STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

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

ADMINISTRATIVE ORDER

NFL 88

INFILL DRILLING FINDINGS 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-A

I.

Operator ARCO OIL & GAS COMPANY Well Name and No. State Vacuum Unit Well No. 23

Location: Unit J Sec. 32 Twp. 17South Rng. 34 East Cty. Lea

II.

THE DIVISION FINDS:

(1) That Section 271.305(b) of the Federal Energy Regulatory Commission 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 that the infill 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.

(2) That by Order No. R-6013-A, dated February 8, 1980, 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 completed in the Vacuum Grayburg San Andres Pool, and the standard spacing unit in said pool is 40 acres.

(4) That a 40-acre proration unit comprising the NW/4 SE/4 of Sec. 32, Twp. 17South, Rng. 34 East, is currently dedicated to the State Vacuum Unit Well No. 14 located in Unit J of said section.

(5) That this proration unit is (X) standard ( ) nonstandard; if nonstandard, said unit was previous 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 12,950 MCF of gas from the proration unit which would not otherwise be recovered.

(8) That all the requirements of Order No. R-6013-A 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.

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 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 8 day of August, 19 84.

cc: WELL FILE
OCD HOBBS
NM LAND OFFICE

DIVISION DIRECTOR ___ EXAMINER ___

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT

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

Received: 12/13/83
ADMINISTRATIVE ORDER
NFL

INFILL DRILLING FINDINGS 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-A

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

DIVISION DIRECTOR ___ EXAMINER ____

cc - Well File
OCD Hobbs
N.M. Land Office

Received
12/13/83

State Vacuum Unit #23
Lea County, New Mexico
AR #46429

"Infill Finding"

Rules and Regulations
Natural Gas Policy Act Infill Findings
Administrative Procedure

Rule 3: No waivers from offset operators are necessary. See Exhibit 1

Rule 5: See attached approved Form C-101 for the infil well and Form C-102 showing proration unit dedicated.

Rule 6: See Well Completion Report and Log for name of the pool in which the infill well has been drilled and the standard spacing unit size therefor.

Rule 7: Exhibit 2: Number of the Division Order approving the non-standard proration unit dedicated to the well.

Rule 8: Exhibit I: Description of all wells drilled on proration unit.

Rule 9: See Engineering Discussion plus all "figures" associated within.

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

May 23, 1983

TONEY ANAYA
GOVERNOR

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

ARCO OIL AND GAS COMPANY
P.O. Box 1610
Midland, Texas 79702

Attention: J. A. Fraga

Administrative Order NSL-1699

Gentlemen:

Reference is made to your application for a non-standard location for your State Vacuum Unit Well No. 23, to be located 1530 feet from the South line and 2490 feet from the East line of Section 32, Township 17 South, Range 34 East, Vacuum Grayburg-San Andres Pool, Lea County, New Mexico.

By authority granted me under the provisions of Rule 104 F of the Division Rules and Regulations, the above-described unorthodox location is hereby approved.

Sincerely,

JOE D. RAMEY
Director

JDR/RLS/dp

cc: Oil Conservation Division - Hobbs
Oil & Gas Engineering Committee - Hobbs
Oil & Gas Division - State Land Office - Santa Fe

Engineering Discussion of Infill Drilling on the State Vacuum Unit

INTRODUCTION

ARCO Oil and Gas Company's State Vacuum Unit produces from the Vacuum Grayburg-San Andres field in Lea County, New Mexico. It has been concluded that to effectively and efficiently produce this reservoir 20-acre well spacing is necessary. The following is a brief history of the State Vacuum Unit and the engineering and geological data supporting this finding.

HISTORY

The State Vacuum Unit was formed by ARCO on November 11, 1976 and water injection began on July 1, 1977. The unit was developed on 40-acre spacing using a 5-spot injection pattern. Primary reserves for this unit were calculated to be 3,266 MBO, or 24.8% of the OOIP. The unit has shown favorable response to the flood producing 347 MBO of secondary reserves as of April, 1983. However, several wells have experienced premature water breakthrough which has reduced the efficiency of the waterflood (see Figures 1, 2, and 3).

On July 26, 1983 we completed the State Vacuum Unit No. 23, our second 20-acre infill in the unit (see attached plat, Figure 4). This well had a 24 hour pump potential of 40 BO, 14 BW and 35 MCFPD. Because of the short producing history on this well, it is still too early to make any ultimate reserve predictions. Our first 20 acre infill, the No. 22, completed February, 1983, has been encouraging. The No. 22 had a 24 hour pump potential of 189 BO, 23 BW, and 15 MCFPD. The No. 22 is expected to recover new reserves of approximately 74 MSTBO. Gas production in association with this oil will be 12.95 MMCF. Figure No. 11 shows the Unit's predicted performance with the No. 22 infill. The final stabilized rate on the No. 22 was 75 BOPD and was projected to decline at 30% per year.

ARCO is presently in the process of updating its Engineering Study of 1976 for the State Vacuum Unit. This study will evaluate the current infill drilling program and will also lay out the final development plans for the unit.

GEOLOGY

The Vacuum Grayburg-San Andres field is located on an east-west trending anticline at the east end of the Artesia-Vacuum trend along the southern edge of the northwestern platform. The State Vacuum Unit is located in the western portion of the field (see attached structure map, Fig. 5). Oil production is principally from dolomite in the San Andres formation with minor contributions from limestone in the Grayburg. The main pay zone (first porosity zone in the San Andres) is an oolite dolomite continuous throughout the State Vacuum Unit (see cross-section Fig. 6). Attached is Table No. 1 showing basic reservoir data for this unit.

VOLUMETRIC CALCULATIONS

Volumetric calculations for the San Andres formation in the State Vacuum Unit yield an original-oil-in-place of 10,381,109 STB for the main pay and 13,305,882 STB for the total pay zone. The Grayburg formation was not included in any volumetric calculations. These calculations involved determination of porosity-feet (Øh) for each well. Two isopachs were prepared, one for total Øh (Figure 7) and one for main pay Øh (Figure 8). These maps were constructed using logs and core data where available. Acre-Øh numbers were determined by planimetering the isopach maps.

The original-oil-in-place numbers were calculated by transforming acre-Øh numbers into net hydrocarbon pore volume and converting to stock tank barrels using a formation volume factor of 1.26. The water saturation used in the conversion was taken from Figure 9, "Average of First Porosity vs. Water Saturation" from a field study of the Wasson San Andres reservoir by Shell Oil Company.

SECONDARY RESERVES FOR 40-ACRE SPACING

ARCO's Engineering Study of 1976 concluded that only the "main pay" section of the San Andres was continuous enough to be economically flooded. Secondary reserves were calculated to be 1,300 MBO which represents a ratio of 0.5:1 of secondary to primary reserves. This low ratio is due to the main pay being the only zone floodable on 40-acre spacing.

Secondary performance was determined with the aid of one of Atlantic Richfield Company's computer programs, which calculated sweep-out for a five-spot pattern. Three five-spot patterns were used to model performance within the 800-acre proposed project area. Each pattern was broken down into quarters five-spot elements. In each element, core and log analysis helped determine porosity, permeability, and net pay. Twelve elements were analyzed in a total of three five spots. Total performance of the eight five-spots were determined by summing representative five-spots. Permeability distribution was determined for each well having core data with Atlantic Richfield's core data sorting program. Stratification analysis was handled by dividing each five-spot into layers. Table 2 gives the data used in each of the three typical five-spots.

SECONDARY AND PRIMARY RESERVES FOR 20-ACRE SPACING

By infill drilling, additional pay in the San Andres will be floodable on closer spacing. Based on the Engineering-Geological Committee Report, November 1977, (Exhibit No. 4, Case No. 6570) for the East Vacuum Grayburg-San Andres Unit, it was determined that an estimated 3.9% increase in recovery of OOIP for the EVGSAU could be expected on 20-acre spacing. Since the State Vacuum Unit has similar reservoir characteristics and quality, an increase recovery value of 3.9% of the OOIP was used in predicting additional secondary oil reserves with 20-acre infills. This value includes encountering discontinuous intervals of porosity and improvement in recovery efficiency.

Using the 3.9% infill recovery value and the total pay zone OOIP reserves, additional secondary reserves of 518,929 STB were calculated for the unit. The 800 acre unit would require 20 equivalent 20-acre infill wells for a recovery of about 26 MBO/well location. These calculations are outlined in Appendix A.

Primary drainage analysis of the State Vacuum Unit were done using volumetrics, decline curves and production data. This analysis indicated that each 20-acre infill well will drain 5 acres previously missed at 40-acre spacing. Incrementally each infill well will recovery 26 MBO (see Appendix A).

The State Vacuum Unit No. 23 will also produce primary reserves from a lower zone near the top of the Lovington Sand (see Figure 10). The porosity logs indicate this zone to contain 8 feet of net pay with about 12% porosity. Estimate recoverable primary reserves for the lower zone, using 20-acre spacing and a 24.8% recovery factor, is 22 MBO. Secondary reserves were not calculated since this zone at present is not being flooded.

Premature water breakthrough has been experienced in several wells, as is seen in the attached plots (see Fig. 1-3). The 20-acre spacing will drain reserves being bypassed due to the breakthrough.

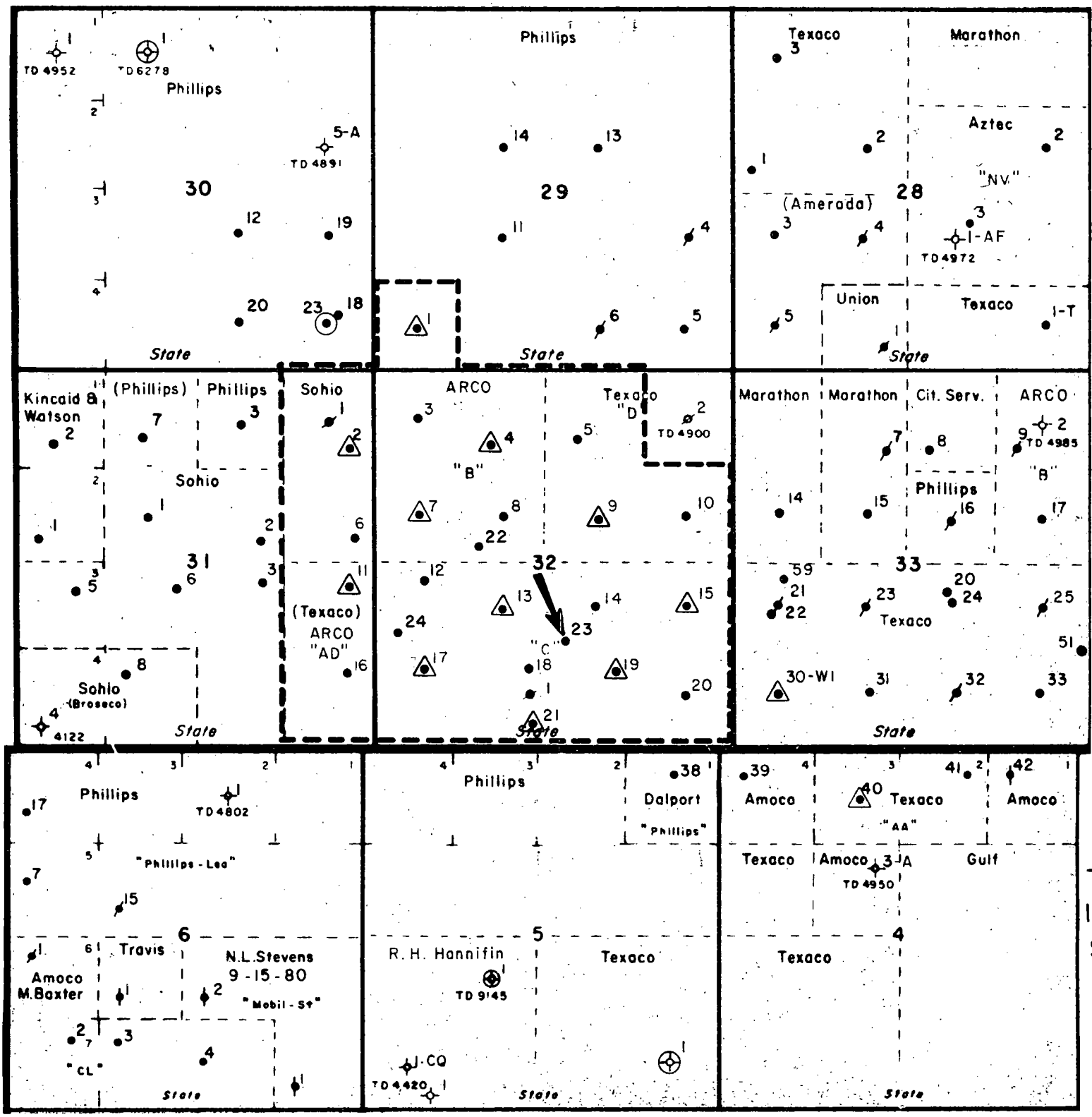
CONCLUSION

By drilling the infill Well No. 23 we will recover new reserves of approximately 74 MSTBO. Gas production in association with this oil will be 12.95 MMCF.

The production history of the State Vacuum Unit and other units in this field indicate that to effectively and efficiently produce the Vacuum Grayburg-San Andres reservoir, 20-acre spacing is necessary. By going to this closer spacing, additional pay will be encountered and flooded. Additional primary reserves that were undrained on 40-acre spacing will be recovered along with secondary reserves bypassed due to premature water breakthrough.

JAF:dmm

11/21/83



LEGEND

- UNIT BOUNDARY
- PRODUCER - SAN ANDRES
- INJECTOR - SAN ANDRES
- PROPOSED LOCATION

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

VACUUM (GRBG - S.A.) AREA
STATE VACUUM UNIT

Lea County, New Mexico

Scale 1" = 2000'

By J A Fraga	Drawn By TCB	Date 10-82
Date 10-20-82	Revised By	Date 5-83
Dept West Engineering	Dwg No	

HPP RELEASE 8.6 - PLOT SEQ NO. 2
CONFIDENTIAL. (A O G C)

Figure 1
State Vacuum Unit No. 6

FIELD, 830 - VACUUM
LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES

o -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

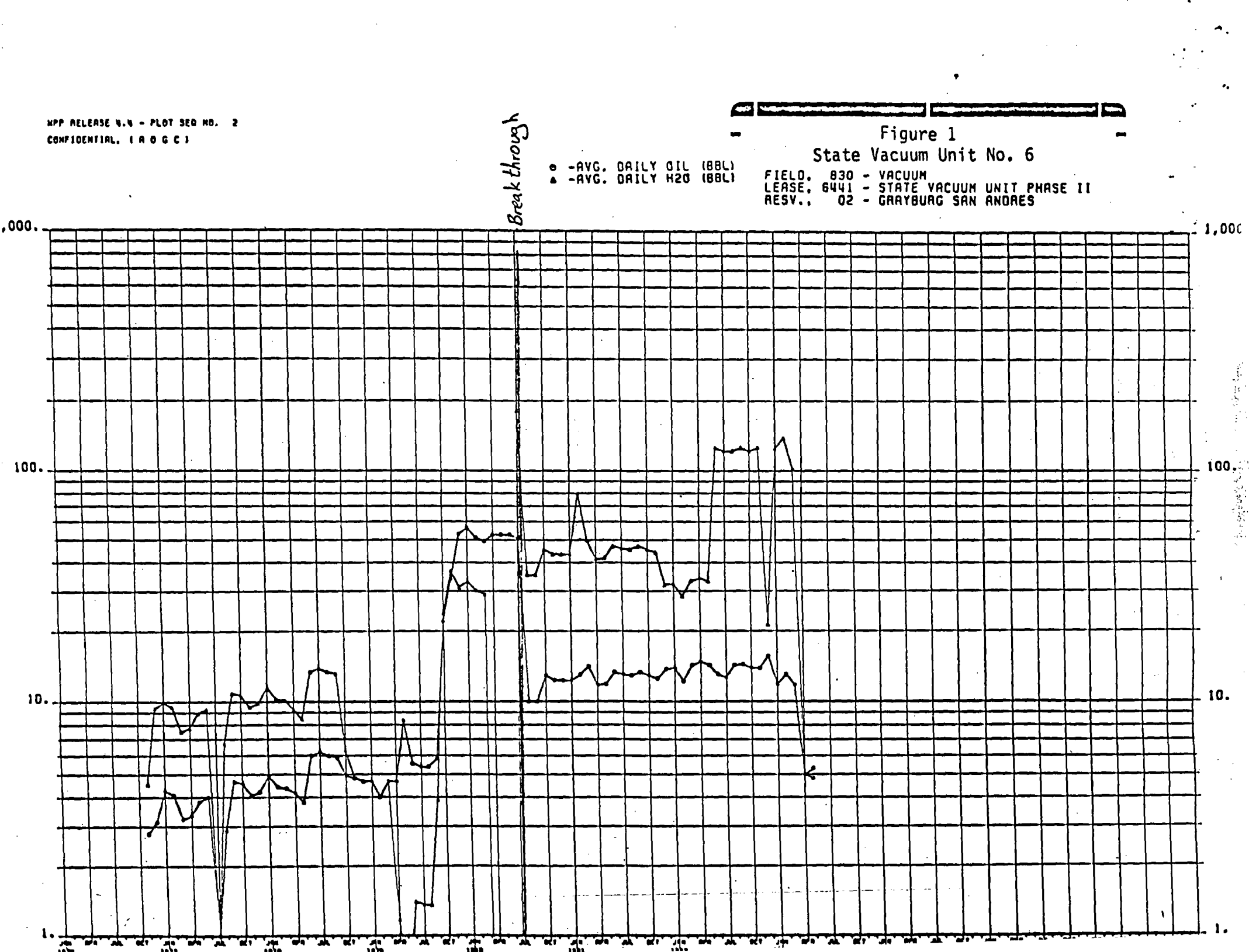


Figure 2
State Vacuum Unit No. 10

LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES
● -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

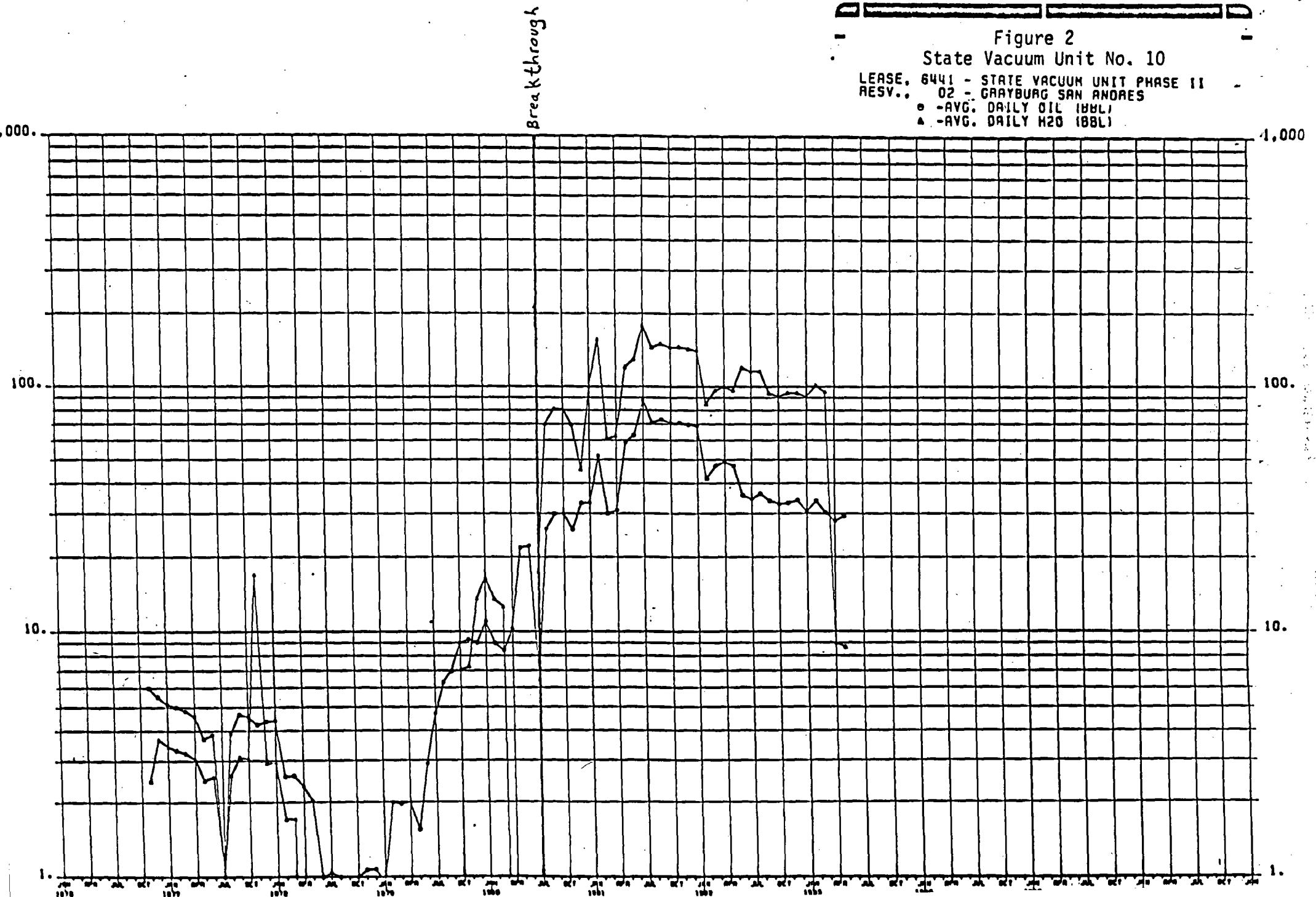


Figure 3
State Vacuum Unit No. 14

LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES

● -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H20 (BBL)

