FOSSIL ENERGY

DOE/BC/14860-5
(DE95000109)

DETAILED EVALUATION OF THE WEST KIEHL ALKALINE-SURFACTANT-POLYMER FIELD PROJECT AND ITS APPLICATION TO MATURE MINNELUSA WATERFLOODS

Annual Report for the Period
January to December 1993

November 1994

Performed Under Contract No. DE-AC22-93BC14860

Surtek Inc.
Golden, Colorado

Bartlesville Project Office
U. S. DEPARTMENT OF ENERGY
Bartlesville, Oklahoma

DOE/BC/14860-5
Distribution Category UC-122

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Prepared for
U.S. Department of Energy
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Abstract

The combination of an interfacial tension agent and a mobility control agent has the potential to produce additional oil beyond a waterflood. The West Kiehl alkaline-surfactant-polymer project is the most advanced application of this chemical enhanced oil recovery technique. The West Kiehl alkaline-surfactant-polymer flood was initiated in September 1987 as a secondary application after primary recovery. A preliminary analysis of the West Kiehl alkaline-surfactant-polymer flood indicates that incremental oil of 20% of the original stock tank oil in place will be produced above waterflooding. The cost of the incremental oil will be less than $2.50 per incremental barrel.

A statistical analysis of approximately 120 Minnelusa oil fields in the Powder River Basin indicates that the original stock tank oil in place exceeds one billion barrels. If the enhanced oil recovery technology implemented at West Kiehl field could be successfully applied to these fields, the potential incremental oil recovery would approach 200 million barrels.

"Detailed Evaluation of the West Kiehl Alkaline-Surfactant-Polymer Field Project and It's Application to Mature Minnelusa Waterfloods" objective is to evaluate both the field performance of the alkaline-surfactant-polymer enhanced oil recovery technology as well as its potential application to other Minnelusa oil fields. The objectives of the project are:

- Evaluate the geological depositional environment of the West Kiehl and of adjacent Minnelusa sand reservoirs with similar fluid and rock characteristics.
- Those reservoir analogs with depositional environments similar to the West Kiehl field will be compared on an engineering basis to define both geological and reservoir performance analogs to the West Kiehl field.
- Compare the production performance results of the best geological and reservoir performance analogs to the West Kiehl field and select two fields for future study. Polymer floods and waterfloods performance were defined.
- Compare the two best field analogs to the West Kiehl field using numerical simulation.
    - History match the results of the laboratory radial coreflood simulating the West Kiehl field
    - History match the actual field performance of the alkaline-surfactant-polymer flood at West Kiehl field
    - Forecast the future performance of the West Kiehl project and determine the incremental oil recovery above waterflooding

- History match the actual field performance of the waterflood analog
- History match the actual field performance of the polymer flood analog

- Predict the results of applying the alkaline-surfactant-polymer technology as a tertiary oil recovery technology on the two mature Minnelusa waterflood analog units using classical engineering and numerical simulation.

- Predict the waterflood and polymer flood performance of the West Kiehl field using numerical simulation and the parameters established in the analog field numerical simulations.

Executive Summary

The West Kiehl is the first field to have the combination of alkali plus surfactant plus polymer co-injected to improve oil recovery. The combination of chemical injected into the West Kiehl were 0.8 wt% sodium carbonate (Na_2CO_3) plus 0.1 wt% active Petrostep B-100 plus 1,050 mg/l Pusher 700. The Na_2CO_3 and Petrostep B-100 were injected to shift the end point of the relative permeability curve to a lower oil saturation by changing the capillary number. Pusher 700 was injected to improve the mobility ratio so the mobilized oil is displaced effectively from the reservoir.

The West Kiehl field characteristics and production are documented. Classical engineering analysis projects the ultimate oil recovery from the swept area of the Unit to be 70.2% OOIP, leaving 0.205 PV oil upon completion. The Kottabra 25-15 to the north the Unit was drilled and put on production after approximately 2 years of alkali plus surfactant plus polymer injection. As a result, 0.12 PV of alkali plus surfactant plus polymer solution was injected toward the Kottabra 25-15 compared to 0.33 PV into the Unit. The resulting oil recovery from the flooded volume by the Kottabra 25-15 is predicted to be 63.8% OOIP, leaving 0.250 PV oil in place. The Kottabra 25-15 also experienced earlier water break through at 0.11 PV injection compared to the Unit wells at 0.28 PV injected, suggesting poorer oil recovery efficiency.

Laboratory studies consisting of interfacial tension, linear corefloods and radial corefloods were performed to provide data to incorporate into the numerical model. Linear coreflood oil recovery by water injection was 56.3% OOIP, leaving a waterflood residual oil saturation of 0.343 PV. Injection of alkali plus surfactant plus polymer produced an additional 17.3% OOIP for a cumulative oil recovery of 73.7% OOIP with a final residual oil saturation of 0.207 PV. Radial coreflood oil recovery by waterflood averaged 46.6% OOIP while mobility control polymer flood oil recoveries averaged 42.8% OOIP and alkali plus surfactant plus polymer flood oil recoveries averaged 61.7% OOIP.

Radial coreflood waterflood, polymer flood and alkaline plus surfactant plus polymer flood oil production and chemical production were matched in a numerical simulator to calibrate the numerical simulation model. The West Kiehl history match is currently being performed.

To define suitable waterflood and polymer flood fields for comparison to the West Kiehl, a 275 square mile area around the West Kiehl was studied. Seventy two Minnelusa fields were identified. From the 72 fields, 35 were studied in detail to define the waterflood and polymer flood analogs. Each of the fields were mapped and an ultimate recovery estimated using classical engineering and geologic techniques. Two of the fields will be studied in detail by numerical simulation. The two fields selected for comparison to the West Kiehl were Simpson Ranch for the polymer flood and Prairie Creek South for the waterflood.

Introduction

The amount of oil recovered from porous media by fluid injection can be described in equation form by

$$N_o = \frac{E_{VI} E_A E_D S_{oi} N_p}{B_o} \qquad (1)$$

The value of each of the efficiency factors (E_{VI}, E_A, and E_D), the initial amount of oil present (S_{oi}), and the pore volume of the oil zone (N_p) dictates the amount of oil which is produced from an oil bearing porous media.

The displacement efficiency, E_D, can be increased by adding an interfacial tension reducing agent to the injected solution to alter the capillary number. Capillary number is defined as[1]

$$N_{ca} = \frac{viscous\ forces}{capillary\ forces} = \frac{u\mu_{displacing\ phas.}}{\gamma_{ow}} \qquad (2)$$

where $\mu_{displacing\ phase}$ is the viscosity of the injected phase, u is the darcy velocity of the injected phase and γ_{ow} is the interfacial tension between oil and water. Abrams[2] has demonstrated that capillary number changes of 10^3 to 10^4 are necessary for residual oil saturation to be decreased significantly. Because petroleum reservoirs injection rates and pressures are constrained, increases of $\mu_{displacing\ phase}$ or u are limited. Reduction of the interfacial tension between oil and aqueous solution of three or more orders of magnitude are achievable, resulting in a corresponding increase in capillary number and ultimately E_D.

However, adding an interfacial tension agent alone to the injected water can create problems. Viscous instabilities and early break through of the injected fluid can occur.[3] The exacerbated viscous fingering results in decreased reservoir contact efficiency. Including a polymer or mobility control agent in the injected solution can control the viscous fingering.

The chemical enhanced oil recovery project in the West Kiehl Field is unique in simultaneously co-injecting alkali (sodium carbonate) plus low concentration surfactant (Petrostep B-100) plus polymer (Pusher 700). The co-injection of a mobility control agent plus a combination of interfacial tension agents into the West Kiehl Field was done to improve the three efficiency factors at the same time. Vertical, E_{VI}, and areal, E_A, sweep efficiency factors were increased by the addition of polymer to the injected solution. E_D was increased by adding alkali and surfactant to the injected solution to decrease the interfacial tension between oil and water.

The West Kiehl alkaline-surfactant-polymer project is one of only three such projects worldwide and the first in the United States in which a mobility control agent (polymer) was co-injected with interfacial tension reduction agents (alkali plus surfactant). This project is unique in that low cost chemical combinations were injected. The West Kiehl project is also unique in that it allows the amount of incremental oil produced as a result of the injection of two different volumes of chemical solution to be calculated in the same field demonstration. This because two wells were drilled in the field north of the West Kiehl Unit 2 years after chemical injection started or 6 months before alkaline-surfactant-polymer ended.

The objective of this project is

- To quantify the incremental oil produced from the West Kiehl alkaline-surfactant-polymer project by classical engineering and numerical simulation techniques.

- To quantify the effect of chemical slug volumes on incremental oil recovery in a field application.

- To determine economics of the application of the alkaline-surfactant-polymer technology.

- To forecast the results of the injection of an alkaline agent plus a low concentration surfactant plus a polymer solution to mature waterfloods in similar reservoirs.

- To provide the basis for independent operators to book additional oil reserves by using the alkaline-surfactant-polymer process.

History of Development of the West Kiehl Field

The West Kiehl Field was discovered in August 1985 by the Terra Resources State 31-36. State 42-36 was drilled and completed in January 1986, State 32-36 was drilled and completed the following month and State 41-36 was drilled in April 1986, but not completed until January 1988 following field unitization in March 1987.

The northern part of the field extends outside the Unit boundary into Section 25 with development starting 21 months after chemical injection was initiated into the Unit. The Kottabra 25-15 was completed in September 1989 and Kottabra 25-10 was completed in July 1990. Kottabra 25-11 was drilled in October 1992 into a water-leg and completed as a water disposal well. Figure 1 shows the location of these wells on the net porosity-foot isopach.

Geology

The West Kiehl reservoir is a Permain Minnelusa Lower "B" Sand. The Lower "B" Sand is interpreted to be a preserved remnant of a highly dissected coastal eolian dune complex. The eolian sequence marked the beginning of several cycles of transgression and regression of the Wolfcampian seas in the Lusk Embayment and provided outstanding reservoir rock.

Structural contours of the lower "B" sand porosity indicate a slight northwest-southeast trending feature. Dip to the southwest is probably a combination of depositional geometry and regional dip while the very slight indication of the anti-regional dip to the northeast is a result of deposition.

The isopach of the net lower "B" sand as shown in Figure 1 depicts a rather small northwest-southeast sand preservation with thickness ranging from 0 ft to greater than 30 ft (11.6 m). The sand body probably was much larger than shown in Figure 1 at one time. However, subsequent post-Minnelusa erosion has virtually destroyed the original form. It appears from current mapping that the zero edge surrounding the field is totally the result of erosion, with abnormally thick overlying Opeche shale being the norm.

Injection History

State 31-36 was converted to injection in September 1987. Fox Hills water was injected from mid-September of 1987 to early December 1987 to study the injectivity and response to waterflood. Water injection was 685 bbl/day (109 m^3/day) in early December with a stable well head pressure of 775 psi (5,343 kPa). The Hall plot demonstrated no injection problems with water.[4]

On December 3, 1987, sodium carbonate injection began with no change in the Hall plot slope, suggesting no damage to the formation by injection of alkali. Surfactant was added to the injection water in addition to the sodium carbonate on December 17, 1987. Co-injection of 15 Mbarrels (2.5 Mm^3) of the alkali-surfactant occurred with a decline in the

injectivity factor.[4] The decline in the slope suggests that the residual oil saturation around the well bore was reduced by chemical injection. On January 28, 1988 polymer was added to the alkaline-surfactant solution. Injection of the alkaline-surfactant-polymer solution continued until June 22, 1990 when surfactant was discontinued. Soda ash was discontinued on July 5, 1990. The total alkaline-surfactant-polymer solution injected was 501,063 barrels (79,662 m^3). Polymer injection continued for 122,926 barrels (19,543 m^3) at the design concentration until April 25, 1991 when a taper of the polymer concentration began. Polymer was injected through December 1991 with water injection beginning in January 1992.

Injection pressure has exceeded formation parting pressure, (estimated to be 0.75 psi/ft - 1.58 kPa/m) beginning April 1988 or after 158,000 barrels (25,120 m^3) were injected. No change in slope of the Hall plot[4] was observed in April 1988 when injection pressures exceeded 0.75 psi/ft (1.58 kPa/m). This would indicate that the fractures were not communicating with other sands or the producing wells. Injection/withdrawal ratios of approximately 1.0 indicate that the injected fluid is staying in zone. The inadvertent limited fracturing may have helped maintain injectivity by increasing the effective wellbore radius. The Hall plot and the injectivity factor plot show no damage to the formation by injection of alkali-surfactant-polymer.

The swept volume is that volume between the injector and the producer contacted by the injected fluids or effected by the pressure gradient. The volume of alkaline-surfactant-polymer solution injected into the Unit swept area was 0.33 PV and, through December 1991, 0.15 PV of a taper polymer solution was injected. Water injection after the polymer taper began in January 1992. To the north, the area swept by Kottabra 25-15 received 0.12 PV of alkaline-surfactant-polymer solution followed by 0.21 PV polymer.

Production History

The producing wells in the West Kiehl Unit are: State 31-36, State 32-36, State 42-36 and State 41-36. The initial oil production from State 31-36 was 278 bbl/day (44.2 m^3/day) occurring in October of 1985 with a rapid decline to 34 bbl/day (5.4 m^3/day) before conversion to injection in September 1987. State 42-36 initially produced 176 bbls/day (31.2 m^3/day) of oil in February 1986 and declined to 29 bbls/day in September 1987. State 32-36 initially produced 23 bbls/day (3.7 m^3/day) in March 1986 and declining to 8 bbls/day (1.3 m^3/day) in September 1987. The maximum combined primary oil production occurred in February 1986 with 339 bbl/day (53.9 m^3/day).

The response to fluid injection beginning in September 1987 was rapid. Unit production increased from a low of 63 bbl/day (10.0 m^3/day) to a peak of 460 bbl/day (73.1 m^3/day) in February 1988. Unit production in excess of 400 bbl/day (63.6 m^3/day) was maintained from February 1988 until February 1989, when the Kottabra 25-15 began producing. Water production was observed almost immediately upon fluid injection but remained constant at about 2% until May 1990. The Unit oil and water production with and without the two Kottabra wells is shown in Figure 2.

State 32-36 responded immediately to fluid injection, increasing from 8 bbl/day (1.3 m^3/day) to 155 bbl/day (24/6 m^3/day) in February 1988. During injection, the water cut maintained a nearly constant 5% from November 1987 until May 1990. Water production increased rapidly for three months at which time the water cut has stayed between 50% to 65%. Figure 3 depicts the State 32-36 oil and water production. Oil production as of November 1993 was 35.6 barrels/day (5.7 m^3/day).

State 42-36 also responded immediately to fluid injection. Oil production increased from 29 bbl/day (4.6 m^3/day) in August 1986 to a peak value of 324 bbl/day (51.5 m^3/day) in February 1986. Initial water break through of about 1 bbl/day (0.16 m^3/day) occurred in June 1990. The water cuts reached a stabilized value between 50 and 60% between November 1991 and October 1992. Water cuts have increased to 77% in November 1993. Oil production has declined to 45.9 bbl/day (7.3 m^3/day). Figure 4 depicts the State 42-36 oil and water production.

State 41-36 began production in January 1988 with a peak oil production of 14 bbl/day (2.2 m^3) in February 1988. Water production began immediately with production from the well. Water cuts began in the 40 to 60% range and by October 1990 had increased to 60 to 75%. Oil production remained essentially constant at 3 to 5 bbl/day (0.48 to 0.80 m^3) from September 1988 until January 1991 when production declined to the 1 to 2 bbl/day (0.16 to 0.32 m^3/day) range. The well was shut-in November 1991 but is periodically turned on until production water cut exceeds 80%.

In the northern part of the field, the Kottabra 25-15 began production in September 1989, 21 months after the beginning of alkaline-surfactant-polymer solution injection. It reached peak production of 327 bbl/day (51.9 m^3/day) in December 1989. Oil production maintained near peak production levels until water break through in May 1990. Water production increased from 2 % at break through to approximately 50% in June 1991. Water cut remained constant from June 1991 through April 1992. Water cut has increased to 87% with the corresponding oil production declining to 52.6 bbl/day (8.4 m^3/day) in November 1993. The Kottabra 25-15 oil and water production are depicted in Figure 5.

Kottabra 25-10 began production in July 1990 and reached peak production values of 35 bbl/day (5.6 m^3/day) in the same month. The water cut has remained essentially constant from initial production at 33%. Oil production has declined from the initial production level to 10 bbl/day (1.6 m^3/day) in October 1992. Injection of water into Kottabra 25-11 in October 1993 has increased production to 15 bbls/day.

Discussion of Evaluations

West Kiehl Analyses

Geological and Reservoir Analyses West Kiehl

The productive reservoir at West Kiehl consists of a single lower "B" member eolian sand dune complex. The dune is approximately one mile long and less than one-half mile wide with the longitudinal axis trending north north west. The maximum gross sand thickness is 30 ft. The "A" and upper "B" members of the Minnelusa have been eroded at West Kiehl and the unconformable overlying Opeche shale provides the upper seal. The impermeable Minnelusa C Dolomite provides the lower seal. The trapping mechanism is entirely stratigraphic and is controlled by the geomorphology of the sand dune.

The effective porosity (over 10%) is developed and preserved in five mappable and conformable horizontal zones. Zones 1 through 3 are labeled Figure 6 which depicts the cross section. Zones 4 and 5 are delineated but not labeled. The zonation is based on the sonic log correlation and porosity variations. Zones 1 through 3 are oil bearing with an oil-water contact at 2255 ft sub-sea, as determined from log analysis, drill stem tests and completion results. Zones 4 and 5 are below the field oil-water contact, are non-productive and are not perforated. Zone 4 has low porosity and permeability. Figures 7 through 11 show the net porosity isopachous map for each of the five layers. Figure 7 also shows the wells included in the cross section. Only zones 1 through 3 were used in the numerical simulator.

The productive reservoir at the West Kiehl has a small water leg constituting less than 25% of the total pore volume. There is no discernable gas cap. The primary drive mechanism is entirely solution gas, rock and fluid expansion with no apparent natural water drive.

The West Kiehl has a pore volume of 3,084 Mbbls. The unit pore volume contacted by chemical injection is 1,295 Mbbls and the pore volume contacted by chemical injection to the north toward Kottabra 25-15 is 645 Mbbls. The initial oil saturation in the flood area is 71.8%. The reservoir data are summarized in Kiehl West Field table in the Appendix.

Classical Engineering West Kiehl Project Performance

The alkali-surfactant-polymer flood in the West Kiehl Unit was evaluated by analyzing the production from State 32-36 and State 42-36 in a similar manner as discussed by Meyers et. al.[5] The incremental gross swept area between the State 31-36 injection well and the State 32-36 and State 42-36 production well have a pore volume of 1,295,000 barrels (205,857 m^3), as determined using the method of Slider.[6] Primary production out of the swept area was 43,364 barrels of oil (6,894 m^3) or 0.033 PV. No water was produced on primary production. Prior to water break through, an additional 361,959 barrels of oil and water (57,467 m^3) or 0.280 PV were produced. Some water was produced almost immediately upon fluid injection from the State 32-36 with the water production continuing at a water

cut never exceeding 4% until break through. No water was produced from the State 42-36 until break through. As of November 1993, a total of 524,513 barrels (83,391 m^3) or 0.405 PV of oil have been produced from the gross swept area between the State 31-36 and the State 32-36 plus the State 42-36. Current water cut for the State 32-36 is 63.2% and 77.3% for State 42-36. Based on the water cut versus cumulative oil produced plots for State 32-36 and State 42-36 (Figures 12 and 13), the ultimate oil recovery from the gross swept area was estimated to be 252,600 barrels of oil (40,160 m^3) from State 32-36 plus 340,500 barrels of oil (54,135 m^3) plus 34,500 barrels (5,485 m^3) of oil from State 31-36 during primary production. Total oil production from the Unit gross swept area is estimated to be 627,600 barrels of oil (99,780 m^3) or 0.485 PV at an economic limit water cut of approximately 92%. Oil saturation in the Unit 32-36 gross swept area after completion of the project is estimated to be 0.205 PV. The resulting E_t in the oil recovery equation is 0.702.

The Kottabra 25-15 well started production after chemical injecting into the State 31-36 for 21 months. As a result, this well is a good comparison of the State 32-26 and State 42-36 wells performance because the volume of alkaline-surfactant-polymer solution injected was a fraction of the amount injected into the Unit area. The gross swept area of the Kottabra 25-25 has a pore volume of 645,100 barrels (102,563 m^3). From September 1989 to December 1992, the area received approximately 80,000 barrels (12,719 m^3) or 0.12 PV of alkaline-surfactant-polymer and approximately 135,000 barrels (21,463 m^3) of polymer or 0.21 PV. This compares with 0.33 PV of alkali-surfactant-polymer and 0.15 PV polymer injected into the areas swept by State 32-36 and State 42-36. No primary production occurred from the Kottabra 25-15. Total fluid produced at water break through was 72,643 barrels (11,549 m^3) of fluid or 0.113 PV of which only 221 barrels (35 m^3) was water. As of November 1993, 235,415 barrels (37,428 m^3) or 0.365 PV of oil have been produced from the Kottabra 25-15 swept area. Current water cut is 87%. Estimated ultimate oil production is 249,300 barrels of oil (39,635 m^3) from the Kottabra 25-15 plus 34,500 barrels of oil (5,485 m^3) produced during primary by State 31-36 for a total of 283,800 barrels of oil (45,120 m^3) or 0.444 PV. Figure 14 depicts the Kottabra 25-15 water cut versus cumulative oil extrapolation. Oil saturation in the gross swept area after completion of the project is estimated to be 0.250 PV. The E_t of the oil recovery equation calculates to be 0.638. Figure 15 and the following table compare the oil recovery of the West Kiehl Unit with the Kottabra 25-15.

Comparison of Unit and Kottabra 25-15 Oil Recovery

	West Kiehl Unit	Kottabra 25-15
Volume Na_2CO_3-Petrostep B-100 -Pusher 700 Injected (PV)	0.33	0.12
Volume of Pusher Drive Injected (PV)	0.15	0.21
Oil Recovery (%OOIP)	70.2	63.8
Final Residual Oil Saturation (PV)	0.205	0.250

The State 41-36 and the Kottabra 25-10 production performance was not evaluated because the volume of fluid produced from both these wells is minimal. Also, the configuration of

the Kottabra 25-10 well relative to the State 31-26 and Kottabra 25-15 suggests a minimal impact by the injected fluids on the Kottabra 25-10 performance. Cumulative oil production as of November 1993 was 6,695 barrels of oil (1,064 m^3) from the State 41-36 and 20,086 barrels of oil (3,193 m^3) from the Kottabra 25-10.

West Kiehl Laboratory Evaluations

The initial laboratory evaluation was presented by Clark et. al.[4] The ion content of the Fox Hills injection water and the produced water are listed in the following table. The produced water is from a new drilled well outside the flood area and is believed to be indicative of the connate water.

Ion Type	Fox Hills Water	25-11 Produced Water
	Ion Concentration (mg/kg)	
Calcium	1.4	537
Magnesium	0.4	92
Barium	0	5.9
Strontium	0.4	23
Sodium	240	1,490
Potassium	0	60
Iron	0	0
Chloride	15	1,474
Carbonate	37	66
Bicarbonate	446	272
Sulfate	280	4,253
Total Dissolved Solids	838	9,686
pH	8.44	8.33
Resistivity at 21°C (ohm-m)	10.3	1.28

West Kiehl Crude oil is 24 degree API with a viscosity of 17.6 cp at 134°F.

The alkaline plus surfactant plus polymer solution injected into the West Kiehl field was 0.8 wt% Na_2CO_3 plus 0.1 wt% active Petrostep B-100 plus 1,050 mg/l Pusher 700. Interfacial tension measurements were repeated at the design concentration and half the design concentration for the numerical simulation. The solutions were also diluted with produced water. The results are summarized on the next page.

Na_2CO_3 wt%	Interfacial Tension at 134°F (mN/m) 0.05 wt% active Petrostep B-100	0.1 wt% active Petrostep B-100
0.00	18.3	18.3
0.40	0.216	0.024
0.60	<0.001	<0.001
0.80	<0.001	<0.001
1.00	<0.001	<0.001

0.8 wt% Na_2CO_3 plus 0.1 wt% Petrostep B-100 to Produced Water ratio	Interfacial Tension at 134°F (dyne/cm) 0.05 wt% active Petrostep B-100	0.1 wt% active Petrostep B-100
100:0	<0.001	<0.001
80:20	0.015	0.002
60:40	0.046	0.046
40:60	0.065	0.065
20:60	1.5	1.5

No core was taken at the West Kiehl Field. Therefore, core from near-by Minnelusa Lower "B" reservoirs was used for the laboratory work. The core used were from the Wolf Draw Field, well Wolf Draw Federal 14-18, and the Guthery Field, well Brehm #3. Two linear corefloods and seven radial corefloods were completed. Relative permeability analysis indicated the Minnelusa Lower B sand is water-wet and the mobility ratio for water-displacing oil averages 2.2. Figure 16 depicts the relative permeability curve. Oil saturation shifts were from 0.788 PV to 0.343 PV, for a recovery of 56.5% of the initial oil saturation. Injection of polymer (Pusher 700) after the waterflood recovered no additional oil. Injection of 0.8 wt% Na_2CO_3 plus 0.1 wt% Petrostep B-100 plus Pusher 700 reduced the oil saturation to 0.207 PV for an additional recovery of 0.136 PV of incremental oil or 39.7% of the waterflood residual oil. Dynamic retention of chemical from the linear corefloods averaged 72,966 lb/acre-ft for Na_2CO_3, 5,123 lb/acre-ft for Petrostep B-100, and 723 lb/acre-ft for Pusher 700 injected with Na_2CO_3 plus Petrostep B-100 and 314 lb/acre-ft when injected dissolved in Fox Hills water prior to alkaline-surfactant-polymer solution. When Pusher 700 dissolved in injection water was injected after the alkaline-surfactant-polymer solution, an additional 49 lb/acre-ft was retained by the Minnelusa sand. Based on resistance factor and chemical retention data of these linear corefloods the injection concentration of 1,050 mg/l Pusher 700 is sufficient for mobility control if 1 PV of polymer were injected.

Chemical oil recoveries of the radial corefloods using 4 inch radial discs are summarized in the following table. The chemical floods were performed with no waterflood prior to chemical injection with the exception of two corefloods. This is because the West Kiehl Field alkaline-surfactant-polymer project was performed in a secondary application.

Chemical Injected	Waterflood Recovery $\%S_{oi}$	Chemical Flood Recovery $\%S_{oi}$	Combined Recovery $\%S_{oi}$
Waterflood followed by 37% PV ASP	45.4	12.6	58.0
Waterflood followed by 13% PV ASP	47.7	5.5	53.2
29% PV ASP - 10% PV Polymer	----	61.2	----
13% PV ASP - 26% PV Polymer	----	52.7	----
94% ASP - no Polymer	----	65.9	----
43% Polymer	----	40.0	----
35% Polymer	----	45.7	----

The average polymer flood performed no better than the average waterflood, 42.8% S_{oi} versus 46.6% S_{oi}, respectively. However, injection of 0.8 wt% Na_2CO_3 plus 0.1 wt% Petrostep B-100 plus 1,050 mg/l Pusher 700 recovered an additional 15% S_{oi}. Additional oil was recovered when 30% PV or more of ASP slug was injected. Reducing the volume of alkaline-surfactant-polymer slug injected to 13% PV lowered the incremental oil production to 6.2% S_{oi}.

Numerical Simulator

The West Kiehl alkaline-surfactant-polymer flood area is being modeled using the GCOMP reservoir simulator. This simulator provides black-oil, compositional, pseudo miscible, or chemical matching and forecasting capabilities. The chemical phase of the simulator accounts for in-situ surfactant generation or saponification of oil by alkali, the partitioning of surfactant into the oil and water phases, the adsorption and desorption of chemicals onto rock surfaces, increased aqueous phase viscosity by polymer addition based on resistance factor data, and the shift in the residual oil saturation dependant upon contact with the alkaline-surfactant solution and the concentration of each species in solution.

Numerical Simulation - West Kiehl Radial Coreflood History Match

The coreflood history match is performed to obtain values for chemical adsorption, resistance factor and capillary number response that result in the oil recovery observed during the coreflood.

Three radial corefloods were matched to calibrate the chemical portion of the model. The first was a waterflood followed by chemical injection and the second and third were polymer and alkali plus surfactant plus polymer injection after injection of 0.043 PV of water. The chemical systems injected were 1,050 mg/l Pusher 700 and 0.8 wt% Na_2CO_3 plus 0.1 wt% Petrostep B-100 plus 1050 mg/L Pusher 700. The alkaline-surfactant-polymer chemical solution composition is the identical chemical system injected into the West Kiehl Field.

The coreflood simulation consists of 5 uniform thickness layers of 5 radial grid blocks each of equal porosity. The permeability of the bottom layer is about $1/10^{th}$ that of the top 4 layers. The core dimensions, pore volume, and porosity are the same as the average values for radial corefloods.

The coreflood matches are depicted in Figures 17 through 19. Polymer rheologic parameters and alkali plus surfactant capillary number parameters were identical for all three corefloods. The overall oil recovery and oil cut matches of the radial corefloods were good. The comparative oil recovery data are listed in the following table.

source of data	initial saturation (PV)	final saturation (PV)	Total oil recovery $\%S_{oi}$
coreflood 3			
Waterflood - actual	0.588	0.321	45.4
Waterflood - simulation	0.589	0.323	45.1
coreflood 3			
ASP - actual	0.321	0.247	58.0
ASP - simulation	0.323	0.244	58.6
coreflood 5			
ASP - actual	0.673	0.261	61.2
ASP - simulation	0.674	0.282	58.1
coreflood 8			
Polymer - actual	0.733	0.398	45.7
Polymer - simulated	0.733	0.400	45.4

Oil recovery in the layers varied from 40% OOIP to 70% OOIP for the alkaline-surfactant-polymer floods and 30 to 55% for the polymer flood.

Figures 17 through 19 also depict the produced chemical concentrations. No Na_2CO_3 was produced in either coreflood and Petrostep B-100 was only produced at low concentrations in coreflood 5.

Numerical Simulation - West Kiehl History Match

Data Used for Simulation - The basic reservoir description for the West Kiehl Field was determined by geological and reservoir engineering interpretation as described earlier. Other data were obtained from various reports and data about the West Kiehl. These include:

- the "Secondary Recovery Feasibility Study" Engineering Committee Report for the West Kiehl Field dated October 1986

- well testing reports for the following wells

State 31-36	State 32-36	State 42-36
State 41-36	Kottabra 25-10	Kottabra 25-15
Kottabra 25-11		

- well logs and log analyses providing depth, porosity, water saturation and completion intervals for the following wells

Argentine 33-25	Flo State 21-36
Kottabra #1	Kottabra 25-10
Kottabra 25-15	Kottabra 32-25
State 31-36	State 32-36
State 41-36	State 42-36
Waliszek 25-14	Kottabra 25-11

- monthly oil and water production from all producing wells through November 1993

- daily injected volume, pressure, and chemical concentration for State 31-36

- isopachs including the following

top of structure	gross sand
net porosity foot	hydrocarbon pore volume

- Routine core analysis from other Minnelusa lower B reservoirs in the vicinity of the West Kiehl field

- reservoir fluid study for State 42-36

Reservoir Parameters Fluid Properties - The properties of the West Kiehl reservoir oil and gas were obtained from the "Reservoir Fluid Study for Terra Resources, Inc. State 42-36 Well Wildcat."[7] These data are compiled in Table 1. Figure 20 shows the crude oil viscosity versus pressure and Figure 21 depicts the oil density and volume factor versus pressure. The reservoir oil is essentially a dead oil. A reservoir water viscosity of 0.635 cp with a density of 1.023 g/ml and a compressibility of 2.95×10^{-6} vol/vol/psi were used.

The physical properties of the chemical solutions injected at West Kiehl were also required for the simulation. The resistance factor and residual resistance factor data and non-newtonian rheological solution properties are used to calculate the viscosity of the polymer solution during the simulation. The viscosity data for the polymer solutions injected at the West Kiehl Field are depicted in Figure 22.

Relative Permeability - The relative permeability data were developed in the linear corefloods as depicted in Figure 16. Wolf Draw core was used. A compilation of 18 relative permeability evaluations conducted on Minnelusa Lower "B" core shown in Figure 23 indicates that the relative permeability using the West Kiehl fluids is typical. The relative permeability data in Figure 23 was used for the reservoir models.

Permeability and Porosity - No routine analysis had been performed for the West Kiehl. Thus, permeability data was not available. In order to provide permeability information for numerical simulation, data from an adjacent lower "B" Minnelusa field were used. The permeability for the simulator was obtained from a cross-plot of permeability versus porosity. The data, representing measurements from 5 Minnelusa routine core analyses using a 10% porosity cut-off, are presented in Figure 24. The line shown is the correlation used in the models.

Grid Data - The study area was divided into a grid spacing of 13 by 33 with 3 layers for a total of 1,287 grid blocks. Figure 25 shows the grid system and well locations. The three zones included in the numerical model are shown in the diagrammatic structural cross section shown in Figure 26.

Various properties were assigned to each grid block. The porosity for each layer was obtained by estimating porosity for each zone from the logs and averaging the porosity tabulated for the interval. The resulting porosity maps can be seen as Figures 27 through 29. The greatest porosity for the reservoir was seen for layer 3 and was the greatest around well Kottabra 25-15.

The permeability for each grid block was initially derived from the permeability versus porosity data of Figure 24. Permeability is the parameter for which there is the least information and, as a consequence, is the value that is most manipulated to provide a history match.

Because the model takes into account gravitational forces, the orientation of the structure was also needed. The elevation (sub-sea) of each grid block is determined from the top of structure, the sum of the thickness of layers for overlain grids.

Initial Conditions - The initial oil and water saturation conditions were obtained by determining a oil-water contact. From the individual well log analyses, the depth of the oil-water contact averaged 2,255 ft sub-sea. The oil saturation below this depth was then set to zero and above this depth at the endpoint of the relative permeability curve, 0.718 PV. Because of the orientation of the structure and the occurrence of an oil water contact, much of the northwest portion of the reservoir is underlain by water. Drilling of the Kottabra 25-11 into this area in October 1992 verified the area to be wet.

Drill stem testing on well State 31-36 indicated an initial reservoir pressure of about 2200 psi, which was used for the reservoir model.

Field History Match - The performance of the alkaline-surfactant-polymer flood is currently being matched through December 1993. During the history match, the actual injection rates and oil plus water production rates are the limiting criteria for the simulation. The proportions of water to oil are dictated by the relative permeabilities, the chemical model parameters, and grid saturations. The pressure within a grid block is dictated by the pressure in adjoining grid blocks and the transmissivity between grid blocks. The transmissivity is a function of the thickness, porosity, and effective permeability of the grid blocks. The effective permeability of the fluids depends upon the grid saturation. The pressure of a grid block containing a well depends upon the rate at which fluids are injected or withdrawn from the well, the pressure of adjoining grid blocks and the transmissivity between grid blocks.

Geological and Reservoir Analyses of Fields Surrounding West Kiehl

A study area around the West Kiehl field, located in Sections 25 and 36, Township 53 North, Range 68 West, Crook County, Wyoming, was selected to encompass a quantity of productive Minnelusa oil fields. The area selected includes:

Twp 52N - Rge 67W	Sections 4 to 9
Twp 51N - Rge 68W	Sections 1 to 12
Twp 51N - Rge 69W	Sections 1 to 5 & 8 to 17
Twp 52N - Rge 67W	Sections 4 to 9, 16 to 21 & 28 to 33
Twp 52N - Rge 68W	All
Twp 52N - Rge 69W	Sections 1 to 3, 10 to 15, 22 to 27 & 34 to 36
Twp 53N - Rge 67W	Sections 4 to 9, 16 to 21 & 28 to 33
Twp 53N - Rge 68W	All
Twp 53N - Rge 69W	Sections 1 to 3, 10 to 15, 22 to 27 & 34 to 36
Twp 54N - Rge 67W	Sections 4 to 9, 16 to 21 & 28 to 33
Twp 54N - Rge 68W	All
Twp 54N - Rge 69W	Sections 1 to 3, 10 to 15, 22 to 27 & 34 to 36
Twp 55N - Rge 67W	Sections 28 to 33
Twp 55N - Rge 67.5W	Sections 25 & 36
Twp 55N - Rge 68W	Sections 25 to 36
Twp 55N - Rge 69W	Sections 25 To 27 & 34 to 36

Over 1600 Minnelusa penetrations have been drilled in this 275 square mile area at depths ranging from 2000 feet in the northeast to over 7000 feet in the southwest. Seventy-two separate Minnelusa oil fields have been developed with projected ultimate recoverable oil reserves ranging from 2,100 to 6,632,600 barrels. Log suites were retrieved from the Denver Earth Resources Library on all of the 1600 plus wells. These log suites consisted of an induction and a sonic log covering the interval from the top of the Pennsylvanian

Minnekahta formation to total depth. In the absence of either induction or sonic log gamma ray, density or micro logs were substituted.

The Upper Minnelusa Formation of Permian age was deposited in the eastern portion of the Powder River Basin, Wyoming as a series of eolian sand dunes. In his bench mark work on Minnelusa sand deposition in the Powder River Basin Steven Fryberger[8,9] sub-divided the Upper Minnelusa Formation into three sand members; the A, B and C. This sub-division has been incorporated into the correlation grid for this study with the further subdivision of the B into the Upper and Lower zone. Each of these four members, A, Upper B, Lower B, and C represents an episode of progradation of eolian sand dunes. Each episode is separated by the deposition of a marine dolomite representing a period of maximum transgression of the sea to the north and west over the dune deposits. Within the study area, individual sand dune complexes within each member vary in maximum thickness from 25 to over 100 feet and cover an area ranging from 160 to over 640 acres. A period of regional uplift in the late permian terminated the deposition of the Minnelusa. During the uplift, the Minnelusa in the study area was cut by 2 series non-marine erosional channels conforming roughly to the underlying eolian deposits. These channels, varying in width from a few hundred feet to several miles and ranging in depth to over 100 feet were filled with the non-marine Opeche shale.

The sand dune complexes within the Upper Minnelusa Formation provide the reservoir for oil entrapment. Within the study area, almost all of the oil traps are geomorphic relating to original dune topography. The regional structural setting consists of a simple monocline with little or no structural closure. Either the unconformable Opeche shale or an overlying dolomite or anhydride form the upper seal and an underling marine dolomite forms the lower seal for each productive trap.

An east-to-west and a north-to-south stratigraphic cross section grid of the Pennsylvanian Minnekahta, Opeche, and upper Minnelusa formations was constructed on an approximate two mile spacing (ten east-to-west and four north-to-south). The top of the Minnelusa C dolomite (Fryberger[8,9]) was used as a datum and the cross sections incorporated approximately one well per section. Using the cross sections as reference, sequence boundaries, stratigraphic unit tops and porous intervals within the upper productive portion of the Minnelusa were determined for all 1600 plus wells.

The system boundary lines defined by Fryberger[8,9] for Rourke Gap and Basin Minnelusa oil fields were incorporated into this correlation grid. Fryberger described the upper portion of the Minnelusa formation as a series of eolian sand deposits separated by impermeable marine dolomitic carbonates.

A data table was prepared for all of the retrieved reservoirs (Table 2). This table includes the tops and bases of the correlated sand units, their porous intervals, drill stem tests, completion results and current production history (through January 1992). Figure 30 is a regional map depicting the field and well locations.

Using the data table, a series of geological work maps and stratigraphic cross sections were constructed over all seventy-two Minnelusa oil fields to clearly define the sequence boundaries and the geometry of the productive reservoirs. From these work maps, thirty-five individual fields, including West Kiehl, were selected for reservoir analysis. Table 3 lists the thirty-five fields studied.

On the thirty-five selected fields, net oil pay isopachous maps were constructed for each of the productive eolian sands within the field boundary. Net pays were determined from sonic logs using a porosity cutoff of 10 per cent. Field oil water contacts, if present were established using a combination of conventional log analysis and analysis of drill stem, completion and production tests. The oil columns for each reservoir were planimetered and a reservoir volume was calculated using the average of three methods. A weighted field average for porosity and true resistivity within the productive zone was calculated by analyzing the logs within the complete productive interval. Water resistivities were generally determined from water analyses obtained from early drill stem or production tests. In the absence of such analyses, resistivities were "backed out" by analyzing the logs of water-wet Minnelusa sand sections well below the established field oil water contacts. Irreducible field water saturations were then calculated using a Schlumberger nomograph.[10]

Field production histories for each of the thirty-five fields were retrieved from Dwight's production data file. Field decline curves were plotted and both primary and secondary decline rates were extrapolated from these curves. Water injection data was also incorporated into the field production histories. These data were retrieved from the State of Wyoming Oil and Gas Commission hard copy production files in Casper, Wyoming. Figures in the Appendix for each of the thirty-five fields depict the net pay isopachous map and well locations paired with the oil and water production.

A data table was prepared for the thirty-five selected fields incorporating the data from both the reservoir analyses and the production decline analyses. The table of each field as well as a plot of oil and water production versus time are included with the net pay and well location Figures in the Appendix. These tables were utilized to establish ranges of recoveries from analogous Minnelusa oil fields as a function of stratigraphic interval, drive mechanism and well density.

The range of pore volumes of the thirty-five selected fields is 1,540,600 to 30,250,300 while the range of projected ultimate recoveries in terms of pore volumes ranges from .070 to a maximum of 0.379. The weighted average estimated remaining oil in place after primary and waterflood (including polymer augmentation) is 0.403 pore volumes with a range from 0.303 to 0.626.

The breakdown of fields by stratigraphic interval is as follows:

Minnelusa A and Upper B Zones (combined)	4
Minnelusa Upper B Zone	15
Minnelusa Lower B Zone	14
Minnelusa C Zone	2

The breakdown by primary drive mechanism is as follows:

Solution Gas Drive (or rock expansion)	20
Partial Water Drive	4
Water Drive	11

The breakdown by secondary drive application is as follows:

Waterflood - Solution gas and Partial Water Drive	13
Waterflood - Augmented Water Drive	3
Polymer Augmented Waterflood - Solution Gas and Partial Water Drive	10
ASP Augmented Water Flood - Solution Gas Drive	1
No secondary recovery - Water Drives	8

West Kiehl field which produces from the Lower B Zone has a solution gas and rock and fluid expansion primary drive mechanism with no indication of water encroachment. For the reservoir simulation of West Kiehl field the Lower B Zone was subdivided into five separate units on the basis of stratigraphic correlation. Separate isopachous maps of the net effective oil porosity were constructed for each unit. An oil water contact was established by conventional log analysis and by analysis of the drill stem, completion and production test recoveries. Each unit map was planimetered and the rock volume of both the oil and water columns was determined. Porosity variations were mapped separately for each zone.

Two additional fields were selected for reservoir simulation from the twenty solution gas primary drive reservoirs. The first field, Prairie Creek South, was selected from the solution gas reservoirs among the thirteen waterfloods. The second field, Simpson Ranch, was selected from the solution gas reservoirs among the ten polymer augmented water floods. In the selection process, an attempt was made to chose fields with similar reservoir geometries and well spacing. Preference was also given to fields which had produced at least 0.150 pore volumes of oil and injected at least 0.30 pore volumes of water with a reasonable balance of fluid produced (oil and water) against fluid injected.

Both Prairie Creek South and Simpson Ranch Fields produce from the Minnelusa Upper B Zone and both have solution gas (or rock expansion) primary drive mechanisms. As at West Kiehl, the productive zones for both fields was subdivided into three or more units on the basis of stratigraphic correlation. Oil water contacts were determined and the respective

isopachous maps were planimetered to calculate the rock volumes. Again porosity variations were defined on separate maps for each unit.

Future Research

Future research on the West Kiehl Field will be:

- Complete History Match of Alkaline-Surfactant-Polymer Flood
- Complete Forecast of Alkaline-Surfactant-Polymer Flood
- Predict Waterflood Oil Recovery for West Kiehl
- Predict Mobility Control Polymer Flood Recovery for West Kiehl
- Define Alkaline-Surfactant-Polymer Flood Incremental Economics

Future research on Simpson Ranch Polymer Flood will be:

- Finalize Geological and Reservoir Analyses Report Format
- Finalize Classical Engineering Project Performance in Report Format
- History Match Simpson Ranch Polymer Flood
- Forecast Simpson Ranch Polymer Flood Performance
- Predict Waterflood Oil Recovery for Simpson Ranch
- Predict Alkaline-Surfactant-Polymer Flood for Simpson Ranch
- Define Polymer Flood and Alkaline-Surfactant-Polymer Flood Incremental Economics for Simpson Ranch

Future research on Prairie Creek South will be:

- Finalize Geological and Reservoir Analyses Report Format
- Finalize Classical Engineering Project Performance in Report Format
- History Match Prairie Creek South Waterflood
- Predict Mobility Control Polymer Flood Oil Recovery for Prairie Creek South
- Predict Alkaline-Surfactant-Polymer Flood for Prairie Creek South
- Define Polymer Flood and Alkaline-Surfactant-Polymer Flood Incremental Economics for Prairie Creek South

Based on these simulations, an estimate of the alkaline-surfactant-polymer potential incremental oil production of the other 32 fields in the study will be made.

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West Kiehl Oil PVT Properties

TABLE 1

		---- SATURATED OIL ----						---- RESERVOIR OIL ----					
PRES	RS	FVF	VISC	DENS	CO	COMPOSITION		FVF	VISC	DENS	CO	COMPOSITION	
PSIA	CF/SB	RB/STB	CP	LB/CF	1/PSI	GAS	ST-OL	RB/STB	CP	LB/CF	1/PSI	GAS	ST-OL
14.6	0	1.0800	9.96	52.13		0.000	1.000	1.0800	9.96	52.13		0.000	1.000
					1449.3						1449.3		
31.6	0	1.0550	9.86	53.37		0.001	0.999	1.0550	9.86	53.37		0.001	0.999
					18.6						18.6		
114.7	0	1.0540	10.03	53.42		0.001	0.999	1.0540	10.03	53.42		0.001	0.999
					7.3						5.0		
514.7	1	1.0520	10.50	53.52		0.001	0.999	1.0519	11.01	53.53		0.001	0.999
					7.8						5.0		
1010.7	1	1.0493	11.21	53.66		0.002	0.998	1.0493	12.23	53.66		0.001	0.999
					5.7						5.0		
2014.7	2	1.0445	12.61	53.92		0.004	0.996	1.0440	14.70	53.93		0.001	0.999
					5.5						5.0		
3014.6	2	1.0393	14.62	54.19		0.006	0.994	1.0388	17.16	54.20		0.001	0.999
					4.9						5.0		
4014.6	3	1.0346	16.48	54.44		0.007	0.993	1.0336	19.62	54.47		0.001	0.999
					13.6						5.0		
5014.6	3	1.0210	18.35	55.17		0.008	0.992	1.0285	22.08	54.74		0.001	0.999

Minnelusa Field Production – ASP Study
TWP 51N to 55N – RGE 67W to 69W
Listing of all known Minnelusa Reservoirs in study area

Field	Minnelusa Producing Zone	Drive Mechanism	Location SEC	TWP	RGE	Average Net Pay Feet	Average Porosity %	Average S_w %	Volume acre ft	Area acres	Pore Volume Mbbls	Original O. I. P. Mbbls	Pore Volumes OOIP	Ult Oil Rec	Cum Oil Rec	Cum Wtr Rec	Cum Inj	Balance	abd O.I.P
Alpha	C	Polymer	1,2&11	51N	69W	35	16.6%	33.0%	13,922	394	17,929	11,449	0.639	0.281	0.215	0.076	0.229	−0.062	0.358
American	Upper B	Polymer	5&6	52N	68W	15	17.6%	27.0%	3,024	205	4,124	2,867	0.695	0.070	0.059	0.020	0.082	0.003	0.625
Ammo	Upper B	Polymer	16&17	52N	68W	13	20.1%	21.7%	988	76	1,541	1,168	0.751	0.132	0.112	0.297	0.422	0.013	0.618
Art Creek	A & Upper B	Waterflood	8	51N	67W				3,950		5,932	3,953	0.666	0.161	0.146	0.121	0.291	0.024	0.505
Ash	Upper B	Waterflood	27&28	52N	69W	22	16.8%	15.5%	2,086	96	2,715	2,264	0.833	0.236	0.100	0.001	0.008	−0.093	0.597
Berger Hill	Lower B	Water Drive	6	53N	67W	17	25.0%	40.0%	3,079	184	5,971	3,445	0.577	0.162	0.154	1.775			0.415
Bertha	Lower B	Water Drive	23	54N	69W	6	13.6%	30.0%	473	77	497	331	0.667	0.030	0.030	0.152			0.637
Bracken	Upper B	Polymer	12&13	52N	69W	15	17.4%	25.0%	3,092	200	4,181	2,986	0.714	0.191	0.113	0.064	0.353	0.176	0.524
Bracken South	C	Water Drive	13	52N	69W	14	21.2%	39.0%	1,300	94	2,137	1,242	0.581	0.119	0.081	1.178			0.462
Breaks	Lower B	Waterflood	26	52N	69W	31	23.0%	29.0%	6,357	205	11,333	7,663	0.676	0.320	0.157	0.164	0.142	−0.179	0.356
Breaks South	Lower B	Aug Wtr Dr	35	52N	69W	22	21.1%	43.0%	3,559	155	5,827	3,163	0.543	0.037	0.034	0.319			0.506
Brislawn	Lower B	Water Drive	13	54N	68W	8	25.6%	32.0%	702	89	1,393	920	0.660	0.057	0.069	0.699			0.603
Brousa Draw	Upper B	Water Drive	8	53N	67W	11	28.0%	50.0%	421	38	915	448	0.490	0.242	0.161	0.258			0.248
Cambridge	Upper B	ASP	28	53N	68W	23	20.2%	32.0%	5,066	218	7,947	5,247	0.660	0.296	0.027	0.004	0.000	−0.031	0.364
Cardinal	C	Water Drive	28	51N	69W	15	15.6%	45.0%	1,849	124	2,236	1,171	0.524	0.094	0.083	0.514			0.430
Carr Creek	Upper B	Water Drive	25	55N	67.5W	15	13.9%	40.0%	1,859	127	2,000	1,165	0.583	0.170	0.185	1.918			0.412
Corral Creek	Upper B	Water Drive	26&35	55N	68W	16	25.6%	41.0%	2,451	153	4,875	2,792	0.573	0.092	0.116	1.084			0.481
County Line	Lower B	Water Drive	31	52N	68W	20	24.6%	40.0%	2,769	141	5,290	3,023	0.571	0.274	0.192	0.707			0.297
Deadman Creek	Lower B	Polymer	18&19	53N	67W	25	18.1%	24.0%	5,461	266	7,656	5,595	0.731	0.289	0.210	0.225	0.713	0.278	0.441
Edsel	Upper B	Waterflood	25,26,35&36	54N	68W	27	22.5%	32.0%	10,060	376	17,575	11,603	0.660	0.286	0.242	0.425	0.697	0.029	0.374
Guthery	A & Upper B	Waterflood	3	51N	67W				8,338		13,670	8,544	0.625	0.300	0.289	0.415	0.709	0.005	0.325
Gurthery North	U & L B	Solution Gas	2&3;34&35	51&52N	68W				2,981		3,972	2,482	0.625	0.063	0.061	0.006			0.562
Guthery Northwest	Upper B	Solution Gas	34	52N	68W	14	15.3%	38.0%	1,650	122	1,959	1,168	0.596	0.014	0.014	0.003			0.582
Heath	C	Water Drive	8&9	52N	68W	28	18.5%	45.0%	6,845	248	9,825	5,146	0.524	0.084	0.073	0.279			0.440
Heath North	Lower B	Water Drive	4&5	52N	68W	20	26.9%	40.0%	2,060	88	4,291	2,452	0.571	0.187	0.159	0.237			0.385
Hilda	Lower B	Water Drive	36	51N	69W	11	22.5%	35.0%	871	77	1,520	941	0.619	0.273	0.072	0.050			0.346
Hoover Gulch	Upper B	Waterflood	24	52N	69W	14	16.7%	24.0%	2,078	124	2,697	1,952	0.724	0.243	0.130	0.157	0.082	−0.205	0.481
JB	Lower B	Water Drive	20	53N	68W	25	22.2%	45.0%	3,086	125	5,322	2,788	0.524	0.008	0.007	0.064			0.516
Jewel	Lower B	Water Drive	7	54N	67W	23	25.7%	45.0%	2,176	96	4,343	2,319	0.534	0.204	0.175	0.591			0.330
Kiehl	Upper B	Polymer	30&31	53N	68W	35	22.1%	23.0%	10,621	307	18,210	13,613	0.748	0.260	0.139	0.037	0.179	0.003	0.488
Keihl West	Lower B	ASP	25&36	53N	68W	14	19.1%	27.5%	2,086	145	3,084	2,170	0.704	0.325	0.254	0.079	0.348	0.015	0.379
Lad	A & Upper B	Waterflood	17,18&19	54N	67W	28	21.2%	35.0%	8,912	323	13,501	8,520	0.631	0.211	0.197	0.140	0.346	0.009	0.420
Lad South	C	Water Drive	20	54N	67W	12	18.1%	38.0%	1,013	87	1,421	856	0.602	0.113	0.030	0.410			0.489
Lily	A & Upper B	Waterflood	26,27,34&35	54N	68W				5,077		9,240	6,841	0.740	0.234	0.211	0.157	0.364	−0.004	0.506
Little Missouri	Lower B	Polymer	5;31,32	54&55N	67W	19	19.2%	23.0%	5,284	278	7,858	5,875	0.748	0.253	0.126	0.025	0.156	0.005	0.495
Little Mitchell Creek	Lower B	Waterflood	11,14	52N	69W	29	20.4%	25.0%	19,077	664	30,250	21,607	0.714	0.339	0.313	0.118	0.419	−0.013	0.375
Little Mo	Lower B	Water Drive	23	53N	68W	16	20.8%	30.0%	696	43	1,121	755	0.673	0.357	0.356	1.279			0.316
Little Mo South	Lower B	Water Drive	26	53N	68W	14	21.2%	35.0%	850	59	1,394	871	0.625	0.320	0.313	0.503			0.305
Lone Cedar	Upper B	Polymer	8,9,16&17	51N	69W	28	20.7%	15.0%	7,219	261	11,593	9,385	0.810	0.379	0.224	0.176	0.431	0.032	0.431
M–D	Lower B	Water Drive	6;1;25&31,36	52&53N	68&69W	18	16.3%	30.0%	13,778	765	17,370	11,580	0.667	0.318	0.314	0.800			0.348
Mellott Ranch	A & Upper B	Waterflood	2,10&11	52N	68W				14,172		21,174	15,135	0.715	0.297	0.293	0.997	1.275	−0.014	0.418
Missouri	Upper B	Solution Gas	26	53N	68W	12	16.7%	30.0%	651	55	842	572	0.680	0.051	0.050	0.001			0.629
Moorcroft East	A	Water Drive	6	51N	67W	8	24.8%	30.0%	351	43	675	459	0.680	0.021	0.053	1.179			0.658

Minnelusa Field Production – ASP Study
TWP 51N to 55N – RGE 67W to 69W
Listing of all known Minnelusa Reservoirs in study area

Field	Minnelusa Producing Zone	Drive Mechanism	Location SEC	TWP	RGE	Average Net Pay Feet	Average Porosity %	Average S_w %	Volume acre ft	Area acres	Pore Volume Mbbls	Original O. I. P. Mbbls	Pore Volumes OOIP	Ult Oil Rec	Cum Oil Rec	Cum Wtr Rec	Cum Inj	Balance	abd O.I.P
Moorcroft North	Upper B	Solution Gas	24	52N	68W	8	16.0%	48.0%	813	107	1,009	510	0.505	0.001	0.009	0.010			0.504
Moorcroft Northeast	A	Water Drive	31	52N	67W	15	23.7%	45.0%	1,040	68	1,911	1,021	0.534	0.139	0.140	0.231			0.395
Moorcroft West	A	Waterflood	12	51N	68W	7	18.0%	33.0%	353	49	493	321	0.650	0.295	0.150	0.000	0.167	0.016	0.356
Morel	Lower B	Water Drive	17	53N	68W	19	23.3%	24.0%	1,679	89	3,035	2,218	0.731	0.145	0.087	0.084			0.586
Mule Herder	Lower B	Water Drive	32	52N	68W	8	26.9%	40.0%	367	46	765	437	0.571	0.168	0.143	3.469			0.403
Oshoto	Lower B	Water Drive	22&27	53N	68W	14	22.0%	34.0%	3,471	250	5,927	3,762	0.635	0.272	0.198	0.249			0.363
Oshoto North	Lower B	Water Drive	22	53N	68W	26	22.0%	36.0%	2,755	107	4,701	2,893	0.615	0.312	0.221	0.169			0.303
Oshoto South	C	Water Drive	27	53N	68W	16	18.8%	28.0%	1,282	78	1,870	1,294	0.692	0.067	0.067	2.726			0.625
Ponderosa Ridge	Upper B	Water Drive	21	53N	67W	8	30.0%	25.0%	226	27	526	391	0.743	0.000	0.005	0.144			0.743
Prairie Creek South	Upper B	Waterflood	16	53N	68W	18	20.9%	23.0%	1,651	94	2,682	2,005	0.748	0.286	0.243	0.050	0.327	0.034	0.462
Reynolds Ranch	Upper B	Water Drive	6;1	52N	67&68W	21	26.6%	40.0%	1,840	88	3,797	2,212	0.583	0.256	0.315	2.878			0.326
Rule	Lower B	Waterflood	15	52N	69W	30	17.1%	33.7%	2,577	87	3,419	2,179	0.638	0.191	0.114	0.000	0.082	−0.032	0.447
Scribner	Lower B	Solution Gas	10	53N	69W	9	15.0%	16.0%	222	26	259	207	0.800	0.238	0.233	0.000			0.562
Scribner South	Lower B	Water Drive	10	53N	69W	6	13.0%	31.0%	100	18	101	66	0.657	0.010	0.021	0.122			0.647
Semlek	Lower B	Water Drive	27	52N	68W	25	21.2%	27.0%	6,438	253	10,588	7,432	0.702	0.322	0.304	0.473			0.380
Semlek North	Lower B	Aug Wtr Dr	16&21	52N	68W	19	16.8%	32.0%	3,846	207	5,016	3,280	0.654	0.304	0.287	0.098	0.177	−0.208	0.350
Semlek West	Upper B	Aug Wtr Dr	28&29	52N	68W	27	18.7%	35.0%	15,284	574	22,209	13,881	0.625	0.272	0.261	0.704	0.557	−0.408	0.353
Sidner Draw	A	Water Drive	17	53N	67W	15	24.0%	25.0%	597	40	1,112	810	0.728	0.058	0.046	0.207			0.670
Simpson North	Lower B	Water Drive	10	51N	69W	17	21.3%	35.0%	769	45	1,269	786	0.619	0.320	0.286	0.247			0.299
Simpson Ranch	Upper B	Polymer	15	51N	69W	21	18.0%	35.0%	3,587	172	5,017	3,106	0.619	0.173	0.158	0.377	0.548	0.013	0.446
Simpson Ranch N	A	Solution Gas	15	51N	69W	13	17.8%	35.0%	1,478	112	2,040	1,263	0.619	0.155	0.086	0.001			0.464
Spirit	A	Waterflood	26&35	54N	68W	18	20.0%	30.0%	827	45	1,284	881	0.686	0.328	0.276	0.011	0.193	−0.094	0.358
Terrace	Lower B	Water Drive	11,12	51N	69W	33	23.5%	23.0%	8,886	268	16,213	11,890	0.733	0.357	0.224	0.176			0.376
Terry Draw	Upper B	Water Drive	2	54N	68W	8	13.0%	42.0%	185	24	186	105	0.563	0.012	0.040	0.293			0.551
Texas Trail	Lower B	Aug Wtr Dr	14&23	53N	68W	16	22.0%	30.0%	5,752	354	9,835	6,620	0.673	0.386	0.241	0.155	0.220	−0.176	0.287
Trava	A	Waterflood	16&21	52N	67W	14	24.3%	34.0%	861	60	1,625	1,052	0.647	0.021	0.021	0.000			0.626
Wagonspoke	Lower B	Waterflood	3;34	52&53N	69W	24	19.6%	24.0%	6,296	258	9,573	6,929	0.724	0.295	0.305	0.780	1.425	0.340	0.429
Wildfire	U & L B	Water Drive	21	53N	68W				2,252		3,901	2,163	0.554	0.051	0.046	0.084			0.503
Wolf Draw	Upper B	Polymer	18;24	52N	68&69W	16	17.3%	23.0%	4,436	296	5,958	4,369	0.733	0.210	0.085	0.016	0.087	−0.013	0.523
Totals									272,208		423,730	282,607	0.667	0.248	0.199	0.382			0.419

Minnelusa Field Production – ASP Study
TWP 51N to 55N – RGE 67W to 69W
Listing of all known Minnelusa Reservoirs in study area

Field	Disc Date	Unit Date	Oil Gravity	Depletion Factor %	1992 Production Oil bbls	1992 Production Water bbls	Cum Prod thru 1992 Oil Mbbls	Cum Prod thru 1992 Water Mbbls	Injection 1992 Mbbls	Injection Cum Thru 1992	Est Pri Tot Rec Mbbls	Est Pri Rec % OOIP	1992 Rate bopd	Oil Cut %	Proj Rem Rec Mbbls	Proj Tot Rec Mbbls	Est Rem Life Months	Est Ult Rec % OOIP
Alpha	1986	1989	25.3	76.6%	854,237	538,832	3,856	1,355	1,468,500	4,108	1,894	16.5%	2,340	61.3%	1,179	5,036	60	44.0%
American	1986	1988	20.9	84.0%	28,505	24,156	244	84	63,028	340	73	2.5%	78	54.1%	47	291	26	10.1%
Ammo	1985	1988	19.9	84.8%	15,207	93,019	173	458	168,160	650	39	3.4%	42	14.1%	31	204	40	17.5%
Art Creek	1981	1985	22.3	90.8%	40,069	80,935	868	715	262,700	1,725	401	10.2%	110	33.1%	88	957	49	24.2%
Ash	1987	1992	20.0	42.5%	12,754	1,171	272	3	21,378	21	281	12.4%	35	91.6%	368	640	60	28.3%
Berger Hill	1975		19.0	95.1%	35,407	1,019,955	921	10,600			969	28.1%	97	3.4%	48	969	20	28.1%
Bertha	1984		25.4	100.0%	0	0	15	75			15	4.5%	0		0	15	0	4.5%
Bracken	1983	1986	21.4	59.1%	80,977	52,108	471	269	422,655	1,477	148	4.9%	222	60.8%	326	798	117	26.7%
Bracken South	1981		27.0	67.8%	31,986	720,635	172	2,517			254	20.4%	88	4.2%	82	254	35	20.4%
Breaks	1976	1990	21.0	48.9%	329,751	357,216	1,775	1,855	745,305	1,604	1,947	25.4%	903	48.0%	1,854	3,629	176	47.4%
Breaks South	1976	1989	27.0	92.4%	8,773	141,663	197	1,860	531,134	1,816	219	6.9%	24	5.8%	16	214	24	6.8%
Brislawn	1988		23.0	122.0%	9,207	163,700	97	974			79	8.6%	25	5.3%	(17)	79	0	8.6%
Brousa Draw	1988		16.0	66.3%	25,551	107,901	147	236			221	49.4%	70	19.1%	75	221	76	49.4%
Cambridge	1989	1993	20.2	9.2%	38,195	10,409	217	33	0	0	316	6.0%	105	78.6%	2,139	2,356		44.9%
Cardinal	1966		19.6	88.6%	4,700	45,630	186	1,150			210	17.9%	13	9.3%	24	210	81	17.9%
Carr Creek	1984		26.1	108.7%	36,123	768,310	371	3,837			341	29.3%	99	4.5%	(30)	341	0	29.3%
Corral Creek	1962		25.0	125.5%	7,423	174,934	564	5,282			450	16.1%	20	4.1%	(115)	450	0	16.1%
County Line	1974		26.0	70.0%	75,078	555,463	1,016	3,739			1,451	48.0%	206	11.9%	435	1,451	116	48.0%
Deadman Creek	1973	1979	22.0	72.5%	79,229	219,374	1,607	1,726	526,574	5,461	268	4.8%	217	26.5%	609	2,216	202	39.6%
Edsel	1981	1984	21.0	84.7%	208,157	1,671,895	4,260	7,469	1,895,200	12,244	817	7.0%	570	11.1%	769	5,029	63	43.3%
Guthery	1963	1968	21.0	96.2%	118,734	962,914	3,946	5,676	1,037,399	9,688	789	9.2%	325	11.0%	157	4,103	57	48.0%
Gurthery North	1963		21.0	97.3%	8,833	1,418	243	24			250	10.1%	24	86.2%	7	250	10	10.1%
Guthery Northwest	1982		21.0	100.1%	1,681	0	28	7			28	2.4%	5	100.0%	(0)	28	0	2.4%
Heath	1980		22.0	87.1%	24,872	177,234	716	2,740			822	16.0%	68	12.3%	106	822	81	16.0%
Heath North	1987		22.0	85.4%	131,282	506,119	684	1,018			801	32.7%	360	20.6%	117	801	25	32.7%
Hilda	1987		22.0	26.4%	31,644	20,118	109	76			415	44.1%	87	61.1%	305	415	160	44.1%
Hoover Gulch	1971	1986	19.0	53.5%	32,643	44,140	350	423	43,580	220	126	6.5%	89	42.5%	305	655	173	33.5%
JB	1986		23.4	94.2%	7,212	93,665	39	343			41	1.5%	20	7.1%	2	41	65	1.5%
Jewel	1961		21.3	85.8%	13,131	131,314	762	2,568			888	38.3%	36	9.1%	126	888	163	38.3%
Kiehl	1973	1985	21.8	53.4%	300,759	383,664	2,524	678	810,300	3,264	789	5.8%	824	43.9%	2,202	4,726	238	34.7%
Keihl West	1985	1987	24.0	78.0%	76,000	126,075	783	242	220,821	1,073	96	4.4%	208	37.6%	220	1,003	64	46.2%
Lad	1978	1982	21.3	93.5%	84,534	326,536	2,664	1,890	436,400	4,674	385	4.5%	232	20.6%	184	2,848	42	33.4%
Lad South	1984		23.0	26.7%	15,698	0	43	583			160	18.7%	43	100.0%	117	160	99	18.7%
Lily	1984	1987	21.7	90.1%	181,941	682,172	1,951	1,453	853,503	3,364	768	11.2%	498	21.1%	215	2,166	31	31.7%
Little Missouri	1986	1989	22.9	49.8%	210,902	96,820	989	199	352,364	1,228	304	5.2%	578	68.5%	997	1,986	137	33.8%
Little Mitchell Creek	1966	1969	25.4	92.4%	204,682	340,648	9,481	3,575	576,745	12,666	2,143	9.9%	561	37.5%	785	10,267	115	47.5%
Little Mo	1966		25.0	99.7%	7,299	76,015	399	1,435			401	53.1%	20	8.8%	1	401	3	53.1%
Little Mo South	1966		25.0	97.9%	8,125	69,101	437	701			446	51.2%	22	10.5%	10	446	15	51.2%
Lone Cedar	1984	1987	25.0	59.3%	390,602	828,631	2,601	2,035	1,250,481	5,001	842	9.0%	1,070	32.0%	1,788	4,389	115	46.8%
M-D	1967		24.6	98.5%	117,964	1,120,374	5,446	13,891			5,538	47.8%	323	9.5%	82	5,528	14	47.7%
Mellott Ranch	1960	1965	20.7	98.4%	139,015	1,457,911	6,195	21,110	1,990,428	27,001	992	6.6%	381	8.7%	102	6,297	13	41.6%
Missouri	1987		21.5	98.0%	3,785	64	42	1			43	7.4%	10	98.3%	1	43	3	7.4%
Moorcroft East	1983		22.4	251.2%	4,049	154,694	36	796			14	3.1%	11	2.6%	(22)	14	0	3.1%

Minnelusa Field Production – ASP Study
TWP 51N to 55N – RGE 67W to 69W
Listing of all known Minnelusa Reservoirs in study area

Field	Disc Date	Unit Date	Oil Gravity	Depletion Factor %	1992 Production Oil bbls	1992 Production Water bbls	Cum Prod thru 1992 Oil Mbbls	Cum Prod thru 1992 Water Mbbls	Injection 1992 Mbbls	Injection Cum Thru 1992	Est Pri Tot Rec Mbbls	Est Pri Rec % OOIP	1992 Rate bopd	Oil Cut %	Proj Rem Rec Mbbls	Proj Tot Rec Mbbls	Est Rem Life Months	Est Ult Rec % OOIP
Moorcroft North	1983		22.4	861.3%	899	0	9	10			1	0.2%	2	100.0%	(8)	1	0	0.2%
Moorcroft Northeast	1972		22.4	100.8%	3,614	38,841	268	442			266	26.1%	10	8.5%	(2)	266	0	26.1%
Moorcroft West	1983	1989	22.4	50.9%	11,005	0	74	0	17,365	82	28	8.8%	30	100.0%	71	145	131	45.3%
Morel	1982		23.6	60.0%	25,327	48,106	264	255			440	19.8%	69	34.5%	176	440	136	19.8%
Mule Herder	1986		20.0	85.0%	15,474	143,827	109	2,655			129	29.4%	42	9.7%	19	129	22	29.4%
Oshoto	1983		22.4	72.8%	72,532	165,319	1,173	1,478			1,611	42.8%	199	30.5%	438	1,611	162	42.8%
Oshoto North	1984		22.4	70.7%	83,461	123,286	1,037	792			1,467	50.7%	229	40.4%	430	1,467	136	50.7%
Oshoto South	1981		22.4	100.0%	6,479	438,112	126	5,096			126	9.7%	18	1.5%	0	126	0	9.7%
Ponderosa Ridge	1989		12.0		0	0	2	76			0	0.0%	0		(2)	0	0	0.0%
Prairie Creek South	1985	1988	21.2	85.1%	50,772	115,159	653	135	185,784	878	133	6.6%	139	30.6%	114	766	52	38.2%
Reynolds Ranch	1974		24.0	123.0%	24,617	972,161	1,197	10,928			973	44.0%	67	2.5%	(223)	973	0	44.0%
Rule	1985	1991	25.0	59.7%	88,668	0	389	0	205,805	280	425	19.5%	243	100.0%	263	652	70	29.9%
Scribner	1988		24.0	98.0%	3,603	0	60	0			62	29.8%	10	100.0%	1	62	0	29.8%
Scribner South	1982		24.0	208.0%	0	0	2	12			1	1.5%	0		(1)	1	4	1.5%
Semlek	1962		22.6	94.5%	44,841	320,062	3,224	5,010			3,411	45.9%	123	12.3%	188	3,411	69	45.9%
Semlek North	1975	1988	22.6	94.2%	51,661	118,919	1,438	492	185,754	889	1,051	32.0%	142	30.3%	88	1,526	60	46.5%
Semlek West	1962		23.0	95.8%	128,646	1,285,470	5,791	15,637	536,708	12,369	5,297	38.2%	352	9.1%	256	6,047	33	43.6%
Sidner Draw	1988		22.0	78.2%	15,410	21,640	51	230			65	8.0%	42	41.6%	14	65	18	8.0%
Simpson North	1988		22.0	89.5%	26,788	114,759	363	313			406	51.7%	73	18.9%	43	406	37	51.7%
Simpson Ranch	1977	1990	21.0	91.0%	21,741	242,655	792	1,891	243,195	2,749	130	4.2%	60	8.2%	79	870	78	28.0%
Simpson Ranch N	1971		21.0	55.3%	10,751	3,897	175	2			316	25.0%	29	73.4%	141	316	261	25.0%
Spirit	1985	1992	21.0	84.0%	54,428	13,936	354	15	190,328	248	312	35.4%	149	79.6%	67	421	47	47.8%
Terrace	1985		20.2	62.7%	419,311	585,989	3,631	2,847			5,792	48.7%	1,149	41.7%	2,161	5,792	147	48.7%
Terry Draw	1982			328.2%	0	0	7	54			2	2.2%	0		(5)	2	0	2.2%
Texas Trail	1974	1982	25.1	62.4%	169,997	223,916	2,371	1,527	277,147	2,162	1,389	21.0%	466	43.2%	1,426	3,797	240	57.4%
Trava	1985	1992	22.6	97.4%	4,164	0	34	0	38,123	38	35	3.3%	11	100.0%	1	35	3	3.3%
Wagonspoke	1972	1978	28.0	103.2%	36,635	1,192,634	2,916	7,467	1,102,741	13,640	1,124	16.2%	100	3.0%	(91)	2,825	0	40.8%
Wildfire	1985		19.0	90.7%	16,308	46,473	181	326			200	9.2%	45	26.0%	19	200	22	9.2%
Wolf Draw	1988	1992	21.5	40.3%	121,299	7,752	504	92	515,628	516	461	10.5%	332	94.0%	747	1,251	114	28.6%
Totals					5,545,147	20,569,846	85,090	163,485	17,175,233	131,477	53,127		15,192		22,146	107,236		37.2%

Minnelusa Field Production
TWP 51N to 55N – RGE 67W to 69W
Listing of Select Minnelusa Reservoirs in Study Area

