STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

OIL CONSERVATION DIVISION
P. O. Box 2088
SANTA FE, NEW MEXICO
87501

ADMINISTRATIVE ORDER
NFL 113

INFILL DRILLING FINDINGS AND WELL-SPACING WAIVER
MADE PURSUANT TO SECTION 271.305(b) OF THE
FEDERAL ENERGY REGULATORY COMMISSION REGULATIONS,
NATURAL GAS POLICY ACT OF 1978 AND OIL CONSERVATION DIVISION
ORDER NO. R-6013

I.

Operator ARCO OIL & GAS COMPANY Well Name and No. Seven Rivers Queen Unit Well #61

Location: Unit F Sec. 34 Twp. 22S Rng. 36E Cty. Lea

II.

THE DIVISION FINDS:

(1) That Section 271.305(b) of the Federal Energy Regulatory Commission Interim Regulations promulgated pursuant to the Natural Gas Policy Act of 1978 provides that, in order for an infill well to qualify as a new onshore production well under Section 103 of said Act, the Division must find, prior to the commencement of drilling, that the well is necessary to effectively and efficiently drain a portion of the reservoir covered by the proration unit which cannot be so drained by any existing well within that unit, and must grant a waiver of existing well-spacing requirements.

(2) That by Order No. R-6013, dated June 7, 1979, the Division established an administrative procedure whereby the Division Director and the Division Examiners are empowered to act for the Division and find that an infill well is necessary.

(3) That the well for which a finding is sought is to be completed in the South Eunice Seven Rivers Queen Pool, and the standard spacing unit in said pool is 40 acres.

(4) That a 40 -acre proration unit comprising the SE/4 NW/4 of Sec. 34, Twp. 22S, Rng. 36 E, is currently dedicated to the applicant's Seven Rivers Queen Unit Well No. 24 located in Unit F of said section.

(5) That this proration unit is (X) standard ( ) nonstandard; if nonstandard, said unit was previously approved by Order No. NA.

(6) That said proration unit is not being effectively and efficiently drained by the existing well(s) on the unit.

(7) That the drilling and completion of the well for which a finding is sought should result in the production of an additional 79,500 MCF of gas from the proration unit which would not otherwise be recovered.

(8) That all the requirements of Order No. R-6013 have been complied with, and that the well for which a finding is sought is necessary to effectively and efficiently drain a portion of the reservoir covered by said proration unit which cannot be so drained by any existing well within the unit.

(9) That in order to permit effective and efficient drainage of said proration unit, the subject application should be approved as an exception to the standard well spacing requirements for the pool.

IT IS THEREFORE ORDERED:

(1) That the applicant is hereby authorized to drill the well described in Section I above as an infill well on the existing proration unit described in Section II(4) above. The authorization for infill drilling granted by this order is an exception to applicable well spacing requirements and is necessary to permit the drainage of a portion of the reservoir covered by said proration unit which cannot be effectively and efficiently drained by any existing well thereon.

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

DONE at Santa Fe, New Mexico, on this 28th day of January, 19 86.

Michael A. Stogner

DIVISION DIRECTOR ___ EXAMINER ✓

cc: OCD Hobbs
NMO&GEC HOBBS

Rec. 7/27/84
Release Immediately

OIL CONSERVATION DIVISION
P. O. Box 2088
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87501

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

ADMINISTRATIVE ORDER
NFL 113

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MADE PURSUANT TO SECTION 271.305(b) OF THE
FEDERAL ENERGY REGULATORY COMMISSION REGULATIONS,
NATURAL GAS POLICY ACT OF 1978 AND OIL CONSERVATION DIVISION
ORDER NO. R-6013

I.

Operator ARCO Oil & Gas Company Well Name and No. Seven Rivers Queen Unit Well No. 61

Location: Unit F Sec. 34 Twp. 22 South Rng. 36 East Cty. Lea

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(8) That all the requirements of Order No. R-6013 have been complied with, and that the well for which a finding is sought is necessary to effectively and efficiently drain a portion of the reservoir covered by said proration unit which cannot be so drained by any existing well within the unit.

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

DONE at Santa Fe, New Mexico, on this _____ day of _____, 19_____.

cc. OCD Hobbs
NMOGEC Hobbs

DIVISION DIRECTOR ___ EXAMINER ___

OIL CONSERVATION COMMISSION

STATE OF NEW MEXICO
P. O. BOX 2088 - SANTA FE
87501

GOVERNOR
BRUCE KING
CHAIRMAN

LAND COMMISSIONER
ALEX J. ARMIJO
MEMBER

STATE GEOLOGIST
A. L. PORTER, JR.
SECRETARY – DIRECTOR

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

July 19, 1984

New Mexico Oil Conservation Division
P. O. Box 2088
Santa Fe, New Mexico 87501

Dear Sirs:

ARCO Oil and Gas Company (AOGC) respectfully requests the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61 in the Seven Rivers-Queen Unit (SRQU). AOGC also requests that the infill finding apply to future wells drilled in the SRQU.

Infill drilling is necessary to promote efficient and effective drainage of the South Eunice and Langlie Mattix Pools. The development drilling will result in increased recovery and prevention of waste caused by oil trapped in discontinuities between wells on the present 40-acre spacing. In addition, infill drilling will reduce effects of a steep structural dip which causes a decrease in correlative pay between wells.

Documentation to support these claims is found in the attached engineering discussion. Additional information necessary to the infill finding application is also included. Copies of this application and a request for a waiver of protest have been furnished the offset operators by registered mail. A copy of the letter sent to the offset operators is included in this package. Should any questions arise, please do not hesitate to call me at (915) 684-0149. We will be happy to assist you with any concerns you may have. Your early consideration in this matter would certainly be appreciated.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

ENGINEERING DISCUSSION OF IMPROVEMENT IN RECOVERY

FROM THE SEVEN RIVERS-QUEEN UNIT

Seven Rivers-Queen Unit Wells 58, 59, 60, and 61 were recently drilled as development wells on 20-acre spacing. The wells were approved by the New Mexico Oil Conservation Division under Order Number NSL-1649. They were drilled to produce from locations within the present 40-acre spacing that are not efficiently drained throughout the unitized interval, which consists of the entire Queen formation and bottom 100' of the Seven Rivers. Evidence supporting the need for Wells 58 to 61, as well as future infill wells, follows in the discussion below.

The recovery factor of the SRQU will increase as the effects of reservoir heterogeneity and structural dip are reduced. These factors combine to reduce the correlative pay between wells; subsequently resulting in a low injection efficiency. The unit's waterflood material balance analysis and pattern performance plot (Figures 4 and 5) support the fact that injection efficiency within the unit is low. As shown in Table 1, the injection efficeincy lies between 40% and 58% when water injection values are recalculated to the center and edge of the recovery triangle. The stratification and dip which cause this low injection efficiency are illustrated in cross-sections (Figures 6 and 7) through the four infill wells, 58 through 61. These cross-sections, prepared from gamma ray-neutron porosity logs, were correlated using an 8% minimum porosity cutoff; the 8% cutoff is typical for Seven Rivers and Queen zones in the area. No pay is included above the GOR at -150' ss or below the WOC at -285' ss, both industry accepted depths. Production from the gas zone would decreased reservoir energy and reduce recoverable oil. Infill wells, however, were drilled below the WOC to determine if it is actually the start of a transition zone. Preliminary test data indicates commercial production below -285 ss is feasible. Future infill wells will complete into this zone and significantly increase reserves.

Both cross-sections confirm stratification as numerous high porosity stringers fail to correlate. The largest of the zones is the six foot stringer at 3735' in cross-section B-B'. Of the zones that do correlate, net pay may vary dramatically from well to well. For instance, the same cross-section shows the 14' pay zone at 3753' in SRQU #10 reduces to three feet in the adjacent well, SRQU #59. The cross-section A-A' reveals the ten foot pay zone of SRQU #61 diminishing to three feet in the SRQU #24. The infill well, SRQU #61, will recover much oil which otherwise would have been trapped, and also the oil's solution gas.

The effect of the GOC and WOC on net correlative pay is best seen in cross-section A-A', running through the flank of the anticline (Figure 8). The SRQU #24 shows pay zones at 3666' and 3678' rising above the GOC before reaching the SRQU #32, the closest offset on 40-acre spacing. Water-flooding this zone from adjacent injection wells SRQU #25 and #33 moves

little oil toward the producers, #24 and #32, since the oil is trapped between the water bank and the GOC. Infill drilling, as the SRQU #61 shows, reduces the amount of trapped oil by providing a drawdown to which it can flow. Oil may also become trapped between the water bank and the WOC, as seen in the zones below 3737' for SRQU #32. Because most SRQU wells never penetrated the transition zone, production cannot come from below the WOC. Infill drilling will recover much of this trapped oil and its solution gas.

Continuity curves show the effects of reduced spacing on continuous pay (Figures 10 and 11). The curves were prepared from cross-sections through the north and south halves of the unit (Figure 9). On 40-acre spacing, 75% of the oil productive pay is continuous in the north area while only 63% is continuous in the south. Reducing the spacing to 20 acres, however, increases net correlative pay to 81% and 72%, respectively. The net increase is 7.5% when figures from the north and south areas are averaged.

Seven Rivers-Queen Unit Wells 58 through 61 were drilled to reduce the effects of stratification and structural dip, thus increasing the unit's recovery factor. Wells 58, 59, 60 and 61 are expected to recover 47 to 53 MBO new reserves per well, based on OOIP and the change in recovery efficiency. Daily production figures from offsets indicate the infill wells will increase daily production from the SRQU by 200 BOPD. OOIP for each well was estimated by volumetric analysis using an average net pay of the four offsets to each well, an initial oil saturation of 68% and a porosity of 11% from core analysis data, and 1.21 RVB/STB formation volume factor from a pre-unitization study. Greater recovery efficiency will result from increased injection efficiency and net correlative pay. The change in injection efficiency is +10%, based on experience in the area. The net correlative pay increases, ranging from 6% to 10% for the four wells, is read from the continuity curves. Other variables influencing recovery efficiency are formation volume factor and displacement efficiency. The formation volume factor decreased from an original 1.21 RVB/STB to 1.04 RVB/STB at the time of unitization in 1974. Displacement efficency is the ratio of movable oil to the initial oil saturation. Example calculations for the SRQU #60 are included in Table 2. SRQU #60 shows an OOIP of 786.5 MBO on 40 acres, a change in recovery efficiency of 5.95%, and estimated new reserves of 46.7 MBO at an initial rate of 100 BOPD.

Should the entire unit be reduced to 20 acre spacing, calculations in the same manner as those above indicate ultimate recovery would increase by 5.21% (Table 3); a change based on 10% and 8% increases in injection efficiency and continuous pay, respectively. OOIP for the unit's 2240 acres is 33,302 MBO from volumetric analysis. The calculations assume a 31' net pay, slightly higher than the 28' used to obtain the primary recovery OOIP of 30, 080 MBO. The difference is due to deepening efforts

in existing wells at the time of unitization. The other factors of porosity, initial oil saturation, and formation volume factor are the same as those used in calculations for the SRQU #58.