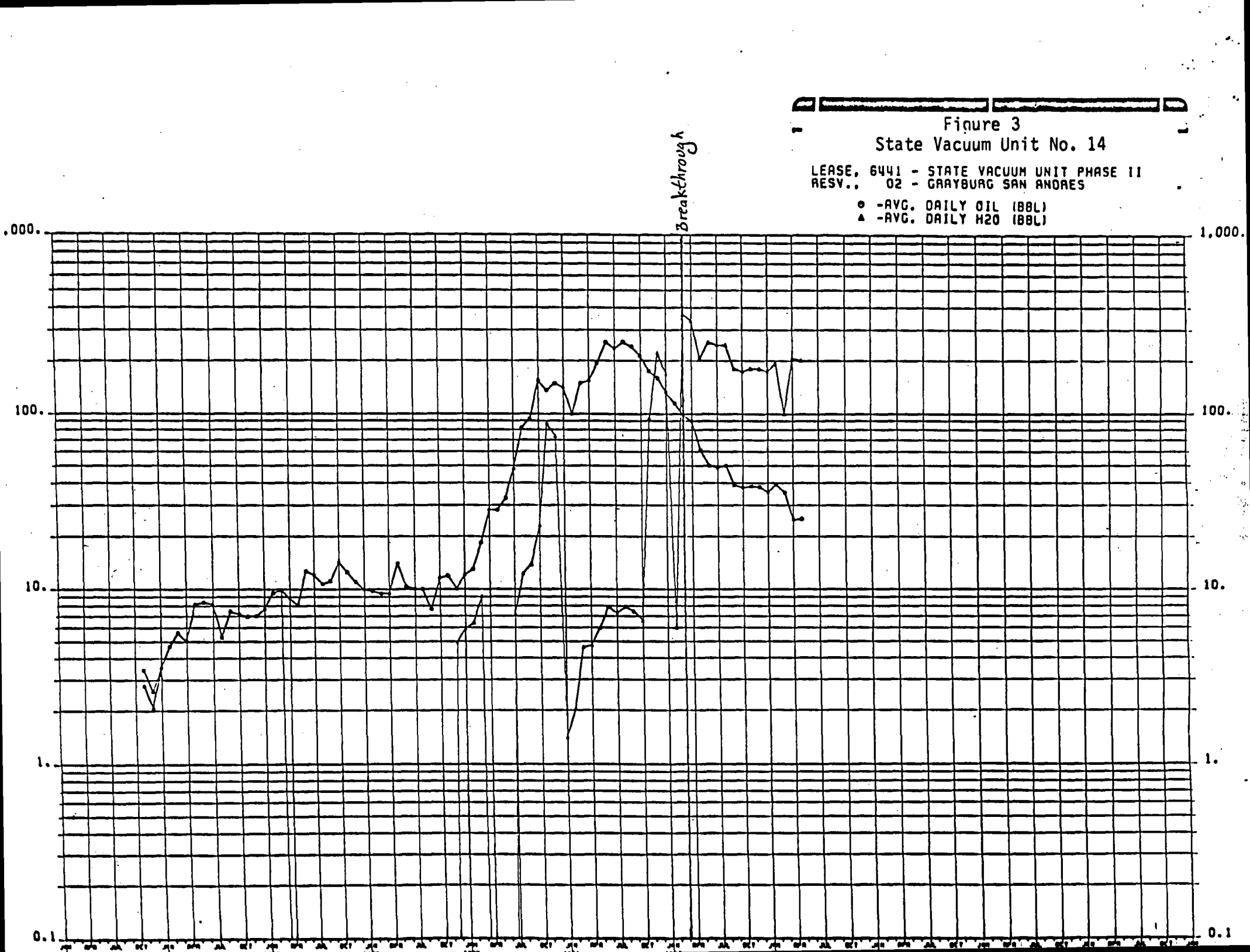
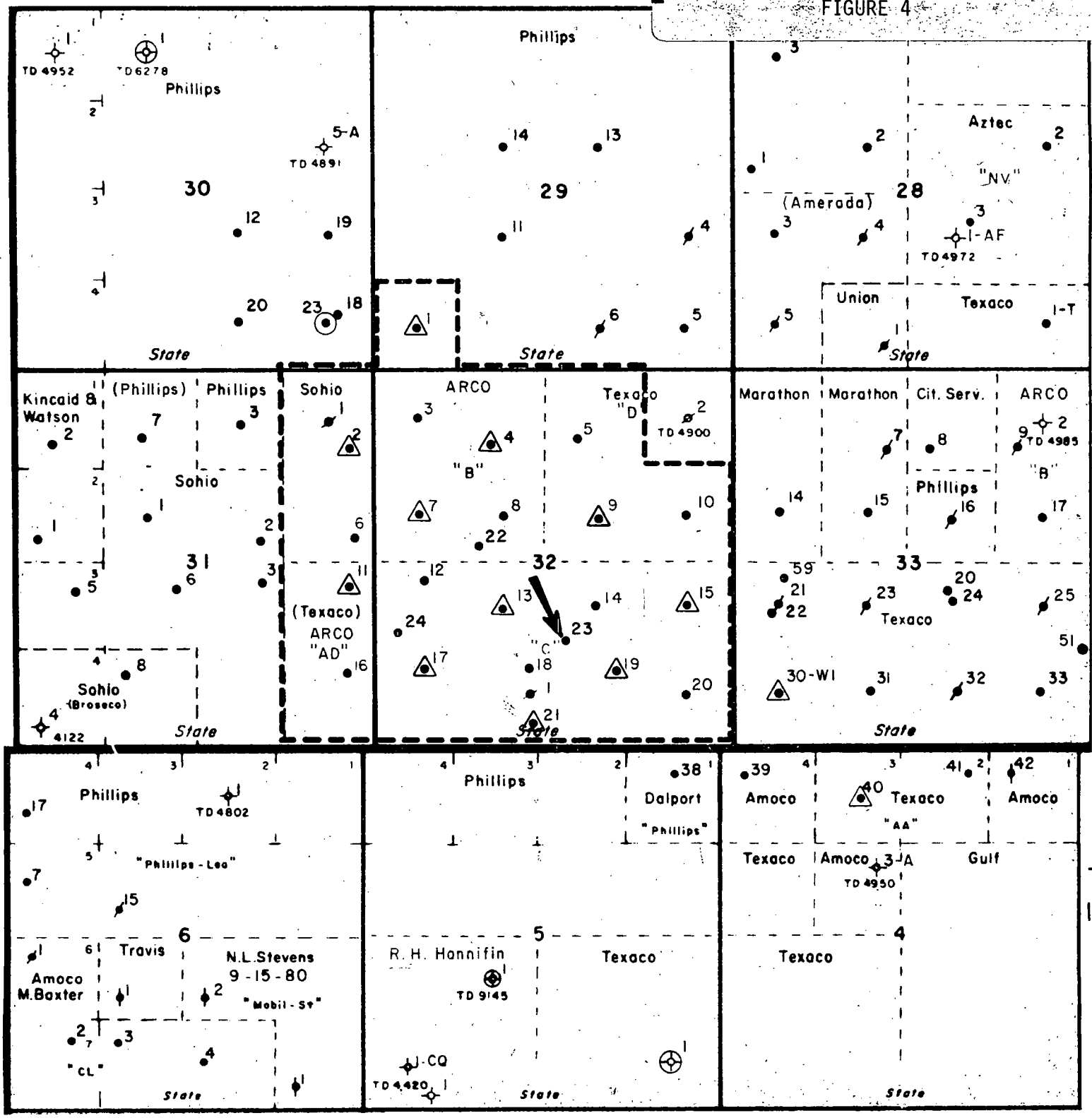


FIGURE 4



R 34E

LEGEND

- UNIT BOUNDARY
- PRODUCER - SAN ANDRES
- INJECTOR - SAN ANDRES
- o PROPOSED LOCATION

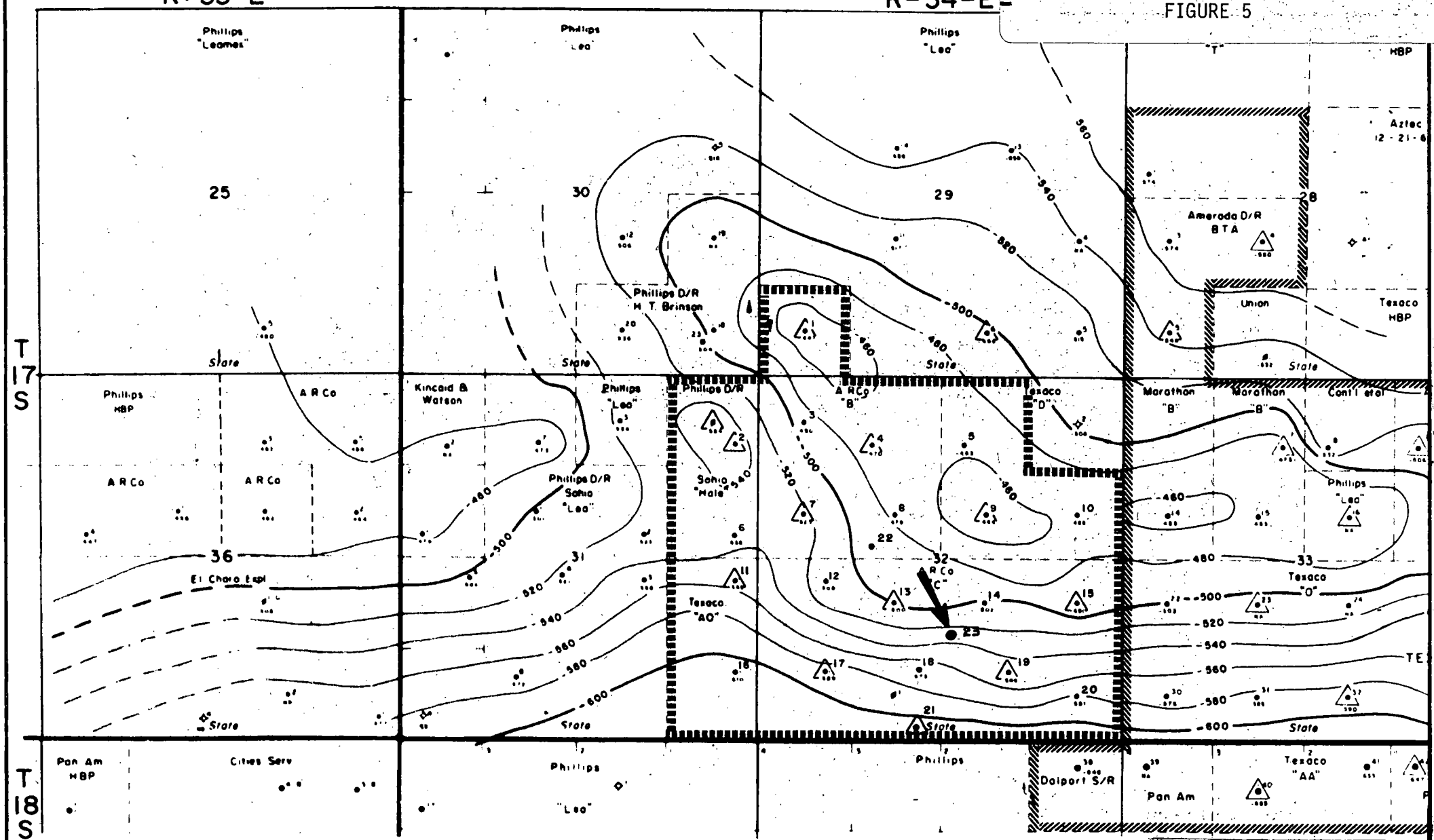
ARCO Oil and Gas Company
Division of Atlantic Richfield Company
Permian District Midland, Texas

VACUUM (GRBG - S.A.) AREA
STATE VACUUM UNIT
Lea County, New Mexico

Scale 1" = 2000'

By J A Fiuga	Drawn By TCB	Date 10-82
Date 10-20-82	Revised By	Date 5-83
Dept West Engineering	Dwg No	

FIGURE 5



LEGEND

STATE VACUUM UNIT BOUNDARY

PROPOSED WELL LOCATION

Atlantic Richfield Company
North American Producing Division
Permian District Midland, Texas

VACUUM FIELD
Lea County, New Mexico

STATE VACUUM UNIT

STRUCTURE MAP
TOP OF SAN ANDRES

BY J. A. FRAGA	DRAWN	3-83
DATE 3-83	REVISED	
FOR WEST ENGR.	SCALE	

INTENTIONAL OMISSIONS

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

FILE # NFL 88

DESCRIPTION OF OMITTED DOCUMENTS

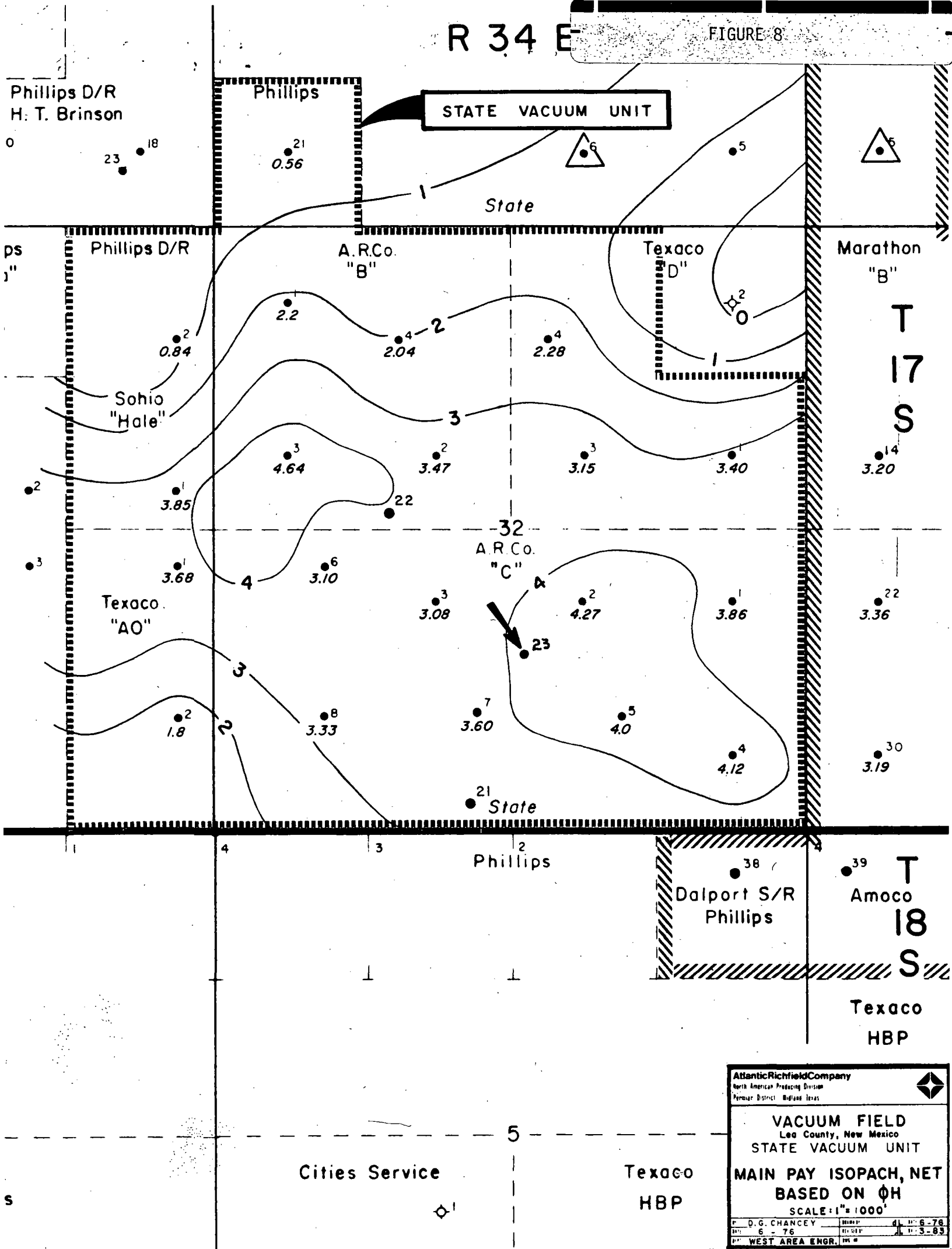
OMITTED DOCUMENT	REASON OMITTED
figure 6 (Index Map - Graph)	Too Large

FIGURE 7

Atlantic Richfield Company
North American Producing Division
Permian District Midland Texas

VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT
TOTAL PAY ISOPACH, NET BASED ON ϕH

D. G. CHANCEY		dL 6-76	
6 - 76		3-83	
WEST AREA ENGR.			


R 34 E
FIGURE 8
STATE VACUUM UNIT
Phillips D/R
H. T. Brinson
Phillips
State
Phillips D/R
A.R.Co.
"B"
Texaco
"D"
Marathon
"B"
T
17
S
Sohio
"Hale"
32
A.R.Co.
"C"
Texaco
"AO"
Phillips
Dalport S/R
Phillips
Amoco
T
18
S
Texaco
HBP
5
Cities Service
Texaco
HBP
0.56
0.84
2.2
2.04
2.28
4.64
3.47
3.15
3.40
3.20
3.85
3.68
3.10
3.08
4.27
3.86
3.36
1.8
3.33
3.60
4.0
4.12
3.19
AtlanticRichfieldCompany
North American Producing Division
Permian District Midland Texas
VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT
MAIN PAY ISOPACH, NET
BASED ON ϕH
SCALE: 1" = 1000'
D.G. CHANCEY
6 - 76
WEST AREA ENGR.
6-76
3-83

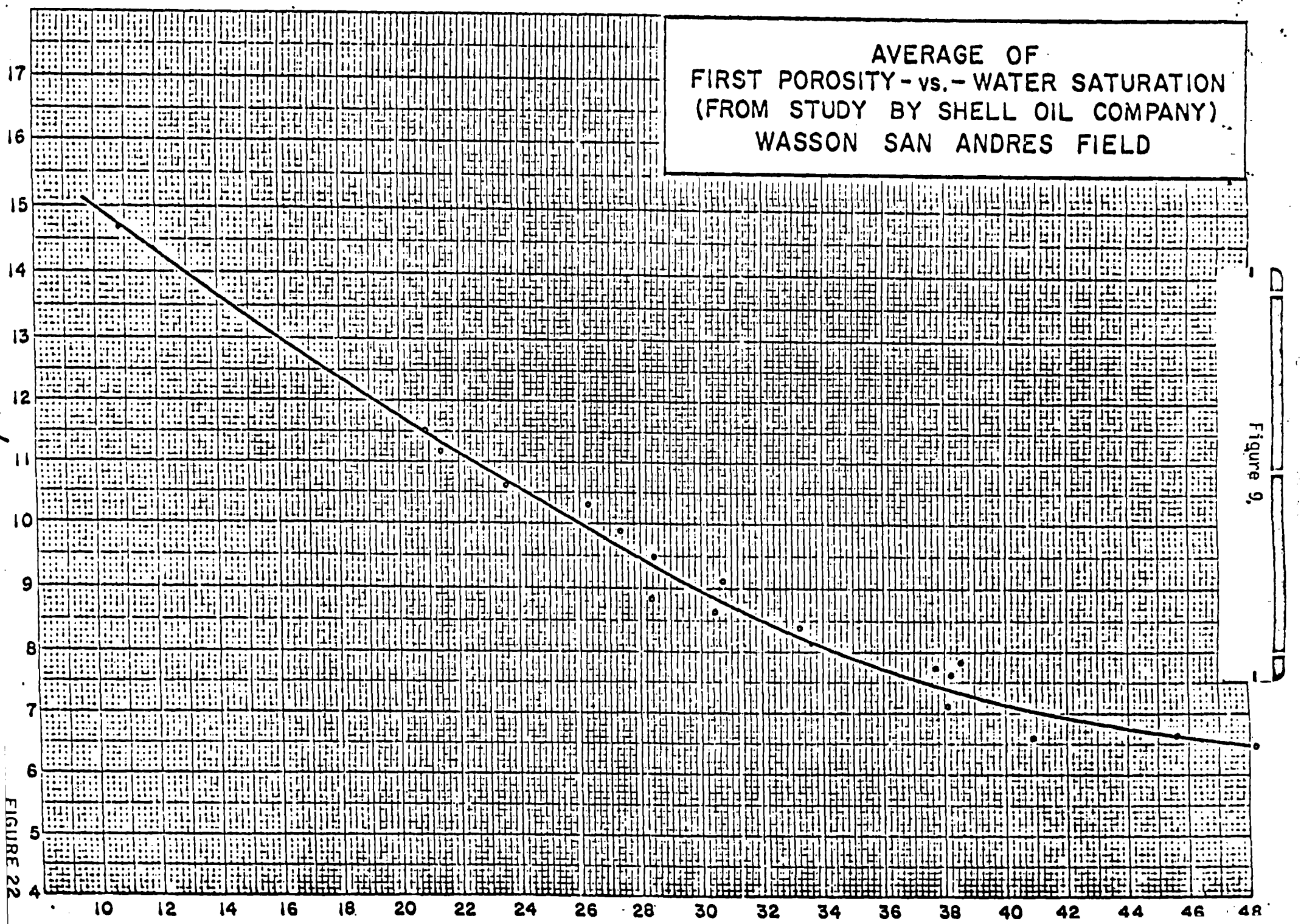


Figure 9.

