Ex 47

GAS INJECTION PROJECTS
SPRABERRY (TREND AREA) FIELD
RAIL ROAD COMMISSION OF TEXAS DISTRICTS NO. 7-C & 8

RRC DIST.	OPERATOR LEASE/UNIT	DATE	ACRES	NO. GAS INJ. WELLS	RESULT OF GAS INJECTION
7-C	TRI-SERVICE, ET. AL.				
	(04794) Rocker "B"	07/27/66	17,300	6	Failure
	No gas injection wells are shown on the Railroad Commission's 12/68 Oil Proration Schedule				
7-C	EXXON CORP.				
	(04088) Pembrook Unit	12/09/62	44,154	1	Failure
	Railroad Commission of Texas, 2/20/63 Proposal For Decision:				
	"...injectivity tests conducted on the unit using the Humble-Pembrook Well No. 6 resulted in break through of gas to the Humble-Pembrook Well No. 4 within 24 hours after injection was initiated. Pembrook No. 4 is about 2200 north and 48° east from Pembrook No. 6."				Failure
	"A subsequent test using a nitrogen tracer slug resulted in break through of the tracer material to the Pembrook No. 4 after only 4 hours of injection."				Failure
8	MOBIL PRODUCING TX. & N.M. INC.				
	(18551) Preston Spraberry Unit	02/70	17,038	1	Failure
	Plant Residue Gas (PRG) injection began in 2/70 and was permanently discontinued in 5/70. Mobile evaluated the effectiveness of gas injection as NOT EFFECTIVE				

E+49

$\overline{P}$ at +370' SEA LEVEL

6 / 30 / 87

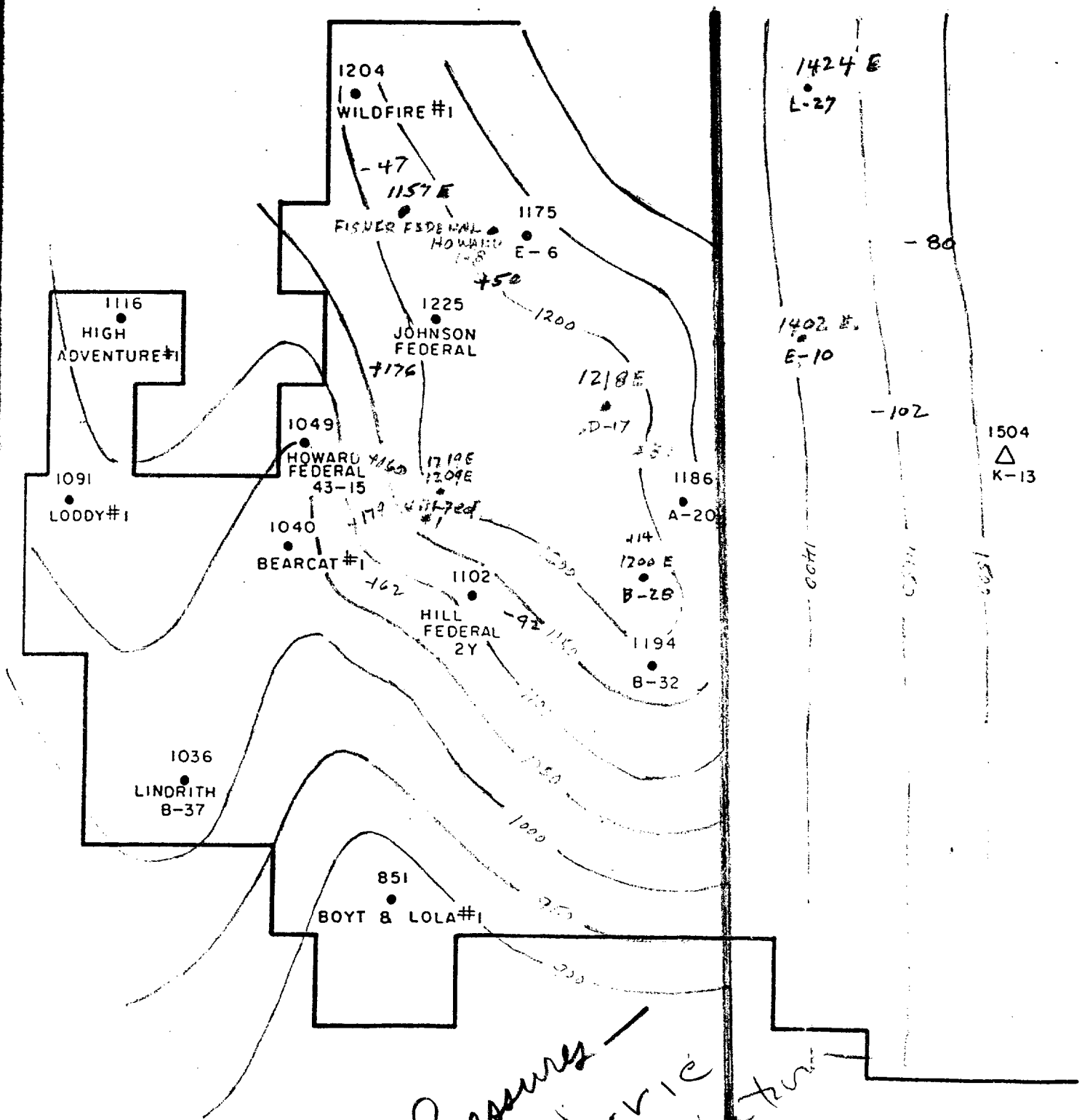


Figure 2

Pressures — Isobaric Interpretation

Mat Powell

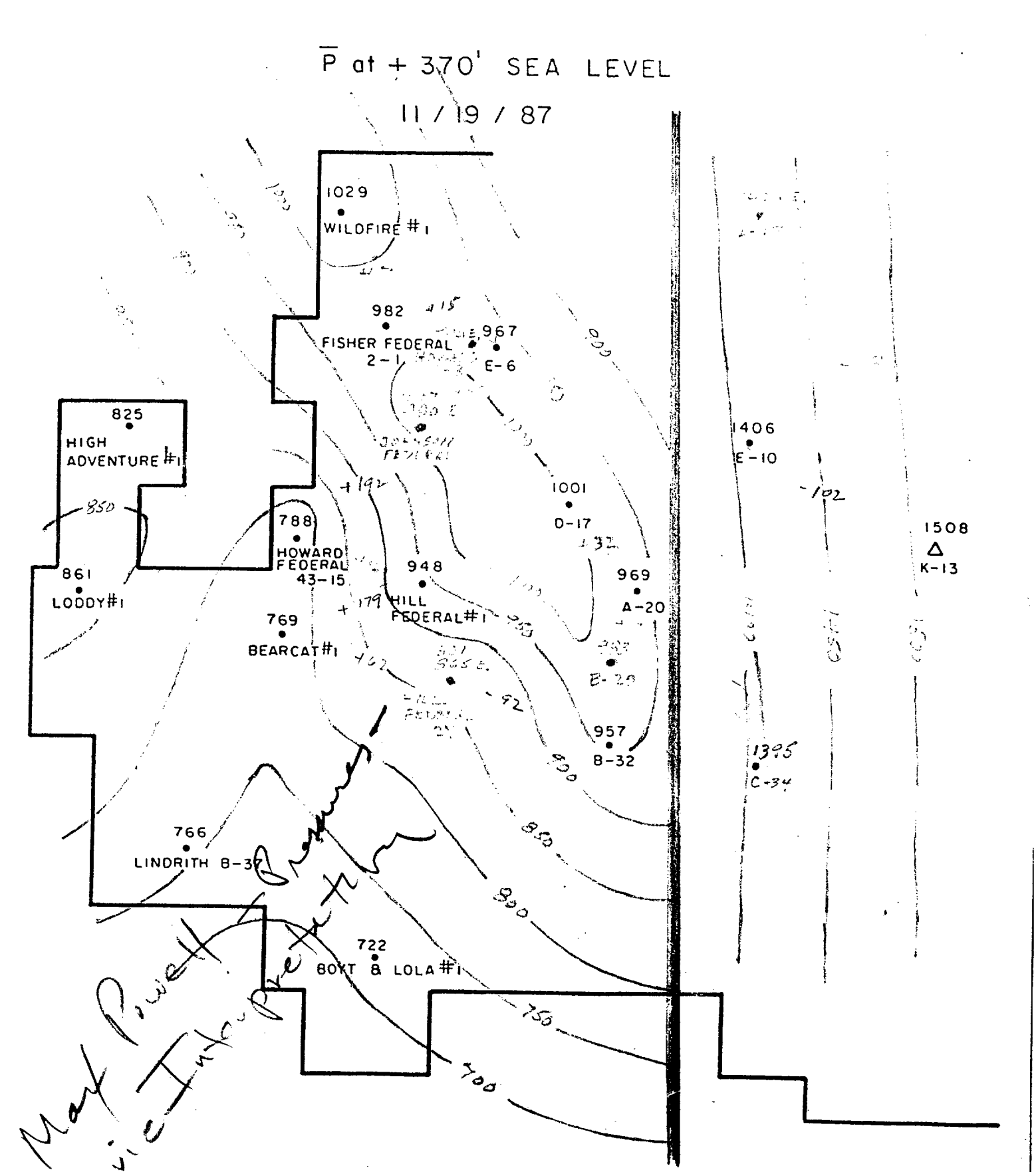

P at + 370' SEA LEVEL
11 / 19 / 87
1029
WILDFIRE #1
982
FISHER FEDERAL 2-1
967
E-6
825
HIGH ADVENTURE #1
1406
E-10
1001
D-17
788
HOWARD FEDERAL 43-15
948
HILL FEDERAL #1
969
A-20
861
LODDY #1
769
BEARCAT #1
957
B-32
1395
C-34
1508
K-13
766
LINDRITH B-37
722
BOYT & LOLA #1
Mark Powell Engineering
Ysabrie Interpretation
E-49

Figure 3

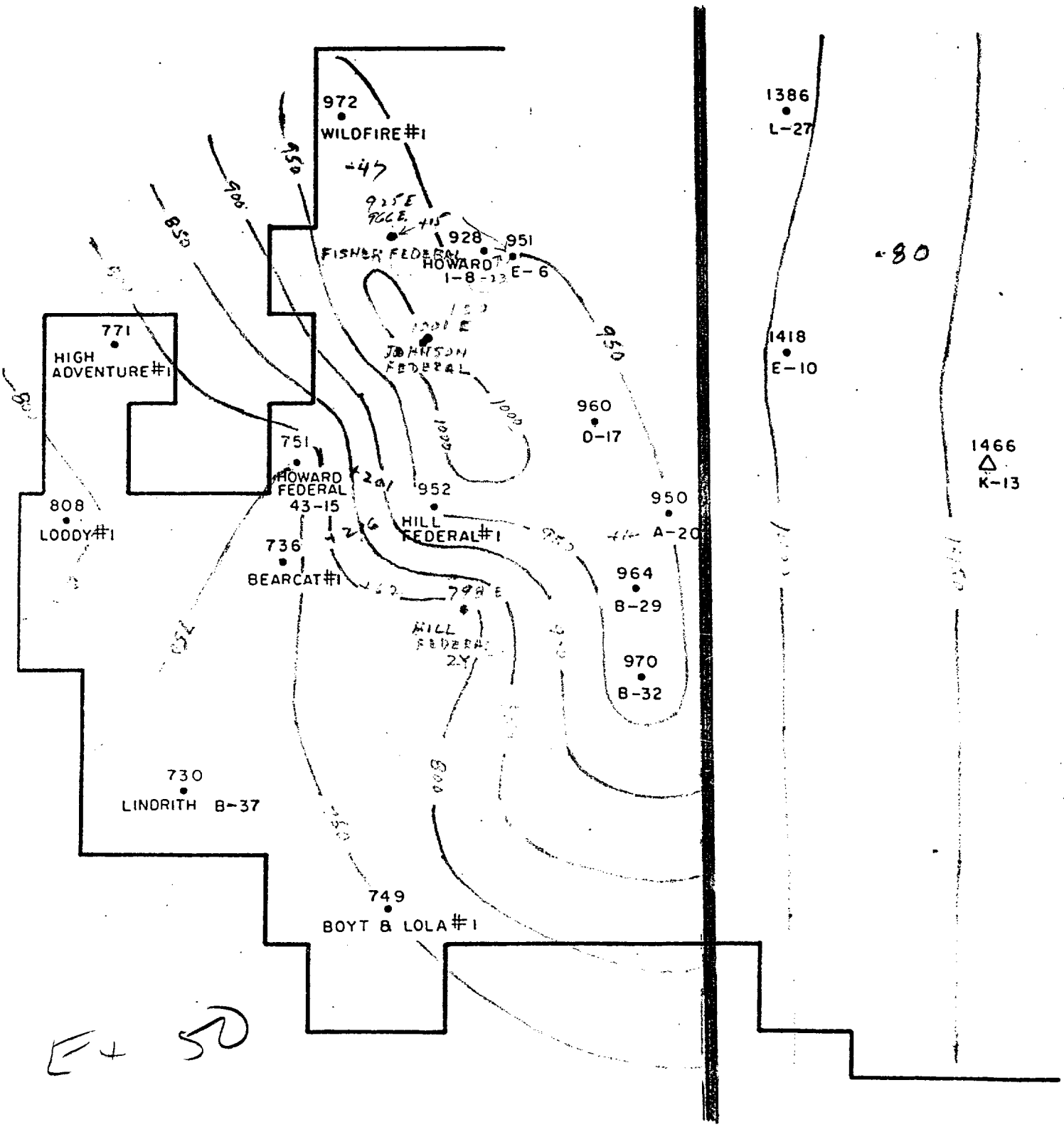


Figure 4

Mat Powell – Pressures

Isobaric Interpretation

Mullins Exhib. # 51

Roe Testimony
March 1987
Transcript Book 2 of 5

recommending to Mr. Dugan that we go out there and develop our undeveloped acreage one well per 320, knowing that I'm going to average 35,000 barrels per well.

Q If I understand you right, then, on Exhibit Number Five, under a better managed scenario, those curves, those confining curves would flatten out?

A If I had my total say-so, if we were able to -- I hate to use this word,-- but if we were able to unitize, we would be able to change that slope of that curve, yes, sir.

Q What would an optimum curve look like, if that curve flattened out and --

A Well --

Humphries Q -- you had the best of all worlds, what would that curve look like?

A For twenty years the unit maintained a rate of pressure decline of about 11 pounds per year.

Q Which unit, the --

A The Canada Ojitos Unit, with pressure maintenance, matching -- attempting to maintain reservoir pressure and produce the reservoir at a rate that approximately matched the gravity drainage rate, the rate of pressure decline, and again I said twenty years, I'm not sure how many years, but the rate of pressure decline was about 11 pounds a year.

Mallon Ex 52

too undoubtedly was in communication with the gas injection well several miles away.

Q Will you now go to the information on the A-16 Well on the green sheets that follow?

A The A-16 is one well that we did not have a pressure fall-off curve on, but we can tell from its production history that it has been affected by the pressure maintenance of wells several miles away. The well had an initial capacity of about 25 barrels a day and it had an initial decline rate of about one and a half percent per year.

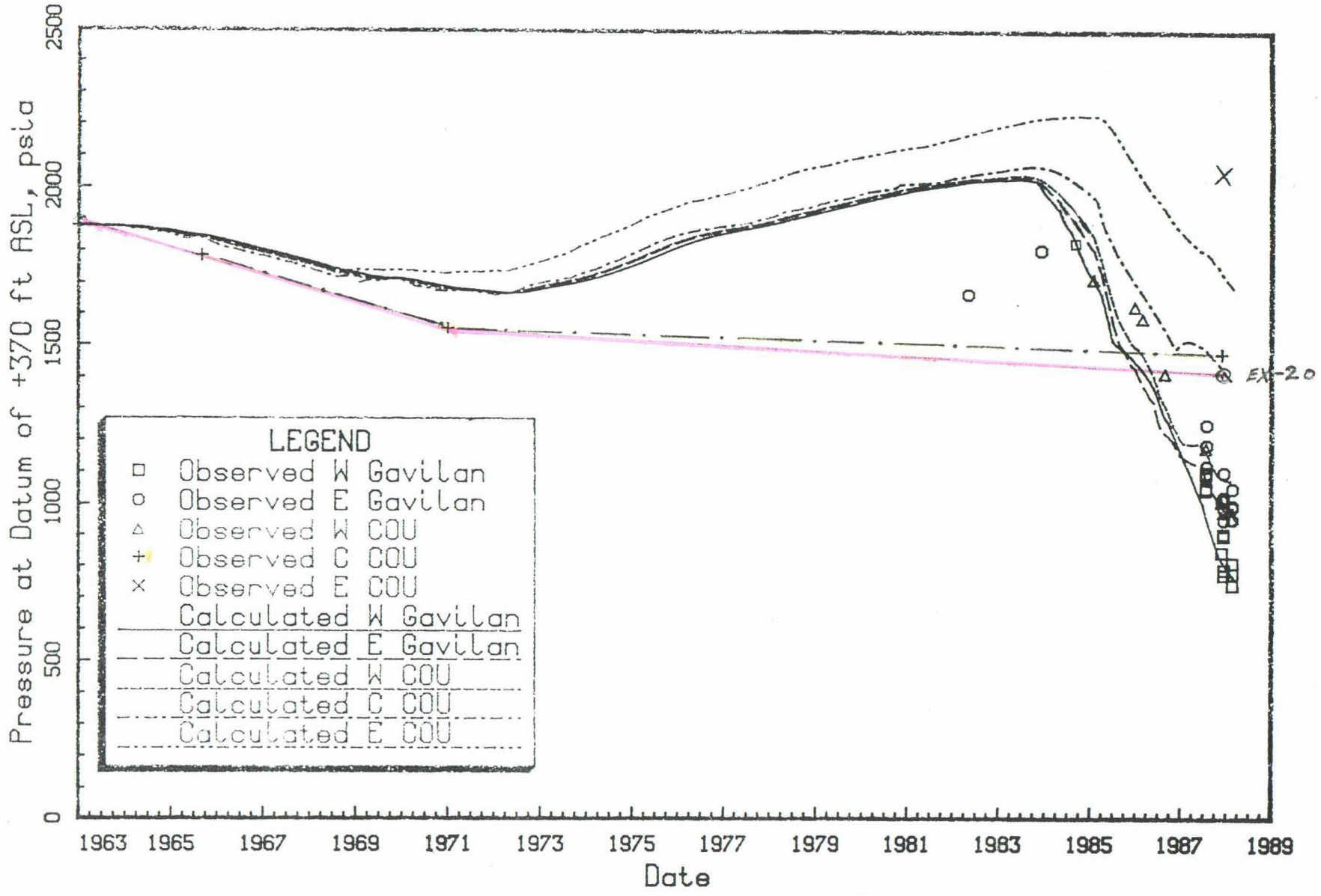
Then in 1976 it picked up a steeper rate of decline and that, we think, was a consequence of our lowering our pressure maintenance gas injection.

Prior to 1976 the price of oil or gas was low enough that we over-injected in the reservoir, and by over-injected I mean we injected more gas than was necessary to just replace the oil. To maintain the pressure, of course, we had to over-inject as the oil falls down the structural dip, then it's necessary to increase the pressure in the gas cap in order to maintain the pressure in the producing wells. So even though we over-injected we still did not quite keep up with the pressure but it's very interesting with a well this small, 25 barrels a day capacity, several miles from the injection wells, would have that response to the pressure maintenance established.