Field	Minnelusa Producing Zone	Drive Mechanism	Location SEC	TWP	RGE	Average Net Pay Feet	Average Porosity %	Average S_w %	Volume acre ft	Area acres	Pore Volume Mbbls	Original O. I. P. Mbbls	Pore Volumes OOIP	Ult Oil Rec	Cum Oil Rec	Cum Wtr Rec	Cum Inj	Balance	abd O.I.P
Alpha	C	Polymer	1,2&11	51N	69W	35	16.6%	33.0%	13,922	394	17,929	11,449	0.639	0.281	0.215	0.076	0.229	−0.062	0.358
American	Upper B	Polymer	5&6	52N	68W	15	17.6%	27.0%	3,024	205	4,124	2,867	0.695	0.070	0.059	0.020	0.082	0.003	0.625
Ammo	Upper B	Polymer	16&17	52N	68W	13	20.1%	21.7%	988	76	1,541	1,168	0.758	0.132	0.112	0.297	0.422	0.013	0.626
Art Creek	A & Upper B	Waterflood	8	51N	67W	27	19.3%	31.2%	3,950	145	5,932	3,953	0.666	0.161	0.146	0.121	0.291	0.024	0.505
Ash	Upper B	Waterflood	27&28	52N	69W	22	16.8%	15.5%	2,086	96	2,715	2,264	0.834	0.236	0.100	0.001	0.008	−0.093	0.598
Berger Hill	Upper B	Water Drive	6	53N	67W	17	25.0%	40.0%	3,079	184	5,971	3,445	0.577	0.162	0.154	1.775			0.415
Bracken	Upper B	Polymer	12&13	52N	69W	15	17.4%	25.0%	3,092	200	4,181	2,986	0.714	0.191	0.113	0.064	0.353	0.176	0.524
Breaks	Upper B	Aug Wtr Dr	26	52N	69W	31	23.0%	29.0%	6,357	205	11,333	7,663	0.676	0.320	0.157	0.164	0.142	−0.179	0.356
Cambridge	Upper B	Polymer	28	53N	68W	23	20.2%	32.0%	5,066	218	7,947	5,247	0.660	0.296	0.027	0.004	0.000	−0.031	0.364
Deadman Creek	Upper B	Polymer	18&19	53N	67W	25	18.1%	24.0%	5,461	266	7,656	5,595	0.731	0.289	0.210	0.225	0.713	0.278	0.441
Edsel	Upper B	Waterflood	25,26,35&36	54N	68W	27	22.5%	32.0%	10,060	376	17,575	11,603	0.660	0.286	0.242	0.425	0.697	0.029	0.374
Guthery	A & Upper B	Waterflood	3	51N	67W	38	21.2%	35.0%	8,338	217	13,670	8,544	0.625	0.300	0.289	0.415	0.709	0.005	0.325
Heath	C	Water Drive	8&9	52N	68W	28	18.5%	45.0%	6,845	248	9,825	5,146	0.524	0.084	0.073	0.279			0.440
Heath North	Lower B	Water Drive	4&5	52N	68W	20	26.9%	40.0%	2,060	88	4,291	2,452	0.571	0.187	0.159	0.237			0.385
Hoover Gulch	Upper B	Waterflood	24	52N	69W	14	16.7%	24.0%	2,078	124	2,697	1,952	0.724	0.243	0.130	0.157	0.082	−0.205	0.481
Kiehl	Upper B	Polymer	30&31	53N	68W	31	22.1%	23.0%	10,621	307	18,210	13,613	0.748	0.260	0.139	0.037	0.179	0.003	0.488
Kiehl West	Upper B	ASP	25&36	53N	68W	14	19.1%	27.5%	2,086	145	3,084	2,170	0.704	0.325	0.254	0.079	0.348	0.015	0.379
Lad	Upper B	Waterflood	17,18&19	54N	67W	28	21.2%	35.0%	8,912	323	13,501	8,520	0.631	0.211	0.197	0.140	0.346	0.009	0.420
Lily	A & Upper B	Waterflood	26,27,34&35	54N	68W	24	21.3%	23.0%	5,077	213	9,240	6,841	0.740	0.234	0.211	0.157	0.364	−0.004	0.506
Little Missouri	Lower B	Polymer	5;31,32	54&55N	67W	19	19.2%	23.0%	5,284	278	7,858	5,875	0.748	0.253	0.126	0.025	0.156	0.005	0.495
Little Mitchell Creek	Lower B	Waterflood	11,14	52N	69W	29	20.4%	25.0%	19,077	664	30,250	21,607	0.714	0.339	0.313	0.118	0.419	−0.013	0.375
Lone Cedar	Upper B	Polymer	8,9,16&17	51N	69W	28	20.7%	15.0%	7,219	261	11,593	9,385	0.810	0.379	0.224	0.176	0.431	0.032	0.431
Mellott Ranch	A & Upper B	Waterflood	2,10&11	52N	68W	27	21.6%	24.5%	14,172	518	21,174	15,135	0.715	0.297	0.293	0.997	1.275	−0.014	0.417
Oshoto	Lower B	Water Drive	22&27	53N	68W	14	22.0%	34.0%	3,471	250	5,927	3,762	0.635	0.272	0.198	0.249			0.363
Oshoto North	Lower B	Water Drive	22	53N	68W	26	22.0%	36.0%	2,755	107	4,701	2,893	0.615	0.312	0.221	0.169			0.303
Prairie Creek South	Upper B	Waterflood	16	53N	68W	18	20.9%	23.0%	1,651	94	2,682	2,005	0.748	0.286	0.243	0.050	0.327	0.034	0.462
Reynolds Ranch	Upper B	Water Drive	6;1	52N	67&68W	21	26.6%	40.0%	1,840	88	3,797	2,212	0.583	0.256	0.315	2.878			0.326
Rule	Lower B	Waterflood	15	52N	69W	30	17.1%	33.7%	2,577	87	3,419	2,179	0.638	0.191	0.114	0.000	0.082	−0.032	0.447
Semlek	Lower B	Water Drive	27	52N	68W	25	21.2%	27.0%	6,438	253	10,588	7,432	0.702	0.322	0.304	0.473			0.380
Semlek North	Lower B	Aug Wtr Dr	16&21	52N	68W	19	16.8%	32.0%	3,846	207	5,016	3,280	0.654	0.304	0.287	0.098	0.177	−0.208	0.350
Semlek West	Upper B	Aug Wtr Dr	28&29	52N	68W	27	18.7%	35.0%	15,284	574	22,209	13,881	0.625	0.272	0.261	0.704	0.557	−0.408	0.353
Simpson Ranch	Upper B	Polymer	15	51N	69W	21	18.0%	35.0%	3,587	172	5,017	3,106	0.619	0.173	0.158	0.377	0.548	0.013	0.446
Terrace	Lower B	Water Drive	11,12	51N	69W	33	23.5%	23.0%	8,886	268	16,213	11,890	0.733	0.357	0.224	0.176			0.376
Wagonspoke	Lower B	Waterflood	3;34	52&53N	69W	24	19.6%	24.0%	6,296	258	9,573	6,929	0.724	0.295	0.305	0.780	1.425	0.340	0.429
Wolf Draw	Upper B	Polymer	18;24	52N	68&69W	16	17.3%	23.0%	4,436	296	5,958	4,369	0.733	0.210	0.085	0.016	0.087	−0.013	0.523
Totals									209,920	8,404	327,398	223,418							
Average (weighted)						24	20.1%	29.0%	5,998	240	9,354	6,383	0.682	0.273	0.215	0.343	0.388	0.170	0.409
Maximum						38	26.9%	45.0%	19,077	664	30,250	21,607	0.834	0.379	0.315	2.878	1.425	0.340	0.626
Minimum						13	16.6%	15.0%	988	76	1,541	1,168	0.524	0.070	0.027	0.000	0.000	−0.408	0.303

Minnelusa Field Production
TWP 51N to 55N – RGE 67W to 69W
Listing of Select Minnelusa Reservoirs in Study Area

Field	Disc Date	Unit Date	Oil Gravity	Depletion Factor %	1992 Production Oil bbls	1992 Production Water bbls	Cum Prod thru 1992 Oil Mbbls	Cum Prod thru 1992 Water Mbbls	Injection 1992 Mbbls	Injection Cum Thru 1992	Est Pri Tot Rec Mbbls	Est Pri Rec % OOIP	1992 Rate bopd	Oil Cut %	Proj Rem Rec Mbbls	Proj Tot Rec Mbbls	Est Rem Life Months	Est Ult Rec % OOIP
Alpha	1986	1989	25.3	76.6%	854,237	538,832	3,856	1,355	1,469	4,108	1,894	16.5%	2,340	61.3%	1,179	5,036	60	44.0%
American	1986	1988	20.9	84.0%	28,505	24,156	244	84	63	340	73	2.5%	78	54.1%	47	291	26	10.1%
Ammo	1985	1988	19.9	84.8%	15,207	93,019	173	458	168	650	39	3.4%	42	14.1%	31	204	40	17.5%
Art Creek	1981	1985	22.3	90.8%	40,069	80,935	868	715	263	1,725	401	10.2%	110	33.1%	88	957	49	24.2%
Ash	1987	1992	20.0	42.5%	12,754	1,171	272	3	21	21	281	12.4%	35	91.6%	368	640	60	28.3%
Berger Hill	1975		19.0	95.1%	35,407	1,019,955	921	10,600			969	28.1%	97	3.4%	48	969	20	28.1%
Bracken	1983	1986	21.4	59.1%	80,977	52,108	471	269	423	1,477	148	4.9%	222	60.8%	326	798	117	26.7%
Breaks	1976	1990	21.0	48.9%	329,751	357,216	1,775	1,855	745	1,604	1,947	25.4%	903	48.0%	1,854	3,629	176	47.4%
Cambridge	1989	1993	20.2	9.2%	38,195	10,409	217	33		0	316	6.0%	105	78.6%	2,139	2,356		44.9%
Deadman Creek	1973	1979	22.0	72.5%	79,229	219,374	1,607	1,726	527	5,461	268	4.8%	217	26.5%	609	2,216	202	39.6%
Edsel	1981	1984	21.0	84.7%	208,157	1,671,895	4,260	7,469	1,895	12,244	817	7.0%	570	11.1%	769	5,029	63	43.3%
Guthery	1963	1968	21.0	96.2%	118,734	962,914	3,946	5,676	1,037	9,688	789	9.2%	325	11.0%	157	4,103	57	48.0%
Heath	1980		22.0	87.1%	24,872	177,234	716	2,740			822	16.0%	68	12.3%	106	822	81	16.0%
Heath North	1987		22.0	85.4%	131,282	506,119	684	1,018			801	32.7%	360	20.6%	117	801	25	32.7%
Hoover Gulch	1974	1986	19.0	53.5%	32,643	44,140	350	423	44	220	126	6.5%	89	42.5%	305	655	173	33.5%
Kiehl	1973	1985	21.8	53.4%	300,759	383,664	2,524	678	810	3,264	789	5.8%	824	43.9%	2,202	4,726	238	34.7%
Kiehl West	1985	1987	24.0	78.0%	76,000	126,075	783	242	221	1,073	96	4.4%	208	37.6%	220	1,003	64	46.2%
Lad	1978	1982	21.3	93.5%	84,534	326,536	2,664	1,890	436	4,674	385	4.5%	232	20.6%	184	2,848	42	33.4%
Lily	1984	1987	21.7	90.1%	181,941	682,172	1,951	1,453	854	3,364	768	11.2%	498	21.1%	215	2,166	31	31.7%
Little Missouri	1986	1989	22.9	49.8%	210,902	96,820	989	199	352	1,228	304	5.2%	578	68.5%	997	1,986	137	33.8%
Little Mitchell Creek	1966	1969	25.4	92.4%	204,682	340,648	9,481	3,575	577	12,666	2,143	9.9%	561	37.5%	785	10,267	115	47.5%
Lond Cedar	1984	1987	25.0	59.3%	390,602	828,631	2,601	2,035	1,250	5,001	842	9.0%	1,070	32.0%	1,788	4,389	115	46.8%
Mellott Ranch	1960	1965	20.7	98.4%	139,015	1,457,911	6,195	21,110	1,990	27,001	992	6.6%	381	8.7%	102	6,297	13	41.6%
Oshoto	1983		22.4	72.8%	72,532	165,319	1,173	1,478			1,611	42.8%	199	30.5%	438	1,611	162	42.8%
Oshoto North	1984		22.4	70.7%	83,461	123,286	1,037	792			1,467	50.7%	229	40.4%	430	1,467	136	50.7%
Prairie Creek South	1985	1988	21.2	85.1%	50,772	115,159	653	135	186	878	133	6.6%	139	30.6%	114	766	52	38.2%
Reynolds Ranch	1974		24.0	123.0%	24,617	972,161	1,197	10,928			973	44.0%	67	2.5%	(223)	973	0	44.0%
Rule	1985	1991	25.0	59.7%	88,668	0	389	0	206	280	425	19.5%	243	100.0%	263	652	70	29.9%
Semlek	1962		22.6	94.5%	44,841	320,062	3,224	5,010			3,411	45.9%	123	12.3%	188	3,411	69	45.9%
Semlek North	1975	1988	22.6	94.2%	51,661	118,919	1,438	492	186	889	1,051	32.0%	142	30.3%	88	1,526	60	46.5%
Semlek West	1962		23.0	95.8%	128,646	1,285,470	5,791	15,637	537	12,369	5,297	38.2%	352	9.1%	256	6,047	33	43.6%
Simpson Ranch	1977	1990	21.0	91.0%	21,741	242,655	792	1,891	243	2,749	130	4.2%	60	8.2%	79	870	78	28.0%
Terrace	1985		21.0	62.7%	419,311	585,989	3,631	2,847			5,792	48.7%	1,149	41.7%	2,161	5,792	147	48.7%
Wagonspoke	1972	1978	28.0	103.2%	36,635	1,192,634	2,916	7,467	1,103	13,640	1,124	16.2%	100	3.0%	(91)	2,825	0	40.8%
Wolf Draw	1988	1992	21.5	40.3%	121,299	7,752	504	92	516	516	461	10.5%	332	94.0%	747	1,251	114	28.6%
Totals					4,762,638	15,131,340	70,291	112,376	16,121	127,130	37,887		13,048		19,086	89,377		
Average (weighted)			22.1	78.6%	136,075	432,324	2,008	3,211	597	4,709	1,082	17.0%	373	23.9%	545	2,554		40.0%
Maximum			28.0	123.0%	854,237	1,671,895	9,481	21,110	1,990	27,001	5,792	50.7%	2,340	100.0%	2,202	10,267		50.7%
Minimum			19.0	9.2%	12,754	0	173	0	0	0	39	2.5%	35	2.5%	(223)	204		10.1%

Figure 1

West Kiehl Net Pay Isopach with Well Locations

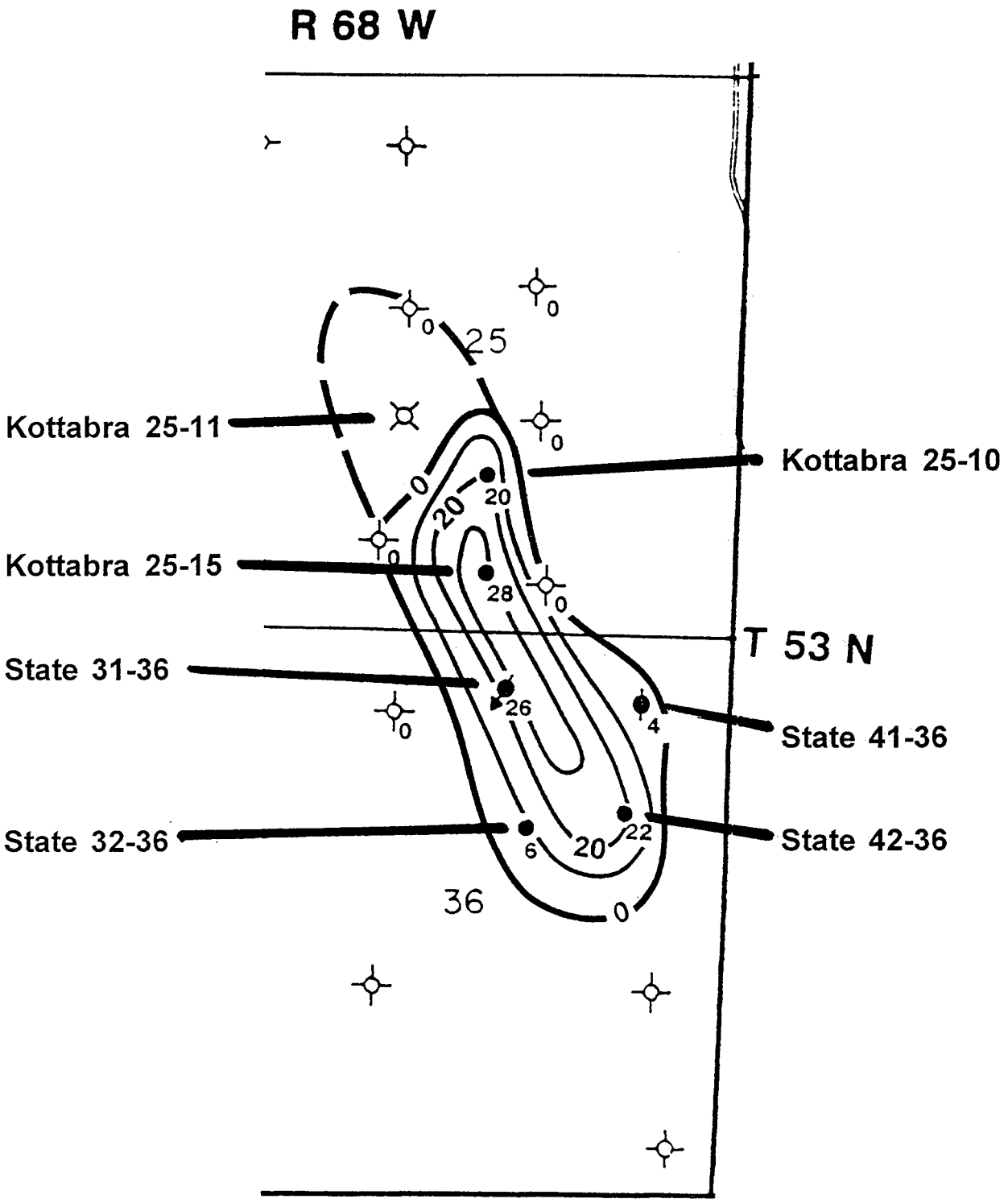


Figure 2

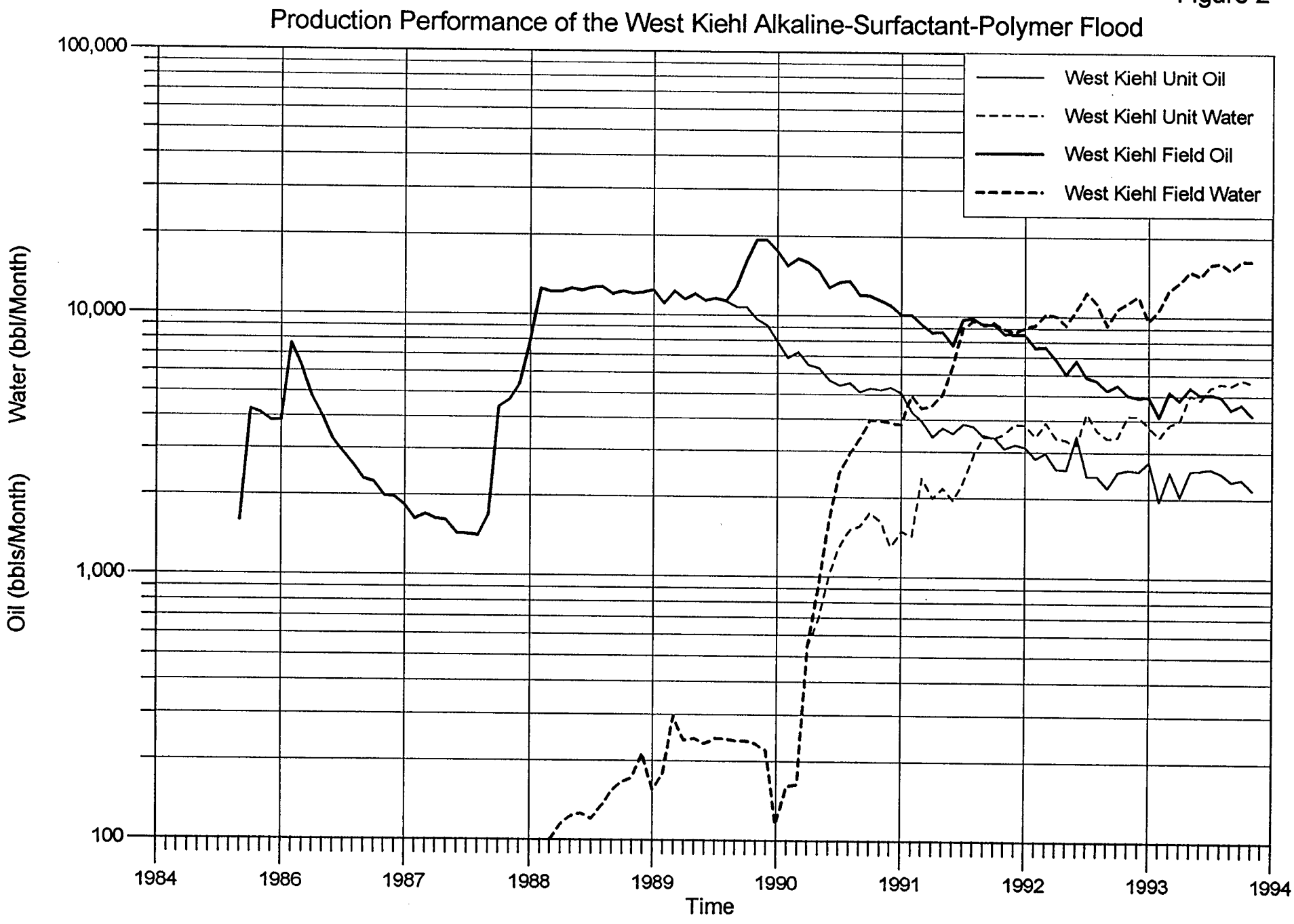

Production Performance of the West Kiehl Alkaline-Surfactant-Polymer Flood
100,000
10,000
1,000
100
Oil (bbls/Month) Water (bbl/Month)
West Kiehl Unit Oil
West Kiehl Unit Water
West Kiehl Field Oil
West Kiehl Field Water
1984
1986
1987
1988
1989
1990
1991
1992
1993
1994
Time

Figure 3

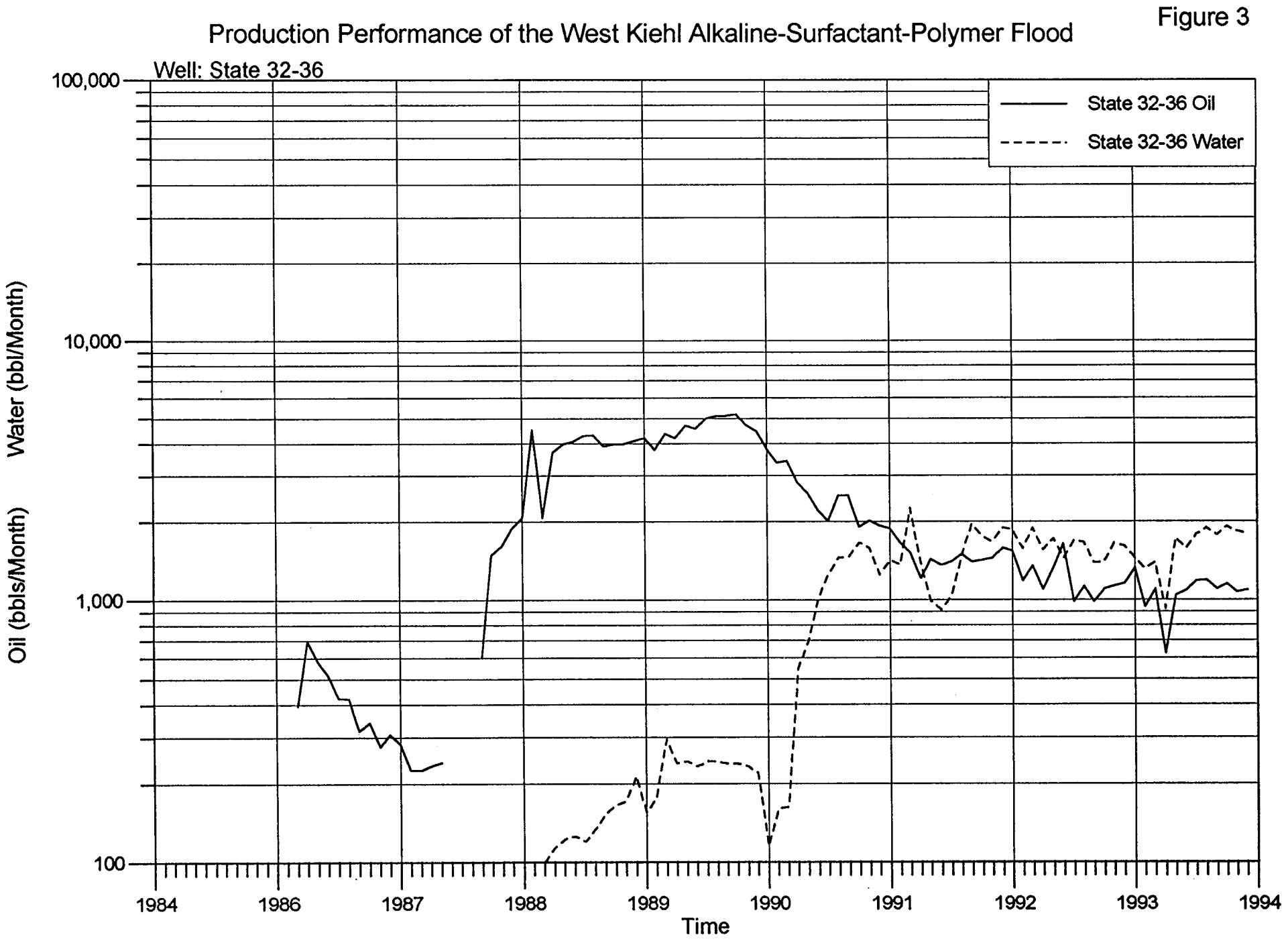

Production Performance of the West Kiehl Alkaline-Surfactant-Polymer Flood
Well: State 32-36
State 32-36 Oil
State 32-36 Water
Oil (bbls/Month) Water (bbl/Month)
100,000
10,000
1,000
100
1984
1986
1987
1988
1989
1990
1991
1992
1993
1994
Time

Figure 4

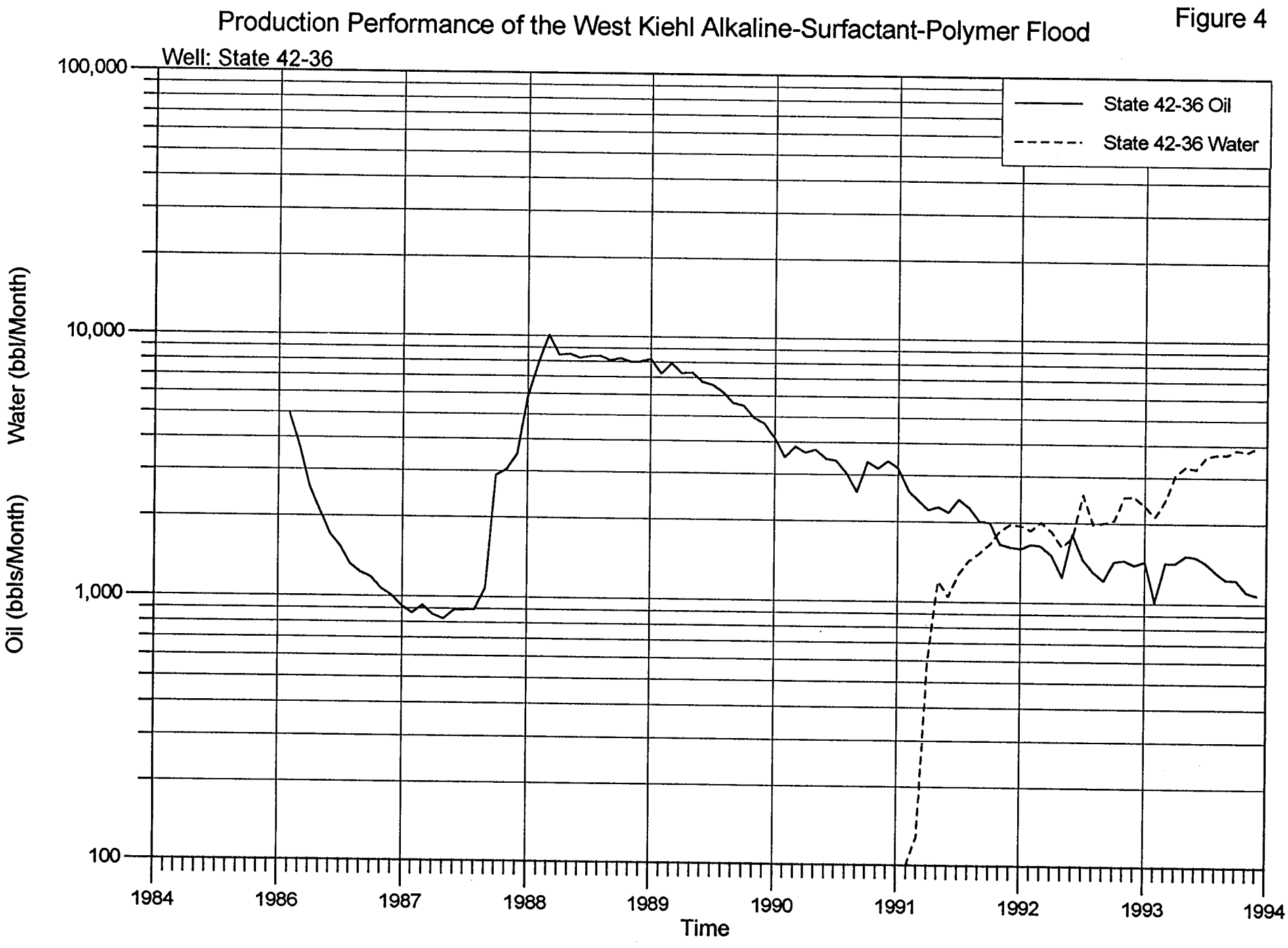
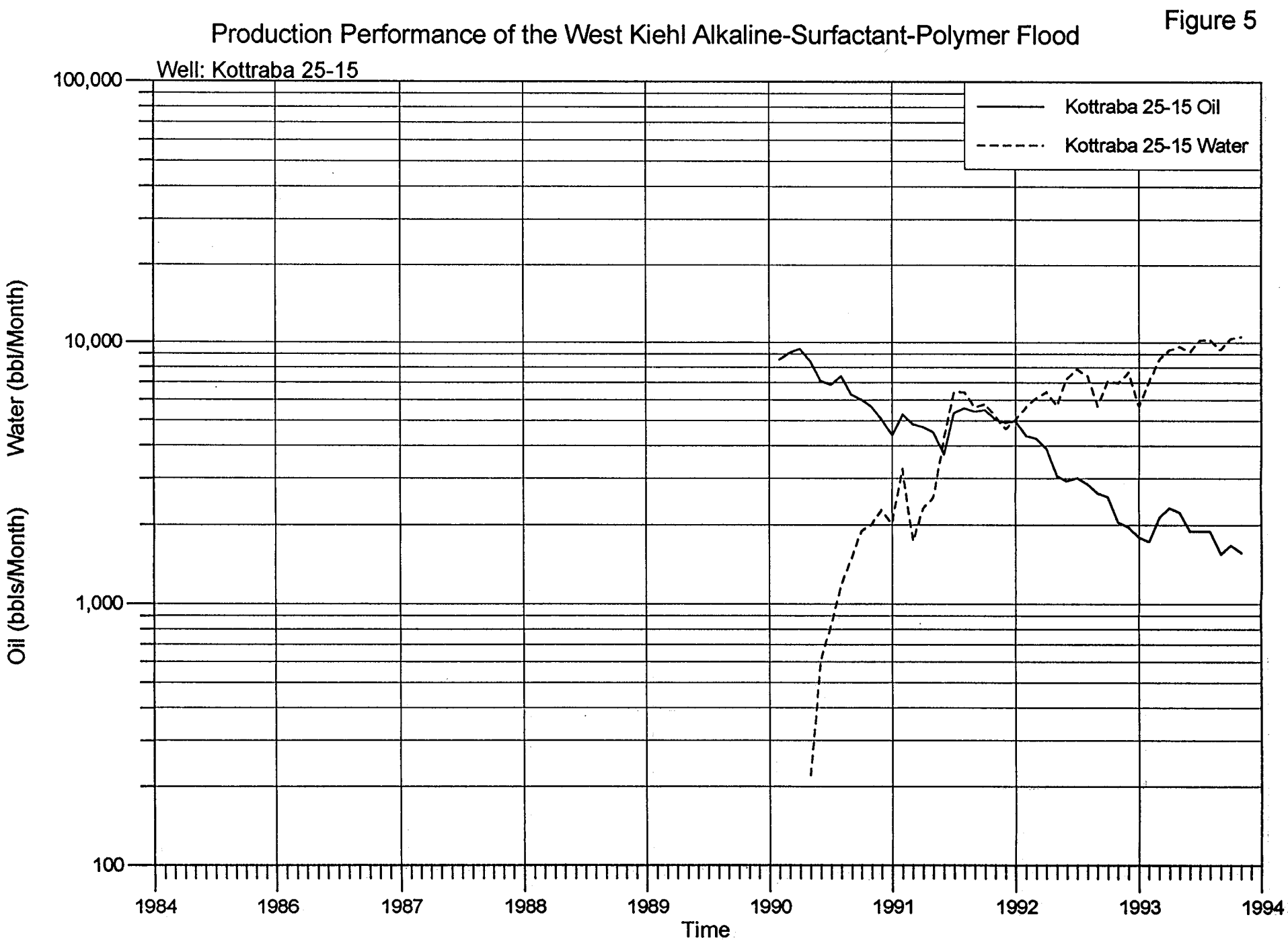
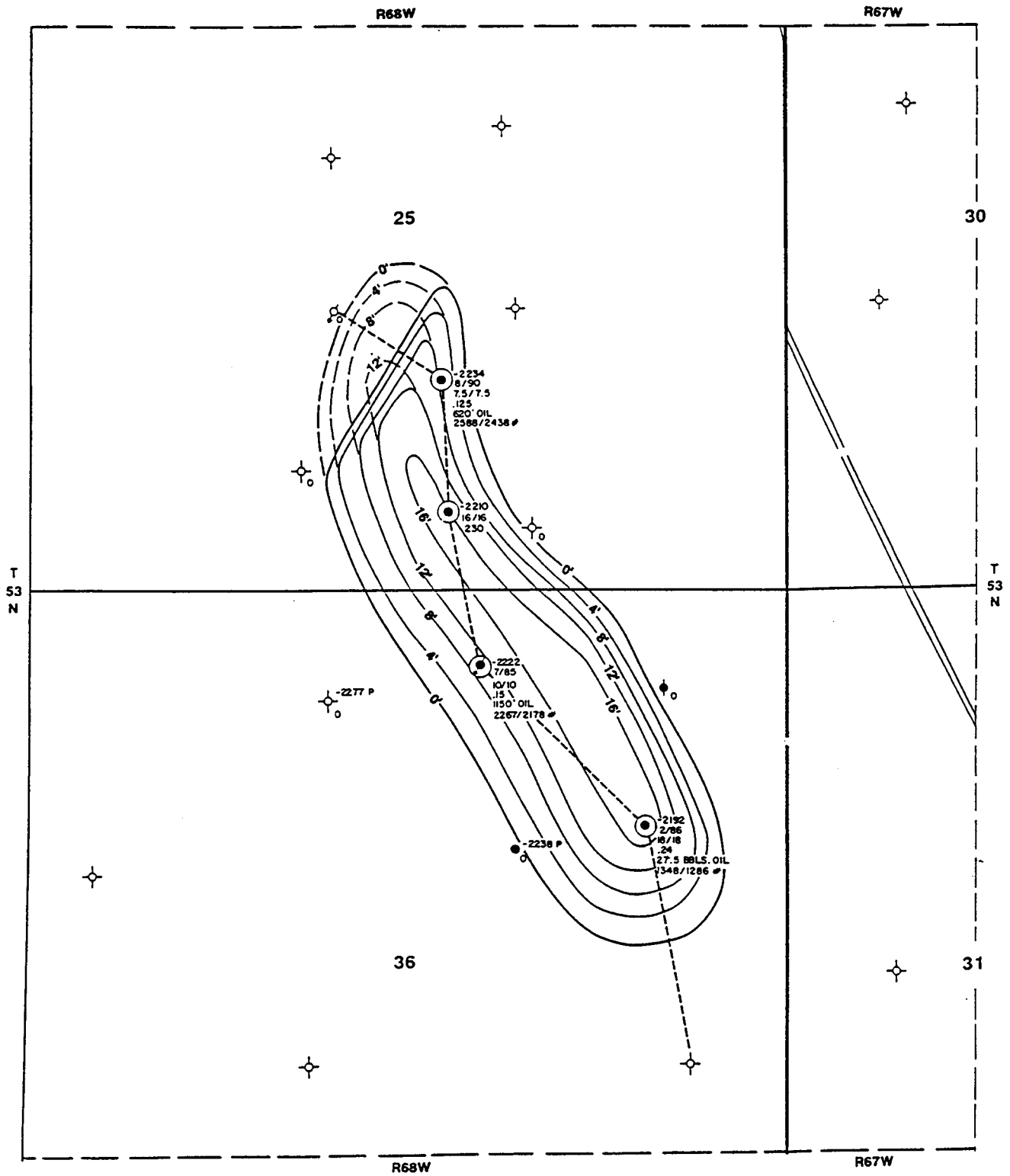

Production Performance of the West Kiehl Alkaline-Surfactant-Polymer Flood
Well: State 42-36
State 42-36 Oil
State 42-36 Water
Oil (bbls/Month) Water (bbl/Month)
100,000
10,000
1,000
100
1984
1986
1987
1988
1989
1990
1991
1992
1993
1994
Time

Figure 5


Production Performance of the West Kiehl Alkaline-Surfactant-Polymer Flood
Well: Kottraba 25-15
Kottraba 25-15 Oil
Kottraba 25-15 Water
Oil (bbls/Month)
Water (bbl/Month)
100,000
10,000
1,000
100
1984
1986
1987
1988
1989
1990
1991
1992
1993
1994
Time



LEGEND

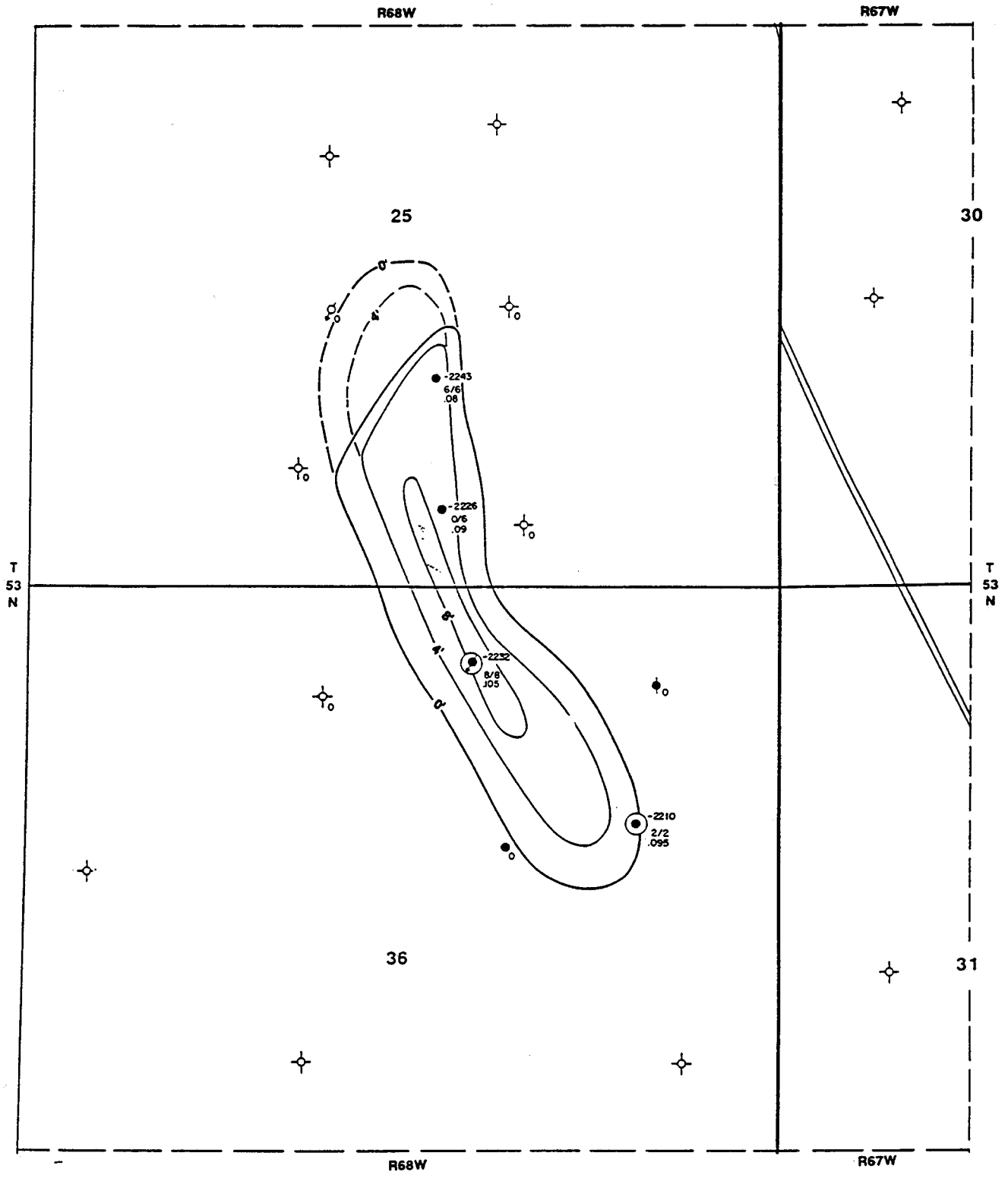
- OIL
- WATER
- PERF'D IN ZONE
- TOP POROSITY
- COMPLETION DATE
- NET POROSITY/NET OIL PAY
- POROSITY
- DST RECOVERY
- SHUT IN PRESURE
- P PHANTOM DATUM

KIEHL WEST AREA
Crook County, Wyoming

ISOPACH MAP-NET POROSITY
LOWER MINNELUSA 'B' SAND
ZONE 1
INTERVAL=4 FEET

GEOLOGY: L.S.GRIFFITH
DATE: 12-'93

Figure 7



LEGEND

OIL

WATER

PERF'D IN ZONE

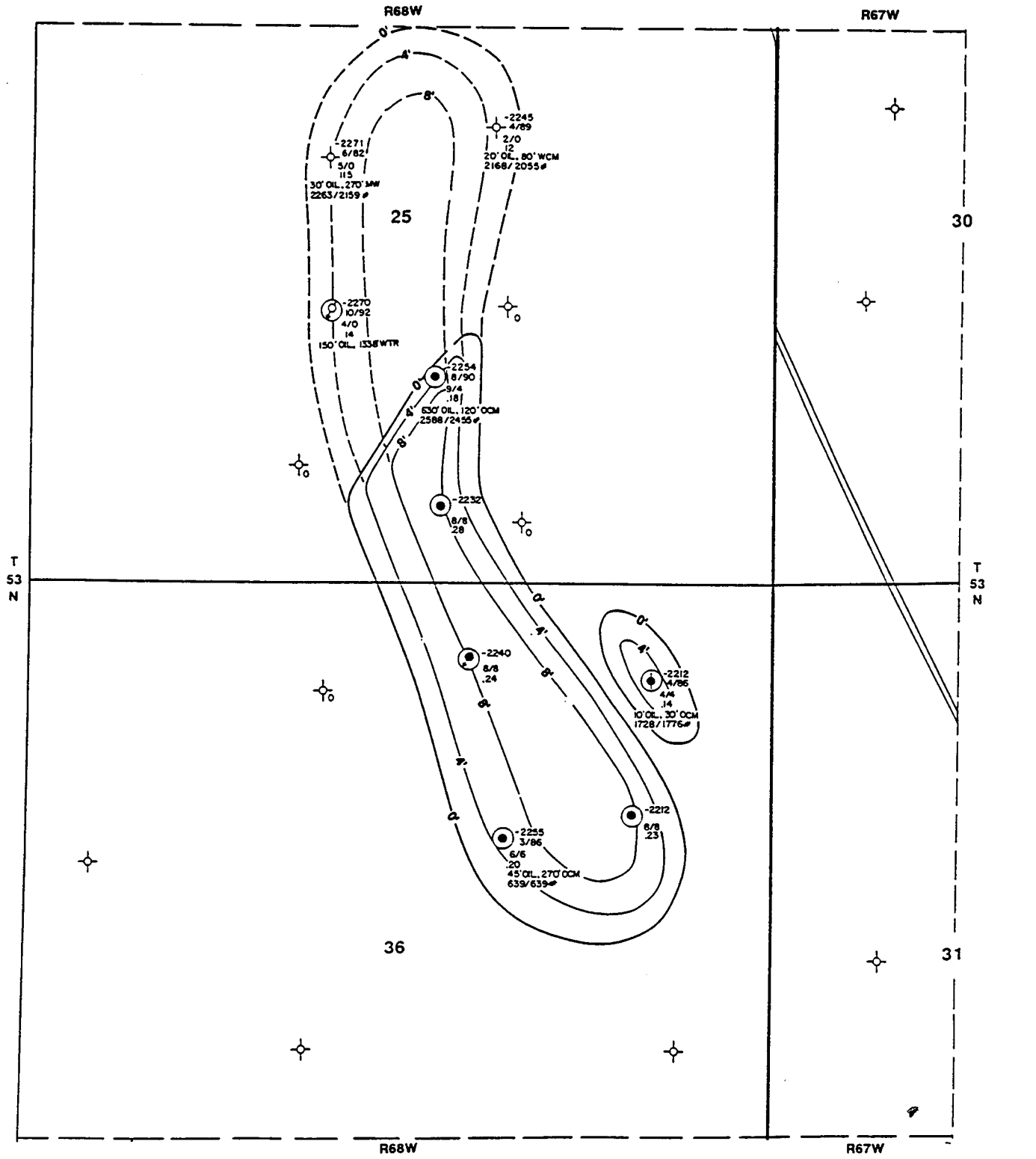
TOP ZONE 2
NET POROSITY/NET OIL PAY
POROSITY

KIEHL WEST AREA
Crook County, Wyoming

ISOPACH MAP-NET POROSITY
LOWER MINNELUSA 'B' SAND
ZONE 2
INTERVAL=4 FEET

GEOLOGY: L.S.GRIFFITH
DATE: 12'93

Figure 8



LEGEND

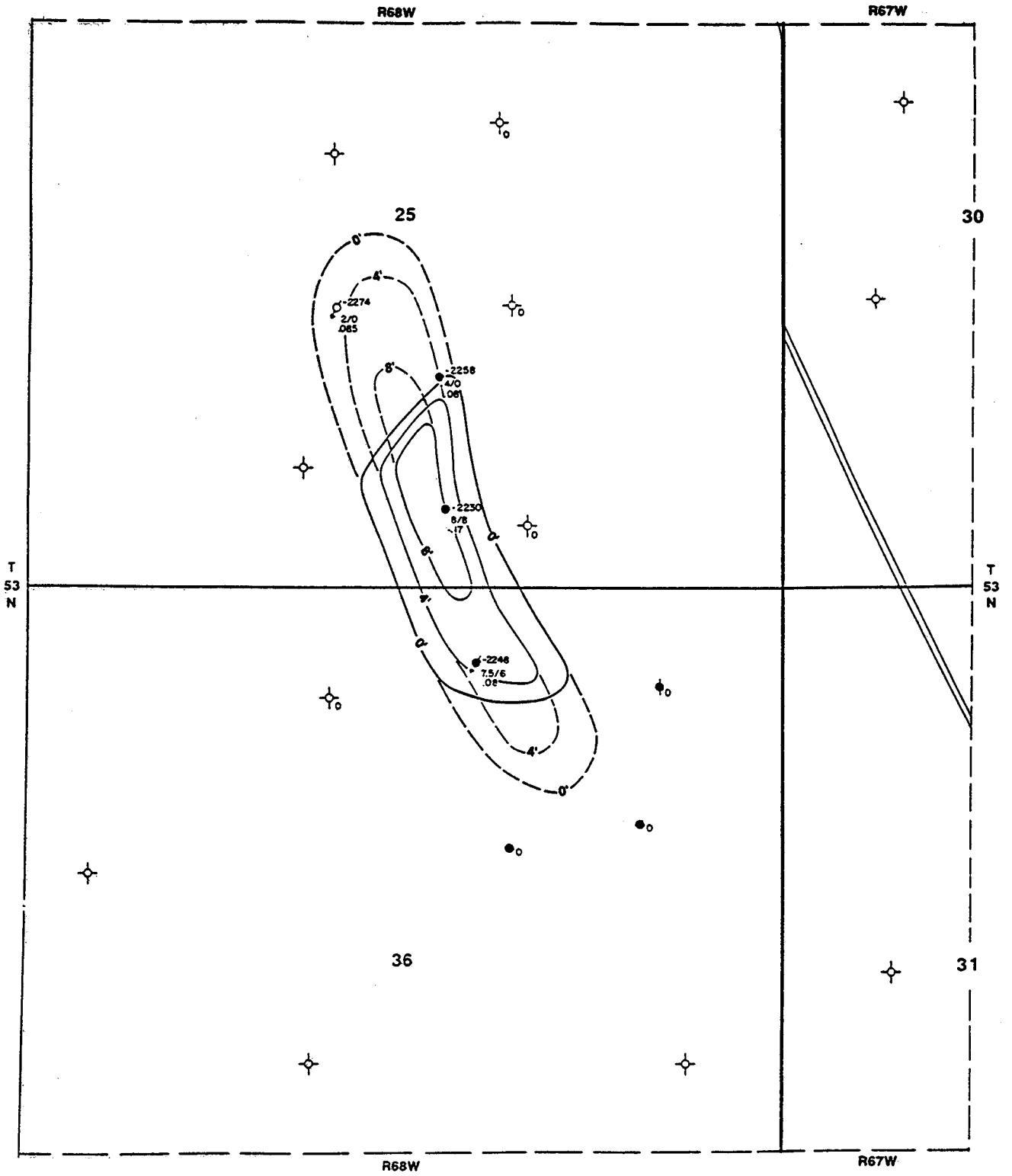
- OIL
- WATER
- PERF'D IN ZONE
- TOP ZONE 3
  COMPLETION DATE
  NET POROSITY/NET OIL PAY
  POROSITY
  DST RECOVERY
  SHUT IN PRESSURE

KIEHL WEST AREA
Crook County, Wyoming

ISOPACH MAP-NET POROSITY
LOWER MINNELUSA 'B' SAND
ZONE 3
INTERVAL=4 FEET

GEOLOGY: L.S.GRIFFITH
DATE: 12/93

Figure 9



LEGEND

OIL

WATER

PERF'D IN ZONE

TOP ZONE 4
NET POROSITY/NET OIL PAY
POROSITY

KIEHL WEST AREA
Crook County, Wyoming

ISOPACH MAP-NET POROSITY
LOWER MINNELUSA 'B' SAND
ZONE 4
INTERVAL=4 FEET

GEOLOGY: L.S.GRIFFITH
DATE: 12/92

Figure 10

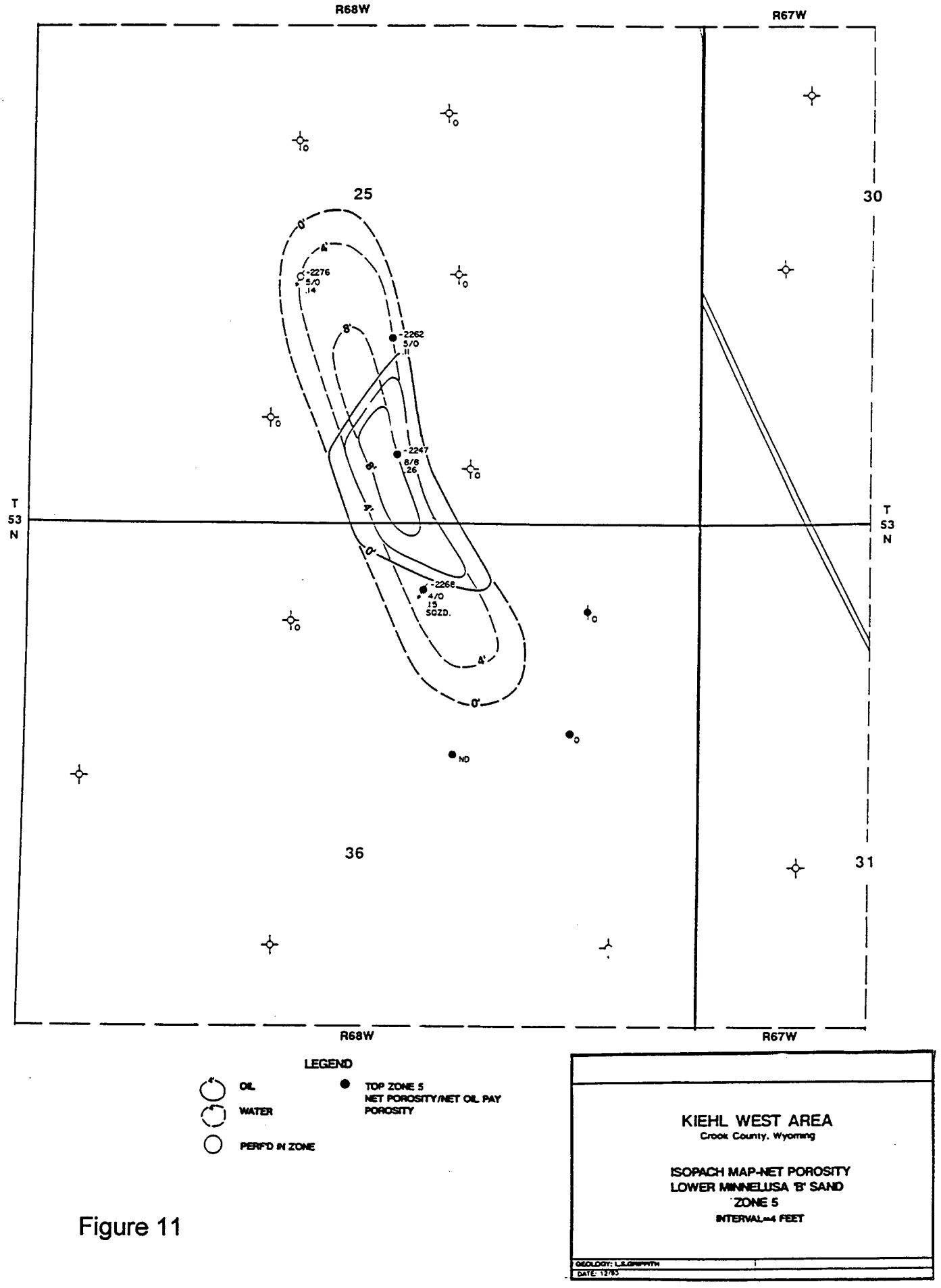

R68W
R67W
25
30
36
31
T 53 N
T 53 N
0'
4'
8'
-2276
5/0
.14
-2262
5/0
11
-2247
8/8
26
-2268
4/0
15
SQZD.
ND
LEGEND
OIL
WATER
PERF'D IN ZONE
TOP ZONE 5
NET POROSITY/NET OIL PAY
POROSITY
KIEHL WEST AREA
Crook County, Wyoming
ISOPACH MAP-NET POROSITY
LOWER MINNELUSA 'B' SAND
ZONE 5
INTERVAL=4 FEET
GEOLOGY: L.S.GRIFFITH
DATE: 12/83

Figure 11

Figure 12

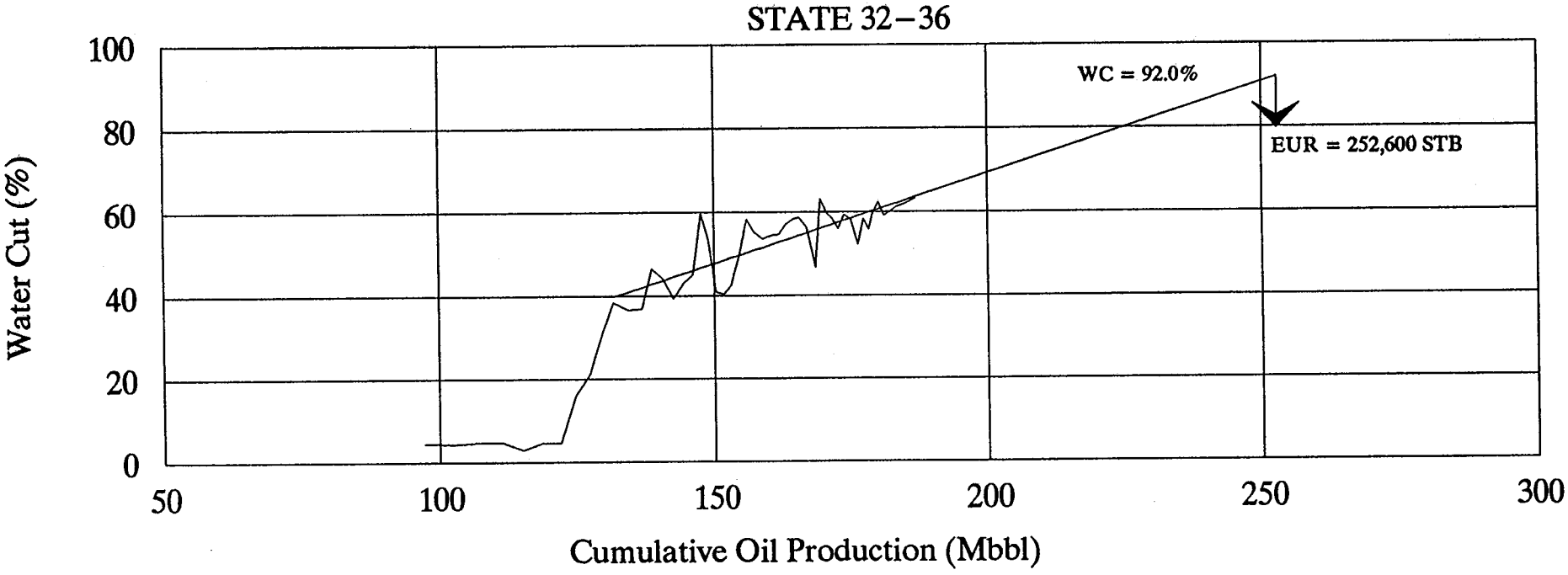

STATE 32−36
WC = 92.0%
EUR = 252,600 STB
Water Cut (%)
100
80
60
40
20
0
50
100
150
200
250
300
Cumulative Oil Production (Mbbl)

Figure 13

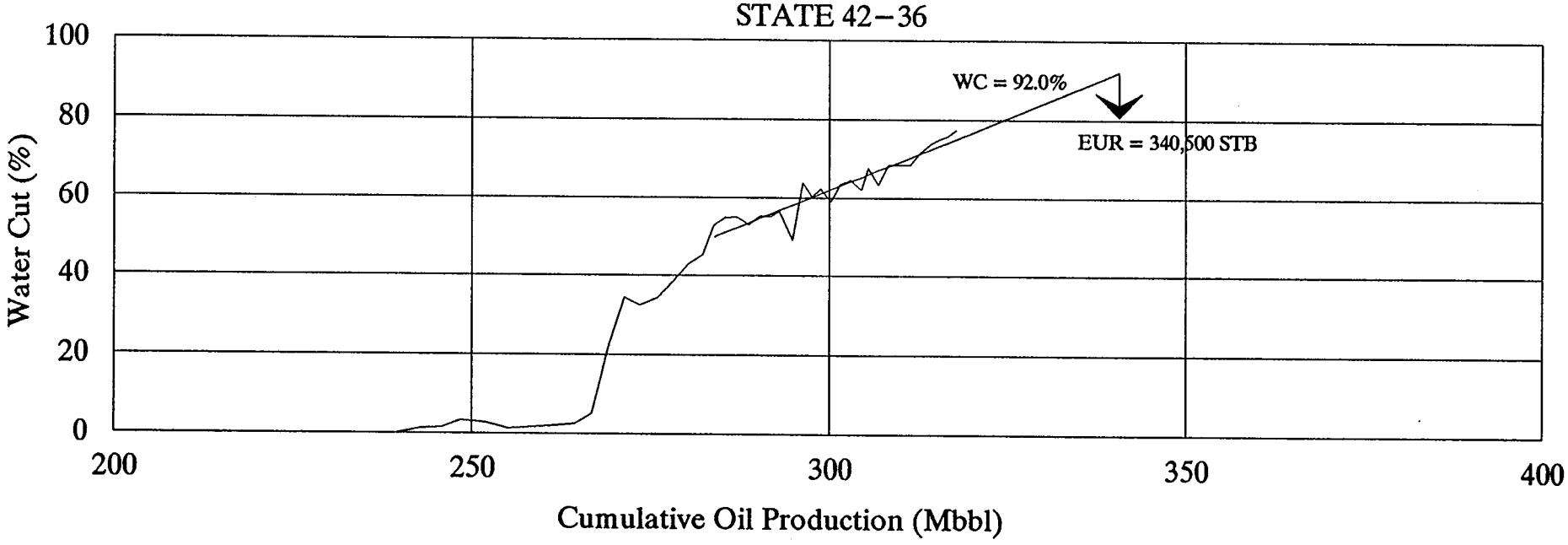

STATE 42−36
WC = 92.0%
EUR = 340,500 STB
Water Cut (%)
100
80
60
40
20
0
200
250
300
350
400
Cumulative Oil Production (Mbbl)

Figure 14

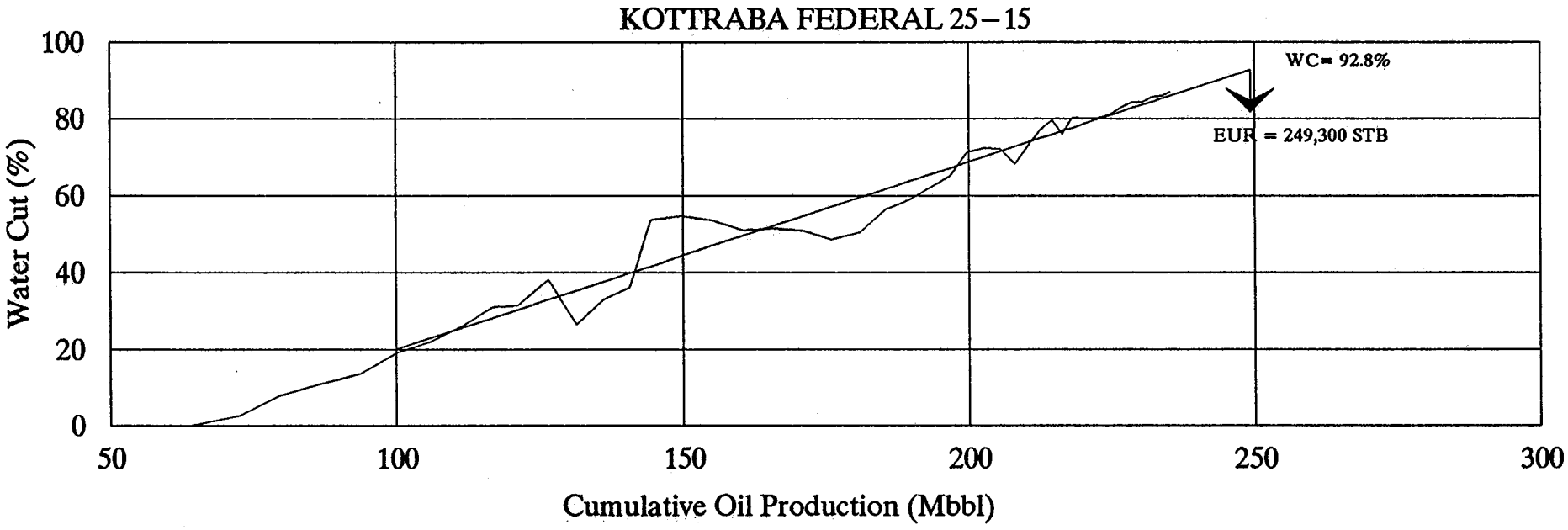

KOTTRABA FEDERAL 25–15
WC= 92.8%
EUR = 249,300 STB
Water Cut (%)
100
80
60
40
20
0
50
100
150
200
250
300
Cumulative Oil Production (Mbbl)

Figure 15

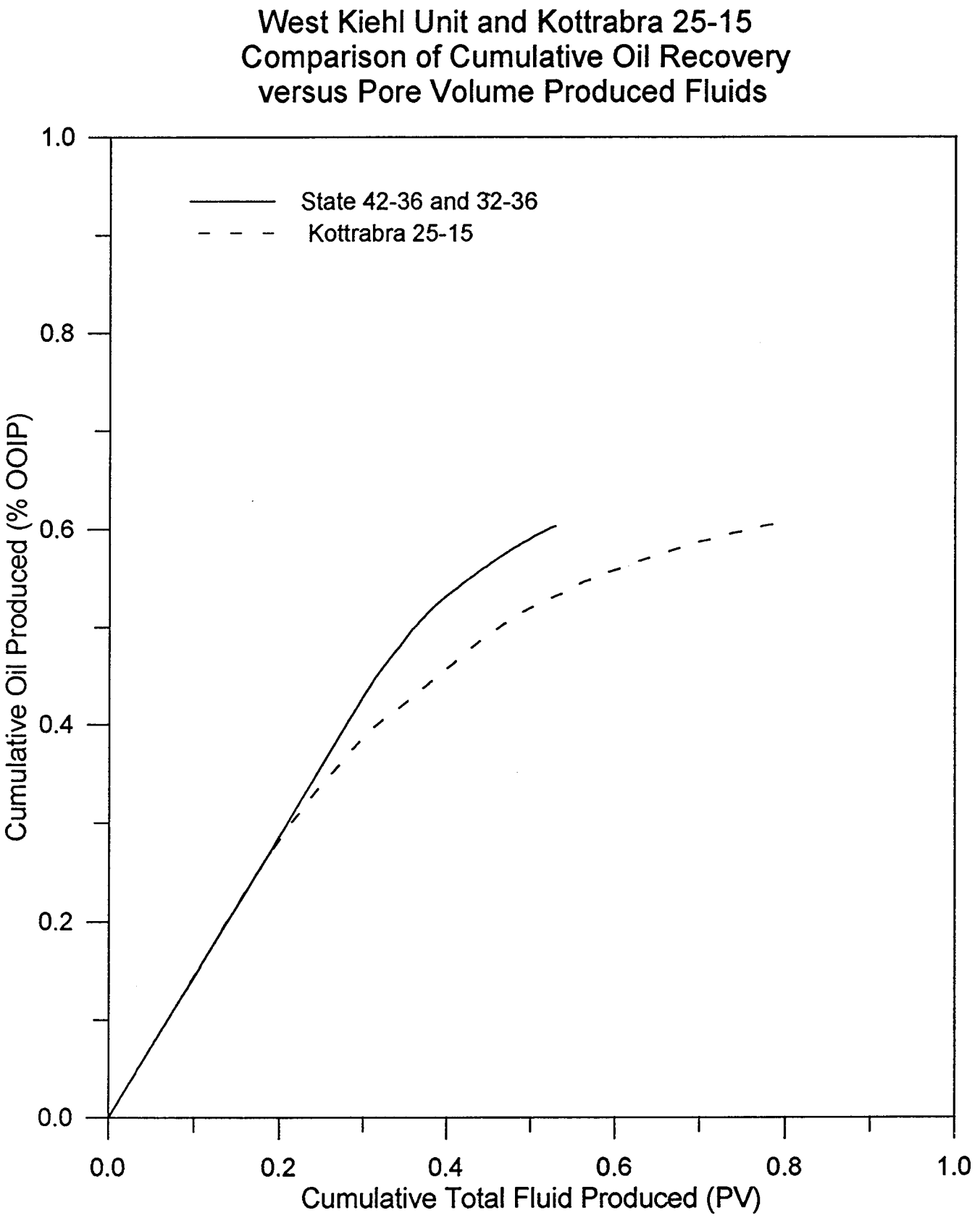
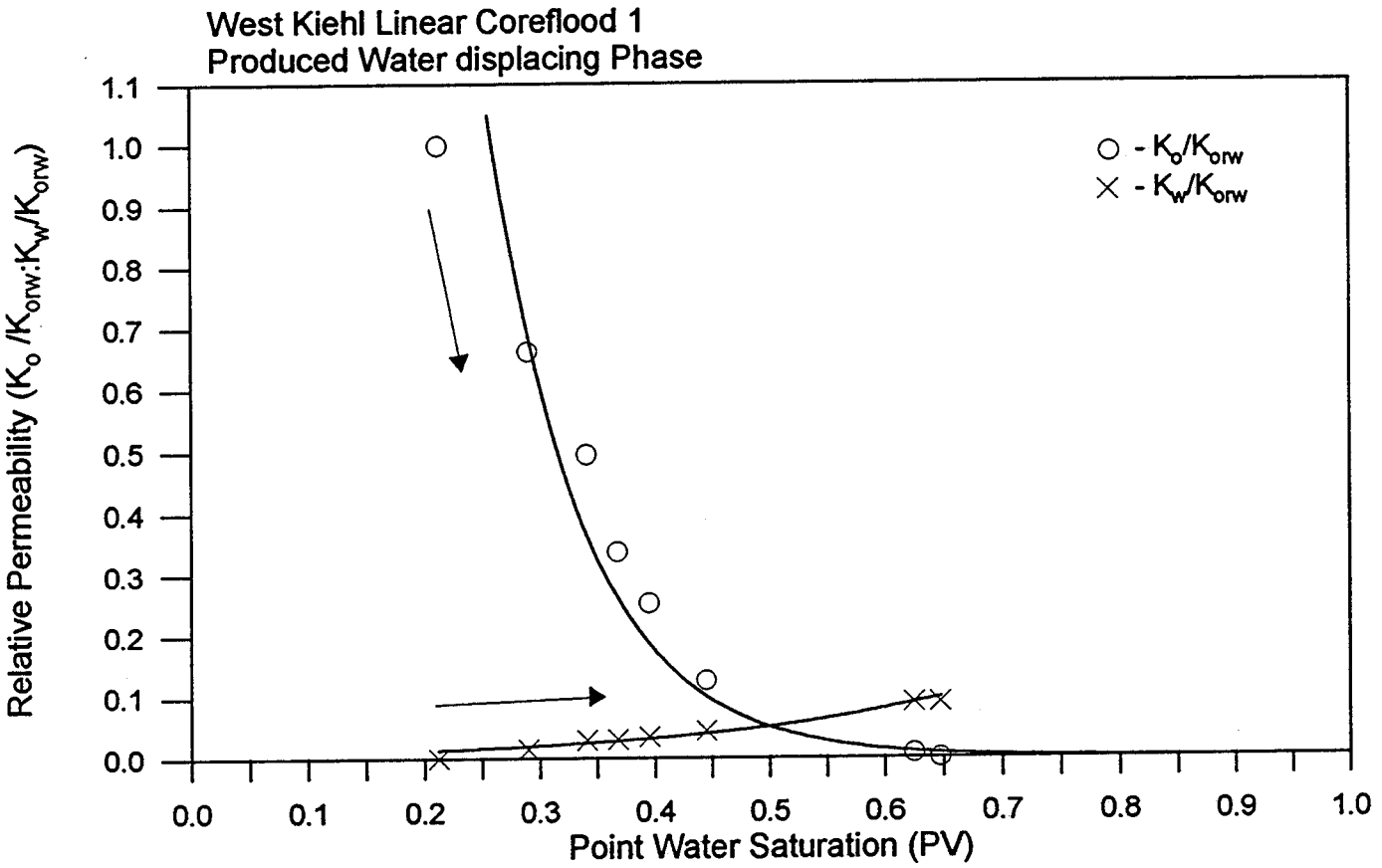

West Kiehl Unit and Kottrabra 25-15
Comparison of Cumulative Oil Recovery
versus Pore Volume Produced Fluids
State 42-36 and 32-36
Kottrabra 25-15
Cumulative Oil Produced (% OOIP)
Cumulative Total Fluid Produced (PV)
0.0
0.2
0.4
0.6
0.8
1.0

Figure 16

West Kiehl Relative Permeability



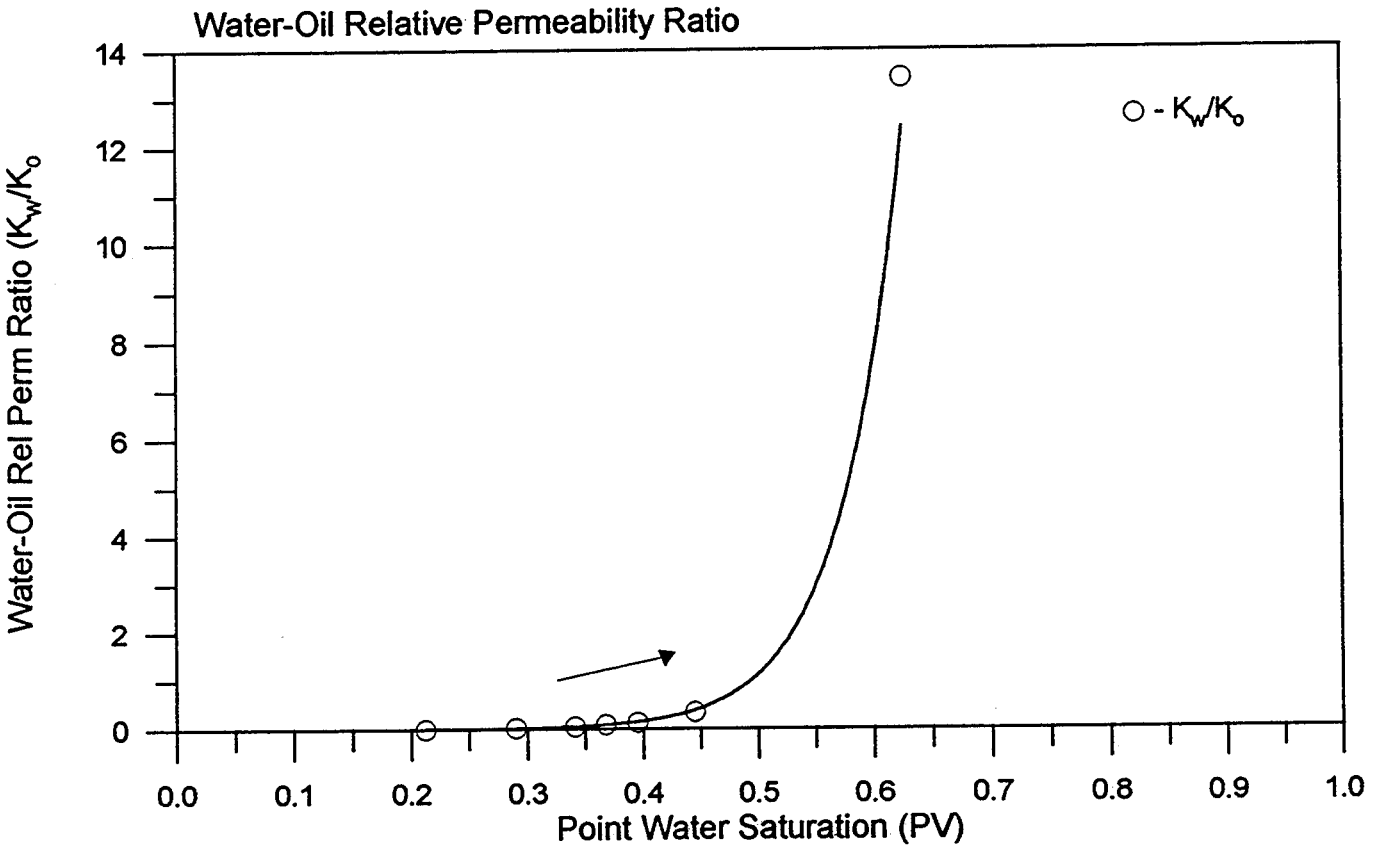


Figure 17

West Kiehl Cumulative Oil Recovery, Oil Cut and Chemical Production versus Produced Fluids

