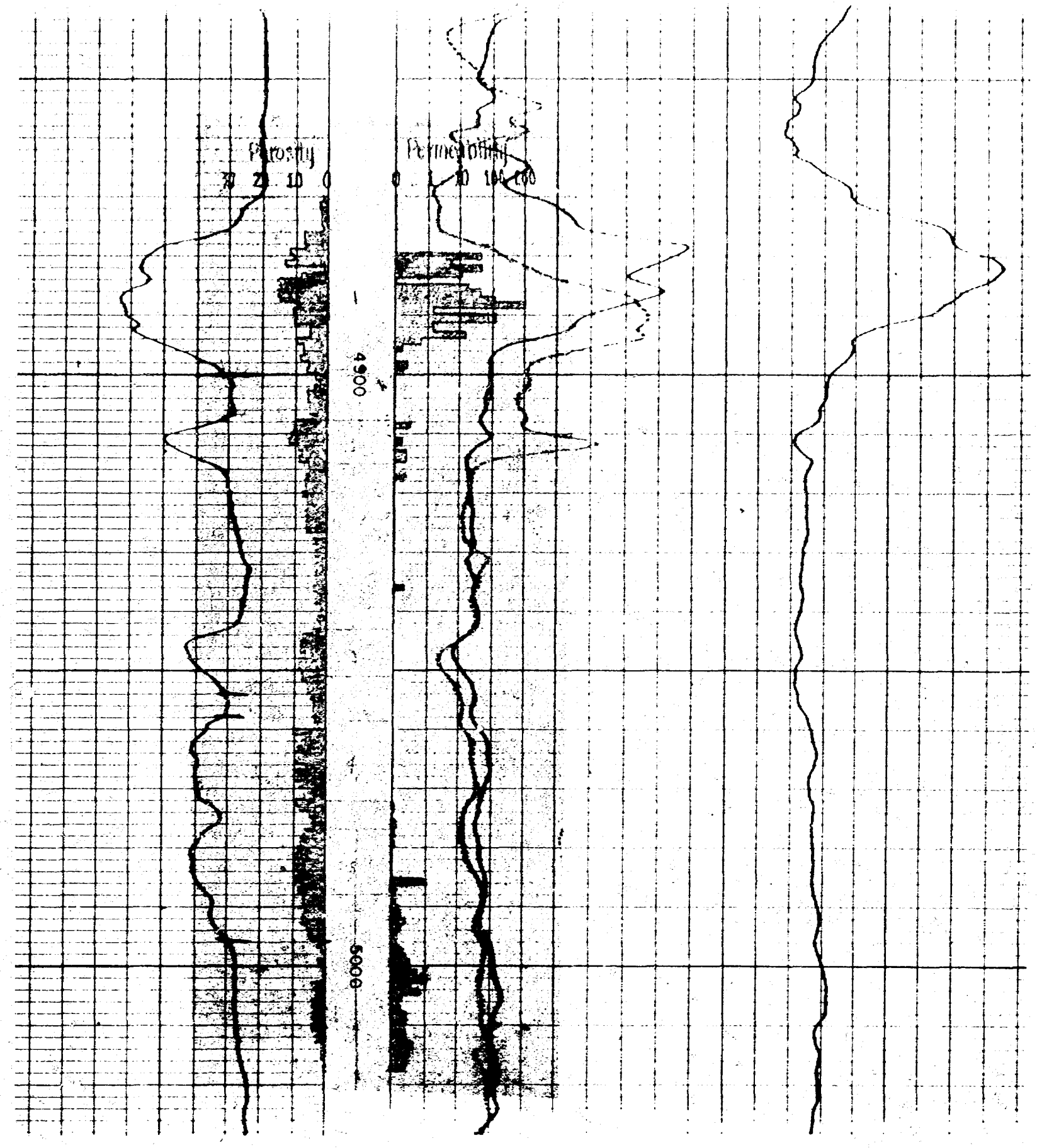


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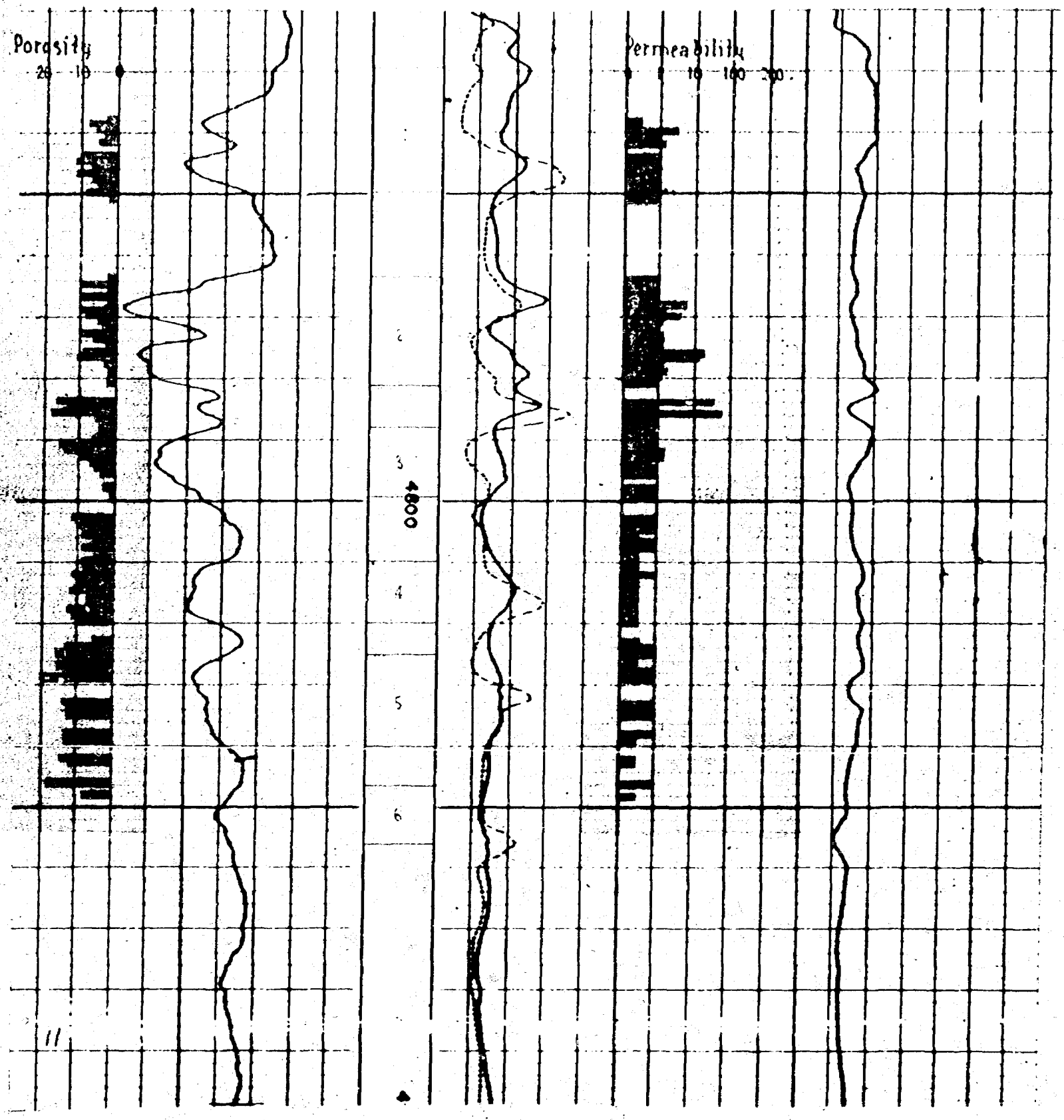
Sunray Mid-Continent Oil Company
Federal C-#1
Section 3-29N-12W



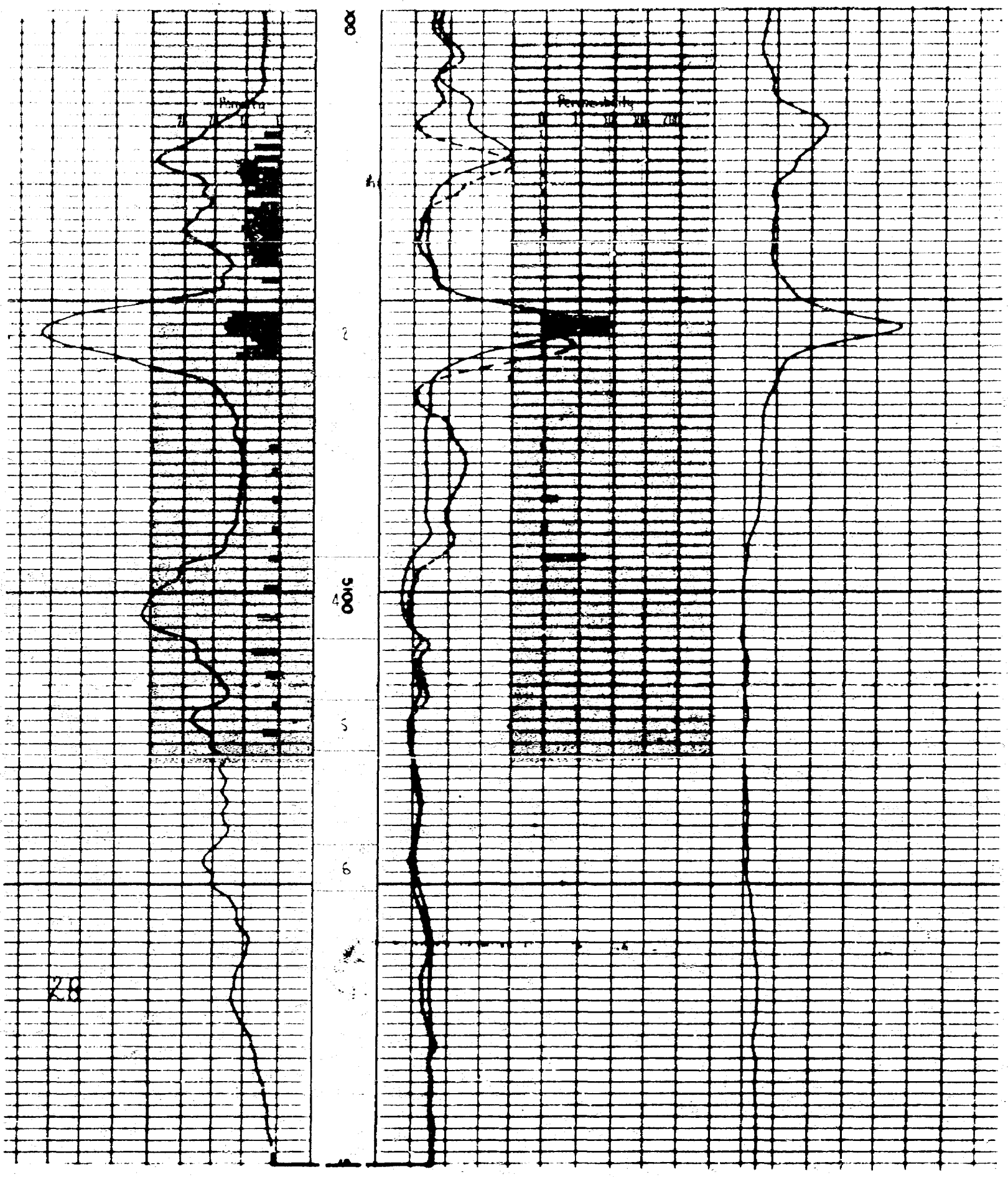
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Carson #1
Section 24-25N-12W



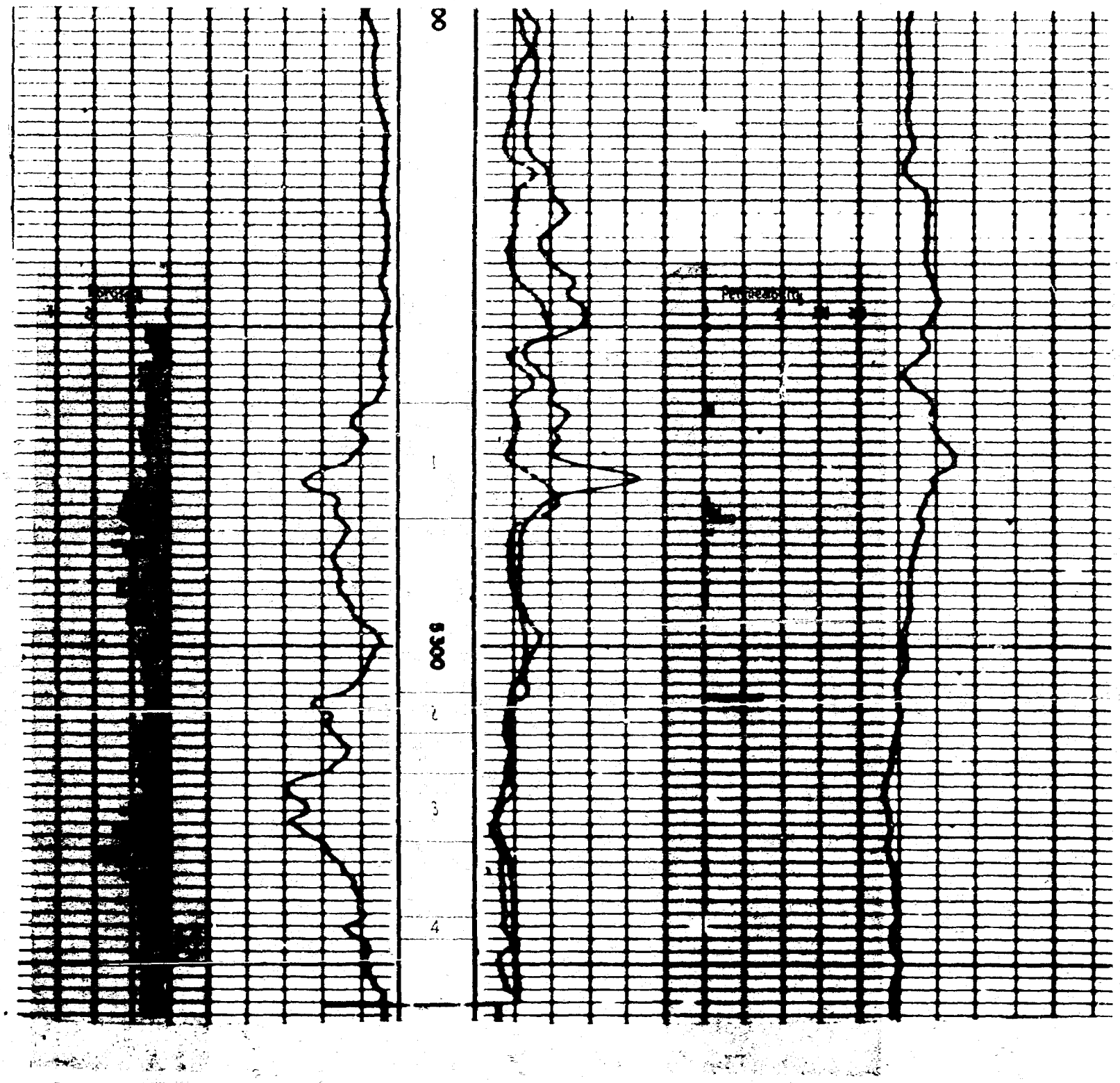
El Paso Natural Gas Products Company
Kelly State #1
Section 16-25N-12W



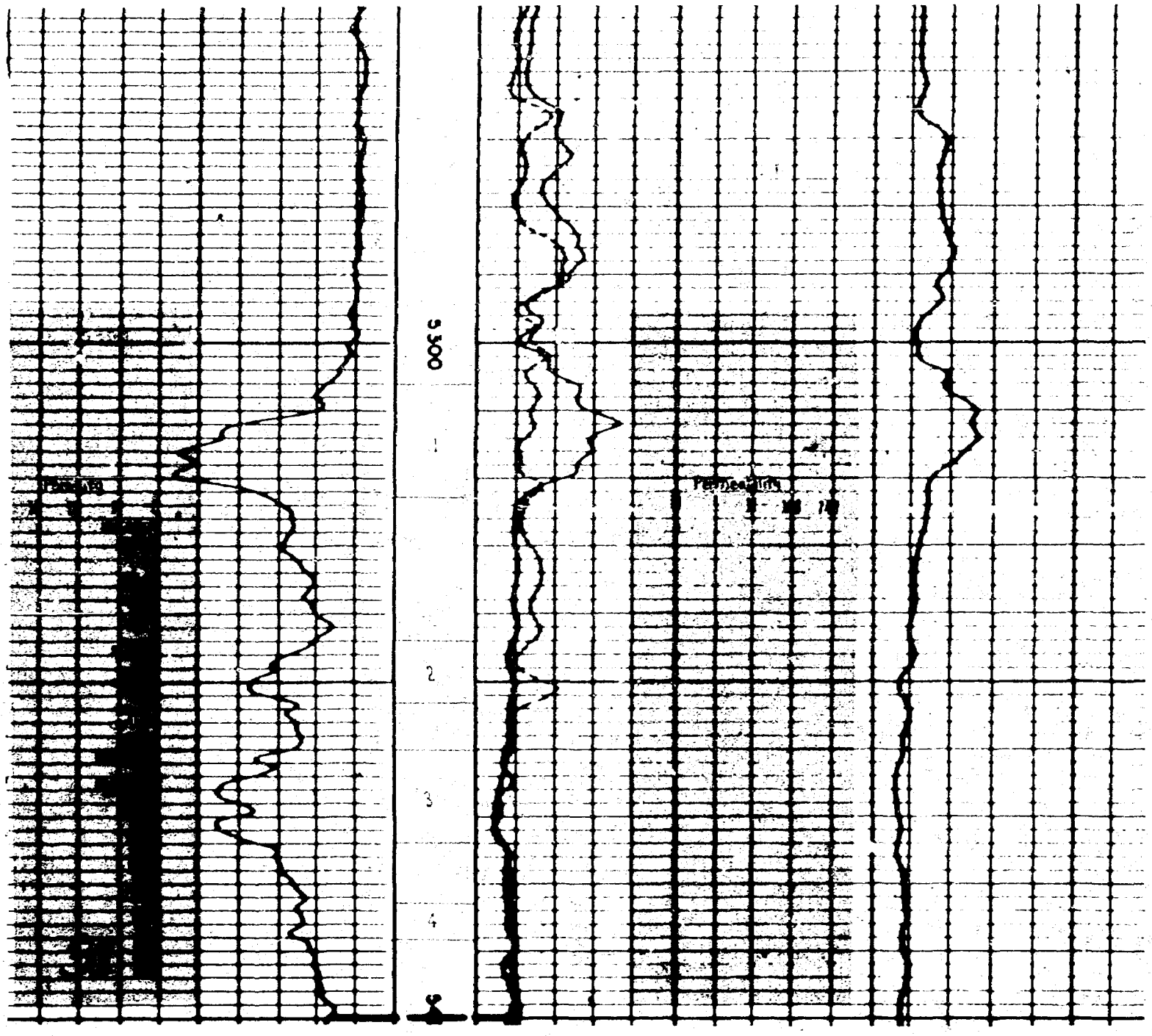
Anderson Prichard
Harold Bagey #1
Section 25-25N-11W



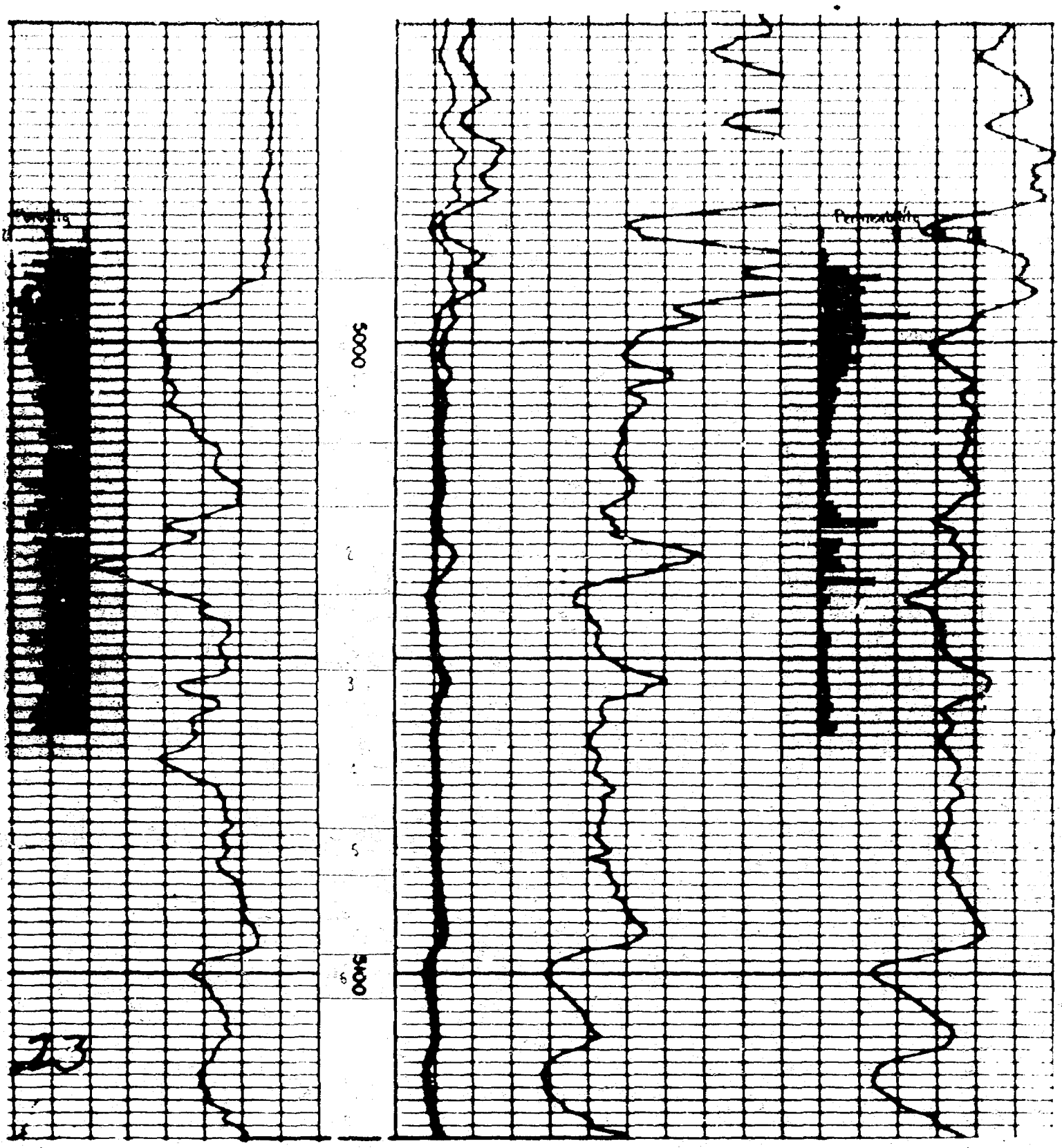
C.M.&W. Drilling Company Inc.
Elliott #2
Section 30-26N-13W



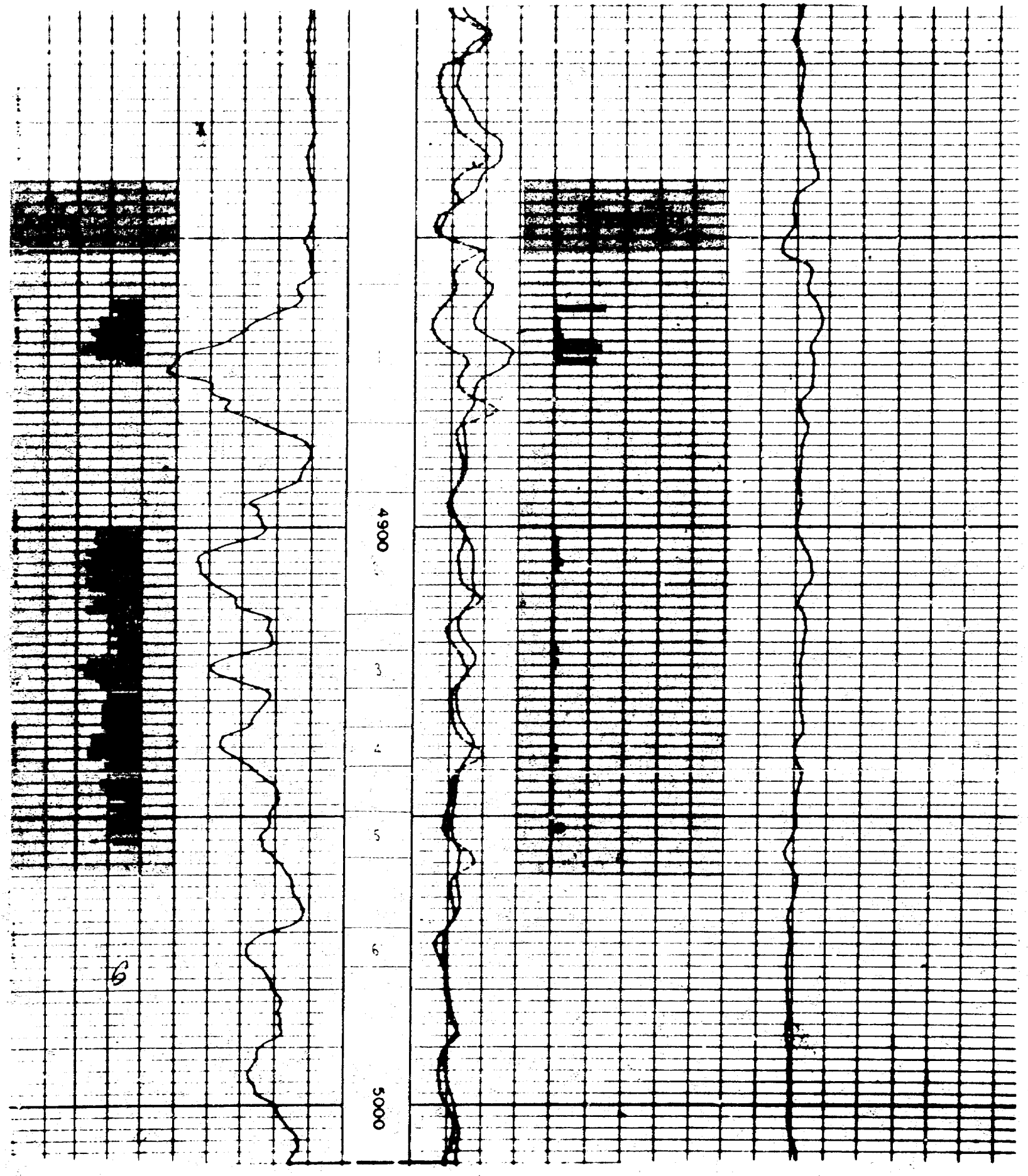
C.M.&W. Drilling Company, Inc.
Elliott #1
Section 30-26N-13W



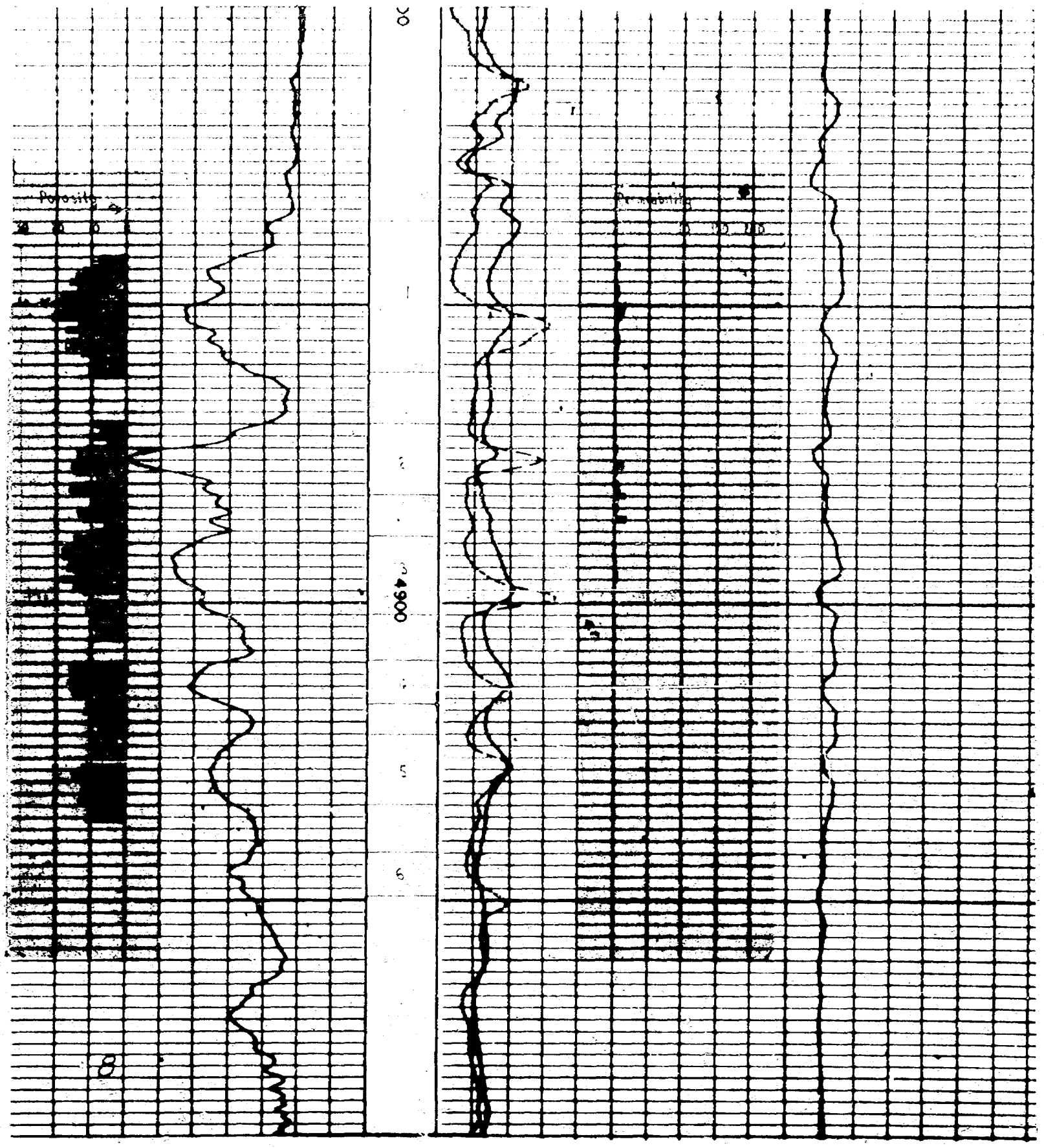
British-American Oil Prod. Co.
Salge B-5
Section 33-26N-13W



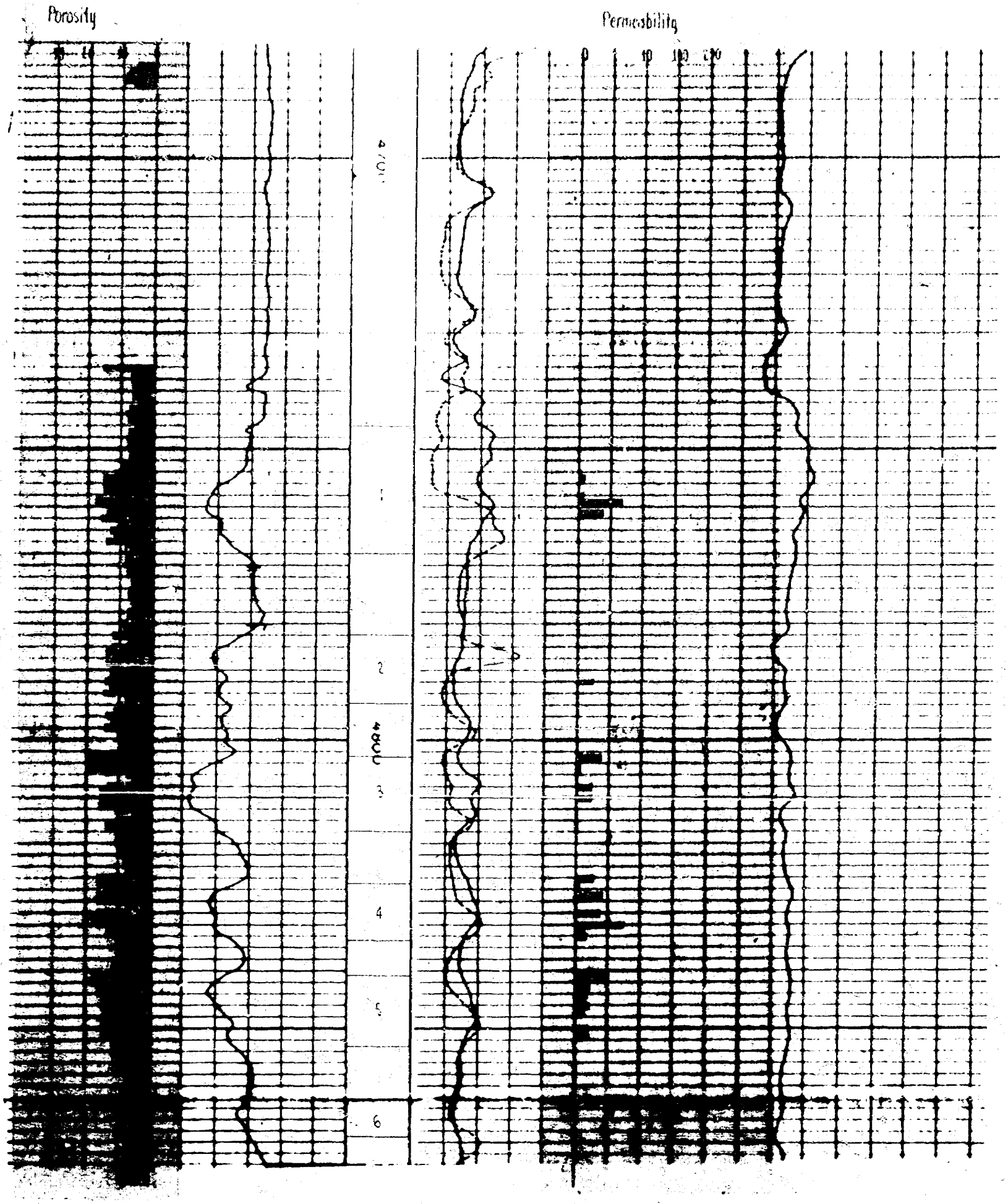
El Paso Natural Gas Products Company
Kelly State #11
Section 2-25N-13W



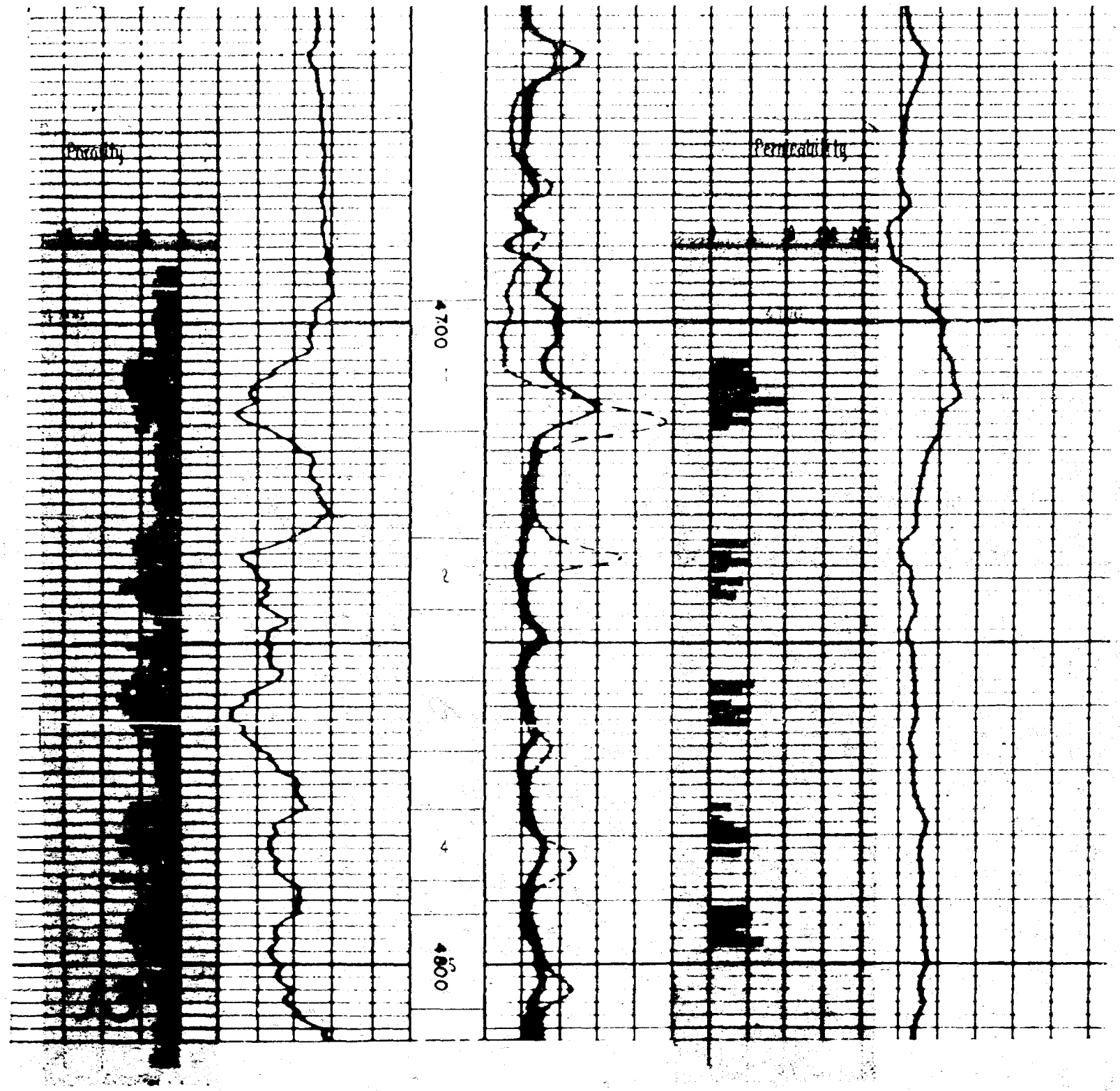
Sunray Mid-Continent Oil Company
Federal C-18
Sc[illegible]on 7-25N-12W



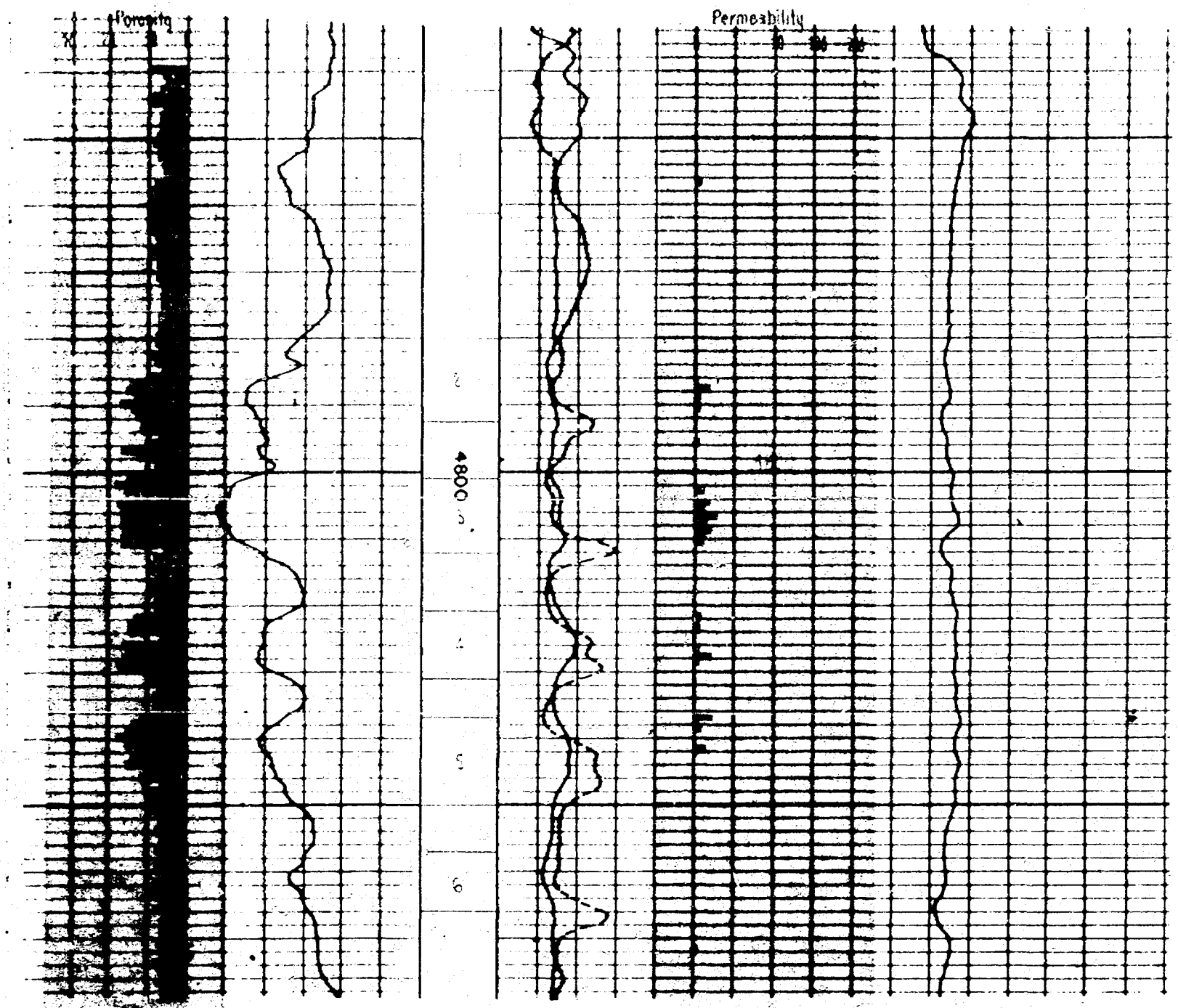
El Paso Natural Gas Products Company
Kelly State #2
Section 16-25N-12W

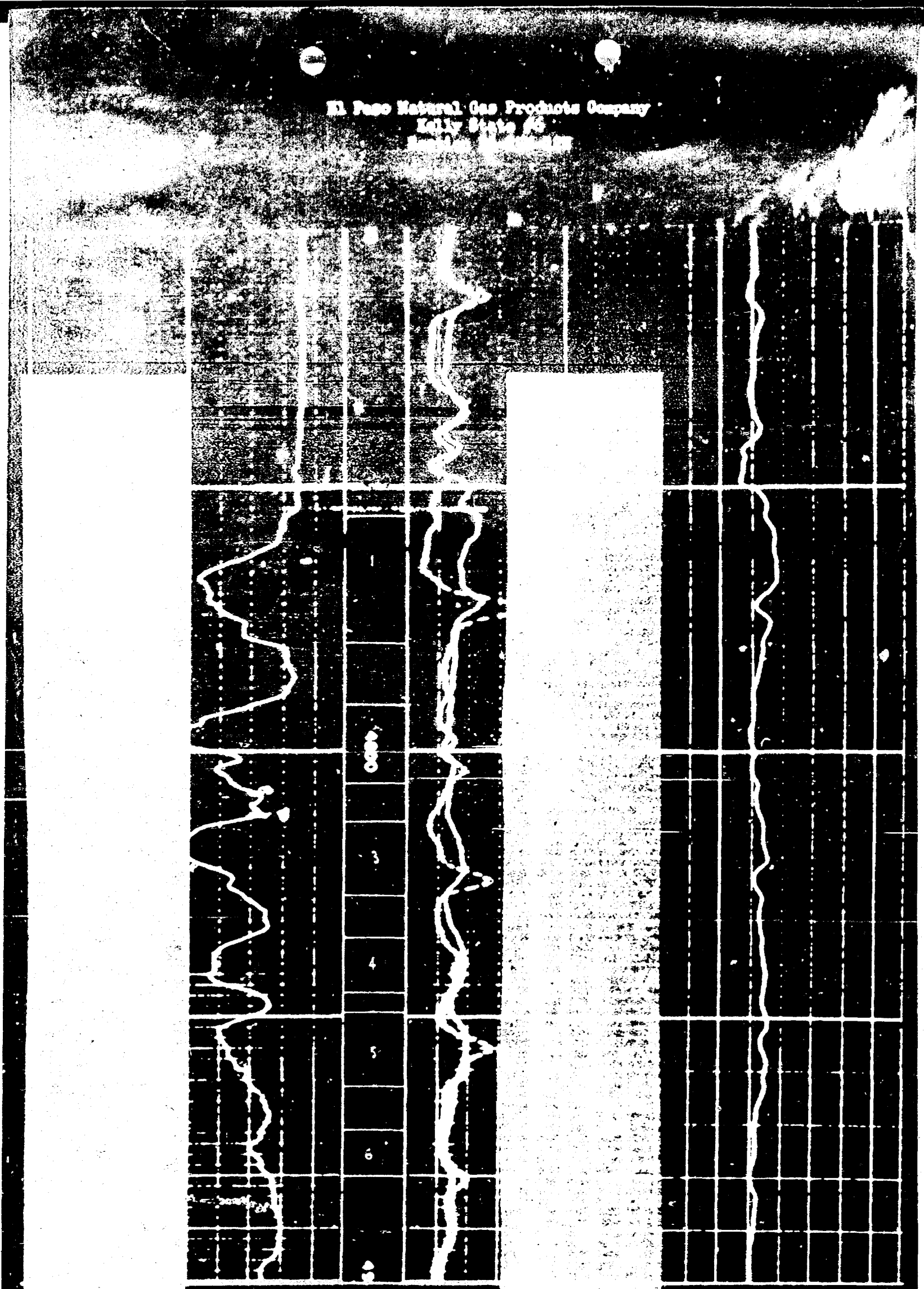


El Paso Natural Gas Products Company
Kelly State #3
Section 16-25N-12W



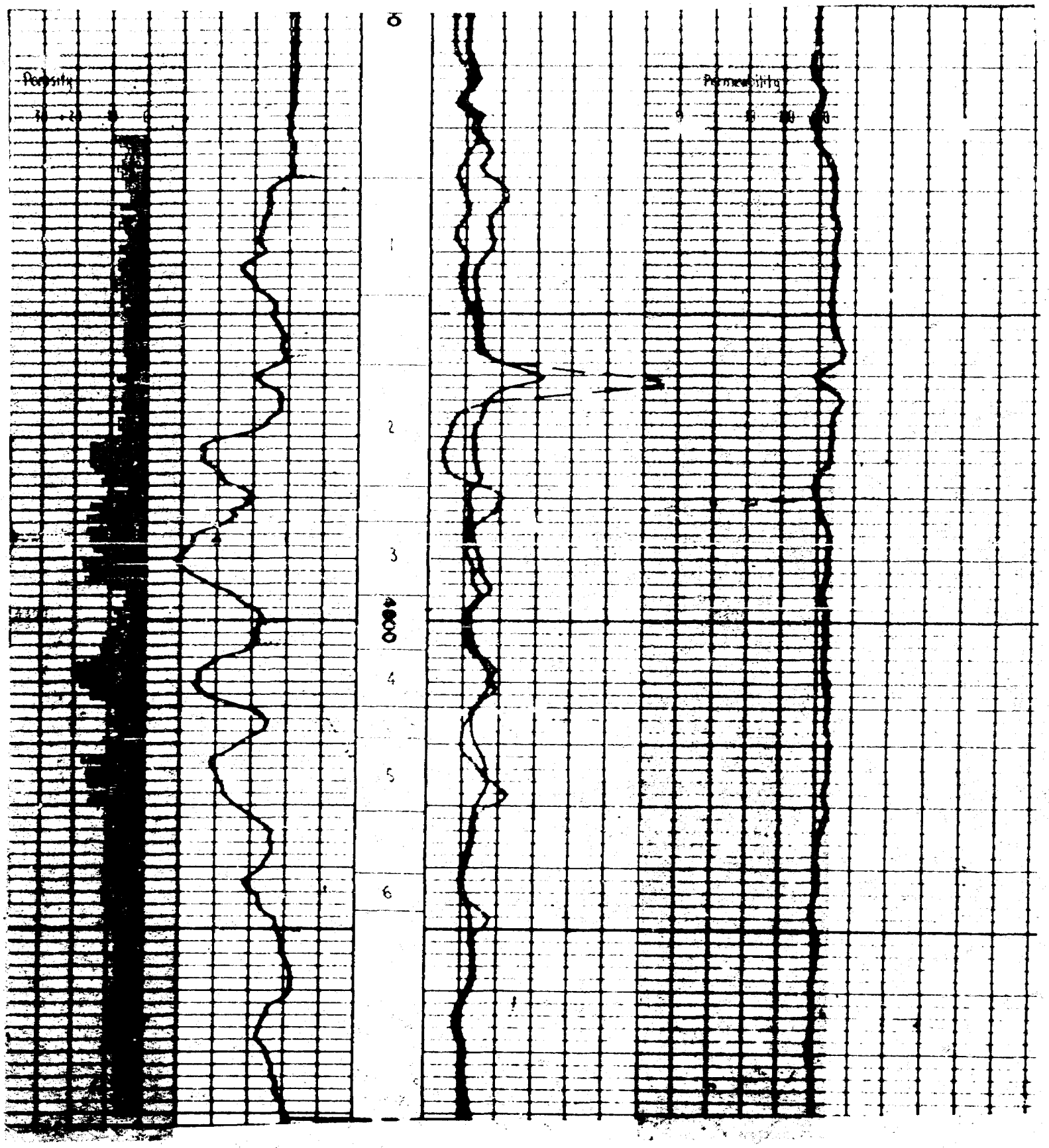
El Paso Natural Gas Products Company
Kelly State #4
Section 16-25N-12W



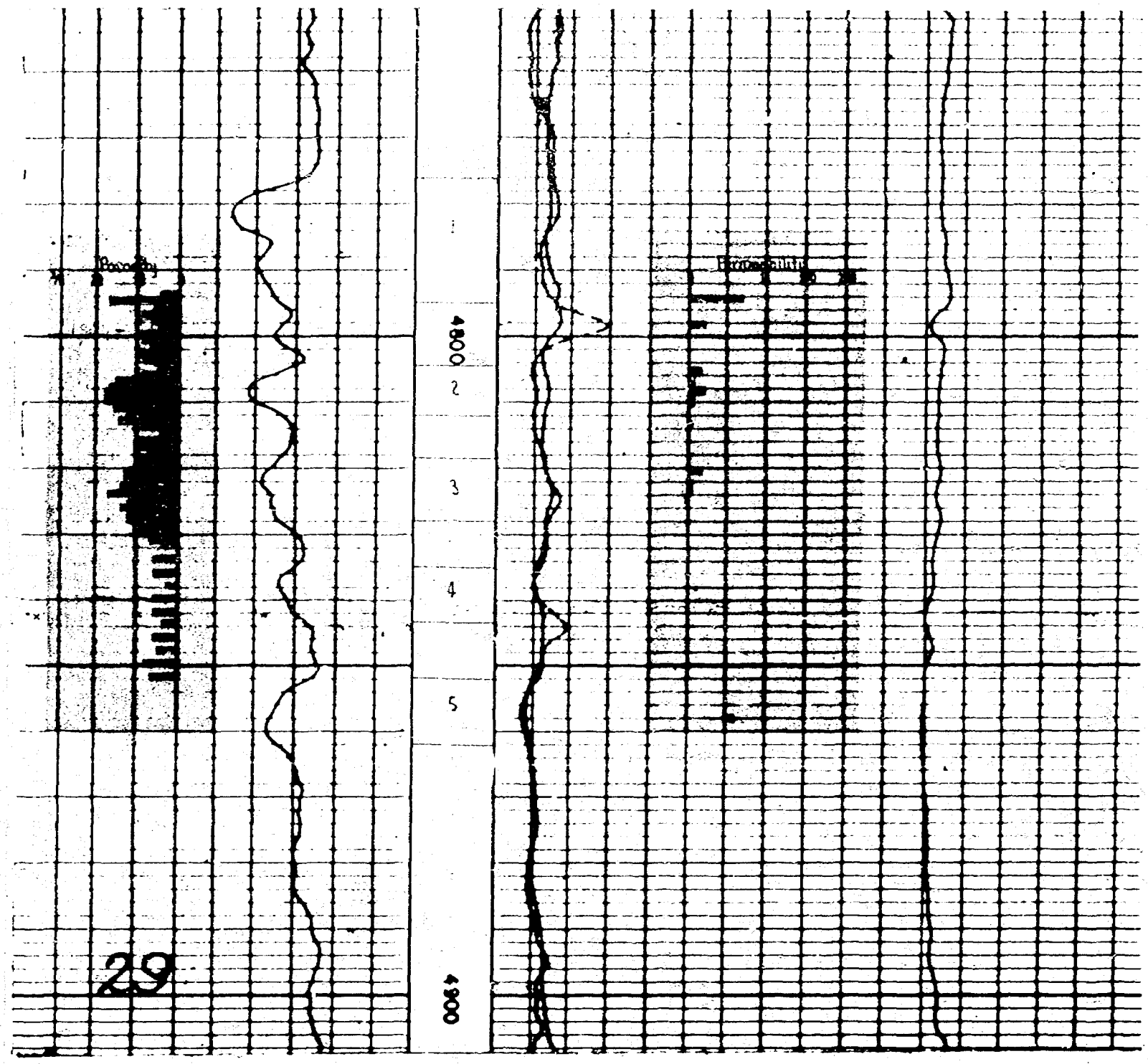


SUNRAY MID-CONTINENT OIL COMPANY
EXHIBIT NO:_____ CASE NO. 1308

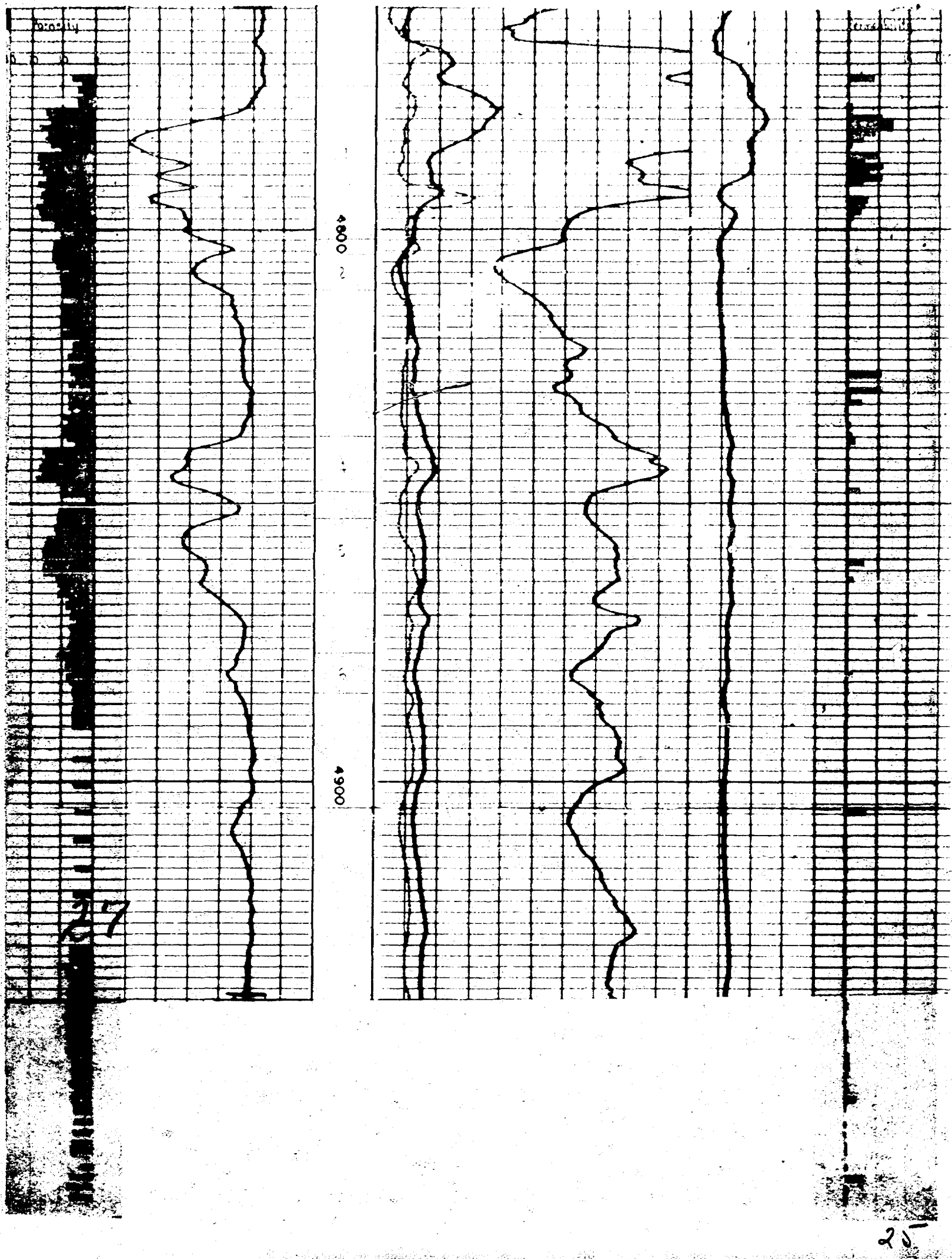
El Paso Natural Gas Products Company
Kelly State #7
Section 16-25N-12W



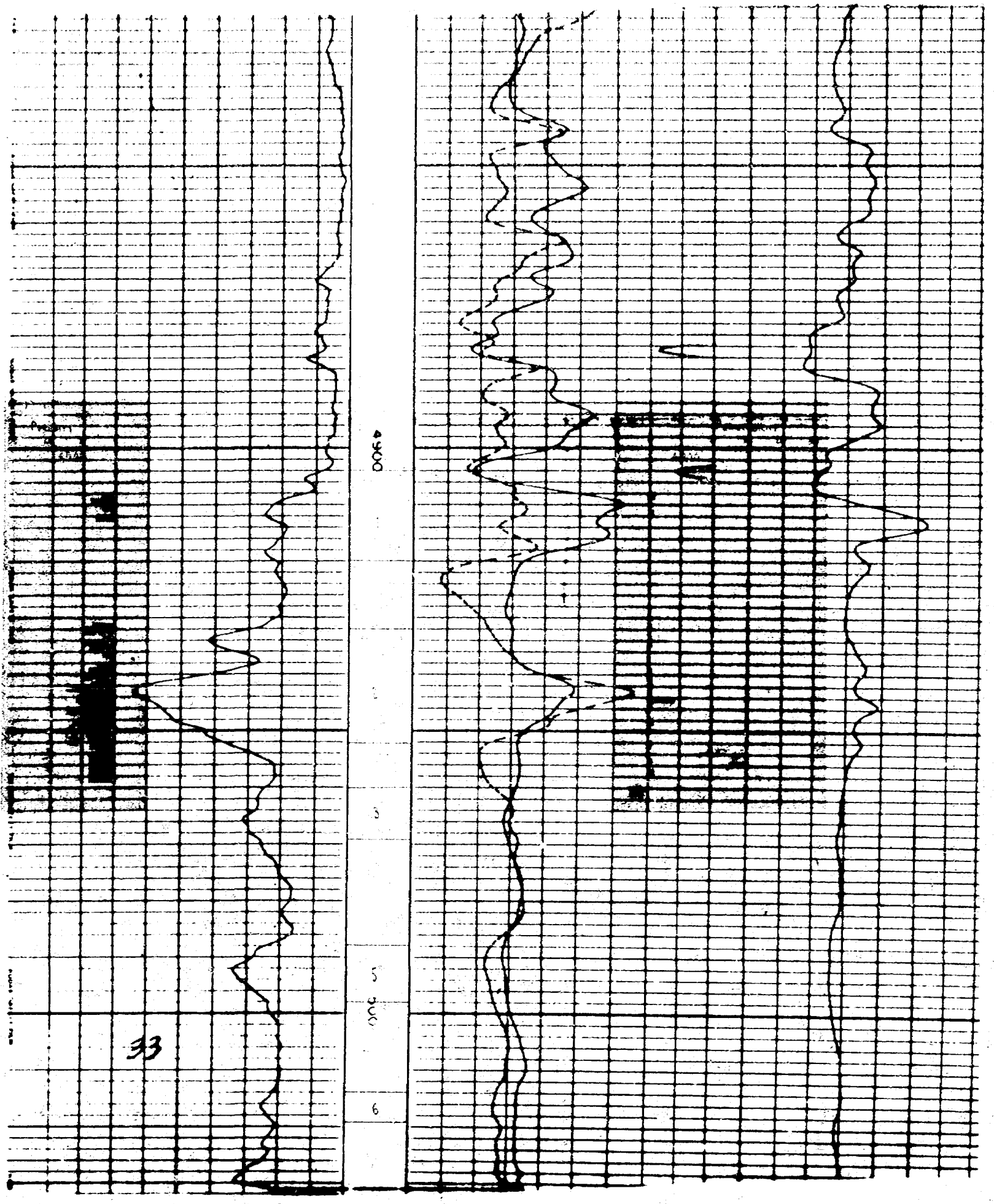
F. R. Anderson Petroleum Company
Federal 21-29
Section 29-25N-12W



Amerada Petroleum Corporation
Ole-Na-Hup-Poh #2
Section 5-25N-12W



El Paso Natural Gas Products Company
Sullivan #1-B
Section 30-26N-12W



BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

September 19 and 20, 1957

TRANSCRIPT OF HEARING

Case 1308

VOLUME I

DEARNLEY - MEIER & ASSOCIATES
INCORPORATED
GENERAL LAW REPORTERS
ALBUQUERQUE - SANTE FE
3-6691 2-2211

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

September 19 and 20, 1957

IN THE MATTER OF: Case 1308

Application of Sunray Mid-Continent Oil Company for an Order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, and temporarily establishing uniform 80-acre well spacing and promulgating special rules and regulations for said pool. Applicant, in the above-styled cause, seeks an order extending the Bisti-Lower Gallup Oil Pool to include:

TOWNSHIP 24 NORTH, RANGE 10 WEST
All Sections 2 & 3
Section 4: S/2

TOWNSHIP 25 NORTH, RANGE 10 WEST
All Sections 19, 26, 27, & 28
Section 31: S/2
All Section 35

TOWNSHIP 25 NORTH, RANGE 11 WEST
All Sections 7, 13, 14, & 15
Section 16: N/2
All Section 24
Section 27: SW/4
All Sections 28, 29, 30, 35, & 36

TOWNSHIP 25 NORTH, RANGE 12 WEST
All Section 3
Section 4: N/2
Section 5: NE/4
Section 7: SW/4
Section 10: E/2
All Sections 11 & 12
Section 17: SW/4
All Section 18
Section 25: S/2

TOWNSHIP 25, NORTH, RANGE 13 WEST
Section 1: SW/4
All Section 2
Section 3: S/2 & NE/4
All Sections 4 & 11
Section 12: S/2 & NW/4

TOWNSHIP 26 NORTH, RANGE 12 WEST
Section 31: N/2
All Section 32

TOWNSHIP 26 NORTH. RANGE 13 WEST
Section 26: N/2
Section 29: S/2, NW/4 & W/2 NE/4
All Sections 30, 31, & 32
Section 36: NE/4

The applicant further seeks the establishment of temporary 80-acre well spacing in the Bisti-Lower Gallup Oil Pool with units to run either North and South or East and West and with well locations on diagonal quarter-quarter sections within a governmental quarter section; and further, for the promulgation of special rules and regulations for the said Bisti-Lower Gallup Oil Pool, including but not limited to, the taking and reporting of gas-oil ratio and bottom hole pressure tests.

BEFORE:

Mr. A. L. Porter
Mr. Murray Morgan
Honorable Edwin L. Mechem

TRANSCRIPT OF HEARING

MR. PORTER: The hearing will come to order. The Commission will consider next Case 1308.

MR. COOLEY: Application of Sunray Mid-Continent Oil Company for an order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, and temporarily establishing uniform 80-acre well spacing and promulgating

special rules and regulations for said pool.

MR. CAMPBELL: If the Commission please, I am J. M. Campbell, Campbell and Russell, Roswell, New Mexico, appearing on behalf of the applicant. I would like to enter an appearance also for L. C. White; Gilbert, White and Gilbert, and for Mr. Burns Errebo, Tulsa, Oklahoma, attorneys for the applicant.

With the permission of the Commission, I would like to make a brief statement of the position of the applicant in this particular case. Most of the spacing cases of this nature which this Commission has heard in the past have involved deep reservoirs with effective water drive mechanism. The testimony here will show that in this particular reservoir, which is approximately 5,000 feet, there is a solution gas drive. There is another element present in this case, which to my knowledge, has not been present in any other spacing case before this Commission. A few weeks ago, months ago, this Commission entered its order authorizing a pilot pressure maintenance program in the Bisti-Lower Gallup Pool. This project, of which the applicant is operator, is now in operation. It is the primary position of the applicant here that in order to effectively develop that program of pressure maintenance and obtain the greatest ultimate recovery of oil from this reservoir, that the spacing which has been developed to date on a general 80-acre density should not at this time, at least, be disturbed, and to disturb might injuriously affect the operation of this effort

at pressure maintenance, which applicant's information indicates, and as will be presented in the evidence, is the only method by which a reasonable recovery of investment can be obtained from this reservoir.

We have two witnesses which we would like to have sworn at this time, and Mr. Errebo will interrogate these witnesses on behalf of the applicant.

MR. PORTER: Mr. Cooley, will you swear the witnesses?

MR. COOLEY: Are there any other witnesses in this case? Any other testimony to be presented?

MR. SETH: If you would like to swear the witness, we would enter an appearance on behalf of Shell, Mr. Oliver Hill and Mr. Oliver Seth, Seth and Montgomery. We do have some witnesses.

MR. MALONE: Ross Malone for Gulf Oil Corporation. We would like to enter Gulf's appearance in opposition to the application and to enter the appearance of Mr. Booth Kellough, Division Attorney from Denver, in addition to Ross Malone. Both of us expect to participate in the hearing, and Mr. Willard Bauman is our witness.

MR. SULLIVAN: Just one moment. The reason I didn't rise earlier is I didn't want to interrupt. My name is R. W. Sullivan. I am a lawyer from Denver representing the British American Oil Company, and I will have two witnesses, Mr. Thomas Hogan and Mr. Stein that I ask to be sworn with the group.

MR. SELINGER: I would like the record to show that George Selinger appears for Skelly Oil Company.

MR. PORTER: No witnesses?

MR. SELINGER: Perhaps a witness.

MR. COOLEY: Would you have your witnesses stand up and be sworn.

(Witnesses sworn.)

MR. BUSHNELL: Bushnell, attorney for Amerada. I would like to enter an appearance, no witness.

MR. KELLAHIN: Jason Kellahin, appearing on behalf of the Phillips Petroleum Company. At the present time we do not contemplate having a witness.

MR. HINKLE: Clarence Hinkle of Hervey, Dow and Hinkle, and I would like to enter an appearance on behalf of Humble, although we don't expect to put on any testimony.

MR. WADE: H. N. Wade, Texas Company.

MR. LEWERS: Robert Lewers, attorney for Sun Oil. I would like to enter an appearance for Sun here. I don't believe we have any witnesses at this time.

MR. KEELER: E. P. Keeler, Magnolia Petroleum Company. I would like to enter an appearance. We will have no witnesses.

MR. WOODS: A. W. Woods, Monsanto Chemical Company. I want to enter an appearance. We have no witness.

MR. TOMLINSON: Tomlinson for Atlantic. We will have no

witnesses but would like to enter an appearance.

MR. PORTER: Anybody here who isn't appearing in the case? Mr. Errebo, you may proceed with your witness.

MR. ERREBO: As the applicant's first witness, I would like to call Mr. L. G. Finfrock.

If it please the Commission, we have passed out to the members of the Commission and to your Staff all of the exhibits which will be offered in testimony and in evidence by our first witness. These exhibits are copies of the exhibits which you see on the wall and which will be used by the witness in his testimony. The only difference being that they are on a smaller scale. We would like to make one set of these exhibits on the smaller scale, the official exhibits for the Commission.

L. J. FINFROCK

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

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, occupation and by whom are you employed?

A L. J. Finfrock, Staff Geologist, Sunray Mid-Continent Oil Company in Tulsa, Oklahoma.

Q Will you please state briefly your background of education and experience?

A Graduated from the University of Illinois in 1940 with Bachelor of Science degree in geology and received my Masters of Science degree in geology from University of Illinois in '48. I worked for the Carter Oil Company for a period of seven and one-half years as a subsurface geologist, and have been with Sunray Mid-Continent for a period of seven years, at which time I served six years as a District Geologist and the past year as a Staff Geologist in the Tulsa Office.

Q Mr. Finfrock, are you familiar with the geology of the Bisti-Lower Gallup Oil Pool? A Yes. I am.

Q Have you ever previously testified before this Commission?

A I have.

MR. PORTER: His qualifications are acceptable.

Q What is the geographic location of the Bisti-Lower Gallup Oil Pool?

A The Bisti-Lower Gallup Oil Pool is located twenty miles south and slightly east of the City of Farmington in San Juan County, New Mexico.

Q A map which has been marked Exhibit No. 1 has been placed on the wall. Will you please go to this map and identify and explain it?

A Exhibit No. 1 is an area map of the Bisti-Lower Gallup Oil Pool located in portions of Township 24, 25, 26 North, Ranges 10, 11, 12, 13 West of San Juan County, New Mexico. We have shown

on this exhibit in the heavy red border, the outline of our proposed area for 80-acre spacing. We have shown here in the green border at the common corners of Township 25 and 27 North, Ranges 12 and 13 West, the area of our pilot injection program which has previously been okayed by this Commission. We have shown also on this map in colors the various types of leases in this area. Shown in red are the Federal leases. Shown in green are the State leases, and in orange are the Federally administered Indian leases in this area.

Now, we do not find any patented land within the area of this proposed application. Within this area there is 46,720 acres, approximately, of which 4200 acres belong to the State, which is approximately 9% of the total. The Federally administrated leases, approximately 23.3% of the total within this area, and the Federal leases, 67.7% of the area within this proposed 80-acre spacing program.

Q What was the discovery well for this pool, Mr. Finfrock?

A The discovery well for this pool was the El Paso No. 1 Kelly State, located in Section 16, Township 25 North, Range 12 West, San Juan County, New Mexico, which was initially completed on October 7, 1955 with an initial production of 180 barrels of oil flowing after fract treatment.

Q Are all of the completed wells shown on this map completed in the Lower Gallup?

A Yes, all of the wells shown on this map are completed from the Lower Gallup formation. We have, according to the best information available to us, as of September 4, 1957, 134 wells drilled within this area, of which a total of approximately 120 were oil wells, 5 shutin gas wells, and 9 dry holes.

Q Is present development on an 80 acre lease density?

A Yes, the present development of the pool is on an 80 acre density. However, we have a few areas within the outline of this map of which locations have been established for 40 acre locations, and should these locations be drilled, they would violate the 80 acre density pattern that has so far been adhered to by the operators in the Bisti-Lower Gallup Oil Pool.

Q What companies have established those locations?

A To my knowledge, these locations were established by the Shell Oil Company in and around the Carson Unit area.

Q How was the proposed spaced area determined, Mr. Finfrock?

A The proposed spaced area, which is outlined here in red, was determined from the following conditions: As a result of engineer's studies of the Bisti, Engineering Committee results of geologic study, results of sand studies, and also the results of the drilling of the exploratory and development wells within this area to roughly define this pool.

Q Will this pool probably extend southeastward from its present limits?

A I feel that this pool will very likely extend further in a southeasterly direction inasmuch as it has not been definitely defined by the drill.

Q Will you please refer to Applicant's Exhibit No. 2 and identify and explain it?

A Exhibit No. 2 is a reproduction of a portion of electric log of the Shell Oil Company No. 1 Carson Well, a wildcat, located in Section 24, 25 North, 12 West. This well was chosen as our type well inasmuch as it penetrated completely through the Lower Gallup formation. We have shown here, or indicated in yellow, the extent of the Lower Gallup formation, the top of which we have shown here at 4860 feet, and the base of the Lower Gallup formation at 5143 feet. The Lower Gallup formation in this area of the Bisti-Lower Gallup Oil Pool has an approximate average thickness of 380 feet. The sands in the Lower Gallup formation are composed of fine, light grain, fine to medium sands, with clean, well sorted sands in the central portion or core of the bar deposit. These sands grade laterally from the core of the bar into finer grained sands, silt stones and shaly sands.

Q Mr. Finfrook, have you read the application in this matter?

A Yes, I have.

Q The Shell No. 1 Carson is one of the wells in which the top of the Lower Gallup was identified in that application, is it not?

A That is correct.

Q Will you please refer to Exhibit No. 3 and identify and explain it?

A Exhibit No. 3 is an isopack of the upper sand of the Lower Gallup formation, contoured with a contour interval of two feet, based on the microlog separation as seen in the Schlumberger wells that were available to us. We have shown here also the outline of the proposed spaced area. As can be seen from this exhibit, the attitude of this upper sand in a northwesterly, southeasterly direction is that of a bar type deposit with the thicker sequence of beds going through the central portion or core of this deposit, of which a maximum of 22 feet of separation had been noted.

As you can also see from this exhibit, they grade laterally down to the zero isopack line, which is shown here to the northeast and to the southwest, by a dashed line. We find in these Lower Gallup sands, particularly in the uppermost sand of the Lower Gallup, that the permeabilities and porosities of the sand are better developed in the central portion or core of this bar, and in the subsidiary sands in this formation, and as we approach the outward limit of the bar, the sands become less permeable and less porous.

Q In other words, what we have here then is simply a buried sand bar, is that correct? A That is correct.

Q Do you find any interruption in the sand development from one end of this pool to the other?

A On the basis of our geologic study of the sand in the

Lower Gallup formation, we have found no evidence of a break in this deposit throughout this entire area of approximately 30 miles.

Q Will you please refer to Exhibit No. 4 and identify and explain it?

A Exhibit No. 4 is an isopack map of the second sand in the Lower Gallup formation, also contoured on a two foot contour interval and based on microlog separation. This sand, as can be seen on this exhibit, also reflects the same general strike pattern of that, of the upper sand, although this sand is not as well developed as the upper sand, nor does it continue completely across the area as does the upper sand.

Q This sand does appear to be continuous throughout the entire area to the best of your knowledge, which you now have available to you, is that correct?

A We have seen in our study no definite evidence that this sand is terminated in the core part of this deposit.

Q Will you please refer to Exhibit No. 5, which I believe is the structural map, and identify and explain it?

A Exhibit No. 5 is an aerial structure map of the Bisti-Lower Gallup Oil Pool with the datum on the top of the Lower Gallup formation on which these structural contours were made. The contour interval of this map is 20 feet. We have also shown hereon by the red border, the proposed area for 80 acre spacing, and by the yellow border here we show the area presently classified by the Commission

as the Bisti-Lower Gallup Oil Pool.

We also refer to the outline of our LPG gas injection at the location of the common corners of 25, 26 North, Range 12 and 13 West. Also shown on this map in the longitudinal direction is the blue line A, A_1, which represents the trace of our cross section, Exhibit 6-A. The transverse line on this map, B, B_1, C, C_1, D, D_1, E, E_1, and F, F_1, represent the traces of the transverse cross sections labeled Exhibit B, C, E, D, and F.

As can be seen from the structural map, we see an anticlinal dip into the basin in a northeasterly direction. We show no evidence of structural closure within this entire recommended area.

We believe that the trap for the Lower Gallup oil was afforded by nature of a stratigraphic trap rather than that of structural closure, with the buried sand bar being the reservoir and the bounding impermeable silts and shales affording the impermeable barrier needed to make this trap. We also show here in the southeastern portion of this map by a dashed red line and a dashed green line, the area which we label here and zone of oil and gas production, within this bounds we would find wells drilled should encounter both gas and oil, with wells drilled to the northeasterly direction from the dashed green line encountering only oil and wells drilling to the updip or southwest direction from the red line to its limitations would encounter gas.

Q Mr. Finfrock, will you please refer now to Exhibits 6-A

through 6-F inclusive, and identify and explain them.

A Exhibit 6-A, which Mr. Devlin will point out to you on our structural map, is the longitudinal cross section A, A_1, as shown here. This is a northwest, southeast electrical log cross section of the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico. We have shown here by this heavy dark line the top of the upper Gallup formation, and by this second heavy dark line the top of the Lower Gallup formation. We have shown hereon in a dark yellow color the upper sand in the Lower Gallup formation, which is the predominant reserve of this Lower Gallup reservoir.

We have shown in a pale yellow color the subsidiary sands in the Lower Gallup formation as they occur throughout this area. As can be seen from this exhibit, you will note that in each and every well on this cross section you will find that this upper sand of the Lower Gallup formation is present and well developed, and this sand has a very near uniform thickness throughout the area represented by this cross section.

Those who are closer will be able to see that within each of the well bores we have shown here the zones that have been perforated or tested for completion, and each of the sands that we have indicated in a yellow color have had perforations or tests made in them. This section is only to show those sands within the Lower Gallup formation of which perforations or tests had been made, and is not a straight stratigraphic section of the entire

Lower Gallup formation.

This section, as you can see here, has a difference of approximately 300 feet between its low portion and its high portion, which is in the area of the gas cap. Exhibit 6-B shown there by Mr. Devlin on our structural map, is the first of our transverse sections, and we show here the same features that we did on cross section A, A_1, with the deep yellow being the upper sand member. You can see here from this section that we do have the northeast dip into the basin. Cross Section C, C_1, also reflects the same information of the previous two exhibits, with the upper sand being shown in dark yellow. This cross section occurs in Sections 12 and 6 in Township 25 North, Range 26 West, San Juan County, New Mexico.

Exhibit D, D_1, third of our transverse sections, located in Sections 13 and 7 of Township 25 North, Range 11 and 12 West also show the same sequence of beds in the Lower Gallup formation, and this also shows the northeast dip into the basin as well as thinning of the Lower Gallup sand section as we go further away from the central portions of this bar..

Also shown here in this exhibit is one of the situations of which we feel there are probably many in the Bisti area, of which we have sands that are separated at the core of the bar in the Shell 14, 13 Carson, correlating and intermingling with the Shell 41-13 Carson, showing we do have direct communication of sand to sand in some areas within the Bisti Pool, or the Bisti-Lower Gallup Pool.

Cross Section E, E_1, is the essential north-south cross section through Section 20, and 17 of township 25 North, Range 11 West, San Juan County, and this exhibit also shows the northeasterly dip into the basin and the thinning of the sand sequence section as we leave the central portion of the bar proper.

You will note here on this exhibit that this is one of the instances where we find the uppermost sand member shaling out on the flank of the bar, and this occurs on this cross section between the Shell 23, 17 Carson and the Magnolia No. 1 sand wall test.

Exhibit F, F_1, is the essential southwest-northeast section through sections 27, 22, 25 and 14, San Juan County, New Mexico. This cross section shows a gentle dip and then a more abrupt dip into the basin as we go in a southeasterly direction. We also show here the evident thinning of the Lower Gallup sands as we go in a northeasterly direction. We also show on this exhibit the shaling out of this upper sand member at the outer fringe of the bar deposit between the Texas Company M-1 Navajo Well and the Benson, Montin and Greer No. 1 Harvey at the extreme north end of this section.

Q Is it your opinion then, Mr. Finfrock, that these cross sections show a continuous sand development of the Lower Gallup formation throughout this entire area?

A It is my opinion that this cross section shows that we have in the longitudinal direction, continuity of sand deposits

throughout the entire area with, as I pointed out in Exhibit 6-E and F, we do show the lateral gradiation as we leave the bar proper of some of the sand bars which is to be expected in this type of deposit; as you leave the core of the deposit and move out you will find the sands disappear on the flanks. That is to be expected.

Q Will you please refer now to Exhibit No. 7, the three dimensional drawing, and identify it?

A Exhibit No. 7 is a three dimensional drawing of the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico. This drawing was made up of all of the available Schlumberger logs that we could get ahold of to prepare this drawing.

Q Actually, Mr. Finfrock, that represents a large number of cross sections, doesn't it, on one exhibit there?

A Actually this map, as you can see here, shows innumerable areas of cross section within this dimensional map connecting the individual wells.

Q Will you please tell us how that three dimensional drawing was prepared?

A In looking at this drawing, I would like to orient you that on a map these heavy dark lines are the township lines in the north direction, with these being the east-west lines. You will be looking at this plane in a northeasterly direction. This plane surface we have depicted here is as if we had cut a slice out of the earth and an elevation of plus 1660 feet in elevation.

On this plain surface we have located on there surface location the individual wells that have been drilled within this Bisti Pool. After these wells have been spudded, we took their true subsea depth and plotted each individual well in its actual subsea location, and as you can see from these exhibits in the northeasterly or back portion of this map, we have much greater area shown by the dashed line between the actual location of the test and the top of the sand, whereas you move updip into the southwest you find that these locations actually approach into the top of the sand, showing that the beds have a dip here which we are attempting to show in this three dimensional view, dipping back to the north and northeast.

After these individual Schlumberger logs were traced upon this map in their new location, we then correlated from the top of the upper Gallup sand, which is the dark yellow sand in our cross section, we correlated each individual well to show the structural attitude on the top of the upper sand in the Lower Gallup formation. We then connected the base of the sand sequence where penetrated by another line, by a green line, this giving the aspects of individual cross sections. We then colored in green that portion of the Bisti-Lower Gallup Oil Pool which is oil productive.

We have shown in red that portion of the reservoir that is gas, and we have shown on this exhibit the gas-oil contact approximately plus 1530 feet, and have been able to show from this designation of

colors the projected outer limits of this gas cap.

All of this has been put on this plane map at this elevation of approximately 1660 feet to give you a picture, as we see it, of the structure of the Lower Gallup formation, the existence and the continuity of the sands as shown in each and every individual log, as well as to show the attitude of the contact between the oil and gas columns.

Q Mr. Finfrock, what would you say then is the significance of this exhibit?

A I feel that the significance of this exhibit is that it shows to us in one drawing the structural aspects of this field as well as showing us the continual type of deposition that we have within the Lower Gallup formation with our sand sequence gradually building up in each and every well into the uppermost sand, or predominant sand, in this bar deposit. And we can show from this exhibit that these sands are continuously developed, and we feel that a well drilled on 80 acre spacing in any position through this field would encounter the same sand conditions as a well drilled on closer spacing.

Q Will you please refer to Exhibits 8A through 8F and explain and identify them?

A Exhibit 8A is a distribution map of the upper sand member of the Lower Gallup formation. This is the same sand member we have referred to in our cross sections as the deeper colored yellow sand

in the upper portion of the Lower Gallup formation.

We have also shown hereon the outline of our proposed area for 80 acre spacing.

Q When you call that a distribution map, you mean that is a map that simply shows in orange where the sand is found, is that correct?

A I made a detailed study of each log that was available to me to study, and see what sands were present in each well. I then plotted this information on a work map and compiled from that work map these six individual distribution maps which we have here as Exhibit 8. We have only attempted to show on this map by this method the areas where we have encountered this sand developed in the individual wells. We have not tried to define the quality of the sand. We have wanted to show where the sand was developed, and as you will note on this exhibit in the area of Section 30 of 26 North, Range 12 West, we have a solid line shown which defines the northeasterly limit of this sand at that point inasmuch as it was not present in the El Paso No. 1-B Well in Section 30, also in Section 16 of 25 North.

We show a solid black line to indicate that in the Skelly State Well No. 8 this sand was not present, defining in that position a portion of the southwesterly limits of the bar deposit. Also in Section 25 North, Range 11 West, we find a portion of this area defined by a black line indicating the sand was not present in this

area. Also in Section 14 of 25 North, 11 West, we find that same area where the sand was not defined, but in the rest of the entirety of this exhibit we find the sand present as shown by the shaded orange area.

Exhibit No. 8-B is the sand distribution map of the second sand member or bench in this Lower Gallup formation. We have also shown here the outline of our proposed unit, and show here in orange the distribution as proven in the individual well logs of this second sand member. In the northwestern portion of this field you will note that we have a solid black line extending from Section 29 in 26 North, 13 West through in a southeasterly direction into Section 5 of 25 North, Range 12 West, at which point we were able to define the outer limit of this sand.

Exhibit 8-C is a distribution map of the third sand member in the Lower Gallup formation, also showing the outline of the proposed area, and in orange showing our known distribution of this sand. We have here two instances where the outer limits of this sand was defined in Township 25 North, Range 12 West on the north flank of the bar and in 25 North, 11 West in Section 25 on the south flank of this bar deposit.

Exhibit 8-D is the distribution map of the fourth sand member of the Lower Gallup formation showing also the outline of our proposed area for spacing. This map also shows in orange the distribution of this member of the Lower Gallup. In the extreme northwest

portion again we show by a solid black line Section 29, 28 and 27, the northern limit of the sand in that portion, and at Section 30 of 26 North, 12 West, the northeastern limit of the sand at that area.

Exhibit 8-E is the distribution map of the fifth sand member of this Lower Gallup formation; also shown on this exhibit is the outline of our proposed area for spacing with the area known occurrence of the sand shown by orange. We have shown here Section 29, 28 and 33 of Township 26 North, 13 West, a portion of which on the southwest flank this sand was not identified.

Exhibit 8-F is the distribution map of the sixth sand member of the Lower Gallup formation, and like the other maps, in this exhibit, shows the area of our proposed spacing and shows the area of known sand by orange, with the solid black line extending from Section 3, Township 25 North, Range 12 West in a southerly direction into Section 20 of 25 North, Range 11 West, where this sand is defined on the northeast flank.

As you can note from observance of this Exhibit 8, you can find that these sands all lay in approximately the same position along this bar deposit in a northwest-southeasterly direction, and that these sands are present in approximately the same positions, but by some varying degree on each member they are not exactly stacked on each other. There is some variation as can be seen from the discussion of these exhibits.

Q I take it then, Mr. Pinfrock, from these various exhibits that you have presented here today, that you have examined the logs of all the wells in this field, is that correct?

A I have examined 134 electric logs of wells in this field.

Q Actually there are other logs of some of the more completed wells which you haven't had an opportunity to examine?

A That's correct. There are some wells that have been completed in this field which the logs have not come to us as yet. It takes awhile between the completion of the well and the time that you are able to get a Schlumberger log for study. We do not have logs of every well in the field.

Q Have any of these sands been found to be absent in any well in this field?

A In a longitudinal direction we have found no evidence of these sands being present, but as I pointed out in the discussion of this exhibit, we find that in a lateral direction we have found instances where these sands do shale out as we approach the outward limit of this deposit.

Q To correct the record, you said you found no evidence of these sands being present, you mean absent?

A Absent, yes, sir.

Q Have you found any faults in this general area?

A I have seen no evidence of faulting in my study.

Q Is it your opinion then that the main sand body and each

of the other subsidiary sands are present and probably present or probably present throughout the entire area covered by this application? A That is my opinion.

Q Is it your opinion that these sands are continuous and form a common source of supply? A Yes, it is.

Q Would you call the Lower Gallup reservoir a lenticular reservoir?

A No, I would not call the Lower Gallup reservoir a lenticular reservoir inasmuch as we have been able to define its presence over an area of approximately 20 miles in length. I do not consider that a lenticular type of deposit inasmuch as in a lenticular type deposit you do not anticipate the sand in the lenticular nature in offset locations, and this is not the case here in this study.

Q You believe that the 80 acre proration unit and plan of well location, as proposed by Sunray Mid-Continent in this application, is reasonable? A Yes, I do.

Q Were all of the exhibits which have been offered as a part of your testimony here today prepared by you or under your supervision? A They were.

MR. ERREBO: We will at this time like to offer these exhibits, I believe 1 through 8, in evidence.

MR. PORTER: Any objection to the admission of these exhibits? They will be admitted.

MR. ERREBO: That's all the direct examination we have

of this witness.

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

MR. SETH: I would like to ask several questions, please.

CROSS EXAMINATION

BY MR. SETH:

Q Mr. Finfrock, you indicated at the outset that the field had been developed so far on an 80 acre density --

A Density.

Q What do you mean by that I'm not familiar with that term?

A By that term we mean that this field has been developed in a manner such that any well drilled at this time in this field can be assigned an 80 acre unit.

Q Then by so arranging the 40's you can assign acreage to any well?

A To any well that has now been drilled.

Q That, if I understand it correctly, is what you wish to accomplish by your application here, is to continue that same method throughout the life of the field, is that right?

A That 80 acres be assigned to each well?

Q Yes, just as you testified has been done heretofore.

A Well, before it's, as I understand, it has been on a voluntary basis and these wells have been drilled at a density at which 80 acres can be assigned to them, and under our application we would define 80 acre units which they have not been defined as

such to this point.

Q Now, had you made any examination to see how many wells are off pattern if a regular 80 acre spacing program had been put into effect? A As if --

Q (Interrupting) When I say 80 acre, I mean limited to the northwest, southeast quarter or northeast, southwest.

A I do not have a figure at hand, but there are several locations I know that are not drilled on a stated location as you suggested there.