Figure 12 discloses that reduced spacing has increased ultimate recovery in several other AOGC operated waterfloods in the Permian Basin. As seen, the SRQU can expect an increase of 8% in ultimate recovery, comparable to the 5.21% calculated increase. The lower curve of Figure 12 shows a 20% ultimate recovery on 40-acre spacing, increasing to 28% on 20-acre spacing, a difference of 8%. The 20% figure is quite consistent with the SRQU's 19.24% estimated ultimate recovery on 40-acre spacing. Table 4 shows a 9.75% recovery factor from primary production, plus a 9.49% recovery factor expected from secondary operations. The former is the ratio of production up to the time of unitization, 2932 MBO, to the OOIP for primary operations. The latter represents a ratio of anticipated recoverable reserves, determined from production and decline curve analysis, to OOIP from secondary operations. Through December, 1982 the SRQU had produced 1549 MBO since unitization. Based on a rate of 420 BOPD and an 8% annual exponential decline (Figure 3), recoverable reserves from secondary operations are estimated at 3160 MBO. A reduction in spacing has increased ultimate recovery for several other Permian Basin waterfloods, and the SRQU will follow with a similar increase.

The exhibits show a reduction in the effects of reservoir heterogeneity and structural dip is achieved through infill drilling. Four infill wells, the SRQU Numbers 58, 59, 60, and 61 have already been drilled. Expected to increase production from the unit by 200 BOPD, the four wells initialled an average 171 BOPD. Similar increases are expected from future infill wells drilled in strategic locations. Drilling will result in more efficient and effective drainage of the SRQU of both oil and solution gas reserves.

David C. Brucker

D. C. Brucker
Engineer

DCB:dmm

PERMIAN DISTRICT – WEST AREA

LOCATION MAP

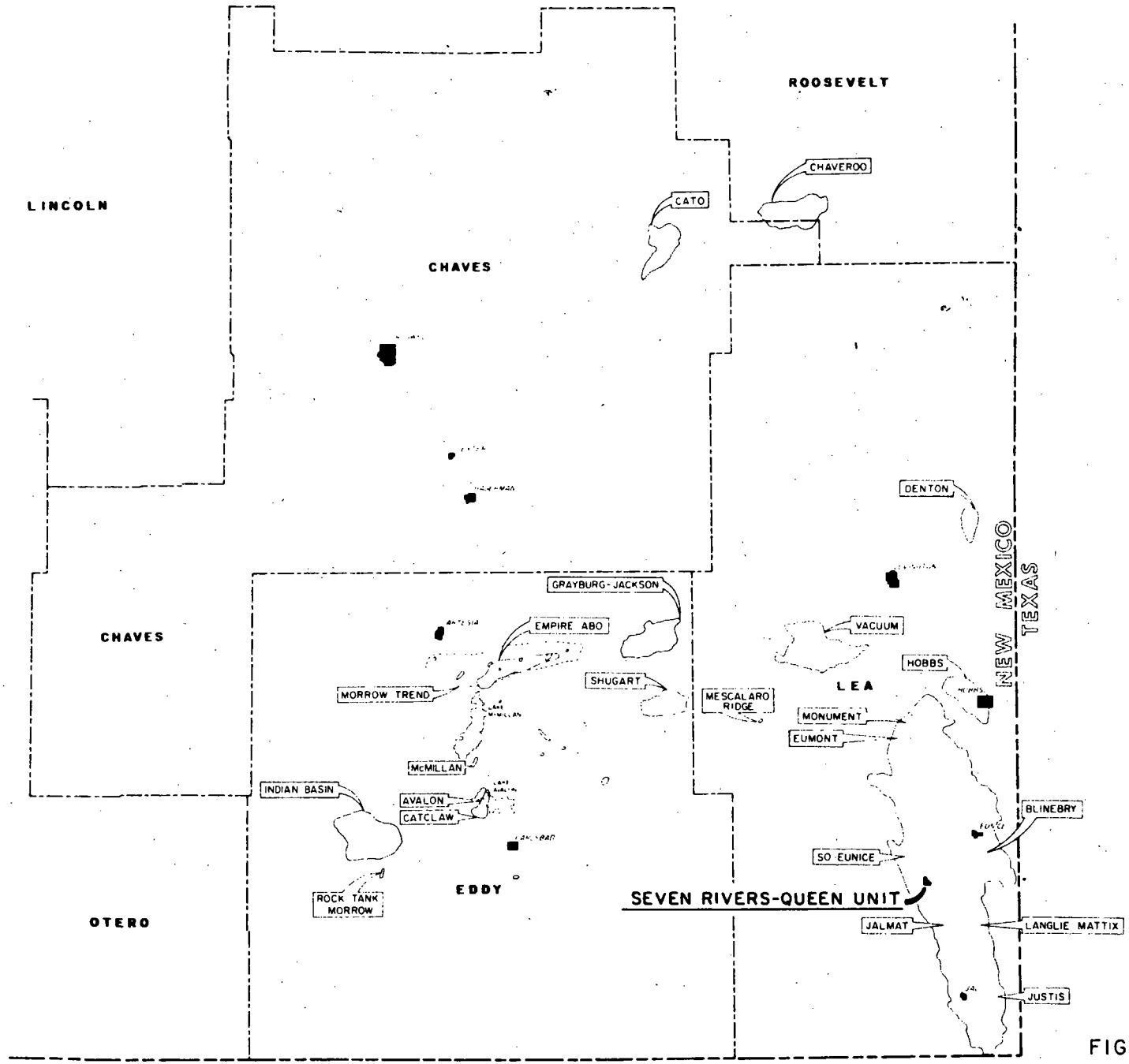
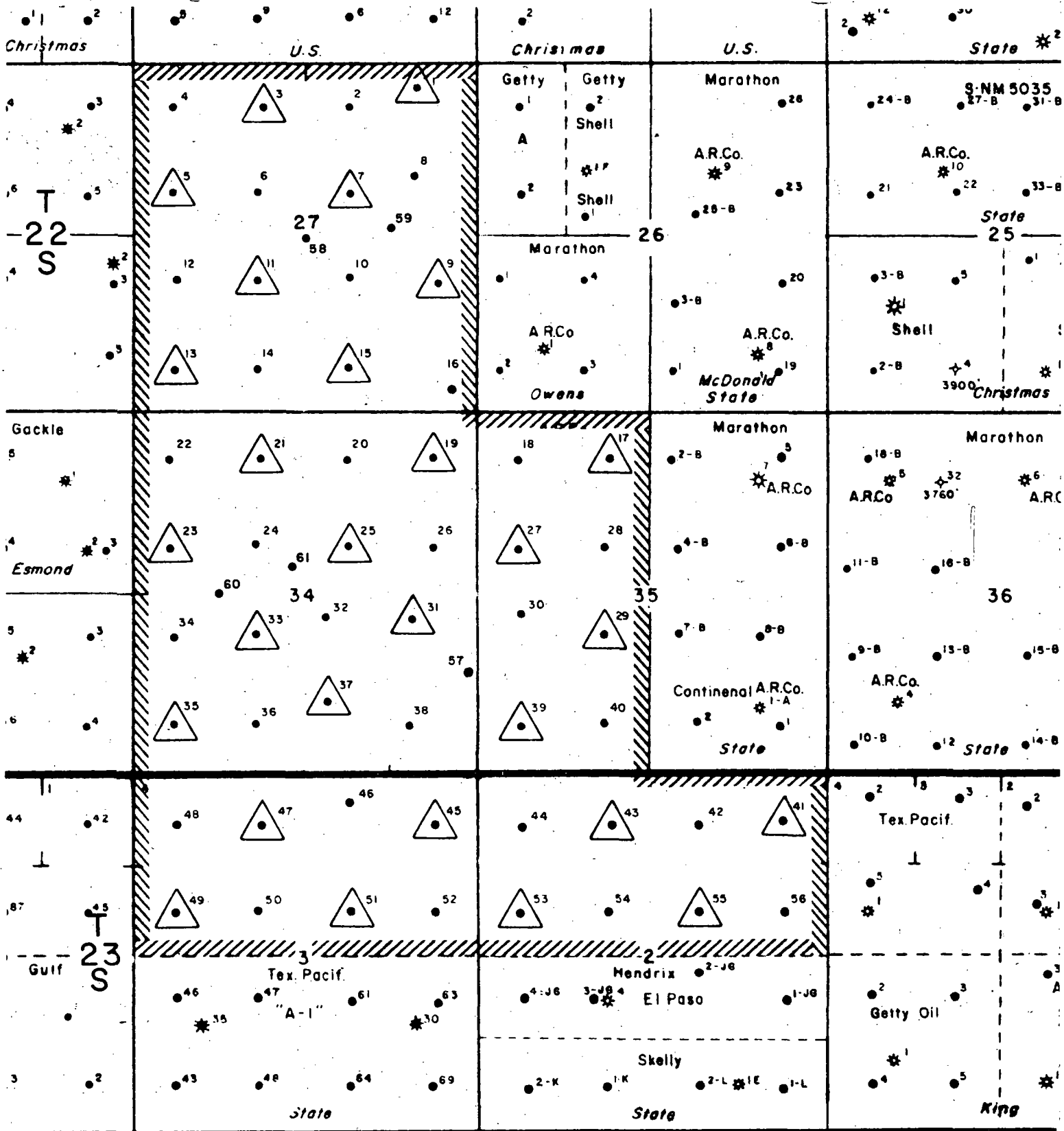


FIGURE 1



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UNIT BOUNDARY

ARCO Oil and Gas Company
Division of AtlanticRichfieldCompany
Permian District Midland, Texas

SEVEN RIVERS-QUEEN UNIT

LEA COUNTY, NEW MEXICO

UNIT MAP

Figure 2

SCALE: 1" = 2000'

By: D. BRUCKER		Drawn By:	Date: 5 - 83
Date: 5 - 83		Revised By:	Date:
Dept.: WEST AREA ENGR.		Dwg No.:	

AtlanticRichfieldCompany ◆ **Waterflood Material Balance Analysis**

Field: South Eunice-Langlie Mattix

Reservoir: Seven Rivers-Queen

Element area: 2240 Acres

Average thickness: 31 Feet

Date start of injection: 3/74

Cumulative production at start of injection

Oil (N_p) =	2,932	MSTB
Gas (G_p) = Avg. GOR = 1500	4,398	MMCF
Water (W_p) = Avg. WOR = .7	2,052	MBbls

Rock and fluid data

ϕ = .11	S_{cw} = .32
B_{ox} = 1.04	S_{or} = .32
B_{oi} = 1.21	

Map: SEE TABLE 2 (N)

Pattern volumetric data

$V_p = 7758 \times \phi \times h \times \text{Area} = 7758 \times .11 \times 31 \times 2240 = 59{,}259\ \text{M}$ RVB

$V_D = V_p \times (1.0 - S_{cw} - S_{or}) = 59{,}259 \times (1.0 - .32 - .32) = 21{,}333\ \text{M}$ RVB

$$\text{O.O.I.P.} = \frac{V_p \times (1.0 - S_{cw})}{B_{oi}} = \frac{59{,}259 \times (1.0 - .32)}{1.21} = 33{,}302\ \text{M}\ \text{STB}$$

$$S_{gx} = S_{oi}\left[1.0 - \frac{B_{ox}}{B_{oi}}(1 - f)\right] = .68\left[1.0 - \frac{1.04}{1.21}(1 - .0880)\right] = .1470$$

$V_{fillup} = V_p \times S_{gx} = 59{,}259 \times .1470 = 8709$ RVB

$$\text{Disp. eff.}\ (E_D) = \frac{S_{oi} - S_{or}}{S_{oi}} = \frac{.68 - .32}{.68} = .5294$$

$$\text{ABAR} = \frac{S_{gx}}{1.0 - S_{cw} - S_{or}} = \frac{.1470}{.36} = .4083$$

AR3B-2668-A

FIGURE 4

Analysis start time is start of injection.