Malem
E+53

Material Balance Verification

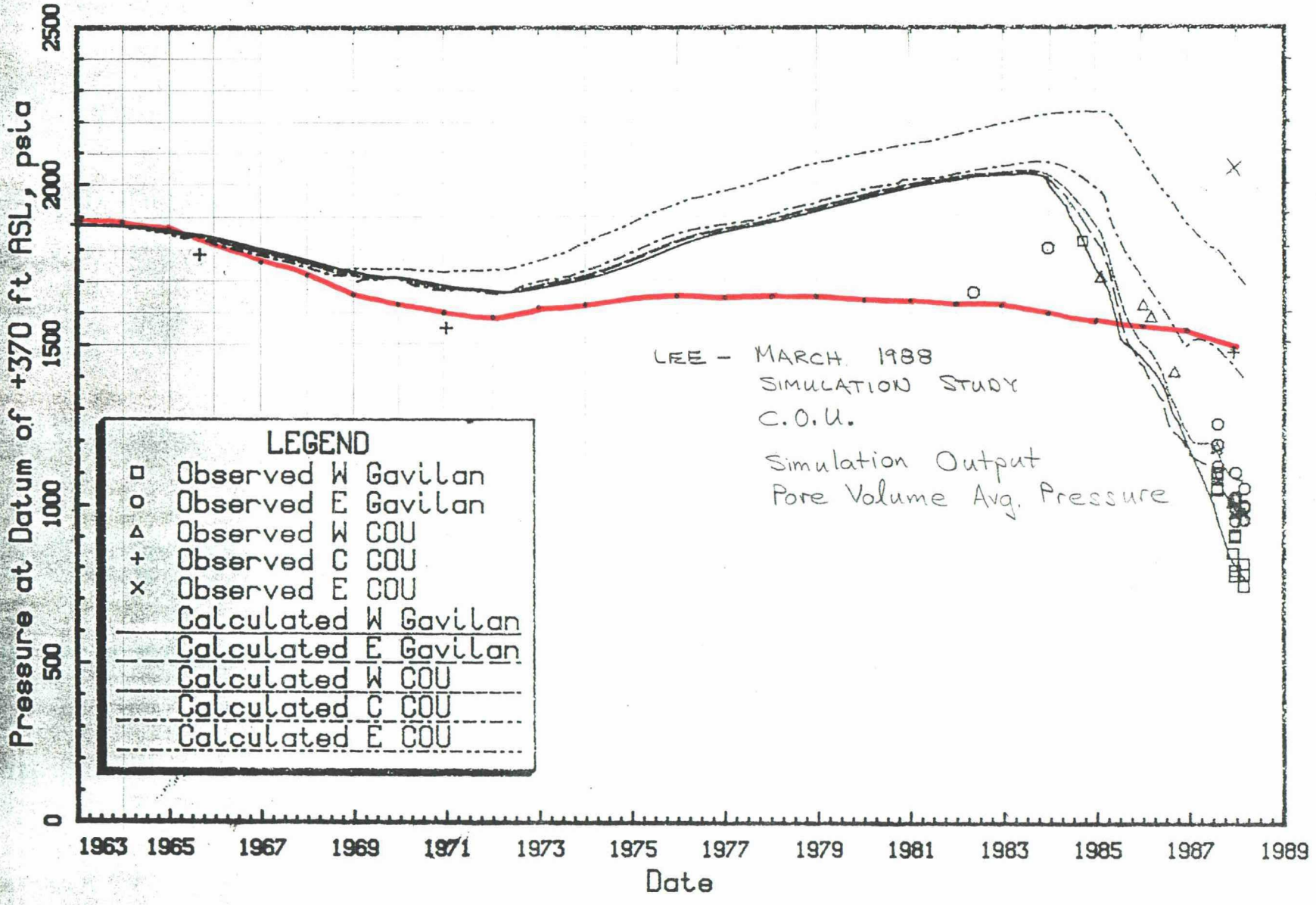
Comparison of Calculated and Measured Pressures



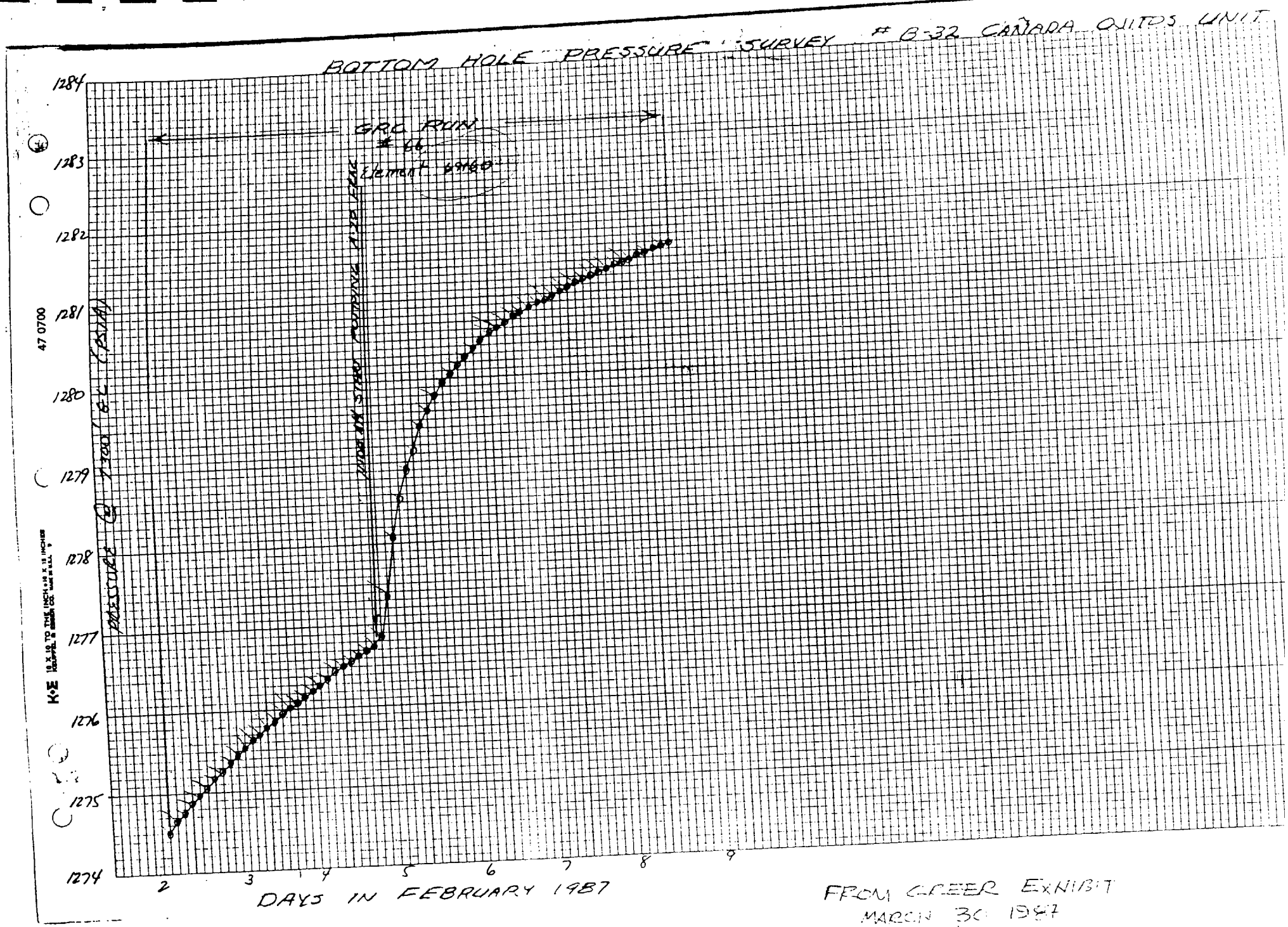
3

Material Balance Verification

Comparison of Calculated and Measured Pressures



Mallon Ex 54



FROM GREER EXHIBIT
MARCH 30 1987
TAB N

"SUPERSTAR" GAVILAN WELLS

(INCLUDING EXPANSION AREA)

BASED ON OCTOBER, 1987 RATES

RANK	WELL	OPERATOR	BOPPD*	SPACING
1	COU #28 (B-29)	BMG	993	640
2	COU #25 (B-32)	BMG	771	640
3	COU #33 (F-18)	BMG	396	640
4	COU #30 (F-30)	BMG	333	640
5	COU #29 (E-6)	BMG	313	320
6	Fisher-Fed #2-1	Mallon	268	320
7	Howard-Fed #1-8	Mallon	264	320
8	High Adventure #1	Sun	241	320
9	Howard #1-11	Mallon	239	320
10	Lindrith B-37	Mobil	223	320
11	Native Son #2	Sun	215	320
12	COU #37 (G-5)	BMG	191	640
13	COU #31 (N-31)	BMG	159	640
14	Tapacitos #4	Hixon	143	640
15	Brown #1	Mesa Grande	121	505
16	Beck's Babbitt #1	Sun	112	320
17	Homestead Ranch #2	Sun	111	320
18	Divide #3	Hixon	107	320
			5200	

TOTAL GAVILAN PLUS EXPANSION AREA: 6205

*Barrels per Producing Day

Mallon
3-55

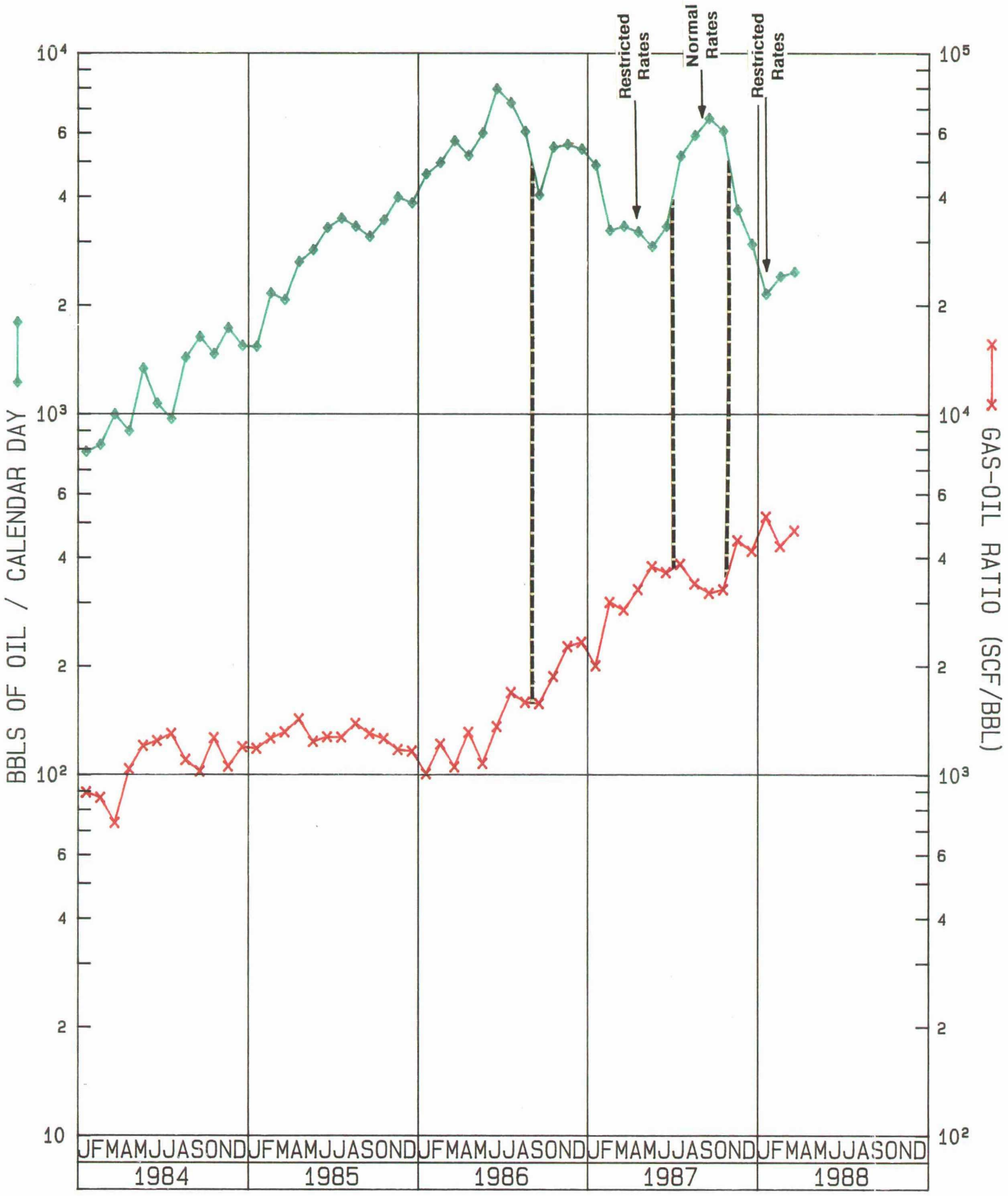
Mallon
E-56

"SUPERSTAR" GAVILAN WELLS

(INCLUDING EXPANSION AREA)

BASED ON MARCH 1988 CUMULATIVE
OIL PRODUCTION

RANK	WELL	OPERATOR	CUM OIL (STB)
1	COU #25 (B-32)	BMG	623,000
2	COU #28 (B-29)	BMG	491,000
3	Native Son #2	Sun	401,000
4	Native Son #1	Sun	250,000
5	Fisher Fed #2-1	Mallon	207,000
6	COU #29 (E-6)	BMG	180,000
7	Motherlode #1	Sun	177,000
8	COU #30 (F-30)	BMG	175,000
9	Howard Fed #1-8	Mallon	173,000
10	Rucker Lake #2	Mesa Grande	168,000
11	Homestead Ranch #2	Sun	167,000
12	Howard Fed #1-11	Mallon	157,000
13	Hawk Fed #3	Meridian	155,000
14	Full Sail #1	Sun	143,000
15	Janet #1	Sun	138,000
16	Janet #2	Sun	134,000
17	Rucker Lake #3	Mesa Grande	121,000
18	Wright Way #1	Sun	111,000
19	COU #31 (N-31)	BMG	100,000
20	E.T. #1	Sun	100,000
		Subtotal	4,171,000
	Total Gavilan Plus Expansion Area		5,518,000



GAVILAN MANCOS AREA

PLOT OF OIL PRODUCTION RATES AND GAS – OIL – RATIO VERSUS TIME FOR ALL WELLS PRODUCING AS OF JULY, 1987

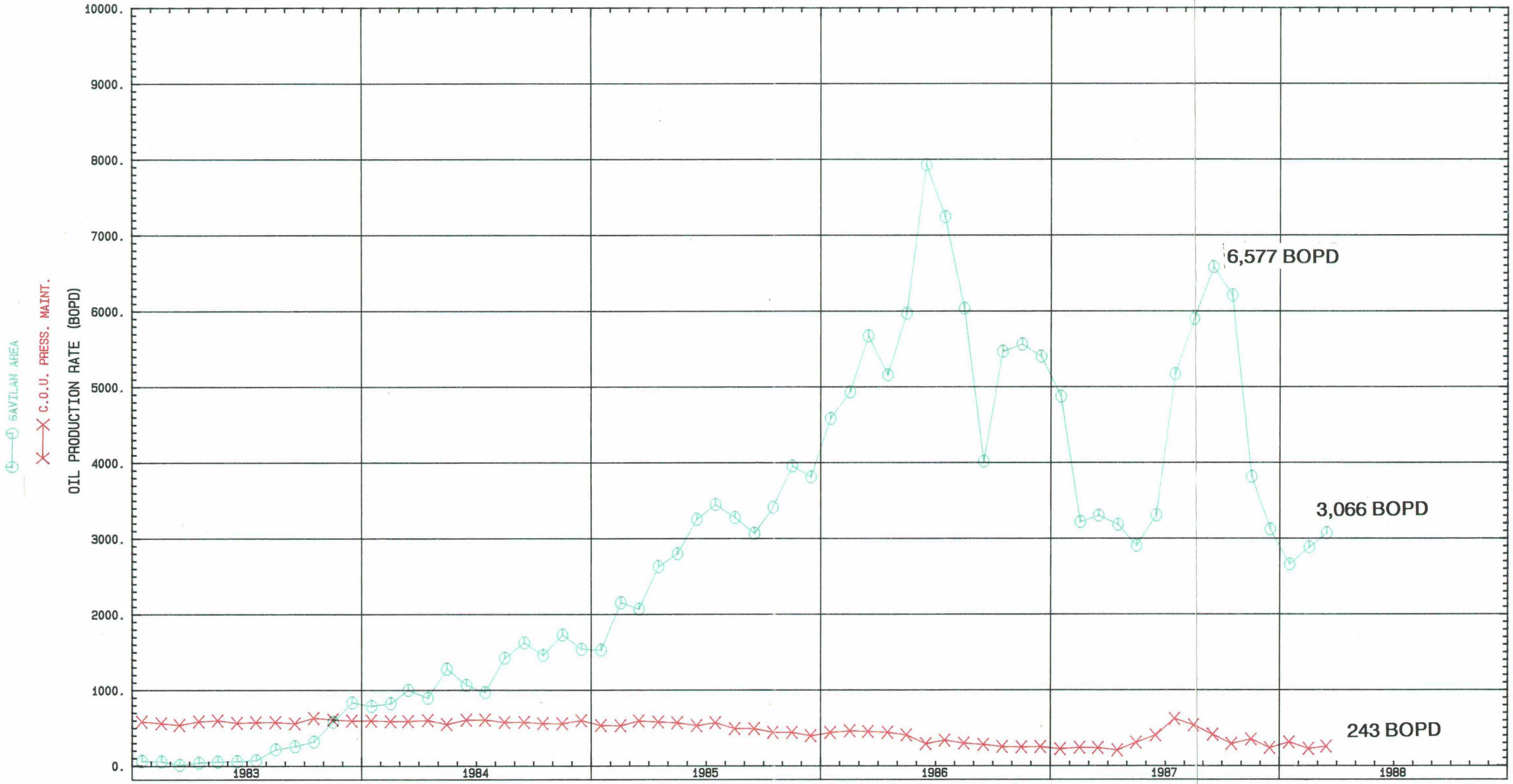
CONCLUSIONS

Restricted oil rates increased the Gas – Oil – Ratio trend causing waste both economical and physical

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 6 DATE: JUNE 13, 1988



PRODUCTION HISTORY THROUGH MARCH, 1988

GAVILAN MANCOS FIELD STUDY

COMPARISON OF
TOTAL GAVILAN AREA
AND
C.O.U. PRESSURE MAINTENANCE AREA

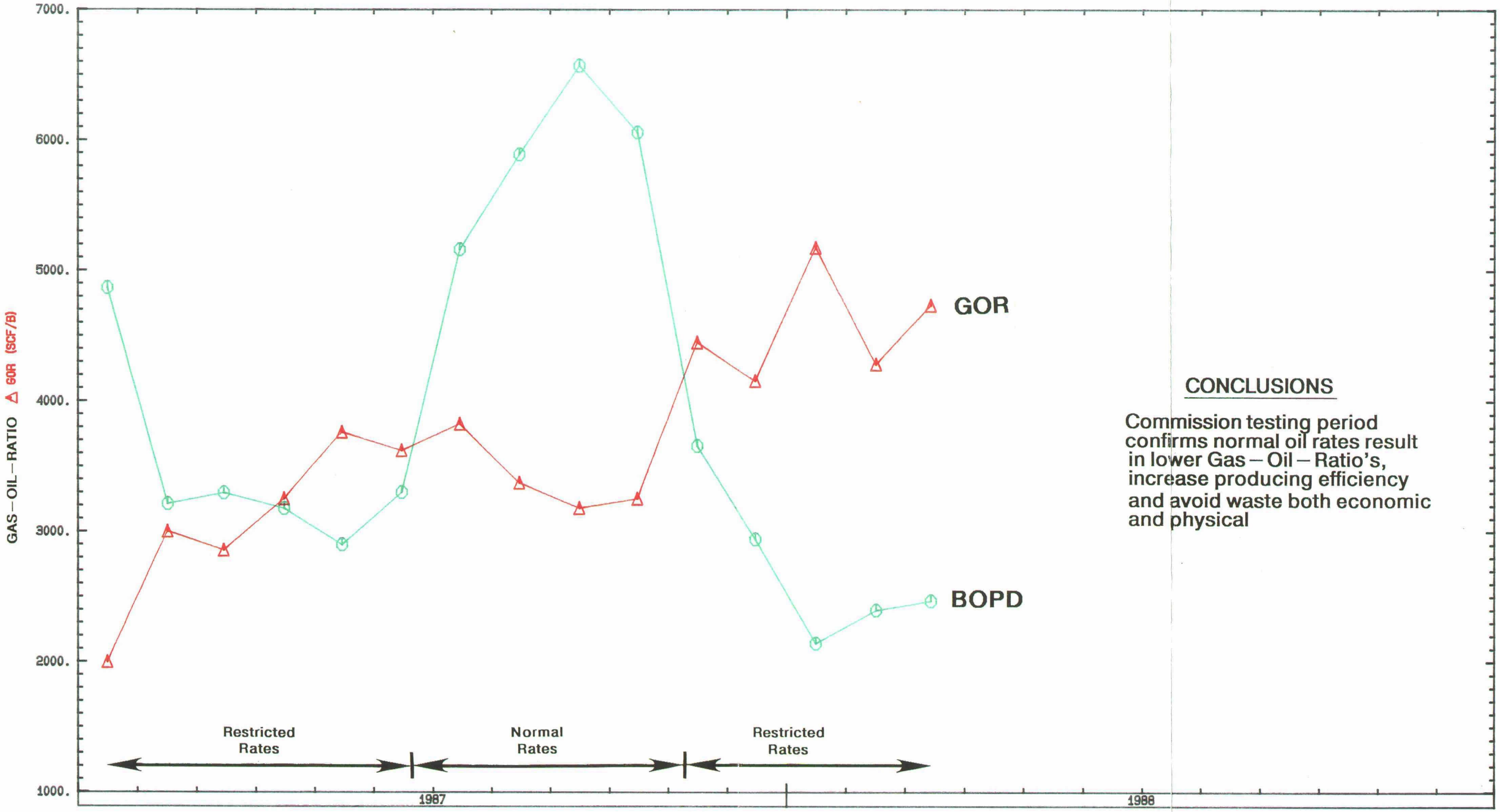
FILE: 2-CMB.GRF	DATE: 6-JUN-88
SOURCE:	TIME: 6:22

Jerry R. Bergeson & Associates, Inc.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 7 DATE: JUNE 13, 1988



CONCLUSIONS

Commission testing period confirms normal oil rates result in lower Gas – Oil – Ratio's, increase producing efficiency and avoid waste both economic and physical

Exh. 4 & 8

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS AREA STUDY

PLOT OF OIL PRODUCTION RATE VS GAS-OIL-RATIO FOR ALL WELLS PRODUCING AS OF JULY, 1987 JANUARY 1987 - MARCH 1988

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SOURCE:	TIME: 15:25

Jerry R. Bergeson & Associates, Inc.