Q Would you say half of them, half of the wells in that field?

MR. ERREBO: If I could, Mr. Seth, I would like to state at this time Sunray has made a count of the wells which would be located off pattern, which are located off pattern according to our best information, and that would be 15 wells.

MR. SETH: Off what pattern?

MR. ERREBO: Well, that would be wells which would be located, for instance two wells located in the same half of a quarter section.

MR. SETH: But you have made no study, if I understand it correctly, on a strict northeast, southwest, northwest, southeast basis?

MR. ERREBO: Yes.

MR. SETH: Fine, that was the question.

Q As to the nature of these particular sands, would it be

your opinion that they are relatively undisturbed sands that have been layed down under quiet conditions, or how would you characterize them?

A I would say these sands have been layed down in what we would call a near shore position which they have been reworked and sorted with the better sorting and larger grain size near the central portion of the sand bar and with these sands as they go in a lateral direction from the core, decreasing in size to a finer grain sand, and finally to silt stones that we have separation of the sands by water action.

Q Then there was a certain amount of wave action which disturbs the sands from time to time, is that correct?

A Very probably.

Q Were they disturbed by marine organisms of any sort, do you know?

A Well, now, not to the extent that we were just discussing as disturbed by deposition. Now marine organisms, minute microscopic marine organisms are known to be present in the Gallup formation. Personally, I can't see that there would be much in the way of disturbance from this presence other than being there in the reservoir itself.

Q I see. Have you examined the actual cores that have been taken?

A Personally, I have not examined the actual cores.

Q Then you wouldn't know whether there was evidence of disturbance of any character?

A I have not made that examination myself.

Q I believe that Sunray has testified in previous hearings that there is a wide range in the well bore of porosity and permeability, is that correct? A That is correct.

Q Now, in presenting the Exhibits, I believe it's 6-A, this longitudinal cross section? A Yes.

Q You have colored in yellow there the entire upper Gallup sand, is that correct, based upon an electric log?

A Electrical log correlations.

Q In doing that you have not taken into consideration any variations vertically in the character of the sand, is that right?

A If you were closer to the cross section you could see that we have shown by indentations and also by little zones of white within the yellow where you do have change in the overall thickness of the formation. In other words, where it varies from well to well we have shown that variance.

Q I wasn't thinking of the thickness of the formation. I was considering more the character of the sand. You have drawn a fairly continuous yellow band across there, which if I understand it correctly, is the upper Gallup? A That is correct.

Q That is as far as you have gone in coloring the exhibit?

A That is right.

Q Likewise on your exhibit which you called a distribution map of the sands, you have approached it similarly, is that right?

A Yes, that is not a quality analysis.

Q What would you say the ranges are of permeability and porosity, or will another witness consider that?

A Well, our Engineering witness will testify on permeability and porosities in this reservoir.

Q Generally such structure as the dips to the northeast, did you say? A Yes.

Q Would you point out, I don't recall where the gas wells are, would you point those out?

A Yes, sir. In the southeast quarter of section 21, in the southwest quarter of Section 22, in the southeast quarter of 22, in the southwest quarter of 25 in Township 25 North, Range 11 West, in the southwest quarter of 30, Township 25 North, 10 West, five gas wells.

Q Now, are there any, considering those gas wells, are there any upstructure oil wells in that vicinity?

A To my knowledge, no.

Q There are not.

A Upstructure, you mean in a southwesterly direction updip?

Q Yes.

A On the map it is different.

Q I mean upstructure as far as the dip upstructure is concerned.

A No, that is correct.

Q You are aware of no oil wells upstructure then, is that correct?

A No, we have no knowledge of any oil wells above this area which we have defined as the zone of oil and gas production.

Q Now, referring again to your eight service there, your distribution, you have cut off the lateral extent of those sands by your finding that they did not occur in the offset well, is that correct? A That is right.

Q Does that necessarily mean that they might not again re-occur as we get further north?

A No, it does not mean that. This study just means that in this bar which we have defined here in the Bisti Pool does shale out in these areas we have shown, and as it is disappearing in a basinward direction, we would not expect them logically to appear again, but that does not rule out the possibility that there may be some sand deposits in that direction.

Q You conclude, I believe, or it was your opinion, that the sand was not lenticular because you found it throughout a considerable area here. Now in that testimony you are again referring merely to the occurrence of the upper Gallup sand or whatever member concerned, and not with perhaps the lenticular character of the permeability and porosity, is that right?

A We are defining these maps on sand continuity in these

exhibits here, and on the Exhibit No. 3 which was an isopack of this upper member, the isopack was made on a microlog separation which shows permeability, and we found that by microlog interpretation we found that the upper deep yellow zone was present and permeable throughout this entire area as we showed on Exhibit 3.

Q It was present throughout. Would you turn back to 3 please?

A Exhibit 3, yes, sir.

Q Now, if you'll just select one isopack near the center of the field there and trace it out, if you would, for the Commission.

A A certain thickness?

Q Yes.

A Contour. Well now, we have here our 20, this is our 20 foot contour at this position, and at this position, at this position and now, that is not going into the record so good.

Q Well now, when, you are referring to Exhibit 3, are you not?

A Exhibit 3 which I am defining --

Q (Interrupting) You are pointing now to the isopack, what is the number or the contour?

A The 20 foot contour, which is --

Q (Interrupting) What township?

A We have the 20 foot contour shown in Township 26 North, Range 13 West, also in 25 North, 12 West and in 25 North, 10 and 11 West, we do not show the 20 foot contour. The sand is beginning to thin in the southeastern direction. We do not show the 20 foot

contour in Township 25 North, Range 10 and 11 West.

Q Now, in tracing those out you have indicated that they cover relatively small areas, especially in the northwest part of the field. Doesn't that indicate there are considerable local variations throughout the field as shown by your Exhibit 3?

A There are variations in the thickness of this bar sand which you would expect to find due to the fact that it is a shallow water type deposit, and you have sorting and the affect of current action, and you would not expect in my estimation to find this sand to be exactly a 20 foot thickness over a period of 20 miles; geologically we wouldn't expect it to be that consistent over that great an area.

Q That is not a continuous sand. You, I believe, testified that it was a continuous --

A (Interrupting) Well, yes.

Q (Continuing) -- sand deposit?

A It is a continuous sand.

Q The sand is continuous, but its character varies locally, is that a correct statement?

A The character varies as you leave this central portion as you go towards the outer edges of the bar.

Q It varies from east to west? A Laterally.

Q East to west also. You traced out the particular contour up there?

A It varies in thickness, yes, sir, from northwest to southeast.

Q You are not testifying now as to whether the quality permeability, porosity likewise varies laterally?

A No, this exhibit is not based on porosity and permeability figures.

Q Now, on the character of the sands, again, would you say they're uniformly cemented or what about the cementing?

A I would say about the character of the sands themselves that in this central portion of this deposit these sands are fairly clean, fairly well sorted with better permeability and porosities, and as you approach the flanks of this deposit you find increasing amounts of silt stones and exclusion of gray shales which would impair or lower the permeability factor.

Q Then again your exhibits, as 6-A over here, you again make no differentiation as here on the quality of the sand. You are showing the Commission here the occurrence of the Gallup sand and you are testifying that it is fairly continuous throughout this particular area. Now, it does not, or I might ask you, does the sand likewise occur outside the limits of your structural map over there, which is Exhibit No. 5?

A Outside the limits?

Q Of the red border.

A We haven't defined the outer limits of the Lower Gallup formation, but as you know, the Lower Gallup formation outcrops on the surface and it is present in the subsurface in New Mexico

Q Then its being a relatively common formation, we would expect if you trace just the formation or just the sand itself it would recur over a considerable area, is that correct?

A That is correct.

MR. SETH: I believe that's all.

MR. PORTER: Anyone else have a question of the witness?

By MR. MALONE:

Q Mr. Finfrock, when did you first have occasion to begin a study of the Lower Gallup sand in the Bisti Field?

A In the earlier part of June of this year.

Q When did Sunray drill its first well in the pool?

A In 1956.

Q And you have, since June of 1957, devoted yourself to a study of the conditions as to which you have testified?

A That is correct.

Q I believe you said that you are familiar with the application which Sunray has filed? A I have read the application.

Q Have you given any consideration to the effect of that application as it relates to the protection of correlative rights or the prevention of waste? A Yes.

Q Do you recommend the application as made to the Commission as protecting the correlative rights of the various owners of sands in this field?

MR. ERREBO: Excuse me. Isn't that asking the geological

witness a legal question?

MR. MALONE: The question of the occurrence of saturation in the sand formation and its distribution with relation to an 80 acre development pattern would seem to be a geologic rather than a legal question. I agree with you the question of what will protect correlative rights may be a legal question, but whether a well on 80 acres is going to let a man get all the oil that he is entitled to as layed down geologically, would seem to be a geological question.

Q Is it your opinion that development on the proposed spacing pattern will protect the correlative rights of the operators in this pool?

MR. ERREBO: Mr. Malone, I fail to see, I think you could ask this question a little better. This witness does not know about correlative rights from the legal standpoint.

MR. MALONE: All right, I will be glad to.

Q First I might ask the witness if he knows the meaning of correlative rights.

A I am not an attorney, but I understand that the correlative rights means the protection of the individual where there is a royalty owner or working interest of his portion of the pool or his reserves or what he should get out of it. I couldn't give you a correct definition.

Q I didn't expect a legal definition. You have testified before this and other commission on previous occasions, have you not?

A Yes, I have.

MR. SELINGER: I would like to make a formal objection to the Commission that this witness is incompetent, irrelevant to testify on matters of correlative rights. He is presented purely as a geological witness and we would like to make a formal objection to this line of questioning from this witness.

MR. MALONE: I have no intention or desire to ask this witness to testify as to anything that he does not purport to be qualified to testify to. He stated in answer to my question that he recommended to the Commission 80 acre spacing. I was asking him whether or not on the basis of the geological information to which he has testified, that spacing would recover, would protect the correlative rights by permitting each owner to recover his equitable share of the oil.

MR. SELINGER: We renew our objection.

MR. MALONE: If the witness states he is not in a position to answer the question, I will save it for another witness.

A I believe that is getting into the field of engineering more than pure geology.

Q Perhaps we can get at it from another point of view then. May I invite your attention to your Exhibit E, E_1 that you testified to over there. If I recall your testimony correctly, that that upper and thick yellow band was the principal and most prolific sand member in the Lower Gallup, is that correct?

A That is correct.

Q And that the lower band was additional sand members which are saturated and from which production has been obtained?

A Yes.

Q I believe you also testified -- may I inquire what the last well to the extreme right, your right, of that is?

A The Magnolia No. 1 Sanda Wall I believe.

Q Now, if you would indicate the well which you are now indicating, what is the designation of that well?

A The Magnolia No. 1 Sanda Wall, located in Township 18, 25, Range 11 West, San Juan County, New Mexico.

Q I believe you testified in that well the upper sand member had pinched out between the Shell No. --

A (Interrupting) 23-17.

Q (Continuing) -- 23-17 Carson and the Magnolia well, is that correct?

A That was my testimony.

Q The lower member was continuous over to the Magnolia westward?

A That is correct.

Q Now you mean that the upper member extends on to the 80 acre location on which the Magnolia well has been drilled, but that it does not extend to the location of that well, the Magnolia well will not obtain any portion of the oil that is in that upper member will it?

A This location of this well here in relation to the location

of this well, you asked me to state if this well would be able to get any, I mean this well, being the Magnolia well, would be able to get any of the oil that was present in the upper zone?

Q That is correct, and which might exist on the 80 acre spacing unit on which the Magnolia well is drilled.

A Now, we have, I don't know whether it would be my position to state or not, but we have in additional exhibits to come forward in this hearing, some exhibits on porosities and permeabilities in which we show that there is vertical permeability through this entire section, and I don't know whether that should be in the realm of me to answer the question about drainage.

Q I'll be glad to direct that question to a later witness. Can you testify whether or not in your opinion the Magnolia well would recover the oil from the upper sand member?

A I would say in primary operations it would not likely be, but under secondary recovery operations you would expect a program with vertical permeability there to sweep through the field and recover the oil that was not recoverable under the primary operation. That is as far as I can go into that.

Q You are not prepared to testify as to any barriers that may exist vertically to communication? A No.

Q That will come from another witness?

A Yes.

Q But insofar as your testimony goes, I just want to be sure

that I understand it, it is through primary operations the Magnolia well will recover none of the oil that may be in the upper member of the Gallup sand? A As far as I can see.

Q Now, with reference to the several sand members that you have testified to, what is the relative thickness of those sand members as you have found them?

A I would say the average thickness of the upper sand throughout this field average would approximate 15 feet, and of the secondary sands, these individual zones or benches would probably average four to six feet.

Q Is it --

A (Interrupting) I haven't made a study to get an average. That is just an estimate.

Q I'm not sure that I understood the delineation of those members. Now, is the first member that was shown on your Exhibit 8-A, that is the 15 or 20 foot principal member?

A That's right.

Q From which the best production will be obtained?

A That is correct.

Q The additional five members compose the lower yellow band that you have showed on your A, A_1 longitudinal cross section?

A That is correct.

Q Are the lateral limits of those various segments uniform or are they stacked on top of each other with various lateral

limits or aerial limits?

A Using your term they are stacked on top of each other, but their vertical limits are not precisely at the same point above each other. There is a variation.

Q There is a variance. So a well drilled at a given location might encounter one of these members but not encounter the next member even though an offset location would encounter both of them?

A In speaking of these reservoirs, we're dealing with marginal reservoirs here, and if you were looking for say one of these reservoirs or say two of these reservoirs, you very probably would not be looking at a commercial reservoir.

Q My question was whether the lateral edges of the sand barriers are so irregular that a well which penetrated one might not penetrate the same ones which were penetrated on an offset well.

A I do not have a definite figure, but based on my study of the logs and the preparation of the distribution maps, my estimation would be that out of the 134 wells that I studied that very probably, I don't know, maybe 90% of them encounter all the sands. That is just an estimate and it may be more than that.

Q Of the wells that have been drilled to date?

A The wells drilled to date. Those would be the wells on the marginal limits of this bar deposit.

Q If I may invite your attention to the Exhibit 3, the pinch out of the sands or the sand members which occur, occur as you proceed

away from the center of the sand bar, do they not?

A That is correct.

Q So that as we get out on the north and south flanks we find that one or more of those six members may have pinched out a little sooner or a little later than the next one, and they would not be coexistent in a given location as we come along the edge of the zone of saturation?

A That is correct. I would not be a precise point at which all members would shale out.

Q That lack of uniformity in those various oil-bearing members would exist along the flank of this entire field both north and south, would it not?

A Yes, that would exist on the marginal flank of the field.

Q So that wells drilled along the marginal flank of the field have no assurance of encountering all of the sand members which an offset well might encounter?

A Would not get all of the sands that an offset well near the central portion.

Q Near the central portion --

A Of the bar?

Q Yes. Did you testify as to the range of permeability which you found to exist in these sands?

A No, I did not.

Q Are you prepared to testify on that?

A We have exhibits. I could give some estimates. We have exhibits prepared and a witness who is to testify on that phase of the reservoir.

Q You have not studied permeabilities yourself?

A Not personally. I have read figures.

Q So you couldn't testify as to the range of permeability or porosity that may exist?

A No, other than figures that I have read, that would be all.

Q Your entire testimony is based on figures that you have read and logs that you have studied, is it not?

A Well, it has been my personal interpretation. I haven't measured permeability, I'm not an engineer. I have not measured any permeability.

Q All right. We will address that question to a later witness, thank you. In connection with your study of the Schlumberger logs, have you studied micrologs as well on these wells?

A I did not personally study the micrologs inasmuch -- I studied a few, I will say about fifteen, to familiarize myself with the picks that have been made by our geologist in our district office, of which the Bisti Field is under their guidance.

Q So that the testimony which you have given is not based upon an examination of micrologs of these wells to any extent?

A That is correct.

Q Do you have any opinion as to the relative value of

micrologs and electric logs?

A Yes. I would be lost without it.

Q Do you think that the information which might be disclosed by microlog study would be of value in the questions which the Commission is here considering?

A Yes, I think that microlog information as well as electric log information is a great help to the Commission and to anybody who does make a study of it.

Q Referring again now to the six members which compose the Lower Gallup Sands, you said that you had not examined any cores, I believe. A That is correct.

Q Are you in a position to testify what, if any, barrier or division exists between those members?

A We find that in this section, as I mentioned in my testimony, that the Lower Gallup formation is composed of sand, sandy shales and silt stones throughout its entirety, and we have endeavored to show here the sand members which are the members which we are interested in inasmuch as they do show the greater permeability and porosities, although it has been found by engineers, and based upon core analysis studies and microlog studies, that we do have a vertical permeability range through this section.

Q But the fact that you have divided the lower segment into six members and the upper segment in a single member indicates that there are barriers between those lower members which do not exist

in the upper member, is that correct?

A We have divided the Lower Gallup, for the purpose of this display, into the upper member, the five. There is a total of six, the five subsidiary members which we feel are part of one and the same formation. We have only done this to show the outline of the better developed portions of this sand.

Q Why, then, did you not divide the upper member likewise into a group of members?

A Because we did not see a continuity in the change that was in the formation there, whereas you can see from our cross sections that you will find that these silt stone and shaly sand breaks, as we call them, are consistently present in their position in the section throughout this.

Q It is true, I think we are in agreement, but I can't get you to say so, that the reason you recognize several members in the lower segment is because of shales and silts which separate the sands which are the zones of saturation from which you do produce.

A These do stand out on our electric log in our means of correlation.

Q And because there is a separation of some type between them, can it mean a loss of porosity or permeability shale or silt?

A Yes, because there is a facies change.

Q There is a facies change. That change does exist in the lower segment made up of the five members?

A That is correct.

Q You find them, call them barriers, call them separations, call them facies, they still exist in a tier of a five-layer cake down there, is that correct?

A These facies changes exist and are correlative, but we do not define them as barriers.

Q Well, I believe you said that you were not prepared to testify on that? A That is true.

Q And since you cannot testify as to communication that would exist there, you would not be able to say whether they were barriers or not?

A Not from the electrical log basis alone, no, I wouldn't.

Q Would you like to withdraw that answer then?

A Well --

Q (Interrupting) That's all right.

MR. CAMPBELL: If the Commission please, I believe counsel has to take the bitter with the sweet.

MR. MALONE: I might suggest that the witness answered a question he wasn't qualified to answer.

Q Can you testify whether or not in your study of the relationship betweenthe gas well and the oil wells producing from this reservoir, whether or not there may be oil wells producing from perforations, at a higher level than gas wells on adjoining land?

A I am not in a position to answer that question.

Q You have not made a study of the logs of any of the gas wells down in Section 20 and 22?

A Yes, I have studied the logs.

Q Have you found that condition to exist?

A I think what you mean, have we found wells in which sands have been perforated lower in the column to complete as oil wells?

Q No, that wells which have been perforated and completed lower that adjoining wells are producing gas from a lower level than the lower wells producing oil.

A Oh, I have seen nothing of that.

Q You have seen no example of that?

A To my knowledge, no.

Q Would that have any significance to you if you did find that situation to exist?

A Well, it depends on if it were the same reservoir.

Q Well, you testified this is all one reservoir, have you not?

A Yes. The Lower Gallup Reservoir, that is correct.

Q If you found that condition to exist in this reservoir, would it have any significance to you?

A Well, it would show that we do not completely understand the mechanics of oil and gas migration, and if one did find gas production below the oil production, that it could be a result of the test or something like that, I'm not familiar with what type

of equipment was used and what testing was made or how these tests might have been conducted.

Q Would you agree with me that a condition of that kind might indicate either a lack of continuity or a lack of communication as between those wells?

A Well, I think that it would more likely be a result of a fract treatment going from one zone into another in opening up another area into the bore of the well to get your --

Q (Interrupting) It could have been caused by that, but it likewise could have been caused by a lack of communication, could it not?

A By lack of communication, I don't quite get your question.

Q Well, I understood you to testify that communication in your opinion existed throughout this reservoir?

A That's right.

Q That is was one common sand bar and that communication existed throughout it? A That is correct.

Q Now, if communication does exist, could the situation I asked you about likewise exist?

A It doesn't sould plausible, but geology is not an exact science. I've seen strange things in my career as a geologist.

Q That would have some bearing on it if the situation existed?

A If the situation existed you would be aware of it and wonder what caused such.

Q You are not prepared to testify it doesn't exist in this reservoir?

A To my knowledge, no.

Q You don't have any knowledge of wells of that?

A I have no knowledge of that.

Q Have you had an occasion to study other sand reservoirs in New Mexico?

A In New Mexico this is the only field that I have studied.

Q So you would not be able to testify whether there is any particular characteristic of this sand bar that does not exist in the numerous other sand horizons from which we are producing in New Mexico?

A I have spent a lot of my life studying cretaceous sands of which these are, and I feel that the type of deposit and the age is just as important as the geographic location, I mean, from the geological standpoint. Geographically I haven't studied any other field in this state.

Q How does this pool compare with the sands in the pool with which you are familiar?

A This is much longer reservoir than I have been able to study before, a larger reservoir, but it is also a reservoir which the permeabilities, as reported, are not as high as I've seen in other portions of the country, but as far as the geology of the deposit is concerned geologically, it is the same type deposit that we find

in this type of --

Q (Interrupting) You find nothing particularly out of the ordinary about this?

A No, it has fallen in every well with our concept of the geology of the field.

MR. PORTER: We will take a ten minute break.

(Recess.)

MR. PORTER: The hearing will come to order. Mr. Malone, will you proceed?

A I have one further question, if the Commission please. With reference to your distribution maps, Exhibits 8-A through F, am I correct in understanding that the area which you have delineated in orange as indicating the existence of a sand deposit, does not take into consideration in any respect the character of the sand or the porosity or the permeability of the sand?

A That is correct.

Q And the same thing is true of the three dimensional drawing up here? A That is correct.

MR. PORTER: Anyone else have a question? Mr. Utz.

By MR. UTZ:

Q Mr. Finfrock, referring to your Exhibit No. 1, the red outline designates your proposed pool limits?

A That is correct, for the 80 acre spacing.

Q Are you aware of the fact that your proposed outline is

substantially larger than the pool outlined as defined by the Oil Conservation Commission? A That is correct.

Q I note that in some instances your outline as you propose is substantially over a mile from the nearest producing oil well, is that correct? A It is correct.

Q On what basis do you believe that it would justify a pool limit that far away from r producing well?

A This border was arrived at because of the fact that as of now at this stage of the development of the field we do not know the definite limits this field will take, and based upon the studies of the sands which we have made, we feel that the sands are present over most of this area and would very likely, under field development, would include most of this area within the Bisti-Lower Gallup Oil Pool at a later date by further development.

Q But you are not sure that that whole entire area is productive, are you? A No, sir.

Q Would it not be better then to extend the pool as completions would justify on the basis of say 150 acres at that time?

A This outline is not definitely submitted as the finalized outline to be arrived at by the Commission, but it was a line that we thought would be reasonable in lieu of future development, but your suggestion would very likely be a good one to follow in enlargement of this field.

Q If we go too far in we might have a lot of dry acres inside

the pool? A That's possible.

Q Are you prepared to discuss this gas cap which I believe you've --

A (Interrupting) Well, that will be discussed under engineering testimony in the latter part of this hearing.

Q As to the means of producing those gas wells?

A That is correct.

Q Referring to your Exhibit 6-F, referring in particular to your cross section on your Shell 5 Carson in 27, 25 North, 11 West, is that a completed well?

A We show it as a location here although I don't believe the well has been officially completed, although it was tested, we do not show it as a completed well officially. According to the records we have available, 27, 25, 11, yes, that is correct, we show an initial production on this well, but we were never able to find an official completion for the well and did not show it as a completed symbol.

Q Is that an oil or gas well?

A I. P. 33 barrels of oil per day. It is listed here on our data. The gas-oil ratio is 17,000 to 1.

Q What was your answer?

A This Shell No. 5 Carson in Section 27 of 25 North, Range 11 West which we do not show as a completed well, has initial

production of 33 barrels of oil per day and a gas-oil ratio of 17,000 to 1.

Q Referring to the Es-Ka-Nel-E-Wood, Section 22, 25 North, 11 West, that was a gas well, was it not?

A Which one, we have Es-Ka-Nel-E-Wood No. 1 and 2.

Q It is the No. 2.

A The No. 2 is a gas well.

Q Do you know what the gas-oil ratio was on that well?

A 1020 to 1.

Q 1020 --

A (Interrupting) No, wait, that's that 1020 to 1 is the ratio for the No. 1 Es-Ka-Nel-E-Wood. I do not have a figure for the No. 2 on my exhibit here, for the No. 2 Es-Ka-Nel-E-Wood.

Q Do you know if it produced any oil or not?

A 4500 MCF of gas per day initial production.

Q No oil reported? A No oil reported.

Q That is undoubtedly a gas well, is that correct?

A Yes.

Q We have a well which is structurally higher than the well we have just discussed, the Es-Ka-Nel-E-Wood No. 2, which produces oil, how do you explain that? This is a gas cap.

A The perforations in the Es-Ka-Nel-E-Wood No. 2 were at plus 1572 to plus 1568, plus 1566 to 1562, plus 1542 to plus 1535, those perforations were throughout considerable amount of section.

In the Carson well we show perforations here plus 1577 to plus 1613, and I don't know, I don't know where those are in the section on the log.

Q Doesn't your Exhibit 6-F show the structural position of your known completion?

A In the Shell 5 Carson we show these perforations, 9112 to 30 and from 5141 to 48. And the No. 2 Es-Ka-Nel-E-Wood we show the perforations 4923 to 29 and 4929 to 33, 4953 to 60, which according to this information, these two are in the same zones of the Lower Gallup formation.

Q Which well is structurally higher?

A This well is structurally higher, that is the No. 5 Carson.

Q No. 5 Carson is structurally higher and that is the one that you reported as producing oil from the 17,000 to 1 ratio?

A This is the report we got through the scout service.

Q If the Es-Ka-Nel-E-Wood No. 2 is a dry gas well and is structurally lower than Shell No. 5 Carson, then does that indicate a gas cap?

A I couldn't give you a definition of a gas cap. I don't know if I am qualified to define what actually constitutes gas cap. We have gas production in this well.

Q Do you have any explanation as to why a well structurally higher would produce oil?

A Based on this exhibit here, both sands were perforated

at the same position within the section I can't answer, give a definite answer as to the reason why there would be that difference, I don't know.

Q But nevertheless that is a fact?

A That is the facts as reported to us, that is correct.

Q In your opinion could there be communication between those two wells?

A Based upon the location of the No. 2 Es-Ka-Nel-E-Wood Well is in the southeast quarter of 22, 25, 11, and the Shell No. 5 Carson in the southeast quarter of Section 27, these wells are almost directly, the Carson well is almost directly north of the Es-Ka-Nel-E-Wood Well, coming away from the bar deposit in going into the marginal area of the bar.

Now, we have found in our studies that, as I mentioned before, that in the core of the bar we have the sand as a coherent body and as it goes out towards the limits of the bar we have found interfingering of the sand into the shale near the limits, and we feel there is communication, but as you approach the outer limits of the bar you may find this interfingering affect will be shown somewhat, but I don't know. That's the only position that I'm able to take on that is that we're approaching the outer limits of this bar here and possibly in the geology there with the differences in what you would suppose to be the permeability between these two wells, it might lead to the fact of encountering some oil in lows out here

which we have shown as would be in a gas area.

Q Then your answer is that you are not sure?

A I am not sure, no.

Q Do you believe that both those wells are in the same common source of supply?

A Well, that's our belief.

MR. ERREBO: Mr. Utz, if I could interrupt to make that determination seems to me like it would take some engineering evidence and information which I believe this witness here has not had any disposal of, and he is not qualified to give it. We have an engineering witness who perhaps can give you better satisfaction on those questions.

MR. UTZ: All right. That's all the questions I have.

MR. PORTER: Anyone else have a question?

MR. SELINGER: I would like to ask the witness a few questions.

By MR. SELINGER:

Q I believe you stated on direct examination that you felt that the area was approximately 43,000 acres more or less?

A I think that was about 47,625, 46,720.

Q Approximately 47,000 acres, and it had approximately 134 wells or thereabouts? A To date.

Q So that the vast majority of the area is yet to be developed, is that correct? A That is correct.

Q And I believe you stated on cross examination that with reference to the upper pay that it averaged approximately 15 feet in thickness if you had to use an average figure?

A That is correct.

Q And that as to the secondary sands, it averaged if you had to use an average figure, in thickness, of four to six feet?

A Four to six feet.

Q Now, referring to Exhibit 3, on cross examination you were asked on the isopack map to trace one of the isopack lines, and you picked at random a 20 foot pay thickness. Can you likewise at random say, pick a 10 foot pay thickness and trace that across the field? A Yes.

Q Laterally from the northwest to the southeast. Will you do so indicating on that exhibit, for the benefit of the Commission, the 10 foot? A Indicating by sections?

Q No, just a continuous line with your pointer.

A The 10 foot contour line is this heavy line here on the north flank of the structure extending in a southeasterly direction as I am showing here, following all along across Township 25 North, 12 West, coming on across Township 25, 11 West, down to Section 29 which it turns and comes back up.

Q Where does that point stop?

A The point here of the furthermost southeasterly direction of this 10 foot contour point stops in the southeast corner of

Section 29, 25 North, 10 West, and we have shown here isolated 10 foot contour closures to the southeast with this original 10 foot contour line coming back up on the southwest flank of this bar on up to the extreme northwest limits of the field as defined by the drill.

Q So that your 10 foot contour line or isopack line can be traced practically across the entire northwest-southeast with the exception of the extreme southeast corner?

A That is correct.

Q Can you at random pick either the 12 or 14 foot isopack line and similarly trace it for the benefit of the Commission?

A The 14 foot contour line is the second contour line above the 10 foot line. I will start at this position and trace it around here and then start at this point and take the 14 foot contour line, trace it back through this large area here, then continue with the 14 foot contour line on across Township 25, 12 West, on through until we get into the southeast quarter of Section 18 of 25 North, 11 West, which we can turn this contour back, come back up in a northeasterly direction, then back to our point of beginning. And also we are able to trace the 14 foot contour point on beyond the break we show in 18 so that it will pick up here and go down in a southeasterly direction on across to this point here in Section 26, which contour line comes back upon itself again, and in Township 25 North, 10 West we do not show any 14 foot contour interval, and

this area here to the southeast is also the area of the less densely drilled portion of the field, and I'm certain, and I certainly would not want to say what the maximum development of the sand would be in this portion of the field.

Q Now, in between your points of control on your isopack map there are areas, you have undrilled area, is that correct?

A Yes, that are areas within this outline which have not been drilled or which we do not have information available to complete a map.

Q If subsequent development takes place and permits the drilling of additional wells in these areas and you have undevelopment, you will have additional information upon which to draw your isopack lines throughout the area, is that correct?

A That is correct.

MR. SELINGER: I believe that's all.

MR. PORTER: Any further questions of this witness? Mr. Errebo.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q Now, Mr. Finfrock, the question of lenticularity has come up this morning. You discussed that briefly in your direct testimony. I would like for you to discuss that a little more thoroughly as to what you mean by lenticularity. I would like to ask you this question, would you say that a lens is a very small local

deposit of sand, would you say that?

A A sand lens?

Q A sand lens.

A Yes, I would.

Q That is different from the surrounding sand, is that correct?

A Well, now, different in character or --

Q (Interrupting) Different in sand character, it may or may not be, is that right?

A A sand lens itself doesn't necessarily have to exhibit different characteristics. It may or may not, depending on the deposit.

Q Will you describe in more detail then what you mean by a sand lens?

A A sand lens or a lenticular sand in my opinion is a sand that in its deposition was not deposited over a wide area. It is normally a thin sand associated in a section which is predominantly sand and shale. Its lateral and longitudinal distances are very severely curtailed. It is, I would say, a local deposit not of a regional nature whatsoever.

Q Then sand extended throughout the entire area of that proposed spaced area, would you call that a lens?

A No, I would not.

Q Would you call it a lens if it just extended over half the area?

A No, not as a sand lens as we are thinking today.

Q That is also generally recognized by geologists and engineers?

A That is correct.

Q What if you had say six sections, would you call that a lens as it is generally regarded? A Not in my opinion.

Q How about one section, do you think that then you might be getting close to what you call a lens?

A We are getting down to the sands that I have dealt with as leaning sands, say where in a section area you drilled numerable wells and found this sand was present in a portion of these wells but not distributed evenly throughout, and that you would find that this sand is present in one well and not necessarily in an offset.

It is erratic in nature.

Q It doesn't necessarily mean it is lenticular, does it, just simply because a sand is erratic doesn't mean it is lenticular, does it?

A In order to have body to a sand you have to define a border of the sand as well as the main portion of the body, and I would, I would say, assume a lens shape

Q Well, let me ask you one other question then. If this is an engineering question I wish you would note that you don't know. Do you generally conceive that the area contained within a sand lens or that the pressure within a sand lens is connected to that part of the reservoir outside the sand lens?

A Would you repeat the question, please?

Q Do you believe that a sand lens is pressure connected with the surrounding reservoir?

A I don't think I can answer that question.

Q Then now it is not surprising actually in any reservoir, is it, to find somewhat of a wide range of permeabilities and porosities?

A That is correct.

Q You can find that in any reservoir in any part of the country?

A I believe so.

Q You would be surprised if you didn't find it?

A I would certainly be surprised to find a field developed with the same permeability and porosity throughout.

Q As you approach the outer limits of this field, you were asked in cross examination whether or not you knew whether or not once the sand lensed out or shaled out that it reoccurred again.

A The sand that shales out here to the northeast does not reoccur again in this immediate vicinity. It is present several miles off, but in this immediatevicinity as far as our studies shows this sand is completely shaled out for quite some area.

Q Then once it shales out, you have no evidence here that in the immediate vicinity it does reoccur again?

A That is correct.

Q If it does reoccur, it is a number of miles off?

A That is correct.

Q This may seem like an obvious question, but it seems

to have been brought into question this morning. All reservoirs have to end somewhere, don't they? A That is correct.

Q They just don't keep on going. That is the reason you drill dry holes? A That is one reason.

Q You can't always tell where they end?

A No, you can't.

Q The extent of reservoirs is no respecter of property lines, is it? A That is correct.

Q If that is a case then a little bit of a reservoir may be a surface acreage of five acres could extend over across a property line, couldn't it? A Yes.

Q Now then, if that were the case, it might even extend further, might it? A That is true.

Q Depending on how much you had extending across a property line would depend on how many wells you had to drill in order to adequately recover that oil, wouldn't it?

A That is right.

Q Or at least to penetrate that sand body?

A Penetrate that sand.

Q It is possible that you may have to drill on a five acre spacing to penetrate a sand body which existed below a lease, is that correct? A That is true.

Q And even 40 acre spacing might miss?

A That is true.

Q Now then, you stated that you had studied, I believe, 15 micrologs out of the wells in this field?

A Yes.

Q That is a little less than 15%, 10 or 15%?

A Yes.

Q You consider those micrologs are representative of the sand conditions in the other micrologs that are in existence and available for the field? A Yes, I did.

Q I believe counsel asked you if this might not be like a five layer cake, this reservoir? A Yes.

Q Don't you think in this reservoir the icing on top is really the best part of this cake? A Yes, I do.

Q It's really not very good icing though, even at that, is it?

A That is correct.

Q Now, do you know of any other Lower Gallup oil fields in this area, do you know of any others in New Mexico?

A According to the best information that I can recall off hand, I think there is a small one-well pool in the Gallup formation approximately several miles to the north. I don't know the Section, 18.

Q In other words, there might be another one, but there are not very many, are there? A No, that is correct.

MR. ERREBO: That's all I have.

MR. PORTER: Anyone else have a question of Mr. Finfrock?

he witness may be excused.

(Witness excused.)

The hearing will recess until 1:15.

(Recess.)

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. Mr. Errebo, will you call your next witness?

MR. ERREBO: For our next witness, we would like to call at this time, Mr. T. W. Brinkley.

T. W. BRINKLEY

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

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, your occupation, and by whom you are employed?

A My name is T. W. Brinkley, Chief Reservoir Engineer, Sunray, located in Tulsa, Oklahoma.

Q Would you give us a brief background of your education and experience as a reservoir engineer?

A 1940 I received a Bachelor of Science degree in petroleum engineering at the University of Tulsa. During the last twelve years I have been a reservoir engineer. Ten of those years was with Carter Oil Company, five being Division Reservoir Engineer, three

being Laison Reservoir Engineer with Carter Research the production field operations and management, two years engineering in charge of Secondary Recovery Group where we evaluated secondary recovery possibilities, and the last year and a half I have been with Sunray, currently as Chief Reservoir Engineer.

Q Have you made an engineering study of the Bisti-Lower Gallup Oil Pool? A Yes, I have.

MR. ERREBO: Are his qualifications acceptable?

MR. PORTER: Yes, sir.

Q Now, Mr. Finfrock, has stated that this pool was discovered in December of 1955. What development has taken place since that time?

A As Mr. Finfrock stated, the pool was discovered in December, 1955, with the El Paso Kelly No. 1. Since then we have drilled, I say we, the operators have drilled 134 wells throughout this area, being bounded by the red line which represents our spacing area. Out of those total 134 wells, 120 of them are completed as oil wells as shown on our exhibit as solid circles. We have identified five completed gas wells down in the southeastern portion of the field. Also there have been nine wells completed as dry holes within the boundary as we have shown here in red.

Hence, we have a pool approximately 20, 25 miles long, contains oil, it contains a gas cap down the southeastern portion, and to date it is not completely defined, but we feel that the future

development necessary in order to completely define this field will be accomplished within the red outline.

Q What development pattern have the operators been following?

A To date the operators have followed a voluntary 80 acre lease density. This means that every well drilled so far can be assigned 80 acres from its own lease. Most wells drilled have been located in the center of diagonal quarter, quarter sections within each Governmental quarter section. On the basis of 80 acres assigned to each of the wells completed to date, would indicate that we have approximately 10,000 acres developed.

Q Mr. Brinkley, do you have any information that this voluntary 80 acre density will not be continued?

A Yes. Section 22, Township 25 North, Range 11 West, northwest quarter, Shell has publicly announced four locations on the 160 acre tract which is 40 acre spacing. Likewise in Section 9, Township 25 North, Range 12 West, the north half, Shell has publicly announced four additional locations in the north half of the section, putting that on 40 acre spacing. In addition, Section 10, same township, Shell has publicly announced at least three additional locations in the southwest quarter, which puts that quarter on a 40 acre spacing.

Q Does this constitute a serious threat then to our present voluntary 80 acre density that the other operators have been following in this field?

A Yes, it constitutes a threat to the lease owners adjoining this closer spacing by requiring offset development.

Q Mr. Brinkley, at what point are we now in the life of this pool?

A We are in the early stage of development in this reservoir not only by incomplete development, incomplete defining of the reservoir, but also the accumulated oil to date represents a probable less than one percent of the oil in place.

Q I refer you to Exhibits 9 and 10 and will ask that you identify and explain them.

A Exhibit 9 is a tabulation of production statistics for the Bisti-Lower Gallup reservoir, San Juan, New Mexico. The data was gained from the New Mexico Oil and Gas Engineering Committee monthly engineering reports. The data shown on Exhibit 9 consists of seven columns which are identified as follows: First one on your left is the year and month, the second column the number of wells produced during the month, the third column is the oil production in barrels per month, the next column is the cumulative oil produced to the end of that month, the next column is the gas production in MCF per month, the next column is the accumulated gas produced in MCF, and the last column is the average gas-oil ratio for that month. The table lists the discovery month, which is December, 1955, when one well produced; immediately below that we have the months for the year 1956, and below that the months

through July, 1957.

Now, if you would look in the fourth column at the bottom, you will see where the Lower Gallup reservoir has accumulated 903,689 barrels of stock tank oil. The next to the last column on the right-hand side, 543,260 MCF. That is an average ratio of approximately 600 cubic feet per barrel. This again demonstrates that the accumulated oil to date is a small percent of the original oil in place, again meaning that we are in the early stage of development.

Exhibit No. 10 is a graphical representation of some of the data carried on Exhibit No. 9. You will notice the graph is in two parts, an upper part and a lower part. The upper part represents the monthly gas-oil ratio, the dates of course are on the bottom of the graph, and the scale on the left side on the vertical side for the upper portion shows produced gas-oil ratio in cubic feet per barrel.

An inspection of the upper part of the graph indicates that the average ratio to date has been roughly 600 cubic feet per barrel. Also it indicates that for the last month that we have on this graph, being July, 1957, has indicated an advancing trend of the produced gas-oil ratio. The lower portion of the graph contains the produced oil and the produced gas, the former is shown as a heavy line, a bar graph, if you will, and the later the produced gas is in a hashered area, the produced gas is shown as a hashered area.

This is only a graph showing the same data presented in Exhibit 9, but some people prefer a graph, some prefer a table. Hence we have included both.

Q The allowables in this field are pretty low now, aren't they?

A Yes, the allowables have been low.

Q Do you know what they are for this month, Mr. Brinkley?

A I'm not sure, but I think they are seven barrels per well a day.

Q Have all operators been requested to furnish their information?

A Yes, the Engineering Committee for the Lower Gallup reservoir, Bisti, of which Sunray is the Chairman, have agreed, all the operator members of this Engineering Committee have agreed to furnish all available test information to permit an engineering evaluation of the Lower Gallup reservoir. I might mention the members of this committee, the following operators are members: British American, Phillips, Amerada, Gulf, Lyon, Shell, El Paso, and Sunray.

Q In other words, the operators have agreed to exchange information, is that correct? A That is correct.

Q Then your testimony today is based on such information as has been made available to you by the operators?

A That is correct.

Q What information do you have on the characteristics or the fluids which are contained in the Lower Gallup?

A We have the results of two bottomhole samples. The first sample was taken on Sunray Mid-Continent C-21, located in Section 8, 25 North, 12 West. The second sample is the British American Mayre No. 1 located in Section 1, 25 North, 13 West. Both of these bottomhole samples have been analyzed in the laboratory. The significant results of these laboratory tests are summarized as follows: The bubble point pressure, 1207 pounds per square inch absolute. Solution gas-oil ratio, 405 cubic feet per barrel. Reservoir volume factor, 1.26, reservoir barrels per stock tank barrel. Viscosity of the reservoir oil, 0.83 centipose.

Q Based on the engineering information now available, and the studies which you have made, what spacing do you recommend that this Commission adopt?

A It is my opinion, based on present information, that 80 acre spacing is proper for this pool. I feel we have sufficient data to justify that a permanent order would be proper and fitting, but no objection to a temporary order since we believe any additional data would confirm our present conclusions.

Q Do you recommend that this Commission, in its issuance of an order, extend the present area defined as the Bisti-Lower Gallup Oil Pool to include the area which is contained within the red outline on the various exhibits which Mr. Finfrock presented this morning?

A Yes, as Mr. Finfrock presented this morning, the yellow boundary represents the present known, or the presently defined boundary of the Lower Gallup reservoir. We have enlarged the area as shown by our red spaced outline. It is my recommendation that the Conservation Commission enlarge the presently known or identified yellow boundary to include the boundary as we have defined it here in the heavy red line.

Q Do you concur in Mr. Finfrock's testimony that the Lower Gallup formation is continuous throughout this area?

A Yes, I do.

Q Do you have any engineering information showing the quality of the sand which is covered by this application?

A Yes, I do.

Q Will you please refer to Exhibit No. 11 and identify and explain its significance?

A Before we open Exhibit No. 11, I would like to make some opening remarks. Exhibit 11 is the bound booklet of core analyses. This exhibit contains the results of cores taken on 26 wells. Bearing in mind now we have drilled and completed 134 wells, yet we have core analyses on only 26 wells. I believe that is enough information to permit a reasonable interpretation of the sand quality and sand characteristics for the Lower Gallup reservoir.

The first eleven pages in Exhibit 11 contain the results of core analyses for wells located along the longitudinal axis of this

reservoir. Now, that part of the reservoir contains the best quality rock in the entire reservoir. Also, as we will show later, not only is it better quality rock contained in the wells located along the longitudinal axis, but also it is more or less confined to only the upper portion of the reservoir. In addition to that, these cores which we have shown on the exhibit, represent the rock that has been taken as we drilled down through these wells, and we have taken the cores and had them analyzed and many many instances in our core analyses we find and can identify permeability throughout the entire section.

Furthermore, we find that as we move from the center, better-developed sand in the upper portion of the reservoir, to the northeast edge, we grade into inferior rock characteristics. Likewise, as we move a long way from the longitudinal axis to the south portion of the reservoir, we again grade into inferior rock characteristics. Which means if you take a transverse section across the reservoirs, you will go from inferior to the best you have got back to inferior rock characteristics.

Let us turn to page one of Exhibit 11. This sheet represents the electric log with the core analysis superimposed for the Phillips Petroleum Company Benally No. 2 located in Section 5, 25 North, 12 West. Mr. Devline will point to the location of the well. Bearing in mind again that the first eleven pages that we talk about, these wells represent the best wells that we have. They will all be

contained along the longitudinal axis of the reservoir. Page one shows the electrical log. In the center we have, we might say, the well bore and the depth. Also we have identified the upper sand with a one, and then the subsequently lower sands with numerical numbers, on the left we show the porosity graph. It is a bar graph plotted with depth according to the electrical log. The base line, which is on the right-hand side of the bar graph, represents zero percent porosity. As we move to the left, each division represents ten percent of porosity. You can see from this porosity graph that we have identified porosity throughout the entire cored interval.

On the right-hand side we have the permeability plotted as a bar graph. The base line representing zero millidarcies permeability, the next line to our right, one millidarcy, the next line ten millidarcies, the next 100 and the next 200 and the next 300 millidarcies. As you can see there looking up and down the permeability graph throughout the vertical section, we have identified permeability.

I direct your attention also opposite the sand which we identify as one being the upper member of this reservoir, the porosity is greater, also the permeability is greater.

Let's turn to page two. Here again we identified similar characteristics. This well is the Amerada Petroleum Joan White No. 2 located in Section 9, 25 North, 12 West. Again the porosity graph illustrates higher porosity opposite sand No. 1, yet we have

porosity throughout the vertical section. On the permeability graph we have identified greater permeability opposite sand No. 1, and also we have identified permeability throughout the vertical section.

I might mention possibly the average permeability for this upper member is of the order of 100 millidarcies. You will notice that the permeability in the lower portions of the reservoir is inferior to this 100 millidarcy sand.

Page three is the British American Douthit No. 11 located in Section 29, 26 North, 13 West. Again we display the same rock characteristics, better porosity and better permeability opposite the better sand, the uppermost sand. In this well the complete section was not cored. Sometimes we don't always core in the entire section, but what is there does show porosity and permeability.

Page four shows the similar thing, that is the British American Douthit B-2, located in 28, 26 North, 13 West. Without taking too much time, it is obvious that the upper portion of this reservoir identified as sand 1, is better developed in porosity as well as in permeability, and the relative values of each of these wells are consistent with one another.

Page five, the British American Mayre B-5, located in Section 35, 26 North, 13 West. Again we have a duplication of the similarity that we have been through.

Page six, the British American Mayre B-1 located in Section 35, 26 North, 13 West. Again a repetition of the preceding

information, namely that the upper sand is better developed both in porosity and permeability, and we have porosity and permeability in the vertical section.

Q Could I interrupt you for a moment, Mr. Brinkley?

A Yes.

Q On page five, on Mayre B-5, that shows an interval in approximately the center of the section shown with no porosity and no permeability. That means that no core was taken there?

A There was no core taken in that interval. We sometimes take what we can get and we try to do the best we can, but that's all we got.

Page 7, British American Producing Company, Mayre No. 1, located Section 1, 25 North, 13 West, again the upper sand shows better development. The lower portions show porosity where we have taken cores and we show permeability in some of those sections. Now, it's expecting too much from nature to have permeability every place. We take the reservoir as we get it, and in this section we found no permeability, very normal.

Page eight, Sunray Mid-Continent Oil Company Federal C-1, located in Section 6, 25 North, 12 West. Only the upper portion was cored, but again we have better-developed porosity and better-developed permeability, and those values are consistent with the previous illustration.

Page nine, again the same thing, which is the Sunray

Mid-Continent Federal C-10, located in Section 6, 25 North, 12 West.

Page 10, Sunray Mid-Continent Federal C-14, Section 8, 25 North, 12 West. Again the upper sand is better developed in porosity and permeability than the lower sections.

Page eleven, which is the last well now along this longitudinal axis that we have cores on that permit us to compare and conclude that that is the better-developed sand and that the relative values of the porosity and permeability throughout the longitudinal section where we have these cores shows consistency in values. So that at page eleven is Shell Oil Company Carson No. 1 located Section 24, 25 North, 12 West. Here we have better-developed porosity and permeability opposite the main body of the sand and below.

Now, pages twelve through twenty-four represent wells in the southwest flank. We have 13 wells that are between the longitudinal axis where the better sand is, and the southwest edge of the field, so these 13 wells in this inferior rock area will be studied next. Again we will attempt to show that although all these 13 wells show inferior rock characteristics when compared to the center of the pool, when we take them one at a time there is a great similarity as we go from northwest down to southeast.

Page twelve is El Paso Natural Gas Products Company Kelly State No. 1, the discovery well, located Section 16, 25 North,

12 West. Opposite Sand 1 we have a porosity about equivalent to the remaining porosity throughout the vertical section. On the permeability we have a permeability opposite the upper portion of the sand, which is also consistent in value with the lower portions of the reservoir. I should like to remind you that the previous examples we had average permeabilities of 100, 200 millidarcy range. Here we are talking about one millidarcy range. Again we show permeability in the vertical section.

Page thirteen, Anderson Prichard Begay No. 1, Section 25, 25 North, 11 West. This is an interesting well. The upper sand, you will notice, has inferior porisity and it also has inferior permeability. In fact, there are three sections in here, three intervals that the permeability hardly shows, the field has kind of slipped off, but there are three samples that did show this permeability. But this well is completed in the section immediately below the No. 1 sand. The No. 1 sand, you will recall, is the heavily colored yellow section shown on the cross section. This is the only well, to my knowledge, that is completed in the second sand which is the sand immediately below this better-developed upper sand, but even so, the second sand has inferior rock characteristics, namely down to the order of ten millidarcies. That is only one tenth of the average pe.. .ability in the upper sand. The porosity still remains inferior to the center located wells.

Section CM and W Drilling Company Elliott located 30, 26 North,

13 West. Here we find inferior porosity throughout the vertical section and inferior permeability throughout the vertical section.

Page fifteen, CM and W Drilling Company Elliott No. 1, Section 30, 26 North, 13 West. Again we find inferior porosity with zero permeability. According to the core analysis, actually they made a well.

Page sixteen, British American Oil Producing Company Salge B-5, 33, 26 North, 13 West. Here we find poor sand development, although it is better than the lower sections, it is still inferior for the upper sand member. The same is true with the permeability, yet throughout the vertical section that was cored, we have permeability, also porosity.

Page seventeen, El Paso Natural Gas Products Company Kelly State No. 11, located in Section 22, 25 North, 13 West. Here opposite Sand No. 1 we find permeability and porosity, yet of inferior quality, but consistent with the previous values for the wells along the southwest portion of the field. Sunray Mid-Continent Federal C-18, a similar condition exists.

Page nineteen, the El Paso Natural Gas Kelly State No. 2, Section 16, 25 North, 12 West. A similar condition exists here, also. The same for page twenty, which is the El Paso Kelly State No. 3 located in Section 16, 25 North and 12 West. Here possibly the upper sand is better developed than the lower portions, but yet inferior to the wells located along the longitudinal axis.

Page twenty-one, El Paso Kelly State No. 4, Section 16, 25 North, 12 West. Again we have inferior rock characteristics and consistent with the other wells along the southwest portion of the field.

Page twenty-two, El Paso Kelly State No. 6, the same condition exists there. Page 23, El Paso Kelly State No. 7 located in 16, 25 North, 12 West. Here we find porosity and zero permeability. F R Anderson Petroleum Federal 21, 29, Section 29, 25 North, 12 West. This is the last well of the 13 that I explained that we have core analysis for along the southwest portion of the field. The same condition exists in this well, namely the rock characteristics for all wells completed in the southwest portion of the reservoir are, contain sand characteristics inferior to the wells along the longitudinal axis, yet when we examine wells along that trend, that they are generally similar to one another. We have two wells remaining which are the two wells along the northeast portion of the reservoir. Amerada Petroleum Gle-Na-Nup-Nah No. 2, Section 5, 25, 12 West. Here we find that the porosity and permeability are inferior to the wells located along the longitudinal axis, yet they resemble a similarity to those wells located along the southwest flank of the pool.

And the last well is the El Paso Natural Gas Sullivan No. 1-B, Section 30, 26 North and 12 West. Here we find better development in the No. 2 sand as far as porosity is concerned, yet it is of

inferior quality and we find, you might say, very little permeability in either the first or second sand.

In summary, we find that the better sand development occurs along the longitudinal axis. We find that there is great similarity in the values of the better quality sand as we proceed along the longitudinal axis, as we go to the southwest part of the field we find we get into inferior sand characteristics, yet have a similar quality from well to well. Also in the northeast part of the pool where we have the data, we find a similar condition, namely inferior sand characteristics, yet similarity between the wells.

So, in summary, it is my conclusion that the Lower Gallup reservoir consists of a thick sand section and the entire section contains permeability with the better development in the upper sand, and the upper development further confined only to the longitudinal axis. Although the better quality of the sand is contained in the upper sand, we do find an inferior gradiation as we proceed to the southwest, and an inferior gradiation as we go further to the east.

It is further my opinion, it is my opinion predominantly the reserves in the Lower Gallup reservoir will be contained in the upper sand and further the recoverable reserves will be regained predominantly out of the upper sand.

Q Mr. Brinkley, do you find evidence of well interference?

A Yes. Exhibit No. 12 has four wells circled, and the wells are located roughly along a transverse section at Section 6, Township

25 North, 12 West. The wells circled, starting from the top, are the Sunray 2-C located in Section 31, Section 6, No. 4, No. 6 and down in Section 7, C-18. Those wells have been shutin for about a year. I would like to direct your attention to one little statement here that two of the wells intermittently produced a small amount of oil during that one-year period. They are the two wells, No. 4 and No. 6, but they are the only wells that we know of that we can estimate interference. I should like to direct your attention also that No. 18, located in Section 7, is in the inferior rock character area. Also Well No. 2-C is located in the northeastern portion of the field, again where the rock characteristics are inferior. Wells 4 and 6 are located in the area where the rock characteristics are good.

Briefly, we have observed pressure interference in all four of these wells across this transverse section, indicating that the pressure reduction occurs equally as good in the inferior rock characteristics as well as in the good rock characteristics, and the magnitude of the interference is sufficient to warrant us to conclude that interference will extend over a large area.

Let's take some detailed data. The insert on Exhibit 12, you will notice the insert on Exhibit No. 12, the first well C-18 which is the southerly-most well. Again it is located in the inferior sand characteristic area. I think we had six feet of sand, something like that. Five or six feet, perhaps one millidarcy of sand. The

table states that on October 22, 1956, over in the fourth column we measured a bottomhole pressure, 1535 pounds after the well was shut in thirty-three days. Approximately a year later, September 5, 1957, we measured the bottomhole pressure and it was 1430 pounds. That's a drop of 105 pounds per square inch throughout this period, the accumulated oil was 640 barrels, namely it did not produce during that eleven-month period. So we have experienced a draw-down of 105 pounds per square inch, and that draw-down is due to the production of offset wells only.

Now, if we consider that pressure draw-down as a result of producing the offset wells and taking the nearest offset well that produced and use that distance as a radius and circumscribe a circle around that well, that would give us an effective area. Now, that effective area is 250 acres in the inferior rock characteristics area. Let's take the last well, Sunray Mid-Continent Federal O No. 2. That well, on October 24, 1956, we measured a bottomhole pressure of 1512 pounds. On August 15, 1957 we measured 1207 pounds, a drop of 305 pounds per square inch.

I shall direct your attention again that this well is in inferior sand characteristics area. The interference, the drop in pressure being due to production, this well being shut in, hence the interference was due to the production in areas surrounding that well.

Again taking the radius of an area of drainage equal to the

closest well that produced during this period, we got an effective drainage area of 126 acres, the same condition exists for No. 4 and No. 6 where on the table in similar fashion we have identified drop of 82 pounds and 97 pounds. That's in the good quality sand. So in my opinion we have evidence that drainage occurs even in the inferior sand characteristics areas for a minimum of 126 acres. That's considerably in excess of 80 acres.

Q Then, based on this information, Mr. Brinkley, is it your opinion that one well will drain 80 acres economically and effectively?

A It is my opinion that it will with what information we have, and even in the inferior rock characteristics area will effectively drain an area in excess of 80 acres.

Q Then, Mr. Brinkley, if wells are drilled on a 40 acre density, will unnecessary wells be drilled?

A Yes.

Q How many?

A Approximately 300. Now, that is only an approximate figure, we don't know precisely what the definition of the boundary of this reservoir is, but it will be conservatively estimated that we will drill at least 300 unnecessary wells if we go to 40 acre spacing.

Q How much would it cost the operators to drill these unnecessary wells?

A We are looking at a minimum of twenty million dollars.

Q Will economic waste result if unnecessary wells are drilled?

A Yes. If we have to drill these unnecessary wells, this minimum of twenty million dollars could be more prudently spent in exploring for new oil finds or in purchasing equipment or materials for pressure maintenance and secondary recovery operations.

Q Have you made a study of the economics of drilling this pool to an 80 acre density as compared to a 40 acre density?

A Yes, I have.

Q Please refer to Exhibit No. 13 and identify and explain it.

A Exhibit 13 is an economic comparison of 40 acre development versus 80 acre development for the Lower Gallup reservoir. On the right-hand side we have two columns, one for 40 acre values and one for 80 acre values. The first number is the original oil in place, 40 acre wells and 80 acre wells. Now, the original oil in place at Footnote 1 means that we determine the oil in place volumetrically from the isopacks that you have seen this morning, core analysis, which I have presented, the fluid analysis that I also presented. The ultimate recovery which is Item 2 under Footnote 2, we have calculated a probable recovery. I would like to emphasize that probable. Now, in my opinion it is a probable number. A 40 acre well, 44,000 and 80 acre well, 88,000 barrels. The value of the recoverable oil, $111,000 for the 40 and $222,000 for the 80 acre well.

Investments to drill and complete a flowing well, based on an

average of nineteen wells, that we have drilled where we have the closed out accounting records, have averaged $55,000 each. The surface equipment, Footnote 5, consists of artificial lift, $10,000, miscellaneous surface equipment flow lines, proportionate share of tank battery, roads, water wells and various and sundry things, $11,000 per well. A total cost for the nineteen wells that we had adequate records to analyze, was $76,000 per well.

Operating expense, lease and well costs and taxes, we have estimated at $37,000 for a 40 acre well and $75,000, roughly, for an 80 acre well. Now, when we take the total revenue from the production and subtract out the investment and the operating expense, it indicates that a 40 acre well is a bread-even proposition. In fact, with our figures we show a loss. An 80 acre well shows a profit of some $70,000. That profit is a non-discounted profit, based on future earnings; in order to get an economic comparison of your present investment and your future earnings, we convert the future earnings back to the present condition. Hence, using a present worth compound interest factor of six percent, we show a material loss of 40-acre development and a very modest profit on an 80-acre well. Let me point out also that these economics do not include the cost of acquiring the leases. Also may I point out that there is differences of opinions among operators as to investment values, operating costs, various things like that which are inherent to the operation of different companies. This represents our

interpretation as a, may we say as a preliminary economics based on only what we know today. I don't think our economics would be materially affected with any reasonable differences in operating techniques and things like that, or even with additional information.

Q In view of the economic picture which you have presented, is it economic waste to drill on 40 acre spacing in this field?

A Yes.

Q What has been the industries success ratio of wells drilled compared to discoveries made?

A That success ratio is commonly referred to as demanding industry to drill ten wildcat wells in order to achieve a new discovery oil well.

Q Actually, your economics show a rather low profit even on 80 acre spacing, don't they, is that correct?

A That is correct.

Q In your opinion then, is the profit which can be made on 80 acre drilling commensurate with the risks which an operator must take to find oil and stay in business?

A No, it is not.

Q In other words, will the expected profit from this pool on 80 acres be sufficient to support exploratory drilling in New Mexico and elsewhere? A No, it will not.

Q Is there anything that can be done to increase the expected recoveries from this pool and improve this situation?

A Yes. By the application of secondary recovery operations with pressure maintenance at as early a date as possible.

Q What are the operators now doing to determine if secondary recovery will be feasible?

A At the present time Sunray, Phillips and British American are conducting a missible phase displacement test. That test is located at the intersection of Township 25 and 26 North, Range 12 West, 12 and 13 West. We went in and drilled a well in the center of four closely located oil wells. We have injected approximately 30,000 barrels of LPG. It is our plan to follow that LPG with injected gas. The gas will drive the LPG slug through the reservoir, displacing the reservoir oil and improve the recovery.

To date, in fact, today we will complete the injection of the 30,000 barrels of LPG a few days ahead of schedule. We have equipment arriving and will start gas injection in a very few days. This program, this test will continue so that we can evaluate and see if this reservoir is susceptible to this improved recovery method.

In addition to Sunray, Phillips and British American physically participating in this test, three other companies are contributing money to this test. They are namely the Shell, Amerada and El Paso.

Q Mr. Brinkley, if this is successful, how much do you expect this process to increase recoveries?

A My opinion, we can reasonably expect more than twice the recovery with this process than by natural depletion. That, in

effect, is just like picking up approximately two more oil finds with the wells already drilled.

Q Has Sunray had any experience in other types of secondary recovery that lead you to believe that LPG injection will be successful?

A Yes. This missible phase displacement is not a mysterious thing. It has appeared in magazines, papers and whatnot as a new recovery method. Missible phase displacement can be applied in several forms. Sunray has practiced missible phase displacement for several years. Several other companies have too, but they don't realize it. Our gas cycling pressure maintenance operations are nothing but a missible phase displacement operation where we have a reservoir field with wet gas and we inject dry gas to displace the wet gas, that very simply is a missible phase displacement. You are using a dry gas to displace something of more value, wet gas, and missibility means that they mix that is all it means. You can effectively displace the wet gas with the dry gas. Something that we have done for a number of years.

This LPG test that we have is a little bit different than that because not only are we pushing the slug forward by wet gas driven by dry gas, but in addition to that we have the extraction process ahead of it where the LPG extracts or washes out, if you will, the oil ahead of it. So we have no apprehension as to the applicability of this process, but it does require a field test to see if the

reservoir is susceptible to it and see if the reservoir fluids will react like we think they will.

Q You expect this program to be successful, don't you, Mr. Brinkley?

A The evidence we have to date, there is nothing available yet that would indicate that it will fail. Now we are in the early stage of this test and we don't have all the information we intend to get to fully evaluate the test, but to date there is no evidence to the contrary.

Q Now, in the event it should not be successful, you are not fully relying on this program of LPG gas injection to recover additional oil, are you?

A No, we are not relying entirely on the missible phase displacement program. It's customary to evaluate several recovery methods and pick the optimum one for prudent operation. So we have investigated the possibility of injecting the produced gas and the results of that engineering study indicates that if we should go that route, that we can improve the recovery by fifty percent as compared to primary methods which economically is better than the present competitive methods.

Q In other words then, gas, just straight gas injection is a proven method, is that correct?

A It is a proven method and people have become educated to it and have accepted it.

Q You are of the opinion it would work here?

A Yes.

Q Now, Mr. Brinkley, what effect does close spacing have on the success of an LPG gas or just a regular gas injection program?

A In my opinion close spacing would offer a hazzard to the effectiveness of achieving the maximum possible recovery. In other words, 80 acre spacing would be advantageous because the greater the distance between your injection well and your oil well the greater will be your overall flushing efficiency, because it minimizes the channel, the channeling nature of your driving fluid. I have observed that in many water floods. I have observed it in our cycling projects, and other experts who have published their opinions, recognized experts if you will, have made the same statement.

In checking the overall flushing efficiencies of several gas cycling projects, we have defined overall flushing efficiencies within the swept portion as high as 80 percent. So in my opinion it behooves us to follow as wide a spacing for secondary application whether it be gas drive or whether it be LPG injection, or water flooding or what you may want to use, it would behoove us to use as great a distance between the injection wells and the producers as possible.

In addition to that, the Sacroc Engineering Committee have also observed in their flooding operations quick break through on

first row offset and prolonged displacement flushing officiencies at a high value on the second row offsets, and they have gone to shutting in near wells in order to achieve the higher flushing efficiency.

Q Can you name any of these experts that agree with this theory of yours, Mr. Brinkley, that the wider spacing is conducive to a higher ultimate recovery?

A The theory is not unique with me. I have learned from the other people, but I have observed that the statement that these recognized authorities have released, and my association with the research people as well as the practical operators leads me to believe that the wide spacing is the prudent thing to follow. Now, specifically, one recognized expert that I can mention who has made this statement is Morris Muscat in his book Physical Principles of Oil Recovery. I believe that is about the name of it, but he makes that statement.

Q Who is Mr. Muscat employed by or affiliated with?

A Dr. Muscat is connected with the Gulf Oil Corporation in their research facility.

Q Then would 80 acre spacing increase the oil recovery which could be obtained under secondary recovery programs which the operators are now considering?

A In my opinion it would assure a maximum flushing efficiency, whereas a closer spacing would hinder it.

Q Mr. Brinkley, what other rules do you have at this time to offer to the Commission for the regulation of this field?

A The location of the wells to be in diagonal 40 within a Governmental 160 acre tract, no closer than 330 feet from lease lines. The location in diagonal 40's will encourage uniform spacing, 330 foot formations will permit flexibility of well location where needed, especially near the edges of the field or at the gas cap. Most of the wells drilled to date are in the center of 40's. In addition I would recommend that we have original bottomhole pressures, better state it this way, originally completed bottomhole pressures and gas-oil ratio tests and semi-annual gas-oil ratio and production tests fitting a schedule consistent with what the Commission would desire. Also a limiting statewide gas-oil ratio of two thousand to one.

Q Then, based on your testimony today, Mr. Brinkley, is it your opinion that the granting of this application is necessary to prevent waste and secure the greatest ultimate recovery of oil from this pool? A It is.

Q Were all exhibits offered by you today as a part of your testimony prepared by you or under your supervision?

A Most of them were prepared personally by myself. Some of them were delegated and I supervised them.

MR. ERREBO: If it please the Commission, at this time we would like to offer Exhibits 9 through 13 in evidence.

MR. PORTER: Are there any objections to the admittance of these exhibits? They will be admitted to the record.

MR. ERREBO: That's all we have.

MR. PORTER: Anyone have a question of Mr. Brinkley? Mr. Seth.

CROSS EXAMINATION

BY MR. SETH:

Q I would like to ask just a very few questions. First, on the secondary recovery test you referred to Sacroc. Would you compare the permeability existing there with this pool here?

A That is a very dangerous statement to make because of the heterogenity of rock characteristics. Now here we have very good permeability, here we have very poor, we have observed in Sacroc we have very good permeability, we have very poor.

Q Can you compare the two, the good there and the good here?

A No.

Q The bad here? A No.

Q Do you have any figures on that at all?

A No, I don't.

Q Well, how can you compare with the Sacroc for your secondary recovery to this pool then if you have no basis of comparison as far as permeability is concerned?

A I can answer you best this way, that fluids follow a freedom path, that is they will follow a path of least resistance.

Now their path of freedom would be affected by pressure differential and distance. Now, that physical condition has been observed in many, many reservoirs with many kinds of rock characteristics. I'm afraid that I would mislead people if I got down to a minute rock characteristic because to me it is irrelevant.

Q It is just pressure and distance are the only factors as far as you are concerned? A That is the important thing.

Q You are assuming, in your testimony, about the sweep efficiency and so forth that this is entirely a homogenous reservoir?

A No reservoir is entirely homogenous.

Q Are you assuming it or are you not?

A I beg your pardon.

Q. Can you answer the question first and then explain your answer?

A I am not assuming that the reservoir is homogenous.

Q You are not? A No, sir.

Q Go ahead and explain.

A Since we recognize that fluids follow a freedom path, then it is up to the engineers to direct the flow of the fluids and encourage them to follow a definite path, which is what we try to do.

Q How do you try to do that?

A By the proper location of our wells and withdrawal rates and injection rates.

Q But your initial wells where you pilot flood are for all practical purposes on the 20 acre spacing, is that right?

A Yes, the oil wells are located in centers of 40, but the injection well --

Q The injection well is a five spot?

A That is correct, yes.

Q Why didn't you begin it on a wider spacing if you are going to direct the course of this LPG as you stated?

A That is a very interesting question. Don't misunderstand me, we can explain it. We searched around for an area where the wells were closely located.

Q Why did you do that?

A We wanted our results quickly. We were experiencing rapid reservoir pressure drop and we had to get our rules soon enough so that we could apply this method, if it can be proven applicable, before sufficient pressure drop had occurred that would prevent the application of this method. That is the reason we did it.

Q Then does time of the recovery of the LPG, is that a factor in a project of this character?

A I don't understand what you mean about time of recovery.

Q This LPG I assume costs considerable amount of money. If you inject it you are interested in getting it back, I assume, in reasonable time.

A Economics are not only based on recovering the LPG, but

recovering more oil.

Q Can you answer the question directly?

A What is your question?

REPORTER: Reading: This LPG I assume costs considerable amount of money. If you inject it you are interested in getting it back, I assume, in reasonable time.

A Yes, we are interested in getting it back in a reasonable time, and LPG does cost money.

Q Then isn't that the case the closer the spacing the quicker you will get back the slug and the recovery of oil?

A So that I don't confuse the Commission --

Q (Interrupting) I don't believe the question will be confused if I may say so, they have a lot of witnesses. Just go ahead and tell us the story.

A All right. We are interested in making money. Now, there is an economic optimum spacing which would keep our investments at a minimum yet provide a maximum recovery in revenue that would permit us then to define the spacing so that we could get the maximum amount of oil, make the maximum amount of money with the minimum amount of investment. We can't always achieve precisely the optimum condition, but we have to assure ourselves of the best chance of getting the most oil out within a reasonable period of time, and the 80 acre spacing qualifies for that decision.

Q Would you testify, or would you state that you would get it

brok sooner if it were on 40 acre spacing, or would you not?

A You might get it back quicker on 40's than you would on 80's. It is also a function of how fast you inject it and how fast you withdraw. It is a complex thing. I don't want to be evasive with you.

Q The reason I asked the question was you testified that you pick the four close wells because you wanted a quick answer?

A Yes.

Q From that I assume the closer the wells the quicker you get an answer, so consequently the closer the ultimate spacing the quicker you get back the secondary recovery oil?

A No.

Q The quicker you get back the LPG?

A No, I misled you.

Q I'm easily misled.

A One thing we are interested in is channeling, we want to know when the LPG breaks through to the oil wells, by knowing how much we have injected and the time at which it broke through, then that will give us some idea of the flushing efficiency. Another thing we wanted to know, and know fast, was the pressure. We have to maintain roughly 1250 pounds pressure before this method will work. Another thing we wanted to check and learn quickly would be the injection capacity of these wells. If we can't get the LPG in we want to know it now. If we can get it in, we want to know it now.

So for the reasons we picked the wells that were closely spaced, so we can find the answer in six-month's time rather than wait a year and a half or two years when the pressure is down so far we couldn't apply the method.

Q Well, Shell is participating in the program?

A Yes.

Q You are using some of their money at least?

A Yes.

Q Now, I want to refer to your Exhibit 13. Do you have one handy there? That's the well cost. Do you have that there?

A Yes.

Q Now, would you please state the factors that you use in making these computations? A Yes, I'll be glad to.

Q Will you start with the oil in place?

A Start with the first one, oil in place?

Q Yes.

A We find that the better quality sand is along the center part of the reservoir, so we took the isopack and said that the sand contained within the 20 foot isopack line was better quality than the sand contained between the 10 and 20 contour line, the inferior rock than would be along the edges of the field where the isopack thicknesses were less than 10 feet. Now that is a means of dividing the reservoir up into three parts where we studied the inferior rock, we studied the best rock and then the rock in between. So we

determined the oil in place in the best quality rock, the oil in place in the poorest quality rock, and then the oil in place in between and added them together, which would define the oil in place.

Once we defined that, then we followed the solution gas drive performance equations.

Q Excuse me, give me a little detail on how you determined the oil in place between the bad and the good section, what thickness did you use and all the factors?

A Between the zero and 10 foot line that would be the poor quality sand, we found or measured 14,203 acres which had 17,016 acre feet. The rock properties were 10.6% porosity, 6.2 millidarcies permeability, 43% connate water, and it contained 26,600,000 barrels of stock tank oil in place. Between 10 and 20 foot contours on the isopack, we had 9,736 acres, 146,045 acre feet, a porosity of 12.7%, permeability of 43.6 millidarcies, connate water of 23% with 83,200,000 barrels of oil in place. For the best sand where we had 20 or more feet or in that area we had 732 acres, 15,376 acre feet, a porosity of 14%, a permeability of 100 millidarcies, connate water of 10% with 12,000,000 barrels of oil in place.

Now then, out of that reservoir volume I had to subtract the gas cap volume. Now, the gas cap covered 3,906 acres approximately, or 24,390 acre feet, or roughly 16,400,000 reservoir barrels.

Q Now, on your first point zero to ten foot contour, how

did you arrive at this 10.6%?

A I took all of the core analyses that were on wells located between the zero and ten foot isopack line, of which there were thirteen. I added them up for the porosity and permeability and divided by thirteen and got arithmetic average porosity and permeability.

Q It is not a weighted average?

A No, sir, just an arithmetic average.

Q The same on your permeability?

A Precisely.

Q Do you feel that a more accurate analysis could have been made if you had used the weighted average? What were the maximum and the minimum porosity within that area?

A The maximum value between the zero and ten foot isopack line was 18% porosity and 70 millidarcies permeability, the minimum value on a producing well was 6% porosity, and zero millidarcies permeability.

Q Then your average of zero and 70 is your arithmetical average, is that a very true picture of the situation?

A Well --

Q (Interrupting) How much of the interval was 70 and how much was zero, is that a factor or not?

A Well, that is only one of the thirteen samples. The other twelve average one millidarcies.

Q You are using just bare averages and you disregard entirely, if I understand you, the thickness of the particular formation for which that factor is given, is that right?

A I don't understand you.

Q You are just using a maximum and minimum, you disregard how much of the interval is the maximum and how much is the minimum, is that right?

A No, I'm afraid I haven't made myself clear.

Q Tell me how you arrived at your average again.

A I got the average porosity for each of thirteen wells, I got the average.

Q How did you get the average?

A By reading the core graphs we have here.

Q What figures did you use, the maximum and the minimum?

A Well, the maximum -- let me check here -- I'm sorry, I misled you. This is 7 millidarcies instead of 70. What I did was just by inspection, take the sand interval, the average value from the bar graph, just by inspection, I didn't try to refine it, and I did that for each of the thirteen wells completed within the zero isopack line. And I take the averages for each well and add them up and divided by thirteen.

Q The selection and the manner of getting the average would have quite an influence on your final figure, would it not?

A No, it would not.

Q It wouldn't have any influence?

A Oh, one percent maybe. It's a nebulous thing.

Q If the same is true for both porosity and permeability, wouldn't it have an effect on your figures in a substantial amount?

A With the data we have, no. Now, if every well were cored we could construct iso-permeability maps, iso-porosity maps, and set up a grid network and run it through the electronic computer, which we do in many cases. But I have observed where we have, I'll put it this way, usually by arithmetic averaging, if you have enough samples that you are still representing, shall we say, the average rock properties, I hold no apprehension as to the average values I have used.

Q Does that hold true where there is a great spread between the maximum and minimum which we have here in which you say the spread is great here?

A We have minimized the spread that you are referring to by breaking the reservoir up into three smaller segments, so we have eliminated that hazzard.

Q Do you have any figure on the per acre oil in place within the zero line or within any other particular area?

A The stock tank oil in place?

A Yes, the corrected stock tank.

A I would say that the in place oil on an acre basis, assuming an average acre would be someplace in the neighborhood of

5,000 barrels.

Q We're talking about per acre feet, per acre foot.

A Per acre foot?

Q Yes.

A Yes, I can give that. In the neighborhood of 520 barrels per acre foot. That would be for an average acre foot.

Q Now, would you say that since it is an average it would hold true pretty well throughout the area that you have defined here?

A No. No, no, not at all.

Q That's perhaps, I might state it this way, in the testimony of Sunray at the LPG hearing, you had a slightly different figure I believe. Would you explain the difference?

A Do you have an exhibit?

Q Is that a different area?

A I would have to refer to the previous exhibit.

MR. ERREBO: If it please the Commission, I think the record will show that a different witness testified.

Q I believe a Mr. Brooks testified. Are you acquainted with Mr. Brooks?

A Yes.

Q He testified, I am reading from page sixteen of the record in Case No. 1280, now this is the case on the LPG understand. We will assume that it is limited to that general area, although it doesn't express it as so. You say that other witnesses have said it is pretty much the same all throughout the reservoir, we can

use this figure. He testified that there are 670 barrels per acre foot of original oil in place.

A Yes, I certainly appreciate that statement. The pilot area is in the better quality sand. Now, if you take the better quality sand of 670 per acre foot and add to it the poorer quality sand which has less than 100, the overall average is still consistent with the figures that were presented at the previous hearing.

Q Sunray, in a letter to the various operators dated July 8, 1957, indicated that the original stock tank oil, this is a sentence, recovery by primary depletion is calculated to be 20.9% and recovery by LPG is estimated to be 50% of the original stock tank oil, or 234,000 barrels. Original stock tank oil would be 468,000 barrels according to this letter. This letter was written by Mr. Penn. Would you like to look at the letter?

A I'll be glad to look at the letter.

Q Do you have any comment on it?

A I don't know.

Q Do you have any comment on figures used there as compared to your figures?

A No, they are consistent with my figure.

Q You feel they are. Now, referring still to Exhibit No. 13, ultimate recovery, could you give us a time factor on that? How long it is going to take to recover 44,000 barrels?

A For the 40 acre well, thirteen years.

Q How long for the 80 acre? A Twenty years.

Q Twenty, did you say? A Yes.

Q Now, I hate to burden the Commission with this, but our figures are on a little different basis, but I would like to have the witness compute the stock tank oil within the isopack, the zero to 10, the 10 to 20. Would you do that for us?

A You want the oil in place between the contour lines?

Q Separately on a per acre foot basis.

A All right.

MR. PORTER: Let's take a short recess.

(Recess.)

MR. PORTER: The meeting will come to order. Do you have your answer computed, Mr. Brinkley?

A Yes. The original barrels of stock tank oil in place for the zero to 10 foot isopack interval will average 370 barrels per acre foot. For the 10 to 20 foot interval they will average 570 barrels per acre foot. For 20 feet or more, 780 barrels per acre foot, an average for the entire reservoir, 520 barrels an acre foot.

Q Thank you for the calculations. That gives us a little better basis to compare our figures. Now, in making these computations did you use your isopack map that was introduced in evidence --

A Yes.

Q (Continuing) -- earlier in the hearing?

A Yes.

Q On that isopack map those thickness figures, are they based on the net microlog?

A They were based on the net, they're based on the spread in the microlog, logs.

Q It purports then to be the total of the microlog pay?

A Yes.

Q At the point through which the line is drawn, is that correct? A That is correct.

Q Just a few more questions. We have divided this up in the hope of saving time. I have about two more questions. How many wells would you say that you have listed that are in the inferior rock area, as you call it? A Thirteen.

Q How many of these would you regard as being profitable wells? A None of them.

Q None of them?

Well, if a substential portion of this reservoir and the data that you have used is in areas that are not profitable, do you think that should influence the rate of development of the better portion?

A I'll state this, that they are non economic on 40 acre development. I didn't make myself clear to you.

Q Were you testifying on an 80 acre basis then on the economic?

A That is a good question.

Q Well, you are a good witness, can you give us an answer?

A On primary recovery I would judge that they would be non economic under competitive type operation.

Q Then in our data, though we have used those wells and we have used the area inwhich they're located, though, to arrive at an overall figure. A Exactly.

Q Just one more question. On the electric log data, I believe that was Exhibit 11, do you have that?

A Yes.

Q You have been referring to several of the pages there. I believe on page twelve, for example, page two also, I understood your testimony to be that there was permeability throughout the Gallup sands as shown by that exhibit, is that right?

A We have identified permeability throughout the vertical section on page two of Exhibit 11.

Q Let's ~~say~~ with page two a moment.

A All right.

Q What do you mean by the statement that you have identified permeability?

A Anything greater than zero millidarcies.

Q Is the permeability of zero millidarcies, is that significant for your purposes here? A Yes.

Q It is? A Yes.

Q Then you would also testify that there is and can be

vertical migration through the sections since you have identified permeability throughout the sections?

A I would state that there is communication throughout the entire reservoir by virtue of the inherent permeability of the reservoir rock.

Q Will you also state that since you have identified permeability on page two of Exhibit 11, that there will be and can be vertical migration adjacent to that well bore?

A I hate to use specifically vertical migration. Fluids are freed to travel a freedom path. It might be vertical, it might be horizontal, it could be anything in between. There is freedom of travel when we have permeability.

Q Then there is freedom of travel, if you prefer to use that term, vertically adjacent to the well bore?

A There could be.

Q Although the permeability in the area may vary from zero to 50 or 100, is that right? A Exactly.

Q Do you disagree then with Mr. Finfrock on his, as I understood his testimony, that there were barriers existing between the lower five sands, the lower four sands?

A I don't recall exactly what Mr. Finfrock said.

Q Let's put it this way, if he did so testify, I'm not saying that he did or he didn't, if he does you would disagree with that?

A I am not saying I would disagree. I would state my opinion

on what I think the reservoir rock contains. I would rather restrict my testimony to my belief rather than me make a comparison with what he said.

Q If there is silt stone or some other formation between these sands of zero permeability, or a little more permeability than that, you say that is not a barrier, is that correct?

A A barrier is a matter of degree. Now, in any reservoir rock we find a normal hetorogenity in reservoirs we say are homogenous, we still find portions that have zero permeability, it is acceptable. We are just thankful to have what we have got. I don't consider zero permeability in some place in a section like this as a barrier.

Q You don't consider it a vertical barrier?

A No, fluids are still free to flow horizontally to some other place than vertically.

Q Then let us assume that they are some distance from the well bore, there is an area they could rise vertically and get back up to the upper sand or the lower sand as the case may be?

A The fluids follow a freedom path.

Q Is my statement correct? A It could be.

Q Is it or isn't it? Can you answer the question? If you can answer it -- A I don't know.

Q But you feel throughout the reservoir this will occur, you have so testified to that?

A I feel that we can consider this reservoir as possessing permeability in the vertical section as displayed from the core analyses that we have.

Q But if the oil has to move laterally before it can move vertically, why that would assume that there is some sort of a barrier there, would it not be of a lenticular nature or shape, and if there are discontinuities within the reservoir, that is what you are testifying, are you not?

A I don't want to seem vague, actually we don't know what is in the reservoir between our wells. We do know that fluids do follow a circuitous path in the freedom path in reaching an outlet, you might have a barrier right here, but no barrier there. I don't know.

Q Since we don't know, the more wells that are drilled into the reservoir, the more likely we are to encounter these permeability areas, are we not?

A Not necessarily, no, sir.

Q Aren't the chances better the more you drill?

A The more chance you would have of not experiencing them too.

Q Don't you think the odds are better at all?

A No, I don't.

Q To drill twice as many wells?

A No, I don't.

MR. SETH: That's all.

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q I would like to establish the identity of some of the names that have been used in the examination. Mr. M. B. Penn, what is his capacity with Sunray Mid-Continent?

A I should like to ask my counsel to correct me if I am wrong, or perhaps maybe he would be better qualified to give you his complete title.

MR. ERREBO: His complete title is Chief Unitization Engineer.

Q Chief Unitization Engineer. Both you and he are in the Engineering Department of Sunray then?

A I would prefer counsel to answer.

MR. ERREBO: No, sir. As a matter of fact, he is in a separate section from Mr. Brinkley's section.

MR. MALONE: He does have authority to speak for Sunray?

MR. ERREBO: Yes.

Q Mr. Brooks, who testified here in the former hearing?

A Yes.

Q What is his capacity?

A He is in my section as a Senior Reservoir Engineer.

Q Are you his superior or he is your superior?

A I am his supervisor.

Q Were you present when he testified here in the hearing

on the LPG project? A Yes, sir.

Q You heard his testimony at that time?

A Yes, sir.

Q Referring to page sixteen of the transcript, I invite your attention to the following question and answer that appears there. "Q Please refer to Exhibit No. 7 and identify and explain it." "A Exhibit No. 7 is a summary of the average reservoir and fluid characteristics of the Bisti-Lower Gallup Oil Pool. Some of the pertinent information on this exhibit is that 20 wells have been cored and we have shown the average rock properties, the bubble point pressure of fluid analysis was 1207 pounds per square inch, and the bottomhole pressure in April 1957 was 1319 pounds. We have shown that there are 760 barrels per acre foot of original oil in place." You heard him so testify? A Yes.

Q And he stated that he had taken into consideration the average reservoir and fluid characteristics of the Bisti-Lower Gallup Oil Pool, did he not? A That's right.

Q And the core analysis that he considered are the same core analysis that you have based your testimony on here today, are they not? A That is correct.

Q Would you then take 670 barrels per acre foot and compute the oil in place under a typical 40 acre location?

A Yes.

Q Let's assume, for the purposes of the question, a 20 foot

thickness, which I believe you testified was approximately average.

A No, I did not.

Q You did not? A No, I did not.

Q Did Mr. Finfrock, I believe it was Mr. Finfrock who testified to 20, use 20 feet.

MR. SELINGER: He averaged 15 for the upper and 4 to 6 on the lower.

Q For the purposes of the question, would you compute it at 20 feet, please?

A Would you like the original oil in place?

Q Original oil in place.

MR. CAMPBELL: If we are going to have some calculations to establish the case for the protestants, I think they should be based upon what the witnesses have testified as to the average rather than the highest thickness of the pay.

MR. MALONE: I will be glad to state what I had in mind, the economic comparison offered in evidence is based on average oil in place figure on some 210,000 barrels on the 40 acre location. The computation on the basis of the 670 figure used in the former hearing by another representative of the same company gives us a figure of some 536,000 barrels, based upon a 20 foot thickness, which we believe the evidence testified to will support. The question of whether a 40 acre location is profitable or not profitable depends on how much oil there is under it, the difference between

536,000 barrels and 210,000 barrels is very substantial, and we felt that under those circumstances since the testimony from representatives of the same company showed that big an apparent disparity, it would not be unreasonable to ask the witness to verify the fact.

Q Can you give me an answer to that?

A I'm confused what you are asking for now.

Q I'm asking if you would agree with me that assuming a figure of 670 barrels of oil in place per acre foot on a 40 acre location with a 20 foot thickness of the oil sand, whether you would agree that 536,000 barrels would be the oil in place.

A In answer to your questions, I would say, no. In the first place I do not agree with the 20 foot sand thickness.

Q I asked if you would assume that for the purposes of the question.

A It's dangerous to take hypothetical cases. I would prefer limiting my testimony to the facts of the case.

MR. MALONE: If the Commission please, I believe I'm entitled to ask the witness to make the computation or to agree or disagree with the figure given. I don't want to be unreasonable. If the Commission has any question about it, I'll leave it.

MR. PORTER: Mr. Brinkley, go ahead and compute the figures using a 20 foot thickness.

Q What figure do you get?

A Using 640 barrels per acre foot, is that the figure?

Q 670.

A I beg your pardon. I have used 640. 670 barrels of stock tank oil in place, and assuming a hypothetical thickness of 20 feet, and assuming that would be representative for an average 40 acre well, you would have assumed oil in place, calculated on that data, of 536,000 barrels.

Q And that would compare with the figure of 210,000 on Exhibit 13, would it not?

A It depends on how you use the word compare. It would be used in lieu of this, but we are not on the same basis.

Q But both figures relate to stock tank oil in place, do they not? A Yes.

Q Yes, sir. Now, would you compute the recoverable oil that would underlie a 40 acre location on that basis?

A Using my same recovery figures?

Q Using the oil in place figure which you have just obtained. I believe it was 21% that you used in your calculation.

A Yes, 21%. That would give 113,000 barrels of recoverable stock tank oil for that condition.

Q And assuming that condition to be correct, that would compare to a figure of 44,000 barrels which you have shown on Exhibit 13, would it not? A That is correct.

Q And now, would you compute this figure of value of net 7-8

oil recovered for the figure that you have just obtained?

A 280,000 dollars.

Q That would compare with the figure of $111,000 which you have used on Exhibit 13, would it not? A Correct.

Q If that figure was used in lieu of $111,000, the economics of drilling on 40 acres would be apparent, would it not?

A That is correct.

MR. MALONE: Will counsel for Sunray stipulate for me that their geological witness, Mr. Finfrock, that he testified that there were 15 feet in the upper sand and 4 to 6 feet from the lower segment of sands?

