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Transcript of Hearing Nov. 14, 1951

Rangely — Cause No. 2

(2-1)

BEFORE THE OIL AND GAS CONSERVATION COMMISSION

OF THE STATE OF COLORADO

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IN THE MATTER OF THE INVESTIGATION TO TAKE MEASURES TO PREVENT WASTE OF OIL AND GAS IN THE RANGELY FIELD IN THE STATE OF COLORADO.

CAUSE NO. 2

APPEARANCES:

J. J. Zorichak, for the Oil & Gas Conservation Commission;
Ralph Sargent, Esq., for the Oil & Gas Conservation Commission;
J. K. Smith, Esq., Lewis Bond, Thomas Newman, C. F. Bedford, for Stanolind Oil & Gas Company.
Henry Mattson, R. L. Keyes, J. F. Blackwell, Walter Will, S. A. Berthiaume, for the Texas Company;
Woollen H. Walshe, Esq., Mr. Sullivan, Mr. Vitter, Mr. Tuller, Mr. Ashby, for the California Company;
Lee S. Osborne, Esq., Mr. Winterburn, Mr. Kratka, for the Union Pacific Railroad Company;
W. C. Carpenter, Esq., Samuel Butler, for the Sharples Oil Corporation;
Quilman Davis, Esq., and Van Thompson, for the Southern Union Gas Company;
R. B. Laughlin, W. W. Heard, S. B. Richards, P. P. Manion, W. M. Elias, R. G. Bechtel, Don Fulkingham;
Foster Morrell, U. S. Geological Survey;
Jack Schwabrow, H. G. Barton, G. G. Frazier, of the U. S. Geological Survey;
Stuart McLaughlin;
Benjamine E. Sweet;
Charles L. Pickett, for the California Company;
F. T. Chambers, for Stanolind Oil & Gas Company;
L. D. Jacobs, for Public Service Company of Colo.;
E. N. Dunlap, for California Company;
R. M. Williams, for Phillips Petroleum Corporation;
F. L. Kirgis;
Max S. Loy, for Sharples Oil Corporation;
Phil Helmig, Malco Refining Company;
Donald D. Anderson, Malco Refining Company;
John Clinton, Continental Oil Company.

I N D E X

Exhibits

PURSUANT TO NOTICE to all parties in interest, the above-entitled matter came on for hearing before Commissioners Warwick M. Downing, Russell Volk, H. C. Bretschneider, John E. Cronin, Clark F. Barb, in the Hearing Room of the Employment Service Division, 1280 Sherman Street, Denver, Colorado, on the 14th day of November, 1951, at ten o'clock a.m., whereupon the following proceedings were had, to-wit:

COMMISSIONER DOWNING: We are not all here but we have some preliminary work to do and I imagine they will come in before we get started. We have two proceedings set for today. One is commonly referred to as Rangely and the other is Ignacio. I don't know how many is represented in each. Probably the first thing we better do is to enter appearances in both cases to see how many there are and we will try to see how much time we will take. It's fairly possible if the Ignacio people are not too numerous we will get through real quick so we might put them on first, but if they are going to take any great length of time Rangely, I think, has precedence.

MR. SMITH: I represent the Stanolind Oil & Gas Company. My name is J. K. Smith, making an appearance in the Ignacio hearing.

COMMISSIONER DOWNING: I wish you would each rise and give your names and your appearance and who you are appearing for.

MR. SMITH: You might also enter for Stanolind Oil & Gas Company, Lewis Bond, Thomas Newman, and C. F. Bedford.

COMMISSIONER DOWNING: Those are here for the Ignacio hearing only?

MR. SMITH: The men whose names I just called are here for the Ignacio hearing only.

COMMISSIONER DOWNING: Who else wants to enter their appearance?

MR. ANDERSON: Donald D. Anderson, Malco Refining Company, Incorporated. The Ignacio hearing.

MR. HELMIG: Phil Helmig, Malco Refining Company, Incorporated. Ignacio.

MR. MATTSON: Henry Mattson, Texas Company, on the Rangely hearing. Also Mr. R. L. Keyes, Mr. J. F. Blackwell, Mr. Walter Will, and Mr. S. A. Bernhiaume.

MR. WALSHE: In connection with the Rangely hearing I would like to make appearance on behalf of the California Company. My name is Woollen H. Walshe, and I would like to also enter the appearance of Mr. Sullivan, Mr. Vitter, Mr. Ashby, and Mr. Tuller; the Rangely hearing only.

MR. OSBORNE: Lee S. Osborne of Union Pacific. I have also Mr. Winterburn and Mr. Kratka for the Rangely hearing.

MR. CARPENTER: Mr. W. C. Carpenter, representing

the Sharples Oil Corporation, and also Mr. Samuel Butler for that corporation.

MR. DAVIS: Quilman Davis and Van Thompson, representing the Southern Union Gas Company for the Ignacio hearing.

MR. LAUGHLIN: R. B. Laughlin in the Rangely hearing, and also W. W. Heard, S. B. Richards, P. P. Manion, W. M. Elias, R. G. Bechtel, and Don Fulkingham.

MR. MORRELL: Foster Morrell, U. S. Geological Survey in the Ignacio hearing.

COMMISSIONER DOWNING: Mr. Morrell, when we have the Ignacio hearing we hope you participate with us in all matters affecting that hearing.

MR. SCHWABROW: Jack Schwabrow, of the U. S. Geological Survey and Mr. H. G. Barton also of the Survey of our Washington office, and Mr. G. G. Frazier of the Denver office in connection with the Rangely matter.

COMMISSIONER DOWNING: And Mr. Schwabrow, when we take up the Rangely hearing we hope that you will sit with us and participate with us not only with the hearing but with the deliberations.

MR. SCHWABROW: We came down more to find out what was going on and to listen and so forth.

COMMISSIONER DOWNING: Well, I believe that as a matter of constitutional law the police power of Colorado

extends to the conservation of oil and gas from public lands and that is not in the U. S. G. S. survey, but I don't think you agree with me. Until that matter is settled, why, I think it's kind of a joint undertaking. Have all appearances been made?

MR. McLAUGHLIN: Stuart McLaughlin, on the Rangely hearing.

MR. SARGENT: Ralph Sargent, Jr., Assistant Attorney General, in both the Ignacio and Rangely hearings.

COMMISSIONER DOWNING: I might say that Mr. Ben Sweet phoned me Friday and Saturday. He represented some parties greatly interested in the Ignacio hearing. He has just been employed and he couldn't be here and he wanted time to present his case. I told him that our Commission, after consultation with my associates, that we wanted to give him every opportunity to have a hearing and we thought at first it would be better to have the Ignacio hearing at a time when both sides would present their case, but calling up it developed that you would rather go ahead with the hearing today as to present your case and if Mr. Sweet wanted more time to present his, we would fix a later date. He asked for some time later in the month but I think Mr. Sweet ought to be here so that we would agree upon a date and really know that he still wants a hearing. I assume he does but he ought to be here and ask for it if he wants it.

Well, I think then we have got all the appearances.

Next, let me say this that we hope this hearing and all these hearings will be snappy and short. You gentlemen will want to get through both these hearings, of course, today. I know you have fixed this date so you could stay over for the meeting of the Rocky Mountain Oil and Gas Association and have the pleasure of attending their meetings. We don't want to hurry you but we do want you to move fast. If you try you can do the job in half the time than if you proceed too easily. Now, how long will this Ignacio hearing take place?

MR. SMITH: I anticipate Stanolind can put in what evidence it desires to put in in approximately an hour and one-half.

COMMISSIONER DOWNING: Does that include all?

MR. SMITH: That includes the Stanolind presentation. I am not familiar with what California Company or Southern Union may offer.

COMMISSIONER DOWNING: You all know what this application is about in a general way. Now, is there any opposition to any of these other people appearing here in the Ignacio case, or wish to offer opposition to the petition of Stanolind and other companies, or are you in favor of it?

MR. DAVIS: Mr. Chairman, on behalf of the Southern Union Gas Company we came to listen. We don't have anything

in this particular area of Ignacio but we just want to find out what is going on. We don't expect to put in any testimony in opposition to Stanolind's proposal.

COMMISSIONER BRETSCHNEIDER: May I make a suggestion. As I understand you, you were discussing whether or not the Ignacio meeting should be held first or the Rangely meeting should be held first. May I express a preference or suggestior

COMMISSIONER DOWNING: Yes.

COMMISSIONER BRETSCHNEIDER: I would suggest this Rangely meeting be held first unless the group would vote to have it otherwise.

COMMISSIONER DOWNING: I think it's obvious that the Rangely hearing has precedence, it was set first. Unless the Ignacio can get through very quickly, I would agree with Mr. Bretschneider. I will ask the other members of the Commission. I think as long as Ignacio is going to take at least an hour and one-half, I think we better proceed --

MR. SMITH: Mr. Commissioner, I would like to suggest that an hour and one-half figure was a conservative one. I think we could probably get through much quicker in view of the fact we have no opposition at this time. I anticipated some opposition in view of some of the statements in the newspapers, but actually I think we can put our evidence in very quickly.

COMMISSIONER DOWNING: Now, how about you Rangely

boys? If they will get through in an hour and one-half, not over that, we will cut them off sharp if they are not ready, are you willing that they should proceed and get them out of the way? I don't think we hear any consent to it so I think we better go ahead with Rangely. So you who are interested then in Ignacio may be excused until 2:00 o'clock.

All right, now this is our first hearing and we haven't any very definite plan of procedure, but I think possibly the first step would be to call Mr. Zorichak to the stand and a statement of the conditions as he finds them in the Rangely field today.

MR. WALSHE: Mr. Downing, just as a suggestion as to matter of procedure, I think it would be a good idea to read the notice of hearing and have the record show that notice has been published.

COMMISSIONER DOWNING: Yes, sir, you are right. First, will you read the notice of hearing. Let me say that the hearing now is upon the so-called Rangely matter and our Director will read the notice and give proof of publication.

MR. ZORICHAK: In the matter of the investigation to take measures to prevent waste of oil and gas in the Rangely Field in the State of Colorado. Notice of hearing to all interested persons and to whom it may concern:

The Oil and Gas Conservation Commission of the State of Colorado has on its own motion instituted this

proceeding to take measures to prevent the waste of oil and gas in the Rangely Field ir the State of Colorado, and all operators and owners of working interest and all persons interested in that said field are hereby required to appear at a hearing to be held in the Hearing Room of the Employment Service Division, 1280 Sherman Street, Denver, Colorado, on the 14th day of November, 1951, at ten o'clock a.m., and to show cause, if any they have, why the Commission should not enter all appropriate orders to prevent the current waste of oil and gas in the operation of said field, and in particular, why the Commission should not enter an order fixing a gas-oil ratio appropriate for said field, or enter an order requiring all waste gas produced in the field to be injected into the Weber sand; or why an order should not be entered, reducing the daily production from the field in order to reduce the rate of reservoir pressure drop; or why an order should not be entered requiring that there be determined the amount of oil each well in the field can produce without waste, in accordance with sound engineering practices; or why such other orders or combinations of orders should not be made to prevent the present waste in the operation of the said field.

In the name of the State of Colorado. The Oil and Gas Conservation Commission of the State of Colorado. By John E. Cronin, Secretary. Dated October 19, 1951.

COMMISSIONER DOWNING: Now when and where was that

published?

MR. ZORICHAK: It was published in the Denver Post October 24 and it was also published in the Meeker Herald. I don't have the date because the affidavit has not yet been received.

COMMISSIONER DOWNING: When the affidavits of publication are received will you file them as part of this record?

MR. ZORICHAK: That is right.

COMMISSIONER DOWNING: Was any further notice given?

MR. ZORICHAK: Letters were sent to all the operators and to all concerned that we had on the mailing list with the request that each operator notify all parties associated with them in the Rangely Field.

COMMISSIONER DOWNING: Unless there is objection we shall declare that this meeting has been duly called and notice duly given and it will be held for the purpose as set out in the notice. Hearing no objection, so ordered.

Before we continue, some others have come in recently. Will you please rise and enter your appearance for the reporter.

MR. WILLIAMS: R. M. Williams, Phillips Petroleum Company; Fred Kirgis, Phillips Petroleum Company.

MR. CLINTON: John Clinton, Continental Oil Company.

MR. PICKETT: C. L. Pickett, California Company.

MR. DUNLAP: E. N. Dunlap, California Company.

J. J. ZORICHAK

was thereupon called as a witness, and being first duly sworn, was examined and testified as follows:

THE WITNESS: My name is J. J. Zorichak, Director of the Colorado Oil and Gas Conservation Commission, and I have the following statement to make:

Two types of waste are at present occurring in the Rangely Field, in Rio Blanco County, Colorado. Seventy-four Weber wells are producing oil with a gas-oil ratio exceeding 1,000 cubic feet per barrel. Production of oil with inefficient gas-oil ratios constitutes underground waste. Twenty million cubic feet of residue gas is being now released directly into the open air and burned in a flare. Using a value of 10 cents per thousand cubic feet, which is the current market price to the town of Rangely, the gas burned daily has a value of $2000, or at a monthly rate of $60,000 and an annual value of approximately $700,000. This is waste.

The development of the Weber Reservoir in the Rangely Field began in 1943. The initial reservoir pressure at a datum of minus 900 feet was 2750 pounds per square inch. In April 1951 the average weighted bottom hole pressure was 1508 pounds per square inch, or a decrease of 1242 pounds since the beginning, and approximately one-fourth of the

estimated ultimate recovery of oil has been produced with a drop in pressure of almost one-half. The solution gas-oil ratio varied from 250 to 400 cubic feet per barrel, and the bubble point pressure range was from 1700 to 2560 pounds per square inch.

Whereas originally most of the 480 productive wells produced their oil by flow, only approximately 70 wells are now flowing, the remainder being on pump, with the exception of two gas injection wells and five that are shut in for high gas-oil ratios. Considerable oil was initially produced from the Weber Reservoir by virtue of fluid expansion. At present the source of reservoir energy is gas in solution, limited water drive, and gas cap expansion.

During the development period, a large part of the gas produced was consumed as fuel in drilling and production operations. However, since December 1948, approximately 11 billion cubic feet of gas have been flared to the atmosphere. Of this amount, roughly 9 billion cubic feet represents residue gas, one billion cubic feet was wet surplus gas, and one billion cubic feet was lean gas flared at the wells without processing. At 10 cents per thousand cubic feet the 11 billion cubic feet of gas would have a value of approximately $1,100,000.

The ideal solution to this problem of waste would have been reinjection of gas into the Weber formation.

Unitization attempts which would have made such a program possible, have failed. It has now become the duty of the Conservation Commission to take such steps as will be necessary to prevent further waste.

Let us consider for a moment the effect of injection 20 million cubic feet of gas into the Weber formation. This volume of gas under present reservoir conditions represents a volume of approximately 33,800 barrels of reservoir space. If reinjected into the formation the current rate of reservoir pressure drop would be decreased approximately one-half. The benefits of this program would be two-fold:

1. Storage of potential energy within the reservoir to produce oil in the future.

2. The pressure maintenance would prevent gas from boiling out of solution, and increasing the area of the gas cap. It would also help to maintain more favorable viscosity characteristics in the oil.

Even though considerable gas has been produced from the gas cap, through wells having access to the gas cap, the gas cap has already expanded from an area of approximately 2800 acres to an area of approximately 4400 acres. We will have gas cap regardless of whether injection takes place or not. As pressure is reduced on a gas cap, it naturally expands. Furthermore, as the reservoir pressure is reduced below the bubble point, the gas that boils out of solution

accumulates in the gas cap. Therefore, the obvious program is maintenance of pressure to keep the oil as liquid as possible and to supply a reserve of energy to drive the oil through the sand to the producing wells. Permitting the reservoir pressure to drop to atmospheric pressure would increase the viscosity of the reservoir oil from approximately one to two centipoises, or doubling its viscosity. Under such conditions it would take twice the energy to produce one barrel of oil. It is very important to keep this factor in mind.

It is generally agreed that the Rangely Weber ultimate reserves are approximately 350 million barrels if produced by ordinary depletion methods, assuming a recovery factor of 20 to 25 per cent. In fields with uniform characteristics it is estimated that through application of conservation methods, as much as 100 per cent additional recovery can be obtained. However, the Weber reservoir in Rangely has a great variation in reservoir characteristics, and if we assume merely a 25 per cent increase in production due to conservation practices, it would mean an additional recovery of approximately 87 million barrels of oil, with a value of approximately 217 million dollars. The operators who have to date done corrective work and shut in high gas-oil ratio wells are to be commended for their efforts. I will say that they have done a remarkably good job in those

instances. However, it is obvious that a great deal more remains to be done to further conservation.

From the long range standpoint, the problem in Rangely as in all other oil fields, is to recover the maximum amount of oil from the sands. We are all familiar with the remarkable results achieved through conservation methods in such fields as the East Texas field, where it is estimated that the ultimate recovery will be approximately 90 per cent of the oil in place. In the Hobbs pool, through the use of packers, natural water drive has been harnessed to produce additional quantities of oil, and packers have also been set in the gas cap area to prevent excessive gas-oil ratios. As a result of such conservation practices, the ultimate recovery of the Hobbs Pool will be much greater than would have been realized under the old methods. It is realized that the conditions for improved practices are more favorable in these fields than in Rangely, but with the proper application of the improved methods a much greater ultimate recovery shall be realized from the Rangely field than if oil methods are pursued.