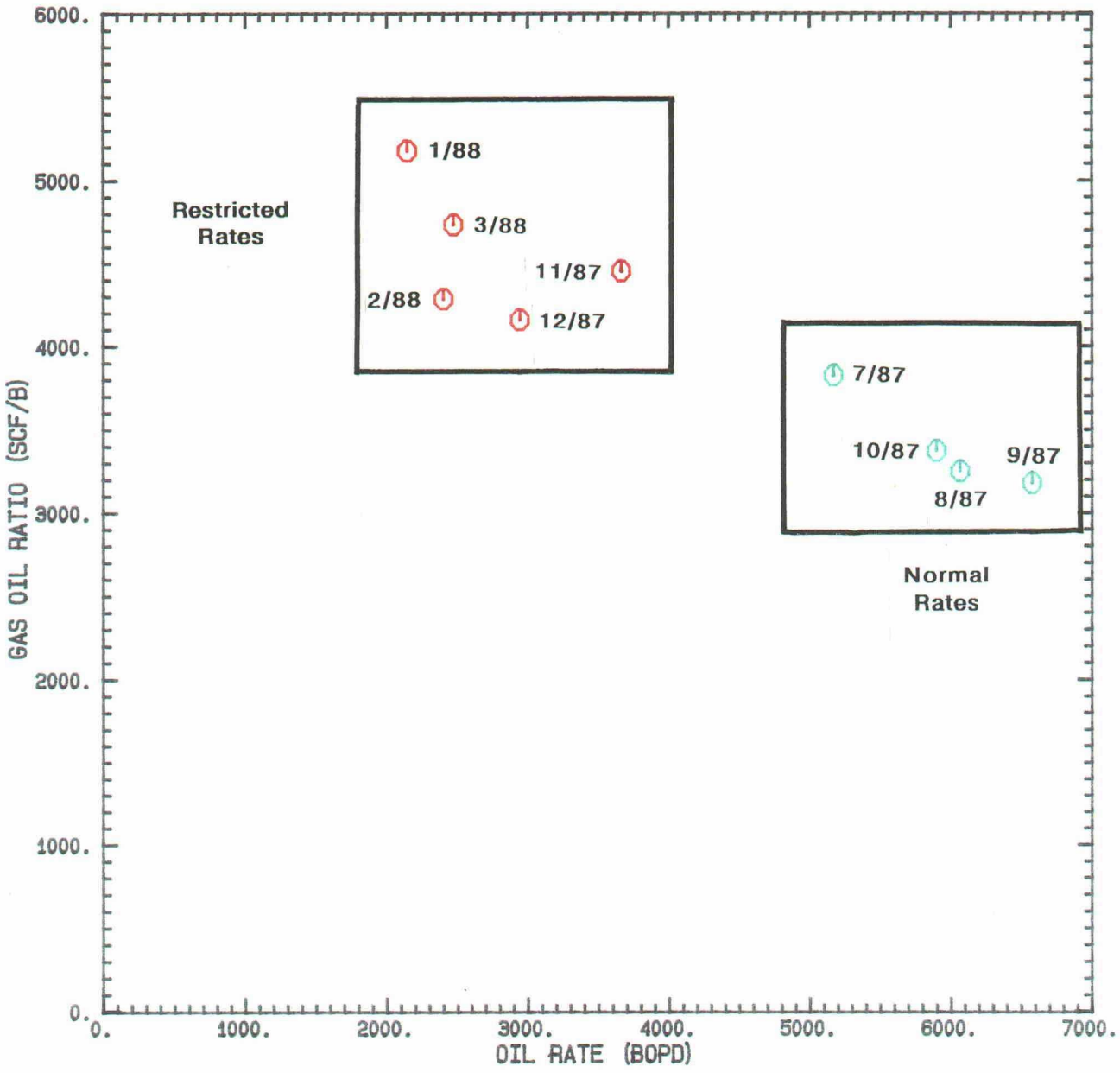


Exhibit 9

GAVILAN POOL STUDY

TOTAL POOL PRODUCTION
GAVILAN MANCOS AREA
GOR VS. OIL RATE
JULY 1987 - MARCH 1988

FILE: 1-GAV.GRF	DATE: 3-JUN-88
SOURCE:	TIME: 16:28

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

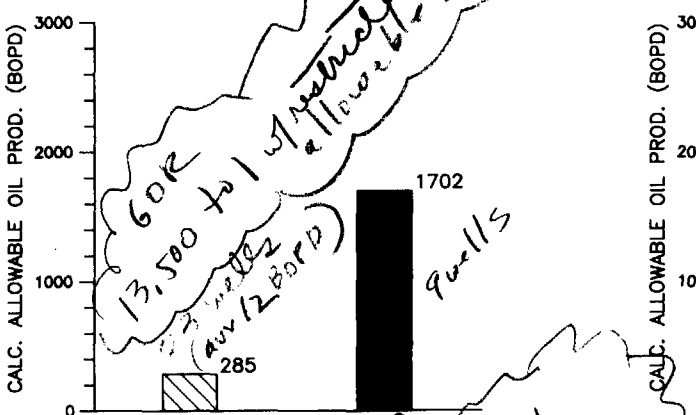
Jerry R. Bergeson & Associates, Inc.

CALCULATED ALLOWABLE PRODUCTION RATES
USING MARCH 1988 GOR &
RESTRICTED GAVILAN ALLOWABLE
400 BOPD & 600:1 GOR

GAVILAN ▨ C.O.U. ■

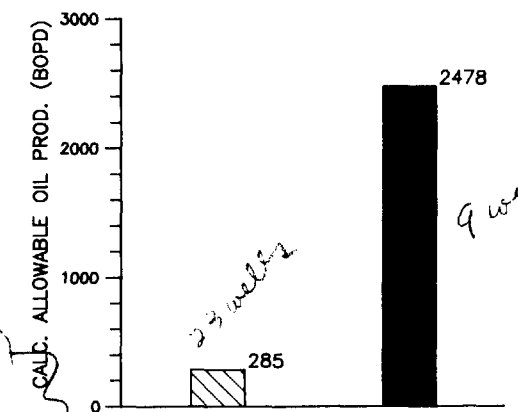
EASTERN TWO TIERS OF SECTIONS IN R2W
(23 ACTIVE WELLS)

ALL WELLS WITH GAVILAN ALLOWABLE



WESTERN TWO TIERS OF SECTIONS IN R1W
(PROPOSED EXPANSION AREA)
(9 ACTIVE WELLS)

C.O.U. WELLS WITH GAS INJECTION CREDIT



BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO. 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT DATE: JUNE 13, 1988

Exh. 15

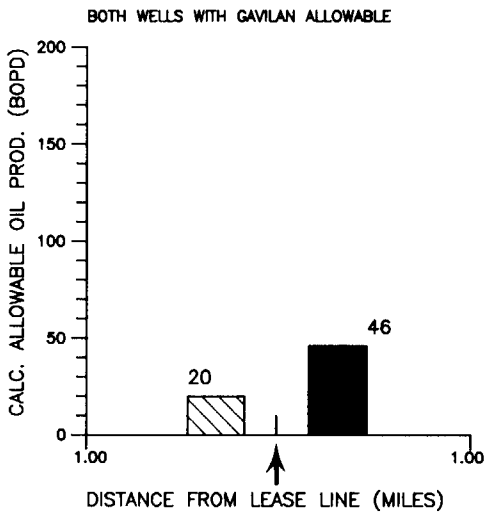
CALCULATED ALLOWABLE PRODUCTION RATES
USING MARCH 1988 GOR &
RESTRICTED GAVILAN ALLOWABLE
400 BOPD & 600:1 GOR

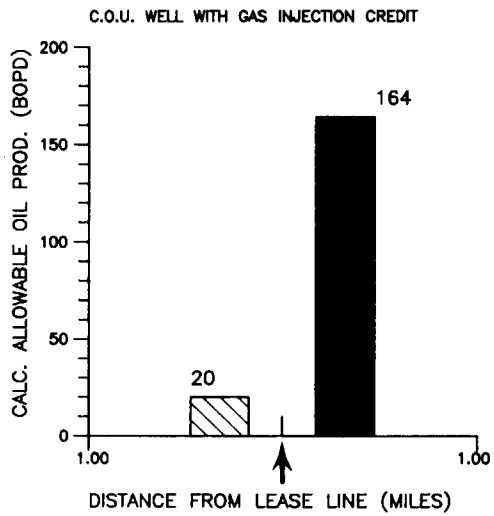
MALLON

HOWARD FEDERAL 1-8
PRODUCING GOR (3-88)
12200 SCF/BBL

BMG

COU #29 (E-6)
PRODUCING GOR (3-88)
5240 SCF/BBL





BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT DATE JUNE 13, 1988

Gavilan Mancos Pool

The Role Of Imbibition In Reservoir Performance Is Well Documented In Petroleum Literature

● "An oil re-imbibition process may take place when some of the oil produced through gas gravity drainage may re-imbibe into lower blocks which have been partially desaturated. In fact, during the descent of oil drops (displaced by gas) through fractures, the oil may enter into contact with the gassing zone blocks which are partially saturated with gas and oil. The re-imbibition of these blocks with oil is, in effect, a reduction of the overall oil production in the reservoir."

Ref: Developments in Petroleum Science 12
Fundamentals of Fractured Reservoir Engineering

by T.D. Van Gof-Racht
page 481 & 565.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS AREA

Summary Of
Oil Lost (Waste) Because
Of Restricted Rates

Physical Waste, which has occurred due to restricted rates from September, 1986, through March, 1988, excluding normal rate test period.

Amount of Lost Oil: 370,000 STB to 441,000 STB

Physical Waste which will occur in the future if normal rates are not restored, March, 1988 forward.

Amount of Lost Oil: 606,000 STB to 720,000 STB

Potential Total Physical Waste due to restricted rates:

976,000 STB to 1,161,000 STB

GAVILAN MANCOS AREA

CALCULATION OF RANGE OF LOST RESERVES DUE TO RESTICTED RATES

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS AREA

CALCULATION OF RANGE OF LOST RESERVES DUE TO RESTICTED RATES

1. Two Methods to calculate degree of loss,

   A. From observed field performance trend of cumulative oil produced versus pressure during normal and restricted rate tests.

      Normal Rate: 3662 STB/psi

      Restricted Rate: 3160 STB/psi

      Recovery Difference = 15.9%

   B. From calcuated matrix, solution gas drive performance based on observed GOR's during Commission ordered testing.

      Recovery Difference = 18.9%

Both methods show higher recoveries when normal rates of production were permitted.

2. Physical Waste, which has occurred due to restricted rates from September, 1986, through March, 1988, excluding normal rate test period.

Measured Cumulative Oil Produced: 2,335,000 STB

Range of Lost Recovery: 15.9% to 18.9%

Amount of Lost Oil: 370,000 STB to 441,000 STB

3. Physical Waste which will occur in the future if normal rates are not restored.

Projected Recovery after March, 1988: 3,810,000 STB

Range of Lost Recovery: 15.9% - 18.9%

Amount of Lost Oil: 606,000 STB to 720,000 STB

4. Total potential lost oil due

to restricted rates: 976,000 STB to 1,161,000 STB

GAVILAN MANCOS AREA

Calculation of Recovery Factor for Oil Based on Solution Gas Drive Applied to Matrix

1. Equation from Dake, "Fundamentals of Reservoir Engineering"

$$\text{Recovery Factor} = \frac{(B_o - B_{oi}) + (R_{si} - R_s)\, B_g}{B_o + (R_p - R_s)\, B_g} \qquad \text{(pg. 84)}$$

2. Initial Properties from prior studies

B_{oi} = 1.3231 RB/STB

R_{si} = 547 scf/STB

3. Properties based on 1000 psi average pressure during normal rate test period.

B_o = 1.249 RB/STB

R_s = 369 scf/STB

B_g = RB/scf

4. Substituting, equation in Item 1 becomes,

$$\text{Recovery Factor} = \frac{151.5}{R_p + 77.1}$$

which indicates the higher the allowed producing gas-oil-ratio (R_p), the lower the recovery factor. Lower producing gas-oil-ratios result in improved recovery.

5. Comparing Gavilan calculated recovery factors during the normal rate test period when the producing gas-oil-ratio was 3395 scf/STB (R_{p1}) to the indicated low rate producing gas-oil-ratio (R_{p2}) of 4050 scf/STB, (estimated from the plot of observed GOR versus time),

$$\text{Ratio} = \frac{(\text{Recovery Factor})_{\text{normal}} = \dfrac{151.5}{R_{p_1} + 77.1}}{(\text{Recovery Factor})_{\text{restricted}} = \dfrac{151.5}{R_{p_2} + 77.1}}$$

$$\text{Ratio} = \frac{R_{p_2} + 77.1}{R_{p_1} + 77.1}$$

$$\text{Ratio} = \frac{4050 + 77}{3395 + 77} = 18.9 \text{ percent}$$

6. Conclusion is that Commission ordered tests indicated recovery will be increased by 18.9 percent if normal rates are restored. Physical waste will occur if restricted rates are maintained.

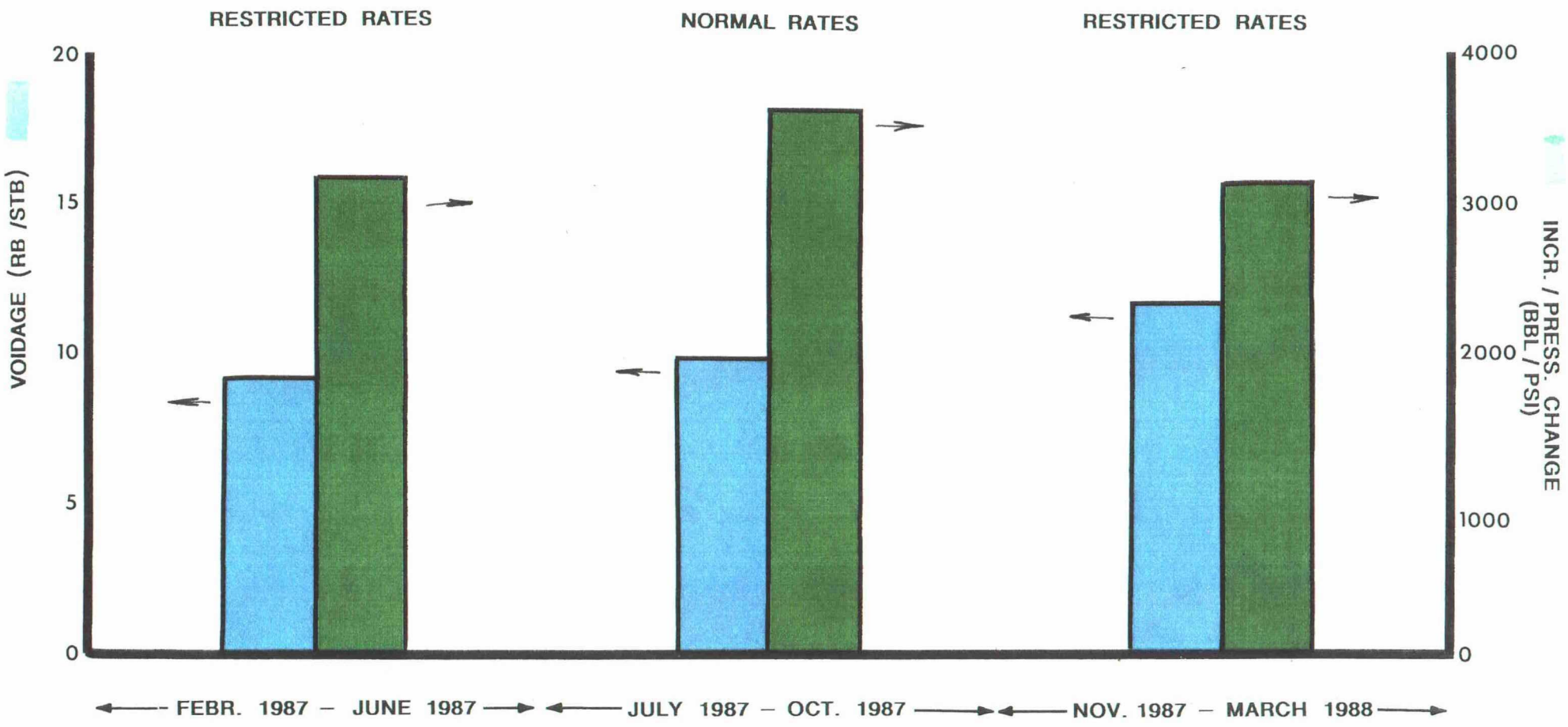
BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