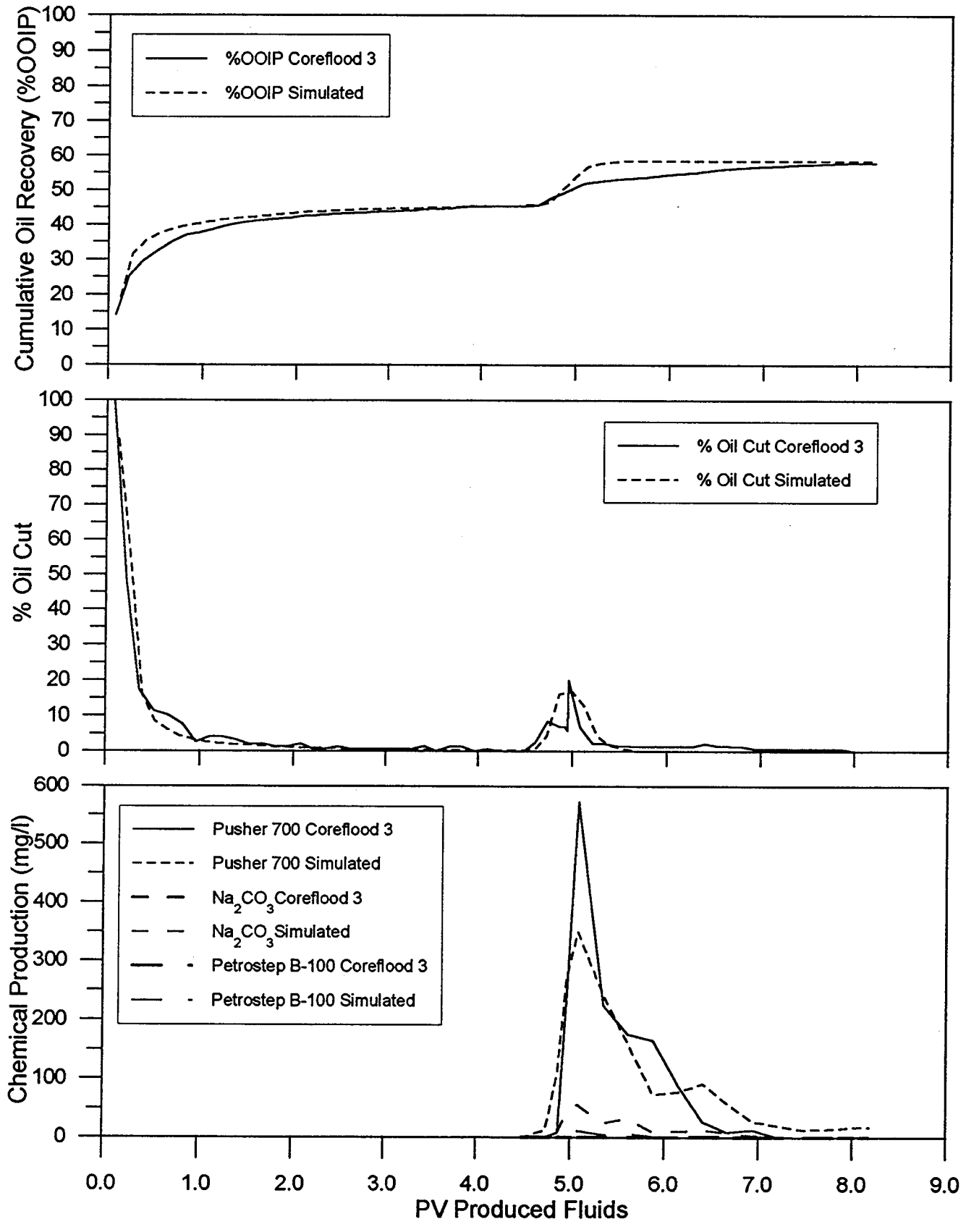


Figure 18

West Kiehl Cumulative Oil Recovery, Oil Cut and Chemical Production versus Produced Fluids

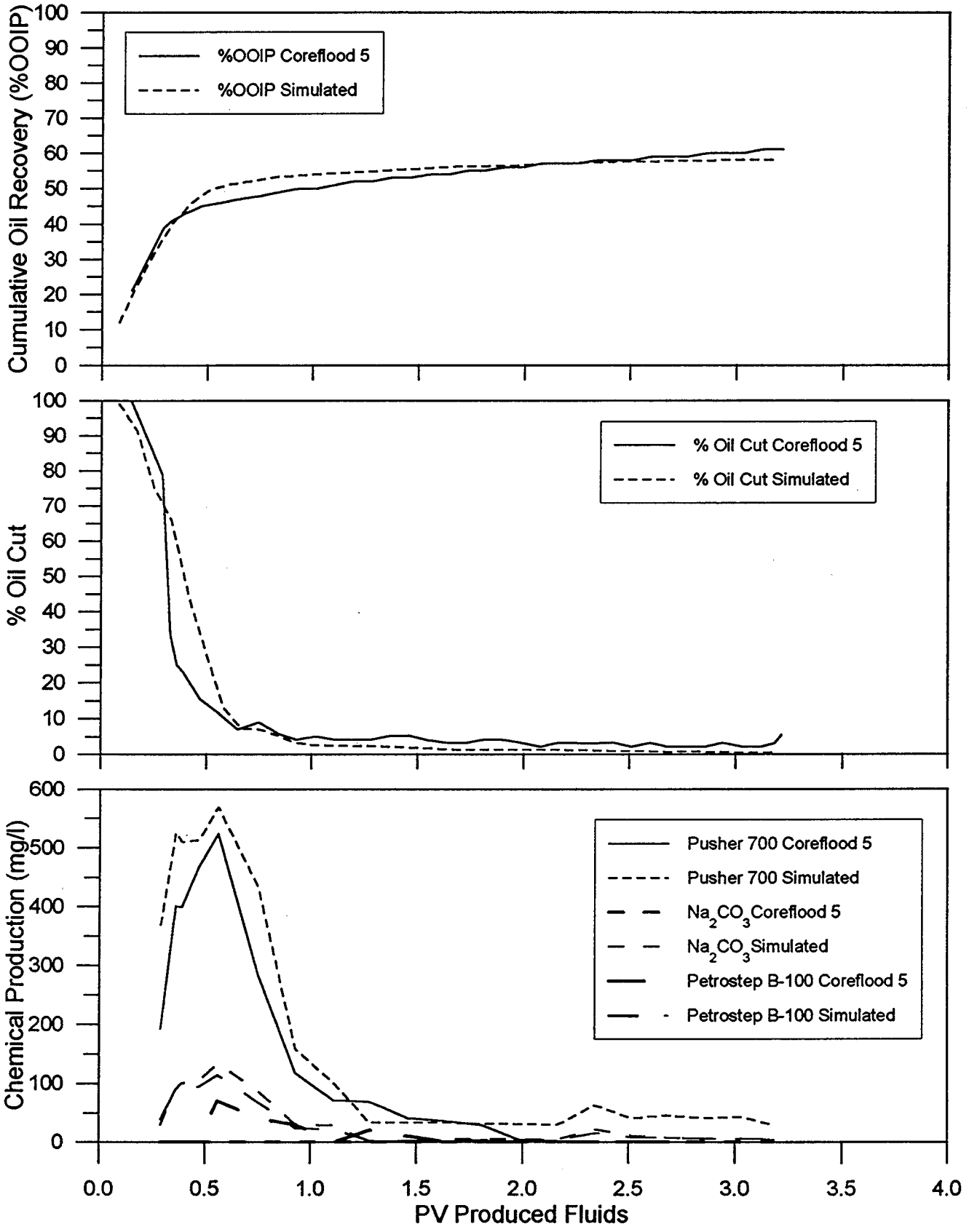


Figure 19

West Kiehl Cumulative Oil Recovery, Oil Cut and Chemical Production versus Produced Fluids

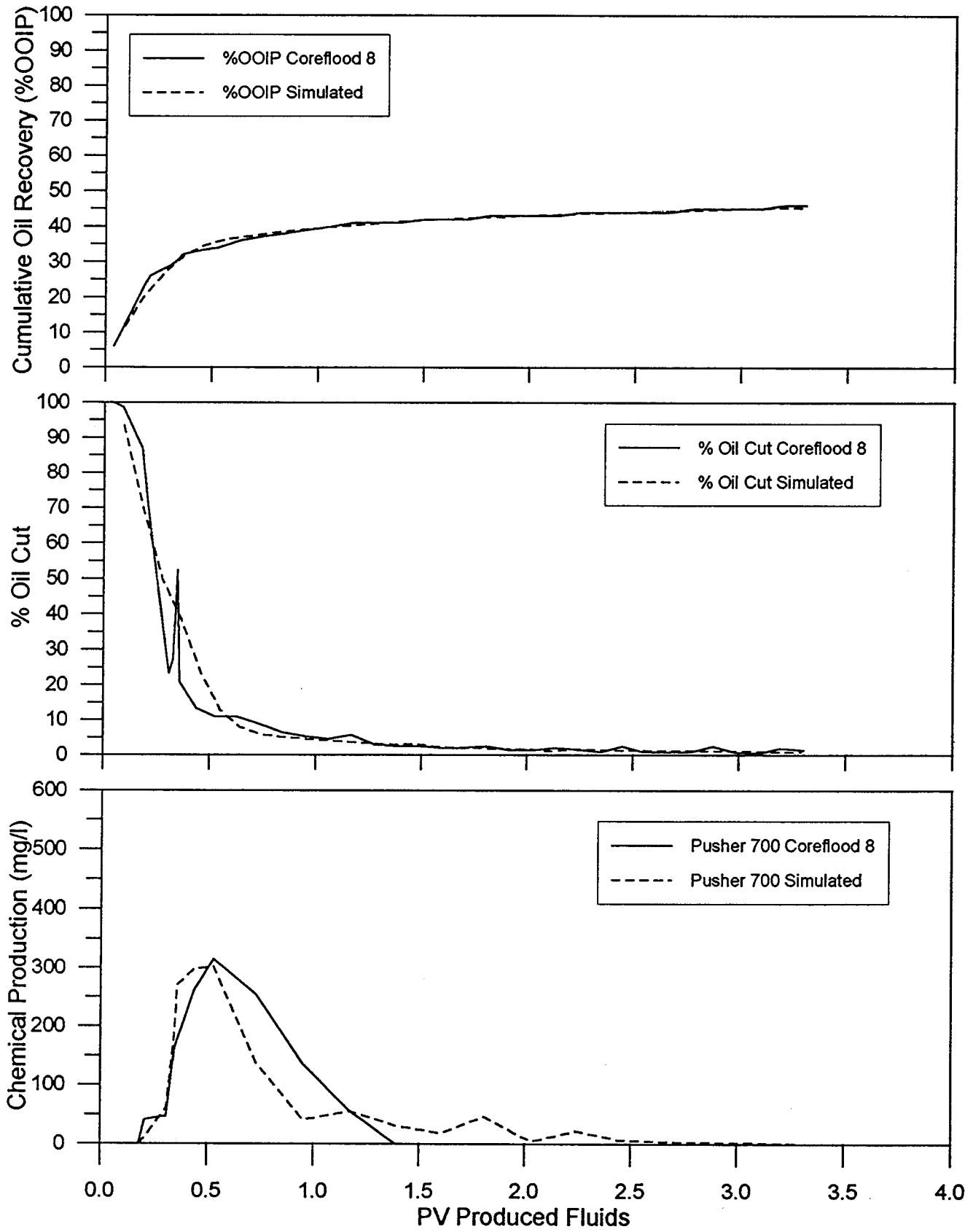


Figure 20

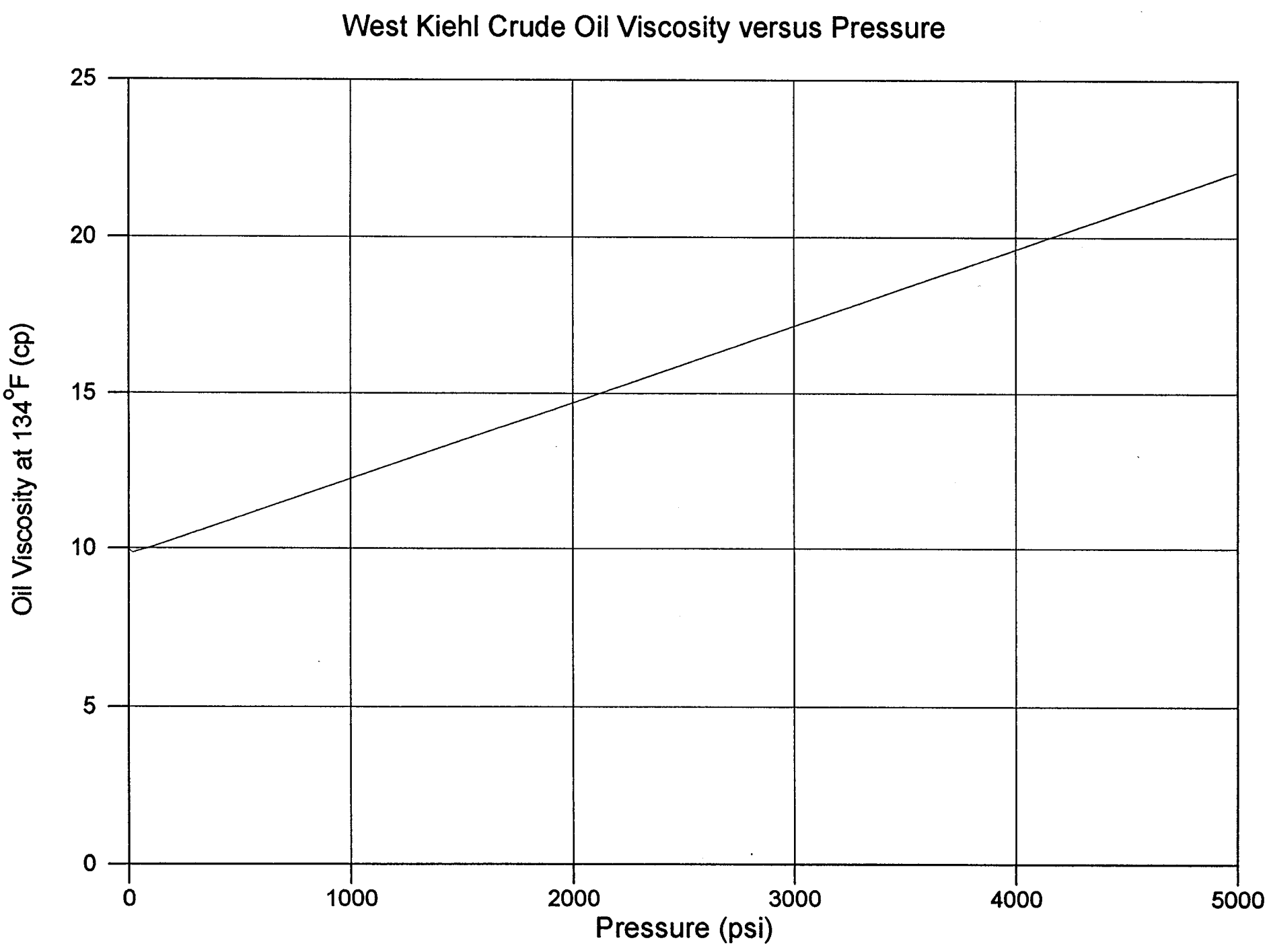

West Kiehl Crude Oil Viscosity versus Pressure
Oil Viscosity at 134°F (cp)
25
20
15
10
5
0
0
1000
2000
3000
4000
5000
Pressure (psi)

Figure 21

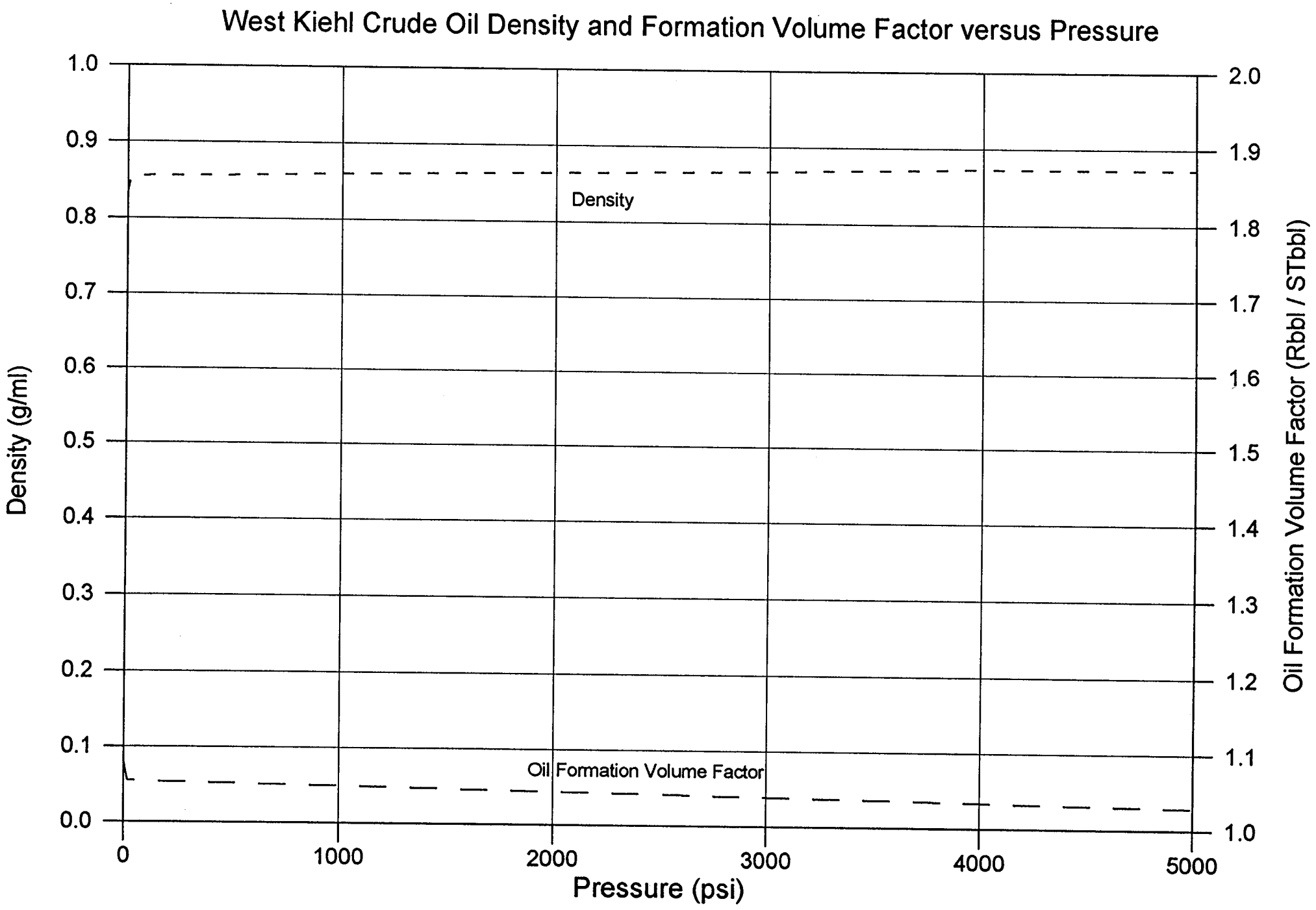

West Kiehl Crude Oil Density and Formation Volume Factor versus Pressure
Density (g/ml)
Oil Formation Volume Factor (Rbbl / STbbl)
Pressure (psi)
Density
Oil Formation Volume Factor
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0
1000
2000
3000
4000
5000

Figure 22

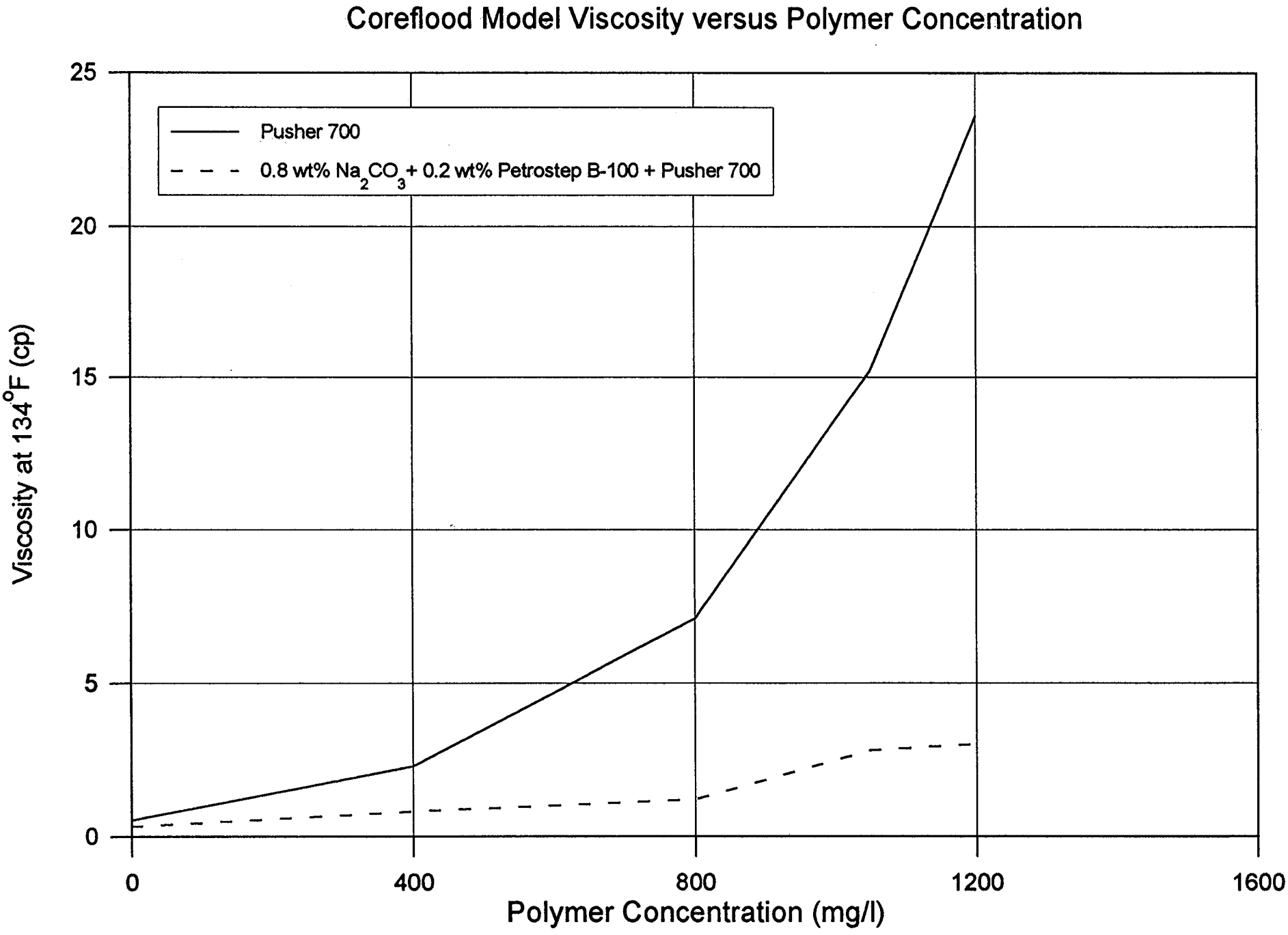

Coreflood Model Viscosity versus Polymer Concentration
Pusher 700
0.8 wt% Na2CO3 + 0.2 wt% Petrostep B-100 + Pusher 700
Viscosity at 134°F (cp)
25
20
15
10
5
0
0
400
800
1200
1600
Polymer Concentration (mg/l)

Figure 23

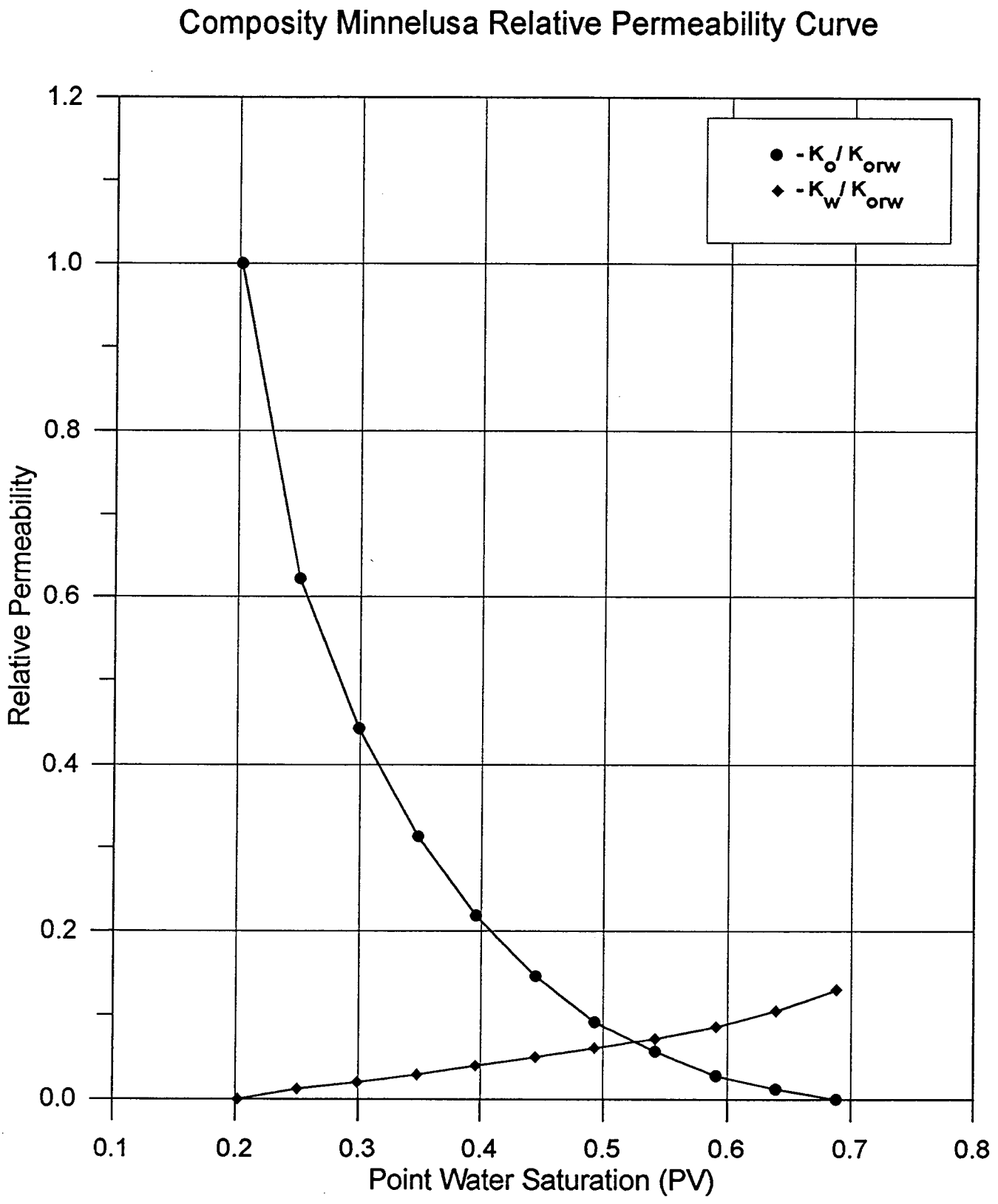
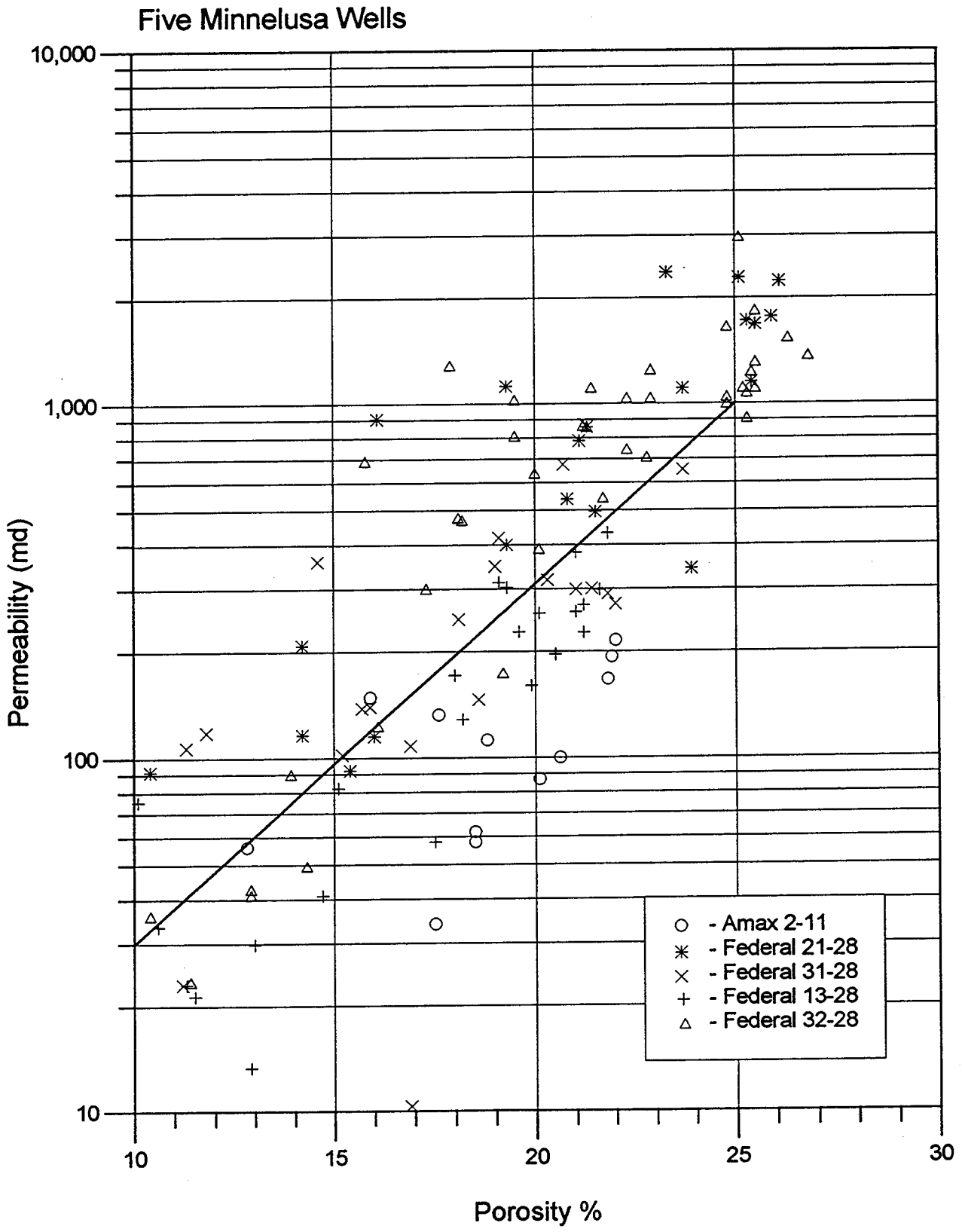
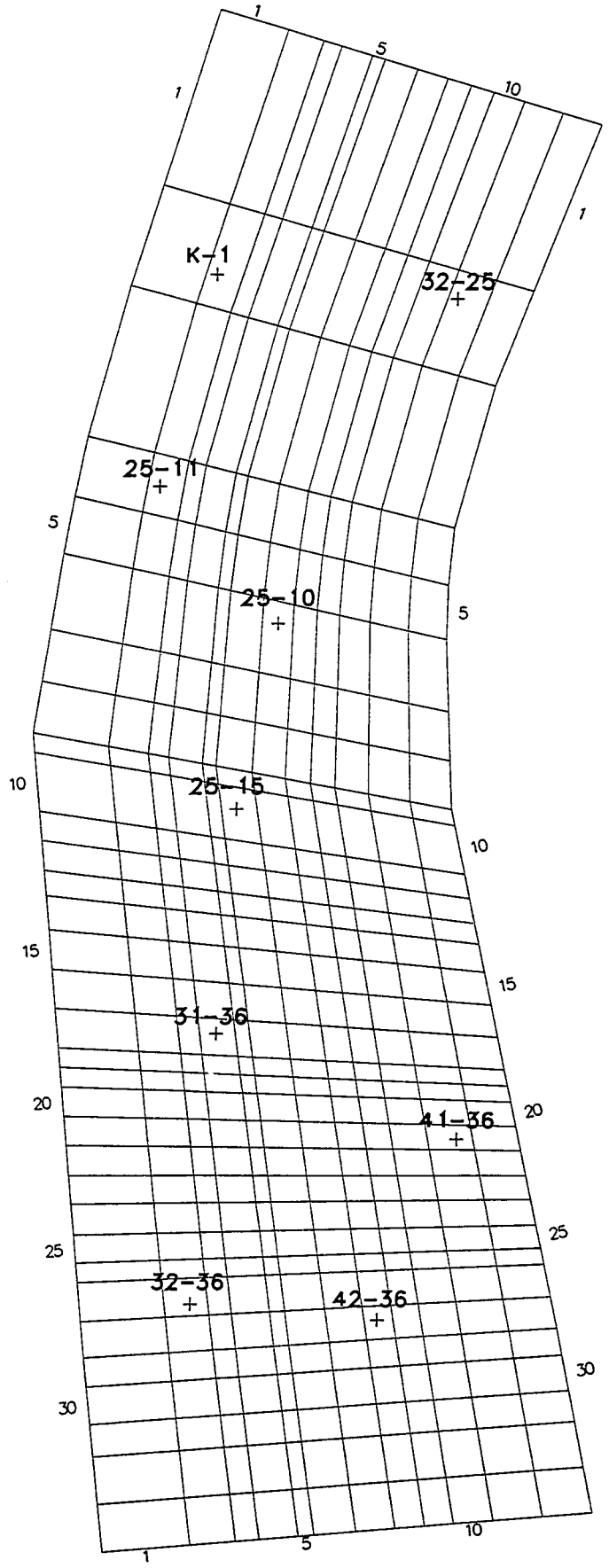

Composity Minnelusa Relative Permeability Curve
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Relative Permeability
- K_o / K_{orw}
- K_w / K_{orw}
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
Point Water Saturation (PV)

Figure 24

Permeability versus Porosity



West Kiehl Numerical Model Grid **Figure 25**



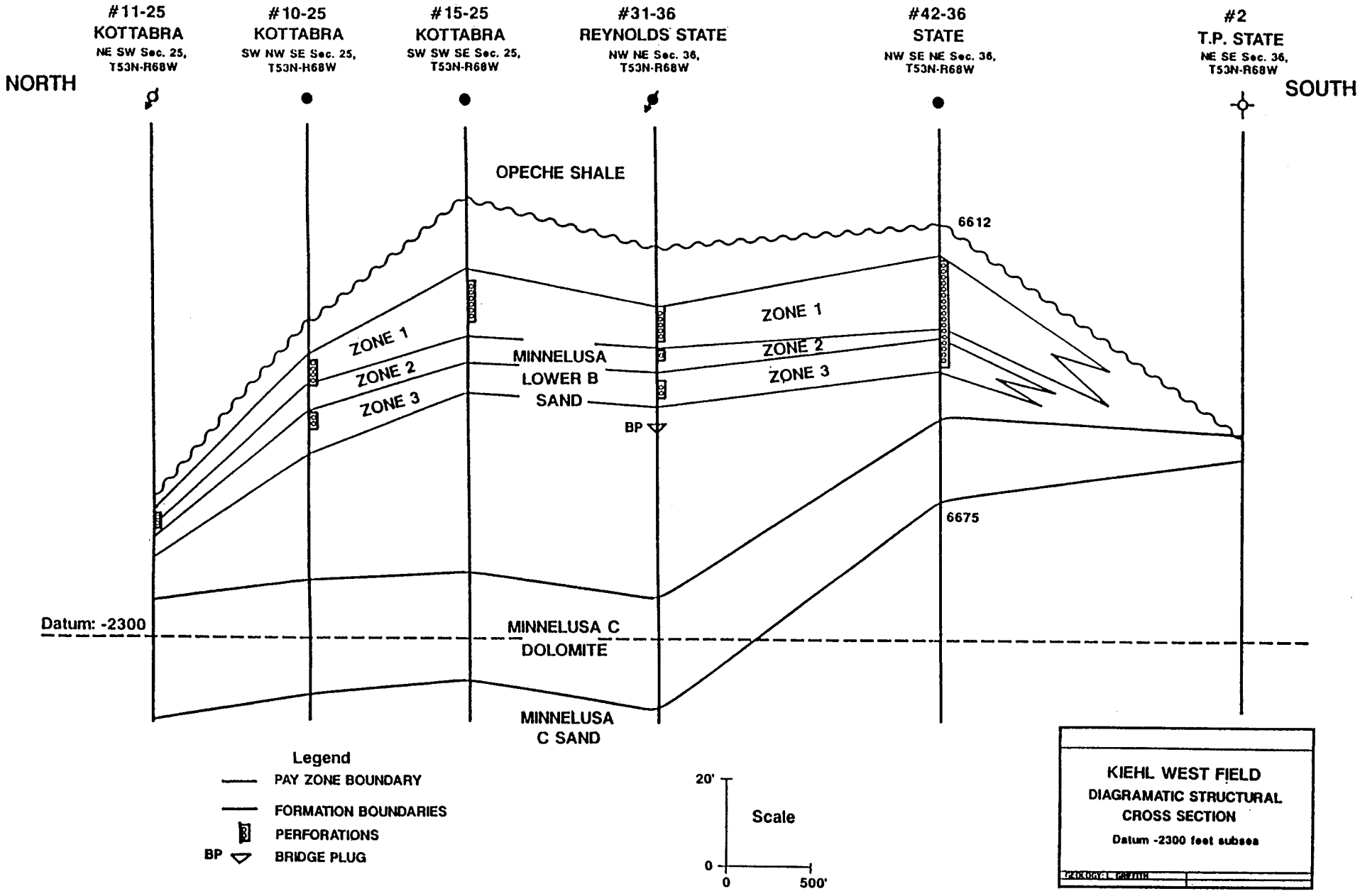
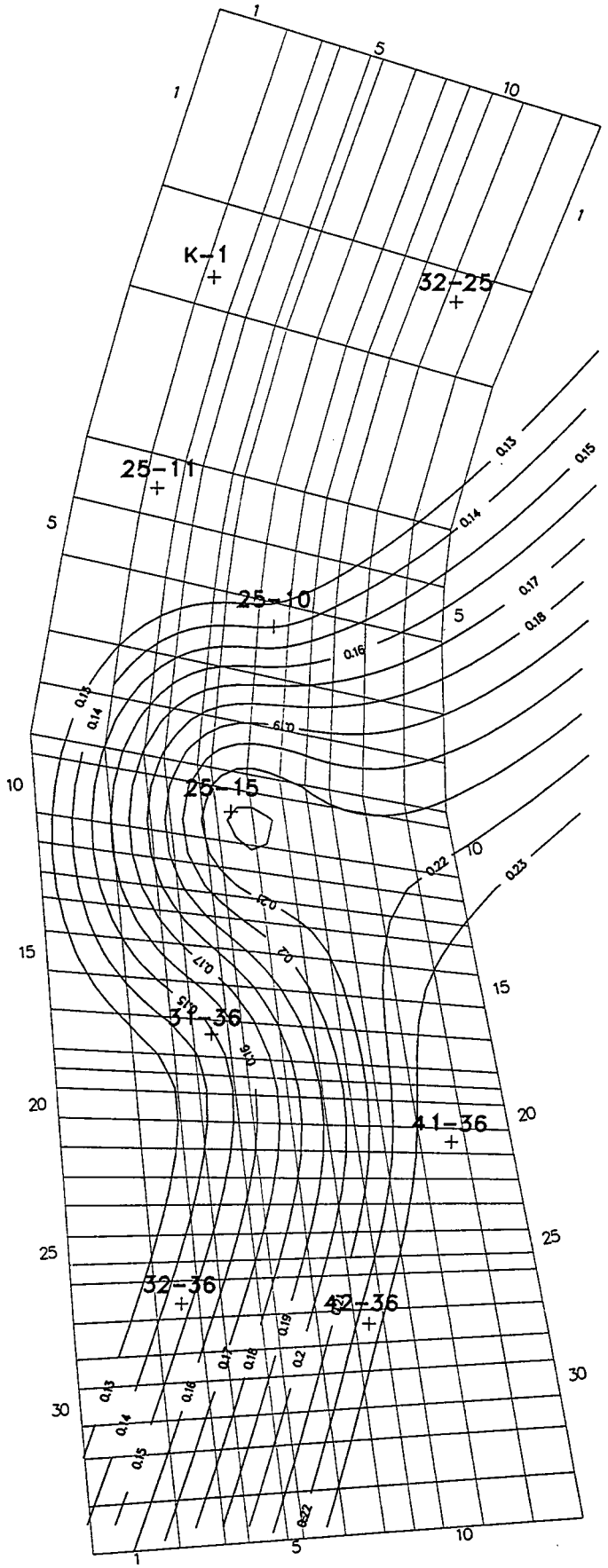

#11-25
KOTTABRA
NE SW Sec. 25,
T53N-R68W
#10-25
KOTTABRA
SW NW SE Sec. 25,
T53N-R68W
#15-25
KOTTABRA
SW SW SE Sec. 25,
T53N-R68W
#31-36
REYNOLDS STATE
NW NE Sec. 36,
T53N-R68W
#42-36
STATE
NW SE NE Sec. 36,
T53N-R68W
#2
T.P. STATE
NE SE Sec. 36,
T53N-R68W
NORTH
SOUTH
OPECHE SHALE
6612
ZONE 1
ZONE 2
ZONE 3
MINNELUSA
LOWER B
SAND
BP
ZONE 1
ZONE 2
ZONE 3
6675
Datum: -2300
MINNELUSA C
DOLOMITE
MINNELUSA
C SAND
Legend
PAY ZONE BOUNDARY
FORMATION BOUNDARIES
PERFORATIONS
BP
BRIDGE PLUG
20'
Scale
0
0
500'
KIEHL WEST FIELD
DIAGRAMATIC STRUCTURAL
CROSS SECTION
Datum -2300 feet subsea

Figure 26

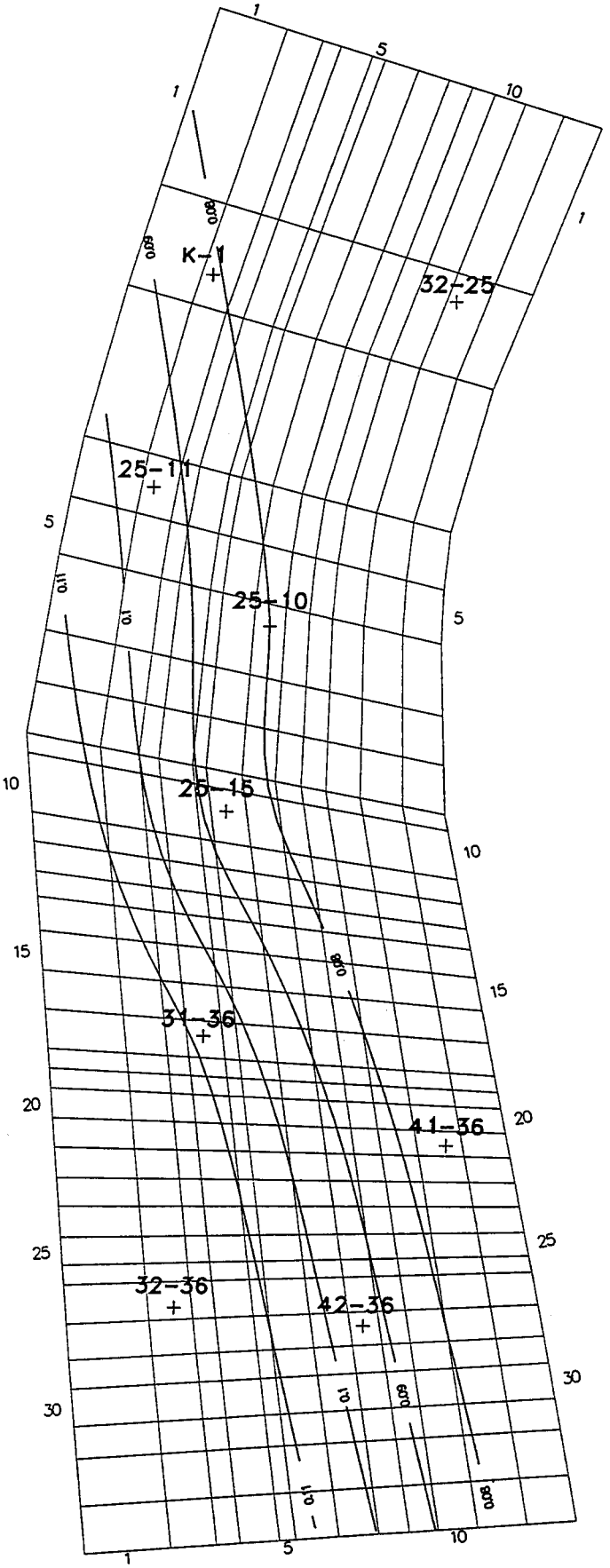
Net Porosity: Layer 1

Figure 27



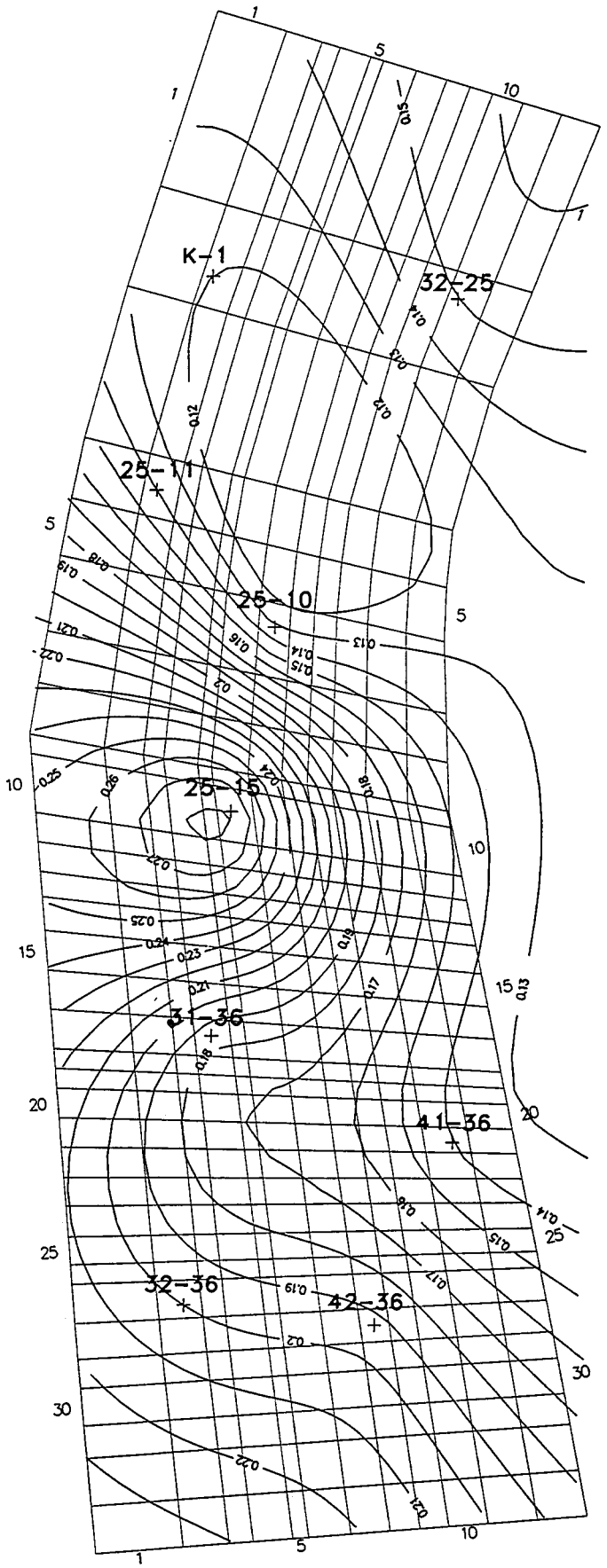
Net Porosity: Layer 2

Figure 28



Net Porosity: Layer 3

Figure 29



Appendix A

Reservoir Data for the 35 Study Fields

Alpha Field

Producing Zone:	Minnelusa C
Location:	Campbell County, Wyoming
	TWP 51 – RGE 69W
	Sections 1, 2 & 11
Drive Mechanism:	Polymer Waterflood
Discovered:	1986
Unitized:	1989

Current Production – 1/1 to 12/31/92	
Oil, bbls	854,237
Water, bbls	538,823

Cumulative Production – thru 12/31/92	
Oil, Mbbls	3,856
Water, Mbbls	1,355
Injection, Mbbls	4,108

Current Rates	
Oil, bopd	2,340
Oil Cut, %	61.3%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	45.0%
Proj. Ultimate Recovery, Mbbls	5,036
Proj. Remaining Reserves, Mbbls	1,179
Estimated Remaining Life, Years (from 1/93)	5.0
OOIP: Pore Volume	0.639
Ultimate Recovery: Pore Volume	0.281
Remaining O.I.P.: Pore Volume	0.358

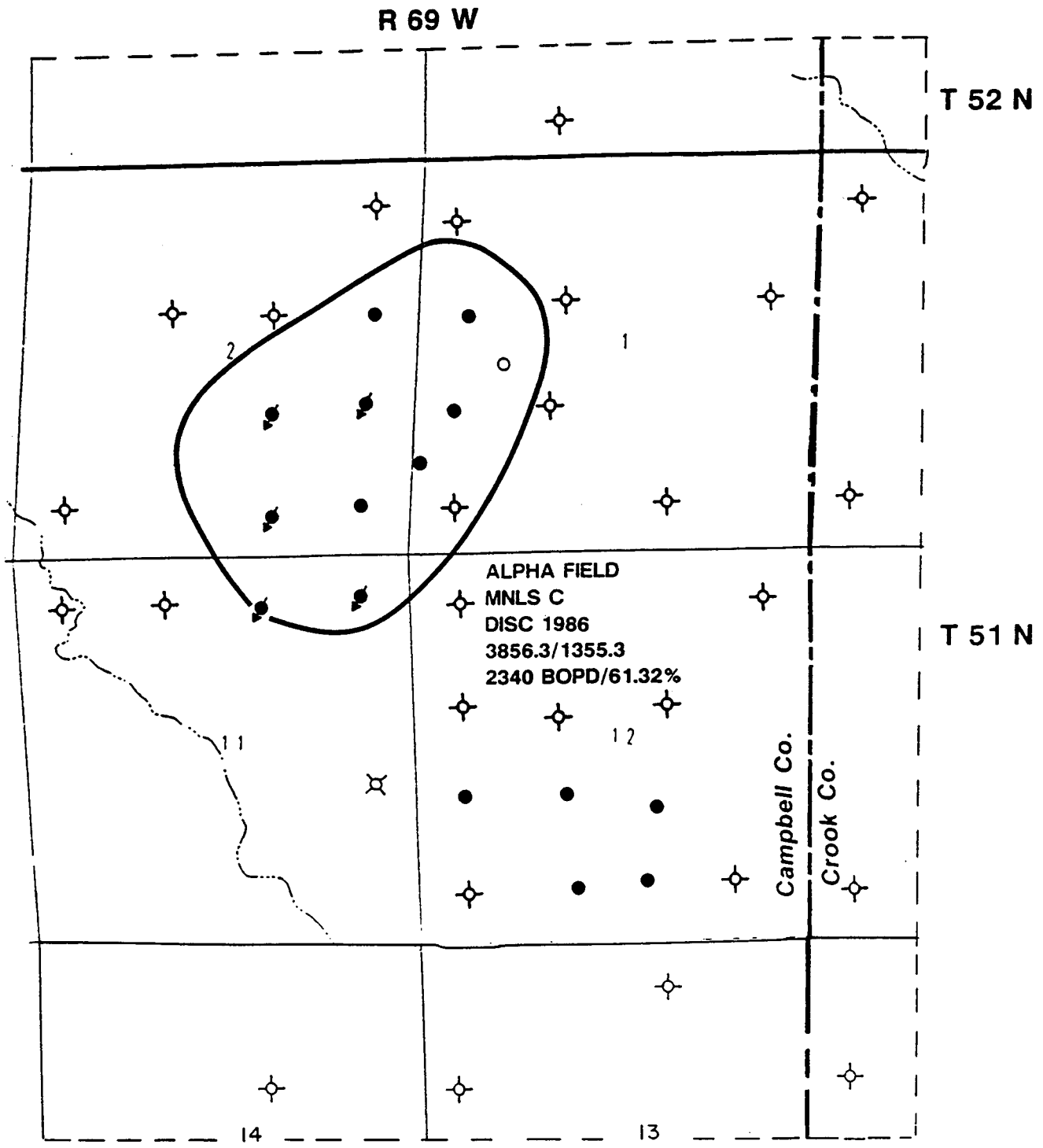
Oil Gravity	25.3
Oil Viscosity, cp	15.3
Water Viscosity, cp	0.5
Depth, feet	7,624
Formation Temperature, degrees F	150
Rw @ Formation Temperature	0.65

Reservoir Properties	
Volume, acre feet	13,922
Area, acres	394
Average Net Pay, feet	35.4
Average Porosity	16.6%
Average S_w	33.0%
FVF Factor	1.050
Pore Volume, Mbbls	17,929
Oil in Place, Mbbls	11,449
Est. Ult. Recovery Factor, %OOIP	44.0%
Current Recovery Factor %OOIP	33.7%
Current Depletion Factor %	76.6%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	100
End of Primary Decline	08/89
Estimated Decline	25.0%
Projected Ult. Recovery, Mbbls	1,894
Primary Recovery Factor %OOIP	16.5%
Cumulative Oil: Pore Volume	0.215
Cumulative Water: Pore Volume	0.076
Cumulative Injection: Pore Volume	0.229
Production – Injection Difference: PV	–0.062

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSW 01–51–69	Lacoy–Fed #13	654,980	92,174	Pump–Oil
SWNW 01–51–69	Malibu–Fed #2	330,719	3,050	Pump–Oil
SWSW 01–51–69	Alpha #1	698,890	38,233	Pump–Oil
NESE 02–51–69	Lacoy–Fed #43	109,407	5,680	Injection
SWSE 02–51–69	John Fee #34	30,646	124,102	Injection
SESE 02–51–69	Lacoy–Fed #44	1,165,134	652,970	Pump–Oil
NWSE 02–52–69	Lacoy–Fed #33	30,843	24,725	Injection
SENE 02–51–69	Amethyst #1	239,266	30,624	Pump–Oil
NWNE 11–51–69	John Fee #31	21,039	19,697	Injection
NENE 11–51–69	John Fee #41	244,001	324,640	Injection

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NESE 02–51–69	Lacoy–Fed #43	303,700	1,278,500	Injection
NWSE 02–52–69	Lacoy–Fed #33	437,100	1,232,000	Injection
SWSE 02–51–69	John Fee #34	218,600	257,000	Injection
NWNE 11–51–69	John Fee #31	377,000	1,107,700	Injection
NENE 11–51–69	John Fee #41	132,200	222,600	Injection



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992
LOCATION	

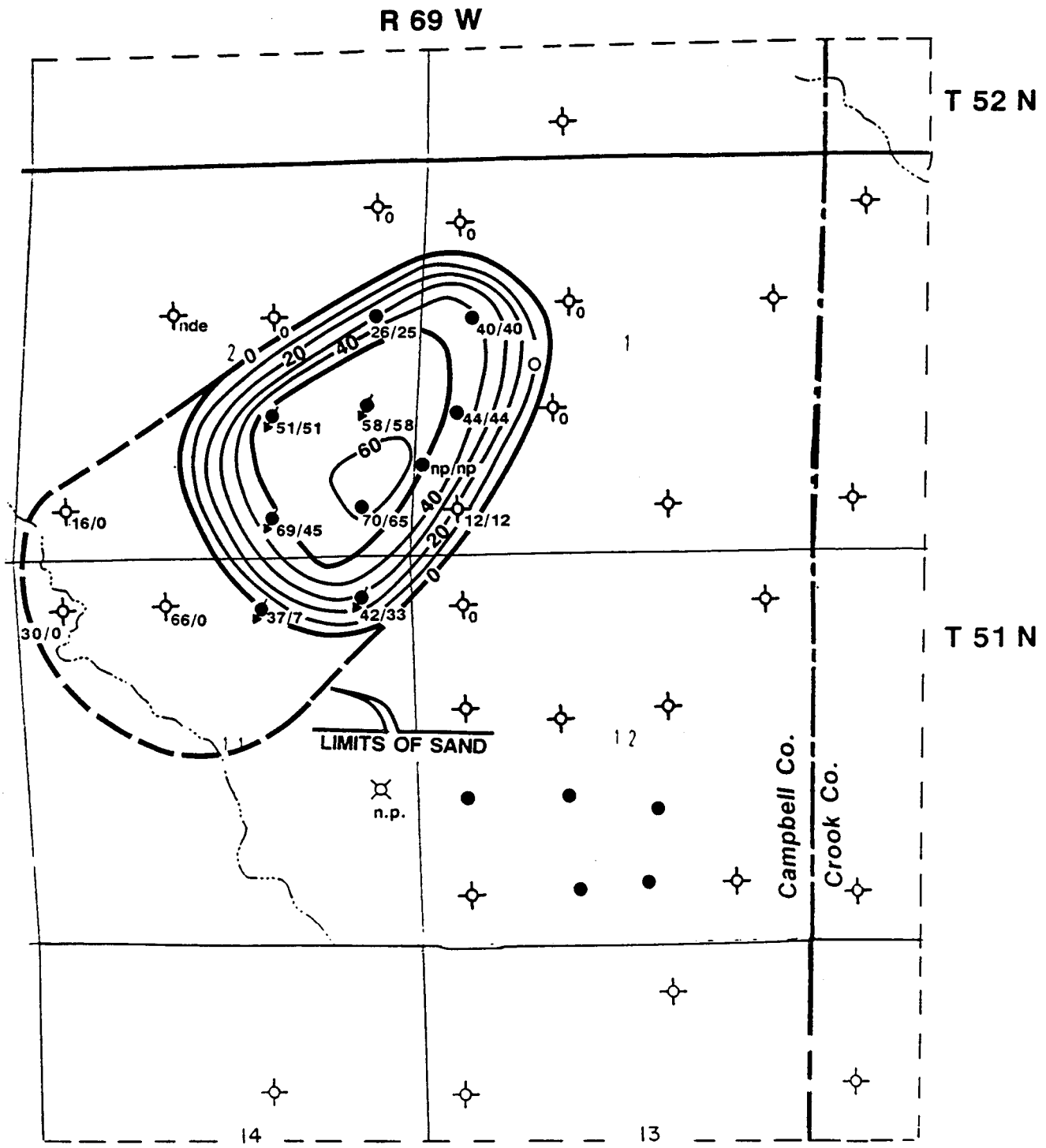
ALPHA AREA

CAMPBELL AND CROOK COUNTIES, WYOMING

ALPHA FIELD-MNLS C
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8-93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		
LOCATION		

ALPHA AREA

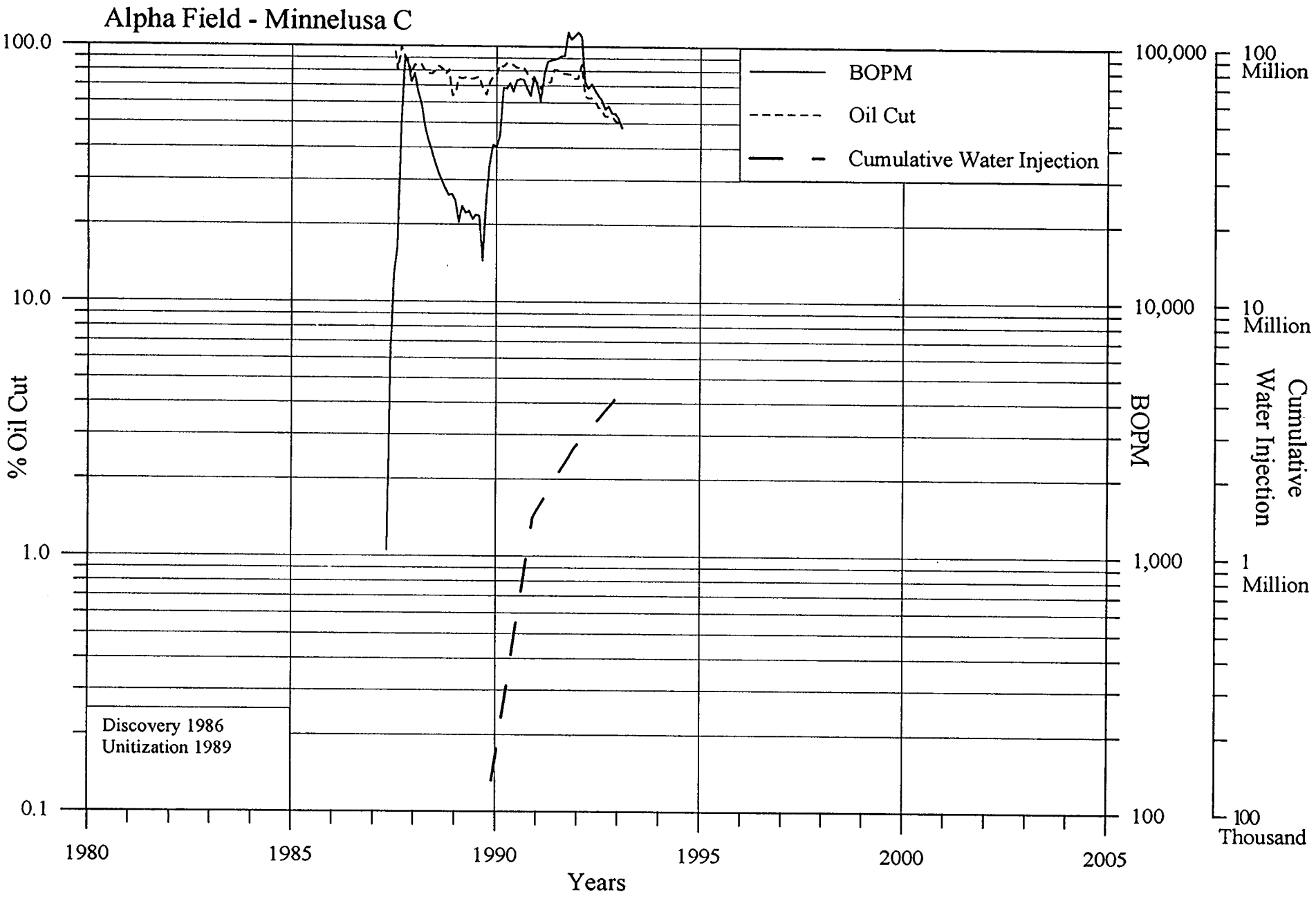
CAMPBELL AND CROOK COUNTIES, WYOMING

ALPHA FIELD-MNLS C
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8-93


Alpha Field - Minnelusa C
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1986
Unitization 1989
1980
1985
1990
1995
2000
2005
Years

American Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 5 & 6
Drive Mechanism:	Polymer Waterflood
Discovered:	1986
Unitized:	1988

Current Production – 1/1 to 12/31/92	
Oil, bbls	28,505
Water, bbls	24,156

Cumulative Production – thru 12/31/92	
Oil, Mbbls	244
Water, Mbbls	84
Injection, Mbbls	340

Current Rates	
Oil, bopd	78
Oil Cut, %	54.1%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	40
Oil Cut	
Estimated Decline	35.0%
Proj. Ultimate Recovery, Mbbls	291
Proj. Remaining Reserves, Mbbls	47
Estimated Remaining Life, Years (from 1/1/93)	2.2
OOIP: Pore Volume	0.695
Ultimate Recovery: Pore Volume	0.070
Remaining O.I.P.: Pore Volume	0.625

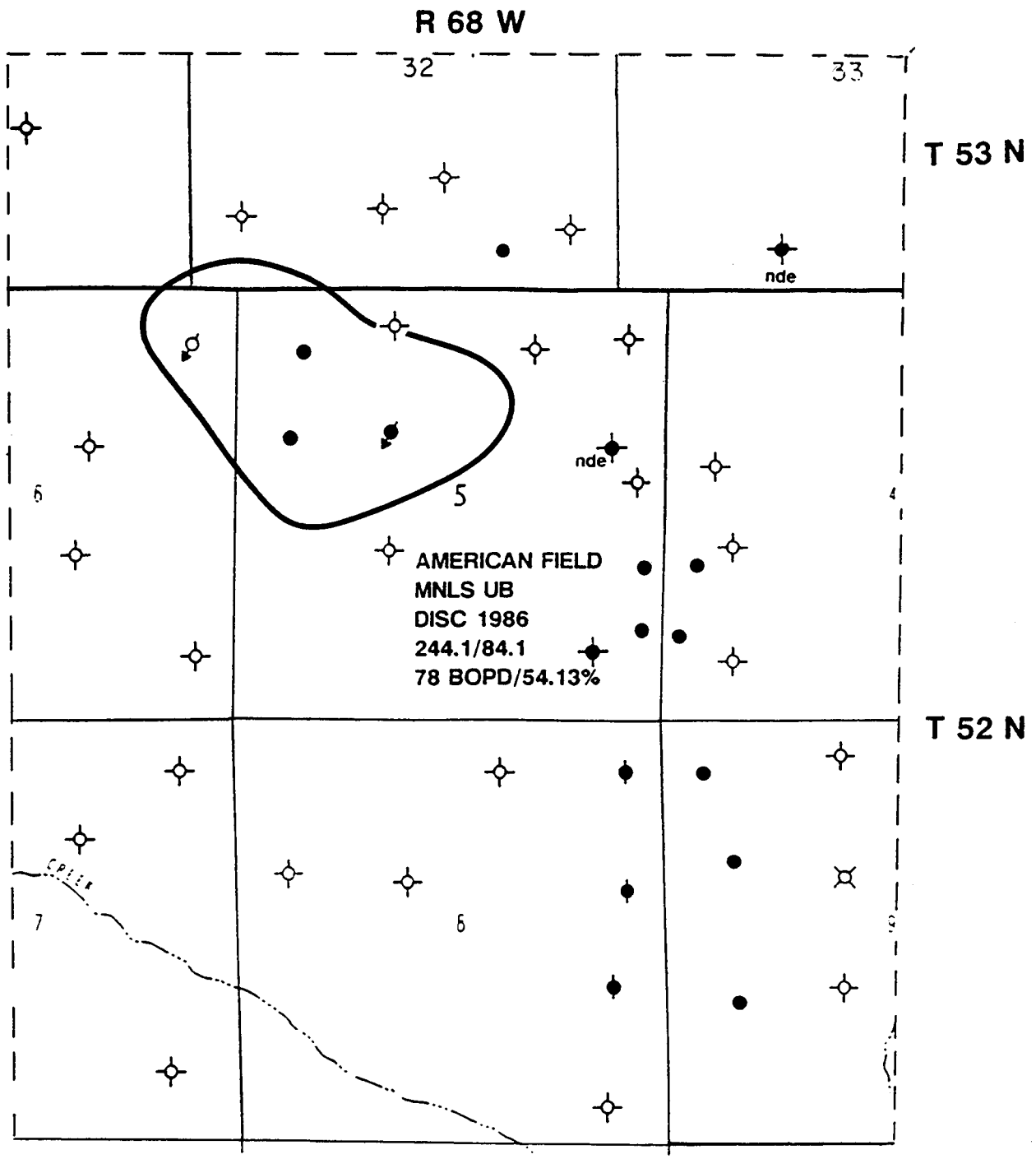
Oil Gravity	20.9
Oil Viscosity, cp	18.0
Water Viscosity, cp	0.5
Depth, feet	7,145
Formation Temperature, degrees F	133
Rw @ Formation Temperature	0.39

Reservoir Properties	
Volume, acre feet	3,024
Area, acres	205
Average Net Pay, feet	14.8
Average Porosity	17.6%
Average S_w	27.0%
FVF Factor	1.050
Pore Volume, Mbbls	4,124
Oil in Place, Mbbls	2,867
Est. Ult. Recovery Factor, %OOIP	10.1%
Current Recovery Factor %OOIP	8.5%
Current Depletion Factor %	84.0%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	02/1988
Estimated Decline	45.0%
Projected Ult. Recovery, Mbbls	73
Primary Recovery Factor %OOIP	2.5%
Cumulative Oil: Pore Volume	0.059
Cumulative Water: Pore Volume	0.020
Cumulative Injection: Pore Volume	0.082
Production – Injection Difference: PV	0.003

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWNW 05–52–68	Federal #1	3,322	20,944	Injection
SENW 05–52–68	Federal #2	169,534	40,212	Pump–Oil
NWNW 05–52–68	Federal #3	61,247	0	Pump–Oil
NENE 06–52–68	Unit #4	8,829	21,086	Injection

Injection Location	Name	1992 Year Curr Inj, bbls	to 1/93 Cum Inj, bbls	Status
SWNW 05–52–68	Federal #1	24,851	38,177	Injection
NENE 06–52–68	Unit #4	38,177	381,918	Injection



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

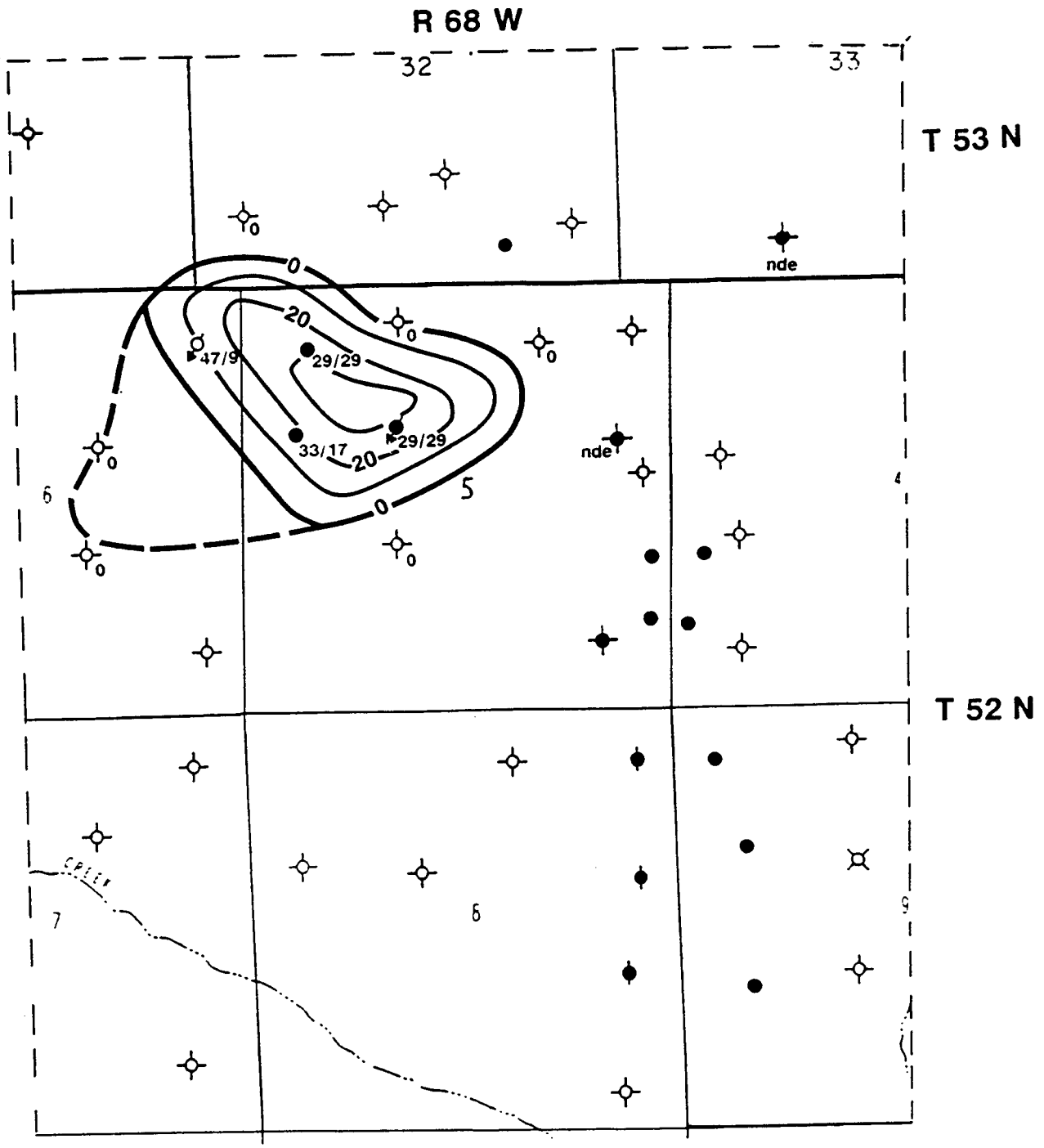
HEATH AREA

CROOK COUNTY, WYOMING

AMERICAN FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8-93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

HEATH AREA

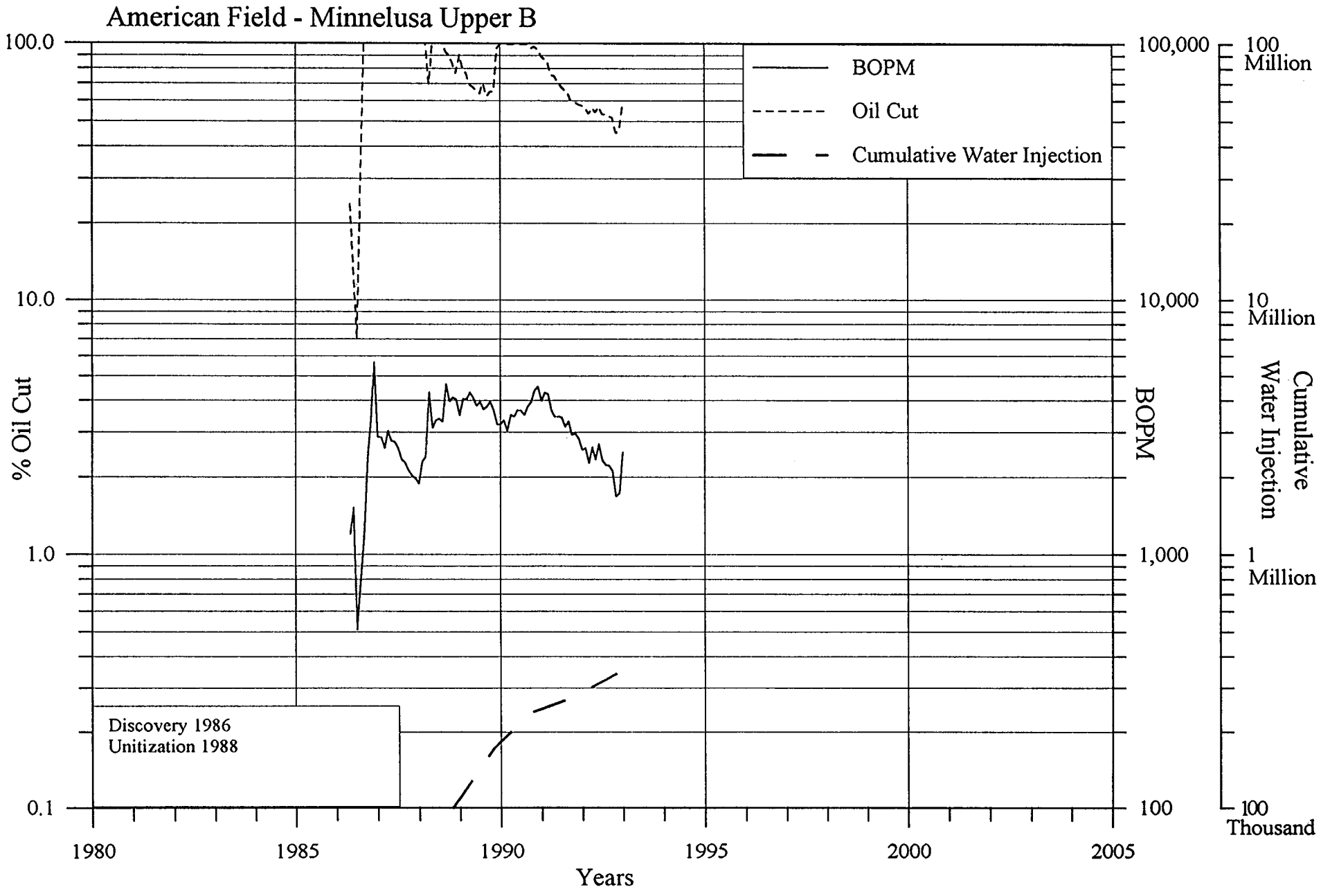
CROOK COUNTY, WYOMING

AMERICAN FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I. = 10'