FIGURE 22

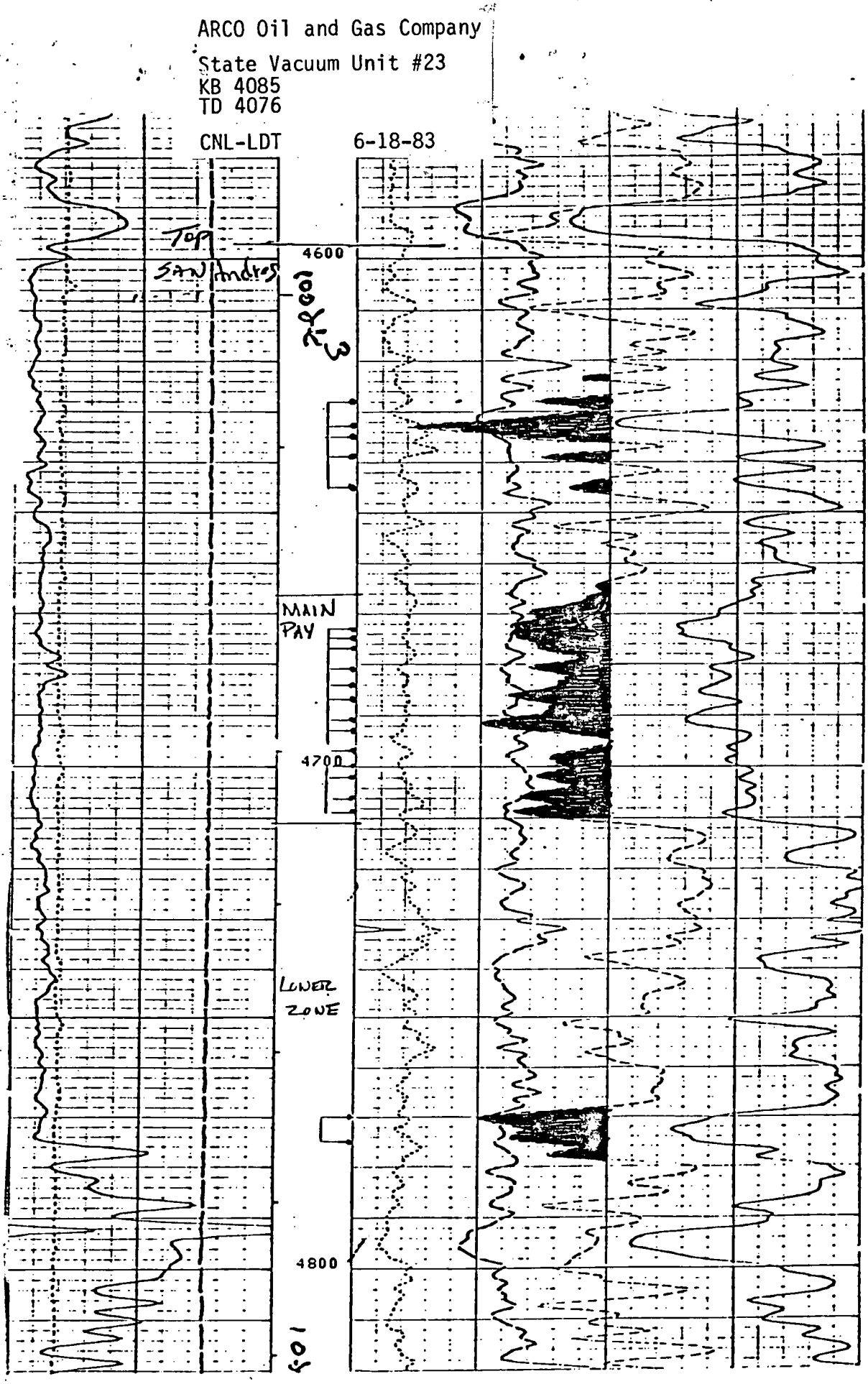

ARCO Oil and Gas Company
State Vacuum Unit #23
KB 4085
TD 4076
CNL-LDT
6-18-83
Top
San Andres
4600
MAIN
PAY
4700
LOWER
ZONE
4800

FIGURE 10

Figure 11
Continued Operations vs Infill Drilling

LEASE, 6441 - STATE VACUUM UNIT PHASE II
WELL COUNT - 31

o -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H20 (BBL)
+ -GAS OIL RATIO

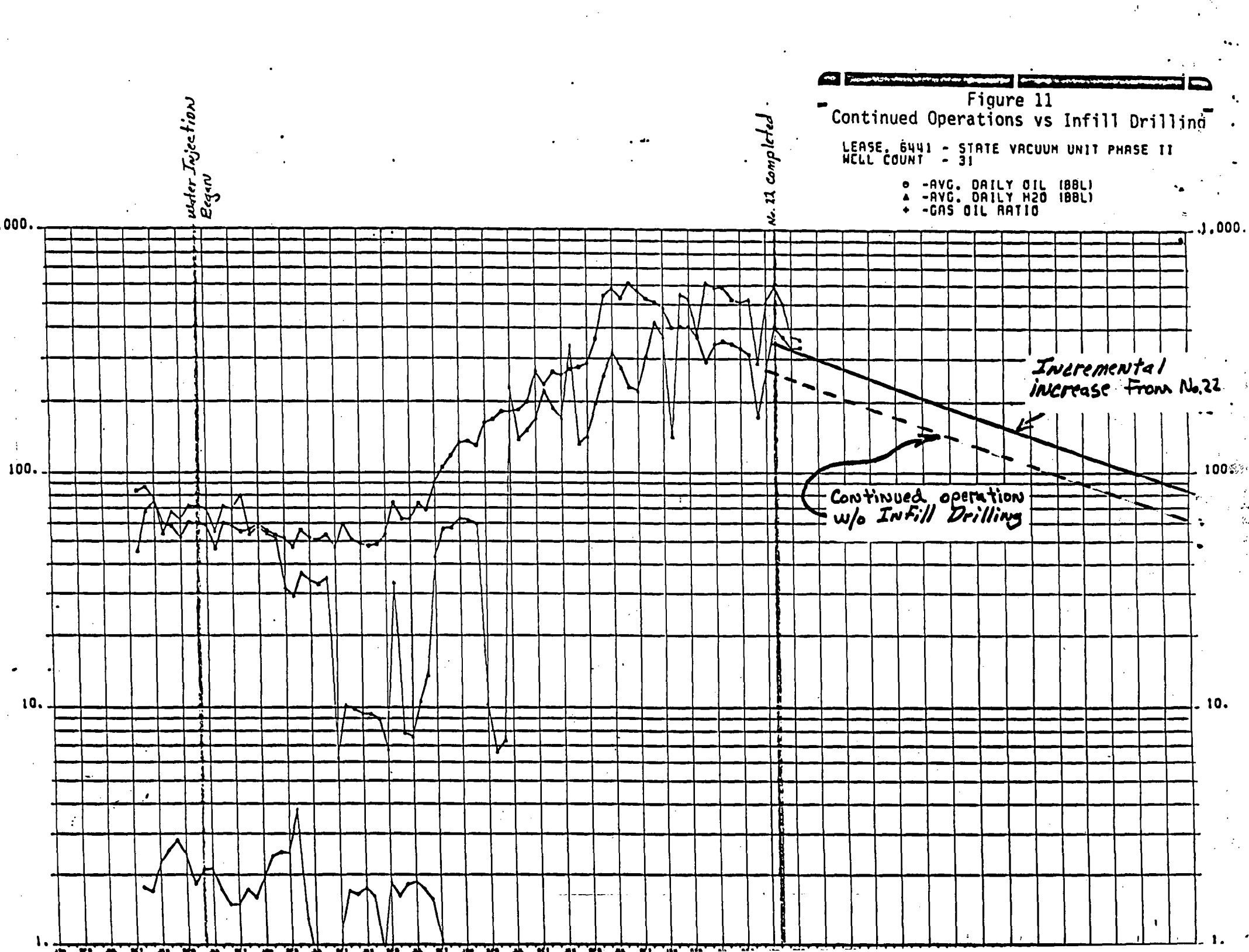


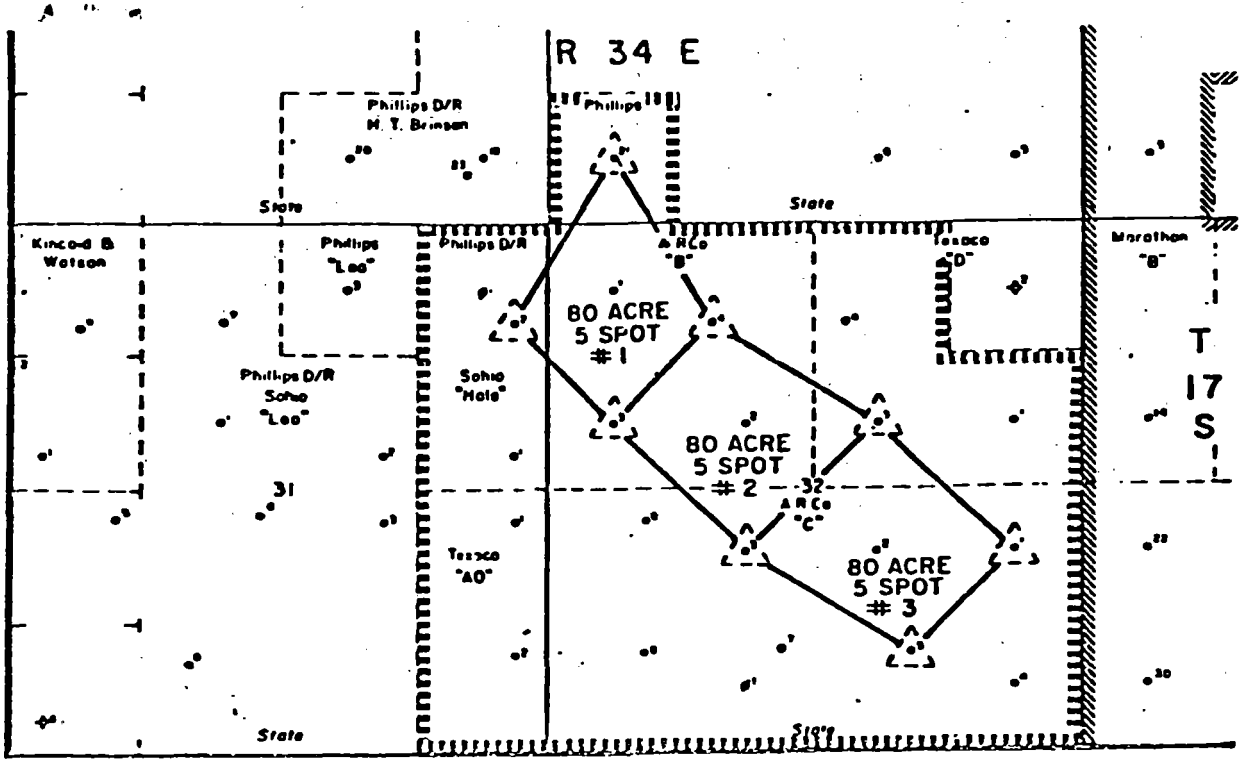
Table I

Basic Reservoir Data

Unit:	State Vacuum Unit
Operator:	ARCO Oil and Gas Company
Field:	Vacuum Grayburg-San Andres
Lithology:	Dolomite and Limestone
Area:	800 Acres
Average Porosity:	9.88%
Average Permeability:	17.8 md
Initial Formation Volume Factor:	1.26 RB/STB
Connate Water Saturation:	26.5%
Residual Oil Saturation:	30.0%
Oil Gravity:	37° API
Average GOR:	175 SCF/bbl
Original Oil In Place:	13,306 MSTBO
Primary Recovery (40-acres):	3,266 MSTBO
Secondary Recovery (40-acres):	1,700 MSTBO

TABLE 2

STRATIFICATION ANALYSIS



	% Thickness of Total	Kl, md	Scw,%	Sgx,%	Sor,%
80-ACRE 5-SPOT NO. 1					
Layer #1	42.1	4.6	26.5	24.0	30.0
Layer #2	37.0	1.7	26.5	24.0	30.0
Layer #3	20.9	0.5	26.5	24.0	30.0
	100.0				
80-ACRE 5-SPOT NO. 2					
Layer #1	25.4	26.0	26.5	24.0	30.0
Layer #2	30.8	8.6	26.5	24.0	30.0
Layer #3	17.6	2.8	26.5	24.0	30.0
Layer #4	14.9	1.0	26.5	24.0	30.0
Layer #5	11.3	0.4	26.5	24.0	30.0
	100.0				
80-ACRE 5-SPOT NO. 3					
Layer #1	18.2	19.8	26.5	24.0	30.0
Layer #2	23.5	7.0	26.5	24.0	30.0
Layer #3	29.4	2.6	26.5	24.0	30.4
Layer #4	12.6	0.9	26.5	24.0	30.4
Layer #5	16.3	0.3	26.5	24.0	30.4
	100.0				

Appendix A

I. Incremental Secondary Reserves with 20-acre Infills:

OOIP = 13,306 MBO (Eng. Study 1976)
Recovery Factor = .039 (EVU Eng. Study, Phillips)
Additional Reserves from 20-acre Spacing = 519 MBO
Unit Area = 800 acres
therefore, Equivalent 20-acre infills required = 20

519 MBO ÷ 20 Wells = 26 MBO/Well Incremental Oil

(26 MBO/Well)(175 SCF/STB) = 4.55 MMCF/Well Incremental Gas

II. Undrained Primary Reserves for Typical 20-acre Infill Location:

Øh = 4.56 (log data)
Sw = .265 (Eng. Study 1976)
Recovery Factor = .248 (Eng. Study 1976)
Boi = 1.26 RB/STB (Eng. Study 1976)
A = 6 acres (Undrained area planimetered from drainage maps)

$$\frac{7758\ A\emptyset h(1-Sw)}{Boi} \times R_f = \frac{7758(5)(4.56)(1-.265)}{1.26} \times .248 = 25.6 \text{ MBO Primary Reserves from 20-acre Spacing}$$

25.6 MBO x 175 SCF/STB = 4.48 MMCF Primary Gas

III. New Primary Reserves from A Lower Zone:

Øh = 0.96
A = 20 acres

$$\frac{7758\ A\emptyset h(1-Sw)}{Boi} \times R_f = \frac{7758(20)(1)(1-.265)}{1.26} \times .248 = 21.6 \text{ MBO Primary Reserves for Lower Zone}$$

21.6 MBO x (175 SCF/STB) = 3.78 MMCF Primary Gas

State Vacuum Unit #23
Lea County, New Mexico
AR #46429

"Infill Finding"

Rules and Regulations
Natural Gas Policy Act Infill Findings
Administrative Procedure

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Rule 9: See Engineering Discussion plus all "figures" associated within.

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

May 23, 1983

TONEY ANAYA
GOVERNOR

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

ARCO OIL AND GAS COMPANY
P.O. Box 1610
Midland, Texas 79702

Attention: J. A. Fraga

Administrative Order NSL-1699

Gentlemen:

Reference is made to your application for a non-standard location for your State Vacuum Unit Well No. 23, to be located 1530 feet from the South line and 2490 feet from the East line of Section 32, Township 17 South, Range 34 East, Vacuum Grayburg-San Andres Pool, Lea County, New Mexico.

By authority granted me under the provisions of Rule 104 F of the Division Rules and Regulations, the above-described unorthodox location is hereby approved.

Sincerely,

JOE D. RAMEY
Director

JDR/RLS/dp

cc: Oil Conservation Division - Hobbs
Oil & Gas Engineering Committee - Hobbs
Oil & Gas Division - State Land Office - Santa Fe

RECEIVED
JUN 01 1983

CENTRAL FILES

Engineering Discussion of Infill
Drilling on the State Vacuum Unit

INTRODUCTION

ARCO Oil and Gas Company's State Vacuum Unit produces from the Vacuum Grayburg-San Andres field in Lea County, New Mexico. It has been concluded that to effectively and efficiently produce this reservoir 20-acre well spacing is necessary. The following is a brief history of the State Vacuum Unit and the engineering and geological data supporting this finding.

HISTORY

The State Vacuum Unit was formed by ARCO on November 11, 1976 and water injection began on July 1, 1977. The unit was developed on 40-acre spacing using a 5-spot injection pattern. Primary reserves for this unit were calculated to be 3,266 MBO, or 24.8% of the OOIP. The unit has shown favorable response to the flood producing 347 MBO of secondary reserves as of April, 1983. However, several wells have experienced premature water breakthrough which has reduced the efficiency of the waterflood (see Figures 1, 2, and 3).

On July 26, 1983 we completed the State Vacuum Unit No. 23, our second 20-acre infill in the unit (see attached plat, Figure 4). This well had a 24 hour pump potential of 40 BO, 14 BW and 35 MCFPD. Because of the short producing history on this well, it is still too early to make any ultimate reserve predictions. Our first 20 acre infill, the No. 22, completed February, 1983, has been encouraging. The No. 22 had a 24 hour pump potential of 189 BO, 23 BW, and 15 MCFPD. The No. 22 is expected to recover new reserves of approximately 74 MSTBO. Gas production in association with this oil will be 12.95 MMCF. Figure No. 11 shows the Unit's predicted performance with the No. 22 infill. The final stabilized rate on the No. 22 was 75 BOPD and was projected to decline at 30% per year.

ARCO is presently in the process of updating its Engineering Study of 1976 for the State Vacuum Unit. This study will evaluate the current infill drilling program and will also lay out the final development plans for the unit.

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The Vacuum Grayburg-San Andres field is located on an east-west trending anticline at the east end of the Artesia-Vacuum trend along the southern edge of the northwestern platform. The State Vacuum Unit is located in the western portion of the field (see attached structure map, Fig. 5). Oil production is principally from dolomite in the San Andres formation with minor contributions from limestone in the Grayburg. The main pay zone (first porosity zone in the San Andres) is an oolite dolomite continuous throughout the State Vacuum Unit (see cross-section Fig. 6). Attached is Table No. 1 showing basic reservoir data for this unit.

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Volumetric calculations for the San Andres formation in the State Vacuum Unit yield an original-oil-in-place of 10,381,109 STB for the main pay and 13,305,882 STB for the total pay zone. The Grayburg formation was not included in any volumetric calculations. These calculations involved determination of porosity-feet (Øh) for each well. Two isopachs were prepared, one for total Øh (Figure 7) and one for main pay Øh (Figure 8). These maps were constructed using logs and core data where available. Acre-Øh numbers were determined by planimetering the isopach maps.

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SECONDARY RESERVES FOR 40-ACRE SPACING

ARCO's Engineering Study of 1976 concluded that only the "main pay" section of the San Andres was continuous enough to be economically flooded. Secondary reserves were calculated to be 1,300 MBO which represents a ratio of 0.5:1 of secondary to primary reserves. This low ratio is due to the main pay being the only zone floodable on 40-acre spacing.

Secondary performance was determined with the aid of one of Atlantic Richfield Company's computer programs, which calculated sweep-out for a five-spot pattern. Three five-spot patterns were used to model performance within the 800-acre proposed project area. Each pattern was broken down into quarters five-spot elements. In each element, core and log analysis helped determine porosity, permeability, and net pay. Twelve elements were analyzed in a total of three five spots. Total performance of the eight five-spots were determined by summing representative five-spots. Permeability distribution was determined for each well having core data with Atlantic Richfield's core data sorting program. Stratification analysis was handled by dividing each five-spot into layers. Table 2 gives the data used in each of the three typical five-spots.

SECONDARY AND PRIMARY RESERVES FOR 20-ACRE SPACING

By infill drilling, additional pay in the San Andres will be floodable on closer spacing. Based on the Engineering-Geological Committee Report, November 1977, (Exhibit No. 4, Case No. 6570) for the East Vacuum Grayburg-San Andres Unit, it was determined that an estimated 3.9% increase in recovery of OOIP for the EVGSAU could be expected on 20-acre spacing. Since the State Vacuum Unit has similar reservoir characteristics and quality, an increase recovery value of 3.9% of the OOIP was used in predicting additional secondary oil reserves with 20-acre infills. This value includes encountering discontinuous intervals of porosity and improvement in recovery efficiency.

Using the 3.9% infill recovery value and the total pay zone OOIP reserves, additional secondary reserves of 518,929 STB were calculated for the unit. The 800 acre unit would require 20 equivalent 20-acre infill wells for a recovery of about 26 MBO/well location. These calculations are outlined in Appendix A.

Primary drainage analysis of the State Vacuum Unit were done using volumetrics, decline curves and production data. This analysis indicated that each 20-acre infill well will drain 5 acres previously missed at 40-acre spacing. Incrementally each infill well will recovery 26 MBO (see Appendix A).

The State Vacuum Unit No. 23 will also produce primary reserves from a lower zone near the top of the Lovington Sand (see Figure 10). The porosity logs indicate this zone to contain 8 feet of net pay with about 12% porosity. Estimate recoverable primary reserves for the lower zone, using 20-acre spacing and a 24.8% recovery factor, is 22 MBO. Secondary reserves were not calculated since this zone at present is not being flooded.

Premature water breakthrough has been experienced in several wells, as is seen in the attached plots (see Fig. 1-3). The 20-acre spacing will drain reserves being bypassed due to the breakthrough.

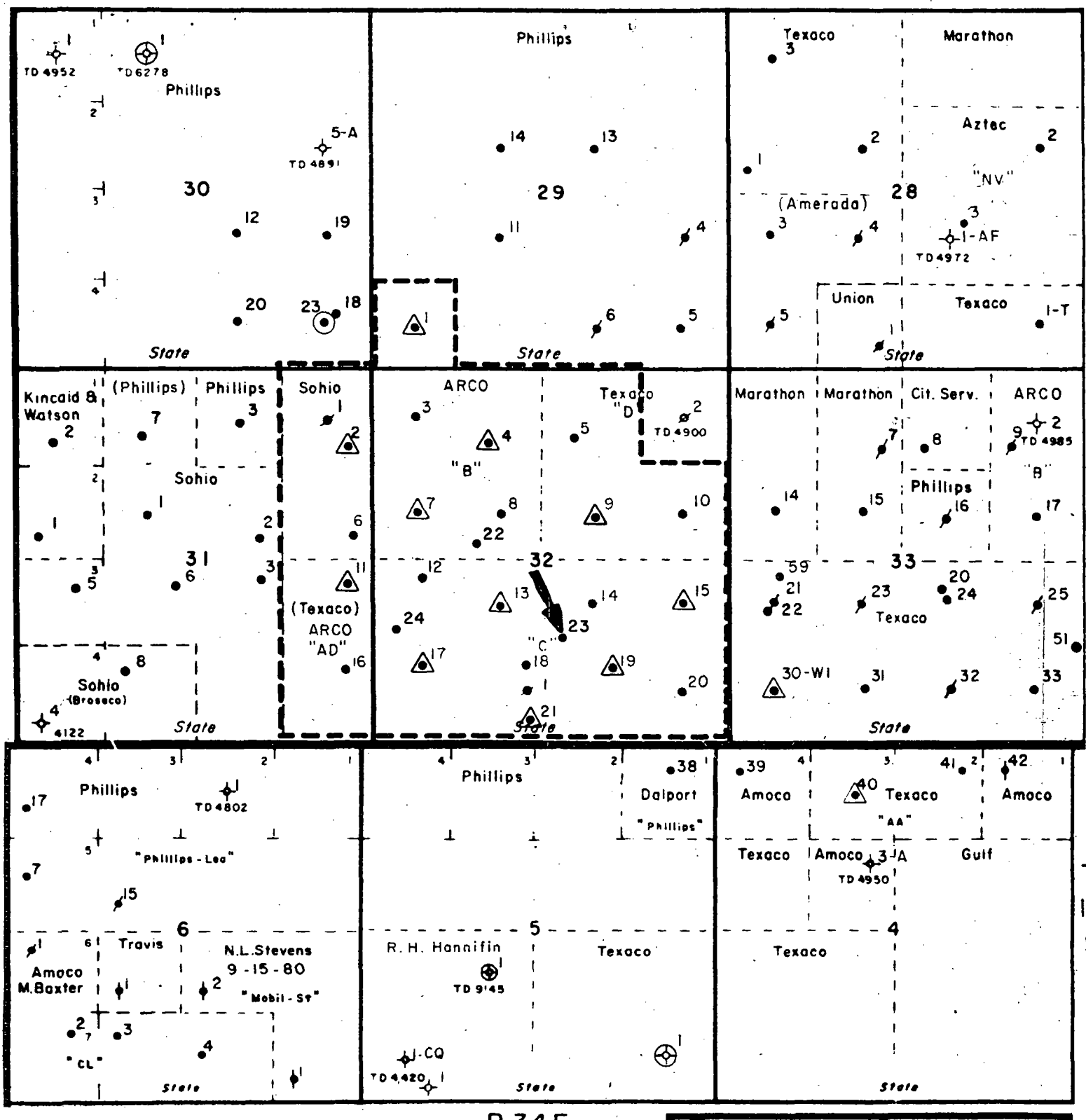
CONCLUSION

By drilling the infill Well No. 23 we will recover new reserves of approximately 74 MSTBO. Gas production in association with this oil will be 12.95 MMCF.