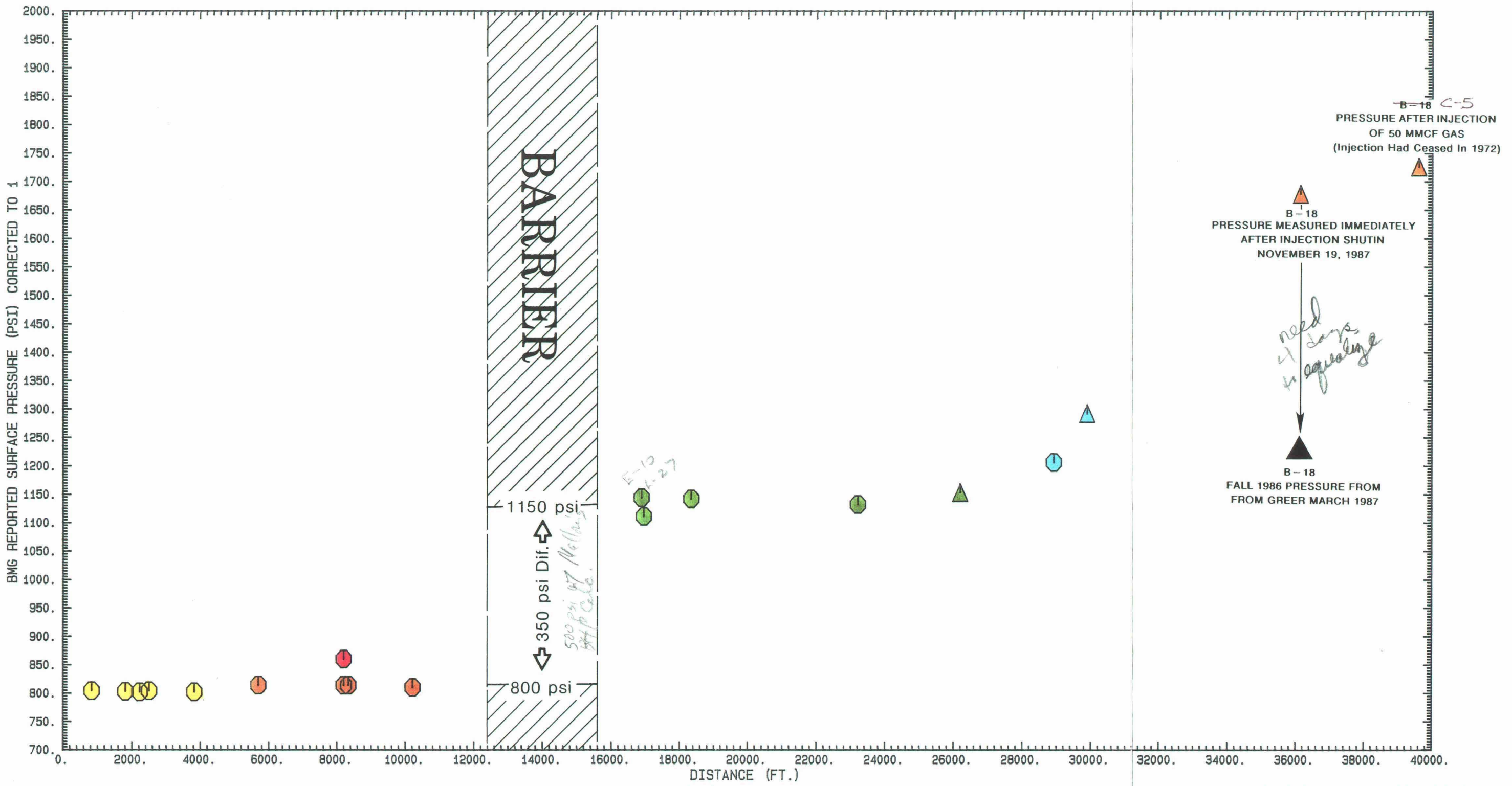
CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 23 DATE: JUNE 13, 1988

GAVILAN MANCOS AREA

VOIDAGE COMPARISON: NORMAL VS RESTRICTED RATES
BASED ON FIELD AVERAGE PRESSURE PRODUCTION TRENDS





GREER'S RAINBOW PRESSURE MAP

Nov. 1987

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

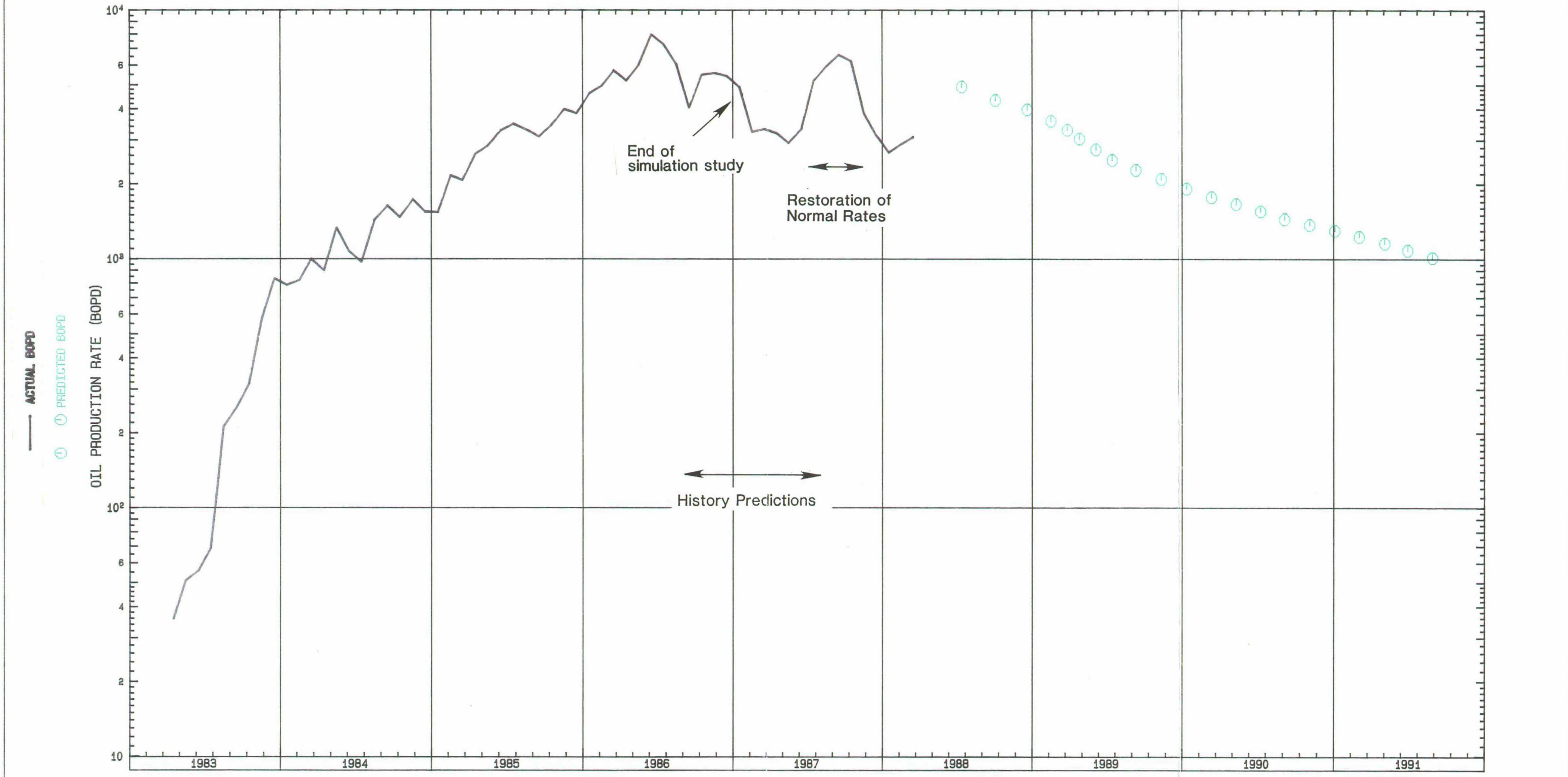
CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

Exhibit 21

GAVILAN MANCOS FIELD STUDY	
WEST PUERTO CHIQUITO AREA PRESSURE PROFILE WITH DISTANCE WEST TO EAST MEASURED FROM GAVILAN BOUNDARY (NOV. 1987)	
FILE: 1-PRESS.GRF	DATE: 7-JUN-88
SOURCE:	TIME: 16:21

Jerry R. Bergeson & Associates, Inc.



BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

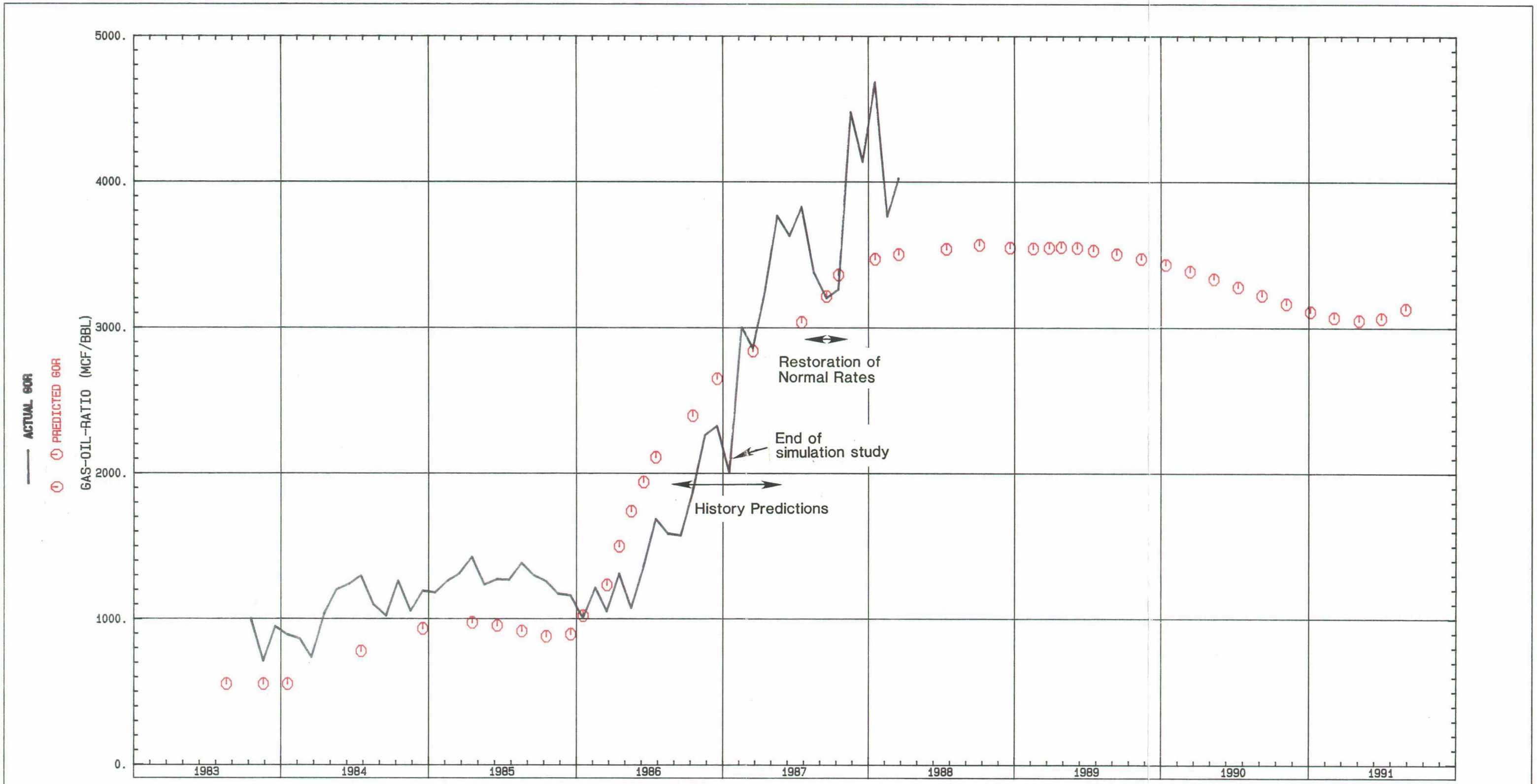
GAVILAN POOL MEMBER EXHIBIT: 24 DATE: JUNE 13, 1988

GAVILAN MANCOS FIELD STUDY

COMPARISON OF ACTUAL OIL RATE
AND PREDICTED OIL RATE
VERSUS TIME
TOTAL POOL PRODUCTION

FILE: 1-ACTPRED.GRF	DATE: 8-JUN-88
SOURCE:	TIME: 13:15

Jerry R. Bergeson & Associates, Inc.



BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

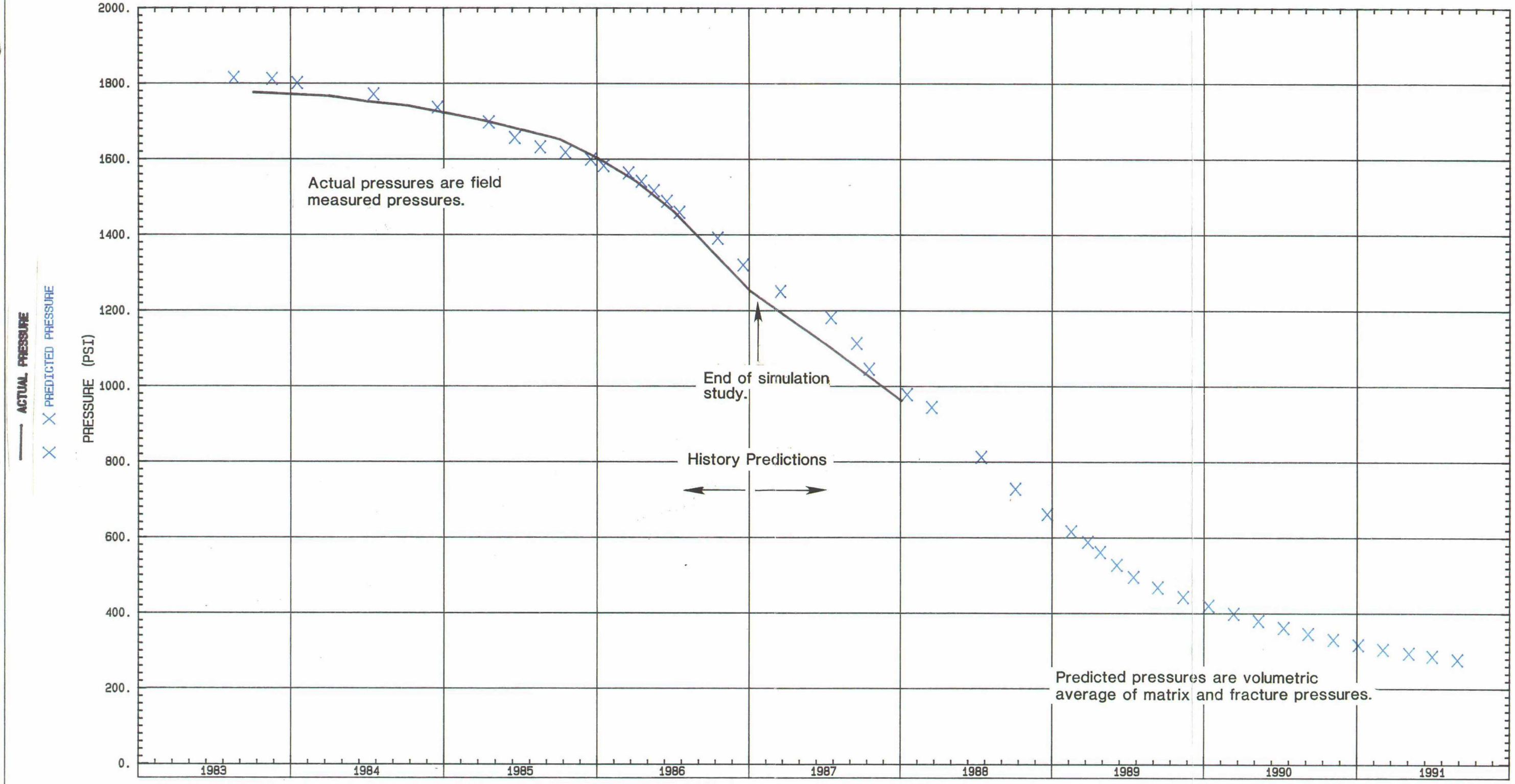
GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS FIELD STUDY

COMPARISON OF ACTUAL GAS-OIL-RATIO
AND PREDICTED GAS-OIL-RATIO
VERSUS TIME
TOTAL POOL PRODUCTION

FILE: 2-ACTPRED.GRF	DATE: 8-JUN-88
SOURCE:	TIME: 13:25

Jerry R. Bergeson & Associates, Inc.



BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS FIELD STUDY

COMPARISON OF ACTUAL PRESSURES AND PREDICTED PRESSURES VERSUS TIME TOTAL POOL PRODUCTION

FILE: 3-ACTPRED.GRF	DATE: 8-JUN-88
SOURCE:	TIME: 13:16

Jerry R. Bergeson & Associates, Inc.

GAVILAN MANCOS AREA

VOIDAGE COMPARISON : NORMAL VS RESTRICTED RATES

- Restricted Rates – Average February 1987 to June 1987

  Voidage = 8.35 RB/STB
  $\Delta Np / \Delta p$ = 3176 STB/psi

- Normal Rates – Average July 1987 to October 1987

  Voidage = 9.72 RB/STB
  $\Delta Np / \Delta p$ = 3662 STB/psi

- Restricted Rates – Average November 1987 to March 1988

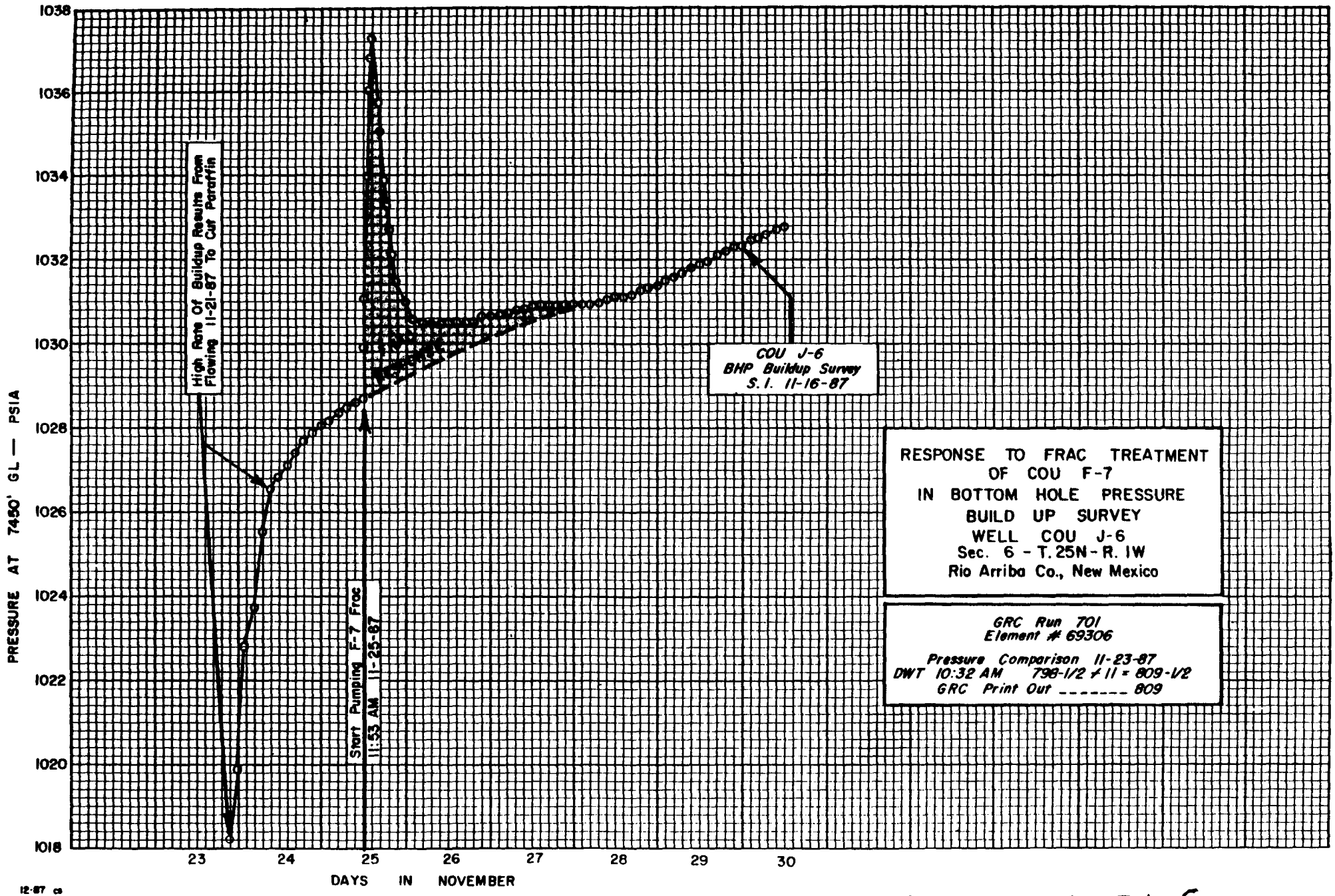
  Voidage = 13.26 RB/STB
  $\Delta Np / \Delta p$ = 3144 STB/psi

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8945, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: ___ DATE: JUNE 13, 1988