GEOLOGY: L.GRIFFITH

8-93


American Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1986
Unitization 1988
1980
1985
1990
1995
2000
2005
Years

Ammo Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 16 & 17
Drive Mechanism:	Polymer Waterflood
Discovered:	1985
Unitized:	1988

Current Production – 1/1 to 12/31/92	
Oil, bbls	15,207
Water, bbls	93,019

Cumulative Production – thru 12/31/92	
Oil, Mbbls	173
Water, Mbbls	458
Injection, Mbbls	650

Current Rates	
Oil, bopd	42
Oil Cut, %	14.1%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	25.0%
Proj. Ultimate Recovery, Mbbls	204
Proj. Remaining Reserves, Mbbls	31
Estimated Remaining Life, Years (from 1/93)	3.3
OOIP: Pore Volume	0.751
Ultimate Recovery: Pore Volume	0.132
Remaining O.I.P.: Pore Volume	0.618

Oil Gravity	19.9
Oil Viscosity, cp	41.9
Water Viscosity, cp	n.i.
Depth, feet	7,050 *
Formation Temperature, degrees F	134 *
Rw @ Formation Temperature	0.22 *

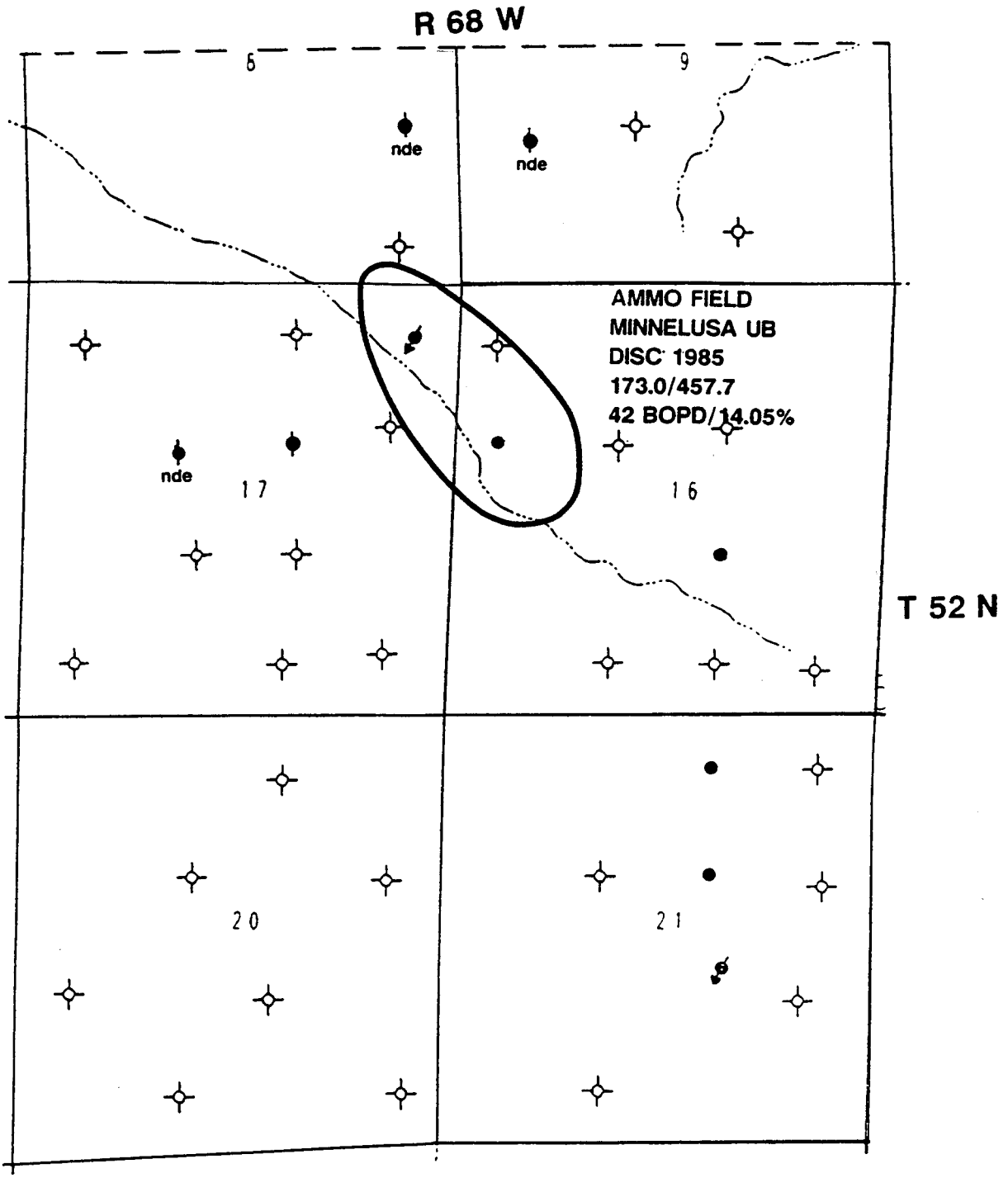
Reservoir Properties	
Volume, acre feet	988 *
Area, acres	76 *
Average Net Pay, feet	13.0 *
Average Porosity	20.1% *
Average S_w	21.7% *
FVF Factor	1.043 *
Pore Volume, Mbbls	1,541
Oil in Place, Mbbls	1,157
Est. Ult. Recovery Factor, %OOIP	17.6%
Current Recovery Factor %OOIP	15.0%
Current Depletion Factor %	84.8%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	
End of Primary Decline	11/88
Estimated Decline	
Projected Ult. Recovery, Mbbls	39
Primary Recovery Factor %OOIP	3.4%
Cumulative Oil: Pore Volume	0.112
Cumulative Water: Pore Volume	0.297
Cumulative Injection: Pore Volume	0.422
Production – Injection Difference: PV	0.013

		------- to 1/93 -------		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWNW 16–52–68	Terra St #12	134,178	355,235	Pump–Oil
NENE 17–52–68	Rule #41	30,525	21,692	Injection

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NENE 17–52–68	Rule #41	168,160	650,343	Injection

*Reservoir and fluid parameters from unit report



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

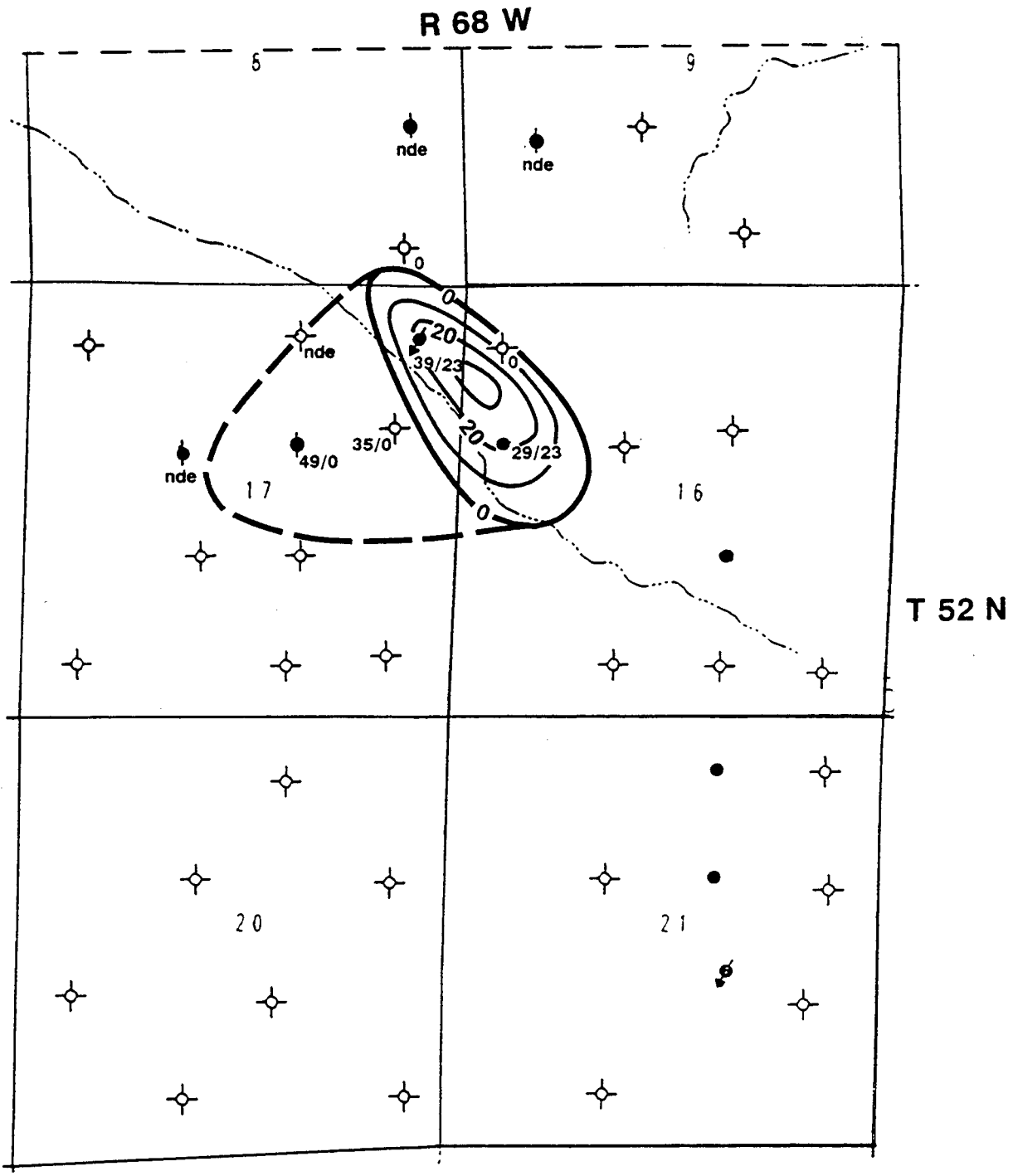
SEMLEK NORTH AREA

CROOK COUNTY, WYOMING

AMMO FIELD
MINNELUSA UB
PRODUCTION

GEOLOGY: L.GRIFFITH

8'93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

SEMLEK NORTH AREA

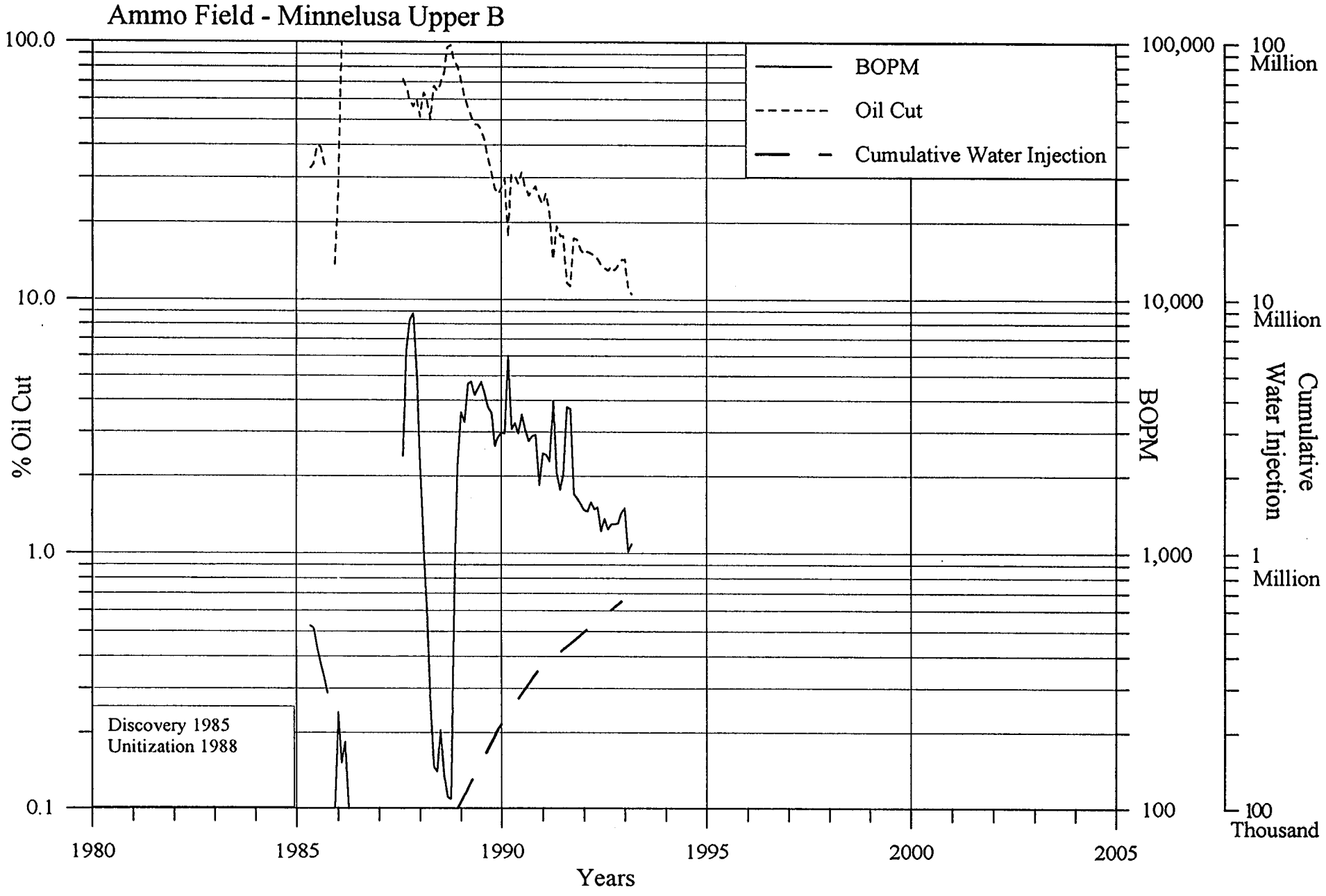
CROOK COUNTY, WYOMING

AMMO FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8'93


Ammo Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1985
Unitization 1988
1980
1985
1990
1995
2000
2005
Years

Art Creek Field

Producing Zone:	Minnelusa A & Upper B
Location:	Crook County, Wyoming
	TWP 51N – RGE 67W
	Section 8
Drive Mechanism:	Waterflood
Discovered:	1981
Unitized:	1985

Oil Gravity	22.3
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	5,311
Formation Temperature, degrees F	104
Rw @ Formation Temperature	0.20

Current Production – 1/1 to 12/31/92	
Oil, bbls	40,069
Water, bbls	80,935

Cumulative Production – thru 12/31/92	
Oil, Mbbls	868
Water, Mbbls	715
Injection, Mbbls	1,725

Current Rates	
Oil, bopd	110
Oil Cut, %	33.1%

Reservoir Properties	A	UB	A & UB
Volume, acre feet	1,868	2,082	3,950
Area, acres	145	126	145
Average Net Pay, feet	12.8	16.5	27.2
Average Porosity	19.0%	19.7%	19.3%
Average S_w	24.1%	38.3%	31.2%
FVF Factor	1.020	1.030	1.025
Pore Volume, Mbbls	2,753	3,179	5,932
Oil in Place, Mbbls	2,049	1,904	3,953

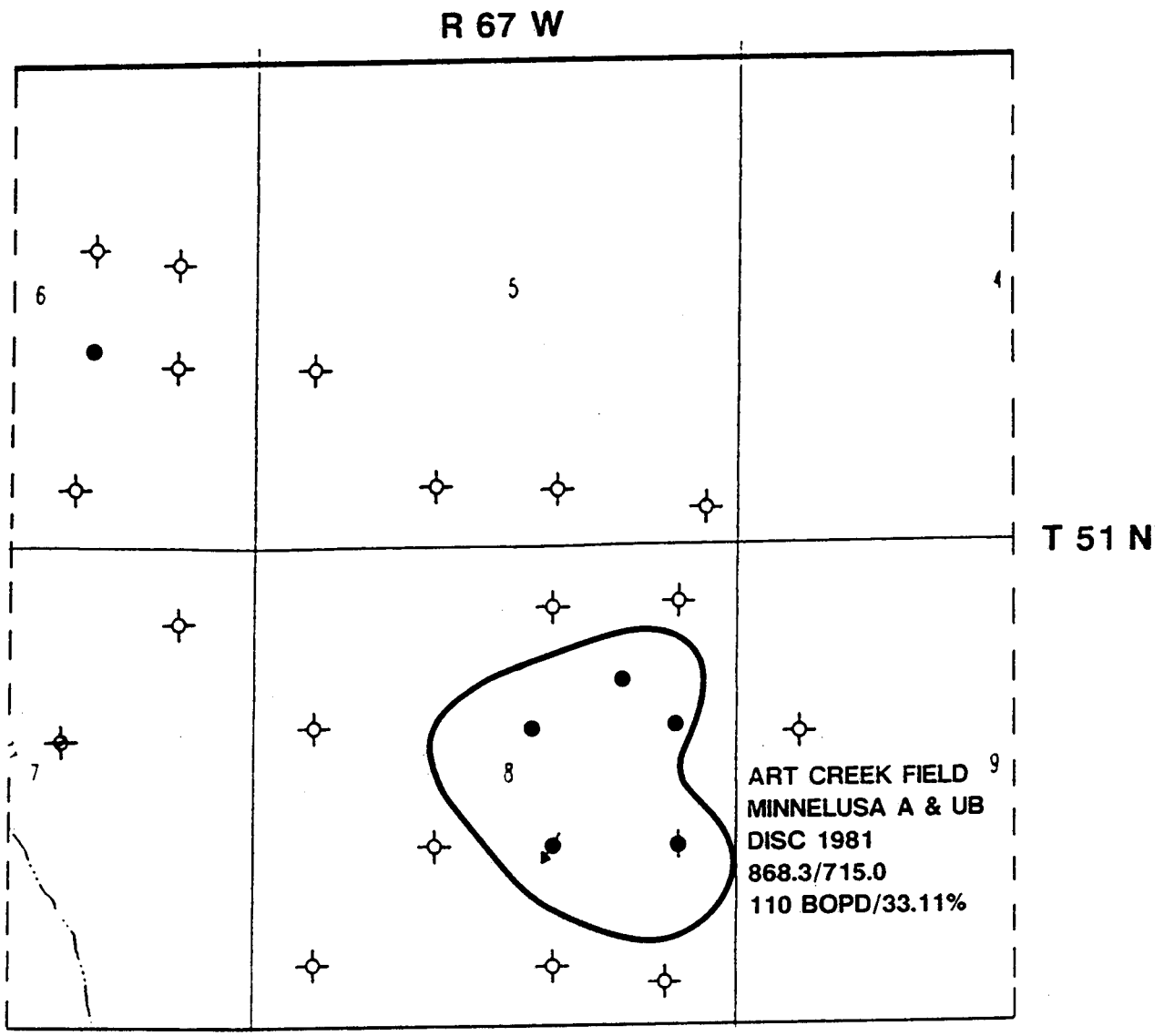
Est. Ult. Recovery Factor, %OOIP	24.2%
Current Recovery Factor %OOIP	22.0%
Current Depletion Factor %	90.8%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	30
Oil Cut	
Estimated Decline	30.0%
Proj. Ultimate Recovery, Mbbls	957
Proj. Remaining Reserves, Mbbls	88
Estimated Remaining Life, Years (from 1/93)	4.1
OOIP: Pore Volume	0.666
Ultimate Recovery: Pore Volume	0.161
Remaining O.I.P.: Pore Volume	0.505

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	06/1984
Estimated Decline	25.0%
Projected Ult. Recovery, Mbbls	401
Primary Recovery Factor %OOIP	10.2%
Cumulative Oil: Pore Volume	0.146
Cumulative Water: Pore Volume	0.121
Cumulative Injection: Pore Volume	0.291
Production – Injection Difference: PV	0.024

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWNE 08–51–67	Federal #1	553,576	304,123	Pump–Oil
SENE 08–51–67	Federal #3	47,826	257,451	Pump–Oil
NWSE 08–51–67	Federal #4	221,136	61,166	Injection
NESE 08–51–67	Federal #6	224	151,171	TA–Oil
SENE 08–51–67	Federal #7	85,738	4,617	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NWSE 08–51–67	Federal #4	262,700	1,725,022	Injection



LEGEND

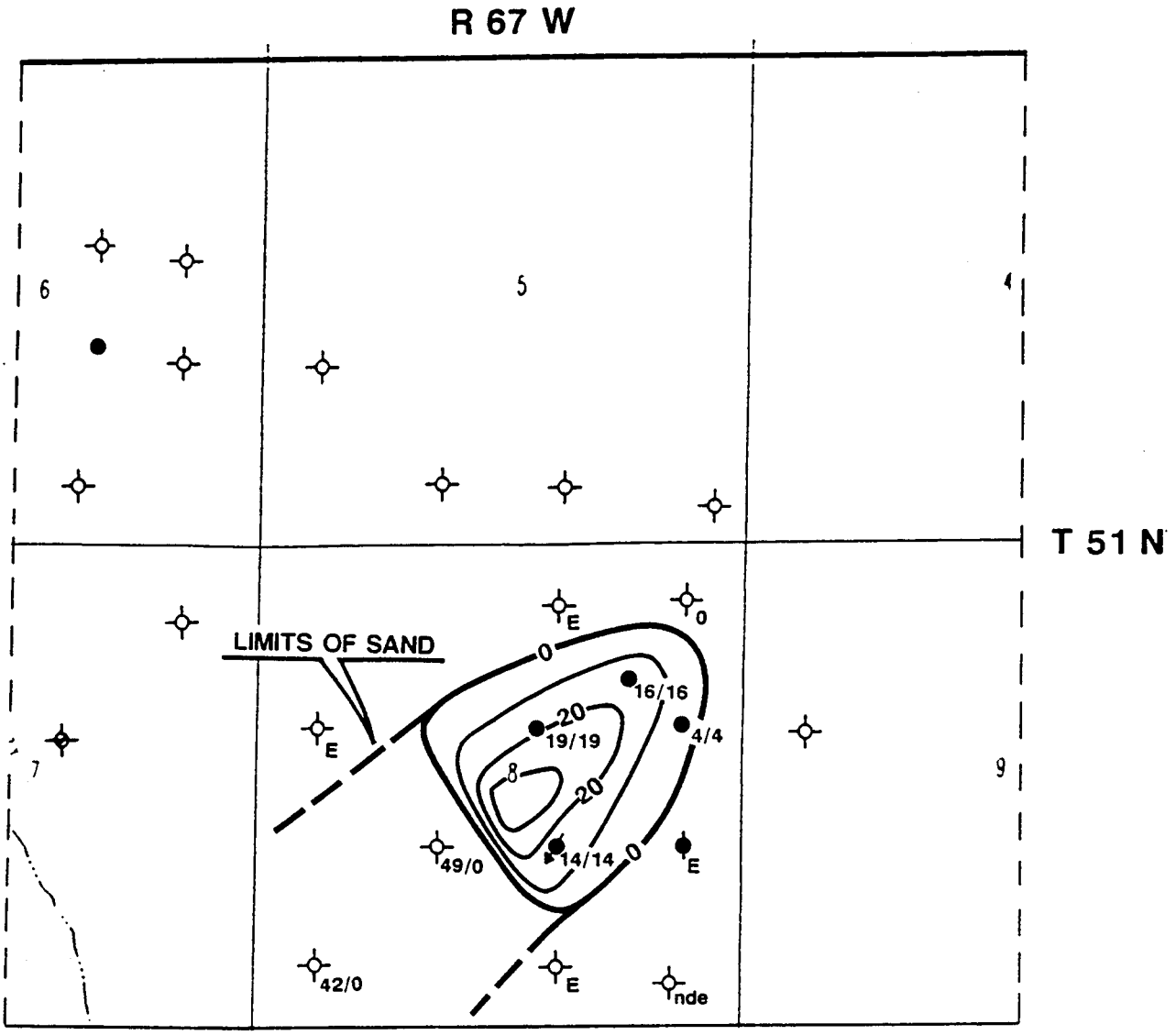
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

ART CREEK AREA

CROOK COUNTY, WYOMING

ART CREEK FIELD
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

⊹	DRY HOLE	70/65	Net Porosity/Net Oil Pay
⊹	PRODUCING OIL WELL	nde	Not Deep Enough
⊹	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
⊹	ABDN. OIL WELL	E	Production Zone Eroded
⊹	WATER INJECTOR	n.i.	No Well Information
⊹	WATER DISPOSAL		

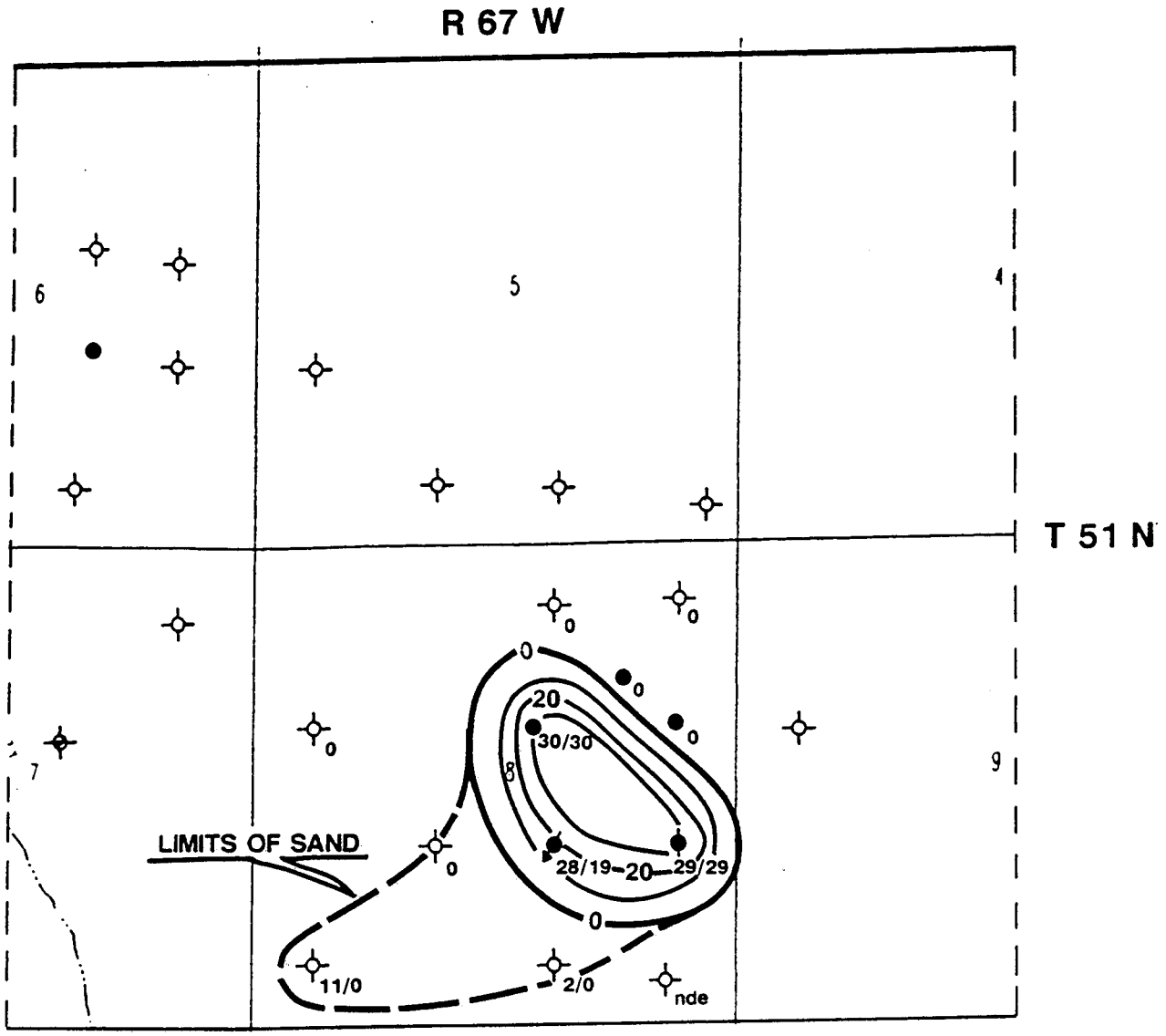
ART CREEK AREA

CROOK COUNTY, WYOMING

ART CREEK FIELD
MINNELUSA A
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

ART CREEK AREA

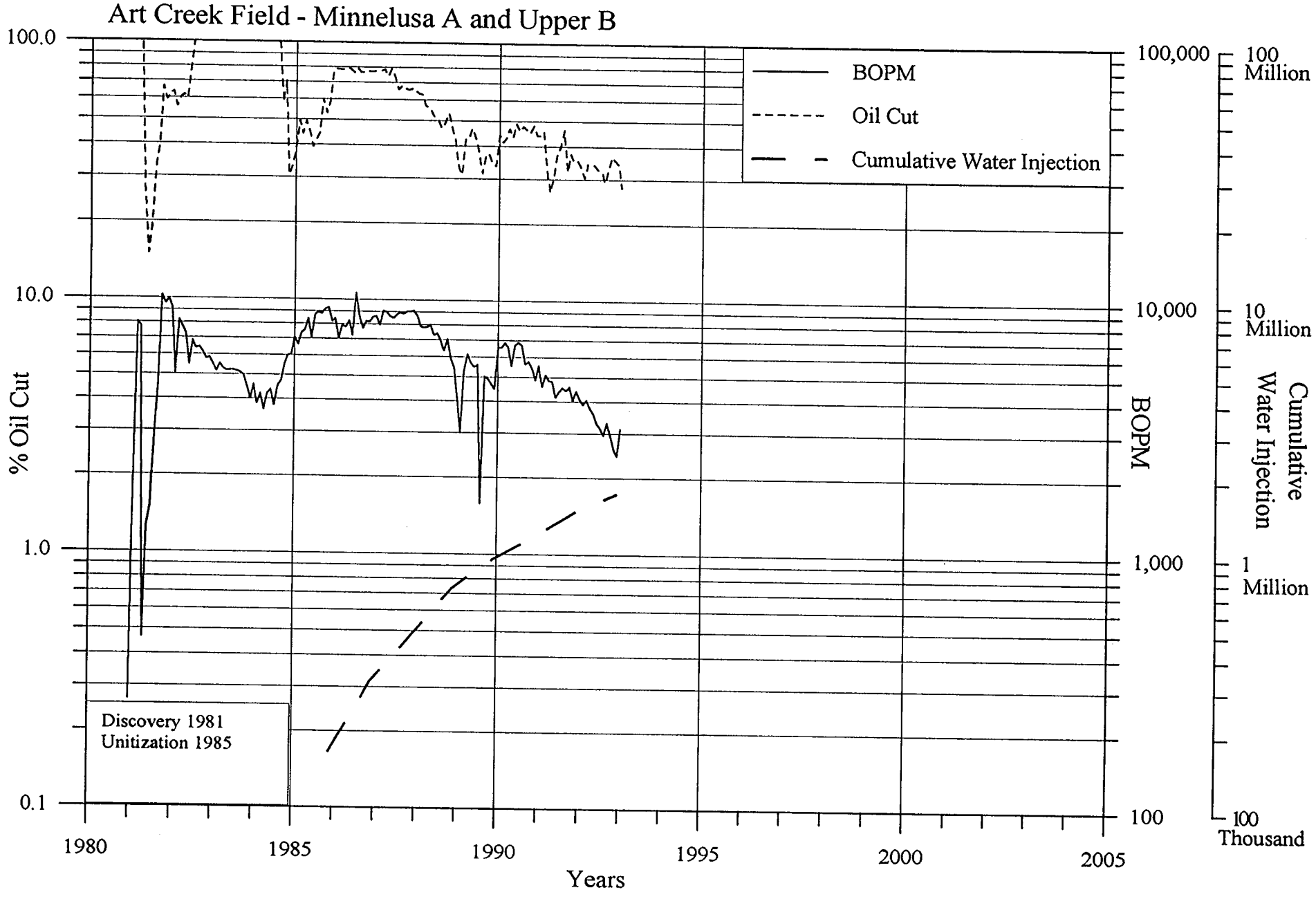
CROOK COUNTY, WYOMING

ART CREEK FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Art Creek Field - Minnelusa A and Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1981
Unitization 1985
1980
1985
1990
1995
2000
2005
Years

Ash Field

Producing Zone:	Minnelusa Upper B
Location:	Campbell County, Wyoming
	TWP 52 – RGE 69W
	Sections 27 & 28
Drive Mechanism:	Waterflood
Discovered:	1987
Unitized:	1992

Current Production – 1/1 to 12/31/92	
Oil, bbls	12,754
Water, bbls	1,171

Cumulative Production – thru 12/31/92	
Oil, Mbbls	272
Water, Mbbls	3
Injection, Mbbls	21

Current Rates	
Oil, bopd	35
Oil Cut, %	91.6%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	n.a.
Oil Cut	n.a.
Estimated Decline	n.a.
Proj. Ultimate Recovery, Mbbls	640 *
Proj. Remaining Reserves, Mbbls	368
Estimated Remaining Life, Years (from 1/93)	5.0
OOIP: Pore Volume	0.833
Ultimate Recovery: Pore Volume	0.236
Remaining O.I.P.: Pore Volume	0.597

Oil Gravity	20.0 *
Oil Viscosity, cp	32.6
Water Viscosity, cp	0.1
Depth, feet	7,775 *
Formation Temperature, degrees F	138 *
Rw @ Formation Temperature	0.05 *

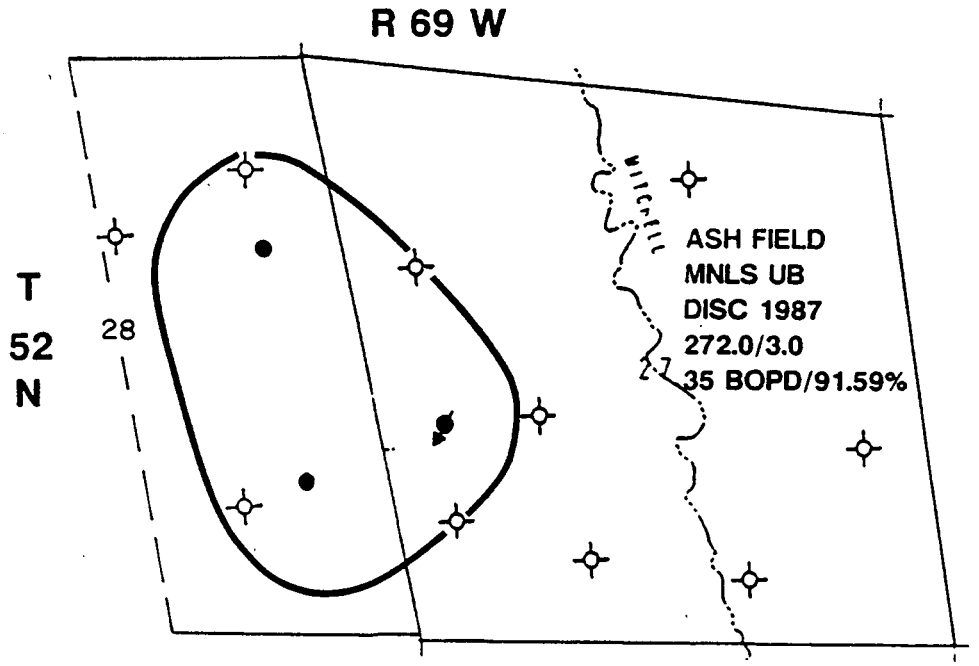
Reservoir Properties	
Volume, acre feet	2,086 *
Area, acres	97 *
Average Net Pay, feet	21.6 *
Average Porosity	16.8% *
Average S_w	15.5% *
FVF Factor	1.014 *
Pore Volume, Mbbls	2,715
Oil in Place, Mbbls	2,263
Est. Ult. Recovery Factor, %OOIP	28.3%
Current Recovery Factor %OOIP	12.0%
Current Depletion Factor %	42.5%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	11/93
Estimated Decline	45.0%
Projected Ult. Recovery, Mbbls	281
Primary Recovery Factor %OOIP	12.4%
Cumulative Oil: Pore Volume	0.100
Cumulative Water: Pore Volume	0.001
Cumulative Injection: Pore Volume	0.008
Production – Injection Difference: PV	–0.093

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSW 27–52–69	Ash–Fed #1	114,503	11	Injection
SENE 28–52–69	Ash–Unit #42–28	638	244	Pump–Oil
NESE 28–52–69	Aspen–Fed #1–28	156,029	2,753	Pump–Oil

Injection Location	Name	1992 Year Curr Inj, bbls	to 1/93 Cum Inj, bbls	Status
NWSW 27–52–69	Ash–Fed #1	21,378	21,378	Injection

*Projected ultimate recovery and reservoir parameters from unit engineering report

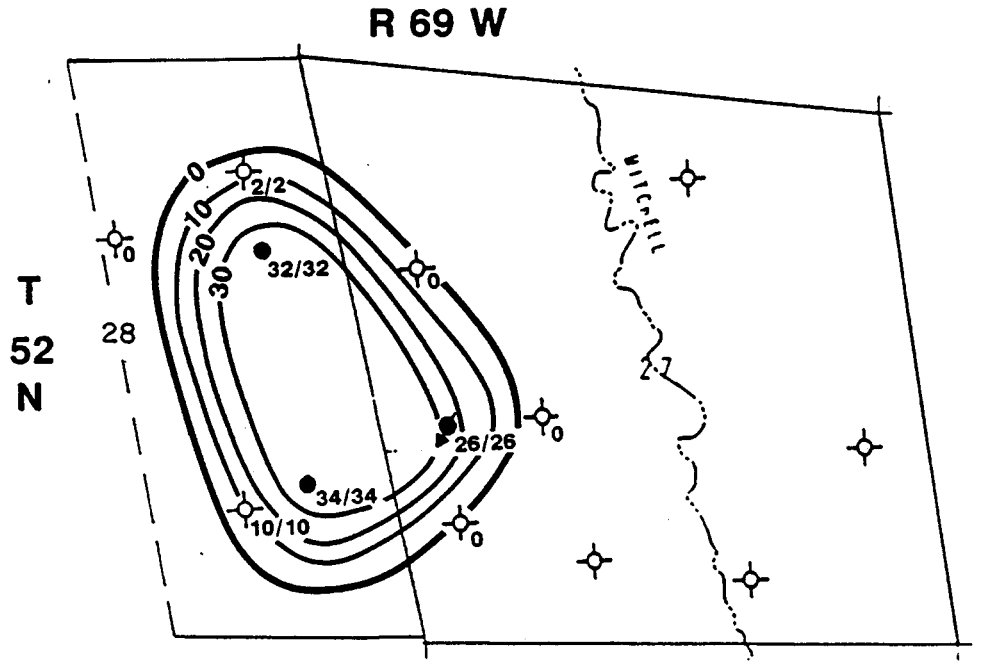


LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

ASH AREA
CAMPBELL COUNTY, WYOMING
ASH FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

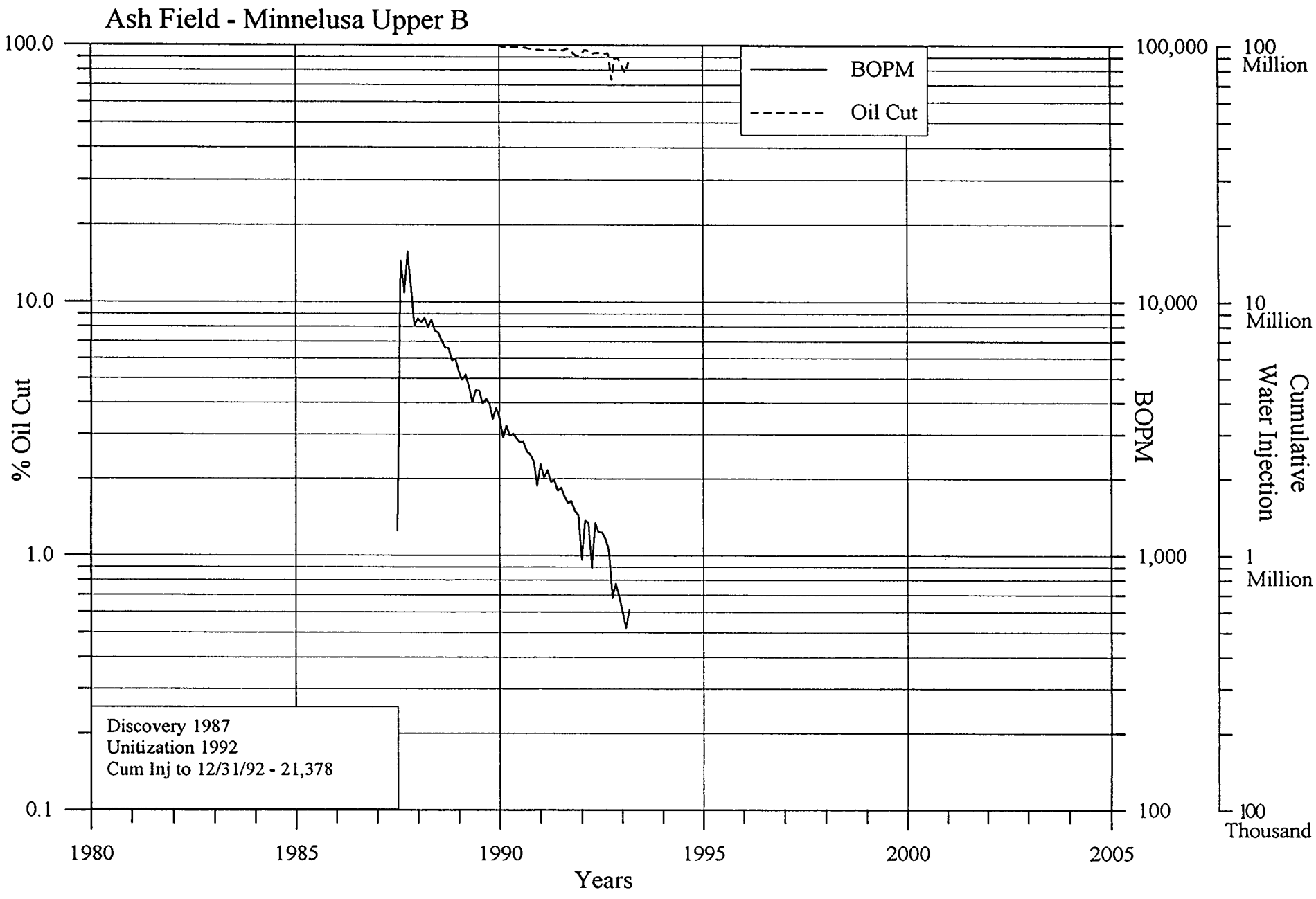
ASH AREA

CAMPBELL COUNTY, WYOMING

ASH FIELD
MINNELUSA UB
ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93


Ash Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1987
Unitization 1992
Cum Inj to 12/31/92 - 21,378
1980
1985
1990
1995
2000
2005
Years

Berger Hill Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 53N – RGE 67W
	Section 6
Drive Mechanism:	Water Drive
Discovered:	1975
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	35,407
Water, bbls	1,019,955

Cumulative Production – thru 12/31/92	
Oil, Mbbls	921
Water, Mbbls	10,600
Injection, Mbbls	n.a.

Current Rates	
Oil, bopd	97
Oil Cut, %	3.4%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	n.a.
Oil Cut	n.a.
Estimated Decline	n.a.
Proj. Ultimate Recovery, Mbbls	969
Proj. Remaining Reserves, Mbbls	48
Estimated Remaining Life, Years (from 1/93)	1.7
OOIP: Pore Volume	0.577
Ultimate Recovery: Pore Volume	0.162
Remaining O.I.P.: Pore Volume	0.415

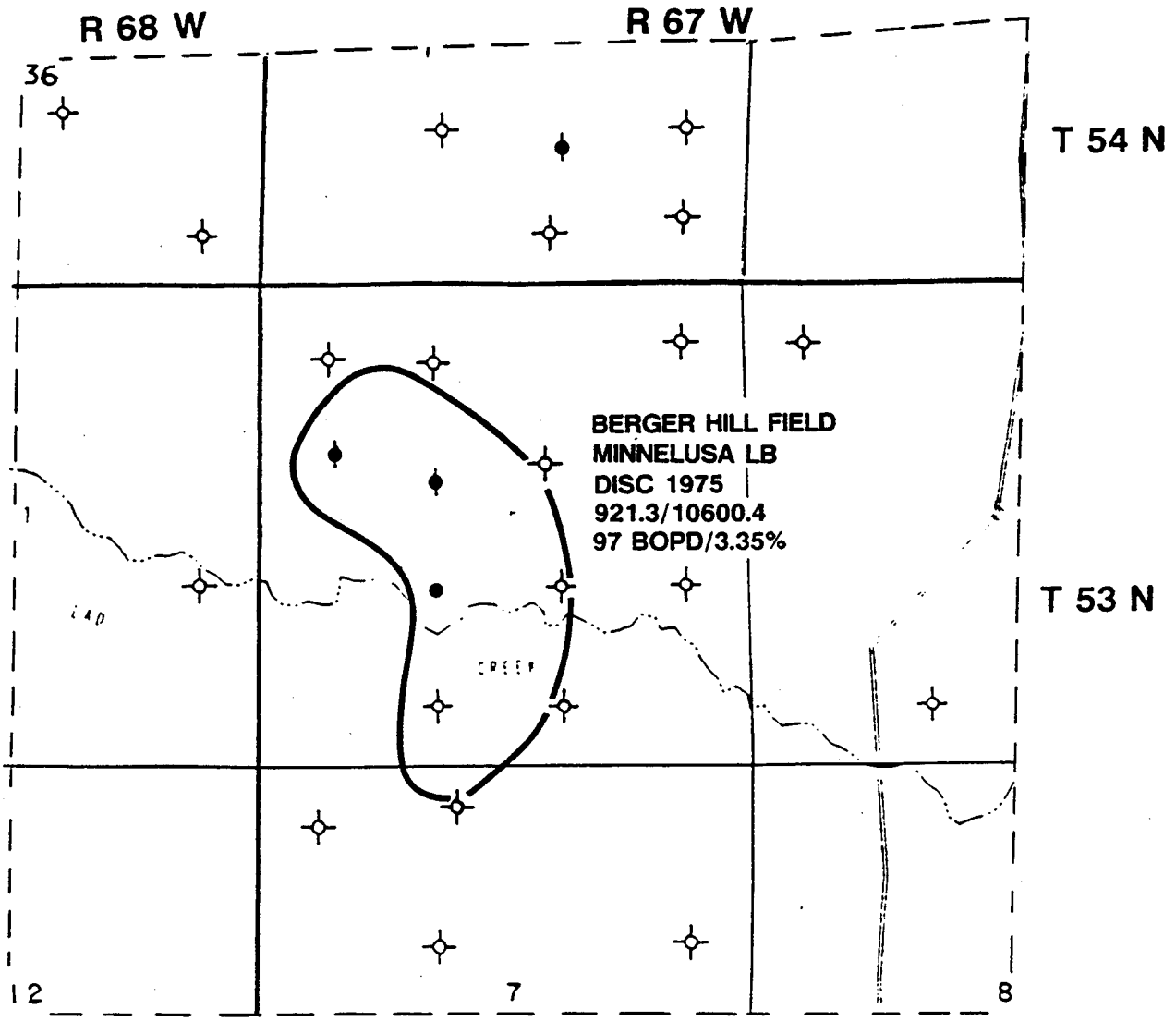
Oil Gravity	19.0
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	6,146
Formation Temperature, degrees F	140
Rw @ Formation Temperature	2.00

Reservoir Properties	
Volume, acre feet	3,079
Area, acres	184
Average Net Pay, feet	16.7
Average Porosity	25.0%
Average S_w	40.0%
FVF Factor	1.040
Pore Volume, Mbbls	5,971
Oil in Place, Mbbls	3,445
Est. Ult. Recovery Factor, %OOIP	28.1%
Current Recovery Factor %OOIP	26.7%
Current Depletion Factor %	95.1%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	60
End of Primary Decline	08/1994
Estimated Decline	25.0%
Projected Ult. Recovery, Mbbls	969
Primary Recovery Factor %OOIP	28.1%
Cumulative Oil: Pore Volume	0.154
Cumulative Water: Pore Volume	1.775
Cumulative Injection: Pore Volume	n.a.
Production – Injection Difference: PV	n.a.

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSE 06–53–67	Blatt #1	816,758	5,852,205	Pump–Oil
SENW 06–53–67	Welch #1–B	85,378	4,373,727	SI–Oil
SWNW 06–53–67	Blatt #2	25,669	398,743	TA–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

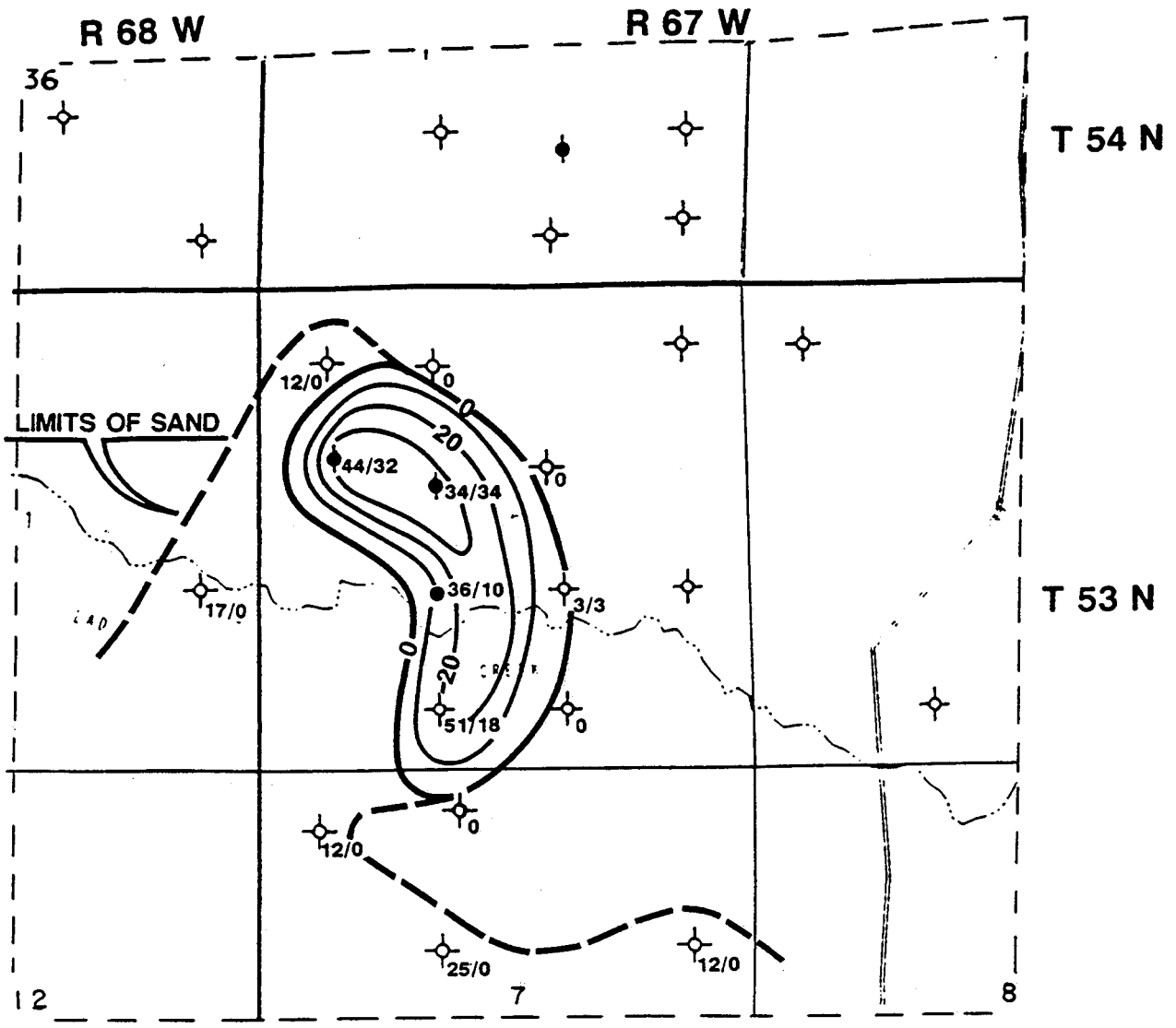
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

BERGER HILL AREA
CROOK COUNTY, WYOMING

BERGER HILL FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

BERGER HILL AREA

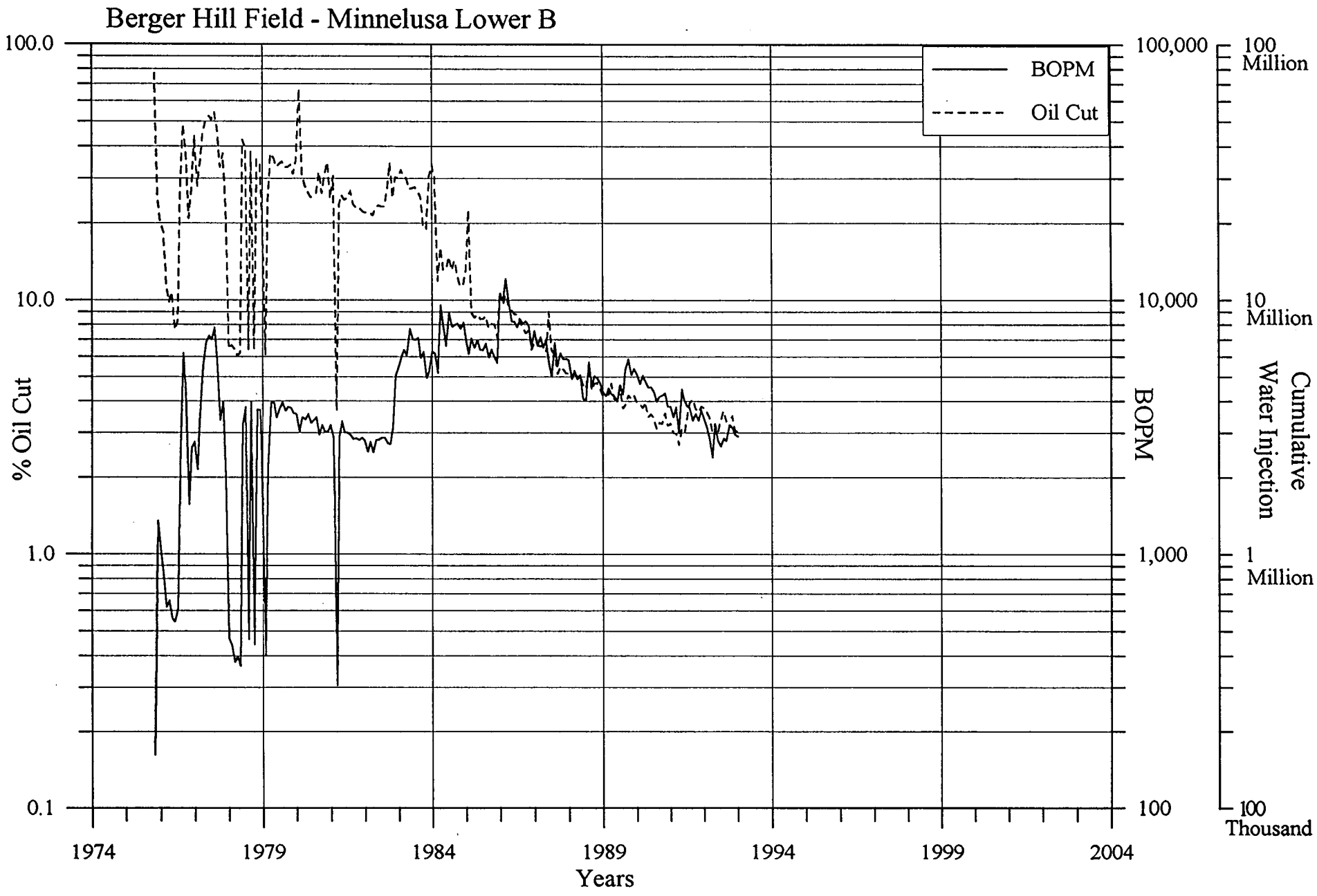
CROOK COUNTY, WYOMING

BERGER HILL FIELD
MINNELUSA LB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Berger Hill Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
1974
1979
1984
1989
1994
1999
2004
Years

Bracken Field

Producing Zone:	Minnelusa Upper B
Location:	Campbell County, Wyoming
	TWP 52N – RGE 69W
	Sections 12 & 13
Drive Mechanism:	Polymer Flood
Discovered:	1983
Unitized:	1986

Current Production – 1/1 to 12/31/92	
Oil, bbls	80,977
Water, bbls	52,108

Cumulative Production – thru 12/31/92	
Oil, Mbbls	471
Water, Mbbls	269
Injection, Mbbls	1,477

Current Rates	
Oil, bopd	222
Oil Cut, %	60.8%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	30
Oil Cut	
Estimated Decline	20.0%
Proj. Ultimate Recovery, Mbbls	798
Proj. Remaining Reserves, Mbbls	326
Estimated Remaining Life, Years (from 1/93)	9.8
OOIP: Pore Volume	0.714
Ultimate Recovery: Pore Volume	0.191
Remaining O.I.P.: Pore Volume	0.524

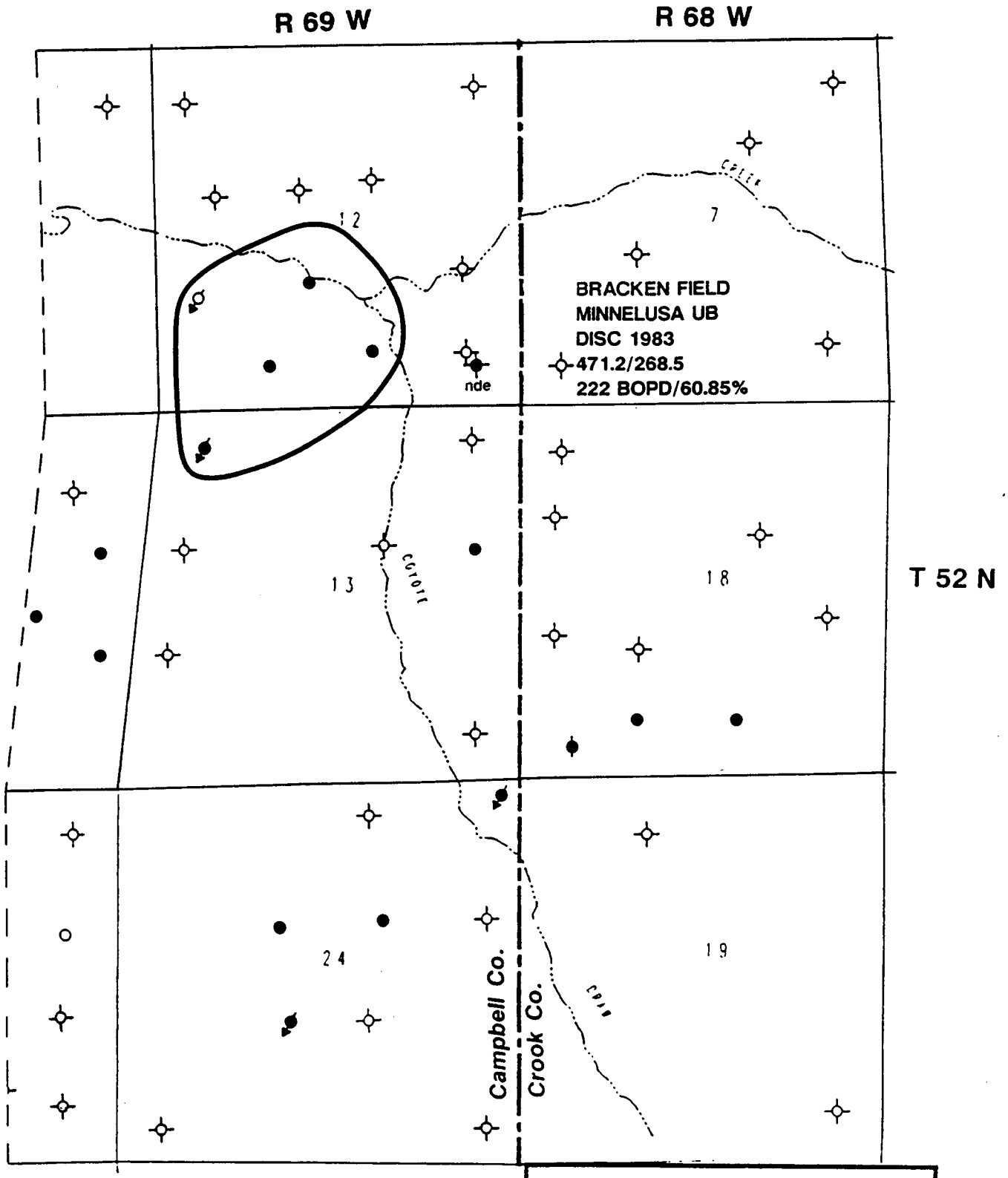
Oil Gravity	21.4
Oil Viscosity, cp	14.0
Water Viscosity, cp	n.i.
Depth, feet	7,220
Formation Temperature, degrees F	132
Rw @ Formation Temperature	0.13

Reservoir Properties	
Volume, acre feet	3,092
Area, acres	200
Average Net Pay, feet	15.5
Average Porosity	17.4%
Average S_w	25.0%
FVF Factor	1.050
Pore Volume, Mbbls	4,181
Oil in Place, Mbbls	2,986
Est. Ult. Recovery Factor, %OOIP	26.7%
Current Recovery Factor %OOIP	15.8%
Current Depletion Factor %	59.1%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	02/1986
Estimated Decline	20.0%
Projected Ult. Recovery, Mbbls	148
Primary Recovery Factor %OOIP	4.9%
Cumulative Oil: Pore Volume	0.113
Cumulative Water: Pore Volume	0.064
Cumulative Injection: Pore Volume	0.353
Production – Injection Difference: PV	0.176

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NESW 12–52–69	Eason #A–1	252,834	109,944	Pump–Oil
SWSE 12–52–69	Rule #A–1	98,761	3,089	Pump–Oil
SWSW 12–52–69	BMU #3	110,268	110,604	Pump–Oil
NWNW 12–52–69	IW #2	6,402	46,814	Injection

Injection Location	Name	1992 Year Curr Inj, bbls	to 1/93 Cum Inj, bbls	Status
NWSW 12–52–69	IW #1	224,202	609,520	Injection
NWNW 13–52–69	IW #2	198,453	867,110	Injection



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL
- LOCATION

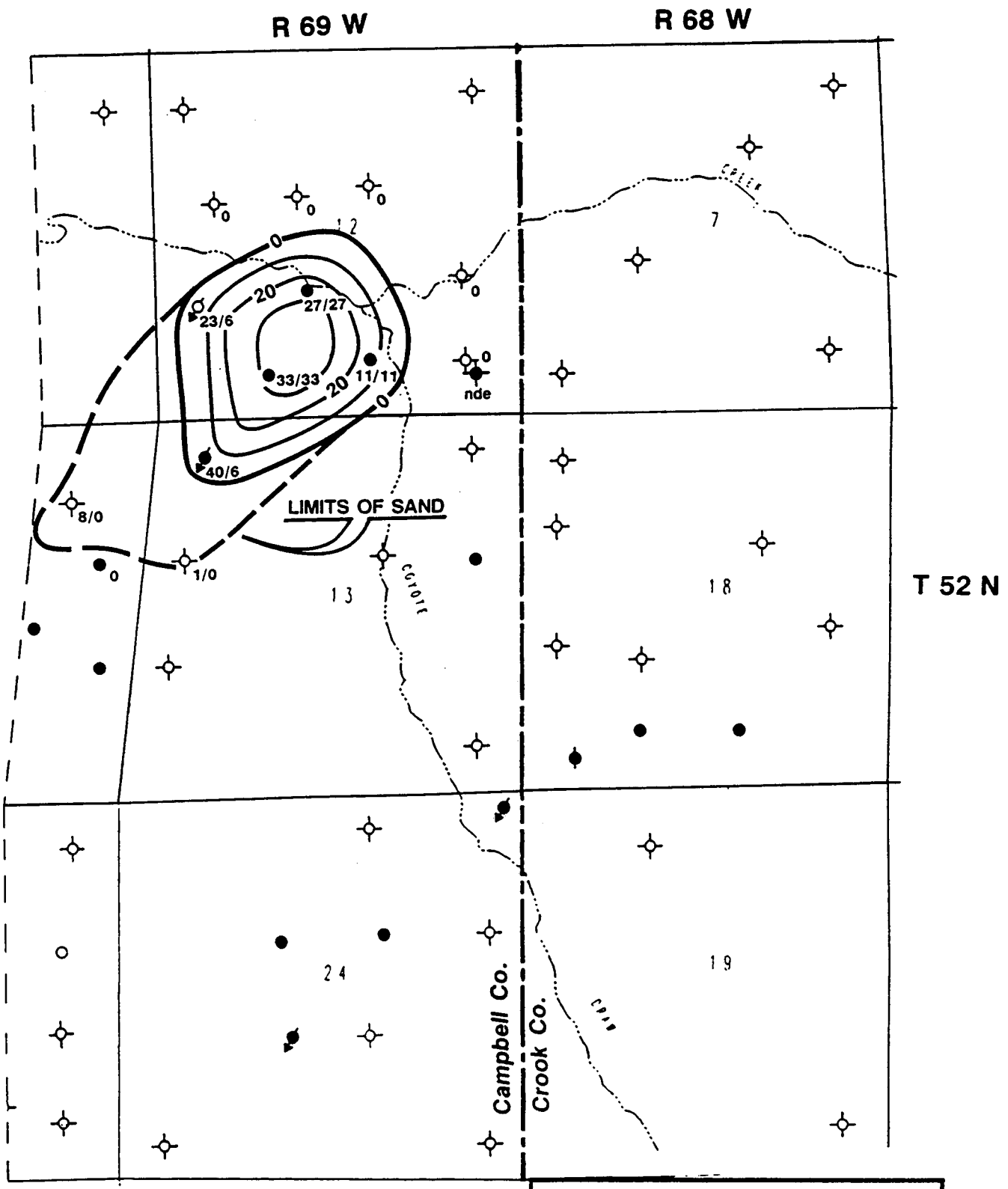
FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

BRACKEN AREA

CAMPBELL AND CROOK COUNTIES, WYOMING

BRACKEN FIELD MINNELUSA UB PRODUCTION PLAT

GEOLOGY: L.GRIFFITH | 8/93



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL
- LOCATION

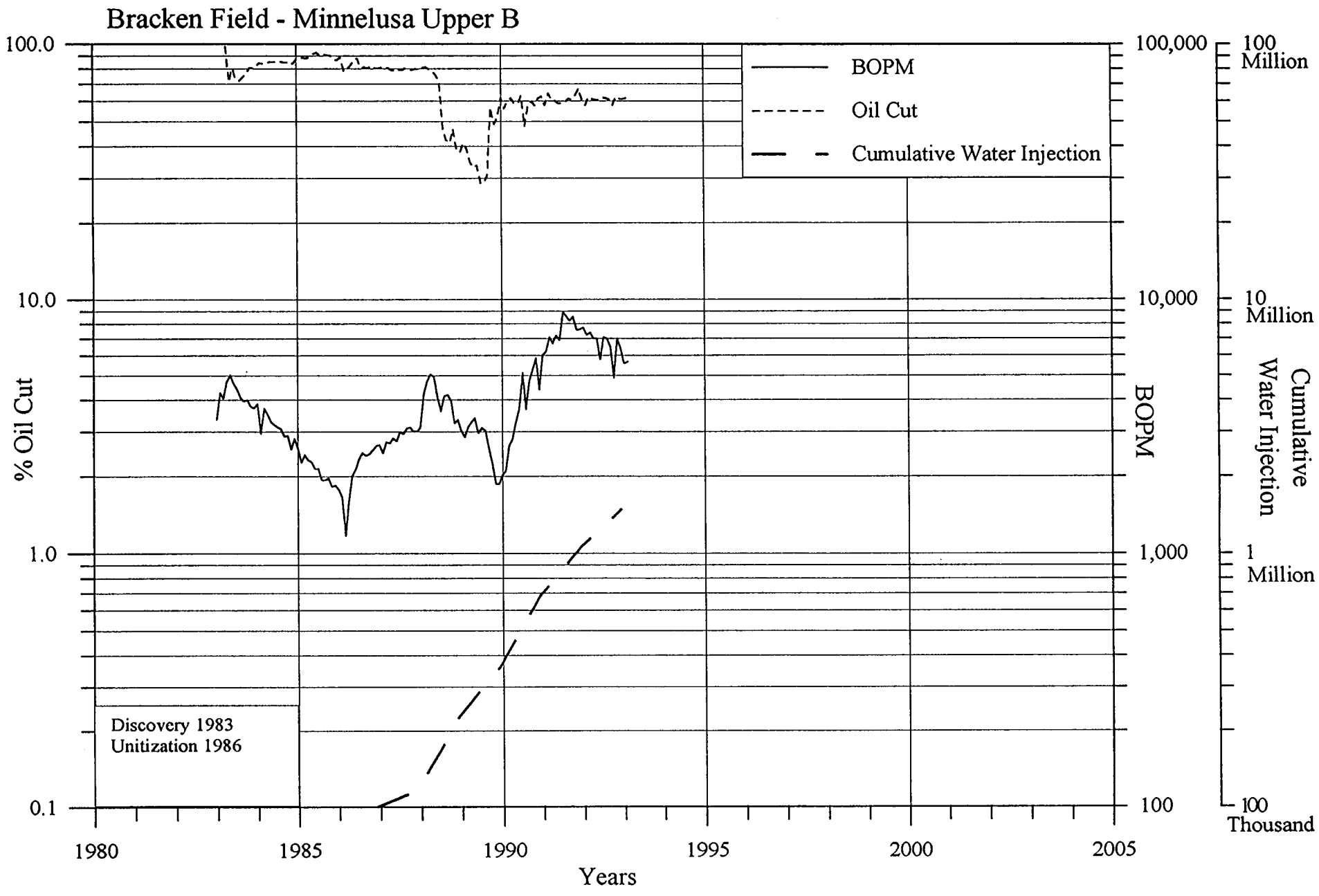
FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

BRACKEN AREA

CAMPBELL AND CROOK
COUNTIES, WYOMING

BRACKEN FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH | 8/93


Bracken Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1983
Unitization 1986
1980
1985
1990
1995
2000
2005
Years

Breaks Field

Producing Zone:	Minnelusa Lower B
Location:	Campbell County, Wyoming
	TWP 52N – RGE 69W
	Section 26
Drive Mechanism:	Waterflood
Discovered:	1976
Unitized:	1990

Current Production – 1/1 to 12/31/92	
Oil, bbls	329,751
Water, bbls	357,216

Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,775
Water, Mbbls	1,855
Injection, Mbbls	1,604

Current Rates	
Oil, bopd	903
Oil Cut, %	48.0%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	15.0%
Proj. Ultimate Recovery, Mbbls	3,629
Proj. Remaining Reserves, Mbbls	1,854
Estimated Remaining Life, Years (from 1/93)	14.7
OOIP: Pore Volume	0.676
Ultimate Recovery: Pore Volume	0.320
Remaining O.I.P.: Pore Volume	0.356

Oil Gravity	21.0
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	7,433
Formation Temperature, degrees F	143
Rw @ Formation Temperature	0.30

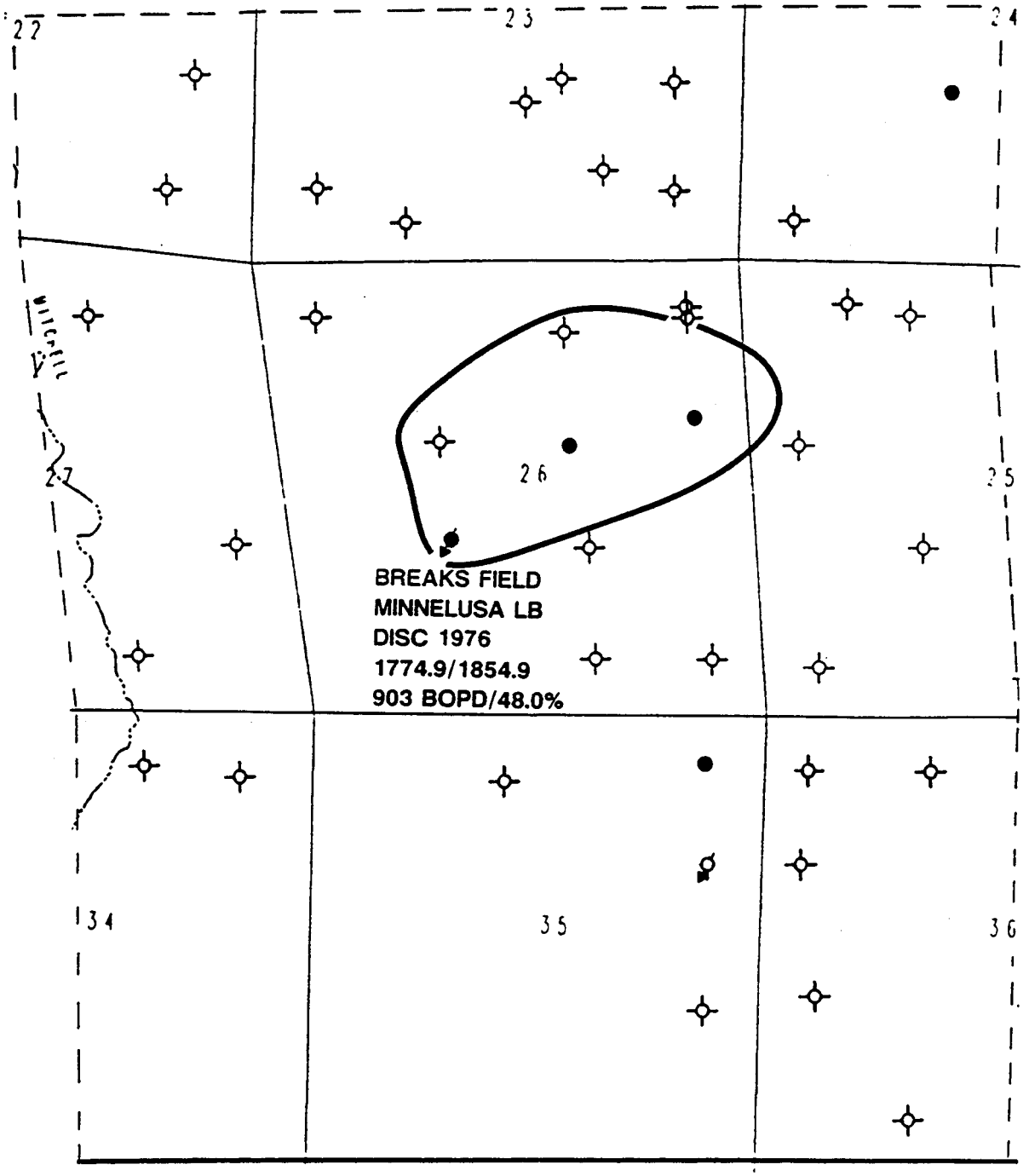
Reservoir Properties	
Volume, acre feet	6,357
Area, acres	205
Average Net Pay, feet	30.9
Average Porosity	23.0%
Average S_w	29.0%
FVF Factor	1.050
Pore Volume, Mbbls	11,333
Oil in Place, Mbbls	7,663
Est. Ult. Recovery Factor, %OOIP	47.4%
Current Recovery Factor %OOIP	23.2%
Current Depletion Factor %	48.9%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	40
End of Primary Decline	11/1989
Estimated Decline	5.0%
Projected Ult. Recovery, Mbbls	1,947
Primary Recovery Factor %OOIP	25.4%
Cumulative Oil: Pore Volume	0.157
Cumulative Water: Pore Volume	0.164
Cumulative Injection: Pore Volume	0.142
Production – Injection Difference: PV	–0.179