It should be our ultimate object in the conservation of this field, to bring about the very highest possible amount of recovery. Any failure to do less than what should be accomplished is waste.

COMMISSIONER DOWNING: Are there any members of the

Commission that want to ask Mr. Zorichak a question?

MR. SARGENT: Mr. Downing, I wonder if the record may show any qualifications of Mr. Zorichak as an expert has been waived by all interested parties.

COMMISSIONER DOWNING: Tell us your present position and what experience you have.

MR. SARGENT: I made the suggestion that the necessity of those qualifications be waived if it's all right with all interested parties.

COMMISSIONER DOWNING: Does anyone object to the qualifications of Mr. Zorichak as an engineer to testify to the matters that he has? Hearing no objection, why, your qualifications are admitted. Now, does anyone else wish to ask Mr. Zorichak some questions?

(Witness excused.)

COMMISSIONER DOWNING: I have this morning an article entitled "Conclusions from Experience" by Mr. Kaveler, a very worthy presentation representative of one of the companies who is also represented by very able counsel at this hearing, and it was recently delivered. This is not testimony but it is a challenge or statement that I wish to have considered and it's just two or three sentences I want to read from it. "Oil production is exhausted when the pressure of gas or water is spent, for without the pressure within the reservoir rock there is no means of expelling oil

from the rock, and the production of oil must necessarily cease. In the face of this fact, one may further observe the amount of pressure within a reservoir as a measure of the amount of oil remaining to be recovered." It fits in with what the gentleman just said. "It also follows that the degree of reservoir pressure maintenance whether accomplished by the natural energy or supplementing the natural energy by the suppression of mixed gas and water is a measure of degree of ultimate recovery to be had from any deposit of petroleum." And I think one more sentence. "And it may be said further that the repressuring operations and water flooding operations are the more effective and productive of increased recovery the earlier in the life of a pool that such pressure maintenance operations are commenced. In the nine statements just made, we come to the conclusion which is that oil pools should be operated by pressure maintenance practices from a time beginning early in the productive life of the pool."

Now, the meeting is open to hear such evidence as anyone wishes to present. I might say we are more interested in the present and in your advice and suggestions as to the future and not so much interested in the past. We are interested in the present, and we hope that something very good and constructive may come out of your presentation of evidence here. Have you agreed among yourselves about the order that you will proceed or how many of you wish to

present evidence?

MR. WALSHE: Woollen Walshe, representing the California Company. I think it has been tentatively agreed I would make a statement first and then present certain evidence for and on behalf of the California Company and make certain suggestions. The other operators will then comment on our suggestions and make their own.

COMMISSIONER DOWNING: If that is agreeable to the Commission and to those present, just proceed then in that manner.

MR. WALSHE: I would first like the record to show that this California Company is interested only in the Weber Sand Pool. We are not interested in the shallow production at Rangely, and I don't know whether this Commission intended the notice to be broad enough to cover the shallow rights and shallow production, but my statements and the entire testimony as put on by the California Company will be limited to the Weber Sand Pool.

Mr. Zorichak has reviewed the problems at Rangely and have stated certain conclusions. Mr. Zorichak is, of course, ably qualified. He has been working with Rangely for quite sometime. The notice of hearing that has been sent out seems to indicate that this Board has already prejudged the question of whether or not there is any waste being committed in the Rangely Field; and when I speak of waste,

I am talking of waste as defined by the Colorado Statute. We are coming before you in a sincere effort to work with the Commission to arrive at a solution for Rangely. But we are not coming before you as defendants or as culprits in the exercise of our operations in that field. We think we have done a very good job at Rangely. As early as 1945 we made studies of the reservoir and we have been continuing to make studies up to the present time.

The California Company has worked for years in trying to work out a unitization project for Rangely. Stanolind and all the rest of them have joined in on it and I think there has been more studies and more engineering reports made on the Rangely Field than practically any other field in the United States. The operators have built a gasoline plant in the field and that plant cost several million dollars. It is processing some 30 million cubic feet of gas a day. It's extracting some one and one-half million gallons of products and that has a very definite value to all of the operators in the field.

In 1950 the California Company and the Texas Company and Union Pacific instituted a pilot injection program to see how gas injection would work, if it would work. We are continuing to make those studies. So we would like the Board to bear with us in recognizing the many problems at Rangely, because we want to work with them in doing the best for the

operators, for everybody concerned.

Now, we do have some testimony and we have some charts and maps we would like to put up if we may have a two-minute recess we will do that.

COMMISSIONER DOWNING: We will take a two-minute recess.

(Whereupon a short recess was taken.)

COMMISSIONER DOWNING: The hearing will come to order

A. L. VITTER

was thereupon called as a witness, and being first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. WALSHE:

Q Your name is A. L. Vitter?

A That is correct.

Q Mr. Vitter, by whom are you employed?

A I am employed by the California Company as Assistant Chief Engineer.

Q Will you very briefly tell the Commission your educational background.

A I received my Bachelor of Science Engineering Degree at the University of Notre Dame in 1935. I received a Master Science Degree also at the University of Notre Dame in physics in 1937. After that time I went into oil and gas production

business for the first time in 1938, after spending a year in teaching, and was employed by the Department of Conservation for those years prior to the war.

Q That Department of Conservation, Mr. Vitter, was that in Louisiana?

A That is the state regulatory body in the State of Louisiana, which has the similar function that the Colorado Oil and Gas Conservation Commission has in this state.

Q Generally, what were your duties with the Commission?

A I was Petroleum Engineer with the Department of Conservation and devoted a great deal of my time to gas cycling and secondary recovery work.

Q On leaving the Department of Conservation, you went with the California Company?

A No. There was an interim of about three and one-half or four years during the war when I was in research work at the Massachusetts Institute of Technology and I joined the California Company in the fall of 1945 and have been with them ever since working in petroleum engineering.

Q Are you familiar with the Rangely Field in Colorado?

A Yes. I started work on Rangely very shortly after I joined the California Company in the fall of 1945. I made my first trip to Rangely in January of 1946 when the Rangely Engineering Committee had just become organized and was getting started and functioning, and under Mr. Zorichak's

direction. All during the intervening years between 1945 and to date I have been directly involved in studies of the various problems at Rangely, and have worked on them individually for the California Company and as a member of various committees on which all the various operators were represented.

MR. WALSHE: Mr. Chairman, we are offering the testimony of Mr. Vitter as an expert witness and we would like the Board to recognize his qualifications as such.

COMMISSIONER DOWNING: He qualified.

MR. WALSHE: Thank you, sir. In connection with Mr. Vitter's testimony we will introduce some seven exhibits and for the purpose of identifying these exhibits I would like to have the reporter number them and we will identify them and introduce them later. The first exhibit which is on this side of the board is a structure map of Rangely and we are designating this exhibit as California Exhibit No. 1.

The next map is an Oil Isovol of the Weber formation, which we are identifying as California Company Exhibit No. 2. The third is a graph of the Weber Reservoir Performance as related to time. The fourth is a Performance Graph related to Cumulative Production, and we are designating these as California Exhibit No. 3 and California Exhibit 4.

California Company Exhibit No. 5 is a Pressure Map which has been prepared by the Rangely Engineering Committee of which Mr. Zorichak was the Chairman. That was a map

showing the April 1951 bottom hole pressure survey. We designated that as Exhibit No. 5. Exhibit No. 6 is the same map which has been brought up to date to, I understand, October of 1951. This map has just been prepared in the field, in fact we just got a copy of it yesterday. We only had the two copies It's exactly the same basic map as No. 5 which has been brought up to date as of October. We did not have enough prints for everyone but we do have one for the Board and one we will introduce into the record. We will be glad to supplement your graphs with one just as soon as we can have it made.

The last is a graph showing the Performance of the West Block, the Central Block, and the East Block, which are the blocks that are shown on Exhibit No. 2 outlined in red. Those blocks have merely been set up for engineering study work

Q Mr. Vitter, will you first define the Weber Sand Pool and designate just the general area that is underlain by the Weber Sand Pool.

A The Weber Sand Pool is Pennsylvanian and is located at Rangely. The Weber is approximately 5500 to 6000 feet below the surface of the ground. It's in general located in the stratigraphic section between the Park City Lime above it and the Morgan Sand below it. The Rangely Field is located in Range 102 West and Range 103 West, Township 102 North.

Q The map that we have shown as Exhibit No. 1, Mr. Vitter, are you familiar with that map?

A Yes. Exhibit No. 1 is a structure map showing the contours on top of the Weber Sand, the producing sand from which our current oil production is being obtained. This map shows the sub-sea depth of the top of the Weber Sand. You will note that contours on it appear from minus 300 sub-sea at the top of the structure down to minus 1150 feet sub-sea on the flank of the structure. There are several outlines shown on this map in addition to showing the general structure of the field. We have shown the general productive limits and the oil, water, and gas and oil contacts.

The dashed lines around the outside of the field show the presently developed area of the field. The blue line around the periphery of the field a little further out which is actually on the minus 1150 sub-sea contour is the oil-water contact. It is the absolute limits of production in the field. There is a gap between the oil-water contact in the wells due to the fact that the section toward the edge is too thin to make a commercial well for most parts of the field and other parts of the field it's too tight.

Also in the red is shown the original gas cap. It is delineated by the original gas-oil contact at minus 330 feet sub-sea. There is one major fault in the Rangely Field, it is not too large a fault, it has only a throw of about 50 feet at the most, which is shown running from northeast to southwest approximately in the center of the field and

perpendicular to the major axis of the structure.

Q This fault is not a sealing fault, is it, Mr. Vitter?

A To the best of my knowledge it isn't. As I will bring out a little bit further, the production section of the Weber is very thick, several hundred feet, and the plane of this fault is only on the order of 50 feet. It therefore follows that the productive Weber is in a position at the plane of this fault and therefore you would ordinarily expect transmission of fluids across the fault.

Q This map, Mr. Vitter, does in your opinion show the general area and also the developed area of the Weber Reservoir in the Rangely Field?

A Yes, it does.

Q Will you please now very briefly give us something of the development and history of the field, not too much in the past, but using the other exhibits give us briefly the development in the field.

A The Weber Pool of the Rangely Oil Field was discovered in August of 1933 when the California Raven A-1 was drilled. It made a commercial well in our present day sense and in our present day economics, but it was not economical in those days. The price of oil as you know was less than half of its current price. The transportation facilities from Rangely to the nearest market were non-existent, and to put in facilities to transport the oil would have absorbed

the full gross price of the oil at the delivery point. For that reason there were never any more wells drilled down to the Weber until during the war when the demand for oil increased.

In 1943 the California went back into the field, as well as several other operators, and the first well we drilled at that time I believe was Emerald 1, also in Section 30 in the northeast side of the discovery well. The development started in 1943 and got underway actively through the years '44 and '45, and about the peak of the boom was around 1946 and '47 when there were approximately 50 rigs operating in the field.

Sometime during about 1947 there was a very active program of coring in the field and through this coring program with a diamond core bit. The operators obtained a great deal of information about the type of sand from which we were producing and the Exhibit No. 2 shows some of this information. There were in Rangely approximately 339 wells cored. The cored intervals in those wells representing some 20 or 21 miles of core, and forms the basis for the Isovol map shown in Exhibit No. 2.

Q Will you please show how that Isovol map was prepared Mr. Vitter, and what it represents.

A Perhaps I could come back to that a little bit later and finish up with the history first of the field.

Q All right.

A Exhibit No. 3 and 4 show the productive history of the field. These are actually taken from Mr. Zorichak's last report for the Rangely Engineering Committee and represents graphs which he maintained while with the engineering committee, and we are simply taking these graphs and enlarging them and adding information for the last five or six months on them.

Exhibit No. 3 shows the plot of various factors, various pertinent production factors, for the Weber Reservoir versus time. It shows on it there the bottom hole pressure history of the field. It shows a decline from an original 2750 pounds to the current pressure of the order of 1500 pounds. During this interval some 90 million barrels of oil were produced, approximately 90 million barrels, and as I will bring out a little bit later, the reservoir pressure is a measure of the state of depletion in the field; and that this performance is perfectly natural and in line with what you would expect from this type of reservoir.

Exhibit No. 3 also shows the gas-oil ratio during the life of the field. It shows it was originally at a gas-oil ratio -- that is after some production was developed -- of approximately 300 cubic feet per barrel and has very gradually risen to something between five and six hundred cubic feet per barrel. It also shows the plot of the cumulative oil

production as function of time getting up to our current figure of approximately 90 million barrels.

MR. MORRELL: Would you point those particular curves out.

THE WITNESS: Reservoir pressure here, gas-oil ratio curve shown here, both values being read on the left. The cumulative production curve shown here, its values being read to left. This figure here showing about 90 million over here. Cumulative water production which has been very small is shown here on an exaggerated scale. It's not on the same scale as the oil production and -- excuse me, it is on the same scale and it has amounted to approximately two or three hundred thousand barrels.

MR. ZORICHAK: About seven hundred thousand.

THE WITNESS: Oh, yes. You may see from this graph the way in which the field was developed. There is a plot here of the number of wells. The major part of the field was developed from the year 1946, '47, and for the most part completed by the middle of '48, although some wells were drilled thereafter into 1949. We now have 478 producing wells in the field. There were only six dry holes drilled in the development of Rangely Field and those for the most part were quite outside what we know as the productive limits now.

This graph across here shows the average daily oil

production rate. The oil production rate in thousands of barrels on this scale over here increases as the number of wells. These curves you can see are very similar and then they leveled off during the period of 1947 and '48 when the production from the wells were limited, for one thing by the pipeline, but another pipeline went into operation in 1948 which allowed a higher level of production and for the past year or so we have been producing at a rate of approximately 60 thousand barrels a day. The last six month period I have being 58,300 barrels a day.

For reservoir purposes it is oftentimes desirable to show this same type of information on a different scale. In place of the time scale is substituted accumulative production. The reason for this, as I will bring out a little bit further on, is that in a dissolved gas drive field such as the Weber Reservoir in Rangely --

COMMISSIONER DOWNING: What kind of field?

THE WITNESS: Dissolved gas.

Q Will you please explain that term a little bit more fully, Mr. Vitter.

A There are several types of energy which are responsible for the recovery of oil, some of which you touched on, Mr. Downing, in quoting from Mr. Kaveler. The one that is prevalent and by far the most significant in Rangely, and I

will substantiate this a little later, is the energy derived from the gas dissolved in the oil. This gas has a great expansion power and in expansion pushes oil out to the well bores where it is produced.

Exhibit No. 4 shows the same type of information here except on a cumulative production scale. It will be noted that the reservoir pressure has been declining and has had a steady decrease in its function. That is the pressure has not gone straight down along a fixed line but has steadily flattened out, and as I will bring out a little bit later, has flattened out a little bit further in this last October 1951 survey. Mr. Zorichak from time to time kept this recovery factor curve up to date. This recovery factor should be used with certain discretion. It is useful to look at it and I think you will get some information out of it. It has shown that the decline in bottom hole pressure has steadily decreased or that the bottom hole pressure has become less and less as oil is being produced. This is brought out by the fact that this general trend has gone from approximately 50,000 barrels per pound drop up to the latest one of 175,000 barrels per pound drop. This recovery factor as used here is simply the ratio of the production in barrels of oil during a certain interval divided by the drop in pressure during that same interval. So as this increase, as this recovery factor curve increases, it in the same sense is the same as saying the

reservoir pressure curve has been flattening out.

COMMISSIONER VOLK: What is the reason for the interruptions in that recovery curve factor?

THE WITNESS: By interruption, you mean the jagged marks?

COMMISSIONER VOLK: This one.

THE WITNESS: I can't tell you for sure why this is up here. I would caution anyone to not take too seriously minor fluctuations in this curve. I think the major thing that you should limit your conclusion to, is the general up-trend of the curve in this direction. The reason I say that is that there are two factors that go into computing that factor, the production and the bottom hole pressure. The production is measured very accurately. The bottom hole pressure is measured as accurately as we know how and as accurately as present day techniques allow. However, the Rangely Weber Reservoir is a very tight low permeability formation. That is, it offers a great deal of opposition to the flow of oil and gas.

This means that when a well is on production for say six months and the time comes for the semi-annual bottom hole pressure survey that when you shut that well in that it takes quite an appreciable time for the pressure to rise from its flowing condition, from its flowing pressure, up to what we call the static pressure, the pressure with no oil

being produced. It has become the practice to shut wells in for 72 hours in order to obtain this static pressure as close as we can. In many parts of the field, particularly in the western portion of the field, this is a satisfactory shut-in time. In various parts of the eastern portion of the field this is not a sufficient time to get a build-up. We have during the last four or five years run a build-up test, and the results of these tests appear in the various Rangely Engineering Committee Reports by Mr. Zorichak and these tests have run for periods of days and weeks and we have detected increases after even that long a time of shut-in.

COMMISSIONER VOLK: Doesn't it mean that your daily production will drop about 45,000 barrels a day?

THE WITNESS: I don't think that correctly follows. There is a certain inertia in oil field behavior. You do not get an immediate reaction to a certain change. In other words, the fact that we reduce production during this period does not mean that you will immediately get a rise in this factor or a flattening out of the reservoir pressure curve because this oil is compressible and it takes a certain amount of time for the effect of production to be reflected in the bottom hole pressure so I do not think due to the inertia effect of the oil and gas that it was possible to directly associate at any given position one of these points with one of those points. I think it is fair to say that a general trend in this curve

could be associated with a trend in this curve, but there are other factors which I will mention a little bit later on which are actually more to the point in defining the trend of that curve. Just to perhaps bring that out a little bit clearer, you will note that the last October 1951 survey shows the recovery factor of 175,000 barrels a pound drop which is at a production level up here of approximately 58,000 barrels a day, which corresponds to quite a bit higher production rate than the 45,000 which happened during the early part of 1950.