MR. ERREBO: I think the record will show, of course.

MR. MALONE: I didn't want to search the record on it.

MR. ERREBO: Fifteen feet for the average for the upper sand.

MR. MALONE: And 4 to 6 feet to the lower?

MR. ERREBO: I think that would be all right.

MR. MALONE: And I am sure that we can stipulate that fifteen and four make nineteen and fifteen and six make twenty-one, and that twenty is halfway between them.

Q So that if we use as a figure for recoverable oil in place the figures which you have just computed, development on a 40 acre basis would be economic, would it not?

A Assuming this condition, correct.

Q Now, referring to the letter of Mr. Penn from your company,

which was heretofore referred to and which I would like to identify and offer in evidence.

(Marked Gulf's Exhibit No. 1, for identification.)

Q Will you examine the exhibit and see if you can identify the signature of Mr. Penn? A Yes, I do.

Q That is a letter that was sent out to the operators in the Bisti Field, is it not? A Yes.

Q I read you the paragraph beginning on the first page of that letter: "In the 40-acre area to be swept lying within the 160-acre pilot area, our engineers estimate the original oil in place to be 468,000 stock tank barrels." Am I correct in construing that is a statement that in 40 acres that lies between your four wells up there in the pilot -- A That's correct.

Q (Continuing)--That the original oil in place was 468,000 barrels? A That is correct.

Q That will compare to figure of 210,000 barrels used on Exhibit 13, will it not? A No, it will not.

Q Bearing in mind that this refers to a particular portion of the field? A Exactly.

Q And that you have used an average as to the remainder of the field? A Exactly.

Q But with that difference it has the same reference, does it not? A Exactly.

Q So the figures do relate to the same thing?

A No, they do not.

Q Well, I believe you will agree with me that your figure is your computation of the number of barrels of oil in place under an average 40 acre location in this field.

A That is correct.

Q And that the figures stated in this letter relate to the number of barrels of oil in place under a particular 40 acres?

A That is correct.

Q And as between the average that you arrived at and the particular 40 acres, there is a difference on your own statements of 210,000 as against 468,000 barrels of oil in place?

A That is exactly right.

Q You would agree that the 468,000 acre reserve would justify the drilling of this field on a 40 acre basis, would you not?

A At that particular location, yes.

Q Now, in arriving at your estimate and allocating the reserves throughout the field, how much of the field have you treated as being production? In other words, what was the area that you have used in dividing your oil in place over the field or the pool? How many acres? A 24,671.

Q How did you arrive at that figure of 24,000, by measuring the isopack?

A By measuring the isopack, yes.

Q Did you take into consideration the portion of the field that had the rich upper sand as well as the portion that had the less desireable lower segment?

A I took that into consideration, yes.

Q You have in effect allocated the production from the good sand out over the area which is not actually overlain by that good sand? A Would you restate that?

Q That is the effect of your allocation is to allocate it over the entire area whether the good sand exists there or not?

A We have allocated, we have computed the oil in place for the productive reservoir, yes.

Q And you have allocated it without reference to the boundaries of this upper segment of sand? You have allocated it over the whole 24,000 acres and not just a portion overlain by the --

A (Interrupting) That is correct.

Q (Continuing) -- by the good bar that you have testified to?

A That is correct.

Q This figure of 24,000 acres compares to what figure, that is the total for the entire proposed field which you have outlined?

A The area within the area we asked to be spaced represents 46,720 acres, or 73 Governmental sections.

Q You have treated 24,000 of that as being productive for the purpose of this allocation? A At the present time --

Q (Interrupting) Well, is that the figure that you did treat?

A Yes.

Q Thank you. Go ahead and explain your answer, I wanted to find out if that was going to be correct.

A The only thing I was going to say is that based on the information that we have, the productive boundary to date is the 24,671 acres, but I want to qualify that and state that before we could adequately define productive boundary, it is going to take more development, and it will be concentrated within the area we have asked to be spaced.

Q So your answer is that is true. Now, Mr. Brinkley, I believe you testified to a serious threat that occurred when Shell announced some 40 acre locations. You are aware of the fact that the rules of the Commission provide for 40 acre location in absence of other order by the Commission, are you not? A Yes.

Q So there was not a threat to do anything except what the rules provided, was there?

A There is a caution signal since our evaluation certainly spells caution to us to not drill on 40 acre spacing, and we consider it a threat.

Q Yes, well that subjectively you considered, but insofar as the rules of this Commission are concerned, Shell was perfectly entitled to do what they did do, were they not?

A Yes.

Q Now, with reference to the hearing on this 40 acre pilot

gas LPG injection system, you were present at the hearin , you testified? A That is correct.

Q And you now say that because of the possibility that a large part of the recovery will have to be secondary, it is your opinion that this field should be developed on 80 acre spacing?

A Exactly.

Q That ties into the repressuring project of Sunray's?

A Exactly.

Q Did you or any other Sunray witness at the time of the meeting in which you got the Commission to approve that project, testify that you expected if it worked it was going to require 80 acre spacing?

A I didn't testify. Now, the man, Mr. Brooks, who did testify, I don't recall what he said in that regard.

MR. MALONE: I believe the record in that case has been incorporated here?

MR. COOLEY: No, it has not.

MR. MALONE: We would like to ask that the record in that case be considered a part of the record in the case now before the Commission.

MR. CAMPBELL: For what purpose?

MR. MALONE: For the purpose of disclosing the fact that there was no statement of a proposed 80 acre spacing plan in connection with the LPG pilot.

MR. CAMPBELL: I wasn't within the call of the hearing. It wasn't suggested there we will stipulate that. Rather than encumber the record any further with the entire record of the other case.

MR. MALONE: If it can be stipulated the witness said he didn't know what had been testified to, if it be stipulated that there was no reference in that hearing. That is the thing we wanted to establish by the record.

MR. COOLEY: Does Sunray so stipulate?

MR. ERREBO: So stipulate.

MR. CAMPBELL: Yes.

Q Would you agree, Mr. Brinkley, that the results which you will get from your pilot test as it is now set up, will be more applicable to the results you would obtain on 40 acre development than on 80 acre development?

A You speak of results. Would you like to ask me specifically what results?

Q Well, the results which you felt you must get in a hurry, and hence you had proceeded on that basis. My question is will the information that you obtained be more applicable to 40 acre or to 80 acre spacing when you receive it?

A Yes. Without the results --

Q (Interrupting) It will be more applicable to the 40 acre development?

A No, it would be more applicable to the 80 acre.

Q Now the density of those wells is one to each 40 acres, isn't it?

A Yes.

Q You have an injection well in the center of the four wells?

A Exactly.

Q It is your testimony the results you obtain from that pilot project will be less applicable to 40 than it would be to 80 acre?

A I will state it this way, that as an example, a specific example, we will need to know the injectivity capacity of the injection well before we can go to 80 acre spacing, and hence we have to qualify the well. Now then, if we were unable to get insufficient volume of LPG into the injection well, it would automatically throw out the 80 acre spacing. We know from our experience that 80 acre spacing is desireable and warranted, fitting and proper, but we were waiting on the injection well to qualify itself to show and display sufficient injection capacity in order to completely achieve that.

Q My question was when you do know that, it will be more applicable to 40 acre development because those wells are on 40 acre?

A No.

Q You do not agree to that?

A I do not agree.

Q Can you tell me whether or not you feel that the information which you obtained from this pilot project will be a sound basis for you to recommend to your management development if the field is developed on an 80 acre basis?

A Yes.

Q You feel the information will be adequate?

A Yes.

Q I believe you testified that it's your opinion that any well or any pool can better be subjected to secondary recovery and LPG flood or recirculating if it is developed on 80 acre locations than on 40 acre locations?

A If I said any pool, let me rephrase my statement that we would confine that to a reservoir.

Q Then any --

A (Interrupting) Then with --

Q Excuse me.

A Then within the reservoir, which by definition would imply continuity, then you would achieve greater overall flushing efficiency as you increased the distance between the injection and the producing wells.

Q So that it is your testimony that you favor 80 acre spacing in all fields where a single reservoir is involved in order that secondary recovery may be more sufficient?

A Yes.

Q Now, you are aware of the fact that the policy of this Commission is to develop the field on 40 acre location, are you not?

A I think that is a legal decision, and I am not a lawyer.

Q Do you have knowledge of any sandstone fields in New Mexico which are developed on an 80 acre basis?

A I'm not acquainted with all the pools or fields in New Mexico. I feel unqualified to answer the question.

Q You do not know of any yourself, though?

A No, I do not.

Q The testimony you have given then as to why you feel that the Commission should adopt 80 acre spacing, would be equally applicable to any other single reservoir pool in New Mexico, would it not?

A Let me answer it this way, each reservoir possesses its own inherent problems, and each reservoir has to be evaluated with its own characteristics. It would be dangerous to make a blanket statement for promiscuous use. I would be hesitant to make a statement like that.

Q You did state on direct examination that 80 acres would make for a more efficient second recovery program than 40?

A In the Lower Gallup, yes.

Q You quoted an authority, that was Mr. Muscat from Gulf. He was not referring to this particular reservoir, I assume?

A It was Dr. Muscat, and he was not referring to this pool.

Q Do you or do you not feel that as a general proposition 80 acre spacing is desireable in order to make secondary recovery more efficient?

A Generally, but let me make a qualifying statement on this. The spacing problem in industry as well as with Commissions is an educational problem. Years ago we had close spacing, no conservation,

the spacing has grown wider and wider as we have become better acquainted with the recovery mechanism in the recovery of oil. We have all become educated along these lines, both from a recovery, conservation and economic standpoint. It's been a tough battle, but I think you will have to agree that the trend toward wider spacing has prevailed and we will experience wider and wider spacing even in the future.

Q I appreciate your statement. I'm not sure it answers my question. But I won't repeat the question. May I ask you how many fields that were developed on 80 acre spacing you have had experience with in secondary recovery projects?

A The McKenny patent field in Louisiana is on possibly 160 or 640 acres the way it is being operated. I completely evaluated that on it.

Q That is not an 80 acre field?

A It is greater than 80 acres.

Q It is greater? A Yes, sir.

Q Have you had experience with any spaced on 80 acres?

A We have ....

MR. CAMPBELL: May I ask that he be permitted to continue his answer to the question.

MR. MALONE: It wasn't responsive, but I'll be glad for him to answer.

A Maybe it would be better if I summarize it that in most gas

condensate reservoirs in liquifying operation, which is a miscible phase operation, spacing is considerably in excess of 80 acres, the flushing efficiencies are upward of 80%.

Q This is not a gas condensate reservoir?

A No, it is not.

Q Have you ever had an experience with a reservoir of this type? A Yes.

Q Which is spaced 80 acres and which you have had a secondary flood project? A Yes.

Q Now, that is my question.

MR. CAMPBELL: What is that field?

A Of course I have had a few years experience, but I kind of forget the names of the pools. But I might cite that I have investigated several pools where part of the pool would be developed on 40 acres, part of it on 80 acres, in water flood operations, and the recovery within practical limits have been identical. When I was with Carter --

MR. PORTER: Excuse me.

A When I was with Carter, we evaluated one like that where the pool was separated, they were separate, but the rock properties, the reservoir properties, the structural conditions, pressured, things like that very similar, again we found that the recoveries was independent displacement.

Q So that is the basis of the testimony which you have given?

A Yes.

Q You have testified with reference to some interference tests on four wells. Will you refer to Sunray's Exhibit 12? The copy of that exhibit, which I had, did not have the wells marked on it and I may not have gotten them correctly.

A I am sorry.

Q No, that's all right, I am just leaving myself a way out if I need it. If you will refer to Well 2-C, which I believe was one of them on which you based your testimony.

A Yes, sir.

Q In Section 31? A Yes.

Q Well, now, that well is offset by two direct 40 acre offset and one diagonal 40 acre offset, is it not?

A That is correct.

Q Would or would not the interference to which you testified have resulted from those 40 acre offset wells?

A That is precisely what I used.

Q So that your testimony merely established that there is communication between 40 acre locations?

A No. No.

Q The wells which were the basis of your testimony are spaced on 40 acre locations, are they not? A Exactly.

Q And the interference which resulted was between those wells, was it not? A That is correct.

Q Would you give us then your interpretation of that interference?

A Certainly. Take the south offset well, if it would drain 40 acres, the radius of effective drainage would not reach beyond the 40 acre tract, but this radius of drainage extended beyond that and engulfed the next well which is not 660 feet apart, but 1320 feet apart. It's a common misconception.

Q You have not used, well, let's refer, what were the other wells that you used here?

A The No. 18 which is in Section 7.

Q And how is it offset?

A It is offset to the northeast and it's offset to the southeast.

Q These are on 80 acres, what would be the equivalent of 80 acres or 40 acres?

A They would be the normal 80 acre locations.

Q Are any of the other wells that you used in the interference tests besides 2-C the equivalent of 40 acre locations?

A The other 40 acre location would be at well location 2-C.

Q That was the well you listed as the fourth well on the interference measure? A That is correct.

Q Thank you. Do you know whether or not under-saturated oil has been encountered in any of the wells which have been drilled in this pool? A Yes.

Q Where has that been encountered?

A The two wells that I mentioned where we had bottomhole samples each displaced under saturated conditions.

Q There is a gas cap in other portions of the field, is there not? A Correct.

Q Do you have any difficulty in reconciling the existence of a gas cap in one portion of the field with under-saturated oil in the other portion if there is good communication?

A Not at all, it is very common.

Q How do you reconcile the two?

A We have observed it.

Q It is now an unusual phenomenon in your experience?

A None whatsoever.

Q In connection with the question which was asked by your counsel as to whether or not you considered the 80 acre locations would prevent waste, you answered that in your opinion they would. You were not asked whether or not in your opinion the granting of this application would protect correlative rights. Have you given any consideration to that question?

A I think you would have to define correlative rights. Maybe it's a legal question, I don't know. Now under certain conditions it might be important.

Q I will ask you then, if you are not in a position to answer the question, please merely say so, whether or not in your opinion, if the application is granted, each of the owners in this

field will recover his just and equitable share of the oil underlying the property?

A I would like to decline that question at this time.

Q All right. Now, in your Exhibit 11, let's refer to page number four, I notice in the center portion of the exhibit the numbers one, two, three, four, five and six. To what do those refer?

A One would be the upper sand, two would be the second sand, the one immediately below the one, three would be the third sand from the top, four, five and six would be the successive lower and lower sands consistent with the cross sections as we have previously presented.

Q So that regardless of whether the frosting or the cake is the best part, you will agree we have layers here?

A That's a matter of degree.

Q Do we have some layers, isn't that what is indicated when you can make one, two, three, four, five and six here?

A In a way. I am not apprehensive in referring to them as layers, that is all right.

Q I just want to get your opinion as an expert as to whether in fact those are separate sands, and if they are, whether communication vertically exists between them throughout the area included in this application.

A I don't know -- now this is my view, I'm not a geologist. I'm not going to get into geological work.

Q I wouldn't want you to.

A But from a reservoir standpoint, flow of fluids, permeability measurements, core analyses, things like that, I am hesitant in thinking of this thing as a layer type sand. You got a sand body, period. It displays permeability through the vertical section, that's it. That's the way I look at it.

Q You don't look at it as your geologist, Mr. Finfrock, in any event you prefer not to adopt his description of these several sand members?

A I neither refute them nor accept them. I have my personal views and I would like to think of a reservoir as a whole, I have to in my business.

Q Now, in thinking of this reservoir as a whole, have you been able to establish to your complete satisfaction that communication exists between these several members throughout the reservoir?

A I think the core analysis substantiates that statement.

Q Does the core analysis show a marked uniformity or non-uniformity of permeability and porosity?

A Now which way are you directing the uniformity?

Q I'm directing it to the way that you have testified it exists.

A Yes. When we consider one condition similar to the next condition, in other words, we compare similar conditions, we get evidence of similar rock properties. But when we cross similar

conditions or have conditions that are dissimilar, why then we are not making a fair comparison.

Q Is it your opinion that on the basis of those 15, or was it 21 cores? A Twenty-six cores.

Q Twenty-six cores that you have examined, that you can testify with certainty that there is communication between these various members so that if a particular well failed to penetrate one of the members, the other members would nonetheless be drained by that well?

A Let me direct your attention that core analysis themselves do not define interference or continuity. You have to establish that from pressure interference.

Q You have not made a pressure interference study except upon the four wells as to which you testified?

A That is all the available information, yes.

Q In that case you would not be able to testify with certainty that communication does exist so that various members might be drained, whether they were penetrated or not?

A The best information we have, I would say they would be drained.

Q It is your opinion they will? A That is correct

Q That is your opinion as to the entire area in the proposed pool?

A Based on my experience, I find that would be a reasonable

opinion.

Q I want to be sure we have clear the basis and not be repetitious, it is the interference test on four wells that you have testified to plus the 26 cores that you have examined?

A Let's take about one thing at a time. Are we talking about interference or core analysis?

Q I am talking about the basis of the opinion you just expressed. I want to be sure it's clear what you reached that conclusion on. Would you state the basis on which you reached the conclusion that vertical communication exists and that a single member would be drained by a well penetrating another member, whether or not all members were penetrated?

A That's a pretty big order. Let me answer it this way: We have defined from the core analysis that predominantly the bulk of the reserves and the bulk of the recoverable oil will be gained out of the sand we call No. 1. We have defined interference from our interference tests, which shows that a well can drain an area in excess of 80 acres. So based on that data I say that we can effectively deplete the reservoir on spacing of 80 acres.

Q You say that each well will effectively drain the 80 acres that is allocated to it as a unit?

A Yes.

Q And that is your opinion? A Yes.

Q There is a rather broad variation in the permeability

which you found in this sand section, is there not?

A Yes.

Q From one-tenth of one millidarcy up to one hundred millidarcies?

A Or greater than a hundred.

Q Or greater than one hundred?

A Yes.

Q There is no uniformity in the relationship between the areas where those variations occur? That was a bad question. I think we agree on the answer. You heard some testimony this morning as to the existence in this reservoir of oil wells which were up structure from gas wells? A Precisely.

Q Are you aware of that condition existing in the reservoir?

A I'm assuming that you are referring to the Carson No. 5 Shell Well located in Section 27?

Q Well, refer to the well that was used this morning by Mr. Nutter.

A I would like to have the well defined, so I know precisely what we are talking about.

Q I'm not going to ask you with reference to the particular well. Are you aware that condition does exist?

A No, I'm not.

Q You have not taken into consideration the possibility that it may exist, in your testimony? You are not aware it does exist?

A No, I am not. I am confused, are you talking about a well located structurally higher than the five defined gas wells?

Q Yes, which is producing oil from a point structurally higher than gas wells in the immediate vicinity.

A Let me state this, with the data we have being of a conflicting nature and without any source of additional test information that we cannot, I cannot say if it's an oil well or a gas well, and I would prefer having some complete test information. Once I get that I will be happy to make you my interpretation of what that well is.

Q Do you feel that if that situation exists, it would have some effect on your testimony as to the reservoir?

A I can't give an opinion until I check that specific well with its test data.

Q Have you in any other hearing before this or another commission, ever recommended that any field be spaced on 40 acres?

A State that again.

Q Have you ever in any hearing before this commission or any other commission recommended that a well be developed on 40 acre spacing? A Yes.

Q Where was that?

A Well, it might be any one of several states. I don't have my list handy.

Q All right. Thank you very much.

MR. PORTER: Does anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Brinkley, referring to your Exhibit No. 13, with special attention to the ultimate recovery column, I note that you have stated there that the recovery on 80 acres is exactly twice the recovery on 40 acres? A That is correct.

Q I would assume that your recovery factor is identical for both spacings? A That is correct.

Q 40 acre radius, drainage radius, is somewhat smaller than an 80 acre drainage radius, is it not?

A That is correct.

Q Is it not true that it is the pressure differential between the reservoir and the well bore that causes the oil to flow to the well bore? A That is correct.

Q Then it would follow that your testimony here would be that the pressure and the depletion at the 80 acre radius would be the same as the pressure at the 40 acre radius?

A Appreciably so.

Q Would you care to elaborate why you feel that would be true, that depletion stage?

A I'll be glad to. As I stated earlier, the problem of well spacing is one of the industry's unsolved problems. Many of the experts have done considerable research in comparing recoveries on 40 acres versus 80 acres. They find no evidence of any

appreciable difference in ultimate recoveries when they can define the rock and fluid properties. That it might ease people's minds if I state that an 80 acre well draining a circular area, would have contained twice the energy as a circular area containing 40 acres. Yet, the radius of the 80 acre well is only 41% greater than that for a 40 acre well. Also flow is not only affected by a pressure differential, but by friction, and of course that is affected by velocity. When one computes the velocity of the liquid flowing, we find that we are advancing just few inches a day until we get very close to the producing oil well.

Hence, with low velocity you would normally assume that you would be in the streamlined flow, and your friction would be approaching zero. Those values have been computed both for an 80 acre spaced well and 40 acre spaced well with good characteristics here. We find that to be the case. Again, may I state that it is one of the unsolved problems of industry, and I have some quotations in my bag that if you would like for me to quote from I would be glad to do that, but it is one that we will be faced with for some time. It's an educational problem. But our experience, so forth, leads us to conclude that there is no appreciable difference in ultimate recovery on a 40 and an 80 acre, I mean two 40's or one 80 acre tract.

Q Thank you. I believe that you have stated in your testimony that it is your belief that we have a gas cap in the Bisti Field?

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A That is correct.

Q Would you have any recommendation as to how those gas cap wells should be produced?

A Yes. I think they should be permitted to produce at a rate commensurate with the oil voidage for an oil well, incorporating the limiting gas-oil ratio.

Q Would it be your thought that 40 or even 80 acre gas well in this area would not be a commercial well?

A Are you talking about a gas well?

Q Yes.

A It would be non-commercial.

Q Do you think that more acreage should be dedicated to the gas well in this gas cap than an oil well?

A I do.

Q Let's dwell a moment on the 80 acre unit which I believe you have requested. Am I correct in my understanding that you have requested 80 acre units to run north and south the long ways, to run north and south? A No, sir.

Q You have not requested that? A No.

Q Do you have any opinion?

A I would prefer that the counsel make a statement on that. I believe he is more acquainted with the details of the content of our application than I.

Q You have made no recommendations as to where the well

should be located?

A Yes, we have made a recommendation. I think I misunderstood your question. Yes, I have made a recommendation. I stated that the location of wells to be in diagonal 40's within a Governmental 160 acre tract and no closer than 330 feet from the lease lines. There is no statement whether the tracts would run north and south or east and west, but they can be fitted in like a puzzle, like little squares or little rectangles; the way some of the wells are spaced, we will have to go north and south, and other ways east and west. We have tried to leave it flexible to the discretion of the operator for more flexible operation.

Q It is your testimony that you could run them either way?

A Yes.

Q According to the situation? A Yes.

MR. PORTER: Anyone else have a question of the witness? Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, you testified that you feel that the ultimate recovery will be substantially the same on the 80 acre spacing, as it would be with the two 40 acre wells?

A Correct.

Q Under what specific conditions did you recommend 40 acre spacing?

A I did not recommend 40 acre spacing.

Q I believe you, in answer to counsel's question, stated on several occasions in the past you have recommended 40 acre spacing.

A I beg your pardon. That was on another field. As I further stated that each reservoir has to stand on its own merits, and the spacing and various other things are dependent on the peculiarities of that reservoir.

Q That's what I am getting at, what are the specific conditions that make it possible or impossible, advisable or inadvisable to space 40 or 80, in your opinion?

A Well, we had more sand.

Q Thicker sand?

A Yes. One hundred feet of sand possibly.

Q That has no bearing on drainage, but economics?

A Exactly.

Q What is another one?

A That would be the important thing, the oil in place. The whole thing could be summed up as to the oil in place and recoverable oil, if we had sufficient oil to justify a reasonable profit return to carry on exploitation and things like that, why then of course we do that.

Q Then the simple underlying factor for the recommendation of 80 acres rather than 40 is the economic factor?

A Yes, that is right.

Q You feel it is not economical to drill 40 acre wells throughout the field?

A Under a competitive situation it is hardly economical on the 80, on the average conditions.

Q Would it be so, I think you continued to use the term throughout this hearing, competitive conditions?

A Yes.

Q That does not take into consideration fieldwide unitization and secondary recovery project, does it?

A That is correct.

Q And is it not contemplated by your company and the major companies and possibly all the people in this pool, for this pool to be operated effectively, there will have to be secondary recovery?

A That is right. The salvation of the pool will be through the secondary means, pressure maintenance with unitization.

Q Assuming we achieve this salvation, would it then be economical to develop the wells on 40 acre spacing?

A No, sir. It might be economical, but --

Q (Interrupting) You wouldn't make as much money?

A You wouldn't make as much money and it wouldn't be prudent operations to spend twice as much money to gain the profit. What I am getting at is unnecessary wells are a waste. We can accomplish the same thing on wider spacing.

Q Now, when a well is drilled into a reservoir like this,

isn't there immediately a low pressure area created which causes the oil to drain toward the well bore and get your production?

A When it is produced, that is correct.

Q Is not this pressure a gradiation back off into the reservoir back off into a point where the pressure is that of the original reservoir pressure?

A The gradiation phenomenon?

Q It is not a sharp drop, it is gradiation throughout on the reservoir? A That is correct.

Q While you might have a thousand pounds, what was the initial pressure of this reservoir?

A Probably of the order of 1500.

Q When a well is immediately drilled, what does it drop to?

A As it is produced, the pressure will drop.

Q What does it drop, say within a week, to make it produce?

A I can't give you the precise answer.

Q Just a rough estimation, that is to point out the gradiation factor.

A I would just guess, produce a week might get five pounds drop, ten pounds drop, just a guess.

Q This drop will be a gradiation down through the reservoir?

A Correct.

Q As you go ahead producing, what do you think that differential would be between the pressure right at the well head and out

away from the well, you don't know, you don't believe one well will drain this entire pool?

A Given enough time, yes.

Q If you drill a well right up in the middle of the 25 mile lateral area, you think the pressure of this well would ultimately drop even though that is the only well the pressure would drop to abandonment pressure?

A Yes, it would ultimately drop to abandonment pressure.

Q Do you feel that the well, when it reaches the abandonment pressure, do you feel you can go out to the other ends of the pool and still drill a producing oil well?

A We are getting into a hypothetical condition.

Q Well, let's answer it then.

A Given sufficient time, it might take a century, the well would drain the reservoir.

Q But this pressure gradiation goes off to practically original reservoir pressure, would it not?

A The gradiation?

Q From abandonment at the well head to original well head pressure at the extreme ends of the pool.

A No, I can't say that. You do get a pressure gradiation at the well bore. It is not a sharp drop.

Q When you abandoned your 80 acre well, don't you feel that the pressures out at the periphery at the edge will be something

in excess of abandonment pressure? A No.

Q At what point in the development of this well does the pressure level off instead of grade off?

A You are kind of losing me.

Q You drilled a well and you had the pressure gradiation?

A Yes.

Q Low at the well head and high away from it?

A Yes.

Q At some place in your test, instead of grading off to a higher pressure, somewhere away from the well, it levels off it is abandonment pressure through the pool?

A No, you always have that, you just don't have sufficient pressure differential to produce the production of oil in economic quantities.

Q At the outer perimeter of your drainage area of your 80 acre well, you will have somewhat higher pressure than your --

A (Interrupting) That is correct.

Q Would there not be a larger perimeter of this well if it were drilled on 40 instead of 80 since you have a shorter radius on your 40 acre drainage, it would just be half would it not?

A No, on the contrary, you could have less oil remaining on 80 acre spacing than on 40.

Q Let me ask my question again, see if you still want to answer it the same way. This is still a gradiation?

A Yes.

Q It is lower and it's going out away from the well?

A Yes.

Q If it has to drain roughly 2,000 feet or more?

A A thousand some.

Q Twenty-two hundred feet? A For an 80 acre?

Q Yes. A 1,070 feet.

Q Draining to the other end. If it drains 1,070 feet at the 1,070 foot the pressure would be higher than it would at the 500 foot? A Yes.

Q With 40 acre wells, the outermost boundary of the drainage areawould be the 500 foot?

A No, it would be 750 feet.

Q 750 feet? A Yes.

Q Nonetheless, it would be [illegible]

A Yes.

Q On the 80 than the 40?

A Yes.

Q You would get more recovery on 40 acres than 80?

A No.

Q Would you care to explain in reference to your Exhibit No. 1, it seems to be another enigma, maybe you can solve this one for me. I believe you testified that the No. 4 and No. 6 wells, these are referred to as wells outlined in red, and you refer to

them as your interference wells? A Yes.

Q Your 6 and 4 wells are in what you referred to as in the superior sand? A Yes.

Q The 4 and 6 were produced intermittently or just once?

A Each of them produced roughly a thousand barrels some time during that year period.

Q And neither the C-18 nor the C-2 was produced at any time?

A That is correct.

Q Can you tell me why the C-18 and C-2, which are in the inferior sand, I believe you testified?

A That's right.

Q Were less permeable and less porous, why did they get more pressure drop than the 4?

A They had more interference.

Q Was it a time period?

A No, they had more interference.

Q Isn't that another enigma that an area with less permeability and less porosity would show more interference than it would in an area of high permeability and high porosity?

A Interference can be any magnitude, it's a matter of degree. All I can say is that they suffered more interference.

Q Wouldn't it logically be the other way, that in the good permeability and good porosity you would get a bigger draw down?

A Not at all. No. Not at all, just the reverse of what you are

thinking.

Q Well, I could be very well mistaken, it would seem to me that the draw down would be greater in this high permeability area.

A No. For the same quantity of oil it would be opposite to what you say.

(Discussion off the record.)

MR. PORTER: Let's go back on the record. Mr. Cooley.

Q I believe you testified in answer to a question on cross examination a short while ago, that your recommendation, or the advisability of 80 acre spacing in this pool, would be directly dependent on the injectivity of your injection wells in this pool?

A Yes, the injection well would have to qualify for the wider spacing.

Q Are you prepared to state unqualifiedly at this time that the injectivity of the wells in the Bisti-Lower Gallup Oil Pool are adaptable to 80 acre spacing? A Yes, they are.

MR. COOLEY: That's all.

MR. SULLIVAN: Mr. Chairman, my name is Sullivan, representing British American Oil Producing Company.

By MR. SULLIVAN:

Q Mr. Cooley was questioning you a moment ago with regard to the reasons why the two wells in what you have referred to as the inferior sand area, did not have as great a pressure drops the two wells in the superior sand area?

A You have them reversed.

Q Very well. Would a simple explanation of that be the fact that the wells in the area of the inferior sand simply had lesser area from which to rebuild the pressure while shutin?

A You can't give, in my opinion, you can't give a simple explanation like that because what we measure is the compounding effects of not only reservoir depletion, but interference from offset wells which we cannot precisely define. All we measure is the composite effect.

Q I thought perhaps there might be a simple or elementary answer to this enigma. I was puzzled also during Mr. Seth's cross examination of you, Mr. Brinkley, about this factor. With regard to the quantity of LPG products necessary to carry out a successful flood program -- A Yes.

Q Assume that your pilot program there proves to be successful to a practicable degree. A Yes.

Q Assume that the well spacing in the field stays on an 80 acre basis, would you not be able to carry out your missible slug program with about the same quantity of LPG products on an 80 acre spacing that would be required if the field were developed on 40 acre spacing?

A Comparing an 80 tract with two 40 acre tracts?

Q Yes. A Correct.

Q Then, in other words, with an 80 acre spacing as compared

with 40 acre spacing, at least you would make a greater or more efficient use of your LPG products in sweeping through the field?

A Precisely.

MR. PORTER: Anyone else have a question of the witness? The witness may be excused.

(Witness excused.)

I believe it's apparent that this case will not be concluded today at least during daylight hours. There are some parties who entered an appearance this morning who have indicated that they cannot be here beyond today and would like to make a statement, so we will entertain those statements at this time, and if you have a copy of the statement written out, I would appreciate it if you would leave it with the reporter.

MR. MALONE: I thought maybe in view of the time, if we might not be able to file written statements, say within a ten-day period.

MR. PORTER: In lieu of the oral statements, the written statements from the interested parties will be acceptable within a period of ten days.

MR. MALONE: May I be certain that Gulf's Exhibit 1 is admitted in evidence? It was identified but not offered.

MR. PORTER: Without objection, Gulf's Exhibit No. 1 will be received.

(Discussion off the record.)

MR. PORTER: Will the next witness come forward, whoever that may be? Is that all of your witnesses?

MR. MARRS: That concludes the applicant's case.

MR. BUSHNELL: Did I understand correctly the conclusion of this discussion that statements may be mailed in and that those statements will be incorporated in this record?

MR. PORTER: They will be put in the record, yes, sir, within ten days.

MR. SETH: We are prepared to proceed, if the Commission would like. I was just hesitating, I thought some of the other people would like to put on some other witnesses.

MR. PORTER: Before proceeding with any further testimony, I would like to make a brief announcement. This hearing will not continue in this auditorium in the morning. We have arranged to meet in the Highway Comdission Building on Cerrillos Road. We will take about a five minute break.

(Recess.)

MR. PORTER: The meeting will come to order. Mr. Seth, will you proceed with your first witness, please?

DONALD R. LINDSAY

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please?

A Donald R. Lindsay.

Q Were you sworn earlier during the course of this hearing?

A Yes, I was.

Q Would you state briefly your educational qualifications, your experience?

A I received the degree of Bachelor of Science and Mechanical Engineer from Stanford University in 1948, and degree of Master of Arts in Geology from the University of California at Los Angeles in 1952.

Q What has been your experience and by whom have you been employed?

A I have been employed by Shell Oil Company for the past six years in the capacity of exploitation engineer.

Q Have you made a study and are you familiar with the geology in the Bisti Pool? A Yes, I am.

MR. SETH: May he testify as a geologist?

MR. PORTER: He may. His qualifications are accepted.

Q Now, have you made a structure contour map of the Bisti Field?

A I have. That is Exhibit No. 1.

Q Would you point it out, please?

A Yes.

Q Would you please state to the Commission what it shows,

Mr. Lindsay?

A This is a structure contour map on the top of the Gallup formation. The map includes the western two-thirds of Range 11 West, Township 25 North, and the eastern five-sixths of Range 12 West, Township 25 North, San Juan County, New Mexico. This is a portion of the Bisti Field and is located about in the central part of the Field. The map shows the property lines within this area and the locations of the wells which have been drilled within the boundaries of the map.

Contours which have been drawn with respect to sea level at a contour interval of twenty foot show a northerly dip of about eighty feet to the mile. This map has been submitted at this time primarily to show the geographical locations of some forthcoming exhibits. We have indicated with red arrows Shell Carson No. 1 an Shell Carson 33-24, which are located in Section 24, Range 12 West, Township 25 North. These wells were cored through the productive portion of the Gallup formation, and on this map we also show the lines of Section A-B, C-D and E-F which will be referred to later in the testimony.

Q Now, would you proceed to your next exhibit, you have a stratigraphic section, do you not? A Yes.

Q We'll refer to this as Exhibit No. 2.

A Yes.

Q Was this prepared under your supervision and direction?

A Yes, it was.

Q Would you please describe what it shows?

A This section illustrates the subsurface data which we obtained from Shell Carson No. 1 and Shell Carson 33-24, which were cored through the Gallup formation. The wells are located about 2950 feet apart, slightly more than a half mile, and are shown at a vertical scale of four feet to the inch. They are hung on a datum of electric log marker G0 which occurs at the top of the uppermost oil productive sand in the field.

Q The following information is provided for each well: The self potential and resistivity curves have been traced from the electric log. We show with heavy black lines the interval in each well which exhibits microlog separation. Porosity values are shown with open circles and have been connected with lines to show a porosity profile for each well. The porosity scale on the chart is zero to fifteen percent, and those values which are more than ten percent have been shaded with green.

We show permeability values with solid circles, which have also been connected in this case to show a permeability profile for each well, and the scale for permeability is a logarithmic scale from one-tenth of a millidarcy or less to a hundred millidarcies, and we have shaded each portion of each well showing more than one millidarcy in red.

The chart shows correlation lines between the wells which

connect correlative electric log markers in the two wells. These markers are identified as used by Shell, from top to bottom, GC, GD, GE, GF and GG. Two intervals contain the majority of permeable sands which supply most of the production from the field. The upper one is between marker GC and GD, and I'll refer to that as the GC sand. This is the same interval as was discussed by Sunray witnesses as the best sand, the one that was referred to as essentially a sand bar deposit.

The lower sands are between marker GD and GE and I will refer to this interval as the GD sands. This chart represents the differences in the location of permeable sands in various wells in the field. For example, in Shell Carson Unit No. 1, the GC sands exhibit very favorable reservoir characteristics. There is considerable microlog pay permeables ranging up to one hundred millidarcies, and the porosities are generally of ten to fifteen range. In the GD interval there is virtually no sand, the section appears to be almost entirely at this time impermeable silt zone.

Carson 33-24, the converse is true. The GC interval has almost entirely silted out, there is only a short interval showing microlog separation. On the other hand, the GD sands in this well possess favorable reservoir characteristics inasmuch as they have permeability characteristics which range up to over a hundred millidarcies, and have about ten feet of net microlog pay. This section, I think, illustrates the fact that sands in the Gallup

formation are not continuous and that permeability sands within the Gallup occur at different stratigraphic positions in different wells in the field.

Q Now, would you tell the Commission the source of the data that appears on this Exhibit No. 2?

A This chart contains data which were obtained from electric logs, micrologs and core information, core analysis.

Q Now, would you say that the variation in permeability in each of those sections is great or is in small or how would you care to describe it?

A I would say that these sands in the Gallup formation in Bisti Field are characterized by a very wide range of porosity and permeability values.

Q You would say then that they were greater than you would ordinarily expect in a sand reservoir or that are usually encountered in a sand reservoir?

A They are greater than any I have seen in sand reservoirs prior to this.

Q Now, does this section also represent the wide variation from well to well? What is the distance between those two wells?

A The distance is a little over a half a mile.

Q What other conclusion do you draw from Exhibit No. 2, if any?

A I would say that the petrophysical data and the core

analysis data that we have from these wells indicates a considerable amount of discontinuity in the permeable sands between these wells. The sands which show microlog pay are separated by intervals of very dense silt stone and tightly cemented sandstone, which I would say would be impermeable to the passage of oil.

Q This section, would you say this is consistent with or confirms the microlog surveys which you have used and will use in the subsequent exhibits?

A I think that this section illustrates a remarkable correspondence between microlog pay and porosity and permeability values. This is in each case where we have core data available where we have microlog separation, we also have correspondingly high values of porosity and permeability, and where we do not have microlog separation in other portions of the well, we have fairly consistently low values of porosity and permeability.

Q Would you explain, please, what is microlog separation and how useful is the data obtained?

A Well, the microlog is an instrument for detecting the presence of mud cake in the well bore and that is produced when the liquid portions, the liquid phase of the drilling fluid filters into the formation and deposits a mud cake. It is thus an indication of permeable sand and also a porous sand.

Q Do you consider it a good or reliable indication?

A I think it is a very reliable source of information in the

Bisti Field, and I believe that most of the operators in the Bisti Field evaluate it because virtually all the operators in the Bisti Field run micrologs in their wells.

Q Could you say whether or not these two wells are pretty much typical of what you find in the field as far as a unit?

A I would say that no one well is typical of what you find in the Bisti Field because there are such extreme variations from well to well. However, I think that these wells are fairly representative of what you would find in an average well.

Q Now, have you prepared an isopach map from the data you collected? Would you point out again on your contour map the location of the stratigraphic section again?

A The stratigraphic section shows these two wells, Carson No. 1 and 33-24.

Q Go ahead with the isopach.

A Exhibit No. 3 is an isopach map of the net microlog pay in the Bisti Field. That is the portion of the Bisti Field which is included by the map, and the Exhibit 3 includes the same area as is covered by Exhibit No. 1. The map illustrates the distribution of net microlog pay in the Gallup sands by the use of isopach lines drawn to an isopach interval of five feet.

Q What do you mean by that, what is an isopach interval of five feet?

A Isopach line connects points of equal thickness of net

microlog pay. For example, a closed curved line labelled 20 feet situated in Section 20 of Range 11 West, Township 25 North, means that every point on that line represents a location where approximately twenty feet of net microlog pay would be encountered in a well, and since the values decreased away from that, this implies that a well within the closed line would probably encounter more than twenty feet of net pay.

Q When you say twenty feet, referring back to Exhibit 2, would that be the total of the black, what you labeled there in black? A Yes, it would.

Q Regardless of where it occurs vertically?

A The map does not represent one large continuous sand body, but it is actually a composite map of the sum totals of many streaks of thinner pay.

For example, in Carson 33-24, there are intervals of 5 feet, 3 feet and 1 foot and half a foot, another half a foot, which adds up to 10 feet of net microlog pay, and those several intervals are combined, that gives you the 10 foot isopach value on the map.

Q That means just the total at that point, there could be a large number of stringers, is that correct?

A That's right. Actually the map illustrates that there are considerable variations in net microlog pay thickness through the field. For example, in the upper portion of Section 16 in Range 12 West, 25 North, there is a region of twenty feet of net microlog

pay and less than half a mile there is a region of five feet which to me illustrates a very rapid change in the sedimentary characteristics from one region to the other.

Q Do you have any further comments on the isopach Exhibit 3?

A Not now.

Q Would you go ahead to your cross sections, please?

A We have constructed two sections which were selected in a relatively densely drilled area, Section AB, which is Exhibit No. 4, which is located in Sections 10, 15, and 16, Range 12 West and Township 25 North. The well shown on this section are from southwest to northeast El Paso Kelley State 8. State 3, Shell Government 12-15, Shell Government 21-15, Shell Government 34-10 and Shell Government 43-10: The wells are ranged vertically with respect to sea level as a datum and are shown at proper relative horizontal positions according to the scale of the section, and the wells are an average of about 1800 feet apart.

Again we have shown with correlation lines, the correlative electric markers from well to well as we did on Exhibit No. 2. We have made schematic and interpretive correlations of net microlog pay from well to well.

We have indicated these intervals in green on each section. These correlations indicate the changes from well to well in the stratigraphic location of the interval, showing microlog pay. In other words, they show that the permeability sands, the most

permeable sands in the Bisti Field are irregular and discontinuous. For example, in Shell Government 34-10 the GC sand has a considerable microlog pay thickness which rapidly pinches out to the southwest, and is gone by the time Shell Government 12-15 is reached. This well exhibits no microlog pay in the GC sand.

Continuing in a southwesterly direction, El Paso Kelley State 3 does have some microlog pay in it, and this I interpret as a discontinuity in the permeable sand in the GC interval in this portion of the field. The degree of discontinuity of these sands is fairly well controled, suggests to me that there is probably a much greater degree of discontinuity and lenticularity of sands and permeable sands than we can possible know about.

These correlations have been made in as simple and continuous a manner as possible, and probably denser well control would reveal a much greater degree of discontinuity and lenticularity that can now be demonstrated.

Q You consider that a reasonable interpretation of the data?

A I would consider it a reasonable interpretation of the data available.

Q Of course, between wells, where it is noncontinuous, these could be terminated, but you don't know where they terminate?

A We don't know exactly where they terminate. No one knows that.

Q There could be certainly some variation from what you have

shown there?

A Yes, there could be, but I think that it is correct in principle. This also, I think, is suggestive of the fact there may be other permeable sand streaks existing between the wells which are on this particular section, which are not penetrated by any well. For example, in the GE sands in Shell Government 12-15, there is good microlog development in the GE sands which is not present in either El Paso Skelley State C or Shell Government 2315 to the southwest and northeast. It seems to me very likely that had by chance these wells been spaced at the alternate positions at which they are, this sand may have been missed completely, or it may just have been penetrated on the edge. At least it may have been inadequately penetrated by these wells.

Q Then it's possible then for wells on relatively wide spacing to miss these stringers entirely, is that correct?

A I believe that is true.

Q Are the chances of encountering them greater by reason of a number of wells than are drilled?

A Yes, they are greater. Incidently, I would like to say also that it is not to be inferred from these sections that we believe that the only production from the field is from these permeable streaks of sand and, contrary, we know that we obtain some production from the remainder of the sands where they are oil saturated, but that the permeability is so low in these sands that we feel that

wells completed in these sands without microlog pay alone would be very poor producers. In attempting to define the limits of the field, we located Shell Carson No. 2 in Section 25, which did not exhibit any microlog pay at all, although it did have, according to the electric log, some SP development, and therefore it did contain a sandy interval that well was completed for only an allowable of 21 barrels a day and has declined from that.

Q On your Exhibit No. 4 you have shown perforations, have you not, in addition to the microlog?

A Yes, I did. That illustrates, I think, the perforated interval does not show microlog pay because we have obtained enough oil from the intervals.

Q Now, Exhibit 4 is the cross section across the narrow dimension of the field, is that right?

A Exhibit 4 is a southwest northeast cross section which is across the main trend of the Gallup sand.

Q Do you have another cross section longitudinally?

A Yes, Exhibit No. 5.

MR. PORTER: The hearing will be recessed until tomorrow morning at nine o'clock when we will reconvene in the Auditorium of the State Highway Commission Building on Cerrillos Road.

Mr. Seth, could you have your exhibits posted there at nine o'clock?

MR. SETH: Yes.

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

October 17, 1957

CASE 1308

VOLUME II

Transcript of Hearing

DEARNLEY - MEIER & ASSOCIATES
INCORPORATED
GENERAL LAW REPORTERS
ALBUQUERQUE - SANTE FE
3-6691 2-2211

(Whereupon, the hearing was recessed until 9:00 A.M., on Friday, September 20, 1957.)

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(Whereupon, on Friday, September 20, 1957, the hearing was continued in the Auditorium of the State Highway Commission Building on Cerrillos Road in Santa Fe, New Mexico.)

MR. PORTER: The meeting will come to order, please. I would like to announce that the Governor has said he will be a little late on account of some previous commitments. He will be here later in the morning. We will resume Case 1308. Mr. Seth, would you continue with your witness, please?

DONALD R. LINDSAY

called as a witness, testified further as follows:

DIRECT EXAMINATION (Continued)

By MR. SETH:

Q Mr. Lindsay, when we concluded yesterday, you had testified concerning the cross section Exhibit 4, I believe. Would you mind going up to the exhibits, please, and indicate again where Exhibit 4 is located, the cross section Exhibit 4 on your contour map there?

A Exhibit No. 4 is cross section AB which is located in portions of Section 10, 15, 16 in Range 12 West and Township 25 North. It has been drawn in a southwest, northeast direction, and therefore is across the trend of the sands.

Q Now, do you have a section, longitudinal section through a

portion of the field?

A Yes. Exhibit No. 5 is a longitudinal section CD which is located in portions of Sections 9, 15 and 16 in Range 12 West, Township 25 North.

Q Would you point it out on there so we can see where it is?

A (Indicating.)

Q Okay.

A This longitudinal section includes the following wells, Amerada Joan White 2, Amerada Joan White 1, Phillips Mayre B-5, El Paso Kelly State 1, Shell Government 12-15 and Shell Government 23-15. This section has been constructed similarly to the cross section AB. The following information is provided for each well, a tracing of the SP and resistivity curves on the electric log, the interval showing microlog pay has been shown with a heavy black line and perforations and completion data are shown where applicable. Similarly to section AB, I have made correlations of microlog pay intervals from well to well. Again, we find that the permeable sands as indicated by the microlog occur at different stratigraphic positions in different wells. In comparing the longitudinal section with the cross section we can see that the sands are somewhat more persistent down the Gallup sand as compared with across it, but again we find that the sands occur in discontinuous streaks.

That is the permeable sands, for example, in the left four wells the sands are well developed, the GC sands are well developed, and

pinch out toward the southeast and are not present in Shell Government 12-15 in sufficient permeability to exhibit microlog separation, and that they again resume to the southeast appearing in Government 23-15. The GD sands indicate an opposite trend in that they are well developed as a series of permeable sands in the southeastern part of the section and gradually pinch out, grading laterally into silt stones and tightly cemented sand stones toward the northwest and apparently begin to resume development at the northwestern end of the section in Amerada Joan White, 2.

Q You colored this Exhibit 5 in green on the basis of the microlog separation, is that correct?

A That is correct. I have shown in green only those portions of the section which I interpret to be permeable sands, permeable enough to exhibit microlog separation, and again this section is not meant to imply that the remainder of the Gallup sands are not oil-bearing, and it does not imply that they are not productive of oil. Certainly we have seen that we do get some production from them, and therefore we perforate the Gallup sands wherever they are oil-bearing and wherever they show SP development on the electric log.

I think that we can expect these tighter sands to contribute production throughout the life of the field mainly through migration of oil flow, those sands into the adjacent permeable sands and thence through those more permeable paths to the well bore.

Therefore I would conclude from this that the efficient

drainage of this field will depend on the adequate penetration and development of the more permeable sands.

Q Which then, in your opinion, more wells would be preferable rather than fewer?

A I would say that the more wells we drill in this field the more of these discontinuous sands we will drain. I feel quite certain in my opinion wells on 80 acre spacing will miss a good deal of the permeable sands in the field, and that wells on which closer spacing, I would say that wells on one acre spacing or even ten wells to an acre would still probably miss some of the smaller sand stringers.

Q Now, Exhibit 5, as Exhibit 4, you have colored it on the basis of a reasonable interpretation, have you not, that's generally accepted by geologists?

A As I mentioned earlier, I think that the microlog is a very effective tool for detecting permeable sands in these wells where we don't have core data. I think if you will run your little eye up and down these wells shown on Exhibit 2, that at least you can't help but be impressed by the general core of microlog pay with intervals showing high porosity and high permeability.

Q Now, I was thinking take this first microlog section in Shell Government 23-15, you colored that and it is finally pinched out before reaching 12-15? A That is correct.

Q In your opinion is that a reasonable delineation of that

condition.

A I think so, to be consistent I was not able to show micro-log pay going through Shell Government 12-15 in the GC sand because there is no microlog separation there.

Q But it was in 23-15, not in 12-15, so we assume that it stopped somewhere in between. Now, exactly where we don't know, do we?

A No, that is an interpretive problem.

Q You saw the applicant's exhibits as far as the cross section concerned the lower sands, do these exhibits actually show some discontinuity also?

A Yes. On examination of the longitudinal section, I noticed that in the lower sands which we referred to as the GD sands, there were discontinuities apparent on that section which I did not hear brought out in testimony.

Q Now, would you expect in this longitudinal section for these stringers to be longer than you would in Exhibit No. 4, which is a-cross the section, and if that is the case, would you explain why that occurs?

A I would expect the permeable sands to be more continuous and longer in the longitudinal section than I would in the cross section since the longitudinal section is drawn parallel with the depositional grain of the Gallup sand in the Bisti Field.

I would agree with many of the points that were brought out

in the geological testimony of a previous witness, that the Gallup sand is a sand bar type deposit which was deposited in fairly shallow water, and that the sands are best developed in the vicinity of the core of the central part of the bar, and that they pinch out away from the bar in both directions.

Q Tell us a little bit more about this deposition, was it at a beach or how?

A We believe that the Gallup sands were deposited as an off-shore sand bar, probably in very shallow water very possibly, in fact, very probably during most of its deposition, I would say that the sand bar was within wave base and therefore suffered considerable disturbance by the action of waves while the sediments were being deposited, and that it was probably deposited on a fairly flat sea bottom with very low slope.

Q Do you have any other comments concerning Exhibits 4 or 5?

A I think that for the moment I have said what I wanted to about them.

Q Do you have some further data on the detailed situation in the well bores? A Yes, I do.

Q Would you tell us first a little about the coring and how you handled the cores?

A We have cored to date three wells through the Gallup sand. We attempted to core continuously through the productive portion of the Gallup sand and to best examine these cores we saw them

down the middle and photograph them.

Exhibit 6 is a photograph of a portion of the continuous core taken in Carson 33-24, and in the exhibit the core extends from the depth of 4893 to 4911, and this portion of the Gallup sand is within the productive GD zone in this well.

Q Could you point the well out on the map and on the stratigraphic section?

A The well is located in Section 24, Range 12 West in Township 25 North. The portions which are shown on the photograph is in 4893 to 4911. about in there.

Q That is the entire photograph covers that portion, does it?

A That is correct.

Q Do you consider that fairly representative section of a core and of the wells that were cored?

A Yes, I do. I have examined the cores from Carson No. 1 and Carson 33-24 and in both of those cores I find conditions similar to this throughout the Gallup in both wells. The cores I think exhibit very typically the absence of smooth, even bedding planes and exhibit the disturbed sedimentary structure which are characteristic of these sands. To augment this photograph I would like to produce core samples from this interval.

Q Yes, do you have them there?

A I regret that I don't have several copies of these. Exhibits 7 and 8 are respectively core samples from depths of

4894 and 4909 in Carson 33-24, and their positions are indicated by the left red arrows on the photograph respectively. These particular examples show what we interpret to be a result of reworking of the sediments by marine organisms, resulting in very irregular pods and tube lenses of permeable sand, which are closely associated with very tight, tightly sedimented sand stones, and I think exemplify the limited continuity of the permeability in these sands on a microscopic scale.

Exhibits 9 and 10 are core samples from Carson Unit No. 1 for which I do not have a photograph present. Exhibit 9 is from the GC zone in this well. It was taken from the interval 4878 to 94 and Exhibit 10 is from 4964. Exhibit No. 9 is from the GC sand in this well and it also exhibits very irregular and disturbed bedding, and Exhibit 10 is from the lower portion of the Gallup sand below the GD sand, and this is an example of a core which exhibits SP development on the electric log, but no microlog separation. And again I believe that the evidence of disturbance of bedding planes is extreme.

I would conclude from examination of cores and the cores that I have seen in the Bisti Field, that the permeable paths in these sands are very irregular, very torturous and very, very limited continuity.

Q Now, there was some testimony yesterday concerning some gas wells in the area. Do you have anything further on the cores

before we can discuss that matter?

A Nothing at the present.

Q Do you have an exhibit prepared showing the relative location of the gas wells to the oil wells?

A Yes. Exhibit No. 11 is a presentation chart showing the wells in the southeastern part of the field, the portion of the field that we have studied. It is referred to as Penetration Chart EF and extends from the eastern portion of Range 12 West, Township 25 North, to the eastern portion of Range 11 West, Township 25 North, and includes the following wells: Shell Carson No. 2, Shell Carson 33-24, Shell Carson No. 1. Let me start this order over again. Shell Carson No. 2, Shell Carson 33-24, Shell Carson 1, Shell Carson 4, Gulf Gle-Na-Nup-Nah No. 1, Sunray Es-Ka-Nel-E-Wood 2, Sunray or Anderson Prichard To Sah 1, and Anderson Prichard Harold Begay 1. These wells are not spaced at their respective relative distances, but the total distance from the left well to the right well is six miles, approximately. They are, however, ranged vertically with respect to sea level. On the section we have colored with red opposite the perforation intervals, those wells which produce gas, and with green those wells which produce oil. The significance of this is that gas wells have been completed in the field at comparable and even lower structural positions to oil wells in the Gallup formation.

As an example, Gulf Gle-Na-Nup-Nah No. 1 was completed with an

initial production of 1515 MCF a day dry gas and no oil. Shell Carson 33-24 to the west is 21 feet structurally higher than the other well, and completed for an initial flowing production of 470 barrels a day of oil, the GOR of 620, which is about in the average range for the field. The westernmost well, Shell Carson 2, was completed at a structural elevation 64 feet higher than Gle-Na-Nup-Nah-No. 1 and as pointed out previously in the testimony, this well does not have microlog pay, but does have SP development, and was completed for an initial production 21 barrels a day of oil with a very small amount of gas.

I would conclude from this situation that the existence of gas wells down structure from oil wells in the reservoir of this type and an unfaulted reservoir, that there must be some sort of discontinuity in the sediments themselves. I can arrive at no other conclusion at the present.

Q You agree, do you not, generally with the dip of the field as testified to by the proponents? A I do.

Q Was this existence of the gas referred to by the proponents as a gas cap, is this the same matter you are referring to now?

A I believe these gas wells were referred to by the proponents of 80 acre spacing as being in a gas cap.

Q Do you have any further conclusions or statements you would like to make, Mr. Lindsay?

A Yes. I would like to briefly summarize the results of my investigation of the Gallup sand stone reservoir of the Bisti Field

as follows: Isopach maps of the net microlog pay in the field reveal that the permeable sands are irregularly distributed and of variable thickness throughout the field. Cross section and longitudinal sections, both which show detailed correlation of microlog pay intervals, reveal that the permeable sands are located in different stratigraphic positions from well to well, and that they are discontinuous and grade laterally into tight silt stone and tightly cemented sand stones.

Correlation of core data between continuously cored wells also reveal with core analysis data that the permeable sands are variable in their stratigraphic position and that there is a very wide range of porosity and permeability within the Gallup sand stone.

Examination of cores indicates that the Gallup sands are not evenly bedded, but that they exhibit evidence of severe disturbance during deposition, with the result that permeability paths are very irregular on a small scale as wells on a large scale. Production anomalies occur in the southeastern part of the field where gas wells have been completed down structure from oil wells, which to me is virtually positive evidence of discontinuity in the sediments. Inasmuch as every avenue of investigation has indicated that the Gallup is a very heterogenous reservoir, the possibility that the field can be efficiently drained on a spacing as wide as 80 acres appears to me to be very unlikely. And that if drilling is not carried out on a denser spacing pattern, that it is probable that

much of the primary recoverable oil will remain in the ground.

Q Now if I may just make a statement, and the data you have presented concerns a large segment of the field, but is it, in your opinion, fairly representative of the entire area?

A I think that it was brought out by the proponents of 80 acre spacing that the field is fairly, conditions in the field are fairly continuous from one end to the other, and I feel that our approach of sampling about a third of the field is what we have done; on a very detailed examination has revealed a good deal more than a very broad view of the field as a whole. I do feel that our sampling is adequate and representative of the field as a whole.

MR. SETH: That's all the direct we have. We would like to move the admission of exhibits, Shell Exhibits 1 through 11 at this time, if the Commission please.

MR. PORTER: If no objections, the exhibits will be admitted in the record. Does anyone have a question of Mr. Lindsay? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Lindsay, I believe you stated that you had been employed by Shell Oil Company for six years?

A Correct.

Q As exploitation engineer? A Correct.

Q That is not exploration, is it?

A No.

Q Where has most of your work been done?

A Most of it has been in California in sand stone reservoirs. About fifteen months of that were in the Rocky Mountains in oil fields in Utah, I have to qualify that, it was a dry hole.

Q (Interrupting) I consider that experience -- Beg your pardon.

A All right, I'm through.

Q Do you feel that the sands that are encountered in this particular reservoir are reasonably comparable with those that you have encountered and studied generally in the State of California?

A I would say that these are not typical of the sand stone reservoirs in California. Although I believe that our method of geological investigation would apply in either case.

Q Isn't it not generally true that the sands encountered in the area in which you have worked have contained considerably greater pay and net pay than these sands? A That's true.

Q Does that not, in your opinion, have some bearing upon the density with which you develop these reservoirs, or recommend to your management that they be developed? A Yes, it does.

Q Now, Mr. Lindsay, you have stated that you have taken your information as to these wells from a certain area of the reservoir which you agree is of approximately the lateral extent that the proponents have testified here. Is that area generally in the

vicinity of the Carson Unit that you operate?

A Yes.

Q How many wells have you actually studied in that area?

A I would say approx --

MR. SETH: (Interrupting) What do you mean studied?

A Excuse me.

Q I mean which one have you conducted detailed geological studies on, all of them in the area, all of them in the field, or how many?

A I would say approximately twenty-five to thirty.

Q How many wells have been drilled in this reservoir so far?

A I don't have the count.

Q If you have studied only the wells, twenty-five or thirty wells in this area, how can you make the statement that they are fairly representative of all the wells in the area in the reservoir?

A I believe that portion of the testimony which was brought out by the proponents of 80 acre spacing in which it was stated that the reservoir conditions are, and geological conditions are fairly uniform throughout the field.

Q Do you believe that it is an adequate study of a reservoir twenty to twenty-five miles in length with 134 wells, to geologically study twenty-four or twenty-five of the wells?

A I think it is an adequate sampling of the field. If you are worried about how representative this is, then you must be

concerned about the possibility of discontinuities in the field?

Q I'm asking you to satisfy me at least that your conclusions with regard to this entire reservoir which we are studying here, your conclusions are predicated upon an adequate sampling of the reservoir. Now, you have indicated that you base your conclusions as to the lack of uniformity in this reservoir principally upon the study of microlog separation?

A I think that is one of our most powerful tools.

Q Am I correct that is what you are using principally?

A No, we have used the electric log, microlog and core data and production characteristics of the wells.

Q These Exhibits 4 and 5 are predicated on microlog separations, are they not?

A The manner in which the shaded green portions are drawn are predicated upon the microlog.

Q You have admitted, as I understand you, that you will concede there is some continuity of sand, but you will not concede there is a uniformity of sand, is that correct, uniform condition of sand characteristics, permeability?

A I will concede there is a certain amount of continuity, yes.

Q So then it becomes a matter of the degree of movement rather than the movement itself, is that not true?

A Not necessarily, I don't believe. I think that a considerable portion of this reservoir is so impermeable that oil will not

move through it.

Q And you base that upon the absence of microlog separation principally, do you not?

A No, there's no need to compare microlog with an interval which the electric log shows obviously is a silt stone or shale.

Q Well, this green differential is based on microlog separation?

A That is based primarily on microlog separation.

Q Now, Shell has completed some of its wells in zones that you show that don't have any microlog separation, haven't they?

A Yes.

Q How have they done that? A How?

Q Yes.

A By perforating the sands as shown by the SP curve of the electric log.

Q They have obtained production in that manner?

A Non-commercial production.

Q Have they fracted any of those wells?

A I think they have.

Q Well, now, Mr. Lindsay, this may be a production question, but it has a bearing upon your conclusion of lack of permeability, isn't it true that it is not uncommon in a reservoir of this nature where you do not show absence of microlog separation, that by perforating and fracting you may induce sufficient permeability to

create a rather satisfactory production situation, isn't that the purpose of fracturing?

A The purpose of fracturing is to increase the permeability around the well bore of the formation you are attempting to produce, but I'm not sure just how far these fractures extend into the reservoir, and I would like to refer to cross section AB where there is considerable distance as I have interpreted it from, for example, Government 12-15 in the GC sands to where I believe the permeability sands pinch out, and I would state that I doubt that fractures would reach that far.

Q Of course, you have admitted, Mr. Lindsay, that you are just guessing after you leave the well bore in any of those situations where that pinches out?

A As has been testified, geology is an inexact science.

Q I become more aware of that constantly.

A So do I.

Q As a matter of fact, if you carry your argument to its logical conclusion, which apparently is done in California, you might have some of these streaks of permeability extending immediately adjacent to the well bore, mighten you?

A I would say that is very unlikely.

Q And the only way that you could actually be assured on primary methods of recovering the oil, all of the oil in the reservoir, would be to mine it out, wouldn't it?

A I don't think any operator ever will make the claim that he will get all the oil out of a reservoir.

Q The greatest ultimate recovery of oil, I'll put it that way.

A I think that the amount of oil that you will recover from any reservoir will increase with the density of the development and that, well oil has been mined as a matter of fact.

Q Your company recommends that in this instance, would it?

A No, because it would be a very con-commercial enterprise.

Q Exactly. So it becomes a question of where you reach the point of no return, does it not, as far as economics is concerned?

A That is true, yes.

Q Have you made your analysis and your conclusion that you stated at the end of your testimony with reference that primarily recoverable oil may be lost by 80 acre spacing with any consideration of the possibility of pressure maintenance in this reservoir during the stages of primary recovery?

A I am not an expert by any means on secondary recovery or pressure maintenance, or for that matter reservoir engineering.

Q Then you have not made that statement in consideration of the possibilities of any such approach?

A As I was about to say, however, I would say that no matter how continuously you attempted to maintain the pressure in this reservoir throughout its productive life, there are sufficient discontinuities that you will never efficiently flush this well on a

wide acre, or flush this field on a wide spacing.

Q Of course you are making that in the light of your previous statement that you don't have any understanding of pressure maintenance or secondary recovery?

A I didn't say I had no understanding of it. I said I was not an expert.

Q With regard to the photograph of the core that you presented in evidence here, which is Exhibit 6, that core is taken from one of the lower zones in this sand formation, is it not?

A Correct.

Q Do you agree with the witness for the proponents that the most likely producing zone in an economic sense in this reservoir lies at the top of the sand formation?

A I agree that there are probably more reserves in the upper portion of the reservoir, that is what we call the GC sand, than there are in the lower.

Q Then the photograph of the core which you have taken represents a portion of the formation which is in what we would consider a poorer sand?

A In this particular well this sand is better developed on the electric log as regards microlog pay and as regards core data, than is the uppersand.

Q Do you think that this Exhibit No. 6 represents a poorer sand zone?

A No, I would say it is a fairly good sand zone.

Q What is the point of this, what are you trying to establish that the colors aren't the same, or would you explain it a little further to me?

A I was attempting primarily to illustrate the very irregular bedding planes and the evidence that we have of disturbance during deposition of the sands to point out that we are not dealing with long, continuously even bedded sands, but sands which are disturbed and irregular on a very small scale as well as on a large scale. I think this supplements, on a microscopic scale, what we show with our cross sections on a microscopic scale.

Q Did this reflect any unusual condition in this sand reservoir that is not present in other sand reservoirs in this area that you have studied?

A I have not studied other sand reservoirs in this area.

Q Now, with regard to your Exhibit No. 11, as I understand it, none of the gas wells which have been completed in this pool have ever been produced, is that right?

A I don't know of the production history of those gas wells.

Q And it is also true, is it not, that there has been limited production history with regard to the oil wells because of lack of market, isn't that also true?

A I have heard that that is true.

Q Do you know how much oil those wells on your exhibit have

produced? A No, I don't.

MR. SETH: This is a geological witness. We'll have other witnesses who are production people.

Q Have you had experience in examining the geological characteristics of a sand reservoir containing a possible gas cap?

A Yes.

Q Where was that? What reservoir?

A That was in the Ventura Field in California.

Q Does that definitely contain a gas cap?

A We believe that it did not contain a primary gas cap, but that at its present stage of depletion some of the zones have increased. Again, I'm not a reservoir engineer, but they have been depleted to the stage where considerable gas has come out of solution and that the high structural wells have extremely high gas-oil ratios, and we feel that this is evidence that a gas cap is probably forming in the stage of development of those pools.

Q You have recognized, I believe, that the rock characteristics in this particular reservoir are in some instances rather poor and variable, have you not? A Yes, I have.

Q Well, now, as a geologist, can't you say that it is true that it is not uncommon in a reservoir with non-uniform rock characteristics, to have a transition zone between oil and the gas cap that may establish anomalies over vertical distances of considerably more than 21 feet and still not eliminate the

possibility of a gas cap?

A I would say that under the geological conditions of this field that there has almost certainly been enough geologic time for equilibrium to be attained in the reservoir, and that if this were one continuous reservoir I would expect the gas cap to occur only at a higher structural position than at relatively down-structure position to oil-bearing sands.

Q Do you mean to say that in a reservoir of this type that there should be a positive distinguishing cleavage between the oil reservoir and the gas reservoir in order for you to consider there is a gas cap?

A I would not consider myself qualified to say just how sharp that cleavage would be.

MR. CAMPBELL: I believe that's all.

MR. PORTER: Anyone else have a question of the witness?

MR. SULLIVAN: Just a minute, please.

By MR. SULLIVAN:

Q Mr. Lindsay, unfortunately I was sitting down here today and yesterday I wasn't furnished with copies of your exhibits, but I believe they're all marked so that I can see them up here now. I was going to ask you to read, refresh my memory on a number of them, but I see it wouldn't be necessary.

A All right.

Q Now, have you ever appeared, Mr. Lindsay, as an expert

witness for Shell or any other company before in a hearing of this type?

A No.

Q I thought I detected a nervousness or, I want to explain something very briefly. The role of the lawyer in a thing of this kind, and I consider it my role, is to elucidate, we are not here to spar with you. My client, the British American Oil Producing Company, is as eager to make known the facts in this case as is Shell. So that I don't want to approach this now, Mr. Lindsay, in the spirit of sparring with you.

A Suits me.

Q Good. But I want to start off, let's reduce this thing to elementals and we will take a hypothetical question. Let's assume that this was your oil field, or that these interests in this field were yours individually and not Shell's or British American's or Sunray's or some other relatively large company. Now, if that were the case, how would you classify the oil field as to quality, just generally let's say three general classifications, real good, fair, below fair?

A On what basis?

Q Just generally overall, is it a really good oil field, is it a fair oil field, or is it a below fair oil field?

A Are you referring to the amount of oil that I might expect to recover from this field?

Q Yes, on that basis, real good, fair or less than fair.

A I would put it some in the middle.

Q It's either fair or less than fair?

A I would call it fair. Better than some and not as good as some others.

Q Now, we have picked out some standard, it's in the middle here. It's kind of an average oil field. Look at it again from your personal viewpoint, your overall satisfaction with the performance of this field is going to be governed by how much money you make on it, off it, isn't it? A Oh, definitely.

Q And secondly on the basis of whether or not you have in effect recovered all of the oil that is recoverable within practical economic limits, is that correct?

A Yes.

Q Now, I think we now have established what your aim, what probably your employer's aim, and what the other people involved in this hearing, their general aim is with regard to this field, if we can consider that their attitude would be much the same as yours, is that probably a correct deduction?

A I think we have.

Q Now, I believe that you testified in effect that from the viewpoint of establishing, tapping, let's put it --

A What is that?

Q From the viewpoint of tapping each of these individual sands, the best method of making certain that you recovered all of the recoverable oil in each of those sands would be to mine it, but of course, that is preposterous, isn't it?

A Yes.

Q We depart from that degree of preposterousness. You wouldn't drill it on one acre spacing would you?

A No.

Q You would drill it on 40's I infer. I don't believe you ever made that recommendation directly, but I infer that you suggest that the field should be developed on 40 acre spacing?

A That seems to me to be a reasonable spacing for this field.

Q Do you think that at some time in the future you might recommend 20 acres, if 40 is proved to be less satisfactory than you now think they would be?

A I'm not prepared to say. I think that would depend entirely on what we found on 40 acre spacing. I am not in a position to recommend what we do in the future.

Q I am not asking that you recommend. I am asking if it may be shown that if you develop it on 40 that subsequently in order to tap each one of the disconnected sand bodies, it might be necessary to drill it on 20's?

A I would say that it is very improbably. This is only an opinion that I think that is improbable that we would want to drill 20 acre wells to attempt to recover more of the primarily recoverable oil in this field.

Q Is there any condition attached to that?

A No.

Q If it were profitable to do so?

A There would have to be a very thorough profitability investigation made of that. I am not, that is not my particular specialty.

Q Now, one point in your direct testimony, or either upon cross examination by Mr. Campbell, I'm not sure which, but I'm certain that you said something to this effect, that you felt that the type of sampling that you have done here with minute study was of a better grade than a general sample taken throughout the field?

A I think that information gained this way is more pertinent for a spacing study, that is for a general ruling for an entire field, than would a more superficial examination.

Q Well, but do I understand correctly that your study was confined to a relatively, I won't say relatively, absolutely, this series of diagrams here represents these two lines, does it not?

A It does.

Q And what is the distance of each of those lines?

A Oh, about two miles each.

Q You were present in the hearing room yesterday all day, were you not? A Definitely.

Q You heard Mr. Finfrock testify, did you not, the first witness yesterday morning? A I did.

Q Did you see the charts that he exhibited to the Commission

which were his Exhibits I recall 6, with sublettors down through F?

A Yes.

MR. SETH: We'll stipulate that the proponents Exhibits were longer than ours and covered more territory.

MR. SULLIVAN: Mr. Seth, I don't want to spar with you either.

MR. SETH: We just want to get to the point here.

MR. SULLIVAN: The point is, this young man testified Exhibit 8, this young man testified that he thought his examples were better than general examples. I assume that he referred to Mr. Finfrocks exhibits. I'm not going to refer to the length.

MR. SETH: I don't believe he characterized the proponent's exhibits at all.

A No.

MR. SETH: I don't think it is fair to put him in that position.

A You are putting words in my mouth. I did not say mine are better than his. I think his are admirable.

Q Let's go at it another way. All I want to establish was, would a study of logs extending the entire longitudinal length of the field, or as nearly along its entire axis as those logs are available, give a good picture of the entire sand bar?

A It would depend on what information is shown, what geologic tool we employ in interpreting those wells. I would say

that --

Q (Interrupting) Suppose that we employ a good geologist, an experienced geologist, to examine those logs. That's an important tool, isn't it, an experienced, competent examiner of the data? A Yes.

Q And then in addition to that examination he also makes studies of cross sections, the entire longitudinal length of that field comparable in length to your AB line, and he does five of them, would that give a more complete picture of conditions in the field than taking that same study in an isolated area?

A Only if he used all the tools which were available to him, including the micrologs.

Q Let's assume that he does use all of those tools, core analysis, microlog, anything else that has been made available to him, then we get a more truly representative picture of the entire structure, would we not? A Yes, you would.

Q Let's get around to this problem of whether or not there is any other possible set of physical circumstances which could lead to the discovery in this structure of oil above gas. That is simply stated, but a good deal of your testimony was directed to that situation, was it not?

A A very small part of it.

Q Are there any other conditions other than the non-connection of the oil and the gas bearing sands that could possibly count in this

particular instance for production of oil above the production of gas in two fairly adjacent wells?

A There is nothing that I can think of for a reservoir of this type.

Q Now, you are down here close, or on the gas cap of this structure, are you not, in this situation where the two wells, the two wells that you have referred to and which were fairly adjacent wells in which gas is produced at one in a lower elevation than the oil is produced in the adjacent well, is that on or near what has been referred to in this hearing as the gas cap?

A Yes.

Q Let's find out, one, is it not possible, let's start out this way: I believe that you stated that assuming equilibrium of the fluids in this reservoir, that that was the only conclusion that you could arrive at was the lack of connection between the sands?

A That is correct.

Q Assuming equilibrium. Well, now, if those fluids in the reservoir were not in equilibrium, would your conclusion necessarily be, would it be an inexhoribile conclusion?

A No.

Q Is it possible that the fluids in this reservoir are not in equilibrium?

MR. SETH: I think he should answer the question first. Were you going to answer the first question there?

MR. SULLIVAN: I'm sorry if I interrupted. Would you read back one question, please?

REPORTER: Reading: Assuming equilibrium. Well, now, if those fluids in the reservoir were not in equilibrium, would your conclusion necessarily be, would it be an inexhorible conclusion?

A May I answer your first question?

MR. SULLIVAN: Yes, go ahead.

MR. SETH: Yes, do.

A I think that that is a question pertaining to reservoir engineering and I think that one of the subsequent witnesses will be better qualified to testify upon that than I am.

Q Would a tilted gas, the general tilt result here in a possibility of a gas cap?

A I don't think there would be a tilted gas cap in this case if the testimony of the geological witness yesterday were correct, because as I remember on this big three-dimensional illustration there was shown a definite line, a horizontal line, showing the base of the gas cap.

Q But if the gas cap were tilted, if the gas cap were tilted, we could state this as a hypothetical question if you like, but if the gas cap were tilted, then it is possible to produce gas at a lower level than oil is produced, is it not, even with inter-connecting sands?

A Again I would like to remind you that these questions involve the field of reservoir engineering, which I think one of our subsequent witnesses would be better qualified to testify.

MR. SULLIVAN: I will take it up with him, Mr. Lindsay.

Q Are you prepared to qualify as to whether or not you believe there's any vertical permeability? I think it was referred to as vertical permeability by Mr. Brinkley.

A Is there any?

Q Yes, any. A Yes, there is some.

Q To what degree, in your opinion, does it have any substance or importance in this reservoir?

A I would say it has an importance in that I believe that vertical migration of oil may take place from the very low permeability oil-bearing sands into the very permeable streaks of sand in a vertical direction where they are adjacent to them, and then I would expect them to travel more or less horizontally there to the well bore.

Q Do we have any modern method other than in your cores, of determining the extent of vertical permeability? Is there any method of determining vertical permeability except from the study of the cores? A I don't know.

Q Did your cores there show any signs of vertical permeability in any of these sands? A Yes.

Q Of which they were illustrative?

A As a matter of fact, the core sample No. 7 shows some vertically distributed sand streaks which I would assume to have some vertical permeability.

Q I had one other thought too, Mr. Lindsay, which maybe we shouldn't pass by in connection with this gas above the oil, or oil above the gas situation. Are you familiar with the term relative permeability? A Yes.

Q In a tight sand, does the relative permeability of the sand to gas as compared to oil make it possible that an oil-bearing sand will produce gas when it does not produce oil?

A I believe that is possible.

MR. SULLIVAN: I think that's all, Mr. Chairman.

MR. PORTER: Anyone else have a question of the witness?

MR. SELINGER: I have a few questions to ask. Would you care to have a short intermission before I embark on my series?

By MR. SELINGER:

Q Mr. Lindsay, I represent Skelly Oil Company, so you may know who I am. I want to direct your attention to the exhibits that you yourself have made and presented to the Commission, and in order to avoid any misunderstanding of questions and answers to be forthcoming, I want to get it clear as to the extent of your study. Is your study confined to the one-third of the area of the field, or do you have any knowledge at all of the entire field?

A My study has been concentrated in the approximately

one-third of the field which I have described in my exhibits.

Q Do I take that answer to mean that you know nothing about the entire field as a whole? A No.

Q Then to what extent is your knowledge for the entire field? Do you have knowledge, for example, as to the aerial extent of the field? A Not precisely.

Q Do you have any idea then as to the approximate amount of productive acreage as disclosed by presently drilled wells?

A I cannot give you a figure.

Q Do you have any knowledge of that? I didn't ask for any specific figure.

MR. SETH: I think that is a reservoir question.

MR. SELINGER: I am not asking him about any reservoir data whatsoever. I am asking geologically, the productive limits of the field, if he knows.

A All right. I would say that the presently proven productive limits are a little more than twenty miles long and a little more than two miles wide.

Q Does it extend beyond Ranges 11 and 12 West?

A Yes.

Q And by your answer then, I assume that you have made detailed study of the area in Ranges 11 and 12 West, but a study of a great deal minor detail in Ranges 10 and 14 West, is that correct?

A That is correct.

Q Now, within the area that you have made a detailed study, particularly Ranges 11 and 12 West, are there any areas of undeveloped acreage lying in those ranges?

A Yes.

Q Would you mind pointing it out to the Commission as well as indicating for the record the approximate four or five, six sections that have little or no producing wells?

A I would say that portions of Sections 11, possibly, 12, 13, 14, 23 and 24, 15, you say little or no? I'm pointing to the ones for which there are remaining locations to be drilled.

Q Thank you. That is what I had in mind.

A These are in Range 12 West, in Range 11 West. I would consider remaining locations to be drilled in Section 16, little or no you say, 18, 19, 20, 21, 16, we're getting into the gas area. I have no idea how densely that will ever be.

Q That is sufficient, you have answered my question. In answering that question, you have referred to Exhibit No. 3?

A Yes.

Q Now, on that exhibit, have you determined geologically the limits of production in that particular area?

A We have defined the approximate limits of production in that area.

Q Both on the northeast and southwest along its entire line?

A Yes. You said along its entire line?

Q Along its entire line northeast and southwest.

A I think from the drilling that has been carried out in that area that we have a pretty good idea of where the productive limits are in the northeast and southwesterly direction.

Q So that as a geologist, you can say to the Commission that you have determined for all practical purposes the productive limits of the Gallup zones in Ranges 11 and 12 West?

A I think we have.

Q Now, on that Exhibit 3, which is an isopach map of the net microlog, is that correct? A Correct.

Q Can you trace, for example, across the entire area delineated on that particular exhibit for example, a line oh, ten foot along the south line and then along the north line?

A Shall I describe where it is?

Q No, I ask you first can you do so?

A Yes.

Q Will you do so by merely pointing and we'll let the record be silent in that respect, but the Commission can get it from your pointing? A All right.

Q Now, along the north line can you similarly do so?

A I think I can. I thought I could.

Q Thank you, Mr. Lindsay. Would you be able to continue the tracing of the ten foot line, which is not exhibited on Exhibit 3 in Ranges 11 and 12 West, but could you similarly tract that, a

continuation on through Ranges 14, to the northwest and Ranges 10 to the southeast?

A I think I could if we were to draw one.

Q Thank you. I want to refer your attention particularly to your Exhibit 2 which is styled stratigraphic section in which you have depicted there on two wells, the Shell Carson No. 1 and the Shell Carson 33-24, and you have indicated on this exhibit the distance between these two wells as being 2950 feet?

A Correct.

Q You have indicated on your Carson No. 1 your permeability, which is depicted in millidarcies in red, is that correct?

A Correct.

Q Do you have any of whatever nature on your Carson 33-24?

A Any what?

Q Any permeability in the so-called GC sand which the proponents have indicated as the upper, do you have any permeability of whatever nature on that well? A Yes.

Q How many feet? A Of permeability?

Q Yes.

A Permeability of what magnitude?

Q Of any kind. Do you have any, I said, and you said, yes, and I'm asking you how much. A How many feet?

Q Yes. A Or magnitude?

Q Any magnitude, I ask.

A I cannot give you a figure at the moment because on this chart, since we have a logrithmetic scale for permeability, there is no zero in a logrithmetic scale, so I do not know how many of those marked one-tenth of a millidarcies include the zero or less, which may include some intervals of zero permeability.

Q Do you have any coloring of red on that?

A No, I do not.

Q Will you kindly step to the exhibit and see whether or not there is any red appearing on that?

A In the GC sand you say?

Q In the GC sand.

A I'm sorry, I am mistaken, there is a small amount.

Q Would you care to correct your answer? We started out by saying, and you agreed, there was some degree of permeability, you didn't know how much. Now will you kindly, since you have stepped to the board and looked at Exhibit 2 closely, indicate whether or not there is any degree of permeability in that well, referring to the Carson 33-24.

MR. SETH: He already testified there was.

A There is some degree of permeability in that sand.

Q Do you know how much, to what degree?

A Do I know what is the magnitude of the permeability?

Q Yes.

A I know of over the portion of the zone, but unfortunately

when we cored the well there is no recovery over the interval which shows the microlog pay.

Q Can you give us any figures as to the red color that you have there?

A Yes, I have a small interval which shows slightly more than a millidarcy.

Q Is it possible to correlate the permeability from the Carson No. 1 to the Carson No. 33-24 in the GC sand or upper sand from this exhibit?

A I can only say that those intervals of permeability may or may not be connected.

Q If there is additional permeability which is not shown on this exhibit because of what reason --

A There was no core recovery in that interval.

Q Because of the lack of core recovery, then would it be possible to show your correlation through there?

A That would depend upon what well control you had in between those two wells.

Q Are there any other wells in between those two wells?

A No.

Q So that it's a matter of speculation as to the extent of the permeability and the correlation between those two wells, is that correct?

A I believe it is.

Q That speculation is due primarily to the lack of additional

wells between those two wells? A That is correct.

Q And if there were additional wells between those two particular wells depicted on Exhibit 2, you would be in a better position to give a more clarified answer?

A I think you would be in a better position.

Q Thank you. Now, I want to ask you about this Exhibit 4 in this well known as the Shell 12-15, you have depicted on this Exhibit 3 major green lines, is that correct?

A Green intervals.

Q Green intervals? A Yes.

Q Do you show these three green intervals separated from each other? A I do.

Q Do you show these three green intervals separated from the respective wells on each side? A I do.

Q Is it your view as a geologist only that these three green intervals are separated from each other and that they each bear oil or gas?

A I think that they are separated from either no, or very little, permeability between them.

Q Is it your view as a geologist that they are not connected, that they are separated? A It is.

Q Is that well perforated in all three of these separate lenses?

A It has perforations in all three of them.

Q From that, then, you would assume that the well is

producing from all three of those intervals?

A I would.

Q Now, I might ask you in the interval between the Shell, what is that, 21-15 and 12-15, how far apart are those wells?

A Those are about 1800 feet apart.

Q Would you have any opinion as a geologist if a well was drilled in between those two wells we have mentioned, and which I am pointing to, whether or not that well would find production in the zone of production in Well 21-15 and in the zone, one of the zones of Shell 12-15?

A I think that I can only say that it may or may not do so.

Q And your answer is given on the basis of lack of additional drilling in between those two wells, is that correct?

A That is correct.

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

MR. PORTER: Anyone else have a question of the witness? Mr. Bushnell.

MR. BUSHNELL: I just have one or two quick questions.

By MR. BUSHNELL:

Q Mr. Lindsay, as a geologist, is it your opinion that the oil in this Bisti Field originally originated these sands, or would you say in your opinion that it migrated to these sands?

A I would say that probably the oil was supplied from both sources.

Q From both sources? A Yes.

Q Did I understand you to say from both sources?

A You did, yes.

Q So that part of it could have been formed elsewhere and then migrated into the sands now known here as the Bisti Field?

A I'm not prepared to say how far.

Q No, I wasn't asking how far. I was trying to repeat what you had said that in your opinion, am I correct, you just said that in your opinion part of the oil here now migrated from some other source, is that correct? A That's correct.

Q If that is true, then, Mr. Lindsay, would it not follow that the oil in the Bisti Field would be all one common source as to that portion that migrated at least?

A I can't say at the moment whether that's true or not.

Q Does that sound logical?

A I would say it's not impossible.

Q Does that mean the same as it sounds logical? Let me ask you one other question, then, you have used the word discontinuity several times here. A Yes.

Q Were you using that to mean that you are denying communication? A No, I am not.

Q In other words, you can have discontinuity and still have communication, is that correct?

A You can have all degrees of communication.

Q So that you could have discontinuity and still have communication, is that correct?

A Not where you had discontinuity, no. I would say what I'm referring to is the Gallup sand as a whole, I would say that there is a limited amount of continuity in it, but where there is discontinuity there is just discontinuity.

Q You are not denying that there could not be communication by use of that word, are you?

A Communication from where?

Q To these terms that have been used between these intervals of the Bisti sand.

A Up and down?

Q Yes.

A I don't believe there is communication up and down between these two intervals, these two main groups of sands that I have referred to, since there appears to be fairly persistent silt and shale bodies existing between them, which I would say is impermeable to migration of oil.

Q I thought I had you saying what I wanted you to say, but I lost you. Let me repeat once more, Mr. Lindsay. You have used the word several times here this morning, discontinuity, is that correct?

A That's right.

Q Are you using that word to mean that when you have that condition you cannot have communication? You are not using one opposite the other, are you?

A One what?

Q Opposite of the other. One is not to the exclusion of the other, is it?

A I would say in some places discontinuity.

Q This is a general principle. I'm not a geologist. I am a lawyer with Amerada, I forgot to introduce myself.

Q How do you do. Could you restate the question, please?

Q The word you are using, the word discontinuity, is not to the exclusion of communication is it? I'm not referring to any particular piece of testimony, I'm just using it to define in my mind the word discontinuity.

A I used discontinuity to refer to a portion of the reservoir where I think oil will not migrate. I use communication to refer to a portion of the reservoir where I think oil can pass through, to a certain degree.

Q Let me put it this way, in an oil pool that is a common source, you could have parts of it where there exists what you used the term discontinuity, but in other parts of that field there could be communication? A Yes.

MR. BUSHNELL: That is all the questions I have.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsay, does your general geologic picture here look more favorable or less favorable from the standpoint of recovery of oil than Mr. Finfrock's? A On what spacing?

Q Any spacing. It doesn't make any difference. Does it look like there is more oil to you in the reservoir from the pictures you have drawn than it did from the pictures that Mr. Finfrock drew?

A His pictures, no. I would say that his look better than mine.

Q That's what I thought. Then yesterday the argument developed between the proponents and protestants as to how much oil there was in the reservoir. In that argument, Shell was on the other side. Now I can't understand how there can be more oil by Mr. Finfrock's picture, which is put in terms of barrels at 210 foot per 40 acre tract, I don't see how this is consistent with the geologic picture you drew.

A What I meant by better, that is that Mr. Finfrock's pictures looked better, was that they showed more continuity than mine do.

Q Didn't they also show more oil?

A I don't think he specifically showed where the oil existed in his pictures.

Q No, but if the conditions that he portrayed exist, there would be more oil than if the conditions you portrayed existed, would there not?

A Not entirely, because he had an isopach map of net microlog pay which would compare pretty much with ours. If they base their estimate on how much oil there is in the field on that

net isopach map, then our pictures I think would be quite comparable.

Q Thank you.

MR. PORTER: Mr. Utz, did you have a question?

MR. UTZ: Yes, sir.

By MR. UTZ:

Q Mr. Lindsay, through all of this gas well discussion here, I still haven't determined in my own mind as to whether or not you have an opinion as to whether there is a gas cap in this pool or not.

A I don't know whether there is a gas cap or not. There certainly is some gas production, and I would, in my opinion, those gas wells produce from sands which are not connected with sands which produce oil in upstructure positions. Whether or not you would call that a gas cap, I don't know.

Q Is there a possibility that it could be a local gas cap condition?

A I think there is a possibility, but I don't know how continuous that gas cap would be from gas well to gas well.