The production history of the State Vacuum Unit and other units in this field indicate that to effectively and efficiently produce the Vacuum Grayburg-San Andres reservoir, 20-acre spacing is necessary. By going to this closer spacing, additional pay will be encountered and flooded. Additional primary reserves that were undrained on 40-acre spacing will be recovered along with secondary reserves bypassed due to premature water breakthrough.

JAF:dmm

11/21/83



LEGEND

- UNIT BOUNDARY
- PRODUCER - SAN ANDRES
- INJECTOR - SAN ANDRES
- PROPOSED LOCATION

ARCO Oil and Gas Company

Division of Atlantic Richfield Company

Permian District Midland, Texas

VACUUM (GRBG - S.A.) AREA
STATE VACUUM UNIT

Lea County, New Mexico

Scale 1" = 2000'

By J A Fruga	Drawn By TCB	Date 10-82
Date 10-20-82	Revised By	Date 5-83
Dept West Engineering	Dwg No	

HPP RELEASE 5.6 - PLOT SEQ NO. 2
CONFIDENTIAL. (A G G C)

Figure 1

State Vacuum Unit No. 6

o -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

FIELD, 830 - VACUUM
LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES

Breakthrough

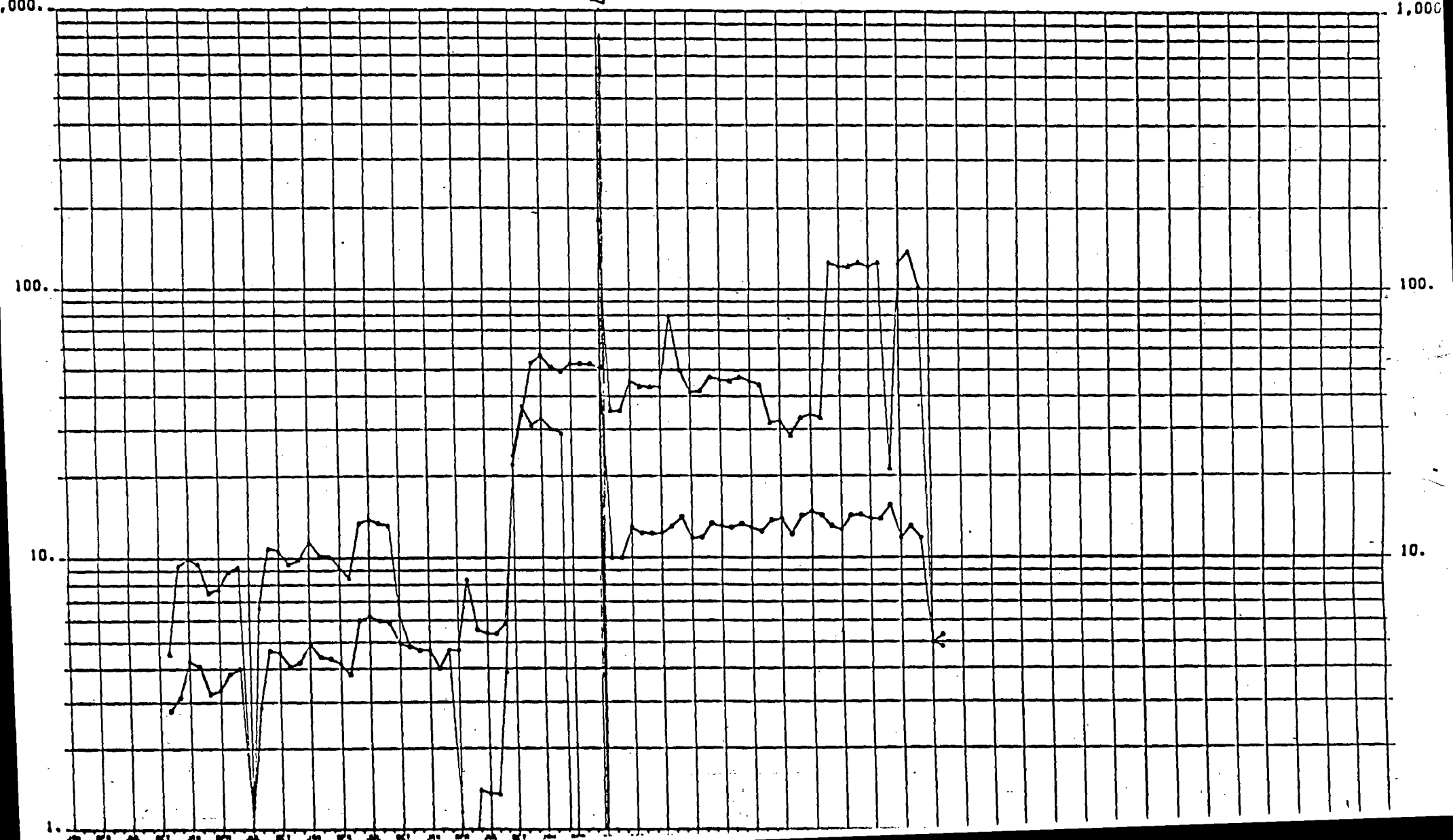


Figure 2
State Vacuum Unit No. 10

LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES
● -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

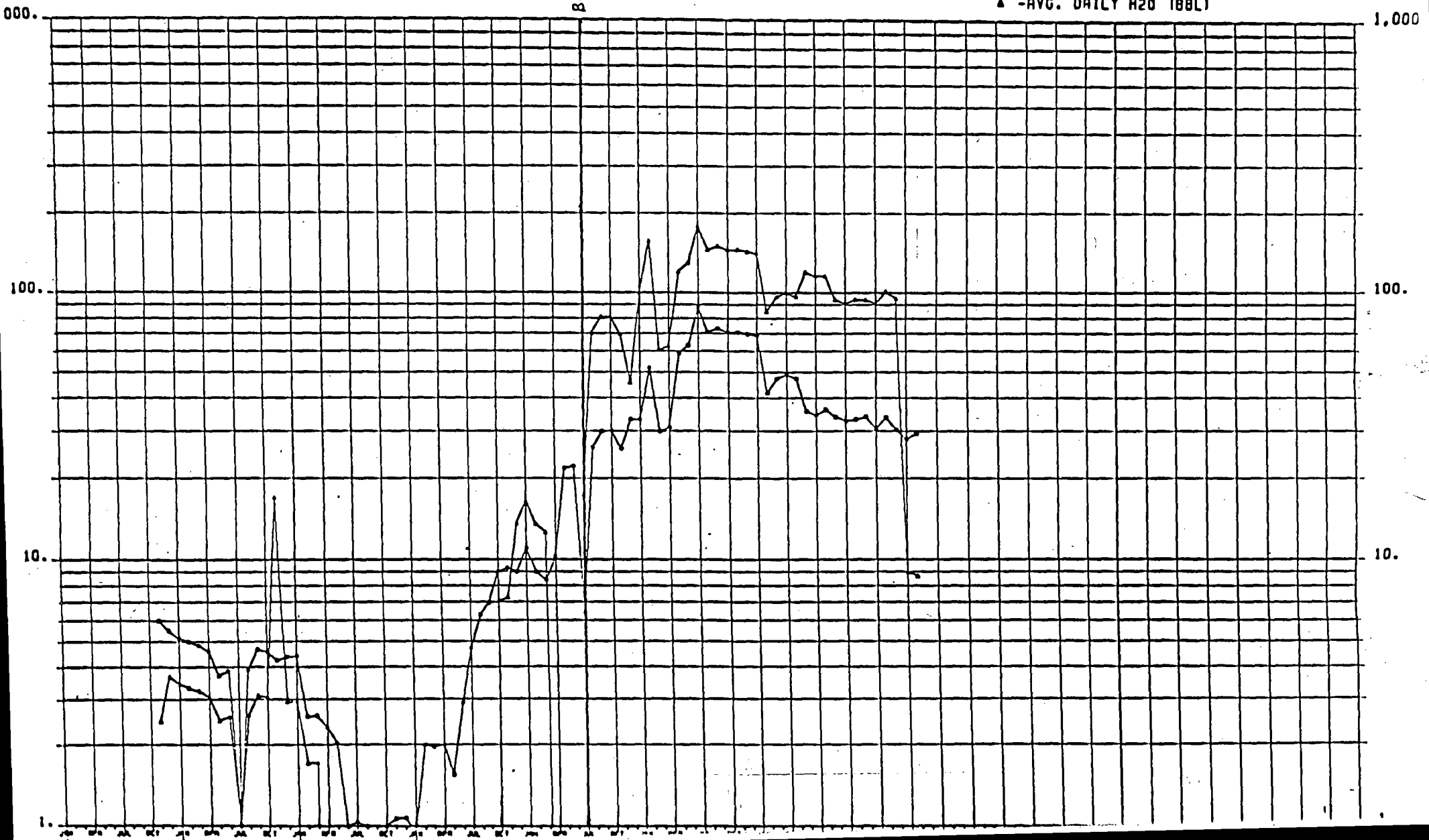


Figure 3
State Vacuum Unit No. 14

LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES

● -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

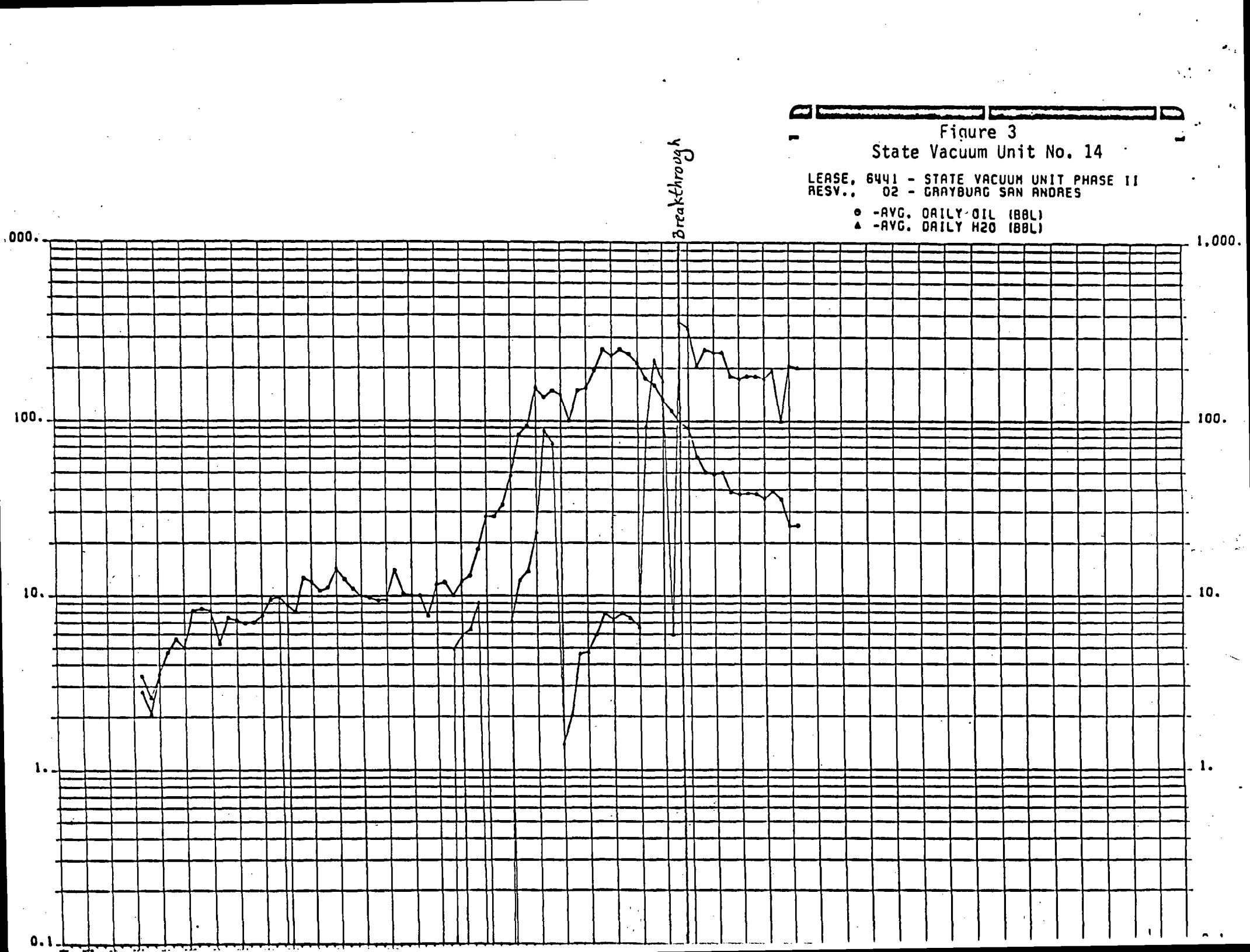
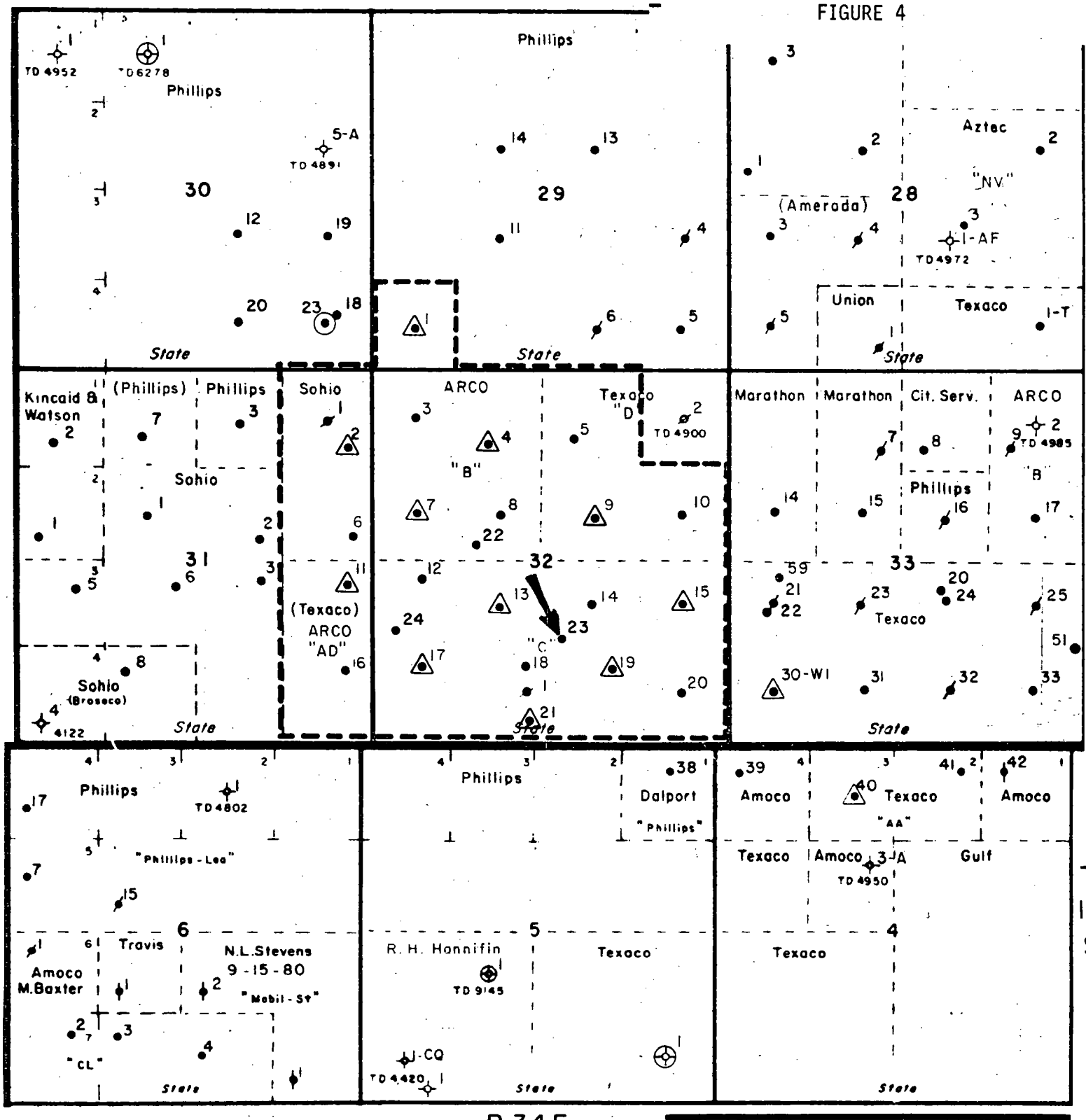


FIGURE 4



LEGEND

- UNIT BOUNDARY
- PRODUCER - SAN ANDRES
- INJECTOR - SAN ANDRES
- o PROPOSED LOCATION

ARCO Oil and Gas Company

Division of Atlantic Richfield Company

Permian District Midland, Texas

VACUUM (GRBG - S.A.) AREA

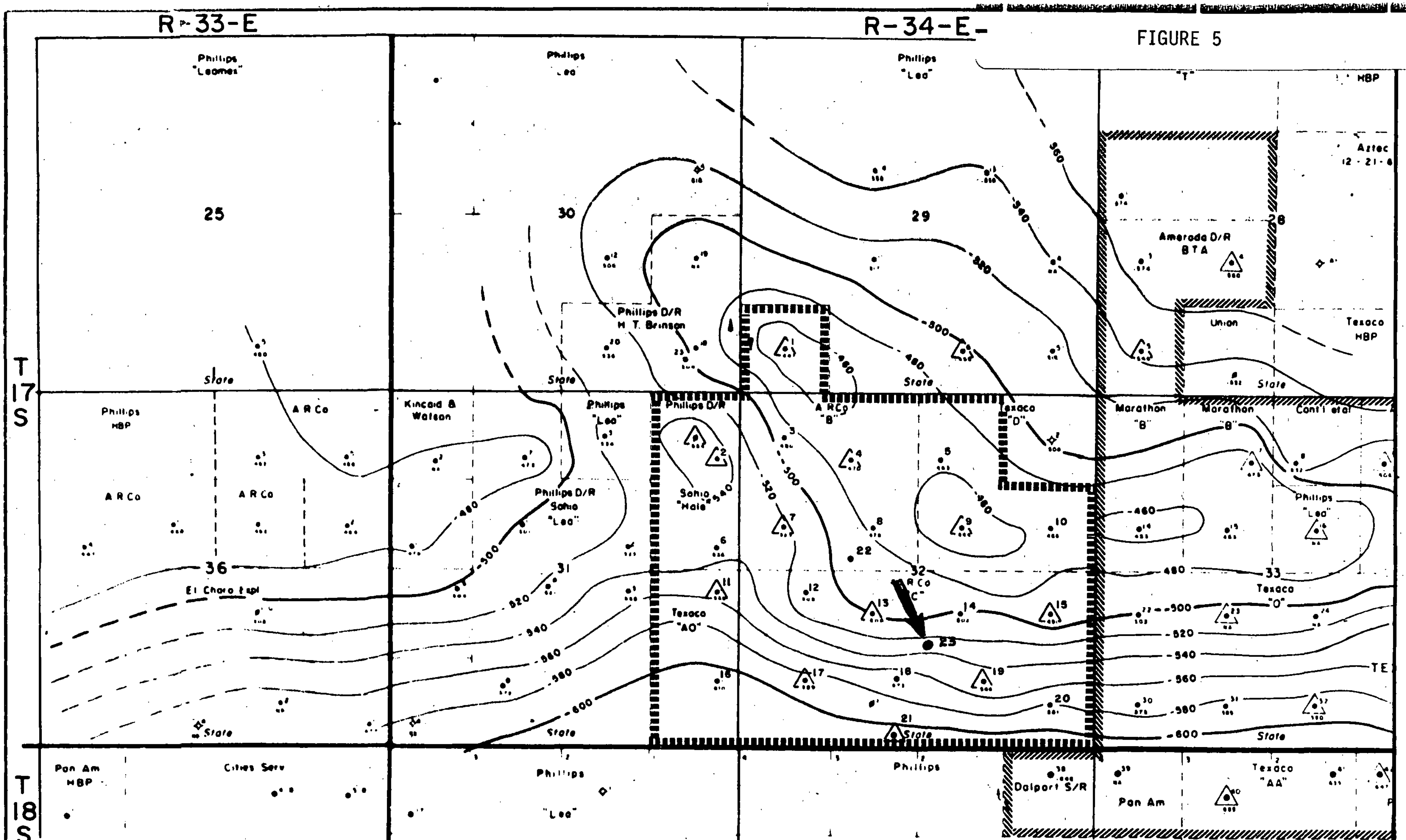
STATE VACUUM UNIT

Lea County, New Mexico

Scale 1" = 2000'

By J A Fruga	Drawn By TCB	Date 10-82
Date 10-20-82	Revised By	Date 5-83
Dept West Engineering	Dwg No	