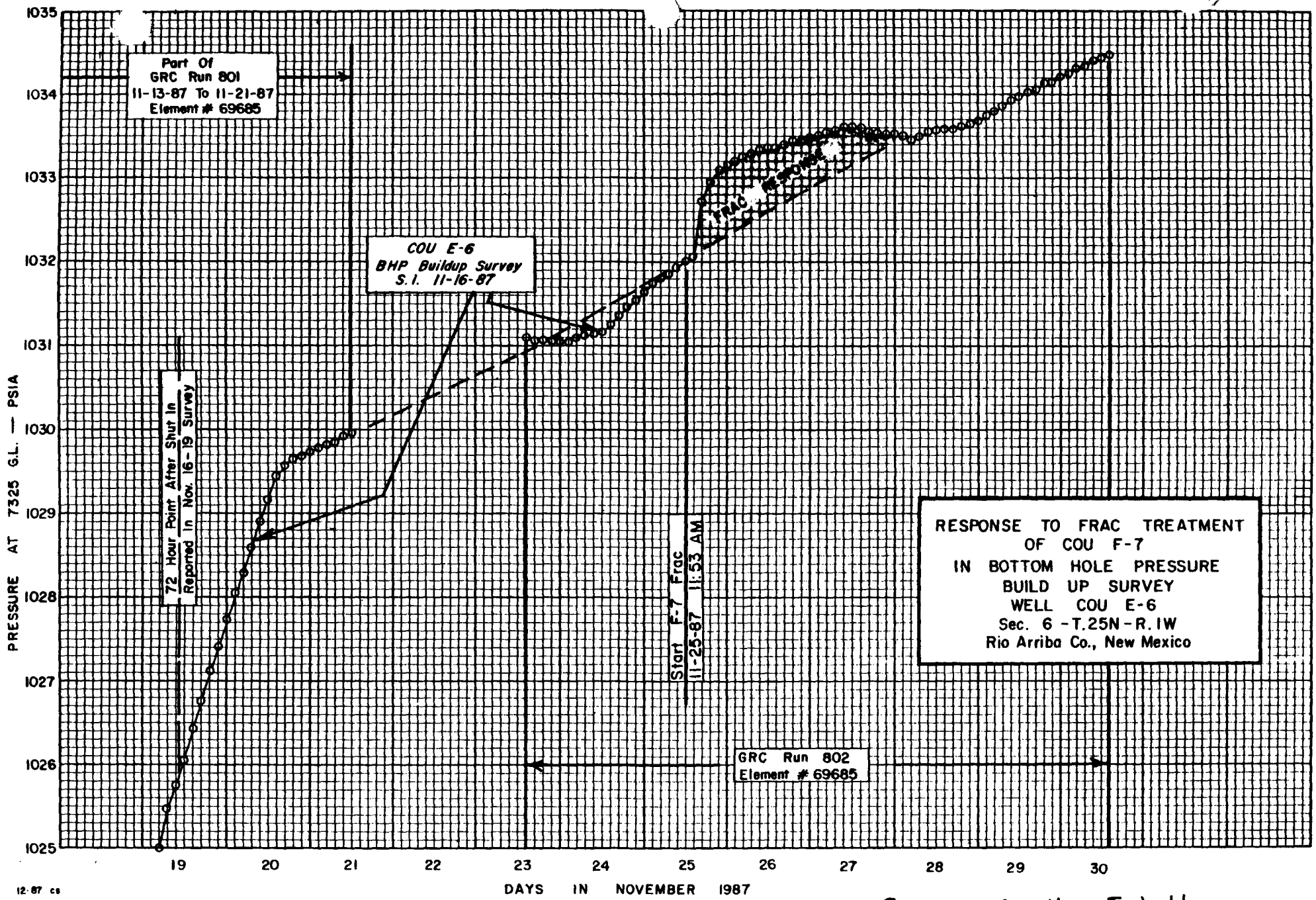
COMPARISON OF OIL RECOVERY
GAVILAN MANCOS AREA
VS.
CANADA OJITOS UNIT PRESSURE MAINTENANCE AREA
RIO ARRIBA COUNTY, NEW MEXICO

	Gavilan Area (47,200 acres)	Canada Ojitos Unit Pressure Maintenance Area (50,000 acres)
A. Oil Recovered By 5th Full Year Of Development		
Barrels	3,686,857	1,111,014
Bbl / Acre	78	22
B. Oil Recovered Through March 1988		
Years	6	25
Barrels	5,518,393	7,928,224
Bbl / Acre	117	159
C. Estimated Ultimate Recovery		
Barrels	9,390,000	8,032,000
Bbl / Acre	199	161

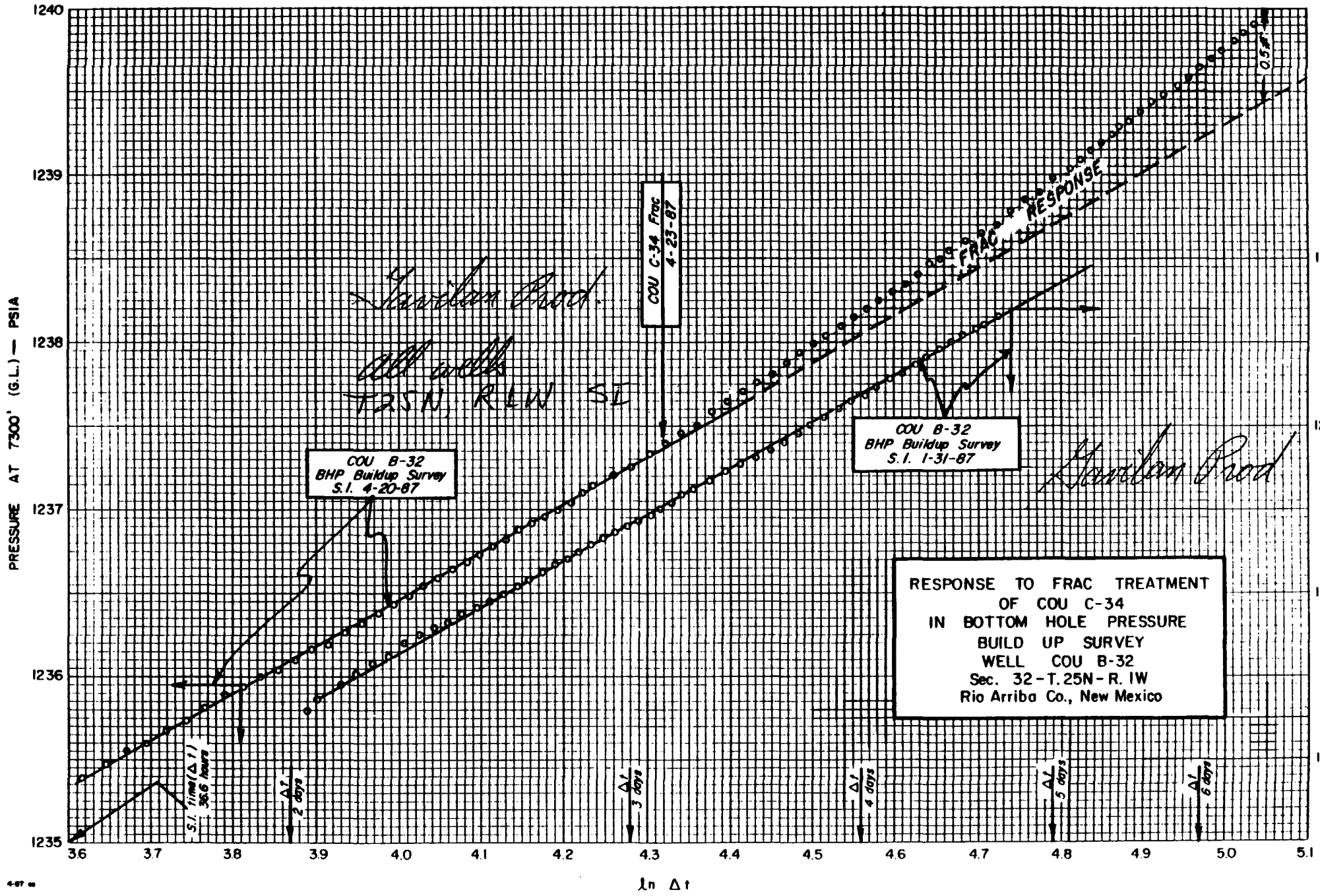
BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO. 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT
DATE JUNE 13, 1988

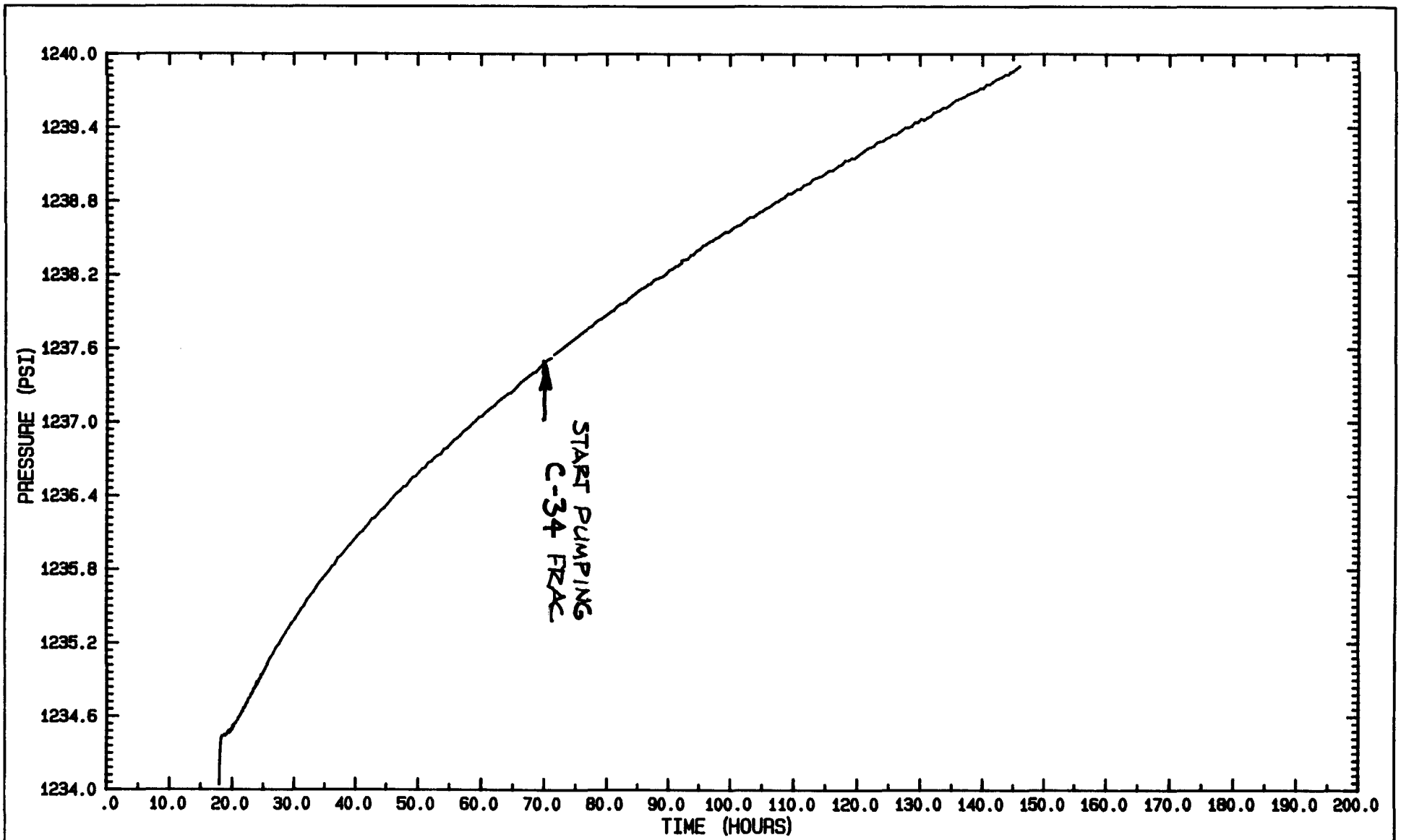


Greer Ex #2, Tab G
March 17, 1988



Greer Ex #2, Tab H
March 17, 1988


PRESSURE AT 7300' (G.L.) — PSIA
1240
1239
1238
1237
1236
1235
1277
1276
1275
1274
3.6
3.7
3.8
3.9
4.0
4.1
4.2
4.3
4.4
4.5
4.6
4.7
4.8
4.9
5.0
5.1
ln Δt
COU B-32
BHP Buildup Survey
S.I. 4-20-87
COU C-34 Frac
4-23-87
COU B-32
BHP Buildup Survey
S.I. 1-31-87
1st FRAC RESPONSE
0.5 psi
S.I. time (Δt)
36.6 hours
Δt
2 days
Δt
3 days
Δt
4 days
Δt
5 days
Δt
6 days
RESPONSE TO FRAC TREATMENT
OF COU C-34
IN BOTTOM HOLE PRESSURE
BUILD UP SURVEY
WELL COU B-32
Sec. 32 - T. 25N - R. 1W
Rio Arriba Co., New Mexico



GAVILAN MANCOS FIELD STUDY

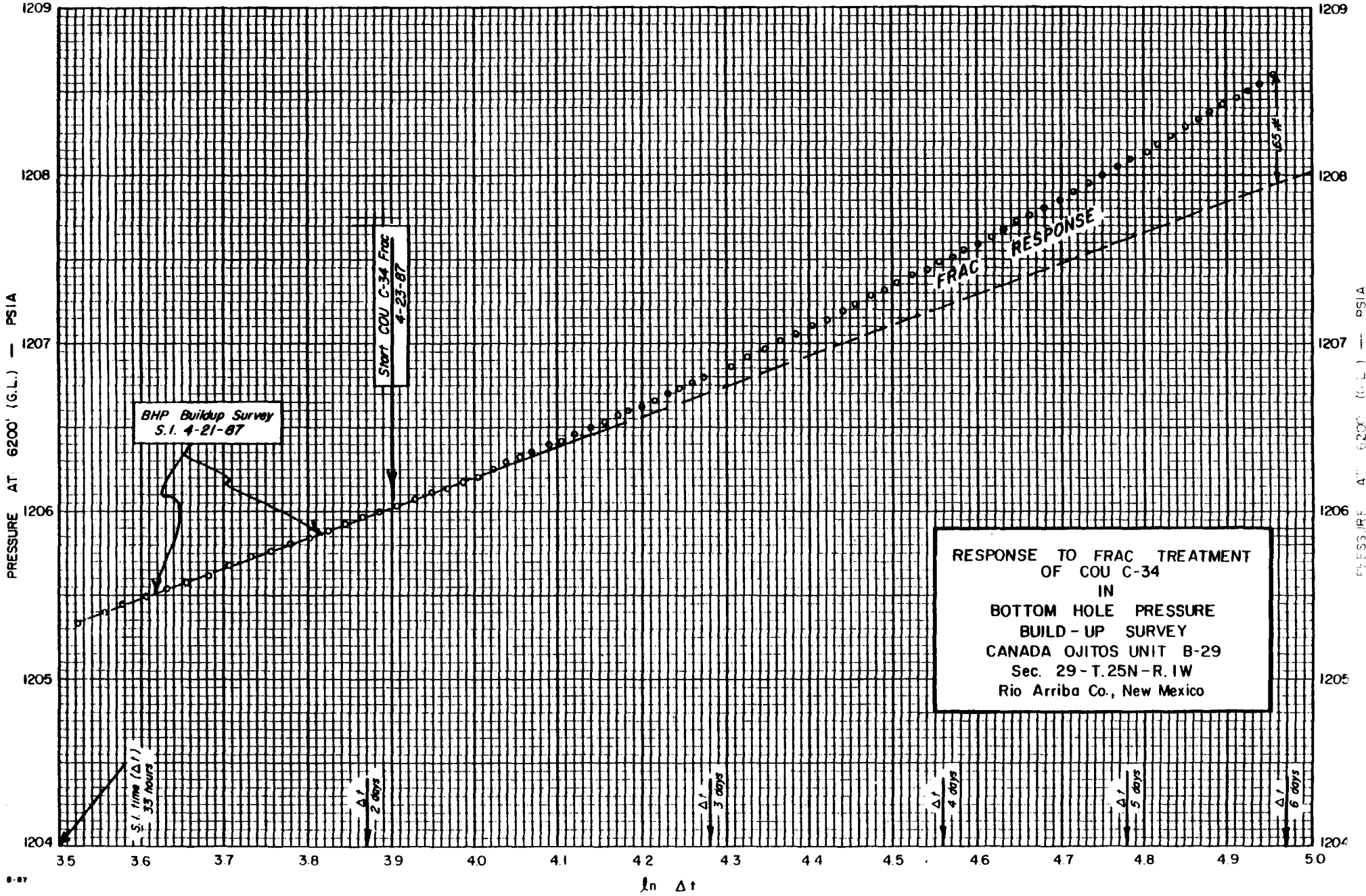
B-32 4/20/87

GAUGE SN 70059

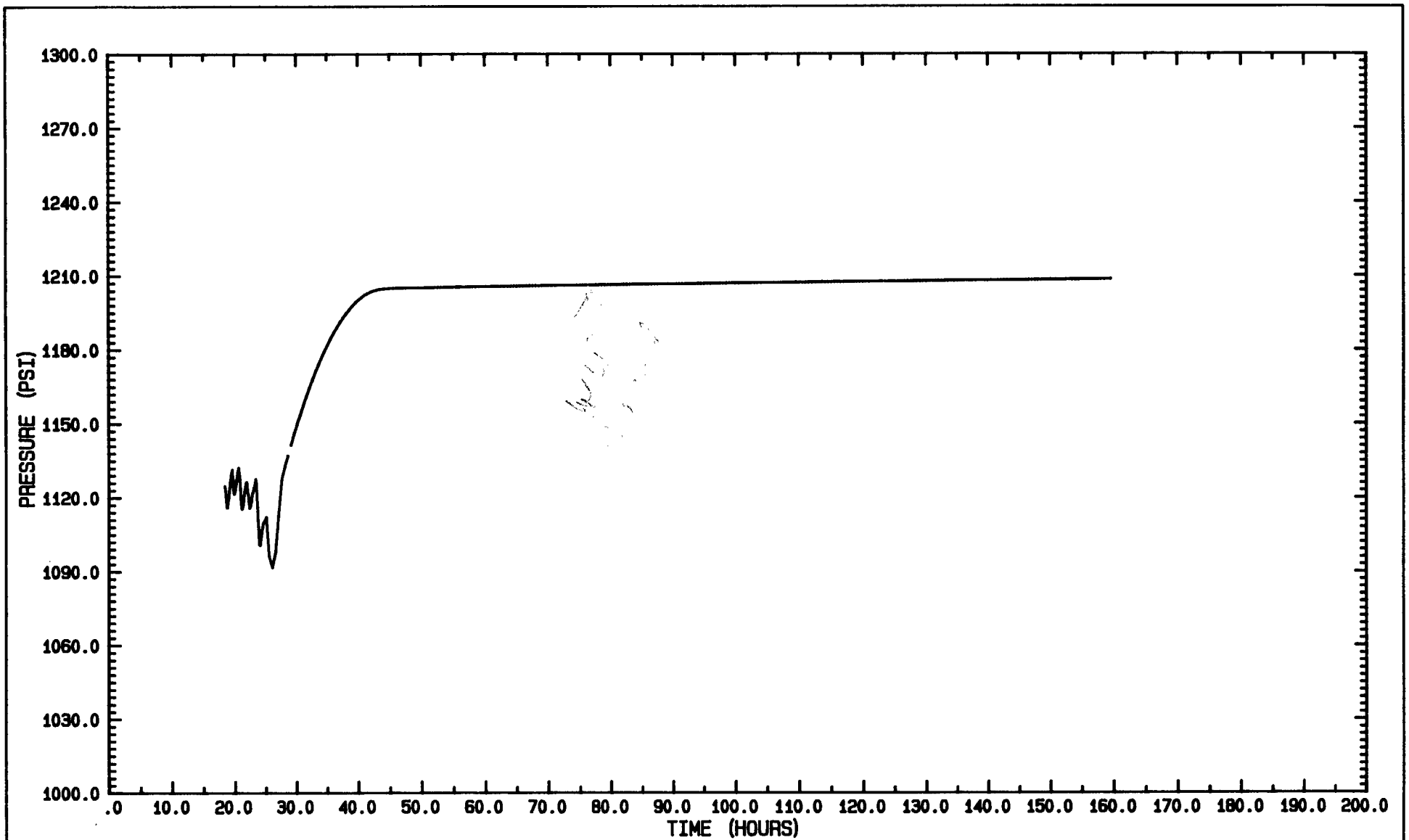
BHP @ 7300 GL DWT TBG 999 PSIG

FILE: 23-WTEST.GRF	DATE: 15-MAR-88
SOURCE: B-32_2	TIME: 21:38

Jerry R. Bergeson & Associates, Inc.