Q I see. On these four different cores that you have submitted here as exhibits, would you have any permeability information as to those individual cores? Would you be in a position to say what the permeability was in each core?

A You are including these?

Q Yes, I'm referring specifically to these rock cores that you have brought in.

A Well, the situation is that permeabilities within these cores, Exhibits 7 and 8, would probably range from zero to some considerable number of millidarcies of permeability, depending upon which part of the core I sampled.

Q By considerable, you mean what, hundred millidarcies?

A These streaks may or may not contain a hundred millidarcies. I think they could.

Q I'm trying to establish in my mind what the relationship between flow of oil and permeability would be, referring specifically to the type of oil we have in the Bisti Pool. How low a permeability can we have, if this is an engineering question please say so. How low a permeability can we have and still have a movement of oil through it?

A It is an engineering question, however, I would estimate that the range of permeabilities through which oil would flow might be on the order of a tenth of a millidarcy to a millidarcy. Actually I would say that it might be actually less than that through which oil could flow at all. I would certainly say that sand showing zero permeability oil would not certainly flow with any ease through that type of sand, but as to the break-off point, as to where oil will flow and oil will not flow, I am not prepared to say.

Q But you don't think that at a tenth of a millidarcy oil would flow through it?

A I can only give an opinion on that, and I would say that oil would probably flow through a tenth of the millidarcy sand, but probably very, very slowly.

Q It would flow better through one millidarcy?

A Certainly.

MR. UTZ: That's all I have.

MR. PORTER: Does anyone else have a question? Mr. Kellahin?

By MR. KELLAHIN:

Q Mr. Lindsay, I'm representing Phillips Petroleum Company. I just wanted to ask you, you just have the two cores, is that correct?

A Pardon me.

Q Two cores which you brought here?

A Four.

Q About what are the sizes of the cores, about three inches?

A Yes.

Q Then you are taking about a twelve-inch section of the pool to relate the twelve miles, is that right?

A Twelve inches?

Q Well, you have four cores three inches across, that is about twelve inches.

A No, these are not the extent of our reservoir information about the reservoir rock.

Q Those are the only ones that you have presented to the Commission?

A That's right.

Q You are relating that, and by inference saying it covers twelve miles.

A I am prepared to testify that these cores are representative of the Gallup sand, the entire Gallup sand, which was cored in these two wells.

Q Those four cores are from two wells?

A That's correct.

MR. KELLAHIN: That's all.

MR. PORTER: Anyone else have a question? Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsay, you are familiar with the term common source of supply?

A I have heard it, but I have never used it, and I do not know its definition.

Q Do you feel that questions concerning common source of supply should be better directed to an engineering witness rather than a geological witness? A Yes.

MR. COOLEY: No further questions.

MR. COOLEY: Mr. Nutter.

By MR. NUTTER:

Q Mr. Lindsay, I believe it has been stated at this hearing that the length of this pool is some twenty miles, is that correct?

A I think I heard that figure, twenty or perhaps a little more.

Q What is the overall length of the entire study which you have made as depicted on Exhibits 1 and 2 by the red lines, the general overall length of your study?

A About, I would say, between nine and ten miles. I would say nine miles as a figure.

Q And that lengthwise study has been made, or that nine or ten mile study has been made along the longitudinal axis of the pool, is that correct?

A No, both along the longitudinal and across the axis of the trend.

Q How many miles of study have you made along the longitudinal axis of the pool?

A You are right, about nine.

Q In other words, that nine or ten miles of study that you have made along the longitudinal axis of the pool represents a study of some half of the length of the pool?

A Approximately. Slightly less, I would say.

Q And I think that you stated, correct me if I am not correct you stated that you believe that the general reservoir conditions along the longitudinal axis of the pool are similar from one end to the other?

A I would say that I have stated many times that this is a very hetergenous reservoir, and I think that the hetergenity that we would find in these nine miles would probably exist throughout the

entire reservoir.

Q Did you hear the testimony yesterday, Mr. Lindsay?

A Yes.

Q Was the general tone of the testimony yesterday such that would indicate that the general conditions of the reservoir would prevail from the northwest to the southeast end of the reservoir?

A Yes, they do.

Q Do you feel that your nine or ten mile study, therefore, along the longitudinal axis of the pool is typical of the entire length of the pool?

A I believe that it is.

Q What length are the crosswise studies that you have made across the pool? A About two miles.

Q What is the general width of the pool throughout the length of the pool?

A I would say about two and a half miles.

Q So you have pretty adequately studied the cross section of the pool, do you feel that is true?

A I feel that I have.

Q Mr. Lindsay, in response to a question by Mr. Selinger, you pointed out certain areas where the acreage had not been completely developed? A Yes, I did.

Q Has Section 5 of Township 25, 12, been fully developed in your opinion?

A It has been fully developed on 80 acre spacing.

Q Has Section 8 been fully developed?

A On 80 acre spacing, yes.

Q Are there several other sections there that haven't been developed on 40 acre but they have been fully developed on 80 acre spacing? A Yes, there are others.

Q So that no part of the pool has been fully developed insofar as 40 acre spacing is concerned?

A That is correct.

Q In response to another question by Mr. Selinger, he was mentioning a hypothetical well that could be drilled between, referring to your exhibit of cross section AB, a hypothetical well which could be drilled between the third well and the fourth well on that exhibit reading from the left?

A Yes.

Q Where would that well be located on your red line on the exhibit showing the plat of the area? A Here.

Q Would that be a standard location for a 40 acre well?

A No.

Q So that even on 40 acre spacing it would be impossible to know what would prevail between those two wells as depicted on cross section AB? A Correct.

Q In response to another question, Mr. Lindsay, I believe this question was directed by Mr. Bushnell, he asked the origin of the oil which is in Bisti-Lower Gallup Pool?

A Yes.

Q Whether the oil had occurred somewhere else and migrated into the pool, or whether it occurred in the pool, you stated that you believed it could possibly have occurred in both places?

A Yes.

Q If the oil had occurred somewhere else, would it have been possible for the oil to have found its way through geological time into any zones which may be permeable but are surrounded by relatively impermeable sections?

A That could depend partly on when the oil was formed and what the geological conditions were when oil migration took place. Have I evaded your question?

Q No, I think you have answered it. Do you think that the oil, if the oil was formed someplace else throughout geological time, would it have a better chance of getting into the, now you say, I believe that there are isolated permeable sections, isolated sections of permeability and porosity? A Right.

Q Would the oil have a better opportunity or lesser opportunity of getting into that isolated section of permeability and porosity in geological time or of getting out of the isolated section of permeability and porosity during the normal life of an oil well?

A I would say the oil would have a much better chance of getting in than getting out.

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

A Unless we drilled enough wells.

MR. PORTER: Are there any further questions? The witness may be excused. We will take a short recess.

(Witness excused.)

(Recess.)

MR. PORTER: The hearing will come to order. Mr. Seth, will you call your next witness?

MR. SETH: I want to call Mr. Norbert E. Methven.

NORBERT E. METHVEN

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

DIRECT EXAMINATION

By MR. SETH:

Q Mr. Methven, were you sworn during the course of this hearing?

A I was.

Q Will you state your name and position with Shell and your educational experience, please?

A My name is Norbert E. Methven. I was granted a Bachelor of Science degree in electrical engineering from Oregon State College in 1953. I have been with Shell four years, specializing in reservoir engineering.

Q Where do you live at the present time?

A I'm living in Farmington, New Mexico.

Q Have you made a study of the Bisti Field in this connection?

A I have.

Q Are you generally familiar with the reservoir characteristics in that field? A Yes, I am.

MR. SETH: May he testify as an engineer?

MR. PORTER: Yes, sir, his qualifications are acceptable.

Q Mr. Methven, will you please proceed and describe the reservoir characteristics and the source of your data and how you arrived at your various figures and computations?

A Yes, I will.

I'm employing the geologic interpretations as presented by our previous witness, also employing the petriphysical analysis and the study of the reservoir data. We find in general that wells spaced in accordance with the rules and regulations of the New Mexico Oil Conservation Commission, firstly will recover more oil than wider spaced wells, secondly will run a sufficient profit, and thirdly will pay out the cost of this development within a reasonable length of time. These findings are based on calculations of the total oil in place and an estimate of the amount of recoverable oil. These calculations involve the use of the average reservoir porosity, in the region we are discussing this value is 15%, we are using an average water saturation of 25% as determined by electric log interpretation, core analysis, mercury capillary pressure curves, we are using a shrinkage factor of .78 as determined

by PBT analysis and permeables with ranges as previously testified to in this hearing of one to two hundred, and averages of ten and thereabouts millidarcies.

We also are basing this on a drive mechanism of solution gas drive receded by gas expansion while the reservoir is above the bubble pressure. Using these data, the total oil in place as calculated, is 680 barrels per acre foot.

I want to point out that this is in the microlog pay interval. Now, we think that the primary recovery efficiency, or I think, that the primary recovery efficiency will be about 20% of the oil in the microlog pay regions as described in its Exhibit 3 as previously mentioned. Now, this 20% would be of the 680 which is 135 barrels per acre foot. We also want to point out that I believe that this value is applicable only to wells spaced at 40 acre intervals and it will not hold 80 acre spaced wells due to these previously testified to discontinuities. These have been exemplified by Exhibits 2 through 11. I would like to present an Exhibit No. 12.

(Marked Shell's Exhibit No. 12, for identification.)

This Exhibit No. 12 constitutes well data in the Bisti Field of properties operated by Shell Oil Company, and generally in the region as depicted by the Exhibits 2 through 11.

Column 1 are the well numbers as we have them on our exhibits.

Column 2 is the location of that well. Column 3 are the perforated intervals. Column 4 is the microlog pay pick or thickness, and we also have tabulated what we term poor pay in that same column. The next column, 5, are the amounts of fluid used in fract treatment wherever applicable. The sixth column is the total depth of the well. The seventh column is the elevation in feet measured from the Kelly Burk, the next column is the initial rate and barrels per day of these wells where applicable. The next column is the initial pressures of these respective wells. The next column is the most recent pressure data of these wells, the eleventh column is the cumulative oil in barrels. These numbers are up to 8157 unless otherwise noted.

I want to qualify especially Column 10 which are the recent pressure data, and these data were obtained by Amerada type RPG pressure bomb which was hung in the perforated interval of the respective well and these data in Column 10 represent shutin pressure of wells, those wells having been shut in for periods of 19 to over 180 days.

These, therefore, represent average reservoir pressures in the region of the particular well.

I would like to point out some of these wells on one of our exhibits. I would like to make the general statement that in the interior region of the Shell operated properties, in the region of the central portion of the Shell operated properties, and I might

qualify that by giving some specific wells, Carson Unit No. 1 which is in Section 24.

Q Mr. Methven, why don't you stand over on this side, and I think everybody can see.

A Carson No. 1 in Section 24, 12 West is this well right here. This well as of 9-2-57 had a pressure, static pressure of 1546. Another well in that region would be Carson 4 of Section 20, which is right here. This well had a pressure of 1580, 1,504 on PSI. Another one is Carson 14-13 in Section 13, which would be right here, had a pressure value of 1539, which as I said the evidence is very near original pressures in that region, primarily because of the lack of withdrawals in there. To the west in Sections 10 and 15, significant withdrawals have been made. I think the discontinuities become evident from these data.

Now, specifically 14, 15 in Section 15, which would be this well right here, had a value of 1177 PSI after withdrawals of 6,555 barrels. Now, Well No. 12-15 had a pressure of 1154 PSI, which is the next well up here, after withdrawals of 22,309 barrels. Now, the next well to the north, 14-10, this one right here, had a reservoir pressure or average static pressure of 1454 PSI after withdrawals of 15,152 barrels.

I would like to qualify this data as I neglected to do before, the pressure data, these have been corrected to a common elevation of 1500 feet, common datum. My point here is that this well 14-15.

12-15 and 14-10, these are in Township 25 North and Range 12 West, have values of only in the region of a little over 1100 PSI, while the well to the north has 1454 PSI. In accordance with the testimony the other day, I do not have the specific example, but they had a similar situation where the pressures were the same in general on locations like that, but here it does not occur. But there is a significant difference and yet withdrawals have been appreciable here. I think it's a kind of a comparable example, and yet it points to or suggests a different conclusion. It suggests another discontinuity, or at least a hetergenous type of reservoir in view of the fact these wells have been static for quite some time, or shut in.

Now, based on the previous reservoir perimiters that I have listed, and based on the isopach map of the microlog pay which is Exhibit 3, and based on an average microlog pay of 12 feet, based on 40 acre spaced wells and the previous recovery factor of 20% and the 135 barrels per acre foot recovery average, I have calculated that there would be 65,000 barrels per well from this sand. This I want to repeat again is the isopach, from the isopach of the net microlog pay. Now, in addition to that we have what we term poor pay. These are sands that are within these major microlog pay intervals and others, and we think that there will be some oil from there, in fact this is based on the fact that we have wells that have been, exemplified that. My estimate of that oil per well

will be on the order of 10,000 barrels. Thus there should be about 75,000 barrels per 40 acre well. This figure of 75,000, of course, disagrees with the previous testimony. Economics of this recovery of 75,000 barrels and an estimated drilling and development and completion cost of $18,000 will render adequate profit, the pay-out on the basis of this cost and this recovery will be less than two years, assuming existing New Mexico allowables.

Now, in conclusion, I feel that 40 acre spaced wells will recover a greater percentage of the oil in place. I also feel that 40 acre spaced wells will be profitable and will have favorable and acceptable pay-outs. Therefore, I think it's imperative for us to recover this additional oil in the interest of all concerned and in accordance with the rules and regulations of the New Mexico Oil Conservation Commission.

MR. SETH: I believe that's all the direct. We would like to have the exhibit introduced into evidence.

MR. PORTER: Exhibit No. 12?

MR. SETH: No. 12, yes, sir.

MR. PORTER: Without objection it will be admitted in the record.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Methven, Shell, up-to-date at least, has generally confined its operation in this area to the Carson Unit area, has it

not?

A With the exceptions to the west of one or more sections.

Q Has Shell followed a practice in this area of drilling wells and delaying the actual completion of these wells, in other words, not actually been producing them? Have you done that?

A That is true. Exhibit 12 exemplifies that some of these wells have not been completed.

Q Just how much production history do you have from the wells you have drilled in this reservoir?

A I do not have the cumulative number, but it is only a matter of several thousand barrels. You may be able to add that up if you would care to be more specific.

Q I have noted that a number of the wells in the Carson Unit with which your company has been principally concerned, contain a number of blanks in your well data exhibit.

A Yes, sir.

Q I assume that is due to the fact that you have not completed those wells? A Yes, sir.

Q Do you think that you have enough data upon the basis of Shell's experience in this pool, to reach a firm conclusion that permanent 40 acre spacing is justified in this whole reservoir?

A In my opinion it was sufficient to recommend this spacing.

Q Do you feel that there would be any disadvantage of retaining the present 80 acre well density in this pool for a period of

one year to obtain additional production data upon which you could base firmer conclusions?

A As will be brought out in subsequent testimony, it will be disadvantageous in some respects to delay the more dense spacing program.

Q You have stated that in your opinion wells should be drilled now in this reservoir upon a 40 acre spacing pattern. Do you make that recommendation with regard to all of the areas in this reservoir or just to the more prolific areas in the center strip that you, I believe, or the other witness have referred to?

A I believe I testified to this, was on the average of the microlog pay region as depicted by Exhibit 3.

Q Yes. My question now is when you leave the areas of thicker microlog pay and move to the boundaries of the reservoir on the exterior edges of it, would you recommend to your company drilling wells on 40 acre spacing in those areas?

A No, I wouldn't and, because these are unprofitable ventures as testified by one of Sunray's witnesses.

Q All right. Then assuming that you are correct in your analysis that this reservoir lacks uniformity and that there are areas on the edge that are not as prolific of oil or profitable financially, would not your proposal result in the loss of oil from those areas if you drilled your best areas on 40 acre spacing and recognize that you cannot drill theother areas on 40 acre spacing?

A There will be some of that oil left behind, of course. In fact, there might be quite a bit of it. However, I don't think any industrial organization would want to go, would want to go there and drill these wells because they are uneconomical.

Q Your recommendation is based on the belief that you can, by 40 acre drilling at the apex of this reservoir --

A (Interrupting) Would you repeat?

Q Your conclusion on 40 acre spacing, as I understand you, is based upon your belief that because of the thickness of the sands in the better areas of this reservoir, you can recover more oil than if you drill on 80 acre spacing throughout the entire reservoir, am I right in that? Do you believe that you can do that?

A I want to be sure I understand the question.

Q Perhaps it was vague. Do you believe that if this reservoir is developed by drilling on 40 acre spacing in the areas of the reservoir, that contain the thickness of the sand which you say will pay these wells out rather than drilling 80 acre wells throughout the entire reservoir, in which system would you get the most ultimate recovery of oil?

A As stated, I don't believe that I could give an opinion because as stated, the question infers that if you develop on an 80 acre spacing pattern that you will drill wells out in the non-profitable region.

Q Well, don't you believe as a matter of practical economics

and mathematics that you are more likely to do it under those circumstances than if you are called upon to drill it on 40 acres where it is only half the investment?

A If it's a loss, I don't think that anybody would care to put their money into a losing venture.

Q That would depend too upon the rate of withdrawal, would it not? A Excuse me.

Q That too would depend to some extent upon the rate of withdrawal permitted from the 80 acre well just as your --

A (Interrupting) I said a loss. I mean if it constitutes a loss in dollars.

Q Is your conclusion as to the advisability of 40 acre spacing from an economic point of view for your company, predicated to any degree upon the desire of your company to acquire oil from this reservoir for its pipeline and refining and marketing purposes?

A Sir, I'm in the Production Department, and as you know, our job is to produce and develop these fields. I am not qualified to speak as far as the other phases of the company are concerned.

Q Have you made any study of the proposed effort to establish a pressure maintenance program in this reservoir?

A Yes, I have.

Q Have you in connection with your studies of proposed spacing in this reservoir at this time taken into consideration the possibilities of that effort? A Yes, we have.

Q Is it your opinion that if wells are immediately drilled on a 40 acre basis and withdrawals take place at the assumed rate that you used of the present allowable, that there will be a pressure decline in the entire field somewhat equivalent to the pressure declines you pointed out in Sections 10 and 9?

A I believe that you have stated that if wells are drilled immediately. I don't think that's a practical consideration. I don't think it's a practical question.

Q All right. If wells are not to be drilled immediately upon that basis, what objection can you have to an order of 80 acre spacing for one year?

A I just testified previously that that would be brought out in future testimony.

Q You don't have any views or ideas on that at all?

A Would you state a question?

Q If you do not believe it is feasible, and it obviously isn't, to drill wells on a 40 acre basis in the next year, what objection do you have to continue the field on the 80 acre basis until at least the pressure maintenance program is tested?

MR. SETH: I don't believe the witness so testified. He didn't testify it was not practical to drill wells on a 40 acre spacing during the nest year.

Q Do you think that you can drill enough wells in the next year to develop the Carson Unit on a 40 acre basis?

A That is quite probable.

Q How many wells would that take?

A Oh, estimating in the next year?

Q Yes.

A Probably -- Carson Unit?

Q Well, on your acreage.

A Well, something like fifty wells, I believe.

Q And how many do you believe it would take to develop this field on a 40 acre basis entirely during the next year?

A Are you speaking of the same area now?

Q I'm speaking of the entire Bisti-Lower Gallup Oil Pool as we presently know it.

A The entire Bisti Pool. I believe that's brought out in the testimony the other day of a very great number of wells.

Q Approximately 300 wells, was it not?

A Something like that.

Q Now, do you think it's practical to drill that many wells in a year?

A I think I already said that it wasn't.

Q That it wasn't? A No.

Q What do you consider to be the bubble point pressure in this reservoir?

A My figure is very close to that figure as testified to yesterday.

Q That I believe was 12 -- A 1207.

Q 1207.

A 1207 I believe it was, yes.

Q I notice that with the limited production that has taken place in the field, that two of the wells to which you referred as having some production in Section 15, that the recent pressures are already below the bubble point, am I correct?

A That is correct.

Q As a reservoir engineer, does that have any significance to you insofar as ultimate recovery from this reservoir is concerned?

A Significant of this pressure?

Q Pressure decline to below the bubble point with the amount of oil that has been produced.

A Would you restate the question?

Q Does that have any significance to you, the decline of reservoir pressure in the short production history of these wells below the bubble point have any significance?

A Very definitely. It's a very normal reaction.

Q Doesn't it indicate to you that this is a reservoir that requires a rather conservative approach as far as spacing and withdrawal is concerned?

A That's why we have given it a very thorough study.

Q Do you think that the overall production history is

sufficient to justify the risk that you think must exist, the caution that must be used in the development of this reservoir?

A Yes, I do. I think that it justifies the risk in my recommendation I wouldn't have recommended it.

MR. CAMPBELL: That's all.

MR. PORTER: The hearing will recess until one-fifteen.

AFTERNOON SESSION

September 20, 1957.

MR. PORTER: The meeting will come to order, please. Anyone have any further questions of Mr. Methven?

MR. SETH: We have a few more exhibits we would like to offer at this time. They only relate to the general study that Shell has made of the field and we wanted a complete picture. We would like to offer Exhibits 14, 15, 16, 17 and 18 at this time.

MR. PORTER: Are those studies by Mr. Methven?

MR. SETH: No, they are by other personnel in the company who occupy similar capacities to Mr. Methven.

MR. CAMPBELL: I would like to take a look at those.

MR. PORTER: Surely.

MR. SELINGER: While Mr. Campbell looks those over, may I interrogate the witness?

MR. SETH: I might explain those are copies of letters that have been sent out to the people interested in the Carson unit and the United States Geological Survey. I think most

everybody here has copies. Excuse me, Mr. Selinger.

MR. CAMPBELL: What are the marks appearing on them? There are some red marks.

MR. SETH: No particular significance.

MR. CAMPBELL: Are any of those people going to be present to testify? Is Mr. MacAlister going to testify?

MR. SETH: Yes.

MR. CAMPBELL: Mr. Robison, I assume, is not?

MR. SETH: Mr. Robison is here. Mr. MacAlister will be prepared to discuss the letters, Mr. Campbell.

MR. CAMPBELL: Mr. Pickell?

MR. SETH: No, he is not here.

MR. CAMPBELL: I won't offer any objection. If you desire, as far as I'm concerned, offer them at this time. Is that all of the letters that have been sent to the participants in the Carson Unit by Shell as operator?

MR. SETH: I doubt that very much. These are the regular geological reports. There have been innumerable letters written on the Carson Unit, I'm sure.

MR. CAMPBELL: Are these all the geological reports?

MR. SETH: Mr. MacAlister can answer that. Is that right?

MR. MacALISTER: Yes, that's right.

MR. CAMPBELL: Do you have extra copies of these?

MR. SETH: No, we don't.

MR. CAMPBELL: I don't mean to be arbitrary, if the Commission please, but this is quite a number of geological conclusions, without even an opportunity to read the letters I hate to accept them in evidence, particularly in view of the fact that the witness is not here to testify. I don't mean to be arbitrary. If I could have a little time while the cross examination is going on to look them over, perhaps I can accept them.

MR. SETH: We are not in any hurry.

MR. PORTER: Then it would be agreeable to you to wait until the other witnesses have been accepted before you offer these exhibits?

MR. SETH: Yes, certainly.

MR. SULLIVAN: Could you lay your foundation for the introduction of those through a subsequent witness like Mr. MacAlister?

MR. SETH: Perhaps we could if that would be --

MR. SULLIVAN: (Interrupting) Then you can identify them and they would come in in a more regular fashion, would that be preferable, Mr. Campbell, from your viewpoint?

MR. CAMPBELL: It would be acceptable.

MR. SETH: That's right, I would like the record to show that we offered them, but we will defer urging their admission until Mr. MacAlister has had an opportunity to testify and to further identify them.

MR. PORTER: Well, the Commission will delay the acceptance or any consideration of acceptance of these exhibits until after your other witnesses have appeared. Mr. Selinger.

CROSS EXAMINATION

By MR. SELINGER:

Q Mr. Methven, as an engineer do you likewise have the opinion that the previous geological witness had that, particularly with reference to Exhibit 11, that there are some oil wells producing structurally higher than gas wells?

A If that's as the exhibit presents, yes, I believe it.

Q Is your testimony, is your opinion based on that Exhibit 11?

A Well, it's based on Sunray's exhibit as presented yesterday also. It shows the same structural relationship.

Q And referring to Exhibit 11, are you familiar with Shell's completion methods of your wells in this field?

A Somewhat, yes.

Q You are somewhat? A Yes.

Q Which of the oil wells produce structurally higher than the gas wells? Just name them.

A Could I refer --

Q (Interrupting) Surely. If you want to refer to the exhibit. It's all right to.

A Yes. Would you repeat the question again?

Q Which of the oil wells produce structurally higher than the

gas wells on that exhibit, or any other information that you may have?

A Which of the oil wells produce structurally higher than the gas wells?

Q Yes.

A It appears that most of these oil wells on this exhibit produce structurally lower than the gas wells. I believe there's an exception here. Yes, Shell Carson 2 produces higher structurally, I believe.

Q Then that's the only well on this exhibit that produces oil structurally higher than the gas well, is that correct, on this exhibit?

A On the exhibit.

Q Do you know whether or not Shell individually tested the various perforations to determine whether or not those particular perforations were productive of oil?

A I do not know if they tested those individually.

Q In the event that the well was tested through all of the perforations simultaneously, how can you ascertain whether or not the particular, the uppermost perforations produced oil?

A We can't testify to.

Q Now, look at the log, are you familiar in reading logs?

A Somewhat.

Q Does that indicate that it might be productive of oil itself?

A The log doesn't tell you whether it's gas or oil.

Q Does the indenture lines on the left-hand column, the left-hand side of the well bore column indicate what does that indicate?

A You mean this line over here?

Q Yes, on the left-hand side.

A I believe that our geologist said that depicted sand development.

Q Then I'll ask you does the sand development, as indicated by this particular log, indicate the ability of the well to produce oil from that particular perforation?

A Certainly not. Just a minute. Your question was does this --

Q (Interrupting) Yes. A Does this what?

Q Then I'll ask you does the sand development, as indicated by this particular log, indicate the ability of the well to produce oil from that particular perforation? You will have to speak so the Court Reporter can hear your answer also.

A Okay.

Q My question is whether or not this Exhibit 11 indicates that the sand development on the Carson No. 2 shows the ability of a well to produce oil? A No, it doesn't.

Q Do you have an explanation, I didn't mean to cut you off, Mr. Witness, do you have an explanation?

A No, that will be all.

Q Now, I want to call your attention to Exhibit 12, this morning you referred to your Exhibit 12 and in pencil indicated on Exhibit 1 in red, three wells, two of which are located in Section 15, Township 25 North, Range 12 West, and one located in Section 10, Township 25 North, Range 12 West.

Do you recall your testimony on direct and cross examination in which you put those figures in red?

A Yes.

Q Do you have your Exhibit 12 in front of you?

A I have.

Q I note that a number of wells were fracted and a number of wells were not fracted, is that correct?

A That is.

Q A number of those wells were fracted with 30,000 gallons of acid, is that right, or treatment?

A Oil and --

Q Treatment? A Treatment.

Q You indicated on this morning's session that the two wells in Section 15 had quite a rapid drop or decline in bottomhole pressure as compared to the well in Section 10, did you not?

A The wells are specifically --

Q (Interrupting) The wells are specifically 12-15 and 14-15?

A Yes.

Q Are those two wells at the present time from your exhibit

the lowest pressures in the field that you have measured?

A In accordance with the exhibit I believe they are.

Q Are they both below the bubble point?

A We have established that they were.

Q Your answer is yes? A Yes.

Q How many gallons of treatment was used in fracting the well in Section 10, Well 14-10?

A That well has not been fracted.

Q How many gallons of treatment were used in fracting the Well 12-15?

A That was 117,450 gallons.

Q How many gallons of treatment were used in fracting Well 14-15? A 115,280 gallons.

Q Did you, in any completion of your wells, use that fracting in any of the other wells from your Exhibit 12?

A No, those are the largest ones.

Q From an eyeball survey of Exhibit 12, would you say that the average gallonage used in fracting the wells in this field were approximately from thirty to fifty thousand gallon?

A That may be, yes, the most of them are in the thirty to fifty thousand gallon region, yes.

Q As an engineer, would you likely expect a more rapid decline in pressure after an unusually large fracting?

A If you had two completely similar wells the objective,

of course, of fracting is to improve their productivity, and therefore the larger fract may not decline as rapidly as the other.

Q Have you had experience in fracting in the completion of oil wells generally in your career?

A I've been involved in a few cases.

Q In those few cases do you generally find it true the heavier the fracting the more of a pressure decline in those few cases that you are familiar with?

A I don't recall the answer.

Q Very well, would you have an answer then for the explanation of the rapid decline of these two wells in Section 15, 25 North, 12 West, being due to the extremely high gallonage of treatment used for fracting, would that be an explanation for that decline?

A No, I think the reason that these wells have had an abnormally great decline is due to the fact that their drainage area is not large. They have a relatively small drainage area.

Q By a relatively small drainage area, you take into consideration for your answer the thinness of the pay compared to the well in Section 10?

A Of course, the amount of initial oil in place that this well drains very definitely has a definite effect.

Q Does pay thickness have an effect on the original oil in place? A By all means.

Q Then your answer is that you did take into consideration the

thinness of the pay of those two wells in explaining the rapid decline in pressure for those two wells?

A I didn't mention it specifically.

Q You may not have mentioned it directly, but you did after three questions. You said that would depend on the small drainage area, and by the small drainage area you meant the oil in place.

A The drainage volume.

Q Drainage volume, which was in turn controled by your thickness of pay? A Yes.

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

MR. PORTER: Does anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Methven, I'm still trying to arrive at some conclusion as to whether or not there is a gas cap in the Bisti Pool or not. Do you have an opinion on that subject?

A Yes, I have. I don't think I have the answer to it. In the last cross examination the infe.nce was that we didn't know in the case of the oil wells, where the oil was coming from. Now, in the case of the gas wells, the same will hold. However, there were pressure measurements made in those gas wells while producing, and the drawdown was several hundred PSI. I cannot recall the exact number, I don't have the data with me, but it was several hundred PSI, and assuming the pays in the field which are

relatively general, let us assume they are one-tenth BD for PSI, then there should have been a considerable amount of oil with that gas, assuming this rapid drawdown.

Now, then, I believe the figures and the initial production of those wells do not show any oil. Therefore, I can only conclude that gas is coming from all those sands and that oil is not coming from them. Further, to further the explanation, I might go back and say that, let's see, I believe in yesterday's testimony Mr. Brinkley stated that you can have gas occurring, you can have a gas cap, I don't remember his exact words, but this was the thought, that you could have a gas cap in the presence of undersaturated oil. Well, he not only said you can, but he says, I believe his words, that it happens all the time. There are, of course, many cases where it does not happen. Therefore, that is not true.

Also I don't see how it's possible to have a gas cap in conjunction with undersaturated oil just based on the theory of fluid mechanics. So, assuming that you cannot have those two in the presence of one or another, then there has to be some other explanation. I think that in view of the discontinuities that have been placed or are pointed out in our previous testimony, I think you could draw a very logical conclusion that there is another discontinuity in that area which could account for it, but a gas cap existing where you have undersaturated oil, I can't explain that any other way.

Q Then I take it from your explanation that you would gather, or your opinion is, that these gas wells are in a common source of supply of their own and gas only? In other words, a gas reservoir?

A I'm not completely familiar with the exact definition of common source of supply.

Q Well, gas only and no oil?

A Oh, well, the wells have exhibited no oil in their production history, several have exhibited that, so if there was not a discontinuity and, as brought out by the geologist, if there was not a discontinuity, this thing couldn't occur because over the millions of years that this thing took to get there, it will have to be separated some way. There haven't been appreciable withdrawals here so there hasn't been much movement there in many years according to the geologist.

Q Then, do you feel that if these gas wells were allowed to produce unrestrictedly, it would have no effect on the reservoir energy in the Bisti Oil Pool?

A If it was a separate pool, why then it wouldn't, but I do not know what the answer is to their occurrence.

Q You don't know at this time whether it is a separate gas pool?

A No, I do not.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question of the witness? Mr. Kellahin.

By MR. KELLAHIN:

Q Mr. Mothven, I understand that the initial reservoir pressure in this pool were on the order of 1580 pounds?

A Yes.

Q Is that correct? A In that region, yes.

Q I notice on your Exhibit No. 12 you have the Government 12-15 and the Government 14-15 wells, on the first you show an initial pressure of 1330 pounds, and on the second, 1314 pounds, is that correct? A Yes, it is.

Q Does that not indicate that those wells, prior to the taking of initial pressure tests, had suffered some drainage then?

A Yes, and this drainage, I believe, was pointed out by our geologist. He did not make the contention that you had specific 40 acre blocks of oil that you will have some communication, and therefore I should think that that pressure drop would be caused by some communication from other wells.

Q From other wells in that area?

A I should think so.

Q I notice too on the Government 14-15 that shows no microlog pay? A That is correct.

Q And yet it was completed for the production of oil?

A That is correct.

Q And it also suffered this drainage?

A It infers that, yes.

MR. KELLAHIN: Thank you very much.

MR. PORTER: Mr. Sullivan.

By MR. SULLIVAN:

Q Mr. Methven, has Shell conducted, in any of the gas wells, any bottomhole pressure surveys?

A Yes, I just reiterated one, but I do not have the data with me.

Q How did the bottomhole pressures in the gas wells compare with the bottomhole pressures that you discovered in the adjacent oil wells on bottomhole pressure survey?

A I don't remember the specific values, however, if there was an appreciable difference there I may have read it, but I don't remember what those values were.

Q Now, if there had been an appreciable difference, you think you would have remembered that there was an appreciable difference?

A Pardon me.

MR. SULLIVAN: Well, would you go back and read his last answer?

REPORTER: Reading: I don't remember the specific values, however, if there was an appreciable difference there I may have remembered it, but I don't remember what those values were.

Q Do I take that answer to mean that if there had been an appreciable difference in the bottomhole pressures between the gas wells and the oil wells adjacent, that you would have remembered that there was an appreciable difference?

A I said I may have. I also said that I do not remember those values.

Q Well, if the pressures shown in the gas wells and in the oil wells were about the same, certainly upon initial completion, would that be indicative that the gas-producing stratum was a separate stratum from the oil-producing strata in the vicinity?

A It would not tell you that it was or wasn't.

Q Is it likely that if they are one continuous stratum through there between the gas and the oil-producing sands, that the pressures will be identical or substantially so?

A They should be, but if they are of the higher values, we have just previously stated that this case should not exist in view of the laws of fluid mechanics.

Q Do I remember correctly that your testimony was that you anticipated that you could drill and complete the remaining wells on the Shell property in the field at about an average cost of $48,000? A Now --

Q (Interrupting) Feel free to correct me.

A Will you state it over again?

Q Do I remember correctly that your testimony was that it would cost about an average of $48,000 for Shell to drill and complete each well that remains to be drilled on your property?

A That is correct. That would be the cost for each additional well.

Q Would a cost of $48,000 include a figure for a sand fract job? A They did. However --

Q (Interrupting) A sand fract job of the magnitude of the two that Mr. Selinger asked you about in one case, you used 115,000 gallons of treatment and in the other case I think it was 117,000 gallons of treatment. Now, if you conduct a fract job of that magnitude, can you do it and complete the well for $48,000?

A We have a subsequent witness that is going to testify to the specific values, and therefore, I would rather not.

Q Well, Mr. Methven, I assumed that when you testified that the cost of a well was $48,000, that you knew the component parts that went into making up that total cost.

MR. SETH: That is not the correct understanding, it has been furnished, that cost, by Mr. Robison, who will be the later witness.

Q You did not testify --

MR. SETH: He is prepared to discuss the cost in full.

Q You did not testify to the $48,000 then, of your own knowledge?

A I base my profitabilities on that $48,000.

Q But you did not arrive at that figure of your own knowledge or your own figure as to what the wells will cost?

A I did not make that calculation.

MR. SULLIVAN: That is all, Mr. Chairman.

MR. PORTER: Does anyone else have a question of the witness? Mr. Cooley, did you have a question?

MR. COOLEY: Yes.

By MR. COOLEY:

Q Mr. Methven, you testified under cross examination a short while ago, I believe, that you would not advise your company to drill wells out on 40 acre spacing outside the profitable area shown here on Exhibit 3 or Exhibit 1 I believe it is.

A It would be Exhibit 3, which is the microlog.

Q Exhibit 3, that's right.

A Any wells drilled out there would be of an exploratory nature.

Q What area was it that you testified to in answer to Mr. Campbell, that you would not advise your company to drill?

A In the region of only a very few feet of micro pay and there out beyond the zero line. And I also content that you would not drill 80 acre wells out there as admitted in other testimony.

Q That's my next question. Does it make any difference what spacing it is, the purpose for not drilling the well is the fact it wouldn't produce oil? A That's right.

Q If it had a thousand barrel alloweble it wouldn't be any different than if it had a ten barrel?

A No, it wouldn't.

MR. COOLEY: That's all.

MR. PORTER: Any further questions?

MR. SELINGER: I want to ask the witness one more question that Mr. Cooley brought out.

By MR. SELINGER:

Q You said a few feet of microlog. What do you mean by a few feet, five, six, seven, eight?

A Certainly not beyond the zero line or the five foot.

Q Would you drill any wells between five and ten feet?

A Yes, you would.

Q Where in between those two points would you have your line of demarkation?

A I couldn't say because this well assumed you place it, let's assume that you place it on the five foot line, will drain some towards the zero and some toward the thicker pay.

Q Having in mind the exhibit that Mr. Seth was attempting to introduce before and which he graciously withheld, would you say that you would recommend the drilling of a well on ten feet on 40 acre basis? A Yes, I believe I would.

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

MR. PORTER: Any further questions? Mr. Utz.

By MR. UTZ:

Q Mr. Methven, can you tell me from your personal knowledge whether or not Shell has completed any gas wells in this trend or not?

A I do not have data on any specific gas wells, with me that is.

Q Then in your opinion you haven't completed any gas wells?

A I don't know.

Q You're not su ? A That's right.

Q Do you have another witness who could answer this question?

A Possibly, I don't know.

MR. UTZ: That's all I have.

MR. PORTER: Are there any further questions of Mr. Methven?

MR. COOLEY: Did you have something to say in answer to Mr. Utz' question, Mr. Methven?

A I just ran across one of the numbers I have here. It is Shell Carson Unit No. 32-20, that it did produce on an initial test of 1250 MCF per day of gas. Therefore, I believe that one would be it.

MR. UTZ: Did it produce any oil?

A We have a figure of something like three barrels.

MR. PORTER: Was that a twenty-four hour test?

A I'm not sure what it is. I cannot attest to the fact that this is oil or what type of fluid it is.

By MR. UTZ:

Q Do you know what Shell's policy is going to be in regard to producing that well?

A No, I do not. I should think that it would be in agreement with the New Mexico Oil Conservation Commission Rules and Regulations.

Q In the absence of any regulations, do you think they would produce it for whatever it would produce or whatever the market was?

A If under the state regulations they were permitted to produce that.

MR. UTZ: That's all.

MR. PORTER: Mr. Cooley, did you have any more questions?

By MR. COOLEY:

Q Mr. Methven, is there a line or point of demarkation from which you can tell from your engineering experience what is dry gas and what is casinghead gas as those terms are commonly understood?

A There's not a fine line, that I'm aware of.

Q But ordinarily your casinghead gas would contain much more liquids, would it not?

A Yes, yes, the fact is, it is generally referred to as wet gas.

Q Would a gas cap be wet gas? A A gas cap?

Q That is in commonly understood sense a true gas cap, would it be wet gas or dry gas?

A It should have some liquid constituents, I believe.

Q To your knowledge has there been any gas analysis on the gas being produced from the Bisti-Lower Gallup Oil Field?

A There have been gas samples taken, but I do not know which wells these were taken from.

Q Are you aware of the results of those tests?

A No, I'm not and I don't have them with me.

Q I wonder if anyone with your company does.

MR. SETH: We can furnish it to the Commission I'm sure if you would like to have it.

Q In your opinion would the properties of this gas, and particularly the amount of liquids contained therein, have any bearing on whether or not this is a gas cap or is not a gas cap?

A It could, yes.

MR. COOLEY: In view of that answer I would like to have the results of those analysis if possible.

MR. SETH: Be glad to get them.

MR. PORTER: Anyone else have a question of Mr. Methven? The witness may be excused.

(Witness excused.)

ROBERT S. MacALISTER, JR.

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

DIRECT EXAMINATION

By MR. SETH:

Q Have you been sworn previously during the course of this hearing?

A Yes, I have.

Q Would you state your name please, and your position with Shell?

A Robert S. MacAlister, Jr., Division Exploitation Engineer,

located in Farmington, New Mexico.

Q How long have you been with Shell?

A Ten years.

Q What have been your duties during that time?

A I have been an Exploitation Engineer with the company during that entire time. Three years was spent as a specialist in secondary recovery operations.

Q What are your educational qualifications?

A I graduated from the California Institute of Technology in 1947 with a Bachelor of Science degree in mechanical engineering.

Q Have you made a study and became familiar with the Bisti Field in New Mexico?

A I would say that I was familiar with the field. I haven't studied it myself as a full-time project, but I have had a number of people working under me who have studied it, and I'm familiar with their work.

MR. SETH: Are his qualifications acceptable?

MR. PORTER: Yes, they are.

Q Would you proceed, Mr. MacAlister, please, and give us a brief statement, perhaps, of Shell's position with regard to this LPG pilot program?

A I would like to state at the outset that Shell is very much interested in secondary recovery in any field where it can be done profitably, and we can improve the recovery of reserves and, in

particular at Bisti, we're very hopeful that some sort of secondary recovery in one form or another will be found applicable there and it has been testified that we are actively supporting the present LPG injection test.

I would also like to state that I believe that wells drilled on closer than 80 acre spacing will be required for secondary recovery operations in this field, and I see no reason why 40 acre drilling needs to be postponed on account of the secondary recovery prospects. I would like to mention four reasons why I make this statement. First, is that I believe it would be impossible to fit any efficient injection well production well pattern to the present random spacing of wells in the field on 80 acre density. The second reason, I believe that while the current, the form of the current pilot injection test is the best that could have been devised considering all the conditions with which we had to contend, I could not recommend to my management that we extrapolate the hurried results which we must obtain from this pilot project to a project that would be based on 160 acre five spots in that field, and if only 80 acre wells were drilled, then 160 acre five spots would necessarily obtain, if we went to such a pattern. I might say that a five spot is a five-well arrangement in the form of a square, with four wells at the corners, one well in the center, and this is the arrangement that is being used in the pilot injection project at Bisti. In that particular project the injection well is at the

center and the producing wells are at the corners.

The third reason, I believe why 40 acre spacing will be necessary, is that in view of the demonstrated discontinuities and irregularities in this reservoir, an efficient sweep out of the reservoir cannot be done on wide spacing. I might interject here that during the testimony yesterday I heard it said that in one field the recovery efficiency was the same on 40's and on 80's. I found that a little difficult to reconcile with another statement that said if you went from close spacing to wide spacing at Bisti you would get better efficiency. I think it was also mentioned that at sacroc they found that wide spacing was better than close spacing, and while I'm not familiar with all the details of sacroc, I do know that is a reef limestone field with over something in the neighborhood of 200 pay, of pay at a depth of 7,000 feet, and I don't believe that anything that happened there could be said to be relevant to the Bisti situation.

The fourth reason that I believe that closer spacing would be desireable is that the pay-out of a secondary recovery project would be unattractively long with wide spacing. One of the more unattractive features of secondary recovery operations is that you have to make a considerable investment, and your pay-out on your investment doesn't begin for one or more years, doesn't begin for one or more years after you make that investment. I believe that in an LPG injection project, which we all hope will be found

feasible here, that that situation will be even more critical because of the large investment that will have to be made in LPG. Perhaps as much as fifteen to twenty million dollars alone for LPG in this field. Therefore, I believe that spacing on closer than 80 acres would be required to gain an acceptable pay-out in this field. The pay-out time varies roughly with the spacing in secondary recovery operation. It seems to me I had something more to say, but maybe we had better get on with it.

Q What is the arrangement of the initial injection project here, what spacing would that be?

A The four producing wells are on 40 acre spacing, and the injection well is drilled between them would be called a 40 acre five spot, but the actual spacing between injector and producer is 20 acres.

Q You mentioned the importance of the time factor in secondary recovery. Do you mean that once you inject this large investment in LPG gas, it could be a year or several years before you even get the injected gas LPG back, is that what your testimony is?

A Well, the injected LPG in gas would be the last thing you would expect to come out. What I meant to convey was that in order to get additional recovery over and above what you would get by primary operations sufficient to pay out the investment, it takes a number of, well, it takes a year or more for that to begin in most secondary recovery projects.

Q There has been some testimony about pressure changes that have resulted from drilling in the pool. Are those pressure changes a function or related to spacing, or is the pressure change more a function of withdrawals?

A I think pressure drop is related both to withdrawals and the drainage volume from which you are taking those withdrawals. A well with small volume of reservoir attached or being drained by the well would have a relatively higher pressure drop with a small withdrawal.

Q But the overall field pressure would be controlled more by the overall field withdrawals than any other factor, is that correct?

A Yes.

Q Do you have any other comments you would like to make relative to this secondary recovery matter?

A I don't believe so at the moment.

Q Have you written a number of letters to the parties participating in the Carson Unit relative to the geology and engineering in the area?

A We have. As one of our obligations as operator of the Carson Unit, we have to present plans of development for the unit and recommendations as to participating area within the unit. To accompany our recommendation, we have from time to time presented our tentative engineering interpretations.

Q I hand you what has been marked for identification as

Exhibits 15, 16 and 17. Would you describe please, to the Commission what those are?

A These are entitled "Geologic and Engineering Report, Gallup (Upper Cretaceous) Pool - Carson Unit, San Juan County, New Mexico", and the first one is to accompany the proposed first devision of the participating area. That's Exhibit 15.

Exhibit 16 was to accompany the proposed second revision of the participating area. Exhibit 17 to accompany the proposed third revision of the participating area.

Q Now, do these three exhibits represent the opinions andthe thinking of Shell at the time that they were written?

A They do.

Q I will also hand you No. 14 that is signed by Mr. Pickell.

A J. J. Pickell.

Q Who is he?

A He was an Exploitation Engineer who was for a time in charge of the Exploitation Engineering Section in this area.

Q Would you examine 14 and can you state whether or not that is a report similar to 15, 16 and 17?

A It is. It has the same title as the previous reports except that this one is to accompany the proposed initial participating area.

Q Now, do these reports also reflect the development of the study and the thinking of Shell over this period of time?

A Yes, they do.

Q Could you tell the Commission whether or not that shows any slight change in Shell's thinking and approach to this problem during this period?

A I don't believe these letters or reports show the present thinking of Shell. The last one.

Q I meant do they show the position as of the time they were written, each one individually? A Yes.

Q Does that show any change in position?

A Yes, there is some change.

Q Would you describe that to the Commission, just in general terms is sufficient?

A At the time that the first report was written I believe we made statements as to our belief of the general continuity of the sands in this field, especially true along the central portion of the productive test where a good pay development has been observed. I think as we go along in these reports will indicate that we become less and less convinced of the continuity of the sands.

MR. SETH: We would like to offer these in evidence at this time.

MR. CAMPBELL: I have no objection as far as we've concerned.

MR. PORTER: Any objection to the admission of the exhibits?

MR. SULLIVAN: In regard to that, may I ask one

question which may establish whether I want to object to their admission?

CROSS EXAMINATION

By MR. SULLIVAN:

Q What has happened to Mr. Pickell? You have testified that he was in such and such a position. Where is he now?

A Mr. Pickell is in Denver.

Q Still in the employ of the Shell Oil Company?

A Yes, he is.

MR. SULLIVAN: Thank you. I have no objection.

MR. SETH: If the Commission please, I might perhaps make an explanation in order for offering these. We wanted to show the trend in the study and thinking of Shell in this connection over this period of time. We thought the letters, we're a little disappointed, we thought they would be more interesting to the proponent than they are. We think they are a part of the story and the Commission has a picture on them.

MR. CAMPBELL: We haven't had an opportunity to view them yet.

A I believe the Commission has obtained copies of these. They were sent to the Commission as well as the other parties in the unit, and the United States Geological Survey.

MR. PORTER: The Commission rules that Exhibits 14, 15, 16 and 17, Shell Exhibits, will be admitted to the record.

MR. SETH: That's all the direct we have.

MR. PORTER: Anyone have a question of Mr. MacAlister?

By MR. CAMPBELL:

Q First a few questions with regard to your position on the pressure maintenance program in this area. Have you had an experience with a pressure maintenance program of this nature?

A No, sir, I have not.

Q Then the reasons that you give for disagreeing with Mr. Brinkley's conclusion on the effectiveness of the program under 40 acre or 80 acre spacing, are based upon what assumptions or general knowledge of secondary recovery, or what?

A Based on some general knowledge of secondary recovery plus the fact that it will be a fluid drive project, and as are all secondary recovery operations, I think it differs by degree only from say water flood project in that the physics of controling the drive are not greatly different from one project to another.

Q You will agree, will you not, Mr. MacAlister, that in any fluid pressure maintenance or secondary recovery program, that the determination of the pattern of injection has to be determined by experimentation, does it not?

A I would say that that could be part of the answer, it's also based on experience I believe.

Q Well, isn't it conceivable here that continuing study of this pilot program and initial phases of the program itself could,

for example, result in flooding this reservoir from one end to the other or from the gas area toward one end or the other.

I mean isn't that a matter to be determined as the program progresses?

A I believe that a line drive project might be possible, but I think it is probably even more dangerous to try and extrapolate a five spot plug on close spacing to a line drive on wide spacing.

Q But in any event, that is a matter of disagreement of approach between you and Mr. Brinkley, isn't it?

A Yes.

Q And either one of you may be wrong, is that right?

A In my opinion he is more likely to be wrong than I am.

Q I'm sure if he had an opportunity to testify he would express the same views. Now, since that is true, and assuming that he may be right, since there's an honest difference of opinion between you in this engineering matter, what objection can you have to delaying this thing at least a year until that difference at least has a chance to be reconciled?

A I believe that the discontinuity and irregularity within the reservoir is going to require closer spacing for both primary and secondary recovery operations no matter what form the secondary recovery operation takes.

Q That matter can be determined within the early stages, I assume, of the program, can it not, say during the next year?

A In my own mind, why I believe that we have already shown that it has to be. You can't drive oil out of these dead end things.

Q Now, with regard to your statements concerning the pay-out of the secondary recovery or pressure maintenance program, you were referring to the pay-out of the program, it's not the pay-out of the entire investment of the operators in the field, were you not?

A It's the pay-out of the secondary recovery investment.

Q Of course, if wells are drilled on 80 acres instead of 40, and assuming the effectiveness of the LPG program, you will have twice the cost to work against, will you not, on the pay-out for the entire investment?

A The cost would not be twice, but it would be considerably more than on 40, but you have to inject for twice as long to get your oil out.

Q Mr. MacAlister, with regard to the reports of your company as operator of the Carson Unit to the other operators in the unit, and the U.S.G.S. and the Oil Commission, I would like to ask you whether in addition to these, indicating your continuing belief, that there is what I prefer to call a lack of uniformity in this reservoir that these do not also indicate your continuing belief that you cannot determine the pressure declines and other information in the reservoir due to the lack of production history?

A Certainly we're missing some important information by not having some production information. However, we've made these

detailed studies which have been presented here today by previous witnesses since the last of those reports was written. Our ideas are considerably different now than they were at the time that the last of those reports was written as regards the continuity of the sands and the ability to drain on wide spacing.

Q Throughout these letters you refer to wells which Shell has drilled but not completed, is that correct?

A That's correct.

Q How many such wells are there now?

A Oh, there are probably half a dozen, maybe as many as ten now. We have recently embarked on a large completion program in which we perforated some sixteen to twenty wells, I believe, and those wells are undergoing production tests at the present time.

Q I want to ask you one final question which hasn't yet seemed to me to be answered. What disadvantage is there to Shell Oil Company in the light of the circumstances that you present forgetting our testimony, what disadvantage is there to you to space this field on an 80 acre program for a period of one year?

A I think it will be brought out in subsequent testimony. It's going to cost more money to do it that way. That consideration aside, my feeling is that from the standpoint of engineering work we would be better able to concentrate on this development program in a single continuous program rather than an interrupted one. I believe that from the standpoint of efficient utilization of the

primary reservoir energy, it's better to complete your wells on a uniform spacing pattern to begin with rather than get oil going in one direction at one time and then go in and drill more wells and start it going in another direction. I believe that from the standpoint of efficient completion work, the earlier you drill and complete your wells, the better off you are.

Q The better off you are? A Yes.

Q Is that irrespective of the reservoir condition?

A No, that's not irrespective of the reservoir condition.

Q That will depend on each reservoir, will it not?

A In general I think it can be said to be true of almost any reservoir.

Q One last question. I know you don't like to do this, but you pointed out, and I have too, there is a difference of opinion between you and Mr. Brinkley about the effectiveness of this pressure maintenance program. If Mr. Brinkley is right, would you then still feel that this field should be developed at this stage on 40 acre spacing?

A I can't agree with Mr. Brinkley is right.

Q All right.

MR. CAMPBELL: That's all I have.

MR. PORTER: Anyone else have a question of Mr. MacAlister? Mr. Sullivan.

MR. SULLIVAN: Is this the witness that will be able to

testify as to well costs?

MR. SETH: You have to wait one more witness.

MR. SELINGER: May I ask Mr. MacAlister a few questions?

By MR. SELINGER:

Q You talk about the Carson Unit, and your counsel in having you identify Exhibits 15, 16 and 17 and the explanation that it would tell the entire picture of your consistency of your views as operator of the unit, will you kindly tell the Commission the size of the Carson Unit in acreage and who are the owners of the Carson Unit, if you know?

A The Carson Unit is four sections wide by six sections north and south, that is twenty-four sections, 150,000 acres plus or minus, not all, am I wrong, that's too big, 15,000 acres, excuse me. Not all of the leases within that area are participants in the unit, but substantially all of them are, I believe.

Q Will you kindly tell the Commission the owners of the, or the participants of the unit, and if you have it available, the percentage owned by each?

A I can't tell you the exact percentage, but Shell is the largest participant with something in the neighborhood of eight, oh, eighty-five percent of the acreage. Phillips Oil Company and Skelly Oil Company each have in the neighborhood of --

Q (Interrupting) Seven and a half percent?

A Seven and a half percent. El Paso and Humble each have

minor interests.

Q Now, in furtherance of your counsel's explanation for Exhibit 15, 16 and 17, and in order to coincide with his wishes to give the Commission the complete picture, do you have correspondence between you and the U.S.G.S. and you and the other participants or owners of the Carson Unit with respect to bringing Exhibits 15, 16 and 17 up-to-date?

A I'm not sure I understand.

Q Did you have any further correspondence outside of Exhibits 15, 16 and 17 with any other operator in the Carson Unit?

A Oh, yes.

Q Do you have that available here?

A Not all of it, no.

Q Did you get any correspondence from Phillips about the unit?

A Yes, sir.

Q Did you get any correspondence from Skelly about the unit?

A Yes, sir.

Q Did you get any correspondence from any of the others, and if so, from whom? A From Humble and El Paso.

Q Now, can you, since you are familiar with that, can you indicate to the Commission the desires of the other participants in the Carson Unit since you have gone into great detail as to the desires of Shell with respect to this matter?

MR. SETH: I believe the letters would be the best evidence.

perhaps you have them, Mr. Selinger.

MR. SELINGER: No, I haven't. You are putting in the testimony and the exhibits, I would like for you to put the rest of the exhibits in.

MR. SETH: If you have them we will be glad to put them in if the Commission would like to receive them.

MR. SELINGER: I don't have the correspondence from Humble or Phillips.

MR. SETH: I am thinking that you object to the spacing in the --

MR. SELINGER: (Interrupting) Let the exhibits speak for them.

MR. SETH: There is a lot of correspondence.

MR. SELINGER: Let the exhibits speak for them. This witness said he has the correspondence here.

A No, sir, I do not.

MR. SETH: He does not.

A I do not have all of them.

MR. SETH: If you will identify them more particularly, we will be glad to get copies and submit them to the Commission.

Q On examination you stated that you had correspondence from these various companies. Tell the Commission the correspondence you had with Skelly with respect to the Carson Unit.

A We have had more than one series of letters with Skelly.

When we first suggested a plan for spacing in this area, I believe Skelly indicated that they might, that they would be happy to drill some, to have some 40 acre wells drilled on their lease. Subsequently we have had letters from them that indicate that they have changed their mind on that subject.

Q Did they say why they changed their mind?

MR. SETH: If the Commission please, I think the letters are the best evidence. You must have your letter. You are asking about what you wrote.

MR. SELINGER: I am going to ask about Humble and the rest which Skelly has no possession of.

MR. SETH: Do you have your letter with you?

MR. SELINGER: No.

MR. SETH: We would like for you to produce it.

MR. SELINGER: We would like to have Shell furnish the Commission with the correspondence from the other interested parties in the Carson Unit which will indicate likewise the desires of those other participants as well as Shell in their Exhibits 15, 16 and 17 so that the Commission can get the complete picture. They have presented only one, Shell's position. Now my purpose in asking for the additional information tobe supplied, is to show all the participants.

MR. SETH: I believe we told you we got them once and we must distinguish between these exhibits and these are reports by the

operators to the participants in that capacity. This other is just extraneous correspondence, but we'll be glad to furnish it to the Commission, of course, if they would like them.

MR. COOLEY: Mr. Selinger, for what purpose is the correspondence sought?

MR. SELINGER: The same purpose that Exhibits 15, 16 and 17 as explained by Mr. Seth, to show the full picture, it's for the same purpose.

MR. COOLEY: As I understand it, it could not be for the same purpose because I believe the purpose of 14, 15, 16 and 17 was to show the change in policy of Shell Oil Company, and I can see how no correspondence from any other company could indicate that change.

MR. SELINGER: Well, we have no --

MR. COOLEY: (Interrupting) Is that the purpose of 14, 15, 16 and 17?

MR. SETH: That's right.

MR. SELINGER: We have no control over Shell's viewpoint, but they are speaking now on behalf of the Carson Unit. I want the Commission to understand that the consistency or inconsistency of their view in operating the Carson Unit can likewise be indicated by the inconsistency of the views of the other participants.

MR. SETH: I think the record, we speak for Shell Oil Company as Shell Oil Company, we are not speaking for the Carson

Unit. It is not involved in this hearing.

MR. PORTER: In the interest of time, Mr. Seth, the counsel for Shell, has agreed to supply the Commission with copies of this correspondence, which the Commission will accept.

MR. MECHEM: You can include that too in your statements to the Commission.

MR. SELINGER: Yes, sir, we shall.

Q Mr. MacAlister, you said that you had sent copies of Exhibit 15, 16 and 17 to the U.S.G.S.?

A Yes.

Q What was your latest correspondence with relation to those exhibits, Exhibits 15, 16 and 17 to the U.S.G.S. with respect to the development plan?

A We sent them a plan of development suggesting development of the Carson Unit on 40 acre spacing, and we recommended the drilling of 53 wells.

Q Was that subsequent to those exhibits?

A Yes, it was.

Q Was that your latest word to the U.S.G.S., was there any later correspondence you had with the U.S.G.S. with respect to the plan of development? A Yes, there was.

Q What was the date of that later correspondence, in effect, the gist of it, to the U.S.G.S. as to the plan of development in the Carson Unit?

MR. SETH: If the Commission please, I believe the Commission has copies of that correspondence, do they not, Mr. MacAlister?

A I'm not certain.

MR. SETH: Or the Commissioner of Public Lands, in any event. We will get copies of that.

A Ordinarily the correspondence is handled by our Land Department. I'm not familiar with the dates of the correspondence.

Q You mean it will be covered by a subsequent witness?

A No, I'm afraid we don't have one here.

Q You said you were familiar with the later correspondence of the U.S.G.S. as to the latest plan of development as submitted by Shell. Will you tell this Commission in gist form what was that later plan of development?

A We requested the U.S.G.S. to approve certain wells within that plan of development in order to continue our operations in the field while this discussion of spacing in the field was being settled.

Q And that basis was 80 acres for the present, is that correct?

A No. We didn't say that, anything as to spacing as I recall it.

Q You did not say it would be on 80 acre density?

A No, I don't believe so.

MR. SELINGER: That's all I have.

MR. PORTER: Mr. Utz, did you have a question?

By MR. UTZ:

Q Mr. MacAlister, are you familiar with the economics of the Sunray pilot flood which they are beginning to operate now?

A Generally.

Q Do you know what the estimated cost per barrel of oil recovered by secondary means is to be?

A No, I don't believe I can answer your question directly.

Q Do you have that information available that you can furnish the Commission with it?

A Let me try and answer it. Maybe I can satisfy you and maybe I can't. The cost of the project is going to be, I believe, somewhere in the neighborhood of one hundred fifty to two hundred thousand dollars, including the cost of LPG and gas. That's the capital investment, of which I think we can reasonably expect to recover substantially a large part of the LPG and gas eventually, so maybe the total investment would boil down to one hundred thousand, one hundred twenty-five thousand dollars. If the project works as well as they have predicted it will, they will recover something like 136,000 barrels of secondary oil.

Q Did your one hundred twenty-five thousand include the cost of drilling the injection well?

A Yes, but it doesn't include operating costs. I'm not familiar with what the operating costs might be.

Q Roughly it would be about a dollar a barrel?

A I would think that would be reasonable.

MR. UTZ: That is all.

By MR. CAMPBELL:

Q You and Mr. Utz are only referring to the pilot phase of this project, are you not?

MR. UTZ: I am, yes, sir.

Q I wasn't sure he was, I wanted to be clear.

A Of course they won't recover 136,000 barrels in time necessary to recover the pilot and extrapolate it to a full scale flood, if that becomes desireable it comes over the life of the injection project.

MR. PORTER: Anyone else have a question? Mr. Kellahin.

By MR. KELLAHIN:

Q Mr. MacAlister, as I understand it, Exhibits 14 through 17 have been offered for purposes of showing the change of position on the part of Shell, is that correct?

A Yes, sir.

Q Yet, based solely on these exhibits, they reflect no change in Shell's opinion that there is a continuity of the sands in the northwest, southeast direction, is that not right?

A I think you'll have to say that that statement was rather qualified in the letter.

Q Well, I would assume that Exhibit 17 is the last report,

is that right? A Yes.

Q I believe on Page 2 of, Page 2 of Exhibit 17 your statement is to the effect that "In previous proposals for participating areas (see Geological and Engineering Reports supporting the proposals of Initial Participating Area and First Revision of the Participating Area, January 18, 1957 and April 26, 1957 respectively) data were presented suggesting fair continuity of sand development along the northwest-southeast pay trend, and poor continuity in the transverse direction." Is that the qualification you refer to? A Yes, I believe that was.

Q Yet you support that by a reference to the two preceding reports which do not in anywise qualify your statement.

A Can I elaborate on the context of that?

Q I am referring to the contents of the exhibit, if your attorney wants to bring out the explanation.

MR. SETH: You can explain your answer. Go ahead and explain your answer.

A That was written to explain why we had extended the participating area in the direction and meetings that we had, and it was an extension along the grain of deposition of the sands, and it was meant to convey that we felt that we could extend the participating area in that direction with more confidence than we could across the grain, simply because the general deposition indicates that commercial production can be obtained laterally along the

grain, I mean from commercial wells more readily than you can predict a transverse extension of commercial production.

Q But on the basis of those exhibits alone, you request no change in your opinion as to the continuity of the sands aside from the qualification which you state?

A I don't think it reflects a change in our ideas as to the gross picture of the sand deposition.

MR. KELLAHIN: Thank you.

MR. PORTER: Are there any further questions of Mr. MacAlister? Mr. Cooley.

By MR. COOLEY:

Q One of the major factors, Mr. MacAlister, you said in secondary recovery, was to get a quicker pay-out and make it attractive to the company since there was such a large expenditure of monies?

A Yes.

Q You felt that you would get this quicker pay-out on 40 acre spacing, you would get a quicker pay-out on 40 than you would on 80?

A Yes, sir.

Q My only question is was that based on well potentials, you can just produce more out of twice as many wells, or was this based on greater allowables assigned?

A Usually the life of a secondary recovery project depends on the average injection rate that you can maintain in the injection wells. The more injection wells you have, the faster you can inject

and flood out the reservoir.

Q Then it's actual potential of the well and not the allowable? The statewide allowable has nothing to do with your discussion on that point?

A No, injectivity.

MR. PORTER: Anyone else have a question? The witness may be excused. We will take a short recess.

(Witness excused.)

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Seth, will you call your next witness?

MR. SETH: We would like to call our subsequent witness now.

R. R. ROBISON

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Robison??

A My name is R. R. Robison.

Q By whom are you employed?

A I'm employed by the Shell Oil Company as Division Production Manager, Farmington.

Q How long have you been employed by the Shell Oil Company?

A Going on thirty-four years.

Q During that time what experience have you had, Mr. Robison?

A Well, back up to the beginning, I graduated from Stanford University in 1924 and majored in mechanical engineering. I went to work first in our Gas Department for a year or two, and then in mechanical engineering as mechanical engineering work, and later as Division Mechanical Engineer, and then Engineer of the Drilling Department, later Drilling Foreman, Division Superintendent, and since 1953, Production Manager. That is a hurried rundown.

Q At the present time you are in Farmington, is that correct?

A Yes, I came to Farmington when the so-called Farmington Division was organized, April 1st, of this year.

Q Have you, during your work in Farmington, had occasion to become familiar with the costs of wells in the Bisti Area?

A I have.

MR. SETH: Are his qualifications acceptable?

MR. PORTER: They are.

Q Would you please state, Mr. Robison, the experience of Shell with well costs in the Bisti Pool?

A Yes, in that connection I have two tabulations here of costs, one labeled Exhibit 13-A, the other Exhibit 13-B. I might pass these out. Referring to the tabulation labeled Exhibit 13-A, you will note that it includes six wells which were completed this year during the month of July. These costs are not down to the dollar, but serve as representative costs, days drilling costs of Shell's in the Bisti Field. These costs range from $40,800 to a low of

$35,200. The average being $38,000. This $38,000 includes a well completed as a flowing producer including everything from the roads, the drill site, the actual drilling, testing, the casing, casing services, cementing, perforating, the tubing, the wellhead, the flow line as well as the cost of the formation fracturing that we commonly do. Then if you will refer to the tabulation shown as Exhibit 13-B, we go back to the first well that we drilled in the Bisti Field, after a tabulation of total cost for the 37 wells that had been completed the middle of August. You will note that there is a wide variance there in cost, our first wells being, first well being $88,000, that well was drilled in the early part of 1956. The average cost of the, on a per well basis for the 37 listed, is $46,500. The logical question would be why such a marked reduction.

There is nothing in my opinion that's mysterious about it. It is largely due to concentrated efforts, what we now know how to drill, but even more important the cost began to come down mainly because of a development program. This reduction from $46,500 to $38,000 in current cost is rather sizeable, I doubt that we can do as well in the next year and a half, but the downward trend is still with us. Again largely because of the continued development program in the field.

We, as I said earlier, started the, organized the Farmington Division the first of April. Since that time we've in addition

to the two strings that we are now running here, we got up to a maximum of thirteen currently drilling eleven, with eleven strings of tools, two of which are Bisti. The cost of moving the outfits into the Bisti Field is quite sizeable, but that has been, has paid off, so-to-speak, amortized over the wells that have been drilled and are being drilled.

The next group of wells which we have contracted for will be two bits a foot less than we are presently paying, that means roughly a saving of $1250 a well. Again that downward trend is with us. I might right here clear up the figure of $48,000 that a previous witness used. That has been arrived at from these figures, taking into account the reduction that we contemplated in the next group of wells, namely $37,000 complete with fracture treatment, completed as a flowing producer, add $8,000 as being the future cost of pumping equipment, plus $3,000 as each well's share of the field facilities from here on out.

Q What are these field facilities, Mr. Robison?

A Shre of the gas and oil separators, the manifolds, and main roads.

Q Now, how, what effect does it have on the cost of field facilities if you initially plan for an 80 acre spacing and then have to go back to a 40 acre spacing?

A Unless the program were continuous, it would add materially to the cost. It is, as I tried to explain, a reduction in our

drilling costs is largely because of the continuity of operation and we got that for several reasons, we have been able to maintain the same contractor in the field, and I might add too that we had a string of tools of our own, our own crew in there to drill six wells, but mainly it's been contract work. The crews become familiar with the operation and that is quite important in this country, you find it necessary not only, the contractors find it not only necessary to tell us to weed out the crews to get good help, and secondly if we were to have a shutdown in operations, someone has to pay to move this equipment out and move it back in. That pay comes to us or any operator in the field. That runs into rather sizeable figures, and the two together, well, it depends on the number of wells, the amounts to, I had better just say a sizeable figure, several thousand dollars per well.

Q The well costs, you expect them, they would be less ultimately, if you can maintain a continuous program, and they would be less too if you did not have to start on an 80 acre spacing and then go back to a 40, is that right? A Correct.

Q Now, what is your drilling program for the balance of this year?

A The balance of this year we have planned, and our budget approved and calls for the drilling of 29 additional wells in addition to the 37 listed on the exhibit shown as 13-B. For next year under 40 acre spacing, we have tentatively planned in our budget,

and incidentally, our budget is on a calendar year basis, so we are right in the preparation of it now, but we are planning on 58 wells in the Bisti Field for next year. We would like to drill them.

Q Are you prepared to drill them?

A We are prepared to drill them.

Q Is the money budgeted to drill them?

A Only tentatively, but we have had a preliminary budget hearing and top management appears to be in agreement. That was, I might mention this number of wells was originally included in our tentative budget when the Farmington Division was organized. So I look for no problem as far as obtaining the funds.

Q Then Shell is prepared, if the Commission permits it, to go ahead on a 40 acre basis, is that correct?

A Correct.

Q And would you have a rough approximation of the acreage of Shell leases within the proposed pool, just roughly?

A Yes, roughly 25% of the area that's been discussed here previously.

Q As by the other witnesses? A Yes.

MR. SETH: We would like to offer these two Exhibits, if the Commission please, 13-A and B, at this time.

MR. PORTER: Any objection to the admission of these exhibits? They will be admitted.

Q Do you have any further statements you would like to make,

Mr. Robison? A No, I believe not.

MR. SETH: That's all the direct we have then.

MR. PORTER: Does anyone have a question of Mr. Robison? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Robison, just a few questions about your exhibits relating to well costs. The reason as I understand you, that you have been able to reduce your well costs from your first wells to your latest wells is by virtue of the size of your drilling operations, am I correct in that, and the information you have obtained?

A Not so much the size because we are not conducting a large operation now, you might say we only run two strings of tools, but by size I would interpret that to mean, I would rather say it as to continuity of operation. First we went in as sort of an exploratory operation, we drilled a few wells and then there would be a period when there was no development, we would have to go back in again and in turn pay for getting the contractor's equipment into the field.

Q Have you estimated the number of wells that you would be drilling if the 80 acre density were maintained during the next year?

A Yes, I have.

Q How many would that be?

A To what we consider proven now, there would be enough 80

acre wells, for the remainder of 1957 there would be 29 wells to keep us going through the balance of the year the same as the 40, but next year there would be 11 wells.

Q But you could maintain a continuous program for the balance of this year at least with the present operation that you contemplate?

A That's right.

Q Are there, to your knowledge, operators in this field who do not have the amount of undeveloped acreage that you do?

A I couldn't speak with very much authority on that, but I would say that there are probably some that do not have the acreage because I just mentioned that we have 25%.

Q Your plans with relation to the development of your acreage in this field have assumed that you would be permitted to drill it immediately upon 40 acre basis?

A We have gone on the assumption all the time up until the filing of this petition, that we would have 40 acre spacing.

Q That is the sole disadvantage to the delay of 40 acres, assuming that it were later put into operation, that your company sees in this application?

A No, I can't say that is the only objection. I'm merely citing one part of the objection. One objection.

Q What others, that you know of?

A Well, I was listening to a previous witness who thought there might be some inefficient use of reservoir energy through postponing

of drilling of all the wells.

Q Do you feel that the economic loss to your company that you say that would exist for the balance, for 1948 if this were drilled on 80 acres to that time justifies the drilling of additional wells by other operators is a sole reason?

A I don't quite follow you how the other --

Q You mean that your economic loss -

A (Interrupting) Because we would force other operators to drill unwanted 40 acre wells?

Q Yes, sir.

A Well, basically we are sold on the 40 acre spacing, so we don't think that even the other operators would suffer.

Q Well, that of course, is the essence of this discussion, for the last two days, but my reference was whether you thought that was a sufficient sole basis for your feeling you shouldn't go along on a one-year 80 acre spacing program?

A Well, again, I'll just have to say we would like to abide by the present regulation, one well to 40.

Q Would you, if that remained in effect, be able to drill all your 40 acre locations in the next year?

A I'm not positive of that, but I'm sure that we would get the majority of them drilled.

MR. CAMPBELL: I believe that's all.

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

Robison? Mr. Cooley.

By MR. COOLEY:

Q Mr. Robison, has Shell completed as of this date, or commenced, rather, as of this date, any well which could not have 80 acres dedicated to it? Plain words, have you started any 40 acre locations?

A We have not started, or did not start, any 40 acre well after the date of the filing of the petition, but we have, I believe, one well, maybe two, that are on a 40 acre basis, at least I would call them that. Now, I don't know whether we can add another 40 to them. They're not uniformly spaced 80, put it that way.

Q I'm aware of that that there would be several exceptions to the attempted uniform spacing plan in here, but you do have an additional 40 acres that you could dedicate to any existing well?

A That I'm not sure of. If there is any, there's only one or two. If I can leave it as general as that.

Q You stated that Shell has not commenced any 40 acre wells since filing this application. Would you be in a position to state whether they anticipate commencing any until there is a final decision in this case?

A I think that is right, that we will defer, we will like to and probably will defer drilling until there is a decision in this case.

Q You cannot state as an absolute fact that you will not drill any?

A Well, we would advise you people, we would have to get your concurrence to do so and would like to, in perference to discontinuing our present operations. We will attempt to, but we will not do it on our own.

By MR. PORTER:

Q Mr. Robison, I believe you stated that you hadn't started any wells since the application was filed. Do you know whether or not you had completed any prior to that time on 40 acres?

A Yes, that was the one that I was referring to. We did not spud a well on a 40 acre location, at least to which it couldn't be called an 80, we did not spud any 40 acre locations after the petition was filed, but just prior to that we were ready to go and were drilling on one well, the name of which I think was -- was this 44-10.

MR. MacALISTER: I believe Gobernment 31-15 is the well which could not have 80 acres dedicated to it.

A There appears to be one.

MR. MacALISTER: I also believe that Government 44-10 probably could not have 80 acres dedicated to it either because subsequent to the completion of that well we've drilled 14-15, I believe it is. Carson Unit.

A Yes. 44-10 is right in the corner.

Q What section?

MR. MacALISTER: We have drilled this one. I have mistaken in the number. 14-11 has been drilled also.

Q What is the location of the section and township?

MR. MacALISTER: It is in the southwest of the southwest of Section 11, Township 25 North, Range 12 West.

MR. COOLEY: Just a minute, that is not the location of the well which could not have 80 dedicated to it?

A No. That is Government 44-10 in the southeast of the southeast of Section 10, the same township and range that could not have 80 dedicated to it.

Q The other well?

MR. MacALISTER: Government 31-15, which is in the northwest of the northeast of Section 15, Township 25 North, Range 12 West.

Q Those are the only two wells that you know of?

MR. MacALISTER: Yes.

A Yes.

MR. PORTER: Does anyone else have a question of Mr. Robison? Mr. Sullivan.

By MR. SULLIVAN:

Q Mr. Robison, I have before me Shell's Exhibit 13-B from which you have been testifying. I notice that in your tabulation of all of the 37 wells that Shell has drilled in this field, you have two there with double asterisks.

A Yes. I neglected to mention that.

Q The explanation for the double asterisk that I read is "Costs include above single asterisks plus artificial lift equipment."

A Yes.

Q Do I take it that these are the only two wells then in your entire 37 on which you had to set pumping equipment?

A Correct.

Q Are there any of those wells which will necessitate the installation of pumping equipment to put them on production?

A Quite likely.

Q You have several wells over there which have never actually been completed as producers? A Correct.

Q Now, out of those you expect that there will be some that will require pumping equipment? A It's possible.

Q Have you installed flow lines on those wells that are in that situation?

A We are in the process now of dividing our oil gathering system as part of the automatic custody transfer system that we approved a few months ago, and flow lines are in part of that and we are even putting them in for other locations that we expect to drill and feel assured of getting production, and until we put the field under production we will use a gathering system as a water system. We will economize.

Q What I'm asking is are there some of these figures in the

right-hand column on your Exhibit 13-B which do not include, one, the cost of pumping equipment?

A The two wells are the only ones that include pumping equipment.

Q Are some of these wells the figures in the right-hand column, do not include the cost of flow lines?

A Right.

Q As they exist on this page?

A I think you are probably right, probably the flow lines are not in.

Q Are you in a position to make an estimate as to the per well cost --

A (Interrupting) Of a flow line?

Q No, sir, of the installation of your automatic lease --

A (Interrupting) Automatic custody transfer? A.T.C.?

Q Automatic custody transfer equipment. Can you estimate what that will cost per well? Just average it out, you know, take a total figure and divide it by the total number of wells.

A Oh, $3,000.

Q Well, now, that figure is not included in any of this, is it?

A That's right. This figure --

MR. SETH: Just let the witness answer.

Q Excuse me.

A This is not a complete analysis by any means, and the fact

that two wells here have included that cost of pumping equipment, the average of $46,500 is slightly distorted, possibly if you take out $16,000 I doubt if you could read your slide rule, however, to find it, but it does illustrate, I compared that to today's figures in the tabulation marked Exhibit 13-A. Those figures are comparable generally.

Q Mr. Robison, I'm not questioning the accuracy nor the propriety, but we are concerned about the fact that we believe that drilling of a well is completion and the entire works will cost considerably more than the figures that you have testified to here as to Shell's cost, and what we're trying to establish is one, where the discrepancy arises between what we anticipate and what you anticipate, and we think that in view of the fact that these figures have become important in the discussion with regard to the economics of drilling wells on a closer or wider spacing, that it should be brought forth that there may be additional costs other than these which eventually will be added into your well cost in the Bisti Field. Now, let's put it this way, are these the final costs that you anticipate? A To date.

Q And which you will allocate to each of those wells as of the date they start pulling oil into the new pipeline?

A Well, our well costs do not include as such, we have a completed well cost statement that does not include anything in the way of lease facilities, only for profitability of the well do we

include that.

Q Do you cut that off short after say tankage, lease tankage?

A Flow line is where we quit. That is part of the well.

Q So if your accounting methods call for the inclusion of lease tanks as part of well costs, those figures in turn would be increased? A Would be higher, yes.

MR. SULLIVAN: Thank you. That's all I have.

By MR. COOLEY:

Q Mr. Robison, did you say that the figure of $48,000 was your average well cost when you put in the cost of a pump for each well and some other items you enumerated?

A And future share of lease facilities.

Q Which was the same facilities that Mr. Sullivan was referring to?

A Yes, and which was referred to by our previous witness when Mr. Methven used $48,000.

Q The $48,000 that has been used by Mr. Methven and explained by you, all the way through includes all the facilities?

A That is the average expenditure that we expect to incur in the Bisti Field in the way of capital, put it on a per well basis, but in any of our completed well cost statements that will not show the forty-eight.

Q But your total cost allocated to all the wells in the field averages out $48,000? A From here on out.

MR. COOLEY: Thank you.

A We hope maybe to get a slight reduction. That is right.

MR. PORTER: Any further questions of Mr. Robison? The witness may be excused.

(Witness Excused.)

MR. SETH: That's all the witnesses we have, if the Commission please.

MR. PORTER: Mr. Kellough.

MR. KELLOUGH: Booth Kellough. I am a lawyer for Gulf Oil Corporation, and we have a witness we would like to present to the Commission.

MR. COOLEY: Is this the gentleman I swore the other day?

MR. KELLOUGH: Yes. You have been sworn, have you not?

MR. BAUMAN: Yes.

WILLARD BAUMAN

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

DIRECT EXAMINATION

By MR. KELLOUGH:

Q Will you please state your name to the Commission, and will you please spell it for the reporter?

A Willard B-a-u-m-a-n.

Q Where do you live, Mr. Bauman?

A Denver, Colorado.

Q By whom are you employed? A Gulf Oil Corporation.

Q In what capacity?

A Zone Petroleum Engineer.

Q Are you employed by the Denver Division which has within its jurisdiction the northwest part of New Mexico?

A I am.

Q How long have you been engaged in duties as a petroleum engineer for the Gulf Oil Corporation? A Since March, 1946.

Q Do you have an engineering degree, and if so, will you please state from what college?

A I have a degree in mechanical engineering from Texas Technological College in 1941.

Q Has all of your work since that time been in connection with petroleum engineering?

A I spent approximately a year and a half on an engineering training program with Gulf upon graduation, and except for the time I served in the military service, why I have been working in petroleum engineering.

Q Have you made a study of the Gulf wells in the Bisti-Lower Gallup Pool and that portion of the pool upon which they are located? A I have.

MR. KELLOUGH: Are the qualifications of this witness acceptable?

MR. PORTER: They are, Mr. Kellough.

Q Will you please state to the Commission, Mr. Bauman,

the number of acres that Gulf has under lease in the area covered by this application?

A Well, if those are regular Governmental quarter sections, it would be 960 acres.

Q It is approximately 960 acres? A Yes.

Q Would you state for the information of the Commission the number of wells that Gulf has?

A Gulf has completed five wells and is drilling the sixth.

Q In other words, as far as this pool is concerned, Gulf is a small operator? A That is correct.

Q Have you made a study of the economics of drilling wells upon 40 acre spacing as authorized by the statewide rules?

A I have.

Q From that study is it your opinion that it is economical to drill a well under the existing statewide rules without any special 80 acre order? A It is possible.

Q Do you have an opinion as to the amount of profit to be expected to be made from the wells based upon the study of the Gulf wells?

A I would estimate the profit to be in excess of $49,000 per well for a 40 acre tract.

Q Have you prepared an exhibit that will reflect your views in that regard? A I have.

MR. KELLOUGH: Miss Reporter, will you please mark this

as Gulf Exhibit No. 2?

(Marked Gulf Oil Company's Exhibit No. 2, for identification.)

MR. KELLOUGH: Yesterday there was an exhibit identified as Gulf's Exhibit 1, and I thought to keep the record straight this could be Gulf's Exhibit 2.

Q Now, Mr. Bauman, will you please state briefly for the Commission what this exhibit shows?

A This Exhibit No. 2 shows an economic analysis of drilling a typical well on Gulf's leases in the lower flanks of the field. It shows that an estimated ultimate recovery of 60,000 barrels, gross barrels, and on the basis of two dollars and ninety cents per barrel net for the oil, the net revenue would be in excess of $152,000, which does not include any value for the casinghead gas that would be produced and sold. The total outlay to recover this oil would be 50% per net barrel for production expense, amounting to $26,000, production tax, a little over $8,000, and development cost including producing equipment and a proportionate amount for tankage, of $72,000. And after allowing for a small credit for salvage, the total outlay would amount to $103,000, which subtracted from the net revenue from the oil, would yield a profit of $49,000.

Q $49,230, is that the figure there?

A That is correct.

Q Was this exhibit prepared by you?

A It was.

Q Is it based on a solution drive type reservoir?

A It is based on a solution drive recovery.

Q That determines your recovery factor?

A That is correct.

MR. KELLOUGH: We offer in evidence Gulf's Exhibit No. 2.

MR. PORTER: Without objection this exhibit will be admitted.

Q Now, Mr. Bauman, are you familiar with the proposed arrangement for proration units which has been proposed by the applicants here in this case, which is that the units may run either north and south or east or west? A I am.

Q And are you also familiar with the proposed well location pattern which provides that the well may be located in either 40 acres of the 80 acre unit provided that they are diagonal with any one Governmental quarter section?

A Yes, I am.

Q That is a statement, as you understand, the proposal for this floating or flexible well location pattern proposed, is that right?

A That's the way I understand it.

Q Have you made a study of the Gulf leases with respect to whether such a proposal will protect the correlative rights of the Gulf in that case? A I have.

Q I refer you now to what will be identified as Gulf Exhibit No. 3, and ask you to please state what that is.

(Marked Gulf's Exhibit No. 3, for identification.)

A This is a plat of portions of Township 25 North and Range 10 and 11 West, and shows the acreage located within the proposed spaced area, the blue acreage shaded in blue is identified as Gulf leases.

Q Does this exhibit show the location of the presently existing wells by the solid circle, is that right?

A It does.

Q Does it show the authorized location of wells under the proposed well location pattern by crosses?

A It does.

Q Now, referring to the southwest of Section 24, what is that?

A 25 North?

Q 25 North, 11 West. How many wells are located on the Gulf lease?

A Two producing wells.

Q Under the proposed 80 acre pattern, well location pattern, could any more wells be located there?

A They could not.

Q How many wells could be located under the proposed pattern offsetting Gulf lease?

A There could be six wells, six, seven wells on offsetting

Gulf acreage that would not be owned by Gulf.

Q That would be on the authorized pattern?

A That would be on the authorized pattern.

Q And the ratio of seven to two as to that particular 160 acre tract?

A That is correct.

Q Will you please explain to the Commission what the blue circles represent?

A The blue circles merely represent an area of 80 acres as the same scale that this map is drawn.

Q That is drawn on the assumption that a well would drain 80 acres as contended for here in this case, is that correct?

A That is correct.

Q And that is prepared also on the assumption that the Commission will grant the application as it is now asked for?

A That is correct.

Q What does the area between the blue circles represent?

A The area between the blue circles merely represents the area in which there is the highest pressure or the highest oil saturation between the four permitted locations.

Q Is it not an elementary rule of petroleum engineering that oil will migrate from areas of high pressure to areas of low?

A That is generally accepted.

Q Now, in that connection then, what is the significance of your blue arrows?

A Well, the blue arrows merely indicate that from some point in the center of this area the oil under a uniform spacing pattern will move equally to the four wells that are draining that area.

Q That would be the direction of the flow of the direction of the drainage under a uniform 80 acre pattern?

A That is correct.

Q Now, Mr. Bauman, what do the red circles represent?

A The red circles represent an area of equal magnitude of a well, another well that could be drilled under the flexible pattern.

Q Will you please demonstrate to the Commission the effect of the drainage of oil if you add the two other wells which would be permitted wells under the proposed application?

A The effect of adding the other two wells would mean that in the 160 acres that those three wells would be located, you would be taking out three barrels of oil and three barrels of oil here as compared to two barrels of oil from the tract upon which the completed wells are located, and that in effect, would create a pressure somewhere in the vicinity of the three wells that would not be created under a uniform pattern, and in effect, would create additional force that would cause the oil to move toward those additional wells and would result in more oil moving to these three wells from this area right here, and this area here then would be the case under a uniform pattern, and the correlative rights of Gulf would not be protected.

Q In other words, the arrows represent the pull of the oil, and by the addition of that well, is authorized the pull of the oil would be off of the Gulf lease?

A That is correct.

Q Would that result in uncompensated drainage?

A It would.

Q And in your opinion then will the application as proposed protect the correlative rights of Gulf Oil Corporation?

A It will not.

MR. KELLOUGH: That's all.

MR. PORTER: Does anyone have a question of Mr. Bauman? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Bauman, I believe you stated that Gulf owns 960 acres in this area? A That is correct.

Q It's approximately two percent of the present productive proven limits of the field?

A I haven't made the calculation so I presume though that you have stated it correctly.

Q Is it true that Gulf owns 20 percent of the proposed four corners pipeline?

MR. KELLOUGH: I am going to have to object to that line of questioning. It is quite apparent that the question of markets

or market demand or matters of that nature are not germane to an application for a well spacing. That's a proper and appropriate question as to the question of the allowable production for the pool, but certainly the question of what market may exist over the life of this pool should not be an issue in this case to determine the proper location of wells. Therefore, I think it's an improper cross examination to try to delve out of this witness any information with respect to the company's ownership, if it has any, in any proposed pipeline.

MR. PORTER: Mr. Kellough, your objection is sustained.

Q Mr. Bauman, I understood you to say that Gulf has completed six wells to date on their acreage?

A I believe I stated five.

Q What was the figure? Are you completing one now or drilling?

A The sixth one is drilling.

Q According to the information that was presented yesterday, three of those wells are gas wells, is that correct?

A No, sir, there's only two of those wells that are gas wells.

Q I show a well, or this exhibit shows a well in the southeast quarter of Section 21 which is a gas well, that is 25 North, 11 West.

A That is correct.

Q And it shows a well in the, that's southeast quarter of Section 21, the southwest quarter of Section 30.

A In Southwest of Section 30 there is what?

Q A gas well according to this map.

A There is one gas well.