FIGURE 5



L E G E N D

▮▮▮▮▮▮▮▮▮ STATE VACUUM UNIT BOUNDARY

PROPOSED WELL LOCATION

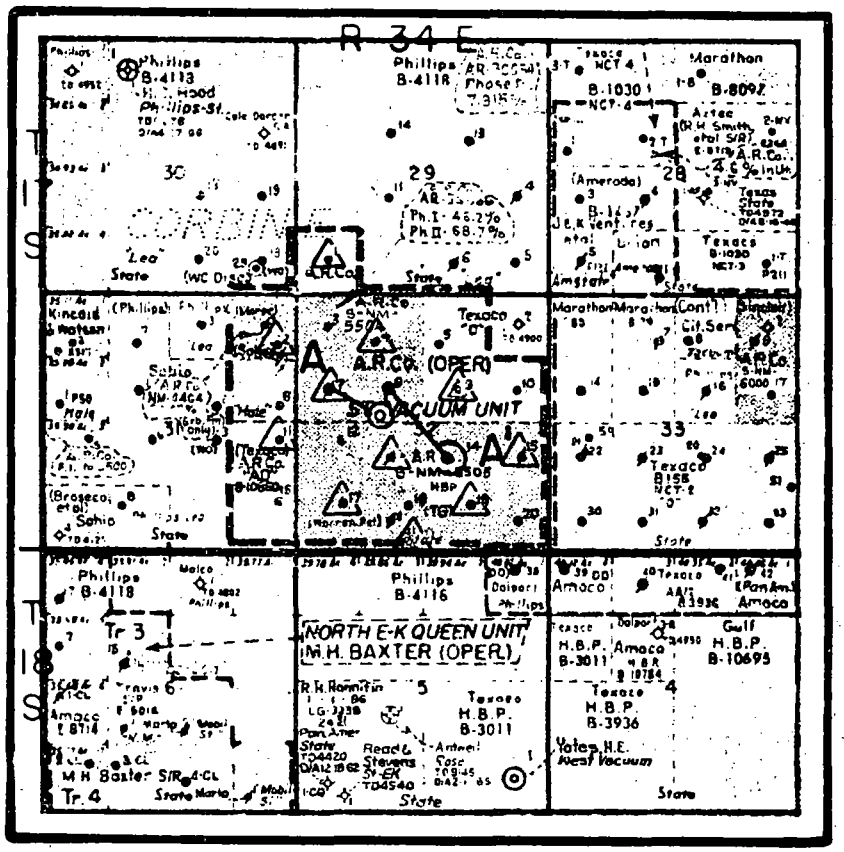
AtlanticRichfieldCompany
North American Producing Division
Permian District Midland, Texas

VACUUM FIELD
Lea County, New Mexico

STATE VACUUM UNIT

STRUCTURE MAP
TOP OF SAN ANDRES

J. A. FRAGA
3-83
WEST ENGR.



INDEX MAP
Scale 1" = 4000'

FIGURE 6

ARCO Oil and Gas Company
Permian District Midland, Texas

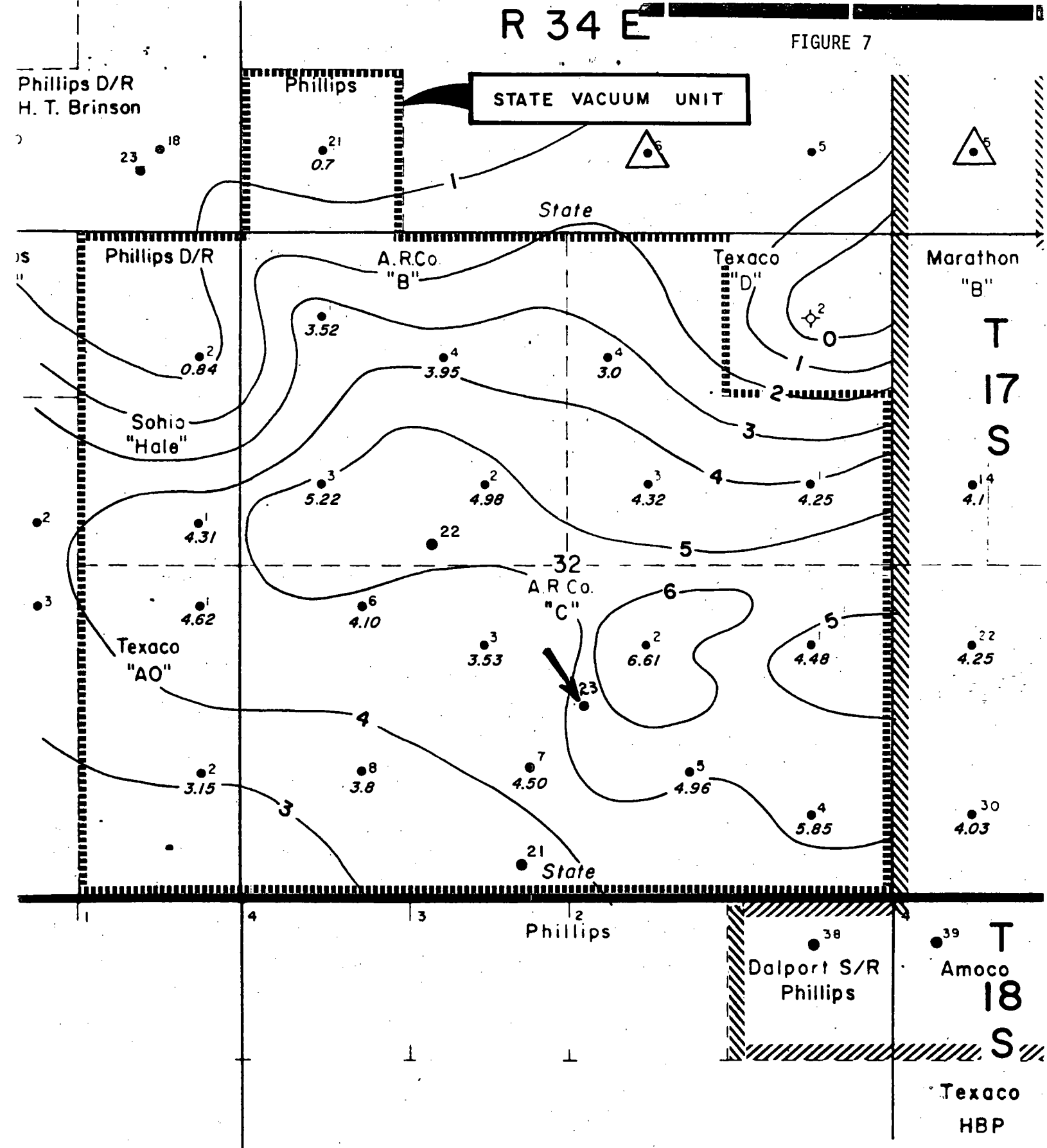
STATE VACUUM UNIT
LEA COUNTY, NEW MEXICO

CROSS SECTION A-A'

VERT. SCALE 1" = 100'

T. FRAGA — 3-82
3-82
WEST AREA ENGR

FIGURE 7

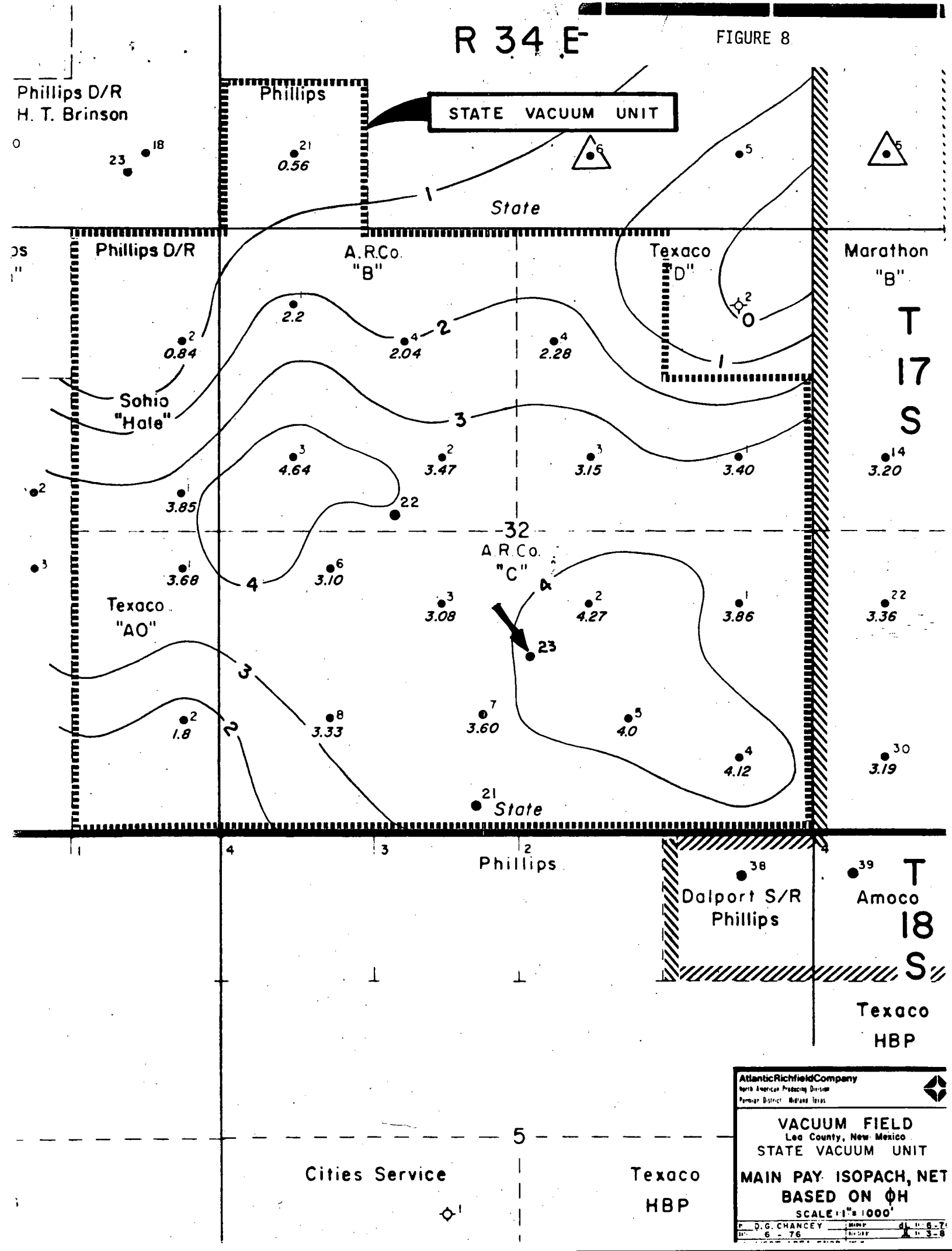


AtlanticRichfieldCompany
North American Producing Division
Permian District Midland Texas

VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT
TOTAL PAY ISOPACH, NET
BASED ON ϕH

D G. CHANCEY — dL 6-76
6 - 76 — 3-83
WEST AREA ENGR.

FIGURE 8



AtlanticRichfieldCompany
North American Producing Division
Permian District Midland Texas

VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT

MAIN PAY ISOPACH, NET
BASED ON ϕH
SCALE: 1" = 1000'

D.G. CHANCEY
6 - 76

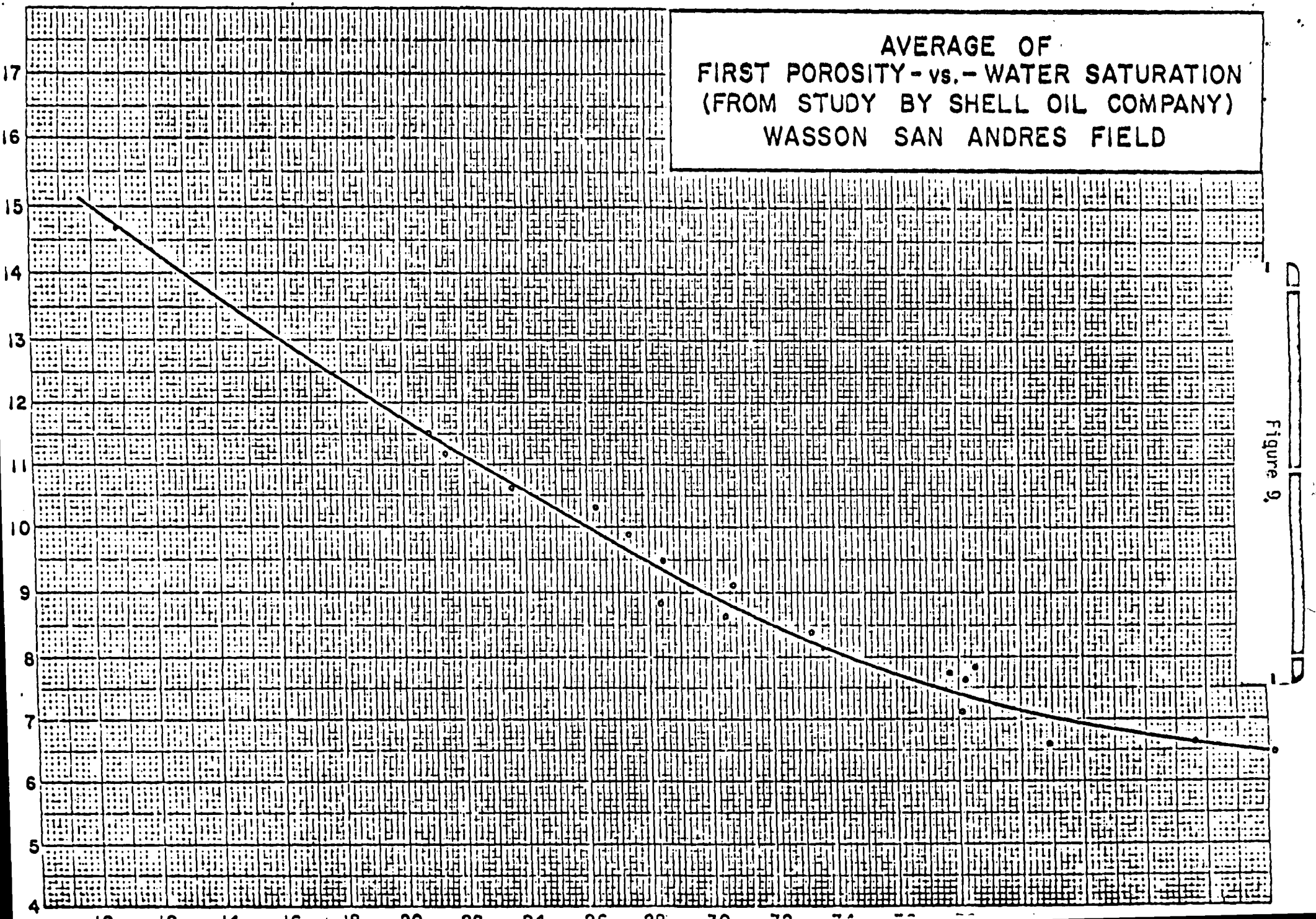

AVERAGE OF
FIRST POROSITY - vs. - WATER SATURATION
(FROM STUDY BY SHELL OIL COMPANY)
WASSON SAN ANDRES FIELD
17
16
15
14
13
12
11
10
9
8
7
6
5
4
10
12
14
16
18
20
22
24
26

Figure 9.

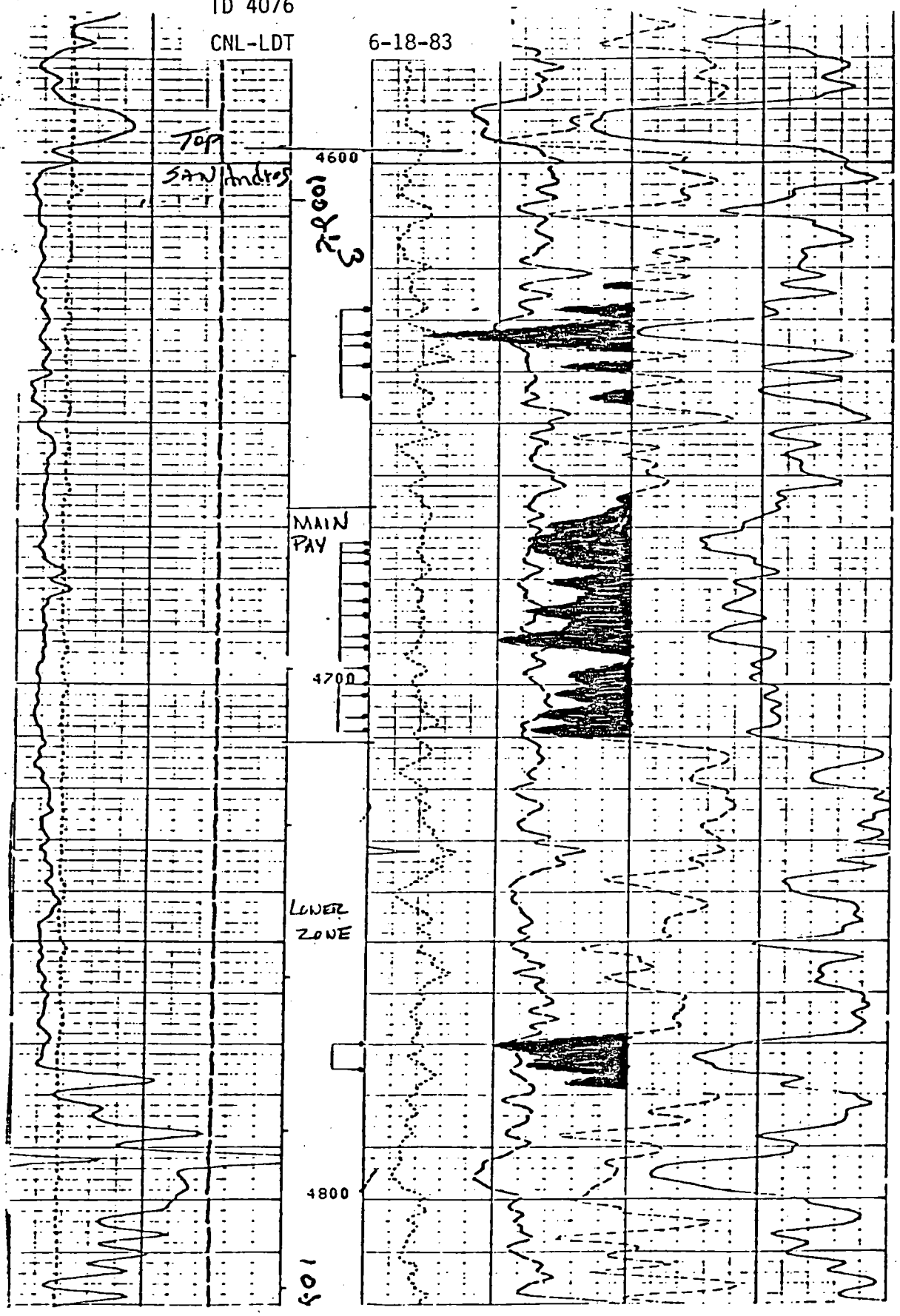

ARCO Oil and Gas Company
State Vacuum Unit #23
KB 4085
TD 4076
CNL-LDT
6-18-83
Top
San Andres
4600
MAIN
PAY
4700
LOWER
ZONE
4800