Greer Exh. # 2. Tab C
March 19, 1987



GAVILAN MANCOS FIELD STUDY

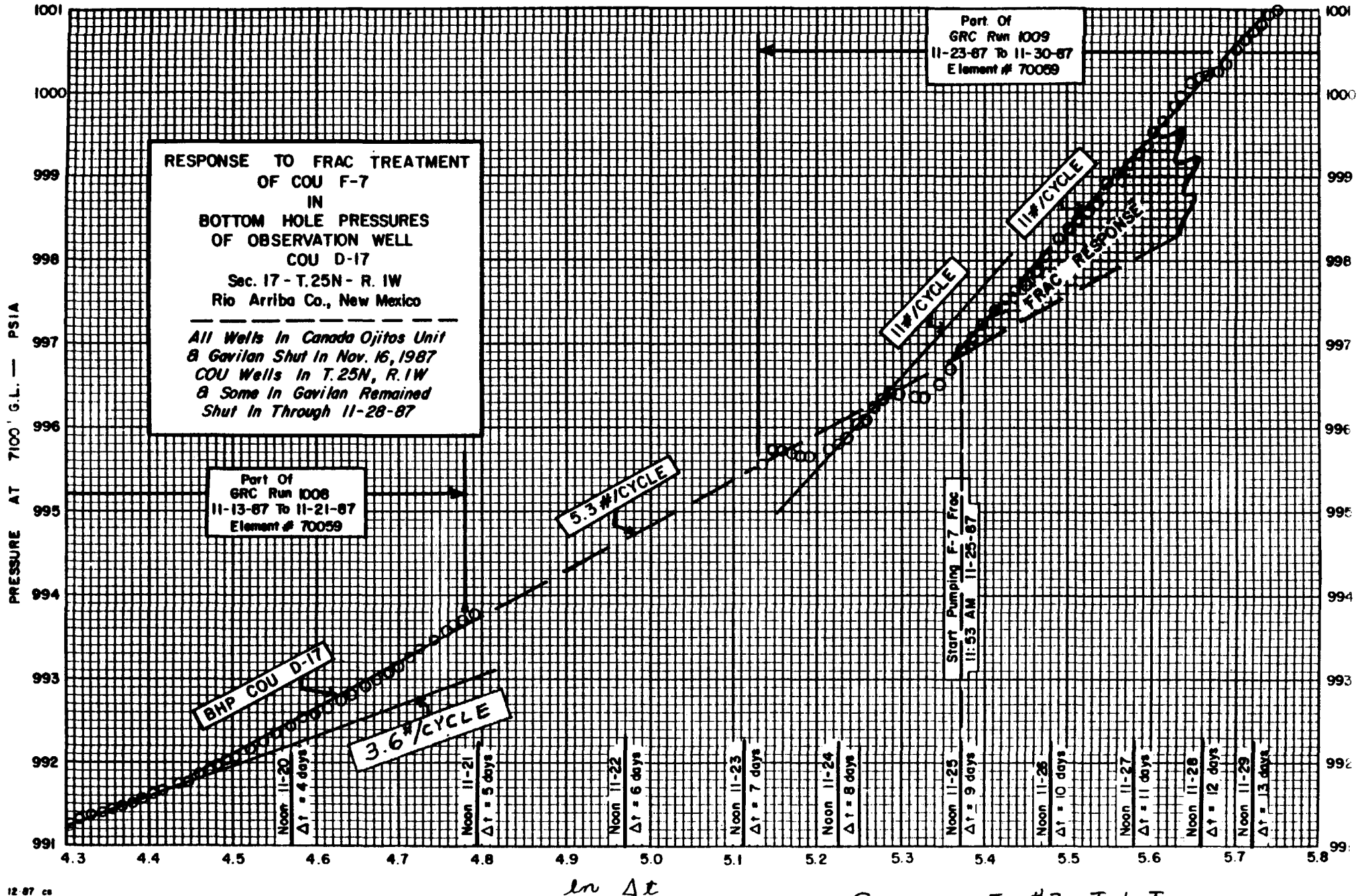
B-29 4/20/87

GAUGE SN 69160

BHP @ 6200' GL DWT TBG 649 PSIG

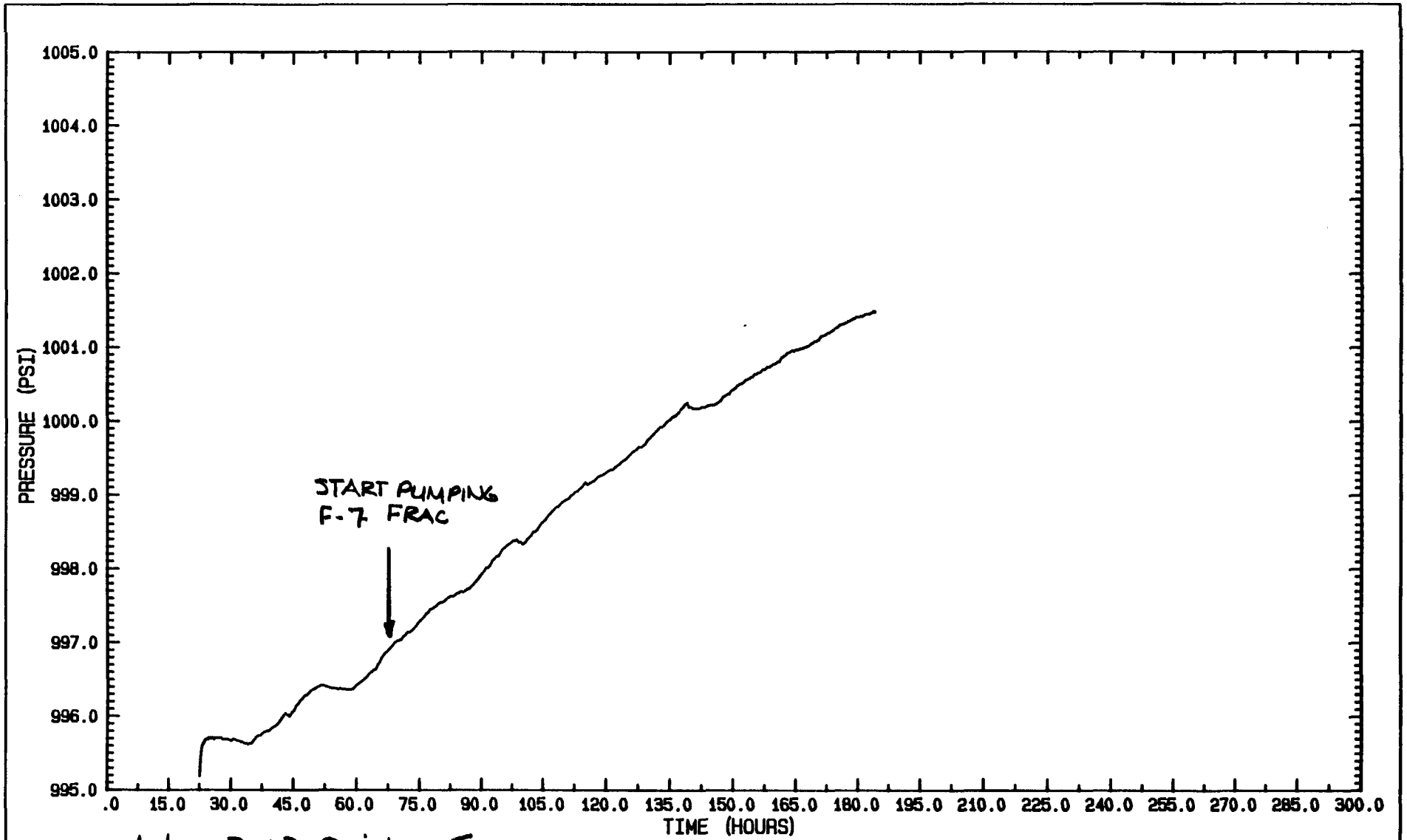
FILE: 25-WTEST.GRF	DATE: 15-MAR-88
SOURCE: B-29_1	TIME: 21:39

Jerry R. Bergeson & Associates, Inc.



12-87 cs

Greer Ex #2, Tab I
March 17, 1988



11/12/87 BHP Buildup Survey
from Greer Exh. # 2, Tab I
replotted on same time basis
as Greer Exh. 2, Tab. G, Tab. H

GAVILAN MANCOS FIELD STUDY

D-17 11/22/87
GAUGE SN 70059
BHP @ 7100' GL

FILE: 16-WTEST.GRF	DATE: 15-MAR-88
SOURCE: D-17_3	TIME: 21:35

Jerry R. Bergeson & Associates, Inc.

Flow Calculations From
Gavilan-Proposed Expansion Area for
Reservoir Rock Described by Mr. Greer
in Exhibit 3, Tab A, Pg. 7, 3/17/88

$$q = 1.127 \quad \frac{Kh}{MB} W \frac{\Delta P}{\Delta L} = 1.127 \frac{KA}{MB} \frac{\Delta P}{\Delta L}$$

q = Oil Flow Rate (BOPD)
Kh PERMEABILITY THICKNESS (D-ft)
W FLOW WIDTH (ft)
ΔP PRESSURE DIFFERENTIAL (PS1)
M VISCOSITY (cp)
B FORMATION VOLUME FACTOR (RB/STB)
ΔL LINEAR FLOW LENGTH (ft) Smiley

Khw = K(hw) = KA

FOR
W = 8 MILES = 42,240 ft
ΔP = 350 Psl
M = 0.6 cp
B = 1.29 RB/STB
ΔL = 2 MILES = 10560 ft
t = 17 YEARS = 6205 DAYS

$$q = 1.127 \frac{Kh}{(.6)(1.29)} (42240) \frac{(350)}{(10560)} = 2039\ Kh$$

	Kh (D-ft)	q (BOPD)	TOTAL OIL FOR 17 YEARS (BBLS)
Greer's Value	14	28500	177,000,000
Reasonable Value	0.01	20	127,000

SUMMARY OF FOUR FRAC PULSE TESTS
WEST PUERTO CHIQUITO POOL

		COU N-31 COU E-6	Tapacitos 4 COU E-6	COU F-30 COU B-32	COU C-34 COU B-32
1)	Well Pair				
2)	Color of Test Area on Facing Page	red	yellow	blue	green
3)	Date of Treatment	4/1/86	2/13/86	9/4/86	4/23/87
	Zones Open				
4)	Treated Well	A, B, C	A, B, C	A, B, C	A, B
5)	Observation Well	A, B, C	A, B, C	A, B, C	A, B, C
	Approximate Area of Investigation (Influence)				
6)	(Acres)	5100	1200	6000	6500
7)	at ending day ( )	(4)	(.7)	(4)	(4)
8)	Pore Volume, øh	.25	.47	.31	.19
9)	Pore Volume, Stock Bbls/Acre	1500	2800	1800	1100
10)	Average Transmissibility, Kh/u Darcy feet/centipoise	64	125	68	48
11)	Estimated GOR (cubic feet/bbl) for Area of Influence	2000	800	1050	1200
12)	Ratio of Koh to Kh/u for GOR (graph, page 4 of Appendix II)	.19	.41	.33	.30
13)	Koh (from lines 11 and 12) (darcy feet)	12	51	22	14

Note: In heavy black outline as noted on plat on facing page are boundaries of the 13th revision of the Canada Ojitos Unit Participating Area (area requested for inclusion in pressure maintenance project).

BMG EXHIBIT 3, TAB A, PG. 7

MARCH 17, 1988

Applied

PETROLEUM RESERVOIR ENGINEERING

B. C. CRAFT

and

M. F. HAWKINS

Petroleum Engineering Department
Louisiana State University

PRENTICE-HALL, INC.

Englewood Cliffs, N. J.

necessary. In general, then, steady-state mechanics will suffice where the readjustment time is small compared with the time between substantial changes in the flow rate, or, in the case of reservoirs, small compared with the total producing life(time) of the reservoir.

5. Linear Flow of Incompressible Fluids, Steady-State. Figure 6.12 represents linear flow through a body of constant cross section, where both ends are entirely open to flow, and where no flow crosses the sides, top

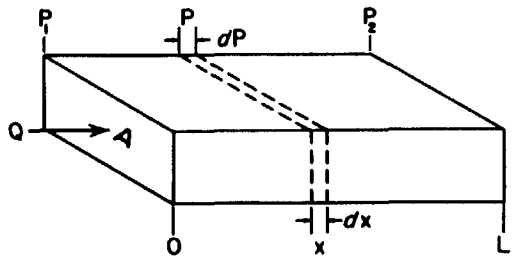


Fig. 6.12.

or bottom. If the fluid is incompressible, or essentially so for all engineering purposes, then the velocity is the same at all points, as is the total flow rate across any cross section, so that,

$$v = \frac{q}{A} = -1.127\,\frac{k}{\mu}\frac{dp}{dx}$$

Separating variables and integrating over the length of the porous body,

$$\frac{q}{A}\int_0^L dx = -1.127\,\frac{k}{\mu}\int_{p_1}^{p_2} dp$$

$$q = \frac{1.127\,kA(p_1 - p_2)}{\mu L} \tag{6.14}$$

For example, under a pressure differential of 100 psi for a permeability of 250 md, a fluid viscosity of 2.5 cp, a length of 450 feet, and a cross-sectional area of 45 square feet, the flow rate will be

$$q = \frac{1.127 \times 0.25 \times 45 \times 100}{2.5 \times 450} = 1.127 \text{ bbl/day}$$

In this integration q, μ, and k have been removed from the integral sign, assuming they are invariant with pressure. Actually, for flow above the bubble point, the volume, and hence the rate of flow, will vary with the pressure as expressed by Eq. (6.6). The viscosity of the oil also varies with pressure as explained in Sec. 2. Fatt and Davis[6] have shown a variation in permeability with net overburden pressure for several sandstones. As the

net overburden pressure is the gross less the internal fluid pressure, a variation of permeability with pressure is indicated, particularly in the shallower reservoirs. As none of these effects is serious for a few hundred psi difference, values at the average pressure may be used for most purposes.

6. Linear Flow of Gases, Steady-State. The rate of flow of gas expressed in either pounds per day or in standard cubic feet per day is the *same* at all cross sections in a steady-state, linear system. However, because the gas expands as the pressure drops, the velocity is greater at the downstream end than at the upstream end, and consequently the pressure gradient increases toward the downstream end. The flow at any cross section x of Fig. 6.12, where the pressure is p, may be expressed in terms of the flow in standard cubic feet per day by

$$q = \frac{q_{sc}p_{sc}Tz}{5.615T_{sc}p} \text{ barrels of gas per day } \textit{at reservoir conditions}$$

Substituting in Darcy's law, Eq. (6.3),

$$\frac{q_{sc}p_{sc}Tz}{5.615T_{sc}pA} = -1.127\,\frac{k}{\mu}\frac{dp}{dx}$$

Separating variables and integrating,

$$\frac{q_{sc}p_{sc}Tz\mu}{5.615 \times 1.127\,kT_{sc}A}\int_0^L dx = -\int_{p_1}^{p_2} p\,dp = \frac{1}{2}(p^2_1 - p^2_2)$$

Finally,

$$q_{sc} = \frac{3.164\,T_{sc}Ak(p^2_1 - p^2_2)}{p_{sc}TzL\mu} \tag{6.15}$$

For example, where $T_{sc} = 60°\text{F}$, $A = 45$ sq ft, $k = 125$ md, $p_1 = 1000$ psia, $p_2 = 500$ psia, $p_{sc} = 14.7$ psia, $T = 140°\text{F}$, $z = 0.92$, $L = 450$ ft, and $\mu = 0.015$ cp,

$$q_{sc} = \frac{3.164 \times 520 \times 45 \times 0.125 \times (1000^2 - 500^2)}{14.7 \times 600 \times 0.92 \times 450 \times 0.015} = 127{,}000 \text{ SCF/day}$$

Here again z, T, k, and μ have been withdrawn from the integrals as if they were invariant with pressure, and as before, average values may be used. If the flow rate is expressed in terms of cubic feet per day at the *mean pressure* p_m, and reservoir temperature T, then

$$q_{sc} = q_m \times \frac{(p_1 + p_2)}{2p_{sc}} \times \frac{T_{sc}}{T} \times \frac{1}{z}$$

where $p_m = (1/2)\,(p_1 + p_2)$. Substituting this in Eq. (6.15) and factoring $(p^2_1 - p^2_2)$ to $(p_1 + p_2)\,(p_1 - p_2)$,

$$q_m = \frac{6.328\,kA(p_1 - p_2)}{\mu L} \text{ cu ft/day}$$

C O U U N I T P R O D U C T I O N D A T A

	PRESENT PRESS MAINT AREA		PROPOSED EXPANSION AREA		TOTAL	
	OIL (BBLS)	GAS (MCF)	OIL (BBLS)	GAS (MCF)	OIL (BBLS)	GAS (MCF)
1985	268186	335222	172111	78956	440297	414178
1986	122107	127793	644483	525847	766590	653640
1987	122320	365904	689811	1120027	812131	1485931

PERCENTAGE OF TOTAL UNIT PRODUCTION

	OIL (%)	GAS (%)	OIL (%)	GAS (%)	OIL (%)	GAS (%)
1985	60.9		39.1		100	
1986	15.9		84.1		100	
1987	15.1		84.9		100	
1985		80.9		19.1		100
1986		19.6		80.4		100
1987		24.6		75.4		100

[WPP:46]

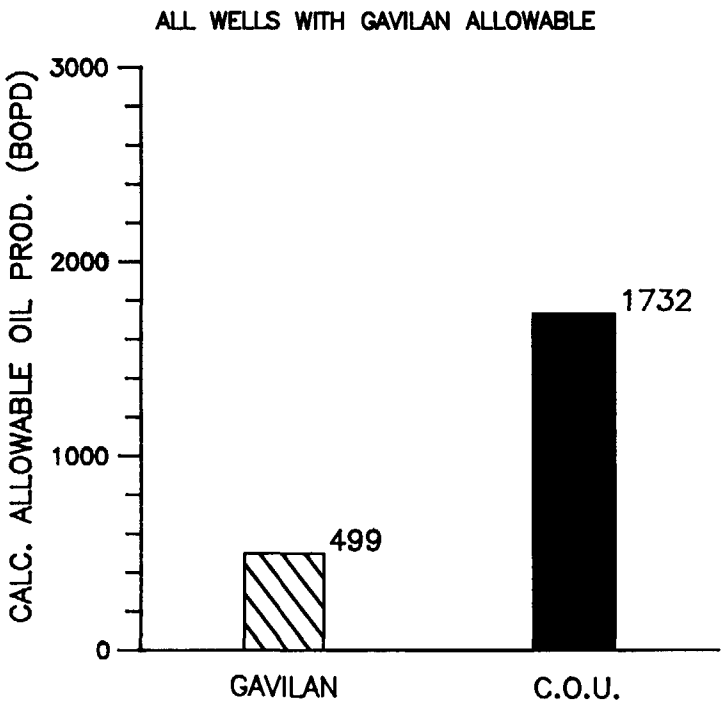
CALCULATED ALLOWABLE PRODUCTION RATES
USING DECEMBER 1987 GOR &
RESTRICTED GAVILAN ALLOWABLE
400 BOPD & 600:1 GOR

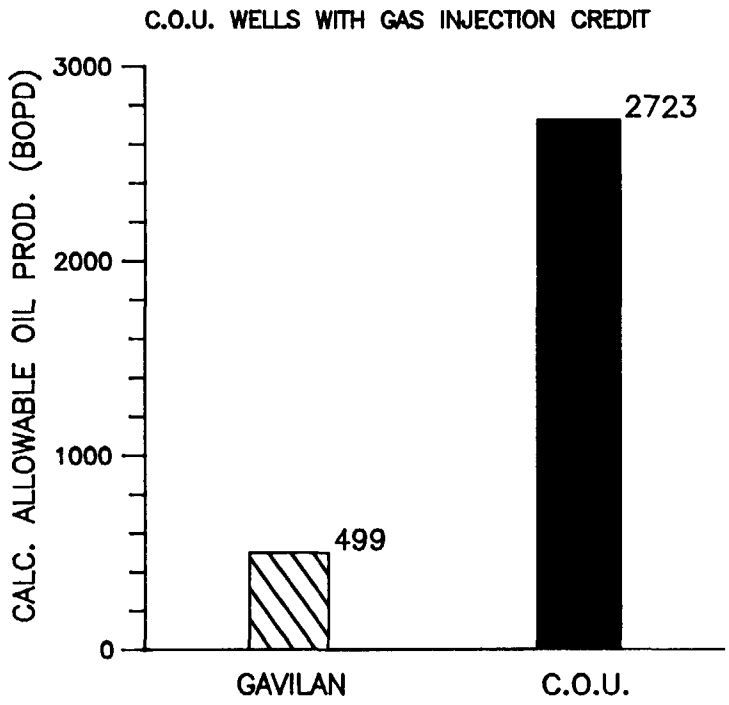
GAVILAN 

C.O.U. 