Q And the southwest -- wait a minute. The well in the additional well in the southwest quarter of Section 30, has that been drilled to total depth yet?

A Which well are you referring to?

Q The one that is now drilling apparently in the southwest of the southwest of 30.

A That is a completed well. That is a gas well that I was referring to.

Q What about the one in the northeast of the southwest of 30?

A That's an oil well.

Q Are you producing it as an oil well now?

A It is.

Q What is --

A (Interrupting) To the best of my knowledge it is being produced.

Q What is the gas-oil ratio?

A The gas-oil ratio of that well at completion was determined as 2300 cubic feet per barrel.

Q How much oil has it produced?

A I don't know how much it has recovered to date. It was only completed in July.

Q How much oil treatment was it given in fracturing, if you have

that information?

A The well was perforated from 5,085 to 92, and 5110 to 20 feet, and flowed naturally 168 barrels of oil per day through 2664 inch choke.

Q With no fracture? A No fracture treatment.

Q Do you have the cumulative amount of oil that Gulf has produced from this reservoir?

A I don't have it available.

Q Is Gulf prepared to drill wells on their acreage in Section 24 on a 40 acre pattern?

A Yes, sir. At least I would recommend it to the management.

MR. CAMPBELL: I think that's all.

MR. PORTER: Anyone else have a question of Mr. Bauman?

MR. SELINGER: I would like to ask one question.

By MR. SELINGER:

Q I couldn't quite hear your answer, what was the cost of drilling and completing a well of your five wells in the Bisti Field? I didn't get that total figure.

A The cost to drill and complete?

Q Yes, everything, complete cost.

A $72,300.00.

Q That's what I thought. Thank you.

MR. PORTER: Mr. Sullivan.

MR. SULLIVAN: I think I can confine myself to one question.

By MR. SULLIVAN:

Q Mr. Bauman, if 40 acres becomes, it stays or becomes the spacing pattern for the field, how many locations will you have offsetting this 160 acres that you were describing in your testimony, that's set forth on your Exhibit 3?

A How many --

Q How many offset locations will there be surrounding your 160 acre lease on a 40 acre pattern?

A Well, there would be, I presume you are referring to these locations off of Gulf acreage?

Q Yes.

A Well, there would be one, two, three, four, five, six, seven, eight, nine, ten, eleven.

Q As compared to how many possible offset locations under the application as submitted by Sunray Mid-Continent?

A I believe this shows one, two, three, four, five, six, seven.

Q So that your correlative rights will be better protected with eleven offset locations than with seven?

A That's correct.

MR. PORTER: Anyone else have a question of the witness?

MR. KELLOUGH: I would like to ask a question on redirect examination if there are no other questions.

MR. PORTER: Mr. Utz has some questions.

By MR. UTZ:

Q Mr. Bauman, would a rigid 80 acre spacing pattern tend to correct this situation which you state will exist under the conditions there?

A In my opinion it would not. I presume you're referring to a uniform 80 acre pattern?

Q That is correct.

A With the wells located in the same Governmental --

Q (Interrupting) Same quarter, quarter section on the 160. Your answer was that you don't think it will?

A I don't believe it will.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Bauman, would you state the rate of flow at which the well which you testified the GOR was 2300 to 1, would you state the rate of flow on that test please?

A 168 barrels of oil per day.

MR. NUTTER: Thank you.

MR. PORTER: Are there any further questions? Mr. Cooley?

By MR. COOLEY:

Q There's been testimony throughout this case that the heart of this pool is highly productive, much better than the fringe areas. Does Gulf own a characteristic proportion of each or do they own more good acreage than bad, or what will be your opinion on that

matter?

A I think we are represented for the area of the southeast portion of the pools insofar as the wells that have been drilled so far.

Q You think you have your representative share of the good acreage and your representative share of the bad acreage?

A Yes, sir.

Q Did you say it would be your recommendation to your company to drill all 24 possible locations under 40 acre spacing? I believe there are twenty-four nine hundred sixty divided by forty nets twenty-four, if my arithmetic hasn't failed me.

A I would recommend that we would drill the 40 acre locations on that tract in the southwest of Section 24 at the present time, and depending upon the results of the well now drilling, that could be extended.

Q You wouldn't care to estimate how many wells Gulf will eventually end up with on the acreage shown on Exhibit 3 on 40 acre spacing?

A That is pretty hard to say without knowing the results of the well now drilling.

MR. COOLEY: That's all.

MR. PORTER: Are there any more questions on cross examination? Mr. Kellough.

RE-DIRECT EXAMINATION

By MR. KELLOUGH:

Q I would just like to ask one question, Mr. Bauman, in the event that this application is denied and the drilling is upon the statewide rules of 40 acre spacing, and if Gulf completed the drilling of wells in the southwest of 24, then in connection with Mr. Sullivan's question, would there be an offset to each of the wells on the adjoining tracts?

A There would be an offset, yes, sir.

Q Did you wish to convey the impression to thic Commission that in your opinion the correlative rights of Gulf would be better protected under the proposed application than they would under the statewide rules?

A I'm not sure that I understand you. They would not be protected the way they are now, but we would be able to protect them if that tract was offset by 40 acre drilling.

Q Then, perhaps you misunderstood Mr. Sullivan's question as I understood your answer, Mr. Sullivan asked you if it was not a fact that the correlative rights of Gulf would be better protected under the proposed application than under the statewide rules and your answer, I believe, was that it would, is that what you intended to testify?

A To the extent that there would be no drainage from our property.

Q Well, I'm trying to get you to express your opinion to this

Commission, Mr. Bauman, as to whether in your opinion, based upon your exhibit, the correlative rights of the company, Gulf Oil Corporation, would be protected under the proposed 80 acre floating well spacing pattern.

A I don't think they would be.

Q Would they under the statewide rules?

A They would.

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

MR. PORTER: Does anyone else have a question of Mr. Bauman. The witness may be excused.

(Witness excused.)

You just had the one witness?

MR. KELLOUGH: That's all we have.

MR. PORTER: Does anyone else have any witness?

MR. SULLIVAN: I would like to call Mr. Thomas Hogan in this case.

MR. PORTER: He has previously been sworn?

MR. SULLIVAN: Yes, sir.

MR. KELLOUGH: I am a little late, but I would like to offer in evidence Gulf Exhibit No. 3, the map. I believe I neglected to do that.

MR. PORTER: Without objection, Gulf Exhibit No. 3 will be admitted to the record.

THOMAS HOGAN

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

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Will you please state your name, your employer, your position with that employer?

A My name is Thomas Hogan, I am employed by British American Oil Producing Company, and what was the other one?

Q What is your position with that employer?

A District Superintendent for the Northwestern District.

Q Where are you located? A Denver, Colorado.

Q You say that you are District Superintendent. Would you explain to the Commission in your company what that district encompasses?

A It encompasses the producing active, the producing and drilling activities in Montana, Wyoming, Colorado, Utah, Nebraska and New Mexico, North and South Dakotas.

Q In those states, Mr. Hogan, just approximately how many oil fields do you have under your jurisdiction as far as drilling and producing is concerned?

A Quite a few, I don't know. We have four field offices with Field Superintendents over them.

Q In other words, in your organization a district is consider-

ably vaster area than we have heard described as being divisions in other organizations? A It is.

Q Briefly, and be as brief as possible, Tom, in this, state your professional experience.

A I received a B.S. degree in mining engineering from the University of Oklahoma in 1933. Since that time I have been employed by the Texas Company in various engineering capacities, with the Iranian-American Oil Company as Superintendent of the Abquiq District and as Chief Development Engineer, and now for the last five years with British American Oil Producing Company as District Superintendent.

Q Mr. Hogan, you have read and are familiar with the application of Sunray Mid-Continent in this case?

A I have.

Q Is the position of your employer, the British American Oil Producing Company, in support of that application?

A Yes,, we are strongly in support of the application, but I would like to point out that we would like to stress the temporary nature of the order that we wish issued.

Q Now, there are two, let us say three, distinguishing parts to the application. One, they ask for 80 acre spacing, two on a temporary basis, three for the expansion of the definition of the pool. Do I take it that you are saying that your company is in support of all three facets of that application?

A It is.

Q But that you believe that there is particular emphasis to the temporary part, what do you mean by the emphasis that your company puts on the temporary feature asked for?

A We do not believe that there has been sufficient production and pressure history from the Bisti Field to enable us to determine that 40 acre spacing is economically feasible.

Q But you, on the other hand, are willing in effect to consider it when you get sufficient information?

A We are.

Q One further question, how many producing wells does British American operate in the Bisti Field? A Thirty.

Q That's approximately what percentage of the total in the field? A Twenty-five.

Q Do you recall how many of those wells, off-hand, you have cored? A Approximately twelve.

Q Do you recall the first witness put on, in Mr. Finfrock's testimony, how many core analysis of wells were involved in the diagrams which he presented, was it twenty-six?

A It was in the twenties I believe. I'm not sure.

Q With all of the producing information that you have from thirty wells, and with the core analysis from twelve wells with the additional information that you have obtained from producing those wells, I take it then that your position is that you still do not

have enough information to determine that you can successfully and economically drill on a 40 acre basis?

A No, we feel that we don't, principally because the production of the field has been restricted so drastically throughout most of its life, and as testified by Mr. Brinkley, it is still in the early steges of the producing life of the field.

MR. SULLIVAN: That's all, Mr. Hogan.

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

By MR. SETH:

Q Just one question. How long have your wells been producing, Mr. Hogan?

A The first well was completed in January of 1956.

Q Been producing over a year? A Yes.

MR. SETH: That's all.

By MR. PORTER:

Q Mr. Hogan, do you recall about what the gas-oil ratios are on your wells?

A Oh, they are in the neighborhood of I would say 450 feet to the barrel. I wouldn't guarantee it, but that is my best recollection.

MR. PORTER: Does anyone else have a question? The witness may be excused.

(Witness excused.)

MR. SULLIVAN: I would like also to ask Mr. John Stein

to testify, Mr. Chairman.

MR. PORTER: All right. Will you take the stand, please?

MR. SULLIVAN: He was sworn yesterday.

JOHN STEIN

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

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Mr. Stein, will you briefly state your name, your professional education and professional experience?

A My name is John Stein. I am a graduate of the Missouri School of Mines with a degree in mining engineering, petroleum engineer. I have been with the British American for eight years, and during the past two years have served in the capacity of District Engineer for the entire Northwestern District.

Q In your capacity as District Engineer, Mr. Stein, are you familiar with the Bisti Field? A Yes, I am.

Q Part of your duties are to study and make recommendations, generally supervise, in effect, the engineering of the Bisti Field?

A Our portion of it, that is correct.

Q You have been present during the last two days of testimony on this cause? A I have.

Q Are you generally in agreement with the conclusions reached by the witnesses for the proponent of this application?

A Yes, I am.

Q Would you like to comment upon the opinion that you have reached with regard to the economics of drilling this field according to the present stage of your knowledge on a 40 acre basis?

A Well, at the present time I don't feel that we have sufficient knowledge of how much reserves we can attribute to nine 40 acre wells. We have made some special core studies in which we have come up with a representative figure, we think, of recovery per acre foot. Now, we base most of our profitabilities on one well to 80 acres. Now, in the very heart of the field where we have the good production, we expect to obtain on 80 acre spacing roughly a hundred to ten thousand barrels of oil, which deduct royalty and lifting costs and so forth, would amount to a gross profit, or a gross revenue in the neighborhood of $190,000.

Now, it costs us around $70,000 to drill a well. So that means that on one well to 80 we could get $120,000 gross profit. That is assuming that our recovery estimates are pretty good. Now, if we drill two wells on that 80, that's going to require $140,000 expenditure, and that just cuts the gross profit right down the middle, which would leave somewhere in the neighborhood of $50,000 for that particular 80, which we are not sure we can even get, because there hasn't been enough production decline history, nor bottomhole pressure history to substantiate these initial estimates of recovery of oil per acre foot.

Q Now, I understand that these estimates were based, did you state that these estimates were based upon an average cross section or thickness of pay?

A No, this would only apply in the very best portion of the field. Now, we have some wells that have already been completed and actually indicate that they'll never pay out, and they are on 80 acres.

Q They are completed in the upper bench?

A Yes.

Q As producers. Are they also completed in the lower benches of the sand?

A They certainly are.

Q So there are wells even in your end of the field completed in the upper bench and lower benches which you do not consider economic wells at this time?

A That's right. Actually our core studies indicated that in the poorer sections of the reservoir we might expect from five to fifteen barrels of oil per acre foot. That is pretty low. We have already had a couple of wells which had considerable drop in pressure for only a small amount of oil produced. If we would just take the pressure decline that we have had on those two wells, we can only expect to get roughly 15,000 barrels of oil out of them ultimately, and that will never pay for a $70,000 well, yet they are on 80 acres.

Q Can you corroborate the gas-oil ratio that Mr. Hogan testified to with regard to your average or individual gas-oil ratios

in the section of the field which you are producing?

A Yes, they are running in the neighborhood of 400 to 450. There may be a few in the 500 range, but very few.

Q In connection with your special core studies, did you direct your attention in any respect to the possibility of communication between the upper and the lower benches, and if you did, with what purpose?

A Not particularly with core studies. However, we did note that on our core analysis that there was some minute amount of permeability even in the shalely, silty zones between the better-developed sand benches, so we conducted some communication tests.

Q Other than your core studies?

A Yes. We perforated the third bench of the Gallup sand and fractured it, and swab tested it, and then we went up and perforated the first bench of the Gallup sand, fractured it and swab tested the two together. Of course, established a rate, then we ran a packer on the tubing and set it in the blank interval between these two perforated zones and pump tested the well for, oh, I don't know, about two months, a man ran fluid level surveys on the fluid in the annulus, and the results of that test did indicate that there was communication between those two zones to some degree.

Q You were pumping it from which bench at that point?

A We were pumping from the third bench, the bottom bench, and checking the fluid level in the annulus, which is supposed to be

in the first bench if no communication existed, however, as we pumped from our third bench from the packer, our fluid level in the annulus went down the hole and finally stabilized when we shut the well in for a week to a month at a time, the fluid level in the annulus would build back up. Those are definite evidence of communication between those sand benches in that well.

Q I won't ask you whether or not you have made a deduction from that test. I would like to ask you whether or not you have a suspicion as to what this proves between the relationship as what you refer to as the upper and the third bench?

MR. KELLOUGH: We have had a lot of opinions, but I don't believe we should have a suspicion.

Q Would you state your opinion as to what may be your deduction from the test you have run?

A Actually that is only on one well. Of course both zones were fractured. Now, any time you fracture a well, a fracture is going to go in all directions, we may have caused that communication by fracturing, and again we may not. It may be due to the natural permeability in the reservoir. I don't think we can quite conclude on this test. We do wish to make more tests.

Q That is why I didn't ask you for a conclusion. I just wondered if you had a suspicion. One further question, did you earlier testify in connection with the economics of 40 as versus 80 acre spacing as to what you estimate your completed well cost will be

in that field from here through the foreseeable future?

A I don't know if I made that statement exactly, but our costs, I expect --

Q Would you make it now?

A (Continuing) -- to be between sixty-five and seventy thousand dollars per completed well.

Q Generally what will that include?

A That will include everything pertaining to a well from drilling it, setting the pipe, perforating, logging, perforating fracturing, all of the pumping, lifting facilities and lease facilities. Everything that is necessary to get this well to produce into tank battery.

MR. SULLIVAN: That's all, Mr. Chairman, that I have.

MR. PORTER: Does anyone have a question of Mr. Stein? Mr. Cooley.

CROSS EXAMINATION

By MR. COOLEY:

Q Mr. Stein, you said your company had already completed some wells that in your opinion would not pay out?

A Yes.

Q You stated that that was on 80 acre spacing with the inference at least, I thought, that possibly the payout would be less if they were on 40 acre spacing?

A Certainly we couldn't even expect to offset those wells and

get any more additional oil. I mean we have, already they are on 80.

Q Offsetting is not required where the well is not economic, Mr. Stein? I want to know, if anything, an uneconomic well is drilled, the dedication of no amount of acres to that well will make it economic, will it?

A I don't quite understand.

Q If you dedicate 20 acres to that well, or 1000, it is still an uneconomic well, is it not? A I'm afraid it is.

MR. COOLEY: Thank you.

MR. PORTER: Mr. Utz, do you have a question?

MR. UTZ: Yes.

By MR. UTZ:

Q Mr. Stein, in answer to one of Mr. Sullivan's questions, I understood you to say that you were generally in favor of Sunray's application. Would that indicate that you are not wholly in favor of it, some portion of it that you don't agree with it?

A I am in favor of a temporary 80 acre spacing order, I'll put it that way. I would not be in favor, for instance, of making this a permanent spacing order. Of course, they have not asked for a permanent spacing order. I am in favor of the one well to 80 acre spacing on a temporary one year basis.

Q Are you in agreement with their so-called floating spacing pattern?

A Well, yes, I would be in agreement with that.

Q That would allow you to cluster four wells around a quarter quarter section, or quarter section?

A Yes, it would allow that in certain specific cases. However, there are some wells in the field already that are off spacing and therefore, there is going to have to be an exception made for those particular wells. You have to either give them an east-west 80 or north-south 80. There is also a possibility that a fellow sitting off out here that is maybe only got 70 acres within the zero contour, so I think if you had a little leeway as to where he could drill that well, he would still only have one well to the 80. I think there should be some leeway to that.

Q You are in favor of flexible spacing pattern then?

A To some degree.

Q Even though it would be clustering the wells?

A I think it should be either east to west or north to south. I wouldn't want to throw them on a diagonal.

MR. UTZ: That's all I have.

MR. PORTER: Any more questions? If no further questions, the witness may be excused.

(Wotness excused.)

MR. COOLEY: I would like to direct a question to either Mr. Errebo or Mr. Campbell. As you gentlemen know, this state as a general rule interpreted its spacing orders to permit the drilling of more than one well on a standard proration unit, whatever size it may be. As Mr. Campbell knows, there are many areas in this state

where there are two, three and four wells on 140 acre proration units. In view of the fact that this is somewhat peculiar, since an 80 acre unit will probably get just twice what a 40 acre unit will get, that anyone who desired could drill on a 40 acre spacing pattern even though the established and recognized 80 acre proration unit were established.

MR. PORTER: There is a limitation there, Mr. Cooley, in that regardless of the number of wells that the unit received the same allowable even though one well?

MR. COOLEY: That's correct, but since on a 5,000 foot well there is no depth factor, then a 40 acre well would get just exactly half of what an 80 would and vice versa, which would not occur in any other depth range.

MR. PORTER: Not under any existing rules.

MR. CAMPBELL: What is your question?

MR. COOLEY: The question being does the applicant by this application propose to prohibit the drilling of more than one well on an 80 acre?

MR. CAMPBELL: We would like to have the order so provide, if the Commission issues any order. The interpretation of the statutes we would leave up to the Courts. The section that permits drilling on one unit, if you want to, with one allowable.

MR. COOLEY: Yes. We have not ordinarily interpreted our rules, in say a 40 acre pool, to prohibit the drilling of an

additional well on the 40.

MR. CAMPBELL: You have occasionally permitted after application.

MR. COOLEY: No application, they just drill them.

MR. CAMPBELL: We would like to have the order so provide, if the order is issued, for temporary 80 acre spacing.

MR. SELINGER: May I attempt to answer that likewise? I have here a suggested order, both the findings and the order, which I would like to introduce and merely for the suggestion on the part of Skelly in which it incidentally coincides with Mr. Campbell's suggestion, but it is very short. I might read it, I would like to suggest this:

Findings: That the geological and engineering evidence presented to the Commission bearing on the matter of well spacing indicates that the Bisti Field as classified and defined in this order, should, for a period not to exceed one year from the date of this order, be developed on a pattern of one well to eighty (80) acres in order to drain efficiently the recoverable oil from said pool, assure orderly development, and prevent waste in a manner to protect correlative rights.

That temporary 80-acre spacing in this field will result in a earlier determination of the geologic and engineering characteristic of the pool, avoid the drilling of a number of unnecessary wells should a wider spacing prove to be proper after additional evidence

is obtained as will protect correlative rights.

In the order we suggest that: That effective this day temporary 80-acre spacing is hereby established for the Bisti Field.

That this order shall continue in force for a period not to exceed one year from the date hereof.

It was merely a suggestion and I might add that it is based on practice and procedure that we have in the State of North Dakota which issues temporary spacing orders for the express purpose of securing information upon which to predicate a permanent order.

MR. PORTER: Mr. Cooley, before we conclude this matter we would like to know if there are any other companies who desire to present testimony in this case.

MR. BUSHNELL: At the opening of the hearing Amerada intended to put in a four and one-half page statement at the end of the hearing, but during the course of the hearing the last several days we conclude that we would like to put that statement in the form of testimony since it was prepared by a witness who is here. However, since it appears that this hearing may run on through the lunch hour today, I contacted Mr. Seth and we have stipulated that I may enter this statement of Amerada's, prepared by Mr. Christie, into the record as if it were given by Mr. Christie, and if there is no objections I would like to offer this into the record as Amerada's Exhibit No. 1.

MR. SETH: We have so stipulated. I don't know what

Gulf's position will be on it. We had stipulated that if Mr. Christie were called, he would testify as this statement reads.

MR. KELLOUGH: We have no objection to the admissibility of the statement.

MR. COOLEY: Do both you gentlemen waive the right to examine him?

(Marked Amerada's Exhibit No. 1, for identification.)

MR. PORTER: Under these stipulations, the statement will be accepted as testimony. Does anyone else desire to present testimony in this case?

MR. KELLOUGH: I just want to make one comment, whereas I have no objection to Mr. Christie's statement, on the other hand and quite to the contrary, I do object to any admission of Mr. Selinger's order in the record in this case. If he wishes to present it as argument on his behalf, I think that is very well and good. I certainly don't think, I think it would be a little presumptious to submit to this Commission a finding based upon all of the evidence which has been presented here for the last two days.

Now, I'm sure that Mr. Selinger intended that to be only argument, if that is the case, very well and good, but if it is intended to be admissible in some manner in this case, then I would like to object to it.

MR. SELINGER: I merely intended to give Mr. Kellough

advanced notice that I'm going to attach that to my statement to be filed within the next few days. That's why I had it read.

MR. COOLEY: It has been the practice on occasion, of this Commission and other Commissions, to accept proposed orders, but they have no evidentiary weight whatsoever.

MR. KELLOUGH: Very well.

MR. PORTER: Was this question of number of wells to the unit settled to your satisfaction?

MR. COOLEY: What, the application section? Yes.

MR. PORTER: If there are no further witnesses to appear, no further testimony to be presented, the Commission will entertain statements that you may have. However, as you remember, yesterday we indicated that written statements might be submitted within ten days, ten days from yesterday. However, you still have the privilege of presenting the statement orally if you so desire.

MR. HINKLE: If the Commission please, Clarence Hinkle of Hervey, Dow and Hinkle, Roswell, representing Humble Oil and Refining Company. I would like to present a brief statement on behalf of the Humble. The Humble Oil and Refining Company has a 4.722% interest in the Carson Unit area which covers a part of the Bisti-Lower Gallup Oil Pool and owns additional acreage within the proposed horizontal limit of the pool. The Humble desires to go on record in this case as supporting the application of the Sunray Mid-Continent Oil Company for a temporary order of one year establishing orderly 80

acre spacing in the Bisti-Lower Gallup Oil Pool.

Due to the fact that production from the Bisti-Lower Gallup Oil Pool has been relatively small because of the market outlet, the information accumulated to date with respect to well performance and bottomhole pressure data has been rather limited, and although the production data thus far accumulated indicates that one well will effectively, efficiently and economically drain more than 80 acres, a temporary order entered for a year would permit further development on an orderly 80 acre spacing pattern during such period so that additional well performance and pressure data can be accumulated to enable the Commission to more definitely determine the characteristics of the pool and as to whether at the end of the year development should properly proceed on an 80 acre or 40 acre spacing.

It is also possible after a field has been on a definite 80 acre spacing pattern, to drill the additional wells so as to complete the development on 40 acre pattern if essential to obtain the greatest ultimate recovery. But once development has started to any considerable extent on 40 acre pattern, for all practical purposes it can never be changed, and it would then be too late to prevent economic waste caused by the drilling of unnecessary wells and the unnecessary use of steel and other industry equipment.

We, therefore, urge the Commission to give favorable consideration to the Sunray Mid-Continent application.

MR. PORTER: Anyone else have a statement? Mr. Kellahin.

MR. KELLAHIN: Jason Kellahin appearing for Phillips Petroleum Company. Phillips Petroleum Company owns acreage in the Bisti-Lower Gallup Pool, participates in the Carson Unit area, and it likewise participating in the pilot LPG injection program now under way in this pool. Phillips is of the opinion that the reservoir information which has been presented in this case and is now under consideration shows that one well on 80 acres will efficiently and economically drain and develop the 80 acre unit.

In that connection we would like to call the attention of the Commission to the testimony offered by Sunray Mid-Continent as to four wells which showed an initial pressure below the original reservoir pressures, and also Exhibit 12 offered by Shell which shows on at least two of the wells the same situation, which on the testimony from both the proponents and the opponents of this application, show effective drainage over an 80 acre area. For that reason, Phillips Petroleum Company supports the application and urges the adoption by this Commission of the temporary 80 acre spacing order for a period of one year.

Also in connection with it, we would like to urge the Commission to give serious consideration to the testimony which has been offered in regard to the pilot injection program, the testimony of some of the witnesses indicates that the development of the area on closer spacing could well endanger that program and result in reduced recoveries. The money which would be spent, according to the

testimony of the witnesses, on developing this acreage on 40 acres could more profitably be used to institute this secondary or this pressure maintenance and secondary recovery program with a resulting recovery in excess of that which could be achieved by any multiple program which has been offered.

For that reason Phillips endorses the application and urges the approval by the Commission. I am also authorized to state that El Paso Natural Gas Products supports the application and urges a temporary 80 acre spacing and drilling unit program for the Bisti-Lower Gallup Pool. I am likewise authorized on behalf of Benson-Montin and Greer to state that they likewise support the program. They have an interest in this field as does El Paso Natural Gas Products Company, and urge the approval of the temporary 80 acre spacing order.

MR. SELINGER: If the Commission please, Skelly Oil Company concurs in the application for a temporary 80 acre spacing order for one year. We will file a detailed written statement later.

MR. BUSHNELL: Bushnell for Amerada. I would like the record to show that Amerada is in support of this application subject to the single qualification that Amerada would be agreeable to and would favor an order which provided for uniform spacing.

MR. JUSTICE: My name is P. S. Justice. I am Manager of the Rocky Mountain Division for the Sun Oil Company, Denver, Colorado, with jurisdiction over and responsibility for Sun's

operations in the area of the Bisti-Lower Gallup Oil Pool. I would like your permission to make a statement on behalf of Sun. I would like to make this and have it understood it is a comparatively brief and non-technical statement. Since this is the first time I have had the privilege and opportunity of attending a hearing before the New Mexico Oil and Gas Commission, I wish to express my personal and official appreciation of the impartial, patient, and efficient manner in which this hearing has been conducted by the Commission and its Staff. If at first blush this appears to be apple polishing, I can assure you that you can consider yourself unanimously polished by this attendance here.

Sun Oil Company concurs fully in the application of Sunray Mid-Continent Oil Company for an order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico and temporarily establishing uniform 80 acre spacing in accordance with the details of said application.

Furthermore, in Sun's considered opinion, the evidence so lucidly ably and intelligently presented by Sunray Mid-Continent Oil Company as applicants in this case unmistakably demonstrates the desirability, urgency and practical necessity for prompt establishment of such temporary 80 acre spacing. We believe that this is necessary in order to prevent waste, that it will aid in promoting the ultimate efficient maximum economic recovery of oil from said pool with due regard for the legal, moral, and just or relative

rights of all interested parties.

Finally, we wish respectively to state to the Commission and to the parties opposing this application, that in our opinion the adoption or the establishment of such a temporary 80 acre spacing order would not necessarily be permanently harmful to the premises or position of the opposition even if the same later should be proven to be correct or adviseable. On the other hand, if lesser well spacing regulations remain in force and development on 40 acres is permitted, no later action or order could affectively prevent the waste or other inequities that have clearly been shown to result therefrom.. Thank you.

MR. PORTER: Thank you, Mr. Justice. Any more statements?

MR. ERREBO: Sinclair Oil and Gas Company entered an appearance in the matter after the first day, and they have authorized me to state in their behalf that they strongly support Sunray's application for 80 acre spacing, that they equally strongly oppose 40 acre spacing, and they support our application with the exception that they would favor a permanent order and that their second choice would be a temporary order, and that they will file a written statement subsequent to this hearing.

MR. PORTER: Mr. Sullivan, did you have a statement?

MR. SULLIVAN: I think it behooves me to say one additional word in view of Mr. Cooley's question to Mr. Campbell with regard to the well locations and the way the 80 acre spacing units

would lie. I don't think the position of British American Company should be based on Mr. Stein's position, because in discussing it with him, I don't believe you were on common ground in this discussion with Mr. Utz.

Let me say we are in agreement with the position that Mr. Campbell takes, we feel there should be one authorized well to the 80 acre unit, and the Commission should establish the direction in which the units should lie, and that they should be uniform. Is that essentially correct, Mr. Campbell?

MR. CAMPBELL: The only thing I discussed with Mr. Cooley, that we did question, that if an order is entered that it provide that not more than one well be drilled upon any 80 acre unit. The present application as it stands, permits flexibility in the location of the well on the unit. And there has been some testimony or indication here that some people feel it should be a fixed pattern rather than a flexible one, but our application is for a flexible pattern.

MR. SULLIVAN: So it is within 330 feet of any place within the acre boundary?

MR. CAMPBELL: I believe that is 330 feet from the boundary track which is a part of the 80 acre unit.

MR. COOLEY: Which could put it 330 feet anywhere around.

MR. SULLIVAN: I would go one step further and say we would like to see the present spacing pattern as it exists in the

British American portion of the field maintained.

MR. CAMPBELL: We have no objection to a fixed pattern spacing insofar as it is feasible under the present circumstances.

MR. SETH: Do you modify your application to that extent?

MR. CAMPBELL: We'll let the application stay like it is.

MR. SETH: The same thing that troubled Mr. Cooley has troubled me. Ever since the application first came to us, it's an application for prorationing units in an area where there is no prorationing. It is not really a spacing case when you get right down to it. Under the terms of the application it will be perfectly proper for anybody to drill any number of wells within the 80 acre tracts if they wish to do so. I think the application and publication and so would permit. This is not an application for spacing, it is an application for proration units.

MR. CAMPBELL: I disagree. I think it is broad enough that the Commission could deem it adviseable to limit the drilling in this area of one well per 80 acres.

MR. SETH: We have treated this and tried this as a spacing case. We are prepared to go along with any spacing rule that the Commission has. I don't think the application is for spacing at all.

MR. PORTER: Anyone else have a statement? Mr. Cooley, do you have some letters?

MR. COOLEY: Yes. From Honolulu Oil Corporation:

"Honolulu Oil Corporation owns and operates one well in this field in the area included in the notice of hearing. This well is our State of New Mexico "D", Well No. 1, located 660 feet from the North and West lines of Section 36, T 26N, R 13W, NMPM.

Because of our minor percentage of production and reserves in this field, we do not plan to be represented at the hearing. However, it is our belief that the proposed temporary 80-acre well spacing is proper for this field at this time.

Honolulu Oil Corporation respectfully requests that the Commission adopt the special rules and regulations for the Bisti-Lower Gallup Oil Pool as proposed by Sunray Mid-Continent Oil Company."

From the El Dorado Refining Company: "Notice has been received in the matter of Sunray Mid-Continent Oil Company's application for the purpose of establishing spacing and special rules for the Bisti-Lower Gallup Oil Pool, San Juan County, New Mexico. It is our understanding that this matter has been scheduled for Wednesday, September 18, 1957, in Santa Fe, New Mexico.

This is to advise that as an operator in this area The El Dorado Refining Company supports Sunray Mid-Continent Oil Company in their request for 80 acre proration units and well spacing plus special rules and regulations for the subject pool."

From Anderson-Prichard Oil Corporation: "Anderson-Prichard Oil Corporation recommends that the Commission approve the

application of Sunray Mid-Continent Oil Company for an order which will (1) extend the horizontal limits of the Bisti Lower Gallup Oil Pool, (2) temporarily establish uniform 80-acre spacing for oil wells, and (3) require semiannual gas-oil ratio and bottom hole pressure tests.

Anderson-Prichard Oil Corporation further recommends that the Commission include in the field rules a volumetric withdrawal formula for computing allowables for gas wells which are completed in the gas cap portion of the Lower Gallup oil reservoir. The equities of all parties can best be preserved by permitting the operators of such wells to attribute up to 320 acres to each well for allowable purposes provided that said acreage is proven productive of gas."

From Shiprock Industries, Inc.: "It is our understanding that you are having a meeting on 9-18-57 to consider oil well spacing in the San Juan Basin, New Mexico.

We are the holders of thousands of acres, both proved and unproved, in this area and it is our studied opinion, after advice from our geologists, that it is quite improbable that more than forty acres of oil land can be drained by a well thereon. We therefore violently oppose changing of the laws of the State of New Mexico to allow for spacing greater than forty acres per oil well."

From Laurence C. Kelly Trust: "I have been notified that a meeting of your Commission will be held in Mabry Hall on September 18th, at 9 A.M. to consider among other things Case #1308,

the application of Sunray Mid-Continent Oil Company for an order extending the horizontal limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, and temporarily establishing uniform 80-acre well spacing and promulgating special rules and regulations for said pool.

The Laurence C. Kelly Trust, of which I am Trustee, holds State of New Mexico Oil and Gas Leases Nos. E-6597, E-6644, and E-7698, aggregating a total of 4,118.59 acres. All of this acreage is in Township 25 North, Ranges 12 and 13 West, and covers all of the State owned acreage in this Township and Ranges, with the exception of 1,000 acres.

You will remember no doubt that the discovery well of the Bisti Pool was on Section 16, Township 25 North, Range 11 West, which is part of our State Lease.

As Trustee for the above Trust, I would like to make formal protest against changing from the present established 40-acre spacing to 80-acre spacing, as requested by Sunray Mid-Continent Oil Company, for the following reasons:

1. The Oil Conservation Commission of the State of New Mexico has never before found it necessary to change the spacing from to to 80 acres as it has no doubt found 40-acre spacing satisfactory from every angle.

2. It is the considered opinion among a great many well qualified geologists that one well cannot possibly drain in excess of 40 acres, because of the nature of the Gallup Sandstone which has been established as a very tight formation with low porosity and permeability.

3. The only sound reason in the opinion of the writer that have been advanced to date, namely, lack of market for the oil, will be completely eliminated before the end of the year when the Four Corners Oil Pipeline to California will be in operation and the Refinery of the El Paso Natural Gas Products Company will be on stream.

4. It would appear to be short-sighted policy to restrict the production of oil from the Bisti Pool at a time when there is a very strong demand for it and the Refineries of California are clamoring for it. This condition might not prevail for too long and should be taken advantage of while it does.

5. A change in the established 40-acre spacing could be very detrimental to the revenue obtained from oil by the State, which undoubtedly, like nearly every other State, needs more and more revenue every year for school purposes. It is more than likely to bring about requests for wider spacing than the present 40 acres.

In view of the above facts I cannot urge you too strongly to allow the present established spacing of 40 acres to remain in effect."

MR. PORTER: Let the record show that these letters are entered in evidence.

MR. ERREBO: I have a copy of a letter from Honolulu. Did you read that?

MR. COOLEY: Yes, supporting.

MR. CAMPBELL: Are you going to make a statement, Mr. Seth?

MR. SETH: Mr. Carroll will make the summation. You go ahead, you are the applicant.

MR. CAMPBELL: Normally they close. I don't want to be contentious about it.

MR. CARROLL: I appreciate this has been a long hearing. I do not want to labor the evidence, but I would like to summarize

the principal issues that have been brought out in this case. In particular to review very generally the nature of the spacing order that has been requested, the economic consideration involved, the relationship of the spacing to secondary recovery, and the effect of the spacing on correlative rights. Insofar as the nature of this spacing order itself is concerned, as I am sure the Commission is well aware, this represents what is an unprecedented request for 80 acre fieldwide spacing at 500 foot depth. Previous spacing orders have been eight to nine thousand feet or greater depth.

The Commission would have every reason to believe and expect that were applicants come forth requesting exceptions from statewide rules which have been established and followed, they would present evidence of some unusual circumstances or conditions existent in this reservoir which would justify a variation from the rules.

However, the applicants have utterly failed to do this, and as a matter of fact, as I think their evidence has shown, they have testified that the conditions in this reservoir do not vary materially in any other respect from other reservoirs in the state.

The next point I would like to present, the correspondence in connection with the application itself, is in regard to the so-called density pattern. It is obvious from examination of the petition itself as well as from a review of the testimony, they avoided the use of the word spacing pattern. This is easy to understand

because this so-called stratogy of arbitrarily dedicating acreage to a well to achieve an 80 acre unit is contrary to the practices of the Commission and contrary to the ordinary spacing pattern.

Furthermore as has been emphasized by some of the early discussion, what has been requested is a floating pattern with diagonal 80 east-south or north. It is to produce an indefinite spacing pattery rather than a fixed orderly pattern which is normally fixed by the Commission. Other considerations in connection with the order, and one in which the applicant has placed great emphasis, that a temporary order cannot possibly hurt anyone or do damage to present development in the field. We firmly believe this is not true. If, in fact, an 80 acre order is given and 80 acre wells are actually drilled, although we are firmly convinced they will not by any means effectively or adequately drain an 80 acre area, they may yet take enough oil out of the area so that later on it will be uneconomical to drill the area on 40 acre basis.

Furthermore, we have demonstrated if you drill on 80 and try to drill on 40 again, you will have waste and dissipation of reservoir energy. Next, having briefly considered the petition, I would like to go into economic conditions involved. In this connection I think it quite significant that if you take the figures with regard to potential reserves, figures that have been established in the prior LPG hearing by the applicant, figures that have been established by

virtue of correspondence which the applicant wrote to various operators trying to interest them in LPG operation, and finally evidence of reserves as presented by their testimony in this case, I think it can be firmly established that drilling on a 40 acre basis is economically practical and feasible.

Furthermore, there are other considerations in this case that I feel that perhaps hasn't been too adequately emphasized, I think for obvious reasons, that is namely in addition to the interest of the State of New Mexico in the lands affected by the petition, which are substantial, there are also some very substantial interests of the United States of America of various Indian wards. In my opinion these interests should have the effect of the maximum development that can be obtained and are entitled to, and I think they should not be penalized in terms of development of the reservoir by the higher drilling cost of some of the operators.

Then the next factor I would like to consider is the emphasis that has been placed on secondary recovery operations. Now, it is true and has been emphasized by a lot of testimony, that Shell did participate in Sunray's LPG project, it is Shell's project to participate in any experimental secondary recovery project. I might add that we are hopeful of its success. However, it is necessary to view this project realistically in terms of what it actually is, namely an experimental project for the injection of LPG as has been admitted by the testimony of the applicants.

They have just now completed injecting the gas into their pipeline.

Therefore, it would seem somewhat premature at this time during the early phases of primary recovery, to regard a project of this nature as a substantial factor in establishing fieldwide spacing in a 47,000 acre area.

Furthermore, insofar as this secondary recovery through the use of LPG is concerned, we consider it quite significant that they did not use an 80 acre pattern as they suggested would have to be followed, but they used instead what was in essence a 20 acre pattern consisting of four 40 acre locations with the injection well in the center.

Now, if the applicant contends that it seriously believes that some jeopardy might be done to future secondary recovery operations by having wells drilled on a 40 acre basis, as a matter of fact, they said anything less than 80 acre basis, and if they have conceded this is a continuous reservoir and if this LPG is in what they regard as in a better paying location, it is difficult for me to understand why they would jeopardize this project themselves starting on a 20 acre basis.

I think Shell's testimony has established with regard to secondary recovery operations, that the ultimate pattern will have to be, at least will be, on a nature of 40 acre rather than 80 acre pattern.

Finally, I would like to point out that insofar as the doctrine

of correlative rights is concerned, it has been quite convincingly illustrated by the exhibits and by the testimony of the Gulf Oil Corporation that many inequities may develop by virtue of the use of the floating spacing pattern proposed by the applicants, particularly where wells are drilled along lease boundary lines. Such inequities violate the principal of correlative rights as set forth in the New Mexico Statutory provision and this Commission's regulation. Thank you.

MR. KELLOUGH: May I very briefly summarize. In a case of this kind there are three basic issues. First your reservoir performance, that is your reservoir characteristics and performance, second the economics and third the correlative rights. Now, referring only to the high points of these three issues, if you are looking at, considering as this Commission must do, the question of the reservoir characteristics and performance, I'm sure we will all agree that this oil pool is not one big solid porous mass that ties this room in four miles wide and four miles wide, or square. You remember the longitudinal exhibit that ran clear across the room, looks like 66, the applicants themselves did not rely on that interpretation as to what is productive. When they figure reserves they go over to the exhibit based on the microlog which showed numerous variations, and showed a much smaller area. There has been in this case, I think, two clinchers.

You have heard too entirely diametrically opposed

theories.

The applicants on one hand have stated in their opinion that there is continuous porosity and continuous permeability throughout. On the other hand the witnesses for the Shell have presented to you their opinion that this pool consists of lenses of permeability overlapping and massing throughout this pool. The clinchers that would appear to tip the scale, the balance in the scale, is number one, the evidence that you have gas lower than oil, oil higher than gas in this reservoir. Now, no real explanation has ever been given for that, no satisfactory explanation, the only inference I submit that can be inferred is that because of the lenticularity of the nature of this pool, you must have local traps that will cause that condition. It would seem that it would be impossible if you had a continuous permeability, continuous porosity, this pool has been layed down over millions of years, that you would have gas below the oil.

Second, unescapable point, is that you have in this pool in certain parts of it undersaturated oil. In other words, the oil in that part of the pool has less gas than it could absorb, and on the other part of the same reservoir you have either a gas cap or certainly you have a very high gas-oil ratio well. So if there is a great continuity and continuation of porosity and permeability, then it would seem most unlikely that in part of the reservoir you would have the oil which had not absorbed the gas.

Now then, as to the question of economics, you have first the testimony of the applicants in their pilot area several months ago where it was unquestionable economical to drill a well on 40, and you have the evidence of Gulf in its own wells, and you have heard the testimony of Shell and as to applicant's testimony, you'll recall that the engineer testified in basing his calculations on recovery where he concluded that a well would not be off on 40 acres, he did not give any average porosity, but he took certain areas of this field aggregating about half of the total area to be included. He used only a small portion of acreage in the pool and upon that basis calculated reserves which were way under those which had been calculated by his associates in the former hearing.

And furthermore, when you consider testimony of the geologist for the applicants, where he stated the upper sand averaged 15 feet and the lower sands from 4 to 6, making an average pay thickness of about 20 feet, if you compute that on the same figures that were used by the applicant's other witness, then according to that computation a well would be profitable on 40 acres.

Issue No. 3, is the question of correlative rights, and though we submit that this floating well spacing pattern will undoubtedly result in a cluster of wells through the streak of the field, they have testified that the heart of the pull is down the middle. The opportunity to cluster the wells anywhere you want, you are bound to have clustering of the wells on the center of the field,

and you wouldn't have 80 acre spacing in anybody's book. It is no answer to say this will be temporary for only one year. It's no answer to say that you are only going to be hurting for a little while. It's the duty of the Commission to protect the correlative rights of the parties now and not let them suffer for a temporary period however short or however long it may be.

Now then, if you pass on that consideration to the proposal that this should be temporary because you don't have enough information to know the performance of the pool, it all ought to be built on 80 acres. I submit how that argument goes to a challenge on the statewide rules. If that is true, you should have 80 acres for statewide rules in any pool. If you don't get enough information, I don't know how to space the pool. If the argument is valid, the lack of information to justify 80 acre spacing, that is a challenge to the statewide rules and not any specific valid argument in this particular case. For these reasons we ask that the application be denied.

MR. PORTER: Mr. Campbell.

MR. CAMPBELL: If the Commission please, I would be less than honest if I didn't admit that some of the statements just made on behalf of Shell Oil Corporation and Gulf Oil Corporation give me a slight lift, even at this hour of the evening after some of the spacing cases that I have been in in which they have been participants. I quite agree with the gentleman with Shell that in order

for the Commission to justify, even a temporary 80 acre spacing order in a reservoir at 5,000 foot depth, it must be an unusual reservoir. It is my opinion that perhaps the only time such an order is justified is when you have either a very poor or a very good reservoir. So far as I am concerned, from the testimony of the witnesses of Shell themselves, this has been established at best as a poor reservoir, and it seems to me that what little information is available at this time clearly indicates that the reservoir condition due to rapid pressure declines below the bubble point, and this is also from Shell's own witnesses, indicates that there are conditions in this reservoir which require careful study.

That was recognized by practically all the operators in this pool when they participated in the installation of a pilot pressure maintenance program at a stage of development in this field where it had only been one percent depleted; to me that is a very unusual situation. At least in the spacing cases with which I am acquainted, such a condition has never been present. It seems to me that the crux of this thing boils down to whether there is sufficient basis for the arguments by the protestants to justify to the Commission the risk that obviously exists so far as our people are concerned, and I think they are just as honest in their opinions as the witnesses for the protestants so long as there is a risk, that to develop this field at this stage on a narrow spacing program might adversely affect the ultimate recovery of the oil.

It seems to me that in the basic question of conservation a part of all these controversies about how much it cost this company or that company to drill a well or how quick they got their money back. It seems to me the responsibility of the Commission would be if they find there is some risk involved, to see that that risk is not taken unless there is a serious disadvantage to somebody if the risk must be taken. The only disadvantage that has been testified to here that I have heard, and I have tried to get it from a number of witnesses, is that they have assumed and made arrangements on the basis that they were going to drill on 40 acre spacing. I don't think that the inconvenience or even loss of revenue to an individual operator in the field justifies the risk which we believe exists that you may not get the greatest ultimate recovery from this reservoir, to me that is the crux of the matter, and I don't think any of the evidence that has been introduced here today or yesterday even can get around that basic proposition.

If the Commission should permit the drilling of these additional wells, and if it should result in the pressure maintenance program not having the effectiveness that it would under the other basis, it not only would risk a tremendous amount of capital which could be used to find oil fields somewhere else in the San Juan Basin, but it would run the risk of loss of oil, a natural resource which this Commission has the obligation to protect.

MR. PORTER: Does anyone else have anything in this case?

The Commission will take the case under advisement.

C E R T I F I C A T E

STATE OF NEW MEXICO)
: ss
COUNTY OF BERNALILLO)

I, ADA DEARNLEY, Court Reporter, do hereby certify that the foregoing and attached transcript of proceedings before the New Mexico Oil Conservation Commission 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 day of October, 1957.

Notary Public-Court Reporter

My commission expires:

June 19, 1959.

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

December 19, 1957

TRANSCRIPT OF HEARING

Case 1308

DEARNLEY - MEIER & ASSOCIATES
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3-6691 2-2211

I N D E X

	PAGE
L. J. ELLERBROCK	
Direct Examination by Mr. Errebo	4
Cross Examination by Mr. Seth	17
Redirect Examination by Mr. Errebo	30
T. W. ERTINKLEY	
Direct Examination by Mr. Errebo	32
Cross Examination by Mr. Seth	48
Redirect Examination by Mr. Errebo	65
Re-Cross Examination by Mr. Grenier	66
Statement by Mr. Verity	85
C. D. GAINES	
Direct Examination by Mr. McGowan	86
Cross Examination by Mr. Seth	100
Redirect Examination by Mr. McGowan	116
Recross Examination by Mr. Seth	119
Redirect Examination by Mr. McGowan	121
Recross Examination by Mr. Cooley	121
Redirect Examination by Mr. McGowan	123
Recross Examination by Mr. Cooley	123
JOHN STEIN	
Direct Examination by Mr. Sullivan	127
Cross Examination by Mr. Cooley	133
E. F. LEWIS	
Direct Examination by Mr. Kellahin	137
Cross Examination by Mr. Seth	153
Redirect Examination by Mr.Kellahin	163
Recross Examination by Mr. Cooley	164
R. S. CHRISTIE	
Direct Examination by Mr. Bushnell	166
DONALD R. LINDSAY	
Direct Examination by Mr. Seth	174
Cross Examination by Mr. Campbell	202
Statement by Mr. Grenier	243
Redirect Examination by Mr. Seth	245

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GENERAL LAW REPORTERS
ALBUQUERQUE, NEW MEXICO
3-6691 5-9546

I N D E X

	PAGE
NORBERT METHVEN	
Direct Examination by Mr. Seth	245
Cross Examination by Mr. Campbell	261
Redirect Examination by Mr. Seth	284
Recross Examination by Mr. Utz	286
STATEMENTS	290

BEFORE THE
OIL CONSERVATION COMMISSION
STATE OF NEW MEXICO
Santa Fe, New Mexico

December 19, 1957

IN THE MATTER OF:	
(Rehearing) In the matter of the rehearing requested by Sunray Mid-Continent Oil Company, et al, for reconsideration by the Commission of certain portions of the application in Case 1308 for the temporary establishment of uniform 80-acre well spacing and promulgating Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.	Case 1308

BEFORE:

Mr. Murray Morgan
Mr. A. L. Porter

TRANSCRIPT OF HEARING

MR. PORTER: The meeting will come to order, please. The Commission will consider this morning Case 1308.

MR. COOLEY: Case 1308. (Rehearing.) In the matter of the rehearing requested by Sunray Mid-Continent Oil Company, et al, for reconsideration by the Commission of certain portions of the application in Case 1308 for the temporary establishment of uniform 80-acre well spacing and promulgating Special Rules and Regulations in the Bisti-Lower Gallup Oil Pool.

With your permission, Mr. Commissioner, I would like to outline the conditions under which this hearing will be heard.

MR. PORTER: You may proceed.

MR. COOLEY: In Order 1069-A wherein this rehearing was granted, it was ordered, one, that the above-styled cause be reopened and a rehearing be held at nine o'clock A. M. on December 18, 1957, Mabry Hall, Santa Fe, New Mexico, at which time and place all interested parties may appear. That order goes on to say, "It is further ordered that testimony on rehearing shall be limited to, one, new evidence on the issues raised in the petition for rehearing." It is the intention of the Commission to strictly enforce the provisions of this order in this hearing today. With that understanding, you may proceed unless there is some misunderstanding.

MR. PORTER: Any questions of Mr. Cooley's statement? Mr. Errebo.

MR. ERREBO: If it please the Commission, Burns Errebo from Tulsa appearing for Sunray Mid-Continent Oil Company, in addition L. C. White for Sunray Mid-Continent from Santa Fe, and Mr. Jack Campbell, Campbell and Russell of Roswell. We will have two witnesses.

(Witnesses sworn.)

MR. ERREBO: The first witness I would like to call, Mr. L. J. Finfrock.

L. J. FINFROCK

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

DIRECT EXAMINATION

By MR. ERREBO:

Q You are Mr. L. J. Finfrock?

A That is correct.

Q And you are located in Tulsa, Oklahoma as a staff geologist for the Sunray Mid-Continent Oil Company?

A I am.

Q You testified as a geologist in the previous hearing in this matter, is that correct? A That is correct.

Q Mr. Finfrock, since the original hearing in this matter in September, have you made or caused to be made additional studies of this area, and as a result do you know of additional information concerning this reservoir and its adaptability to the spacing which Sunray has requested? A Yes, I have.

Q Will you please refer to an aerial map which has been placed on the board and marked Sunray Exhibit 1-R and identify and explain it?

MR. ERREBO: Incidently, at this point I would like to explain that our exhibits have been identified by the letter R after the number to indicate rehearing exhibits.

(Marked Sunray's Exhibit 1-R, for identification.)

A Exhibit 1-R is an aerial map of the Bisti-Lower Gallup Oil Pool situated in portions of Township 25, 24, 25 and 26 North,

Ranges 10, 11, 12 and 13 West, in the San Juan County, New Mexico. As can be seen from this exhibit, we have brought it up-to-date as near as possible at the time we left for this hearing. There have been several wells drilled within the area of the Bisti-Lower Gallup Pool since the last hearing. These wells have been posted and added to this field.

You can also see that the boundary indicated in red which we outline as our proposed area for 80 acre spacing has been reduced in area, and this boundary reflects the orders of this Commission outlining the Bisti-Lower Gallup Oil Pool.

We have shown here that the green line, the traces of the micro-log cross sections which will follow as additional exhibits in this rehearing, and these are as follows, A A_1, from the British American No. 1 Marye in Section 1 of 25 North, 13 West, to the Shell 3220 in Section 20, 25 North, 11 West. Section B B_1 starts with the Shell 3220, continues in a southeasterly direction to the Monsanto No. 1 Blanch located in Section 34 of 25 North, Range 10 West.

Microlog section C C_1 through the pilot area extends from the BA No. 5 Marye in Section 1 of 25 North, 13 West in a northeasterly direction, terminating with the Sunray C-7 Federal in Section 31, 26 North, 12 West.

The fourth and final microlog, D D_1 starts, a north-south section, starts with the Shell No. 5 Carson in Section 27, 25 North,

11 West, terminates with the Sunray Mid-Continent No. 1 Platero in Section 15 of 25 North, 11 West.

Q Then as I understand your answer, Mr. Finfrock, the area which Sunray now proposes to space in this application has been reduced since the original hearing in this matter and is now confined to that area which has been heretofore recognized by this Commission as being a part of the Bisti-Lower Gallup Oil Pool, and certain one other 160 acre tracts upon which there have been drilled and completed certain oil wells, is that correct?

A That is correct.

Q Now, Mr. Finfrock, since the original hearing have you obtained micrologs of wells in this field which were not available to you at the time of the original hearing?

A I have.

Q And have those micrologs been used in constructing certain cross sections and have they formed the basis for a new study which you have made in this field? A Yes.

Q Mr. Finfrock, will you please refer to Exhibit 2-R which is a cross section and identify and explain it?

(Marked Sunray's Exhibit 2-R, for identification.)

A Exhibit 2-R is a northwest-southeast microlog cross section along the central part of the section. It is a microlog cross section of the main pay sections in the Bisti-Lower Gallup

Oil Pool. Starting with the British American No. 1 Mayre in Section 1 of 25 North, 13 West, and terminating with the Shell 32-20, this section is composed of portions of the micrologs of the wells that compose this cross section. On these micrologs we have defined the positive microlog separation by the dark red shading, which you will see in each of these logs. We have connected this positive separation by the solid lines and have connected between these wells with a lighter shading to indicate the continuity of this porous and permeable sand body. As you will note in the northwestern portion of this cross section, we have only the positive separation on the upper of these two main sand bodies. Whereas in the last four wells of this cross section, namely the Shell 34-13 Carson in Section 13, 25, 12 South, the Shell 34-18 in Section 18, 25, 11, The Shell No. 4 Carson in 20, 25, 11, and the Shell No. 32-20 in Section 20, Township 25, Range 11, both evidenced by positive microlog separation in the two main pay sands.

Q In the original hearing, Mr. Finfrock reference was made to microlog separation and there were certain exhibits offered showing microlcg separation. This Exhibit and some of your subsequent exhibits are exhibits showing microlog separation. Will you please explain what you mean by microlog separation and to what extent it is significant in determining sand continuity and permeability?

A In referring to microlog separation, we are here referring

to positive microlog separation as shown by these electrical characteristics which I have just described.

In a bore hole the fluid will leave a thin veil of filtrate on the bore of the hole, and this is common throughout the hole except at those positions in the hole where a porous and permeable body is encountered and at these positions in the bore hole a filter cake will be built up as we have lost fluid into this porous media.

The micrologging tool, the pad that is pressed against the wall of this bore hole, when it is reading the filter cake, it will read a positive separation at that point where the filter cake is built up opposite a porous and permeability formation, and thereby resulting in the positive separation that is shown on micrologs.

Q Mr. Finfrock, how many wells are there in this field, to the best of your knowledge?

A To the best of my knowledge at the time we prepared these exhibits, there were 187 wells.

Q And you have studied micrologs on how many of these wells?

A I have obtained and studied micrologs on a total of 164 of these wells.

Q You have studied micrologs on 164 of 187 wells in this field, is that correct? A That is correct.

Q Now, Mr. Finfrock, will you please refer to Exhibit 3-R and identify and explain it?

(Marked Sunray's Exhibit No. 3-R, for identification.)

A Microlog cross section 3-R is a continuation of 2-R from the 3220 Carson down to the Monsanto No. 1 Blanch in Section 34, 25 North, 10 West. This microlog section as the previous, has been built from portions of the micrologs of the individual wells that have been drilled in the field, and we have shown here by the same symbols that we had on the previous section, the positive microlog separation by the solid red color.

In these sections you can see both the main producing sand bodies have been found in each of these wells, though in varying degrees of thickness. We have found that in this study we have the opportunity to use wells that were not available at the previous hearing, which have given us closer spacing in order to get a better correlation between wells than we had before, and we feel as a result of these studies that our opinion about the continuity of these pay zones in the Bisti-Lower Gallup Oil Pool has not been changed as evidenced by these exhibits.

Q In fact, would you say that your opinion has been strengthened as a result of these new studies?

A Yes, I would.

Q Will you please refer now to Exhibits 4-R and 5-R and identify and explain them?

(Marked Sunray's Exhibits No. 4-R and 5-R, for identification.)

A Exhibit No. 4-R, microlog section C C_1, which is essentially a north-south, I mean a north-south cross section through the microlog section through the Bisti gas injection area. This cross section, as previous, has been built in the same manner as before and we have shown here the positive separation and the continuity of the permeability between these wells.

As can be seen from this exhibit, which is a transverse exhibit to the lengthwise of the field, that we do have a definite thinning of the porous and permeable zones on the flank with a definite thickening in the central well, indicating that these sands do thin as they approach the flanks of the field, and do lose some of their porosity and permeability.

Section D D_1 is a north-south section in the gas cap area from the Carson No. 5 to the Sunray No. 1 Platero.

Q That is actually down toward the southeast part of the field, is it not?

A Yes, it is. We have shown here by the same symbols we had in the other exhibits, this exhibit shows one thing, two things that we didn't have in the other. It shows the absence of the upper sand in the No. 1 Platero and the absence of the second sand in the Shell No. 5 Carson.

I would also like to point out to you the difference in the stratographic position of these two sands in the wells in which they are present. The upper sand, you'll see the belt of porosity

and permeability assumes an arc which I feel represents more or less the relief of the sand bar, while the second sand stratographically climbs the section as we move northward, becoming a little higher in the section as we move northward. Although the dip is to the northeast, the lower sand does not drop in the same relation that the upper sand, because it is structurally higher sand as we move north.

Q Of the 164 micrologs which you studied, how many had microlog separation in the upper sand?

A Of the 164 wells that I studied, I found a total of 138 which showed microlog separation in the upper sand.

Q Then microlog section indicates a continuity of porous and permeable sand, is that correct?

A That is correct.

Q How many, if any, showed no microlog separation?

A I found a total of 26 wells which did not show positive microlog separation.

Q Were the micrologs which you studied well distributed throughout the field, or were they bunched up, leaving large areas or substartial areas which had no micrologs available?

A No, the 164 wells were very well distributed throughout the length and breadth of the field.

Q Did you find any micrologs in the better portion of the field which has been referred to as the fairway, which showed no

separation? A No, I did not.

Q In other words then, is it true that the micrologs which showed no separation were taken from wells located on the flanks of the field where the Lower Gallup thins out, is that correct?

A Yes, that is correct.

Q Now, does your testimony and your exhibits which you have presented down to this point, do they further confirm the continuity which was shown by the electric log cross sections offered by Sunray at the first hearing?

A Yes, I feel that they do.

Q One more question with regard to these wells, on the flanks which have no microlog separation, are all or a part of those wells producing even though they have no microlog separation?

A To my knowledge the wells that are on the flanks of the field, they are productive of oil and have been perforated.

Q To be productive of oil, they have to have some permeability in them, don't they?

A They would have to evidence some.

Q Throughout the main portion or the fairway of this field, have you found the main body of the Lower Gallup to be continuous and permeable and porous without interruption?

A Yes, I have.

Q Then is it therefore your conclusion that the main body of the Lower Gallup formation is a sand body of continuous porosity

and permeability which may thicken and thin throughout some parts of the fairway, is that correct?

A Yes, I think that is evidenced by our cross section, that it isn't continually the same thickness throughout, it does vary.

Q Is it also your conclusion that the lateral edges of the other subsidiary reservoir do not always line up vertically with each other so that wells drilled on the edge of the sand bar can be expected to find erratic sands of fairly low permeability?

A That is correct.

Q Mr. Finfrock, has Sunray Mid-Continent Oil Company recently drilled and tested a well known as the No. 1 Platero, located in the southwest quarter of Section 15, 25 North, 11 West?

A Yes, it has.

Q Did that well produce gas on its initial test?

A Yes, that well produced dry gas at the rate of 566 MCF per day on an 1864 inch choke with a tubing pressure of 840 pounds.

Q On the first test was that a dry gas?

A Yes, it was.

Q Is there anything unusual which might be considered unusual at first blush in this situation?

A Yes, it was at first appearance.

Q Have you prepared a structural map which explains this situation?

A Yes, I have.

Q That map has been identified as Sunray Exhibit 6-R. Will you please proceed to explain it?

(Marked Sunray's Exhibit 6-R, for identification.)

A Sunray Mid-Continent Exhibit 6-R is a structural map on the top of the second sand member in the Lower Gallup formation of the Bisti-Lower Gallup Oil Pool. This map is contoured on an interval of ten feet. We have shown hereon the various wells in the area, near the Platero well, so that we could reconstruct geologically the reason to explain the dry gas test that we had in our Platero well.

As can be seen from these contours, this structure dips into the north and northeast and across the central portion of this map, we find a very definite nosing, on this nosing in a downdip position we find a structural closure within which structure closure we find two wells, the Sunray Mid-Continent No. 1 Platero in the southwest quarter of Section 15 and the Shell 2122 A in the northwest quarter of Section 22.

As can be seen from this interpretation, it is my opinion that when the hydrocarbons were moving into the Lower Gallup sand in this Bisti Field, that this anomaly, this closed anomaly was filled with gas and oil, but there were more hydrocarbons present than could be accounted for by this small structure and it spilled over from this small structure and moved on updip to the updip limit or

shaleout of the sands which afforded the updip trap of this stratographic type field.

We find updip from this Platero area the gas cap area, and we also find updip from the Platero area that there have been completions in these same Lower Gallup sands for oil.

It is our conclusion that with this structural picture that we have here, we can explain the position that although it appears that the Platero well was downdip structurally, that actually it is on a closed high which is higher than many of the producing oil wells in that area.

Q Have you prepared a schematic cross sectional diagram which further explains this situation? A I have.

(Marked Sunray's Exhibit No. 7-R, for identification.)

Q Will you please refer to that schematic diagram which has been marked Sunray Exhibit 7-R, and explain it?

A Sunray Exhibit 7-R is a schematic diagram in the gas cap area of the Bisti-Lower Gallup Oil Pool. Shown hereon in a schematic fashion is an interpretation of the structural map which we have just looked at.

On this diagram we have spotted the Sunray Mid-Continent No. 1 Platero in the small anomaly which is downdip from the major portion of the Bisti Field. In an updip position we have spotted the Sunray Mid-Continent No. 1 Es-Ka-Nel-E-Wood well which was completed as an oil well, which is actually fifteen feet higher

structurally than the No. 1 Platero well, but we feel that this interpretation shows why we would find some gas accumulated though in small volumes below updip oil.

Q Then is it your opinion that the gas which is being produced lower on the structure than oil is being produced from a local pimple or bump on this structure as it dips to the northeast?

A Yes, it is my opinion that this gas was trapped in a local anomaly on this large stratographic feature.

Q Is it further your opinion that this gas that has been so entrapped can not move on upstructure to the main gas body?

A Yes, there's a certain amount of gas that was trapped in this structure that was not able to move on updip, although the major portion did.

Q Then, based upon your studies of this area, Mr. Finfrock, is it your opinion that a gas cap exists, a major gas cap, which is in communication with the oil which is found in the other portions of the reservoir? A That is correct.

Q Now, Mr. Finfrock, have you changed your opinion from the previous hearing, or has it been further confirmed by the additional studies based on this new information, the drilling of new wells and the passage of three months' time?

A Well, my original position has not been changed.

MR. ERREBO: I believe that's all we have from this witness.

MR. PORTER: Anyone have a question of Mr. Finfrock?

Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q Mr. Finfrock, I would just like to ask you a couple of questions about your exhibits. On your cross sections there you apparently have no horizontal scale, is that correct? They're just arbitrarily placed?

A No, they are placed at the same intervals throughout the length of the field. The scale is shown, well, here is the scale shown here in these sections, and then up here we have shown where the wells are located across the sections of the field. They vary from quarter of a mile up to about a three-quarters of a mile.

Q But you have not represented on the cross section other than the diagram, is that right?

A Well, we show the scales as such here with a vertical scale of fifty feet to the inch and there's no scale on the horizontal, they are equally spaced.

Q Likewise you have no vertical control of down either, do you?

A Yes, we have hung these from a correlation point at the top for the Lower Gallup Formation here. They are all hung from the same correlation point electrically. It is an electrical location point.

Q The diagrams don't indicate that, do they?

A Well, we have this same chracteristic across here, and we

come to the same position above it to the tie.

Q You have done that regardless of the depth below --

A (Interrupting) These aren't hung from a subsea datum. They are hung from the Upper Gallup here. These are not subsea.

Q Then you have not attempted to show the relative positions --

A (Interrupting) Structurally.

Q (Continuing) -- structurally at all?

A No.

Q It's more or less an arbitrary arrangement then of these various long pictures both vertically and horizontally?

A We have picked a correlation point to hang each log from regardless of its structural position.

Q Well, your C C_1 would show quite a dip, would it not?

A Yes, it would show a dip in this direction from south to north if we had hung it from a subsea datum, we would take these lines here and they would assume an angle like that.

Q Then your points of microlog separation would not be opposite each other necessarily, would they?

A Opposite each other?

Q From one well to the next they would not be on the same horizontal line?

A No, because we would be connecting the same porous sand in here. If we hung them from a subsea datum the line would be tilted in this manner with the updip sand in a higher position than the

downdip sand, and these correlations would drop as we move northward. It would be the same correlation though.

Q You have arranged them so the lines appear --

A (Interrupting) They are not straight, no, but we have just correlated between the sands as has been shown.

Q Have you shown all the microlog separations in each well? Take for example, on B B_1, Skelly No. 2 Longhart, is there some separation that you haven't shown there, for example?

A Yes, there is. There is separation right at this position here that we have not shown.

Q And the Monsanto No. 1 Frank, is that likewise true?

A I don't believe that I can read from this print whether that is microlog separation or not, but there are, I would say out of the 43 wells that are on these cross sections, I think I counted 6 wells of which we had a position like this in the Skelly Longhart, of which there was a small amount of microlog separation, and we did not attempt to show those microlog separations in these inferior sands.

We are attempting to show that in the main pay sands of the Bisti-Lower Gallup Oil Pool we had this continuity of porosity and permeability.

Q Then there are other productive sands, or at least sands showing microlog separation that you have not attempted to show? You haven't shown them all?

A That is the inferior sands. That is correct.

Q You have testified, I believe, that there was continuous porosity and permeability throughout, but you do not testify on any variations in either one of those factors, do you?

A I believe I stated that we had variable thicknesses of the porous zones within the sands, as can be seen from these sections, that they do vary.

Q You certainly recognize that there is varying porosity and permeability throughout the general sands that you speak of?

A It does vary, yes.

Q The information with reference to the existence of the gas wells, I believe you mentioned that the sands shale out?

A Yes, we have an updip shaleout of the lower sand, I mean of the sands of the Lower Gallup Formation, which afford the updip trap for the sole stratographic feature known in the Lower Gallup Pool.

Q Would you expect to encounter similar shaleout in other portions of the pool?

A It is continuous from one end of the pool to the other. The sands do shale out.

Q Why did you, on 6-R, Mr. Finfrock, why did you prepare that on the top of the second sand member?

A Because that was the sand that was encountered in our No. 1 Platero well, and was the sand that came in for a dry gas test to begin with, and I wanted to find an explanation for it, and I had to

map on the productive horizon to do so.

MR. PORTER: Anyone else have a question of Mr. Finfrock? Mr. Malone.

MR. MALONE: Ross Malone, Atwood and Malone of Roswell, New Mexico for Gulf Oil Corporation. I would like to enter the appearance of Booth Kellough of Denver, Colorado for Gulf Oil Corporation.

By MR. MALONE:

Q At the time that you testified in the case previously, Mr. Finfrock, was there any doubt in your mind as to the conclusions to be drawn from the evidence which you presented?

A No, I thought from the evidence, you mean presented geological testimony?

Q Yes, geological evidence.

A As far as I could see from the geologic standpoint, and not taking in the other aspects of the case, I thought that we had shown the continuity of the Lower Gallup Formation through the field.

Q The further study which you have made since that hearing has merely further strengthened your conclusion in that regard?

A It has my personal conclusion, yes.

Q Your conclusions now are actually identical with those to which you testified here on the original hearing, are they not?

A I would say not exactly identical, no.

Q Would you say substantially the same?

A Substantially the same, yes.

Q You have limited your study of the microlog separation shown by these logs to the two principal members as you define them in this Bisti-Lower Gallup Pool, have you not?

A I studied the entire area of the Lower Gallup Formation. We have limited our exhibits to the main productive zones of the Bisti-Lower Gallup.

Q So that for instance on a number of those logs where perforations are shown opposite which you have not indicated microlog separation, there are other areas of permeability and porosity?

A As I mentioned, I think there were six wells out of the forty-three on these sections that we were able to see a positive microlog separation, and in those same zones in the other wells there was no evidence of microlog separation.

Q Your exhibits do not indicate any continuity or communication as between those zones and the members which you have portrayed?

A No, as can be seen from these exhibits, you are not able to show from the positive microlog separation a vertical connection, is that your question?

Q Yes. Are there other areas in the pool in which this condition exists in which oil wells were found apparently upstructure from gas wells in addition to the area to which you testified?

A To my knowledge this area in 25 North, 11 West is the only area that has come to my attention that this does exist.

Q If there are other areas, would you account for them in the same way you have accounted for this one?

A If there are such areas I would want to make a geologic study of them before I would attempt an answer. I had to do that in this case.

Q You wouldn't account for them necessarily in the same way?

A No, but I would say this, that where it exists in one place it's possible that the same situation could exist again.

Q If I may invite your attention for just a minute to Exhibit 5-R and to the Shell No. 21-22 Government A shown on there.

A Yes. That is this well here.

Q In the upper member that is shown there I notice that you show what appears to be a separation of that member into an upper and lower segment by a loss of permeability, I assume?

A That is correct.

Q Now, as you proceed toward D, you show that loss of porosity or permeability? A To the right?

Q No, that is D_1.

A Towards D, I see.

Q As you proceed towards D you show that loss of permeability to terminate and the two segments to again become one, so that the lower segment would have complete communication with the upper members shown in the Magnolia well? A That's right.

Q How do you reach the conclusion that there is a continuous

area of porosity and permeability there rather than that there is a pinchout of it between the Shell and Magnolia well?

A I find that in the Shell well, as we have shown, there is about a one and a half feet, it looks like, of known positive microlog separation, and we find in the Magnolia well, we have no such separation, and this point is an arbitrary point, I have picked it halfway between, it could be here, it could be there, we don't know where the point, the juncture is. It is a common geologic practice when you are dealing with an unknown, to put it at a point halfway between the two knowns.

Q Would it be an equally acceptable conclusion, in your opinion, that the lower segment pinched out between those two wells so that there would be no communication between it and the separation in the Magnolia well?

A I would have no information to state what actually did happen to that lower portion of that sand.

Q So that it is --

A (Interrupting) This is my interpretation, my geologic interpretation of the facts as we have them.

Q But you don't have information by which you can actually substantiate the way that is portrayed on your exhibit, do you?

A Well, looking at it in its plain diagram, we do not. Possibly taking other wells in the vicinity and studying the whole picture, it might be able to prove another thing, I don't know.

Q It would also be possible though, would it not, that that, if there is a pinchout in that lower segment, that that would be one of the erratic sands that would not have communication with the rest of the member?

A The sand itself is present electrically all the way through there. We're dealing here with measured positive microlog separation, but the sand itself I have no doubt that it is not present between the well.

Q And you would not be able to say with certainty that communication would exist through that, would you?

A Well, the microlog tool I would say is one of the more accurate electrical tools in the industry, but it does not measure down to zero permeability, and it's possible that though we do show here a zero permeability from reading, not zero permeability, but non permeable streak there, that if we had core analysis through the section we would possibly show low order permeability.

Q So that the conclusion which you have portrayed with reference to the continuous nature of that lower segment, is the conclusion that you draw from it, but one which there would be a difference of opinion on?

A Yes, that is geology.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question of the witness?

MR. BUSHNELL: H. D. Bushnell, attorney with Amerada.

By MR. BUSHNELL:

Q Mr. Finfrock, I believe you stated this morning that the hydrocarbons in the Lower Gallup sand migrated into the sand, is that correct?

A Yes. There will be some migration and some inside too, hydrocarbons.

Q If that's true, would it not necessarily follow that this reservoir would be one common source in your opinion?

A I think it is.

MR. BUSHNELL: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Utz.

By MR. UTZ:

Q Mr. Finfrock, I'm not sure that I understood for sure whether or not you interpreted the gas wells in the upstructure from your Platero No. 1 to be a gas cap.

A Yes, it is our opinion it is a gas cap.

Q Then, referring to your Exhibit D D_1 --

A Which exhibit?

Q D D_1. A D D_1, yes.

Q Between the Magnolia No. 1 Ah-Nus-Bah and the Shell No. 21-22 Government A, would you say that there was a low trough in there which separated the Platero and your Shell 21-22 from the Magnolia Ah-Nus-Bah?

A Yes, that is my interpretation.

Q Is it your opinion that some volumetric limitations should be put on those gas wells in the gas cap?

A I'm not sure I understand your question.

Q Well, something --

A (Interrupting) You mean volumetric is --

MR. ERREBO: (Interrupting) If the Commission please, this gentleman is a geologist. We will have an engineer on the stand who will discuss the gas cap and make the recommendation, I believe, you are seeking.

MR. PORTER: Would you refer your question to that witness?

MR. UTZ: Yes, sir, I will. That's all I have.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Finfrock, was the Sunray No. 1 Platero well originally a gas well and is now an oil well?

A Yes. I will be glad to read here a short dissertation on that well. This well was perforated December 5, 1957, in the Lower Gallup sand from 4852 to 4903, on the twenty-four hour test with a 1864 inch choke the well flowed at a rate of 566 MCF gas per day, with a tubing pressure of 840 pounds.

After that test the well was shut in for a period of nine days. On a test of the same perforation on December 14, 1957, the No. 1 Platero flowed oil at a rate of 73.24 barrels in twenty-four hours

on a three-quarters inch choke. Tubing pressure had dropped to 280 pounds, casing pressure was 500 pounds, and the gas-oil ratio 34,000 to 1.

Q What has happened there, has the gas in that nose or that little pimple been depleted and the oil is moved upstructure?

A I think that that would answer a major portion of the question, that we have a small gas cap in this area and when we initially tested it we tested the dry gas and when it was, the well was perforated through the entire sand and which was through the gas in the oil column, when the well was opened back up again we got our liquid hydrocarbons.

Q Which had moved up the structure while the well was shut in?

A No, I believe they had been there to begin with, and we had as I might say it, I might be getting into reservoir engineering over my head, as I see it we had a little gas cap above this oil and in our initial test we got the dry gas.

Q You don't think that the perforations penetrated oil that was in place originally?

MR. ERREBO: If I might interrupt you, Mr. Nutter. We will have an engineering witness later on that I think can give you quicker answers.

MR. NUTTER: That is fine. We will defer that line of questioning. No further questions.

MR. PORTER: Anyone else have a question.

MR. McGOWAN: I have one question. James McGowan, Sinclair Oil and Gas Company.

By MR. McGOWAN:

Q Mr. Finfrock, the Definition 46 of the Commission Rules and Regulations reads in part as follows: I quote: "Pool means any underground reservoir containing a common accumulation of crude petroleum oil or natural gas or both". Is it your opinion that the Bisti-Lower Gallup Pool constitutes such a common accumulation as is referred to here in this definition?

A Yes, I do.

MR. McGOWAN: Thank you.

MR. GRENIER: A. S. Grenier, representing Southern Union Gas Company.

By MR. GRENIER:

Q Mr. Finfrock, in response to a question by Mr. Seth, I believe you stated that although this was in your opinion a continuous reservoir, at least as to these two main members there, there were some variations as to porosity and permeability within the pool area? A Yes.

Q Are you familiar with any producing pool or field which does have completely homogenous porosity and permeability?

A No, I am not.

Q In other words, this variant characteristic of porosity and permeability is typical of any continuous formation, and they're

never exactly the same all the way through?

A I would say that would be the natural result, yes.

MR. GRENIER: Thank you.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. ERREBO: I have several questions on redirect examination.

MR. PORTER: Go ahead.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q With regard to the lower zones which you did not show, Mr. Finfrock, on your cross sectional exhibits, those actually from your study, are those not rather negligible insofar as the major part of the oil accumulation in this reservoir is concerned?

A Yes, I think they are.

Q That is the reason you did not show them?

A Yes.

Q With regard to the way in which you ranged the logs for correlation and interpretation, is that not the generally accepted way among geologists of ranging logs on cross sections for interpretation?

A There are two ways, you can range them this way and hanging from subsurface to get a structural picture. I am not trying to define structure here. It is an accepted way of making cross

sections.

Q I believe you previously testified, have you not, that the porosity and permeability varies from the center to the edge of the field? A Yes.

Q So that therefore our cross section D to D_1 in going from the Shell No. 21-22 Government A to the Magnolia No. 1 Ah-Nus-Bah, you would not expect the formation to thin or to pinch out, would you?

A I wouldn't normally.

Q That would be contrary to the trend which has been observed throughout the entire field? A That is true.

Q In further regard to that point, have you found any well in the main portion of this field that has not had either, have you found any well in which either the upper or the lower sand pinched out once that sands continuity has been established?

A Would you repeat the question, please?

Q In the northwest portion of the field, the upper sand is shown to be continuous throughout? A That is correct.

Q In that portion of the field have you found any well in which the upper sands pinched out?

A Not except on the flanks.

Q Except on the flanks? A That is correct.

Q And in the southeast part of the field have you found any well in which either the first or the second sand is pinched out?

A I think the situation is the same.

MR. ERREBO: I believe that's all.

MR. PORTER: Anyone else have a question?

MR. ERREBO: If it please the Commission, at this time --

Q Mr. Finfrock, the exhibits were prepared by you, were they not?

A Yes, sir, they were.

Q Or under your supervision.

MR. ERREBO: If it please the Commission, we would like to offer in evidence Exhibits 1-R through 7-R.

MR. PORTER: Without objection these exhibits will be admitted to the record. The witness may be excused.

(Witness excused.)

We will take a short recess.

(Recess.)

MR. PORTER: The hearing will come to order, please. Mr. Errebo, will you proceed with your next witness?

MR. ERREBO: If the Commission please, we would like at this time to call Mr. Brinkley as our next witness.

(Witness sworn.)

T. W. BRINKLEY

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

DIRECT EXAMINATION

By MR. ERREBO:

Q Will you state your name, please?

A My name is T. W. Brinkley.

Q By whom are you employed and where, Mr. Brinkley?

A I'm employed by Sunray Mid-Continent Oil Company in Tulsa.

Q And you are Chief Reservoir Engineer for Sunray?

A That is correct.

Q And you testified as a Reservoir Engineer at the original hearing in this matter, did you not? A That is correct.

Q Since this original hearing have you made additional studies of this pool, taking into consideration new information which you obtained? A Yes, I have.

Q Does this new information that you have obtained consist primarily of bottomhole pressure data in the area surrounding the pilot area of the experimental LPG project in this field?

A Yes. Considerable additional information is now available in the pilot area that was not available at the last hearing.

Q Have you prepared a plat showing this data which has been accumulated since the last hearing? A Yes, I have.

(Marked Sunray's Exhibit 8-R, for identification.)

Q That plat has been identified as Exhibit 8-R. Will you please go to that plat on the wall and explain what is shown on it?

A Exhibit 8-R, which we have a large copy of, I believe you will want to mark your exhibit. Exhibit 8-R is a pilot area map,

the pilot area is shown with heavy dashed lines at the intersection of Township 25, 26 North and Range 12 and 13 West. This pilot area, for your convenience, is located in a previous exhibit in the northwest portion of the field where I am pointing. The pilot area consists of four oil wells, Sunray Federal 2-C located in the southwest of Section 31, Phillips Hospah No. 1-A located in the southeast portion of Section 36, British American Marye No. 1 located in the northeast portion of Section 1 and Sunray Federal No. 1 located in the northwest portion of Section 6.

In the center of these four oil wells we have an injection well. We have shown in the four sections, Section 31, 36, 1 and 6, all of the wells that have been drilled in those sections. In addition to showing the wells we have listed measured bottom hole pressures, also the date when the pressures were run and the type of instrument we used to measure the pressure.

As an example, British American Marye No. 1, located in the northeast portion of Section 1, we showed five pressure measurements. The first pressure measurement was taken in October 23, 1956. The B indicates a bomb measurement, the 1252 represents the reservoir pressure at an elevation of plus 1300 feet.

The next pressure was August 15, 1957, S standing for sonolog. That is an echo device which we used to estimate the reservoir pressure and the pressure on that date was 1203 pounds. The next pressure was in September, the 4th, 1957. Again a sonolog pressure

and the value at plus 1300 feet was 1298 pounds.

October 1, 1957 is the next pressure, again with a sonolog, and the measured bottom hole pressure was 1292 pounds. On November the 6th, 1957, sonolog method indicated a pressure of 1386 pounds. It is quite significant with this information that all notice between the first and second pressures that there is a decrease in reservoir pressure over the period of roughly ten months. The decrease in pressure is 49 pounds. That means that the natural decline in reservoir pressure for the ten-month period prior to the injection of LPG and gas amounted to 49 pounds.

It is significant too that the third pressure on September 4, 1957 had shown an increase of 95 pounds over the preceding pressure. Further, the October 1, 1957 pressure further substantiates the higher pressure than the reservoir pressure immediately prior to the injection of LPG. Also, the last pressure, November 6, 1957, shows the pressure to be 1386, still greater than the pressure immediately prior to injection of LPG.

This is a pressure reversal from the normal decline experienced by this well as a result of injecting LPG and gas.

Q Mr. Brinkley, could I ask you one question at that point? How long was it between the second and third pressure maintenance, that was roughly three weeks there, was it not?

A Slightly less than three weeks.

Q Was that not a significant increase in such a short period

of time? A That is correct.

Q And you also have quite a large increase between the first of October and the sixth of November, do you not?

A That is correct.

Q And was the decrease in pressure that occurred from October the 23rd of 1956 to August the 15th, 1957, a significantly large decrease considering the amount of oil which had been withdrawn from that reservoir and from thát well over that period of time?

A That is correct.

Q Thank you.

A Let's consider another well. Sunray Mid-Continent No. 5 Federal which is almost a mile south of the gas injection well. Again we find the same characteristics on October 22, 1957, as you were, 1956 with a bomb measurement, we measured the reservoir pressure of 1446 pounds. On April the 5th, 1957 again with a bomb we measured the reservoir pressure to be 1343. The third pressure taken in October 7, 1957, again with a bomb, we found the pressure to be 1412 pounds.

Again we find the normal decline in pressure during the period prior to LPG and gas injection and the characteristic pressure reversal, after the injection of fluids, that same characteristic is observed in other wells in this area.

Generally we expect a higher pressure reversal or pressure benefit in the wells nearer the injection well, and they occur

earlier than outlying wells. In any event, we can construct possibly a line around the injection well in a radial fashion, indicating that fluids have moved away from the injecting well, and the reason we know the fluids have moved is because of this pressure reversal effect that we have noted.

Now, this fluid movement confirms sand continuity in this immediate area consistent with the previous exhibit presented by Mr. Finfrock. I believe that's all.

Q Will you please refer to your Exhibit No. 9-R, Mr. Brinkley, and identify and explain what it shows?

(Marked Sunray's Exhibit 9-R, for identification.)

A Again I would suggest that you number your exhibit; Exhibit 9-R illustrates the basic information that was presented on Exhibit 8-R, only we show it in a chronological fashion. As an example, the red line as shown on our exhibit according to the date of August 21, 1957 which corresponds to the scale at the bottom, represents the date at which we started the injection of LPG. At that time you will notice that the reservoir pressure in the pilot area based on the factual data presented on Exhibit 8-R was in the range of 1100 pounds to roughly 1350 pounds.

I invite your attention also to the date of October, 1956, when the reservoir pressure was the range of 1200 pounds to 1400 pounds. The trend shown by the data for those two periods indicates

the normal decline experienced in the pilot area prior to the injection of LPG. That decline averages approximately a hundred pounds per square inch for the ten-month period. This trend is defined or illustrated by two heavy lines, the extrapolation of that defined trend to periods past the injection of our LPG indicates that at the present time we would have suffered additional pressure decline as substantiated by later pressures in outlying wells.

The portion of the curve to the right of this red line and above the probable extension of the pressure decline indicates the pressure restoration or the pressure reversal that we have experienced in the pilot area by the injection of LPG and gas.

It is significant that the pressure has remained stable since the start of gas injection. Moreover, it has been restored to the value that we observed ten months before the pilot. In addition to that we have withdrawn high oil rates out of the four oil wells.

You will notice Phillips Hospah 1-B and 2-A, 1-B, 2-A on Exhibit 8-R have shown the pressure increase, but at a later date as we would expect.

Further, every well in this area with the exception of No. 9, an outlying well, has experienced a pressure reversal due to the movement of fluids through the sand, supporting continuity.

Finally, the benefit that we have gained in the pilot area by pressure buildup has amounted to approximately 200 pounds, had we not started the project, and that benefit will continue the longer

the pilot project is in operation. I believe that pretty well covers the significant items.

Q The results of these tests then show, do they not, that wells almost a mile away from injection well have already shown pressure increases as a result of the injection of LPG and gas into the injection well, is that not correct? A That is correct.

Q Mr. Brinkley, have you calculated the amount of acreage which has been affected by this injection well, and will you state how much it is?

A The circle that we have drawn or indicated in the pilot area as being affected by fluid movement through a continuous sand, taking that radius of 4500 feet, the distance from the injection well to the No. 5 would circumscribe an area approximating 1500 acres.

Q Then is it your opinion, based on this information, that one well will drain some 1500 acres in this field?

A The evidence that we have here indicates that it will drain an area approximating 1500 acres.

Q Your Exhibit 9-R then shows a decrease in pressure which you say is normal for this reservoir up to the point at which injection was commenced in the pilot well, is that right?

A That is correct.

Q You say this is normal. You mean it is normal for a reservoir of this low oil in place originally?

A The pressure decline on withdrawals is normal in a solution drive type mechanism. But the rate of pressure decline with the small volumes that have been removed here is abnormally high.

Q Then actually the second portion of your curve shows a rather sharp increase over a short period of time after the commencement of injection of LPG and gas into this well?

A This shows a rapid increase in pressure occurring shortly after the injection of our LPG, and that same characteristic is repeated and will repeat itself as we go further and further away from the injection well.

Q Would you then say that this LPG injection program would be just as effective on 80 acre spacing as on 40 acre spacing?

A Absolutely.

Q That being the case, are 40 acre wells needless wells insofar as secondary recovery by LPG injection and gas injection into this field are concerned?

A Forty acres are a waste. They are not needed in this process.

Q Now, Mr. Brinkley, in order that we may have a little closer look at this matter of efficient and economical drainage, will you please state what in your opinion is one of the prime requisites for such drainage?

A The first requisite for efficient and economical drainage is pressure interference.

Q What would you say would be a second requisite for an efficient and economical drainage?

A The second requisite would be proper permeability and viscosity of the oil.

Q And what would be another requisite for an efficient and economical drainage?

A Finally, sand continuity.

Q Pressure differentials which you have stated are the first requisite for drainage have been found to exist as far as one mile from the injection well, have they not?

A That is correct.

Q As to your next requisite for efficient and economical drainage, is the ability of fluids to flow, which requires fluids of proper viscosity and reservoir rocks of sufficient permeability to permit such flow important?

A I should like to invite your attention to the fact that Well 2-C is in a thin sand section, it is not shown here, but as previously testified to, also of inferior rock characteristics. The main body of the pool lies in here, and of course, this would represent one of the edge wells where you encounter thin sand and poor permeability, yet we detected pressure interference due to the fluid movement.

Moreover, Well No. 5, a mile away approximately, also represents a south flank well where the rock properties are inferior and thin,

Yet again we detect the pressure reversal due to fluid movement from the injection of our LPG and gas clear through this area and being felt down here.

Q Then, as for your third requisite of sand continuity, that has also been established then by the pressure tests has it not?