Oil production at start of injection, Np = _____ MSTB

Time interval ending	Cumulative Oil production	Total cumulative Recovery	Cumulative water injection	Cumulative water Production	Conformance	Percent fillup	Displaceable Volume Injected	Water bank Radius
	ΔN_p	$\frac{\Delta N_p + N_p}{OOIP}$	W_i	ΔW_p	$\frac{W_i - \Delta W_p}{V_D}$	$\frac{W_i - (\Delta N_p + \Delta W_p)}{V_{Fillup}}$	$\frac{W_i}{V_D}$	r
	MSTB	Fraction	MBbls	MBbls	Fraction	Percent	Fraction	Feet

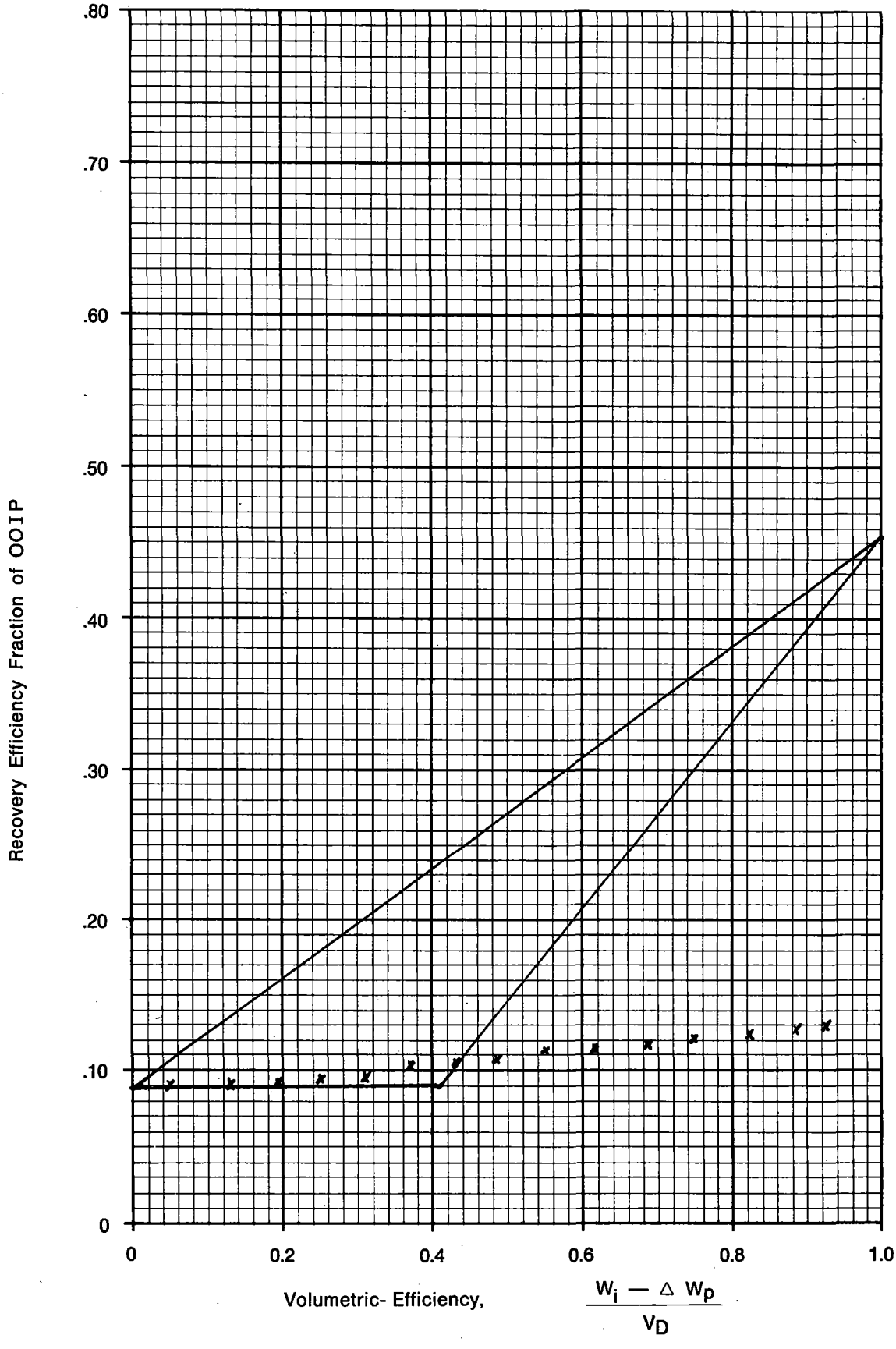
Analysis start time is start of injection.

Oil production at start of injection, Np = _____ MSTB

Time interval ending	Cumulative Oil production	Total cumulative Recovery	Cumulative water injection	Cumulative water Production	Conformance	Percent fillup	Displaceable Volume Injected	Water bank Radius
	ΔN_p	$\frac{\Delta N_p + N_p}{OOIP}$	W_I	ΔW_p	$\frac{W_I - \Delta W_p}{V_D}$	$\frac{W_I - (\Delta N_p + \Delta W_p)}{V_{Fillup}}$	$\frac{W_I}{V_D}$	r
	MSTB	Fraction	MBbls	MBbls	Fraction	Percent	Fraction	Feet

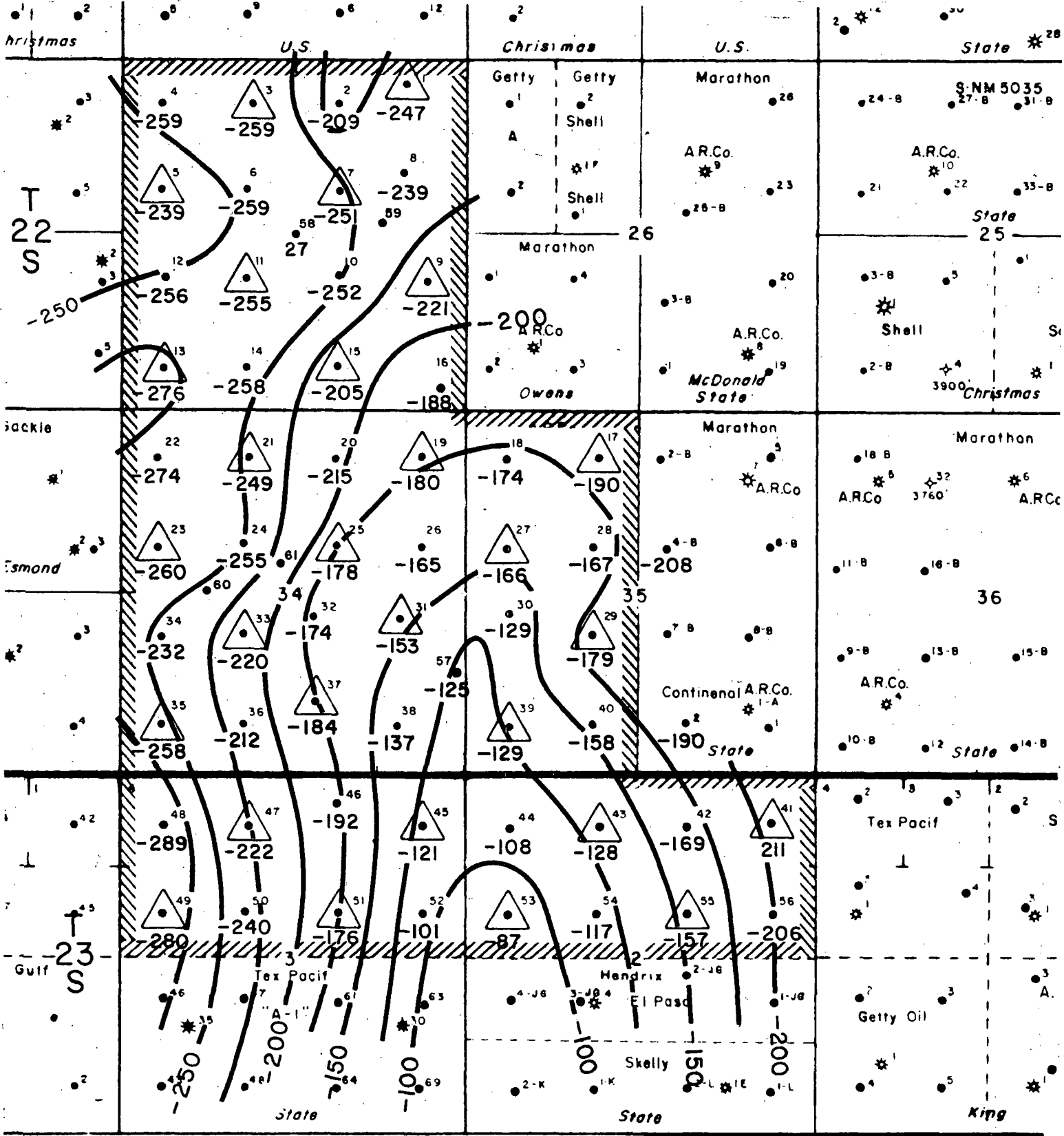
AtlanticRichfieldCompany ◆ **Pattern Performance**

F at start of flood	ABAR	F at $E_v = 1.0$ $F = 1.0 - \frac{B_{oi}}{B_{ox}}(1.0 - E_D) =$	Pattern No.
.088	.4083	$1 - \frac{1.21}{1.04}(1 - .5294) = .4525$	Unit