EASTERN TWO TIERS OF SECTIONS IN R2W
(23 ACTIVE WELLS)

WESTERN TWO TIERS OF SECTIONS IN R1W
(PROPOSED EXPANSION AREA)
(12 ACTIVE WELLS)





Before The New Mexico Oil Conservation Commission
Case No.: 9111 Date: March 17, 1988
Mallon Exhibit No.: _____

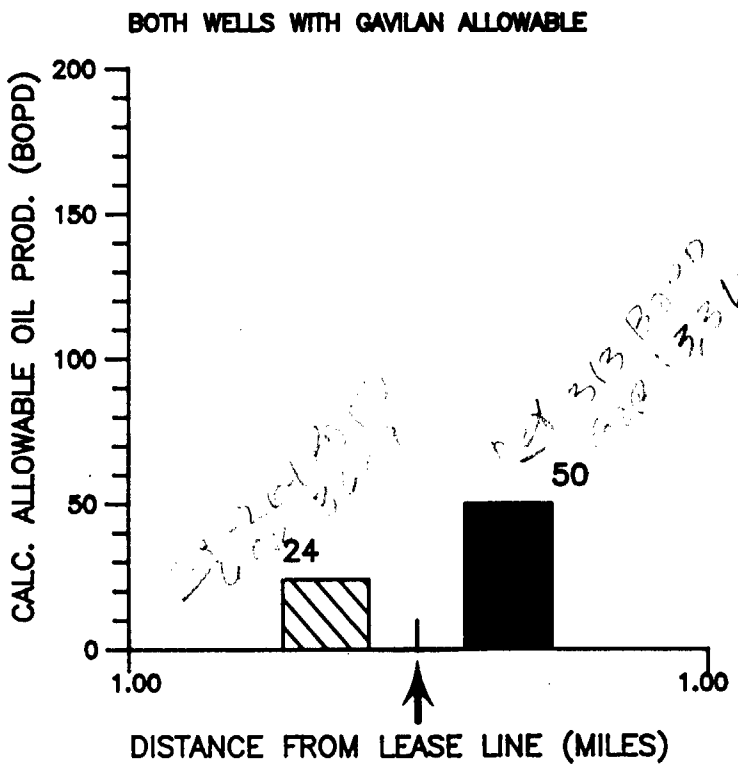
CALCULATED ALLOWABLE PRODUCTION RATES
USING DECEMBER 1987 GOR &
RESTRICTED GAVILAN ALLOWABLE
400 BOPD & 600:1 GOR

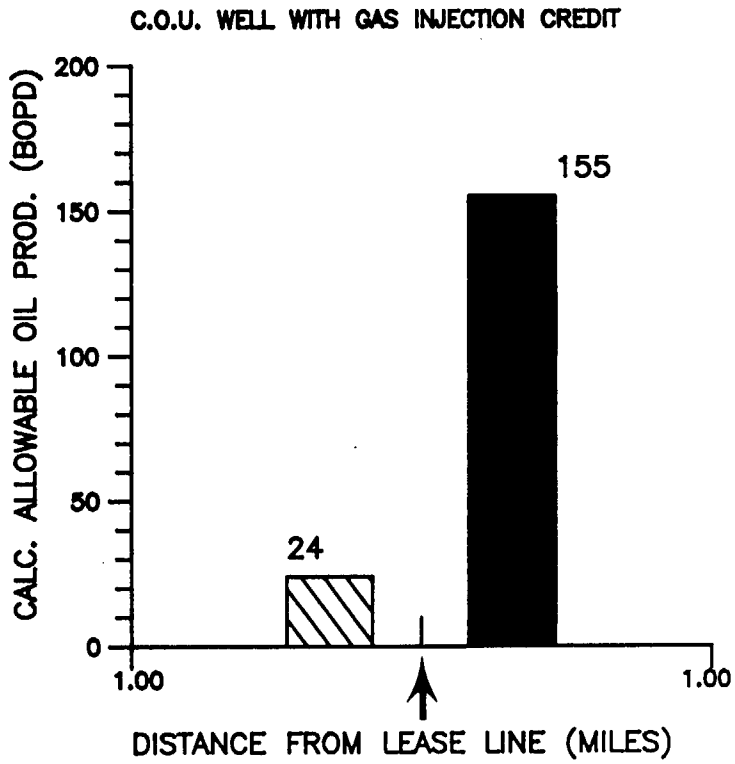
MALLON

HOWARD FEDERAL 1-8
PRODUCING GOR (12-87 & 1-88)
10199 SCF/BBL

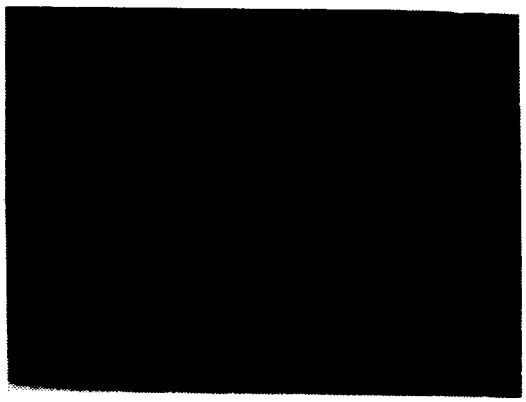
BMG

COU #29 (E-6)
PRODUCING GOR (12-87)
4818 SCF/BBL



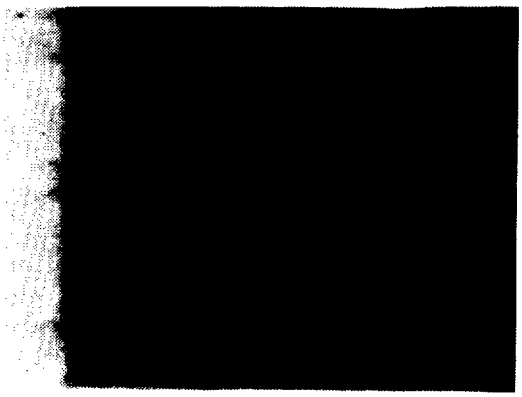


Before The New Mexico Oil Conservation Commission
Case No.: 9111 Date: March 17, 1988
Mallon Exhibit No.: _____



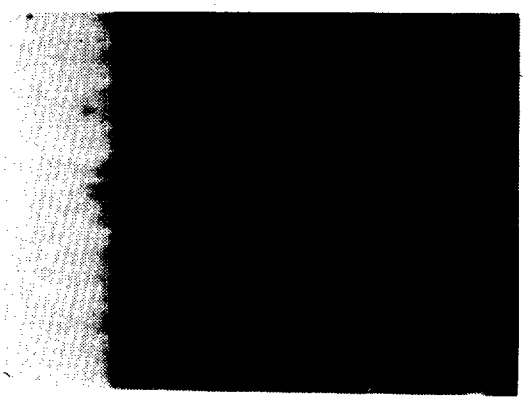
A

Initial condition: Plate of Spraberry rock, 2.7 × 1.5 × 0.25 in., fully saturated with oil and sealed on the top, bottom, and three edges to limit imbibition to the left edge only.



B

After 21 hours: oil–dark; water–white.



C

After 47 hours.

Fig. 3 – Water-imbibition Displacement Flood of Spraberry Rock

ILLUSTRATION OF WATER IMBITITION WITH TIME, SPRABERRY TREND AREA CORE

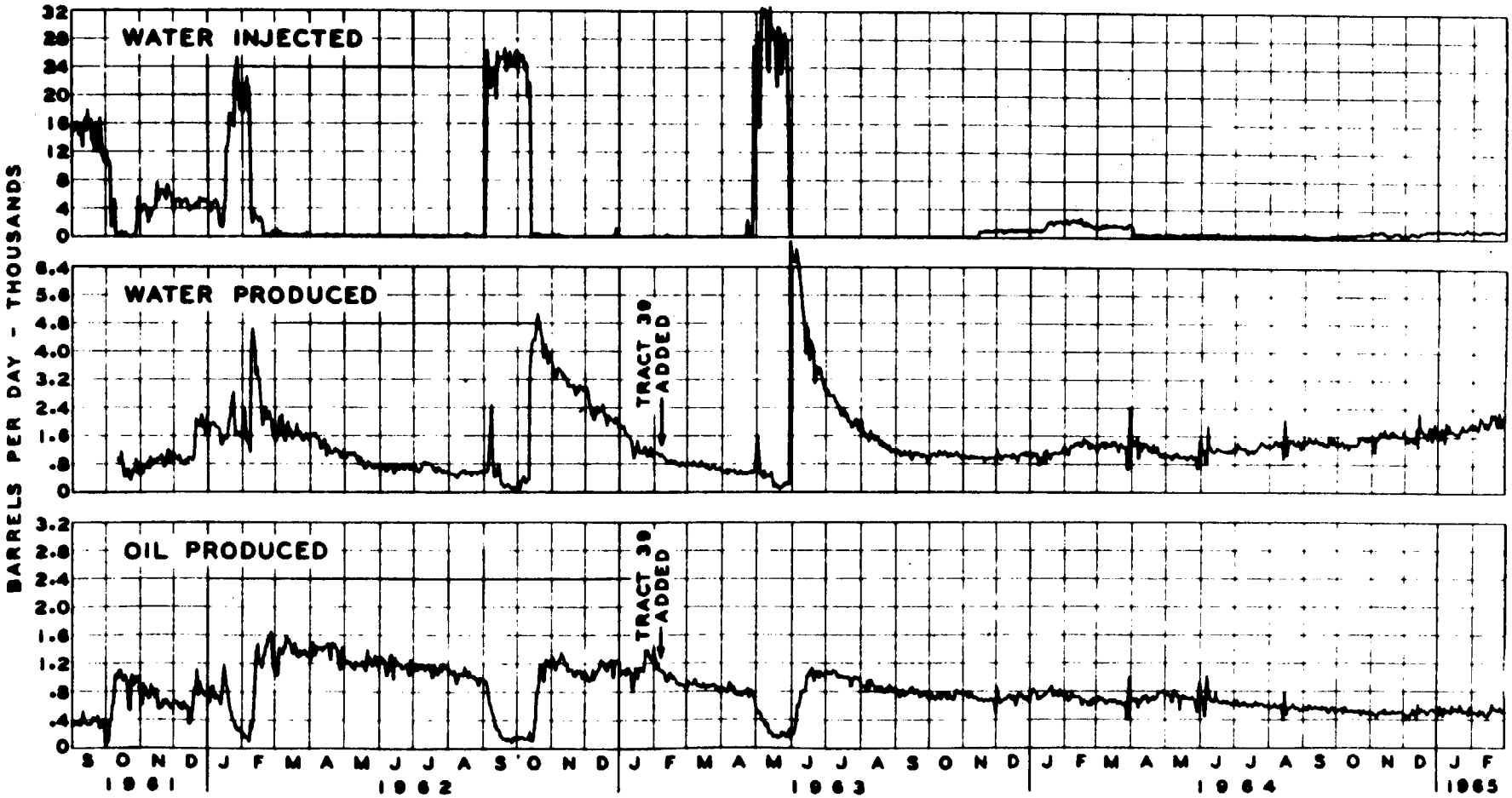
(Taken from Brownscombe and Dyes, "Water – imbibition Displacement – A Possibility for the Spraberry," Drilling and Production Practice, API, 1953, pg. 385)

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 32 DATE: JUNE 13, 1988

CYCLIC WATERFLOOD PERFORMANCE, SPRABERRY DRIVER UNIT



After "Progress Report on Spraberry Waterflood Reservoir Performance, Well Stimulation and Water Treating and Handling", by L. F. Elkins, A. M. Skov, and R. C. Gould, JPT, Sept. 1968, Page 1042.

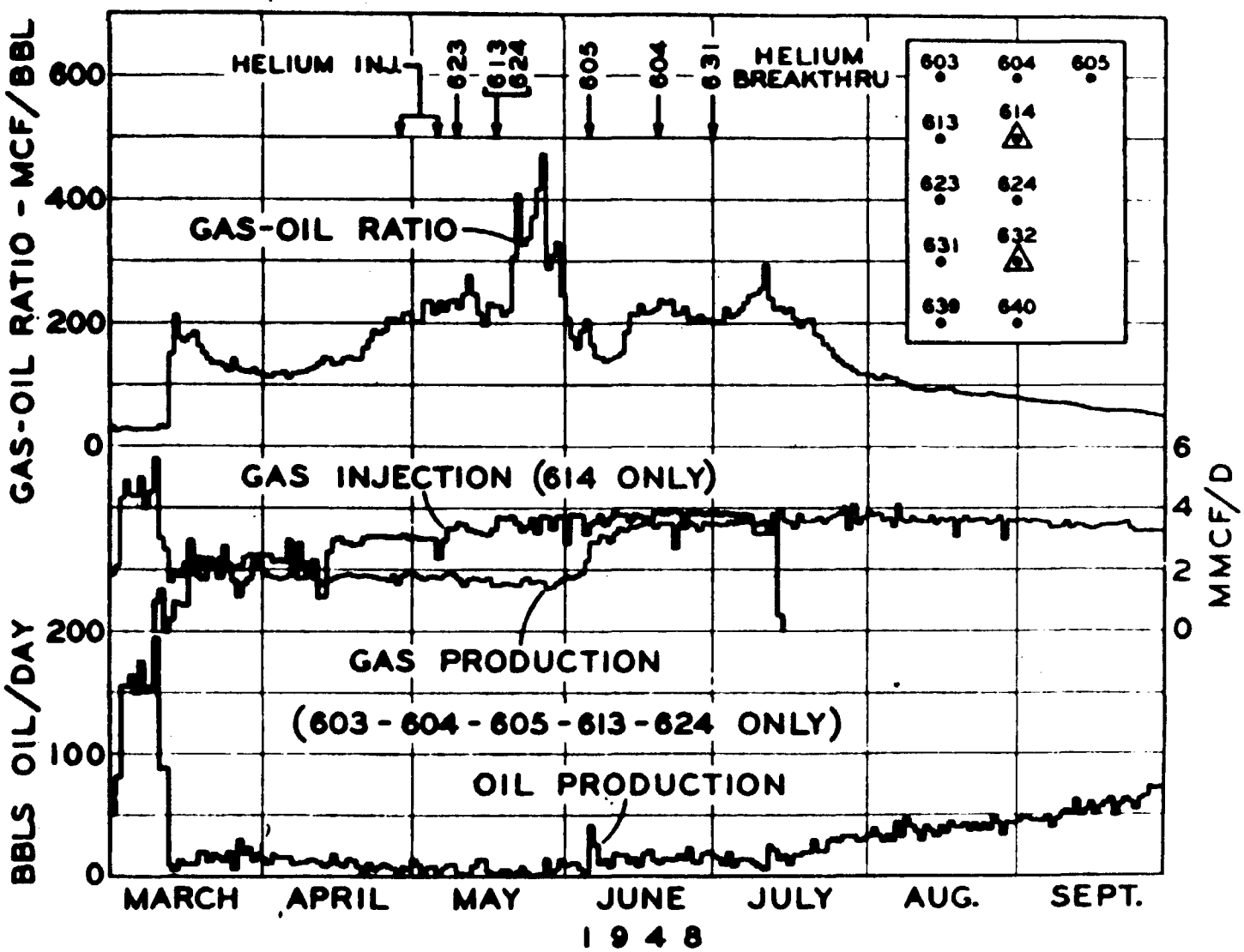
BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 33

DATE: JUNE 13, 1988

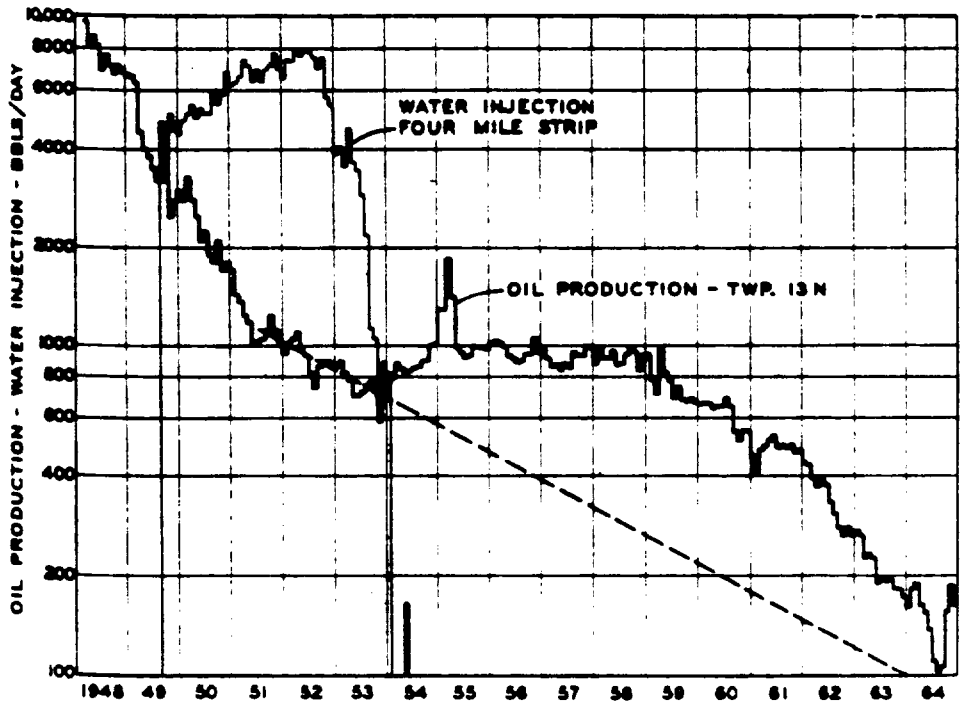
PILOT GAS INJECTION TEST NO. 2, BOIS D'ARC



After "Internal Anatomy of a Tight, Fractured Hunton Lime Reservoir Revealed by Performance – West Edmond Field, by L. F. Elkins, JPT, Febr. 1969, Page 226.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: 34
DATE: JUNE 13, 1988

BOIS D'ARC WATERFLOOD PERFORMANCE, TWP 13N



After "Internal Anatomy of a Tight, Fractured Hunton Lime Reservoir Revealed by Performance – West Edmond Field, by L. F. Elkins, JPT,Febr. 1969, Page 226.