FIGURE 10

Figure 11
Continued Operations vs Infill Drilling

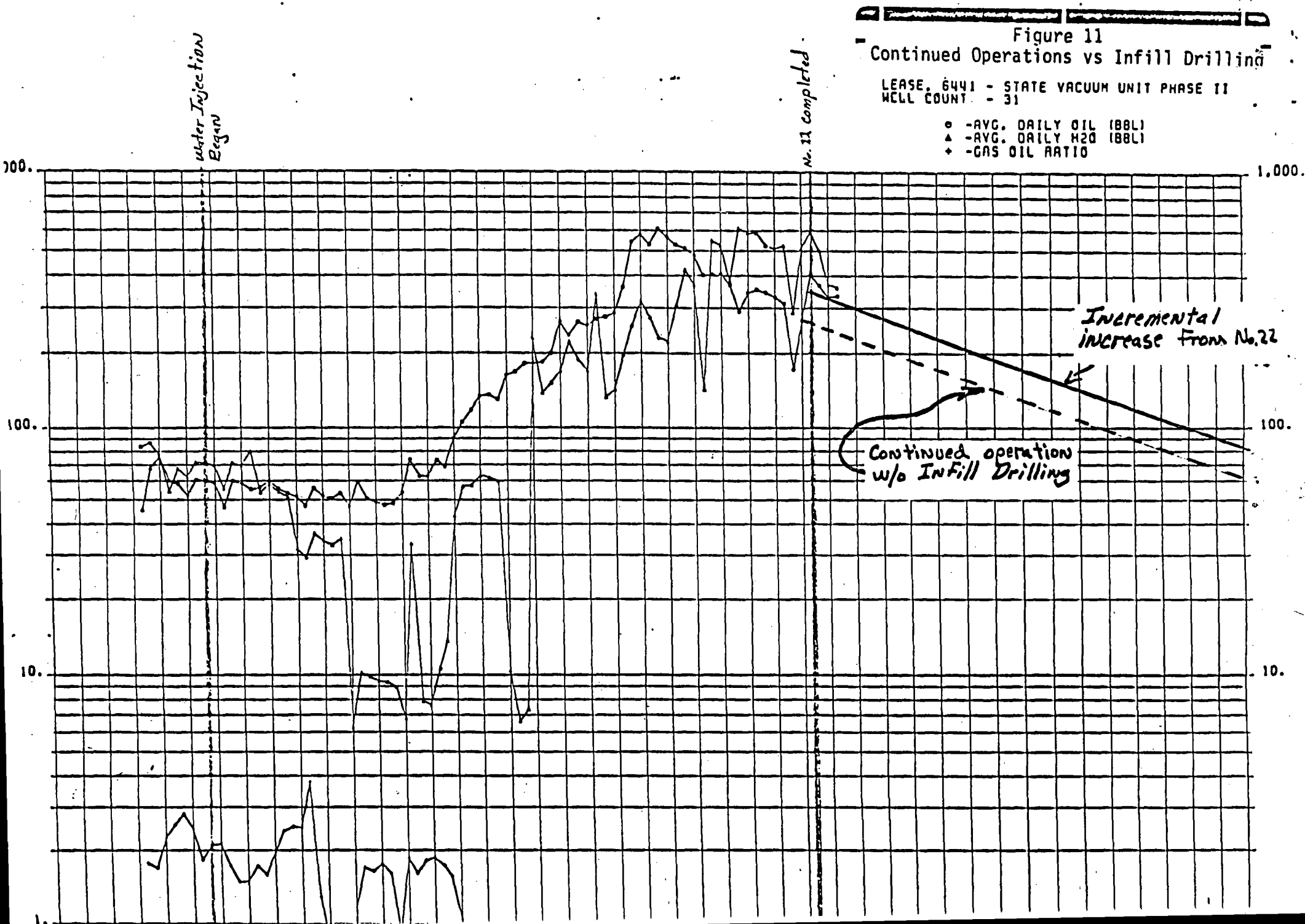


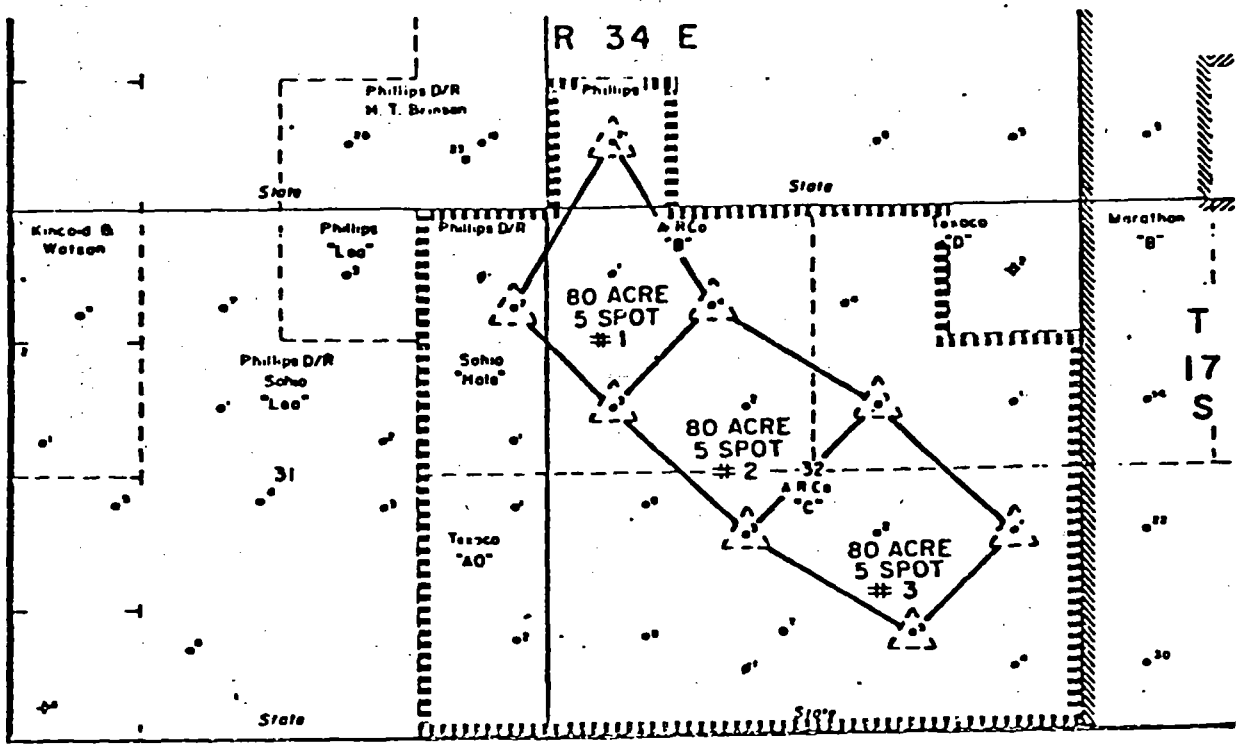
Table I

Basic Reservoir Data

Unit:	State Vacuum Unit
Operator:	ARCO Oil and Gas Company
Field:	Vacuum Grayburg-San Andres
Lithology:	Dolomite and Limestone
Area:	800 Acres
Average Porosity:	9.88%
Average Permeability:	17.8 md
Initial Formation Volume Factor:	1.26 RB/STB
Connate Water Saturation:	26.5%
Residual Oil Saturation:	30.0%
Oil Gravity:	37° API
Average GOR:	175 SCF/bbl
Original Oil In Place:	13,306 MSTBO
Primary Recovery (40-acres):	3,266 MSTBO
Secondary Recovery (40-acres):	1,700 MSTBO

TABLE 2

STRATIFICATION ANALYSIS



	% Thickness of Total	Kl, md	Scw,%	Sgx,%	Sor,%
80-ACRE 5-SPOT NO. 1					
Layer #1	42.1	4.6	26.5	24.0	30.0
Layer #2	37.0	1.7	26.5	24.0	30.0
Layer #3	20.9	0.5	26.5	24.0	30.0
	100.0				
80-ACRE 5-SPOT NO. 2					
Layer #1	25.4	26.0	26.5	24.0	30.0
Layer #2	30.8	8.6	26.5	24.0	30.0
Layer #3	17.6	2.8	26.5	24.0	30.0
Layer #4	14.9	1.0	26.5	24.0	30.0
Layer #5	11.3	0.4	26.5	24.0	30.0
	100.0				
80-ACRE 5-SPOT NO. 3					
Layer #1	18.2	19.8	26.5	24.0	30.0
Layer #2	23.5	7.0	26.5	24.0	30.0
Layer #3	29.4	2.6	26.5	24.0	30.4
Layer #4	12.6	0.9	26.5	24.0	30.4
Layer #5	16.3	0.3	26.5	24.0	30.4
	100.0				

Appendix A

I. Incremental Secondary Reserves with 20-acre Infills:

OOIP = 13,306 MBO (Eng. Study 1976)
Recovery Factor = .039 (EVU Eng. Study, Phillips)
Additional Reserves from 20-acre Spacing = 519 MBO
Unit Area = 800 acres
therefore, Equivalent 20-acre infills required = 20

519 MBO ÷ 20 Wells = 26 MBO/Well Incremental Oil

(26 MBO/Well)(175 SCF/STB) = 4.55 MMCF/Well Incremental Gas

II. Undrained Primary Reserves for Typical 20-acre Infill Location:

Øh = 4.56 (log data)
Sw = .265 (Eng. Study 1976)
Recovery Factor = .248 (Eng. Study 1976)
Boi = 1.26 RB/STB (Eng. Study 1976)
A = 6 acres (Undrained area planimetered from drainage maps)

$$\frac{7758\ A\emptyset h(1-Sw)}{Boi} \times R_f = \frac{7758(5)(4.56)(1-.265)}{1.26} \times .248 =$$ 25.6 MBO Primary Reserves from 20-acre Spacing

25.6 MBO x 175 SCF/STB = 4.48 MMCF Primary Gas

III. New Primary Reserves from A Lower Zone:

Øh = 0.96
A = 20 acres

$$\frac{7758\ A\emptyset h(1-Sw)}{Boi} \times R_f = \frac{7758(20)(1)(1-.265)}{1.26} \times .248 =$$ 21.6 MBO Primary Reserves for Lower Zone

21.6 MBO x (175 SCF/STB) = 3.78 MMCF Primary Gas

ARCO Oil and Gas Company
Natural Gas Marketing
Post Office Box 2819
Dallas, Texas 75221
Telephone 214 880 4675

Paul T. Davis
Manager, Gas Regulations

February 1, 1984

Department of Energy and Minerals
Attn: Michael Stogner
Oil Conservation Division
P. O. Box 2088
Santa Fe, New Mexico 87501

RE: NGPA - Well Pricing Category Determination
State Vacuum Unit #23
Lea County, New Mexico
AR #46429

Gentlemen:

Pursuant to Order No.R-5878-B of the Oil Conservation Division, ARCO Oil and Gas Company, a Division of Atlantic Richfield Company (ARCO) submitted an application for determination of Section 103, New Onshore Well pricing category on December 13, 1983.

Please find attached another copy of our application for Infill Findings. We hope this is in compliance with New Mexico Oil Conservation Division's Order No. R-6013-A. We are sorry for this inconvenience.

Please return the extra copy of this letter with evidence of your receipt thereof, in the enclosed, self-addressed envelope.

Very truly yours,

Donna G. Harrison

Donna G. Harrison
Sr. Gas Regulations Administrator
(214) 880-5168

DGH/ld

Enclosures

State Vacuum Unit #23
Lea County, New Mexico
AR #46429

"Infill Finding"

Rules and Regulations
Natural Gas Policy Act Infill Findings
Administrative Procedure

Rule 3: No waivers from offset operators are necessary. See Exhibit 1

Rule 5: See attached approved Form C-101 for the infil well and Form C-102 showing proration unit dedicated.

Rule 6: See Well Completion Report and Log for name of the pool in which the infill well has been drilled and the standard spacing unit size therefor.

Rule 7: Exhibit 2: Number of the Division Order approving the non-standard proration unit dedicated to the well.

Rule 8: Exhibit I: Description of all wells drilled on proration unit.

Rule 9: See Engineering Discussion plus all "figures" associated within.

STATE OF NEW MEXICO
ENERGY AND MINERALS DEPARTMENT
OIL CONSERVATION DIVISION

May 23, 1983

TONEY ANAYA
GOVERNOR

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

ARCO OIL AND GAS COMPANY
P.O. Box 1610
Midland, Texas 79702

Attention: J. A. Fraga

Administrative Order NSL-1699

Gentlemen:

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By authority granted me under the provisions of Rule 104 F of the Division Rules and Regulations, the above-described unorthodox location is hereby approved.

Sincerely,

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Director

JDR/RLS/dp

cc: Oil Conservation Division - Hobbs
Oil & Gas Engineering Committee - Hobbs
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RECEIVED
JUN 01 1983

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Using the 3.9% infill recovery value and the total pay zone OOIP reserves, additional secondary reserves of 518,929 STB were calculated for the unit. The 800 acre unit would require 20 equivalent 20-acre infill wells for a recovery of about 26 MBO/well location. These calculations are outlined in Appendix A.

Primary drainage analysis of the State Vacuum Unit were done using volumetrics, decline curves and production data. This analysis indicated that each 20-acre infill well will drain 5 acres previously missed at 40-acre spacing. Incrementally each infill well will recovery 26 MBO (see Appendix A).

The State Vacuum Unit No. 23 will also produce primary reserves from a lower zone near the top of the Lovington Sand (see Figure 10). The porosity logs indicate this zone to contain 8 feet of net pay with about 12% porosity. Estimate recoverable primary reserves for the lower zone, using 20-acre spacing and a 24.8% recovery factor, is 22 MBO. Secondary reserves were not calculated since this zone at present is not being flooded.

Premature water breakthrough has been experienced in several wells, as is seen in the attached plots (see Fig. 1-3). The 20-acre spacing will drain reserves being bypassed due to the breakthrough.

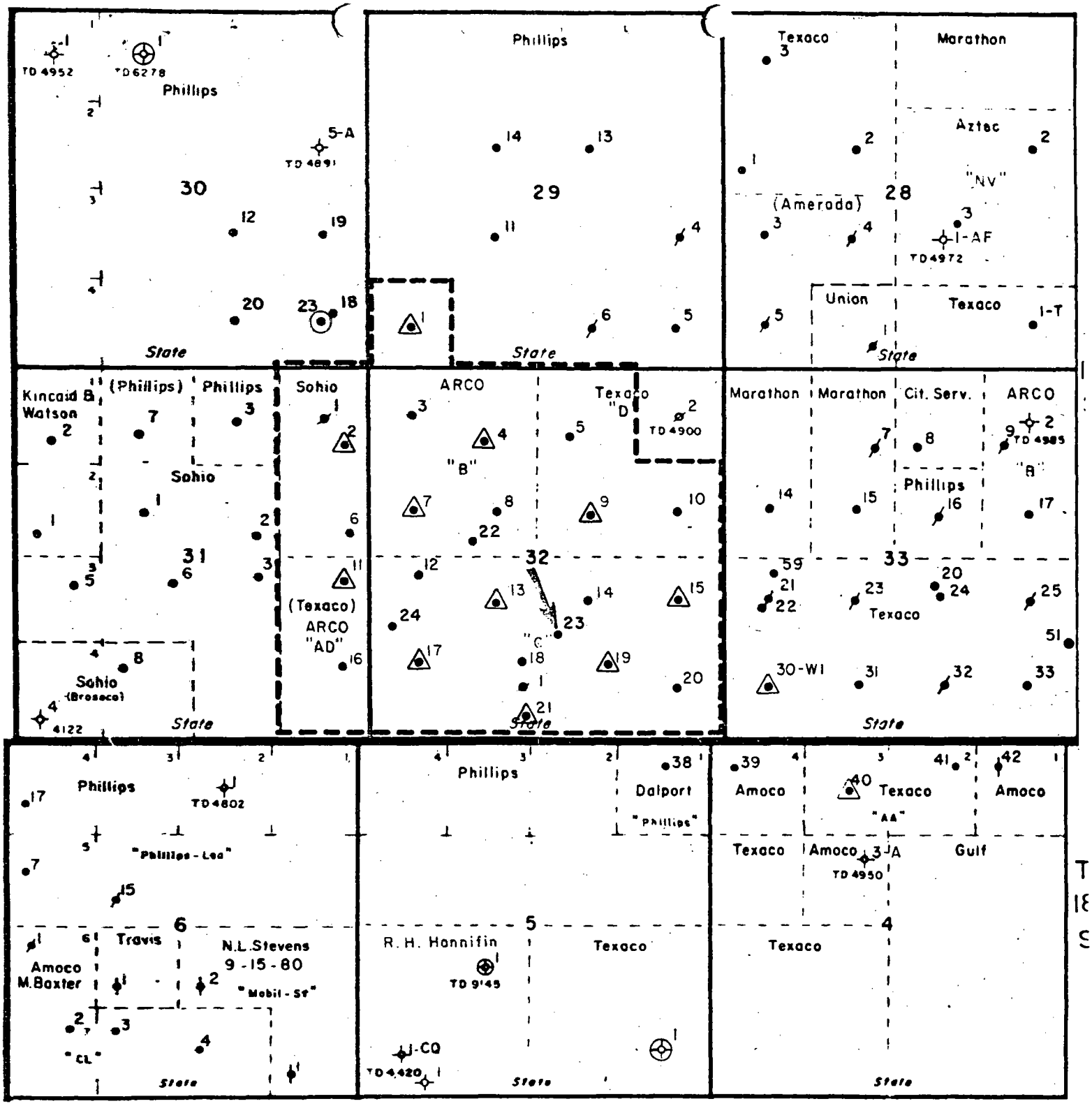
CONCLUSION

By drilling the infill Well No. 23 we will recover new reserves of approximately 74 MSTBO. Gas production in association with this oil will be 12.95 MMCF.

The production history of the State Vacuum Unit and other units in this field indicate that to effectively and efficiently produce the Vacuum Grayburg-San Andres reservoir, 20-acre spacing is necessary. By going to this closer spacing, additional pay will be encountered and flooded. Additional primary reserves that were undrained on 40-acre spacing will be recovered along with secondary reserves bypassed due to premature water breakthrough.

JAF:dmm

11/21/83



R 34 E

T 18 S

LEGEND

- UNIT BOUNDARY
- PRODUCER - SAN ANDRES
- INJECTOR - SAN ANDRES
- PROPOSED LOCATION

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

VACUUM (GRBG - S.A.) AREA
STATE VACUUM UNIT
Lea County, New Mexico

Scale 1" = 2000'

By J A Frigo	Drawn By TCB	Date 10-82
Date 10-20-82	Revised By	Date 5-83
Dwgr West Engineering	Dwg No	

HPP RELEASE 4.6 - PLOT SEQ NO. 2
CONFIDENTIAL, (A O G C)

Figure 1
State Vacuum Unit No. 6

o -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

FIELD. 830 - VACUUM
LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES

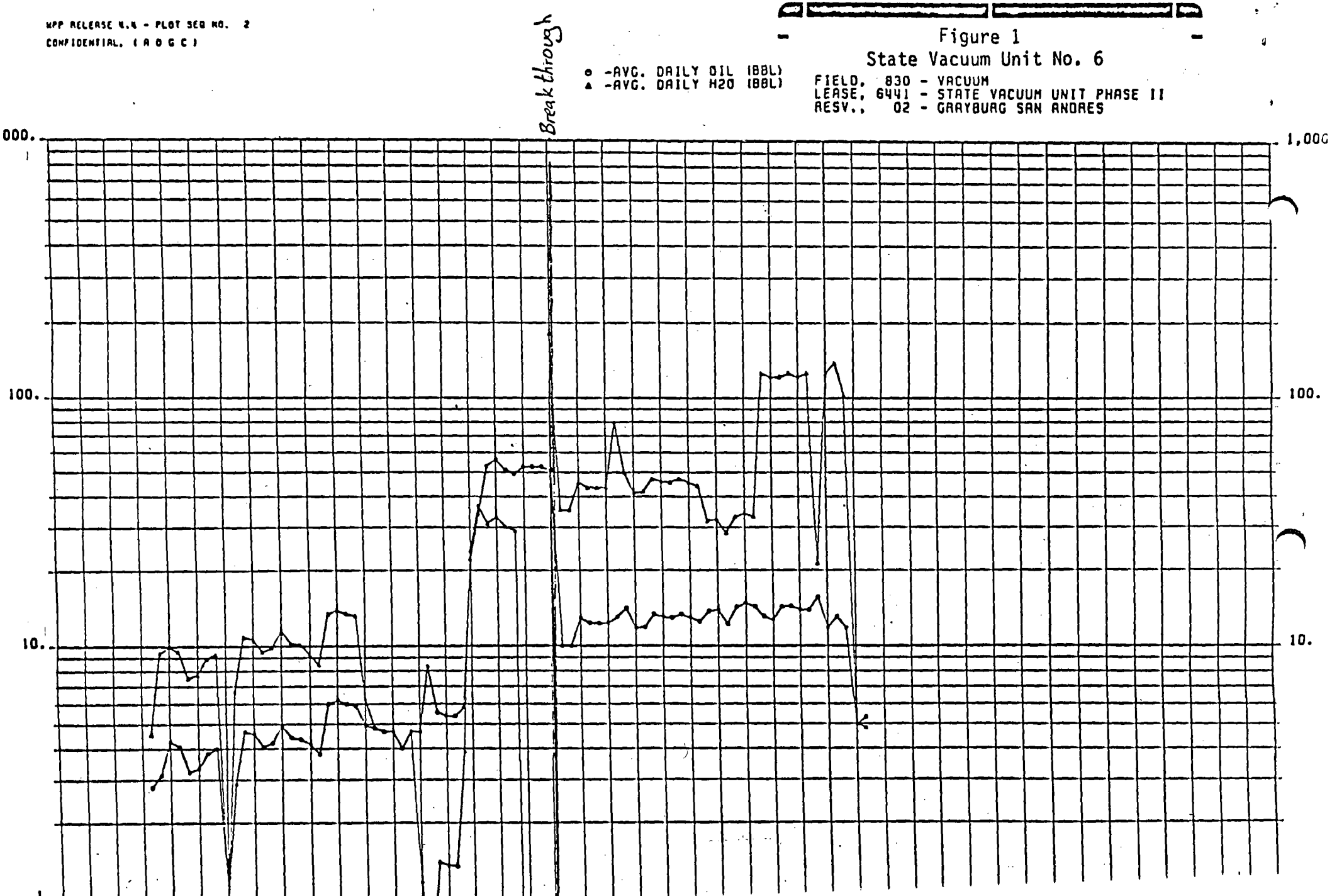


Figure 2
State Vacuum Unit No. 10

LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES
● -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

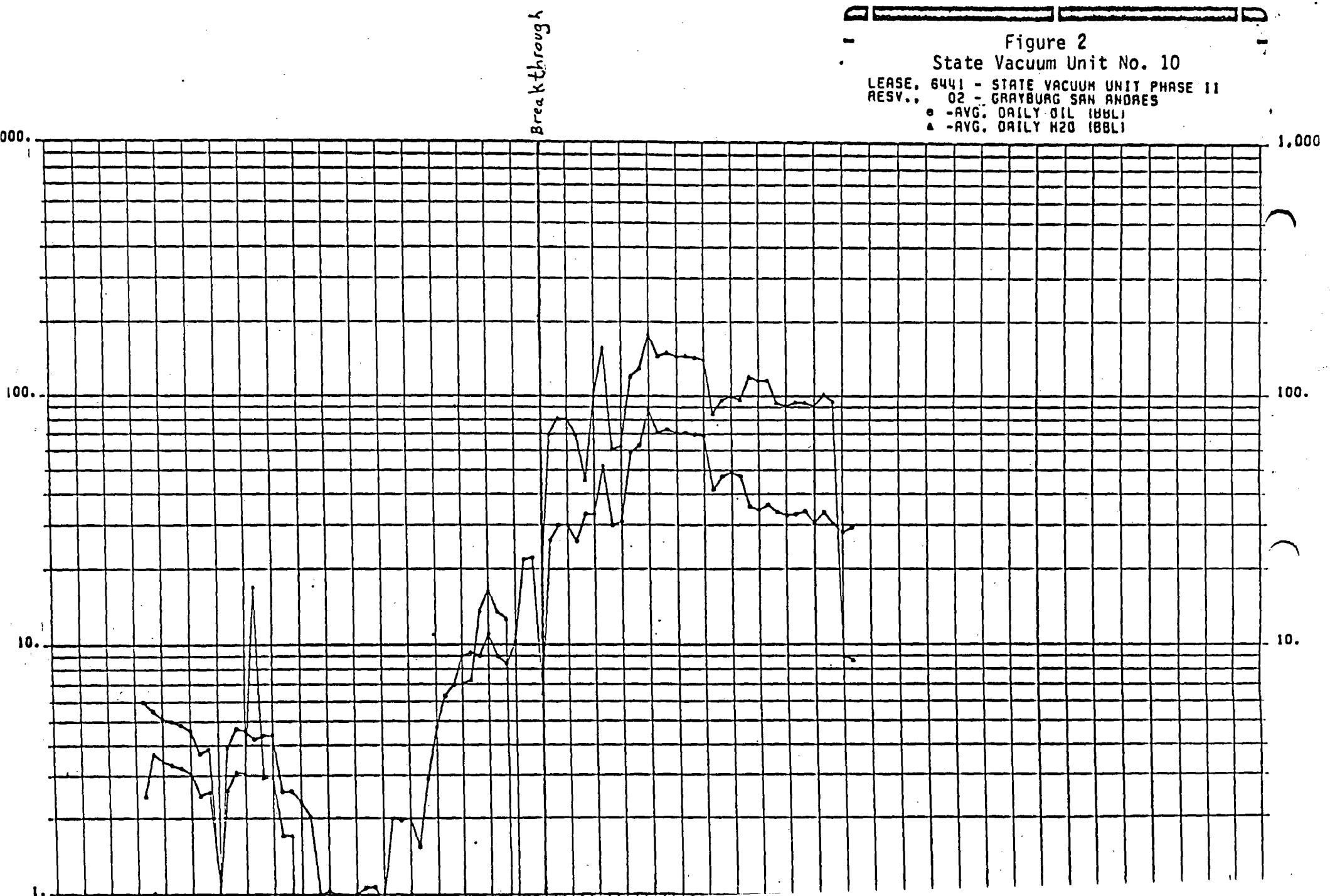


Figure 3
State Vacuum Unit No. 14

LEASE, 6441 - STATE VACUUM UNIT PHASE II
RESV., 02 - GRAYBURG SAN ANDRES

• -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)