AR3B-2669-A

FIGURE 5



ARCO Oil and Gas Company

Division of AtlanticRichfieldCompany

Permian District Midland, Texas

SEVEN RIVERS-QUEEN UNIT

LEA COUNTY, NEW MEXICO

STRUCTURE MAP

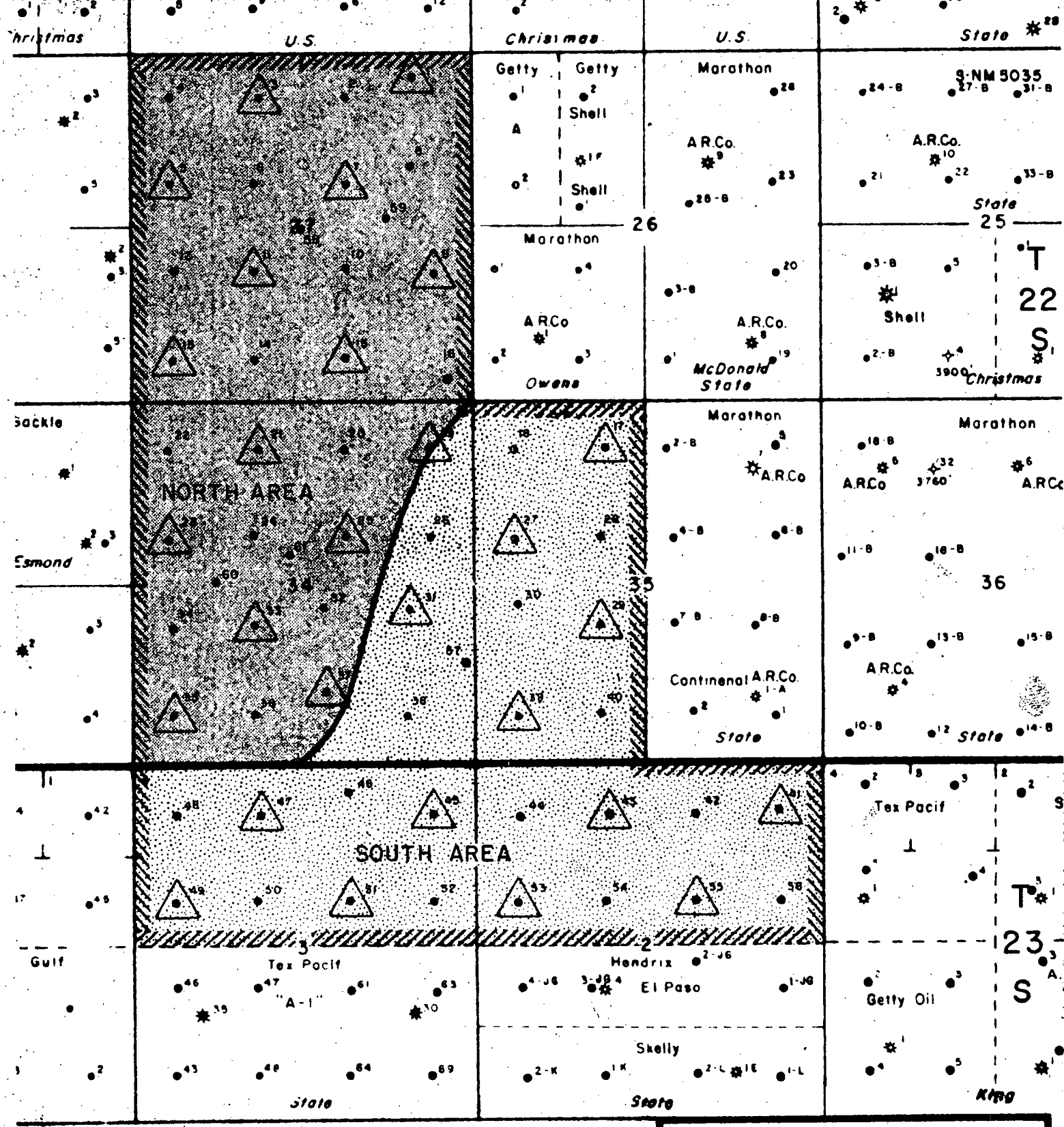
TOP OF QUEEN

C.I. = 25'

Figure 8

SCALE: 1" = 2000'

By: D. BRUCKER		Drawn By:	Date: 5 - 83
Date: 5 - 83		Revised By:	Date:
Dept.: WEST AREA ENGR.		Dwg No.:	



ARCO Oil and Gas Company
Division of Atlantic Richfield Company
Permian District Midland, Texas

SEVEN RIVERS-QUEEN UNIT

LEA COUNTY, NEW MEXICO

NORTH AND SOUTH AREAS

Figure 9

SCALE: 1" = 2000'

By: D. BRUCKER		Drawn By:	Date: 5 - 83
Date: 5 - 83		Revised By: BS	Date:
Dept: WEST AREA ENGR.		Dwg No:	

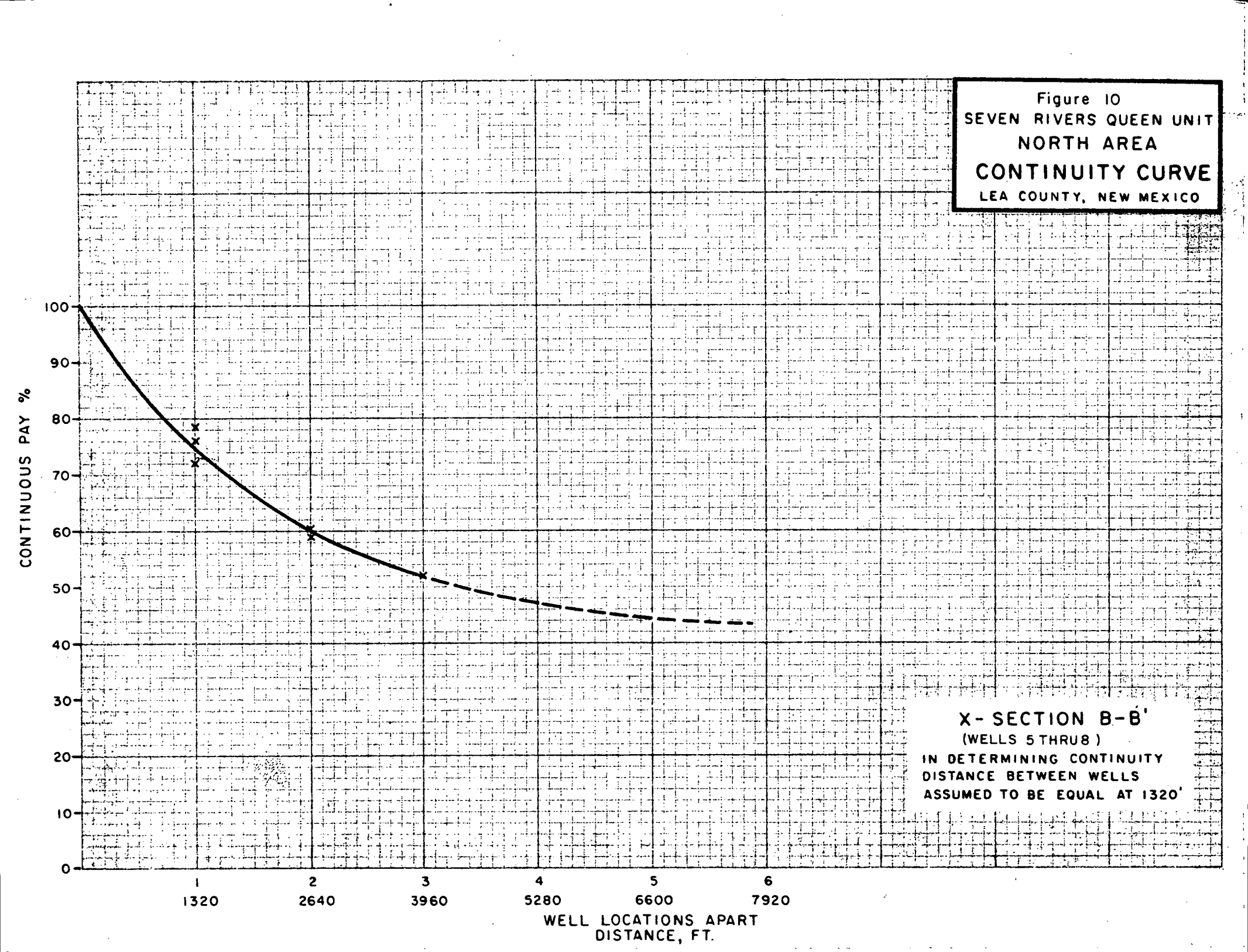


Figure 10
SEVEN RIVERS QUEEN UNIT
NORTH AREA
CONTINUITY CURVE
LEA COUNTY, NEW MEXICO
CONTINUOUS PAY %
100
90
80
70
60
50
40
30
20
10
0
1
1320
2
2640
3
3960
4
5280
5
6600
6
7920
WELL LOCATIONS APART
DISTANCE, FT.
X-SECTION B-B'
(WELLS 5 THRU 8)
IN DETERMINING CONTINUITY
DISTANCE BETWEEN WELLS
ASSUMED TO BE EQUAL AT 1320'