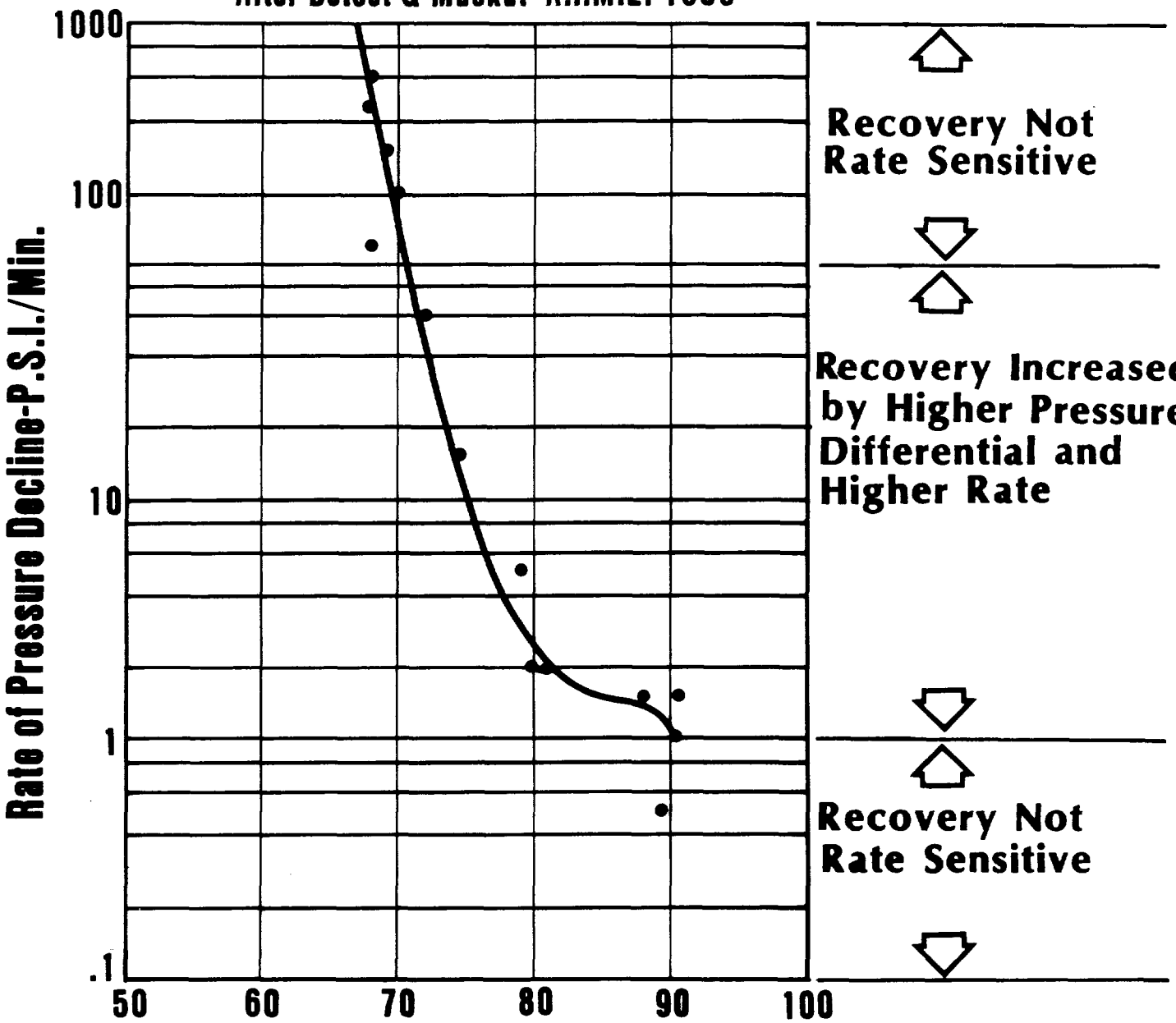
BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 35 DATE: JUNE 13, 1988

Effect of Rate of Pressure Decline on Final Oil Saturation.

After Botset & Muskat A.I.M.E. 1939



BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO. 7980,8964,8950,9111,9412
GAVILAN POOL MEMBER EXHIBIT: 36 DATE: JUNE 13, 1988

Results of Laboratory Experiments
Pressure Depletion of Oil Saturated Spraberry Cores

CORE PROPERTIES

Porosity	8.15%
Permeability	1.1 md
Size	2.18" diam. x 6.1" length

TEST NO. 1

Simulated Connate Water Saturation	28.5 %
Saturation Pressure of Crude Oil	2000 Psi
Average Rate Pressure Drawdown	200 Psi/Min.
Residual Oil Saturation by Weight Difference	25 %
Calculated Oil Recovery — Per cent of Oil in Place Initially	52 %

TEST NO. 2

Simulated Connate Water Saturation	13.4 %
Saturation Pressure of Crude Oil	1990 Psi
Average Rate of Pressure Drawdown	100 Psi/Day
Residual Oil Saturation by Weight Difference	57.5 %
Calculated Oil Recovery — Per cent of Oil in Place Initially	7 %

After "Reservoir Permance and Well Spacing, Spraberry Trend Area Field of West Texas", by L. F.Elkins, Petroleum Transactions, AIME, Vol. 198, 1953, Page 195.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 37 DATE: JUNE 13, 1988

GAVILAN AREA

REVENUE LOSS TO STATE OF NEW MEXICO

9/1986 through 5/1988

Oil Tax Revenue Lost:	$1,915,431
Gas Tax Revenue Lost:	849,311
ROYALTY	
Federal:	$1,493,201
State:	53,393
TOTAL LOSS:	$4,311,336

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: 27 DATE: JUNE 13, 1988

How effective gravity drainage w/ my angle of dip

Maximum Prod. rate to effect gravity drainage → 1,000 BOPD

FRACTURED MANCOS FIELDS

	BOULDER MANCOS 20° dip	LA PLATA GALLUP	OTERO GALLUP	E. PUERTO CHIQUITO	VERDE GALLUP	W. PUERTO CHIQUITO (PRESS. MAINT.) 5° dip
RECOVERY THRU 12/87 (MBBLS)	1,809	615	2,369	4,135	7,884	7,905
ESTIMATED AREA (ACRES)	2,000	3,000	4,800	6,400	20,500	50,000
PRODUCTION	PRIMARY	PRIMARY (SECONDARY FAILED)	PRIMARY	PRIMARY	PRIMARY	PRIMARY SECONDARY
RECOVERY (BBLS/ACRE)	905	205	494	646	385	159
YEARS TO PRODUCE 90%	12	21	15	22	9	22
OPERATOR	MOBIL VARIOUS	BMG	VARIOUS	BMG	VARIOUS	BMG
ESTIMATED ULTIMATE RECOVERY (BBLS/ACRE)	905	230	606	718	402	161
NUMBER OF WELLS	25	6	49	21	200	11 19
AREA PER WELL (ACRES)	80	500	98	305	103	4,545 2,631 acres per well

225 BoPD

22 BoPD

0.5° dip

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: ...
DATE: JUNE 13, 1988

GAVILAN AREA

REVENUE LOSS TO WORKING AND NON-FEDERAL ROYALTY INTEREST

9/1986 through 5/1988

Total Revenue Lost:	$28,475,963
Less State Taxes and Royalty:	4,311,336
Less Federal Royalty:	1,493,201
Lost Operating Profits and Non-Federal Royalties:	$22,671,426

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: 28 DATE: JUNE 13, 1988

GAVILAN MANCOS AREA
SUMMARY OF PRIOR STUDIES
MARCH 1987 (CASE 7980 ETAL)
AND
MARCH 1988 (CASE 9111)

CONCLUSION	STILL VALID
Dual Porosity : Major Fractures Matrix (Primary, Microfractures, Small Fractures)	Yes
High Rock Compressibility (Lab Tests) and Flow Into Matrix	Yes
Oil – In – Place of 55 MM – STB (Material Balance)	Yes
In – Situ Oil Permeability Thickness Generally < 1000 md – ft (Pressure Buildup, Well Performance)	Yes
Gravity Segregation Vertically in Fractures (Production Logs, GOR Performance)	Yes
Gavilan Produces From Niobrara A, B, but not C (Production Tests, Production Logs, Televiewer Logs)	Yes
Gavilan and C. O. U. Proposed Expansion Area In Excellent Pressure Communication (Pressures and Interference Tests)	Yes
Gavilan and C. O. U. Pressure Maintenance Area not in Communication (25 Years Interference Test and Commission Ordered Pressure Tests)	Yes
Simulated Gavilan Historical Performace And Predicted Future Performance Indicates Ultimate Recovery of 9.4 MM – STB (Reservoir Model and Field Performance)	Yes
Gavilan Ultimate Recovery Not Reduced By Increased Rate (Reservoir Model and Field Performance)	Yes
Gas Injection in Gavilan Will Not Improve but Will Hurt Current Operations	Yes

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 29 DATE: JUNE 13, 1988

CONCLUSIONS

- BULK OF GAVILAN OIL IN MATRIX
- INJECTING GAS INTO FRACTURED SYSTEM WILL NOT RECOVER OIL FROM MATRIX
- OIL WILL BE LOST IF HIGHEST POSSIBLE PRESSURE DIFFERENTIAL IS NOT MAINTAINED BETWEEN MATRIX AND FRACTURE

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO: 7980, 8946, 8950, 9111, 9412
GAVILAN POOL MEMBER EXHIBIT: 30 DATE: JUNE 13, 1988

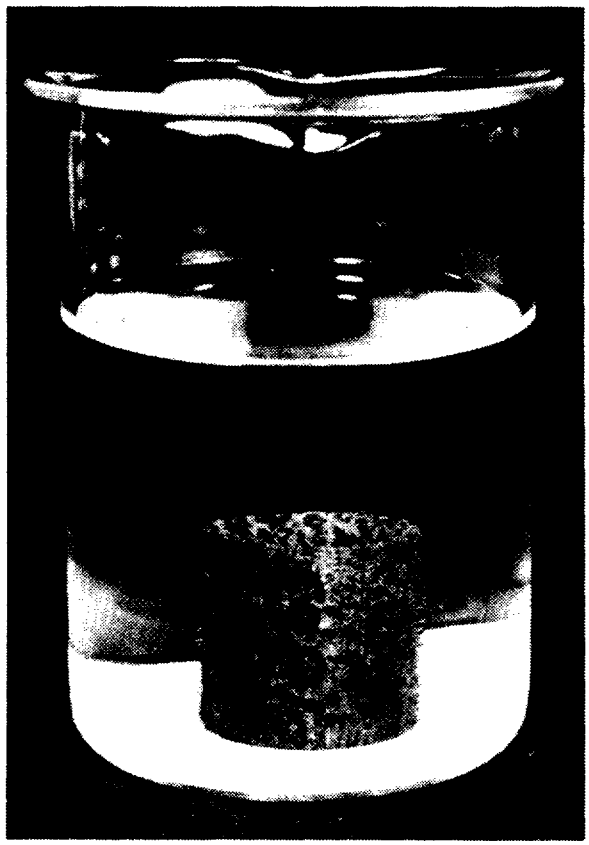


Fig. 1 – Oil Displacement from Spraberry Core by Water Imbibition

ILLUSTRATION OF SPONTANEOUS IMBIBITION OF WATER AND EXPULSION OF OIL, SPRABERRY TREND AREA CORE

(Taken from Brownscombe and Dyes, "Water – imbibition Displacement – A Possibility for the Spraberry," Drilling and Production Practice, API, 1953, pg. 384)

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

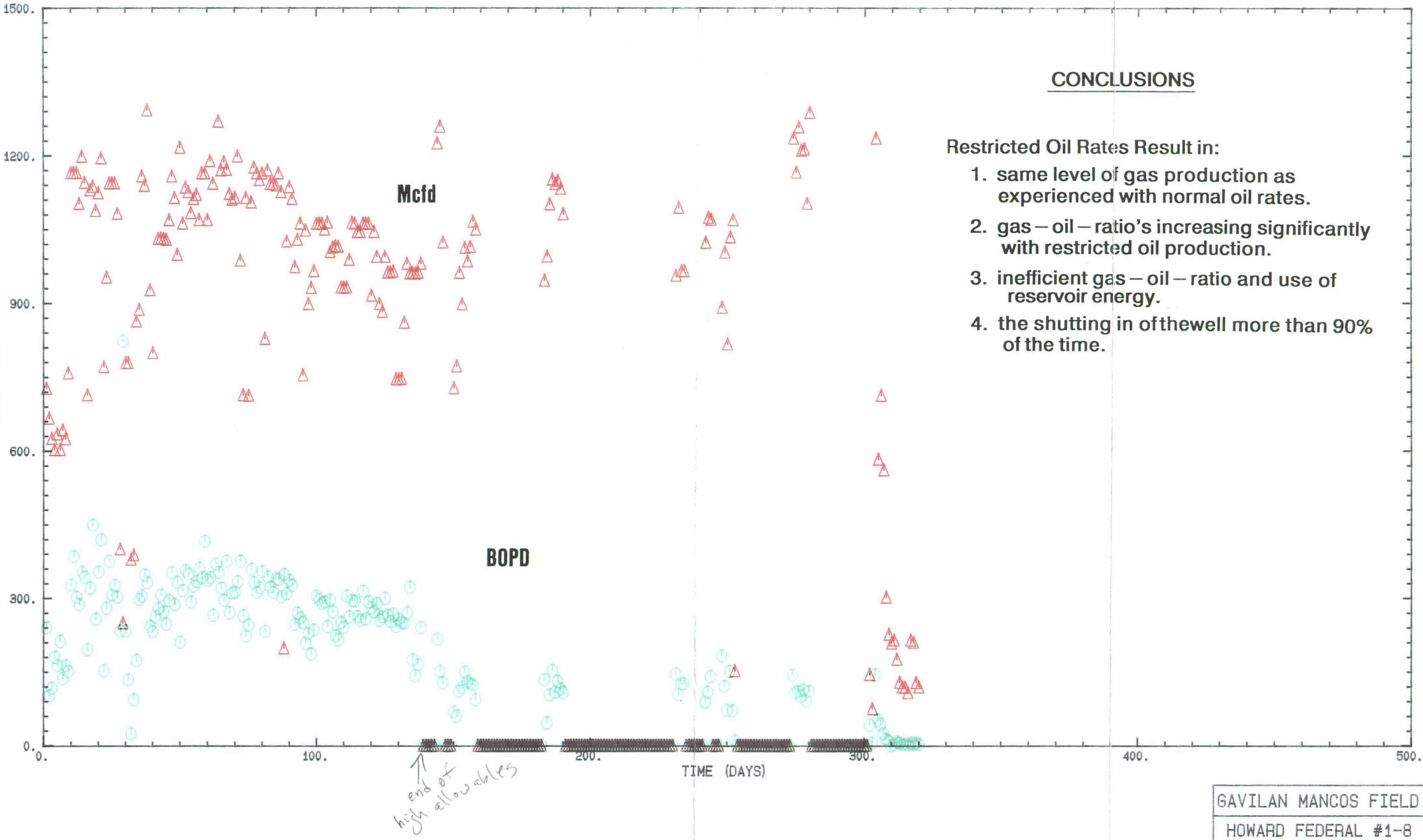
CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: 31 DATE: JUNE 13, 1988

GAVILAN MANCOS AREA
PLOTS OF DAILY OIL
AND GAS PRODUCTION

JULY 1, 1987 THROUGH
MAY 15, 1988

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION
CASE NO. 7980, 8946,8950,9111,9412
GAVILAN POOL MEMBER EXHIBIT: 11
DATE: JUNE 13, 1988



CONCLUSIONS

Restricted Oil Rates Result in:

1. same level of gas production as experienced with normal oil rates.
2. gas – oil – ratio's increasing significantly with restricted oil production.
3. inefficient gas – oil – ratio and use of reservoir energy.
4. the shutting in of the well more than 90% of the time.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

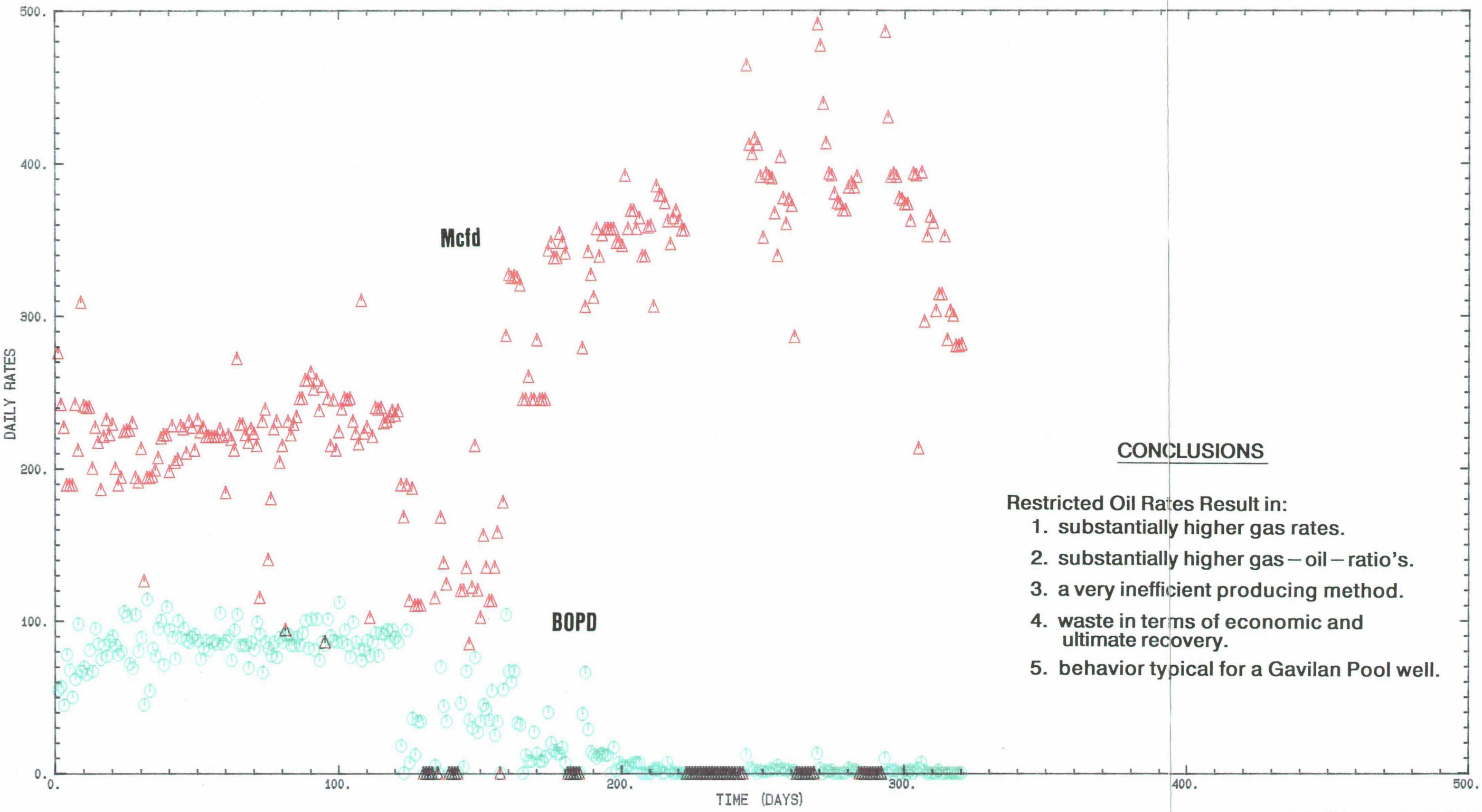
GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS FIELD STUDY

HOWARD FEDERAL #1-8 (H-1)
SEC 1, T25N-R2W
DAILY RATES VS. TIME
JULY 1, 1987 - MAY 15, 1988

FILE: 1-DAILY.GRF	DATE: 4-JUN-88
SOURCE:	TIME: 12:21

Jerry R. Bergeson & Associates, Inc.



CONCLUSIONS

Restricted Oil Rates Result in:

1. substantially higher gas rates.
2. substantially higher gas – oil – ratio's.
3. a very inefficient producing method.
4. waste in terms of economic and ultimate recovery.
5. behavior typical for a Gavilan Pool well.

BEFORE THE NEW MEXICO OIL CONSERVATION COMMISSION

CASE NO: 7980, 8946, 8950, 9111, 9412

GAVILAN POOL MEMBER EXHIBIT: _____ DATE: JUNE 13, 1988

GAVILAN MANCOS FIELD STUDY

RIBEYOWIDS-FEDERAL #2-16 (P-2)
SEC 2, T25N-R2W
DAILY RATES VS. TIME
JULY 1, 1987 - MAY 15, 1988

FILE: 2-DAILY.GRF	DATE: 4-JUN-88
SOURCE:	TIME: 12:28

Jerry R. Bergeson & Associates, Inc.