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWNE 26–52–69	Fed #7	601,128	408,874	Pump–Oil
SENE 26–52–69	Fed #8	1,168,087	1,364,216	Pump–Oil
NESW 26–52–69	Fed #11	5,621	64,600	Injection

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NESW 26–52–69	Fed #11	745,305	1,603,999	Injection

R 69 W



T 52 N

LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

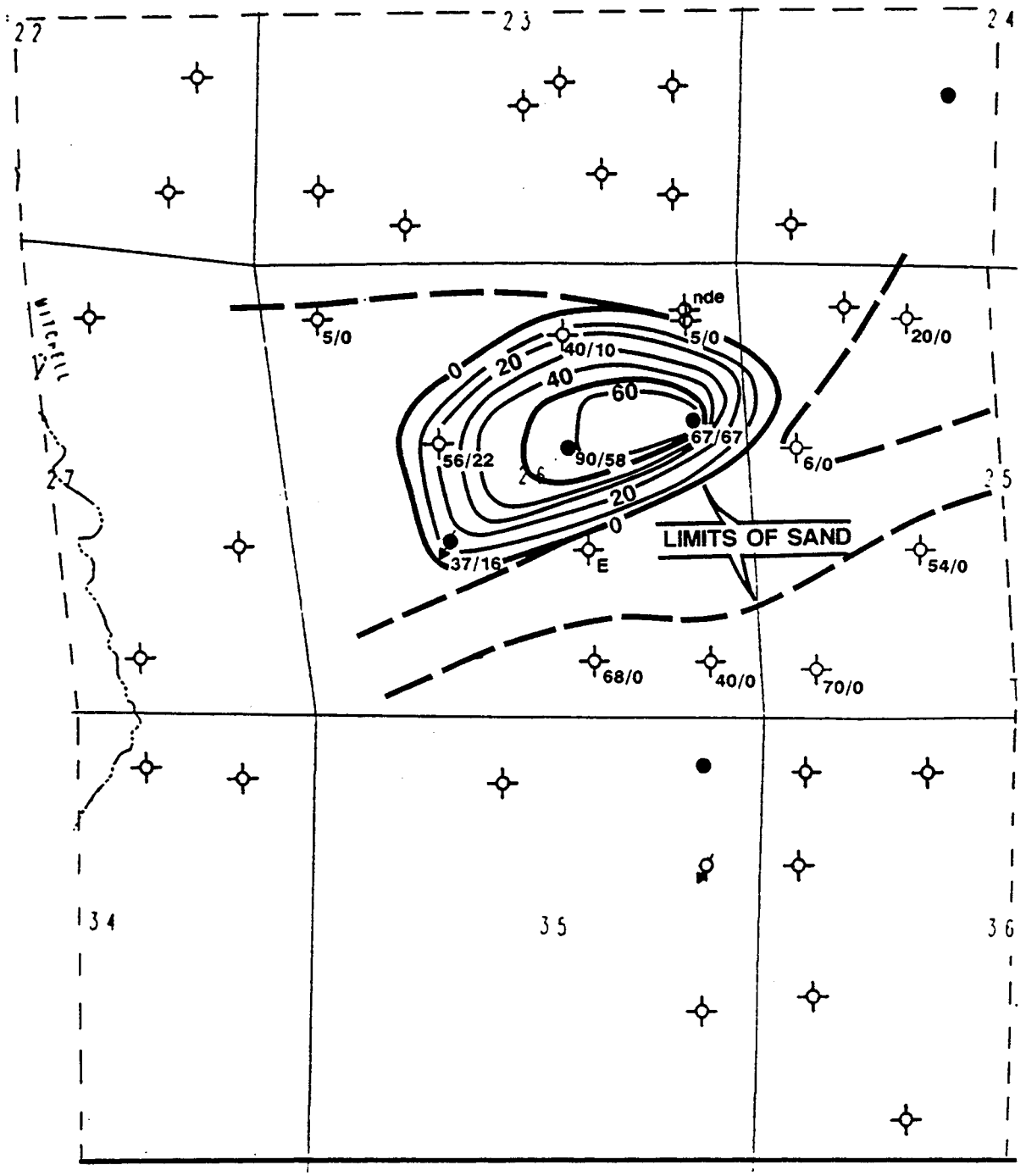
BREAKS AREA

CAMPBELL COUNTY, WYOMING

BREAKS FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93

R 69 W



T 52 N

LEGEND

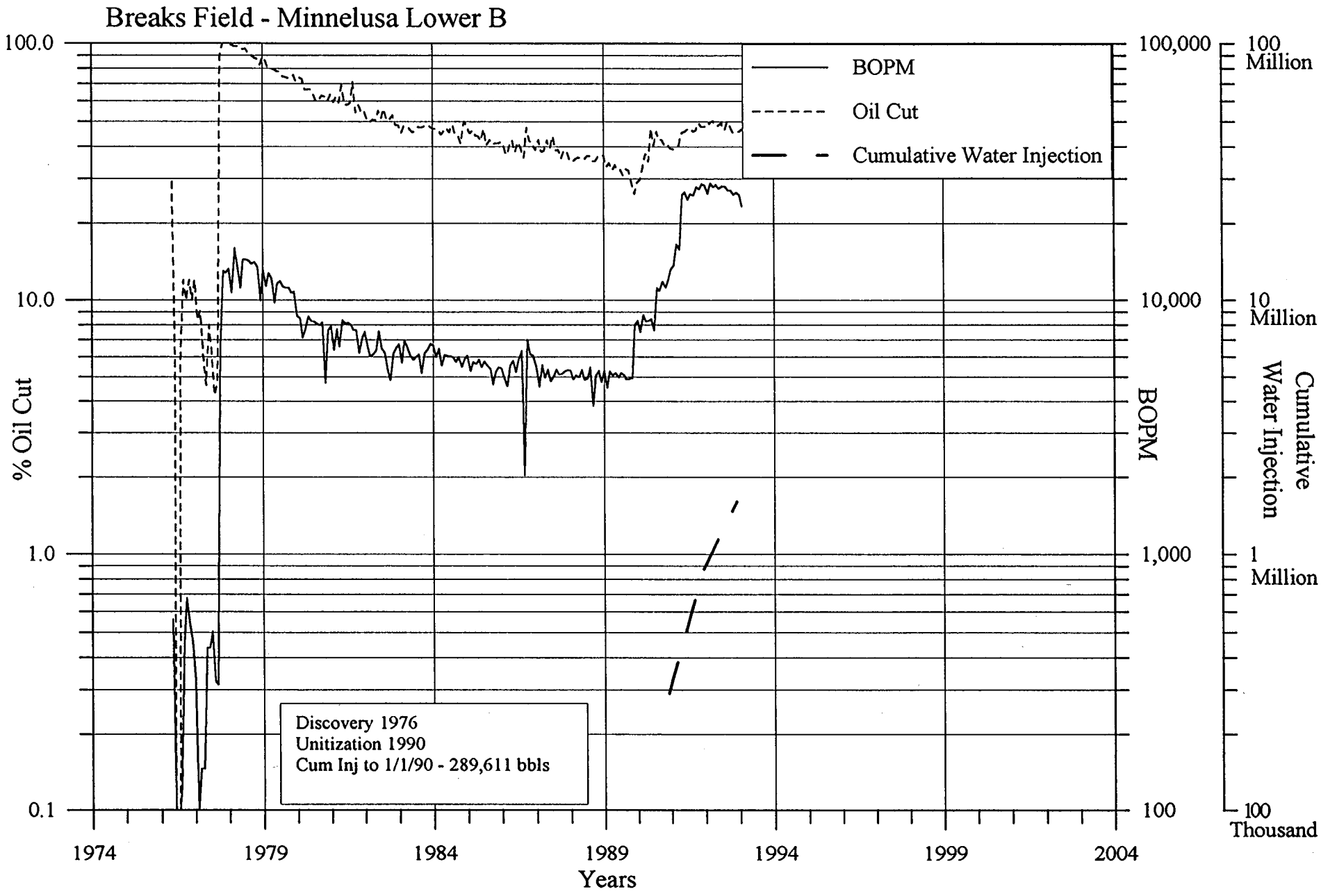
✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
♦	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
⌀	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		

BREAKS AREA

CAMPBELL COUNTY, WYOMING

BREAKS FIELD
MINNELUSA LB
ISOPACH: NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93


Breaks Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1976
Unitization 1990
Cum Inj to 1/1/90 - 289,611 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Cambridge Field

Producing Zone:	Minnelusa Upper B
Location:	Crooks County, Wyoming
	TWP 53N – RGE 68W
	Section 27
Drive Mechanism:	New Waterflood–ASP
Discovered:	1989
Unitized:	1993

Current Production – 1/1 to 12/31/92	
Oil, bbls	38,195
Water, bbls	10,409

Cumulative Production – thru 12/31/92	
Oil, Mbbls	217
Water, Mbbls	33
Injection, Mbbls	0

Current Rates	
Oil, bopd	105
Oil Cut, %	78.6%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	
Estimated Decline	
Proj. Ultimate Recovery, Mbbls	2,356 *
Proj. Remaining Reserves, Mbbls	2,139
Estimated Remaining Life, Years (from 1/93)	?
OOIP: Pore Volume	0.660
Ultimate Recovery: Pore Volume	0.296
Remaining O.I.P.: Pore Volume	0.364

Oil Gravity	20.2
Oil Viscosity, cp	24.0 to 37.0
Water Viscosity, cp	
Depth, feet	7,071
Formation Temperature, degrees F	133
Rw @ Formation Temperature	0.30

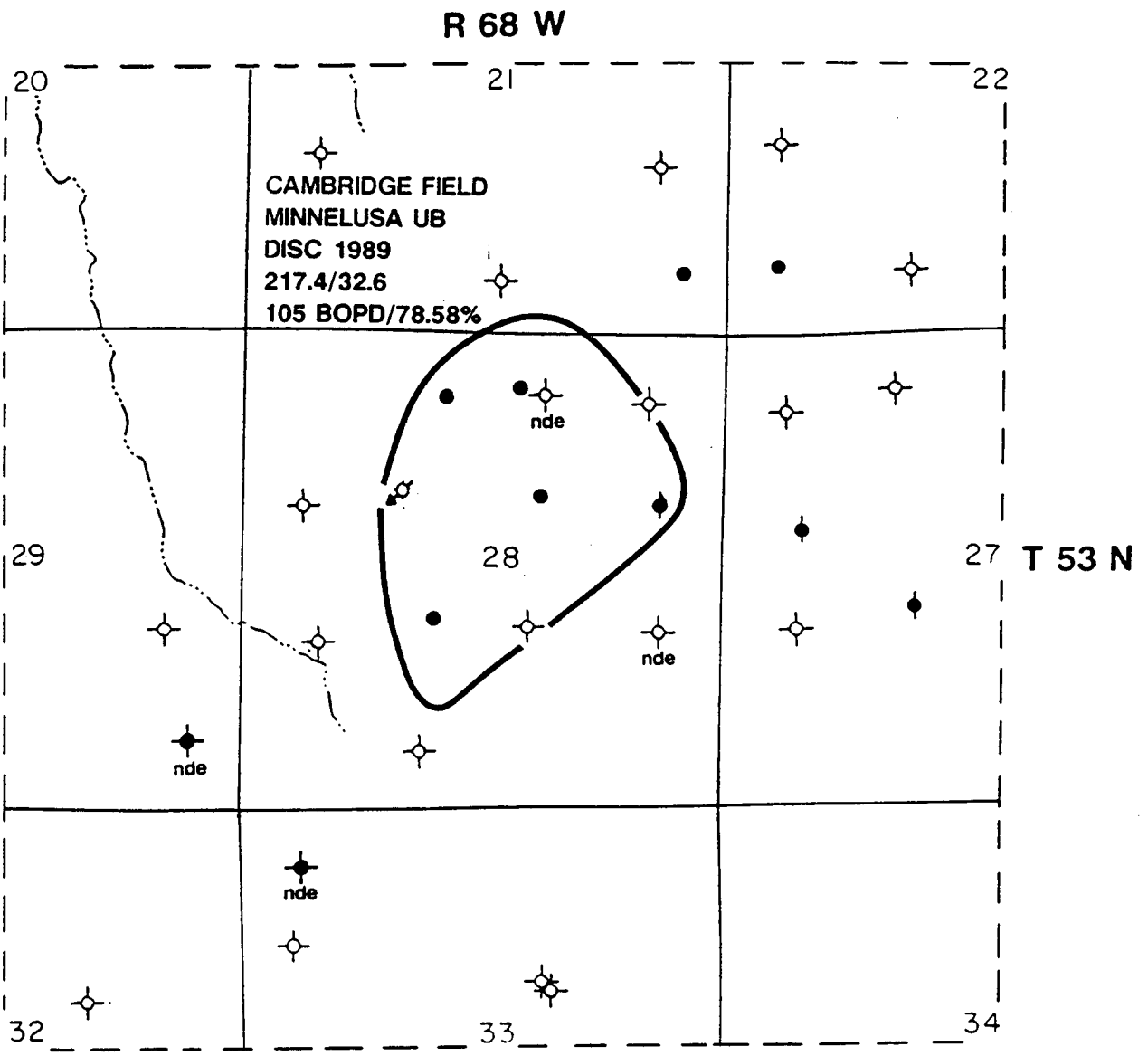
Reservoir Properties	
Volume, acre feet	5,066
Area, acres	218
Average Net Pay, feet	23.3
Average Porosity	20.2%
Average S_w	32.0%
FVF Factor	1.030
Pore Volume, Mbbls	7,947
Oil in Place, Mbbls	5,247
Est. Ult. Recovery Factor, %OOIP	44.9%
Current Recovery Factor %OOIP	4.1%
Current Depletion Factor %	9.2%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	60
End of Primary Decline	11/92
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	316
Primary Recovery Factor %OOIP	6.0%
Cumulative Oil: Pore Volume	0.027
Cumulative Water: Pore Volume	0.004
Cumulative Injection: Pore Volume	0.000
Production – Injection Difference: PV	–0.031

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNE 28–53–68	Fed #31	93,594	0	Pump–Oil
NENW 28–53–68	Fed #21	23,655	0	Pump–Oil
SENW 28–53–68	Fed #22	717	6,162	Injection
SWNE 28–53–68	Fed #32	57,219	0	Pump–Oil
SENE 28–53–68	Hahn #42	30	0	TA–Oil
NESW 28–53–68	Fed #23	42,164	20,300	Pump–Oil
NWNE 28–53–68				

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SENW 27–53–68	Fed #22			Injection

*Ultimate recovery estimated from unit report



LEGEND

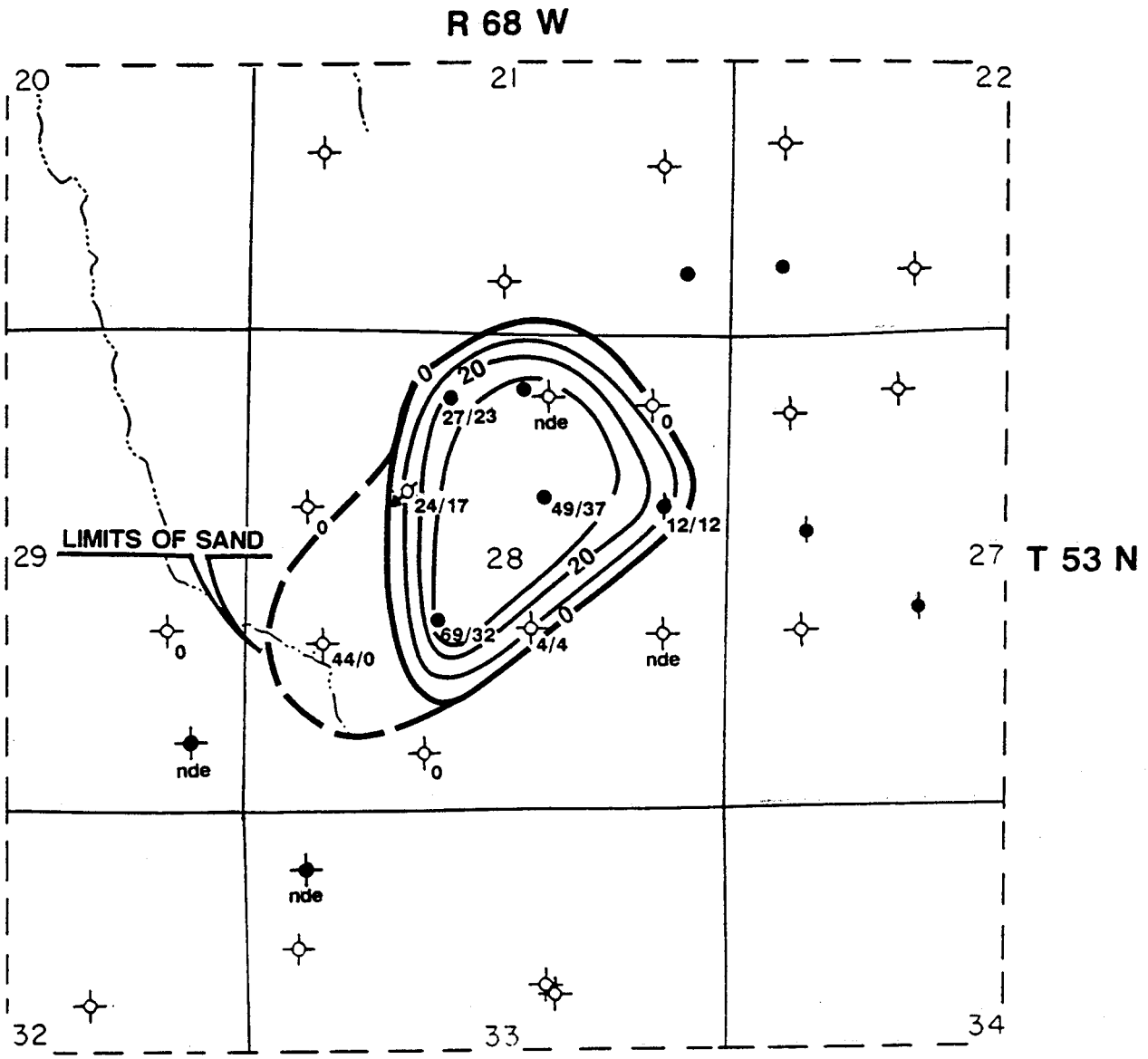
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

CAMBRIDGE AREA

CROOK COUNTY, WYOMING

CAMBRIDGE FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

CAMBRIDGE AREA

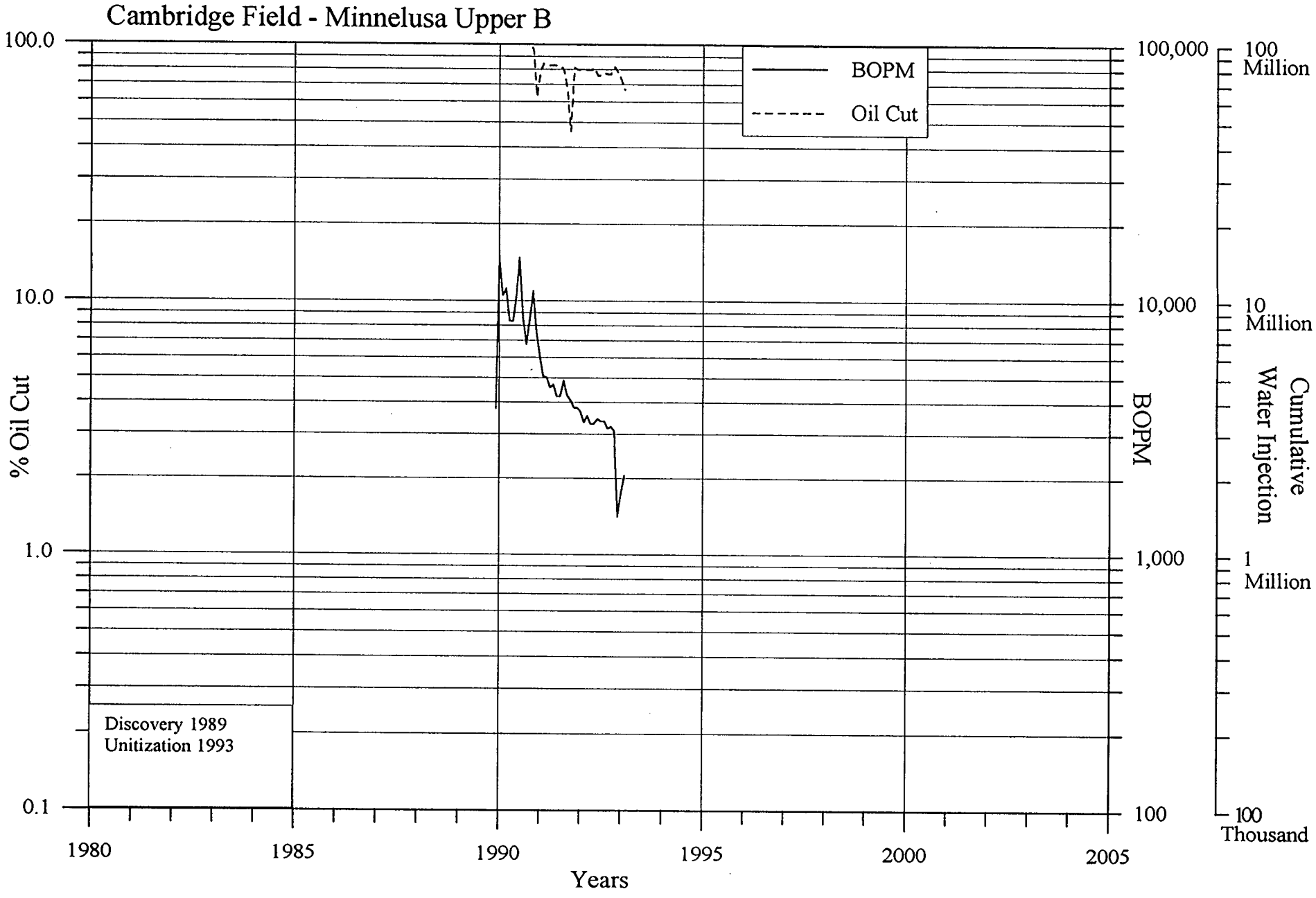
CROOK COUNTY, WYOMING

CAMBRIDGE FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Cambridge Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1989
Unitization 1993
1980
1985
1990
1995
2000
2005
Years

Deadman Creek Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 53N – RGE 67W
	Sections 18 & 19
Drive Mechanism:	Polymer Waterflood
Discovered:	1973
Unitized:	1979

Current Production – 1/1 to 12/31/92	
Oil, bbls	79,229
Water, bbls	219,374
Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,607
Water, Mbbls	1,726
Injection, Mbbls	5,461
Current Rates	
Oil, bopd	217
Oil Cut, %	26.5%

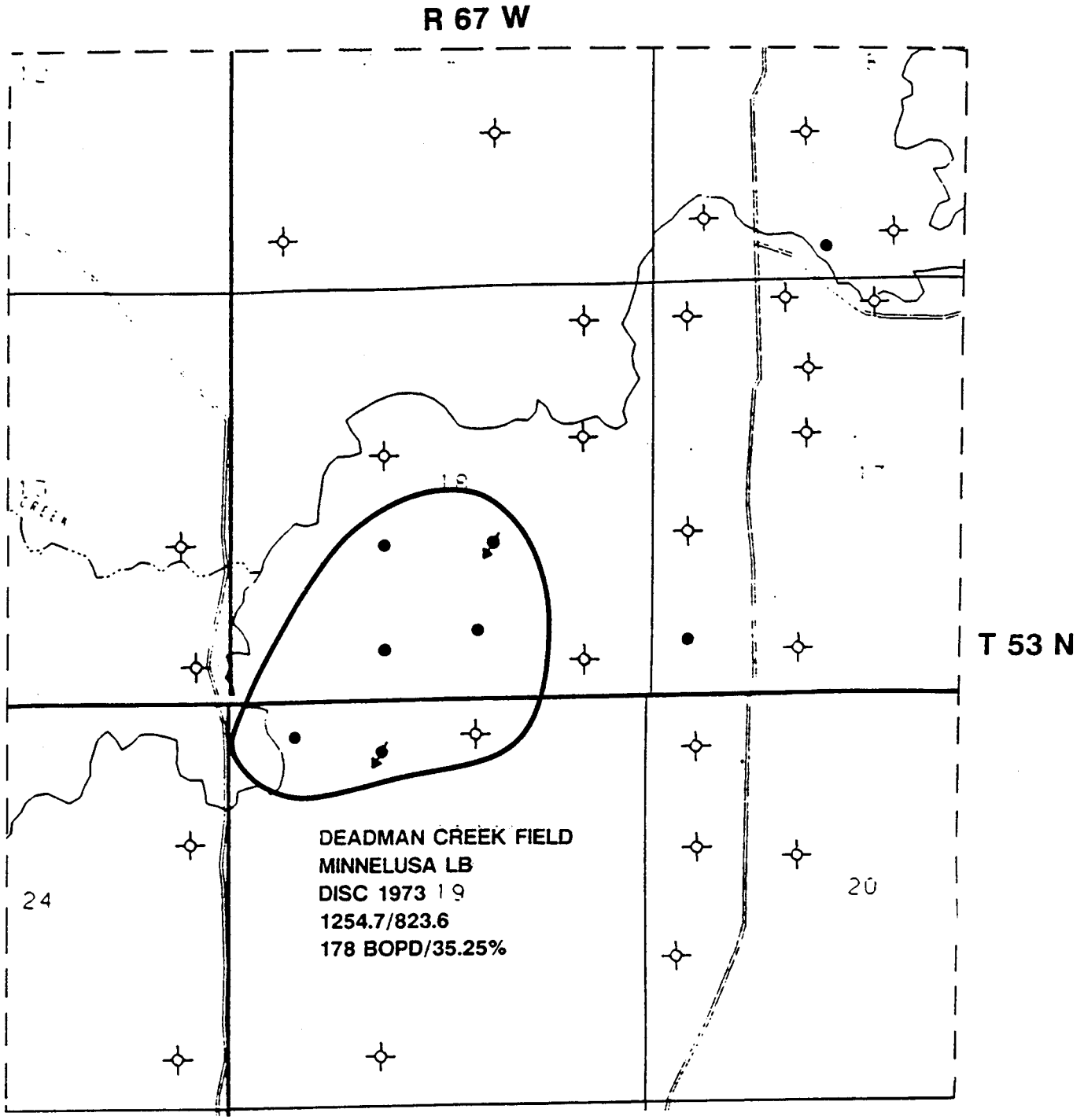
Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	10.0%
Proj. Ultimate Recovery, Mbbls	2,216
Proj. Remaining Reserves, Mbbls	609
Estimated Remaining Life, Years (from 1/93)	16.8
OOIP: Pore Volume	0.731
Ultimate Recovery: Pore Volume	0.289
Remaining O.I.P.: Pore Volume	0.441

Oil Gravity	22.0
Oil Viscosity, cp	29.0
Water Viscosity, cp	0.6
Depth, feet	6,264
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.24
Reservoir Properties	
Volume, acre feet	5,461
Area, acres	266
Average Net Pay, feet	24.8
Average Porosity	18.1%
Average S_w	24.0%
FVF Factor	1.040
Pore Volume, Mbbls	7,656
Oil in Place, Mbbls	5,595
Est. Ult. Recovery Factor, %OOIP	39.6%
Current Recovery Factor %OOIP	28.7%
Current Depletion Factor %	72.5%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	07/79
Estimated Decline	20.0%
Projected Ult. Recovery, Mbbls	268
Primary Recovery Factor %OOIP	4.8%
Cumulative Oil: Pore Volume	0.210
Cumulative Water: Pore Volume	0.225
Cumulative Injection: Pore Volume	0.713
Production – Injection Difference: PV	0.278

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSE 18–53–67	Fed #33	62,062	87,935	Pump–Oil
NESW 18–53–67	State #23	201	2,417	Injection
SESW 18–53–67	State #24	344,319	901,825	Pump–Oil
SWSE 18–53–67	Robinson #34	692,739	199,856	Pump–Oil
NENW 19–53–67	Unit #21	15,324	5	Injection
NWNW 19–53–67	Reynolds #11	492,227	533,524	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NESW 18–53–67	State #23	346,209	4,043,435	Injection
NENW 19–53–67	Unit #21	180,365	1,417,652	Injection



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL

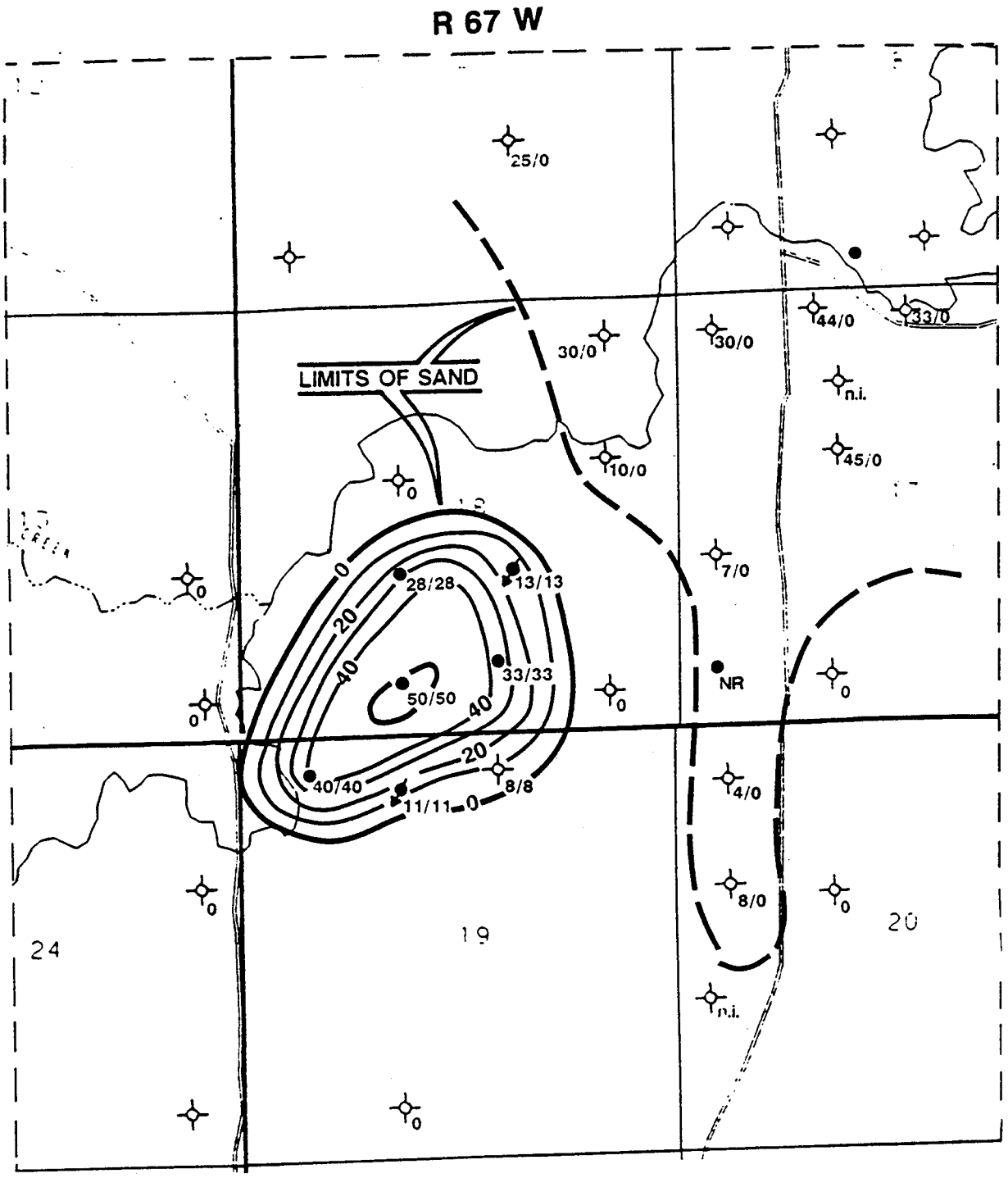
FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

DEADMAN CREEK AREA

CROOK COUNTY, WYOMING

DEADMAN CREEK FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

⊹	DRY HOLE	70/65 Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde Not Deep Enough
⊹	SHUT IN OIL WELL	n.p. Production Zone Not Penetrated
⊹	ABDN. OIL WELL	E Production Zone Eroded
⊹	WATER INJECTOR	n.i. No Well Information
⊹	WATER DISPOSAL	

DEADMAN CREEK AREA

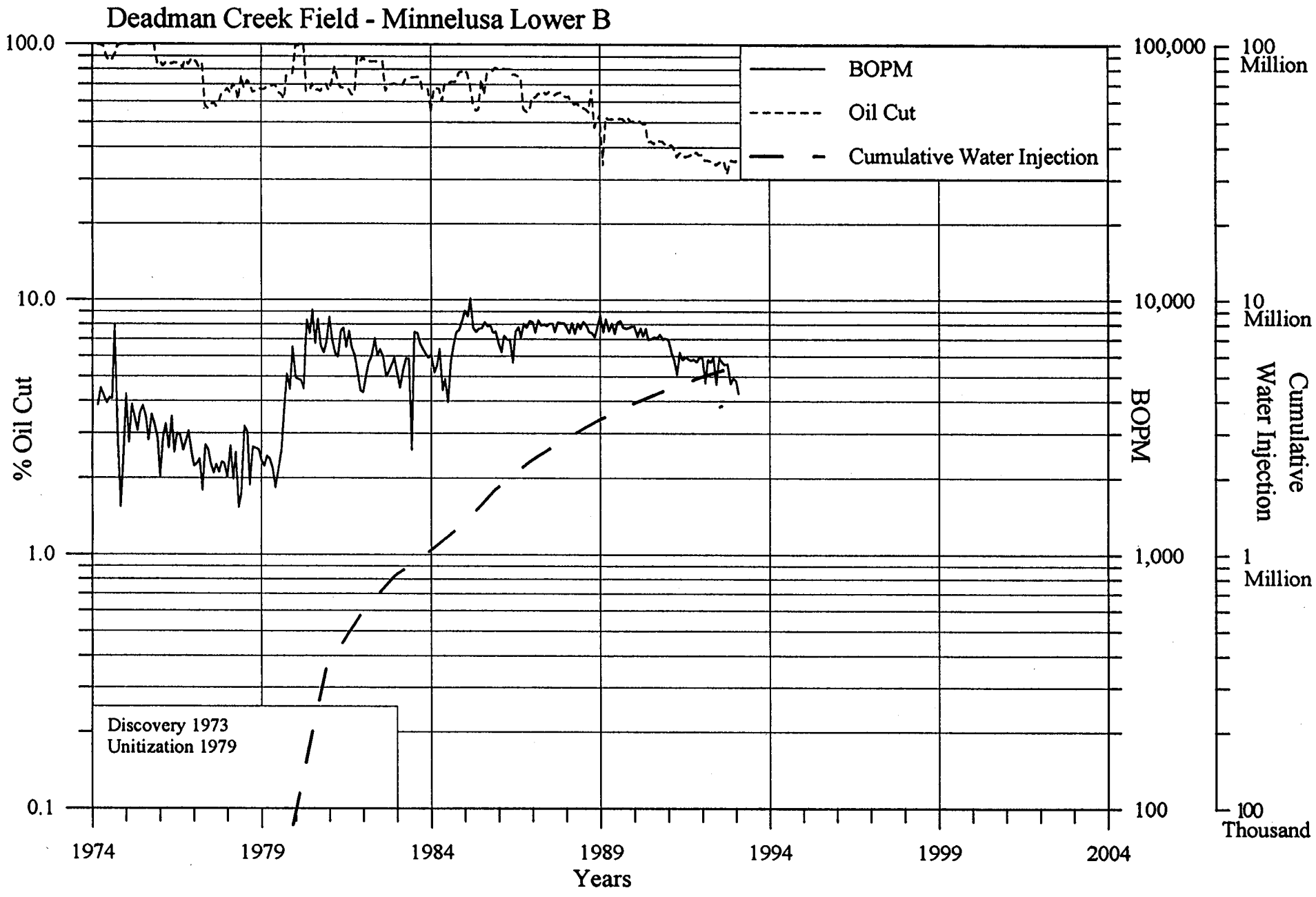
CROOK COUNTY, WYOMING

DEADMAN CREEK FIELD
MINNELUSA LB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Deadman Creek Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1973
Unitization 1979
1974
1979
1984
1989
1994
1999
2004
Years

Edsel Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 54N – RGE 68W
	Sections 25, 26, 35 & 36
Drive Mechanism:	Waterflood
Discovered:	1981
Unitized:	1984

Current Production – 1/1 to 12/31/92	
Oil, bbls	208,157
Water, bbls	1,671,895

Cumulative Production – thru 12/31/92	
Oil, Mbbls	4,260
Water, Mbbls	7,469
Injection, Mbbls	12,244

Current Rates	
Oil, bopd	570
Oil Cut, %	11.1%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	15.0%
Proj. Ultimate Recovery, Mbbls	5,029
Proj. Remaining Reserves, Mbbls	769
Estimated Remaining Life, Years (from 1/93)	5.3
OOIP: Pore Volume	0.660
Ultimate Recovery: Pore Volume	0.286
Remaining O.I.P.: Pore Volume	0.374

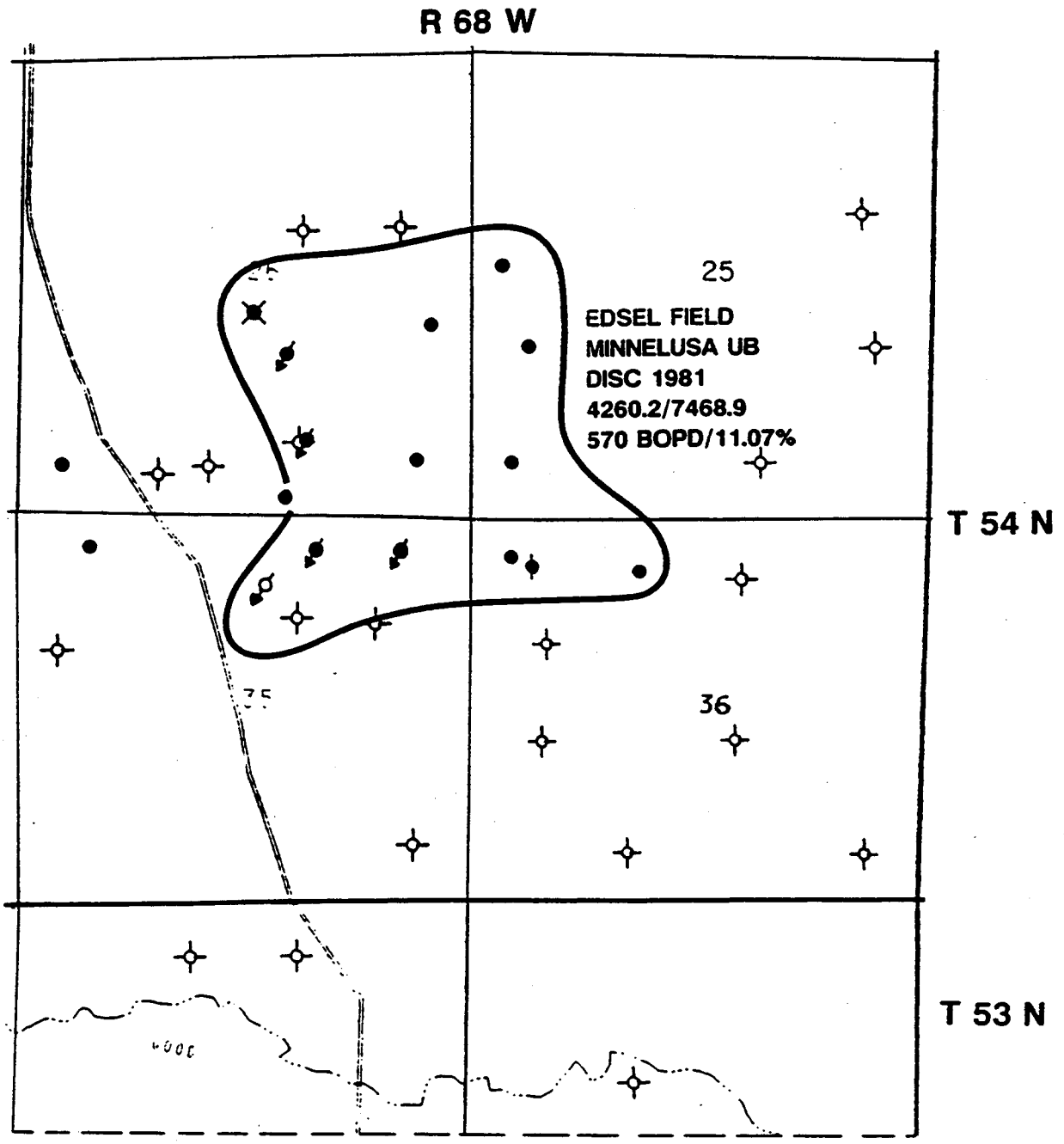
Oil Gravity	21.0
Oil Viscosity, cp	17.2
Water Viscosity, cp	n.i.
Depth, feet	6,431
Formation Temperature, degrees F	147
Rw @ Formation Temperature	0.25

Reservoir Properties	
Volume, acre feet	10,060
Area, acres	376
Average Net Pay, feet	27.1
Average Porosity	22.5%
Average S_w	32.0%
FVF Factor	1.030
Pore Volume, Mbbls	17,575
Oil in Place, Mbbls	11,603
Est. Ult. Recovery Factor, %OOIP	43.3%
Current Recovery Factor %OOIP	36.7%
Current Depletion Factor %	84.7%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	90
End of Primary Decline	03/84
Estimated Decline	45.0%
Projected Ult. Recovery, Mbbls	817
Primary Recovery Factor %OOIP	7.0%
Cumulative Oil: Pore Volume	0.242
Cumulative Water: Pore Volume	0.425
Cumulative Injection: Pore Volume	0.697
Production – Injection Difference: PV	0.029

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWSW 25–54–68	Brislawn #7	571,285	1,385,670	Pump–Oil
NWSW 25–54–68	Brislawn #8	393,139	71,992	Pump–Oil
SWNW 25–54–68	Unit #9	343,769	110,273	Pump–Oil
NWSE 26–54–68	Brislawn #1	93,064	48,139	Injection
NESE 26–54–68	Brislawn #4	1,888,014	3,765,755	Pump–Oil
SESE 26–54–68	Brislawn #5	432,390	339,238	SI–Oil
NWSE 26–54–68	Brislawn #2	2,760	14,843	SWD
SWSE 26–54–68	Good Lad #1	20,518	17	Injection
NENE 35–54–68	Unit #7	22,152	29,344	Injection
NWNW 36–54–68	State #1	465,649	1,647,019	Pump–Oil
NENW 36–54–68	State #2	54587	31	Pump–Oil
SWNW 36–54–68	State #3	265	5280	TA–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SWSE 26–54–68	Good Lad #1	412,991	3,572,024	Injection
NWSE 26–54–68	Brislawn #1	430,515	3,839,904	Injection
NENE 35–54–68	Unit #7	1,051,676	4,851,724	Injection



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

EDSEL AREA

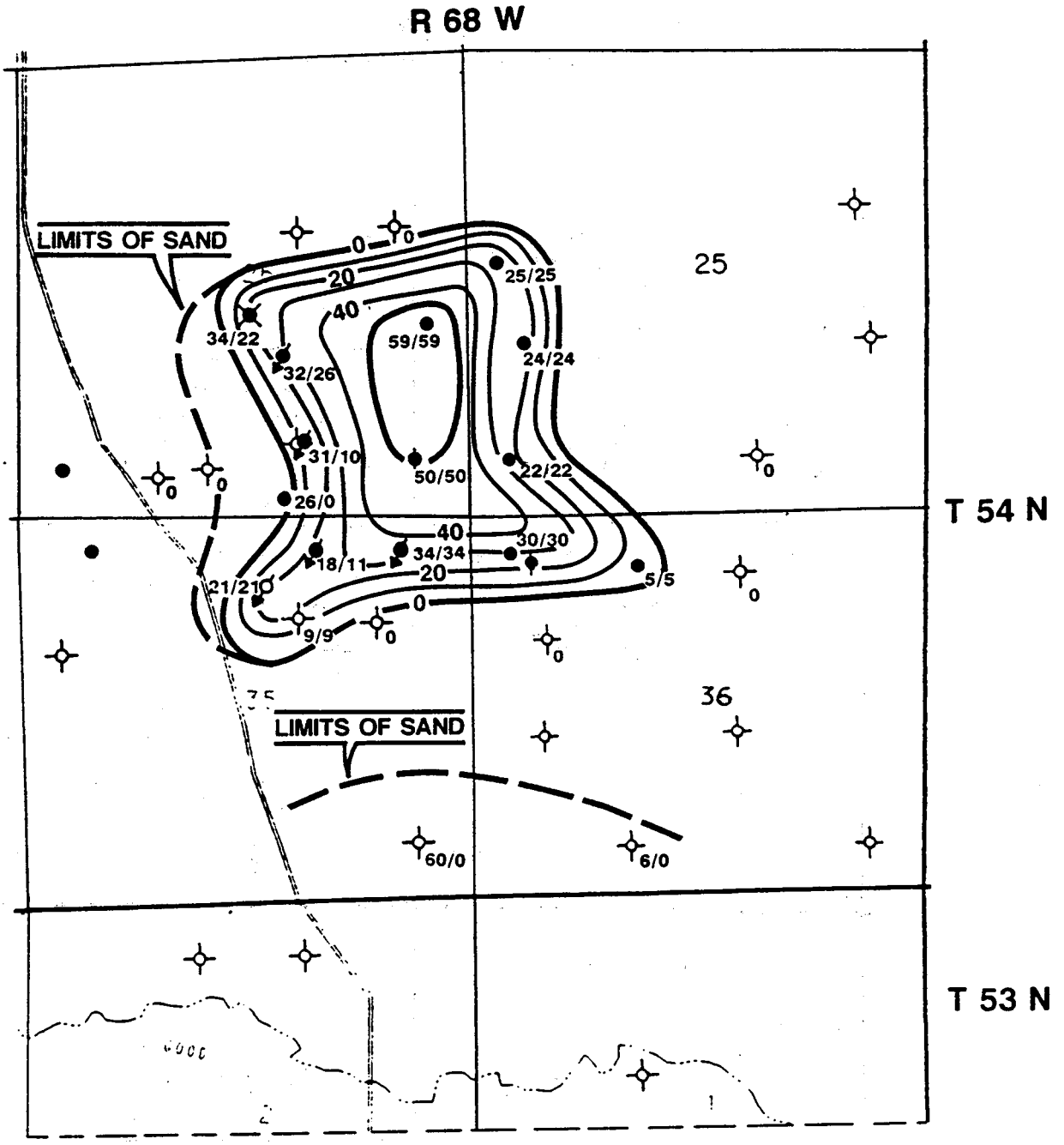
CROOK COUNTY, WYOMING

EDSEL FIELD

PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

EDSEL AREA

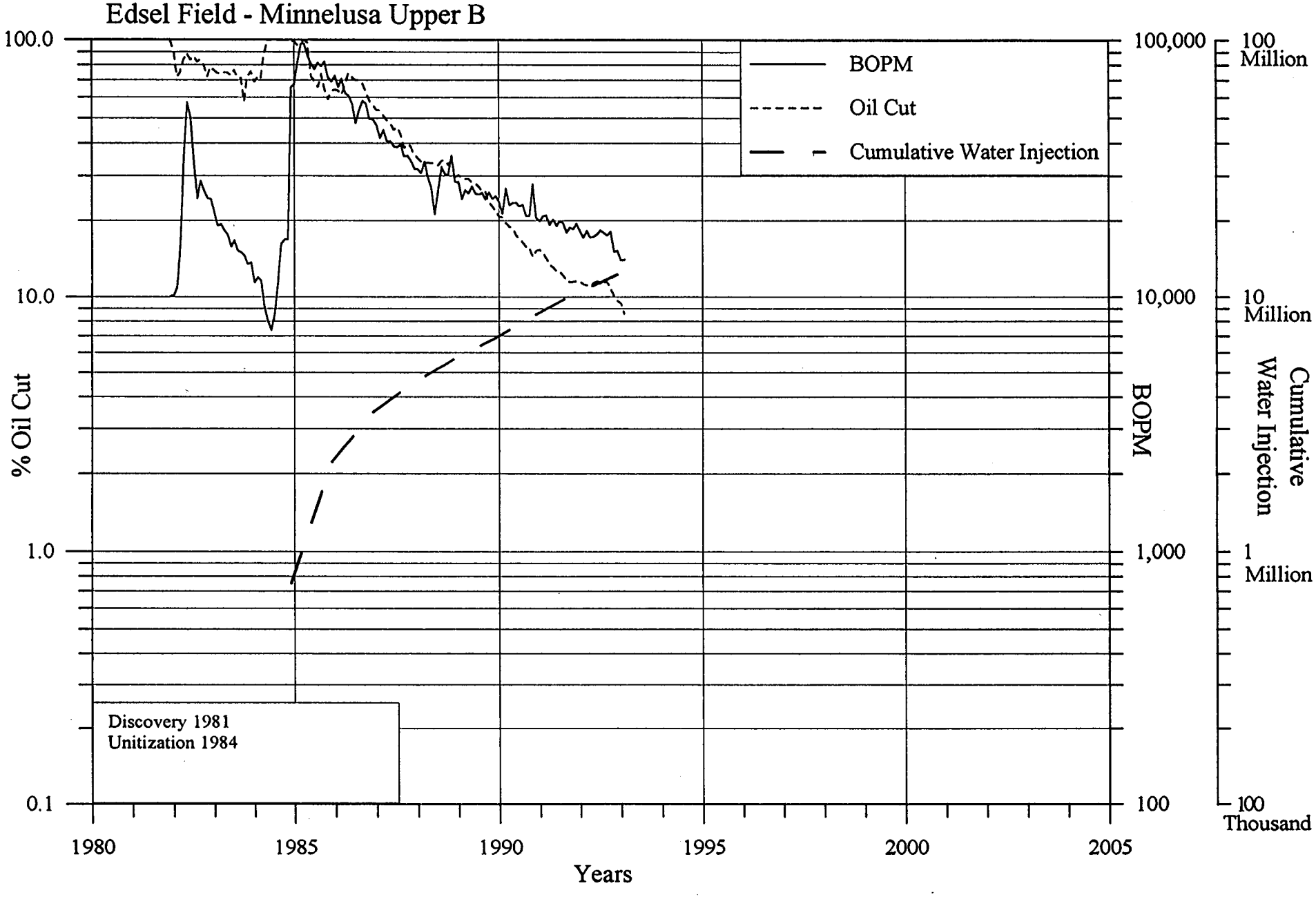
CROOK COUNTY, WYOMING

EDSEL FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Edsel Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1981
Unitization 1984
1980
1985
1990
1995
2000
2005
Years

Guthery Field

Producing Zone:	Minnelusa A & Upper B
Location:	Crook County, Wyoming
	TWP 51N – RGE 68W
	Section 3
Drive Mechanism:	Waterflood
Discovered:	1963
Unitized:	1968

	A
Oil Gravity	21.0
Oil Viscosity, cp	19.0
Water Viscosity, cp	0.5
Depth, feet	7,037
Formation Temperature, degrees F	130
Rw @ Formation Temperature	0.30

Current Production – 1/1 to 12/31/92	
Oil, bbls	118,734
Water, bbls	962,914

Cumulative Production – thru 12/31/92	
Oil, Mbbls	3,946
Water, Mbbls	5,676
Injection, Mbbls	9,689

Current Rates	
Oil, bopd	325
Oil Cut, %	11.0%

Reservoir Properties	A	UB	Total
Volume, acre feet	3,796	4,543	8,338
Area, acres	207	217	217
Average Net Pay, feet	18.3	20.9	38.4
Average Porosity	22.3%	20.2%	21.2%
Average S_w	35.0%	35.0%	35.0%
FVF Factor	1.040	1.040	1.040
Pore Volume, Mbbls	6,558	7,112	13,670
Oil in Place, Mbbls	4,099	4,445	8,544

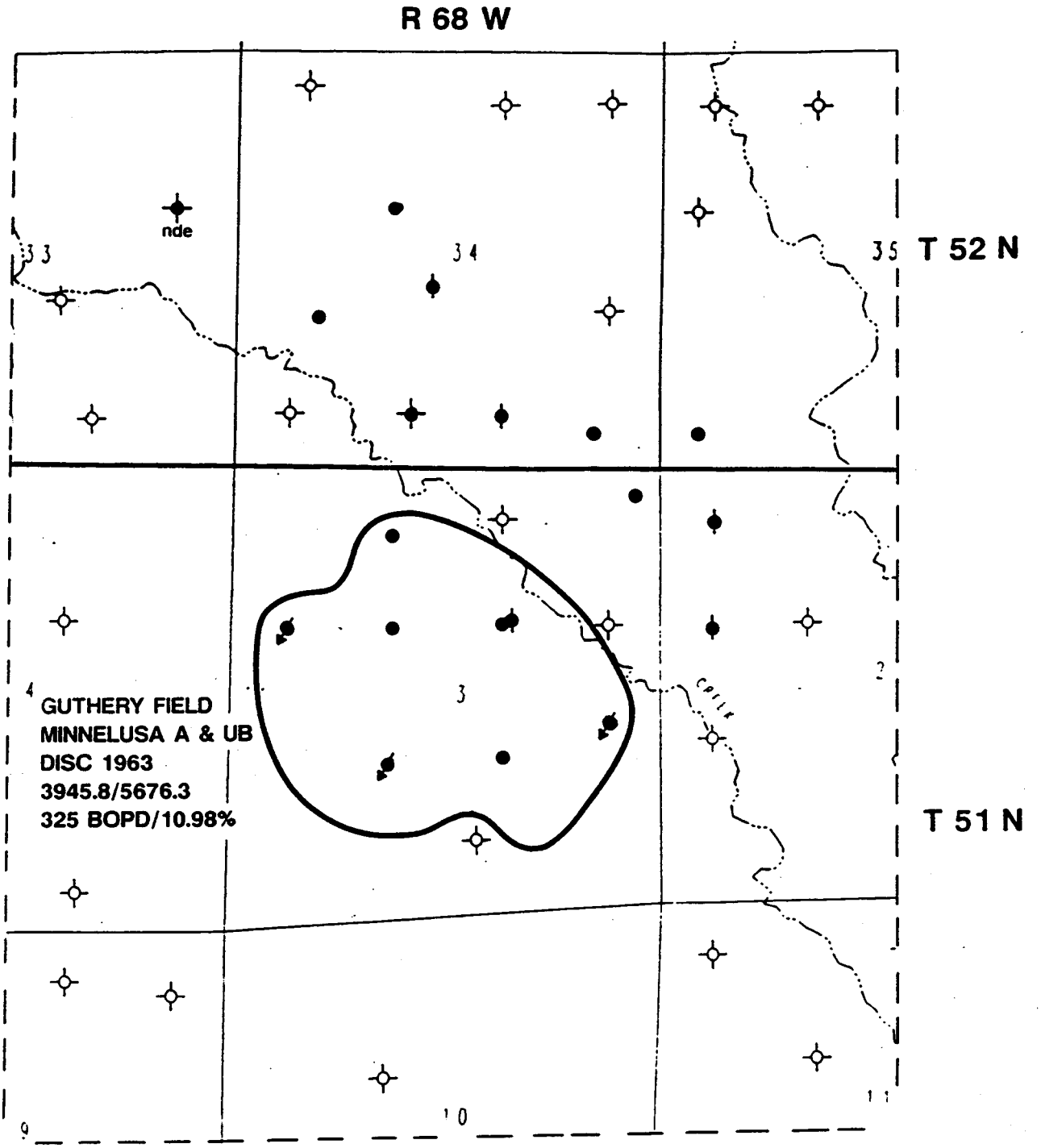
Est. Ult. Recovery Factor, %OOIP	48.0%
Current Recovery Factor %OOIP	46.2%
Current Depletion Factor %	96.2%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	15.0%
Proj. Ultimate Recovery, Mbbls	4,103
Proj. Remaining Reserves, Mbbls	157
Estimated Remaining Life, Years (from 1/93)	4.8
OOIP: Pore Volume	0.625
Ultimate Recovery: Pore Volume	0.300
Remaining O.I.P.: Pore Volume	0.325

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	12/67
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	789
Primary Recovery Factor %OOIP	9.2%
Cumulative Oil: Pore Volume	0.289
Cumulative Water: Pore Volume	0.415
Cumulative Injection: Pore Volume	0.709
Production – Injection Difference: PV	0.005

		------- to 1/93 -------		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSE 03–51–68	Mellott #1	2,441,386	2,186,226	Pump–Oil
SWNE 03–51–68	Guthrey #2	---	---	SI–Oil
NESW 03–51–68	Stockyard #5	489	23,961	Injection
SENW 03–51–68	Stockyard #2	316,242	870,143	Pump–Oil
SWNE 03–51–68	Guthrey #2–A	587,078	909,265	Pump–Oil
NENW 03–51–68	Stockyard #6	197,965	119,122	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NESE 03–51–68	Mellott #2	72,846	2,541,800	Injection
SWNW 03–51–68	Guthrey #1	179,735	5,106,841	Injection
NESW 03–51–68	Stockyard #5	784,818	2,040,050	Injection



LEGEND

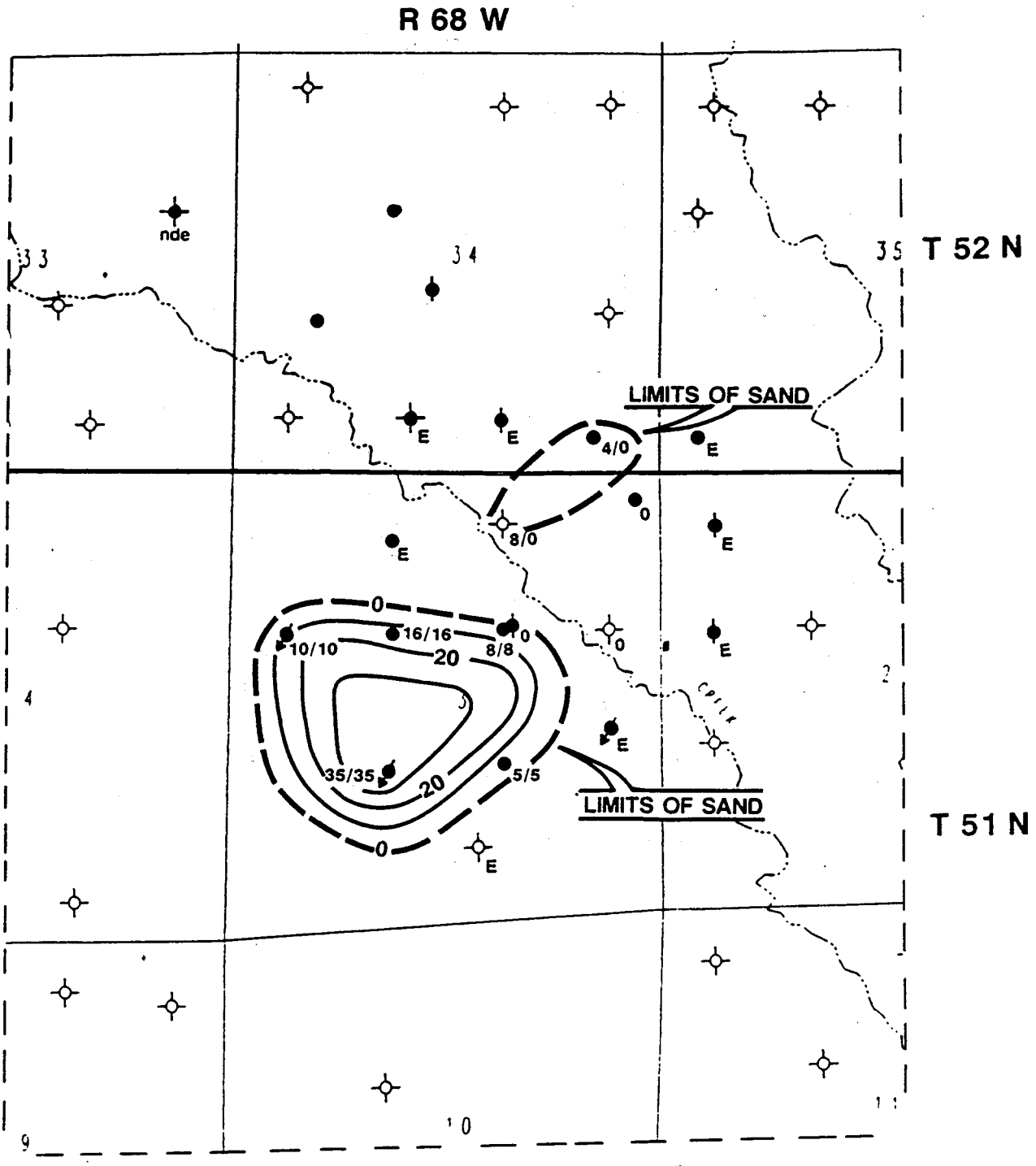
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

GUTHERY AREA
CROOK COUNTY, WYOMING

GUTHERY FIELD
MINNELUSA A & UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⧫	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
⚲	WATER INJECTOR	n.l.	No Well Information
⧖	WATER DISPOSAL		

GUTHERY AREA

CROOK COUNTY, WYOMING

GUTHERY FIELD

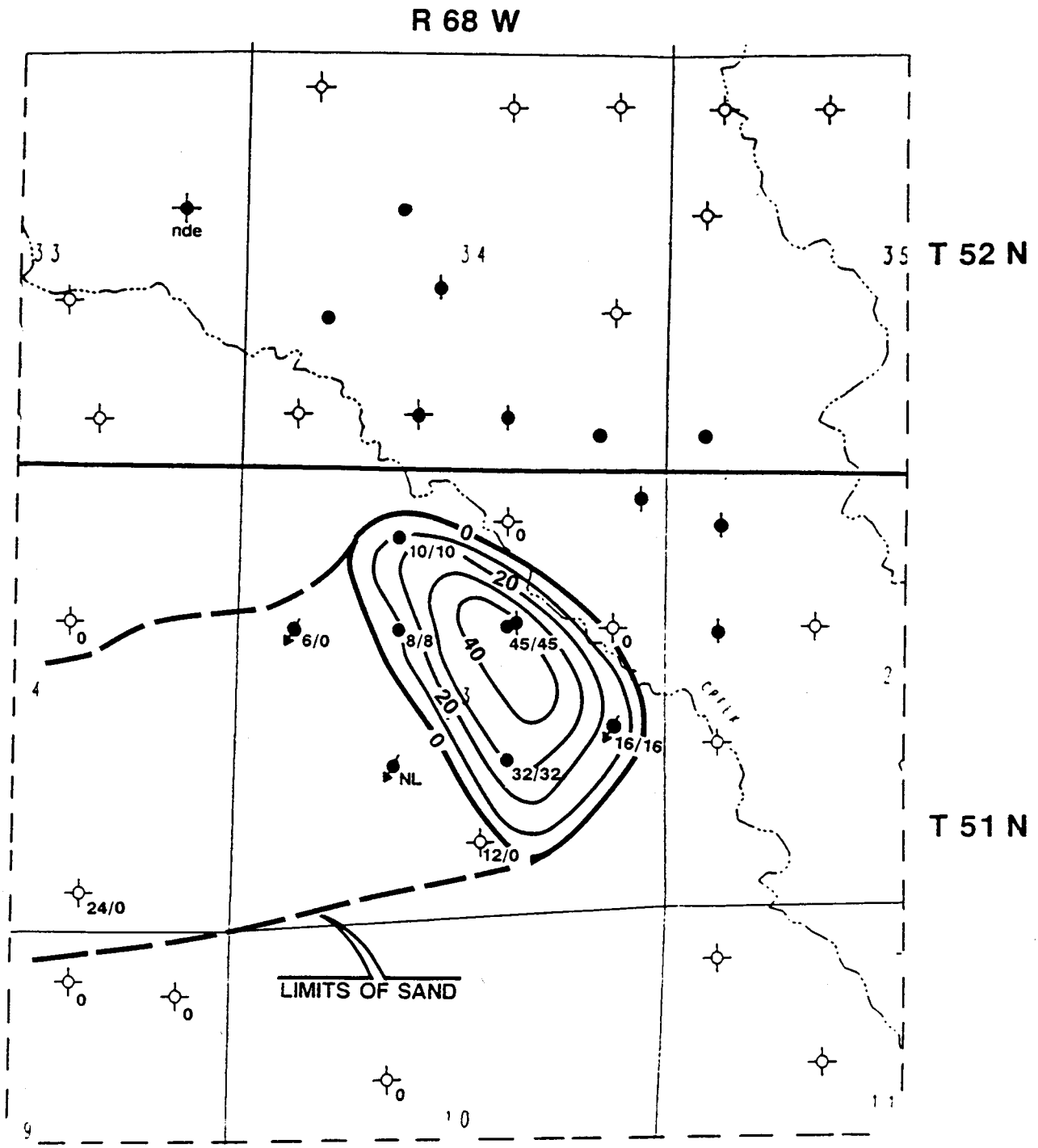
MINNELUSA A

ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
♦	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
☌	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		

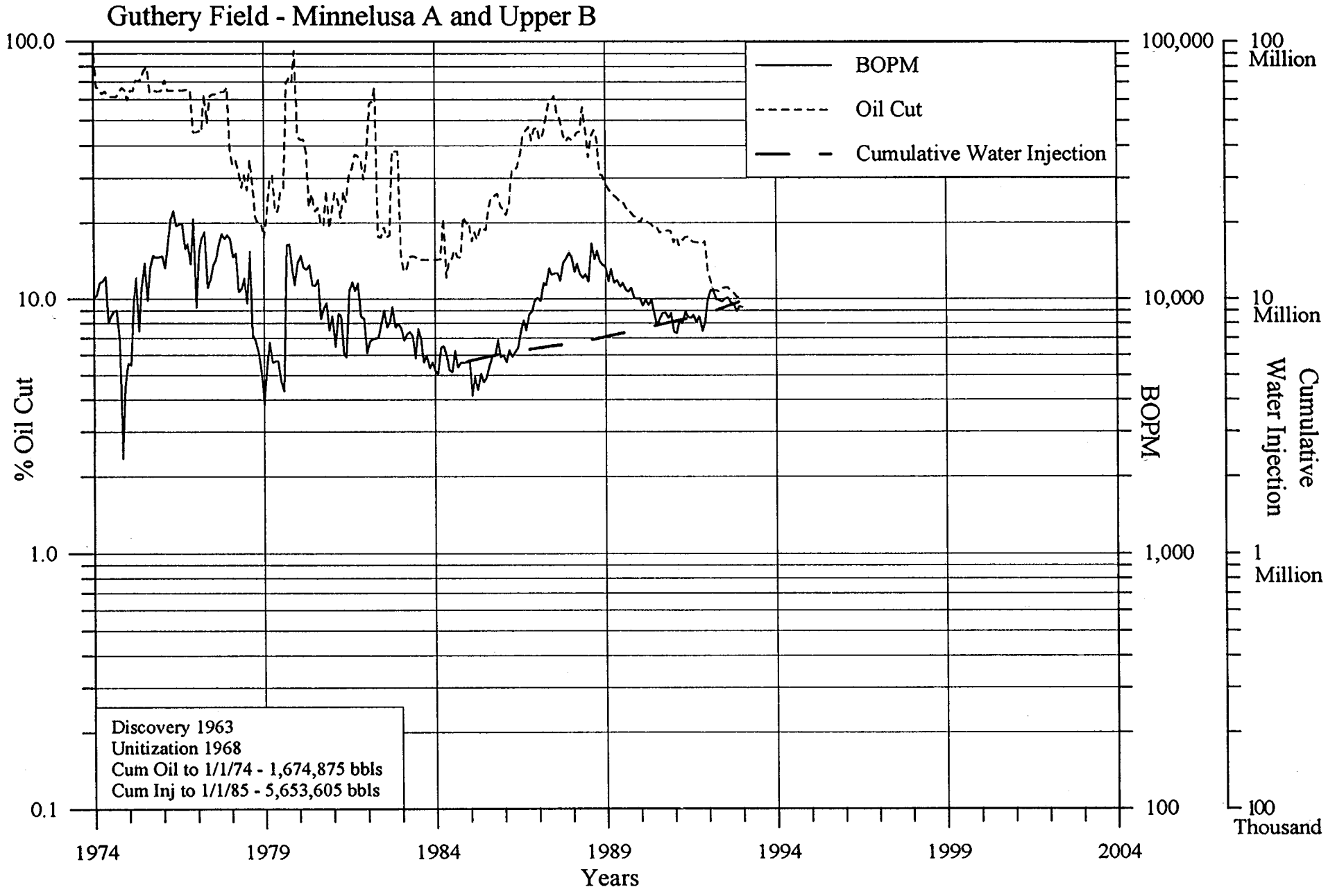
GUTHERY AREA

CROOK COUNTY, WYOMING

GUTHERY FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93


Guthery Field - Minnelusa A and Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1963
Unitization 1968
Cum Oil to 1/1/74 - 1,674,875 bbls
Cum Inj to 1/1/85 - 5,653,605 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Heath Field

Producing Zone:	Minnelusa C
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 8 & 9
Drive Mechanism:	Water Drive
Discovered:	1980
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	24,872
Water, bbls	177,234

Cumulative Production – thru 12/31/92	
Oil, Mbbls	716
Water, Mbbls	2,740
Injection, Mbbls	

Current Rates	
Oil, bopd	68
Oil Cut, %	12.3%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	
Estimated Decline	
Proj. Ultimate Recovery, Mbbls	822
Proj. Remaining Reserves, Mbbls	106
Estimated Remaining Life, Years (from 1/93)	6.8
OOIP: Pore Volume	0.524
Ultimate Recovery: Pore Volume	0.084
Remaining O.I.P.: Pore Volume	0.440

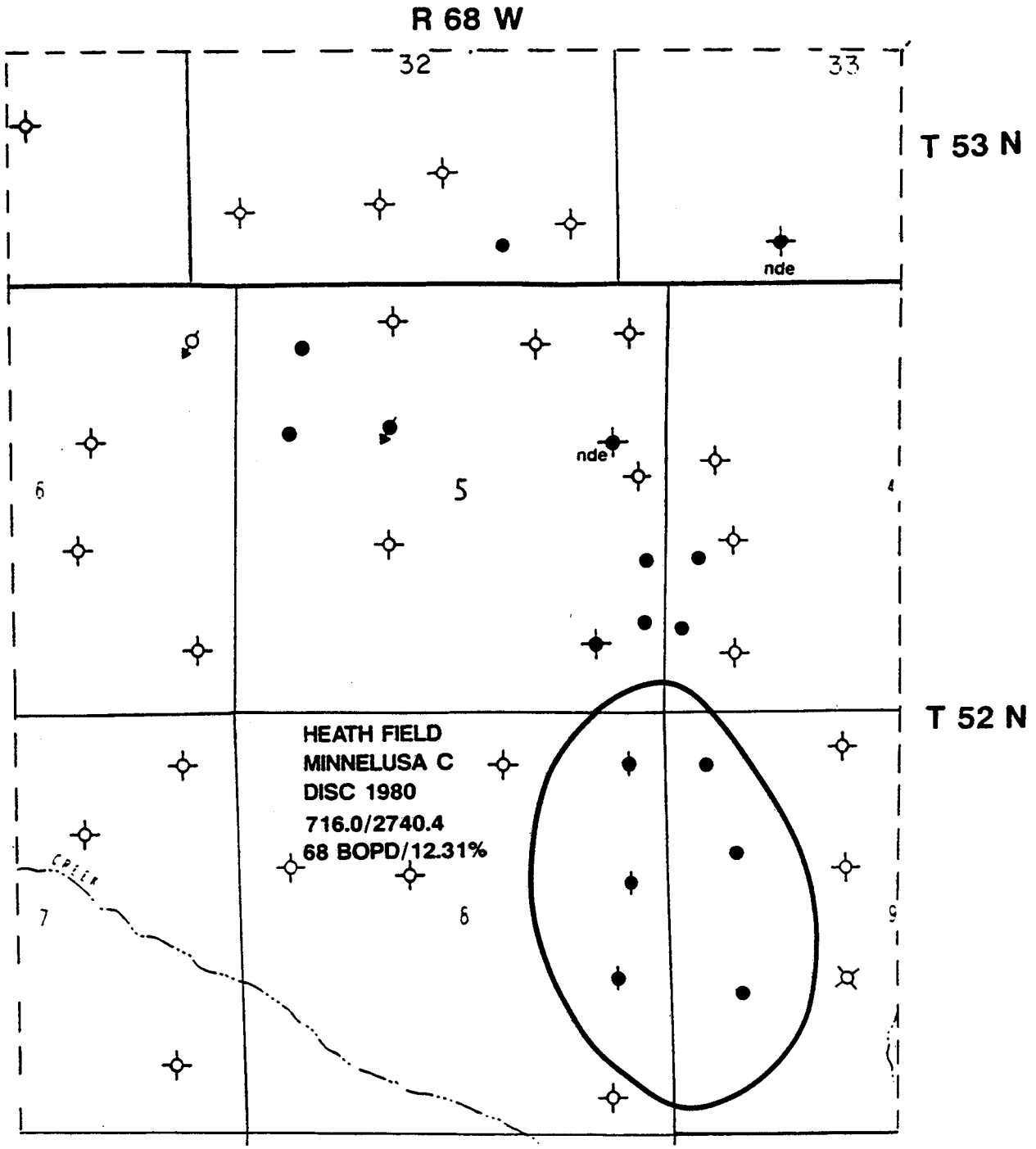
Oil Gravity	22.0
Oil Viscosity, cp	
Water Viscosity, cp	
Depth, feet	7,208
Formation Temperature, degrees F	154
Rw @ Formation Temperature	1.00

Reservoir Properties	
Volume, acre feet	6,845
Area, acres	248
Average Net Pay, feet	27.8
Average Porosity	18.5%
Average S_w	45.0%
FVF Factor	1.050
Pore Volume, Mbbls	9,825
Oil in Place, Mbbls	5,146
Est. Ult. Recovery Factor, %OOIP	16.0%
Current Recovery Factor %OOIP	13.9%
Current Depletion Factor %	87.1%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	09/99
Estimated Decline	10.0%
Projected Ult. Recovery, Mbbls	822
Primary Recovery Factor %OOIP	16.0%
Cumulative Oil: Pore Volume	0.073
Cumulative Water: Pore Volume	0.279
Cumulative Injection: Pore Volume	
Production – Injection Difference: PV	

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NENE 08–52–68	Ratcliff #1			TA–Oil
SENE 08–52–68	Ratcliff #2			TA–Oil
NESE 08–52–68	Ratcliff #3	3,006	29,462	TA–Oil
NWNW 09–52–68	Wm–Fed #3	199,473	867,923	Pump–Oil
SWNW 09–52–68	Wm–Fed #1	346,081	1,130,394	Pump–Oil
NWSW 09–52–68	Schwinn #1	131,764	412,158	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

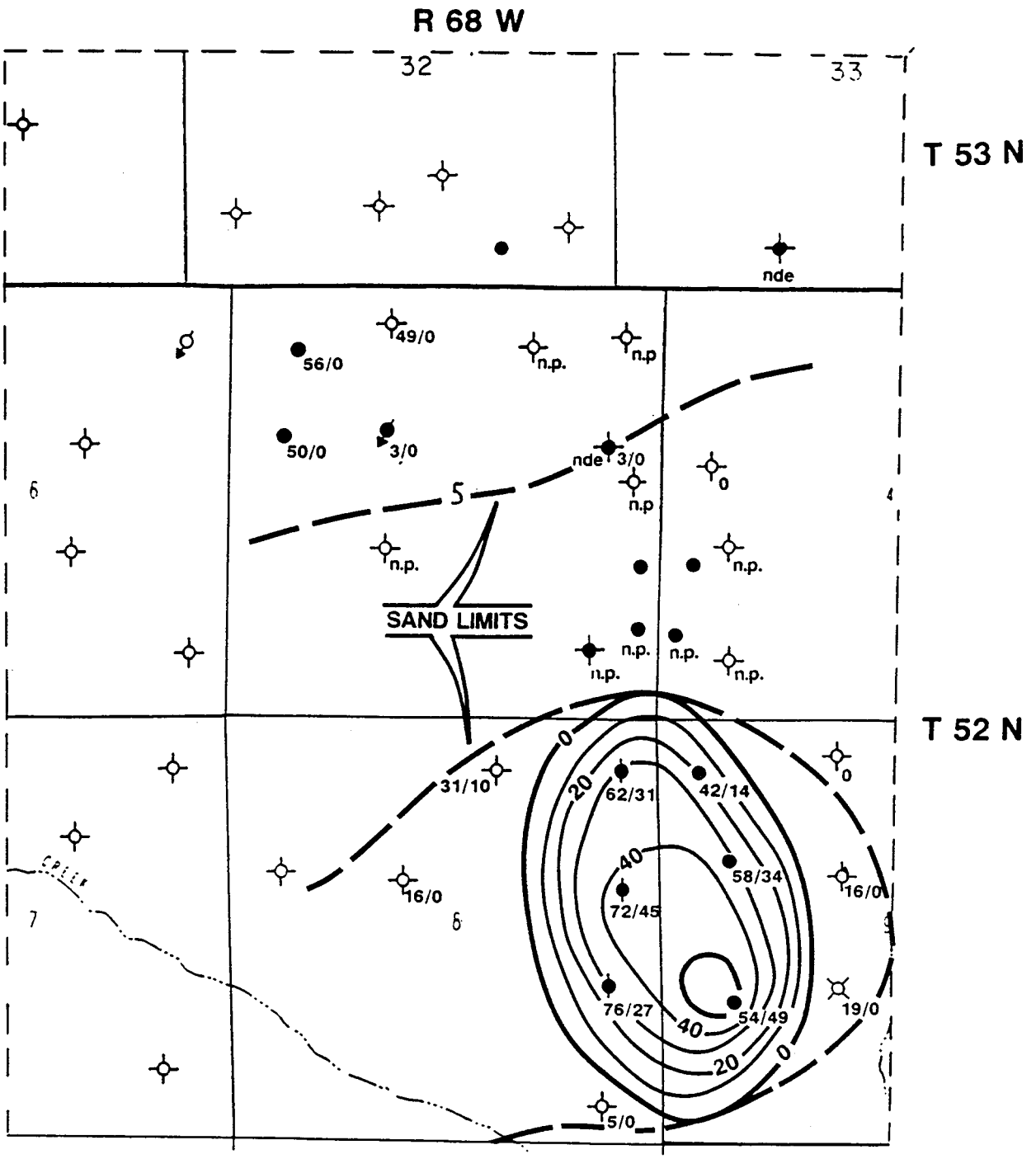
HEATH AREA

CROOK COUNTY, WYOMING

HEATH FIELD-MNLS C
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8-93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

HEATH AREA

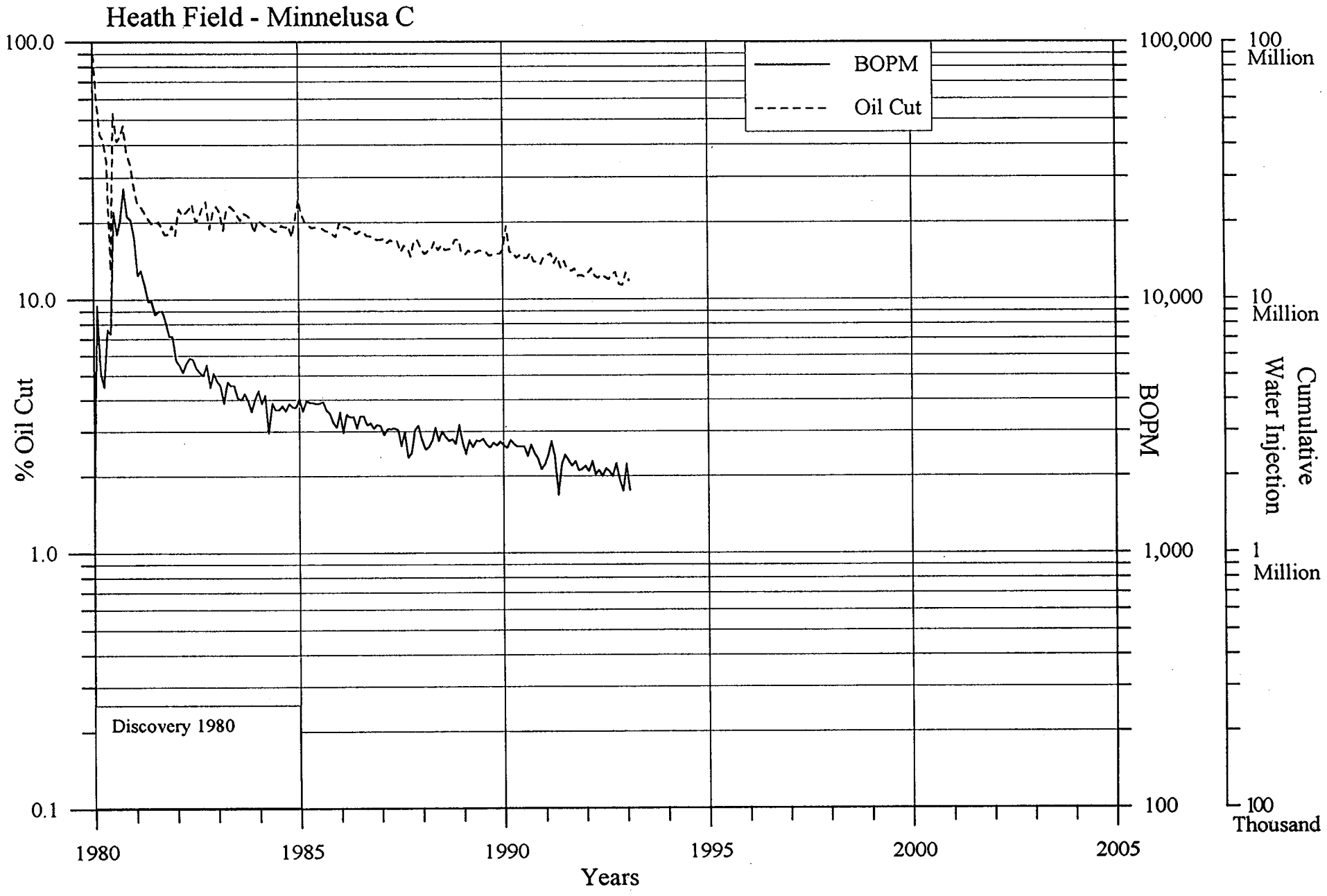
CROOK COUNTY, WYOMING

HEATH FIELD
MINNELUSA C
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8-93


Heath Field - Minnelusa C
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1980
1980
1985
1990
1995
2000
2005
Years

Heath North Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 4 & 5
Drive Mechanism:	Water Drive
Discovered:	1987
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	131,282
Water, bbls	506,119

Cumulative Production – thru 12/31/92	
Oil, Mbbls	684
Water, Mbbls	1,019
Injection, Mbbls	n.a.