I didn't quite finish up why the pressure in recovery factors has certain limitations. We cannot determine these reservoir pressures as shown in Exhibit No. 5 and 6 with too great an accuracy, particularly in the eastern portion of the field, and although we take approximately 120 key wells in which we measure pressure, which is approximately one out of four wells, it is still difficult to interpolate and draw the pressures over all portions of the field with sufficient control to say with assurance that the average pressure has changed to any greater accuracy than maybe 10 or 20 pounds. So you must realize that although the pressure drops between periods in the past has been of the order of 50 to 75 pounds, that the limitations in the build-up time, in the variations of those build-up times, do not allow us to determine the average pressure any closer than 10 or 20 pounds; and I dare say that some may feel that even an accuracy of 10 or 20

pounds may be somewhat optimistic, but I think the general trend is certainly realistic and representative of the reservoir.

Q Will you discuss now, Mr. Vitter, the sand conditions and sand thicknesses as shown on Exhibit No. 2 and point out the relative difference in you might say conditions and values in the field.

A All of the core analysis information which is available in the field has been made available to all parties of interest, all operating parties. All the operators have given their core analysis information to all the other parties and during the course of the last several years California Company with the help of several other companies have compiled all this information into what we call an Isovol Map. I better go back a little bit in the history of Exhibit No. 2. The Weber Sand Stone is a sand stone reservoir and the oil saturated portion of it is approximately 700 feet thick. A great portion of this 700 feet is not effective in producing oil. There is intermingled in there bodies of shale and beds which are not productive of oil. The Weber Sand Stone, the portion which is effective in producing oil, varies in porosity of 6 to 18 per cent and has an average of between 12 and 13 per cent porosity.

Q Mr. Vitter, if you don't mind, would you define the term porosity for the Board.

A The porosity expressed in percentage means that portion of the rock, of the bulk volume of the rock, which is void; that is, which is capable of holding material other than the rock, the fluids, oil, water, and gas. In other words, when we say that the average porosity of the Weber sand stone at Rangely is 12 per cent we mean that 12 per cent of the bulk volume -- in other words, if we had a one-cubic foot section of the Weber sand stone that 12 per cent of that one cubic foot of the bulk volume, if this were 12 inches on a side, this cube, that 12 per cent of the volume actually was void space and could contain oil, water, and gas. There is a great variation in this Weber sand stone. It varies a great deal from one end of the field toward the other, and this figure that I mention is an average.

COMMISSIONER DOWNING: The figures on the map under porosity feet, what do they represent?

THE WITNESS: The figures on the map represent the product of porosity and thickness of effective oil section. Another way of saying it is that it represents, if you wanted to idealize or simplify it, it represents the thickness in feet of space available to oil, of void space available to oil. In other words, when this map says 30 feet in this portion of the field it means that the oil contained in there could be contained in an open tank which was 30 feet high and covering the area.

COMMISSIONER DOWNING: You have another term, don't you, that measures porosity?

Q I think he must be referring to permeability. Will you tie those together.

A That is another factor. The permeability is the term which is used to measure the resistance to flow of the various fluids in the formation, oil, water, and gas. The Weber sand stone is very heterogeneous, that is it's not a very uniform sand. It varies considerably within the same well and within and from place to place in the field. When we say that the permeability varies from zero to 500 millidarcies we mean that the sand stone permits practically no flow in those regions where the permeability is very low of the order zero to one or two millidarcies, and it permits moderate flow of oil, gas, and water where the permeability is larger on the order of two to five hundred millidarcies. I use the term oil, gas, and water in a general sense for the most part we are concerned about the movement of oil and gas in the Weber sand stone.

COMMISSIONER VOLK: May I ask, do you mean total fluids of 30 porosity feet at saturation in there along with the porosity? I think that should be explained.

THE WITNESS: Yes, in this 30 feet you must put all the oil, gas, and water that may be in the reservoir. In other words, all the oil, gas, and water in the Weber sand

stone could be contained in a tank which has this general areal extent and which is thick enough, has a thickness shown on this map anywhere between zero and 35 feet; or the oil, water, and gas could be contained in a pit which is dug to that depth.

COMMISSIONER VOLK: I think it's confusing because you said the porosity varied from 6 to 18 per cent.

THE WITNESS: Yes.

COMMISSIONER VOLK: That the total porosity is not saturated with fluids, that is the point.

THE WITNESS: This factor is a product of porosity in feet. In other words, when this map shows a value of 30 porosity in feet it means for instance, well, I will take the average case where it shows a value of 15 porosity feet, which is the average for the whole field. In the developed area it means there is 120 feet of section in that whole Weber sand stone which is productive of oil and that 120 feet has a porosity of 12 1/2 per cent, so when you multiply the 120 feet of rock by the 12 1/2 per cent of void space, which can be occupied by the fluids, you get a net total of 15 porosity feet.

COMMISSIONER VOLK: 700 feet, you mean. You said your section was 700 feet thick.

THE WITNESS: Yes, but the average section productive is only 120 feet. The Weber sand stone is very

non-uniform, permeability varies considerably from place to place and there is a general regional trend in the porosity and permeability. This is perhaps best brought out by Exhibit No. 2. Exhibit No. 2 shows the contour of these porosity feet and in order to show the general regional effect we have colored certain values in there. The red areas are the thickest sections which shows that they have sections thicker than 30 porosity feet. The blue have sections between 20 and 30. The green have sections between 10 and 20, and the yellow varies between zero and 10 porosity feet. It is for this reason that the productivity also varies considerably from one end of the field to the other, both the reserves and the ability to produce oil vary quite a bit.

As Mr. Zorichak mentioned earlier, I believe there are some 70 flowing wells yet in the field and those for the most part are contained up in this area of the field in the northwest where the reserves have been greater per acre and therefore inasmuch as the production per well has been more or less uniform throughout the history today and inasmuch as this uniform production per well represents the smaller portion of the total reserve in the northwest portion, the reservoir pressure has not declined as fast.

Mr. Zorichak has pretty well described to you the various characteristics of the reservoir oil. It's a 33 to 36 gravity oil depending upon its structural location in the

field. It has viscosity characteristics which vary from .7 to 1 1/2, depending upon the structural location of the field. This viscosity I perhaps should explain is a characteristic of the oil in the reservoir and it is a measure of the resistance which the fluid offers to flow. The higher the viscosity the more difficult it is to flow, and vice versa.

I might mention that there has been a considerable amount of work done on the study of the reservoir fluid characteristics both by the operators as individuals and coordinated by the committee, and also by the U. S. Bureau of Mines, the Department of Interior. The Bureau of Mines have published a very fine paper on this which has appeared as a report of investigation and was done under the direction of Mr. Ralph Espach, at the Laramie Station. This publication is entitled, "Variation of Characteristics of the Oil in the Weber Sand Stone Reservoir, Rangely Field, Colorado," dated April, 1951, Report of Investigation 4761, authors are Cupps, Lipstate, and Joseph Rock.

I will not go into the details of those characteristics except to tell you generally what they are. There is a correlation of these various characteristics with structural position. High on the structure the solution gas is high, of the order of 400 cubic feet per barrel. That is every barrel of oil in the reservoir contains approximately 400 cubic feet of oil up high on the structure. It gradually tapers off

where at the edge of the structure it's approximately 200 cubic feet per barrel and as this oil is produced to the surface this gas which is dissolved in it is released and produced as gas on the surface. The formation volume factor varies also in a similar correlation of structural point of about 1.12 on the flank up about 1.24 on the top of the structure.

COMMISSIONER DOWNING: Are you introducing that Bureau of Mines Report or just referring to it?

THE WITNESS: I would like to introduce it by reference; I thought you may be interested in it. I would like to have it by reference in the record.

COMMISSIONER DOWNING: It will be introduced then by reference, if there is no objection.

THE WITNESS: We have glossed over the geology of Rangely Field and it might be interesting to mention also there is a publication on it which pretty well covers the geology of the field, which is published in Volume 3 of Typical American Oil Fields, by Picken & Dawn, and I believe that was published in 1948.

COMMISSIONER DOWNING: You wish to introduce that by reference?

THE WITNESS: Yes, I do.

COMMISSIONER DOWNING: If there's no objection, it will be admitted by reference.

Q Mr. Vitter, your conclusions then from a brief review of the development of the history of the field is that the recovery oil in place varies very greatly over the field and therefore the values in the field greatly depend upon the location and structural position?

A That is very true, and as a rough rule of thumb you can say that Exhibit 2, although I explained what it actually means, you can take those numbers and say that they represent the thousands of barrels of recoverable oil per acre in the various portions of the field. In other words, when you see a line of 20 on this map, very roughly that means that the natural recovery will be of the order of 20,000 barrels per acre in that portion of the field. Actually the number you should multiply is a little higher than a thousand but that is in general what it will be. So that the recoverable oil varies in various portions of the field that are developed from 3,000 barrels per acre up to as high as 35,000 barrels per acre, or practically 12-fold.

Q Is there anything further, Mr. Vitter, you would like to bring out in the general history before we bring out the studies that have been made with a view to unitization of the field, the general engineering studies?

A For the most part I have now related the factual information of the field. I would now like to for the benefit of the Board give the general conclusions I have made as to

the type of reservoir, the type of drive it is, and the basis for that conclusion.

Q All right.

A Exhibits No. 5 and 6 show the two most recent bottom hole pressure surveys. Exhibit No. 5 made in April of 1951, and Exhibit No. 6 just completed in October of 1951. In those exhibits you will see a general trend in reservoir pressures, from fairly high pressures in the northwest end down to very low pressures in the southeast end. As Mr. Walshe mentioned earlier, there are seen two red lines on Exhibit No. 3 drawn approximately north and south which delineate the field into three blocks which we have called west, central, and east blocks. These blocks were designated in part for engineering studies and the reason we have done that is that there is a material difference in the characteristics and in the reserves per acre in different portions of the field, and therefore decided to try and break them up into proportions which are more or less in relation with them and which are more or less adjoining.

COMMISSIONER DOWNING: Where are those marked, the different divisions?

THE WITNESS: On Exhibit No. 2 they are shown by these red lines. They very roughly divide the field into three parts. In order to show the behavior of these various areas of the field we have plotted on Exhibit No. 7 a plot

of the bottom hole pressure, average bottom hole pressure, of these various reservoir versus cumulative production. I will ask you to ignore the last point because we attempted to estimate that last October survey after getting some of the initial pressures at the end of last week, and we subsequently found out they were not complete, there were minor revisions, so I think this exhibit if you will just ignore the last point as being somewhat inaccurate you will see that there is a considerable difference between the west, central, and east block. This graph shows inasmuch as the horizontal axis here is an accumulation of thousands of barrels of production per acre that the west block must have a larger reserve per acre because the pressure has not fallen as greatly in producing out to any certain value indicating that there is a smaller state of depletion in that proportion of the block. There is a general transition from the west to the central to the east, bringing out what I tried to show on Exhibit No. 2 a great variation in the reserves per acre.

The point I would like to make in bringing this out is that this variation in reserves has been for the most part the major factor in explaining the pressure history of the field, as shown by the Exhibits 5 and 6, the last two pressure surveys. Because there are more reserves per acre in the west end the pressures have not been depleted to as large extent and therefore the pressures have held up further

there. There have been a very small amount of water production, I think 700,000 barrels, which is very small compared to the many millions of barrels of oil which has been produced and for the most part this has come in a very limited extent on the southwest flank of the field. I believe there are only six or seven wells along there that are producing water to any great extent.

After having produced the field as long as we have since 1946 when it was the first appreciable production, one would expect that there would be a great deal more water production if there was going to be any appreciable influx of water, in other words, if there was going to be any appreciable water derived. But such a thing has not happened. The water production has been very small and it has not increased and flooded into portions of the field. Furthermore, it is —

COMMISSIONER DOWNING: You think the water drive is non-existent?

THE WITNESS: No, sir, I think there is a small amount of water drive but I do not think it's a significant factor in the recovery of oil at Rangely Field. We have attempted to estimate how much water there is coming in, how much water drive there is, and it is very difficult to say with any assurance just how much it is, except you can bracket it. I think you can say with some assurance it is not more

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than this and as small as just a very little amount, a very small amount.

The way in which we do this in addition to explaining the pressure history as I have just done, we have also tried to make what we call material balances on the western portion of the field and this is a material balance. In simple terms it's simply a bookkeeping affair. You know you have so much material in a certain volume and you must account for it one way or another. If you take so much out and what is left expands to a little bit lower pressure, then you can detect if some other material such as water comes into it or not.

Well, inasmuch as the Weber sand stone is very heterogeneous you are not too sure what the volume of this container is so the best thing you can do is make several assumptions of that volume, which would cover all reasonable assumptions, and see what answer you get for the amount of water influx. If you make such assumptions to give the most optimistic estimate of the amount of water coming in, the most you can possibly expect to come in is approximately 8,000 barrels per day of water of that order. I would expect that it is probably less than that, probably the order of four or five thousand barrels a day of water. I think you can say with assurance that it is no greater than those figures

To give you an example of what the significance of such a small amount of water in Rangely would mean if you take

this production rate, this rate of water influx, it would take approximately 120 years to flood just the western portion of the reservoir so it is hardly an important factor or significant factor in the recovery of oil. It will do a little bit of good in the very limited area along the southwest flank but it can hardly do any good in the major portion of the field.

COMMISSIONER BRETSCHNEIDER: Mr. Vitter, on the order of the Chart No. 7 at the side it says p.s.i. Shouldn't that be hundred pounds per square inch?

THE WITNESS: Oh, yes, it should, that is an error. I would like the pressure to show those figures on the scale to be in hundreds of pounds instead of as shown.

Q Mr. Vitter, you show on the map No. 1 a small gas cap. Will you discuss the effect of that gas cap in so far as ultimate recovery is concerned.

A This gas cap we know there is a very small portion of our total reservoir at its thickest point. The cross section is only about 100 feet and if you determine the volume of that gas cap from the core analysis available you find out the volume of that gas cap is only of the order of 1 to 2 per cent of the total volume of the productive section of the Weber, so it too is a rather small factor in the recovery of oil, which leaves us with the dissolved gas. The dissolved gas in the oil is the predominant factor in

the recovery of oil.

Q Has the gas cap expanded to any great extent?

A Yes. It has expanded principally up to the northwest from this pink area shown here as original area. It has expanded up into this area. It has also expanded up along this area up in Sections 27 and 28 and in general has increased a little bit in almost all directions.

Q Even though there has been quite a bit of gas taken out of the field there hasn't been any movement of oil up into the gas cap which would saturate that part of the field and cause the possibility of waste of oil?

A No, there has not been a movement of oil up into the gas cap and that is one thing that in this type of field we certainly want to avoid. That would constitute waste in the ordinary sense of the word because once the oil goes up in the gas saturated zone even though it is later produced from it it will leave some residual oil in the gas cap which would not be recovered. So in this type of field, which is essentially a gas dissolved type of field, we want not to produce excess gas-oil ratios and we want to keep the oil from contracting into the gas cap and if we do those two things we have avoided waste.

Q Mr. Vitter, you have stated that there has been quite a bit of studies made in so far as the possibility of unitizing the field and I believe you stated to the Commission

unfortunately we had no concerted plan to offer at this time concerning unitization. Would you like to review briefly the efforts that have been made along these lines?

A Since about 1946 there has been an effort led predominantly by the major operators in the Rangely Field to get the field unitized. During the years 1946 and '47 we were not able to accomplish a unitization plan mostly because of the differences of opinion of the central and eastern end of the field, which had not been developed to any extent at that time. Several studies were made and in April of 1947 the California Company presented the first plan for unitization and presented it to the other operators at a meeting here in Denver. As I said, we were not successful at that time because we were not able to agree on the equities involved due to the very great difference in values in various portions of the field.

When the field was developed and essentially completed by 1948 and '49 unitization was again actively explored, but there still was a difference of opinion as to the values of the various properties. During all these various studies the operators have jointly met and studied the problem and published several reports. Would you like to have those?

Q I don't think so.

A They pretty well outline the properties of the

field as I have discussed today. Up until just a few weeks ago we had high hopes that we would accomplish the unitization of the whole field this year. It appears that this will not be possible and that maybe this can be obtained some time in the future. At the present time we do not have any hopes of accomplishing unitization during the year 1951.

Q In connection with this study concerning unitization, the California Company, the Texas Company, and U. P. established in 1950 a pilot injection program in order to determine whether or not the Weber Reservoir would first take the gas; and second, what effect that might have on the recovery. Would you mind discussing that briefly.

A In the year 1949 the Texas Company and California Company and Union Pacific decided that it would be worthwhile to instigate such a pilot program to answer some of these questions. These plans finally evolved in a pilot gas injection program which started November 26, 1950. I believe it would be best to show you on Exhibit No. 6 where we are injecting gas and what the effect of it has been.

Q Maybe Exhibit No. 5, they have copies of that.