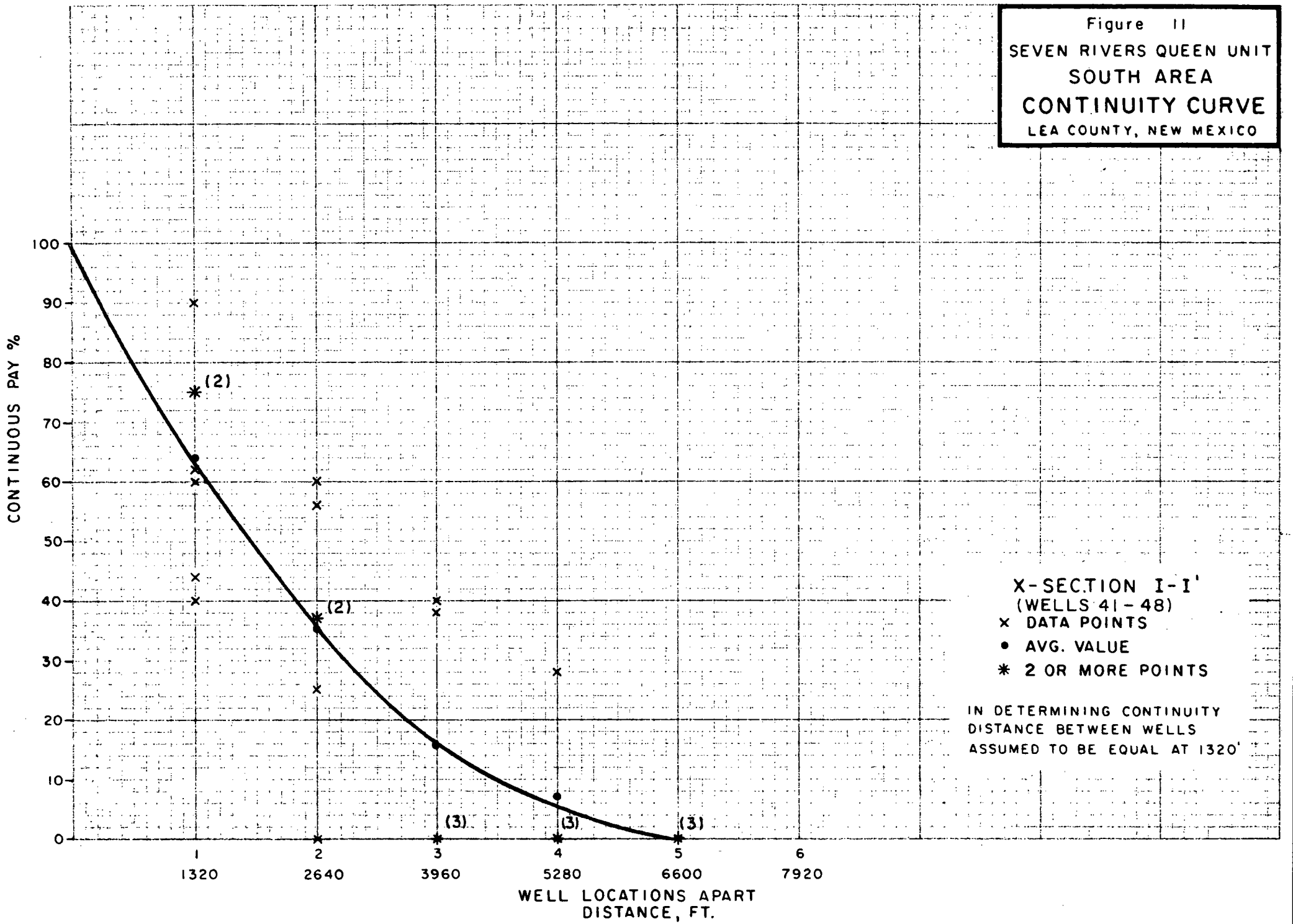
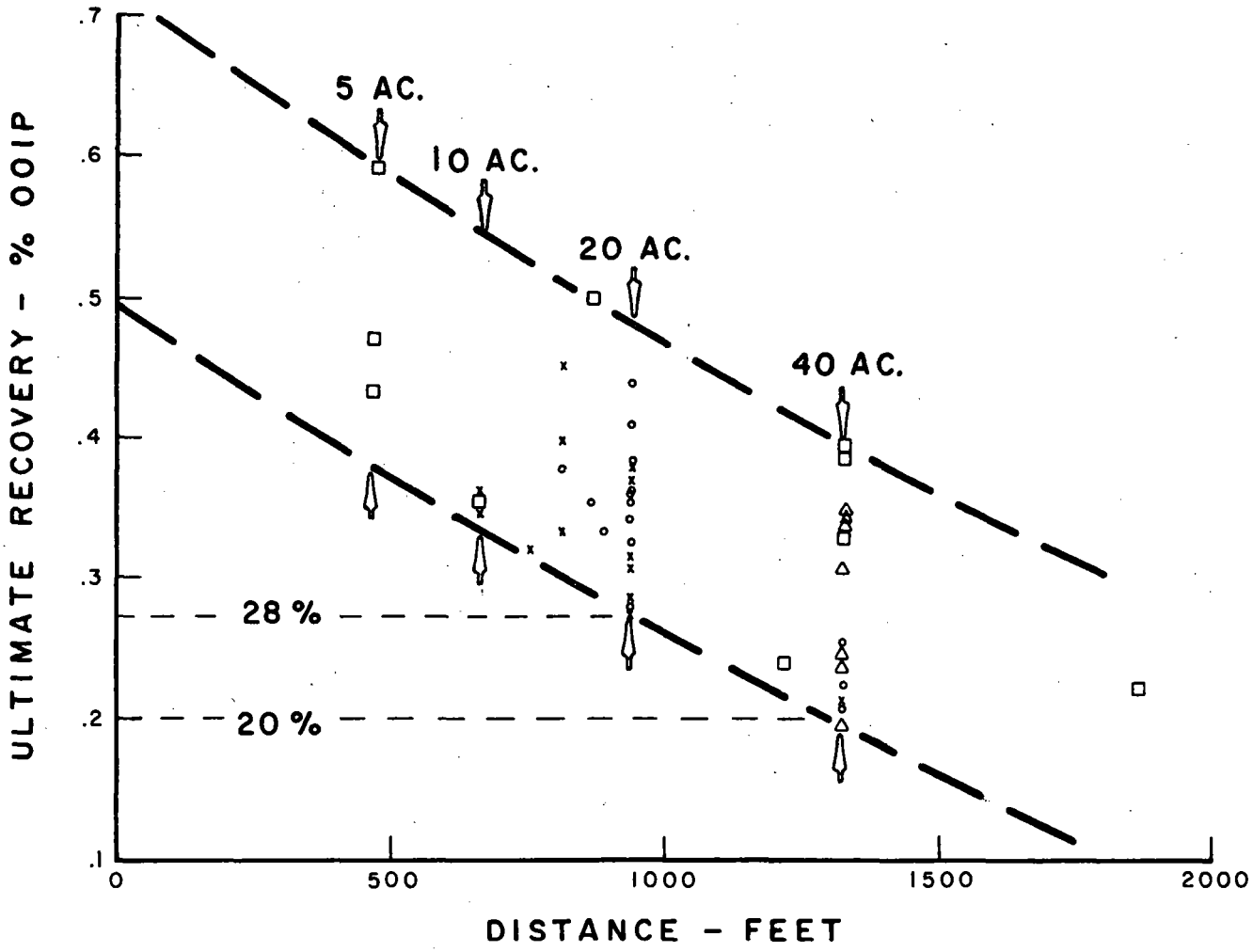


Figure 11
SEVEN RIVERS QUEEN UNIT
SOUTH AREA
CONTINUITY CURVE
LEA COUNTY, NEW MEXICO
CONTINUOUS PAY %
100
90
80
70
60
50
40
30
20
10
0
(2)
(2)
(3)
(3)
(3)
1
1320
2
2640
3
3960
4
5280
5
6600
6
7920
WELL LOCATIONS APART
DISTANCE, FT.
X-SECTION I-I'
(WELLS 41-48)
× DATA POINTS
• AVG. VALUE
* 2 OR MORE POINTS
IN DETERMINING CONTINUITY
DISTANCE BETWEEN WELLS
ASSUMED TO BE EQUAL AT 1320'

ULTIMATE RECOVERY AS A FUNCTION OF SPACING



L E G E N D

- o N. PERMIAN PROJECTS
- x S. PERMIAN PROJECTS
- △ W. PERMIAN PROJECTS
- □ MID-CONTINENT PROJECTS

Figure 12

TABLE 1

INJECTION EFFICIENCY CALCULATION

FROM PATTERN PERFORMANCE PLOT

TO REACH OUTSIDE LINE OF TRIANGLE

$E_V = .48$

$$\frac{Wi - Wp}{V_D} = .48$$

$$Wi = .48\ V_D + Wp$$

$$Wi = 12{,}435.1 \text{ MBW}$$

$$\text{INJECTION EFFICIENCY} = \frac{12{,}435.1}{22{,}114.1} = \underline{\underline{58\%}}$$

TO REACH CENTER OF TRIANGLE

$E_V = .30$

$$Wi = .30\ V_D + Wp$$

$$Wi = 8{,}595.1 \text{ MBW}$$

$$\text{INJECTION EFFICIENCY} = \frac{8{,}595.1}{22{,}114.1} = \underline{\underline{40\%}}$$

TABLE 2

SRQU NO. 60
INCREASED RECOVERY DUE
TO INFILL DRILLING

Avg. Pay of 4 Surrounding Wells

Well	Net Pay Logged	Estimated Add. Pay	Total Net Pay
No. 23	25+	8'	33'
No. 24	40+	12'	42'
No. 33	28+	19'	47'
No. 34	42	-	42'
Total	135+		164'
Avg.	33.75		41'

Additional pay was estimated by correlating logs to nearest offsets which penetrated the formations below the logged TD's of the shallow wells.

From Avg. of North and South Area

Continuity Curves

% Continuous pay - 40 acre spacing (1320')	69.5%
% Continuous pay - 20 acre spacing (933')	77.0%

From Relative Permeability Data

Soi = 68% Sor = 32%

$$E_D = \frac{Soi-Sor}{Soi} = \frac{.68-.32}{.68} = .5294$$

From Cores on SRQU Nos. 41, 53, and 57

Avg. ϕ = 11%

From "Proposed Seven-Rivers Queen Unit Waterflood Study"

Boi = 1.21 RVB/STB Box = 1.04 RVB/STB

$$OOIP_{40\ acres} = \frac{(7758)(40)(41)(.11)(.68)}{1.21}$$

= 786.5 MBO

TABLE 2 (Cont.)

Primary Recovery From Pattern

Well	Primary Recovery BO	Allocation Factor	Allocated Production BO
No. 23	49,115	.25	12,279
No. 24	71,993	.25	17,998
No. 33	64,360	.25	16,090
No. 34	74,783	.25	18,696
Total	260,251		65,063

From the Waterflood Material Balance Analysis this pattern currently has an injection efficiency of 68%, assuming a 10% increase in injection efficiency through infill drilling yields,

$$\Delta E_R = \frac{Boi}{Box} E_D [(Ev_2-Ev_1)f_1 + (Ev_2-\bar{A})(f_2-f_1)]$$

$$= (\frac{1.21}{1.04})(.5294)](.78-.68)(.695) + (.78-.3997)(.77-.695)]$$

$$= .0595$$

$$\Delta E_R = (.0595)(786.5) = \underline{46.7} \text{ MBO}$$

Where:

Soi = initial oil saturation
Sor = residual oil saturation to waterflood
Sgx = gas saturation at start of flood
E_D = displacement efficiency
Ev = volumetric efficiency
$\bar{A}$ = displaceable pore volume occupied by gas
f = floodable pay
1 = before infill drilling
2 = after infill drilling

TABLE 2 (CONT.)