Current Rates	
Oil, bopd	360
Oil Cut, %	20.6%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	
Estimated Decline	
Proj. Ultimate Recovery, Mbbls	801
Proj. Remaining Reserves, Mbbls	117
Estimated Remaining Life, Years (from 1/93)	2.1
OOIP: Pore Volume	0.571
Ultimate Recovery: Pore Volume	0.187
Remaining O.I.P.: Pore Volume	0.385

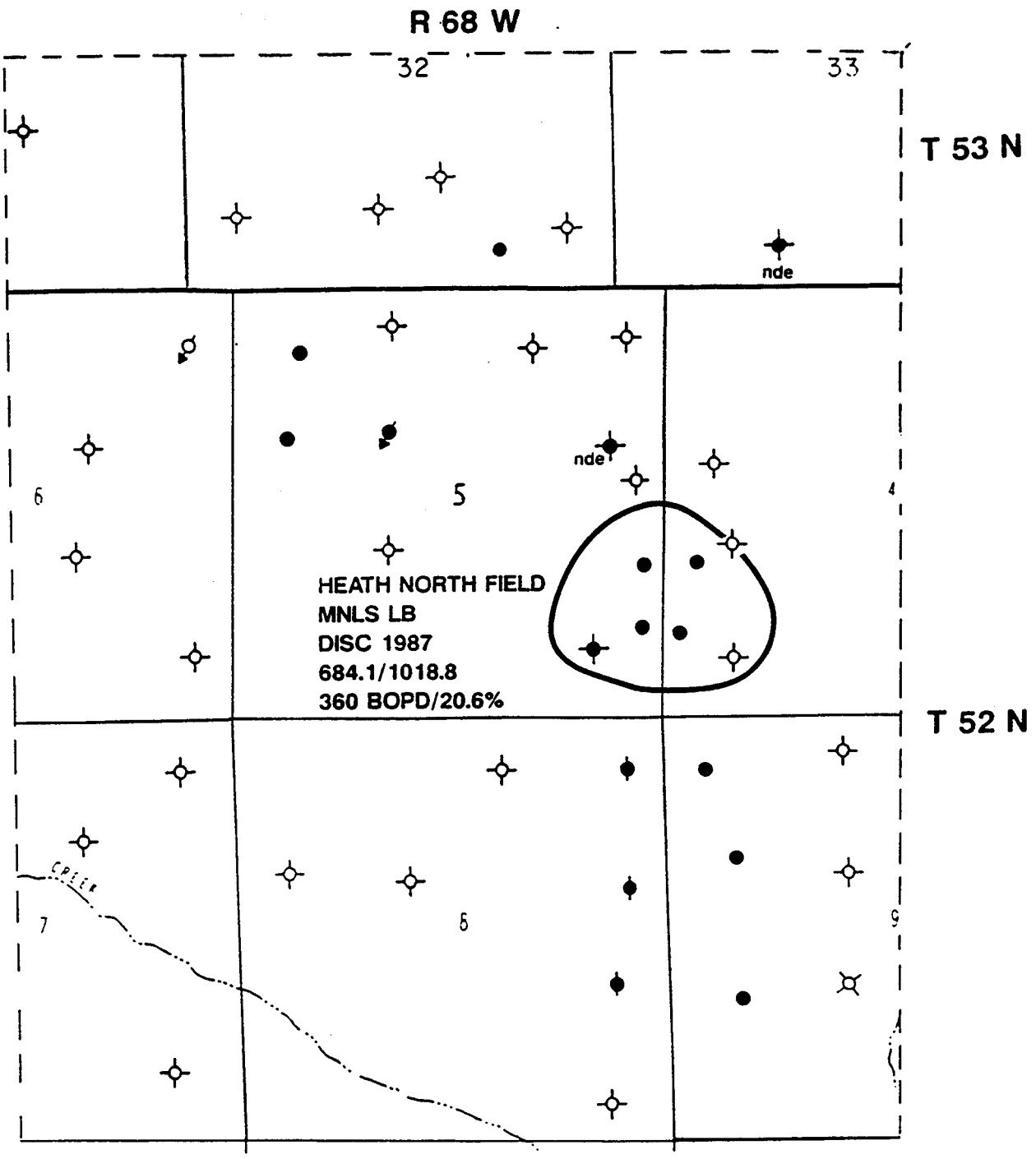
Oil Gravity	22.0
Oil Viscosity, cp	
Water Viscosity, cp	
Depth, feet	7,122
Formation Temperature, degrees F	150
Rw @ Formation Temperature	1.02

Reservoir Properties	
Volume, acre feet	2,060
Area, acres	88
Average Net Pay, feet	19.6
Average Porosity	26.9%
Average S_w	40.0%
FVF Factor	1.050
Pore Volume, Mbbls	4,291
Oil in Place, Mbbls	2,452
Est. Ult. Recovery Factor, %OOIP	32.7%
Current Recovery Factor %OOIP	27.9%
Current Depletion Factor %	85.4%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	80
End of Primary Decline	01/99
Estimated Decline	55.0%
Projected Ult. Recovery, Mbbls	801
Primary Recovery Factor %OOIP	32.7%
Cumulative Oil: Pore Volume	0.159
Cumulative Water: Pore Volume	0.237
Cumulative Injection: Pore Volume	n.a.
Production – Injection Difference: PV	n.a.

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSW 04–52–68	Miramar #	154,530	176,099	Pump–Oil
SWSW 04–52–68	Miramar #	265,712	241,587	Pump–Oil
NESE 05–52–68	Miramar #	129,526	261,910	Pump–Oil
NESESE 05–52–68	Miramar #	115,251	253,012	Pump–Oil
SENESE 05–52–68	Shiloh #1	19,111	86,236	TA–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

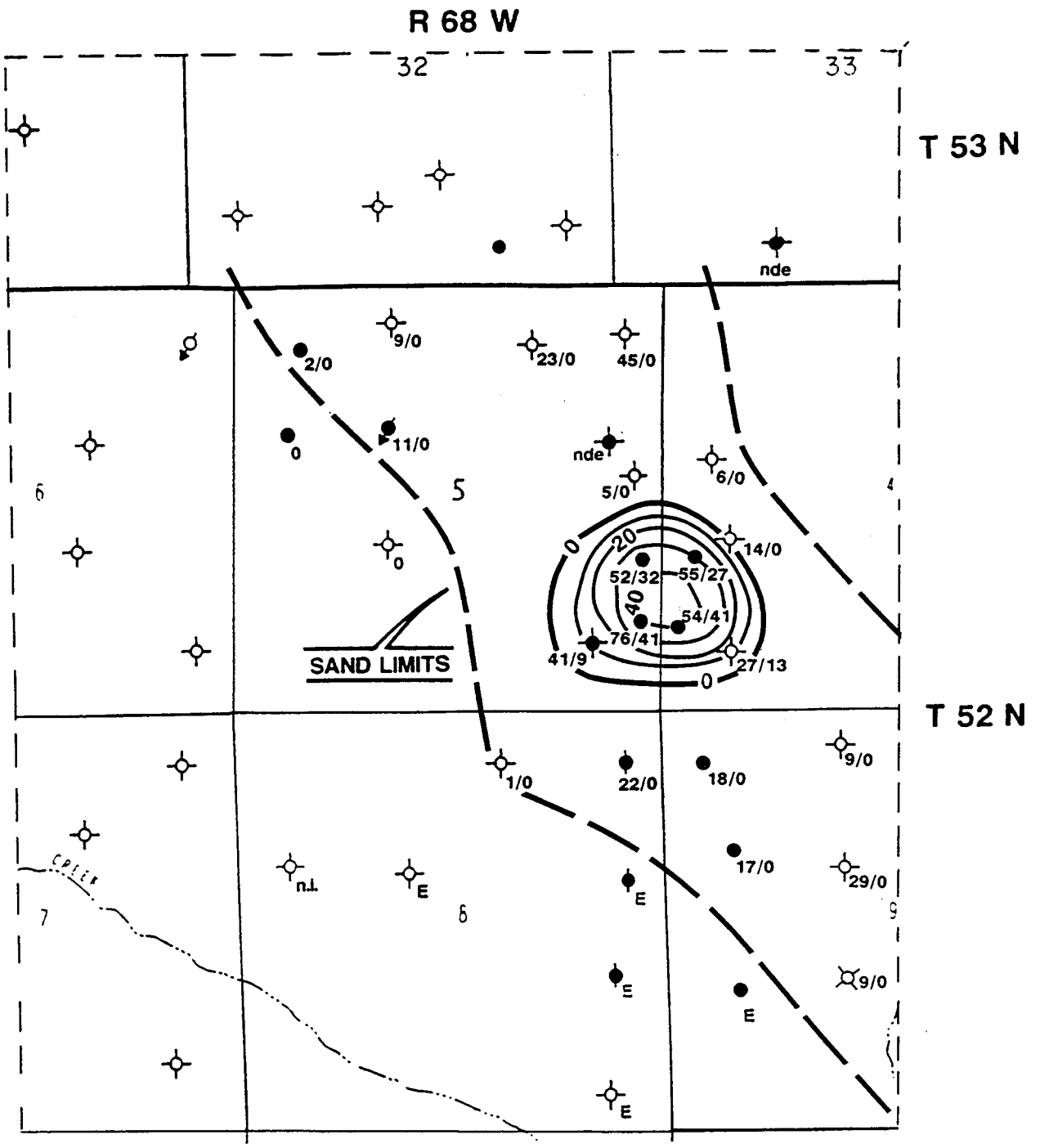
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

HEATH AREA

CROOK COUNTY, WYOMING

HEATH NORTH FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.l.	No Well Information
WATER DISPOSAL		

HEATH AREA

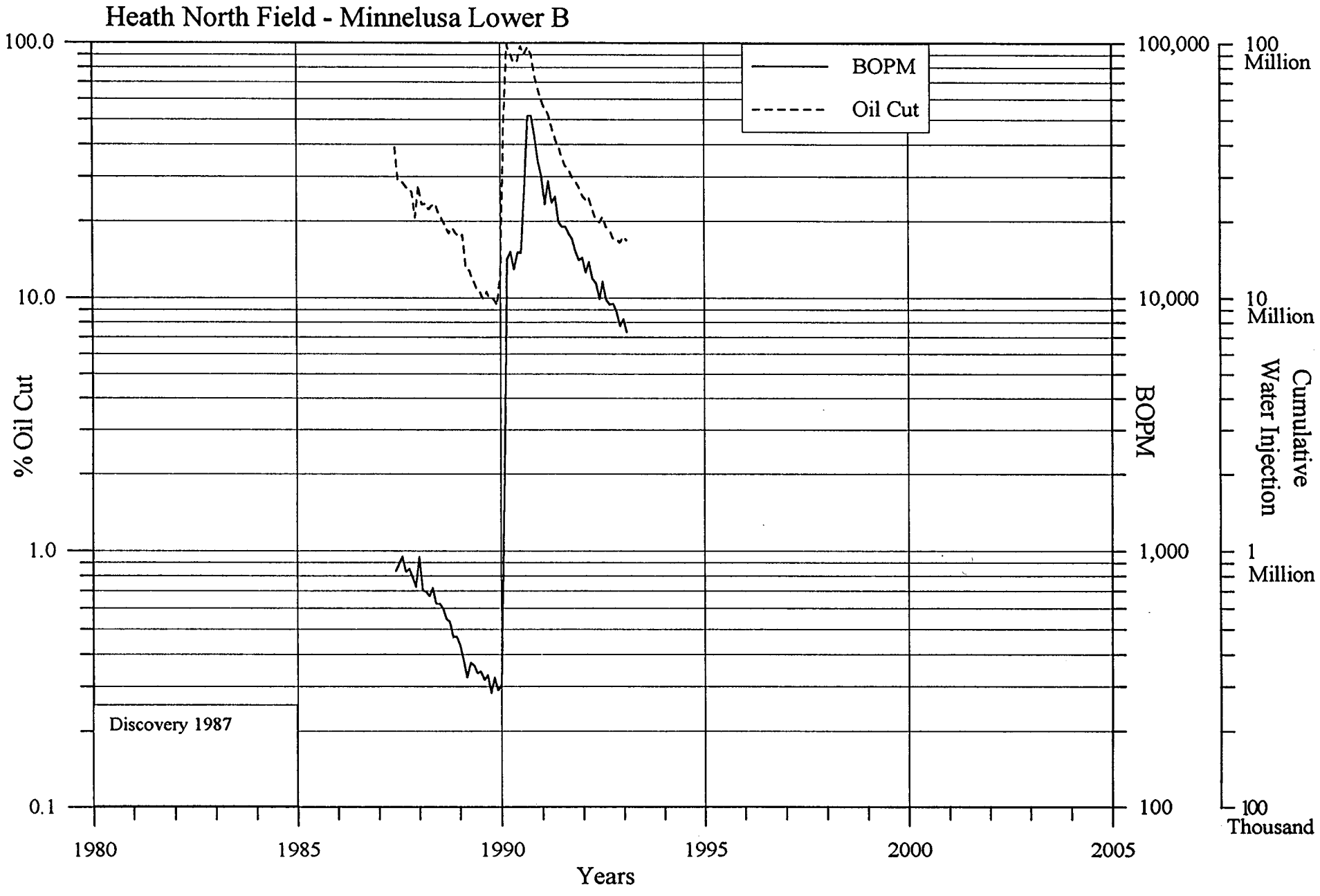
CROOK COUNTY, WYOMING

HEATH NORTH FIELD
MINNELUSA LB
ISOPACH: NET OIL PAY

C.I. = 10'

GEOLOGY: L.GRIFFITH

8-93


Heath North Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1987
1980
1985
1990
1995
2000
2005
Years

Hoover Gulch Field

Producing Zone:	Minnelusa Upper B
Location:	Campbell County, Wyoming
	TWP 52N – RGE 69W
	Section 24
Drive Mechanism:	Waterflood
Discovered:	1974
Unitized:	1986

Current Production – 1/1 to 12/31/92	
Oil, bbls	32,634
Water, bbls	44,140

Cumulative Production – thru 12/31/92	
Oil, Mbbls	350
Water, Mbbls	423
Injection, Mbbls	220

Current Rates	
Oil, bopd	89
Oil Cut, %	42.5%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	40
Oil Cut	
Estimated Decline	50.0%
Proj. Ultimate Recovery, Mbbls	655
Proj. Remaining Reserves, Mbbls	305
Estimated Remaining Life, Years (from 1/93)	14.4
OOIP: Pore Volume	0.724
Ultimate Recovery: Pore Volume	0.243
Remaining O.I.P.: Pore Volume	0.481

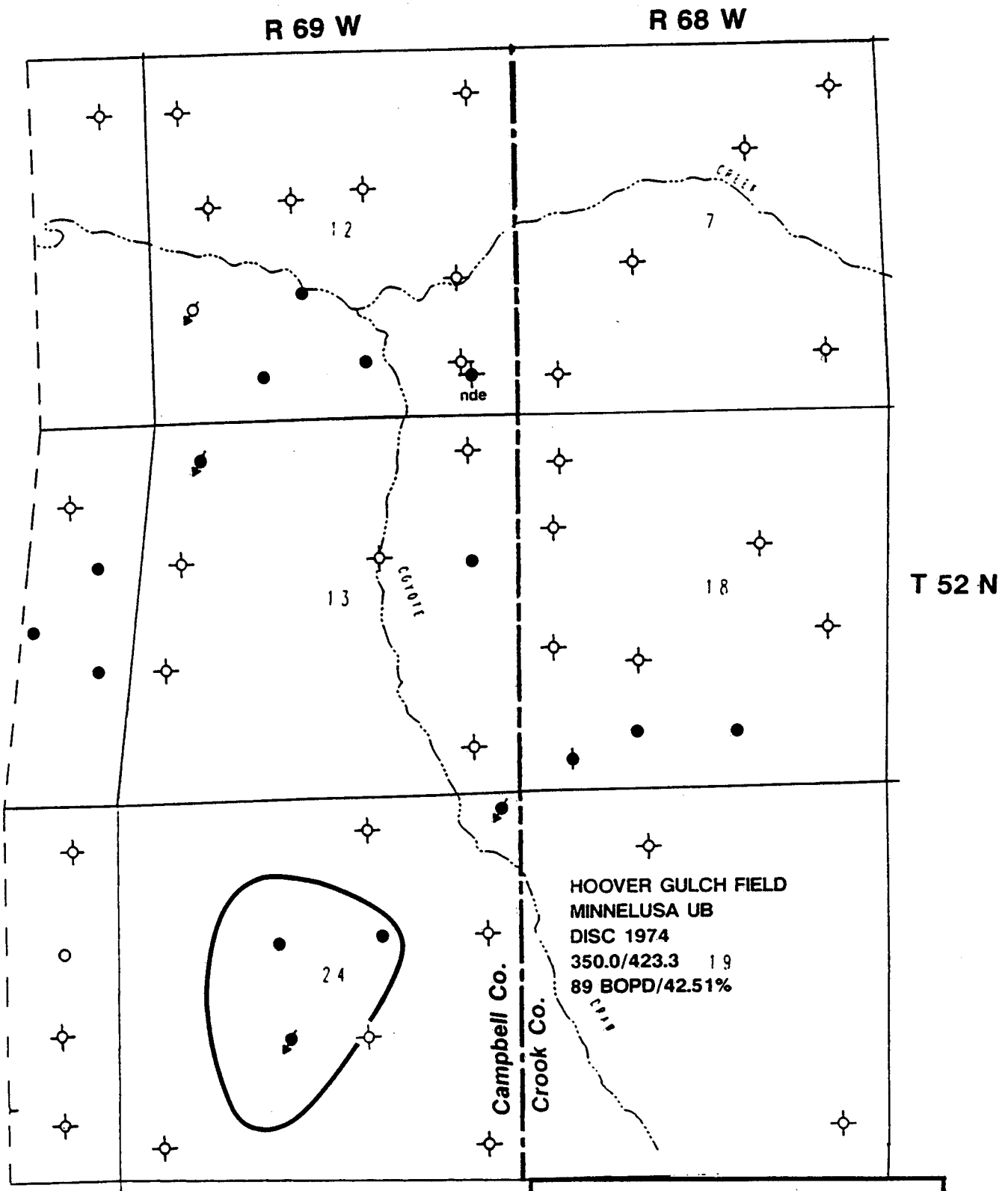
Oil Gravity	26.9
Oil Viscosity, cp	
Water Viscosity, cp	
Depth, feet	7,440
Formation Temperature, degrees F	135
Rw @ Formation Temperature	0.06

Reservoir Properties	
Volume, acre feet	2,078
Area, acres	124
Average Net Pay, feet	13.6
Average Porosity	16.7%
Average S_w	24.0%
FVF Factor	1.050
Pore Volume, Mbbls	2,697
Oil in Place, Mbbls	1,952
Est. Ult. Recovery Factor, %OOIP	33.5%
Current Recovery Factor %OOIP	17.9%
Current Depletion Factor %	53.5%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	02/1986
Estimated Decline	
Projected Ult. Recovery, Mbbls	126
Primary Recovery Factor %OOIP	6.5%
Cumulative Oil: Pore Volume	0.130
Cumulative Water: Pore Volume	0.157
Cumulative Injection: Pore Volume	0.082
Production – Injection Difference: PV	–0.205

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NESW 24–52–69	USA #21–1	55,946	146,187	Pump–Oil
SWNE 24–52–69	Govt #1	100,724	15,049	Injection
SENW 24–52–69	Fed #22–24	205,142	246,169	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SWNE 24–52–69	Govt #1	43,580	219,922	Injection



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL
- LOCATION

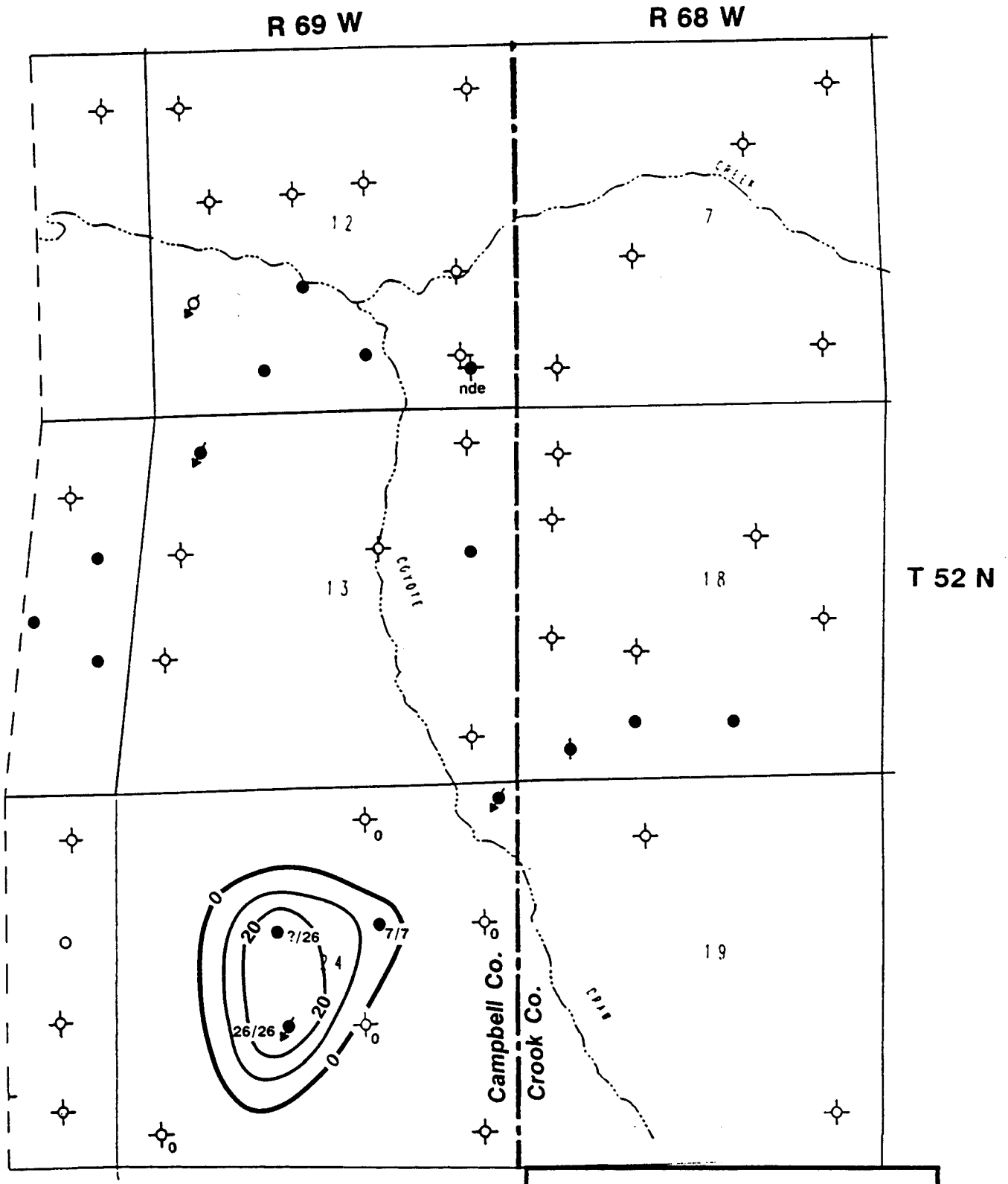
FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

BRACKEN AREA

CAMPBELL AND CROOK
COUNTIES, WYOMING

HOOVER GULCH FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH | 8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		
LOCATION		

BRACKEN AREA

CAMPBELL AND CROOK COUNTIES, WYOMING

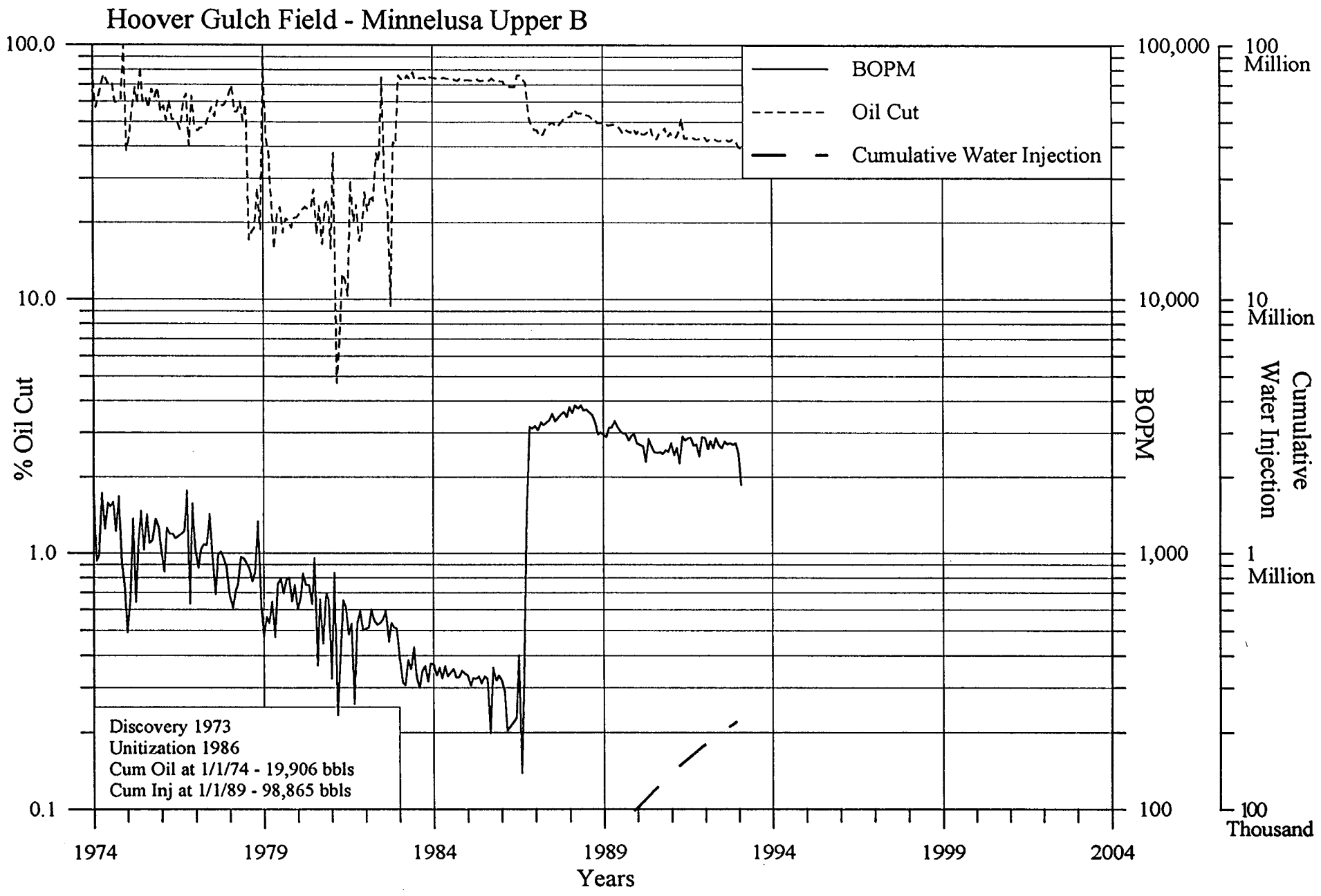
HOOVER GULCH FIELD

MINNELUSA UB

ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH 8/93


Hoover Gulch Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1973
Unitization 1986
Cum Oil at 1/1/74 - 19,906 bbls
Cum Inj at 1/1/89 - 98,865 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Kiehl Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 53 – RGE 67W
	Sections 30 & 31
Drive Mechanism:	Polymer Waterflood
Discovered:	1973
Unitized:	1985

Current Production – 1/1 to 12/31/92	
Oil, bbls	300,759
Water, bbls	383,664

Cumulative Production – thru 12/31/92	
Oil, Mbbls	2,524
Water, Mbbls	678
Injection, Mbbls	3,264

Current Rates	
Oil, bopd	824
Oil Cut, %	43.9%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	10.0%
Proj. Ultimate Recovery, Mbbls	4,726
Proj. Remaining Reserves, Mbbls	2,202
Estimated Remaining Life, Years (from 1/93)	19.8
OOIP: Pore Volume	0.748
Ultimate Recovery: Pore Volume	0.260
Remaining O.I.P.: Pore Volume	0.488

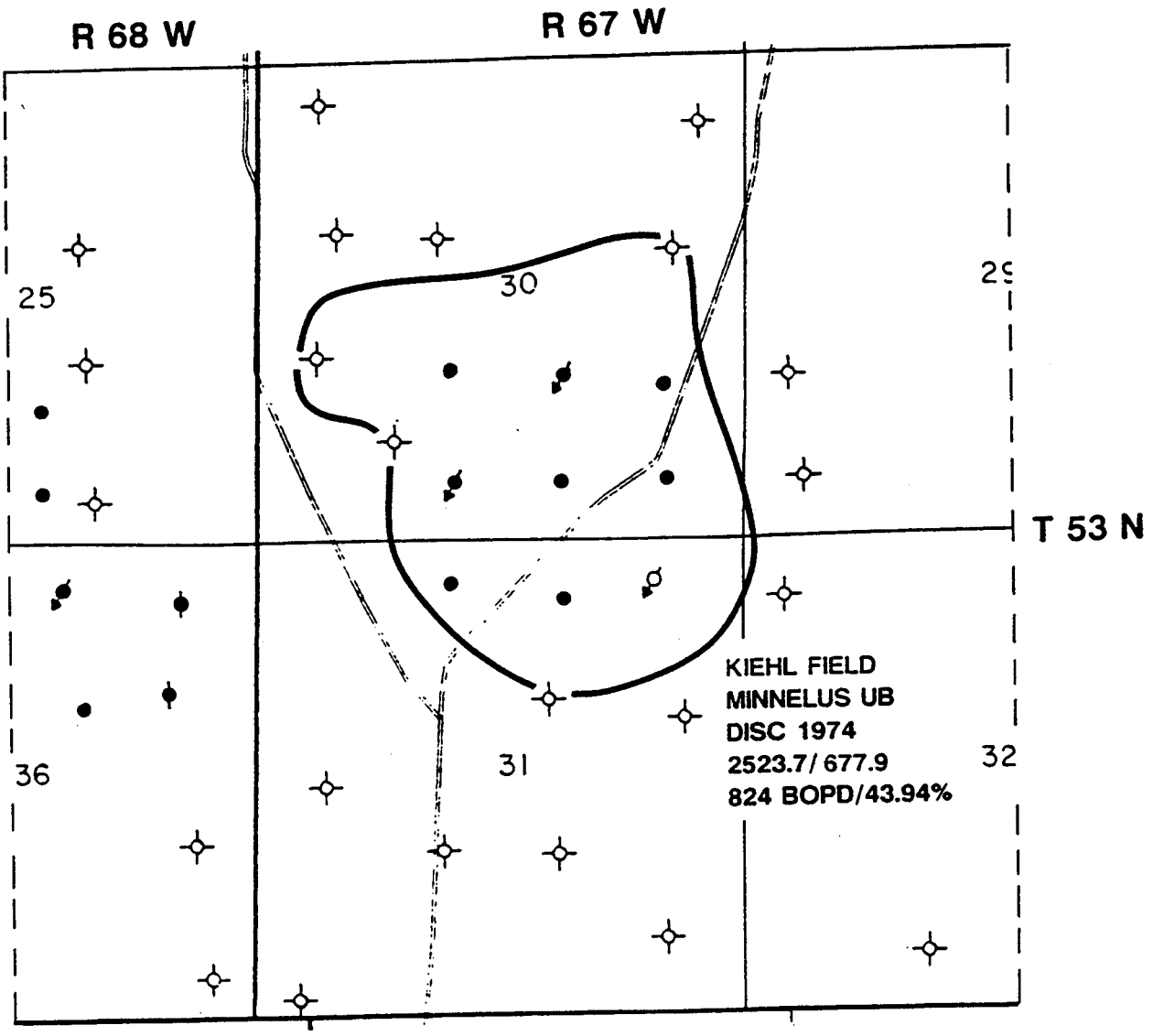
Oil Gravity	21.8
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	6,364
Formation Temperature, degrees F	137
Rw @ Formation Temperature	0.15

Reservoir Properties	
Volume, acre feet	10,621
Area, acres	307
Average Net Pay, feet	34.6
Average Porosity	22.1%
Average S_w	23.0%
FVF Factor	1.030
Pore Volume, Mbbls	18,210
Oil in Place, Mbbls	13,613
Est. Ult. Recovery Factor, %OOIP	34.7%
Current Recovery Factor %OOIP	18.5%
Current Depletion Factor %	53.4%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	05/1985
Estimated Decline	30.0%
Projected Ult. Recovery, Mbbls	789
Primary Recovery Factor %OOIP	5.8%
Cumulative Oil: Pore Volume	0.139
Cumulative Water: Pore Volume	0.037
Cumulative Injection: Pore Volume	0.179
Production – Injection Difference: PV	0.003

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NESE 30–53–67	Kiehl #9	19,114	1,568	Pump–Oil
NWSE 30–53–67	Kiehl #4	79,176	2,188	Injection
NESW 30–53–67	Kilroy #30–1	106,296	34,616	Pump–Oil
SESW 30–53–67	Kiehl #2	74,839	511	Pump–Oil
SWSE 30–53–67	Kiehl #7	33,481	191,612	Injection
SESE 30–53–67	Kiehl #3	1,066,604	60,546	Pump–Oil
NWNE 32–53–67	Kiehl #1	1,102,158	381,883	Pump–Oil
NENW 31–53–67	Reynolds #1	52,386	2,713	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SESW 30–53–67	Kiehl #2	346,539	1,872,212	Injection
NWSE 30–53–67	Kiehl #4	407,996	1,259,974	Injection
NENE 31–53–67	Kiehl #6	55,770	131,919	Injection



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL

FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

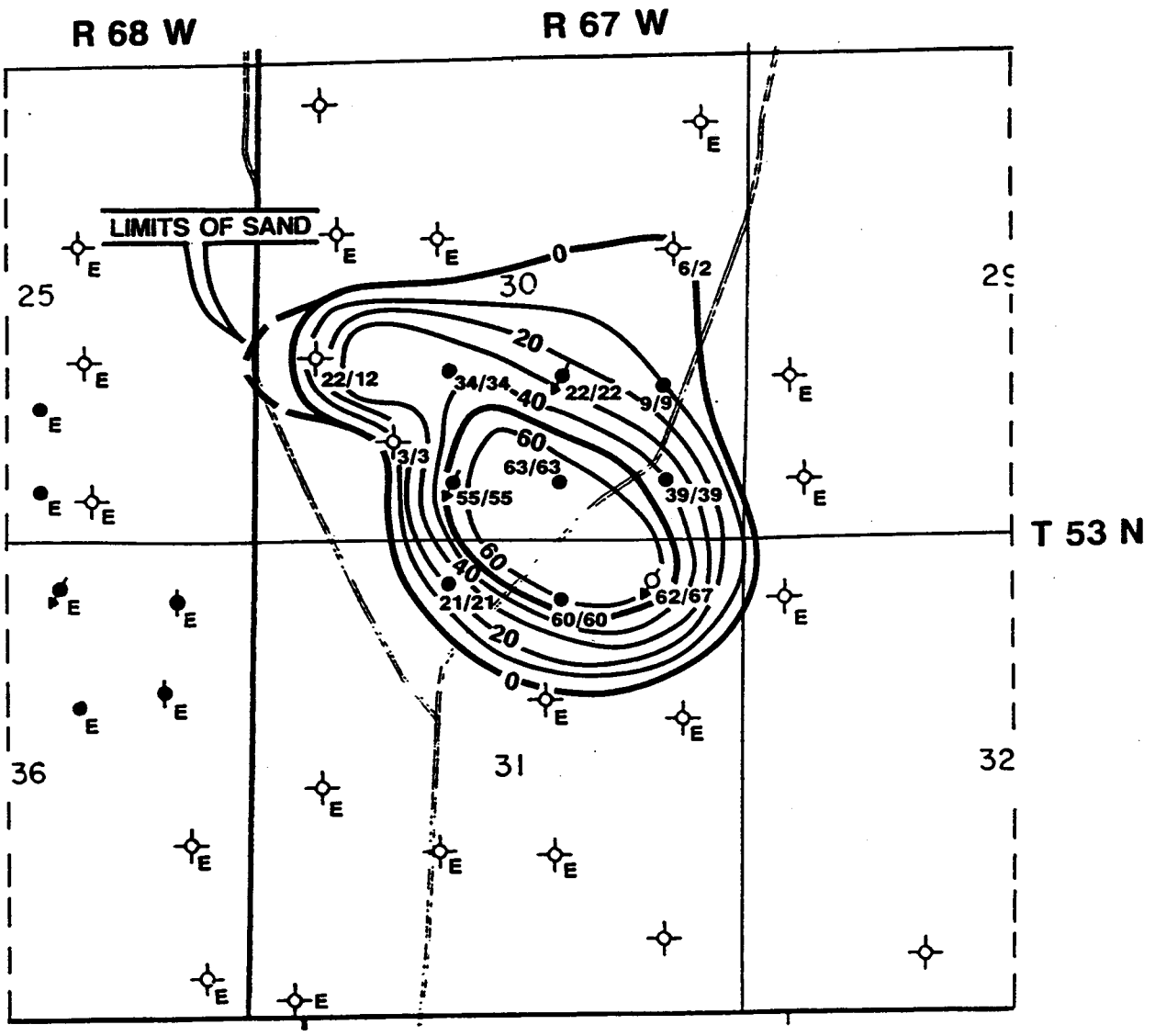
KIEHL AREA

CROOK COUNTY, WYOMING

KIEHL FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

KIEHL AREA

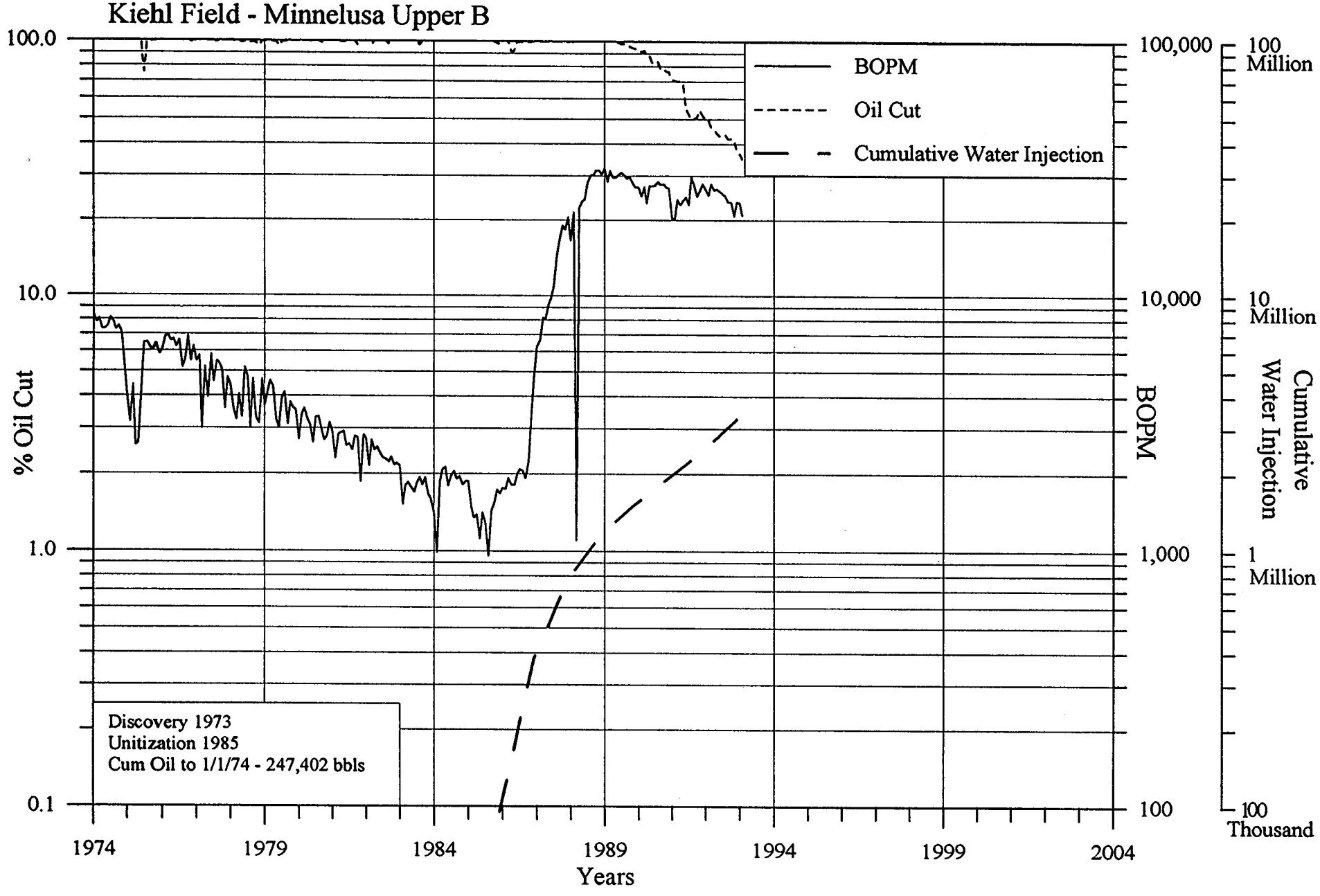
CROOK COUNTY, WYOMING

KIEHL FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Kiehl Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1973
Unitization 1985
Cum Oil to 1/1/74 - 247,402 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Kiehl West Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 53 – RGE 68W
	Sections 25 & 36
Drive Mechanism:	ASP Waterflood
Discovered:	1985
Unitized:	1987

Current Production – 1/1 to 12/31/92	
Oil, bbls	76,000
Water, bbls	126,075

Cumulative Production – thru 12/31/92	
Oil, Mbbls	783
Water, Mbbls	242
Injection, Mbbls	1,073

Current Rates	
Oil, bopd	208
Oil Cut, %	37.6%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	40
Oil Cut	
Estimated Decline	25.0%
Proj. Ultimate Recovery, Mbbls	1,003
Proj. Remaining Reserves, Mbbls	220
Estimated Remaining Life, Years (from 1/93)	5.3
OOIP: Pore Volume	0.704
Ultimate Recovery: Pore Volume	0.325
Remaining O.I.P.: Pore Volume	0.379

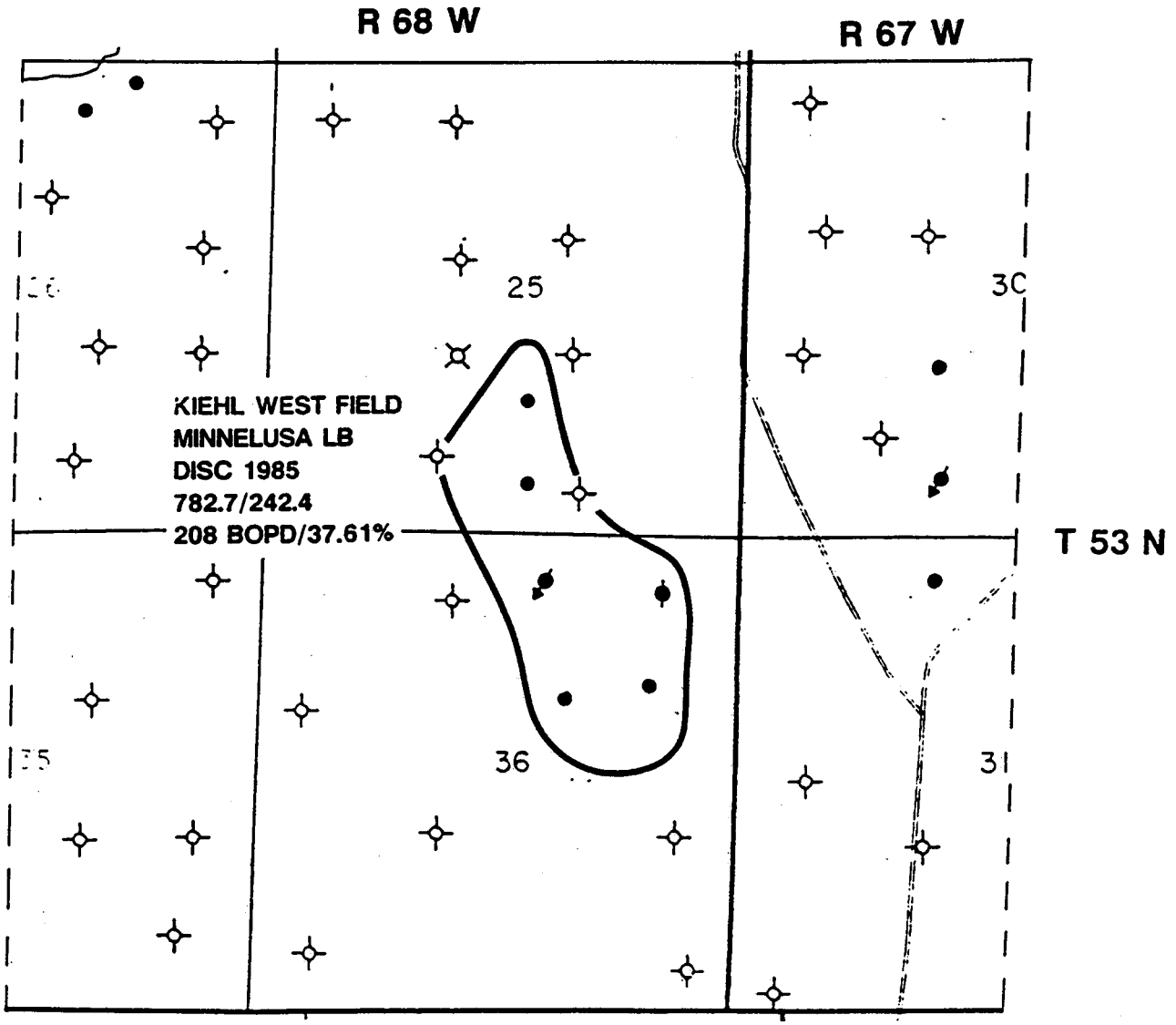
Oil Gravity	24.0
Oil Viscosity, cp	19.5
Water Viscosity, cp	0.6
Depth, feet	6,671
Formation Temperature, degrees F	134
Rw @ Formation Temperature	0.25

Reservoir Properties	
Volume, acre feet	2,086
Area, acres	145
Average Net Pay, feet	14.4
Average Porosity	19.1%
Average S_w	27.5%
FVF Factor	1.030
Pore Volume, Mbbls	3,084
Oil in Place, Mbbls	2,170
Est. Ult. Recovery Factor, %OOIP	46.2%
Current Recovery Factor %OOIP	36.1%
Current Depletion Factor %	78.0%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	08/87
Estimated Decline	35.0%
Projected Ult. Recovery, Mbbls	96
Primary Recovery Factor %OOIP	4.4%
Cumulative Oil: Pore Volume	0.254
Cumulative Water: Pore Volume	0.079
Cumulative Injection: Pore Volume	0.348
Production – Injection Difference: PV	0.015

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSE 25–53–68	Kottraba #10	14,542	6,625	Pump–Oil
SWSE 25–53–68	Kottraba #15	214,805	139,580	Pump–Oil
NENE 36–53–68	State #41	6,551	4,911	SI–Oil
NWNE 36–53–68	State #31	69,071	33	Injection
SWNE 36–53–68	State #32	176,043	53,381	Pump–Oil
SENE 36–53–68	State #42	303,171	37,871	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NWNE 36–53–68	State #31	220,821	1,072,540	Injection



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL

FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

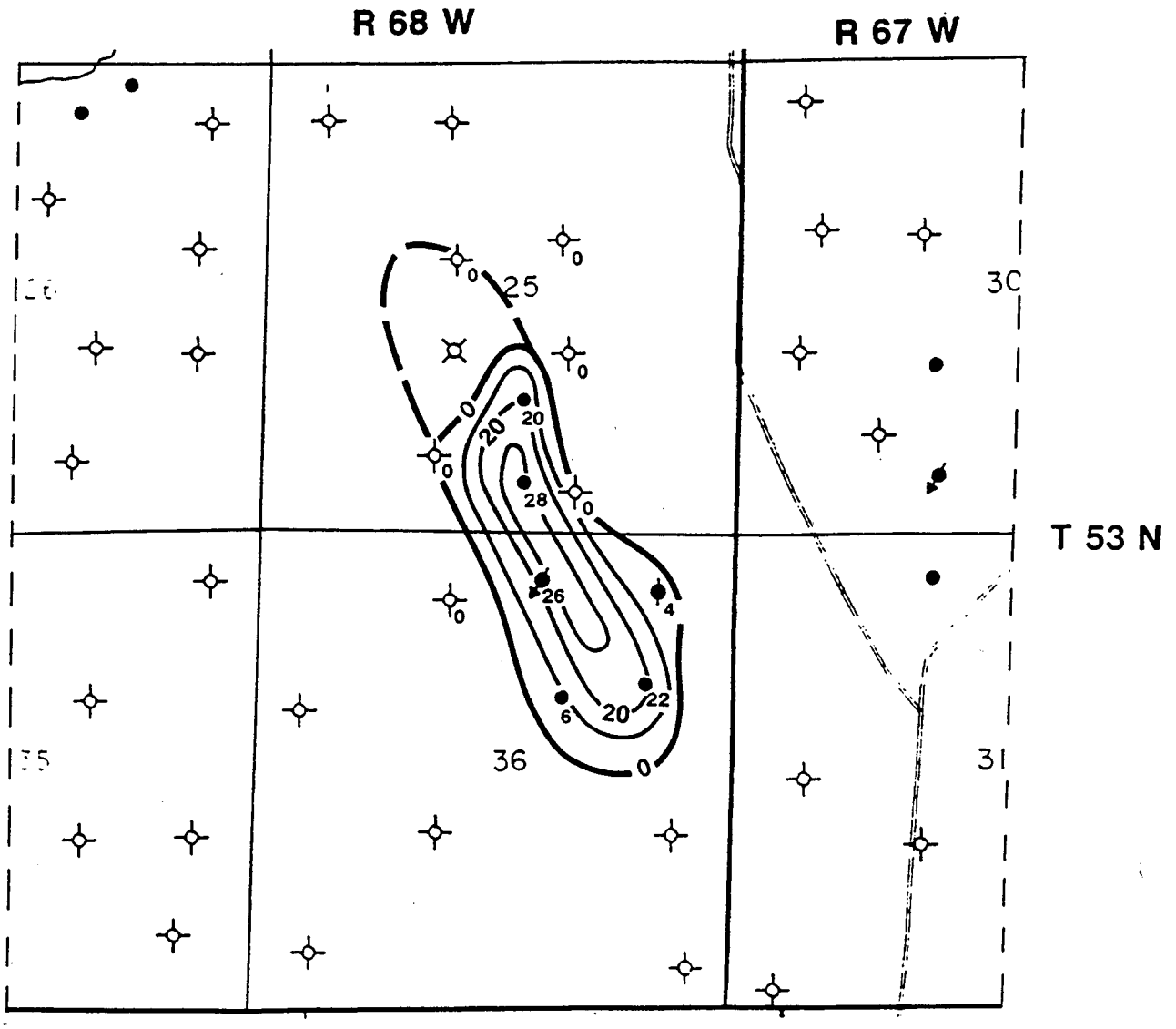
KIEHL WEST AREA

CROOK COUNTY, WYOMING

KIEHL WEST FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⧫	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
☌	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		

KIEHL WEST AREA

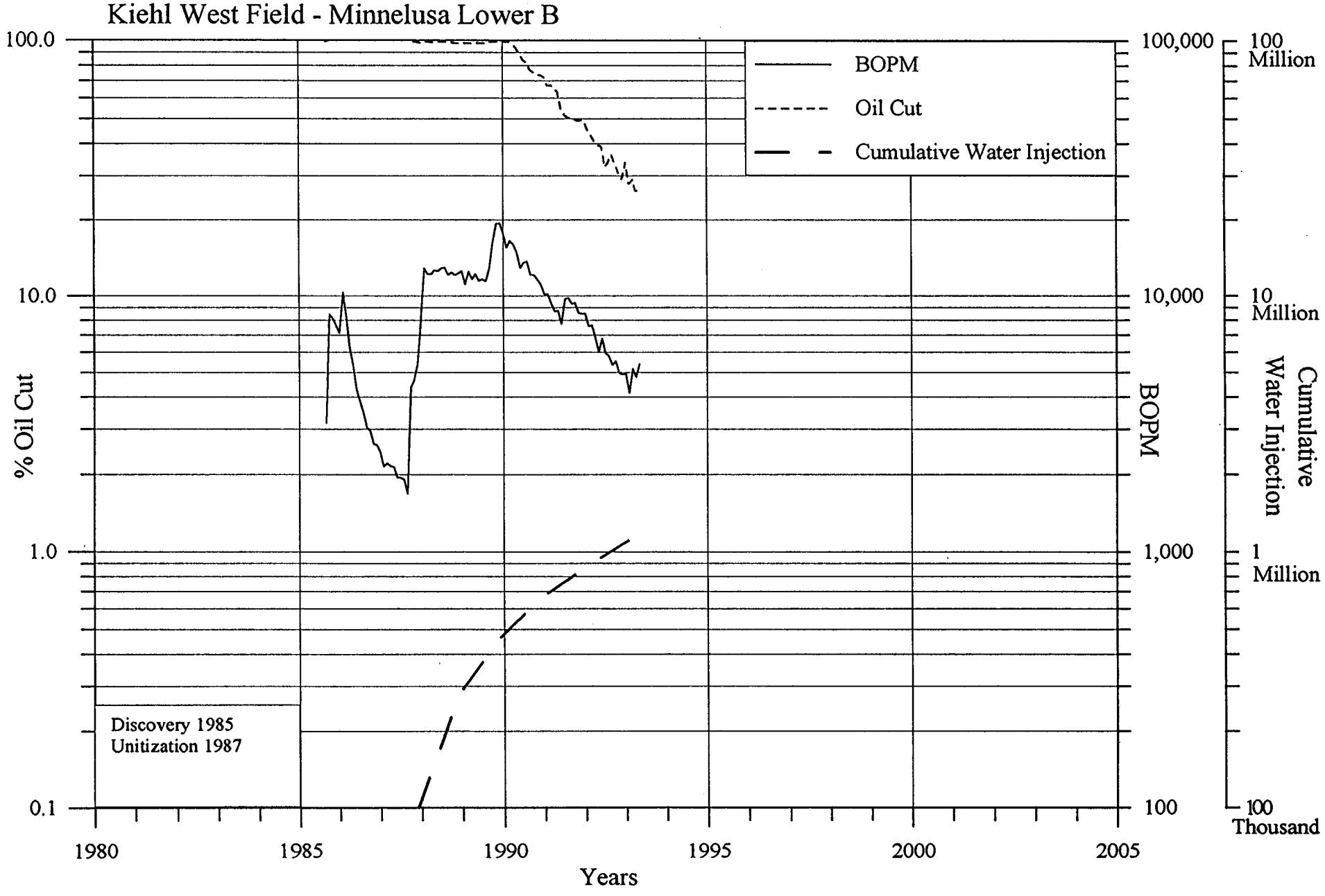
CROOK COUNTY, WYOMING

KIEHL WEST FIELD
MINNELUSA LB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Kiehl West Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1985
Unitization 1987
1980
1985
1990
1995
2000
2005
Years

Lad Field

Producing Zone:	Minnelusa A & Upper B
Location:	Crook County, Wyoming
	TWP 54 – RGE 67W
	Sections 17, 18 & 19
Drive Mechanism:	Polymer Waterflood
Discovered:	1978
Unitized:	1982

Current Production – 1/1 to 12/31/92	
Oil, bbls	84,534
Water, bbls	326,536

Cumulative Production – thru 12/31/92	
Oil, Mbbls	2,664
Water, Mbbls	1,890
Injection, Mbbls	4,674

Current Rates	
Oil, bopd	232
Oil Cut, %	20.6%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	100
Oil Cut	
Estimated Decline	20.0%
Proj. Ultimate Recovery, Mbbls	2,848
Proj. Remaining Reserves, Mbbls	184
Estimated Remaining Life, Years (from 1/93)	3.5
OOIP: Pore Volume	0.631
Ultimate Recovery: Pore Volume	0.211
Remaining O.I.P.: Pore Volume	0.420

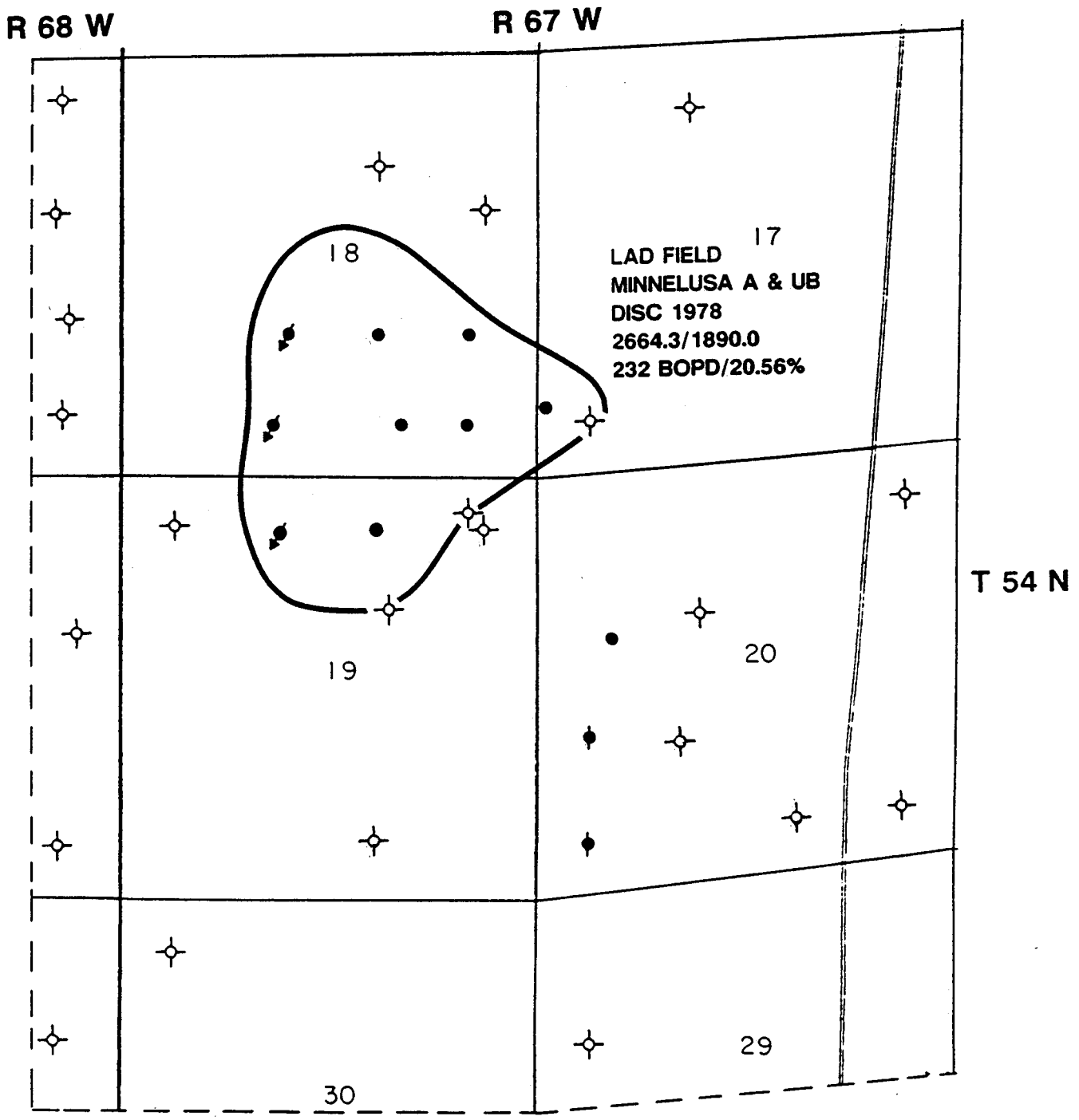
Oil Gravity		21.3
Oil Viscosity, cp		n.i.
Water Viscosity, cp		n.i.
Depth, feet		6,062
Formation Temperature, degrees F		112
Rw @ Form. Temp.	0.25	0.28

Reservoir Properties	A	UB	A & UB
Volume, acre feet	316	8,596	8,912
Area, acres	36	323	323
Average Net Pay, feet	8.9	26.9	27.6
Average Porosity	23.0%	19.4%	21.2%
Average S_w	35.0%	35.0%	35.0%
FVF Factor	1.030	1.030	1.030
Pore Volume, Mbbls	563	12,938	13,501
Oil in Place, Mbbls	355	8,165	8,520
Est. Ult. Recovery Factor, %OOIP			33.4%
Current Recovery Factor %OOIP			31.3%
Current Depletion Factor %			93.5%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	02/1982
Estimated Decline	45.0%
Projected Ult. Recovery, Mbbls	385
Primary Recovery Factor %OOIP	4.5%
Cumulative Oil: Pore Volume	0.197
Cumulative Water: Pore Volume	0.140
Cumulative Injection: Pore Volume	0.346
Production – Injection Difference: PV	0.009

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWSW 17–54–67	Shepherd #11	97,879	2,872	Pump–Oil
SWSE 18–54–67	Shepherd #1	466,205	448,295	Pump–Oil
SESW 18–54–67	Shepherd #2	27,091	40,159	Injection
SESE 18–54–67	Shepherd #4	1,056,001	282,132	Pump–Oil
NWSE 18–54–67	Shepherd #5	532,676	670,009	Pump–Oil
NESE 18–54–67	Shepherd #6	112,985	4,395	Pump–Oil
NESW 18–54–67	Shepherd #8	1,371	8,687	Injection
NWNE 19–54–67	Shepherd #3	472,254	429,905	Pump–Oil
NENW 19–54–67	Shepherd #9	729	6,443	Injection

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SESW 18–54–67	Shepherd #2	93,357	2,307,128	Injection
NESW 18–54–67	Shepherd #8	162,031	1,190,868	Injection
NENW 19–54–67	Shepherd #9	181,002	1,176,180	Injection



LEGEND

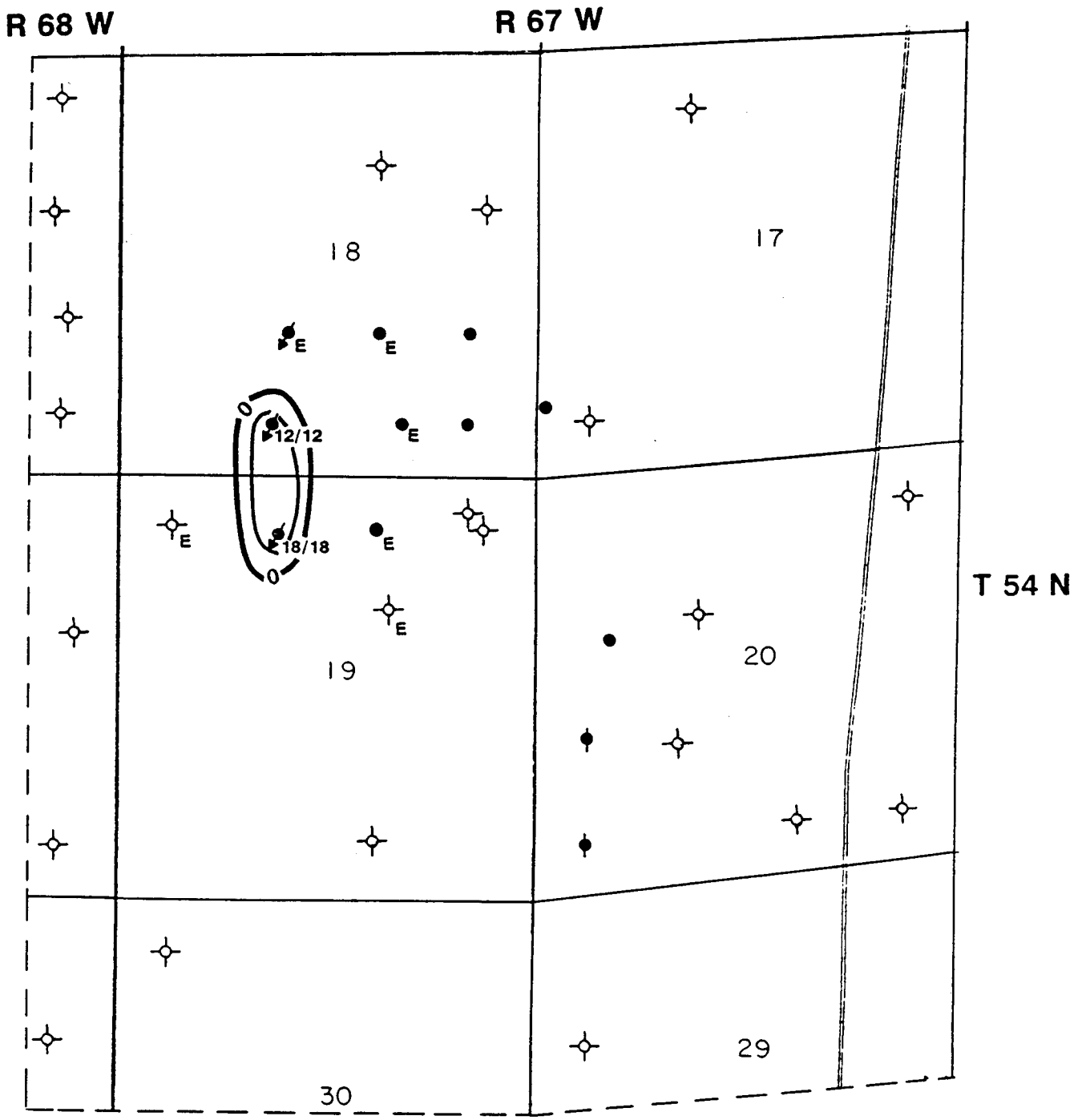
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