A No. 5. Section No. 20, California Company 365 is the injection well which was used up in the northwest corner of Section 20, and the Texas operated well is Union Pacific 357 located in Section 21 in the northeast part of the southeast corner. You notice on that exhibit there is a high

pressure area around both of those wells and on into the adjoining wells. That program has been in operation almost a year now and I think that the results of it have been encouraging. We know for sure that the Weber sand stone will take gas about as one would expect it to from the general characteristics which I have described to you, and in the amounts that you would expect them to take gas. We know that the gas did not abruptly go to the next well and bypass oil. It is a little too early to say how successful it will be in recovering oil but we know or are satisfied that it has not been alarmingly poor. It is not unusual to expect a fairly early appearance of injection gas at a producing well, for the first row of offset producing wells, from the injection well, but with time and distance that gas begins to more effectively flush out oil ahead of it and recover oil in the further wells.

Q Is the California Company planning to continue this program and possibly try injection of gas in other parts of the field if practical, Mr. Vitter?

A We intend to continue this pilot program and we would like very much to do something on a little bit larger scale. Right now we are trying to work out some plan by which we can accomplish that. I might say that when we started this plan in 1950 the Texas and Union Pacific and California Company were probably in the only position to

start something like this because we had a large area of fee land between ourselves in which we were the only interested parties. It was large enough that the effect of gas injection would not be felt outside of those fee properties and we felt that we could go ahead with such a pilot program without stepping on the toes of anybody else in the field, and it certainly has worked out that way.

COMMISSIONER VOLK: How much gas do you inject in a day?

THE WITNESS: We are injecting approximately three million cubic feet of gas a day. Approximately 1 1/2 million cubic feet of gas into each well, and up to date through the end of October, we have injected -- oh, it's approximately 430 million cubic feet of gas into each of the wells making a total injected gas of approximately 860 million cubic feet. We think the program has been encouraging.

COMMISSIONER DOWNING: How successful results have you had in that gas injection?

THE WITNESS: As I said, Mr. Downing, it has not been alarmingly bad. It is a little too early to say how good it will be, but it is sufficiently encouraging. We think it's worth continuing on and considering that type of operation on a larger scale.

COMMISSIONER DOWNING: Those wells are not on the gas cap?

THE WITNESS: No, sir, they are down further on the flank of the structure, about half way down.

COMMISSIONER DOWNING: In other words, you are injecting them for the purpose of increasing the amount of oil ultimately dissolved, the amount of gas ultimately dissolved?

THE WITNESS: It's a matter of pushing the oil ahead of it and increasing the fluidity of the oil, and it is an experiment.

COMMISSIONER VOLK: May I ask how much that pilot program has cost you?

THE WITNESS: Oh, it's no secret. We have got a 300 horsepower compressor which cost us about $60,000 installed, something like that, and we have a pipeline out to there. The whole project probably ran between one hundred and one hundred and twenty thousand dollars.

Q That is not counting the cost of the original gasoline plant which was designed to deliver gas, I think about 450 to 500 pound pressure?

A That is right, we had only to go from 600 pounds at the gasoline plant up to our injection pressure of 1800 pounds, so it does not by any means represent the total cost as a means of judging the total cost of the larger operation.

COMMISSIONER DOWNING: Has there been an increase in bottom hole pressure by reason of gas injection?

THE WITNESS: Yes. Exhibit 6 and 7 show an increase in pressure in the area of injection.

COMMISSIONER DOWNING: To a considerable extent?

THE WITNESS: No, a reasonable extent.

COMMISSIONER DOWNING: To a satisfactory extent?

THE WITNESS: Yes, to within one or two locations it has effected pressures.

MR. WALSHE: Mr. Downing, I think that completes generally the background and history of Rangely. We are sorry that we do not have a concerted plan to offer you at this time for gas injection. However, in line with aiding and assisting the Commission in its duties we do have certain recommendations in connection with the Rangely Field. We admit that it's not going to accomplish everything that Mr. Zorichak or possibly the Board would like to accomplish. We think it's a step forward in operating the field and continuing operating the field according to good engineering practices. I might just briefly run over those suggestions and then if you would like to adjourn and come back we can substantiate them later.

First, we would like to recommend the establishment of drilling units in the field. You will notice from the maps that the field developed was generally on a 40-acre spacing pattern. We would like to continue this pattern and actually like to establish drilling units in the field.

COMMISSIONER DOWNING: Is there any more drilling to be done?

MR. WALSHE: Well, there is some thought of testing additional wells in there. I am not sure, but we do think it's advisable at this time to establish units around the producing wells.

Second, we think it would be advisable to fix a gas-oil ratio for wells in the field and we are recommending that a gas-oil ratio be fixed at 1,000 cubic feet of gas per barrel of oil produced. We feel that that thousand cubic feet is necessary to produce a barrel of oil and that under the express definition of waste in the Colorado law that the use of that gas is reasonably necessary to produce the oil. Now, anything produced over that we think is waste and we are suggesting to the Commission that they therefore restrict the high gas-oil ratio of wells to a given gas limit, and we are suggesting that that limit be 150,000 cubic feet of gas per day.

We are also suggesting that certain tests be made concerning gas-oil ratios and certain reports be made together with annual bottom hole pressure surveys and certain data so we can keep up in our study of the entire reservoir. We would like to back these recommendations up with testimony of Mr. Vitter and we would be glad to go ahead now unless you would like to continue the hearing for a while.

COMMISSIONER DOWNING: I think it's about adjournment time, but maybe we can ask the witness questions. We have a little time yet so are there any members of the Commission that would like to ask some questions?

COMMISSIONER VOLK: Do you have any recommendations as to injection of gas?

MR. WALSHE: No, sir, because we have been unable to solve the many problems involved in gas injection. Legally, I am of the opinion that any large scale injection program requires a unitization of the field or that blocks sufficient to take care of the relative rights of the parties in that block, and unfortunately we have been unable to arrive at that.

COMMISSIONER BRETSCHNEIDER: Mr. Walshe, you mentioned a 40-acre drilling unit. You are referring to the Weber Pool only?

MR. WALSHE: The Weber Pool only.

COMMISSIONER BARB: I don't recall that anything specifically was said from Mr. Vitter although he may have explained it, which explains the difference between a plan to inject the gas in the gas cap area or in the gas cap and other areas as these two pilot plants are now injecting the gas.

MR. WALSHE: What is the difference in effect of that type of program aside from the correction of gas caps

in various areas as related to these?

THE WITNESS: Your question is what is the preference between injections in several places around the field as compared with the gas cap area?

COMMISSIONER BARB: Yes.

THE WITNESS: All things being equal, I would say it's preferable to inject in the gas cap area. First, because it is highest on the structure and although my personal opinion is that segregation will not be a significant factor at Rangely what little effect it might have would tend to favor the injection of gas on the top of the structure because gas would try to occupy a position above the oil. However, at Rangely Field I think this will be a very minor effect except possibly on the steeper flanks along the southwest, which are also more permeable. However, for this segregation to occur it must have appreciable permeability. Perhaps the most significant factor at Rangely is to have all of the injection into one area so that the effect of the gas leaking out and increasing the oil-gas ratio of other wells will be minimized and will have a growth of only one gas bubble instead of several, which in time overlap and create a little bit more difficult production probably.

In general, the choice between a dispersed gas drive of various places and the gas cap area injection is the advantage of the dispersed gas drive is to increase the

productivity of the total field because you are able to affect a portion of the field at an earlier time and increase this productivity, and therefore maintain the production at the higher rate. Rangely will start declining significantly in several years but I do not think the production rate factor is sufficiently significant to give a preference to the type of injection. To sum it up, the gas cap area injection would be preferable.

COMMISSIONER VOLK: What is your average gas-oil ratio?

THE WITNESS: It's a little under 600 cubic feet per barrel, a little bit less than that.

COMMISSIONER DOWNING: I would like to ask one or two questions. You made a statement that the drop of bottom hole pressure is a measure of productivity, the productivity of the field, as I recall it. Now, has that been true universally such as East Texas? In other words, haven't they practically maintained original bottom hole pressure during the last 11 years by conservation measures?

THE WITNESS: It's the decline in bottom hole pressure which I say is a measure of the state of depletion of the reservoir is typical of this type of reservoir. The East Texas Woodbine that you refer to is enormously different than Rangely. For one thing it is highly permeable and because it is highly permeable and because it is connected

to a very large body of sand containing water which is also highly permeable, this water flows into the field and is effective in maintaining pressure in flushing the oil ahead of it sufficiently. We do not have such a condition at Rangely. We do not have an effective water drop and therefore there is no way by which we can accomplish the things that they have accomplished at East Texas.

COMMISSIONER DOWING: Do I understand you cannot maintain or hold bottom hole pressure to an extent by conservation methods over wasteful methods?

THE WITNESS: Well, I am not sure I understand the term "wasteful methods." I think what we collectively and as individuals have done as operators here at Rangely has been good practice, and in the behavior of the field as a result it has been just as one would expect from this type of operation. We think that with this gas-oil ratio limitation that we are recommending to you that we will reduce or eliminate the possibility of waste as you would expect to happen in this type of reservoir. Now it's quite possible, it's possible that gas injection program at Rangely may be beneficial, as I mentioned earlier.

COMMISSIONER DOWNING: I am not talking about the past. I just wanted to bring out whether or not you feel that in the future improved methods could be devised or put into practice which would increase or maintain rather to a

large extent bottom hole pressure?

THE WITNESS: I think this gas-oil ratio limitation will improve the situation.

COMMISSIONER DOWNING: Is that the only way you can increase it or hold it?

THE WITNESS: There is some merit to a gas injection program at Rangely.

COMMISSIONER VOLK: May I ask you this question. You say the average gas-oil ratio is 600 cubic feet per barrel and you are flaring 20 million cubic feet per day. Does it necessarily follow if you would inject that gas it should ultimately recover about, oh, between 38 and 40,000 barrels daily by injecting that gas back in there in the formation?

THE WITNESS: No, sir, and I don't think that is what Mr. Zorichak mentioned when he mentioned that figure. You are quoting from Mr. Zorichak?

COMMISSIONER VOLK: I am not. I am wondering about injecting the 20 million cubic feet of gas back into the formation.

THE WITNESS: I believe Mr. Zorichak mentioned the figure of 33,000 barrels per day. What he meant by that was that the 20 million cubic feet of gas that you would inject would occupy space in the reservoir equivalent to approximately 33,000 barrels so that in effect you have reduced the

net withdrawals from the field by a certain amount, by that amount, and would have retarded the decline in bottom hole pressure; but it does not follow that the additional recovery from the field would be equivalent to 33,000 barrels per day.

COMMISSIONER VOLK: But how much would you estimate it would be if you would inject that gas back in?

THE WITNESS: We have made studies from time to time based upon the information we have at Rangely and we think that the additional recovery may be of the order of 30 or 40 million barrels of oil if we can work out all these problems that we have facing us.

COMMISSIONER VOLK: You mean total gas injection would result in about 30 or 40 million barrels of additional oil?

THE WITNESS: Yes.

COMMISSIONER DOWNING: Have you any comment to make upon Mr. Zorichak's statement so far as the statement is factual? Have you any comment to make?

THE WITNESS: I made some notes while he was talking. Of course, Mr. Zorichak said waste was occurring, and I do not agree that waste is occurring. I am basing my idea of waste on the statute in the Colorado law on which this Commission is operating with the possible exception of -- well, that has not been very significant to date, but I think it is well that some order instituting gas-oil ratios be put

into effect at this time. Other than that, I don't believe -- well, Mr. Zorichak mentioned additional recovery of 87 million barrels, which, of course, does not include the figure that I mentioned.

COMMISSIONER DOWNING: Your figure is about 40 million, isn't it?

THE WITNESS: Something like 40 million.

COMMISSIONER VOLK: Have you made any studies as to what points may be replaced of the oil and gas cap as to drop in pressure? You made a statement as near as you could determine the oil was not replacing the gas in the gas cap in released pressure.

THE WITNESS: Yes, we have done two things to try to find out the answer to that question. We have observed that apparently the gas cap has expanded by the increase in the gas cap, and this is perhaps the most direct observation you could make of this thing. We also tried by means of material balances to find out whether the gas has expanded or contracted, but again this has several limitations and we can't put our figure too closely on that, but it would appear that the gas cap has expanded and that there has been no contraction of oil into the gas cap.

COMMISSIONER DOWNING: If the field were unitized, what would the companies as a whole do to increase ultimate recovery or to prevent waste if there would be waste that

they are not doing now?

THE WITNESS: I think we would inject gas, the residue gas, that is available.

COMMISSIONER DOWNING: Is there anything else you would do?

THE WITNESS: Well, we would possibly make some changes in the operation of more of an open operational problem and not particularly as a conservation means; such as consolidate a few tank batteries. We would enjoy a greater flexibility in production and could control our injection and production in an optimum way, but for the most part I think the major feature would be to inject gas.

MR. SCHWABROW: If they can't get together now on unitization, why don't they inject the gas into some other formation and keep it until sometime when unitization can be accomplished?

THE WITNESS: You mean to subsequently inject it into the Weber?

MR. SCHWABROW: Yes. If you are wasting the gas now, why can't it be put into another formation and kept until some future time and then if unitization is accomplished be put in the Weber? It's now just going off into the atmosphere.

THE WITNESS: Of course, you have I think a similar legal problem there in getting the reservoir. You would have

to, I believe, unitize such a reservoir in which to store that gas in order to protect all the parties concerned.

MR. SCHWABROW: I don't see where there would be any parties that need be protected. You have so much gas in these other formations now, the gas and oil in place under their properties. If we build that up say in the Dakota or one of the other formations they would just be getting that much more gas.

THE WITNESS: We have considered this, Mr. Schwabrow, and another practical difficulty that we are a little concerned about in doing something like that is that the Dakota sand or some such sand as that, that there is not sufficient protection in the casing string between the Dakota sand and some other sand, and perhaps the Dakota sand is not sealed off from some of the other sands. When you increase the pressure in the Dakota although it no doubt is in equilibrium now and there is no transfer of fluid out of the Dakota or into it, but when you disturb that and inject gas into it you might easily lose gas into another formation and not accomplish what you set out to do.

MR. SCHWABROW: Well, if it went into another formation would anybody be hurt too much, if it appears that the wells were leaking gas outside the production string, why, remedial work could be accomplished.

THE WITNESS: Losing the gas and creating a hazard,

this gas may come up; and too, you are losing the gas and would not have it available for injection into the Weber. In other words, when it becomes dispersed into several sands and you try your recovery, your efficiency of recovering that is probably very low.

MR. SCHWABROW: Well, that may be true, but now you don't have any of it, it's going off into the atmosphere. I think if you could save any of it you would have that much accomplished.

THE WITNESS: Well, we have considered it and we have these two problems: The practical problem of keeping the gas in the Dakota and also the legal problem, which I think is just a little bit more complicated than you have stated; and the cost, of course, of doing that.

MR. WALSHE: In other words, Mr, Vitter, we have reviewed this plan, we have given serious consideration to it, and in your opinion it's not feasible to store that gas in a different formation?

THE WITNESS: That is correct. We have considered it quite fully.

COMMISSIONER DOWNING: I think probably we better adjourn. We are terribly in need of advice and information that will lead us to do better and have better results in the future. One thing I would really like to have is a statement of what is it that you would do under unitization

that you are not doing now. The witness I think probably covered it, but if there is anything you want to add to that we would like to hear from you. In other words, that leads up to the question that unitization is highly desirable and necessary. Aren't you gentlemen good enough businessmen to settle your differences and agree? Can't we have conservation by rule and order requiring those things to be done, which you would do if you had unitization? Keep that in mind. We will adjourn until 2:00 o'clock.

(Whereupon the hearing was recessed for lunch.)

AFTERNOON SESSION

COMMISSIONER DOWNING: Will you proceed, Mr. Walshe.

MR. WALSHE: First, I would like to briefly draw a conclusion from the testimony we presented this morning. First, that we believe the unitization of the field would be desirable and if the field could be unitized it would be our recommendation that the gas be returned to the gas cap of the Weber formation; and that we also believe that it's possible that if that was done you would have an increase in the ultimate recovery of oil on the order of between 30 and 40 million barrels. We also point out that we have been five years trying to do that; that there are many legal questions and problems involved in unitization that we have not been able to overcome. We are still studying the field towards

that end. In the interim period we would like to suggest to this Board maybe a step forward in establishing gas-oil ratios in putting a top gas limit we would like to make our suggestions in the form of a proposed order at this time. Before doing that --

COMMISSIONER DOWNING: What could this Commission do to help you unitize to help you to agree?

MR. WALSHE: My personal opinion, Mr. Downing, this Board under the laws has no power to force unitization in an entire field and I don't think that under the definition of waste as is in the law that you would have a right to shut down the field as certain fields have been shut down in Texas. I think you could aid and assist us maybe in this first step of setting gas-oil ratios and gas limit and bearing with us in our problems because I think all of us want to unitize just as much as the Commission would like to see us unitize.

COMMISSIONER DOWNING: I agree with you, but as in Texas we have, as I understand it, exactly the same power as Texas. In Texas they had no specific power, they had simply the general power to prevent waste and under that power they shut down all production of any sort if in connection with that production there was any waste of gas.

MR. WALSHE: I think, Mr. Downing, there is a difference --

COMMISSIONER DOWNING: Am I correct?

MR. WALSHE: No, sir, I don't think you are.

COMMISSIONER DOWNING: Then correct me.