AtlanticRichfieldCompany ◆ **Waterflood Material Balance Analysis**

Field: South Eunice - Langlie Mattix

Reservoir: Seven-Rivers Queen

Element area: 40 Acres

Average thickness: 41 Feet

Date start of injection: 3/74

Cumulative production at start of injection

Oil (N_p) = 65 MSTB

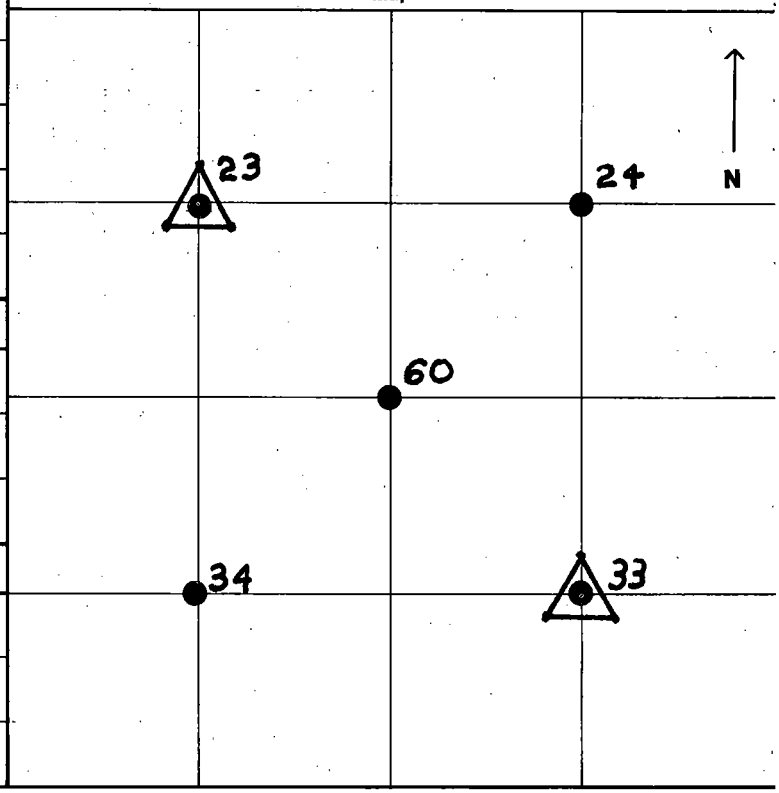
Gas (G_p) = Avg. GOR 1500 97.5 MMCF

Water (W_p) = Avg. WOR .70 45.5 MBbls

Rock and fluid data

ϕ = .11	S_{cw} = 32%
B_{ox} = 1.04	S_{or} = 32%
B_{oi} = 1.21	

Map



Pattern volumetric data

V_p = 7758 x Ø x h x Area = 7758 x .11 x 41 x 40 = 1399.5 M RVB

$V_D = V_p \times (1.0 - S_{cw} - S_{or})$ = 1399.5 x (1.0 − .32 − .32) = 503.8 M RVB

$$\text{O.O.I.P.} = \frac{V_p \times (1.0 - S_{cw})}{B_{oi}} = \frac{1399.5 \times (1.0 - .32)}{1.21} = 786.5 \text{ M STB}$$

$$S_{gx} = S_{oi}\left[1.0 - \frac{B_{ox}}{B_{oi}}(1 - f)\right] = .68\left[1.0 - \frac{1.04}{1.21}(1 - .0827)\right] = .1439$$

$V_{fillup} = V_p \times S_{gx}$ = 1399.5 x .1439 = 201 M RVB

$$\text{Disp. eff.}(E_D) = \frac{S_{oi} - S_{or}}{S_{oi}} = \frac{.68 - .32}{.68} = .5294$$

$$\text{ABAR} = \frac{S_{gx}}{1.0 - S_{cw} - S_{or}} = \frac{.1439}{.36} = .3997$$

Analysis start time is start of injection.

Oil production at start of injection, Np = _____ MSTB

Time interval ending	Cumulative Oil production	Total cumulative Recovery	Cumulative water Injection	Cumulative water Production	Conformance	Percent fillup	Displaceable Volume Injected	Water bank Radius
	ΔN_p	$\frac{\Delta N_p + N_p}{OOIP}$	W_i	ΔW_p	$\frac{W_i - \Delta W_p}{V_D}$	$\frac{W_i - (\Delta N_p + \Delta W_p)}{V_{Fillup}}$	$\frac{W_i}{V_D}$	r
	MSTB	Fraction	MBbls	MBbls	Fraction	Percent	Fraction	Feet

Analysis start time is start of injection.

Oil production at start of injection, N_p = _____ MSTB

Time interval ending	Cumulative Oil production	Total cumulative Recovery	Cumulative water injection	Cumulative water Production	Conformance	Percent fillup	Displaceable Volume Injected	Water bank Radius
	ΔN_p	$\frac{\Delta N_p + N_p}{OOIP}$	W_i	ΔW_p	$\frac{W_i - \Delta W_p}{V_D}$	$\frac{W_i - (\Delta N_p + \Delta W_p)}{V_{Fillup}}$	$\frac{W_i}{V_D}$	r
	MSTB	Fraction	MBbls	MBbls	Fraction	Percent	Fraction	Feet

TABLE 3

Data:

B_{oi} = 1.21 RVB/STB
B_{ox} = 1.04 RVB/STB
EV_1 = 50%
EV_2 = 60%
f_1 = 69%
f_2 = 76.5%

$\bar{A}$ = .4083
E_D = .5294
ϕ = 11%
Scw = 32%
Sor = 32%
Informational sources same as Table 2

$$\Delta E_R = \frac{B_{oi}}{B_{ox}} E_D[(EV_2-EV_1)f_1 + (EV_2-\bar{A})(f_2-f_1)]$$

$$= (\frac{1.21}{1.04})(.5294)[(.60-.50)(.69) + (.60-.4083)(.765-.69)]$$

$$= .0521$$

$$= 5.21\%$$

TABLE 4

Data:

Q_i = 420 BOPD
Q_a = 52 BOPD
R = 8%
Np_1 = 2932 MSTBO (primary cumulative production)
Np_2 = 3086 MSTBO (estimated cumulative production under secondary recovery)
A = 2240 acres
h_1^* = 28 feet
h_1^* = 31 feet
Ø = 11%
Scw = 32%
Boi = 1.21 RVB/STB
Informational sources same as Table 2
*h_1 is the average net pay during primary production.
h_2 is the average net pay during secondary operations. The increase is due to workovers at the time of unitization.

$$OOIP = \frac{7758\ A\ h\ \emptyset\ (1-Swc)}{Boi}$$

Primary Production:

$$OOIP = \frac{(7758)(2240)(28)(.11)(1-.32)}{1.21}$$

= 30,080 MBO

$$\text{Recovery Factor} = \frac{2932}{30,080}$$

= 9.75%

Secondary Production:

Exponential Decline:

$$N = \frac{(Q_i-Q_a)\ 365}{-\ln\ (1-R)} = \frac{(420-52)(365)}{-\ln\ (1-.08)}$$

= 1611 MBO

Secondary production through December, 1982 = 1549 MBO

Secondary production = 1549 + 1611

= 3160 MBO

$$OOIP = \frac{(7758)(2240)(31)(.11)(1-.32)}{1.21}$$

= 33,302 MBO

$$\text{Recovery Factor} = \frac{3160}{33,302}$$

= 9.49%

Ultimate Recovery = 9.75% + 9.49%
= 19.24%

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

July 19, 1984

Offset Operators
Infill Wells Nos. 58, 59, 60, and 61
ARCO's Seven Rivers Queen Unit
Sections 27 and 34, T22S, R36E
Lea County, New Mexico

Gentlemen:

Waiver of Objection
Infill Finding

ARCO Oil and Gas Company hereby notifies you as offset operator to our Seven-Rivers Queen Unit that we have requested the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61, as well as future infill wells, in said unit. If you have no objection to the request, please sign this waiver of protest. Send one copy to the NMOCD, one copy to ARCO, and retain one for your files. Stamped, self-addressed envelopes are enclosed for your convenience. Should any questions arise, please contact me at (915) 684-0149.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

I waive protest to ARCO's application for an infill finding for their Seven-Rivers Queen Unit Wells Nos. 58, 59, 60 and 61.

Name: _____

Title: _____

Company: _____

Date: _____

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

July 19, 1984

New Mexico Oil Conservation Division
P. O. Box 2088
Santa Fe, New Mexico 87501

Dear Sirs:

ARCO Oil and Gas Company (AOGC) respectfully requests the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61 in the Seven Rivers-Queen Unit (SRQU). AOGC also requests that the infill finding apply to future wells drilled in the SRQU.

Infill drilling is necessary to promote efficient and effective drainage of the South Eunice and Langlie Mattix Pools. The development drilling will result in increased recovery and prevention of waste caused by oil trapped in discontinuities between wells on the present 40-acre spacing. In addition, infill drilling will reduce effects of a steep structural dip which causes a decrease in correlative pay between wells.

Documentation to support these claims is found in the attached engineering discussion. Additional information necessary to the infill finding application is also included. Copies of this application and a request for a waiver of protest have been furnished the offset operators by registered mail. A copy of the letter sent to the offset operators is included in this package. Should any questions arise, please do not hesitate to call me at (915) 684-0149. We will be happy to assist you with any concerns you may have. Your early consideration in this matter would certainly be appreciated.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

OFFSET OPERATORS
ARCO's Seven-Rivers Queen Unit
Infill Wells Nos. 58, 59, 60 and 61

Conoco, Inc.
P. O. Box 460
Hobbs, New Mexico 88240

Marathon
P. O. Box 552
Midland, Texas 79702

El Paso Natural Gas Company
One Petroleum Center
Midland, Texas 79701

Getty Oil Company
Two Midland National Center
Midland, Texas 79702

Sun Oil Company
P. O. Box 1861
Midland, Texas 79702

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

TONEY ANAYA
GOVERNOR

POST OFFICE BOX 2088
STATE LAND OFFICE BUILDING
SANTA FE, NEW MEXICO 87501
(505) 827-5800

August 6, 1984

ARCO Oil and Gas Company
P. O. Box 1610
Midland, Texas 79702

Attention: Joe R. Hastings
District Engineer

Re: Infill Finding Request
Seven Rivers Queen Unit
Wells Nos. 58, 59, 60,
and 61 and for Any
Subsequent Well Drilled
on an Existing Proration
Unit in the Seven Rivers
Queen Unit

Dear Mr. Hastings:

Per your letter dated July 19, 1984, concerning the subject Infill Well Findings, this application is being set for the Examiner Hearing to be held on September 5, 1984. This is being done to accommodate the second part of your request and because it is impossible to obtain an Infill Well Finding administratively for a non-existing well (see RULE 2 of Division Order No. R-6013-A).

If you have any questions concerning this matter, you may contact me.

Sincerely,

MICHAEL E. STOGNER
Petroleum Engineer

MES/fd

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

	Date	Noted	Dist.
Div. Manager			
Asst. Div. Mgr.			
Div. Adm. Mgr.			
Div. Engr.			
Drlg. Supt.			
Sys. Supv.			
Cons'v. Coord.			1
Training Coord.			
Adm. Supv.-APM			
Adm. Supv.-S&S			
Sup. Prod. Eng.			
Sup. Resv. Eng.			
Prod. Supt. - H-I			
Prod. Supt. - H-II			
Prod. Supt. - F			

July 19, 1984

Offset Operators
Infill Wells Nos. 58, 59, 60, and 61
ARCO's Seven Rivers Queen Unit
Sections 27 and 34, T22S, R36E
Lea County, New Mexico

Gentlemen:

Waiver of Objection
Infill Finding

ARCO Oil and Gas Company hereby notifies you as offset operator to our Seven-Rivers Queen Unit that we have requested the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61, as well as future infill wells, in said unit. If you have no objection to the request, please sign this waiver of protest. Send one copy to the NMOCD, one copy to ARCO, and retain one for your files. Stamped, self-addressed envelopes are enclosed for your convenience. Should any questions arise, please contact me at (915) 684-0149.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

I waive protest to ARCO's application for an infill finding for their Seven-Rivers Queen Unit Wells Nos. 58, 59, 60 and 61.