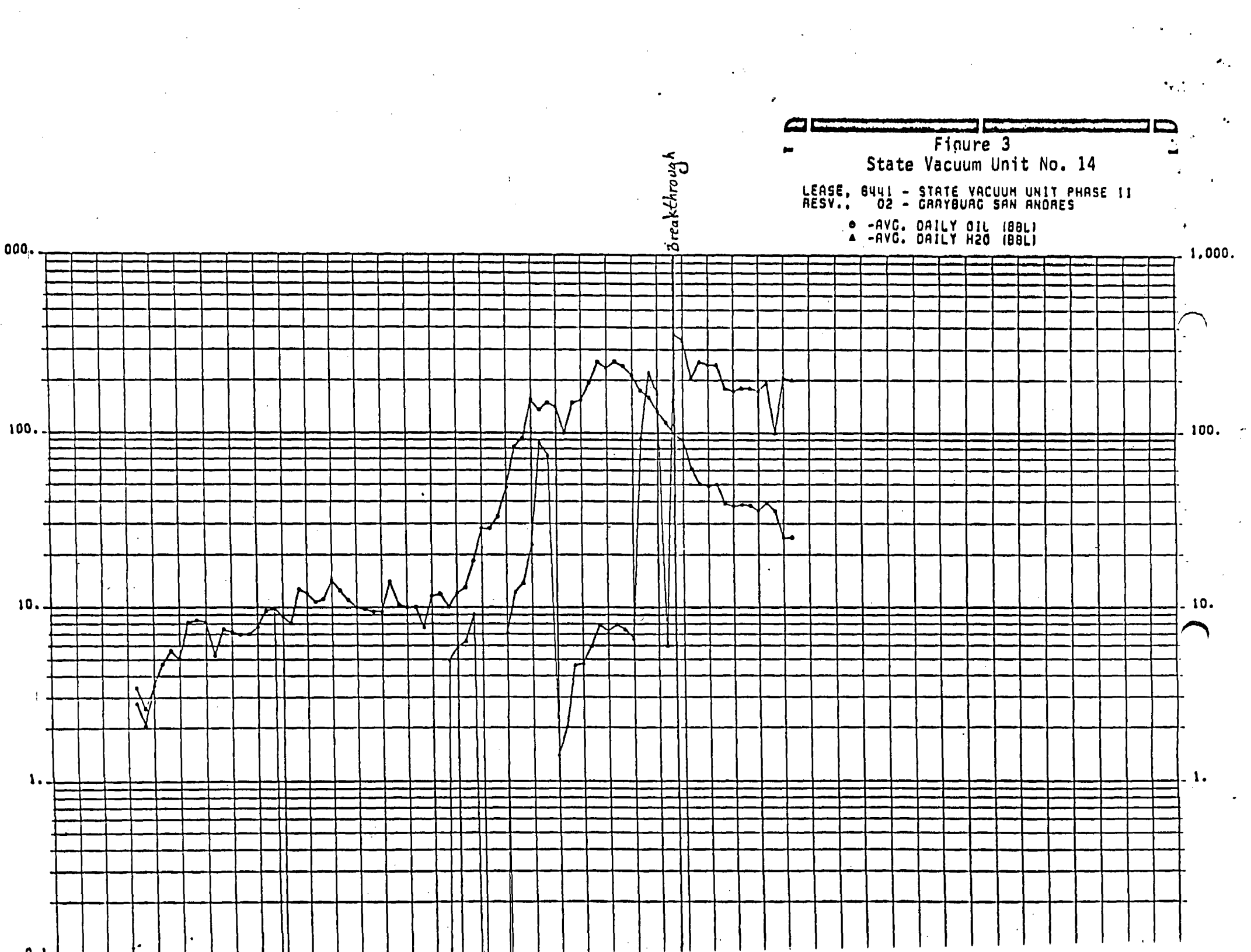
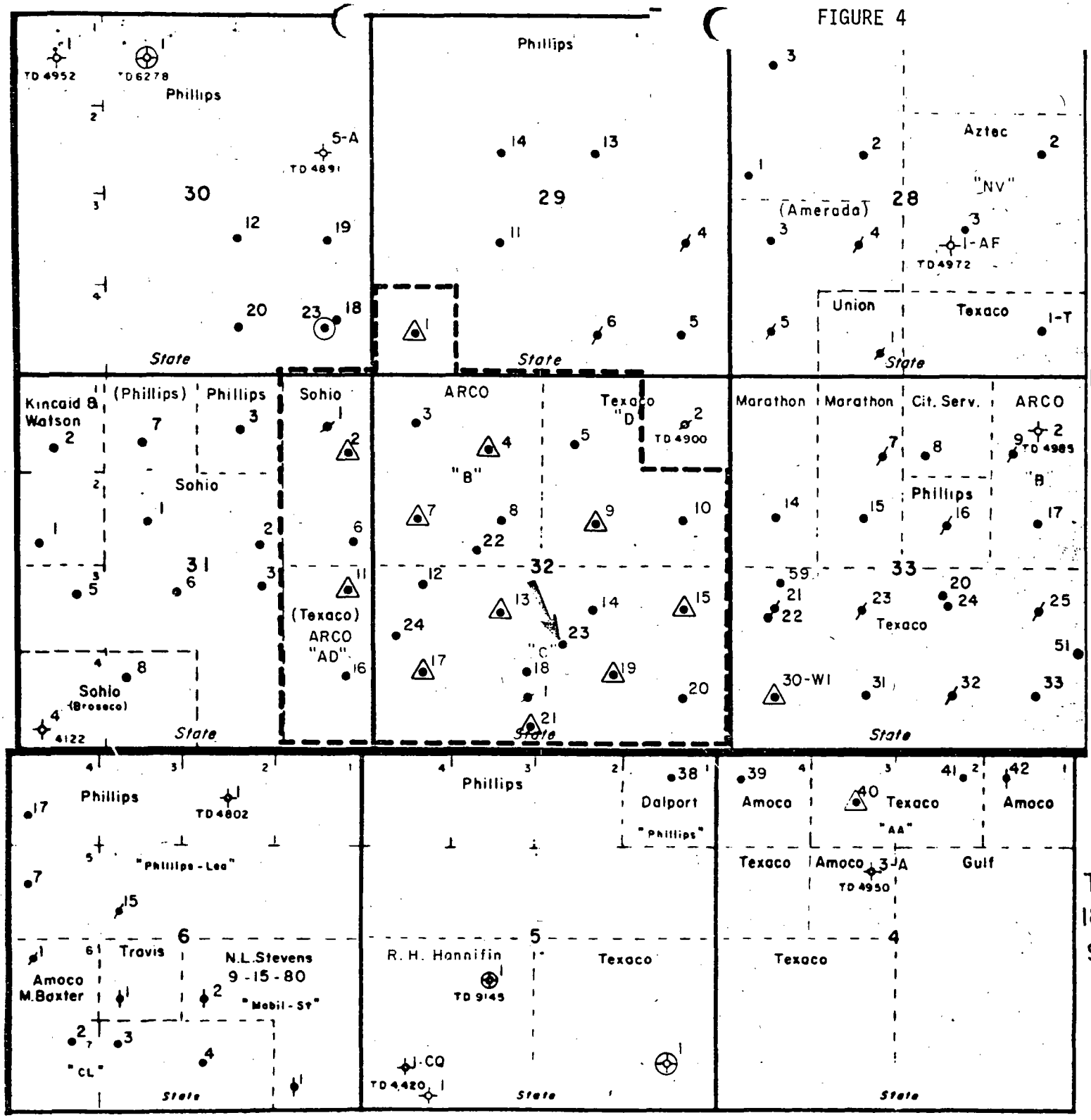


FIGURE 4



R 34E

LEGEND

- UNIT BOUNDARY
- PRODUCER - SAN ANDRES
- INJECTOR - SAN ANDRES
- PROPOSED LOCATION

ARCO Oil and Gas Company

Permian District Midland, Texas

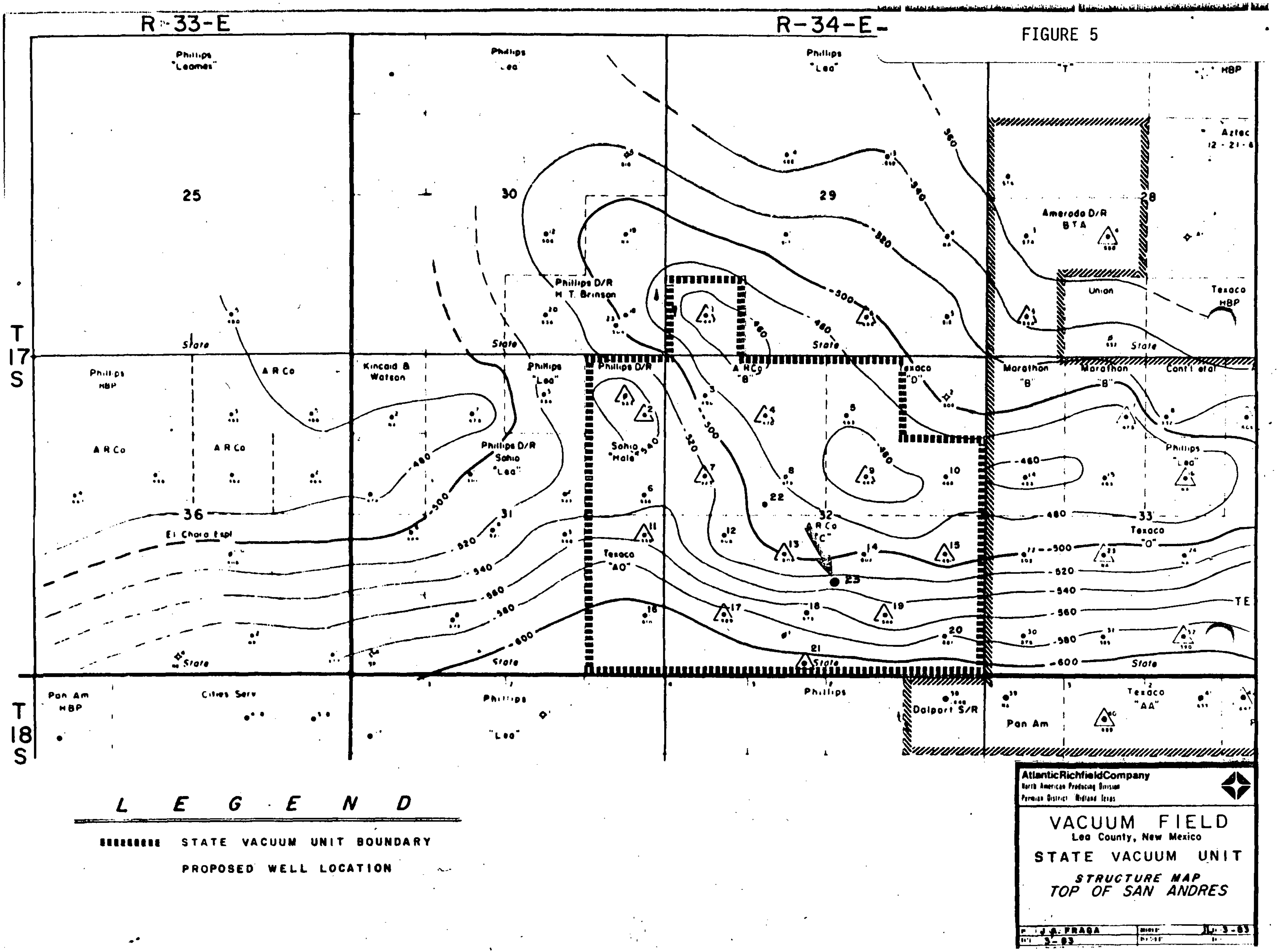
VACUUM (GRBG - S.A.) AREA
STATE VACUUM UNIT

Lea County, New Mexico

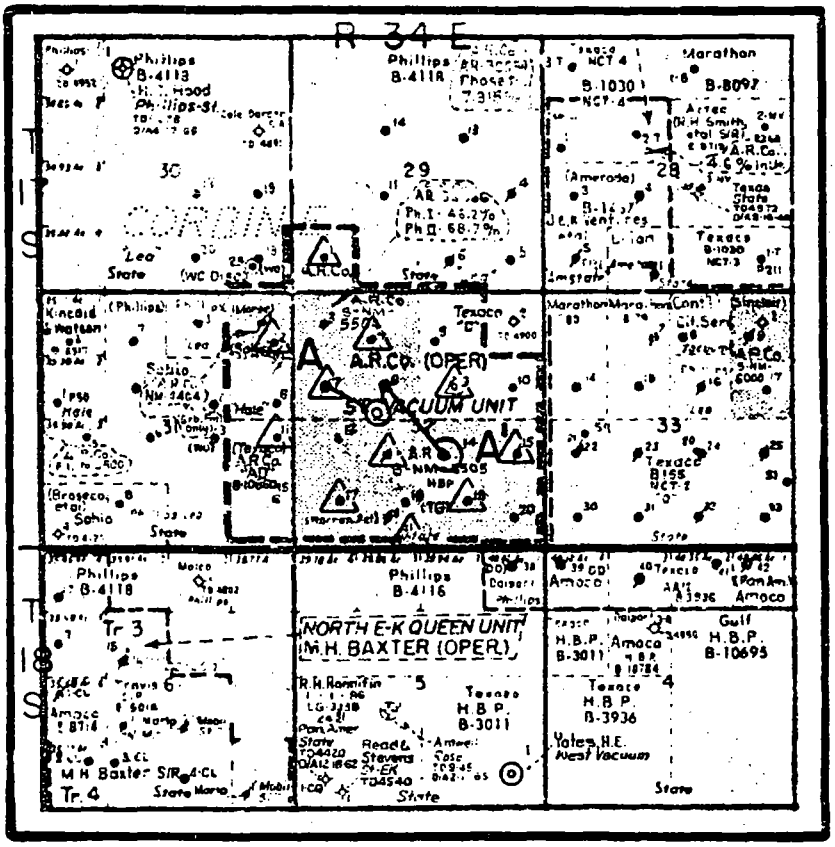
Scale 1" = 2000'

By J A Frigo	Drawn By TCB	Date 10-82
Date 10-20-82	Revised By	Date 5-83
Dwg West Engineering	Dwg No	

FIGURE 5


R-33-E
R-34-E
T 17 S
T 18 S
25
30
29
28
36
31
32
33
Phillips "Leamex"
Phillips "Lea"
Phillips HBP
A R Co
Kincaid & Watson
Phillips D/R H. T. Brinson
Phillips D/R Sohio "Lea"
Phillips D/R
Sohio "Hale"
A RCo "B"
Texaco "D"
Amerada D/R B T A
Union
Texaco HBP
Aztec 12-21-6
Marathon "B"
Cont'l etal
Phillips "Lea"
Texaco "O"
Texaco "AO"
A R Co "C"
El Charo Expl
State
HBP
Pan Am HBP
Cities Serv
Phillips "Lea"
Phillips
Dalport S/R
Pan Am
Texaco "AA"
L E G E N D
STATE VACUUM UNIT BOUNDARY
PROPOSED WELL LOCATION
AtlanticRichfieldCompany
North American Producing Division
Permian District Midland Texas
VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT
STRUCTURE MAP
TOP OF SAN ANDRES
J. A. FRAGA
3-83

SI



INDEX MAP
Scale 1" = 4000

FIGURE 6

ARCO Oil and Gas Company

Permian District Midland Texas

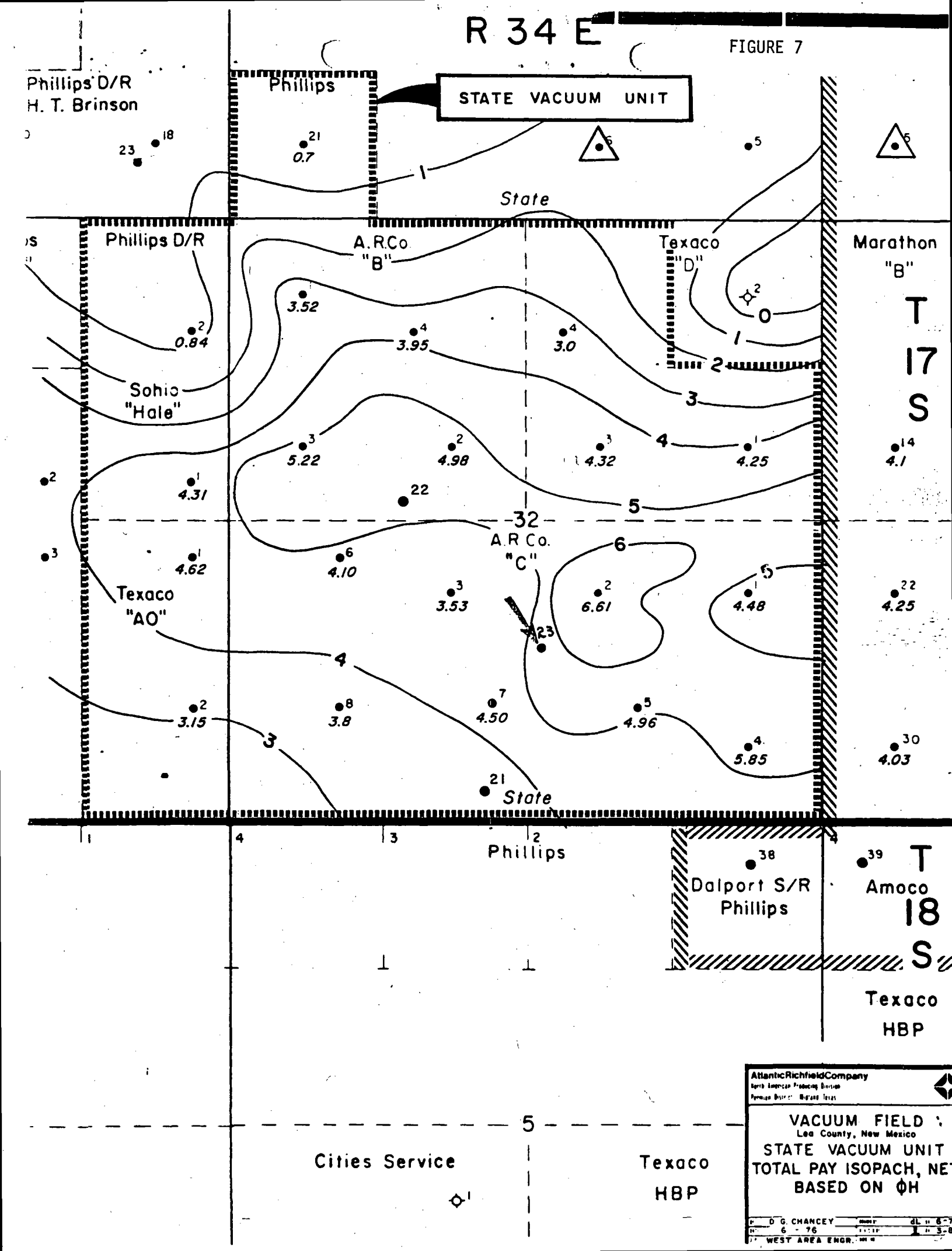
STATE VACUUM UNIT

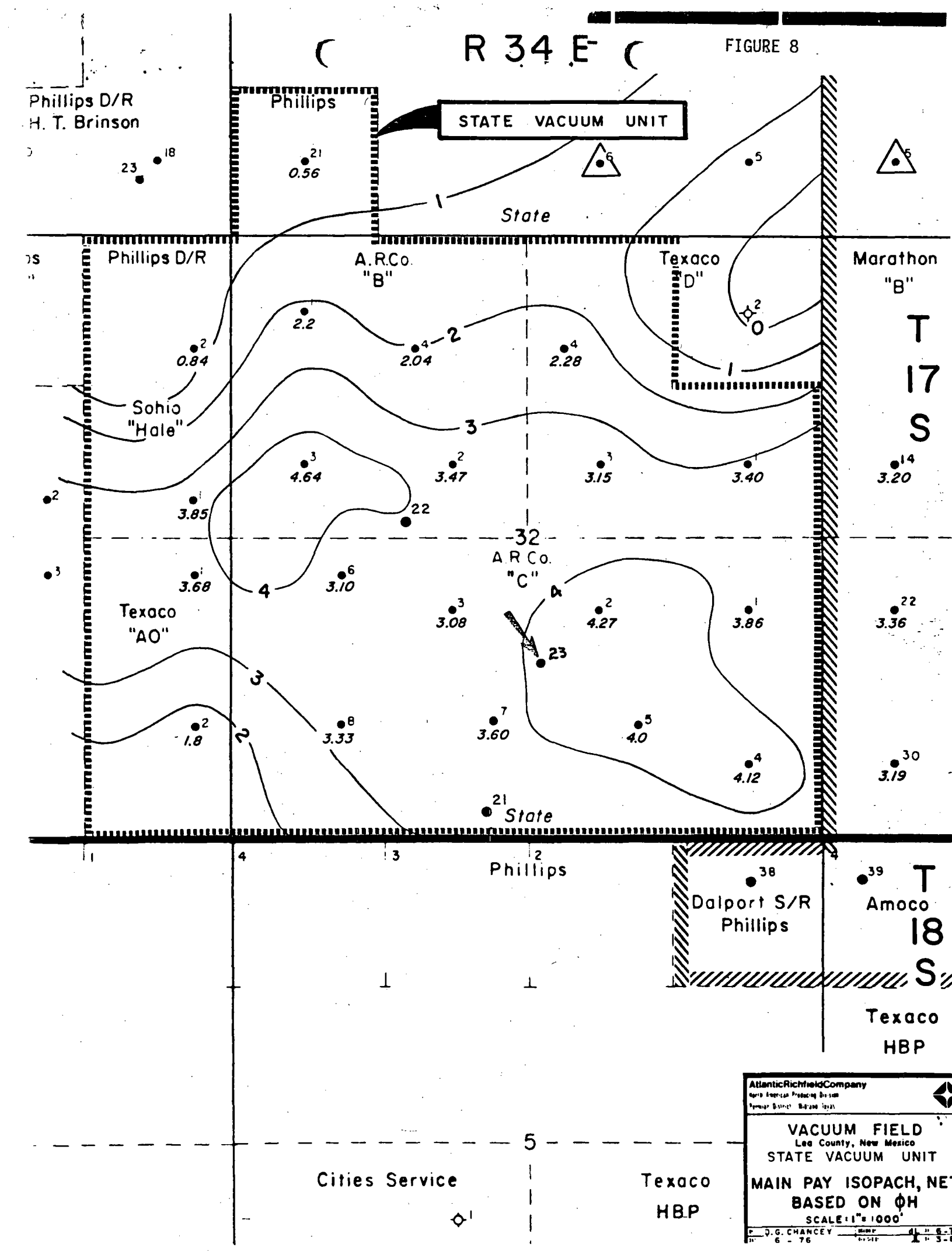
LEA COUNTY, NEW MEXICO

CROSS SECTION A-A

T. FRAGA 3-82

3-82


R 34 E
FIGURE 7
STATE VACUUM UNIT
Phillips D/R
H. T. Brinson
Phillips
State
Phillips D/R
A.R.Co
"B"
Texaco
"D"
Marathon
"B"
Sohio
"Hale"
Texaco
"AO"
A.R Co.
"C"
Dalport S/R
Phillips
Amoco
Phillips
Cities Service
Texaco
HBP
Texaco
HBP
T
17
S
T
18
S
32
5
1
4
3
2
0.7
3.52
0.84
3.95
3.0
5.22
4.98
4.32
4.25
4.1
4.31
4.62
4.10
3.53
6.61
4.48
4.25
3.15
3.8
4.50
4.96
5.85
4.03
AtlanticRichfieldCompany
North American Producing Division
Permian District Midland Texas
VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT
TOTAL PAY ISOPACH, NE
BASED ON ϕH
D. G. CHANCEY
6 - 76
WEST AREA ENGR.