MR. WALSHE: The definition of waste as provided for in the Colorado statute allows the declaring of that amount of gas which is necessary to produce a barrel of oil. That is excepted from the definition of waste of gas and it's our position that the gas that is being produced in this field serves a very useful purpose. It is actually producing 60,000 barrels of oil a day and that we are extracting from that gas all of its liquid components that are practical to extract. Although if we put that gas back in the ground it might do some good, that amount of gas is not waste under your Colorado statute.

COMMISSIONER DOWNING: That is you refer to excepting gas that is reasonably necessary in drilling and producing wells, you think that means gas that comes up with oil we can't restrict?

MR. WALSHE: If that gas is reasonable and necessary to produce the oil, I don't think that you can restrict it.

COMMISSIONER DOWNING: I always understood the gas necessary in drilling, producing, and testing of wells had to do with gas that might be used for lift or for power purposes in connection with the producing of wells.

MR. WALSHE: Not necessarily, sir.

COMMISSIONER DOWNING: In other words, this gas

that comes up with oil is not gas that is necessary in the producing of the wells?

MR. WALSHE: If we didn't have that gas you would be unable to produce the oil. It's a difference of opinion and a legal matter and I have stated my conclusion on it. Our interpretation is that the amount of gas that is reasonably necessary to produce a barrel of oil is exempted from the definition of waste under the Colorado Statutes.

COMMISSIONER DOWNING: Does that mean then that we can't make any gas-oil ratios at all?

MR. WALSHE: No, sir, you can establish gas-oil ratios and you can say which well is producing too much gas if there is waste in that well producing.

COMMISSIONER DOWNING: But you say we cannot shut down a well completely.

MR. WALSHE: That is my interpretation of it.

COMMISSIONER DOWNING: If there is any waste of gas in connection with the production?

MR. WALSHE: That is correct. There is just one point I would like to bring out before we make our suggestions. I have no criticism in Mr. Zorichak's statement as to it. I do have an objection to his statement as to the value of the gas that has been flared at Rangely. Mr. Zorichak, I think, assigned a 10 cent per thousand cubic foot

value to it and estimated that because we were flaring so much gas we were actually losing so much money. The Texas Company sometime ago contacted the Mountain Fuel Supply Company to find out whether or not they were interested in buying this gas that is being flared, and the Mountain Fuel Supply Company wrote back and said they were, of course, interested in a supply of gas but that the gas at Rangely had such a low B.t.u. content it would have to be mixed with an additional supply of gas in order for them to sell it. So at the present time I think it's reasonable to state that there is no market for that gas and therefore it's not proper to assign a definite 10 cent value to that gas if we can't sell it. And for the purposes of the record, I would like to introduce copies of the letter written by the Texas Company to Mr. J. T. Simon of Mountain Fuel Supply Company and the answer by Mr. Simon. I think the Texas Company is represented here, if you would like some proof.

COMMISSIONER DOWNING: No, there is no objection, the matter will be admitted.

(Whereupon the reporter marked for identification Exhibits California No. 8 and 9.)

MR. ZORICHAK: Mr. Chairman, while we are on this subject, could I make a statement about the gas?

COMMISSIONER DOWNING: You can, although I think it's out of order. I would like to have his case

uninterrupted then when it's through if there is any evidence we want it will be a little more logical.

A. L. VITTER

thereupon resumed the stand for further

DIRECT EXAMINATION

MR. WALSHE: As I stated this morning, we are suggesting a set of rules.

COMMISSIONER DOWNING: Are these the same?

MR. WALSHE: With minor changes that we have noted. The first rule that we are suggesting is in connection with the spacing of wells.

BY MR. WALSHE:

Q Mr. Vitter, I understand that the Rangely Field has been developed to a 40-acre spacing pattern, is that correct?

A Yes, it has.

Q Do you feel that that pattern should be continued as to any future wells that might be drilled in the field?

A I strongly think that any future development should continue to a 40-acre development program.

Q Will you please state your reasons for that.

A In my opinion one well will adequately drain 40 acres and that any additional development to a closer spacing would be an economic waste and drilling of unnecessary

wells. To support this opinion I have some evidence here to bear that out. During the development of the field a good portion of it was developed on 80-acre spacing when there was just a few wells with the idea that possibly an 80-acre spacing would work out in the field, and if it didn't, why, we could still infill with 40-acre development. It turned out subsequently that 40-acre development was justified by the conditions and circumstances, and when we went back in and drilled those infilled wells between the wells that had been drilled earlier we made it a practice of measuring bottom hole pressures on those wells shortly after they were completed. The purpose being to satisfy in our own minds at least whether the area drilled by this new well had been drained to any extent by the earlier wells which were drilled on a wider spacing.

I have several examples, there were quite a few, but I have picked out several that bear this out. The first one that we have quite a bit of information on was in the area of the A. C. McLaughlin No. 4, in Section 24. A. C. McLaughlin No. 4 drilled by the California Company was completed in December, 1945, and the first bottom hole pressure was measured in the February 1946 survey, and it had a pressure of 2589 pounds. All these pressures referred to at minus 900 sub-sea datum we have used throughout our pressure surveys.

Some 2 1/2 years later the McLaughlin No. 41 was completed in April of 1948, and this well is a direct north offset to the A. C. McLaughlin 4. Would it help you if I pointed those out on the map? Here's the first well, the early well drilled in 1945. This one marked McLaughlin No. 41 was completed in April of '48. Shortly after the well was completed the bottom hole pressure on it was measured at 2195 pounds and approximately at the same time the pressure on the earlier well No. 4 was measured as 2262 pounds. In other words, the later well, the north well, was actually a little bit lower pressure than the earlier well, which showed that that area was drained to some extent by offsetting wells.

Another example was the well drilled by Stanolind, the Associated A-2 which was completed approximately in July of '46, I don't have the exact date, it had a pressure of 2442 pounds, that is the well south of No. 4, at the same time that the A. C. McLaughlin 4 had a pressure of 2510 pounds. This again indicated by the fact that the pressures were quite comparable and several hundred pounds below the original bottom hole pressure that that area had been drained to some extent.

Q In your opinion, Mr. Vitter, you feel that a drilling unit of this size will efficiently drain the entire 40 acres?

A Yes, I do.

MR. WALSHE: Because the field has been drilled up without the establishment of drilling units, we are suggesting in our Rule 2 the matter of procedure for this Commission to follow in establishing the drilling units. I think that is that every operator should submit to the Commission a plat of the wells that he operates and the acreage to be assigned to these wells. They can all be put together and if they all fit then the Commission can approve the plats and that would be the establishment of the units. If there are any vacancies or possible wells that do not comply with the spacing requirement of the rule, well, they can always come in as an exception and the exception will be granted on that.

COMMISSIONER DOWNING: We would be glad at any time to have suggestions from anybody interested.

Q Rule 3, Mr. Vitter, establishes gas-oil ratios of the wells in the field and fixes a top limit of those wells producing with an excess gas-oil ratio of 150,000 cubic feet of gas per day. Will you please discuss this rule and give your recommendations concerning it.

A As I discussed earlier this morning, the Weber Reservoir is a solution gas drive reservoir and it is natural to expect the gradual increase in gas-oil ratios during the history of the field. However, ratios at this time above 1,000 ratio are a little bit above what one would expect at

this stage of depletion of the field and these wells should be restricted from producing an excess amount of gas if they are producing with the gas-oil ratio above 1,000 to 1. In other words, we are using the gas-oil ratio as a criterion of waste. At the present time in the present stage of depletion, wells with a ratio above that should be restricted from producing excess amounts of gas.

We are suggesting and recommending that wells with a gas-oil ratio greater than 1,000 cubic feet per barrel be restricted to a gas production of 150,000 cubic feet per day. We are making no recommendation as to wells producing with a gas-oil ratio less than 1,000 cubic feet per barrel because they are not creating waste and there is no need to impose any restrictions on those wells.

Q When you speak of waste, Mr. Vitter, you are using that term as defined by the Colorado Statute and the interpretation of that term as has been designated by the Legal Department of the Company?

A That is correct.

Q In other words, you feel that it is not waste if this gas is used to produce 60,000 barrels of oil a day besides extracting from the gas all of the liquid products that are practical to extract. This gas is serving a very beneficial purpose in lifting the oil and therefore is not wasted under the Colorado Statute?

A That is correct.

Q Mr. Vitter, I believe you referred to the rest of the rules in this suggested order, which refer to the gas-oil ratio tests and certain production reports and so forth. You have reviewed these rules?

A Yes, I have.

Q You feel that they would be beneficial in the operation of the Rangely Field?

A Yes, I do.

Q And in suggesting these rules we are referring to the Weber Sand Pool only and we are not referring to any of the shallow production. In other words, the establishment of drilling units and these rules only apply to the Weber Sand Pool?

A That is correct. There is one other thing in regard to the gas-oil ratio, we are recommending that an exception be made in those cases where gas is returned to the Weber Reservoir from which it is produced and that credit be given to that lease for any gas that is injected and that this amount of injected gas be subtracted from the leased production and be allocated back to the producing wells and that those producing wells receive credit in determining a net gas-oil ratio and the net gas-oil ratio would come under this 1,000 gas-oil ratio limitation.

MR. WALSHE: I think that concludes our presentation,

Mr. Chairman.

COMMISSIONER VOLK: Would that save the amount of gas now being produced, 20 million cubic feet now being produced or approximately that, and if you hold the wells to the ratio of 1,000 cubic foot per well how much will that reduce the production of gas?

THE WITNESS: Flared gas?

COMMISSIONER VOLK: Yes, sir.

THE WITNESS: I haven't attempted to estimate that closely, but I should judge it would be in the order of three million cubic feet a day.

COMMISSIONER VOLK: In other words, it would only cut from about 20 million to about 17 million?

THE WITNESS: Yes, sir. The flare is currently reduced by 3 to 3 1/2 million because we are injecting that much now and this recommended gas-oil ratio limitation I believe will reduce the flared gas an additional 3 million, approximately.

COMMISSIONER VOLK: Would you have an estimate on how many wells that would affect that are producing at higher gas-oil ratios?

THE WITNESS: I haven't made a recent count. Mr. Zorichak this morning mentioned 74 wells above 1,000 and that sounds quite reasonable. I could guess more like 50 or 60, but I am sure Mr. Zorichak checked the record on

that.

MR. WALSHE: Mr. Chairman, I believe we identified the exhibits and we would like to introduce them in connection with this witness's testimony.

COMMISSIONER DOWNING: Any objection? They will be introduced. Now, who wants next to be heard?

MR. OSBORNE: Mr. Chairman, my name is Lee Osborne, and I represent Union Pacific Railroad, and I have a few comments I would like to make. I would first like to commend Mr. Vitter on his excellent presentation of the picture of Rangely.

COMMISSIONER DOWNING: Do you want to give testimony or just argument?

MR. OSBORNE: Just comment. There are some factors I think that should be included. For instance, on Exhibit 2 the inference was made by the use of that map you could figure out the amount of recoverable gas for each acre, and there is one factor and that is the productivity of each well was not mentioned. Now, we know that some wells with poorer permeability and poorer porosity are better producers than some wells with a larger permeability and porosity, and we feel that fracturing in the field has a strong bearing on the productivity. Now, fracturing not only constitutes some reserve in itself but it acts as a very permeable conduit from less permeable sand into the well. As a matter of fact,

the presence of fracturing in the field and presence of thin sections of very permeable sand made us a little leery of a wholesale gas injection project in the Weber, and for that reason we and the Texas Company went in with the California Company in the pilot injection to find out what would happen on a small scale injection.

Now, we don't have enough data to say anything except that gas can be injected in the Weber and I think Mr. Vitter's statement in response to your question that to date certainly the gas injection does not look alarmingly bad is a very good summation of the setup. We are not sure in our own mind that it's an economically feasible project. For that reason we feel that the storing of gas, which is now blown to the air, in order to do away with the blowing of gas to air could be accomplished by storing in the Dakota.

We think that Mr. Schwabrow's suggestion is very good. As a matter of fact, it has been our contention for sometime that it could be stored in the Dakota and then at a later time if our project of our pilot injection indicates that storing in the Weber is advisable it will be available for injecting into the Weber. Or in the meantime, if some utility builds a pipeline into the Rangely area it will be available for sale.

Now, as far as the suggestions made by the California Company in regard to field rules and regulations,

we have had in mind for sometime the drilling of at least two 5-spot wells because our experience has been that in fields with very thick productive sections that your ultimate primary recovery has a very direct relationship to the density of development and we feel that the only way that you can actually tell whether you are going to recover enough additional oil to make it economically interesting is to drill a couple of wells and then observe the production characteristics of those wells and the surrounding wells. So in the interest of possibly increasing the ultimate recovery from Rangely, why, we would prefer that no 40-acre drilling unit was established at this time.

As far as the gas-oil ratio rule, Rule 3, is concerned, I go along with the rule with one exception. I would change it to read that for all wells that produce in excess of 150,000 cubic feet of gas per day that the operator has to dispose of that gas either by sale or by injection. That would give the operator freedom to inject into the Dakota if he considered it advisable or free to sell it, because after all I don't think there would be any question if a pipeline were in Rangely now and the gas was being flared, I don't think there would be any question about any wastage, and we think that that gas should be available for sale.

COMMISSIONER DOWNING: Don't you think effort should

be made to conserve this gas to aid the reservoir energy of the field?

MR. OSBORNE: We aren't sure in our own mind, Mr. Downing, that injecting that gas down into the Weber is going to help. While it may maintain or retard pressure decline if you don't get any more oil out and the gas flows through from one well to another, you aren't improving your recovery at all.

COMMISSIONER DOWNING: In other words, you don't believe then that the gas injection in the Weber would help the ultimate recovery?

MR. OSBORNE: I say we don't know. We don't have enough data to decide that and certainly not all gas injections are successful.

COMMISSIONER DOWNING: Why hasn't the field been unitized?

MR. OSBORNE: Well, there are certain factors --

COMMISSIONER DOWNING: Aren't you for it?

MR. OSBORNE: Yes, indeed, we favor it.

COMMISSIONER DOWNING: If you are in favor of it, why don't you accomplish it?

MR. OSBORNE: There seems to be certain factors such as I mentioned, productivity which is very hard to evaluate that make it a little difficult to get together on percentages.

COMMISSIONER DOWNING: Has any real effort been made to get together on percentages on a give-and-take basis?

MR. OSBORNE: I would like to have all the money spent on people's time on the effort made to unitize.

COMMISSIONER DOWNING: In other words, there has been some effort made like in Korea, having a meeting and nothing has been accomplished?

MR. OSBORNE: That is quite right.

COMMISSIONER DOWNING: What can be done to bring about an accomplishment to end that sort of thing and get an agreement?

MR. OSBORNE: I wish I could give you the answer. Maybe if you were to arbitrate it would help things out, I don't know, I mean call meetings together.

COMMISSIONER DOWNING: How about arbitration, is that possible or feasible?

MR. OSBORNE: Well, it's very difficult to say. I think that a very serious effort has been made to arbitrate the differences.

COMMISSIONER DOWNING: You think an effort has been made to arbitrate?

MR. OSBORNE: Yes, sir.

COMMISSIONER DOWNING: You mean there has been no arbitration but someone wanted to arbitrate, is that it?

MR. OSBORNE: There has been arbitration to a

certain degree, yes, I think there has been minor arbitration; but after all when you consider that each person in the field is worth so much money -- I mean you just aren't giving things away.

COMMISSIONER DOWNING: Nobody wants to give it away but the differences are entirely differences of opinion, are they not, not differences of facts?

MR. OSBORNE: I won't say that, no, it's a different way of presenting the different facts is the whole thing.

COMMISSIONER DOWNING: I mean your committee of engineers, as I understand it, you all agree upon the fact on permeability and productivity and acreage and probable yield and all that sort of thing, but you have a different interpretation, a different opinion as to ultimate yield, is that correct?

MR. OSBORNE: That is correct.

COMMISSIONER DOWNING: It always seemed to me that in matters of opinion there is room for arbitration, give and take, get together. Of course, if you've got a dollar in your pocket and somebody wants it you would like to have a reason, that is factual. But on matters of opinion, here's a dollar down here in front of you and I and I think it's mine and you think it's yours, why, unless you're a lot

bigger than I am maybe I would say let's arbitrate, and that would be a natural solution, it's a matter of opinion as to who owns it. In other words, is there anything this Commission can do to get you fellows to agree?

MR. OSBORNE: I think that is hard to answer, that is a tough question. I really don't know, I haven't had a chance to think about that.

COMMISSIONER DOWNING: Well, we assume you wouldn't occupy the positions you do unless you are men of great ability, good citizens, and I have never in my life seen a controversy that can't be settled but what if the people want to. Now, does your company and do you think the other companies really and honestly want to unitize or are they stalling?

MR. OSBORNE: I am only speaking for the Union Pacific, but we always have been in favor of unitizing.

COMMISSIONER DOWNING: Any other evidence? Any other statement?

MR. WILL: Walter Will, the Texas Company. Mr. Chairman, and other members of the Board --

COMMISSIONER DOWNING: Do you want to make an observation or testify?

MR. WILL: We are going to put someone on to supplement the California Case. As this is your first meeting under the new Colorado Conservation Act, the

management of the Texas Company has asked me to express to you their appreciation for the job that you are about to enter upon. They have also asked me to tell you they want to cooperate with you and your Board in any way that they can, both here in the hearing room and in the field. In regard to the meeting right at hand the Rangely Field ---

COMMISSIONER DOWNING: May I interrupt to say thank you very much, we appreciate that. We hope you will continue that opinion when we get through. This Board wants to cooperate with you, and we are not looking for culprits. We want to sit down and talk with sensible people and cooperate with them. Thank you.