Name: David L. Wacker

Title: Acting Division Manager

Company: Conoco Inc.

Date: August 4, 1984

conoco

Production Department
Hobbs Division
North American Production

Conoco Inc.
P.O. Box 460
726 East Michigan
Hobbs, NM 88240
(505) 393-4141

August 6, 1984

New Mexico Oil Conservation
P. O. Box 2088
Santa Fe, NM 87501

Gentlemen:

Infill Wells Nos. 58, 59, 60, & 61, Arco's Seven Rivers Queen Unit, Sections 27 & 34, T-22S, R-36E, Lea County, New Mexico

Conoco Inc. has approved, as offset operator, Arco's request for infill drilling as described in the attached letter ballot. One copy is attached for your file and one copy is being returned to Arco.

Yours very truly,

H. A. Ingram
Conservation Coordinator

:mhe

CC: Arco, Midland

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

July 19, 1984

AUG 2 1984
RECEIVED

Offset Operators
Infill Wells Nos. 58, 59, 60, and 61
ARCO's Seven Rivers Queen Unit
Sections 27 and 34, T22S, R36E
Lea County, New Mexico

Gentlemen:

Waiver of Objection
Infill Finding

ARCO Oil and Gas Company hereby notifies you as offset operator to our Seven-Rivers Queen Unit that we have requested the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61, as well as future infill wells, in said unit. If you have no objection to the request, please sign this waiver of protest. Send one copy to the NMOCD, one copy to ARCO, and retain one for your files. Stamped, self-addressed envelopes are enclosed for your convenience. Should any questions arise, please contact me at (915) 684-0149.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

I waive protest to ARCO's application for an infill finding for their Seven-Rivers Queen Unit Wells Nos. 58, 59, 60 and 61.

Name: D. L. Nichols, Jr.

Title: REGIONAL PRODUCTION MANAGER FOR S. W. REGION

Company: EL PASO EXPLORATION COMPANY

Date: JULY 31, 1984

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

July 19, 1984

Offset Operators
Infill Wells Nos. 58, 59, 60, and 61
ARCO's Seven Rivers Queen Unit
Sections 27 and 34, T22S, R36E
Lea County, New Mexico

Gentlemen:

Waiver of Objection
Infill Finding

ARCO Oil and Gas Company hereby notifies you as offset operator to our Seven-Rivers Queen Unit that we have requested the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61, as well as future infill wells, in said unit. If you have no objection to the request, please sign this waiver of protest. Send one copy to the NMOCD, one copy to ARCO, and retain one for your files. Stamped, self-addressed envelopes are enclosed for your convenience. Should any questions arise, please contact me at (915) 684-0149.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

I waive protest to ARCO's application for an infill finding for their Seven-Rivers Queen Unit Wells Nos. 58, 59, 60 and 61.

Name: J. A. Howard

Title: DISTRICT ENGINER

Company: GETTY OIL COMPANY

Date: JULY 30, 1984

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

July 19, 1984

Offset Operators
Infill Wells Nos. 58, 59, 60, and 61
ARCO's Seven Rivers Queen Unit
Sections 27 and 34, T22S, R36E
Lea County, New Mexico

Gentlemen:

Waiver of Objection
Infill Finding

ARCO Oil and Gas Company hereby notifies you as offset operator to our Seven-Rivers Queen Unit that we have requested the New Mexico Oil Conservation Division grant an infill finding for infill Wells 58, 59, 60, and 61, as well as future infill wells, in said unit. If you have no objection to the request, please sign this waiver of protest. Send one copy to the NMOCD, one copy to ARCO, and retain one for your files. Stamped, self-addressed envelopes are enclosed for your convenience. Should any questions arise, please contact me at (915) 684-0149.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH/DCB:sc
Atts.

I waive protest to ARCO's application for an infill finding for their Seven-Rivers Queen Unit Wells Nos. 58, 59, 60 and 61.

Name: J. Howell

Title: District Engineer

Company: Marathon Oil Co

Date: 7/30/84

ARCO Oil and Gas Company
Permian District
Post Office Box 1610
Midland, Texas 79702
Telephone 915 684 0149

Joe R. Hastings
District Engineer — West

August 15, 1984

Mr. Michael E. Stogner
New Mexico Oil Conservation Division
P. O. Box 2088
Santa Fe, New Mexico 87501

Dear Mr. Stogner:

Infill Finding Request Amendment
Seven Rivers Queen Unit
Lea County, New Mexico

ARCO Oil and Gas Company would like to amend its request of July 19, 1984, for an Infill Finding Request for its Seven Rivers Queen Unit, Lea County, New Mexico. We had requested administrative approval of an Infill Finding Request for our Seven Rivers Queen Unit Well No's. 58, 59, 60, and 61 and for any subsequent well drilled on an existing proration unit in the Seven Rivers Queen Unit. We would like to amend the July 19, 1984 letter to limit the request for administrative approval to the Seven Rivers Queen Unit Well No's. 58, 59, 60 and 61. We would like to drop our request of July 19, 1984 for an Infill Finding Request for any subsequent well drilled on an existing proration unit in the Seven Rivers Queen Unit.

If you have any further comments, please contact Mr. C. L. Payken at 915/684-0151.

Yours very truly,

Joe R. Hastings

Joe R. Hastings

JRH:CLP:sc

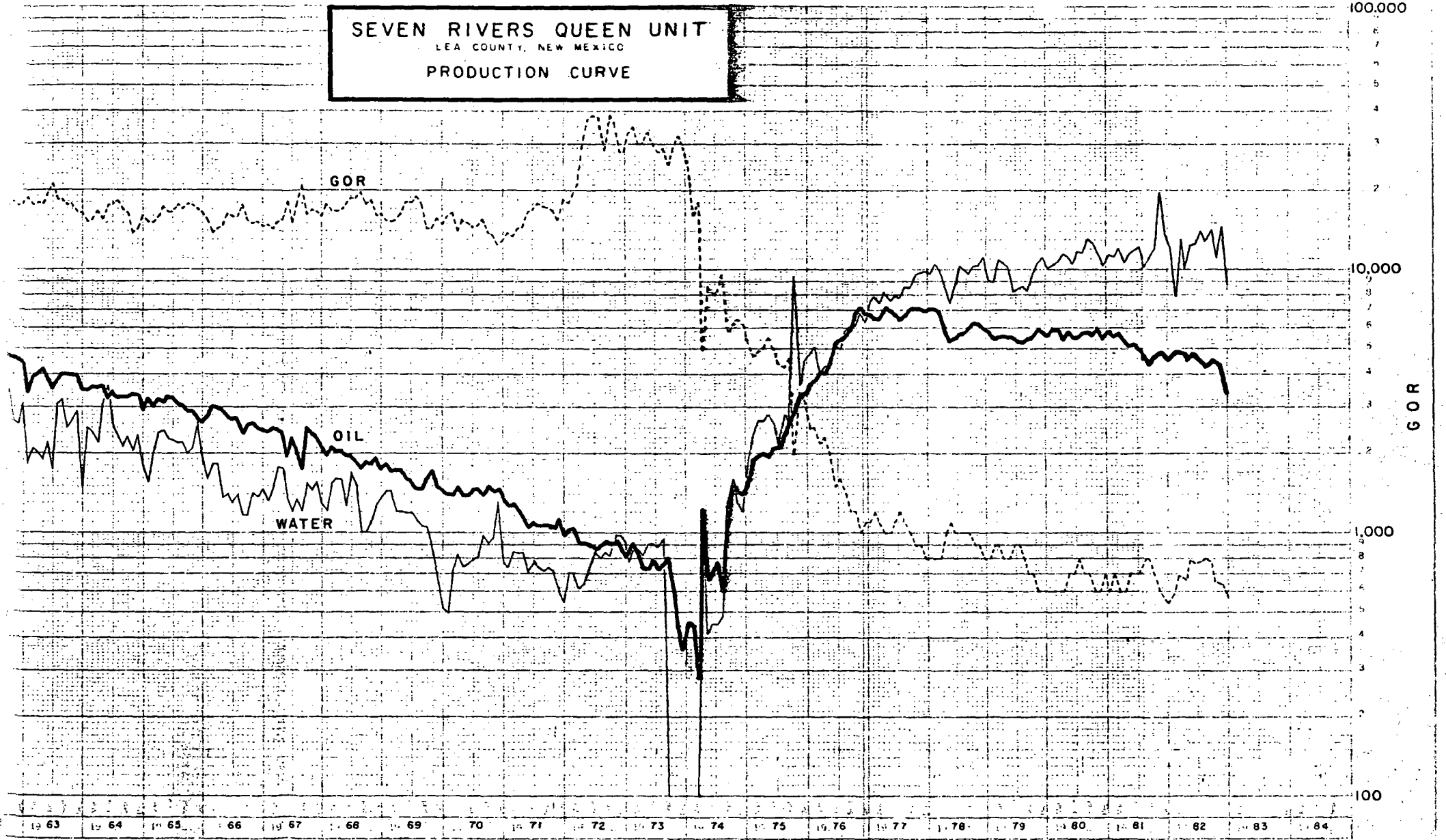
INTENTIONAL OMISSIONS

The following document(s) have been intentionally omitted from this file due to the indicated reasons.