A Obviously since we have detected pressure reversals it has been a result of fluid movement, and that movement has had to move from the injection well past these wells through the intervening space where we had no control or where it was questionable on our cross sections to get to these outlying wells. So we have to accept the fact that the fluid has moved through those areas in order to detect this pressure reversal.

Q Then I believe you state, Mr. Brinkley, that throughout the general pilot area that you have shown, there is some variation of permeability, but that variation of permeability then in your opinion will not prevent adequate drainage and proper and efficient drainage of this area because of the pressure differential you observed?

A That is correct.

Q And the influence of the other requisites that you stated as being necessary for efficient and economical drainage?

A That is correct.

Q Does this further confirm the position which you took with regard to drainage in the original hearing?

A That is correct.

Q In your work as a reservoir engineer, Mr. Brinkley, do you have frequent occasion to make use of micrologs?

A That is correct.

Q Microlog separation indicates a permeability of rock formation which is capable of allowing the passage of fluids and transmitting pressures? A Yes.

Q You heard Mr. Finfrock testify, did you not, that microlog separation, indicating the presence of permeability, has been found in approximately 164 of 187 wells? A That is correct.

Q That have been drilled? A That is correct.

Q Are you in agreement with previous testimony in these two hearings that this reservoir is similar in its general characteristic throughout the area of this field?

A That is correct.

Q That being the case, is it your opinion that the results obtained in the pilot area could be obtained throughout the rest of this field? A That is correct.

Q Is it your opinion that one well located in any part of this field where sand is developed will drain it in excess of 80 acres efficiently and economically? A That is my opinion.

Q Are you in agreement with Mr. Finfrock's testimony that gas is found in this, found in structurally higher locations?

A That is correct.

Q Are you also in agreement with his explanation of the

occurrence of gas at a lower structural level than oil?

A Yes, I am. I might elaborate on that a little bit. I am satisfied that there is no question among we people that gas is found in structurally high positions. Furthermore, the structural configuration forming, if you will, an apex as you go down the flanks, you can encounter irregular highs, you might call secondary highs, which they themselves can trap gas in the high locations.

I have observed this thing in a number of stratographic traps, solution gas drive type reservoirs, and they are secondary gas accumulations along the flanks of a typical gas cap. It is not at all unusual as far as I am concerned.

Q Then is it your opinion that the gas cap in this reservoir is in communication with the down structure of oil?

A It is my opinion.

Q At the last hearing there was some question raised as to the status of the Shell Carson No. 5 located in Section 27 inasmuch as there was a report that this well had produced highly and it is the highest well structurally in the field at least at that time. Have you had opportunity to give some study to this matter and to obtain some additional information on this well which will enable you to explain this situation?

A Yes. The records will reflect that Shell Carson Unit No. 5, located in the southeast quarter of Section 27, 25 North, 11 West, and structurally in the gas cap, is a gas well. The records show

that the well was fractured with 80,430 gallons of oil, and the only oil produced has been a part of this fract oil.

Q In other words then, this well has produced no reservoir oil?

A That is correct.

Q Then would you say that any inferences previously drawn with regard to the apparent production of reservoir oil from this well are at this time not valid in view of this information?

A I believe they were presented by misinformation and are not valid.

Q Mr. Brinkley, have you made a study of the Pedigrew-Tocito Pool, located in the State of New Mexico?

A Yes, I have.

Q How do the reservoir conditions and the structure of this pool compare with those found in the Bisti Field?

A Both Bisti and the Pedigrew-Tocito Pool are quite similar. Both are stratographic traps. The core analyses are very similar, the electric logs when layed side by side are very similar, the reservoir fluids are similar with one exception, the Tocito Pool has a little better quality fluid characteristic.

The reservoir pressures at Tocito are only approximately 600 pounds greater than at Bisti, and that is due to an additional 1600 feet of depth. Both reservoirs are solution gas drive type mechanisms, both reservoirs have identified a gas cap. I believe those are the significant points, high lights at this time.

Q Do you know what spacing the Commission has adopted for that field?

A The order as issued, approved 80 acre spacing. However, out of the 18 wells drilled, 16 of them are on 160 acre allocations.

Q This field has been produced for a period of approximately five years since this spacing order was adopted. Do you have any information as to what has been the drainage efficiency which has been observed in this field under this pattern of 80 acre spacing or greater which has been adopted?

A We have two observations regarding drainage. The first observation is that of the first nine wells, as of the first ten wells drilled, the first well completed indicated an initial reservoir pressure of 2197 pounds on the date of July 26, 1951. The following nine completions each identified a completion reservoir pressure lower than the original completion reservoir pressure by 76 to as much as 193 pounds per square inch, bearing in mind that these nine later completions were on spacing considerably greater than 80 acres.

This is the first indication of interference and drainage. The second observation of drainage efficiency is revealed in the ultimate recovery from the reservoir. The estimated primary recovery for the period before the pressure maintenance went into effect permits the conclusion as to the natural depletion recovery on this wide spacing. That recovery is of the order of approximately 100 barrels

per acre foot consistent with what was predicted there as well as Bisti. Therefor I concluded that the spacing at Tocito, being considerably greater than 80 acres, permits me to conclude along with the similarity of the two reservoirs and their fluids, that we can efficiently and effectively deplete and drain on 80 acre spacing.

Q It is your statement then, based on the efficiency of drainage that has occurred in the Tocito and the similarity of conditions in this pool, the Bisti, that you can consider that a well on 80 acres can efficiently, economically drain 80 acres in this pool, the Bisti Pool?

A That is correct.

Q Then with the testimony that you have given here this morning, does it or does it not confirm the testimony and opinions which you held at the previous hearing before the additional studies were made?

A This additional work that we have done, using additional reservoir pressures et cetera, confirms my original conclusion, and that conclusion was that we can efficiently and effectively drain the Bisti-Lower Gallup reservoir on 80 acre spacing.

Q Do you believe that waste will occur if this application is not granted? A Yes.

Q Do you recommend that the rules which you presented at the original hearing be adopted by this Commission?

A My recommendation is consistent with the recommendation presented at the previous hearing, namely that wells will be located in diagonal 40's in 160 acre tracts, forming 80 acre proration units.

Two, wells will be located a minimum of 330 feet from the 40 acre lines. Three, allowable to be based on 80 acre proration unit. Four, limiting gas-oil ratio of 2,000 cubic feet per barrel.

Five, semi-annual survey for gas-oil ratio and reservoir pressures.

Q Were Exhibits 8-R and 9-R which you presented here this morning, prepared by you or under your supervision?

A They were prepared by me or under my supervision.

MR. ERREBO: We would like at this time to offer them in evidence.

MR. PORTER: Any objection to the admission of the Exhibits 8-R and 9-R? They will be admitted. Does anyone have a question of Mr. Brinkley?

MR. SETH: If I may, I would like to ask Mr. Brinkley three or four questions.

CROSS EXAMINATION

By MR. SETH:

Q Referring to 8-R, Mr. Brinkley, doesn't the data on that map show some considerable pressure differentials between adjacent wells, referring to some of the more recent tests, does it or does it not show that? A Yes.

Q It does? A Yes.

Q For example, on the SDX wells 5 and 6, does that show a considerable pressure between those two wells from time to time?

A Yes.

Q Have you prepared any isobaric map showing this situation?

A No, I have not.

Q If one were prepared, it would show a highly irregular picture, would it not? A That is correct.

Q Now, how would you explain that in view of the testimony of this freedom of pressure communication? Why is it different, why is it irregular?

A Well, we expect this sort of thing like you mentioned, irregular pressure among wells, and it's as I say, what we expect due to the variance in sand quality. The quality varies in this well and the fluid, of course, will follow the path of least resistance.

Q Well, we are speaking just about pressure communication?

A Yes.

Q That shows an irregular pattern, does it not?

A That is correct.

Q How did it happen that this particular area was picked for the pilot project in the first instance?

A We were interested in getting our results of evaluation of this new recovery method as soon as possible. We also wanted to

share with other operators. We searched around for an area where the wells were clustered so that we could get our results quickly rather than selfishly going to our own lease where we had a pattern on wide spacing, yet sacrifice a year or two's time for the results.

We searched and we found the one area in this part of the field where three operators could cooperatively join, pool, their talent, experience and so forth and drill an input well and share and share alike on this new venture.

We all recognized at that time that the salvation for this poor type field would depend on some type of secondary method.

Q You don't need to sell us on the program. We are for it. I just wondered why you picked this area. You certainly didn't pick one where you expected to find poor communication or poor sands, did you?

A Frankly, we were after the close spacing wells on this pilot test to get our results quickly. We realized at the time that this was an inferior well, and might offer problems, but we didn't know enough about the method to know what kind of problems we would get into. We know much more about it now by having that poor quality sand in our pilot area, and I think it is to our advantage that we have looked into this situation.

Q Well, you have certainly picked an area where you expected to encounter good or better communication in the sands certainly?

A Correct.

Q Because you wanted the quick result?

A That is correct.

Q Your testimony as to the facts and the testimony today has been confined to this particular area, and from that you have expressed your opinions as to the entire field?

A Yes.

Q Do you feel confident that from this localized area in the better part of the field you can extrapolate the results over the entire field? A Yes, sir.

Q You have no misgivings on that point at all, is that right?

A We have learned a lot in this past four or five months, and we are quite confident that we can apply these results to the other developed portions of the reservoir.

Q And you would testify that one well in any reasonably good part of the field would drain 1500 acres, is that correct?

A No, I didn't mean to infer that at all. I said the evidence we have here indicates that I have testified that one well drilled on 80 acres would efficiently and effectively drain that 80 acre tract.

Q I thought you testified that one well would drain 1500 acres, that is what I understood. If that is not correct, I was mistaken.

A I will erase my statement, I did say that. I think I prefaced that based on this information that one well will drain 1500 acres. I stand corrected.

Q In view of what you have now testified that one well in any reasonably good part of the developed area would drain 1500 acres--

A Yes, sir.

Q You are basing that testimony primarily on the pressure communication which you have found in this area that you have these pressure interference tests, is that correct?

A That is correct.

Q In this area are the pressures above or below the bubble point?

A In the pilot area right now 1350 pounds are above the bubble point.

Q What were the compressibility factors, what did you use or what would you use here? A For the oil?

A Yes.

A I don't recall precisely what the number is, but it is probably one times ten minus five volumes per delta PSI reservoir conditions.

Q The compressibility would be less in these fluids where the pressures, we haven't reached the bubble point in areas where you have, is that correct? A I didn't follow you

Q Does your compressibility vary whether it is above or below the bubble point? A Yes.

Q Well, then, are there other portions of the field where it is below the bubble point?

A I believe it would be best if I answer this way --

Q (Interrupting) Perhaps you could answer yes or no and then explain the answer.

A Well, I can't give just a one answer because of the variance.

Q Well, go ahead then.

A I will state this, the Bisti-Lower Gallup reservoir contains oil and gas, at the gas-oil interface the reservoir oil is saturated as we proceed down structural elevations lower than gas-oil contact, we get into more and more under saturated oil to the point where the lowest elevation or the lowest structural elevation would be the most undersaturated oil.

Q Your data and your conclusions based on this data would make a difference whether you have taken it in an area that is below or above the bubble point, would it not, Mr. Brinkley?

A What are you referring to?

MR. SETH: Would you read the question to him?

REPORTER: Reading: Your data and your conclusions based on this data would make a difference whether you have taken it in an area that is below or above the bubble point, would it not, Mr. Brinkley?

A I take it that you are referring to the pressure interference?

Q Yes.

A Yes, if you moved toward the gas cap, then the effect of pressure interference will become minimized due to the difference in

compressibility of your fluid.

Q That would be true in any area where the pressures are below the bubble point, is that not right, not only gas cap areas, but any other?

A That would be true if you have sufficient gas. The effect on your pressure interference is directly proportional to the amount of gas that you have, hence they would be more felt in a gas cap area than in the undersaturated area.

Q That is what I was wondering. You have wells of your own with pressure on the order of three or four hundred pounds, do you not?

A I don't believe they are that low. We have some 700 pounds.

Q Then there are, certainly are wells that you know of within the area that are below the bubble point?

A Yes. Yes, in fact the pilot area is below the bubble point, or would have been --

Q (Interrupting) It is not now?

A These surrounding areas down here may be.

Q You say may be. Are they or are they not?

A Yes, this well is low.

Q Now, the cumulative withdrawals have not been large from the area that you have discussed here, have they? Do you have the information on that?

A They vary from well to well. I do have the data if you would

like to go through them well by well.

Q No, I wouldn't like to do that. Can you characterize them as being either large or small or medium, give us the high and the low? That will give us an idea.

A They vary from possibly the order of 2,000 barrels to possibly the order of 30,000 barrels.

Q That would be an estimate on the spread?

A That would be the spread, yes.

Q Just one more question. We note you don't have any pressures on your 2-C well which is within the pilot flood. Why is that? Recent pressures?

A Original pressures.

Q Recent pressures?

A Yes. We ran one just before we came out here and I got the data just in the last few hours. I have it right here. C-2 on forty-eight hour shutin has a casing pressure of 850 pounds and the reservoir pressure was 1389 pounds. 1389 would put it some place in here.

Q Is that a bomb test?

A No, that is an echometer test.

Q How about the British American Marye No. 1? Do you have a December pressure on that?

A No, the last data I had was December 6.

MR. PORTER: Anyone else have a question of Mr. Brinkley?

Mr. Malone.

MR. MALONE: Ross Malone, with Gulf.

By MR. MALONE:

Q Mr. Brinkley, do you have any recent pressures on the Federal 5 and 6 in Section 6?

A No, sir, that's the last data I have.

Q The October pressures are the last ones that you have?

A Yes, sir, that is the last ones I had, yes.

Q The last two pressures on those two wells indicated that the pressure was going up, did they not?

A That is correct.

Q And on the No. 4 well which is an offset, the pressure is going down in the last two, would it not?

A That is correct.

Q You don't know what the December pressures would show on 5 and 6?

A No, sir. We would have to measure it.

Q Your cross section indicates that the injection of gas is being made into a single sand member in the injection well, does it not?

A That is correct.

Q That single sand member condition is not uniform all over the pool, is it?

A No, it is not.

MR. MALONE: That is all.

MR. PORTER: Anyone else have a question of Mr. Brinkley? Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, I believe in answer to Mr. Malone's question you said that the pressure information reflected a single sand member?

A I don't believe he asked that.

Q Well, I'm asking you that then now. Could not this same pressure information, this communication be shown if a single sand member is common to all these wells? A Yes.

Q Then it would not necessarily follow that all of these wells would have every sand member present in the Bisti-Lower Gallup Oil Pool?

A I don't know whether I understand your full statement there.

Q Does the fact that there is communication indicated as a result of your pressures also indicate that the various sand members of the stringer of sands that have been testified to that are contained in the Bisti-Lower Gallup trend would necessarily be present in all the wells shown on your Exhibit 8-R?

A We are injecting into the upper member, and that is the member that is being pressured up, and that is what we have detected in these adjacent wells, and the movement of fluid through the upper member and going over to the adjacent wells, I mean that movement has caused the pressure reversal.

Q This pressure reversal is no indication whatsoever that every stringer in the Lower Bisti Gallup trend is present in every well on your Exhibit 8-R, is it? A No.

Q I believe you testified that it was your opinion, as a result of this information, that one well would adequately and efficiently drain 80 acres? A Yes.

Q Now, tell me, Mr. Brinkley, if a well, any one of the wells on Exhibit 8-R failed to penetrate one of the lesser members, or failed to penetrate any trend or any stringer in the Lower Bisti trend, it would not be possible for that well to drain that particular trend, would it?

A You are speaking of the lower member?

Q Of any member if it failed to penetrate it, it couldn't drain it, could it?

A It is my opinion that the bulk of the reserves is contained in the upper member.

Q Mr. Brinkley, would you please answer my question? If the well --

A (Interrupting) I would like to have it repeated again.

Q If the well does not penetrate a given sand member, it cannot drain that member, can it?

A If the sand member is penetrated?.

Q I say, if it does not penetrate it, it cannot drain it?

A Not that well.

Q Maybe the question is so ridiculous you refuse to answer?

A Not that well. That is correct.

Q Then this information does not conclusively show that a well drilled on 80 acre spacing pattern would drain all of the sand members in the Lower Bisti trend, whether they are important or unimportant, in their opinion it doesn't prove that it would drain all of them?

A That is correct.

Q On primary recovery, Mr. Brinkley, what is the effect on the pressure decline, the normal pressure decline when a well is shut in?

A The pressure decline permits a buildup in gas saturation.

Q I don't believe you understood my question. What is the effect on the pressure decline, the normal pressure decline without any type of secondary recovery measures, what is the effect on the pressure decline when the producing well is shut in?

A I'm sorry, I don't understand you.

Q You get a pressure decline on a well in primary recovery?

A Yes.

Q It is declining at a steady rate?

A Yes.

Q Then the well is shut in, what is the effect on that curve?

A Well, it would continue to decline if the other wells in the field continued to produce.

Q Assume they do not in the area around this well.

A They would maintain the same value.

Q Would there be any possibility of a buildup?

A Not in a solution gas drive reservoir. Once it has built up due to its normal rock properties, then it would remain stable.

Q Are you aware of what production has been taken from the wells shown on Exhibit 8-R other than the four test wells?

A Yes.

Q What production has been taken from those wells during the months of September and October, 1957?

A I don't have it just in that form. I have the accumulated values for the pressure measurements on each well, but I have in my book here the monthly production by each well.

Q Are you aware that none of the wells according to your statistical report on Exhibit 8-R has any production whatsoever for the months of September and October with the exception of the Sunray Federal C-5 in Section 6, Township 25, North, Range 12 West.

A Let me present what I have here on Section 6, 25 North, 12 West.

Q That is the Sunray Federal 5-C?

A Five.

Q C-5? A For what months?

Q September and October. Substantially the period of time since the institution of the LPG injection program that was

commenced on August 21, 1957, is that correct?

A September, my book shows for Federal C-5 to have produced no oil. For October I have 689 barrels.

Q Now, do you have any production whatsoever for any other wells shown on Exhibit 8-R with the exception of the four test wells?

A No, sir.

Q What effect do you think the failure to produce these wells would have on these pressures shown on Exhibit 8-R?

A It would reduce the pressures further.

Q Had they been produced?

A Had they been produced, that is correct.

Q In your direct testimony I believe you referred to a comparison between what you called the Pedigrew-Tocito Pool?

A Yes.

Q I believe that is the pool that the Commission designates the South Blanco-Tocito Pool? A Exactly.

Q On primary production prior to injection of water in the South Blanco-Tocito Pool, the records indicate that they were able to produce 3,152 barrels per PSI decline?

A Yes.

Q Will you state whether you think the Bisti-Lower Gallup Oil Pool could produce a similar quantity of oil without injection?

A No, it would produce less.

Q How much less? It doesn't need to be precise. In the

order of a thousand less or two thousand less.

A It will be the same order of magnitude as observed in the Tocito Pool.

Q It would produce? A Roughly three thousand.

Q Three thousand barrels per PSI?

A That was what we have observed to date. I believe I had better qualify that statement, however, that is in the undersaturated region where we are operating.

Q What would be the importance of that qualification? What would be the effect in a saturated region?

A In a saturated region the barrels produced per delta PSI would be less than the three thousand.

Q Did you explain in answer to Mr. Seth's cross examination, I believe, the apparent anomaly of undersaturated oil and gas cap?

A I don't know.

Q Is it anomalous to have a gas cap in undersaturated oil?

A The oil in contact with the gas cap has to be saturated, but the oil that is downstructure at elevations lower than the gas-oil contact can be undersaturated like we have here at Bisti.

Q This is not an unusual situation?

A This is not unusual, no, sir.

Q You don't feel that this might possibly indicate a lack of communication between the gas cap and the oil?

A No.

Q I believe you testified that if this pool were developed on 40 acre spacing, that waste would occur? Would you please tell me how?

A Waste would occur by the drilling of unnecessary wells requiring investment by the operators.

Q The drilling of unnecessary wells rather than waste as defined by the New Mexico Statutes? A Exactly.

Q The definitions of waste are underground waste and --

A (Interrupting) Yes.

Q (Continuing) -- surface waste through evaporation or burning?

A Yes.

Q Economic waste through production of oil in excess of market demand? A Yes.

Q Waste as related to violation of ratable take. None of these would occur as a result of 40 acre spacing, would it? It would be merely by the drilling of unnecessary wells?

A The drilling of unnecessary wells.

Q Mr. Brinkley, would you direct your attention, please, to Exhibit 8-R please? More specifically to the British American Marye No. 3 well. On October 23, 1956, the pressure reading was taken of 1190 pounds, is that correct?

A That is correct.

Q And on August 15, 1957, the pressure reading was taken showing 1234 pounds? A Yes, sir.

Q This was prior to the injection of any LPG or gas into the Lower Gallup Oil Pool? A That is correct.

Q Would you please explain what in your opinion caused this increase in pressure?

A Let me check my records first.

Q The increase is also indicated on your Exhibit 9?

A Yes. That increase in pressure of 1234 pounds taken August 15, 1957 as compared to October 23, 1956, some 14 pounds.

Q Forty-four pounds, I believe.

A Some 44 pounds. Probably is explainable by the shutin times. The August pressure was shutin quite a few hours longer than the earlier pressure.

Q Are there any other variations in shutin times on the pressures indicated on Exhibit 8-R which might account for some of the variations shown thereon?

A There may be. I didn't try to list all of that information.

Q These tests were not taken under identical conditions for each well? A No, they were not.

Q Can you furnish the Commission with the shutin times for each of the wells for each of the tests?

A Yes.

Q Would you please do so? A Yes.

MR. COOLEY: Thank you very much, Mr. Brinkley. I have no further questions.

MR. PORTER: Mr. Brinkley, I believe you testified that you, in your opinion, this pool could be efficiently drained on an 80 acre spacing pattern? A Yes, sir.

Q Does that mean that you think you would recover as much oil on an 80 acre spacing pattern drilling one well to the 80 acres, as you would two wells to an 80?

A As far as we can be practical about it and honest with ourselves, yes, sir.

Q Then, you would have to assume that these various zones of pay are identical on horizontal limits, wouldn't you?

A We would have to assume that they extended sufficient distance to be penetrated by the wells.

Q All of the wells? A Yes.

MR. PORTER: Anyone else have a question? Mr. Errebo.

RE-DIRECT EXAMINATION

By MR. ERREBO:

Q With regard to Sunray Federal No. 4 well, do you have any explanation at this time for the decrease in pressure from the November 6, 1957 pressure of 1314 pounds to the December 4, 1957 pressure of 1294 pounds?

A Both tests were shut in in the same length of time, namely forty-eight hours. However, the likely reason why we have a variance there between those two dates is probably due to the irregular injection rates that we have experienced, and the reservoir had not

stabilized in that area.

Q Mr. Brinkley, have you calculated the recoverable reserves in this field?

A Yes.

Q What percent of these reserves are found in the two upper main sands?

A I would say essentially 95% of the total producable oil out of this reservoir would be contained in the two uppermost sands.

MR. ERREBO: Thank you. That's all I have.

MR. PORTER: Mr. Grenier.

RE-CROSS EXAMINATION

By MR. GRENIER:

Q Are you familiar with the definition of waste, Mr. Brinkley, as contained in the New Mexico Statute?

A No.

Q Let me then refer you to this portion of Section 65-3-3 of the New Mexico Statutes where it states as used in this Act, , "The term waste, in addition to its ordinary meaning, shall include various other things", then it lists underground waste and surface waste. As I understood, in response to your answers given to Mr. Cooley, you indicated that perhaps the waste that you were talking about in the drilling of excess wells here that weren't needed, would not be either underground or surface waste. But when you drill twice as many wells as might be needed, would you mean that

would be wasteful in the ordinary meaning of the word?

A In my opinion it would.

Q Approximately how many wells, or Mr. Finfrock indicated had been drilled in this pool?

A I think 187.

Q Have those been drilled to date substantially on 80 acre spacing?

A All with but a few exceptions.

Q Do you have any indication as to how many additional wells it would require to drill this up to 40 acre spacing?

A It would be over 200 wells.

Q What would the approximate range of cost of those wells be, would you have any concept of that? I mean per well.

A What a per well would cost?

Q Yes.

A Someplace in the order of $70,000.

Q So that multiplying seventy thousand by two hundred would indicate additional investment of about how much?

A About a million and a half dollars. Close to fifteen million.

Q So that using waste in the ordinary meaning of the word, you would think then there might be waste approaching fifteen million dollars? A That is correct.

Q If your conclusion is correct that 80 acre spacing will adequately drain all but the inferior flank portion possibly

of this pool, is that correct? A That is correct.

Q Now, what is the position of an operator who has drilled his tract on 80 acre spacing and finds that other operators around him have, as permitted by regulation, drilled up to 40, can he adequately protect his position by producing from his 80 acre tracts?

A With the 80 acre unit allowable, I feel that he can.

Q Could he with a 40 acre allowable?

A If he had two wells on the 80 acre unit he could.

Q But if he is only going to drill up his tract to an 80 acre density rather than to a 40 acre density, can he adequately protect himself from drainage in that situation without drilling up his wells also?

A You kind of lost me in there with so many wells.

Q Assuming a situation where 40 acre spacing pattern is permitted by Commission order as at the present moment, assuming an operator has drilled up his tract originally on an 80 acre spacing pattern. His offset acreage around him is now drilled up to 40 acre density by the offsetting operators. Will he be adequately able to protect himself in that situation without drilling his own acreage? A I think so.

Q He will be able to do so even under those circumstances?

A If I understand your question properly, you are wanting to know if you can protect yourself whether you are on 40 acre drilling

or on 80 acre drilling, is that correct?

Q No, I'm saying here he sits still. He doesn't drill up his particular tract to 40 acre density. He just stays put with 80 acre spacing in his particular tract of land, but all around him are 40 acre spaced wells. Will he in a 40 acre spacing pattern established by the Commission be able to protect himself without himself drilling up to a 40 acre density also?

A I'm sorry, I must be dense this morning. I just don't follow the entire question that you are asking.

Q Well, I'm assuming that each of these wells is now going to be getting the same allowable that he is going to have, each of these wells that he has drilled, one every 80 acres, but because he is only given 40 acres for prorationing purposes as his producing unit, he is only going to be getting one allowable for each of his wells. Now, under that circumstance, will he be able adequately to protect himself from drainage by these surrounding wells that are drilled to double the density on his tract?

A I'm still not clear. May I get this clear? Are the 80 acres on 40 acre allowable?

Q Yes. A No, sir, you will not.

Q He will not be able to protect himself?

A No, sir.

Q Without drilling the additional wells necessaryto put him too on 40 acre spacing? A No, sir.

Q So, in effect, once people do start drilling on 40 acres, each operator offsetting that 40 acre drilled area is going to have to drill up to the 40 acre level himself in order to prevent being drained, is that correct? A That is correct.

MR. GRENIER: I think that's all.

By MR. VERITY:

Q Mr. Brinkley, George Verity for Rex Moore. If I understood you, you said there was only approximately five percent of the reservoir in these minor stringers?

A That is correct.

Q That is other than the two that you have graphed?

A That is correct.

Q Or Mr. Finfrock graphed. Assuming for the moment that you wouldn't recover any of it on 80 acres, which we realize is an assumption, and if you recovered all of it on 40 acres, would it pay for the cost of drilling the additional double amount of wells?

A No, sir.

By MR. MALONE:

Q Mr. Brinkley, you were asked a question by counsel for Southern Union as to the effect of developing on 40 as against 80 acre locations. Would you refer to your Exhibit No. 1-R, and in particular to the northwest quarter of Section 10 in Township 25 North, Range 12 West. Tell us how Southern Union developed those locations, drilled those locations, whether it was on 40 or 80 acres?

A You are referring to the northwest quarter of Section 10, Township 25 North, 12 West?

Q Right.

A Those are on 80 acre locations.

Q They are 40 acre offsetting wells, are they not?

A We have 160 acres, and considering 80 acre tracts running vertically, you would have one well on 80 acres. Hence it is consistent with the 80 acre spacing.

Q It does not conform to the pattern which you have recommended to the Commission, however, does it?

A No, sir.

Q Now, with reference to your statement that 95% of the total recoverable oil is in the two uppermost sands, have you computed the recoverable oil in place in this pool?

A Yes.

Q Could you give us that figure, please?

A It would be the same figure you presented in the previous case and it is not new information.

Q I think it relates to some new testimony.

A All right. Will you restate your question, please?

Q I asked you if you had computed the recoverable oil in place in the pool. You said yes, and I asked you what figure you had obtained.

A It would be roughly twenty-two million barrels.

Q Have you allocated that as between the two principal members which are shown on your cross section?

A Yes, sir.

Q Can you give us that allocation?

A You mean split between the two sections?

Q Yes.

A No, I have not done that.

Q Have you allocated it as between those two sections and the lower sections which are perforated in a large number of these wells?

A I don't have that precise number. However, we have arrived at this five percent additional oil out of the lower members by using the rock characteristics and the high water saturation in all of those to show there is very little oil in place and using a small recovery efficiency consistent even with other operators, that the amount of oil recovered is negligible and the five percent is basically an order of magnitude number.

Q Is Mid-Continent perforating in those lower zones in the wells they are drilling?

A We perforate in the lower zones as well as in the upper zones.

Q Would you say then that your figure of 95% was an estimation rather than a computation?

A It is an estimation.

MR. MALONE: Thank you.

By MR. GRENIER:

Q Mr. Brinkley, are you familiar, referring again to this group of Southern Union wells which was just mentioned in Mr. Malone's cross examination? A Yes.

Q Are you familiar with the zones in which those wells are respectively completed?

A No, I would have to refer to cross sections and maps.

MR. GRENIER: If we may make a statement at this time, Mr. Porter.

MR. MALONE: A sworn statement.

MR. GRENIER: I thought it would expedite matters and give you the answer in which you appear to be interested. If you would like to have Mr. Wiedekehr on and sworn, we will be glad to do so.

MR. MALONE: I am willing to accept your statement. I was kidding.

MR. GRENIER: There are, as indicated by Mr. Malone's questions, two wells upon this 160 acre quarter section. There are two completions in the upper zone, there are two completions --

MR. WIEDEKEHR: (Interrupting) If I may make the statement for him. There are two wells completed on 160 offset on 40 acres, one well completed in the upper zone and the other in the 200 feet separating the two; so actually there are the two wells completed on one 160 acre spacing, one well in each zone.

MR. PORTER: Thank you.

MR. SELINGER: May I ask the witness a few questions?

MR. PORTER: Are you going to direct your question to Mr. Brinkley?

MR. SELINGER: Mr. Brinkley.

By MR. SELINGER:

Q Mr. Brinkley, you testified that in your opinion the drilling of more than one well to 80 acres is an unnecessary well, is that correct? A That is correct.

Q You indicated that at the present development that there is some, there would be some 200 wells drilled as unnecessary wells?

A That is correct.

Q Now, every time you drill a well in this reservoir you utilize some of the reservoir energy in drilling that well, is that correct? A That is correct.

Q Now, if the drilling of an unnecessary well utilizes some of the reservoir energy, then that unnecessary well is utilizing reservoir energy unnecessarily, is that correct?

A That is correct.

Q Now, I want to read you the definition of underground waste as being the inefficient, excessive or improper use or dissipation of the reservoir energy, including gas energy. Now, would you have that situation in the drilling of the great many unnecessary wells in this field? A That is correct.

MR. SELINGER: That's all.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Brinkley, just one more point on this definition of waste, 65-3-3 of the New Mexico Statutes Annotated. It says,

Waste-Definitions, This definition is the definition of the waste of hydrocarbon, not the waste of money. Now, under the defined sense of A, B and C, or under the ordinary meaning of the word waste, will there be any wasting of hydrocarbon as the result of drilling on 40 acre spacing?

A Yes, under item A, the dissipation of reservoir energy, gas energy, spacing, drilling, operating, producing.

Q Will there be less hydrocarbon recovered on 40 acre than on 80 acre spacing, Mr. Brinkley? A No.

Q Then there wouldn't be any waste of hydrocarbons?

A There's always a waste in producing.

Q As compared between 80 and 40 acre spacing. You stated that 40 acre spacing would cause waste in this pool. I asked you what you meant by that. I think I know what you meant, you meant the economic loss? A Yes.

Q Of drilling wells? A Yes.

Q But you don't mean you mean to say there is going to be less oil recovered on 40 acre spacing than on 80 acre spacing?

A No.

MR. SELINGER: I believe you were conversing with Mr. Nutter at the time I was interrogating this witness. We are talking about the dissipation of reservoir energy, not the recovery of hydrocarbon, we are talking about the reservoir energy itself in the reservoir. He testified there would be a dissipation, an excessive

inefficie sipation of the reservoir energy in the drilling of unnecessary wells. That is defined as part of underground waste.

MR. COOLEY: I also asked him if there would be more oil recovered on 80 than 40.

A No.

MR. SELINGER: You are talking about a recoverable factor. I'm using the term of underground waste in the use of reservoir energy.

MR. COOLEY: If oil is not recovered it is wasted.

MR. SELINGER: If you drill unnecessary wells and dissipate reservoir energy regardless of your recoverable factor, that is underground waste.

MR. PORTER: Mr. Seth has a question.

MR. SETH: I don't know whether to direct this question to Mr. Selinger or the witness.

By MR. SETH:

Q Mr. Brinkley, you testified in response to Mr. Selinger's question, that there would be reservoir energy lost by the drilling of wells? A That is correct.

Q Now, would you explain how that comes about?

A Well, the fuel that is required in order to drill those wells i fluid that is used to do unnecessary work, and in my opinion that would be waste.

Q Using gas to complete the wells?

A Yes.

Q That is the extent of your point on that particular question?

A That is one example.

Q Well, what else is there, it takes reservoir energy to produce these wells too, is that what you are testifying to?

A Well, now, I'm not an expert on waste and legal matters.

Q I'm not talking to you at all about legal matters. The question was reservoir energy. You are an expert on reservoir energy? A That's right.

Q How is that expended by drilling these 40 acre wells?

A Because you are using fuel to drill unnecessary wells, and the fuel could be diverted to repressuring operations to further the recovery in this reservoir.

I might carry that a little bit further, that we know that we can get additional oil recovery by the injection of gas, and one of our studies right now considered the injection of gas to improve the recovery, and if the gas is wasted and can't be injected, it would be waste.

Q Your testimony now is that it takes gas to power the equipment to drill the wells and for gas depletion, is that right?

A Yes.

Q What is being done with that gas now if it were not used for that?

A Part of it, I'm sure, is being used for fuel, but right now

we are making a study to utilize that gas.

Q Well, then, the extent of your testimony was that you use some fuel to drill wells and the fuel is procured locally?

A Yes.

Q Is that about the extent of it?

A Yes.

MR. GRENIER: May I ask one question?

By MR. GRENIER:

Q In response to Mr. Seth's questioning, I gathered that you were indicating that exclusive of the fuel use, things happening on the surface, that approximately the same amount of reservoir energy would be required to produce the same amount of oil whether on 40 or 80 acre spacing, is that correct?

A I believe it would be the same amount of energy.

Q Now, having used the same amount of energy to produce the same volume of oil on either spacing, which would be the more efficient way of using that reservoir energy, through a program that cost X dollars or through a program through having double the wells, two X dollars?

A The former X dollars.

Q So, it would be the more efficient use of reservoir energy to recover this same amount of oil and make use of this same amount of reservoir energy on an 80 acre spacing pattern than on 40?

A That is correct.

Q So that relatively the 40 acre spacing pattern utilization of reservoir energy would be inefficient, is that correct?

A That is correct.

Q And therefore that would be within the definition as we have it here in this section referred to where it defines underground waste as being a number of things embracing the inefficient use or dissipation of the reservoir energy, which you characterize it, then the use of reservoir energy by 80 acre as being such inefficient use of reservoir energy?

A That is correct.

Q So that it would be wasteful then to that extent?

A That is correct.

MR. PORTER: Mr. Cooley.

By MR. COOLEY: Mr. Brinkley, are you familiar with the way the two Southern Union wells, which were mentioned in the testimony a few moments ago, were completed?

A Only from what I have heard here.

Q These wells are on offsetting 40 acre tracts, are they not?

A That is correct.

Q And since you do not know of your own information that these wells are completed in different zones, let us assume that these wells are completed in two different zones.

A Yes.

Q One is completed in an upper zone and one completed in the

lower zone? A Yes.

Q Then, Mr. Brinkley, my question is this, had the Southern Union wells been drilled in accordance with your recommendations, one of the wells would have been to the northeast corner, I believe was your recommendation? A That is correct.

Q Is there not a good possibility that the zone penetrated by the well in the southeast where it is actually located, might not even have penetrated that zone? A That is correct.

MR. COOLEY: Thank you.

MR. PORTER: I have a question in mind, but I think I will defer it for awhile. Mr. Sullivan.

MR. SULLIVAN: Mr. Sullivan, British American.

By MR. SULLIVAN:

Q There has been a good deal of testimony here, Mr. Brinkley, with regard to the terms of the New Mexico Statute. I would like to read a provision to you and ask you whether or not that this provision existed in the law. You may answer this either yes or no. Are you aware of the fact that Section 65-3-14(b) of the New Mexico Conservation Act reads as follows: "The Commission may establish a proration unit for each pool, such being the area that can be efficiently and economically drained and developed by one well, and in so doing the Commission shall consider the economic loss caused by the drilling of unnecessary wells, the protection of correlative rights, including those of royalty owners, the prevention of waste, the

avoidance of the augmentation of risks arising from the drilling of an excessive number of wells, and the prevention of reduced recovery which might result from the drilling of too few wells." Are you aware that that was in the statute?

A I have never read this.

Q Just the answer no then?

A But through conversation --

Q Just the answer no then? A No.

MR. PORTER: The hearing will recess until one-thirty.

(Recess.)

AFTERNOON SESSION

MR. PORTER: The meeting will come to order, please. I don't recall who was questioning Mr. Brinkley at the recess. Mr. Grenier, were you questioning the witness?

MR. GRENIER: No, but it has been called to my attention during the recess by one of the other lawyers in the case, that apparently I misstated one question and the witness misheard and we got a rather strange question and answer. This relates to the point where I was inquiring of Mr. Brinkley as to whether 40 or 80 acre development of the field would represent the more efficient utilization of reservoir energy. I think I asked, isn't 80 acre spacing less efficient, and he said yes.

My question, I'm sure, was asking him wouldn't 40 acres be more inefficient, and I would ask him what his answer to that would be.

A Yes, a 40 acre spacing would be less efficient.

MR. GRENIER: Thank you.

MR. PORTER: Anyone else have a question of Mr. Brinkley at this time?

MR. UTZ: I have a question.

MR. PORTER: Mr. Utz, I didn't see you.

By MR. UTZ:

Q Mr. Brinkley, how long do you think that it takes to stabilize the shutin pressure in the Bisti Pool?

A We have observed in some of the wells along the longitudinal axis they would completely build up in pressure in less than forty-eight hours. Also the fringe wells have been required a longer period of time than forty-eight hours to stabilize.

Q That would be due to lower permeability?

A Due to poor rock characteristics.

Q In taking shutin pressures in the pool, what would you recommend as the shutin pressure time for the period of stabilization?

A For the wells in the fairway I would recommend forty-eight hours, and in the fringe areas I would recommend a minimum of seventy-two hours.

Q It would be a little bit difficult to have two different times? A Yes, it would.

Q In reference to your Exhibit 9-R, with particular

reference to the Sunray C-2, I note over in the first part of April a shutin pressure in the vicinity of 1270, and apparently there was not any more shutin pressures taken until somewhere about the middle of September? A Yes, sir.

Q Do you attribute that increase to your injection of LPG and gas?

A This is an abnormally high pressure, and I cannot explain it. It could be an error in measurement or instrument or something else, but it is obviously too high. I did put it on here because it was a data I received and I did not try to edit the data.

Q It also shows quite a fast decrease in pressure on the pressure taken the latter part of September, does it not?

A Yes, sir, this point here. I first would like to say that I questioned that point, and since I had this point here I drew a line to connect the two data points and the decline carries no significance as far as I'm concerned.

MR. UTZ: That answers my question.

MR. PORTER: Anyone else have a question of the witness? Mr. Nutter.

By MR. NUTTER:

Q Mr. Brinkley, you stated there would be a difference in the efficiency in the use of the reservoir energy in 40 acre against 80 acre spacing? A Yes, sir.

Q How would this be measured, what would be the ultimate

outcome of the difference in the efficiency in the use of the reservoir energy?

A For one thing, you would have half as many pressure sinks in the reservoir, which of course, a pressure sink causes increase in gas saturation and it is that that I am referring to.

Q The ultimate answer to the use of reservoir energy is the barrels of oil produced, is it not?

A Yes.

Q And then the question could be resolved as to the matter of time in which the oil is produced?

A Yes.

Q The economic limits of the time that it takes to produce a given amount of oil, that is important?

A That's right.

Q Would it be fair to say that one of the criteria here that the Commission must consider, would be how long it would take to produce a given amount of oil in this reservoir?

A That might be one criteria.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question? The witnes may be excused.

(Witness excused.)

The Commission has had a request from counsel for Rex Moore, Mr. Verity, for permission to make a short statement in order to

leave here to make a plane connection. Is there any objection to Mr. Verity making this statement at this time?

MR. VERITY: Your Honor, in behalf of Rex Moore, we don't have any evidence to produce at this hearing, but I would like for the record to show that Mr. Rex Moore, who owns the 1,040 acres of leases within the area that is here under consideration, finds himself in a very embarrassing position. If the Commission establishes a 40 acre spacing as his lease is at the present time, or in the past when it was being developed under a voluntary 80 acre spacing, he, as an independent operator, could develop his lease. I'm sure this Commission is aware of the fact that the average independent must borrow money in order to develop his lease properties under normal circumstances, and certainly Mr. Moore is in that position, and I believe the bulk of the independents in this Bisti Pool. He is in the position that whereas he can borrow money and develop his thousand and forty acres on 80 acre spacing, he as yet has been unable to find any lending agency that will finance him to develop his pool on 40 acres. That leaves him in the position, if this Commission allows its order to stand that it promulgated recently, establishing the 40 acre, he is going to have to sell his lease or else farm it out on whatever kind of a basis can come around.

He feels that that is inequitable and that is unfair, and therefore he joins in the application for 80 acre spacing. He finds that his engineers and bankers concur with the

engineering that recommends the 80 acres to this Commission.

MR. PORTER: Mr. McGowan, did you have testimony to present at this time?

MR. McGOWAN: If the Commission please, we will have three exhibits. I suggest that we continue to number them 10, 11, 12-R so there will be continuity in the record. They are in support of the application for rehearing and in support of the application.

MR. PORTER: We have no objection.

(Marked Applicant's Exhibits 11-R, 10-R and 12-R, for identification.)

C. D. GAINES

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

DIRECT EXAMINATION

By MR. McGOWAN:

Will you state your name and by whom you are employed and what capacity, please?

A The name is C. D. Gaines. I am Division Production Engineer for Sinclair Oil and Gas Company in their Denver Division.

Q You do have a degree in engineering and have had about nine years' experience as a working engineer for Sinclair?

A That is correct.

Q You have not previously testified in this hearing?

A No, sir, I have not.

Q You have previously, however, testified as an expert before this Commission? A Yes, sir, I have.

MR. McGOWAN: Are his qualifications acceptable?

MR. PORTER: Yes.

Q In your capacity, Mr. Gaines, as Division Engineer for the Denver Division, do you have under your jurisdiction what is being referred to here as Bisti Pool? A Yes.

Q Does Sinclair Oil and Gas Company own interests and leases in wells in that pool? A Yes, we do.

Q Are they more or less concentrated in a particular portion of the pool?

A Yes, they are concentrated in Township 25 North, Range 11 West, approximately in this area in here.

Q Now, Mr. Gaines, have you, although you did not testify in it, have you read and are you aware of the testimony that was given at the previous hearing in this matter?

A Yes, sir, I am.

Q You have the information that was contained then in the testimony given at that time, it has been available to you in your studies, has it not? A Yes, sir, it has.

Q Have you also made an independent study of the pool yourself with particular attention to the area you just made reference to?

A Yes, sir. In fact, the study was concentrated on this hearing.

Q Is that the reason that you had more information in that area than other areas?

A It was partially due to the fact that our interests are in this area of the pool and we were interested in evaluating Sinclair Oil and Gas Company's interest, and also that is the data that we had available to work with.

Q Now, you were aware in your study, were you not, that the Commission had under consideration here the proper sized spacing or proration units to develop this pool on, together with the field rules that would be necessary to prevent waste in this pool, were you not? A Yes, sir, I was.

Q Did you make a study of this reservoir to enable you to make what in your opinion would be a recommendation to the Commission which would be in your opinion the best method of so doing?

A Yes, sir, the concentrated study, as I said before, was in Township 25 North, Range 11 West, but I did review other data that was presented at the last hearing.

Q In making such study you were aware, were you not, that the Commission is concerned with the prevention of waste as defined in the statutes, and those definitions you were aware of?

A Yes, sir.

Q You were aware that the Commission has a duty of protecting correlative rights, and you were aware of that in your study?

A Yes, sir.

Q May I ask you, in considering the effect upon correlative rights, were you considering the statutory definition of such, which is essentially to give to each operator the opportunity so far as practical, to recover the hydrocarbons under his lands?

A Yes, sir.

Q Now, Mr. Gaines, evaluating a pool and coming to a conclusion concerning the size of spacing of proration units that would be necessary, do you feel that there is a minimum below which you cannot go? A Yes, sir, certainly.

Q Is that minimum actually based upon economics?

A Yes, sir, it is.

Q In other words, then, any unit that does not contain sufficient recoverable hydrocarbons under it to pay for the cost of drilling and operating a well to depletion plus profit would be uneconomical and therefore below that limit, would it not?

A Yes, sir, it would.

Q Would it be fair to state that you start with that minimum and then see how large an area in your opinion can be drained by one well in order to establish the maximum?

A Yes, sir.

Q Then within those two limits, you decide what you feel is the best proration or spacing unit for that field?

A Yes, sir.

Q Now, in constructing and coming to the recommendation that you are going to make to the Commission, did you consider all these factors and proceed essentially on the matter that has heretofore been outlined? A Yes, sir.

Q Then on that basis, will you advise what your recommendation is concerning this pool?

A We feel that the greatest ultimate recovery could be obtained from the Bisti-Lower Gallup Field by a fixed 80 acre spacing pattern. However, we feel that the establishing of 80 acre prorationing units would essentially accomplish the purpose with respect to preventing waste. We concur in the recommendation of Sunray Mid-Continent that the limiting gas-oil ratio for oil wells be set at 2,000 cubic feet per barrel.

We would further recommend that for the present at least, that a well which is producing with a gas-oil ratio in excess of 15,000 cubic feet per barrel be classified as a gas well.

We would further recommend for allowable purposes that a gas well be permitted to assign up to four 80 acre units, and that the allowable be based upon the volumetric formula.

Q Now, Mr. Gaines, when you used the word spacing unit, you were thinking in terms, were you not, of prescribed 80 acre units with a prescribed well location thereon and prohibition against drilling additional units on this 80 acre unit?

A Yes, sir.

Q When you mentioned the word proration units, you were talking about a proration unit for allowable purposes without any restriction as to whether one or two wells could be drilled thereon?

A Yes, sir.

Q You mentioned a gas cap, Mr. Gaines. With particular attention to the area in which Sinclair has leases and in which you have, in your opinion, sufficient information to evaluate the reservoir, do you feel that you have come to a valid conclusion concerning the approximate location of the gas cap in this reservoir?

A Yes, sir, as to the approximate location.

Q In discussing the gas cap as you envision it in this field, will you refer to Exhibit 10-R? Would you please advise the Commission what that exhibit shows?

A Exhibit 10-R is a structure map in the area that we were speaking of, which is based upon a marker which is approximately ten feet above the top of the first sand in the Lower Gallup. We have indicated two cross sections, A, A_1 and B, B_1 which are shown on Exhibits 11-R and 12-R. The area that is colored in yellow represents our interpretation of the area in which some free gas could be expected.

Q That would be what would normally be referred to then as the gas cap area?

A Yes, I think so. Certainly you would have to move inside this yellow band to get a gas well without making any oil because

there would be marginal areas through there where you would have both oil and gas, and thus high gas-oil ratio wells.

Q Do you feel then that the gas in this area is pretty well concentrated, or the gas in this pool is pretty well concentrated in a gas cap along the southwestern flank except for such free gas as might be found in isolated anomalies as was discussed by a previous witness this morning?

A Sir, we did not go past the town line, rather the range line, between 11 and, Range 11 and 12 West, and our interpretation of the gas area in Sections 19 and 20 in Township 25 North, Range 11 West is based purely on interpretation. We had no gas volumes to use from these wells, but using the same criteria that we did use down in this area where we did have control, we extended this gas cap area across here. We have no proof that it does go there.

Q Do you feel that you have been able at least in that area to define the gas cap to the southwest?

A We have --

Q (Interrupting) Let's say the southwestern edge of the gas cap.

A We have a distance of approximately five miles in lateral extent that we can very definitely define the gas cap.

Q You feel the southwesterly edge of it would be the edge of the pool? A Yes, sir.

Q The northeasterly edge of it would be the gas-oil contact?

A Yes, sir.

Q And the southeasterly and northwesterly limits of it cannot at this time, in your opinion, be defined or at least on the information that you have?

A Based on the information I have, I cannot define them. It might be possible they could be defined.

Q I gather that you are of the opinion there is a significant gas cap area in this pool?

A We are looking at the gas cap area that certainly represents approximately a fourth of the length of the pool.

Q Will you refer to your Exhibits 11-R and 12-R and advise the Commission what they are and the significance of those exhibits? One moment, Mr. Gaines, before you go to the latter two exhibits. It has been called to my attention that on the map there is an error in one or two lease owner names. Would you like to correct that at this time?

A Yes, sir, on this plat we did not catch this until we had them prepared, but the Sunray Mid-Continent Sinclair lease in the southwest quarter of Section 15, Township 25, all of these are in Township 25 North, Range 11 West, the name of that lease should be the Platero. The lease in the northeast quarter of Section 23 should be Bittony NEZ, and the lease in the northwest quarter of Section 25 should be Es-Ka-By-E.

Q Would you mind spelling those lease names?

A Es-Ka-By-E, E-s-k-a-b-y-e, Platero, and B-i-t-t-o-n-y N-E-2.

Q Now, will you refer to Exhibits 11-R and 12-R and state what they are and their significance?

A Exhibits 11-R and 12-R are cross sections, as I stated before. No. 11-R being more or less perpendicular to the field with the exception of the red going over to the Shell Carson Well and the other well diagonally across the breadth of the field, We were concerned about the Shell Carson No. 5 due to the past tests, but we had to report that it was a 33 barrel oil well, and we felt like that certainly it should be a gas well.

I don't believe it is proven that it isn't a gas well as yet. In Es-Ka-Nel-E-Wood No. 2, Sunray Mid-Continent Well afforded us some very valuable information with regard to this gas cap, in that the well was tested separately in both the first and second zones and produced gas from both zones, which meant that our gas-oil contact must lie below the bottom perforations in the second zone, but there is no fluid reported.

Then Sunray Mid-Continent Es-Ka-Nel-E-Wood No. 1 was completed with a gas-oil ratio of 1,020 to 1. That would certainly mean that essentially all of the perforations in Es-Ka-Nel-E-Wood No. 1 must be in the oil zone. Therefore I think certainly in this area here we would expect that the gas-oil contacts in the two zones must be slightly different.

I might add, in talking about these gas-oil ratios, that

practically all of them are potential tests or completion tests on the wells. After short periods of significant fluid withdrawals, I think the gas-oil ratios could change considerably.

Q They would change to a higher rate, would they not, in your opinion?

A Certainly I think in this gas cap area. Yes. We had the Texas Company No. 1 Navajo also, and then the No. 1 Harvey which was a dry hole. We attempted with our other cross section to apply these same gas-oil contacts to the wells that we have in this cross section.

I might add that we did have core data on the Anderson-Pritchard or Sun Oil's No. 1 H Begay, Sun Oil Heirs of Ko-Sa No. 2, the Heirs of Ko-Sa No. 1, the Sun Oil No. Heirs of Ka-Na-Pah and No. 1 and No. 2.

Using the same gas-oil contacts which were a plus 1550 in the first zone, and I believe plus 1530 in the second, we used this same data to apply to this cross section. This was a gas well in the second zone perforated only in the second zone. Magnolia's No. 1 Ken-Nu-To had a gas-oil ratio I believe of about 11,550 cubic feet per barrel. It produced 45 barrels of oil on a 1664 inch choke. We found that to explain a low gas-oil ratio of, and by low I mean approximately a thousand to one in Sun Oil's No. 1 Heirs of Ko-Sa, that we had to tilt the gas cap approximately ten feet, going down structure.

It could be that with more production we would find a higher gas-oil ratio in this well. Then as we go on down structure, we have ratios of a thousand or less, and then we do have included the No. 1 Platero which was discussed this morning, and we also independently put a little gas cap in this area independently, I would say, of Sunray's approach to the gas that is found down structure in the second zone, and the first zone, or rather the second zone which is the producing zone in the Platero No. 1 is found at plus 1510, while the second zone in Sun Oil's No. 2 Heirs of Ka-Na-Pah is down at a plus 1500. In other words, it is higher structurally.

Q You then agree with the conclusions that were expressed concerning that well this morning?

A Yes, sir, I do.

Q One other question on two exhibits. Those two cross sections, I believe, are constructed to scale both horizontally and vertically, are they not? A Yes, sir, they are.

Q Now, Mr. Gaines, you recommend to the Commission 80 acre proration units? A Yes, sir.

Q Did you evaluate this reservoir from an economic standpoint?

A Yes, sir, I did.

Q Is it your opinion, without going into detail very much, the record is full, that 40 acre units in a major portion of this reservoir would be uneconomical? A Yes, sir.

Q They would not produce enough oil for drilling and

operating the well to depletion? A Yes, sir.

Q In making such calculations, and the calculations in the previous testimony are on the same basis, you were assuming a depletion of the wells based upon an allowable at least in line with other allowables in the State of New Mexico?

A We used a ten year life for 40 acre spacing, which I think would be a reasonable life with the allowables in southeastern New Mexico.

Q If that allowable in northwestern New Mexico, and particularly in this pool, remains substantially lower than in southeastern New Mexico as it presently is, that would extend the life of the wells? A Yes.

Q It would also substantially increase the operating costs?

A Yes, sir.

Q It would make wells that might now seem economic, uneconomical? A Yes, sir.

Q You recommended 80 acre proration units, is it your opinion that one well will economically and efficiently drain the recoverable oil from under an area in excess of 80 acres in the oil portion of this reservoir?

A From the data that we have worked with and the data that we have had the opportunity to look at that other people have worked with, I do.

Q Without repeating the testimony to any extent, I gather

then that you feel that the permeabilities in this pool are sufficient to allow drainage in excess of 80 acres in the oil zone?

A Yes, sir.

Q And it is your opinion that the interference test and the information in the test that has been given here before conclusively proves that?

A Yes, sir.

Q Is it your opinion that one well will economically and efficiently drain in excess of 320 acres in the gas cap area?

A Yes, sir.

Q It is the basis of your recommendation of assigning a maximum of four proration units to a gas well?

A Yes, sir, and also on the basis that a lesser spacing would be very uneconomical and in fact 320 acres would be a slightly less than break even proposition to the gas wells located in that area.

Q Do you feel that the method of controlling this field and setting up proration units that you have recommended to the Commission will result in the greatest ultimate recovery of hydrocarbon from the entire pool?

A Yes, sir, I certainly think there is that possibility.

Q Now, Mr. Gaines, without leaving any inference that you feel that one well on 80 will produce more oil than two wells, would, is it nevertheless your opinion that the 80 acre spacing will actually produce more oil from this pool than 40 acre would?

A If we make certain assumptions.

Q And that assumption would be that the fringe areas should not be and would not be developed on 40 acres?

A Together with the assumptions and data that has been previously presented to the Commission.

Q Insofar as each area of this pool could not be economically developed on 40 acres, the oil underlying that land would not be productive except by drainage into the center of the pool?

A Yes, sir.

Q In your study of this reservoir, have you found leases that in your opinion could not be economically developed on 40 acres?

A Yes, sir.

Q Does Sinclair own one? A Yes, sir.

Q Would you recommend to your management that they drill 40 acre wells on that lease if the Commission orders 40 acres?

A No, sir, I would not recommend they drill wells on that lease.

Q It would be to the economic advantage of Sinclair to abandon the lease rather than drill 40 acre wells on it?

A That would be my recommendation.

Q I assume that you feel that in order to prevent waste and protect correlative rights of the parties to the greatest extent possible, 80 acre proration units should be established for the Bisti-Lower Gallup Pool?

A Yes, sir.

Q Do you feel that unnecessary wells would be drilled if such

a program is not adopted by the Commission?

A Yes, sir.

MR. McGOWAN: I believe that's all.

MR. PORTER: Anyone have a question of Mr. Gaines?

MR. SETH: I have a few questions.

MR. PORTER: Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q If I understand your testimony, Mr. Gaines, the issue here is if the Commission continues with the 40 acre spacing, you'll either have to drill that lease up on 40 acre tracts or abandon it, is that right?

A That is not the issue with us, no, sir.

Q I mean is that what you think you are faced with? Is that your choice?

A If we are talking about one lease. I think it is broader than one lease, but there will be leases that we feel would be uneconomical to drill.

Q Let's take the one lease that you spoke of. You feel that if they continue the 40 acre spacing, that you'll either have to drill it up or abandon it, is that correct?

A That is correct.

MR. SETH: That's all.

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q Mr. Gaines, as I understood your study was limited entirely to the area east of the range line, which is depicted on your Exhibit 10-R?

A Yes, sir, it was, other than reviewing, also the results of other people's studies, also.

Q Was your study also limited entirely to the two sand members that are shown on the two cross sections which you have introduced?

A Essentially, we looked at some 30, 31 or 32 wells in this area. We found cases where we would have as much as two or three feet of microlog separation below that.

Q And that was perforated in a number of those wells, was it not?

A There was a very few of the wells that it was perforated in. In fact, I think they were in Township 25 North, 11 West, there were four wells which were perforated in zones other than the first and second zone.

Q Did you make any study of that sand member?

A Not independently, no, sir.

Q So its existence is not taken into consideration in the recommendations that you made to the Commission?

A Other than we feel it will contain very small reserves.

Q You feel that it can be disregarded and you have disregarded it?

A Yes, sir.

MR. MALONE: That's all.

MR. DUTTON: Granville Dutton, Sun Oil in Dallas.

MR. PORTER: Mr. Dutton.

By MR. DUTTON:

Q I have heard two references to I believe it's Shell Carson 5. Am I correct in understanding that this well was represented at the last hearing as being an oil well?

A I believe that's the conclusion that I drew from reading the testimony.

Q And it is your testimony now, and I believe if I understood Mr. Brinkley this morning, that the well has produced only 33 barrels of oil?

A No, sir, I believe it has recovered, I believe he used 80,000 gallons as a fract treatment, and it has yet not recovered the 80,000 gallons of oil.

Q Is it your testimony now that in your opinion this well is a gas well?

A No, sir, we do not have any data as to whether that well tested a gas well or whether it didn't.

Q Well, it is your testimony that a gas cap does currently exist in the southeastern portion of the Bisti-Lower Gallup Oil Pool?

A Yes, sir, I think very definitely.

Q You testified that you have made an economic evaluation

of the leased portions of this field?

A Yes, sir.

Q In so doing did you arrive at an average figure for a cost of a well in this area? A Yes, sir, we did.

Q Would you give us that figure?

A The average figure for an oil well, including the averaging out, the lease equipment and the artificial lift equipment, we used a figure of $70,000. For the well itself we had a figure of $54,800.

Q Mr. Gaines, would it be your opinion that it would be economically feasible to drill a $54,800 development well if the reasonable expectation was to receive a producing allowable of only ten barrels per day?

A Certainly not.

MR. DUTTON: Thank you.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q Mr. Gaines, in making your study of this pool, did you attempt to determine how much of the oil was in the various independent pays that comprised the Gallup formation?

A No, sir. We did not split them up by zones. However, it would be purely an estimate on my part. I would say that probably in excess of 95% would be in the first and second zones in the areas that we have looked at.

Q In these two main zones that you have shown us?

A Yes, sir.

Q Mr. Gaines, in drilling a pool up on 80 acre spacing, on a northeast-southwest basis in each 160 acres or northwest-southeast, does it not follow that the wells would of necessity, to be on a perfectly uniform pattern, have to be 660, 1980 locations?

A Yes, sir. To be perfect.

Q And if a pool is drilled up on 40 acre spacing with completely uniform spacing throughout the pool, it follows that the locations must of necessity be 660, 660 locations, is that correct?

A Well, I believe it would be 1320, if they were in the center of the 40.

Q I mean 660, 660 out of each 40 acre tract in the center of each 40. A Yes, sir.

Q If you drill wells on ten acre spacing, the normal spacing pattern would be 330 feet out of each ten acre tract in order to be in the center, would it not? A That is correct.

Q How many wells does Sinclair have in this area that you have depicted in your exhibit?

A We have a half interest in nine wells that are completed, and I believe at the present time there are two drilling.

Q How many of those wells have been located in such a manner that the minimum distance from the lease line, or minimum distance from the 40 acre tract in which the wells are located, is at least 660 feet?

A It would be an estimate on my part since I don't think right here I have the exact location of the individual wells.

Q These wells are located on your map with respect to the actual distance from the lines, aren't they?

A That's correct.

Q The Platero No. 1, how far does it appear to be from the section line?

A I would guess that to be a 330 location.

Q Sinclair Sunray's Es-Ka-Nel-E-Wood No. 2 is what type of location?

A Could I correct myself on that last statement there, it would be, do you want the distance to the closest lease line?

A That's right.

A Then it would be, it appears to be approximately 330.

Q How about Sinclair Sunray Es-Ka-Nel-E-Wood No. 2 in Section 22 there?

A It looks like it is 660.

Q It is a 660, 660 location?

A Yes, sir, No. 2 is also.

Q The No. 1 and No. 2 on that lease?

A Yes.

Q How about up here, Sunray Sinclair A-Se-Des-Pah?

A Yes, that was the Bittony NEZ and that would be 660 also, I believe.

Q How about Sinclair Sunray's, about this well over here in Section 24?

A I believe that is a 330 location.

Q Sinclair's Margalita No. 1 is a 660, isn't it?

A Yes, sir.

Q How about down here in Section 25, the Es-Ka-By-E No. 2?

A Well, that looks like it could be between 330 and 660 from my plat here.

Q It doesn't appear to be a 660?

A No, it appears to be between 330 and 660.

Q How about the Kas-Na-Des-Pah in Section 25?

A That appears to be 330 from the north line.

Q How about in Section 30, SDX 9 Eton No. 2?

A The No. 2 appears to be 330 from the north line of the lease. The No. 1 appears to be 660 from the east line and greater distance from the south line.

Q So that probably would be close to 330 from the north line of that tract, would it not?

A The No. 2 would, the No. 1 --

Q (Interrupting) The No. 1 from the 40 acre tract?

A From the 40 acre tract, yes, sir.

Q Is there any significance in this location of these wells, Mr. Gaines? I count six wells that are 330 locations from the 40 acre tracts and four wells that are 660. Is there any significance

in the location of those wells?

A I think there might be one significance in the area in that high gas-oil ratios have been experienced down in this area and it's recognized that there is a gas cap here, and I think certainly that any operator would try to stay away from the gas cap.

Q In a field where it becomes necessary to drill more than half the wells on 330 locations, is that any reflection on the ability of the wells to produce an 80 acre tract?

A I don't think it is. As to the reason for it becoming necessary to drill on 330 from the edge of 40 acre tracts, it certainly would have some bearing upon the drainage. However, in the core analysis that we did examine in this area, we found very good permeabilities in the first and second zone. I think certainly I would concur with the opinion that one well could drain in excess of 80 acres.

Q In other words, the location on 330 feet from a line was not necessitated by any lack of permeability whatsoever?

A Having part interest in this property, the recommendations for drilling are submitted to Sinclair and approved by us. As to the exact reasons, we don't know, we do approve them if we agree with them.

MR. NUTTER: Thank you.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Gaines, I believe you stated that you felt that something in excess of 95% of the reserves in the Bisti-Lower Gallup Oil Pool are in the first two zones?

A Yes, sir, based upon the area that we have looked at here.

Q And then limiting yourself to the area that you have studied, to what degree are these first two zones coextensive through this area? A The first two zones?

Q Yes.

A I think that you can trace them completely through the area, as indicated by the two cross sections we have there, until you do get out on the flanks of the field, and then it appears that in this area, as you get to the north edge of the field, that the first zone shales out before the second zone does. To the south it appears that the first zone, the second zone possibly shales out a little before the first does.

Q Could you give a rough estimate in percentage as to what percent of this area you feel these two zones are coextensive, 75% or better or 50% or better?

A Well, what we would have to do to come up with that volume I think is to plot the limits of where the zones would shale out along the flanks of the field and then perimeter that area under that and apply it to the number of feet that we would think would be an average.

I think when we talk about total reservoir volume, that we are

speaking about, probably a significant percent due to the perimeter of the field. Assuming that these conditions do exist all the way around the field, I think that there is a possibility that it would be a significant volume.

Q A significant area over which they are not coextensive?

A By coextensive --

Q (Interrupting) One well drilled at any given point would not penetrate both zones?

A Yes, sir, I think it would be a significant area because of the perimeter of this field. I think you are looking at quite an area if you just drew a circle around the field if it were only one location wide.

Q Of course, this perimeter, I believe, as all the testimony indicates, all the way around are the poorer locations?

A Yes, sir.

Q Mr. Gaines, I am not sure I understand all of your recommendations concerning the proration of the gas wells completed within the gas cap in the Bisti. Would these wells be assigned 320 acres as a standard unit, I believe you testified you are up to four proration units? A Yes, sir.

Q Would a standard, would there be such a thing as a standard unit and would that unit be 320 acres?

A No, sir, I believe that would be the maximum unit size.

Q What would determine whether a 160 or 320 or any figure

would be assigned to a given well?

A I think it would be determined by the area that would be productive of gas, and by that I do mean gas cap gas.

Q Would this area dedicated to a gas well, would it be the possibility under your proposed plan of dedicating certain of that acreage to an oil well also? A No, sir.

Q There would be no simultaneous, it would either be dedicated to a gas well or oil well? A Yes, sir.

Q Did you include a volumetric withdrawal computation into this?

A I mentioned one.

Q I thought you just mentioned, and in passing I wondered if you would expand on that just a little.

A Well, there are several ways that you could approach it, it would be a matter of how exact you wanted to get, and of course, the more exact that you get I think the more data that it would require to regulate these gas allowables. The simplest would be to apply the solution, the limiting gas-oil ratio for oil wells, times the number of 80 acre units assigned to a gas well to come up with a limiting gas volume.

Q If an 80 acre oil well got X, the amount of gas that an 80 acre unit could produce along with its oil would be X?

A That's correct.

Q Then a 320 would produce 4X?

A That is correct, that would be the simplest and then you could go to more or other formulas that would be more complicated and require bottom hole pressure data in that.

Q Do you think there is a danger in the possibility that gas might be withdrawn from this gas cap at higher rates than the corresponding oil production and cause a wetting of sands?

A If it isn't regulated I do.

Q But would this gas-oil ratio type of formula be any insurance whatsoever against that sort of occurrence? Your system would seem to give everyone a fair share of reservoir energy.

A Yes, sir.

Q But would it prevent the wetting of sands?

A It has been my experience that if a gas cap is produced, or if high gas-oil ratio wells themselves were causing some wetting of the gas sand by oil, and likewise the gas will move down structure and you will have oil wells going to high gas-oil ratio wells. About the only way that if you are going to produce from this area of high gas saturation that you can prevent some wetting would be from some type of secondary recovery, gas cap injection to hold that injection above the pressures that would exist in the oil section.

Q I don't believe I understand you. You would advocate the injection of gas and the production of gas in the same area?

A I am not advocating.

Q Is that the essence of what you just stated?

A I think there will be some wetting of the gas cap sand by oil, if wells in the area of high gas saturation are produced.

Q Theoretically it is possible to produce them at a balanced state, is it not, where there would be no wetting if you can determine what that rate would be?

A Theoretically it is; practically, it is very hard to do.

Q And to be on the safe side, you could underproduce the gas and be assured of avoiding the wetting of sands?

A Well, of course, I don't think that you would necessarily be giving the people in the gas cap area --

Q (Interrupting) I mean discounting the possible violation of correlative rights.

A Yes, sir, it would improve, a gas expansion drive would certainly give you a higher recovery.

Q Mr. Gaines, I believe you said that you had certain leases, that Sinclair has certain leases, which you would advise your company not to develop in the event this Commission decides upon 40 acre spacing for the Bisti? A Yes, sir.

Q Do you likewise have some leases that you would advise them not to develop on 80? A Yes, sir.

Q Now, can you tell me what the difference is?

A Yes, sir.

Q I mean in terms of percentage or numbers, how much of the

pool are we talking about that wouldn't get developed at all if we go to 40 as compared to 80, obviously some of it wouldn't warrant development at any type of spacing?

A Yes, sir. Well, for instance, let's take one lease where we happen, well, let's just take the northeast quarter of Section 23, the Bittony NEZ lease there. One well had 16 feet of pay in it. This well that was over in the northwest quarter of Section 24 had six feet of pay in it. I don't think that we would be too pessimistic to say that the average pay over that 160 acre tract, that quarter section, would not exceed ten feet.

We did have control by the dry hole up in the southeast quarter of Section 14 on 80 acre spacing, you could drill a well that probably the well itself would never pay out, it might, you would be taking a risk on that, but at least if you average up the volume of recoverable oil that you could estimate under that tract with two wells I think we could make a reasonable profit. If we drill four wells, I don't think that we would recover our drilling costs.

Q Now, would you advise your company to drill a well anywhere in the north half of the northeast quarter of Section 23?

A Section 23?

Q It is the same area that we have been talking about, could you drill a well in the north half of that section at all under either type spacing?

A Well, I believe, are you speaking of the north half of the

southeast?

Q The north half of the northeast quarter of the section. You have one well in the southwest quarter of the northeast quarter?

A Well, that is the tract that I was speaking of.

Q Yes. Now, would you advise your company to drill a well in the north half of that northeast quarter of Section 23?

A Yes, sir, I would advise them to drill a well there if 80 acre proration units were established for the field.

Q How about the north half of the northwest quarter of Section 23, moving on to the east?

A No, sir, I would not on 80 or 40 acre spacing.

Q Now, would you drill a well in the southeast quarter of the northwest quarter of Section 24? An immediate offset to your, I guess that's a drilling well, isn't it, in the southwest quarter of the northwest quarter?

A Yes, sir. You did say the southeast quarter of the northeast quarter?

Q Yes, it would be an immediate east offset.

A No, sir, I wouldn't recommend a location to be drilled there.

Q Then there wouldn't be too much difference as to the undrillable leases as far as Sinclair is concerned, whether 40 or 80 goes into effect?

A In one instance there was and in the other one there wasn't a difference.

Q I missed the one where you were going to drill, that is the northeast quarter of 23? A Yes, sir.

Q You would drill it in the northeast quarter of the northeast quarter?

A Yes, sir, if we knew that we were going to be committed to two wells for that quarter section, I think we could justify drilling a well there.

Q Couldn't you expect a great deal more recovery drilling a well in the southeast quarter of the northeast quarter?

A From that particular well, yes, sir, comparing the two wells I think you would expect a greater recovery.

Q The point I'm trying to make here, Mr. Gaines, is that it seems to me in a practical operation that all of these fringe wells would be drilled as near the better part of the field as you can and dedicate the acreage on out in the poorer sections away from the trend to the west unless a complete strict type of spacing is enforced there. You could expect, as I believe you testified, considerably more recovery if you drilled your second well in the northeast quarter of 23 in the southeast quarter of the northeast quarter rather than the northeast quarter of the northeast quarter.

A That is considering only the comparison of the two wells that we are considering there.

Q What you can expect by comparison, it would be a better well?

A Yes.

Q You would have every expectation it would be a better well?

A Yes, sir.

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

MR. PORTER: Anyone else have a question?

MR. McGOWAN: I would like to ask a few on re-direct examination.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q In discussing the two well locations with Mr. Cooley in the northeast quarter of 23, you stated that a well on the south 40 acres would be a better well than a well on the north?

A That is correct.

Q Would you expect to recover any more oil from under that 160?

A I would think that the recoverable oil from beneath the 160 would be less than it would be, would be less if both wells were drilled in the 80 to the south than if one well was drilled in the south half of the northeast quarter and the other well were drilled in the north half of the northeast quarter, yes, sir.

Q In evaluating the lease, you are looking at, how you can get the most oil out of it with the least number of wells?

A That is correct.

Q When you talk about recommending wells or well locations to your management, you are talking about it from the purely economic

standpoint as calculated by you as an engineer? In other words, will it make a profit or not?

A Yes, sir.

Q Now, then, looking at the fringe areas again, obviously some of it, whatever portion it might be, would be developed on 80 that could not be developed on 40 from an economic standpoint, is that correct?

A I think that is correct.

Q Would you not also be justified in taking a gamble if you could hope to get all the oil out from under 80 acres on a well that you wouldn't be justified in taking if you had it restricted to 40 acres?

A Yes, sir, I think you would.

Q So what might not be a worthwhile gamble on 40 would be on 80? A Yes, sir.

Q Now, in talking about the wells that Sunray and Sinclair have drilled that they jointly own, all of those wells were at least 330 feet from the lease lines, were they not?

A Yes, sir.

Q That is what is presently and at that time were the requirements of the Commission? A Yes, sir.

Q I believe you stated that at least one of the reasons for so locating them was to avoid the gas cap area?

A I would imagine that that was one reason.

Q That is good conservation practice, is it not?

A Yes, sir.

Q Had the rules that you have advocated here today been in effect allowing us to attribute additional acreage to a gas well, it would not have been so important to do so, would it?

A No, it wouldn't. Assuming that the gas cap were being produced, however, there is very little gas being taken from the gas cap.

Now, just high ratio wells are the only ones that are producing the gas.

Q As to your recommendation for proration units in particular attention to the gas cap area, as I understood your recommendation, it was that the Commission establish 80 acre proration units for the entire Bisti-Lower Gallup Pool? A Yes, sir.

Q And that where a well produced at a gas-oil ratio of higher than 15,000 to 1, it be classified as a gas well?

A Yes, sir.

Q And that to such gas well there may be attributed up to four proration units, assuming those units were underlain by gas for allowable purposes? A Yes.

Q And that the allowable for the gas well would be calculated on the volumetric formula with a 2,000 to 1 limit gas-oil ratio?

A That is correct.

Q These three exhibits were prepared by you or under your

supervision, were they not? A Yes, sir.

Q To reemphasize, the two cross sections are to scale both vertically and horizontally? A Yes, sir, they are.

Q So they show the true dip and variation within the reservoir itself?

A Yes, sir, the horizontal and vertical scales are different, however they are scaled. They are both to scale, both horizontally and vertically.

MR. McGOWAN: I offer these three exhibits in evidence.

MR. PORTER: Without objection to the admission of the three exhibits, they will be admitted.

MR. McGOWAN: That's all.

MR. PORTER: Does anyone else have a question?

MR. SETH: I have a question that was brought up by reason of the re-direct examination.

RE-CROSS EXAMINATION

By MR. SETH:

Q I don't follow you, Mr. Gaines, on the reason why you would get more oil out of the northeast quarter of Section 23 by a well located in the northeast of the northeast?

A Yes.

Q Why do you say that, if you would maintain at the same time that one well will drain 80 acres?

A Well, I maintain that as you get to the flanks, towards the

flanks of this structure, you are going to get into tight sand and that certainly as you get into lower permeabilities your drainage radius is going to become less, and with two wells located on the south half of this 160 acre tract, your drainage radius would be considerably greater than it would be on 80 acre spacing actually to drain the whole 160 acre tract.

Q Your drainage area for your northernmost well would be less than the southern well, is that right? You say they are in tighter sands?

A Yes, sir, it would. It would have less drainage radius.

Q But you feel it would be a better well because it would have more acreage, is that right? Does that improve the well, Mr. Gaines, to have more acreage?

A I said the recovery.

Q Assigned to it.

A I believe I stated that the recovery from that 160 acre tract, and that is disregarding any drainage into that tract, any drainage situation that might occur, but the recovery would be greater with the location of a well in the northeast quarter of the northeast quarter.

Q Well, assuming, as you apparently did, that would be a mediocre well -- A Yes, sir.

Q -- you don't testify it becomes any better because it is on an 80 acre than on 40, or that it is more profitable on 80 than 40?

A I testified that a recovery would be greater if two wells, only two wells were drilled on the south half of the quarter section.

Q You would still, although it is in an obviously poor area, you would still attribute 80 acres to this well, is that right? You would assign 80 acres to it? A Yes, sir.

MR. SETH: That's all.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q Mr. Gaines, I think it's obvious that the assigning of more acres to a well will not make it any better well?

A No, sir, it will not.

Q If through one well you are allowed to recover the oil out from 80 acres, it is going to be more economical than if you can only recover the oil out from under it under 40 acres, would it not? A That is correct.

MR. PORTER: Mr. Cooley.

RE-CROSS EXAMINATION

By MR. COOLEY:

Q I'm confused, Mr. Gaines, I believe in answer to my question awhile ago you said a well drilled in the southeast quarter of the northeast quarter would be a better well than one drilled in the northeast, northeast quarter?

A Yes, sir, if you put the well on the pump or started producing it, it would be a higher capacity well, then certainly,

assuming that something unusual doesn't occur, than your well in the northeast quarter would.

Q Is the reason that your total production from the two wells would be, I think you testified that the total production from the two wells if they were located both in the south half of the northeast quarter, would be less than the total production from the two wells if one is located in the northeast quarter of the northeast quarter, is that your testimony? If one well is located in the northeast of the northeast quarter, will the combined production of the existing well and this new well we are talking about, northeast quarter of the northeast quarter be greater than the combined production from the two wells located in the south half of the northeast quarter?

A Yes, sir, it should be. We are not talking about rates. We are talking about ultimate recovery.

Q When I said better well, I was really referring to ultimate recovery. I possibly should have qualified my question.

A The ultimate recovery of the 160 acre tract should be greater if one well were located in the southwest quarter of the northeast quarter, another well located in the northeast quarter of the northeast quarter, than it would be if one well were located in the southwest quarter of the northeast quarter and the other well in the southeast quarter of the northeast quarter.

Q Is the reason for that that your well in the southeast

quarter of the northeast quarter will interfere or will drain some oil that the well in the southwest, northeast quarter would not have drained?

A Would not have drained you mean?

Q Would the well in the southeast quarter of the northeast quarter cut down the production that you could expect from the well in the southwest quarter of the northeast quarter?

A No.

Q It wouldn't, I don't understand that.

RE-DIRECT EXAMINATION

By MR. McGOWAN:

Q If you drilled two wells on the extreme southern edge of the 160, they would produce more oil than two wells drilled anywhere else on the 160, disregarding where the oil might come from, is that correct? A That is correct.

Q If you are attempting to recover the oil in place from under that 160 acres, then a well in the southwest 40 acres and the northeast 40 acres would come more nearly doing it?

A That is correct.

RE-CROSS EXAMINATION

By MR. COOLEY:

Q Did you mean anybody kicking back any oil that came from his well bore because it came from anybody else?

MR. VERITY: I take exception to that. We are trying to

establish a formula that will establish the greatest ultimate recovery from that pool.

A It would recover possibly more, less uneconomically.

MR. HUTTER: It is a matter of economics?

A Yes, sir.

MR. HUTTER: I think that four wells would probably drain more oil in that quarter section. However, we must take the matter of the economics of the thing into consideration.

MR. COOLEY: That concludes my questions.

MR. PORTER: Anyone else have a question? Mr. Utz.

By MR. UTZ:

Q Mr. Gaines, I believe you recommended a gas well over 15,000 GOR and up to 320 acres be dedicated to a well?

A Yes, sir.

Q Did you make any recommendation as to how the units would be dedicated to the well? In other words, by hearing of the Commission or by just purely a request of the operators as to whether you wanted to dedicate 80 or 320?

MR. McGOWAN: I think that is getting into a procedural question that our engineers should not attempt to answer. We feel that is a matter for the Commission's discretion as to whether they are going to have a hearing on each well or whether they want to do it administratively.

MR. UTZ: I will ask him another question to satisfy me.

Q Do you think, Mr. Gaines, it would be good practice to dedicate oil acreage to a gas well? A No, sir, I do not.

Q Then the dedication of acreage to the gas well should be

controlled quite closely? A Yes, sir.

Q Did you make any recommendation in your fixed spacing as to what part of the 160 acres the wells should be drilled in?

A No, sir.

Q Would you want to?

A Yes, sir. I think it would be certainly to the best advantage if each well were located in diagonal 40's within the 160 acre tract, it wouldn't make an awful lot of difference which way they ran.

Q The pattern is pretty well set up now, is it not?

A Yes, sir, I think so.

Q And to follow that pattern would be in accordance with your thinking? A I think so.

Q And did you make any recommendation, Mr. Gaines, as to what part of the 160 acres would be dedicated to each well, that is, the north-south, or east or west half?

A I have given that some thought. I don't know that I'm prepared to make a recommendation in that respect. However, I think certainly one thing that should be considered in the assigning of this acreage is the condition, or better, I might say the composition of the field, which is rather a long, thin field as far as the length and breadth goes. Also the gas cap possibly should have some influence on that too.

Q Do you agree that it would not be good practice to dedicate

dry acreage to an oil well? A Yes, sir.

Q Then the field being more east and west than it is north and south, would you say that there would be less danger of that if you dedicated the units to the south and north half?

A I think that that would certainly be a point in that dedication.

Q But you wouldn't recommend it?

A I think personally, I'm not speaking for my company, I can say personally that I would recommend it.

MR. UTZ: That's all.

MR. PORTER: Anyone else have a question of Mr. Gaines?

MR. McGOWAN: I might correct one statement for Mr. Gaines. He was speaking for the company.

MR. PORTER: Were you, Mr. Gaines?

A Yes, sir, I am.

MR. PORTER: I believe this is all the witnesses you have. The witness may be excused. We'll take a fifteen minute recess.

(Witness excused.)

MR. SULLIVAN: This is just in the matter of information. I don't think it needs to go in the record.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Sullivan, I believe you have one witness for British American. Would you have the witness stand and be sworn?

(Witness sworn.)

JOHN STEIN

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

DIRECT EXAMINATION

By MR. SULLIVAN:

Q Would you state your name, please?

A I am John Stein.

Q Are you a petroleum engineer?

A Yes, I am.

Q Have you previously appeared before this Commission in this cause?

A Yes, I have.

Q Was that at the hearing held on the application of Sunray Mid-Continent on September 18, 1957?

A Yes, it was.

MR. SULLIVAN: May this man's qualifications be accepted as an expert witness?

MR. PORTER: Yes.

Q Mr. Stein, since the hearing held in this matter in September, has the British American Producing Company conducted any tests and studies to determine whether or not 80 acre spacing is the proper spacing for the Bisti-Gallup Pool?

A Yes, we have.

Q Will you describe the nature of those tests and your

conclusions? A Yes, I will.

I have here on Exhibit No. 1 the results of some bottomhole pressure drawdown tests run by the British American Oil Company of two of our wells in the Bisti-Gallup Field, namely the Douthit B No. 5, located in the southwest of the northeast of Section 28, 26, I believe that is 12, 26 North, 13 West, and on the Douthit B No. 8, which is located in the northeast of the southwest of Section 27, 26 North, 13 West.

At the time we started these drawdown tests, all the wells had been shut in from seven to ten days prior to commencement of the drawdown tests. In particular, the Douthit B No. 5 had been shut in ten and a half days prior to commencing the drawdown tests, the Douthit B-8 had been shut in seven and a half days prior to the drawdown test.

We then initially took a bottomhole pressure on each of the wells, and approximately a day and a half later started producing the wells surrounding the Douthit B-5 and Douthit B-8 wells. Of course the Douthit 5 and 8 wells were left shut in during this time, and twice a day a pressure survey was taken on each of the wells.

The results of these pressures are shown graphically on Exhibit 1. The Douthit B-5 commencement of the test, the bottomhole pressure was 1078 PSI. Approximately a day, roughly two days later it was 1139½, a day later 1150, about four o'clock on the 12th, 1192, and it reached a stable peak at midnight and was 1195, then dropped

rather rapidly, at noon the next day, it was 1061, stayed fairly stable until the next day and a half and then dropped to 1031 PSI on noon of December 15 at which time we ran out of tank room.

The Douthit B-8 at the commencement of the test, the bottomhole pressure was 1036, then over two days it had built up to 1193, and then started a gradual drop 1173, slight build up 1178, very slight drop 1177, a fairly good drop to 1153, and then fairly stable pressure at 1162 to the end of the test at which time we ran out of tank and were unable to produce the wells any longer.

These drawdown tests, as I stated before, were conducted with these two wells shut in and the other wells producing.

Q Mr. Stein, have you indicated on this exhibit, this aerial exhibit on the right here, the wells to which you are referring in the exhibit to which we'll refer as British American No. 1. Have you indicated these wells on this aerial map?

A Yes, I have a circle drawn around them. I also described them in the testimony.

Q Thank you. Proceed, lease.

A Now, as a result of these drawdown tests we can certainly see that interference exists between these wells, between the wells shut down and producing wells, otherwise there would have been no pressure drawdown in these two particular wells. That certainly indicates to me that one well can drain substantially more than 80 acres.

Q In your opinion, Mr. Stein, what is the area, the demonstrative area of interference as indicated by these tests that you have just described?

A Well, I would take the minimum area which would be between the nearest offset wells, these wells being about 1980 feet from the center of each of the shutdown wells, would calculate out something about 280 drainage as the minimum.

Q What do you mean by minimum?

A Of course, there are other wells out here producing. I can't definitely say that the drawdown was caused in B-5, say, from B-13, it was a combining of all the wells, but let's take the very minimum conditions which is the direct offsetting of the wells. That would indicate 280 acres.

Q Then the minimum area of demonstrable interference is, as you have just indicated, at least in the immediate offset well?

A That is true. Of course, the maximum could be this large area here.

Q You need not volunteer that. Let's just confine ourselves to the minimum that we have shown. Mr. Stein, you have across the top of the room a long series of cross sections. Incidently, let us refer to Mr. Stein's Exhibit there, the first one he used as British American Exhibit No. 1. I believe it is the first exhibit we have introduced in this cause. Let us refer to your next exhibit then as Exhibit No. 2, and will you describe to the Commission what

it is, please?

A Exhibit No. 2 is a cross section of certain wells across the field that were cored or on which core analysis were available to me, and of course --

Q (Interrupting) At what time now, you say were available to you, when do you mean?

A Well, during the time I was making this study.

Q Is that since the hearing held in September on this matter?

A Yes, it is.

Q Thank you.

A This cross section was prepared to illustrate the continuity of the sand clear across the field, and this is done by plotting actual measured values of permeability from core analysis opposite each of these wells. It extends from the British American Douthit 11, which is in the northeast, northeast of 29 on across the field and ends up about at the extreme southern edge of the field in the Lion No. 1 Atlas, I believe it is called.

As you can see, we can trace permeability, measured permeability, through core analysis clear across this reservoir on every well that was cored, and at the first bench some measurable amount of permeability was found. To me this indicates that the permeability distribution across this reservoir is continuous.

Q To anticipate a question which I'm certain Mr. Seth will ask, these are all hung from some common marker and do not, on the

cores, and do not represent any tilt or angle to the strata, do they?

A No, these do not attempt to show structure.

Q I do that in the interest of time.

A It's an accepted method of determining or illustrating the continuity of sands across the reservoir.

Q Were you present when Mr. Brinkley testified this morning?

A Yes, I was.

Q Do you recall his Exhibit 8-R?

A Yes, I do.

Q Do you remember what the substance of that exhibit was, Mr. Stein, what did it represent?

A It represented that the pressures in the vicinity of the pilot project had built up considerably and thereby indicated a maximum area of drainage, I believe, in the neighborhood of 1500 acres.

Q Are you a member of the Engineering Committee which was formed to supervise and study the pilot injection program?

A Yes, I am.

Q Do you agree with the conclusions that Mr. Brinkley drew, based upon his Exhibit 8-R this morning?

A Yes, I do agree with him.

Q Do you recall generally, and would you so state if you do recall what the conclusions were? Be as brief as possible.

A He concluded that the gas injection here had caused t pressures to build up in all the wells in the vicinity here and that a maximum drainage area around this particular injection well could be in the neighborhood of 1500 acres.

Q And those are the conclusions with which you agree?

A Yes, I agree.

Q You testified, I believe, at the earlier hearing, that you were in concurrence with the recommendations made by Sunray Mid-Continent in support of their application for 80 acre spacing in this field, is that correct? A Yes, that is correct.

Q Have you changed your opinion with regard to that concurrence since the last hearing? A No, I have not.

MR. SULLIVAN: That's all, Mr. Chairman.

MR. PORTER: Anyone have a question of Mr. Stein? Mr. Cooley.