MR. WILL: In regard to the Rangely hearing, we agree with Mr. Vitter's statements in the main. We would like to put on one of our witnesses just to emphasize or maybe supplement Mr. Vitter's testimony.

HENRY MATTSON

was thereupon called as a witness, and being first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. WILL:

Q Will you state your name.

A My name is Henry Mattson.

Q By whom are you employed and what position?

A I am employed by the Texas Company as Division Petroleum Engineer.

Q And your profession is —

A Petroleum Engineer.

Q In order to qualify you as an expert, will you give your educational background, starting, of course, with the universities.

A I was graduated from the University of Utah with Bachelor of Science Degree and Mechanical Engineering in 1938, at which time I was employed by the Texas Company and have continued in my employment with them through to the present time.

Q Since your graduation, will you give some of your practical experiences.

A I have been located in the Rocky Mountain area throughout this period of time. I was located first of all in northwestern Colorado and in northern Montana, and finally moved to the Denver office in 1944, since which time I have personally worked on a large number of these Rangely studies and have participated in almost all of them with others.

Q The Rangely Field then so far as the Texas Company was concerned was directly under your supervision from the petroleum engineering standpoint?

A Yes.

Q You heard Mr. Vitter's testimony, you were here

during this morning's session and this afternoon?

A Yes, sir.

Q Do you wish to supplement any particular point that he has made?

A With regard to Mr. Vitter's testimony regarding the field as a whole, I would like to add only one thing and that is the great variation that we have in the permeability of the reservoir rock and the fact that approximately one-half of the oil originally in place in that reservoir was in rock, was in very tight rock, having permeability of less than 5 millidarcies; and consequently, we have to be very careful in the conclusions that we draw with respect to the operating procedures which should be adopted in that reservoir. I don't believe that anyone in this room or anywhere else is prepared to say that an operating procedure which would be suitable for the more permeable reservoir rock would necessarily be suitable for the tighter portions of the reservoir.

Q Any other comments with particular reference, I believe, that you wanted to testify a little bit about the pilot test which was made in which the Texas Company, Union Pacific, and California participated. You are familiar with that pilot test?

A Yes, sir, I was in on the inception of that pilot program.

Q What have you learned from these tests concerning the bottom hole pressure and oil and gas ratios?

A We have found two things that are definite and very simple. The first is that the wells will take gas or that the reservoir will take gas. Second, that there has been some increase in reservoir pressure in the immediate vicinity of the well bore. We have also found that within our injection well approximately 58 per cent of the injected gas is going into about 6 per cent of the reservoir exposed within the well bore. We have also found that an additional 17 per cent of the gas was going into about 2.8 per cent of the exposed well bore and that an additional 17 per cent was going into 3.7 per cent of the exposed reservoir. This indicates that there has been considerable non-uniformity in the manner in which the gas has entered the reservoir. The situation has also showed itself in the offsetting wells to our injection well, U. P. Well No. 57, in that gas-oil ratios have increased to figures in excess of 1,000 cubic feet per barrel in three of the first line offsets.

Q Are you familiar with the proposed orders suggested by the California Company and has been submitted as exhibits in the case?

A I have seen a recent draft of the proposed orders and there was one factor with regard to the spacing rule and the setting up of drilling units which I thought should

be emphasized, and that is the fact that drilling units based on present development regardless of whether or not they are equal to 40 acres or less than 40 acres should be excepted as of the present time. There are a number of places in the field where such drilling units, I am sure, would be on the order of 30 acres or less.

COMMISSIONER DOWNING: I didn't hear what it would be.

THE WITNESS: There are a number of places in the field where such drilling units would be equal to or less than 30 acres.

Q In all other respects you agree with the proposed order?

A In all other respects I think the proposed rules are in order.

MR. WILL: I believe that is all.

COMMISSIONER BARB: Mr. Mattson, that statement you made toward the last, gas-oil ratios of the offset to the wells, three of those --- I didn't catch what you said.

THE WITNESS: Three of the first line offsets to our injection well have had their gas-oil ratios increased to a figure exceeding 1,000 cubic feet per barrel.

COMMISSIONER BARB: Since you started injecting?

THE WITNESS: Since we started injecting.

COMMISSIONER VOLK: What were they before, may I ask?

THE WITNESS: They were on the order to 300 to 500 cubic feet per barrel.

COMMISSIONER VOLK: Over a short time? About how much time?

THE WITNESS: Over approximately a period of one year.

MR. WILLIAMS: Has the oil production increased from those same offset wells?

THE WITNESS: I would hesitate to make any definite statement of the oil productivity of those wells in either direction. There have been a few tests indicated some increases, there have been other tests that indicated the increases were not valid. I think it would be premature to say we had any productivity increases.

MR. WILLIAMS: How could you determine the increase gas-oil ratios without at the same time determining the increased oil production or measuring oil production at the same time?

THE WITNESS: We are measuring oil production and as I said we have had oil production figures that have gone up and down, and I would hesitate to interpret them as being indicative of any trend at this time.

MR. WILLIAMS: The gas-oil ratios have gone up and down?

THE WITNESS: The gas-oil ratios have been

definitely upward.

COMMISSIONER DOWNING: Any other questions?

(Witness excused.)

MR. BUTLER: Samuel Butler, the Sharples Corporation. I would like to read a statement for the record. The Sharples Corporation objects to finding No. 6 and Rule No. 3 of the California Company's proposed field rule. This rule concerns gas-oil ratio restrictions and gas injection. We are opposed to the inclusion of this rule in the Weber Rangely Field Rule for three reasons:

1. The gas-oil limitations will not accomplish the objective of preventing the flaring of gas without reducing field production to a non-commercial level.

2. Gas injection on a per lease or per well basis will not protect the legal or equitable rights of all operators and royalty owners.

3. To accomplish the future conservation objective, Sharples feels that pressure maintenance either by the injection of water or gas or both on a field-wide and unitized basis is the only real solution.

COMMISSIONER DOWNING: Any further comments?

MR. LAUGHLIN: R. B. Laughlin, representing Stanolind Oil & Gas Company, and we have one witness to present. The position of Stanolind is not far from that of the California Company as presented here this morning and

this afternoon, but there are one or two points that we would like to emphasize and supplement. To preface the testimony we would like to point out this, that of course there are basically two methods of operation, the normal lease operation and operation under a secondary recovery method. Rangely, of course, has been since its inception and up to now operated on a lease basis, and we do not think that there is being waste committed at Rangely as defined in the Colorado law. The market or the gas that Mr. Zorichak referred to this morning and computed in dollars and cents of course is, I think, a false figure because if you can't sell it it doesn't have the value, 10 cents or any other value. So I think that was an incorrect figure in dollars and cents of any waste.

Now, for secondary recovery methods, of course, we all know and it has been mentioned here before today at this hearing that it can most efficiently be conducted under unitization. I would like to say Stanolind has been active in the efforts and the attempts to unitize the Rangely Field and has participated in those efforts to the fullest extent. Now, with that I would like to call our witness, Mr. Sidney B. Richards. We have a few exhibits we would like to put out so if you would like to take a recess for a moment or two.

COMMISSIONER DOWNING: We will take a recess.

(Whereupon a short recess was taken.)

SIDNEY B. RICHARDS

was thereupon called as a witness, and being first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. LAUGHLIN:

Q Will you please state your name.

A Sidney B. Richards.

Q Where do you live?

A Casper, Wyoming.

Q What is your occupation?

A I am the Petroleum Engineer for the Stanolind Oil and Gas Company.

Q What is your capacity with Stanolind?

A The Assistant Division Engineer in the Rocky Mountain Division of Stanolind.

Q And does the Rocky Mountain Division include the State of Colorado?

A It does.

Q Will you tell the Commission your educational background.

A I was graduated from the University of Oklahoma in June, 1939, with a Bachelor of Science Degree in Petroleum Engineering.

Q In what activities have you been engaged since your graduation?

A I was employed by the Stanolind Oil & Gas Company upon graduation and have been in their employ up to the present time.

Q Is the Rangely Field within the scope of your activities as Assistant Division Engineer?

A It is.

MR. LAUGHLIN: We would like to present evidence now through Mr. Richards testifying as an expert.

COMMISSIONER DOWNING: He is acceptable as an expert.

Q Rangely Field is in the State of Colorado?

A Yes, sir.

Q Have you made a study of the Rangely Field from a petroleum engineering standpoint?

A Yes, sir. I have followed the development and the production of the Rangely Field since 1944.

Q Has Stanolind drilled any wells in the Rangely Field?

A Stanolind has drilled a total of 116 wells in the Rangely Field.

Q And have you made studies of the information developed from those wells?

A Yes, sir.

Q Mr. Richards, I would like to refer you to the California Company Exhibit 4, with particular reference to

the curve on there designated "Recovery Factor." Do you have any opinion and comment to make with respect to this peak that is shown in that curve?

A Yes, sir. I would like to supplement Mr. Vitter's comments on the variations in that curve by a little additional explanation of the variation. I would like to refer you first to the study of build-up curves in the Rangely Field as pointed out in the western portion of the field. There is a high order of porosity and permeability in the eastern half portion of the field. The sand is very tight and it takes a long time for the wells to build up any pressure. The practice in taking the bottom hole pressures in the Rangely Field is to leave wells shut in 72 hours before making the survey. In the case of the wells in the western field after being shut in they rapidly build up to a pressure which is representative of the pressure in between the wells.

Q Mr. Richards, just a minute, do you intend to use this exhibit in connection with this explanation?

A Yes, sir.

MR. LAUGHLIN: We identify it as Stanolind Exhibit No. 1.

Q Referring to this exhibit, which is entitled, "Typical Build-up Curves at Varying Pre-survey Producing Rates," marked Stanolind Exhibit 1. Will you state what

that exhibit is and who prepared it?

A This is an exhibit showing build-up curves on four wells in the Rangely Field, one in the west end, three in the east end of the field. It was prepared by engineers working in Casper under my supervision.

MR. LAUGHLIN: We offer this Stanolind Exhibit No. 1 into evidence.

COMMISSIONER DOWNING: Any objection? If not, it will be received.

A This is a plot of pressure build-up versus time, this is time in hours --

COMMISSIONER DOWNING: Kindly indicate if you can so when we read the record we may understand what you are pointing to.

A On the left hand portion of the exhibit is plotted bottom hole pressure and the bottom is plotted the build-up time in hours. On the west end curves we have two build-up curves in the same well, with the production rate for these pressure build-up curves being considerably different. In one case the well was being produced at approximately 80 barrels per day before the survey and the second case being produced 253 barrels per day before the survey. In both cases within the period of the survey some 72 hours the pressures build up have leveled off indicating that they approached the maximum pressure that those wells build up to

and representative of the pressures in the interval area.

On the other examples there is no leveling off of the pressure build-up curves such as we have in the west end, you will note, and there is quite a variation in the build-up characteristics of the wells depending upon the rate that they were produced at prior to the survey. In the upper right hand corner we have a well which produced for one survey 196 barrels per day and another survey 157 barrels per day. At the low rate of pressure build up there was some tendency for the curve to be flattening out. On the pressure build-up curve after the higher producing rate after 72 hours the curve is no where near the build up. The same comparison applies to the pressure build-up curves on the other two wells.

The point I am trying to illustrate is that of the higher producing rates or wells in the east end field the bottom hole pressure has gone down to a lower point in the well bore and that after 72 hours you have an erroneous picture of the pressure within the well areas, and it is more erroneous for a condition where the well is being produced at a high rate prior to the shut in than when it was produced at a low rate. That condition I think explains the very large variation in the recovery factor curve wherein at the low production rate for the reservoir are some 45,000 barrels per day. The wells were producing at a slightly higher bottom hole pressure in the well bores than they were

when the rates for the reservoir were higher. Consequently, when you shut the wells in for the pressure survey they had less distance, I mean less pounds to build up to the true pressure survey, and after 72 hours of shutting in following a low producing rate we were closer to the true average pressure than you would have had if the field had been produced at a rate of 60,000 barrels per day. I consider the pressure at the high point there to be probably representative. The pressures on the field producing at a higher rate prior to the survey are much more erroneous because of the poor build-up characteristics of the wells in the east end of the field.

Q Is it your conclusion then, Mr. Richards, that that peak is caused by the build-up characteristics of the well rather than a reduction in the production rate of the field?

A To a large extent, yes, sir.

Q Is the last portion of the curve on California Exhibit 4, the recovery factor curve takes an upturn there, does that have any significance in connection with your conclusion?

A That would indicate to me that the present producing rate is not damaging to the reservoir in so far as the barrels of oil produced per pound drop in pressure are concerned.

Q Referring now to California Company Exhibit 2, do

you have any comments with respect to that exhibit?

A I simply wanted to point out that that is a poor volume which I understand is based on considerable porosity in the formation which has a permeability of above 3 millidarcies. I want to point out for the information of all that there is a considerable amount of poor volume in the reservoir, which has permeability of less than 3 millidarcies, that this poor volume contains oil in place which is also contributing to the reservoir performance and is giving up oil to the well bore. For that reason I do not consider that an absolutely true picture of the poor volumes in the length of the Weber Sand. It is a more or less comparative picture and is not an accurate to the nth degree picture.

MR. LAUGHLIN: Mr. reporter, I would like to have this large cross section on the end designated Stanolind Exhibit No. 2.

Q Referring to Stanolind Exhibit No. 2, Mr. Richards, can you state what that exhibit is?

A That is an exhibit prepared by engineers working under my supervision in the Casper office.

Q What does it represent?

A It depicts two cross sections of the field; one more or less across the long portion of the axis, and one across the short portion more or less of a north-south and east-west cross section. As shown on the key map, the cross

section is drawn to the same scale horizontally and vertically and represents the picture you would see if we were to slice away a portion of the Weber Reservoir so you could look at it from the side. The purpose of presenting this cross section is to illustrate from a graph the insignificance of the gas cap. As Mr. Vitter pointed out, the gas cap constitutes only some a little over 1 per cent of the total volume in the field containing oil and gas, and as you may note from looking at the cross section of the field although indicated a large structural control this has some flatness when looking at it from the side and the gas cap is only a bubble located on the top of the structure. The reason for pointing this out is to supplement Mr. Vitter's contention that the gas cap drive there is not of significant importance to be contributing much in the production of the field in the recovery mechanism.

MR. LAUGHLIN: We would like to offer Stanolind Exhibit No. 2 into evidence.

COMMISSIONER DOWNING: Any objection? If not, it will be received.

Q Do you agree, Mr. Richards, with Mr. Vitter as to the significance of the water drive?

A I am not in agreement with him on the significance of a water drive. I think that it has even less significance than he is willing to perhaps admit. He stated it might be

something in the order of 8,000 barrels per day. From all the evidence that we have been able to gather so far considering the fact that the wells around most of the field were drilled completely after to the all water contact and very close to it, considering also that you have taken some 90 million barrels of oil out of this field, I believe where any water drive of any appreciable magnitude, at least five wells or ten wells or wells along the portion where the water is entering the reservoir would have been flooded out at this time. The accumulated water production to date is less than 1 per cent of the total fluid recovery. I am of the opinion that the water drive in the field has a significance of something in the order of 1 per cent of the total recovery mechanism.

Q You made reference to the testimony on Stanolind's Exhibit 2 to the gas-oil contact. What do you mean by that?

A That is the contact between the base of the free gas cap in the reservoir and the top of the oil productive portion of the reservoir.

Q What depth is that contact in the Rangely Field?

A It's found at a datum of 330 feet below sea level and is approximately 100 feet in thickness.

Q Now, referring to California Exhibit No. 3, with particular reference to the reservoir pressure curve, considering the total amount of production from the Rangely

Field do you consider that the pressure decline to be abnormal?

A No, sir. I consider the pressure decline to be entirely normal and in accordance with our expectations for the performance of a reservoir of this type.

Q One of the purposes for this hearing is in order that this Commission may determine whether or not to enter an order reducing the daily production from the field in order to reduce the rate of reservoir pressure drop. Now, in your opinion would a reduction in production have any effect on the rate of reservoir pressure drop?

A No, sir. All the production performance schedules we have to date indicates there has been no abnormal drop in bottom hole pressure. With the producing rates the field has been experiencing in the past, I consider that there has been no abnormal increase in gas-oil ratios. I do not think there is significant water drive nor gas cap drive to be considered or to take advantage of by producing at low producing rates. All of the information we have been able to collect to date indicates this is primarily and essentially a depletion type drive or dissolved gas type reservoir and normally a depletion type reservoir is not affected by the producing rate, assuming that you produce all the wells as uniformly as possible and with as great efficiency as possible. I would expect to reach the same reservoir pressure when the field has produced

150 million barrels of oil regardless of whether we reach that rate at the rate of 10,000 barrels per day or 60,000 barrels per day. In view of the fact that there has been no evidence of abnormal drop in bottom hole pressure, abnormal increase in gas-oil ratio, I see nothing to be gained by a reduction in the producing rate.

COMMISSIONER BARB: Would you mind restating your last question, there was something in the wording of it I would like to ask.

(Whereupon the reporter read back the last question.)

COMMISSIONER BARB: You speak of the rate of pressure drop. Are you referring to rate with respect to time or rate of cumulative production? There would be a difference.