FILE # NFL-113

DESCRIPTION OF OMITTED DOCUMENTS

OMITTED DOCUMENT	REASON OMITTED
Cross Section "AA" Graph	Too large


SEVEN RIVERS QUEEN UNIT
LEA COUNTY, NEW MEXICO
PRODUCTION CURVE
GOR
OIL
WATER
100,000
10,000
1,000
100
GOR
63
64
65
66
67
68
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70
71
72
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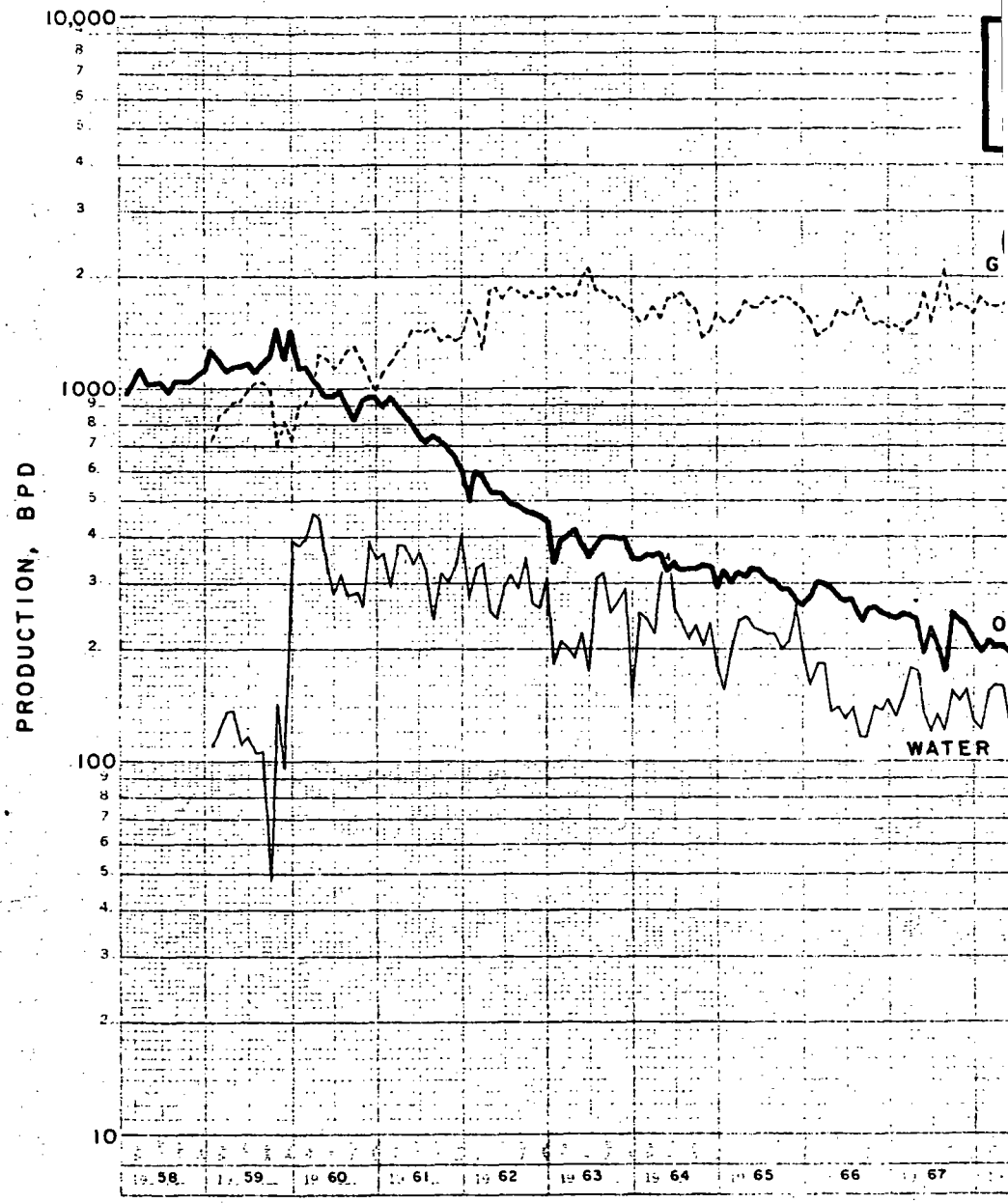
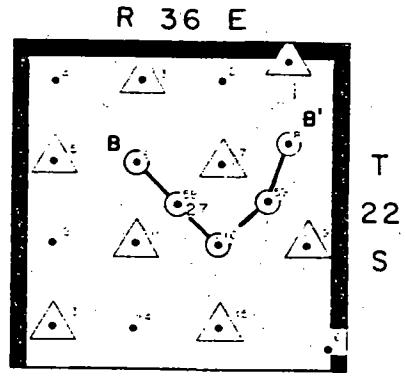
84

Figure 3


10,000
1000
100
10
PRODUCTION, BPD
G
O
WATER
19 58
19 59
19 60
19 61
19 62
19 63
19 64
19 65
66
67



INDEX MAP
Scale 1" = 2000'

ARCO Oil and Gas Company
Permian District Midland, Texas

SEVEN RIVERS
QUEEN UNIT
LEA COUNTY, NEW MEXICO

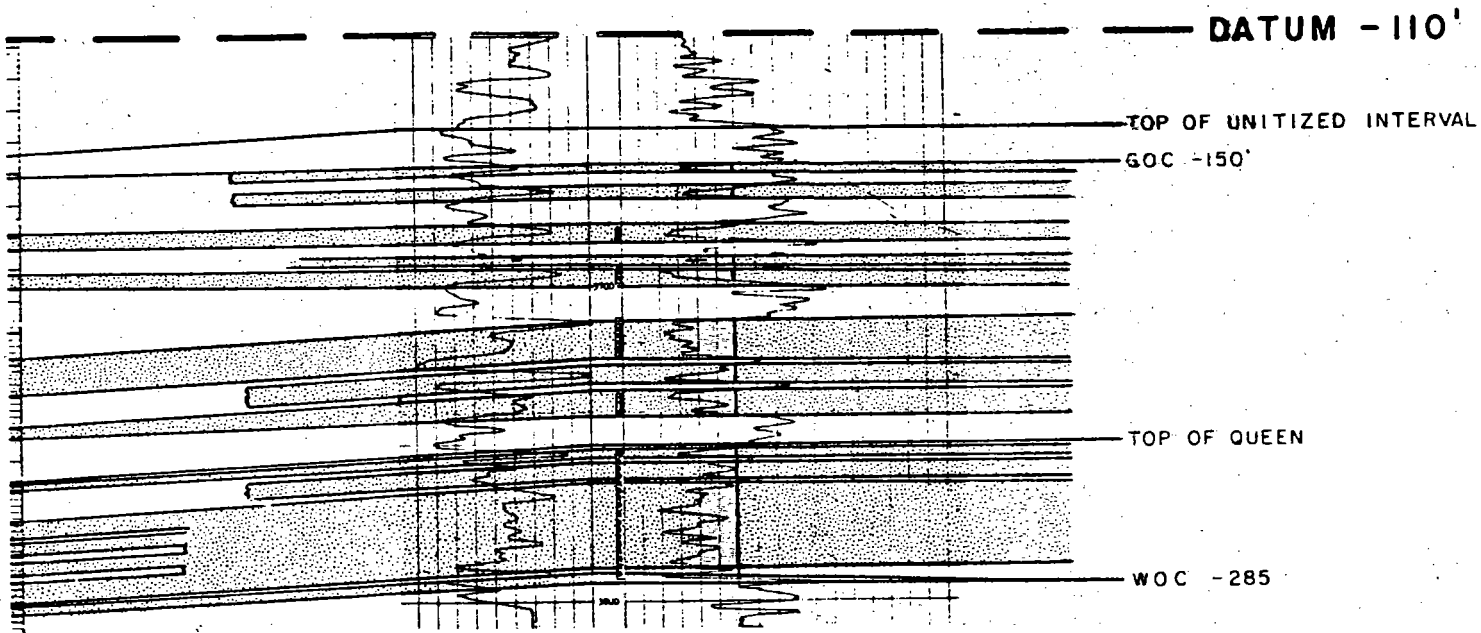
CROSS SECTION B - B'

D BRUCKER	Drawn By	Date 5 - 83
5 - 83	Approved By	Date
WEST AREA ENGR	Dwg No	

Figure 7

B'

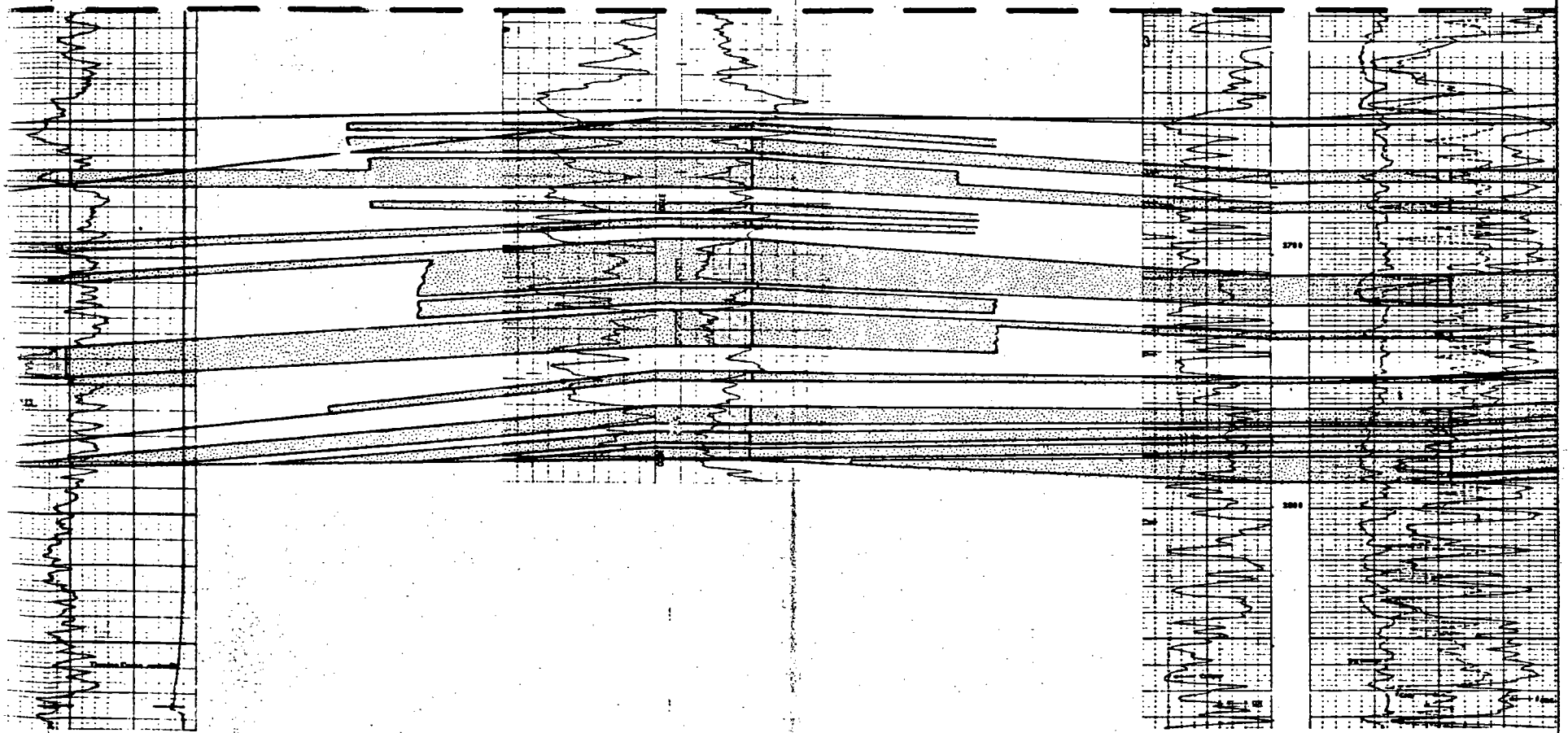
GULF OIL CORP.
SROU NO. 8
ELEV. 3510'
T. D. 3810'



S CO.

GULF OIL CORP.
SROU NO. 10
ELEV. 3515'
T. D. 3810'

ARCO OIL AND GAS CO.
SROU NO. 59
ELEV. 3502'
T. D. 3925'



B

WESTERN NATURAL GAS CO.
SROU NO. 6
ELEV. 3513'
T. D. 3780'

ARCO OIL AND GAS
SROU NO. 58
ELEV. 3498'
T. D. 3880'