LAD AREA

CROOK COUNTY, WYOMING

LAD FIELD
MINNELUSA A & UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

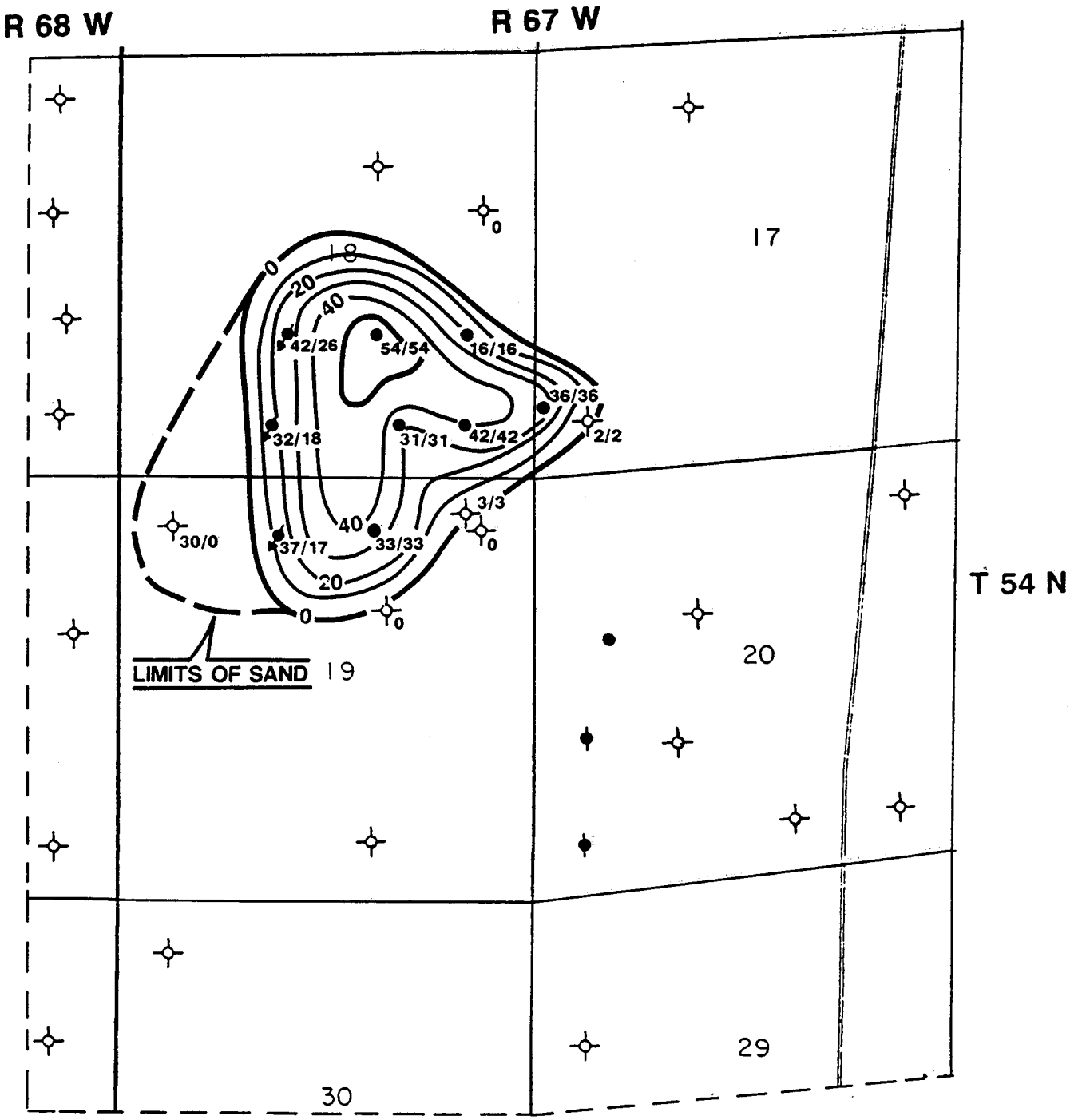
LAD AREA

CROOK COUNTY, WYOMING

LAD FIELD
MINNELUSA A
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

LAD AREA

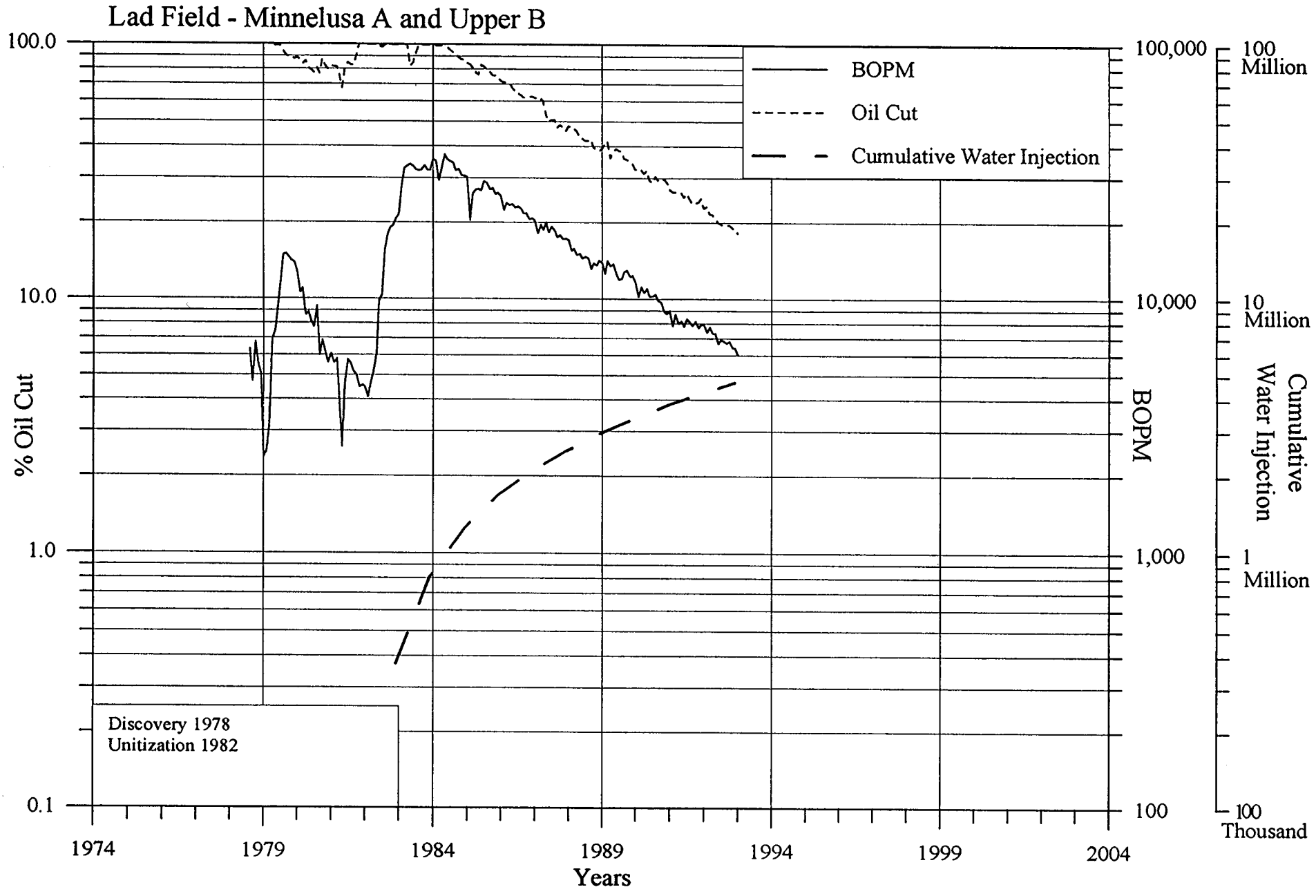
CROOK COUNTY, WYOMING

LAD FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Lad Field - Minnelusa A and Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1978
Unitization 1982
1974
1979
1984
1989
1994
1999
2004
Years

Lily Field

Producing Zone:	Minnelusa A & Upper B
Location:	Crook County, Wyoming
	TWP 54N – RGE 68W
	Sections 26, 27, 34 & 35
Drive Mechanism:	Waterflood
Discovered:	1984
Unitized:	1987

	A
Oil Gravity	21.7
Oil Viscosity, cp	17.2
Water Viscosity, cp	n.i.
Depth, feet	6,461
Formation Temperature, degrees F	140
Rw @ Formation Temperature	0.13

Current Production – 1/1 to 12/31/92	
Oil, bbls	181,941
Water, bbls	682,172
Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,951
Water, Mbbls	1,453
Injection, Mbbls	3,364
Current Rates	
Oil, bopd	498
Oil Cut, %	21.1%

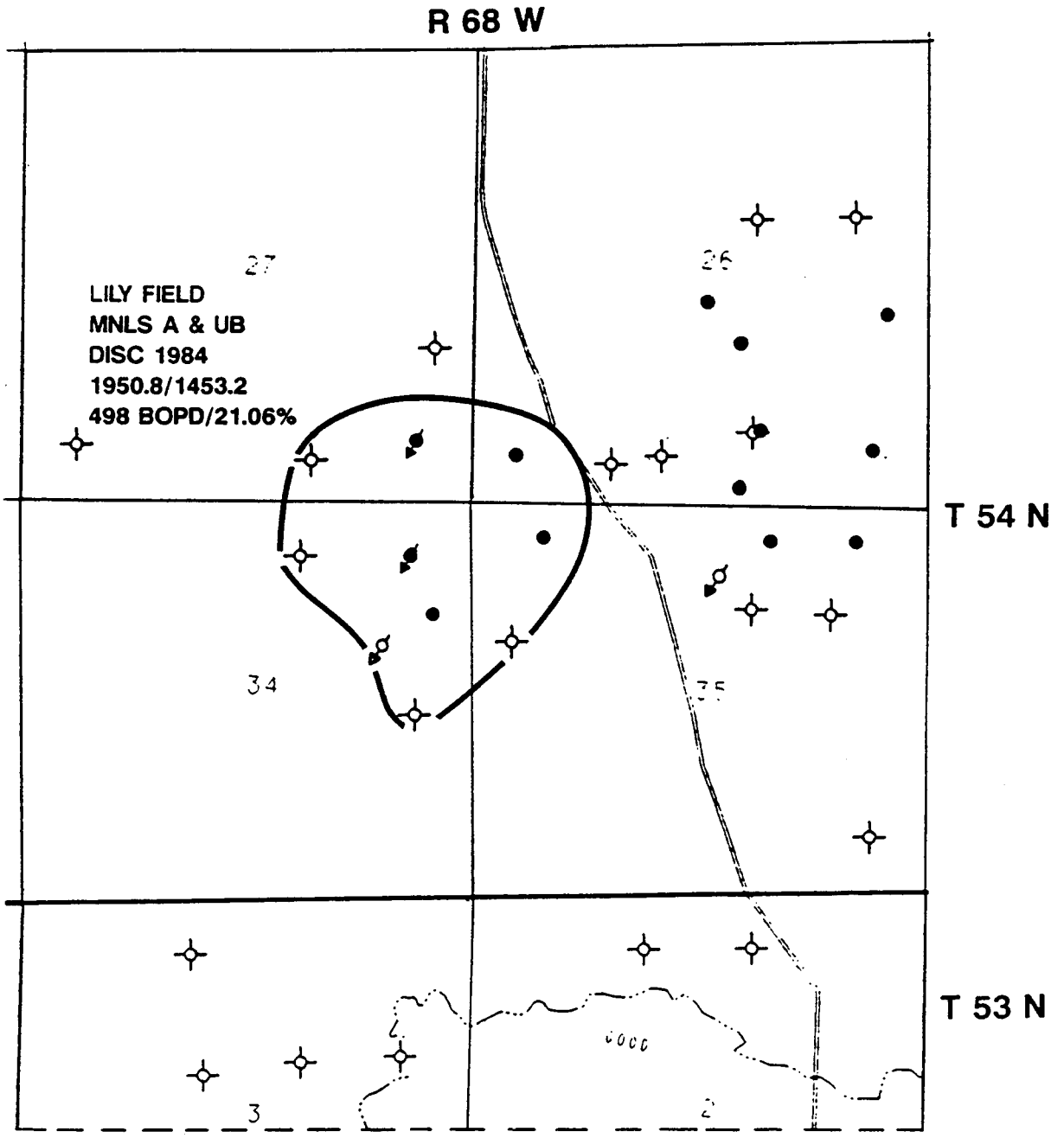
Reservoir Properties	A	UB	Total
Volume, acre feet	807	4,270	5,077
Area, acres	54	213	213
Average Net Pay, feet	14.8	20.0	23.8
Average Porosity	18.2%	24.5%	21.3%
Average S_w	23.0%	23.0%	23.0%
FVF Factor	1.040	1.040	1.040
Pore Volume, Mbbls	1,138	8,102	9,240
Oil in Place, Mbbls	843	5,999	6,841
Est. Ult. Recovery Factor, %OOIP			31.7%
Current Recovery Factor %OOIP			28.5%
Current Depletion Factor %			90.1%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	45.0%
Proj. Ultimate Recovery, Mbbls	2,166
Proj. Remaining Reserves, Mbbls	215
Estimated Remaining Life, Years (from 1/93)	2.6
OOIP: Pore Volume	0.740
Ultimate Recovery: Pore Volume	0.234
Remaining O.I.P.: Pore Volume	0.506

Primary Deline Analysis	A
Economic Cutoff	
Oil Cut	5.0%
End of Primary Decline	07/878
Estimated Decline	40.0%
Projected Ult. Recovery, Mbbls	768
Primary Recovery Factor %OOIP	11.2%
Cumulative Oil: Pore Volume	0.211
Cumulative Water: Pore Volume	0.157
Cumulative Injection: Pore Volume	0.364
Production – Injection Difference: PV	–0.004

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWSW 26–54–68	Govt #1–26	501,911	305,496	Pump–Oil
SESE 27–54–68	Govt #2–27	204,264	166,273	Injection
NENE 34–54–68	Lily #2–34	133,273	23,429	Injection
SENE 34–54–68	Govt #3–34	395,597	392,733	Pump–Oil
NWNW 35–54–68	Govt #1–35	715,975	565,194	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SESE 27–54–68	Unit #2	436,393	1,196,914	Injection
NENE 34–54–68	Unit #1	417,110	2,167,299	Injection



LEGEND

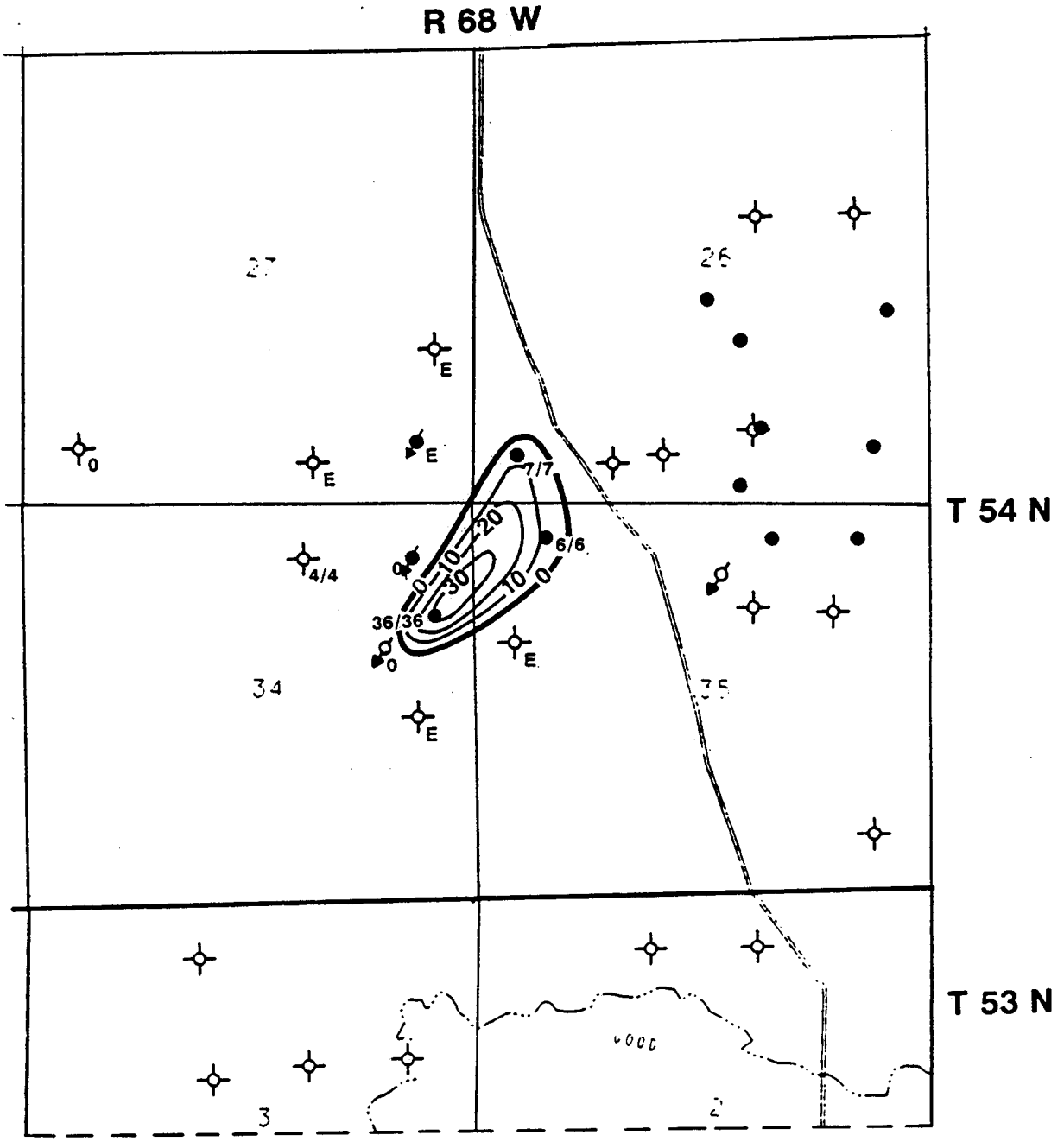
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

LILY AREA
CROOK COUNTY, WYOMING

LILY FIELD
MINNELUSA A & UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

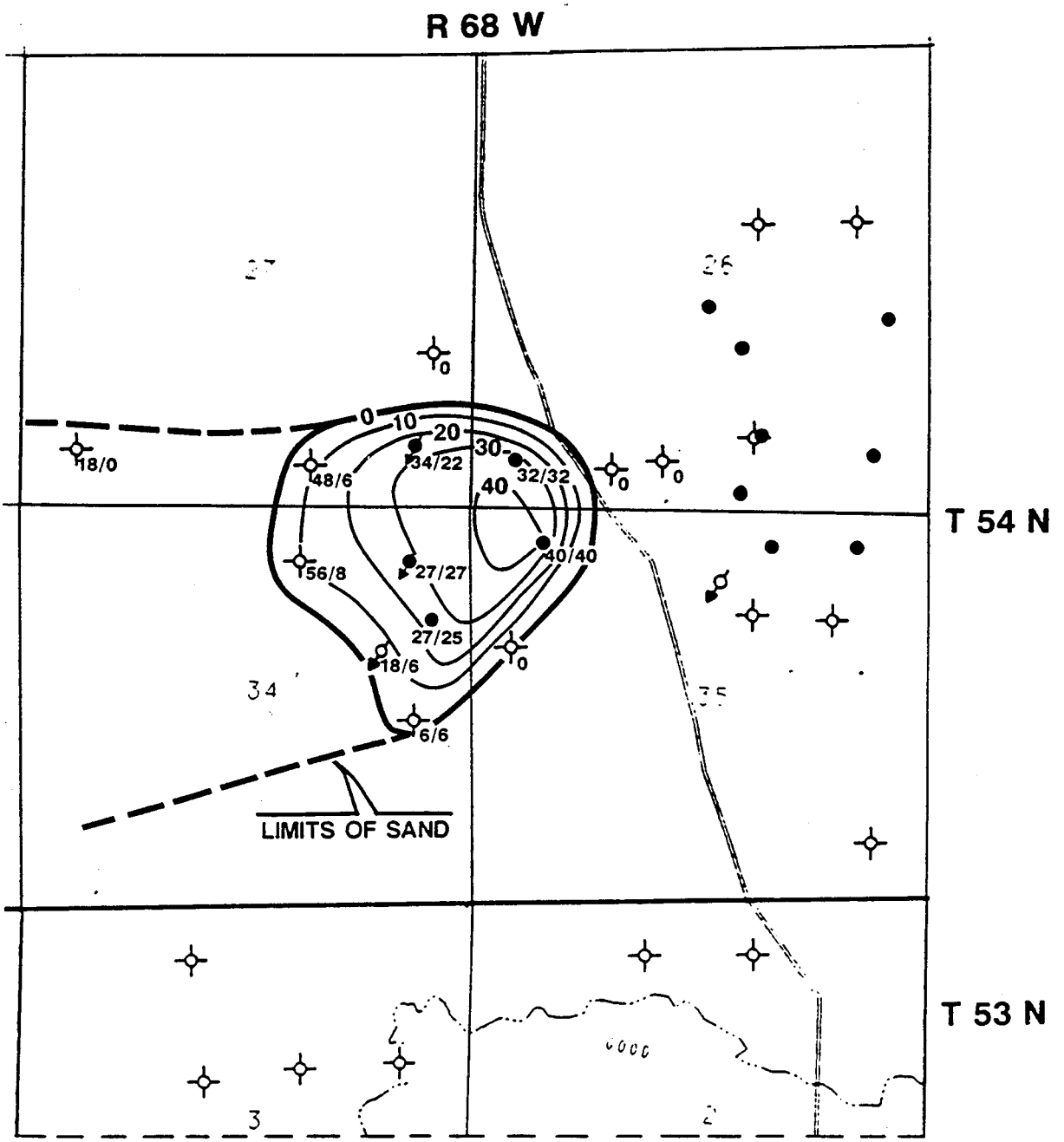
DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

LILY AREA
CROOK COUNTY, WYOMING

LILY FIELD
MINNELUSA A
ISOPACH: NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH

8/93



LEGEND

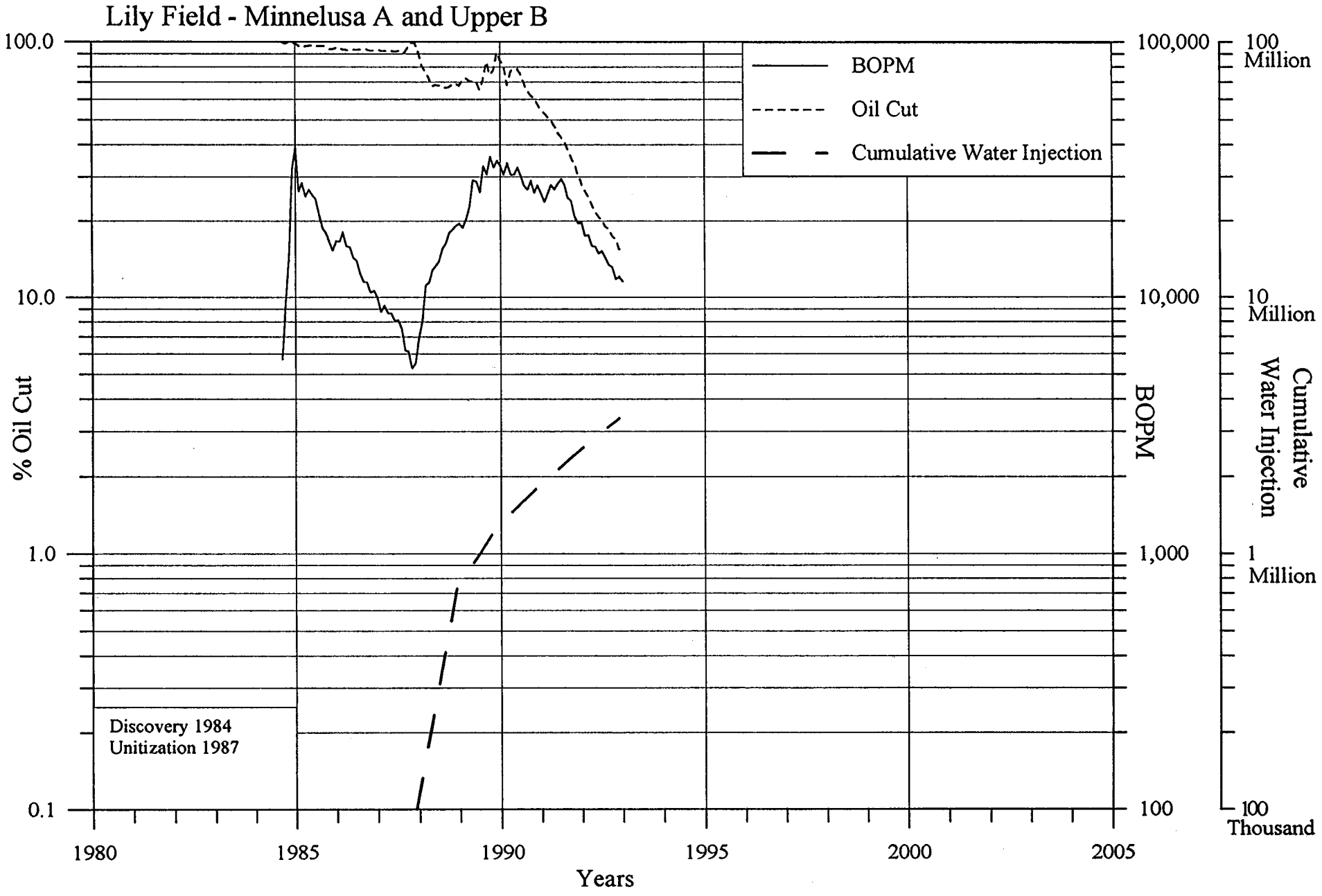
DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

LILY AREA
CROOK COUNTY, WYOMING

LILY FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Lily Field - Minnelusa A and Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1984
Unitization 1987
1980
1985
1990
1995
2000
2005
Years

Little Missouri Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 54 & 55N – RGE 67W
	Sections 5 & 6; 31 & 32
Drive Mechanism:	Polymer Waterflood
Discovered:	1986
Unitized:	1989

Current Production – 1/1 to 12/31/92	
Oil, bbls	210,902
Water, bbls	96,820

Cumulative Production – thru 12/31/92	
Oil, Mbbls	989
Water, Mbbls	199
Injection, Mbbls	1,228

Current Rates	
Oil, bopd	578
Oil Cut, %	68.5%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	50
Oil Cut	
Estimated Decline	20.0%
Proj. Ultimate Recovery, Mbbls	1,986
Proj. Remaining Reserves, Mbbls	997
Estimated Remaining Life, Years (from 1/93)	11.4
OOIP: Pore Volume	0.748
Ultimate Recovery: Pore Volume	0.253
Remaining O.I.P.: Pore Volume	0.495

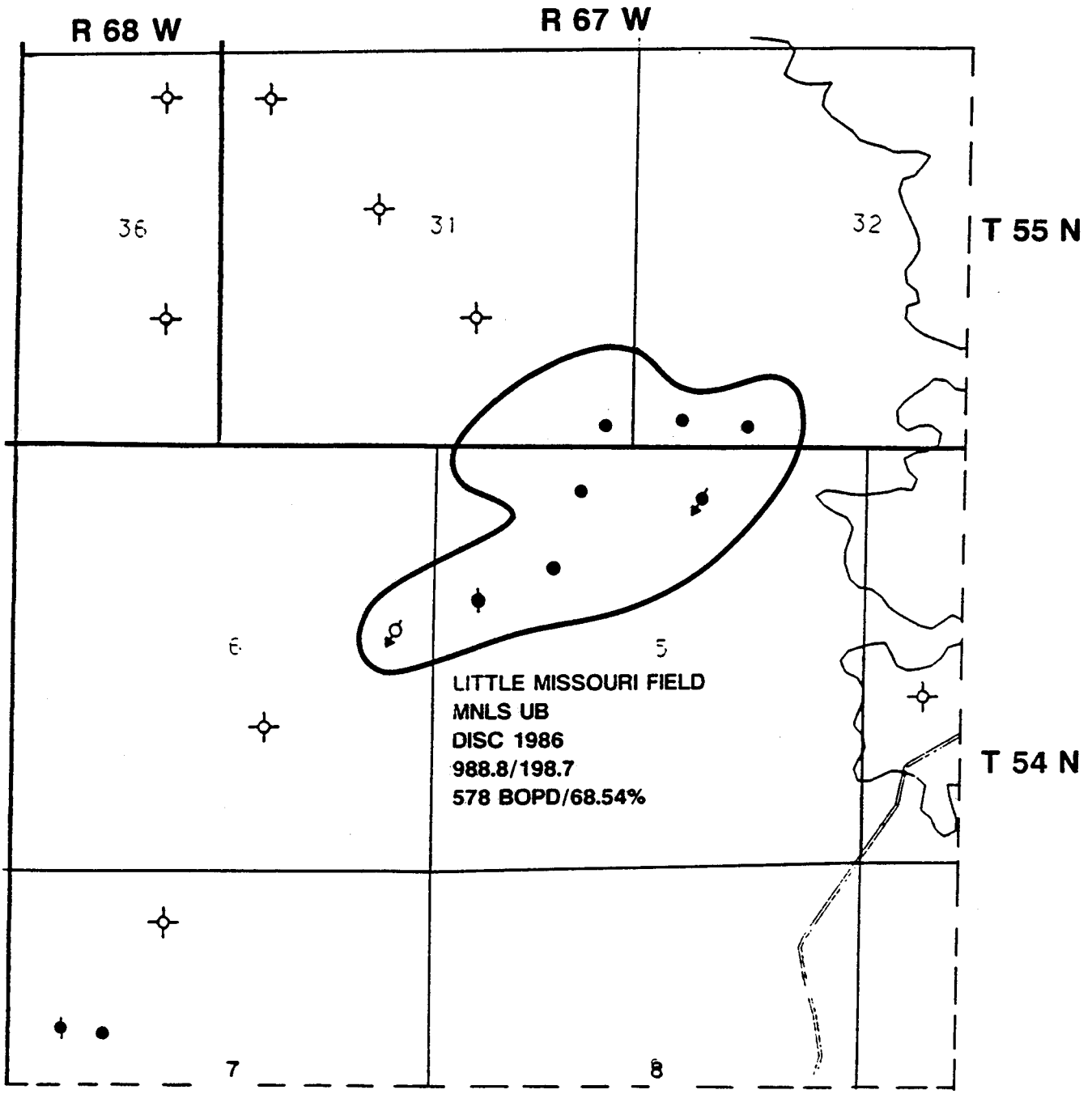
Oil Gravity	22.9
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	5,589
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.14

Reservoir Properties	
Volume, acre feet	5,284
Area, acres	278
Average Net Pay, feet	19.0
Average Porosity	19.2%
Average S_w	23.0%
FVF Factor	1.030
Pore Volume, Mbbls	7,858
Oil in Place, Mbbls	5,875
Est. Ult. Recovery Factor, %OOIP	33.8%
Current Recovery Factor %OOIP	16.8%
Current Depletion Factor %	49.8%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	60
End of Primary Decline	08/89
Estimated Decline	20.0%
Projected Ult. Recovery, Mbbls	304
Primary Recovery Factor %OOIP	5.2%
Cumulative Oil: Pore Volume	0.126
Cumulative Water: Pore Volume	0.025
Cumulative Injection: Pore Volume	0.156
Production – Injection Difference: PV	0.005

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNE 05–54–67	Fowler #1–5	98,621	0	Injection
NENW 05–54–67	Fowler #3–5	105,040	2,845	Pump–Oil
SWNW 05–54–67	Fowler #5–5	35,637	104,996	SI–Oil
SENW 05–54–67	Fowler #4–5	107,040	5,027	Pump–Oil
SESE 31–55–67	Terry #1	211,217	731	Pump–Oil
SWSW 32–55–67	Federal #1	237,769	16,316	Pump–Oil
SESW 32–55–67	Fowler #2–35	200,190	68,878	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NWNE 05–54–67	Fowler #1–5	263,985	919,803	Injection
SENE 06–54–67	Wiegner #1	88,379	308,355	Injection



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

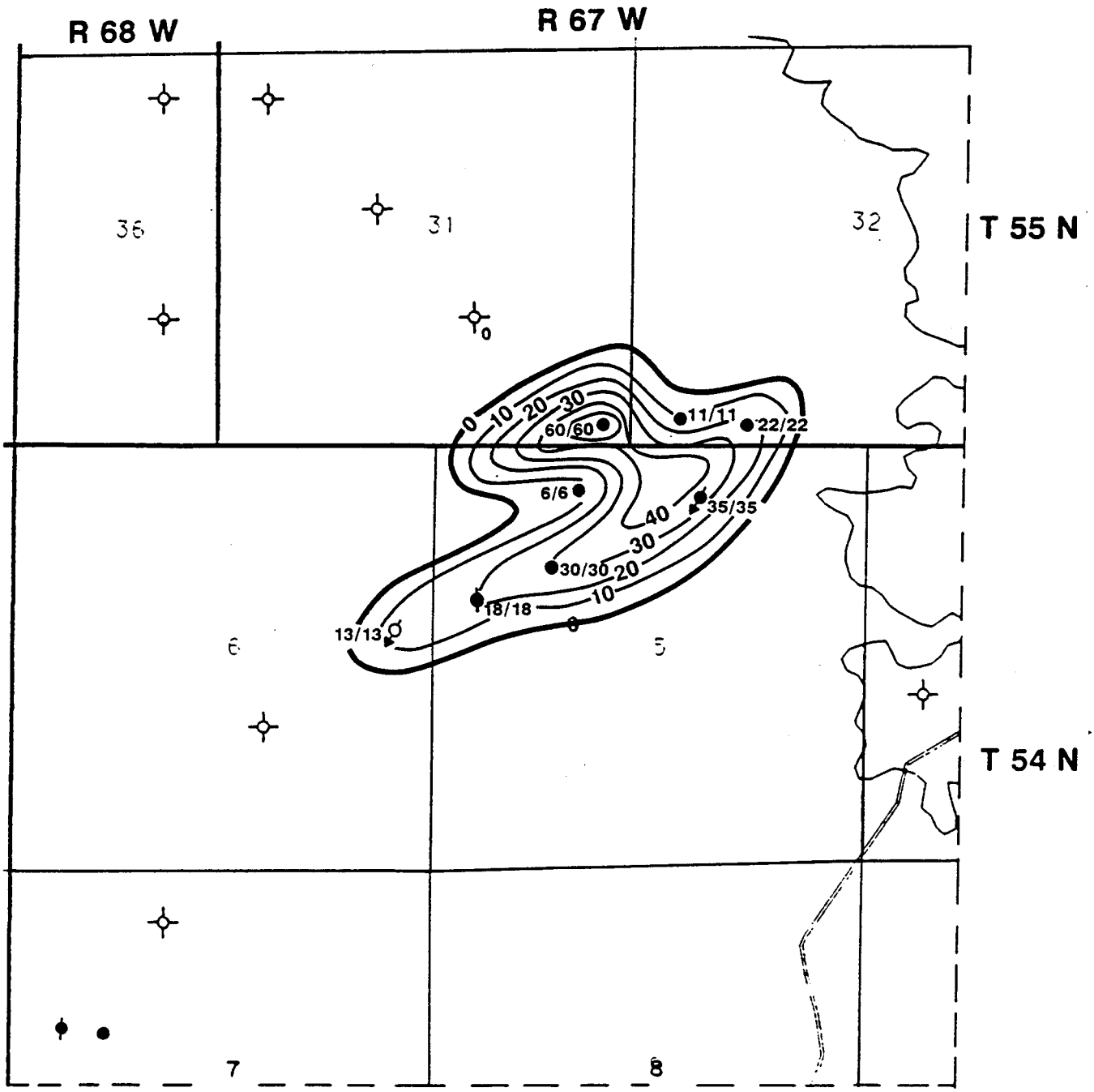
LITTLE MISSOURI AREA

CROOK COUNTY, WYOMING

LITTLE MISSOURI FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

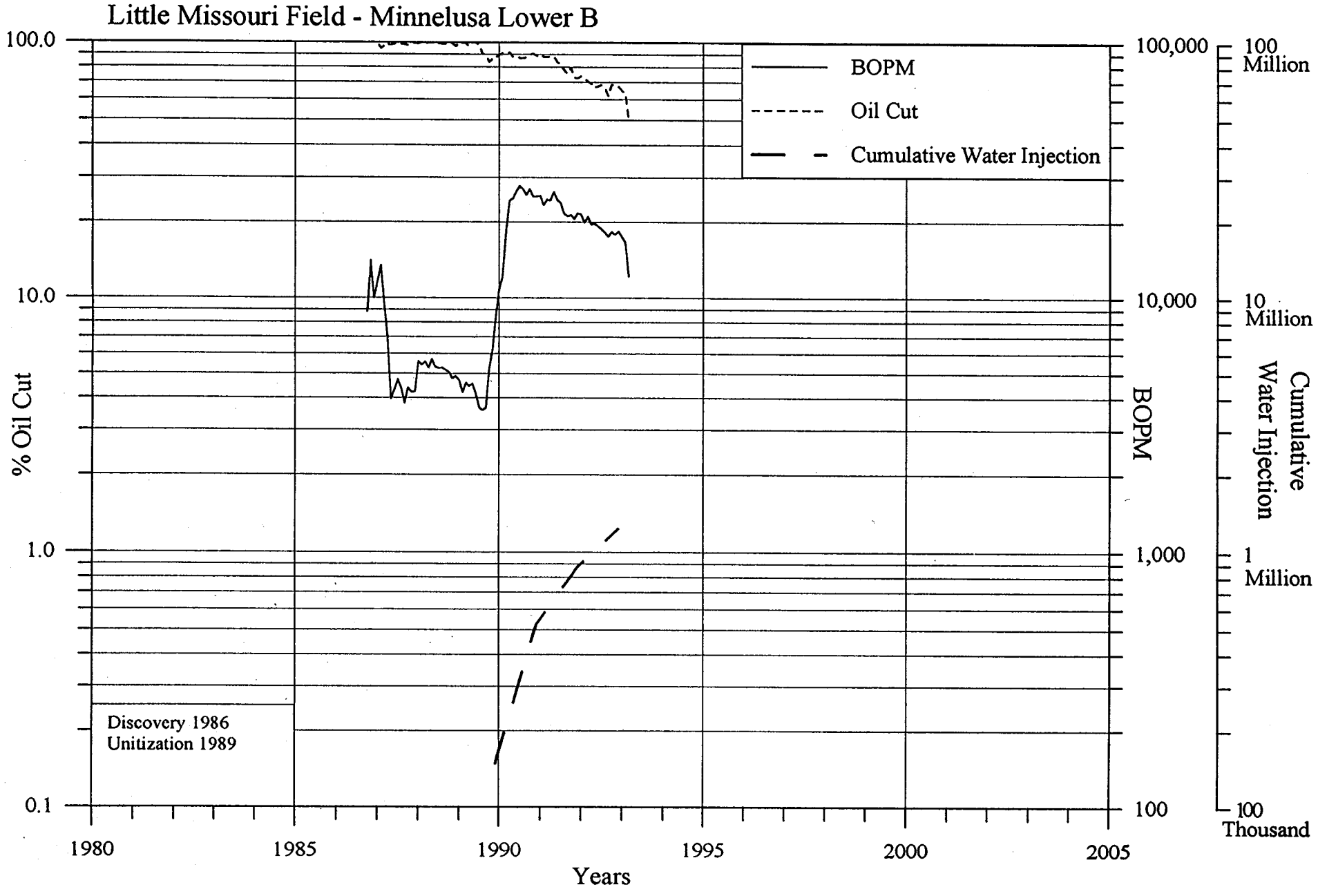
LITTLE MISSOURI AREA

CROOK COUNTY, WYOMING

LITTLE MISSOURI FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93


Little Missouri Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1986
Unitization 1989
1980
1985
1990
1995
2000
2005
Years

Little Mitchell Creek Field

Producing Zone:	Minnelusa Lower B
Location:	Campbell County, Wyoming
	TWP 52 – RGE 69W
	Sections 11 & 14
Drive Mechanism:	Waterflood
Discovered:	1966
Unitized:	1969

Current Production – 1/1 to 12/31/92	
Oil, bbls	204,682
Water, bbls	340,648

Cumulative Production – thru 12/31/92	
Oil, Mbbls	9,481
Water, Mbbls	3,575
Injection, Mbbls	12,666

Current Rates	
Oil, bopd	561
Oil Cut, %	37.5%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	15.0%
Proj. Ultimate Recovery, Mbbls	10,267
Proj. Remaining Reserves, Mbbls	785
Estimated Remaining Life, Years (from 1/93)	9.6
OOIP: Pore Volume	0.714
Ultimate Recovery: Pore Volume	0.339
Remaining O.I.P.: Pore Volume	0.375

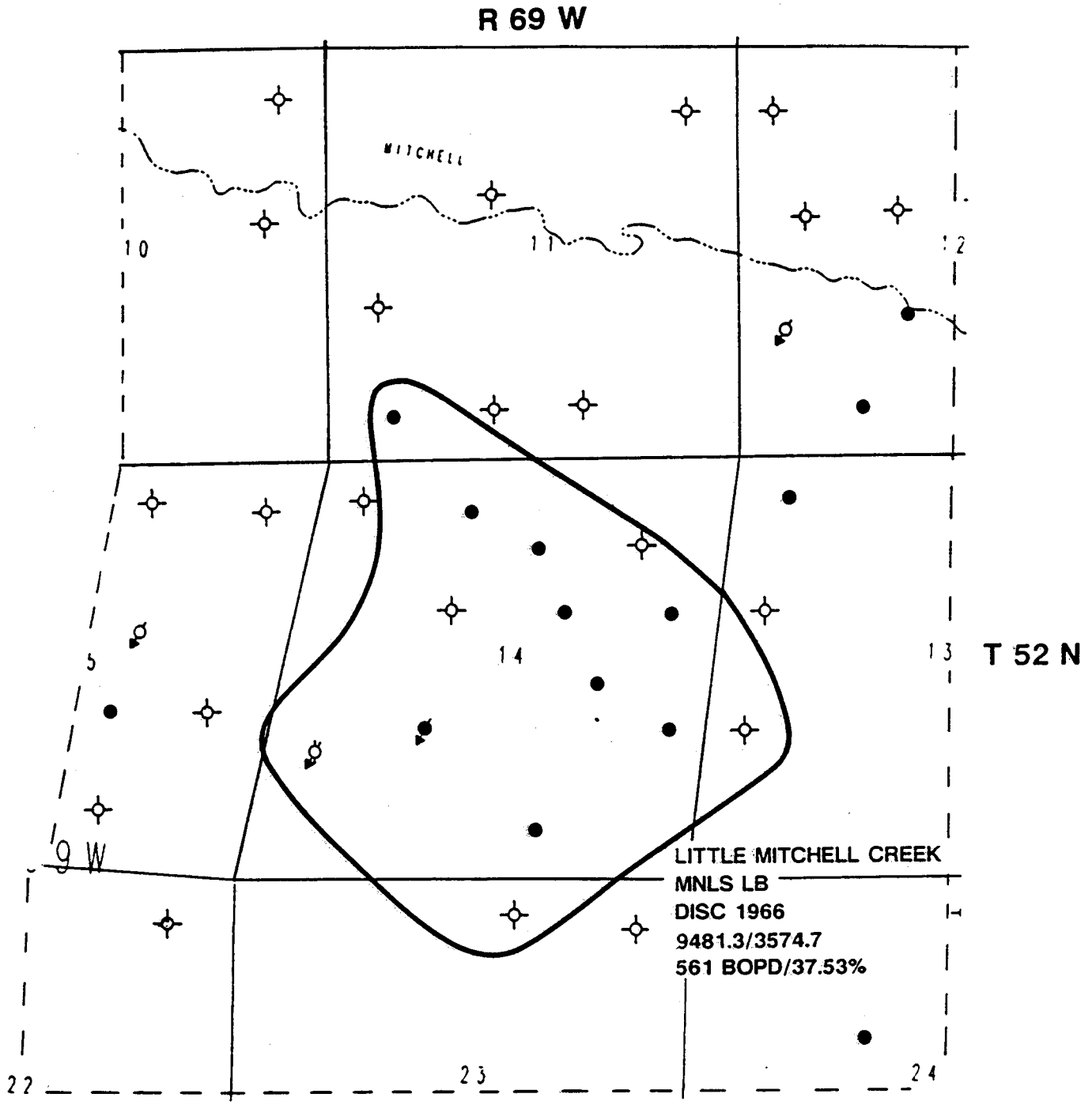
Oil Gravity	25.4
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	7,315
Formation Temperature, degrees F	135
Rw @ Formation Temperature	0.07

Reservoir Properties	
Volume, acre feet	19,077
Area, acres	664
Average Net Pay, feet	28.8
Average Porosity	20.4%
Average S_w	25.0%
FVF Factor	1.050
Pore Volume, Mbbls	30,250
Oil in Place, Mbbls	21,607
Est. Ult. Recovery Factor, %OOIP	47.5%
Current Recovery Factor %OOIP	43.9%
Current Depletion Factor %	92.4%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	40
End of Primary Decline	12/69
Estimated Decline	20.0%
Projected Ult. Recovery, Mbbls	2,143
Primary Recovery Factor %OOIP	9.9%
Cumulative Oil: Pore Volume	0.313
Cumulative Water: Pore Volume	0.118
Cumulative Injection: Pore Volume	0.419
Production – Injection Difference: PV	–0.013

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWSW 11–52–69	Cox #14	242,671	7,804	Pump–Oil
SWNWNE 14–52–69	Federal #15	557,338	411,787	Pump–Oil
NENW 14–52–69	Unit #21–14	386,617	59,489	Pump–Oil
SWNE 14–52–69	Unit #32–14	50,529	671,917	Pump–Oil
SESENE 14–52–69	Federal #15–9	415,429	212,660	Pump–Oil
NESE 14–52–69	Unite #43–14	717,023	68,806	Pump–Oil
NWSE 14–52–69	Federal # 15–8	75,641	674,473	Pump–Oil
NESW 14–52–69	USA #23	357,904	386,649	Pump–Oil
Unit		6,696,121	902,630	

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NESW 14–52–69	Unit #15–5	0	8,294,235	SI–Inj
NWSW 14–52–69	Unite #13–14	576,745	4,371,571	Injection



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL

FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT IN 1992

LITTLE MITCHELL CREEK AREA

CAMPBELL COUNTY, WYOMING

LITTLE MITCHELL CREEK FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH	
	8/93

Lone Cedar Field

Producing Zone:	Minnelusa Upper B
Location:	Campbell County, Wyoming
	TWP 51 – RGE 69W
	Sections 8, 9, 16 & 17
Drive Mechanism:	Polymer Waterflood
Discovered:	1984
Unitized:	1987

Current Production – 1/1 to 12/31/92	
Oil, bbls	390,602
Water, bbls	828,631

Cumulative Production – thru 12/31/92	
Oil, Mbbls	2,601
Water, Mbbls	2,035
Injection, Mbbls	5,001

Current Rates	
Oil, bopd	1,070
Oil Cut, %	32.0%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	15.0%
Proj. Ultimate Recovery, Mbbls	4,389
Proj. Remaining Reserves, Mbbls	1,788
Estimated Remaining Life, Years (from 1/1/93)	9.6
OOIP: Pore Volume	0.810
Ultimate Recovery: Pore Volume	0.379
Remaining O.I.P.: Pore Volume	0.431

Oil Gravity	25.0
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	7,896
Formation Temperature, degrees F	136 *
Rw @ Formation Temperature	0.07 *

Reservoir Properties	
Volume, acre feet	7,219
Area, acres	261
Average Net Pay, feet	27.7
Average Porosity	20.7%
Average S_w	15.0% *
FVF Factor	1.050
Pore Volume, Mbbls	11,593
Oil in Place, Mbbls	9,385
Est. Ult. Recovery Factor, %OOIP	46.8%
Current Recovery Factor %OOIP	27.7%
Current Depletion Factor %	59.3%

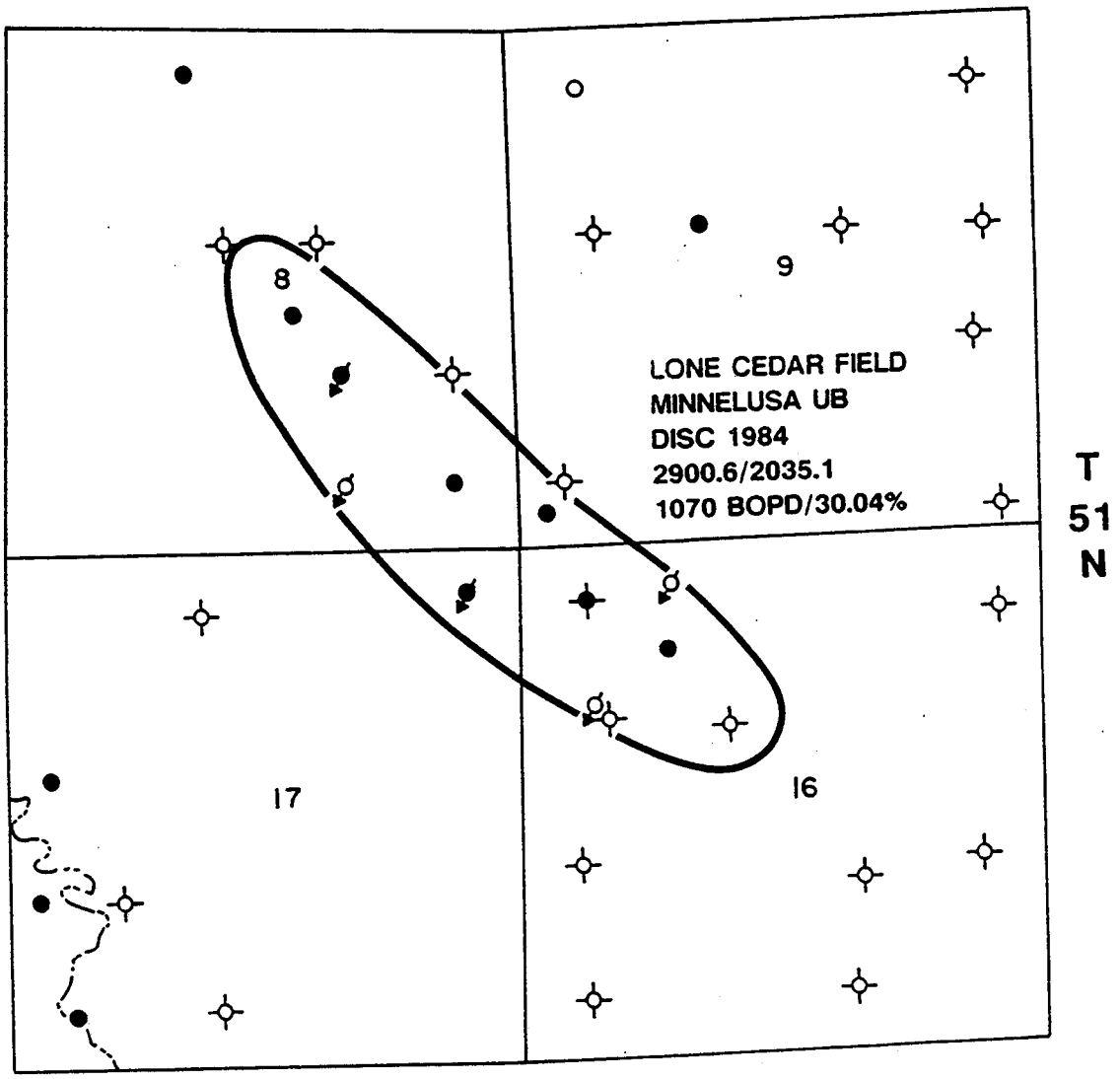
Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	04/12
Estimated Decline	30.0%
Projected Ult. Recovery, Mbbls	842
Primary Recovery Factor %OOIP	9.0%
Cumulative Oil: Pore Volume	0.224
Cumulative Water: Pore Volume	0.176
Cumulative Injection: Pore Volume	0.431
Production – Injection Difference: PV	0.032

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNWSE 08–51–69	Unit #8	117,411	155,926	Pump–Oil
NWSE 08–51–69	Unit #2	80,066	902	Injection
SESE 08–51–69	Unit #4	937,264	919,311	Pump–Oil
SWSWSW 09–51–69	Unit #11	10,843	553	Pump–Oil
SWNENW 16–51–69	Unit #7	380,718	16,377	Pump–Oil
NWNW 16–51–69	Unit #6	1,096,420	948,157	Pump–Oil
NENE 17–51–69	Unit #5	23,781	2,124	Injection

*Formation temperature Rw and Sw from SPE Paper #17539 by Walt King

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NWSE 08–51–69	Unit #2	247,590	1,302,184	Injection
SWSE 08–51–69	Unit #3	0	162,979	SI–Inj
SWNW 16–51–69	Unit #9	754,433	3,168,528	Injection
NWNENW 16–51–69	Unit #10	196,765	315,754	Injection
NENE 08–51–69	Unit #5	52,693	51,693	Injection

R 69 W



T 51 N

LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL
- LOCATION

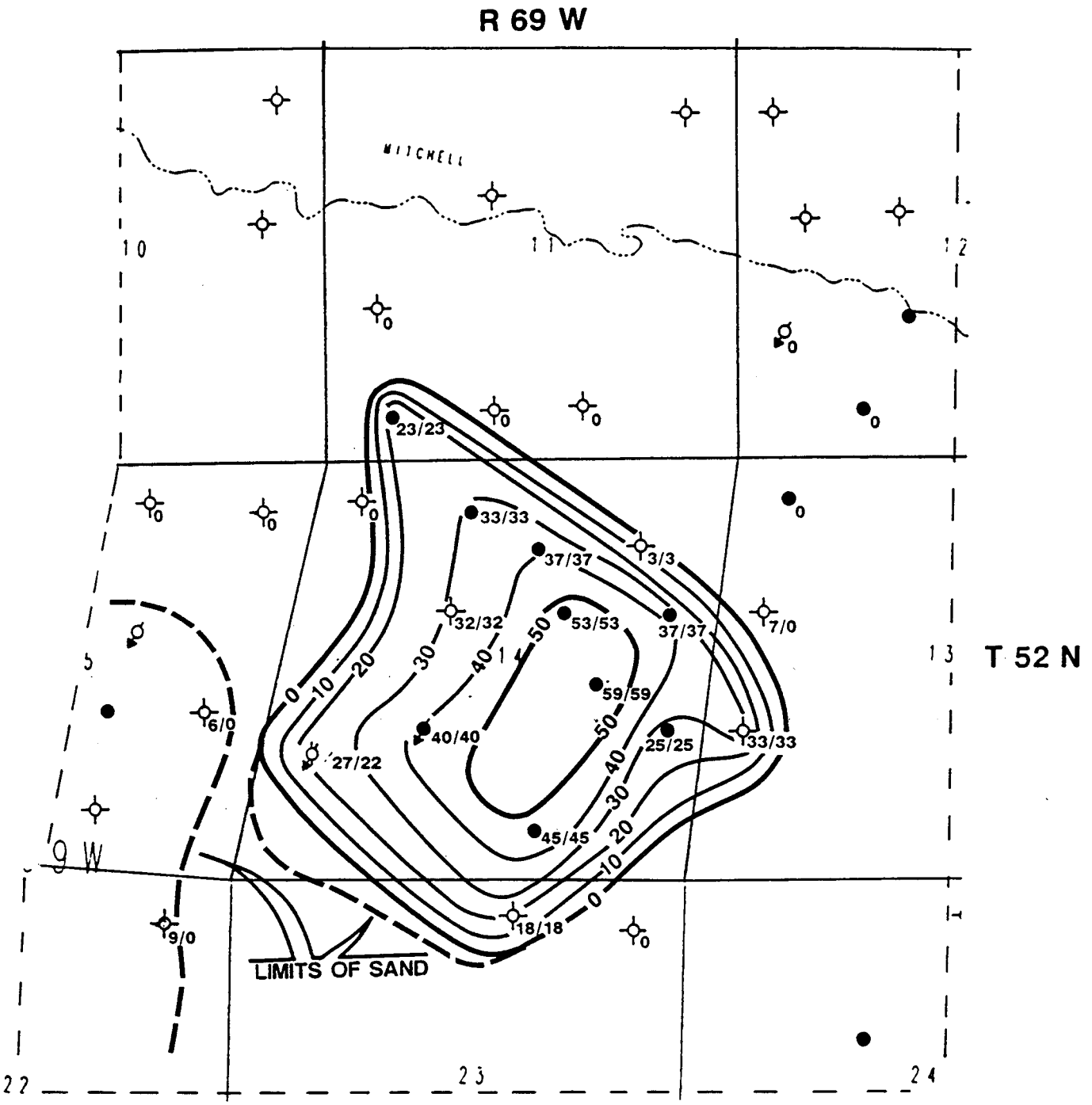
FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

LONE CEDAR AREA

CAMPBELL COUNTY, WYOMING

LONE CEDAR FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH	
	9/93



LEGEND

⊱	DRY HOLE	70/65	Net Porosity/Net Oil Pay
◗	PRODUCING OIL WELL	nde	Not Deep Enough
◗	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
⊱	ABDN. OIL WELL	E	Production Zone Eroded
⊥	WATER INJECTOR	n.l.	No Well Information
⊥	WATER DISPOSAL		

LITTLE MITCHELL CREEK AREA

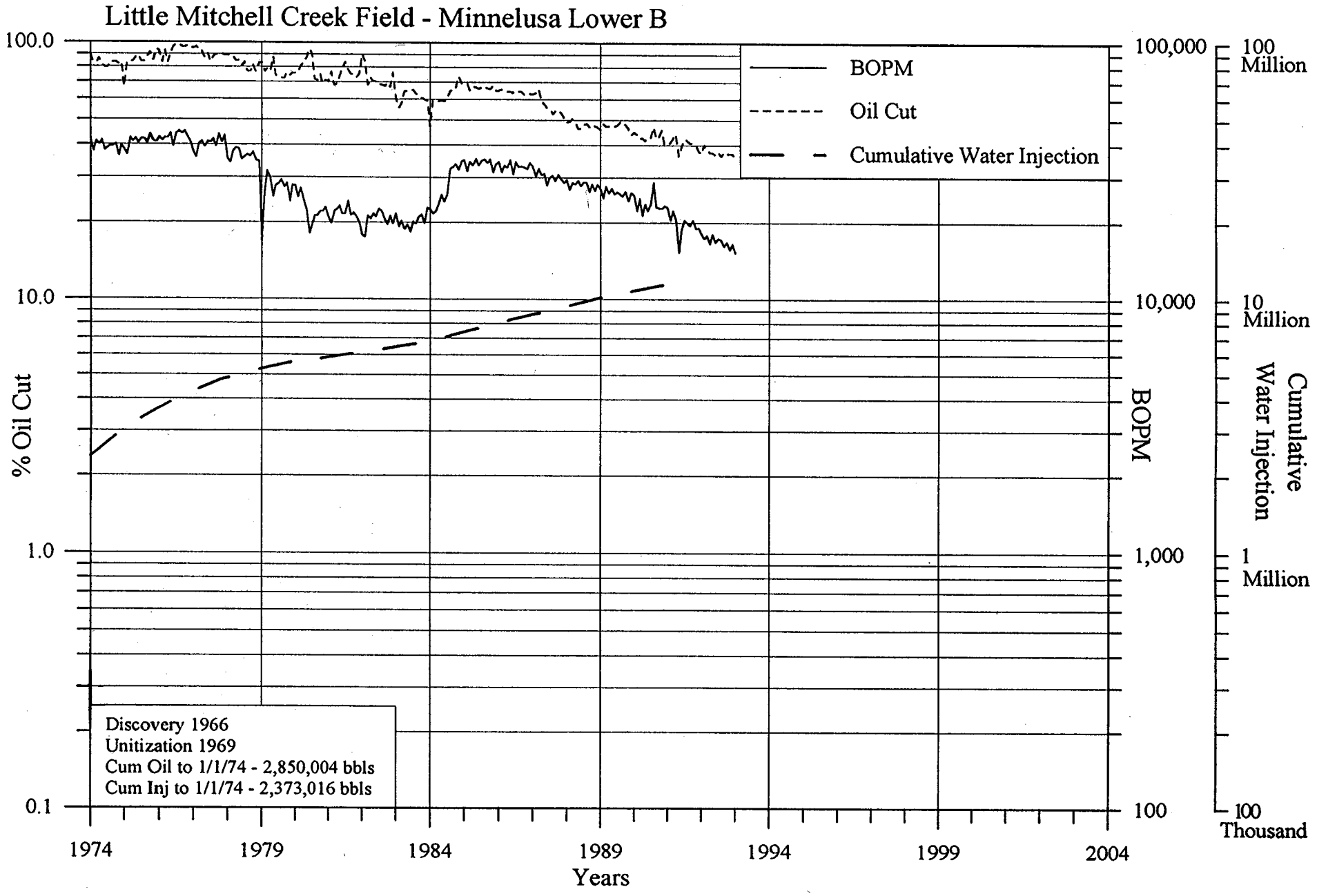
CAMPBELL COUNTY, WYOMING

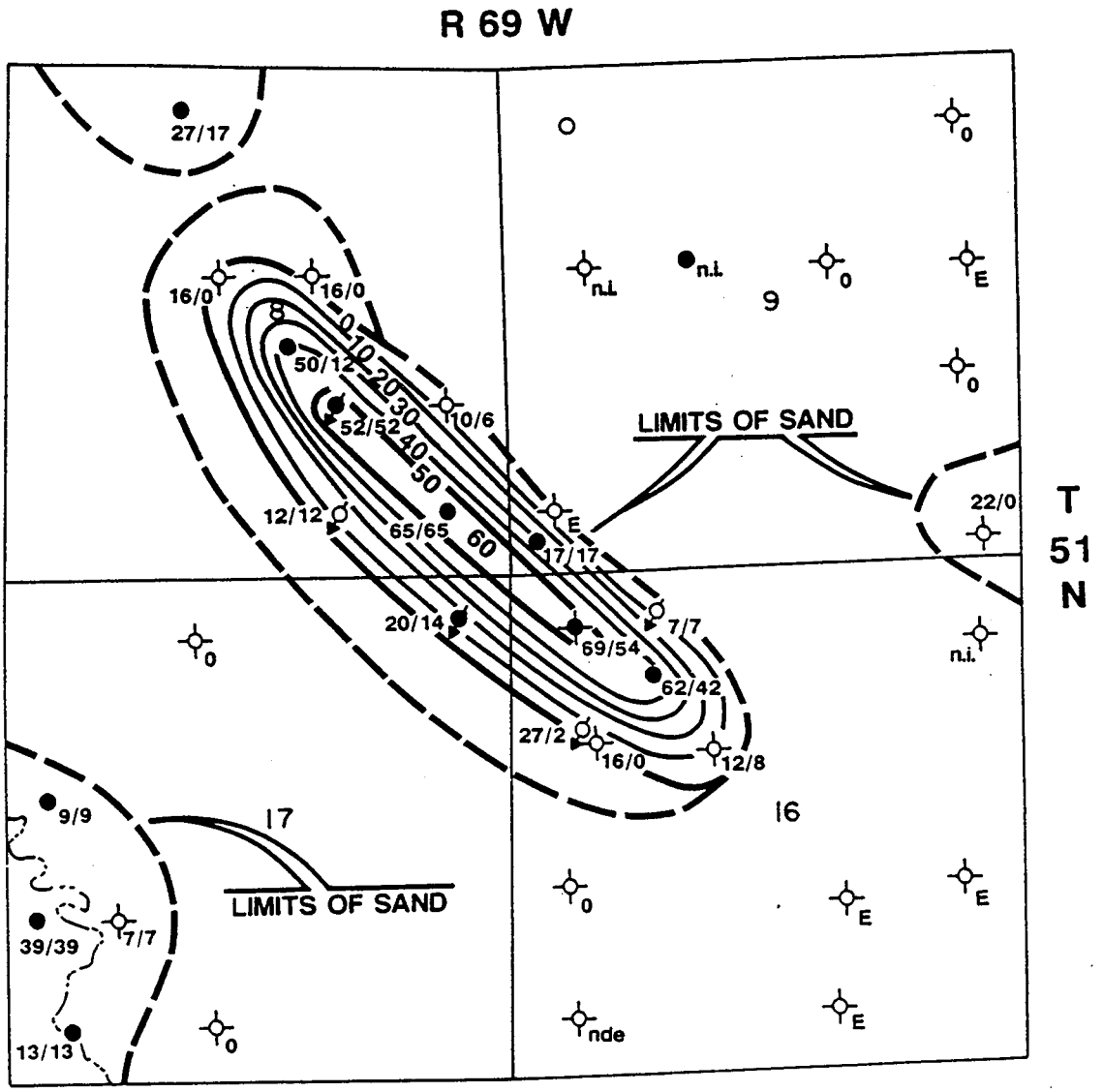
LITTLE MITCHELL CREEK FIELD
MINNELUSA LB
ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L. GRIFFITH

8/93


Little Mitchell Creek Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1966
Unitization 1969
Cum Oil to 1/1/74 - 2,850,004 bbls
Cum Inj to 1/1/74 - 2,373,016 bbls
1974
1979
1984
1989
1994
1999
2004
Years



LEGEND

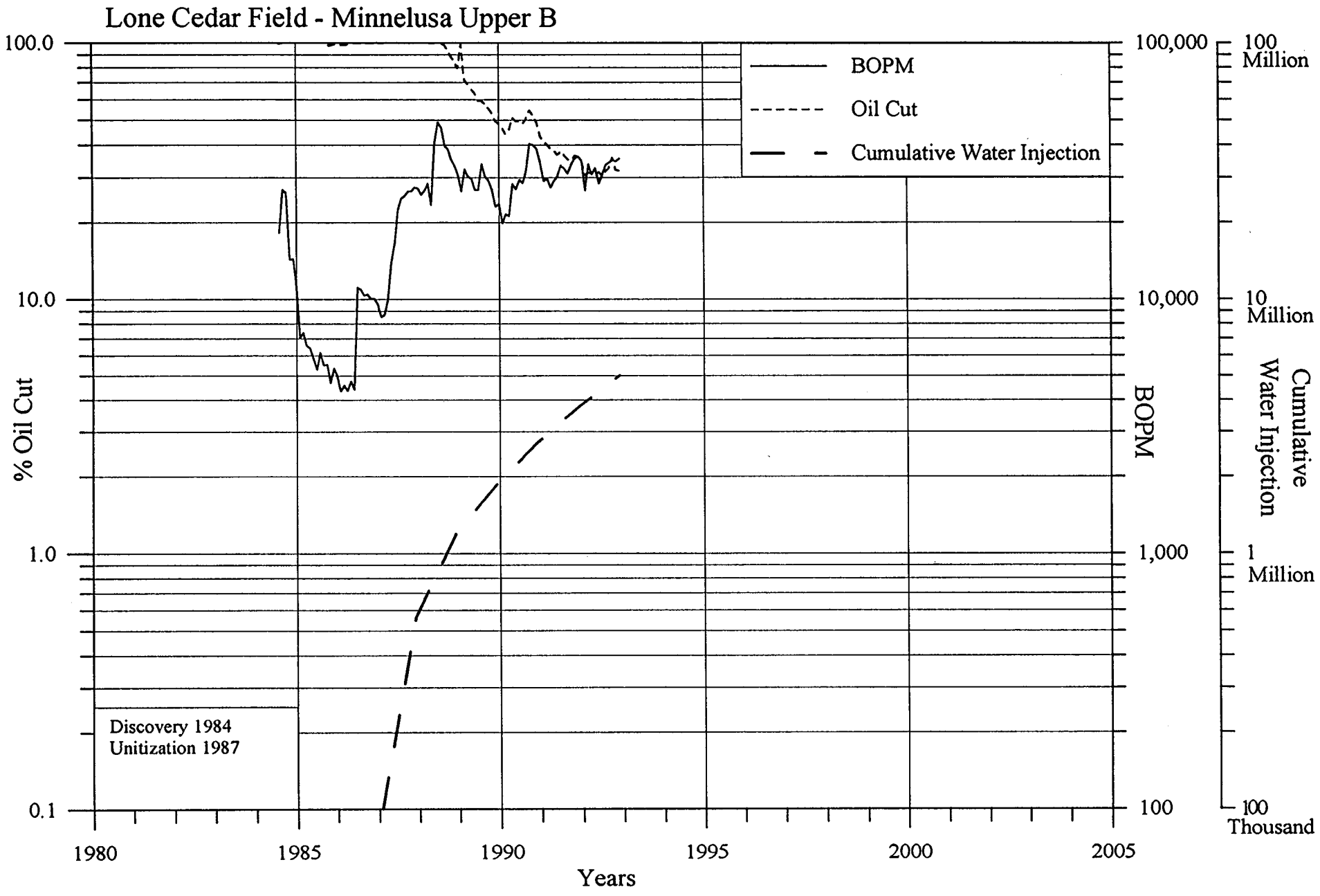
✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
♦	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
⚷	WATER INJECTOR	n.i.	No Well Information
⚷	WATER DISPOSAL		
○	LOCATION		

LONE CEDAR AREA

CAMPBELL COUNTY, WYOMING

LONE CEDAR FIELD
MINNELUSA UB
ISOPAPCH:NET OIL PAY
C.I.=10'

GEOLOGY: L. GRIFFITH	
	9/93


Lone Cedar Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1984
Unitization 1987
1980
1985
1990
1995
2000
2005
Years

Mellott Ranch Field

Producing Zone:	Minnelusa A & Upper B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 2, 10 & 11
Drive Mechanism:	Waterflood
Discovered:	1960
Unitized:	1965

	A	UB
Oil Gravity	20.7	
Oil Viscosity, cp	38.5	
Water Viscosity, cp	0.6	
Depth, feet	6894	6748
Fm. Temp. degrees F	116	116
Rw @ Fm. Temp.	0.27	0.27

Current Production – 1/1 to 12/31/92	
Oil, bbls	139,015
Water, bbls	1,457,911

Cumulative Production – thru 12/31/92	
Oil, Mbbls	6,195
Water, Mbbls	21,110
Injection, Mbbls	27,001

Current Rates	
Oil, bopd	381
Oil Cut, %	8.7%

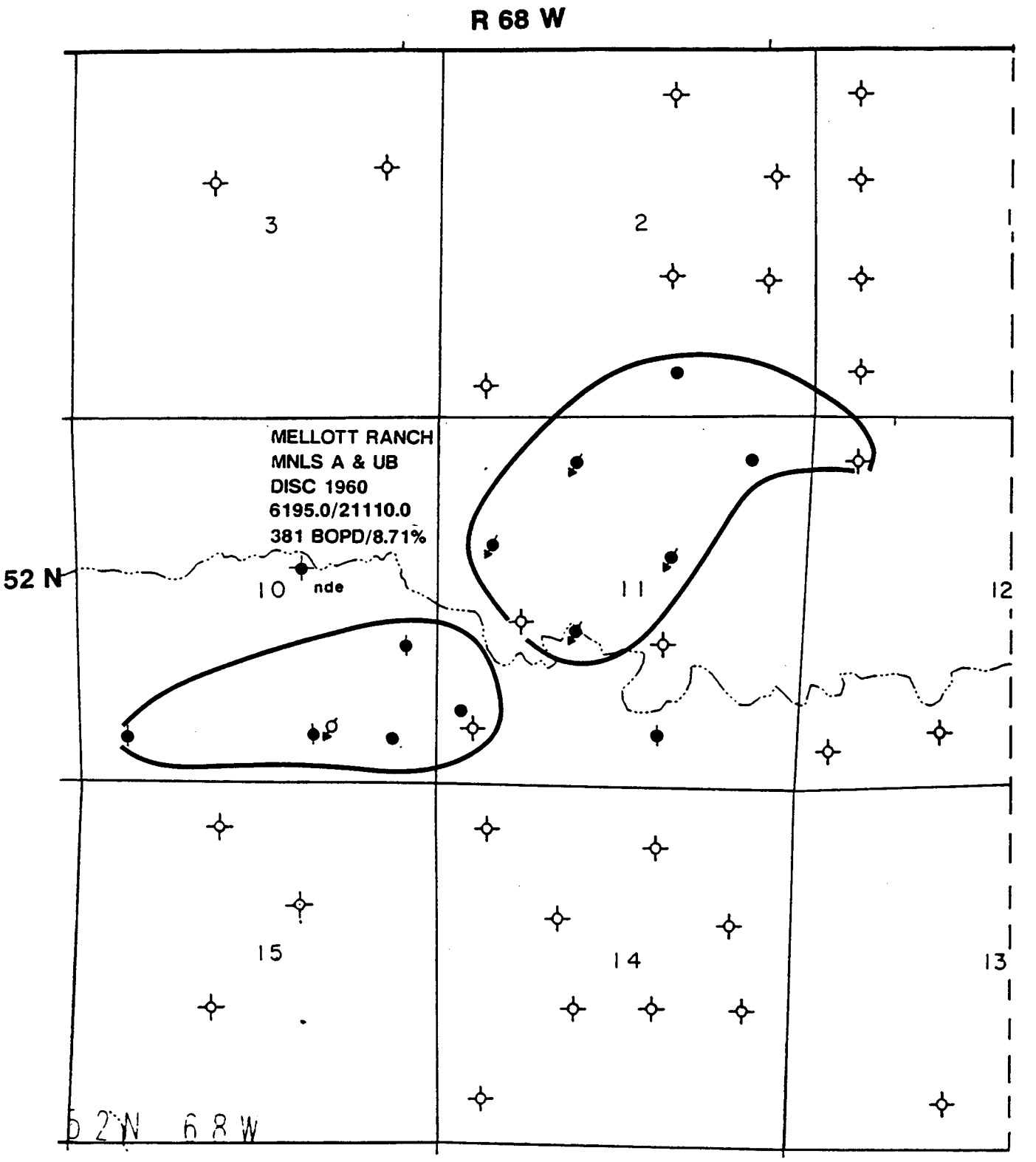
Reservoir Properties	A	UB	Total
Volume, acre feet	2,853	11,319	14,172
Area, acres	189	518	518
Average Net Pay, feet	15.1	21.8	27.4
Average Porosity	25.6%	17.7%	21.7%
Average S_w	22.0%	27.0%	24.5%
FVF Factor	1.040	1.040	1.040
Pore Volume, Mbbls	5,674	15,499	21,174
Oil in Place, Mbbls	4,256	10,879	15,135
Est. Ult. Recovery Factor, %OOIP			41.6%
Current Recovery Factor %OOIP			40.9%
Current Depletion Factor %			98.4%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	35.0%
Proj. Ultimate Recovery, Mbbls	6,297
Proj. Remaining Reserves, Mbbls	102
Estimated Remaining Life, Years (from 1/93)	1.1
OOIP: Pore Volume	0.715
Ultimate Recovery: Pore Volume	0.297
Remaining O.I.P.: Pore Volume	0.417

Primary Deline Analysis	A
Economic Cutoff	
Oil, bopd	90
End of Primary Decline	06/1985
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	992
Primary Recovery Factor %OOIP	6.6%
Cumulative Oil: Pore Volume	0.293
Cumulative Water: Pore Volume	0.997
Cumulative Injection: Pore Volume	1.275
Production – Injection Difference: PV	–0.014

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWSE 02–52–68	Unit #34–2	441,185	9,759,311	Pump–Oil
NESE 10–52–68	Schruicht #43–10			TA–Oil
SWSW 10–52–68	Simpson #1			TA–Oil
SESE 10–52–68	Unit #44–10	39,471	339,430	Pump–Oil
NENE 11–52–68	Unit #41–11	332,844	1,117,379	Pump–Oil
SWNE 11–52–68	Unit #32–11	56,025	1,445,332	Injection
SWSW 11–52–68	Unit #15–11	361,269	558,157	Pump–Oil
Prev–Unit		4,824,981	6,270,670	

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SWSE 10–52–68	Unit #34–10	629,063	6,014,110	Injection
NENW 11–52–68	Unit #21–11	315,256	14,355,547	Injection
SWNW 11–52–68	Unit #12–11	486,310	4,480,518	Injection
SWNE 11–52–68	Unit #32–11	559,799	1,749,628	Injection
NESW 11–52–68	Unit #21–11	0	401,048	SI–Inj