THE WITNESS: My answer was based on the rate of production, barrels produced per pound pressure drop. It would have no effect on that. It would have an effect on the production drop per month or year, but not on per barrel of oil produced.

Q Now, on California Company Exhibit 5 is shown higher bottom hole pressures in the northwest, in the southeast, and east. Do you have any comment to make with respect to that condition as shown on that exhibit?

A I consider the pressure gradient from the west to the east side is primarily due to first, to the fact that the

pressures in the east portion of the field are not representative. They are considerably higher than have been measured. There has been some evidence to support that. There has been one well that I know of was shut in for a considerable length of time and the pressure built up to a much higher degree than had been previously expected on the basis of 72 hours shut in bottom hole pressure surveys.

I also consider the pressure gradient to be partially affected by the fact that you probably have more oil in the highly permeable section from the western portion of the field than you have in the eastern portion of the field and to the extent that you take one barrel of oil out of the western portion of the field would result in less pressure drop than if you take one barrel of oil out of the eastern portion of the field. Therefore, the pressure gradient if it exists would be due to a little higher depletion in the eastern portion than you might have in the western portion.

MR. ZORICHAK: Mr. Richards, why doesn't the static map reflect the condition that you speak of? The static map is supposed to represent the static conditions of the reservoir and the low pressure wells are plotted, the build ups are plotted in an attempt to arrive at a final build up pressure.

THE WITNESS: Yes, sir, I think you probably have three conditions there. You take the pressures after a

straight 72 hours, you are in error in the eastern portion of the field. You attempt to extrapolate these build up pressures to reach the true pressure in the eastern portion of the field and I think the type of curves you have there is impossible to come anywhere close to an accurate extrapolation with the shut in time we are now experiencing. I think it would take a shut in period of at least a month to get an up-curve that could be accurately extrapolated to get the accurate pressure in that eastern portion. I concede that it is an attempt to reach the true pressure in that eastern portion by extrapolating the build-up curves, but I don't think it comes anywhere close to the true pressure in my opinion.

MR. ZORICHAK: As I recall the difference in pressures between the two maps has been on the order of around 50 or 60 pounds at the most so that doesn't reflect a great deal of difference. Of course, I am familiar with the fact that some wells require as much as a month to get a full build up, but we also know the fact that the maximum build up or a large part of the build up is experienced within the first three days of shut in. Practically full build up within a day or so on the high permeability wells and, of course, on the low permeability wells it takes more time.

THE WITNESS: I think the curves I have shown on the board there, Mr. Zorichak, if I were presented with any

one of those curves I would have a very difficult time to reach a true leveling off to extrapolate any of those and decide what point they would start to level off.

Q Do you know of any well that has been shut in for sufficient length of time to indicate the error of these extrapolated figures?

A I believe there was a Phillips well shut in for about three months, wasn't there? I am not too familiar with what the well was.

Q Do you know whether or not it indicated that?

A Yes, it went to a much higher pressure than had previously been indicated in that portion of the reservoir.

MR. LAUGHLIN: At this point I would like to present Stanolind's proposed amendments to the rules presented by the California Company, and we ask those to be placed in the record. For the purpose of the record, I would like to have that marked Stanolind's Exhibit 3 and offered into evidence.

COMMISSIONER DOWNING: Any objection? If not, it will be received.

MR. LAUGHLIN: The only substantial difference between this amendment and the rules proposed by the California Company and the rules amended as suggested by Stanolind would be that there will be a limit of 150,000 cubic feet of gas on all wells in the field. The California rule established a limit for only wells producing in excess of a gas-oil ratio

of 1,000 to 1.

Q Mr. Richards, referring to Stanolind Exhibit 3, which is a proposed amendment to the California rules, what is the reason for the limitation of 150,000 cubic feet of gas per day for any well as distinguished from the rule that would only limit gas production to 150,000 cubic feet per day of those wells producing in excess of gas-oil ratios of 1,000 to 1?

A Under the California rule only the wells producing above a ratio of 1,000 to 1 are restricted in their gas production, and wells which are producing with a gas-oil ratio below 1,000 to 1 are permitted to produce unlimited amounts of oil and gas. We believe that withdrawals in the field should be maintained on as uniform basis as possible and that our rule will require that there be no wells produced at such high ratios; that there would be a lowering of pressure within the vicinity of those wells and perhaps lead to waste.

Q Would you state the difference in the effect of the two rules and the reason for your opinion that the Stanolind Amendment is more applicable to the Rangely Field?

A I would like to start out by saying that the so-called Stanolind Rule and the California Rule are similar and both of them will strongly operate in the interest of conservation in the Rangely Field. In my opinion, however, the Stanolind Rule will operate much more effectively since our

rule proposes that all wells be restricted in their gas production rather than just those wells with a gas-oil ratio limit in excess of 1,000 to 1. By permitting wells in the field to produce with gas-oil ratios below 1,000 to 1 you allow or you make no distinction between the efficiencies of the wells producing below 1,000 to 1 and you allow the wells to produce unlimited amounts of oil and gas regardless of whether their ratio is 300 cubic feet per barrel or 900 cubic feet per barrel.

Under the Stanolind Rule it forces the taking of oil from the most efficient wells or those with the lowest gas-oil ratios and operates or assures uniform withdrawals throughout the range of gas-oil ratios that we have in the Rangely Field. In my opinion the California Rule might lead to an abusement whereby under the transfer of pipeline quotas in the field there a group of wells would be produced in a local area at very high rates leading to a pressure sink in that area, and that in my opinion would be conducive to waste and not in the best interests of conservation.

Q Now, Mr. Richards, in the light of your testimony and referring particularly to the order to show cause issued by the Commission, I would like to have your comments on the specific items covered in the order. The first one is why this Commission should or should not enter an order fixing a gas-oil ratio appropriate to the Rangely Field.

A I am in agreement with that and recommend a gas-oil ratio with limits of 1,000 cubic feet per barrel with a per well gas limit of 150,000 cubic feet per day for every well in the field.

Q The second item is why the Commission should or should not enter an order requiring all waste gas produced in the field to be injected into the Weber Sand.

A I am in agreement with that, with the basis that waste gas be defined as that gas produced in excess of 1,000 cubic feet per barrel.

Q And how are you defining waste gas?

A Under the operation of the proposal which we are submitting it would be all gas produced in excess of 150,000 cubic feet per day for every well in the field.

Q The third item is why the Commission should or should not enter an order reducing the daily production in the field in order to reduce the rate of reservoir pressure drop.

A My previous testimony pointed out the reasoning that I thought would have no effect. A reduction in rates would have no effect on the barrels produced per pound drop in pressure in the reservoir, assuming that all the wells were producing uniformly at equal efficiency.

Q Would it have any effect on ultimate recovery?

A It should have no effect on ultimate recovery.

Q And the last item in the order is why the Commission

should or should not enter an order requiring that there be determined the amount of oil each well in the field can produce without waste in accordance with sound engineering practices.

A We are in agreement with that in principle, but I believe that that objective can best be obtained by setting a gas limit on the field.

Q It would be unnecessary then if the Stanolind Amendment were adopted by the Commission?

A Yes, sir.

Q Do you have any comment to make with respect to Mr. Vitter's testimony on 40-acre spacing?

A We are in complete agreement with Mr. Vitter in that, that the field is adequately drained at the present time on the spacing of one well per 40 acres and we want that provision put in for the drilling of any new wells in the field.

Q Do you have any further comments to make on this hearing?

A No, sir.

MR. LAUGHLIN: That is all.

CROSS EXAMINATION

BY MR. WALSHE:

Q Mr. Richards, you stated earlier in your testimony that rates of production had very little if anything to do

with the ultimate recovery of oil and gas in the field.

A I was speaking on reservoir withdrawal rates as a whole.

Q So that in your recommendation of fixing a top rate of gas production on all wells you are not doing that primarily as a waste measure but possibly trying to protect the rights of the various people in the field?

A No, we are trying to assure that wells are produced as efficiently as possible in the field, that the withdrawals be distributed throughout the field as uniformly as possible.

MR. WALSHE: That is all.

COMMISSIONER DOWNING: Any further questions?

(Witness excused.)

MR. WILLIAMS: I would first like to say to the Commission the Phillips Corporation joins with the other companies in thanking this Commission in the efforts they are making to conserve oil and gas in the State of Colorado. We as a company want to tender this Commission any help in any way possible. Our presence today is in an effort to give this Commission any views that we may have that might be helpful to the Commission in the solving of this problem. We realize you have a tremendous problem, one that the operators have been working with for sometime, and we want to be cooperative and helpful. I would like to call Mr. Herman

Kaveler to the stand.

HERMAN F. KAVELER

was thereupon called as a witness, and being first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION

BY MR. WILLIAMS:

Q State your name please.

A My name is Herman F. Kaveler.

Q By what company are you employed, Mr. Kaveler?

A I am employed by Phillips Petroleum Company and my present capacity is Assistant Manager of the Crude Oil Production Department. Before my present position I might say by way of qualification that I am a graduate of the University of Missouri and the University of Maryland. Like Mr. Vitter, I taught school for a time following graduation and in 1935 was employed by the U. S. Bureau of Mines at their experimenting station. In November, 1936, I found employment with Phillips Petroleum Company as a research engineer devoting my time to research in matters of oil production. I have been employed by Phillips Petroleum Company since 1936 in various capacities relating to engineering, production problems, and my main interest has been in the field of unit operation and those problems associated with the conservation of petroleum.

Q Mr. Kaveler, does your company have properties in the Rangely Field in Colorado?

A The Phillips Company does have property and has had since we drilled our first well about 1946.

Q In what portion of the field were your properties located?

A Our properties are generally scattered over the field on both the west and south, east and north. We are known as one of the small owners in the field.

Q Are you personally familiar with the field and have you made a study of the problems there existent?

A I have since the time we drilled our first well in 1946.

Q Mr. Kaveler, from your study and knowledge of this field and of the objective that the Commission is attempting to reach, prevention of the waste of oil and gas and the eventual recovery of oil and gas, do you have any views in your opinion that would be helpful to this Commission in its consideration of field rules for that pool?

A In answer to that question I say that I am in substantial agreement with the engineers who have testified before me, and I find that their presentation of the history of the field and essential facts in respect to the reservoir are such that I am fully in agreement with them. I think it is quite evident to the Commission that if there be

differences of opinion among the technologists it comes in respect to certain conclusions and speculations that arise from the accumulated information. In my opinion the Rangely Field is to be classified as a gas drive type reservoir. While there may be some water encroachment but from the standpoint of conservative regulation there is no water drive that will bear significantly on the conservation problem in this field. Furthermore, that the history of the field is now so extensive that one could say with some certainty that there will not in the future be any significant water drive. All of the gas is essentially dissolved in the oil. The gas cap while it is present, as Stanolind has shown by their last exhibit, represents but a small source of the energy available for the production of oil.

Now, in the face of the fact that this is a gas drive type pool, this conclusion which other witnesses have stated is equally true, that the rate of daily oil production whether it be high in the mind of some or low in the mind of others will not substantially affect the ultimate recovery. This much may be said with certainty that for each barrel of oil produced from the reservoir and each cubic foot of gas taken from it there will be a pressure decline irrespective of the daily rate which that withdrawal occurs. So that from a technical point of view there is no reason to restrict the daily production of the Weber Sand with the view that having

restricted the daily production there would by that act be ultimately more oil recovered.

There is only one agency that will accomplish the recovery of oil from the Weber Sand and that agency is pressure. Whether it be the pressure of gas or whether it be the pressure of water. So that as the Commission desires to take those steps that will bring about a substantial increase in recovery, and those before me have testified that by pressure maintenance at least 50 million more barrels could be recovered, if you desire those steps to be taken the only manner in which it could be accomplished is by the return of gas or by the injection of water.

The alteration of the daily rate of production will not in my opinion contribute to the ultimate recovery. I make that statement with this one exception. That is, that there must of course be some reasonable control of gas production. It is obvious that if some wells in the field go mainly to gas production with little oil and those wells produced mainly gas, that those gas wells will sap the reservoir energy without the production of oil. So that some reasonable restriction on the production of gas is something that the Commission could do which in itself would contribute to the increased ultimate recovery.

In respect to the recommendation that there be some limitation on gas production, I concur. I think the

Commission might well look at the problem of the Rangely Field from this point of view. There are three ways to produce an oil field. One way is unrestricted where each owner goes about in a manner best calculated to do himself good to take oil and gas from the pool. That is an operation under the so-called rule of capture. That rule of production never did apply to Rangely because there was a limitation of market and the limitation of market restrained the wide open production of the field.

Secondly, there is a second method for the production of the field and that is under some restriction under the regulatory authority of the State, and the Commission is at that point in this hearing.

There is still a third method of operating this field and that is by the method of unit management. Now, all of the technologists have testified that if the greatest ultimate recovery is desired then that can be accomplished by pressure maintenance under a unit plan. Witnesses before me have testified about the five years of effort that have been made to bring individuals together to act in such a manner that there would be the greatest good for all, but those negotiations or arbitrations or conferences have come to nought and in my opinion will not produce a unit in this field in the very near future. So that as a practical matter the only way in which the Rangely Field can be produced

prospectively is by the second method, that is by the method of production under restrictions imposed by this Commission.

The manner of that restriction is difficult to state. I am testifying from the point of view that this Commission cannot start its regulation where other states started. Other states started their regulation by limiting the amount of oil production and in that they have a decided advantage over this Commission. Other states having the advantage of starting with a restriction of the oil production it is easy to step to the next restriction and that is a restriction on gas by the device of fixing a gas-oil ratio. So that the limit of gas production in other states is fixed by multiplying the oil allowable by the gas-oil ratio and then producing then a gas limit.

If one then looked at the viewpoint that the restriction to be imposed by this Commission would be mainly from the viewpoint that there shall be a restriction on gas leaving each operator then free to produce as much oil as he may find market for under that gas cap, I would join the Stanolind in principle in their recommendation and recommend that the Commission adopt the Stanolind proposal. The reason for that I may state briefly is this: Waste is not subject to such a precise definition that it may be defined precisely as occurring the moment a well produces 1,000 cubic feet of gas. Under that definition a well that produces 999 cubic

feet of gas per barrel of oil is not wasteful but the moment it produces 1,000 it becomes a wasteful well. Waste is not subject to such a precise definition.

Secondwise, if there is to be restriction, I will be the first to venture the technical opinion that the restriction should apply equally to all wells. If a gas limit is applied of 150,000 cubic feet per well that limitation goes to every well in the field. Under that each operator would have the right to produce a quantity of oil which his well would permit to be produced within that limit. But if the Commission does not fix that limit to apply to all wells in the field then this situation may exist. A man on Lease A will have a well that has a producing ratio of 1,000 to 1, and under a rule such as the California Company proposed, his production would be limited to 150 barrels a day. But on the adjoining lease and offsetting a man has a well which has a gas-oil ratio of 999 to 1 and he is unlimited in his oil production. I think the consequence of that would be a very serious discrimination between those two offset owners. So that I would urge the Commission if they find it necessary to impose a limit on gas production that the limit be imposed so that it will apply equally to all owners.

I think secondwise the reason that Mr. Richards gave and that is that a limitation on gas should be imposed

field-wide is necessary in order that there may be a field-wide uniform drawing upon the energy of production from the gas, and that there be uniformity of withdrawal over the entire field. If the Commission finds further that gas should be returned to this reservoir and adopts the California Company's recommendation that whenever a well produces in excess of its gas limit that the penalty may be removed by returning the excess gas to the formation, then I should think that there should be this restriction applied to the return of gas: That is, that the gas that is returned to the reservoir shall be returned either from on the lease from which it is produced or at least should not be returned to a lease that is not contiguous to the lease from which the gas is produced.

If the Commission permits producers to return gas to the reservoir to remove the penalty on gas limits, I think the Commission would err if they permitted an operator on the east side of the field to transport all his gas over to the west and put it in some spot that he himself selects. It may be that some owner out there with separate leases might find all of the gas in the field being injected off-setting him and that would work a hardship on that individual owner.

We would recommend that that provision in the California rules which permits the injection of gas to be

written in such a manner that if gas is taken from one lease to be injected to another that the gas be taken only to a lease that lies contiguous to the lease from which it is produced. That suggestion is made with the idea in mind that you should not permit the transportation of gas from one end of the field to its exclusive injection in another part of the field.

I would like to say from a technical point of view in answer to one of the questions that one of the Commissioners asked this morning that the most effective and efficient way to utilize gas injection in this field is by injection in the gas cap. That has great advantage over any other type of injection. Gas should be injected into the gas cap for exactly the same reason that if water is injected. The water is injected on the fringe or the lowest part of the field. I would like to say to the Commission, in my opinion gas injection cannot be carried out in this reservoir in a manner to be fair and equitable to all parties unless the injection program be under a system of unit management, otherwise, some are to be injured.

I would like further to state that in my opinion since Rangely cannot be unitized and since the field can only be produced under a system of regulation and since the Commission obviously is going to put some sort of a gas control on it, that with a reasonable gas control there is

then in my opinion no evidence of waste occurring in that field. The definition of waste is, of course, fuzzy, but with a reasonable limitation on gas production the reservoir pressure is declining in a manner that is characteristic of a pool of this type, and the operators will get as much oil from this pool under a reasonable gas control as could be had by any methods short of unit operation.