CROSS EXAMINATION

By MR. COOLEY:

Q Mr. Stein, how many pounds pressure buildup did you get from shutin in the two wells shown on your exhibit, what is the number? A Exhibit No. 1.

Q Exhibit No. 1.

A Yes. Well, it built during the time that the pressure survey was being conducted, pressure in the No. B-5 well had built up from 1078 to a maximum of 1192, and then leveled off at 1195,

1195 was the maximum.

Q And what was it, something over a hundred pounds, I didn't catch the figures.

A Yes, from 1078 to 1195 would be 113 pounds.

Q What did you get on your other well?

A It built up from 1036 to 1193 maximum.

Q What is the difference there?

A About 167.

Q Now, are these wells affected in any manner, in your opinion, by LPG injection project?

A No, they would not be affected, I don't believe, they are too far away.

Q I believe you stated you were present when Mr. Brinkley was testifying this morning? A Yes.

Q And in response to my question, I had asked him when a well was shut in, what happened to the pressure on that well.

A Yes.

Q He said it would stabilize. I asked him if it would build up and his answer was, I believe, in the negative. Have you found that to be true in your experiments in this field?

A Well, if a well has been produced for any length of time, of course it has a bottomhole operating pressure which is somewhat lower than the static pressure would be. Certainly when you shut that well in that well will try to reach its static pressure.

Q Then do you think --

A (Interrupting) It will be something higher than the bottom-hole operating pressure, of course.

Q Do you think that there might be a possibility that the shut in of the wells around the LPG project might account for the appearance of the pressure buildup?

A I do not, I don't think so in that case.

Q Why?

A It has been a long time since those wells were shut in, oh, 120 days at least, and any additional pressure they have gained has been due to the pressure built up in the pilot project. Perhaps in the first three or four days that they were shut in they probably got some pressure buildup and reached a static, and then from there on any pressure that was added in those wells had to come from the pilot injection project.

MR. COOLEY: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Malone.

By MR. MALONE:

Q Mr. Stein, referring to your cross section up there, did I understand you to say those were all based on core analyses?

A Yes, sir.

Q Not electrical logs?

A No, the electric logs were merely put on there so we could

show the sands themselves. It would be rather difficult to show sands in relation to each other just from a permeability profile.

Q You had how many core analyses to work from?

A Oh, I would have to count them across there. Well, there is nineteen represented here.

Q They extended the entire length of the Bisti-Lower Gallup Pool, did they?

A Well, I would say fairly well over the entire length, yes.

Q So far as I can tell from this distance, as you have colored that area of permeability that you have traced through there, you have found it to be a single area that is coextensive throughout, is that correct?

A I have only attempted to show the permeability continuity in the No. 1 bench of the sand. I did not attempt to show it in the other benches.

Q This is then a single bench?

A Yes, sir, that is correct.

Q You do recognize the existence of other benches that are not portrayed by this exhibit?

A Yes, that is true. There are other benches, you can spot them on here as you go along.

Q The continuity that you found to exist in this bench doesn't necessarily exist in the other, does it?

A It wouldn't be so indicated by this.

Q So your testimony with reference to the communication that would result, is limited to the single bench as to which this exhibit is prepared?

A Yes, sir, that is correct.

MR. MALONE: That's all.

MR. PORTER: Anyone else have a question? Did you wish to offer your exhibits in evidence?

MR. SULLIVAN: Yes, sir, if everybody is through. I submit British American Exhibits 1, 2 and 3 in evidence in this cause.

MR. PORTER: Without objection the exhibits will be admitted. The witness may be excused.

(Witness excused.)

Is there anyone else wishes to present testimony?

MR. KELLAHIN: If the Commission please.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: If the Commission please, Jason Kellahin of Kellahin and Fox, appearing on behalf of Phillips Petroleum Company. We will have one witness, Mr. Lewis.

(Witness sworn.)

E. F. LEWIS

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

DIRECT EXAMINATION

By MR. KELLAHIN:

Q Would you state your name, please?

A My name is E. F. Lewis.

Q By whom are you employed and in what position?

A I'm employed by Phillips Petroleum Company as a supervising area petroleum engineer.

Q How do you spell the last name?

A L-e-w-i-s.

Q Mr. Lewis, does the area under your supervision include the pool under consideration here, the Bisti-Lower Gallup Oil Pool? A Yes, sir, it does.

Q Have you previously testified before this Commission and had your qualifications as an expert accepted by the Commission?

A Yes, sir.

MR. KELLAHIN: If the Commission, please, Mr. Lewis has appeared in examiner hearings. If it is the desire of the Commission we will go through them.

MR. PORTER: If he has previously qualified before an examiner it wouldn't be necessary.

Q In connection with your duties, Mr. Lewis, as supervising area petroleum engineer, have you made a study of the Bisti-Lower Gallup Pool? A Yes, sir, I have.

Q What was the nature of that study?

A Well, the nature of the study was to examine the economics

of 40 acre spacing versus 80 acre spacing in an entirely new approach and specifically to apply to the question raised by the Commission Staff with regard to saturation gradients and pressure gradients as to the recovery under the two types of spacing.

Q In making this study, would you describe the methods which you used?

A Well, in very brief, the method is an application of a material balance method presented by Luper and Calhoun in their technical papers 25, 92 as published in the Volume 186 of the AIME transactions. This study further was modified by the use of Bisti crude properties.

Q Now, in connection with the use of these Bisti crude properties, have you prepared an exhibit showing what those are?

A Yes, sir, I have.

(Marked Phillips' Exhibit 1-R, for identification.)

Q Referring to the exhibit which has been marked as Phillips' Exhibit 1-R, would you state what that is?

A These properties shown in Exhibit No. 1-R are simply the variation in formation of volume factors, solubility, oil and gas viscosity and gas conversion factor as taken, being the average of two bottomhole samples, one taken on Sunray Mid-Continent Federal C-21 and the other was British American Marye B No. 1 well.

Q Now, Mr. Lewis, in making your calculations, what results

did you find in applying this method to the Bisti Pool?

A I found that, essentially, that the result of this calculation was that there was no effective difference between the ability of the well to drain 40 acres as compared to 160 acres, which was the spacing that I used for a particular purpose in this examination.

Q Now, referring to Phillips' Exhibit 2-R, would you state what that is?

(Marked Phillips' Exhibit 2-R, for identification.)

A Exhibit No. 2-R is a graphical portrayal of the saturation distribution as it would be in various stages of depletion in a 40 acre developed area as compared to 160 acre developed area.

I might, if I may, refer to the larger scale copy of that exhibit and briefly explain that this represents the saturation distribution, the heavy line represents the saturation distribution as it would be around a well drilled here, and the second well drilled at this position.

Q You say at this position, what do you mean by the two relative positions, Mr. Lewis?

A Where the two wells would appear they would be on 40 acre spacing. The dashed line represents the saturation distribution around the well bore on a single well drilled on 160 acre spacing at this common location here.

These three curves represent the saturation distribution at

three separate stages of depletion. The bottommost one being the distribution in effect at the abandonment pressure.

Q Which you show as 137 pounds per square inch, is that correct?

A Yes, sir, that is correct.

Q Is that exhibit in proportion, Mr. Lewis, in regard to its size?

A No, sir, of course the significant element in this saturation distribution in the exhibit is the shaded area here which represents the saturation sink which occurs by the drilling of this additional well as against a single well at this point, and of course at this final stage of depletion this relatively pressure sink or saturation sink represents then the difference in recovery which would occur as between the 160 acre well drilled at this point and the infill well drilled at this point.

Q The infill well being on a 40 acre pattern?

A The infill well being drilled on 40 acre pattern. This roughly two feet in height here represents something on the order of 27½% of the total pore space in the reservoir. If we were to represent all of the pore space occupied by oil in this reservoir by a graph, it would be approximately eight feet in height, which is a little bit impractical, it is easy to string them out, but you can't get them up quite that high.

Then with an exhibit eight feet in height, this shaded area

represents the difference in recovery that you would achieve with an infill well on 40 acre spacing.

Q Now, what percentage of the oil in place does the shaded area represent then, Mr. Lewis?

A According to my calculation it represents four hundredths of one percent of the total stock tank oil originally in place.

Q In making this calculation, did you take into consideration any pressure maintenance or secondary recovery process that might be effected?

A No, sir. To have considered that would result in, rather secondary recovery operation or pressure maintenance operation would nullify even that difference in ultimate recovery.

Q Now, have you made a calculation on a material balance method, Mr. Lewis?

A Yes, sir. I have made the calculation material balance performance on this field by the specialized method which I originally referred to, and that method, by its nature, permits one to compare the relative performance on 160 acre spacing versus 40 acre spacing or any other interval that one might wish to do.

In other words, this special adaptation of the material balance equation of Luper and Calhoun considers a bounded area and therefore you can evaluate the performance of whatever area you chose or, in fact, whatever rate of pressure drawdown that you might wish to impose on the reservoir.

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Q Now, is that information reflected on Exhibit No. 3-R?

(Marked Phillips' Exhibit No. 3-R, for identification.)

A Yes, sir, Exhibit No. 3-R is a plot of the gas-oil ratio and pressure performance, using the Bisti crude as applied to this Loper and Calhoun method, the gas-oil ratio is demonstrated by the curve beginning in the lower left-hand portion of the exhibit, and the pressure performance is that curve which begins in the upper left-hand portion of the exhibit.

Now, the several points, the different methods of indicating points at essentially the same spots on this thing represents the performance with the open circle on 160 spacing and the cross on 40 acre spacing. I think that the significant element here is that these points are in effect superimposed on one another and it would be impossible to draw or indicate a separate performance characteristic which would be attributed to the 160 as compared to 40 acre spacing.

Q Are we to understand this is a modified application of the material balance method? A Yes, it is.

Q Have you tested this calculation against the conventional method of arriving at a material balance curve?

A No, sir, I didn't personally make that comparison, but the authors in their paper made a comparison and I have taken a material balance calculation which was made in a completely independent

manner, and which predates both of these hearings and incorporated that as orr Exhibit No. 3-R-A I believe. That is a transparent overlay which when superimposed on this curve will show the agreement in the two methods.

Q Now, does this support then the validity, in your opinion, of your calculations?

A Yes, sir, it is my belief that it does.

Q Do you have anything you want to add to that, Mr. Lewis?

A No, sir.

(Marked Phillips' Exhibit 4-R, for identification.)

Q Now, referring to Exhibit 4-R, would you state what that is?

A That is a tabulation of the same data which is on this Exhibit 3-A on which the 3-R is based.

Q What are the significant factors that appear on that exhibit?

A Here again is the only point or the only manner in which we can see really the difference between 160 acre and 40 acre spacing and that is in the final point here at pressure decrement No. 7 we find the difference in recovery of four hundredths of one percent of the oil in place.

Q Have you calculated what that would represent in terms of barrels of oil?

A Yes, based on an oil in place figure of 220,000 barrels,

this would represent approximately 300 barrels.

Q Would that represent an increase in the cost of recovery as against the spacing on the 40 acres as against 160?

A Well, to express it in terms of development cost, this would require that we spend approximately $180.00 per barrel to develop this additional oil. That cost figure is based on a well cost of $54,000 conservative estimate of well cost, incidently.

Q Were you present at the previous hearing in this case?

A Yes, sir.

Q Was that approximately the well cost represented by the testimony of Shell's witnesses?

A As I recall, that was their estimate of the well cost including pumping equipment and a share of the lease facilities I believe they referred to.

Q Again, Mr. Lewis, does this calculation that you have made as to the amount of oil to be recovered, and the other testimony you have given on these exhibits, take into consideration the effect of pressure maintenance or secondary recovery?

A No, sir, it does not.

Q Does the calculation take into consideration the economic limits of oil production?

A No, it does not consider the effect of economic limits on oil recovery.

Q Now, what effect would a pressure maintenance program have

on this?

A It would tend to further minimize the difference in recovery between the 40 acre and 160 acre spacing patterns.

Q In your testimony so far you have referred to wells spaced on 160 acre spacing as opposed to 40 acre spacing. For what reason did you do this?

A Well, the purpose was to emphasize the lack of difference between recovery on the 40 acre spacing as opposed to some wider spacing, and also to highlight the fact that the distance that oil must travel from the limit of a drainage radius to a well bore is immaterial as to the amount of recovery that may be attained at a well, and also it follows that no matter how tortuous the path, the oil must follow in a low spacing to get to the well bore it will get there with no loss of ultimate recovery, or certainly very little loss.

Q Your answer to that question then, and the calculations which you have made, assume a continuous reservoir, do they not?

A Yes, sir. This material balance method, as in all other methods of evaluation in which gross reservoir properties are used, does require the assumption of continuity within the reservoir.

Q Now, have you made a study and have you had experience with sands of similar characteristics to the sands found in the Bisti Field in that connection?

A Yes, sir. In my personal experience I have observed a

number of reservoirs in which sands are of generally similar characteristic.

Q Now, you have heard the testimony in this case. In your opinion is it a practical thing to attempt to correlate sand continuity on the basis of the presence or absence of the showing of continuity on core data and electric logs?

A No, sir. In my opinion unless you have pressure interference data or some similar type of data, it is extremely hazardous to assume that you have either continuity or lack of continuity.

Q In other words, you would have to have some performance information to consider in connection with that?

A Yes, sir, with the one exception in considering that historically these fields in which we have variation in permeability and variation in an apparent lack of continuity that the reservoirs do perform as a homogeneous mass.

Q Now, what experience have you had that shows that?

A Well, the best example of that arose in the evaluation of a secondary recovery project in which Phillips was the operator in the North Burbank Unit of northeastern Oklahoma.

Now, this reservoir, as in Bisti, is a solution gas drive reservoir. The reservoir is an offshore bar deposit having generally similar sand and fluid characteristics to the Bisti Field.

In that study a series of injectivity profiles were run in injection or input wells and compared with permeability profiles

in the same wells, and in the course of these studies it was observed that there was little or no correlation between the injectivity profile and the permeability profile within the same well.

Q Is that shown on Exhibit No. 5-R?

(Marked Phillips' Exhibit 5-R, for identification.)

A Yes, it is. This is one of the number of permeability profiles that were run on wells in which there was core data available. This illustrates the lack of continuity of injection and the lack of correlation between input rate in a given foot of sand as compared to the permeability in that foot.

Q Well, did you have any experience in connection with this particular pool which supported your contention that it was a homogeneous reservoir?

A Yes, sir, I was employed as a reservoir engineer in this North Burbank District of Phillips for a period of a year and a half. I did not, however, participate in the actual running of these injectivity profiles.

Q What facts, then, supported your contention in that pool that it was the homogeneous reservoir, Mr. Lewis?

A Well, I would like to back off here just a minute, if I may, and further explain something about this peculiar performance that was observed here in this lack of correlation between injectivity profile and the permeability profile and state that in

view of this peculiar performance, our research department took a sample of a core from this well and drilled horizontally through this four and a half inch core sample and divided that cylinder into three separate permeability plugs and tested the permeability on those three small pieces and found that within that four and a half inch section that the permeability varied in the order of 300%, so that naturally disturbed them very much and led to a further investigation to see if this was a peculiarity of that particular four inch sample that they ran or whether it was more nearly characteristic of the nature of permeability itself. And they took then six inch by four and a half inch core section and divided that into forty-eight separate permeability plugs and tested the permeability on each of those forty-eight samples. The results of that detailed, more or less detailed, examination of this one small core sample is shown, I believe, in Exhibit 6-R.

(Marked Phillips' Exhibit 6-R, for identification.)

Q What is the significance of the figures shown on Exhibit 6-R, Mr. Lewis?

A Well, this exhibit, as I see it, illustrates that to take a single core sample from a foot of formation is rather grossly misleading and here we have within six inches a variation in permeability from nine-tenths of a millidarcy to twenty-eight millidarcies, I believe is the highest one shown in this series of

forty-eight samples.

The conclusion then, from this, is that it's somewhat presumptuous to assign permeability value to not simply the one foot vertical distance that is commonly done, but to also assign that same value to a length of 600 or 1300 feet or however far the distance may be between several wells.

So that a fallacy can arise from the use of the very small sample that is given a reservoir by the one sample per foot method.

Q Yet in spite of this wide variation in permeability, you found in this particular reservoir, did you find that it operated as a homogeneous reservoir?

A Yes, sir, this reservoir was a remarkable example of homogeneity despite the lack of continuity in this projectivity profile.

High permeability, the fact that it did behave as a homogeneous unit, was illustrated by the fact that in the area of which these wells are a part, approximately ninety-nine and three-tenths percent of the calculated fillup volume was required to be injected before any increase in oil was observed in the offset oil producing wells.

Now, that fillup volume, incidently, was calculated on the basis of all of the measureable permeable sand in the core sample.

Q Now, in your opinion is this situation similar to the situation that you have found in the Bisti Pool?

A Yes, sir. It is.

Q Are we to infer from what you have said that you do not agree that there is a continuous sand body across the reservoir?

A That I do not agree there is a continuous sand body.

Q The fact that you have shown there may be a discontinuity of permeability, are we to infer it is not a continuous reservoir then?

A No, sir, I would not infer it is not a continuous reservoir because of the lack of continuity of permeability illustrated in the several core samples or core information that has been presented here and because of the fact that you can't correlate specific elements within the gross sand interval, it's my belief that as a result of this work that it is all you have to prove to establish that the reservoir will behave in a homogeneous manner, is that you do have continuity of the gross interval.

I think I might add that the gross, the existence of a gross interval of continuity has been proven here, and certainly it was our intention to prove that and further that continuity has been indicated by the interference tests introduced in evidence here despite this apparent lack of homogeneity and despite the fact that you can't take individual elements of the sand and correlate them from well to well.

Q Now, on the basis of your study of the Bisti and on your experience in other areas, what are your conclusions then, Mr. Lewis?

A Well, it is my conclusion that the effective continuity does exist within this reservoir and that one well therefore will economically and efficiently drain 80 acres.

Q And is that your recommendation to the Commission then?

A Yes, sir, it is.

Q Do you have anything further you want to add to this?

A Well, I believe that my thoughts in the matter are rather well summed up by a report on well spacing by the Research and Coordinating Committee of the Interstate Oil Compact Commission, made September 10, 1951 at a meeting of the Commission. I would like to, if I may, quote several of the conclusions of that Committee which I believe fairly represents my thoughts on the matter.

The first of these is that, and I quote, "While porosity and permeability in most fields are known to be irregular and to lack apparent continuity, fluid flow performances are much the same as if discontinuities did not exist. In either solution gas-water drive or combination drive reservoirs, the production of oil is independent within reasonable limits of well density. Where land lease controls permit, new oil fields could be first developed on wide spacing patterns, final well density and other development and production practices could then be determined in the light of geologic engineering and economic information development."

Q Mr. Lewis, to go back in your testimony a ways to a point I think we overlooked, you stated I believe that you did not take

into consideration the economic time element in connection with your calculations, is that correct?

A The original statement as to the amount or the difference in recoverable oil as between 40 and 160 acre spacing did not consider the economic time of depletion. I did, however, for the purpose of illustration, assume that we might be forced in consideration of economic rates of production, to abandon the reservoir at somewhat higher pressure than we would under 40 acre development, and in that example I used a depletion pressure of 175 pounds.

From Exhibit 3-R. The recovery at that point, as I remember, would have been 19.6% of the original oil in place, and the difference then in recoverable oil would have been 1800 barrels on 80 acre spacing versus 40 acres spacing under those conditions and the development cost of that oil, using the same well cost value would be approximately $30.00 per barrel.

MR. KELLAHIN: That's all the questions we have. Thank you, Mr. Lewis.

MR. PORTER: Anyone else have a question of Mr. Lewis? Mr. Seth.

CROSS EXAMINATION

By MR. SETH:

Q Mr. Lewis, in your calculations, they were of course made on the assumption that it was a homogeneous reservoir?

A Yes, sir.

Q I conclude from your subsequent statements that it doesn't make any difference in these calculations whether it is homogeneous or not?

A No, sir, I don't believe, it certainly wasn't my intention to convey that.

Q I thought you testified that the performance would be, you would expect the same performance where it was homogeneous or heterogeneous.

A No, sir, my intention was to make it clear that reservoirs behave as a homogeneous unit whether they appear to be heterogeneous or discontinuous or not.

Q Then you speak of the performance then as the same whether it is heterogeneous or homogeneous?

A In that sense, yes, sir.

Q Then you would in this particular case, I had a little difficulty in following when you were testifying about the Oklahoma field, and in this field, in this particular field you would ignore the facts if they be established that there are isolated areas in the pool that would be productive of oil, in arriving at these calculations?

A Well, sir, I don't know that we have gotten into the question of isolated areas within the pool as yet.

Q Well, that was part of the heterogeneous nature of it, perhaps I am mistaken in my terms, if there are wide variations in

permeability which result in isolated sand members, would you ignore that situation in these calculations that you have made?

A Well, it is my contention that the wide permeability variations do not result in isolated --

Q (Interrupting) Then you haven't considered that, is that your answer?

A (Continuing) -- areas.

Q So I understand since you do not believe they occur, you have not considered them?

A My experience leads me to ignore them, yes.

Q Then you have ignored them, have you or haven't you?

A Well, fundamentally this method -- this method dictates that you must ignore isolated elements in the reservoir if these isolated elements, in fact, exist. My experience, however, dictates that there are no such things, generally there are no isolated elements in the reservoir.

Q Your answer is that you have ignored them as far as the Bisti Pool is concerned?

MR. KELLAHIN: I submit he has answered the question.

A I don't believe, if I understand all this thing correctly, I don't believe that I want to say that.

Q I'm not trying to lead you into anything. You said your experiences lead you to ignore it, but you would never answer my question. If your experience would lead you to ignore it, did you

or didn't you ignore it?

A Might I say that I don't recognize there are separate elements in this field.

Q They don't make any difference as far as the calculations are concerned? A No, sir.

Q You have also ignored the time factor too, is that correct? I believe in response to Mr. Kellahin's question that the time of recovery does not enter into this picture as far as your calculations are concerned.

A No, sir, it does not. However, the last question that Mr. Kellahin asked brought out that we did make a separate calculation considering to some extent the difference in recovery that would result from economic timing.

Q Yes. Are you in the economics department of Shell Oil Company? A No, sir.

Q I didn't get your qualifications.

A I am not with Shell. I might listen to an offer. I am in the production department.

Q You are in the production department?

A Yes.

Q You would precede your statement that you made an approach to the economics of it, what is the new approach, is that the proposition whether it is heterogeneous or homogeneous doesn't make any difference?

A No, the approach is something that I don't believe was brought forth in the last hearing, that I have attempted to show mathematically that there is no practical difference between the recovery on whatever spacing you might choose to institute here.

Q And your study data took you into the core analysis and that type of data? A I didn't hear you.

Q Did your study of the field take you into the matter of core analysis, core data, or wasn't that necessary for, did you ignore that also?

A It is not necessary to the method that I go into detailed examination of the core data, no, sir.

Q You didn't do it then, is that right, if it is not necessary?

A I didn't do it in respect to this particular calculation I made.

Q It doesn't enter into the material you presented to the Commission today?

A It doesn't enter into the material balance method of calculating oil in place.

Q Does Phillips follow a method of sampling cores every foot or every two feet, what is the practice?

A Every foot. One sample per foot generally.

Q Do you still follow that practice although you are inclined to cast some doubt on it, is that correct?

A Yes, sir.

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

MR. PORTER: Mr. Malone.

By MR. MALONE:

Q Mr. Lewis, with reference to this North Burbank Pool in Oklahoma, I understand that you find a marked similarity between that pool and the pool under consideration here?

A A general similarity, yes.

Q On what spacing pattern is that pool developed?

A Ten acre.

Q With reference to the experiments that were conducted by your company on the core samples, that resulted from your having encountered quite an unusual condition, did it not?

A Yes, sir.

Q And because that condition was so unusual, you performed a number of experiments which you would not normally have performed in the course of the operation you were conducting?

A Yes, sir.

Q You concluded from those experiments, conducted in this unusual situation, that to all intents and purposes the Commission in this case would be justified in disregarding permeability entirely in the treatment of this reservoir, is that a correct conclusion?

A Well, I wouldn't want to go quite that far, not entirely certainly, since we must have some permeability in order to be able

to produce oil.

Q And in determining the characteristics of the reservoir and the manner in which the greatest ultimate recovery can be obtained, it will be appropriate for the Commission to give some consideration to the permeability situation found to exist, will it not?

A Yes, sir.

Q In suggesting that a wide variation in permeability and a great reduction in permeability may be ignored, is there any limit to that? In other words, if we have a, let's say a fifty foot section of extremely low permeabilities, do you mean that its effect on the performance of the reservoir would be different than if it was only ten feet?

A I don't know that I understand exactly what the meaning of your question is. Certainly a well with fifty feet of permeability one-tenth millidarcy is going to have some difference in flow characteristics than one having ten feet of permeability of the same permeability in forty feet as some other permeability.

Q It is true that we spent quite a bit of money fracting wells to improve the permeability even though it may be disregarded, isn't it?

A I don't know whether I want to go all the way along with you or not. We did spend a lot of money fracting wells, that is true.

MR. MALONE: Thank you.

MR. PORTER: Anyone else have a question of the witness? Mr. Nutter.

By MR. NUTTER:

Q Mr. Lewis, this Exhibit 5-R, is this a portrayal of the input rate and the permeability of this North Burbank Unit Well No. 127W8 or it is a North Burbank Unit Well, isn't it?

A These wells are in the same, they may not be the same well. I failed to check that particular point when I got these exhibits together. They are in the same, I believe 90 to 120 acre area, however.

Q Well, whether it is the same well or not, it is immaterial. This is the North Burbank Unit Well?

A Yes, sir.

Q First of all, how did you determine the input rate per foot in this well?

A We used a device, an instrument that has been developed by Phillips' Research Department. I don't know whether I can explain exactly how that works or not or whether my research people would want me to explain how it works, since I think that some features of it are patentable, but it was, part of this study was intended to give this injectivity profile instrument a marketable quality and that's part of what generated our interest in why the injectivity profile didn't agree with the permeability profile.

Q Did you ever solve the reason why the bulk of the water

that finds its way in the reservoir is opposite the zones of low permeability?

A We believe we found the answer to it in the detailed core study which is Exhibit 6-A which indicates that you don't have the same permeability across four inch increment, that you can't presuppose that because the sample that you have at hand has a permeability that it's applicable to the next inch or the next foot or the next 600 feet of formation away from this thing.

Q But a zone of measureable permeability such as from 2980 feet to 2985 which has reasonably high permeability and yet a low injectivity, does this detailed analysis of small cores account for something like that?

A It's our thought that it does, yes, sir.

Q Did you attempt to measure the permeability in a well before you perforate that well?

A Do we attempt to?

Q Yes, sir. By logs or any such means.

A I don't believe we do ordinarily, no, sir. The permeability data is not available until after the fact, so to speak.

Q Well, isn't a microlog an indication of permeability in some cases?

A In a general sort of way.

Q You attempt to determine permeability where you have one according to the law? A Yes.

Q So if where you can have high permeability or high injectivity and conversely a high rate of output on a producing well in a zone with low permeability, you probably attempt to perforate where high permeability is indicated, don't you?

A We're just delighted to get any permeability, and we perforate anything, generally anything that looks good either on these micrologs or the other log characteristics which are not quite as definitive as the microlog is.

Q I see. Was any section of this well on this exhibit stimulated in any way to affect the injectivity?

A No, the only treatment that was given the well, to the best of my knowledge, was a small slack period with perhaps a small acid treatment to relieve any mud effects on the well bore itself.

Q None of this stimulation could have affected the reservoir opposite the well bore?

A Not to a material degree, no, sir.

Q What was that last document that you read from which summarized your thoughts on the subject?

A The report by the Research and Coordinating Committee of the IOC Commission, made at their meeting of September 10th, 1951.

Q The first paragraph that you read, would you read that again, please?

A "While porosity and permeability in most fields are known to be irregular and to lack apparent continuity fluid flow performances

are much the same as if discontinuities did not exist."

Q Did the Research and Coordinating Committee attempt to explain that phenomena?

A I don't know. I believe that there are several references throughout this thing to experiences in which heterogeneous reservoirshave performed as though they were homogeneous.

Q On your Exhibit 2-R where you show a very small difference in the production of oil from a hundred sixty acre spaced well to a forty acre spaced well, does that take into any account the time that these infill wells may be drilled or Exhibit 3-R, is the time in which the infilled wells are drilled considered at all?

A No, sir, I believe it would be immaterial.

Q It would be immaterial? A Yes, sir.

MR. NUTTER: Thank you.

MR. PORTER: Anyone else have a question of the witness?

MR. KELLAHIN: If nobody else does, I do.

RE-DIRECT EXAMINATION

By MR. KELLAHIN:

Q In response to the question by Mr. Malone as to whether you disregarded permeability in your calculation, actual performance as demonstrated by interference is of more importance in your opinion, is that correct?

A Yes, sir, I think that is the critical evaluation of that.

Q We are not to infer from your testimony that you would

greatly disregard the factor of permeability in connection with your testimony, are we?

A I don't believe that we can completely disregard it.

Q Would it be correct to say that your testimony goes to the effort to correlate permeability as between wells and across the field rather than a recommendation that permeability be ignored?

A Certainly I wouldn't recommend that permeability be ignored. I think it's my intention that it was to set forth that specific intervals of permeability need not be correlatable from well to well in order to show continuity from well to well.

Q Were the exhibits which you have used in this testimony prepared by you or under your directions and supervision?

A Yes, sir, they were.

MR. KELLAHIN: At this time we offer in evidence Phillips Petroleum Company's Exhibits 1-R through 6-R inclusive.

MR. PORTER: Without objection these exhibits will be admitted. Does anyone else have a question of the witness?

RE-CROSS EXAMINATION

By MR. COOLEY:

Q Your material balance calculations assume throughout that one well will drain 160 acres, do they not?

A They don't assume, they are intended to prove that they will develop or rather drain 160 acres.

Q They are intended to prove it? A Yes, sir.

Q By what manner? A Well --

Q Can you sit down with a pencil and prove it will drain 160 acres?

A That is what I have done, mathematically proved that one well will drain 160 acres.

Q I don't understand from your figures how you can assume that one well will drain 160 acres.

A It isn't an assumption any longer. As far as I'm concerned, it becomes a fact that according to the mathematics and the mechanical and physical principles involved, that one well will drain 160 acres.

MR. COOLEY: That's all.

MR. PORTER: Does anyone else have a question of Mr. Lewis? The witness may be excused.

(Witness excused.)

MR. KELLAHIN: That's all we have, Mr. Porter. Thank you.

MR. PORTER: Is there any other Applicant in this case that has testimony to present?

MR. BUSHNELL: H. D. Bushnell, attorney, representing Amerada, co-Applicant. We have one witness and four exhibits which we don't have enough copies to pass out to all those who might like a copy, and therefore, we would like to take a couple of minutes to post them on the bulletin board.

MR. PORTER: Take a couple of minutes, we will take a

five minute recess.

(Recess)

MR. PORTER: The meeting will come to order, please. Mr. Bushnell, will you proceed.

MR. BUSHNELL: Amerada has one witness to be sworn in.

(Witness sworn)

R. S. CHRISTIE,

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

DIRECT EXAMINATION

BY MR. BUSHNELL:

Q Would you state your name and the company by whom you are employed?

A R. S. Christie, Amerada Petroleum Corporation.

Q And in what capacity are you employed?

A Petroleum engineer.

Q And you have testified before this Commission on prior hearings, is that right? A Yes, I have.

Q Mr. Christie, will you go up to the blackboard and point out Amerada's Exhibit 1-R and state what it purports to show.

A Exhibit 1-R is drawn to represent the development of a 640-acre section based on the statewide field rule, or statewide rules. To be specific, that is 104-C. The dots represent the wells 330 feet from the corner of each quarter quarter section, if we assumed that one well will drain only 40 acres. The stippled

area represents that area which will not be drained by this sort of development.

Q Now, how many acres is represented by the stippled area showing undistributed area or acreage area?

A The undistributed area, assuming that one well will drain only 40 acres, represent 280 acres.

Q So that means that 280 acres would be undeveloped or undisturbed?

A Yes, sir.

Q Now, this plat, or Exhibit No. 1-R, does not purport to represent the development of any particular field, is that right?

A No, sir.

Q Now, refer, Mr. Christie, to Amerada's Exhibit 2-R. Would you state what that represents?

A Exhibit 2-R indicates the same thing except that the wells indicate that they are draining ratably as we would expect, of course, in any well, so that in this case, we also have a stippled area that represents essentially the same thing as in Exhibit 1-R. I think actually it is about nine acres less.

Q Approximately nine acres less of the undisturbed area than that represented in Exhibit 1, is that correct?

A Yes, sir.

Q Now, Mr. Christie, do you conclude from these two exhibits that any well pattern that locates the wells as close as 330 feet from the outside boundary line prevents the full development of the pool unless each well drains in excess of 40 acres?

A Yes, sir, I do.

Q Now, would you refer to Amerada's Exhibit 3-R and state what that purports to show?

A Exhibit 3-R is intended to show the drainage area of uniformly spaced wells on 80 acre spacing.

Q And that is on the assumption that those wells are located on the center of each alternate 40-acre tract, is that correct?

A Yes, sir.

Q Now, how many acres is represented in the stippled area which purports to be the undisturbed area?

A The total undisturbed area? On Exhibit 3-R it is 57.9 acres.

Q And how does the size of that undisturbed area of 57.9 acres, as shown on Amerada's exhibit, compare with the size of the undisturbed area assuming a 40-acre well development pattern, and that such 40-acre wells were located in the center of each 40-acre drilling unit?

A It would be exactly the same. In other words, if you drilled the section up on a 40-acre basis with the wells located in the center of the 40's, you would have an undisturbed area of 57.9 acres.

Q Now, Mr. Christie, refer to Amerada's Exhibit 4-R and point it out and explain what that purports to show.

A Exhibit 4-R simply shows the development of a section with the wells located similiarly as in Exhibit 3-R and showing the

units running north and south.

Q And such wells are located in the center of the alternate 40-acre tract?

A Yes, sir. And in this case we would have no undisturbed area.

Q Now, is it your conclusion from these four exhibits that if a well will drain 80 acres, the infill wells are unnecessary to develop such a pool?

A It is my conclusion, yes, sir.

Q Were these four exhibits prepared by you or by some one under your supervision? A Yes, sir.

Q Now, Mr. Christie, if you will return to your chair, please. Are you acquainted with the provisions of this Commission's Order R 106, dated October 9, 1957?

A Yes, sir.

Q Is it your understanding that the effect of this order is to authorize the location of wells in the Bisti Pool as close as 330 feet from the boundary line of each 40-acre drilling unit?

A The order would permit that, yes, sir.

Q Is there any findings in this particular order that a well completed in this Pool will effectively and efficiently drain any number of acres? A No, I believe not.

Q Assuming that a well completed in this Pool will effectively and efficiently and economically drain 80 acres or more, in your opinion, will development on an 80-acre well spacing pattern

drain this pool just as adequately as development on the basis of a 40-acre well pattern development?

A Yes, I do.

Q You have heard the testimony and reviewed the exhibits presented at this hearing by the applicant today, is that correct?

A Yes, sir.

Q Based on that evidence and testimony, in your opinion, can the Bisti Pool be adequately developed on the basis of an 80-acre well pattern? A Yes, sir.

Q Do you wish to state anything else or make any other conclusions, Mr. Christie?

A Well, it is not my intention to suggest that the statewide rules be changed. I think they are perfectly adequate to develop any oil field we have, and I think the spacing is probably immaterial since one well will drain, as has been testified, as much as 160 acres, so that the spacing is not material, and the advantage of having the flexibility of a 330, I think is proper also. What I probably intend to show here is that the Commission itself apparently realizes or recognizes the fact that, by their own order, one well will drain more than 40 acres in this field, or any other field for that matter.

Q Now, is it your opinion that one well will drain a minimum of 80 acres in the Bisti Pool? A Yes.

Q And is that the opinion upon which you have now reached the conclusion that this Bisti Pool can be adequately developed on

the basis of an 80-acre pattern development?

A Yes, sir. There has been quite a bit, if I may add -- There has been quite a bit of discussion on how much one well, or what area one well will drain, and I have a report here that I would like to submit to the Commission, if they would like to have it. I would like to read from that report the following exerpt which is very short. This is a report by W. O. Keller and F. H. Calloway. It is titled, "Critical Analysis of the Effect of Well Density on the Recovery Efficiency," and they have found by their experiments and by their work that a hundred and sixty acre spacing, the recovery based on the percent of original oil removed would be only 16.2 percent or would be only 16.2 percent. Now, on an 80-acre basis, the recovery of the percent of the original oil in place would be 16.3 percent. In other words, they found that there is only one-tenth of a percent difference between recovery on an 80-acre and 160-acre tract, and they have continued that on to two and a half acres where they get only 16.93 percent recovery on a two and a half acre basis, and if the Commission would like to have a copy of that, I will submit it for the record.

MR. BUSHNELL: I suppose that should be shown as Amerada's Exhibit 5-R, then. I believe that is all I have.

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

MR. SETH: On your Exhibit 2, if the Commission should require that the well be drilled in the center of a 40-acre tract, would you have any estimate as to --

A I gave that, Mr. Seth, I believe. It would be exactly the same as an 80-acre basis or 57.9 acres.

MR. PORTER: Does anyone else have a question? The witness may be excused.

(Witness excused.)

MR. PORTER: Mr. Bushnell, would you like to move the admission of your exhibits?

MR. BUSHNELL: Yes, I move that Amerada's Exhibits 1-R through 5-R be a part of this record.

MR. PORTER: Is there objection to Amerada's Exhibits? They will be admitted.

Are there any other of the applicants in the case that would like to present testimony?

MR. WHITE: At this time Sunray would like to incorporate by reference the statement made by John Woodward in the consideration of the oil allowable for the Month of December as the statement was given November 14, 1957.

MR. CAMPBELL: Would you mind restating that, Mr. White, incorporate by reference the statement of John Woodward in consideration of the oil allowable for the month of December?

MR. MALONE: Was he under oath?

MR. WHITE: He was under oath.

MR. COOLEY: What is the significance?

MR. MALONE: I object to it, if the Commission please.

I don't know what the statute says, but apparently it has no relation to this hearing. I am sure there are parties who are interested in this hearing who were not present at the time he testified. If there is anything Mr. Woodward could testify to that would be pertinent to this case, he should be presented as a witness so that he would be cross examined by the interested parties.

MR. WHITE: If the Commission please, we think it is very significant as to the economics involved in this hearing, the question of a person being required to go through the cost and expense of drilling on a 40-acre tract in consideration of the probable market demand that might be available to him. Mr. Woodward brought out very clearly that the filling of the pipeline will take until about the middle of February. It is an artificial false market, and also he further stated that it would take more than a crystal ball to even estimate what the market demand on the West Coast might be for New Mexico crude oil. He also brought out that --

MR. SETH: If the Commission please, I believe counsel is virtually stating the contents of the statement, and I think it should be in or out.

MR. WHITE: Mr. Cooley asked what the significance was. I would like to state what material parts of the statement might be --

MR. PORTER: Just one moment, Mr. White.

MR. WHITE: And I might state that as far as Mr. Malone's objection is concerned, there were some twelve representatives of Shell and about four or five representatives of Gulf present at this hearing. It certainly has material bearing on economics in this case. Mr. Malone was present and also Mr. Seth.

MR. MALONE: Can you assure me that I was in the room when the testimony occurred?

MR. PORTER: The Commission rules that the counsel's motion for the incorporation of Mr. Woodward's testimony and statement into the record is overruled or denied.

MR. CAMPBELL: May I inquire the basis for that? Is it because it is immaterial?

MR. MURRAY: Mr. Campbell, I think we have considered some of the testimony Mr. Woodward gave as pertinent to this case, but his entire statement is not to be considered in this case, and if counsel wants to develop similar information insofar as being pertinent in this case, that's his opinion.

MR. WHITE: Can I renew my request to incorporate the record as it appears on Page 39 through 42.

MR. SETH: If the Commission please, we know it is clearly hearsay, because he is not here to be cross examined, but it is simply that, instead of incorporating these statements in other cases, where some of the parties were present and some weren't, and considering them as part of the record in this case as if

given under oath here, there is no opportunity for cross examination, and it is hearsay.

MR. WHITE: Mr. Seth representing Gulf and Ross Malone representing Shell or vice versa are in a position to raise the point, but it is inadequate, that they weren't present, but they were in fact present at the hearing, and I believe the rules permit the admission of statements. They have been read all the time in these hearings, telegrams, and otherwise.

MR. MALONE: We would renew our objection to this further offer, and we would like to point out in connection with it, that counsel says that he wants to put in Mr. Woodward's evaluations of the California market situation. Now, if we had had any idea that that was going to become pertinent in this case, we certainly would have cross examined Mr. Woodward to see if he is an expert and able to testify in the California market situation. We were sitting out in the audience waiting for another hearing to come up, and having no interest on his testimony at that time, we, of course, did not cross examine him at that time.

To permit testimony to be introduced when the witness is not available for cross examination is contrary to any principal of either administrative or judicial hearings that I know of.

MR. PORTER: The Commission's ruling denying your motion extends to all of his statement.

MR. WHITE: In view of the Commission's ruling, I will

request that the Commission take administrative notice of its records and particularly the statement made by Mr. Woodward on Page 39 through 42. That's the testimony in consideration of allowables for December, 1957.

MR. PORTER: The Commission will do so.

MR. WHITE: Thank you.

MR. MALONE: What was the ruling, please?

MR. PORTER: The Commission will take notice --

MR. COOLEY: Take administrative notice of its own records.

MR. MALONE: I don't want to labor this point, but the Supreme Court of New Mexico has held that for a Commission to take into consideration, in deciding a case, material which was not presented in the hearing and to which no opportunity was afforded for cross examination, is reversible error, and I hate to see the Commission put in the record the fact that it is going to do something that the Supreme Court of New Mexico has held improper.

MR. SETH: If the Commission please, this might simplify the question. We have no objection if Mr. Woodward would like to write the Commission a statement, a letter, and the Commission give the letter consideration and give consideration to the statement given in this matter. Our objection is considering it as part of the testimony. The Commission as you all know received statements, and we have no objection to that. If Mr. Woodward wants to write a statement with the same material, that's all

right with us.

MR. MURRAY: That is the light in which we were going to consider it.

MR. SETH: Mr. White is asking it be included as part of the testimony and as part of the sworn testimony.

MR. WHITE: As a mere statement of Mr. Woodward, that's all we care about it.

MR. SETH: I don't think there is any probability it can, as far as I can see. We don't know whether Mr. Woodward wants this in or not. Maybe he doesn't, but if he is prepared to write a letter on it, we have no objection.

MR. McGOWAN: If the Commission please, in taking administrative notice of your records, and you are not making it a part of the record in this case, the only way there is any objection, or any objection can be made, is if you made a decision on taking administrative notice on facts clearly outside the case. You have to take administrative notice of your own regulations and records, and that's all it amounts to.

MR. PORTER: The Commission will stand on the ruling. I believe that I requested the other applicants in this case to come forward with testimony, if they had some to present at this hearing, and nobody took advantage of it.

If there is nothing else at this time, the hearing will recess until nine o'clock tomorrow.

MORNING SESSION

Friday, December 20, 1957

MR. PORTER: The meeting will come to order, please. At this time we will continue with Case 1308.

MR. WHITE: May the record show that I'm also appearing on behalf of The Texas Company at this time?

MR. PORTER: Mr. L. C. White, appearing on behalf of The Texas Company.

MR. COOLEY: Mr. Commissioner, at this time I would like to move the Commission to reconsider its ruling of yesterday on the question of whether the Commission will take administrative notice or judicial notice of previous separate cases heard by this Commission. I believe I found the rule of law to be that the Commission can not take judicial notice of records in another and different case.

MR. POPTER: Mr. Cooley, you refer to the Commission's action of yesterday in taking administrative notice of Mr. Woodward's statement in the previous case?

MR. COOLEY: Yes, sir.

MR. PORTER: The Commission hereby reverses that ruling. We will not take administrative notice of Mr. Woodward's statement. Mr. Seth.

MR. SETH: If the Commission please, we would like to start Shell's case in opposition to Sunray's application for the

change in the statewide rules. I would like to enter the appearance of Mr. Leslie Kell with Shell Oil Company, and Oliver Seth as attorneys. We would like to call as our two witnesses Mr. Methven and Mr. Lindsay who have both previously testified before the Commission.

MR. PORTER: Will the witnesses stand, please, to be sworn.

(Witnesses sworn.)

MR. SETH: Would you take the stand, Mr. Lindsay?

DONALD R. LINDSAY

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Lindsay, and your position with Shell Oil Company?

A Donald R. Lindsay, I'm an exploitation engineer with the Shell Oil Company. I would like to mention that my specialty in that classification has been production geology. I think I failed to say that at the first hearing.

Q You are the same Mr. Lindsay who testified at the original hearing in this case? A I am.

Q Would you please go to Shell's Exhibit 1-R and make your preliminary observations?

(Marked Shell's Exhibit 1-R, for identification.)

A Shell's Exhibit 1-R is a structure contour map of the Bisti Field, and it is a different one than we presented at the first hearing in that it covers the entire field instead of just a portion of it, and it has been contoured on Marker GC which is the highest producing oil productive sand in the field rather than on Marker GA as the previous map.

On this map we have in red lines section lines for new sections which we have constructed for this hearing. In the northwest part of the field are sections GH and IJ, in the central portion of the field are sections KL, MN, and OP. Farther to the southeast is Section QR and in the southeastern portion of the field are sections ST and UV.

We have left on this map, or have shown on this map, section lines AB, CD and EF, which were presented at the first hearing, and we have left them on this map so their locations can be noted. As in the previous case we still maintain that this is a stratigraphic type trap and that structure is not the most critical factor as far as oil accumulation goes, but it does seem to be a factor in the southeastern part of the field in the upstructure portion of the field where there is gas produced.

We have not changed our views on the fact that there have been gas wells completed downstructure from oil wells with no structural explanation for this. I refer to Shell Government 21-22A in Section 22, 25 North, 11 West which was completed as a gas well

at a structural elevation at Marker GC of 1565 feet above sea level.

There are a number of oil wells to the west and upstructure from this well which are completed in the same zone and which are oil wells. I won't take the time now to enumerate all of them, but will do so if requested. I refer also to Shell Carson 32-20 in Section 20, 25 North, 11 West which has also been completed down-structure in the same sands and with no structural reason for this well to be down structure from oil wells. To summarize our views on this, we think these wells which have been completed since the last hearing tend to strengthen our belief that this field does not contain one simple gas cap but a number of gas producing sands which are isolated from upstructure oil-bearing sands.

Q Have you constructed a petrophysical chart based on additional data?

(Marked Shell's Exhibit 2-R, for identification.)

A Yes, Shell Exhibit 2-R is a petrophysical chart of data from Shell Government 24-16A located in Section 26, 25 North, 11 West.

Q Would you point that out on the map, please?

A On the map I have circled that location in red.

This well has been drilled and cored since the last hearing, and I present here data from this well. On it we have traced the

electric log, the SP and resistivity curves, we show the well depths every fifty feet, and we show again with a solid bar the interval I have interpreted as supposing positive microlog separation.

As in the other charts prepared for the last hearing, we have traced on this chart a porosity profile with all values greater than ten percent porosity shaded in green and a permeability profile with all values greater than one millidarcy shaded in red. We also show on this chart several well depths indicated which will point out the positions of core samples which will be presented forthcoming.

The permeability scale, as on the previous charts, is a logarithmic scale and has no zero point, and as on the other chart, the point one or one-tenth millidarcy column includes all values which were one-tenth millidarcy or less. A number of these measured zero permeability core analysis in the lap, and to indicate those which do I have written a zero beside each value in the oh point one column which is actually a zero value.

Q Why is this chart significant? Would you summarzie, please?

A It is significant, in the first place it confirms our previous evidence that there is good correlation between microlog separation and core analysis values.

Q Would you point out that correlation between the permeability and the microlog separation in several examples?

A There are several intervals of microlog separation in the

GC sands, and opposite those are generally concentrated the highest values of permeability and porosity. The GC has the best reservoir characteristics, in this particular well it has permeables up to forty-four millidarcies and porosities up to sixteen percent.

The GC has a short microlog pay interval, GD corrected, and that shows high porosity, but the permeabilities here are all less than one millidarcy, but they are higher than intervening intervals.

I want to mention, in addition to these intervening intervals, that approximately sixty percent of the gross interval core here measured zero permeability. In this well, the GE sands in the lowest part of the section are not productive at this location, but they are elsewhere in the field.

Q Are there areas of zero permeability lying between sections showing microlog separation there?

A Yes, there are. There are several intervals of zero permeability between the two microlog pay intervals in the GC sand, and I think particularly significant is the fact that they are a couple of feet within the GC microlog interval showing zero permeability. In other words, we have an interval which shows microlog separation and does not show correspondingly high permeability.

But this occurs in each case opposite a deflection in the SP curve on the electric log, and I think that these deflections are significant in their correlation with core analysis, and I believe

that from this chart and from cores which we will see in a moment, that they represent interbedded shales and silt stones that are nonproductive and are nonpermeable and are effective barriers to intercommunication between the underlying and overlying sands.

Q And you have an effective horizontal separation between these microlog areas there, is that right?

A I believe so.

Q Are there any further comments on Exhibit 2-R?

A I think those are the main points I wish to mention.

Q Do you have photos of the core from this well?

A Yes, Shell's Exhibit 3-R is a set of photographs of the cores from Government 24-16-A.

(Marked Shell's Exhibit 3-R, for identification.)

MR. CAMPBELL: What was that well again, the same well?

A The same well.

Q Would you describe the preparation of these cores, how these cores were handled?

A Yes, the photographs of the cores from 24-16-A were prepared in the same manner as the core graph of an interval from 33-24-A which we presented in the first hearing. The core was cut down the middle through its entire length, and one-half of that core was mounted and photographed and the other half was sampled every foot for core analysis and for exhibits for this hearing. So

that the exhibits which we will have will not actually be the photographed piece, but its other half, its better half. In this photograph the top of the photograph down to a depth of 4943.

Q Which way does it run on the photographs?

A Well, the top is in the upper left, the well was commenced coring at 4914 to total depth and the upper left of the first photograph is the top of the core and it runs down and then across each page as this comes in order in this exhibit.

The uppermost portion of the core from the top to a depth of 4943 which is near the bottom of the second photograph, includes the interval in the GC to GD group of interbedded sand stones, silt stones and shales.

Q Can you refer to Exhibit 2-R and show us where that is, please?

A From the top to the portion of the petrophysical chart labeled GD. The GD group extends from 4943 to a depth of 4992, and the GE.

Q Show us the top of that again.

A (Witness complies.)

Q From that point to --

A (Indicating.)

Q Thank you.

A Below that are the GE and lower sands and shales, they are not very sandy in this well. Mostly shales and silt stone. This

well is located about two and a half miles east and slightly north of Shell Carson Unit No. 1 which is the nearest cored well by the Shell Oil Company for which evidence was presented at the last hearing.

It lies about a mile north of the depositional trend of the Gallup sands from Carson Unit 1. So it therefore represents a more northerly sampling of the field than the previous two cores presented as exhibits.

Q Would you point out any significant portions of this exhibit?

A Well, viewing as a whole, it appears to be, to have the same, the same general characteristics of sedimentation as the previous examples. It has extremely irregular bedding, the sands in this core are very intricately bedded with shales and silt stones, and you can see countless discontinuities on a very small scale, generally for a sand reservoir I would say it is remarkably heterogeneous. The porosity and permeability on the petrophysical chart were samples measured every foot, but I think that if you measure them every fraction of an inch you would get great differences, so these can only be used as general average values throughout a particular interval.

I think that this set of photographs tends to confirm that the cores which we presented at the last hearing from Carson Unit 1 in 33-24 were representative and characteristic of this formation.

On these photographs there are red arrows which indicate the core samples or the intervals of core samples which will be presented as exhibits.

Q Anything furth[illegible]on those photos?

A I think not at the moment.

Q Do you have the core samples? A Yes.

Q Mr. Lindsay, you have presented the core samples which are Exhibits 4-R A through H? A Yes.

(Marked Shell's Exhibits 4-R A through H, for identification.)

Q Would you proceed with these and indicate their significance and their general location and depth? What well are these from?

A These cores are from Shell Government 24-16A, the same well for which the petrophysical characteristics are shown on Exhibit 2-R. I would like to refer to this chart as I describe just briefly the appearance of each of the cores.

The uppermost core sample is from a depth of 4917 feet, I will give these to the nearest foot. That is in the uppermost microlog interval of the GC sands. It's a fine grain calcareous silty sand stone and this foot of core measured 1.3 millidarcies, but again I think you would have wide variation within that foot.

Referring both to the core sample and the photograph, we again have these little irregular streaks, pods of more friable sand, which I think were caused by marine organism, some of a burrowing

nature which probably left burrows and borings in the sediments and which were later filled with other sand. These generally are of a more permeable nature than the surrounding rock, but I don't think they are very effective as far as communication because generally the walls of each of these little borings are lined with silt, probably deposited during, while the organisms were in action. The second core at a depth of 4925 is from --

Q (Interrupting) That is Exhibit 4-R-B?

A 4-R-B is from an interval between, two intervals of micro-log pay in the GC sand group. This is a silt stone of zero permeability, and it also shows extensive reworking by marine organism and contains many isolated little sand streaks which are apparently not effective to communication because of the fact that we were not able to obtain any permeability in this core in lab measurements at all.

The next sample, 4-R-C, from the depth of 4933 feet, and that is in the longest microlog pay interval in this well in the GC sands, and this consists of very closely interbedded sands, silt stones and shales. This sample measured 10.7 millidarcies, but I think that if you were to get an independent core analysis permeability measurement of a streak of sand by itself, if you could do so, you would probably get a much higher permeability. The permeabilities are in this interval extended up to 44 millidarcies.

The next sample, 4-R-D from a depth of 4939 isn't this same

microlog interval, but from a lower sand which is separated from the previous one by a number of shale breaks, this is from a six inch sand body from which particularly on the photographs the evidence of these borings by marine organisms is particularly in evidence. This particular sample measured 6.2 millidarcies, but it is adjacent to more permeable sands.

The fifth sample, 4-R-E from a depth of 4952 is from a very irregularly bedded shale and silt stone interval which lies between the microlog permeability intervals in the GC and the GD sand groups, and this also measured zero permeability, and I think that this is from an extensive section that separates and isolates the GC and GD sands in this well.

The next sample, 4-R-F, from a depth of 4974 is from the microlog pay interval in the lower part of the GD interval. It is very fine-grined silty calcareous sand which showed a permeability in this foot of 0.3 millidarcies, and again if evidence of reworking is present and on the top of the core where the core was broken is a fossil.

Q Will you point it out, please?

A Yes. Which is a fragment of some mollusk which I think might very well be a bottom dwelling organism and may possibly have been one of the organisms which caused, of the species which caused all this reworking.

The next sample, 4-R-G, the depth of 4991 occurs just above

Marker GE in this well and is a shale with streaks of silt stone and non-interconnecting very fine grain sand streaks of zero permeability, and the lowest sample 4-R-H from a depth of five thousand and three is a slightly more sandy sample, but it is also a predominantly silt stone and shale, and also measured zero permeability.

Q Do you have any comments now on any relationship of the chart to these cores? Before that, I believe you testified that location of these particular samples is shown on the core photographs by some red markers, is that correct?

A Correct.

Q So we can relate the other half of these particular samples to particular points in the photograph?

A Yes, the arrows in each case point to the top of the interval from which the sample is taken. I would summarize from this that inasmuch as we have cored a well some distance away from previously cored wells and found the same nature of sedimentation, that this core has not changed our ideas regarding the nature of the Gallup sands in the Bisti Field, that it is very heterogeneous reservoir, and that I don't think that any further development will modify our ideas regarding the reservoir.

Q Have you prepared some cross sections as indicated on Exhibit 1-R? Would you go to those, please?

A Quite a few. I have already indicated the locations of these sections. In the previous hearing we didn't have any sections

through the southeastern portion of the field, and so I have prepared two cross sections in that area, cross section ST which is Shell Exhibit 5-R, which is along the trend of the sands.

(Marked Shell's Exhibit 5-R, for identification.)

Q Would you point it out to its full extent, please?

A It starts in Section 24, of 25 North, 11 West and extends southeast to Section 34 in 25 North, 10 West. In Section UV which is Shell Exhibit 6-R, is constructed across that section in a southwest-northeast direction. That is entirely within Sections 33 and 34 of 25 North, 10 West.

(Marked Shell's Exhibit 6-R, for identification.)

Q Would you discuss those two sections and point them out, please? ST is Exhibit 5-R and UV is 6-R?

A That is correct. ST is this long section which goes through a number of wells, to save time I won't name them all, but the most northwesterly well is Gulf Carson 4 and at the southeastern end is Monsanto Blanch 1. I have used a similar approach in interpreting pay intervals in these wells and in interpreting their communication or lack of communication.

I have shown on each well a black bar which represents the interval of positive microlog separation. Now, as I pointed out on the petrophysical chart, there may be areas of positive microlog separation which include very thin interbedded shales of zero

permeability and break these intervals into thinly interbedded sands and shales, so I have used the SP curve in conjunction with the microlog in interpreting the position of the pay sands.

As before, we don't maintain that all production comes from only these pay intervals as indicated sections, but these are the best sands, the sands of considerably higher permeability than any of the sands which do not show microlog separation. I have indicated these best sands with this stippled pattern on each cross section. In this Section ST there is pay in both the GC and upper GE sand intervals almost all the way along the section. This, of course, would show the most continuity inasmuch as it is constructed along the depositional grain of the sands.

This does not necessarily mean, though, that where two wells are shown as connected with pay that there is actually effective communication between these wells. I mention that now, but I will show more evidence for it a little later. The most striking situation on this well I think is the Skelly Lockhart No. 2 which is the third from the right on the section. This well was drilled or completed in September, 1957, it is a 40 acre lease line offset to Monsanto Frank 1 which was completed in July, '57.

The well to the northwest of Lockhart 3 is Skelly Lockhart 2 which was completed in October, '57, and I want to point out the greatly increased pay interval picked up in this well, Lockhart 2, of which three sands do not reach either of the other wells.

This, to me, is a very surprising thing, particularly for a longitudinal section. There are two sand intervals in the GC and one in the GD which do not show microlog pay in either of the adjacent wells on this section.

This Skelly Lockhart 2 is the tiein well for our southwest-northeast cross section UV. The wells on this section are Skelly Lockhart 1, Skelly Lockhart 2 and Monsanto Atlas 2. In the middle well, Lockhart 2 again penetrates a much greater pay interval than either of the adjacent wells. I guess Skelly has real good geologists because I would not have been able to predict from the adjacent wells what we would find in this well, and I think it is very surprising that we find a much thicker pay interval than in either of the adjacent wells.

On this section you have, we can see that the uppermost microlog pay sand interval in Lockhart 2.

Q Would you point it out, 2?

A Which was not penetrated by Skelly Lockhart 3 or Monsanto Frank 1 was penetrated by Skelly Lockhart 1 and Monsanto Atlas 2, but the lowest pay interval in the GC group is not penetrated by an adjacent well on either section, including one 40 acre offset.

To me this is strong evidence that that sand would not have been drained had not this well been drilled in this particular location. Again, the lowest GD sand for which there is microlog separation in Skelly Lockhart 2 does not show microlog separation in

either of the surrounding four wells. I reach the same conclusion for that sand.

I would like to show next, in conjunction with these sections, Shell Exhibit 7-R, which is a true scale section of a portion of cross section ST. The wells on this true scale section are from left to right, Skelly Lockhart 3 and Skelly Lockhart 2 and Monsanto Frank 1. The first sections that I referred to, Exhibits 5-R and 6-R are constructed with a ten-fold vertical exaggeration, in order to show the data it is necessary to show, and not have the section unduly large. The scale on the full-sized exhibit is to a horizontal scale of one inch to two hundred feet and a vertical scale of one inch to twenty feet.

(Marked Shell's Exhibit 7-R, for identification.)

Exhibit 7-R, the portion of cross section ST is to both a horizontal and vertical scale of one inch to twenty feet. I constructed this merely to point out that these other sections give a rather distorted view as far as distance between wells go. They look like they are real close together, but this Exhibit 7-R shows their true relationship in distance. So you can see on this section the distance between a 40 acre location from its offsetting well, Skelly Lockhart 2 and Monsanto Frank 1, and the distance between Lockhart 3 and Lockhart 2 represents the distance between two diagonal 80 acre wells.

I think this gives us a better idea of the distances over

which we are correlating these very thin stringers of sand.

Q You have an additional cross section, Mr. Lindsay?

(Marked Shell's Exhibit 8-R, for identification.)

A Yes, cross section QR is Shell Exhibit 8-R. Section QR is the next cross section to the north we have of Sections ST and UV, and it runs in a southwest-northeast direction through this portion of the field.

In this section we can again see evidence of very rapid sedimentary variations in all intervals, the uppermost GC sands, GD sands, and also down in the lower sand group, the GF sands on this section.

This section extends from Shell Carson Unit 34-19 on the left to Shell Government 23-16 A on the right. Shell Carson Unit 32-20 picked up the best sand development in the GC sand group. And of these, the uppermost three pinches out before it reaches either adjacent well, and the lowermost, well, all the interval thins out before it gets to either adjacent well, and even more striking is the upper GD sand which shows no microlog separation in either of the adjacent wells.

Between Shell Carson Unit 41-20 and Shell Government 24-16 A there are very rapid sedimentary changes. It may appear that the wells are not in communication with each other at all.

I would like to amend this section at this time to indicate that the lowest portion of the upper GC sand in Shell Carson Unit

41-20 may connect with the uppermost portion of the upper GC sand in Government 24-16 A. That may be a more preferable interpretation. But even if they do, they are not in exactly the same stratigraphic interval, and it is my opinion there might be very poor communication between those sands.

Q Is there a gas well on this section?

A Yes. Shell Carson Unit 32-20, the third from the left, was completed as a gas well, the initial production on October, '57 was three barrels of load oil and 1250 MCF per day gas. Production since then has indicated that it is a dry gas well. This well is situated downstructure from Shell Carson Unit 23-20 and Shell Carson Unit 34-19. These are oil wells, I believe, that 23-20 has a higher than average gas-oil ratio. I don't believe that 34-19 does. These are in communication as shown on this section through the GC sand.

Now, that's an enigma that we would have oil wells upstructure in communication with gas wells, and this is very significant to me in that even where I can show communication there may be discontinuities between those wells that we know nothing about until we drill there. I think this is a genuine anomaly and I can't explain it structurally.

One final thing, I would like to point out, is the lowest GD sand in Shell Government 24-16 A which was not penetrated by the, I believe in the adjacent 40 acre well, Shell Government 26-13 A.

Giving additional evidence there is discontinuities between 40 acre wells. I show pay in the lower GD sands, they should not be considered as pay inasmuch as they are water bearing.

Q Would you go to KL, Exhibit 9, and point out where KL is on the structure map?

(Marked Shell's Exhibit 9-R, for identification.)

A I would like to refer next to Section KL, MN and OP which are situated close to each other and near our previous Section AB and CD. Section KL, which is a Shell Exhibit 9-R, is a west to east section extending from Section 7 to Section 10, 25 North, 12 West. Section MN is a south to north section within Sections 15 and 10 in the same township and range, and Section OP is another east-west section, cross section, extending from Section 9 to 11 in the same township and range.

On Section KL, the west-east section, there are three Sunray Mid-Continent wells on the left side, Federal C-18, C-16 and C-14 which are spaced at 80 acre locations, and on the right side are five Shell wells extending from Shell Government 12-9, sorry, correction, four Shell wells and a Southern Union well which are at 40 acre locations in the line of the section.

The best sand development is found in the GC sand group, fortunately, on the right side of the section. In Shell Government 32-9 and 42-9 there appear to be as many as five separate inter-bedded sands which pinch out in both directions, thinning down to the

west to three sands, two and then one, which is getting quite thin. The GC sands on the left side of the section there appear to be at least two separate sand stringers which are not at the same stratigraphic position, and therefore, in my opinion they are not in communication with each other, and the GE and GF sands on this section, the lowermost sands are present in most of these wells, showing microlog separation.

They have very erratic distribution up and down the section as well as exhibiting very rapid lateral variations. Probably the thickest GE sand was penetrated in Shell Government 32-9 that pinches out completely to the left in Shell Government 22-9, and thins down to practically the vanishing point in Shell Government 42-9. The lower portion of Shell 42-9, there are two GC sand stringers that doesn't show any microlog pay interval in the adjacent well.

The Shell 22-9 is a GE sand. That does not. Shell Government 12-9 are three GE sands in which neither the upper or the lowest appear to reach either of the adjacent wells, and Sunray picked up one in Federal C-18 which appears to not reach 16 in that it appears there is no microlog separation.

Some of the sands are perforated and do not produce oil, particularly after having been fracted even. Again, I believe that the best developed sands are where they do exhibit microlog separation and where they don't I believe the sands to be very tight and to not communicate over any considerable horizontal distance.

Q Exhibit 9-R, you have instances where there are sand members showing microlog separation that don't even extend from one 40 acre location to another, is that correct?

A That is correct. Several of these wells were drilled since the last hearing as 40 acre location wells, and several of them have picked up new sands.

(Marked Shell's Exhibits 9-R and 10-R, for identification.)

Q Now, Exhibit 10-R. A Excuse me.

Q Well, proceed.

A I have a few more things on this one. I want to point out another drafting error in Sunray Mid-Continent Federal C-14, the lowest GF sand or the GF sand which shows microlog separation was located ten feet too low on this exhibit and should be ten feet higher.

The interval should be 4858 - 60 and that would place it opposite the interval which Sunray wisely perforated, it would probably then communicate with the upper GF sand in Government Shell 12-9 rather than the middle one.

I have one further thing that Southern Union made a very good well out of this Ka-Gee-Tah 1. They perforated it only down to the GE sand as I believe was explained yesterday, and the initial rate, according to our records, was 480 barrels a day from the lower sands alone, even where they don't exhibit microlog separation.

This would appear to me to indicate that it's possible to make a fairly good well out of just the lower sands, and they have been referred to as inferior sands and they aren't the best sands in the field, but I think here is evidence that they are very important in the development of this field.

Now, Section MN is Shell Exhibit 10-R. This is the north-south section in the central portion of the field.

MR. SETH: Mr. Nestor, would you point that out again, please?

MR. NESTOR: Yes.

A I would like to refer to this section in conjunction with Section OP since these two sections cross MN, being the vertical and OP I should say, the north-south and this, the OP, the west to east section. The tiein well on these two sections is Shell Government 34-10. In other words, both sections pass through Shell Government 34-10, and show the same pay intervals.

This well was also shown on Section AB at the previous hearing. If you'll compare them, which I'm sure you will, you will notice that in this section we show four separate sand intervals in the GC, whereas in the previous one we showed only one continuous sand interval. I have reexamined many of these logs and I found a slight streak in the microlog pay in the upper portion in the GE sand in this well which I think actually is not continuous microlog separation, and the reexamination of the SP curve shows there are

many shale breaks which we have seen from the petrophysical chart, and the core samples and photographs do represent interbedded shales which are not pay and which separate the sands into interbedded layers.

I think the explanation for this microlog pay, where we don't really think it is, is that where there is a gross sand interval with many interbedded shale beds, that undoubtedly the microlog zone dragged some mud cake across the face of the shale, gives you a reading where there really isn't enough permeability to really be indicated by the microlog.

I have taken that into account in constructing my section, and that's my explanation for this reinterpretation in 34-10. On other of these sections the GC sands are very well developed. They occur in most wells as many layers of sand rather than one continuous one. The thickest GC interval was penetrated in Shell Carson Unit 11, the far right well on Section OP. There appear to be eight separate sands, and the uppermost and the lowest GC sands in Carson Unit 11 have pinched out by the time, pinched out in Shell Government 44-10 and do not show microlog pay intervals.

Again I think this is evidence of the pinch of permeable sands between two 40 acre wells and that if 14-11 had not been drilled we might not have penetrated these sands in any well. Their easterly extension is undetermined because development hasn't continued that way to date.

On Section OP, the second well from the left, Phillips I-Tah-Nip2 penetrated three intervals of GD sand as indicated by the microlog. This well was also on Shell's cross section CD in the previous hearing. If you check this against that you'll find that the upper two GD sands were penetrated by El Paso Kelly State 1, but the lower one was not. So there are wells on three sides of I-Tah-Nip 2 which do not penetrate a GD sand which was penetrated by I-Tah-Nip 2. On Section MN, Shell Exhibit 10-R, the well second from the right penetrated several sands in the GE and GF group, and on this section they have all pinched out in Shell Government 31-10, that is they don't extend that far.

The middle one of these three sands pinches out before it reaches Shell Government 34-10 with microlog separation, and the top and bottom sands have thinned down to a very small interval.

I think those are the points I want to make on these sections.

Q Do you have any general observations to make to the Commission as a result of this study?

A There are two more sections. These are the last two.

Q All right.

A SectionsGH and IJ were located in the northwesternmost extremity of the field. GH is a section northwest-southeast section longitudinal with the sand trend. It extends from Section 29 to Section 34, in 26 North, 13 West, it extends from British American Douthit B-11 to British American Salge B-3. Section IJ is a

southwest, northeast section which crosses GH at Douthit B-14, it extends from Section 33 to Section 22, the same township and range. It extends from British American Salge B-2 to Benson, Montin, Greer Foster 2.

On Section GH, which is the section longitudinal through the deposition, grain appears to have fairly good, relatively good continuity as indicated by the microlog. But there are again reasons to believe that this does not necessarily mean completely good communication.

The GC interval shows good sand development in British American Salge B-1, and in Salge B-3 there were two microlog intervals in the same sand, and I would have interpreted these as pay except that British American ran a drillstem test including both of these intervals in one test and they recovered 65 feet of drill mud on a one-hour test, so it would appear to me that these sands are quite tight and perhaps just porous enough and barely just permeable enough to exhibit microlog pay.

They are not productive, the well was abandoned. British American Salge B-1, according to our records, was completed for an initial production of 743 barrels a day, and the next well to the northwest, Douthit B-14 which shows even more GC pay but no GD pay although it was perforated there, had an initial production of 185 barrels a day. This, to me, reflects the changes in the quality of this reservoir rock which you cannot pick up merely by

plotting the microlog and suggests to me that the most prolific portions of this field are not very predictable and that many of them may be missed or just grazed if spacing is carried on too wide a pattern in this field.

I have to explain another drafting mistake. It is not important to the discussion, British American Douthit B-15 is mislocated laterally between Douthit B-11 and B-14. The correct distance should be from Douthit B-11 to B-15, the horizontal distance is 1880 feet and from 15 to Salge B-1 the distance should be 47, 10, 1. That would move B-14 farther left on this section, but there do not seem to be significant discontinuities which I will dwell on which this change would affect in any way.

Section IJ, which crosses GH at British American Douthit B-14, shows much more evidently rapid sedimentary variations. British American Douthit B-5 penetrated a fairly thick sand in the GC interval. That is the most, lowermost one which's not penetrated, Douthit B-14, and has practically thinned down to nothing in B-16. In a situation like this, if B-5 were here and B-6 were here, this sand would not be adequately drained, and therefore in the similar situations between 40 acre wells where there is a thick section penetrated in one well and thinned down to a very thin interval in another well, I think the drainage would not be adequate even though it was penetrated in this thin interval, that the drainage of the greater portion of the sand would not be adequate unless it is penetrated in its thickest, best

value portion.

Of course, I say we are more likely to do that on 40 acre spacing than on 80 acre spacing. Other discontinuities on this section are found, British American Douthit B-13 is the lowermost GC sand, I see appears to pinch out before it reaches either of the adjacent wells.

Q Do you believe that these lower sand members are a matter that should be considered and perhaps a significant part of the reservoir after all, based on your study and the presentation of these cross sections and also the completion by Southern Union of a well in the lower pay?

A Yes, I think they have proven to be a significant portion of this reservoir.

Q Do they show a greater or lesser discontinuity, could you generalize on that?

A Yes, the lowermost sands, the ones, the GE and lower are much more irregularly distributed in this reservoir. They don't occur in every place that the overlying sands do, and if you drill, my opinion for only the overlying sands, you may miss many portions of the lower sands. They are generally thinner as a group, but they seem to occur in discontinuous intervals, and they don't seem to extent over as wide areasas the individual stringers, streaks of sand in the upper sands.

Q Is it also the case where you have production from sections where there is no microlog separation too?

A Yes, it is.

Q Do you have any further comments, Mr. Lindsay?

A I think that is all I have to say with reference to the exhibit.

Q Do you have any general conclusions you would like to draw?

A I don't think my conclusions would be different from what they were after the first hearing.

Q Would you restate them just briefly?

A Just very briefly, that my geologic investigation of the Bisti Field has shown it to be an extremely heterogeneous sand reservoir, that it shows frequent numerous discontinuities from well to well, and that examined both on a large scale with maps and sections and also on a very, very small scale with core samples, that I would not expect this sand to have characteristics which would permit it to drain over wide areas, and that I think therefore a spacing as wide as 80 acres is certainly going to miss many sand intervals which would be penetrated by 40 acre wells. I think that that now has been proven.

MR. SETH: I believe that's all the direct we have, if the Commission please.

MR. PORTER: We are going to take a fifteen minute recess.

(Recess.)

MR. PORTER: The meeting will come to order, please. Mr. Seth, you were through with your direct examination?

MR. SETH: Yes.

MR. PORTER: Would you take the stand, Mr. Lindsay? I'm reasonably sure that somebody has a question.

Anyone have a question of Mr. Lindsay? Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Lindsay, first I want to assure you that if you hadn't confessed I wouldn't have found those errors.

A I thought Mr. Selinger would be here this morning.

Q You may have stated at the last hearing, but I'm not sure, would you please tell me the extent of your experience in sand reservoirs of this nature in the Mid-Continent or Rocky Mountain area?

A My experience with sand reservoirs of this nature in the Mid-Continent or Rocky Mountain area consists exclusively of the Bisti Field. I became familiar with the development at Bisti during the latter part of 1956, and since last July I have been Shell's production geologist responsible for the production geology of the Bisti Field.

Q Have you had experience in other areas with fields that you considered to be comparable with regard to the deposition and so forth as the Bisti Field?

A I have not had experience in other fields which are quite like the Bisti Field.

Q How can you then state as a conclusion that this field is, as I understood you, more heterogeneous than other fields of similar nature?

A By other fields of a similar nature, I was referring to sand reservoirs in general. I have never seen so heterogeneous a sand reservoir.

Q It's quite true, is it not, that the Bisti Field, based upon your study, is considerably different in a great many respects than in the sand reservoirs, say on the West Coast?

A Yes, it is.

Q That is true with regard to the characteristics of the rock as well as the pay thickness and so on?

A That is correct.

Q Would you say that this Bisti Field, considering the general pay thickness, is of an inferior quality to many of the sand reservoirs on the West Coast?

A There are many on the West Coast that are much better and there are some I would say of generally comparable quality as a reservoir.

Q Are there reservoirs that you have studied that you have as in this reservoir, various stringers of possible productive sand such as you have described here this morning?

A There are reservoirs of that type, but I have not thoroughly studied this type of reservoir before.

Q Do you believe that it is feasible to drill a sufficient number of wells in this reservoir to penetrate each and every one of the possible productive sand stringers to which you have referred?

A You mean economically feasible?

Q Yes. A No, I don't.

Q So that it is a matter of degree as to the feasibility or advisability of drilling additional wells in this reservoir?

A I think that's a sound basis to go on.

Q Our basic difference then lies in what that degree may be, as I understand, whether it's necessary or feasible to do it on 40 acres or 80 acres?

A That seems to be the controversy.

Q This may be an engineering question, if it is, of course you should defer it to the engineering witness. I would like to refer you to your Exhibit 9-R which I believe is the long exhibit at the top of the main board there. A Yes.

Q As I understand that, you have three wells of Sunray on the left spaced at 80 acres, correct?

A I believe that's correct.

Q Are those wells essentially toward the flank of this sand bar?

A They are near the southernmost extremity of the Bisti-Lower Gallup sands.

Q Would you expect at that point the GC and the GD and all the rest of the sands there would probably thin out due to the

nature of the deposition?

A Thin out in which direction?

Q Thin out towards the flanks. A I believe that they do.

Q Now, then, referring to the four wells of Shell's thare, I would like for you to tell me how much additional oil sand you penetrated by the drilling of those inside wells there that you did not penetrate with the 80 acre location. Considering those two that you just pointed to as your normal 80 acres, it appears to me that you got more sand with those than you got with the 40 acre ones.

A It appears that we got the most in the normal 80 acre well 32-9 and we have just about as much of the 42-9, including two sands in the GE and GF groups that were not present in 32-9, and we appear to have encountered a GE sand in 22-9 which is not at the same stratigraphic position as the GE sand in 32-9.

Q Now, assuming that you have approximately the same amount of sand in your upper zones which I believe is your GC and possibly part of the GD there, in all four of those wells do you consider that you obtained enough additional oil sand or potential production from the lower zones of the infill wells to justify the cost of their drilling?

A You talking about additional oil?

Q Yes. A From the new wells?

Q Yes. That you would not have recovered from the 80 acre wells.

A The mechanics of production and volumes of recovery do merge on the present of our engineering site and I have not made a cost estimate or a volumetric estimate of the type you mentioned. But apparently this is considered by Shell's Engineering Department as a profitable enterprise, so that's the way we are conducting it.

Q I'm sure that is true. Could that be a matter of the rate at which you are able to obtain the oil rather than whether you obtain the oil?

A No. Of course, we'll obtain it faster, now we are getting into supply and demand and I don't want to go into rate and all that, but I conclude that there is a significant amount of additional oil which you would not get at all on 80 acre spacing.

Q Well, now, are you concluding that as a geologist, or do you want me to ask the engineer about the amount of oil?

A Well, from a geological standpoint.

Q Explain that to me, that is what I want to find out.

A Not only on these particular wells.

Q I want you to talk about these particular wells. Those are the ones that are demonstrated there as indicative of the conditions in this field.

MR. SETH: I think the witness can answer the question and explain it further by referring to other exhibits.

A I will explain it here. I will refer to Shell Government 22-9 and 42-9, those wells penetrated sands in the GE and GF groups

which were not penetrated by the other wells, and I believe that that is new oil which will be produced that would not have been produced on the 80 acre wells.

There appears to be a pretty fair correlation of pay zones up in the more prolific pay. Now I mentioned earlier the qualification I placed on these correlations I make. That I am convinced by now that merely because you can correlate a microlog pay from one well to another does not mean that they are necessarily in complete communication. I have attempted to stress the lateral variations in porosity and permeability development in these wells, and their apparent lateral variations in productivity as shown particularly on GH where you can correlate microlog pay zones in one well it is very productive and in this well it is dry.

Q Let's talk about the lateral variations in, or the vertical variation in permeability, do you consider there are inpenetrable barriers between the zones that you have classified in your geophysical chart and as you showed them on your cross sections?

A I lost you.

Q Do you consider there are inpenetrable barriers between your GD and GC or GE there?

A I think that at the location of this well we have direct evidence that there are layers of inpenetrable rock through which oil will not migrate in any practical time.

Q Do you consider that exists throughout this reservoir?

A It is my opinion that it does.

Q Do you think there is more than one oil reservoir involved here?

A It's difficult to define, I would say, an individual reservoir in a field like this. We look at the whole thing as one oil field, but it's my belief that it really consists of many isolated sands which are completely separated from each other, I mean a great many and each of those I think if you wish to cut it very finely you might call a separate reservoir.

Q Would you recommend that any of these particular sands be produced separately? A No, I don't.

Q Do you consider that that situation at this stage of development creates some uncertainty with regard to the nature of this particular reservoir?

A I think that at this date we have an even greater sampling of the reservoir and a portion of it on closer spacing than we had at the previous hearing. At that time I had drawn certain conclusions regarding the nature of the reservoir, and I think that the development since then has only strengthened those and has not really changed them.

Q Let's go to another point which appeared to me to be a matter of considerable uncertainty in your mind. You have referred to a number of what you classify as gas wells being downstructure from oil wells in this reservoir, is that correct?

A Yes.

Q You say that you are unable to find any geological or structural explanation for that situation?

A For the ones that I mentioned, yes.

Q Doesn't that create some degree of uncertainty about the nature of the reservoir and the manner by which it should be developed and produced?

A I draw the conclusion, what sort of explanation was I unable to find?

Q Well, I understood you, you said it was an anomaly and that's it. It's one of those things apparently you are indicating it was another indication of heterogenity in this reservoir.

A What I think I said, and what I meant to say, I find anomalies which I cannot explain on these structural bases, and therefore I conclude it is a stratigraphic reason, the stratigraphic reason being the discontinuity of the sands.

Q Well, as long as that situation exists, an unexplainable situation so far as you are concerned, do you not feel that it creates some degree of uncertainty as to the manner of development and production from this particular reservoir?

A I believe I just explained it.

Q How do you produce your gas wells, do you know?

A No.

Q Do you know how you produce your high gas-oil ratio wells?

MR. SETH: What do you mean how?

Q In what manner. Are you producing them as gas wells or oil wells?

A Some wells we, you mean our wells which produce both oil and gas?

Q Yes.

A I had better not qualify myself as an expert to answer that question.

Q One other question, again, with regard to your Exhibit 9-R. I believe you indicated that in your wells there were some areas that were perforated across that microlog separation which actually didn't produce in one well, it might produce in another. Are those distances sufficiently small that communication could be established by fracturing?

A You mean horizontal distances?

Q Vertical distances. A Vertical distances.

Q In the upper zone there? A Oh, (indicating).

Q Yes.

A Of course the purpose of fracturing is to increase the permeability of the reservoir immediately adjacent to the well bore and as to how far those fractures extend in the reservoir and as to whether they form effective vertical communication I think is something that certainly I don't know, and I don't believe that we could rely on fractures to do anything further than increasing the permeability of the pay, and we hope of the tighter pay right adjacent to the

well bore, but as to establishing an effective vertical system of communication between the various pay zones any distance away from the well bore, I don't think that we can rely on them to do that.

Q One general question. Are you acquainted with the number of wells that have been drilled by Shell, since the original hearing, on a 40 acre spacing pattern?

A I don't have a figure with me, no.

MR. CAMPBELL: That's all.

MR. PORTER: Anyone else have a question of Mr. Lindsay? Mr. Grenier.

MR. GRENIER: I have never been a real good geological lawyer and I'm afraid much of this testimony is just completely beyond my individual depth. With the Commission's permission, I would like to have them permit Mr. Wiedekehr, our reservoir engineer and head of the Production Department, to conduct a portion of our company's cross examination.

MR. PORTER: Yes.

MR. GRENIER: Thank you.

By MR. WIEDEKEHR:

I would like to start back with Southern Union Gas Company's Ka-Gee-Tah, please. I think we will do better if I can go with you so we can see what we are talking about. Referring to your Exhibit 9-R, Southern Union Ka-Gee-Tah No. 1, would you state first approximately where the perforations on that well are?

A They seem to extend from about 4845 to 4865.

Q 4845 to 70 be all right? A Yes.

Q How much microlog separation did you find on that particular well? A I didn't find any.

Q No microlog separation?

A No positive microlog separation.

Q Did you have available to you core analysis from that well by any chance?

A I did not prepare that with core analysis available.

Q In your cross sections that you have used this morning you have been correlating, I believe, potential pay zones using microlog separation, right? In other words, you have shown that these sands pinch out, disappear, come back in, and the basis that you used for that has been microlog separation?

A Not entirely. I have used the data available to me, and as far as drawing my sections, I have used both microlog and SP development.

Now, I do want to make it clear that I did not consider a sand interval as shown by the electrolog without microlog separation as not being a pay zone, but as being very tight.

Q You have, I believe, on your Exhibit 9-R the reported high pay from that well?

A My records show 480 barrels a day.

Q 480 barrels a day flowing? A Yes.

Q Let me assure you that is correct. Then I wish you would explain to me, with no microlog separation, I happen to have the core analysis available, only two feet of it had any permeability, how a well of that category could produce that much oil. I mean geologically how can you get 480 barrels flowing out of a well with no apparent permeability? That's what your microlog is supposed to show.

A It is supposed to show the better permeability. There is permeability there or we would be unable to produce the oil.

Q Right. Wouldn't it require relatively good permeability somewhere adjacent to the well bore to have produced that volume of oil?

A That rate is certainly more than I would expect from the appearance of that well.

Q Well, assuming that we are correct then that that particular zone, no microlog separation, no apparent permeability, matter of fact very poor SP, wouldn't you say?

A Mediocre.

Q Mediocre. All right. Assuming that it produced oil from that type of formation, would it not be possible that say Shell's Government 44-10 in Exhibit 11-R in an interval from 4830 to 4840 or so, showing no microlog separation but having equivalent or better SP, might be productive?

A We have perforated that interval. We have not yet completed

the well at least to my latest knowledge. We have perforated that interval without microlog separation for the purpose we believe it will produce some oil down there.

Q In other words then, we might say that since Shell has perforated in their Carson Unit 14-11 zone with no microlog separation, and this one, the 44-10 and the Government 24-10 and the Phillips 1 I-Tah-Nip, apparently they have perforated that same zone, it is apparently the feeling of both Shell and other companies that these zones will produce, at least if they didn't they wasted a lot of money on perforation even though there is no microlog separation, isn't it considerable that all these zones could be tied together even though you can't correlate them with microlog separation?

A Where there is no microlog separation I infer from that information that the permeabilities are very low. Therefore, I would say that sands of that character would have a much smaller drainage radius than sands of higher permeability.

Q We just got through discussing a well with no permeability made 480 barrels a day flowing.

A It had permeability.

Q But what type of permeability would it have to have, as a geologist would you say it had to have good or poor or fair, or how would you describe the type of permeability required for that kind of a volume?

A From a rate alone, if I had no other information, it would sound to me like you had some pretty fair permeability.

Q Let me ask you, were you in the hearing room yesterday when Mr. Lewis testified for Phillips? A Yes, I was.

Q You heard his testimony about the variation in permeability even within an inch of core?

A Yes, sir, I agree with him on that.

Q You agree with him. Then you would also agree that if we took any one of these wells and moved out three inches further from the well bore that there might be a good change in permeability and there might be good permeability there?

A In the sands in this interval which I have examined in cores are of heterogeneous nature and you certainly will get rapid changes good to bad, good to bad permeability in that very irregular distribution, and you may move out three inches and get better permeability, but in sands of this type, from the appearance of them from cores and from their log characteristics, I wouldn't expect you would go out three inches and encounter a real permeable bed that would go on and on.

Q You wouldn't expect that, yet apparently something on that order happened in this particular well?

A It may have happened in this particular well.

Q Let's look at Exhibit 12-R. I believe you discussed the capacity of a couple of wells. The British American Douthit B-12,

B-1 produced at one rate.

A Our records show 743 barrels a day initial.

Q How about the B-14?

A Pumping 185 barrels a day.

Q You based, I believe now on direct examination you based that on the fact that the sands were, you said that even though sand in the B-14 appeared much better, that the Salge B-1 was the better well. Would it not be entirely possible that that was strictly a matter of completion? In other words, does the method of completion have a lot to do with the IP of these wells in the Bisti Field?

A I think the method of completion does have a lot to do with it. I had better admit right now that I don't know exactly the method of completion in these wells beyond perforating the sands.

Q I believe on direct you did infer that it was a difference in sand that caused it rather than completion practice. I just want to point out and ask you as a geologist if you didn't think that the completion practice might have had a lot to do with it?

A Yes, I am sure it would. I also referred to Salge B-3 which also has sand and microlog development, but which is tight.

Q Was pipe set on that well?

A I can't say for sure, but apparently not.

Q In other words, apparently British American relied on a drill stem test in that area to decide not to set pipe?

A Apparently they did.

Q Is it not true that there have been a number of wells in the San Juan Basin on which pipe was not set because of poor drill stem test and yet future development has proved that area to be productive?

A I'm not familiar with development away from the Bisti Field itself, but the statement that you make as regards in general is true.

Q I was referring particularly to another Gallup field, the Verde Gallup. You are not familiar with it at all?

A No, I am not.

Q For your information, two wells were drilled and plugged and abandoned as dry holes due to poor drill stem test before the first producer was found. What I am trying to point out, that with that well with pipe set on it might have made a little oil well.

A Yes, it might.

Q I'm sure you are familiar with other fields other than Bisti. Do you know of any field in which the sand condition, both the type of sand and the thickness of the sand, does not vary from one portion of the field to another? Let me reverse that. Do you know of any field in which the sand is constant throughout in thickness and characteristics?

A Constant is a relative word.

Q I said thickness. A Oh, in thickness.

Q Yes.

A The constancy of the thickness of the sand certainly depends on the manner in which the sand was laid down, on all manner of geologic events which would govern the thickness of that sand and the extents laterally.

Q You would expect sands in any field to vary in thickness for two miles away or three miles away? It is not unusual for sands to vary just as they do in Bisti?

A No. Sands may vary in constancy over a long area, but others will do it much more rapidly.