R 34 E
FIGURE 8
STATE VACUUM UNIT
Phillips D/R
H. T. Brinson
Phillips
State
Phillips D/R
A.R.Co.
"B"
Texaco
"D"
Marathon
"B"
Sohio
"Hale"
A.R.Co.
"C"
Texaco
"AO"
Phillips
Dalport S/R
Phillips
Amoco
Cities Service
Texaco
HBP
Texaco
HBP
T
17
S
T
18
S
32
5
0.56
0.84
2.2
2.04
2.28
4.64
3.47
3.15
3.40
3.20
3.85
3.68
3.10
3.08
4.27
3.86
3.36
1.8
3.33
3.60
4.0
4.12
3.19
Atlantic Richfield Company
North American Producing Division
Permian District Midland, Texas
VACUUM FIELD
Lea County, New Mexico
STATE VACUUM UNIT
MAIN PAY ISOPACH, NET
BASED ON ϕH
SCALE: 1" = 1000'
D.G. CHANCEY
6 - 76

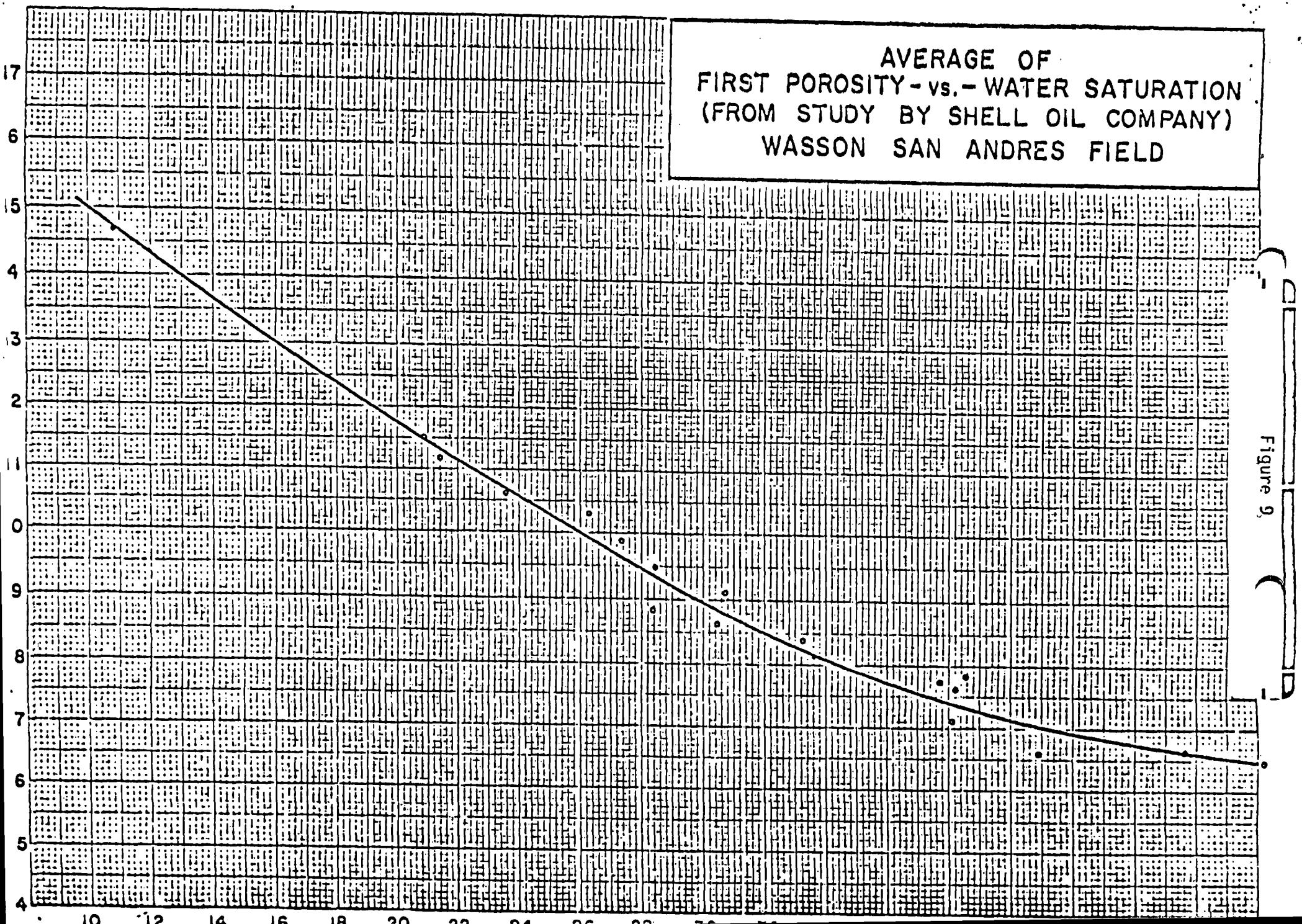

AVERAGE OF
FIRST POROSITY - vs. - WATER SATURATION
(FROM STUDY BY SHELL OIL COMPANY)
WASSON SAN ANDRES FIELD
17
6
15
4
3
2
1
0
9
8
7
6
5
4
10
12
14
16
18
20
22
24
26
28
30

Figure 9

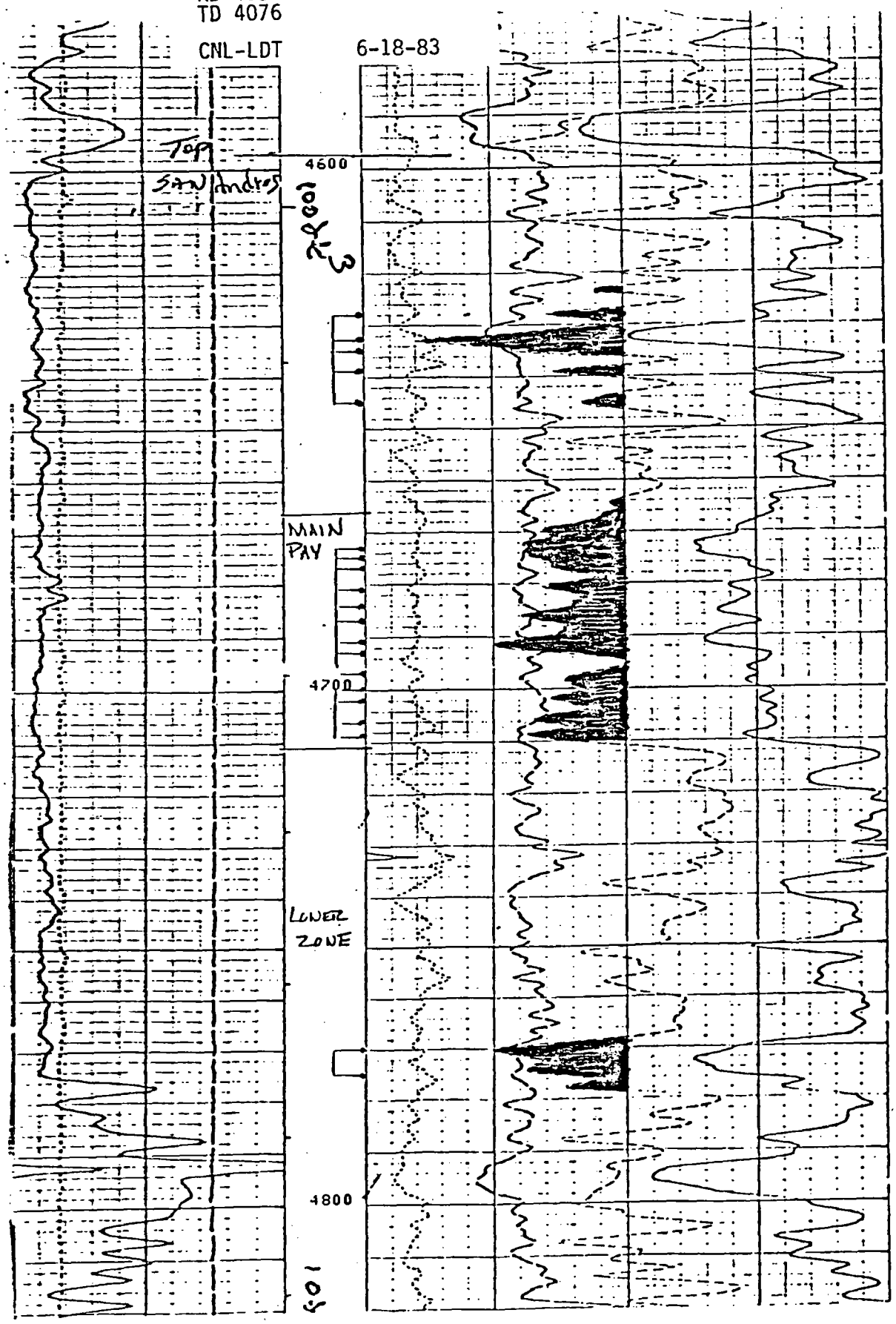

ARCO Oil and Gas Company
State Vacuum Unit #23
KB 4085
TD 4076
CNL-LDT
6-18-83
Top San Andres
4600
MAIN PAY
4700
LOWER ZONE
4800

FIGURE 10

Figure 11
Continued Operations vs Infill Drilling

LEASE, 6441 - STATE VACUUM UNIT PHASE II
WELL COUNT - 31

o -AVG. DAILY OIL (BBL)
▲ -AVG. DAILY H2O (BBL)
♦ -GAS OIL RATIO

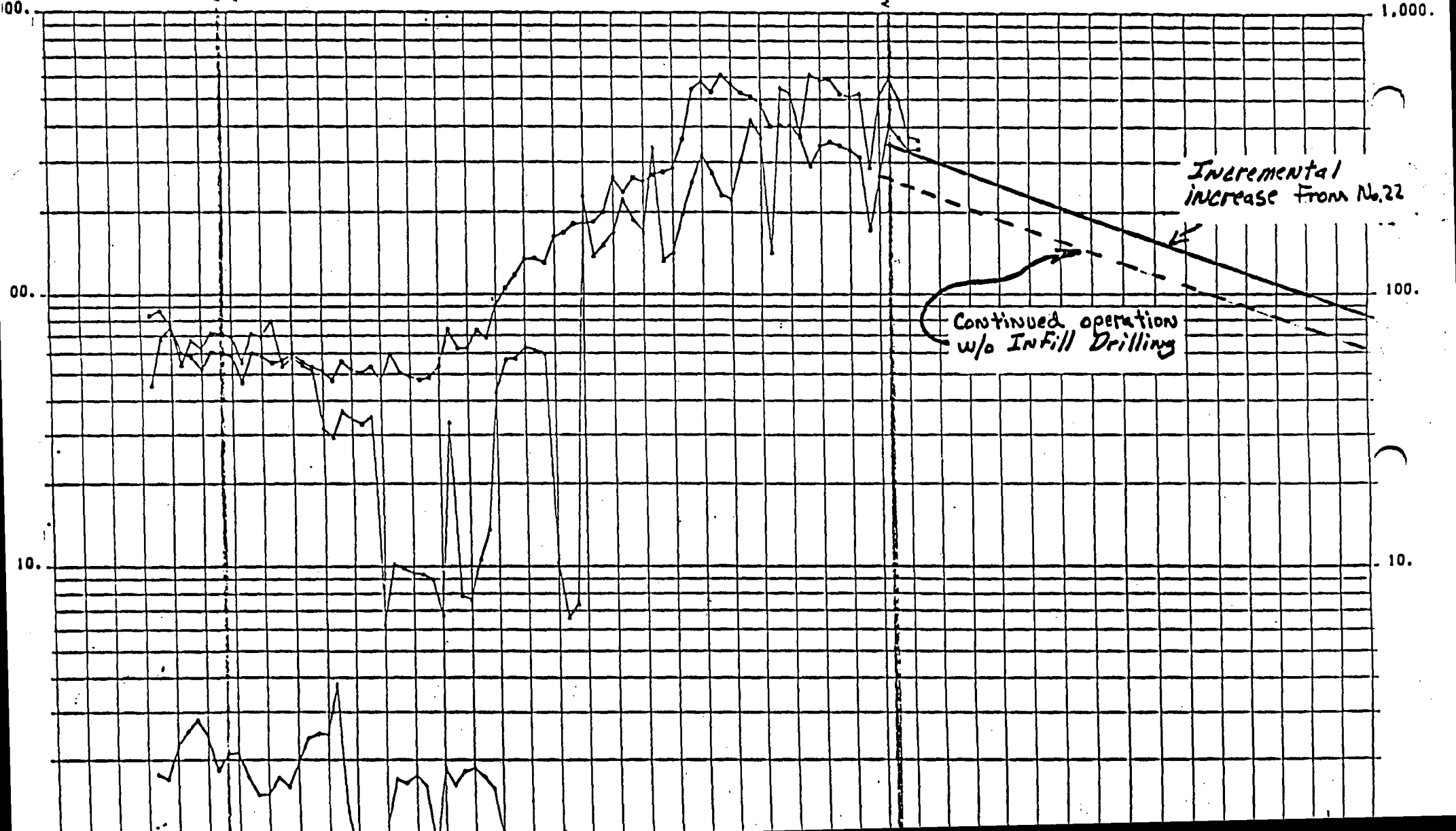


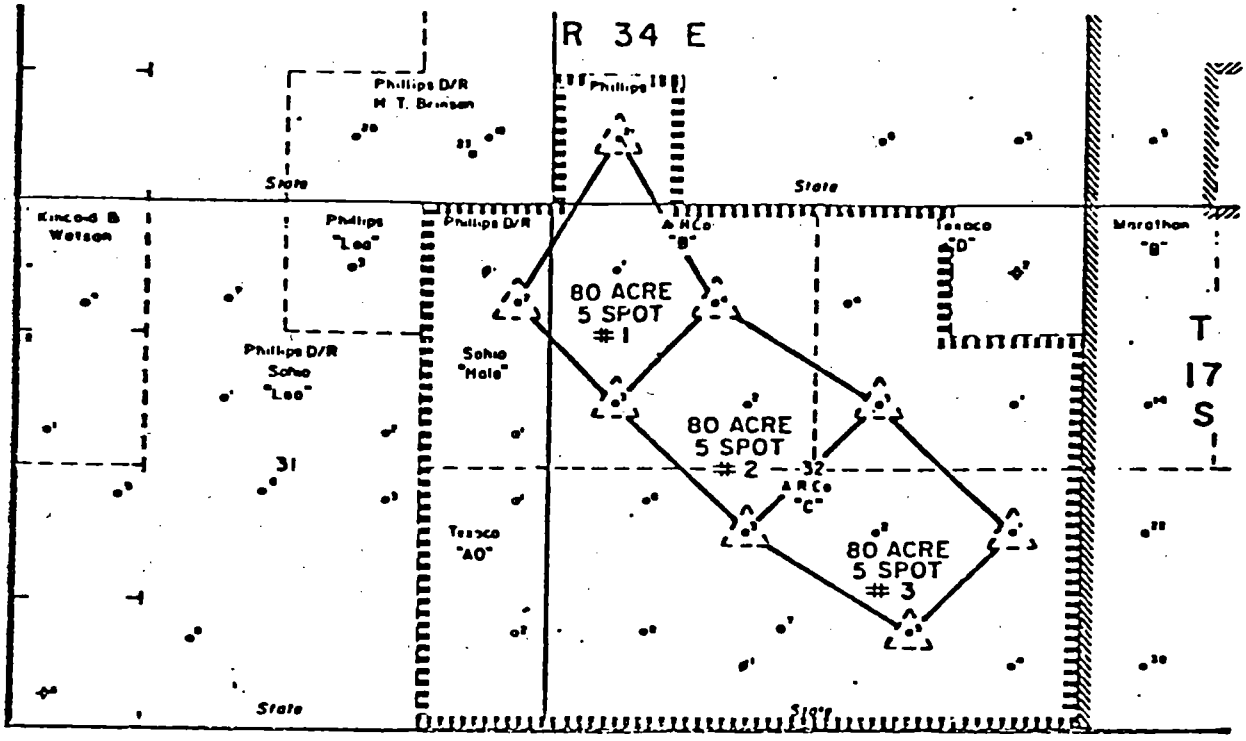
Table I

Basic Reservoir Data

Unit:	State Vacuum Unit
Operator:	ARCO Oil and Gas Company
Field:	Vacuum Grayburg-San Andres
Lithology:	Dolomite and Limestone
Area:	800 Acres
Average Porosity:	9.88%
Average Permeability:	17.8 md
Initial Formation Volume Factor:	1.26 RB/STB
Connate Water Saturation:	26.5%
Residual Oil Saturation:	30.0%
Oil Gravity:	37° API
Average GOR:	175 SCF/bbl
Original Oil In Place:	13,306 MSTBO
Primary Recovery (40-acres):	3,266 MSTBO
Secondary Recovery (40-acres):	1,700 MSTBO

TABLE 2

STRATIFICATION ANALYSIS



	% Thickness of Total	Kl, md	Scw,%	Sgx,%	Sor,%
80-ACRE 5-SPOT NO. 1					
Layer #1	42.1	4.6	26.5	24.0	30.0
Layer #2	37.0	1.7	26.5	24.0	30.0
Layer #3	20.9	0.5	26.5	24.0	30.0
	100.0				
80-ACRE 5-SPOT NO. 2					
Layer #1	25.4	26.0	26.5	24.0	30.0
Layer #2	30.8	8.6	26.5	24.0	30.0
Layer #3	17.6	2.8	26.5	24.0	30.0
Layer #4	14.9	1.0	26.5	24.0	30.0
Layer #5	11.3	0.4	26.5	24.0	30.0
	100.0				
80-ACRE 5-SPOT NO. 3					
Layer #1	18.2	19.8	26.5	24.0	30.0
Layer #2	23.5	7.0	26.5	24.0	30.0
Layer #3	29.4	2.6	26.5	24.0	30.4
Layer #4	12.6	0.9	26.5	24.0	30.4
Layer #5	16.3	0.3	26.5	24.0	30.4
	100.0				

Appendix A

I. Incremental Secondary Reserves with 20-acre Infills:

OOIP = 13,306 MBO (Eng. Study 1976)
Recovery Factor = .039 (EVU Eng. Study, Phillips)
Additional Reserves from 20-acre Spacing = 519 MBO
Unit Area = 800 acres
therefore, Equivalent 20-acre infills required = 20

519 MBO ÷ 20 Wells = 26 MBO/Well Incremental Oil

(26 MBO/Well)(175 SCF/STB) = 4.55 MMCF/Well Incremental Gas

II. Undrained Primary Reserves for Typical 20-acre Infill Location:

$\emptyset h$ = 4.56 (log data)
Sw = .265 (Eng. Study 1976)
Recovery Factor = .248 (Eng. Study 1976)
Boi = 1.26 RB/STB (Eng. Study 1976)
A = 6 acres (Undrained area planimetered from drainage maps)

$$\frac{7758\ A\emptyset h(1-Sw)}{Boi} \times R_f = \frac{7758(5)(4.56)(1-.265)}{1.26} \times .248 = 25.6 \text{ MBO Primary Reserves from 20-acre Spacing}$$

25.6 MBO x 175 SCF/STB = 4.48 MMCF Primary Gas

III. New Primary Reserves from A Lower Zone:

$\emptyset h$ = 0.96
A = 20 acres

$$\frac{7758\ A\emptyset h(1-Sw)}{Boi} \times R_f = \frac{7758(20)(1)(1-.265)}{1.26} \times .248 = 21.6 \text{ MBO Primary Reserves for Lower Zone}$$

21.6 MBO x (175 SCF/STB) = 3.78 MMCF Primary Gas