Q Mr. Kaveler, do you agree with Mr. Richards that the application of a uniform gas limitation on oil wells will more or less bring about a more uniform withdrawal over the field and that would be conducive to conservation?

A Yes, I agree with Mr. Richards on that, that is, treating all wells alike will be conducive to conservation because it will bring about a more uniform withdrawal of energy from all over the entire reservoir.

Q Can it be said that a well producing at a ratio of 1,000 to 1 is wasteful whereas a well producing at a ratio of 950 to 1 is not?

A No, that is much too narrow a conception of what constitutes waste.

Q In your opinion it would be a matter of degree between the two wells?

A Yes.

Q Placing a top limit on the gas any well could produce would have a proportionate effect on the wells with

the varying ratios?

A That is correct. A limit of 150,000, if the Commission finds that 150,000 is what it should be, applying that restriction to all the wells is the way to permit each well to produce in its own manner. The well that will produce with a gas-oil ratio of 150,000 under that rule will get one barrel of oil because it's the most wasteful well, and the well that produces with a ratio of 1,000 under that rule will get 50 barrels because it is less wasteful than the 150,000, so that by placing a limit on each well you place into effect a rule where there is a graded restriction as between the good and the poor wells, and that is a much more reasonable application of the Commission's power in my opinion than is the California Company's.

Q And would be dependent on direct ratio of the degree of efficiency of the various wells?

A That is true.

Q Mr. Kaveler, there has been testimony here as to the establishment of 40-acre spacing for drilling units. Do you have an opinion as to the establishment of such units and what the size of the unit should be?

A I would recommend to the Commission that drilling units be established and that their size be fixed at 40-acres, granting such exception to that rule as the wells now presently drilled might require in order to establish a

drilling unit around each of the presently drilled wells. I would recommend that to the Commission for this reason, that while some of us might look to the drilling of two or three or four wells on 40 acres that the mere drilling of wells in this field will not increase the ultimate recovery. The mere drilling of additional wells might increase the daily rate of production but it's gas that produces the oil, not the wells.

MR. WILLIAMS: I believe that is all, if the Commission please.

CROSS EXAMINATION

BY MR. WALSHE:

Q I have one question. I would like to clarify one of Mr. Kaveler's remarks. He said no large scale injection program could be carried on without unit operations. You don't discount the fact that it might be possible to have two, three, or more units in the field that could carry on say a cooperative gas injection program?

A It is entirely possible that this field might be unitized into three blocks or three blocks might be unitized in which event it may be possible then to bring about large scale gas injection.

MR. LAUGHLIN: Referring to California Company Exhibit No. 2, which I understand eliminates from

consideration all sand having a permeability of less than 3 millidarcies. In your opinion would the sand having a permeability of less than 3 millidarcies have oil or porosity contribute to such a study?

THE WITNESS: Yes, sir, it would have. The Commission has asked several times why this field can't be unitized and California Exhibit 2 is a good basis for stating why it can't. That is without reflection on the California Company. But there might be an operator in the field who has prepared that exhibit would have plotted on there the thickness of the sand that had a permeability of 1 millidarcy and greater and another might have come in and said he thought all of the sand was productive no matter what its permeability was, so that Mr. Vitter prepared California Exhibit No. 2 based upon counting only that sand productive which had a permeability of above 3 millidarcies. Were he to prepare one that showed the thickness of the sand that has a permeability of 1 millidarcy or greater than the yellow area won't stand out quite so viciously and the west end of the field wouldn't look quite so good. So that if someone could prepare an Exhibit 2 such that everybody would say, "Well, that represents my opinion of the productive sand," then we would have the unit.

COMMISSIONER DOWNING: What three blocks have you got in mind? How would you divide the field into three

blocks?

THE WITNESS: Mr. Chairman, Mr. Vitter has drawn three lines on the California Exhibit 2. The red lines would very possibly be a basis for performing a unit west, central, and east as defined by those red lines. They had a name for that, what was it, potatoes?

MR. KEYES: You and the Stanolind both stated that the producing rate in the field would have no effect on ultimate recovery. I agree with that statement, it seems to me it's somewhat contrary to your definition of waste. Under your definition of waste a well producing say at the solution ratio presently of 300 to 1, if it produces more than 150,000 cubic feet of gas it constitutes waste, but under your first premise it would not accomplish the ultimate recovery of the field so why is it waste?

THE WITNESS: Well, the Commission I assume is going to define some figure and I am assuming just for purposes of my testimony the figure will be 150,000 cubic feet as a limit on certain wells. Now as I understand it, no well in the field will be permitted to produce in excess of 150,000 cubic feet of gas and the reason I think that is a reasonable restriction is that I think each owner or each well is entitled to take from that reservoir a certain quantity of reservoir energy daily as its fair and equitable share to its total energy available to production. In the

sense each well will be permitted to produce up to that it is getting a fair share of the energy available and is being produced without waste. Now, Mr. Keyes, the most conservative way to operate this field would be to return to the reservoir all of the gas produced and that is the ultimate in conservation, and that is what Phillips Petroleum Company would like to see done but we find it's impossible to achieve that. So that in the absence of the ultimate in conservation we have to be satisfied with what will result in production of this field under such restrictions as this Commission may impose, and under that view the Commission may find that 150,000 cubic feet of gas produced by each well comes within the concept of conservation. I don't know whether that is in answer to your question.

MR. KEYES: No.

THE WITNESS: Well, ask it again please.

MR. KEYES: Define waste in the well that produces at the present solution ratio and produces more than 150,000 cubic feet of gas. Under your definition it would be waste. I think you are talking about proration and not conservation. I mean you apply it to all wells.

THE WITNESS: I don't think you can consider it without prorating, although I understand that word is not to be used here.

MR. KEYES: That satisfies me.

THE WITNESS: You can't restrict without causing some controlled conduct on the part of an individual who doesn't like to be restricted.

COMMISSIONER BRETSCHNEIDER: On the basis of 150,000 cubic feet per well, is there an estimate of how much gas would be produced per day?

THE WITNESS: Well, the production in the field today is what, 60,000? Sixty thousand barrels of oil a day. It is about 35 million feet of gas being produced a day. Now I think if you put this restriction on you will not substantially reduce that.

COMMISSIONER BRETSCHNEIDER: You will still have 20 million waste, so-called?

THE WITNESS: Yes, sir, 20 million being flared.

COMMISSIONER DOWNING: What could you accomplish in ultimate recovery if you had unitization?

THE WITNESS: Mr. Downing, in my opinion there would be produced from the Rangely Field at least 50 million more barrels of oil ultimately at a higher rate of production. This field will decline --

COMMISSIONER DOWNING: That would be a rather small estimate, isn't it?

THE WITNESS: Yes, I am being conservative today.

COMMISSIONER DOWNING: Yes, I noticed that. And to accomplish that under the unitization, what would you do

that you are not doing now?

THE WITNESS: You would do a number of things. The first you would inject all the produced gas to get more oil, yes, but also to save that gas to run the engines. Rangely might well face the day when there will be no field gas to run pumping engines. We will have to get some fuel to put the gas back in the ground and probably start injecting water and effect economies of operation out there. As Mr. Vitter said, consolidate tank batteries and do this to reduce cost of production.

Now, that is important because if we can reduce the cost of production we can carry Rangely farther to the limit of production before it becomes uneconomical so that we would also give everything value there. As General Thompson said in Chicago, "Nobody destroys something of value." Everything in that field in the way of oil and gas would then have value because it would be the common property of all and there would be no question about whether we would flare the gas.

COMMISSIONER DOWNING: Aren't there tremendous possibilities as suggested by General Thompson that today perhaps 75 billion barrels of oil in sands and fields you might say have been destroyed, and if those fields should be managed by present day conservation practices a very large part of that 75 billion barrels of oil would be available.

Now doesn't that open a door to believe that you technologists with all your brains could devise methods of increasing ultimate recovery far greater than you have now? In other words, isn't it the problem of secondary recovery, not the same problem, but you have a problem of secondary recovery and if you work together and all, don't you think the ultimate recovery of that field might be increased many times?

THE WITNESS: Mr. Chairman, the technologists have already served their purpose in that respect. We know how to get more oil out of Rangely but now come a matter, shall we say it's a matter of political problem, to bring about the unitization because the improved methods to be used efficiently can be managed only under a system of unit management. I wouldn't want to say anything too startling to this Commission but this is a fact. Unless the field is unitized or unless some pressure maintenance procedure is devised, the recovery of Rangely will be only 20 per cent of the oil and 80 per cent will be left in the ground; whereas in my opinion at least 50 per cent could be recovered.

COMMISSIONER DOWNING: With unitization?

THE WITNESS: Yes, sir.

COMMISSIONER DOWNING: Well, with that in prospect, why don't you unitize?

THE WITNESS: We stand ready and willing but not able.

COMMISSIONER BRETSCHNEIDER: You made a statement, Mr. Kaveler, that it's probably impossible to unitize the field.

THE WITNESS: That is my opinion, yes, sir.

COMMISSIONER BRETSCHNEIDER: I assume that one of the difficulties is the general application of it, but perhaps that is not insurmountable. I understand there is a problem, maybe you might explain it, but if you do, what is the division of underlying interests?

THE WITNESS: Well, just to give the Commission some idea --

COMMISSIONER DOWNING: Is there any other testimony that anybody wishes to offer in this hearing? I would just like to know. If not, we can spend maybe a little time in asking questions but if there is other testimony I would like to know it. I don't want to keep you here until midnight, but we do want to finish today. Is there any other testimony? Then let's question Mr. Kaveler.

THE WITNESS: I will try to answer your question about general examples, Mr. Commissioner. If one would take Exhibit 2 as introduced here whereas the productive sand is considered to be that sand which has a permeability of 3 millidarcies and greater, that is sand of a greater potential. You might find that Company X owns 60 per cent of the field on the basis of the sand thickness on that basis;

but if you took the total sand body irrespective of permeability counting all of the sand, you might find that that particular company X would have an interest in this unit of 40 per cent. So then you come to that situation, what would Company X desire to have counted as productive? Obviously they would like to have some high permeability which would give them 60 per cent. Now, my figure doesn't apply to any company, I am using a hypothetical case. Now where between that 60 and 40 shall Company X be willing to settle? As Judge Downing suggested, we all ought to give and take a little bit. Now those who have lines that lie mainly to the east that have permeabilities maybe less than 3, they have oil wells and current income and if you tell them, "Brother, you have got an oil well but your permeability isn't high, it's low, and therefore you just get a little bit in this unit," that brother over there would say, "I would just as soon pump my well for a little bit."

COMMISSIONER BRETSCHNEIDER: I know the reason, I just wanted you to state it.

BY MR. WALSHE:

Q I would like to get this additional recovery fact boiled down a little bit from 20 to 50 per cent. Is all of that due to gas injection, Mr. Kaveler?

A Well, it could be due to water flooding or gas

injection or both.

Q Where do we get the gas?

A I don't know. We could water flood the field.

Q You can water flood the field whether you put gas back in the ground or not?

A Yes, sir.

Q And that can be done at possibly a late date when the pressure goes down?

A Rangely could be. Everybody says, "Well, we haven't got anything anyway so we might unitize and water flood." That is a possibility.

Q What I am driving at, this additional recovery you pulled up a little bit more than any of the others who have testified to with the exception of probably Mr. Zorichak.

A That doesn't make me wrong.

Q No, but it's not accomplished by gas injection alone.

A It could be. It could be.

Q In your opinion if you had enough gas then?

A Yes.

Q Is there enough gas in the Rangely Field to accomplish that?

A Well, there probably isn't but it could be moved up in which we might use that gas.

Q That is possible too, we could always bring it in,

but I just thought in your testimony before the Commission you shouldn't paint this picture so bright.

A I will say this to the Commission. The flared gas situation isn't so serious out there to represent prime examples of waste. There isn't much gas in the Rangely Field by ordinary standards, it's short on gas, so that if we unitized a field and wanted to bring about a higher recovery there is no question but what we would have to water flood to get the 50 per cent.

BY MR. LAUGHLIN:

Q I understood you to say, Mr. Kaveler, that gas is best injected into the gas cap.

A Yes, sir, structurally high part of the reservoir.

Q And you further stated or you recommend to the Commission that the rule in the proposed rules that gives credit for gas between leases that gas is injected may be taken from lease to lease. You recommended that it be limited to the lease from which it's produced or at least no further than the contiguous lease.

A Yes, sir.

Q Doesn't the proposed rule lend itself more to your theory that gas is best injected into the gas cap taking into consideration small scattered leases around through the field?

A Well, on Exhibit 1 you see the general gas cap area of California Exhibit 1. Now the California Company and Stanolind recommend that the Commission permit the injection of gas any place in the field. Now, if all these producers along the west half of the field should suddenly decide they want to come up in this gas cap and inject their gas, I don't know what this fellow with that single 40 acres, what shape he is going to be in. He is going to be gassed out of the field. That is all right for everybody except the fellow who is getting trespassed, that won't be so good for him.

MR. WALSHE: I just wanted to straighten out a point. Our rule does not suggest giving any operator the authority to transfer gas from one part of the field to the other. He can only do it after a notice and hearing before this Commission.

THE WITNESS: That is true.

COMMISSIONER BARB: Mr. Kaveler, there has been a good bit of discussion of this 1,000 cubic feet per barrel. It's just a figure, sort of taking out of the air to give us something to work with. Now this depletion type of reservoir according to all testimony, gas and solution and as you just said if nothing else is done it will follow the historical route and go down. Now as it goes down that route the average well in the field, the gas-oil ratio probably will go up?

THE WITNESS: Yes, sir.

COMMISSIONER BARB: Now, in predicting the future performance of a depletion type reservoir, as I recall you happen to be the author of rather an ingenious method of doing that. Have you predicted the future performance of the Rangely Reservoir and say for any central block what normally gas-oil ratios may go to and still be normal?

THE WITNESS: I don't think, Mr. Commissioner, that one could predict too accurately what the gas-oil ratio of any group of wells will be in the future. This much can be said, however, I would assume that this Commission would from time to time examine the course of the field and may decide at some future date that the limiting gas to be 100,000 or may decide to be 200,000, the Commission is going to have to be attentive to conditions. The more gas conserved by preventing its production, the more the pressure will be maintained, and as I would see it the Commission is subject to certain reasonable rules in the restriction of the gas.

COMMISSIONER BARB: You think the ratio would go considerably above 1,000?

THE WITNESS: I think there are wells in the field already that are producing as high as 3,000 cubic feet.

COMMISSIONER BARB: And is that a wasteful rate on the basis of energy for that particular well?

THE WITNESS: I think it is wasteful for that particular well.

COMMISSIONER DOWNING: Any further questions? The hour is getting late and after the meeting I think the Commission ought to meet with Mr. Schwabrow and Mr. Morrell and so I ask them to meet with the Commission at a conference, not a session, and possibly the Stanolind men who are interested in Ignacio might be available.

Now, it occurs to me as one member of this Commission that you gentlemen have told us very clearly what we can't do, lots of that, and that isn't what I am personally interested in. And yet you have told us this, at least one witness has, that under proper management which can only come through unitization you might recover ultimately 50 per cent of the oil in place as against 20, and that was a very conservative estimate. It does seem to me there is room here for improvement and it seems to me that this hearing therefore ought not to be closed. For my part there is an awful lot that I don't know that I would like to learn a little more about. Some of my associate members of the Commission probably know all about it without any further hearing, but it's my suggestion that we continue the hearing, keep it alive and we may have a number of questions we may want to ask one or more of you. We might even want to ask you to come back for a further hearing.

I would say, Mr. Attorney General, shouldn't we recess now to keep the effect of our notice and perhaps we ought to adjourn to a certain date.

MR. SARGENT: I don't think it makes any difference. I think you can continue this hearing and preserve your jurisdiction without additional publication of notice.

COMMISSIONER DOWNING: Yes, that is what we want to do.

MR. SARGENT: I don't think it makes any difference if you set the date or continue it to be set.

COMMISSIONER DOWNING: Subject to call?

MR. SARGENT: I think it's the convenience of the group.

COMMISSIONER DOWNING: I think probably it would be better subject to call in which event we would undertake to notify those who have entered their appearances in the matter or who may wish to receive notice.

MR. SARGENT: Mr. Downing, I think it would be better if you continue it to a specific date personally. Of course, you don't know about the availability of the hearing room.

COMMISSIONER DOWNING: I don't know that we may want to ask any more questions, but it may be. It would give us an opportunity to present something in addition. We are going to meet on the 29th on Rules and schedule a

meeting on the 6th. What would you suggest, can we adjourn to one of those dates? I would suggest the 29th because most of the parties would want to be present here on that day anyway in connection with the general rules.

All right, the Commission decides that this meeting will be adjourned until the 29th at 10:00 o'clock a.m. at 704 Capitol Annex Building.

(Whereupon the hearing was adjourned until November 29, 1951.)

STATE OF COLORADO,)
) ss.
City and County of Denver,)

I, Donald E. Weimer, do hereby certify that I am a Notary Public of the State of Colorado, am a Certified Shorthand Reporter of the State of Colorado holding Certificate No. 85, am the duly appointed reporter of the Oil and Gas Conservation Commission of the State of Colorado to take the record of the proceedings in Cause No. 2, that I took in shorthand the testimony of the witnesses aforesaid and transcribed the same from my notes into longhand, and declare it to be a true and correct transcript of the testimony of said witnesses.

Dated at Denver, Colorado, this 30th day of November, 1951.

Donald E. Weimer
Reporter.