Q I was never quite satisfied with the answer you gave Mr. Campbell about the additional oil that you expected to recover by the drilling of the Shell 22-9 and the 42-9. Would you tell me roughly how many feet, assuming microlog is correct entirely, how many feet of microlog difference you have from the Shell 42-9 to the 32-9 in the bottom sands only on Exhibit 9-R?

A You referring to the individual sands or the whole group?

Q The bottom sands, that is from your GD down.

A They are approximately the same in total thickness.

Q How about in 42-9, how many feet of sand do you show on microlog below the GD sand? A About four feet.

Q As a geologist, are you familiar with the estimated recovery per acre foot from the Bisti Field?

A I used to know the figure, but I can't recall it.

Q As a geologist, would you recommend that your company drill a well in the Bisti Field for four feet of pay?

A Four feet only, no.

Q But if we assume, and let's make an assumption right now, if we assume that the GC sand could be drained across an 80 acre spacing, then in an appreciable period of time then actually the drilling of the Government #2-9 was drilled for only four feet of sand, was it not?

A If we make your assumption I can't say yes to that because we didn't know how much GC sand we would find. We drilled it for the productive sand that we would find in that location.

Q But you drilled it for four feet now in the lower members. In the lower members now.

A We found an additional four feet of microlog pay.

Q So as I said before, I believe then assuming the upper member could have been drained on 80 acre spacing, you actually then did drill that well and would expect the economics to show that the four feet of pay there would pay for the drilling of the well?

A Based on your assumption that the 32-9 would drain completely and efficiently, that we would get no additional oil from here. Actually I have to subtract about a foot from that four, three feet.

MR. WIEDEKEHR: Thank you, That's all.

MR. GRENIER: Just one or two more questions, Mr. Lindsay, on behalf of Southern Union.

Q How many wells of the, I believe it was the 187 it was testified yesterday, have been drilled to date, have you examined logs on or informed yourself about, substantially all or just a small percentage?

A I should count these before I come in here because I always get asked this.

Q Would it be about half?

A Well, I would say that it is somewhat less than half.

Q Approximately 80 to 90 then would be something in the range that you looked at in some degree of detail?

A Yes.

Q Were most of those wells along the so-called fairway or were they along the flanks or were they spread in a fairly representative fashion?

A The greater part of them would be in the, would be along the fairway, it's been called Route 66, although there is a fair scattering across the entire trend.

Q What proportion of those wells which you have examined logs on exhibited sand, pay sand in the upper member? I believe that's the one you referred to here generally as the GC sand, is that correct?

A That is correct. A good majority of them exhibited pay in the GC interval.

Q In the fairway area would it be correct to state that

substantially all exhibited this?

A Not entirely. Many of them even in the fairway were better developed in the lower, what we call the GD sand group than in the GC, but certainly most of them along the central part of the trend did exhibit better GC qualities than GD.

Q Approximately what proportion or percentage, if you can give it to us that way, of these wells that you have examined did exhibit some microlog separation in the lower sands?

A By lower, do you mean --

Q I'm referring to the GD on down.

A It would be a horseback guess, roughly three-quarters, possibly a little more.

Q Would you have any figure that you can give us as to approximately what the development was there? Was it about the same, three or four feet, that we were discussing in your just preceding cross examination by Mr. Wiedekehr, would that be fairly typical?

A It varies from several feet of sand, perhaps ten or more, to nothing.

Q So that any given well which was drilled here and taken on down to these lower sands would have approximately 75% chance then I gather, based on the wells that you have seen, of hitting something which might vary from zero to ten, is that correct?

A You're referring to sands exhibiting microlog separation?

Q Yes.

A That would depend on which part of the field you are in, in some portions of the field you might have a greater percentage than in the other, but if you are including the GD sand, I probably should have raised my estimate to more than 75, but that might be a fair figure.

Q Now, then, going below the GD, what would the percentage of wells be that exhibited anything below the GD level?

A Well, if the sands exhibit microlog separation they're less than 50%.

Q So that whenever a well was taken down below that either on 80 or 40 acre spacing, you would have somewhat less than a 50% chance of hitting anything there, is that correct?

A I think you would. Well, anything, you may hit sands which might produce a considerable amount of oil on being fractured, but for hitting sands which you would run a microlog and find separation down there, I would say you would have less than a 50% chance.

Q You would have a less than 50% chance if you based it only on microlog separation, but you might have more than that if you based it on what actual production history is shown in the absence of microlog separation, as for example in the Southern Union well which you were discussing a few moments ago?

A Yes, I think that is correct.

Q So that whenever you go down below the GD level, you are

having about a 50% chance of hitting anything at all, if I understand your testimony.

A I think you would have more than 50% chance of hitting sands which are capable of production but less than 50% chance of finding sands which show microlog separation.

Q In your opinion would the additional sands that you would find down there, disregarding the upper strata, be of sufficient likely productivity to justify the drilling of a well?

A I think that the lower sands by themselves probably in most parts of the field would not justify drilling a well just for that alone.

Q Would you have any estimate that you could give us, or have you formed any opinion about this as to what portion of the total reserves in the field are to be found in the area below the GD level?

A I have not formulated an opinion to the point where I could give you any figure.

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

MR. PORTER: Mr. White.

MR. WHITE: Mr. Wade has one question. All of mine have been pretty well covered.

MR. PORTER: Mr. Wade.

By MR. WADE:

Q I would like to discuss nomenclature with you a little bit.

I believe on one exhibit, I believe it was your cross section OP, you referred to eight sands I believe, is that right?

A Yes.

Q Actually you were referring to eight indications of microlog separation, were you not?

A Well, the microlog is in fair agreement with the SP, and I would say that both the microlog and the SP suggest that there are eight sands.

Q Eight separate sands?

A By that I mean that eight sand layers showing microlog pay were penetrated in that well which are separated by interbedded shales, silt stone.

Q You referred to your black bars which are an indication of microlog separation almost uniformly in your testimony as sands. Do you consider that those, each of those black bars is an indication of a separate sand on each of these exhibits?

A Actually my black bars tend to generalize on the real number of discrete sand layers within any microlog separation interval. I have attempted to stress that I consider them to be very thinly interbedded sands for the most part as seen on the cores and as evidenced by the SP in many wells and as evidenced by the very, very irregular permeability profile.

Q Well, in your references to sands and the black bars, again using that nomenclature in this Southern Union well that has been

discussed here, there are no sands in that portion that were opened, is that right?

A The SP shows there are sands.

Q Well, then, the nomenclature that you were using as regards microlog separation does not necessarily mean that when you call them sands that they are sands as such?

A I was perhaps abbreviating somewhat when I referred to them as sands.

Q I didn't want to leave any confusion with the Commission that you were indicating that all of these cross sections and the lack of continuity shown thereon was the basis of sands, but rather that they were drawn to show that there was lack of continuity between microlog correlations only?

A Yes, the sands I referred to in my discussion of my sections, I meant to refer to the portions of the interval which show the stippled pattern as being the sands which do show microlog separation.

Now, there are other sands over sections which do not show microlog separation, and they are sands and I say they are very low permeability.

Q If you eliminated this nomenclature calling the bar sands and correlated on actual sands, the SP curves, this discontinuity or apparent discontinuity that is shown by correlation of micrologs would disappear to a certain extent?

A I have seen quite a few exhibits at this hearing which did show that is true.

Q Showing a continuity of sand, but a discontinuity apparently of microlog separation?

A A discontinuity of the very permeable sands.

MR. WADE: Thank you.

MR. PORTER: Anyone else have a question?

MR. DUTTON: Granville Dutton, Sun Oil, Dallas.

By MR. DUTTON:

Q Mr. Lindsay, to return for a minute to the heterogeneous variations of permeability in sands, would you say that your examination reveals any systematic distribution of those heterogeneous?

A Examination of cores?

Q Of all information available to you.

A A systematic distribution?

Q Systematic distribution.

A Yes, there are in this field certain trends that can be seen if you add up in each well the sum total of all the various microlog pay intervals and plot them as isopacks; as a matter of fact I presented one at the last hearing which do show areas of this field which have more net pay than other areas, and if you can draw isopacks on it and get a trend, the trend does follow generally the trend of the field itself. But I also wish to make clear at that time, and say again, that merely because you can draw isopacks

showing a trend does not mean that all those separate thin layers are all connected.

Q Then within a given core sample, those that you have introduced in evidence here, would you say there is any systematic variation in the heterogenity in those cores?

A In these cores alone?

Q Yes.

A I would say it is quite irregular, some of these sands in this core are massive for perhaps a few inches up and down and others are very small streaks of sand completely encased in shale material, and in these very irregularly distributed, finely interbedded sands in many of those intervals why we were unable to establish communication in our core analysis. That is core analysis showing zero probability, or permeability, showed that they were not interconnected and showing they are radically distributed.

Q The systematic distribution that you have described is primarily one of weighing the permeability in one and the porosity in one and lumping that together and then you find with that weighted average some systematic distribution, is that correct?

A I think that there is some systematic, well systematic, there are trends of more pay in this field, yes.

Q But within the individual core would it be correct to describe the parameter as being randomly distributed?

A Not entirely randomly since this is a bedded formation it is

certainly, certain qualities of sand follow very specific bedding planes, are contained within specific stratigraphic intervals, and perhaps within a certain stratigraphic interval you will find a particular type of sand interbedded a particular way and above and below you may find a dense shale and above that a massive sand, so above that you may say there is some systematic distribution within a core.

Q With respect to Shell Carson No. 5, could you tell me if that is an oil well or a gas well in your estimation?

A I have been informed that is a gas well and that the oil production that I think was referred to in the last hearing was load oil. We have no indication it was an oil well.

Q Would that explain one of these anomalies that you thought was present in the original hearing where you had oil production above gas production or thought you had?

A The anomaly that I referred to and attempted to stress was the anomaly between Gulf To-Nah-Bah Navajo 1, which is a gas well according to my information, and Shell Carson Unit 33-24 and Shell Carson Unit 2, both of which are oil wells and upstructure from that Gulf well.

Q And Carson No. 5 does not indicate any anomaly at this time, is that correct?

A No, there is no anomaly there.

Q You have testified that in your opinion, or perhaps I should

ask this as a question. Is it your opinion that it is economically feasible to develop on 40 acre spacing at this time?

A Well, I have not made those calculations myself, but I'm informed by fellow workers at Shell that it is their opinion that is profitable development.

Q Are these fellow workers under your supervision?

A No.

Q Or do they just give you the advice?

A We give each other advice. They are not workers under my supervision.

Q Your classification is exploitation engineer, do you ever indulge in economic analysis?

A I have from time to time at Shell, but generally the economics are in the province of the Reservoir Engineering Department, and, let me clear something up. Shell's Production Department, there is the Mechanical Engineering Department and the Exploitation Engineering Department. Within Exploitation Engineering there are three specialties, being Reservoir Engineering, Petrophysics and Production Geology, and we all try to familiarize ourselves pretty much with all three fields, but we have one specialty and mine is production geology, so it is therefore not my responsibility to make economic calculations.

Q Then your testimony relative to the desirability of 40 acre spacing is based entirely on the geology of the field and not upon

economics.

A I try to limit my opinions to what the geology alone shows. I don't try to calculate in terms of dollars what we are going to get here or there or even in barrels of oil. But merely I try to the best of my efforts to determine the nature of the geology of this field and then as for the economics, that is a matter of the company policy.

Q In answer to one of Mr. Campbell's questions, I believe you indicated that you did not consider it economically feasible to drill on less than 40 acre spacing, was I correct in your statement?

A You are referring to the first hearing?

Q No, I'm talking about the cross examination by Mr. Campbell today.

A I cannot recall that question.

Q Then I will ask it. Is it your opinion that if this field were developed on 20 acres it would recover more oil than if developed on 40?

A It is my opinion that you would recover more oil.

Q Then would it be your recommendation to develop it on 20?

A Not until our reservoir engineers had made an economic analysis of that situation.

MR. DUTTON: Thank you.

MR. PORTER: Mr. Nutter.

By MR. NUTTER:

Q I have just a couple of questions here. Mr. Lindsay, has any analysis been made of any cores or in any other manner to determine whether any vertical communication exists between these various sand bodies, or within these various sand bodies, for that matter?

A Our core analysis has been limited to one sample per foot, and we have not, to my knowledge, in the lab made any effort to establish vertical communication between individual sands as far as permeability measurements go.

Q Well, now, have you made laboratory analysis, or has a laboratory analysis been made, I should say, of these silt stones and shales to determine whether they are permeable either horizontally or vertically?

A The analyses, for example, in Shell 24-16 A are shown on the petrophysical chart and we have therefore made numerous measurements of the silt stones and shales which do show zero permeability.

Q Laterally? A Laterally.

Q But no analysis has been made on vertical permeability?

A Not to my knowledge.

Q Mr. Lindsay, I can understand why a company might perforate where no microlog separation was evident. These cross sections indicate a lot of perforations in many wells, but I can't understand why a company wouldn't perforate where the separation did exist. What's the reason for that? I note that it has occurred in several

instances.

A Were it my job to recommend perforations in any particular well that we might drill, I would recommend perforating all of the microlog pay intervals, all of them including and in addition the better developed sands from the SP that didn't show microlog. Right off-hand I can't think of a reason why one would not want to perforate microlog pay zones, assuming that those sands were not water bearing.

Q I note on your Exhibit OP, Carson Unit 14-11 has some microlog separation which hasn't been perforated. I just wonder about that.

A I don't know the reason for that. I would have recommended that we perforate the whole thing, I mean the whole microlog pay. There may be a discrepancy in depth measurement which was not corrected when this section was drawn, but I don't know if there is.

Q Mr. Lindsay, you corrected several of the exhibits while you were testifying. Are there any other errors in these exhibits or have they been checked to see if there are errors?

A They have been checked. I have corrected those errors that I have been able to find.

Q This process of checking, have you determined in your own mind that you feel that these exhibits are correct as they are now with the corrections that you made on them?

A They are to the best of my knowledge correct now.

MR. NUTTER: That's all.

MR. PORTER: Mr. Cooley.

By MR. COOLEY:

Q Mr. Lindsay, are the GC sands and the GD sands, as you identify them, the same sands which the Applicants refer to as the top two and most prolific sands?

A I think that they are. They have a different nomenclature.

Q You were present at the hearing yesterday, of course?

A Yes.

Q You heard continuous reference to the top two sands which were referred to as the most prolific sands?

A Yes.

Q From which two witnesses testified that they felt either 95% or something in excess of 95% of all the oil in the Bisti-Lower Gallup oil pool lies? A Yes.

Q Now I would like to know if you agree with this estimate as to the distribution of the reserves through the various sands?

A Well, I believe that this is weighting the upper sands rather heavily. I think that the 95% figure is probably lower than 95%. I would say that there is apparently, in my opinion there is more oil in the lower sands compared to the upper sands than in other opinions.

Q If you were asked to make an estimate to correct this figure, what would you think would make a closer approximation of the

distribution of the oil?

A I would be pretty hard pressed to give a figure, but I should think that I believe that our reservoir engineer has made an estimate and I would hate to give one different from his.

Q I would like to know from your geological examination what you feel the distribution is. I understand there are many factors from the engineer standpoint that come to bear upon these and modify them; strictly from the geological standpoint where do you feel this figure would be more properly placed?

A Well, I would say that as an opinion it would be more on the order of 75 to 80%.

Q Thank you, Mr. Lindsay. Yesterday Mr. Lewis testified that he felt that correlation between microlog pay was an extremely hazardous way of attempting to establish either the presence or the absence of communication between wells due to many factors, one of which you core a very, very small area compared to the distance between the two wells and the wide variations of permeability of which you have no knowledge in between. Do you agree with this statement?

A This approach certainly has limitations. It's an interpretive problem, has a lot of geology, it's the best method that I know of doing that of geologically looking for communication or discontinuity, I make every effort to correlate microlog pay though where they lie in the same stratigraphic position.

I think where they lie in different stratigraphic position, where one exists in one well and does not exist in the next well, I think it is a reasonable interpretation that somewhere between those two wells this sand which is confined between certain bedding planes must decrease sufficiently in permeability that it does not reach the other well, and therefore there is not communication, effective communication between those two wells in that sand interval. That's the best way I know how to do it.

Q You would agree that actual communication tests conducted between the wells would be more conclusive proof of the existence or non-existence of communication rather than an interpretive correlation of microlog pays?

A I think really the two approaches in conjunction might give you more of an answer, but I think that you have to, or that it is more informative if you conduct your pressure tests in individual sands rather than as in the entire interval open to the well. I think in many cases some sands may go through and communicate and show you pressure communication where many others do not go through, but the effect of those as I understand from our reservoir experts, is that where there is even a slight amount of communication you would see a pressure drop or a pressure interference between two wells which does not mean that all the sands are communicated between those two wells.

Q I'm not referring now to any communication test or tests

that have been conducted with reference to this pool, but in general if they are conducted under ideal conditions and as you say we will assume they are conducted for each interval.

A Yes.

Q This would be considerably more conclusive method of determining communication between the wells than would correlation of microlog pays, wouldn't it? A I think it would be, --

Q (Interrupting) Thank you.

A (Continuing) -- conclusive.

Q If you have further explanation I didn't mean to cut you off.

A That's all right. I think that the two really together would probably give you more information if you do test isolated sands, but of course I have confined my investigation to purely the geological approach.

MR. COOLEY: Thank you.

MR. PORTER: Mr. Utz.

By MR. UTZ:

Q Mr. Lindsay, I'm sure by now that you are aware that there are a number of perforations shown on your cross section exhibits which are borne out by microlog separation. Is my understanding correct that those perforations were made on the basis of the SP curve alone? A They were.

Q Then, let's refer to your cross section OP, Exhibit 11-R, for a minute. The perforations below your GD sands on Government

44-10 which do not show microlog separation, can you state whether or not those perforations are still in that well?

A To the best of my knowledge they are.

Q Let's enlarge it to all of your exhibits. Are all of the perforations shown on your exhibits still open in the well bore as far as you know?

A As far as I know they are unless there are any cases that I am not aware of where it has been indicated that the well has been plugged back above those; otherwise, I would assume they are open.

Q Getting back to your Shell 44-10, can you state whether or not the lower perforations below your GD sands produce oil in that well?

A I can't say conclusively that they do because I don't think they have been tested separately.

Q Can you state that any of these perforations shown on your exhibits, which do not show microlog separations, produce oil?

A On one of my cross sections at the previous hearing we showed Shell Carson Unit 2 which showed perforations in an interval of no microlog separation, and that is an oil well, it is not a very good oil well, but it does produce oil from only perforations opposite no microlog pay, and then this Southern Union well on Section KL appears to have perforations only opposite a sand interval without microlog separation. Apparently the sand intervals

which do show microlog separation have not been perforated.

Q That turned out to be a pretty good well then, didn't it?

A Sure.

Q So microlog separation alone is not indicative of whether a well will produce or not, is it?

A No, it is not.

Q I believe that it is your contention that there are quite a number of isolated sand lenses in this reservoir which are completely separated from other sand lenses. Am I correct in your analysis?

A It is again the problem of nomenclature. The sands in, I would say, probably most of these cases do go through to other wells, but those adjacent wells don't show microlog separation and therefore I think that the communication between those wells would be very poor inasmuch as the more permeable sands lose their permeability going between the wells until somewhere between this well and that well the permeability has dropped to so low a figure, probably in the tenth of a millidarcy or less range.

Therefore, I conclude that there is poor communication, if any, between those wells.

Q Have you, or do you know of any pressure tests, gravity tests that have been made as between these individual sand lenses?

A I don't know of any between individual sand lenses.

Q Would that not be a pretty fair way of indicating that they

had complete separation?

A I think that would be a good approach.

Q But you don't know that that has ever been done?

A Not to my knowledge.

Q Just one other question. Mainly out of curiosity, if these sand lenses are completely separated, how do you account for the oil being there in the first place?

A Well, we are getting back to this problem of geologic time. I was asked that question at the last hearing and I stated that I thought some part of the oil was indigenous, but that most of it migrated in the Gallup sands from an outside source, and I would say that the vast majority of it has migrated into the Gallup sands.

The Gallup sands, if you look at them in their environment, are a series of relatively thin sands interbedded with and entirely encased in a vast section of shale, the mancous shale, which I believe is considered to be a good reservoir rock. And I would say that in my opinion the mancous shale is probably the source of virtually all the Bisti oil, and of course when these sands were laid down why they were not tightly cemented like they are now. They had streaks of fairly relatively clean sand which had very little clay in them, and other portions which did have a good deal of clay which would account, would be represented by the shaleout of the sands in lateral directions, and the mancous shale at that time as it was

laid down before and after these Gallup sands, consisted of mud and clay which was gradually compacted, and in that mud and clay I would say from the large concentration of organic remains, that the oil was generated and more or less squeezed out of the shales into the sands.

In other words, as oil is generated in shales and shales are compacted, they become tighter and the oil tries to escape and we find some escaped into the sands and becomes concentrated into the sands. Then, of course, the sediments are buried rather deeply and at some time, at some geologic time, other changes take place, circulation of ground waters which deposit cementing material, much of it probably a result of the calcareous remains of the various fossils which are right in the sands themselves, and that changes the quality of the sands, it changes the nature of the sand, they become differentially cemented and the oil which remains in these streaks and stringers of permeable sand becomes trapped. That is my concept of how the oil got into these sands and why it can't get out until you penetrate it with a well.

MR. PORTER: Mr. Grenier.

By MR. GRENIER:

Q Just a couple of questions that have come to mind in the course of the cross examination by other parties. Referring to your Exhibit 11-R, I believe it was indicated in your Shell Carson Unit 14-11 well there were some eight different microlog separation

intervals there where positive separation was shown, is that correct?

A That's correct.

Q Going over to the next one on the left and the Shell Government 44-10, is that bar correctly shown there as being a continuous positive microlog separation throughout that interval which you have stippled in that well?

A Yes, it is. I can't recall the log itself. I looked at quite a few, but I would assume that the microlog did indicate a solid interval of separation.

Q Now, running through that solid interval I see that you have some four non-permeable streaks which appear to pass right through it, two of them at least going on a couple of wells on further to the left of the exhibit, isn't that correct?

A Yes.

Q What was your basis for determining that those were still impermeable lenses, or whatever, when you had positive microlog separation throughout the full interval?

A The basis for the shale beds separating the sands was the SP curve of electric log.

Q The microlog separation did not indicate that discontinuity?

A Not in thiswell.

Q I gather that you think that these, taking again the eight separate sands over there in 14-11, that some of them pinch out before they get over to offsetting wells. Wouldn't it be just as

likely to assume that some or all of the non-permeable intervals would pinch out before they got over to the next wells?

A A reasonable question, and I think in many cases the non-permeable streaks do pinch out as I show some here which do, Shell Government 14-10, and toward the center of the same section has a solid sand interval, and on the other side of it is a shale which is approaching that, but which pinches out before it gets to it.

The reason why I interpret it that way is because in that particular well that sand appears from the electric log to be fairly continuous sand and the shale is a very thin body and therefore the sand is in the majority. Looking at the field as a whole, the sands are in the minority and I find it easier to visualize thin sands pinching out into shale rather than the shales pinching out into sands.

Q But within these areas, not taking the entire depth of the well, you do have certain intervals which are predominantly sand?

A Yes.

Q With minor stringers within them?

A Yes.

Q With the same line of reasoning, those would be more apt to pinch out? A Yes, they would.

Q Thank you.

A I wasn't quite through. I attempt to correlate all the sands in the same stratigraphic, but if they are not in the same

interval, then I interpret those sands as not being communicated.

MR. PORTER: My watch shows it is noontime.

MR. GRENIER: We are going to have to leave to catch one of the planes. May I say that Southern Union supports the Applicants in this case for 80 acre spacing. It does so primarily on the ground, even after the testimony it is solidly confusing and irreconciliable, the most you can get to from that situation is a condition where we don't know yet, we cannot prove conclusively what the conditions are in this reservoir, that you cannot undrill a well once it is drilled.

It's always easier to drill one that you haven't drilled before, but you can never undrill one, and particularly in the light of the low takes which have been adverted to in the testimony in this case of oil from this pool, at this time this is hardly the time to be pushing people, as it was indicated in Mr. Brinkley's testimony yesterday, into a 40 acre development pattern as opposed to the 80 on which most of the field has been developed to date.

MR. SETH: Is Mr. Wiedekehr going to leave too?

MR. GRENIER: Yes.

MR. SETH: We were going to call Mr. Wiedekehr as a witness since he has given statements from the floor. The only thing we wanted was the cumulative production from the well that is under production. If he would give that.

MR. WIEDEKEHR: I don't have that available. We will be

glad to furnish it. It has been very small. It has been 200 barrels a day.

MR. SETH: How did you measure?

MR. WIEDEKEHR: After swab test, after load oil has recovered.

MR. SETH: What about your practice on core samples?

MR. WIEDEKEHR: Yes, every foot, and you can have that too if you would like to have it. If you will drop me a little note I'll send you all the information I can on it.

MR. SETH: I think that will do it.

MR. PORTER: I realize that these plane connections are difficult to make, so if someone else would like to make a statement.

MR. WOOD: A. W. Wood, from Monsanto Chemical Company. Monsanto wants to express concurrence with the proponents of 80 acre spacing and reiterate its requests made at the original hearing, that the Commission grant temporary 80 acre spacing in the Bisti-Lower Gallup Pool.

MR. PORTER: The meeting will recess until one-thirty.

(Recess.)

MR. PORTER: The meeting will come to order, please. Does anyone else have a question of Mr. Lindsay? The witness may be excused.

(Witness excused.)

Mr. Seth, did you offer your exhibits?

MR. SETH: No, I had one redirect, if I may.

MR. PORTER: I see.

RE-DIRECT EXAMINATION

By MR. SETH:

Q Would you expect that the drainage radius in areas that showed no microlog separation would be smaller than in areas that did indicate a microlog separation?

A Yes, I would expect them to be smaller.

MR. SETH: I believe that's all.

Q Now, referring to the exhibits, were these exhibits prepared under your direction or supervision? A They were.

MR. SETH: We would like to offer at this time Shell's Exhibits 1-R through 13-R, including letters A through H under 4-R.

MR. PORTER: Is there any objection to the admission of these exhibits? They will be admitted.

MR. SETH: I call Mr. Methven.

NORBERT METHVEN

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

DIRECT EXAMINATION

By MR. SETH:

Q Would you state your name, please, Mr. Methven, and your

position with Shell Oil Company?

A My name is Norbert E. Methven. I'm a reservoir engineer with Shell Oil Company, stationed in Farmington, New Mexico.

MR. PORTER: Just a minute, Mr. Cooley. Mr. Cooley says that the witness was not sworn.

A I was sworn with Mr. Lindsay.

MR. COOLEY: You were both sworn at the same time?

A Yes, sir.

MR. SETH: He was sworn with Mr. Lindsay.

Q What type of work are you doing in Farmington?

A I am a reservoir engineer, doing engineering work primarily in the Bisti Field.

Q During the course of that work you have become familiar with the reservoir characteristics of the Bisti Field, have you?

A Yes, I have.

Q What reservoir engineering data do you have that relates to the geological information that Mr. Lindsay has presented this morning?

A Well, there is considerable reservoir data which supports this geologic concept of irregularities and discontinuities. One of these is the apparent absence of vertical communication, and I think most, at least Shell uses, for instance in their completions they use a method of fracting --

Q (Interrupting) Well, in your fract methods do you recognize

and take into consideration the fact that there is no vertical permeability, there is no effective vertical permeability?

A That's right.

Q If so, how do you do that?

A Well, we take that into account, and in order to assure ourselves of fracting each individual sand, remembering that there are various permeabilities of these sands, or the permeability varies, we use a method wherein you use rubber balls in the fracting process. What you do is commence your fract job and in essence you will then fract the higher permeable zones, and then you use the rubber balls, you float the rubber balls and those go into the holes where the velocity of the fracting fluid is greatest and plug those off and the fluid is diverted to the zone of lesser permeability.

Not only does Shell do it, but I have been informed that other operators do likewise. Now, if you felt that you had vertical permeability, you wouldn't be concerned about something like that. You wouldn't need it.

Q What other reservoir characteristics relate to the discontinuity?

A Well, the presence of gas in a lower zone which is structurally lower than the presence of oil in an upper sand would indicate lack of vertical communication. Now, in view of the fact, as our geologist testified, that the oil was put in there in geologic time, surely this separation or migration would have occurred, but

in any event this was depicted in Sinclair's Exhibits 11-R and 12-R as presented yesterday where they showed oil occurring above the gas. Now if they had vertical communication or permeability, surely that gas would have migrated up and the oil down.

Q Now, have you in your reservoir studies, have you made a survey or paid special attention to the pressure picture in the field? Could you give us any over-all analysis or estimate on the pressure picture?

A Yes. There are large differences, large pressure differences, at adjacent well locations. Now, this occurs especially below bubble point.

Q Can you point out or do you have an example?

A Yes, I have some. One of these examples is in the British American properties in Section 28, Township 26 North, Range 13 West. The well that I am going to refer to first is Douthit B-2 in this case. In the month of October, 1956, this well had a static pressure of 760 PSI. Here is a case of a very low pressure, and it is British American Douthit B-4 in Section 27, Township 26 North, Range 13 West had a pressure of 924 during the same month.

Another one in this same area was taken as of a later date, this same British American Douthit B-4 had a value of 601 in April of 1957, while Douthit B-5 had a pressure in the same month of 1326.

Q Does this pressure show a pretty irregular arrangement throughout the field, or is there any sort of pattern to it?

A There is no apparent pattern. I think there's some other examples down here in for instance Amerada No-Des-Pah No. 1 in Section 8 of Township 25 North, Range 12 West.

Now, in April of 1957 that well had a static pressure of 1292, while the well immediately south of that which is in Section 17, Township 25 North, Range 12 West, Sunray Federal B-1 had a pressure of 441 during the same month. Pressure data in general throughout the field exhibits those irregularities. Upon attempting to say make an isobaric map of the field, why you run into those differences, very, very great differences in pressure. Just in general the pressure data is scrambled up and certainly highly indicative of poor communication.

Q That shows irregularity would more or less confirm the geological data that was put in by Mr. Lindsay?

A Yes, sir, it would be.

Q I believe you were here, or did you hear the testimony concerning interference tests conducted in the vicinity of the pilot test area? What does an interference test of that character show?

A Well, an interference test as such shows pressure communication only, and it does not necessarily show the amount, or does not give you a measure of drainage efficiency.

Q Why isn't pressure communication alone a measure of drainage efficiency?

A Well, one thing is where you have isolated sands, why you would not be measuring, for instance if you measured a well here and a well there, and if you had an isolated sand why you wouldn't necessarily measure the pressure or the interference.

Q Does the degree of pressure at the particular time have any significance?

A It has a very definite significance.

Q What is that?

A Well, pressure communication early in the life of a field that is undersaturated, is a function of the time and the compressibility of the fluid at that time. Now, when you are above the bubble point, the compressibility, I mean above the bubble point means you have undersaturated fluids, it means fluid and the compressibility of a fluid is very small. So when you have a certain pressure in say a vessel filled with fluid and you take a drop out, the pressure changes very greatly, but if you have a case where you have this vessel filled with some gas and you take a drop of gas out, then the pressure effect is very slight because the pressure of the fluid, or rather the compressibility of the fluid, is very slight as compared to gas.

Therefore, when you take an interference test when you are above the bubble point in the undersaturated region, then you have a, quite a pressure effect, but not very much or not necessarily very much fluid communication.

Q Well, then, it would be relatively easy to show pressure communication in an area where the pressures are above the bubble point? A Yes, it is.

Q That would hold whether the pressures were obtained artificially or were naturally occurring, is that true?

A Yes. And the difference of say the pressure communication from say above the bubble point to some place below the bubble point can amount to say a hundred times as much as the same amount of, that the time to detect that pressure difference would be say one hundred times.

Q Are there areas in the field that are presently below the bubble point?

A There are, yes. I just cited a few pressure cases that were.

Q I don't believe you told us what the bubble point was, what is it?

A It's in the region of, well, in the original hearing it was stated as 1207 PSI.

Q Now, you have indicated that there can be instances of pressure communication, but that will not show drainage efficiency and will not show the complete drainage picture. Can you refer to any of the exhibits that are presently posted and show us an example where there may be pressure communication through a particular zone while others there is no communication indicated?

A There are, of course, quite a few of them. I think on our

Exhibit 13-R, British American Douthit B-13, you can see that as you check the communication between this well and this well, you could very well have it or you could possibly have it any way through there, but it doesn't tell you what's happening to this sand in here, this separate sand in here.

Q Then if interference tests were conducted, using those two wells, it could possibly show pressure communication and it would be much easier to show it if it were above the bubble point, but still we wouldn't have a very good picture on the drainage situation?

A No, it certainly wouldn't tell you anything about what the drainage situation was of that sand. There's a lot of examples like that. Oh, we can pick say this well right here, this is Government 22-9 as depicted on KL or our Exhibit 9-R, there's a stringer here that you couldn't tell what the effect was by measuring the pressures in here or here as far as drainage is concerned. You could very well have pressure communication there, but you couldn't tell what is happening there.

Q The pressures taken in the well bore generally are not selective of any particular sand, they just measure the total over-all pressure?

A That is the conventional way of measuring pressures, and it is only very occasionally does somebody try to isolate the sand and try to measure the communication.

Q What are the two methods used to try to determine drainage efficiency?

A Of course, interference is good, assuming you have homogeneous sands and you are measuring those sands in particular. However, say a material balance calculation can give you an idea of what the drainage efficiency might be or an extrapolation of pressure and or production decline trends.

Q Considering where we are in the life of the Bisti Field, do you believe that it is, you could apply either one of those two methods?

A Certainly not now. For one thing, say the material balance is based on pressure performance and we have already stated that the pressure performance is very erratic and as a consequence the reliability of any material balance at this stage would be very, very poor.

Q You heard Mr. Lewis testify, and if I understand it correctly, you recognized that method of computation as being a method used generally, is that correct? A Oh, yes. It's --

Q (Interrupting) But you would not feel that it should be applied to the Bisti Pool at the present time, is that right?

A No, his was based on purely a text book example, and a perfect reservoir, and I'm sure this is anything but that, plus the fact that your pressures indicate the same.

Q Would you express an opinion as to when in the life of this

field that you think that you could apply the material balance calculation in order to extrapolate from your production data?

A Well, in order to give you any measure of workable accuracy, you should be say a third of the life or later of the reservoir.

Q Now, from what you know about the Bisti Field, do you think that can happen in the next five years, say, or three years or what, do you have any basis for estimating that?

A I think it could happen, certainly not within three years, and possibly not until five years.

Q Then it's going to be down the line a ways before you start using those particular methods for their drainage efficiency?

A Yes, it will.

Q Now, consider just a delay of say a year on the drilling of 40 acre locations, how will that affect completions, assuming that you had to drill on 80 acre locations now and waited a year to drill on 40's, what effect, if any, will they have on the drilling of these infill wells, a year or some such order from now?

A Well, in view of a certain degree of pressure communication, why these sands that may occur from one well to the next would be, at least their pressure would be lower and thus that would be in some of the sands. However, other sands would have initial reservoir pressures, so in the process of drilling wells through partially depleted sands as compared to virgin sands, why you have a lot of completion difficulties. Some of these are say mudding up of the

lower pressure sand.

Q Does that complication arise by reason of the fact that there are areas of different pressure within the same well bore? Do you get more mud in some sections than others?

A By all means, yes.

Q Explain.

A Well, during the process of drilling the well, you of course carry a certain mud weight to hold back the formation. In this case you would have to carry enough to hold back the pressure of the higher zones. The lower pressure zones would be highly susceptible to taking the filtrate out of the mud itself.

Q That would complicate the efficiency of your completion, is that correct?

A By all means. Not only mudding up, but the fracturing considerations are quite complicated there that, if assuming then that you didn't have mudding up, then if you were to fract the well, then this same lower pressured sand would be the one that would be most receptive to the fract fluid, then you have the problem of fracting the virgin sands to get the additional recovery.

Q Again, on this proposition of delaying the drilling of the infill wells and assuming, as the proponents do, that there is drainage, what effect will it have on changing the direction and movement of this oil? We assume it starts toward the 80 acre location if the proponents would, and that you drill the 40 acre

wells, does the oil have to change its path?

A That's right. You can envision the oil moving toward that well bore and then you drill another well here and it reverses itself.

Q Is that of any significance?

A Well, one thing, based on those assumptions then for one thing, say the gas saturation will be higher and as a result the mobility ratio or the ability of the oil to move back again will be reduced.

Q Does this show that the drilling of these so-called infill wells at a later date would be less attractive to any person to fully develop the field?

A By all means.

Q What other factors are involved, cost factors?

A Well, of course, you will incur higher drilling costs because of say a noncontinuous development program. Your completion costs, as we have already stated, would be higher. The lease facilities that you would have to replan those costs would be higher at a later date.

Q On the pressure aspect of it too, would you expect to encounter in some of the sands at least, lower pressures, and will that affect your payout situation?

A Yes. At a later date some of the pressures will be lower, and the consequent payout of the well will undoubtedly be much longer than they are today.

Q During the course of the hearing there has been a considerable discussion about the importance of the production from the lower members of this sand. Is it your opinion that the expected production from these areas is important, is going to be important in the over-all production from the Bisti Field, or is it of no consequence as the Applicants have indicated?

A No, I think it's quite important that any well you recover there that you should do so, and it is very difficult to calculate how much this will be, but it will be quite a bit, and in the difference of say a 40 to 80 will be even more in view of the discontinuities as indicated in the upper sands too.

Q Well, in drilling the 40 acre locations, you not only get the oil that is in discontinuities that don't extend over the 80 acre distance, but does that have any effect on the efficiency and the drainage in the upper sands?

A I think it will have an appreciable effect on the drainage efficiency of the upper sands.

Q And in these 40 acre wells we have to consider not only the production in the lower areas, but it is a complete well in itself and we should look at the entire well, should we not?

A Certainly.

Q Would you care to express any, or indicate to the Commission any percentage that you would expect, making a division between the upper and lower sands? A Well, --

Q Just considering oil in place in the first instance.

A Well, in the case of the lower sands, let's refer to what we call the GE, GG, which are the lower members as depicted by the cross sections, there is probably some 20% of the total oil in place in those sands.

Q Now, Shell's testimony shows too that these lower sands you probably wouldn't get the same production efficiency that you would from the upper sands. Is that a fair statement?

A I think it is. They're poorer sands in general.

Q Then that should be considered by the Commission also, should it not? Your figures relate to oil in place?

A Yes, they do.

Q But you would feel that it was important to consider also that the production be less efficient from the lower?

A Yes.

Q Are there some examples of each well in the field that have shown some rather high initial production but have dropped off?

A Yes, there are some wells on the edge that appear, that apparently don't have much pay in them, and as a result their pressures have declined and the wells are approaching the economic limit, and I wouldn't think that they would recover, but say several thousand barrels, and those wells are generally where there's small if no microlog pay in them.

Q Do you have any other comments that you would like to make

to the Commission on the reservoir situation?

A Well, I think that one thing, wells completed say in this, in these lower sands that apparently don't show any microlog pay, there has been some brought out today that actually produced oil, produced quite a bit of oil, however I think they'll have rapid declines, especially on a wide spacing program, and I think that's quite applicable to say the sands in the interior where you have poor pay but there's certainly oil there, certainly recoverable and we certainly would like to recover it.

Q This production, you heard testimony about the Southern Union well where there was no microlog pay indicated, and there was production, would you expect the radius of drainage there to be less than in areas where there is a microlog separation?

A Yes. It would be a very logical conclusion, that is a wide-spaced well would not recover a very great percentage of the oil where a closer-spaced well would recover a greater percentage of that oil.

Q This oil that is apparently in the areas where there is no microlog separation, that has a place in the picture, does it not?

A Yes.

Q And our spacing should be geared with that situation in mind, very small drainage radius? A Yes.

Q Is there a considerable development in the field to date on patterns other than any requested by the Applicants? Do you have

an exhibit showing that? A Yes.

(Marked Shell's Exhibit 14-R, for identification.)

Q Would you refer to Exhibit 14-R?

A Yes. This is Exhibit 14-R, which is a contour map of the Bisti-Lower Gallup Pool, and what we have done is colored in the Governmental quarter sections, for instance the ones in red are the Governmental quarter sections on which there have been two wells, which there have been more than two wells drilled. There's eight red ones, I believe.

Now, in the case of the green ones, those are Governmental quarter sections on which two non-diagonal wells have been drilled. So you can see these are spaced throughout the field.

Q In this diagram you have not taken into consideration direct 40 acre offsets, have you? A No.

Q You are just considering quarter sections alone?

A Yes, there are a lot of other wells that are misplaced.

Q There are a lot of forty acre direct offsets?

A There are, yes.

Q Is Shell Oil Company prepared to proceed on the 40 acre development as testified at the previous hearing?

A Yes, as far as I know.

MR. SETH: That's all the direct questions we have.

MR. PORTER: Does anyone else have a question of the witness?

Mr. Campbell.

CROSS EXAMINATION

By MR. CAMPBELL:

Q Mr. Methven, will you stand up and refer to this exhibit again, please, your Exhibit 14-R? Do you have the dates on which the wells in this area were completed by Shell since the first hearing?

A The dates of completion?

Q Yes.

A I could probably get some of them. I think I have some of those dates with me.

Q I'm going to point to various of these red marked quarter sections in the approximate center of the exhibit and ask you to tell me who appears to be the owner of the acreage underlying those red marked quarter sections. Let's take this one right here. Is this Shell acreage? A Yes, it is.

Q Is this one?

A That is Shell's acreage.

Q Is this one? A Yes.
Q Is this one? A Yes.
Q Is this one? A No.

Q Who owns this acreage?

A El Paso is the oil company.

Q Out of the six quarter sections marked in red in that area, Shell is the owner of five, is that correct?

A It is.

Q Can you tell me how many of the wells that are shown in those five quarter sections have been drilled by Shell since the last hearing?

A I don't know exactly, but I think most of them were. There are, I believe a few that were drilled prior to the other hearing.

Q Do you know the number of wells that Shell has drilled on a 40 acre pattern since the last hearing, the total number?

A I don't remember the number, no.

Q As a reservoir engineer, would you say that it is a correct statement to say that in a situation of this type with a cluster of wells as these are clustered in what has been testified to as the fairway or Highway 66, might result in a drainage situation to the advantage of the owner of these properties with the clustered well ownership?

A You mean under the present condition wherein the other people do not have 40 acre wells?

Q Yes.

A Well, I think there might be some room for say some drainage out there based on limited amount of apparent interference.

Q Do you have any data with you on the production history of the wells situated in that area to which we have been referring on the Shell acreage? A Yes, I have some.

Q Can you tell me what the production was from those wells

during the month of November?

A I don't think I have the November figures. I think the book is only up to October, the October figures.

Q Do you know whether Shell has the November figures here available? A I don't think they are.

MR. SETH: We can get them for you if you want them.

A The November figures, of course, come out in December and we apparently didn't have them available.

MR. CAMPBELL: I would like to request that the production figures on the Shell wells in Township 25 North, Range 12 West be furnished to the Commission together with the dates of the commencement of drilling on each of the wells.

MR. SETH: We will be glad to furnish that.

Q Is there any other acreage shown on that exhibit that is owned by Shell than that to which we have referred, your Exhibit 14-R, that is marked in green or red?

A Which ones did you point to?

Q That group in the center of some eight, are there any others marked that are Shell acreage?

A This is Shell here.

Q Have any wells been drilled on that tract since the first hearing? A Yes, sir.

MR. CAMPBELL: I would also like to have the information on that tract, the commencement date on each of the wells, and

the production data.

MR. COOLEY: Mr. Methven, will you identify the last quarter section?

A This last one, Section 16 in Township 25 North, Range 11 West, and this is the southwest quarter of that section.

MR. SETH: We will like the same information on Sunray's offsetting wells.

MR. ERREBO: If you will identify in some general terms, we will know what you want.

MR. PORTER: Is that the November production figures that you have requested?

MR. CAMPBELL: Yes, sir. I understand the October are available to the Commission.

MR. SETH: That is Sunray Mid-Continent C-14 and C-21, those two seem to be the only ones.

MR. PORTER: I believe those reports usually reach the Commission about the 25th of the month.

MR. COOLEY: Will you be willing to furnish the information requested, Mr. Errebo?

MR. ERREBO: Yes, I so stated.

Q During the course of your testimony, you, as I recall, it, made the general statement that at the present time because of the inadequate production history, as I understood you, you could not determine the situation in this reservoir by an examination of the

production usually and the pressure decline, is that correct?

A I believe I made that statement.

Q And what was your reason that you could not determine the movement of fluids by interference tests?

A Interference tests showing only pressure communication above the bubble point.

Q Do you consider that pressure communication is not any measurement of communication or drainage?

A It's an indication of movement and drainage, but it gives you no qualitative or quantitative amount.

Q And at this stage of development and production or completion of this reservoir, there is no quantitative basis on which you can determine that, is there? A Determine what.

Q The drainage, the movement of fluid, the amount of fluid moving that you referred to. If you can't use interference tests and you can't use material balance method, then there is no basis at the present time upon which you can calculate that, is there?

A You have to base your estimates on the geologic picture.

Q And as you said, the indication of pressure changes, is that correct? A Yes.

Q But you do believe that with additional production history in this reservoir some of the factors necessary to make those calculations will appear, will they not?

A I think they might, given sufficient time. However,

say the pressure, the erratic nature of the pressures to date suggest it would be a long time, and matter of years of course.

Q If you are unable to make any of these calculations, are you unable for your company at this time to calculate or estimate ultimate recovery or possible performance of your wells in this reservoir? How would you do that?

A How would I, would you rephrase that?

Q How do you calculate for your company in their economic calculation of drilling, any basis for ultimate recovery from the lease?

A You base that on the geologic picture and the total oil in place.

Q You base it entirely on your geologic picture?

A And your calculation of the total oil in place.

Q How do you calculate that? A By volumes.

Q Do you have enough information in this reservoir to do that?

A I think so. There's quite a few exhibits here that give you a very good means of calculating the oil in place.

Q Is that the method that you used in calculating the 20% of the oil in place in the lower sand zones?

A Yes, volumetric.

Q Do you have your calculations as to the amount of sand you estimate?

A I have some calculations here.

Q Did you consider the reservoir characteristics in the lower sands to be the same as in the upper sands in your calculation? A No.

Q Did you consider the porosity to be the same, the average porosity? A No.

Q Did you consider what you stated was the possibility of rapid decline of production in the lower zone?

A Pardon me.

Q Did you consider what you stated during the course of your testimony was your prediction of a rapid decline in production in the lower zones?

A You are asking me about the total oil in place calculations?

Q Recoverable oil, yes.

A I believe I understood you to be talking about total oil in place, at least I was.

Q Well, were you talking about recoverable oil in place when you were referring to 20%?

A Total oil in place?

Q Total oil in place. A Yes.

Q Do you have any calculations or estimates considering reservoir characteristics and the performance possibilities of the lower sands to indicate recoverable oil as related to the upper sands?

A Well, you have, as you mentioned, the porosities and saturations of those sands.

Q Do you think that the estimates that have been made here by their engineering witness as to the approximately 95% of the recoverable oil being in the upper sands are out of line?

A I think so, yes. I think th[illegible] would leave only five percent of the recoverable in the lower sands. I think there's more than that.

Q How much more recoverable?

A I couldn't give, you can't calculate it, so I can't give a definite number.

Q In other words, there is no way in which you can calculate it, is there?

A No, not the recovery efficiency.

MR. CAMPBELL: I believe that's all.

MR. PORTER: Anyone else?

MR. WHITE: I have one question.

MR. PORTER: Mr. White.

By MR. WHITE:

Q In your testimony as to the delays and the resultant difficulties that wouldarise by development on 80 acre spacing program such as mudding up due to low pressures, you are wholly disregarding, are you not, the possible success of the LPG program?

A Could you read that back to me.

REPORTER: Reading: In your testimony as to the delays and ~~the resultant difficulties that wouldarise by development on 80 acre~~

spacing program such as mudding up due to low pressures, you are wholly disregarding, are you not, the possible success of the LPG program?

A I think you will have these same troubles a year from now whether you flood or not.

Q To the same degree or lesser degree in view of the LPG, assuming it to be a success?

A In order to answer that, you have to make a lot of assumptions, now, for instance who you would propose to flood.

Q Well, you were here yesterday, were you not?

A I was indeed.

Q Let's assume that the LPG program continues to be successful as it is pointed out to be, what would your conclusions then be on that assumption?

MR. SETH: What area are you referring to?

MR. WHITE: Well, wherever the LPG program initiated, where the results of it would be felt.

Q Well, getting back to the original question, did you or did you not give any consideration to the LPG program?

A Well, we're actively considering it, of course.

Q Do you take that into consideration when you state your conclusions as to what difficulties might be encountered by delay caused by drilling on an 80 acre spacing program?

A Well, let's go on to the next question.

MR. SETH: Maybe if you would make them a little more specific as to areas they would be capable --

MR. WHITE: (Interrupting) I merely asked him if in stating his conclusions he took into consideration the LPG program.

Q You stated that Shell was ready to proceed on a 40 acre spacing program, is that true? A I did, yes.

Q Do you intend to drill the outer edges on a 40 acre spacing program?

A We don't intend to drill any non-economical wells. If a well out there is uneconomical, we have no intention of drilling it. We obviously will drill out as far as a well is economical.

Q Then your statement definitely has limitations to Shell's readiness to proceed on a 40 acre spacing program?

A Well, it would if it was any spacing.

MR. WHITE: That's all.

MR. PORTER: Mr. Wade.

MR. WADE: I have just a couple.

By MR. WADE:

Q Mr. Methven, back to this delay business, what will happen on 80 acres, if you were to have to go back in later? I think your first difficulty that you were discussing in completion was this mudding up of the low pressure sands?

A Yes.

Q Do you think that that mudding up situation would be of

such magnitude that the normal fract job wouldn't bring it back in good shape?

A I think there's quite a possibility, yes, that if not mudding up, you could say have some sort of blocking of the formation back into the formation.

Q You are assuming then that the filtrate will penetrate a pretty far distance back from the well bore if a fract job wouldn't eliminate that block, aren't you? A That's right.

Q Has it been your experience, or do you think that that occurs, that you have a filtrate invasion to a considerable degree in this thing?

A We have already experienced some troubles along that line.

Q And a fract job would not bring them back?

A They did in this case, but I suspect that if the sands have been depleted, that the trouble would have been exaggerated over and above what they have been recently, and I think you would encounter considerable difficulty.

Q I think you also indicated that fracturing would be more complicated?

A If not mudding up, then fracturing would be more complicated just, if you didn't have mudding up then you would have the case of the oil going into that depleted sand and possibly not fracting the lower sand.

Q That is just what I was going to get at, what is wrong

with your rubber balls that you are using now?

A In this case it's questionable about the effectiveness at that date, that time.

Q What do you mean effectiveness?

A The effectiveness of the rubber ball fract jobs.

Q Well, that rubber ball fract job is just a physical principle of the rubber balls going to the zone of highest per meability, is it not? A Yes, it is.

Q Wouldn't that physical prinicple still hold?

A In general it might be complicated.

Q I think you also said that you would experience a higher drilling cost the second time around for drilling the infill wells, is that right? A That is, yes.

Q What do you base that on?

A That's based on the previous testimony at the previous hearing.

Q Did you testify to that? A I did not.

Q You really don't know then whether or not it would be more expensive the second time around?

A I would expect it to be.

Q You would base it on your experience?

A Well, I'd base it on the previous testimony, the previous accepted testimony.

Q I think you also indicated payout on the second time around

would be longer?

A It could very well be.

Q That would be based on your assumption that the drilling cost would be higher the second time around to a great extent, would it not?

A That plus the wells capabilities at that time might not be as they are today.

MR. WADE: That's all.

MR. PORTER: Mr. Dutton.

By MR. DUTTON:

Q Mr. Methven, are you one of the members of Shell Oil Company that gets to deal in dollars, respecting economic evaluation?

A I don't handle many dollars.

Q Do you make economic evaluations?

A I do, yes.

Q Have you made one in this field?

A Yes.

Q In making such an economic evaluation, say with particular reference to the drilling of the development well, do you think that payout time should be considered?

A Payout time should be considered. I think so, I think it always does.

Q Do you have any idea of your own, as a reservoir engineer, as to what might be a reasonable payout period for the development

of well costs?

A A reasonable payout time is dependent upon what the company is willing to accept, and I have no, I mean I don't control that.

Q In the original hearing, did you testify that you thought that a 40 acre spacing would pay out in a reasonable length of time?

A I did.

Q At that time were you speaking for Shell Oil Company on your own position as a reservoir engineer and professional man?

A Speaking for Shell Oil, yes.

Q At that time what did Shell consider to be a reasonable payout period?

A I think it's about two years.

Q About two years? A And it varies.

Q Are you familiar with the Bisti Unit allowable that has been recommended for the month of January, 1958, for the standard 40 acre unit? A I believe I heard.

Q What figure do you recall hearing?

A For what period was this?

Q January.

A For the month of January?

Q Yes, expressed in barrels per day.

A I don't think it was definitely decided, but it was something to the effect of ten barrels per day for the month of January.

Q Mr. Methven, what is your idea of the approximate cost of

drilling a well in the Bisti area?

A Previously a witness -- could you define the cost now, what does the cost that you are talking about include?

Q First to define it, I would define it as the total cost of drilling, completing and equipping. I would accept any one of the categories that you would define.

A Which one would you prefer?

Q The sum would be fine.

A The testimony at that time was to the effect of $48,000.

Q On the basis of ten barrels of oil per day production, can you give us an estimate of what the payout time would be for the --

A (Interrupting) Ten barrels per day per month. Are you making an assumption that you can produce the well only at ten barrels a day --

Q (Interrupting) I'm assuming --

A -- forever?

Q I'm assuming that the well will produce ten barrels a day, yes, sir, approximately what time would the payout be on that?

A It is certainly a hypothetical question, and I don't have a handy figure, but there is no question about it, it would be a long time.

Q It would exceed two years by a substantial margin of time, would it not?

A Assuming this hypothetical production rate?

Q Assuming this hypothetical type of an example, would you object to stating that the net income would be roughly to the operator two dollars a barrel after all expenses of lifting the oil?

A Would you rephrase that?

Q Considering all expenses involved to the operator, would you say that his net income per barrel of two dollars would be too far out of the ball park just to talk about years?

A No.

Q At ten barrels per day then, the operator would have essentially a twenty dollar a day income?

A That is right.

Q In $48,000 expenditure, how many days would that involve just roughly?

A Forty-eight divided by twenty?

Q Yes.

A That goes in about thousand --

Q (Interrupting) Would twenty-four hundred be all right?

A Yes.

Q Then twenty-four hundred days would be approximately seven years.

A I presume.

Q Mr. Methven, do you have any information that you would like to submit to the Commission at this time that would indicate that the allowable situation in the Bisti Pool is likely to change

in the immediate future?

MR. SETH: If the Commission please, I don't believe that is within the scope of the direct examination. I don't think it is pertinent. I don't think it is within the scope of the hearing at all.

MR. DUTTON: If the Commission will hear discussion, the purpose of the question was that Mr. Methven's hypothetical term given to this particular example might have left, or did to me insinuate that ten barrels a day would not last very long, and I just wondered if he had any information that would indicate that to be a fact.

A Could I --

MR. SETH: Just a minute.

A Oh.

MR. PORTER: The objection to the question is sustained.

MR. DUTTON: Thank you. That's all I have.

MR. KELLAHIN: Jason Kellahin for Phillips Petroleum Company.

By MR. KELLAHIN:

Q Mr. Methven, you, as a reservoir engineer, recognize the use of the material balance calculation in predicting reservoir performance in terms of oil originally in place, do you not?

A He interrupted my ability to concentrate on the mispronunciation of my name.

Q I apologize. A It's Methven.

Q Shall I repeat the question?

A I wish you would, yes.

Q Mr. Methven. A Thank you.

Q As a reservoir engineer, you do recognize the use of the material balance calculation to predict reservoir performance in terms of oil originally in place, do you not?

A Yes.

Q And do you make that prediction after the pool has been one-third depleted?

A You can make these predictions all along the line, but the accuracy of these predictions on a pool are very poor because the material balance equation is based on a homogeneous reservoir, so they're very poor until you get very, very good data, and that data comes only after a period of years.

Q In that event, then, you wouldn't say that the material balance calculation is useless at the initial stages of reservoir development, would you?

A Well, it gives the reservoir engineer something to do, but I for one couldn't sell it to management in the early stages of development.

Q Have you, yourself, used it for that purpose?

A Like I said -- I have used a material balance equation.

Q In your use of that, did you have the perfect reservoir

to which you referred?

A No, I didn't. And my results showed it.

Q Actually the only assumption in that connection is an assumption of continuity, is it not? A Pardon me.

Q I say the only assumption you make in reservoir characteristic on that point is an assumption that it is a continuous reservoir, is that correct?

A Oh, yes, you have to know all of the factors of the reservoir.

Q I mean in regard to a homogeneous reservoir, you have to assume continuity, is that correct, in a material balance formula?

A Oh, surely.

Q Now, you made some reference to difficulty or impossibility of reversing the flow of the fluids in the reservoir by the drilling of later infill wells. Just what was your testimony on that, Mr. Methven?

A I said that you can -- by drilling wide spaced wells you can have oil moving towards that well and then when you drill a well in between and you, say you draw the pressure down here, would prefer to go to this well then, after having moved possibly beyond that point.

Q Actually it would move to the new well, would it not?

A Pardon me.

Q It would tend to move toward the infill well?

A Some of the oil, yes.

Q The relative permeability at that point being less than at the point of the old well?

A The relative permeability being less at this time and therefore the movement of that oil at this time is impaired as compared to drilling the well initially.

Q Then what is the difficulty in the movement of that oil toward the new well? I don't follow your reasoning on that.

A I just said that you have already moved it away from the new well and now you are going to move it back into the well. Why didn't you drill the well, I mean you should drill the well first and take it out there.

Q But the fact is that it will move, is that correct?

A Yes.

Q To the new well? A Oh, yes.

Q Then there's no loss?

A Oh, on the contrary, the ability for it to move it at a later date then is impaired as compared to initially.

Q In connection with your testimony on the drilling of these infill wells, you expressed some concern about the mudding up of low pressure zones. I believe you also had some testimony to the effect that the pressure communication did not necessarily indicate the ability of the fluids to move through the reservoir in regard to drainage. In that connection, how would pressures be reduced

at the point of these infill wells if there was no effective drainage at that point?

A I did not say there wasn't any drainage. I said that the drainage efficiency could not be measured by pressure interference tests. I did not deny --

Q (Interrupting) There would be drainage?

A I wouldn't deny that if you have communication. The degree, of course, is very important.

MR. KELLAHIN: Thank you, sir.

MR. PORTER: Anyone else have a question of Mr. Methven? Mr. Cooley.

By MR. COOLEY:

Q Mr. Methven, have you, yourself, made any calculation as to the drainage efficiency of one well or an average well in the Bisti-Lower Gallup Oil Pool?

A The drainage efficiency of one well?

Q I don't mean any particular well, but I mean what you feel the drainage efficiency is in this pool over all.

A In certain sands, yes, certain members, the prime members I believe we testified would be something like 20% at the previous hearing.

Q And have you made any calculation as to the area which one well will drain?

A Well, you can't do that, you can't calculate how much one well

will drain. Given enough time, why a well could in this field, could drain over long distances, but I don't think it would drain many of the sands and the efficiency would be very, very poor.

Q Well, I believe you answered that you felt that one well would drain 40 acres, didn't you? A Pardon me.

Q Haven't you testified in this case that one well will drain 40 acres? A Yes.

Q Now, this is what I'm getting at, how did you determine that it would drain 40 acres? What method of calculation did you use?

A Well, you of course use the geologic picture, and from that it appears that you can drain a certain amount of that oil out of that region, and so you estimate what the efficiency would be.

Q It's based primarily on the geologic picture?

A Primarily, plus experience from what you might experience from a field like this.

Q This geologic picture is obtained through the interpretation of micrologs and electric logs and core data?

A All data available, yes.

Q All of this is localized in the area of one well bore and you are interpolating or interpreting what the intervening area will hold? A Oh, sure.

Q You feel that this type of calculation is more reliable than pressure interference information?

A I think it is at this stage, yes. I think that's the method.

I don't mean that pressure interference tests are not applicable, but they don't give you a measure of the degree.

Q Wouldn't the amount of drawdown give you some indication of the qualitative drainage effect? You have stated repeatedly that you can't ascertain the quality of your drainage through communication tests. Wouldn't the degree of drainage pressure variation give you some indication at least of that quality?

A Yes, yes. But you don't have anything to relate that degree to.

Q You are not prepared to state what percentage of recoverable oil you feel lies below the GC and GD sands as you define them?

A Percent of recoverable. I don't know what that would be, but I said that it would probably be less than the upper sands which are better. It's very difficult to estimate what it is. It's something less than that.

Q I believe you also stated that you felt the density of the drilling affects the recovery. Is this only in extremely heterogeneous types of reservoirs? I mean we have had testimony and extractions from papers by various bodies, Interstate Oil Commission Committees and various other agencies, to the effect that density of drilling was pretty much, made very little difference in the ultimate.

A They said that it made some difference and that amount of difference was calculated on the basis of purely textbook example

of a very homogeneous reservoir, so there is, even they admit to some in the case, I mean a small amount in the case of the homogeneous reservoir, and then when you differ from the homogenity that the figure goes up.

Q It is your feeling that the homogenity increase is due to the increased density?

A Yes, I think as the homogenity increases, then your efficiency increases with the denser spacing.

MR. PORTER: Does anyone else have a question of the witness?

MR. SETH: I have a little re-direct.

MR. PORTER: Let's take a five minute recess.

(Recess.)

MR. PORTER: The hearing will come to order, please. Mr. Seth, I believe you have some re-direct.

MR. SETH: Yes.

RE-DIRECT EXAMINATION

By MR. SETH:

Q Mr. Methven, in your calculations on your reservoir here, did you use the methods that are ordinarily used in the industry?

A Yes, volumetric calculations, those are the general and accepted methods.

Q Generally accepted throughout the industry, are they?

A Yes, they are.

Q Your other calculations likewise?

A Very much so, yes.

Q In those calculations you used established permeability, porosity, water data that had been furnished to you, is that correct?

A That's right.

Q And using all of that data you made your calculations as testified to in the original hearing?

A Yes.

Q You were asked about efficiency on 40 and 80 acre tracts. What would your opinion be as a comparative efficiency on the 40 as compared to 80 acre locations, ordinary drainage efficiency?

A Well, related to this pool there would be quite a bit of difference in addition to this lower interval which we've stated has about 20% of the total oil in place. It's difficult to say how much of that you'll get, but you might get, well, half the recovery efficiency there as you would with the upper sand, or say 10% of that, and that plus the additional segregated or discontinuous members that you would get in the upper sands, plus the improved recovery efficiency in general, would amount to a considerable percentage of the oil in place.

Q And you would recommend to the company, as you did before, that they would proceed on such a drilling program?

A Yes, I think so. There's a lot of oil there, and I think

they can recover it, and I think the fact is I advise that they do recover it, and in any event these wells are going to be economical.

MR. SETH: I believe that's all. We would like to ask that our Exhibit 14-R be admitted in evidence. That is the map.

MR. PORTER: This completes all your exhibits? Without objection Exhibit 14-R will be admitted.

Anyone else have a question of Mr. Methven? Mr. Utz.

MR. UTZ: Yes, I would like to ask a question or two.

RE-CROSS EXAMINATION

By MR. UTZ:

Q Mr. Methven, it is your contention, I believe, that you can recover more oil on 40 acres than 80 acre spacing?

A In a non-homogeneous reservoir it quite frequently --

Q (Interrupting) Well, with particular reference to Bisti.

A Yes.

Q Can you state how much more oil you can recover by drilling two wells on an 80 than one well?

A Well, as an estimate I should think it would be at least 20% more.

Q Could you put that in barrels?

A Well now, you mean in barrels for an 80 acre tract?

Q Well, in barrels, you said 20% more oil recovered on 40 acre spacing than 80 acre spacing. A Yes.

Q If you can, I would like to know about how much that is in

barrels.

A Well, it would probably be in the neighborhood of twenty to thirty thousand barrels.

Q It's my understanding that Shell is drilling their wells, or developing their acreage, on somewhat of a mass production, a production line plan, whatever you would like to call it. How much money do you save per well by drilling them in that manner?

A This manner, it means not so much mass production as continuous production. I guess you can interpret that as mass. The amount of saving is, I don't know what it is, but it is several thousand dollars per well.

Q Do you have any idea what your first, second or third well costs?

A I'm not familiar with the cost, no.

Q Would it be $10,000 a well, $20,000 a well, do you think?

A The question is the second and third costs?

Q Well, what I'm really wanting to know is how much money are you saving per well by drilling on a continuous basis as you call it, rather than drilling and contracting one well at a time.

A Well, the move in costs out there, I think they vary quite a bit, oh, something like five thousand, seven thousand dollars or something like that.

Q You stated that your drilling cost was $48,000?

A Yes, it is.

Q Would you say that a figure of $65,000 would be unreasonable for drilling individual wells?

A Oh, I wouldn't think it would be that high, no.

Q $60,000?

A Somewhere between fifty and sixty.

Q Now, is it your opinion that by drilling on 40 acre spacing that you will recover the oil from your acreage in a lesser time than if you drilled on 80 acre spacing, is that a consideration, I will ask this?

A Oh, yes, yes, you normally would expect that you would recover the oil faster with the denser spacing program, and that is not predicting what allowables would be. I don't know what that would come to.

Q Then in your decision to recommend 40 acre spacing to your company, the length of time to recover the oil was a factor?

A By all means, the rate of return is always a very important factor to a development program in the field.

Q The fact that you could recover, as you just stated, twenty to thirty thousand more barrels per acre tract, was that a factor?

A Yes.

Q And likewise the fact that you can save fifteen, or well, we'll say for the purpose of a figure, $15,000 a well by the fact that you can use your continuous development plan, was that also a factor?

A Yes.

Q Which one of those factors was the most important?

A Well, I think they all make each other important.

Q If your wells cost you $60,000 a well to drill as it would say an independent operator with 80 or 160 acres, would you still recommend 40 acre spacing?

A As long as it's an economical venture why I certainly would.

Q Well, you have made those economic calculations, haven't you? A Yes.

Q I'm asking you from your standpoint and what you know from your study, would it be an economical venture?

A Well, of course, it depends where it is located in the field, if the oil isn't there, then no spacing would be economical and so here is the case where you would be incurring additional $10,000, it in that case would detract from the profitability, but I don't have a ready figure to say how much it would amount to.

Q You can't say whether it would detract enough to where you would not recommend 40 acre spacing?

A No, I think you would have to make an individual analysis of it in the specific case. I'm sure in some cases it would be quite economical.

MR. UTZ: That's all I have.

MR. PORTER: Anyone else have a question? The witness may be excused.

(Witness excused.)

MR. PORTER: Anyone else desire to present testimony in this case? Any statements at this time?

MR. HINKLE: If the Commission please. Clarence Hinkle, representing the Humble Oil, and I have a brief statement on behalf of Humble.

Under our statute authorizing the Oil Conservation Commission to establish proration units, a unit must be established that can be efficiently and economically drained and developed by one well. In establishing proration units, it is mandatory that the Commission consider first the economic loss caused by the drilling of unnecessary wells, two, the protection of correlative rights, three, the prevention of waste, four, the avoidance of risks arising from the drilling of an excessive number of wells, and fifth, reduced recovery which might result from the drilling of too few wells.

We believe that the testimony in this case clearly shows that one well will effectively, efficiently and economically drain more than 80 acres in the Bisti-Gallup area, that economic loss will result in loss on 40 acre spacing, and that substantially the same amount of oil will be recovered by development on 80 acre spacing as by development on 40 acre spacing.

In this case we have a pool which covers a relatively large area, and roughly the operators owning less than 50% of the productive area are seeking development on 40 acre spacing and the other

operators want development on 80 acre spacing. The undisputed evidence shows that development on 40 acre spacing will require the drilling of approximately two hundred additional wells, of which the owners of more than half of the acreage in the field would be required to drill more than one hundred additional wells, and to risk in excess of five million dollars in drilling equipment.

The proponents of 80 acre spacing are only requesting a temporary order for one year. As we pointed out in the original hearing, a field which has been developed on an 80 acre pattern can always be further developed on a 40 acre basis, but if an error is made in requiring the field to be developed on 40 acre basis, resulting economic loss can never be recovered. In our opinion it would not, under all the facts and circumstances of this case, be in the interest of good administrative practices under the Oil Conservation Act to require the majority of the operators in this field to develop on 40 acre spacing pattern until it has been demonstrated beyond a reasonable doubt by additional production history that waste will be committed by development on 80 acre spacing.

If there is any doubt about the matter in the minds of the Commission, that doubt should at this time be certainly dissolved in favor of the temporary order. We urge that the Commission grant the temporary 80 acre spacing.

MR. PORTER: Mr. Errebo.

MR. ERREBO: If it please the Commission, Magnolia

Petroleum Company was joined in the application of Sunray and others for rehearing. Its representative H. J. Ramsey appeared at this hearing but has had to leave and has authorized me to make this statement in their behalf. The Magnolia Petroleum Company is an operator within the productive limits of the Bisti-Lower Gallup Oil Pool in San Juan County, New Mexico, operating six oil wells and one gas well with 800 acres under lease.

At the previous hearing of Case 1308, Magnolia supported Sunray Mid-Continent in their application for 80 acre spacing. Magnolia's position has not changed and we again concur with Sunray Mid-Continent for 80 acre spacing.

It is believed that waste of hydrocarbons will not occur with 80 acre spacing. Infill drilling can be accomplished at a greater rate and the productive limits of the field determined sooner on 80 acre spacing. It should be kept in mind that spacing on 40 acres can be accomplished at any time, while initial 40 acre spacing may result in economic waste with little or no ultimate hydrocarbon recovery being realized.

MR. PORTER: Mr. Kellahin.

MR. KELLAHIN: Jason Kellahin, representing Phillips Petroleum Company. Phillips Petroleum Company feels that the testimony which has been offered in this case clearly demonstrates that one well will adequately and economically drain and develop 80 acres;as it was pointed out by Mr. Hinkle in behalf of Humble, if

there is any doubt in the mind of the Commission, certainly that question should on a temporary basis be resolved in favor of a temporary order for 80 acres, and particularly in view of two important factors, one, the present market situation, the other being the pressure maintenance program which is being presently operated on a pilot basis.

Now, the development of this pool on temporary 80 acre proration units, we frequently hear the statement that you can go back and infill. I would rather compare that somewhat to the nature of an exploratory operation as against an autopsy. If we ever are going to find out anything, we can find it out on the basis of 80 acres and then we will know where we are going. If we drill it on 40 acres we have performed an autopsy over a dead body, there is nothing more we can do about it. The development of this field, as has been pointed out, on 40 acre spacing, will result in expenditure of a tremendous sum of money, and if as present indications certainly point out, the fact will be this pressure maintenance program is successful, that money could far more adequately be used in secondary recovery than in development on a 40 acre pattern, and Phillips Petroleum Company urges the Commission to adopt the temporary order.

MR. PORTER: Mr. Malone.

MR. MALONE: May it please the Commission, Ross Malone for Gulf. There are two things that I would like to point out at the

outset that it seems to me should be borne in mind in consideration of the problem that here faces the Commission.

The first is that we are here on a rehearing of the order of the Commission which made applicable the statewide 40 acre spacing rules under which substantially all the oil of New Mexico has been developed. Now, this problem of spacing and large spacing units and small spacing units is one that has been troublesome ever since the industry started and will always be troublesome, and some companies are referred to as wide spacers and some as narrow spacers. Gulf has been before this Commission many times urging 80 acre spacing, it has andundoubtedly will be before the Commission again urging it, but the function of the Commission as we view it is to apply the standards to the particular pools under consideration and see whether as regards that pool the most efficient development and the least waste will result from 80 acre or 40 acre spacing.

Now, if we start out with this homogeneous pool that has been discussed here, that has perfect communication, one well for the entire pool as we all know would ultimately drain and would most efficiently and most economically drain that pool. As we move away from that ideal condition, the spacing unit must inevitably get smaller and smaller. It can be assumed then that when the operators come before the Commission as in this pool and say that the spacing unit should be larger than the one on which 95% of the oil in New Mexico has been developed, that they would have a pool

in which conditions were much better than average and hence you would be entitled to assume that you would get better performance under a wider spacing pattern, but the evidence that has been presented by both sides shows exactly the contrary to that. It shows a pool which in its rock characteristics, in the heterogeneous character of the sands, in the pinchouts of permeability, all of those things make this a less desirable and not a more desirable pool for wide spacing.

Now, under those circumstances, with 95% of the oil of New Mexico having been developed on 40 acre spacing, it's a little difficult to understand other than on the theory of wide spacing for the sake of wide spacing, a recommendation that the pool be developed on 40 acres.

Gulf has a relatively small amount of acreage in this pool. We don't have and won't have any production line drilling operation going on out there, but our experience and the experience of our engineers fully supports the case which has been presented by Shell, which is that we have here a deposit of oil in sands which if not developed on a pretty dense spacing pattern is going to result in a lot of that oil being left in the ground, and that basically as we understand it, is the question that the Commission has before it, the question of how this reservoir can be developed so that it will be efficiently and economically depleted. We believe that the evidence which has been presented here today, as does the

evidence presented in opposition to the Commission order, adds little, if anything, to the testimony that the Commission heard at the outset in this case. It shows again two main sand members in which communication is shown to exist, and nobody has argued about that, there is some communication in the most favorable parts of the sand members.

I don't think anybody would question it. That is not the question that makes the completion of this pool, as we feel indicates that it should be done on a 40 acre and not an 80 acre basis. If the Commission were dealing only with a single sand member such as exists up there in the pilot flood area which has the most favorable communication possible, or the most favorable communication that exists in this pool, it would be one situation. But the evidence shows that is not the situation that exists throughout the pool, and that unquestionably there are going to be not only stringers in these lower producing horizons, but because of the lack of continuous permeability in the upper horizons, there is going to be oil that would not be produced on an 80 acre pattern. We feel that the extent of the pool and the perimeter of it in which these two principal sand members are not coextensive, creates another tremendous area in which oil will be left in the ground on an 80 acre development pattern.

Under those circumstances, Gulf feels that the order of the Commission was proper, that no reason has been shown for it to be

vacated, and that the Bisti Pool should be developed on a 40 acre pattern as have been all other comparable pools in New Mexico.

I would like to add only this, that some reference has been made to gas-oil ratio and field rules in this hearing. As we view it, that was not an issue on this rehearing. Certainly it's a matter which when the Commission gets ready to consider it, should be the subject of a special hearing, that it could be gone into, because I don't believe any of the operators intended to go into it at this time. Thank you very much.

MR. HALL: Hall, representing Elliott and Hall. We are operators in the Bisti Field, southeastern part of the field. We wish to go on record as supporting Sunray Mid-Continent's application for temporary 80 acre spacing.

MR. BUSHNELL: Amerada would like to urge the Commission to consider granting of this application in light of the apparently numerous anomalies existing in the minds of the witnesses of the opposition, Shell Oil Company. Amerada feels that if there is any doubt, and there apparently is, as to certain information concerning the Bisti Pool, that the Commission should consider wider spacing until those apparent anomalies have been resolved. Thank you.

MR. PORTER: Mr. Seth.

MR. SETH: I don't think it is necessary to argue this thing, particularly, or rediscuss the evidence that we have all heard in the last several days. There is one point here I would like to

mention. It relates to, specifically to testimony of Mr. Gaines of Sinclair, I think it has more or less prevailed here in the thinking of a good many of the Applicants. Mr. Gaines testified that he felt that the company would have to drill every 40 acre location on the lease that was then under discussion, or abandon the lease. Again, in the statements this afternoon there was a figure of two hundred wells. That contemplates the drilling of a location regardless of whether it is economical or not. Nobody under any sort of spacing is going to drill these locations.

That was what the proponents have been arguing, that is what Sinclair argued, that they would have to drill every 40 acre location within their lease, within this pool. That is clearly not so. No one is going to have to drill uneconomical wells regardless of what the spacing is. This figure of two hundred wells multiplied by the cost of drilling each well, that figure is based on the same sort of reasoning. Again, perhaps the opponents in this case do not own a majority of the acreage in the field. I don't think we do. We would probably like to, but we certainly don't, but that again, I don't believe that is the basis for consideration. It is strictly a matter of drainage, a matter of waste that is the only consideration.

In examining the applications for rehearing in this case, I think it was apparent to all of us that there has been some confusion about the burden of proof in a situation like this, and in the

original case as far as that's concerned, and again referring to Sinclair, their counsel indicated that there were no rules as I understood him, for this situation, and it was time we got some.

Well, that's not the problem, it wasn't at the original hearing, we have statewide rules. The situation is covered by rules, it is operating properly. Shell has drilled its wells there in accordance with the rules all along, everybody has. We have rules, the situation is that the Applicants want to change the rules. They have the burden of proof.

In the applications for rehearing, the matter of the burden of proof in the original hearing was completely ignored. The applicants have the burden of persuading the Commission to change the statewide rules. Just because there is some doubt created, that doesn't mean the statewide rules should be changed. Several statements just awhile ago said if there is some doubt it should be in the other direction. That is certainly not the burden of proof rule that has always prevailed before this Commission. The Applicant has the burden of making his case. He has to make his case, it is not upon the opponents to.

We feel they have failed to do that in this case. They are trying to offer proof in order to change an existing rule. No reason has been shown to change the spacing. The evidence, we believe, clearly shows that the most efficient development of the field as a whole will be on 40 acre basis. That is the efficient and economic way

to drain the field and to prevent waste.

The discussions concerning these lower sand members are very important. Mr. Finfrock testified that there was virtually nothing in the lower sands, it was negligible. We think that that should be considered, the content of the lower sands. We don't consider the oil in the lower sands alone as a factor. It is one, but you have to consider in addition the improved efficiency and drainage by drilling a 40 acre location, the improved efficiency in the upper sands. You add the increased efficiency in the upper sands with the oil in the very discontinuous lower sands and you clearly have efficient operation in the field.

The wells will be commercial, everybody wants to make money in a situation like this and to have commercial wells within the limits of conservation, and prevention of waste, and we think that the 40 acre program will clearly do that. We don't have any production line drilling program. I don't know quite now how that got into the picture. We operate our drilling program just like everybody else does, the other companies, we try to keep the contractors busy over an extended period of time. It is better for him and it is better for us. The independents do that, individuals do it, there is nothing unusual about it. I don't think we have any more rigs going than anybody else, it is just a matter of planning, and we do just like anybody else, there is nothing unique about keeping a drilling contractor busy for an extended period of time.

In that connection we don't have any production line system. We are no different then anybody else. Our costs are lower, but it is just by using ordinary business planning in that connection, and again, on this burden of proof on the temporary order matter, there seems to be the idea that you can get by with a temporary order when you don't have enough proof for a permanent order, that it is somewhere in between. If you can't make a case on a permanent order you ask for a temporary order. That again, I don't believe is the case. You have to make your proof for any change in the rules whether it is temporary or permanent. And to ask for just a temporary because you are not quite sure or you don't think the proof is strong enough, you are asking the Commission to make a change in the existing rules, you have to make a case to do it no matter what change you are asking for, and to fall back on a temporary argument because you don't have a strong case as you would like and don't think you have a strong case for a permanent order, I don't believe that is contemplated in the rules of the Commission or in ordinary or judicial or administrative rules.

We believe that not only that the Applicant has failed to meet the burden of proof, but that the proof is overwhelming that there should be 40 acre spacing for proper development of this pool, and to prevent a very real danger of waste if the spacing is on an any wider pattern. Thank you.

MR. PORTER: Mr. Campbell.

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MR. CAMPBELL: If the Commission please, I shall not take the time to discuss with the Commission the question of burden of proof except to say that I do not agree with Mr. Seth's construction of the statewide rules, but I'm satisfied that the Commission here intends and will establish in this pool what it considers to be the most appropriate, most efficient, most economic, the least wasteful program that will adequately develop this field, both in the light of primary production and in the light of possible secondary production.

The Commission's order in the original case stated that there was not proof that one well would drain 80 acres. At this hearing the Applicant has undertaken, and I believe has by additional evidence from additional information, additional studies, additional engineers for different companies, undertaken to substantiate its position and to improve its position with regard to this particular point. At the first hearing it was implied by the witnesses for Shell that only a microlog study could really establish the question involved in this drainage. At this hearing the geologist for Sunray presented a fieldwide study of microlog separation in which he concluded as do these exhibits, that appear on the wall, it seems to me at least in general, that there is communication and continuity at least as to the upper two principal producing zones in this particular field.

That information was further substantiated by the witness for

British American who made the same sort of analysis across the entire length of the field from all the cores that he had available, and he correlated those into the same kind of picture that we believe exists in these principal producing sands.

The witness for British American also indicated by pressure drawdown tests, interference tests, that there was communication. These have been minimized by the witness for Shell today. Nonetheless, in the absence of additional production history which we cannot get without the passage of time, certainly that is the best information to establish this particular point whether you are dealing with 40 acre spacing or 80 acre, The testimony of the Phillips' witness used the application of the material balance formula in which he reached the conclusion that only an infinitesimal amount of additional oil would be recovered by 40 acre spacing than 80 acre spacing.

Finally we had the testimony of Mr. Brinkley in connection with the operation of what we considered to be a very important pressure maintenance LPG injection program, and so we think that the testimony at this rehearing has certainly established that one well will drain 80 acres upon the basis of the information now available.

The Applicants conceded in the original application that there has not been sufficient production history in this field perhaps to justify a permanent order. This rehearing has made it even more apparent, even when you consider it in the light of the evidence

offered here by Shell. Let's just look for a moment at some of the uncertainties that exist in this field. These are some of the things that I believe do differentiate this situation from 95% of the pools to which Mr. Malone referred. I agree with him that each pool should be considered on its own. There have been varying estimates in the cost of wells by different companies, different methods of operation. The second place, there has been testimony regarding the lack of production history from these wells, testimony regarding the present limited production from these wells due to market conditions, and finally uncertainty as to what the production might be in the future.

Those things enter into the economic considerations that the statutes require in the establishment of proration units. Then there has been the question of the gas cap, the existence of gas wells at a structurally lower position than oil wells. This is a formation or pool condition which we feel needs to be approached with extreme caution. Then there has been the installation and the development of this pressure maintenance program, which up-to-date appears to be progressing satisfactorily, even on a wide area basis. We believe this should be given an opportunity to work to determine by all of the operators in the pool how they can best invest their money to get the most oil out of this reservoir, and perhaps have a little left over to invest in some other place.

The witness for Shell has testified that they have been unable

to make any determination of vertical permeability in this field to date. They have no pressure or gravity tests in the lower sand zones, apparently have not tested them separately. They have been unable to determine fluid movement because there has been a lack of production history.

All of these factors, when considered in the light of this very important economic factor, the possibility of economic loss from the drilling of unnecessary wells, we feel justifies a temporary order in this particular field. I have heard with some interest a remark of the Sinclair witness and the statement recently made by the Sun Oil Company, whether he is an attorney or engineer or both, Mr. Dutton, in any event in connection with the establishment of 80 acre proration units. I think that is a possibility that the Commission must consider, particularly in view, in the light of the fact that Shell has apparently, since the last hearing, and I would assume since there are some twenty wells drilled since the application for rehearing, continued to develop in their own areas upon a 40 acre basis. We believe that there isn't any evidence here which will run contrary to the issuance of a temporary 80 acre proration unit or spacing order in this field, as the Commission should see fit to apply.

MR. PORTER: Mr. Wade.

MR. WADE: The Texas Company is an Applicant in this rehearing. I would like to make a statement for The Texas Company on this matter.

I think that there are two issues involved essentially in this hearing. The first of which, does communication exist in this reservoir in sufficient nature to justify the drilling of one well on 80 acres, and would that one well efficiently drain that 80 acres.

The second point, I think that we need to consider, would that well more economically drain the acreage than would one well on 40. Texas Company believes that the proponents of 80 acres have presented data here that does justify the acceptance of both of these points, and we would urge the Commission to accept and grant the 80 acre spacing for this field.

MR. PORTER: Mr. Dutton.

MR. DUTTON: Sun is in the same position. If I may make a statement, Sun Oil Company, as an 80-acre operator in the Bisti Field, is seriously concerned with the Commission's action in this case. However, we realize that the Commission's action cannot be predicated upon the alleviation of Sun's concerns, but must embody an attempt to realize the dual proration goals of preventing waste and granting each operator a fair opportunity to recover the hydrocarbons under his property. Such an attempt must of course be within the statutory authority of the Commission.

The status upon which Sun bases its recommendation to the Commission is contained within Paragraph (b) of Chapter 65, Article 3, Section 14 of the New Mexico Statutes. It is requested that the Commission take administrative notice of this statute, particularly the language which parenthetically defines a proration unit to be "....the area that can be efficiently and economically drained and developed by one well....". It is significant that the definition does not read "most efficiently". It is also significant that it reads, "can be" and not "might be" or "will be if the market demand improves" economically drained and developed.

Ample testimony has been given that both 40-acre and 80-acre spacing will adequately and efficiently drain the pool. On the other hand testimony to date has been that it is not economically feasible to drill even the cheapest Bisti well for the January

indicated allowable of 10 BOPD. As the referenced statute is couched in the present tense, it is submitted that the statutory requirement that a proration unit be an area that can be economically developed by one well would not be met by a present designation of a 40-acre proration unit.

Sun Oil Company is on record as being in support for 80-acre well spacing and we do not now alter this position. However, Sun is not merely interested in maintaining a position -- or for that matter in merely enforcing the absolute letter of the law -- but is vitally interested in not only the prevention of waste, but also in the assurance that each operator has a fair opportunity to recover the hydrocarbons. Therefore, in the alternative, Sun would recommend that if the Commission sees fit to establish 40-acre well spacing, that they also adopt an optional 80-acre proration unit. By so doing, the Commission would be granting to those operators who believe they can eventually profit from a 40-acre development an opportunity to prove their point. At the same time, there would be no statutory violation to force such operator's poor domestic cousins into what is currently a patently uneconomical situation. In addition, such an order would overcome the objection that uniform 80-acre spacing would result in failure to drill certain choice locations. Both sides might well benefit from this feature. As to the possible complaint that such an order would result in irregular surface spacing, the evidence introduced by

both sides indicates that the Bisti has hardly been deposited in quarter-quarter sections.

MR. PORTER: Anyone else?

MR. BUELL: Guy Buell for Pan American Petroleum Corporation. In the interest of saving time, may we simply readopt our closing statement that we filed by letter after the September hearing. In that letter we supported 80-acre units. We feel that data are even more conclusive now that the only proper spacing in this field is 80-acre.

MR. PORTER: Anyone else have a statement to make?

MR. SELINGER: If the Commission please, Skelly Oil Company is one of the applicants for the rehearing. We regret that we have no affirmative factual data to present, mainly because we attempted to take some interference tests and unfortunately we are unable to complete them due to the lack of tank room. Likewise, we had no factual data to present as an applicant in view of the lack of production history from our wells, all of which are relatively and comparatively new wells.

At the time of the first hearing we had in the process of completion six producing wells. At this time we have twelve producing wells, and all of the twelve producing wells are on alternate 40-acres or 80-acre spacing as we know it. We have drilled three wells in the gas cap since the last hearing. The first well is 660 feet from the nearest lease lines, and our other two wells

are a minimum of 990 feet, these three wells being in the gas cap. We would like to recommend to this Commission to take consideration of the 80-acre spacing.

MR. McGOWAN: I would like to make this one point. There are no rules on this field. It is simply subject to the restrictions of the state general rules against drilling close to lease lines, and it has a proration unit for your proration purposes. It is a very substantial field; it has a number of wells in it, and it certainly is time the Commission took jurisdiction of it and issue such orders as they feel will come nearest to preventing waste possibly, and we feel it should be whatever program will do it, and not whether the 40-acre proration units should be changed, but an affirmative action on the part of the Commission. As stated by our engineer, we do feel that Sinclair would have been, and even now could recover a greater amount of oil, and in an effort to keep this field under control, and in view of the great development on it already, we are recommending 80-acre proration units as a means of controlling this field, at least on a temporary basis. Thank you.

MR. PORTER: Anyone else desire to make a statement at this time?

MR. STEWART: Standard Oil Company of Texas concurs with the application.

MR. PORTER: Are there any more statements? If there are

no other statements to be made at this time, the hearing will be adjourned.

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STATE OF NEW MEXICO)
)
COUNTY OF BERNALILLO)

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

WITNESS my Hand and Seal this 17th day of February, 1958, in the City of Albuquerque, County of Bernalillo, State of New Mexico.

Ada Dearnley

ADA DEARNLEY, COURT REPORTER
NOTARY PUBLIC

My Commission Expires:

June 19, 1959

CASE 1308: Hearing January 14, 1959
Hearing required by R-1069-B to show cause why rules for Bisti Pool should be continued beyond February 28, 1959.