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

MELLOTT RANCH AREA

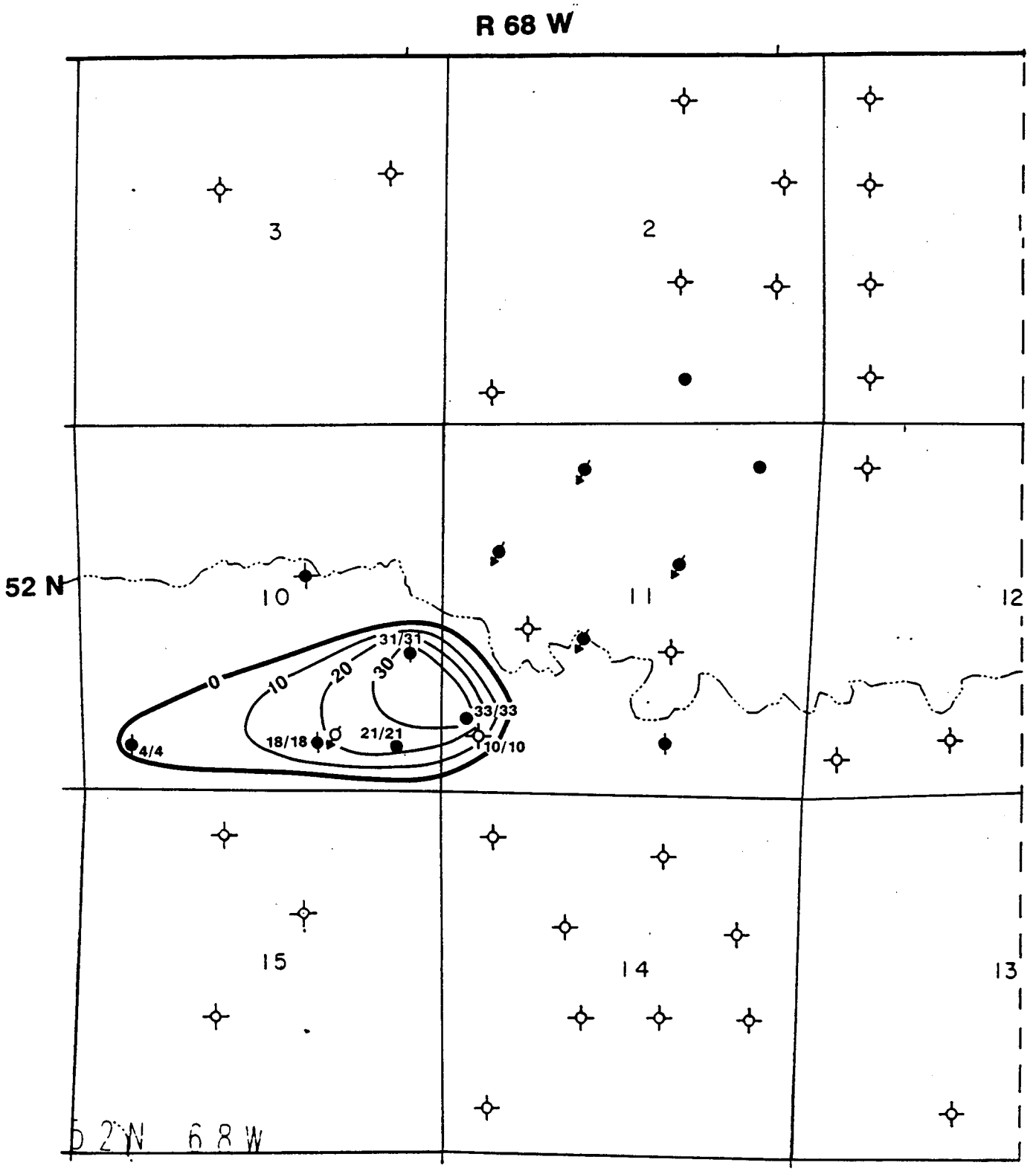
CROOK COUNTY, WYOMING

MELLOTT RANCH FIELD
MINNELUSA A & UB
PRODUCTION PLAT

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93



LEGEND

⊹	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⊹	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
⊹	ABDN. OIL WELL	E	Production Zone Eroded
⊹	WATER INJECTOR	n.i.	No Well Information
⊹	WATER DISPOSAL		

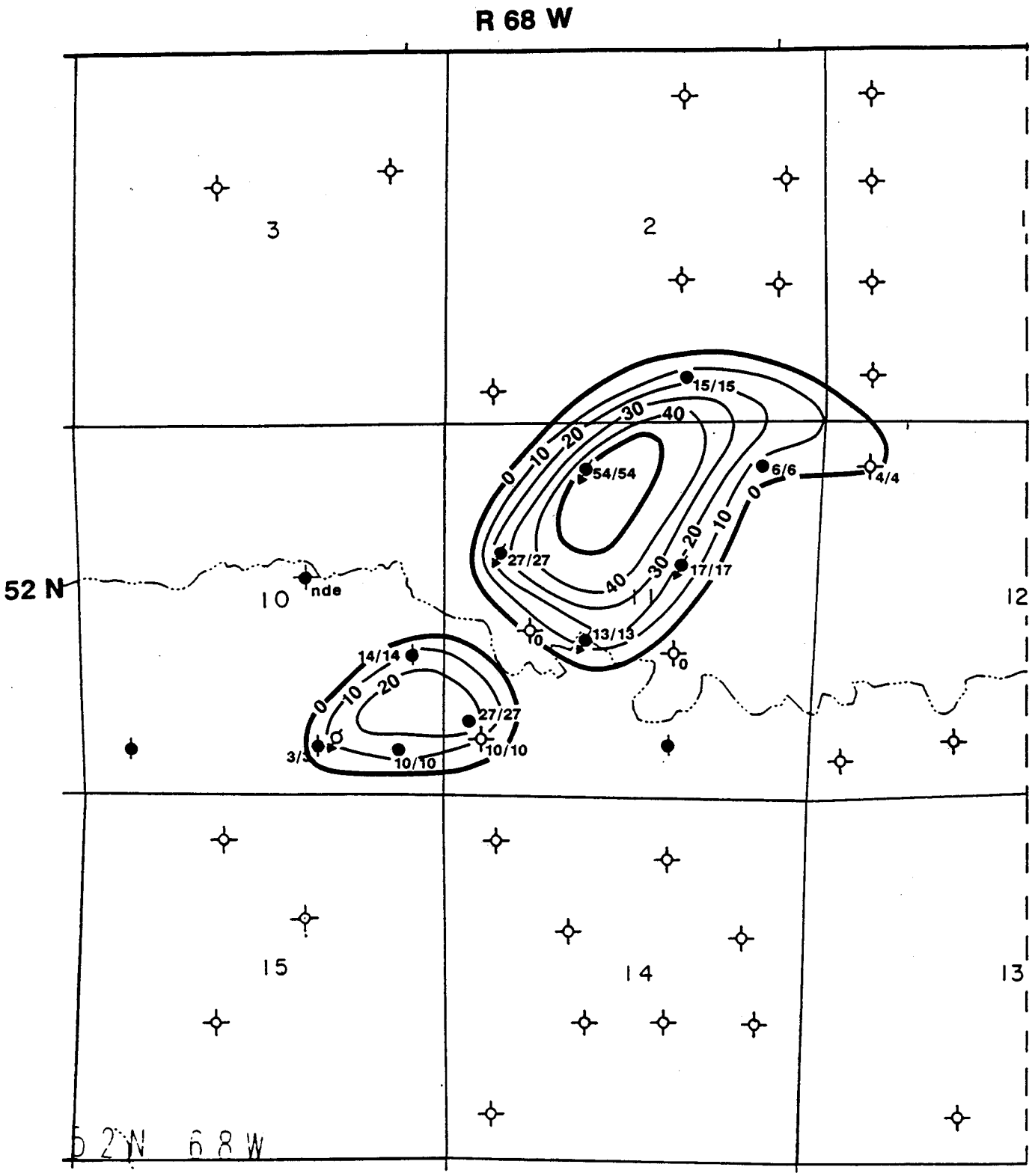
MELLOTT RANCH AREA

CROOK COUNTY, WYOMING

MELLOTT RANCH FIELD
MINNELUSA A
ISOPACH: NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH

8/93



LEGEND

⊹	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⊹	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
⊹	ABDN. OIL WELL	E	Production Zone Eroded
⊹	WATER INJECTOR	n.i.	No Well Information
⊹	WATER DISPOSAL		

MELLOTT RANCH AREA

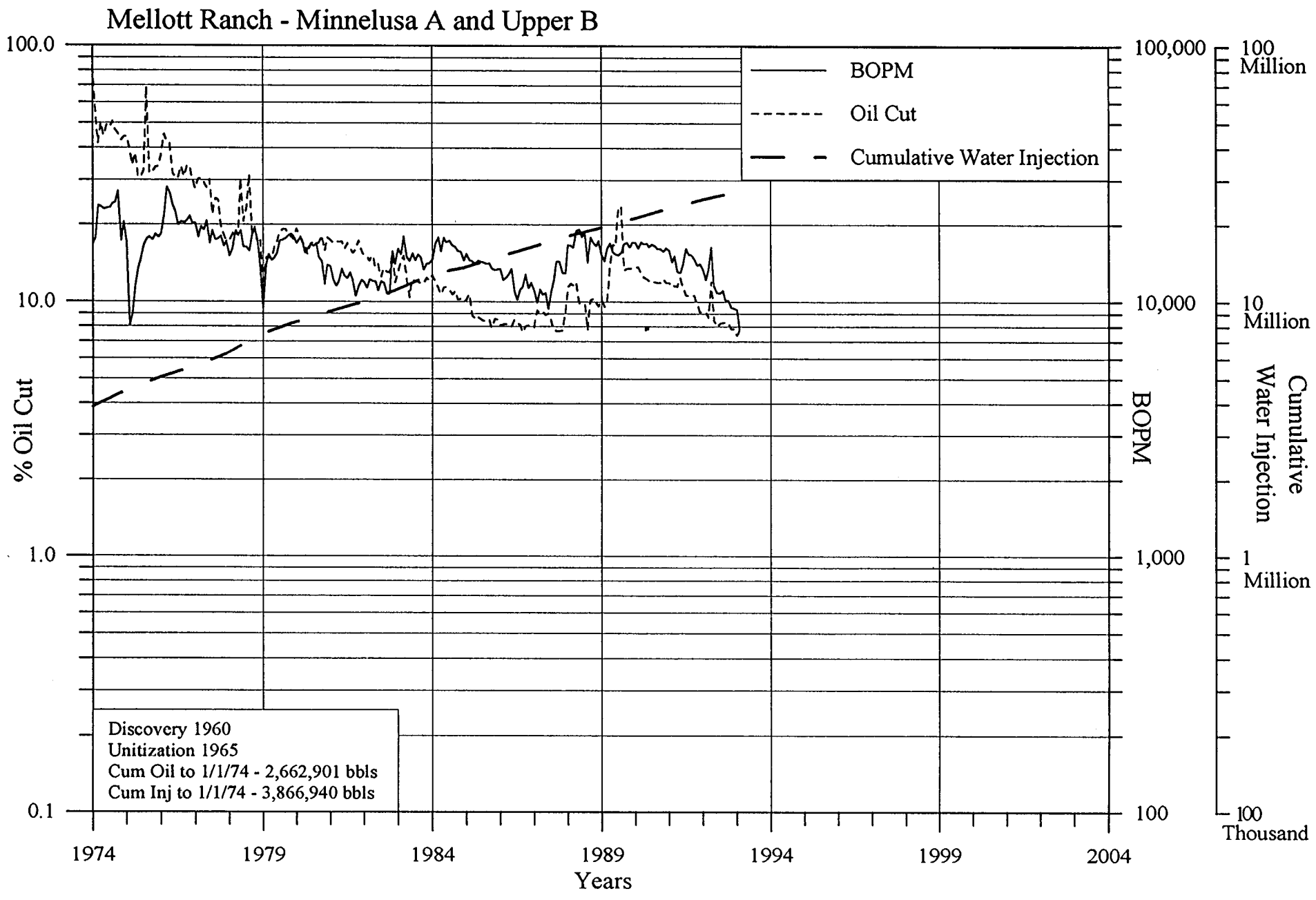
CROOK COUNTY, WYOMING

MELLOTT RANCH FIELD
MINNELUSA UB
ISOPACH: NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Mellott Ranch - Minnelusa A and Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1960
Unitization 1965
Cum Oil to 1/1/74 - 2,662,901 bbls
Cum Inj to 1/1/74 - 3,866,940 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Oshoto Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 53N – RGE 68W
	Sections 21, 22 & 27
Drive Mechanism:	Water Drive
Discovered:	1984
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	72,532
Water, bbls	165,319

Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,173
Water, Mbbls	1,478
Injection, Mbbls	n.a.

Current Rates	
Oil, bopd	199
Oil Cut, %	30.5%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	n.a.
Oil Cut	n.a.
Estimated Decline	n.a.
Proj. Ultimate Recovery, Mbbls	1,611
Proj. Remaining Reserves, Mbbls	438
Estimated Remaining Life, Years (from 1/93)	13.9
OOIP: Pore Volume	0.635
Ultimate Recovery: Pore Volume	0.272
Remaining O.I.P.: Pore Volume	0.363

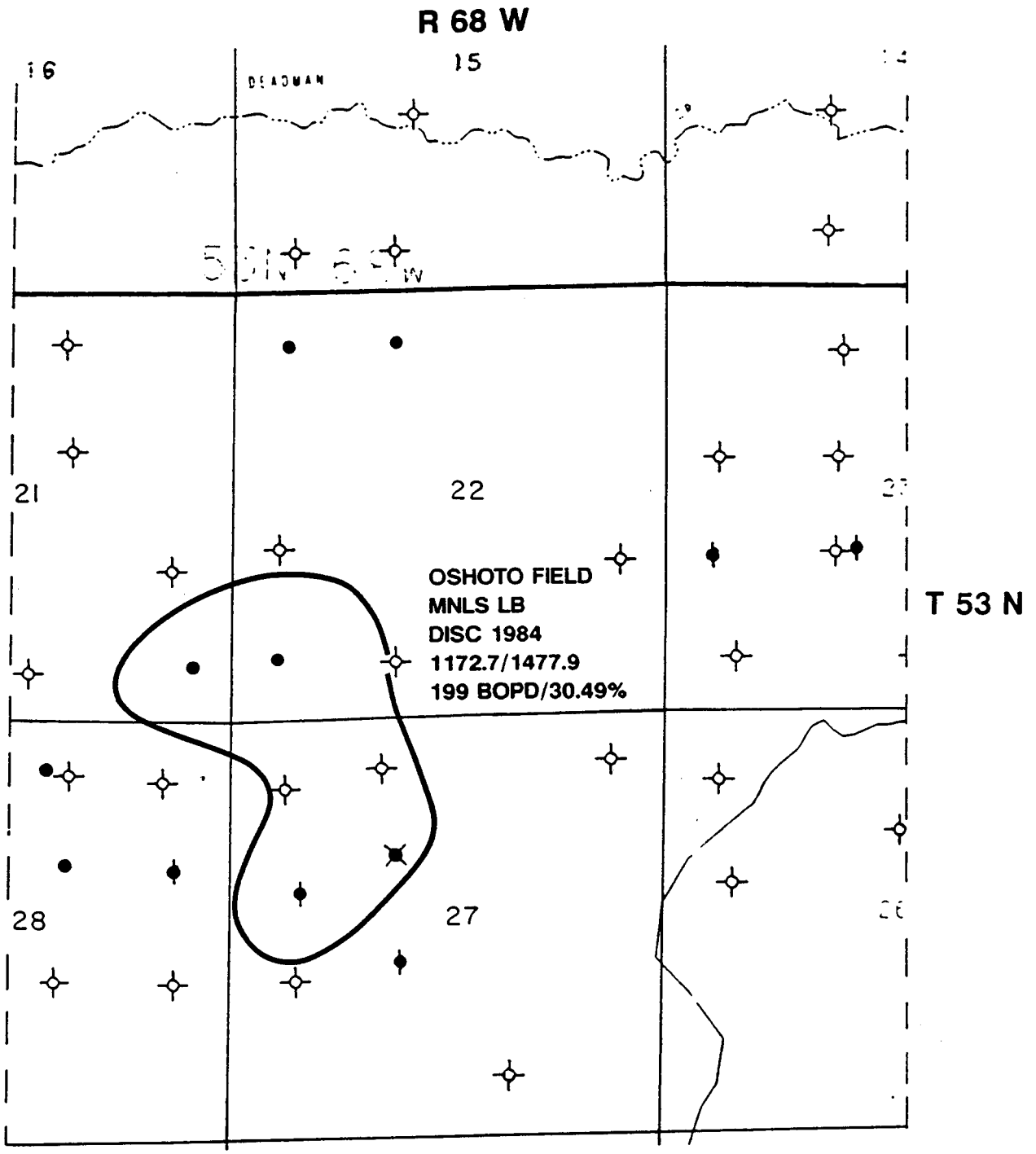
Oil Gravity	22.4
Oil Viscosity, cp	
Water Viscosity, cp	
Depth, feet	6,942
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.45

Reservoir Properties	
Volume, acre feet	3,471
Area, acres	250
Average Net Pay, feet	13.9
Average Porosity	22.0%
Average S_w	34.0%
FVF Factor	1.040
Pore Volume, Mbbls	5,927
Oil in Place, Mbbls	3,762
Est. Ult. Recovery Factor, %OOIP	42.8%
Current Recovery Factor %OOIP	31.2%
Current Depletion Factor %	72.8%

Primary Deline Analysis	
Economic Cutoff	
Oil Cut	5.0%
End of Primary Decline	11/06
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	1,611
Primary Recovery Factor %OOIP	42.8%
Cumulative Oil: Pore Volume	0.198
Cumulative Water: Pore Volume	0.249
Cumulative Injection: Pore Volume	n.a.
Production – Injection Difference: PV	n.a.

		------- to 1/93 -------		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SESE 21–53–68	Hahn #44–12	162,968	679,421	Pump–Oil
SWSW 22–53–68	Hahn #14–22	873,184	107,219	Pump–Oil
SWNW 27–53–68	Hahn #12–27	21,287	373,921	TA–Oil
SENW 27–53–68	Hahn #22–27	28	651	SWD

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

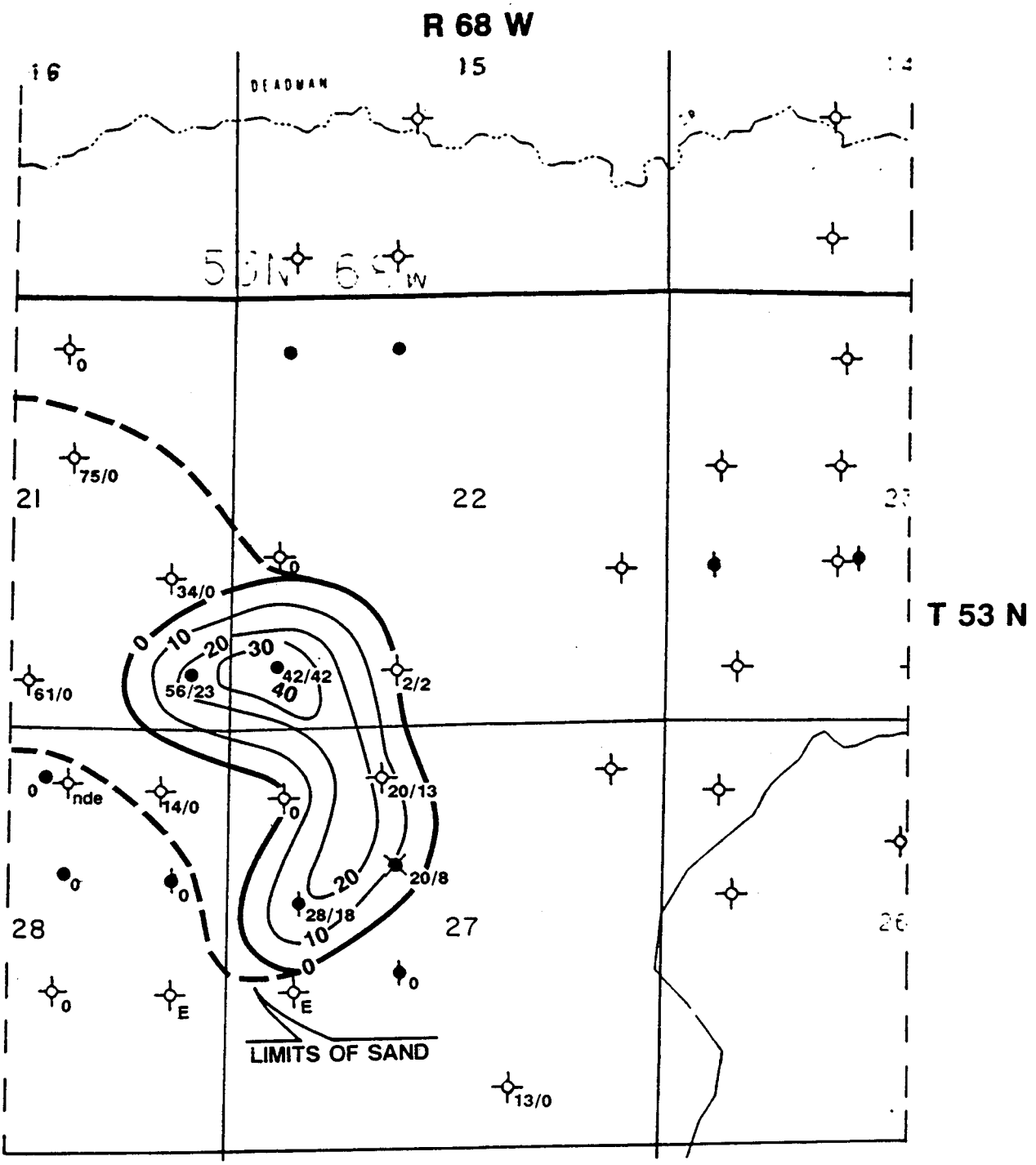
OSHOTO AREA

CROOK COUNTY, WYOMING

OSHOTO FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8/93



LEGEND

•	DRY HOLE	70/65	Net Porosity/Net Oil Pay
•	PRODUCING OIL WELL	nde	Not Deep Enough
•	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
•	ABDN. OIL WELL	E	Production Zone Eroded
•	WATER INJECTOR	n.i.	No Well Information
•	WATER DISPOSAL		

OSHOTO AREA

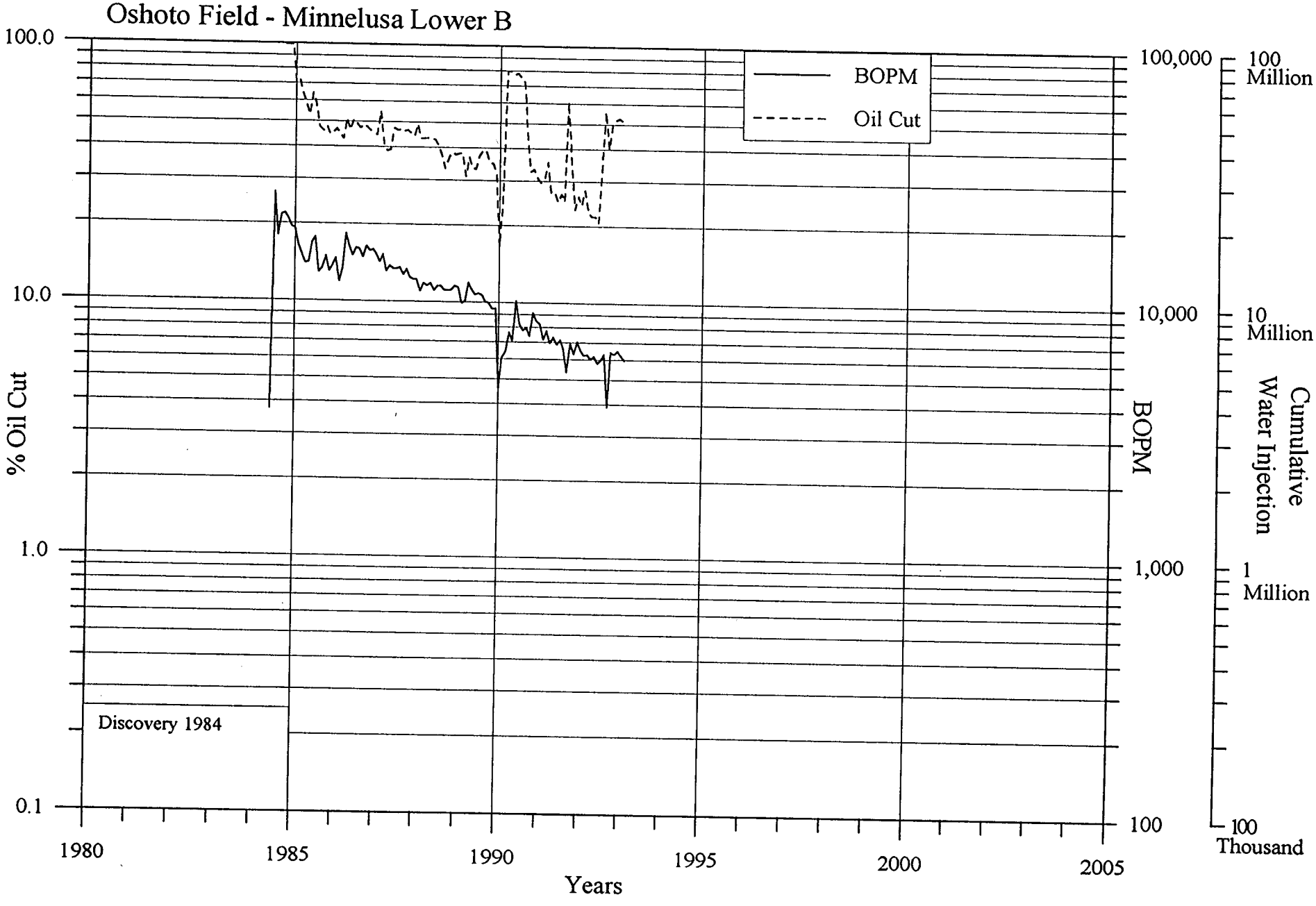
CROOK COUNTY, WYOMING

OSHOTO FIELD
MINNELUSA LB
ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Oshoto Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
BOPM
Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
Discovery 1984
1980
1985
1990
1995
2000
2005
Years

Oshoto North Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 53N – RGE 68W
	Section 22
Drive Mechanism:	Water Drive
Discovered:	1983
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	83,461
Water, bbls	123,286

Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,037
Water, Mbbls	792
Injection, Mbbls	n.a.

Current Rates	
Oil, bopd	229
Oil Cut, %	40.4%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	n.a.
Oil Cut	n.a.
Estimated Decline	n.a.
Proj. Ultimate Recovery, Mbbls	1,467
Proj. Remaining Reserves, Mbbls	430
Estimated Remaining Life, Years (from 1/93)	11.3
OOIP: Pore Volume	0.615
Ultimate Recovery: Pore Volume	0.312
Remaining O.I.P.: Pore Volume	0.303

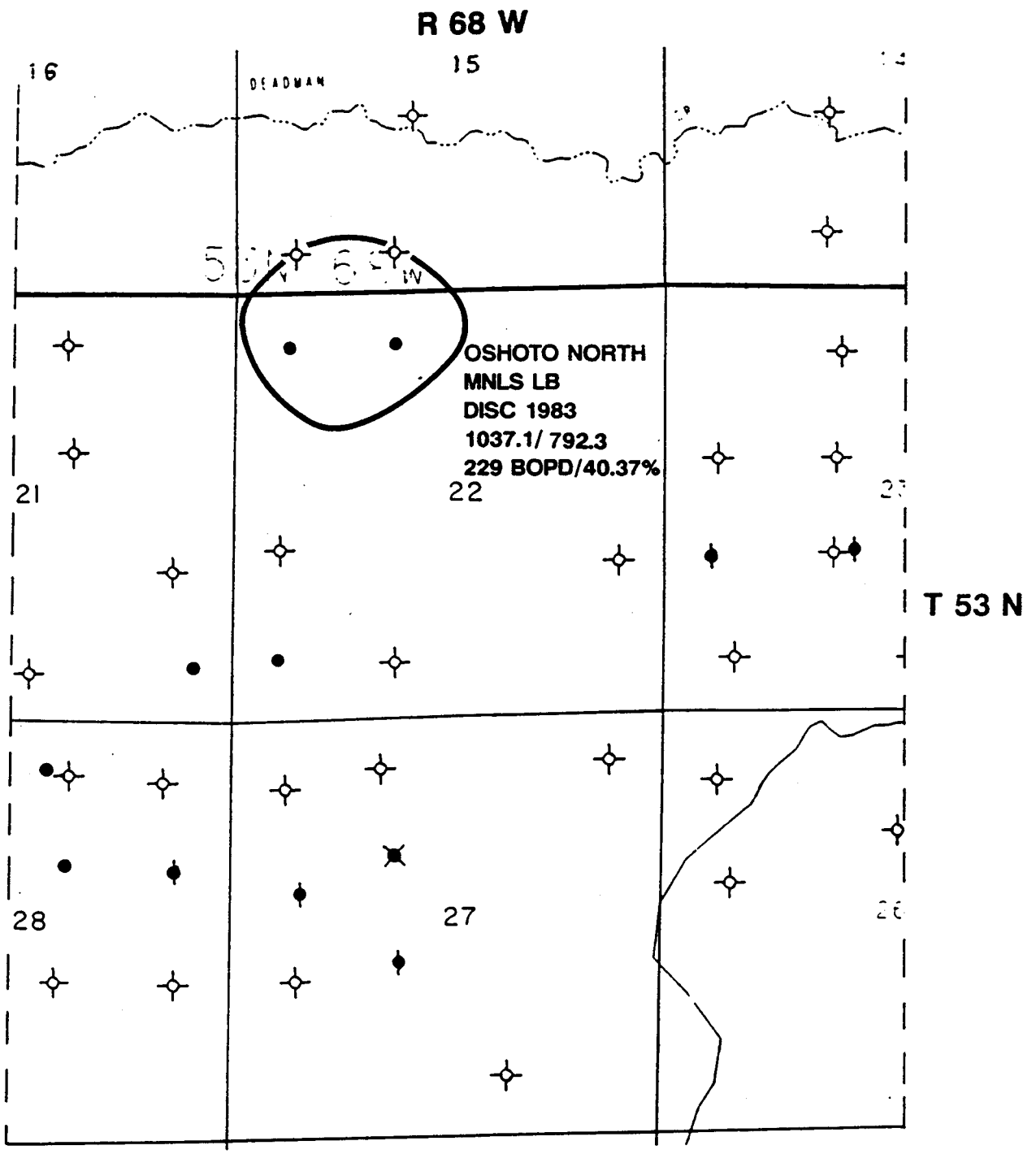
Oil Gravity	22.4
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	6,800
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.45

Reservoir Properties	
Volume, acre feet	2,755
Area, acres	107
Average Net Pay, feet	25.7
Average Porosity	22.0%
Average S_w	36.0%
FVF Factor	1.040
Pore Volume, Mbbls	4,701
Oil in Place, Mbbls	2,893
Est. Ult. Recovery Factor, %OOIP	50.7%
Current Recovery Factor %OOIP	35.8%
Current Depletion Factor %	70.7%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	40
End of Primary Decline	04/04
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	1,467
Primary Recovery Factor %OOIP	50.7%
Cumulative Oil: Pore Volume	0.221
Cumulative Water: Pore Volume	0.169
Cumulative Injection: Pore Volume	n.a.
Production – Injection Difference: PV	n.a.

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NENW 22–53–68	Rodriquez #21–32	933,377	154,432	Pump–Oil
NWNW 22–53–68	Rodriquez #11–32	239,363	1,323,470	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

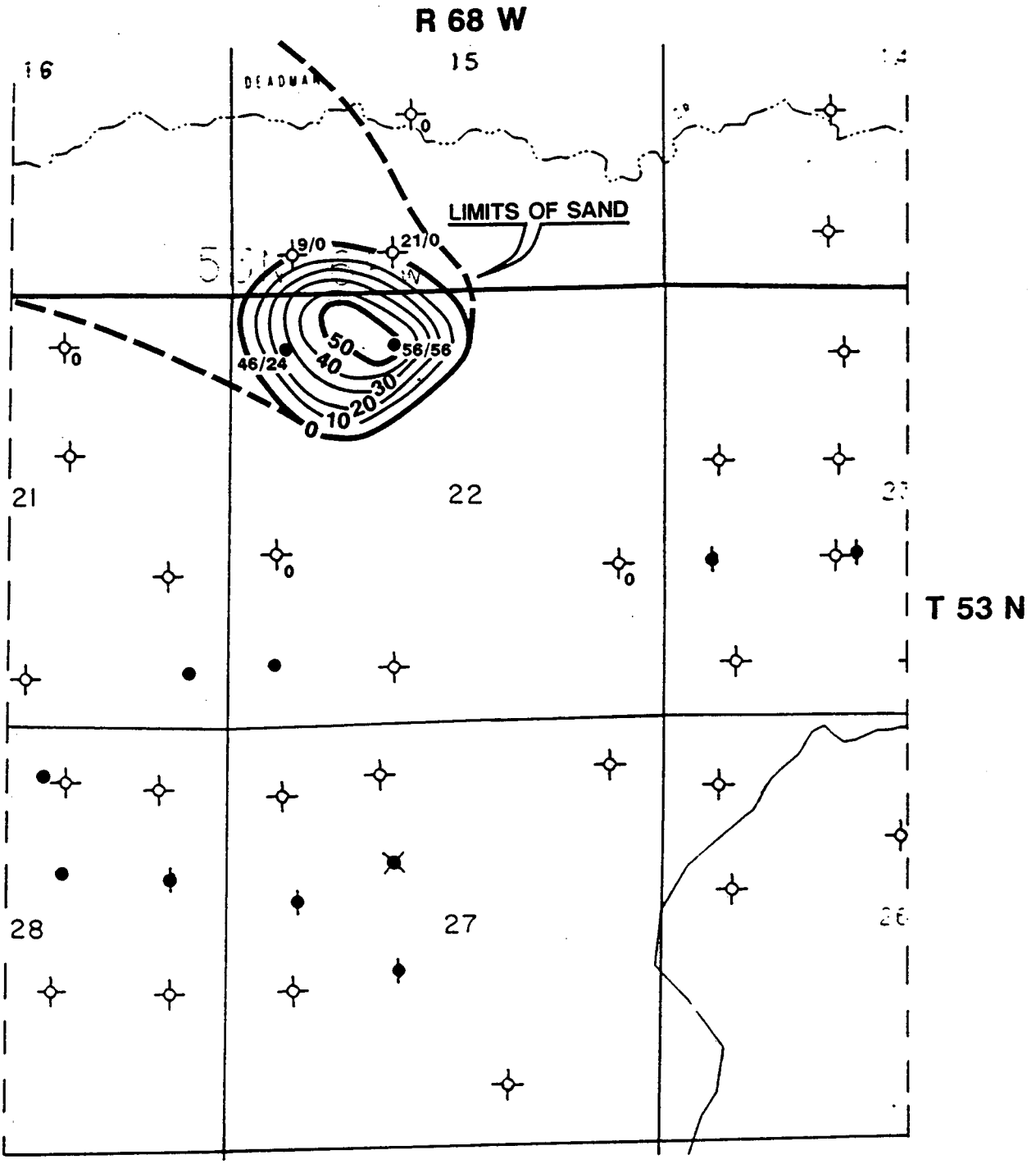
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

OSHOTO AREA

CROOK COUNTY, WYOMING

OSHOTO NORTH FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

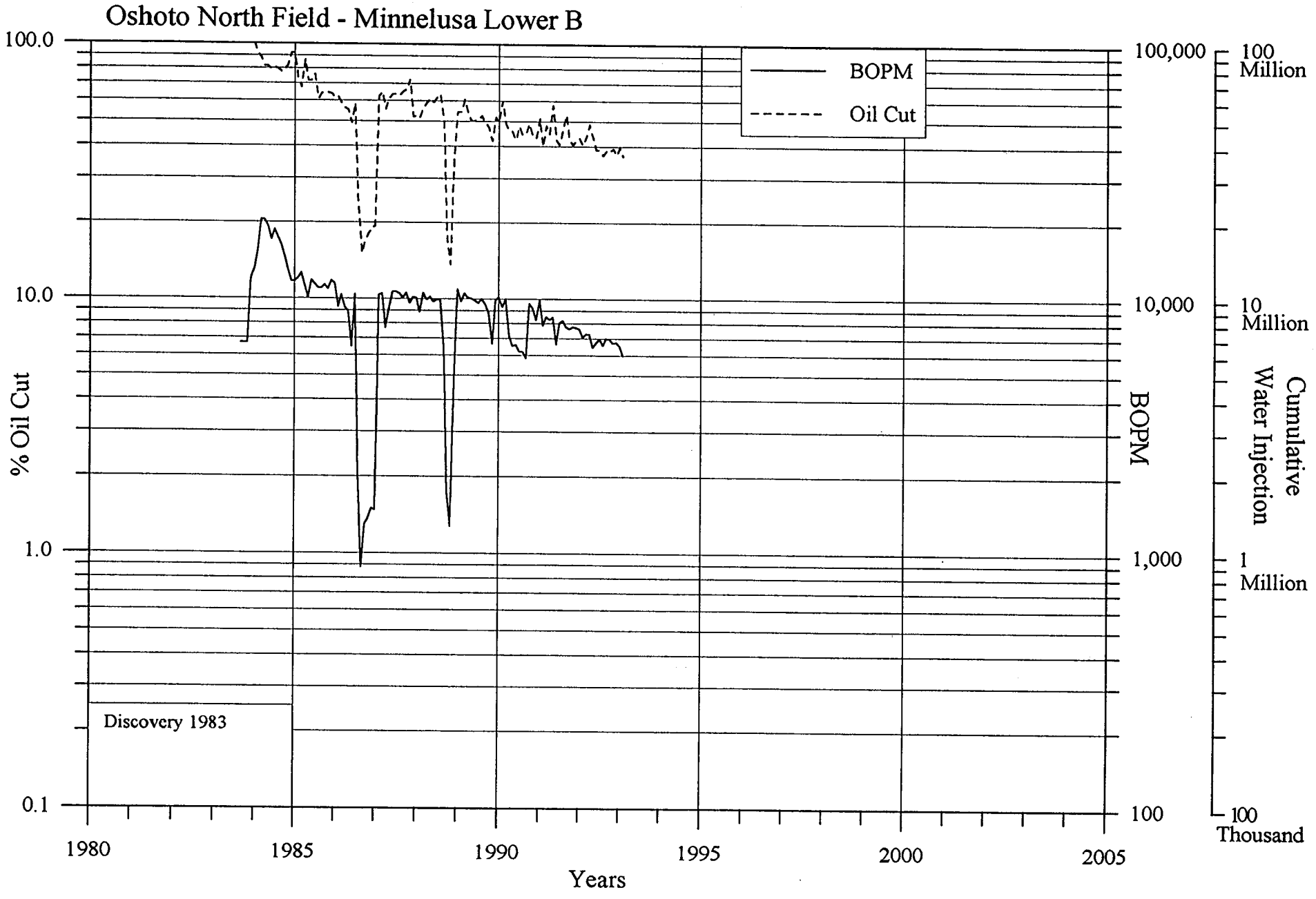
OSHOTO AREA

CROOK COUNTY, WYOMING

OSHOTO NORTH FIELD
MINNELUSA LB
ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH	
	8/93


Oshoto North Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1983
1980
1985
1990
1995
2000
2005
Years

Prairie Creek South Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 53N – RGE 68W
	Section 16
Drive Mechanism:	Waterflood
Discovered:	1986
Unitized:	1988

Oil Gravity	21.2
Oil Viscosity, cp	22.0
Water Viscosity, cp	0.6
Depth, feet	6,992
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.09

Current Production – 1/1 to 12/31/92	
Oil, bbls	50,772
Water, bbls	115,159

Cumulative Production – thru 12/31/92	
Oil, Mbbls	653
Water, Mbbls	135
Injection, Mbbls	878

Current Rates	
Oil, bopd	139
Oil Cut, %	30.6%

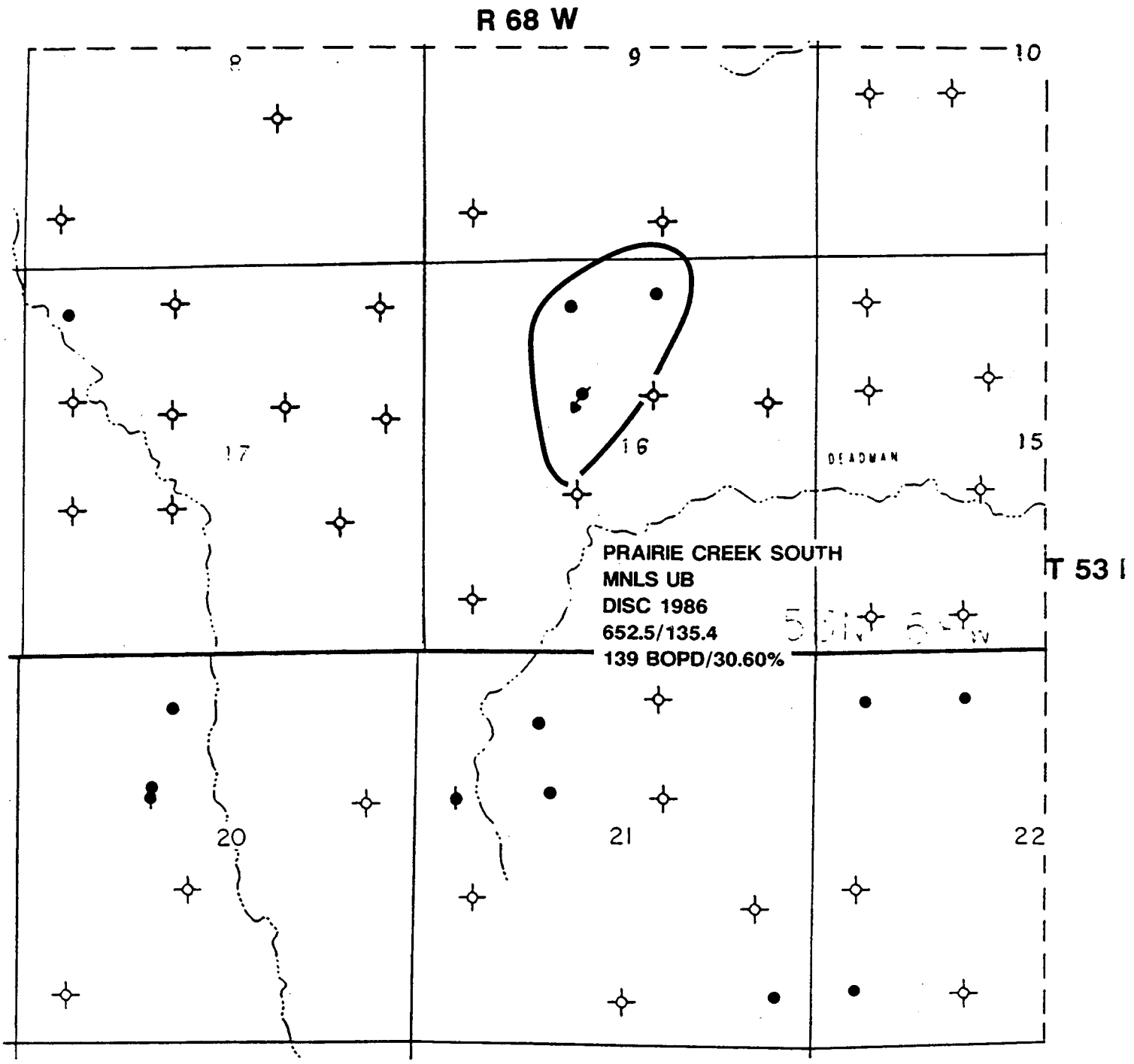
Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	30.0%
Proj. Ultimate Recovery, Mbbls	766
Proj. Remaining Reserves, Mbbls	114
Estimated Remaining Life, Years (from 1/93)	4.3
OOIP: Pore Volume	0.748
Ultimate Recovery: Pore Volume	0.286
Remaining O.I.P.: Pore Volume	0.462

Reservoir Properties	
Volume, acre feet	1,651
Area, acres	94
Average Net Pay, feet	17.6
Average Porosity	20.9%
Average S_w	23.0%
FVF Factor	1.030
Pore Volume, Mbbls	2,682
Oil in Place, Mbbls	2,005
Est. Ult. Recovery Factor, %OOIP	38.2%
Current Recovery Factor %OOIP	32.5%
Current Depletion Factor %	85.1%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	07/90
Estimated Decline	35.0%
Projected Ult. Recovery, Mbbls	133
Primary Recovery Factor %OOIP	6.6%
Cumulative Oil: Pore Volume	0.243
Cumulative Water: Pore Volume	0.050
Cumulative Injection: Pore Volume	0.327
Production – Injection Difference: PV	0.034

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNE 16–53–58	State A #1	532,080	113,099	Pump–Oil
NENW 16–53–58	State B #1	104,757	19,507	Pump–Oil
SENW 16–53–58	Prairie Creek #1	15,667	2,780	Injection

Injection Location	Name	1992 Year Curr Inj, bbls	to 1/93 Cum Inj, bbls	Status
SENW 16–53–68	Prairie Creek #1	174,861	878,231	Injection



LEGEND

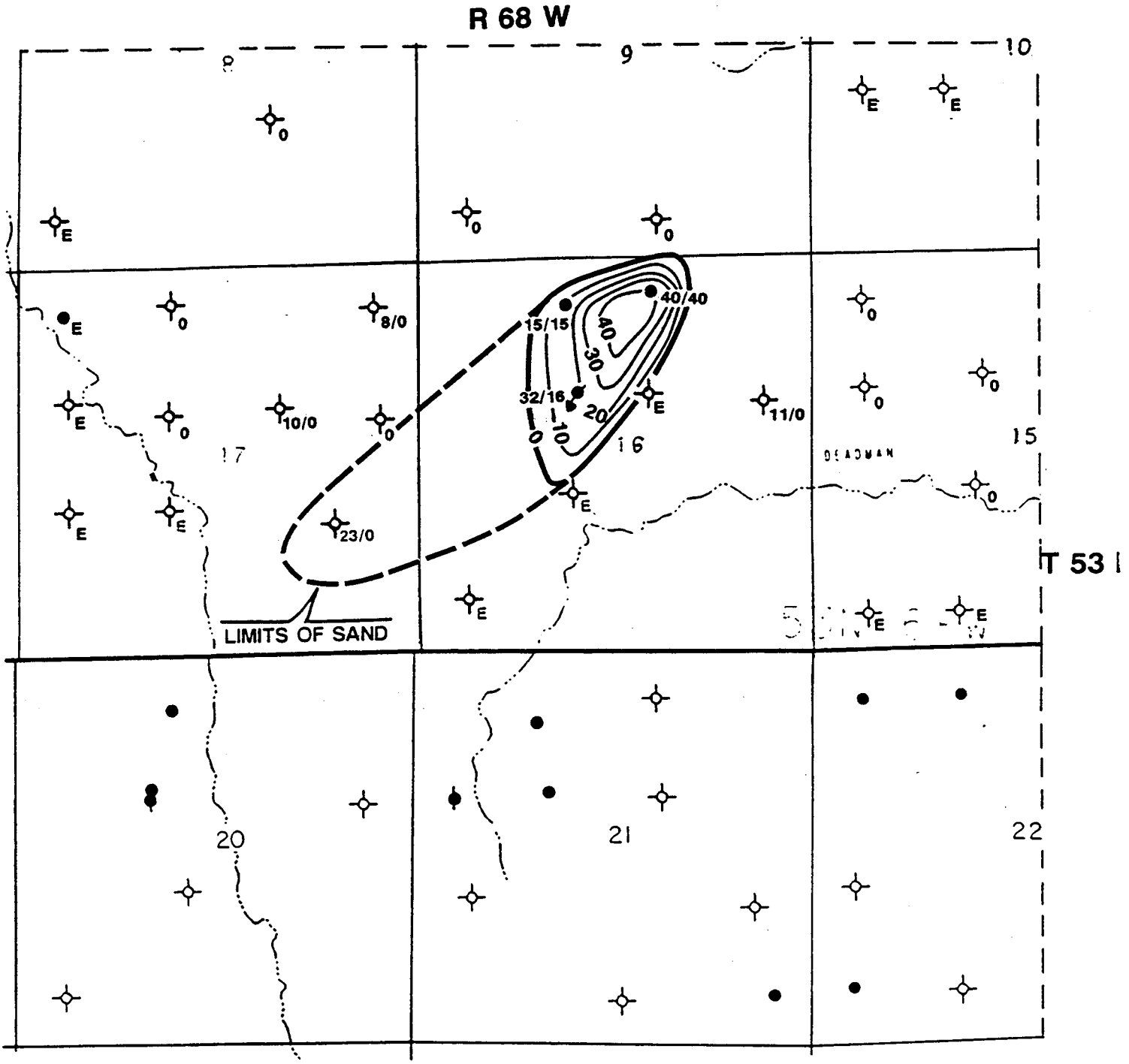
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

PRAIRIE CREEK SOUTH AREA

CROOK COUNTY, WYOMING

PRAIRIE CREEK SOUTH FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

PRAIRIE CREEK SOUTH AREA

CROOK COUNTY, WYOMING

PRAIRIE CREEK SOUTH FIELD

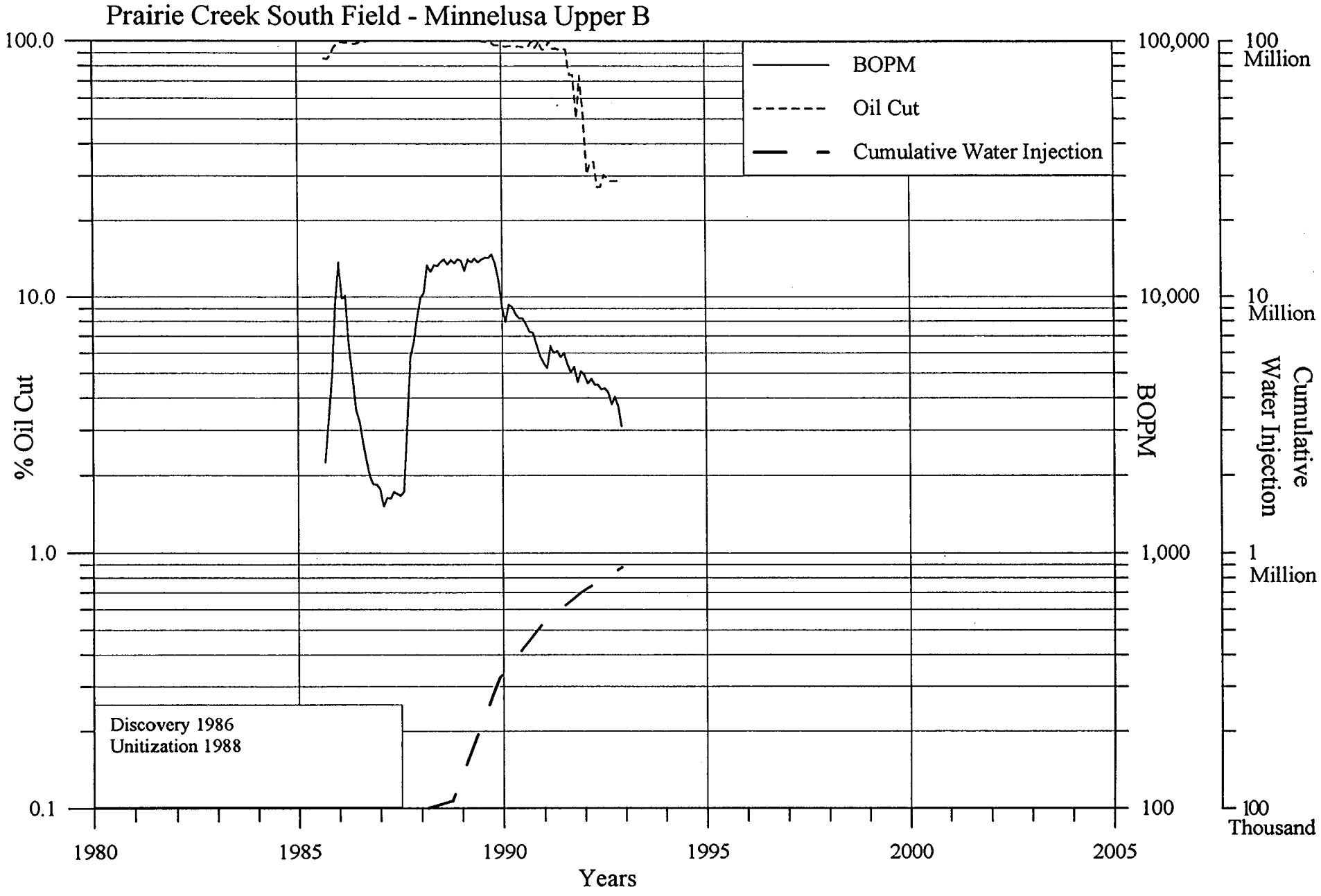
MINNELUSA UB

ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Prairie Creek South Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1986
Unitization 1988
1980
1985
1990
1995
2000
2005
Years

Reynolds Ranch Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 52N – RGE 67 & 68W
	Sections 6; 1
Drive Mechanism:	Water Drive
Discovered:	1974
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	24,617
Water, bbls	972,161

Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,197
Water, Mbbls	10,928
Injection, Mbbls	n.a.

Current Rates	
Oil, bopd	67
Oil Cut, %	2.5%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	
Estimated Decline	
Proj. Ultimate Recovery, Mbbls	973
Proj. Remaining Reserves, Mbbls	(223)
Estimated Remaining Life, Years (from 1/93)	0.0
OOIP: Pore Volume	0.583
Ultimate Recovery: Pore Volume	0.256
Remaining O.I.P.: Pore Volume	0.326

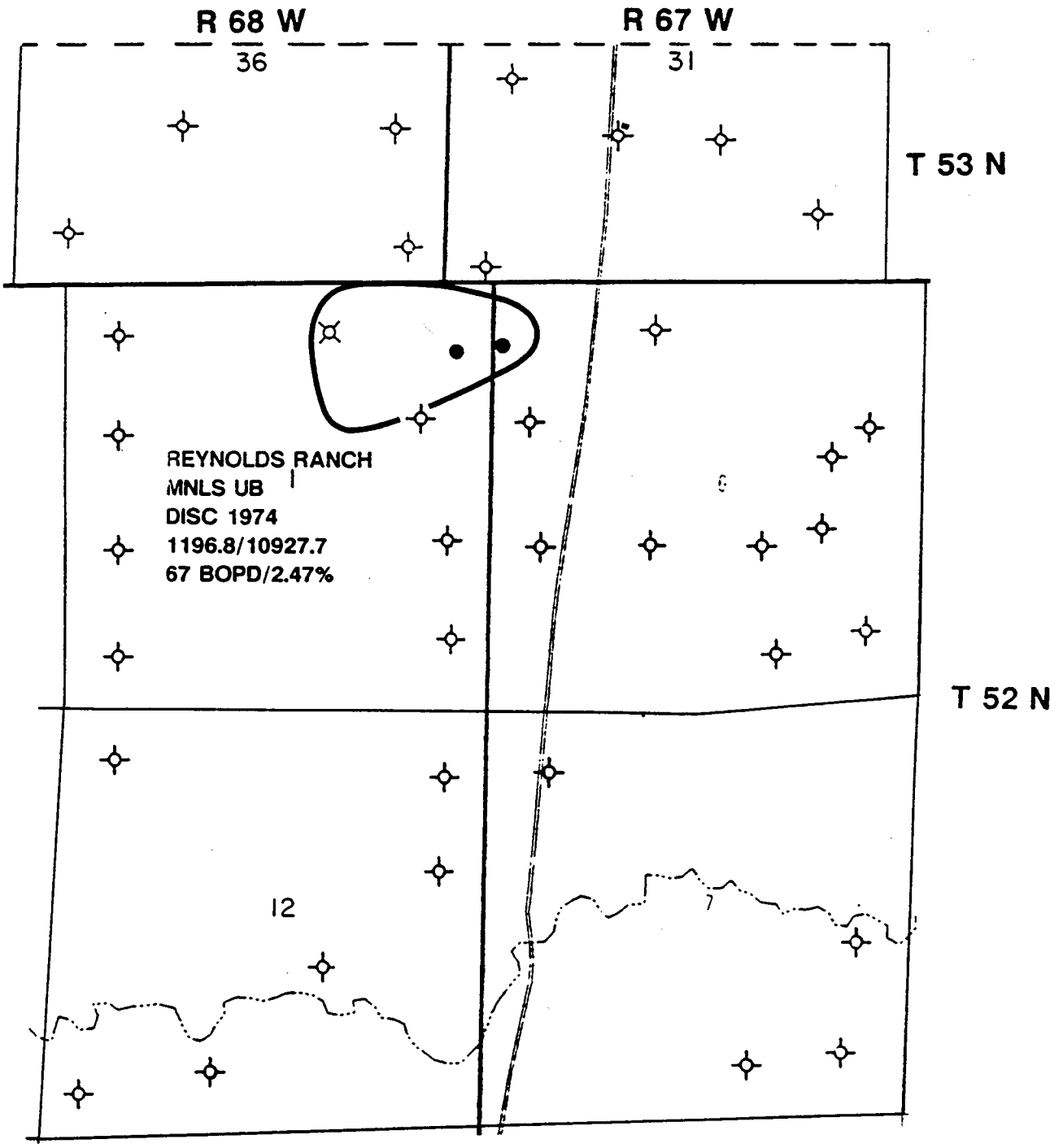
Oil Gravity	24.0
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	6,469
Formation Temperature, degrees F	128
Rw @ Formation Temperature	1.60

Reservoir Properties	
Volume, acre feet	1,840
Area, acres	88
Average Net Pay, feet	21.0
Average Porosity	26.6%
Average S_w	40.0%
FVF Factor	1.030
Pore Volume, Mbbls	3,797
Oil in Place, Mbbls	2,212
Est. Ult. Recovery Factor, %OOIP	44.0%
Current Recovery Factor %OOIP	54.1%
Current Depletion Factor %	123.0%

Primary Deline Analysis	
Economic Cutoff	
Oil Cut	5.0%
End of Primary Decline	03/86
Estimated Decline	10.0%
Projected Ult. Recovery, Mbbls	973
Primary Recovery Factor %OOIP	44.0%
Cumulative Oil: Pore Volume	0.315
Cumulative Water: Pore Volume	2.878
Cumulative Injection: Pore Volume	n.a.
Production – Injection Difference: PV	n.a.

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNW 06–52–67	Reynolds #2–6	408,269	825,341	Pump–Oil
NENE 01–52–68	Reynolds #1	971,399	9,759,311	Pump–Oil
NWNE 01–52–68	TP–State #1			WDW

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

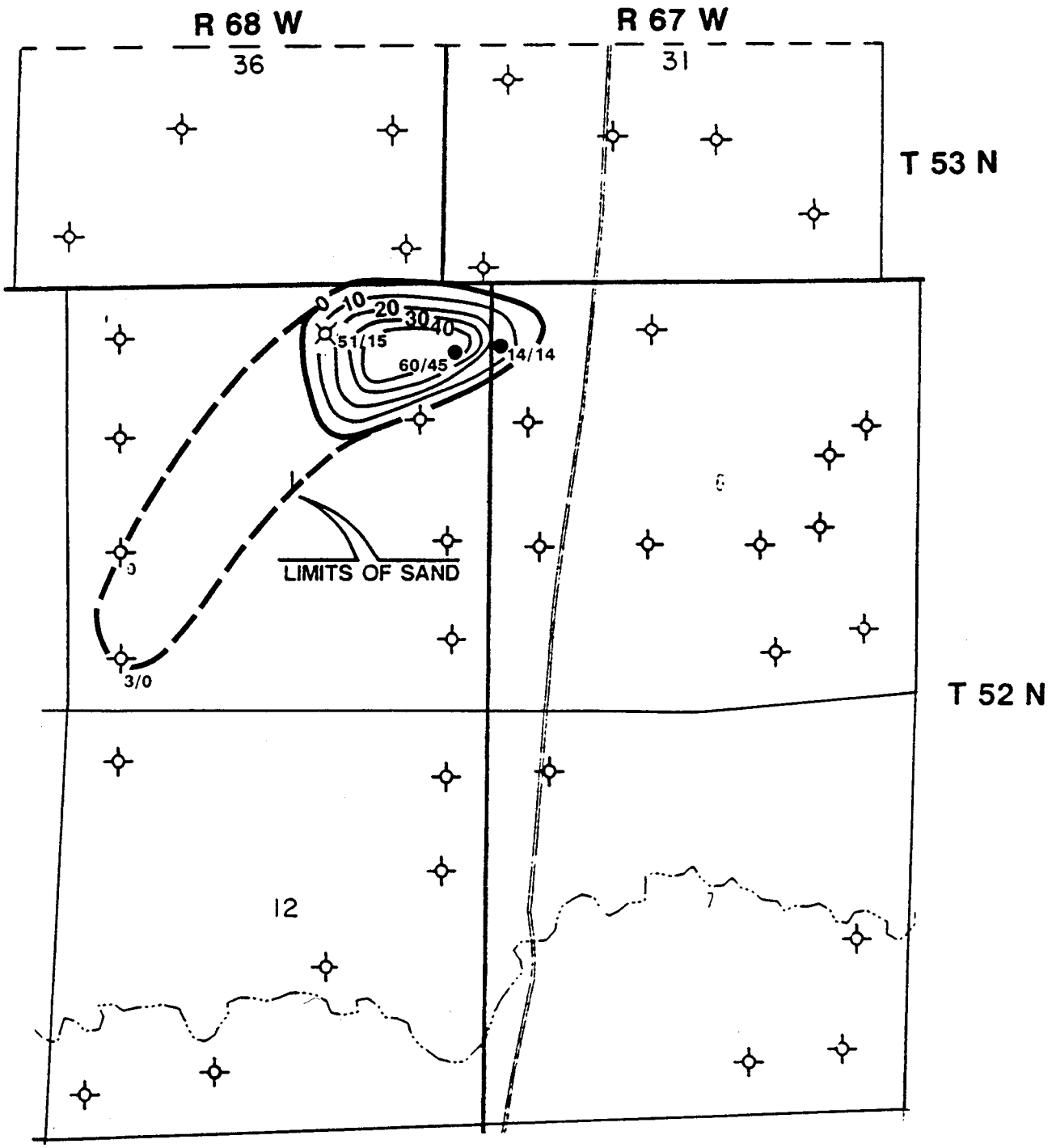
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

REYNOLDS RANCH AREA

CROOK COUNTY, WYOMING

REYNOLDS RANCH FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH	
	8 93



LEGEND

• DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
• ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

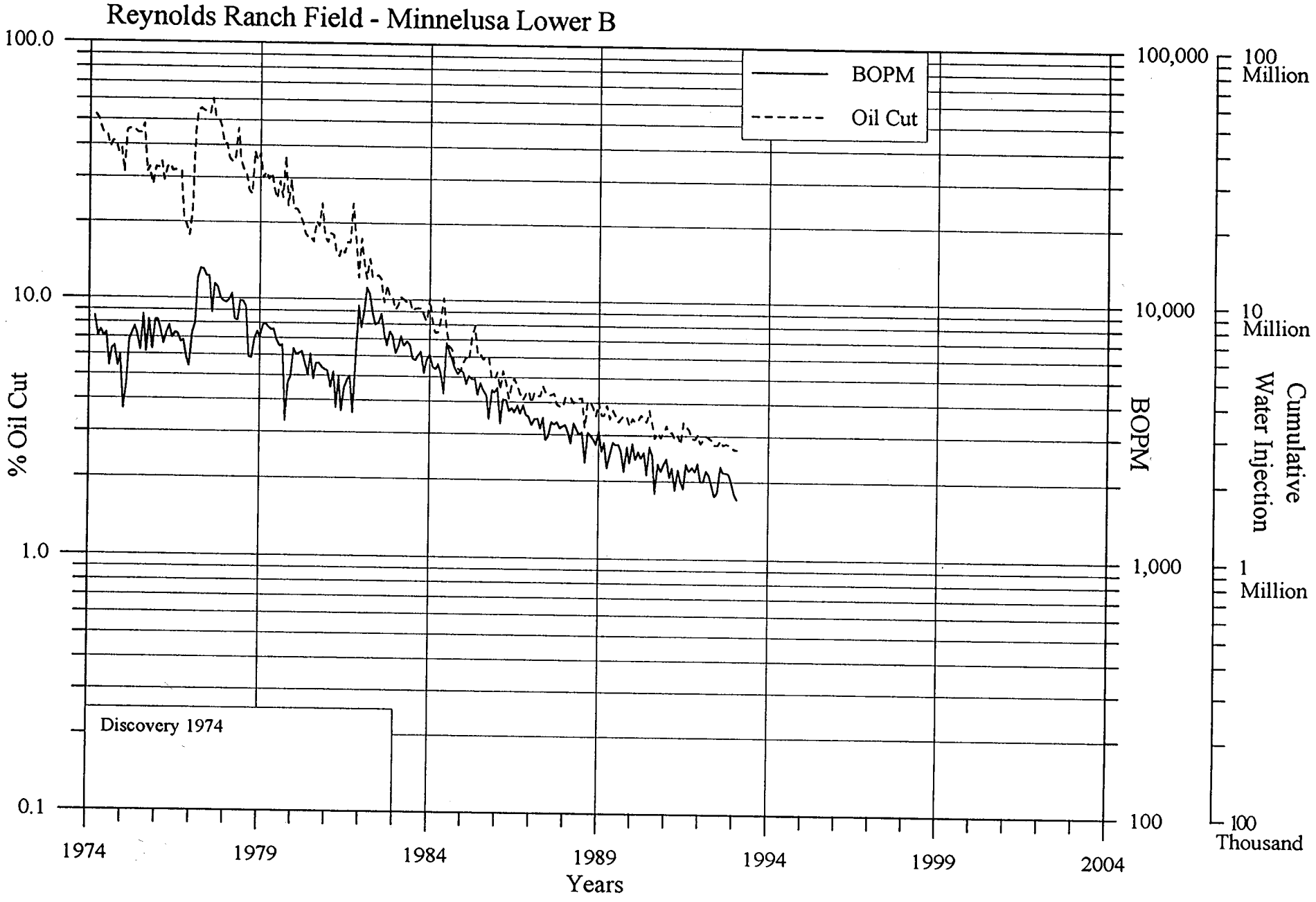
REYNOLDS RANCH AREA

CROOK COUNTY, WYOMING

REYNOLDS RANCH FIELD
MINNELUSA UB
ISOPACH:NET OIL PAY
C.I.=10'

GEOLOGY: L. GRIFFITH

8/93


Reynolds Ranch Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1974
1974
1979
1984
1989
1994
1999
2004
Years

Rule Field

Producing Zone:	Minnelusa Lower B
Location:	Campbell County, Wyoming
	TWP 52 – RGE 69W
	Section 15
Drive Mechanism:	Waterflood
Discovered:	1985
Unitized:	1991

Current Production – 1/1 to 12/31/92	
Oil, bbls	88,668
Water, bbls	0
Cumulative Production – thru 12/31/92	
Oil, Mbbls	389
Water, Mbbls	0
Injection, Mbbls	280
Current Rates	
Oil, bopd	243
Oil Cut, %	100.0%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	10
Oil Cut	
Estimated Decline	65.0%
Proj. Ultimate Recovery, Mbbls	652
Proj. Remaining Reserves, Mbbls	263
Estimated Remaining Life, Years (from 1/93)	5.8
OOIP: Pore Volume	0.638
Ultimate Recovery: Pore Volume	0.191
Remaining O.I.P.: Pore Volume	0.447

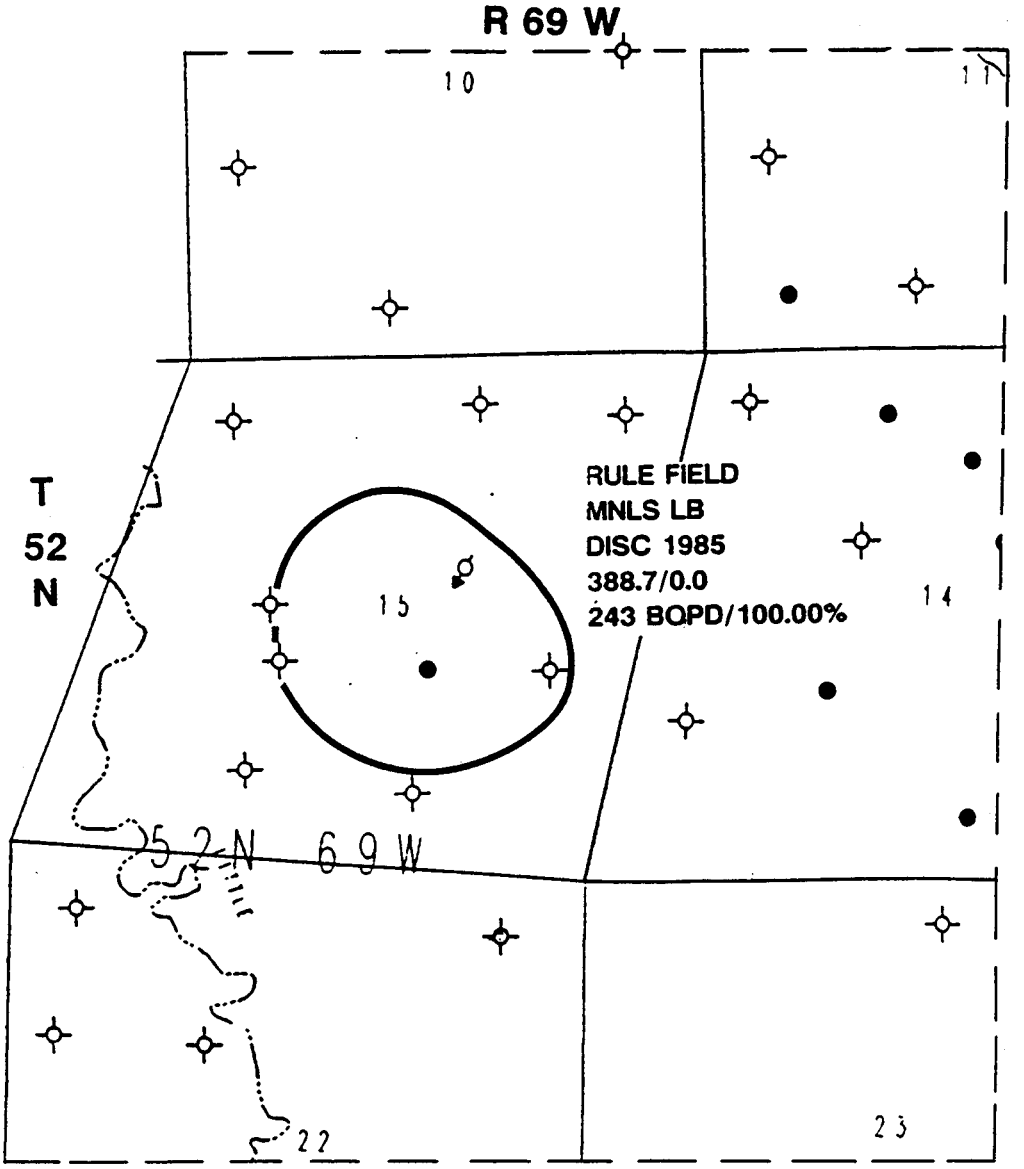
Oil Gravity	25.0 *
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	7,380 *
Formation Temperature, degrees F	n.i.
Rw @ Formation Temperature	n.i.
Reservoir Properties	
Volume, acre feet	2,577 *
Area, acres	87 *
Average Net Pay, feet	29.8 *
Average Porosity	17.1% *
Average S_w	33.7% *
FVF Factor	1.040 *
Pore Volume, Mbbls	3,419
Oil in Place, Mbbls	2,179
Est. Ult. Recovery Factor, %OOIP	29.9%
Current Recovery Factor %OOIP	17.8%
Current Depletion Factor %	59.7%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	10
End of Primary Decline	02/04
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	425
Primary Recovery Factor %OOIP	19.5%
Cumulative Oil: Pore Volume	0.114
Cumulative Water: Pore Volume	0.000
Cumulative Injection: Pore Volume	0.082
Production – Injection Difference: PV	–0.032

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NESW 15–52–69	Federal #10–15	416,567	0	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SWNE 15–52–69	Federal #7–15	205,804	279,790	Injection

*Reservoir parameters from unit report



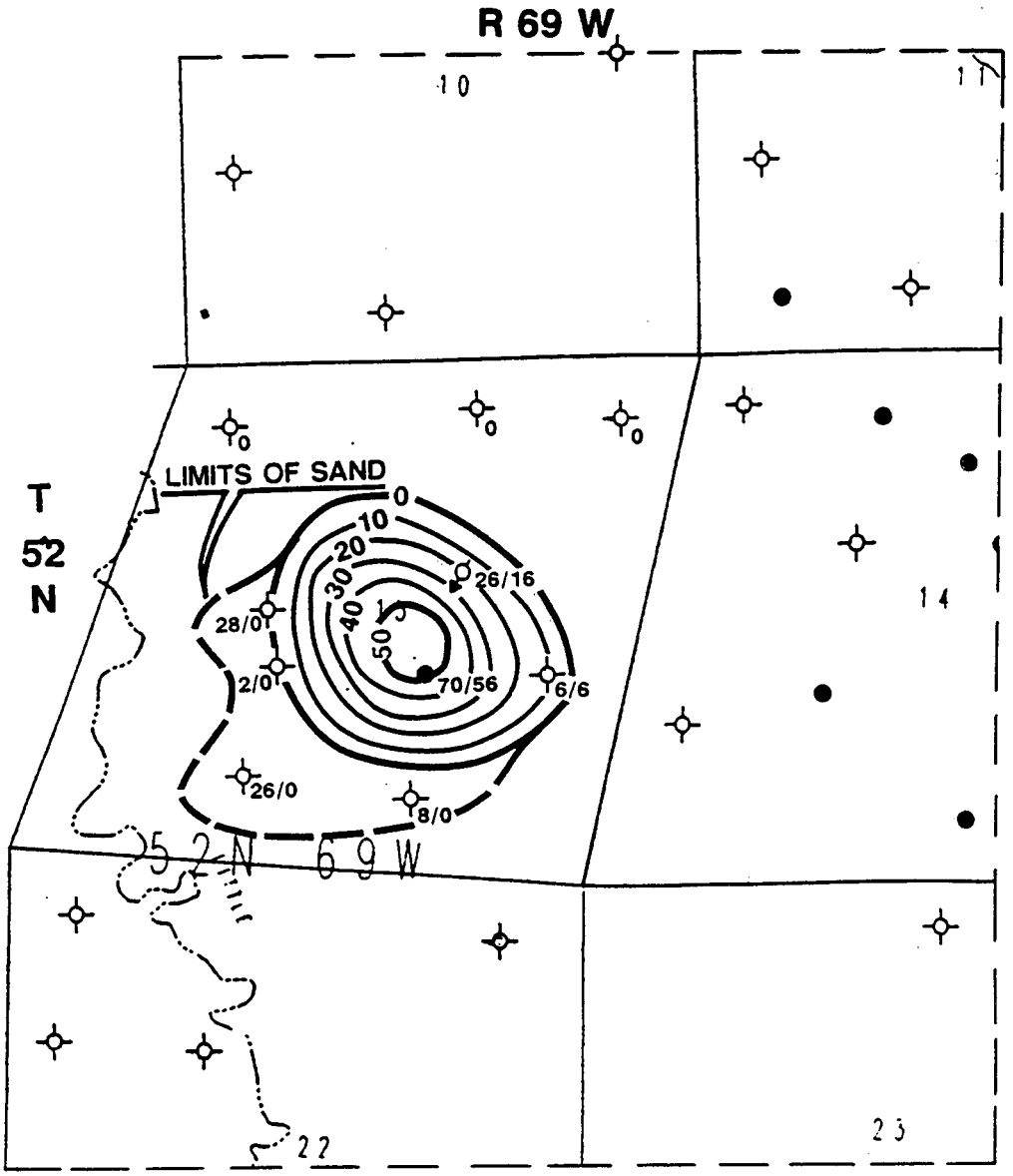
LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

RULE AREA
CAMPBELL COUNTY, WYOMING

RULE FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH	
	8/93



LEGEND

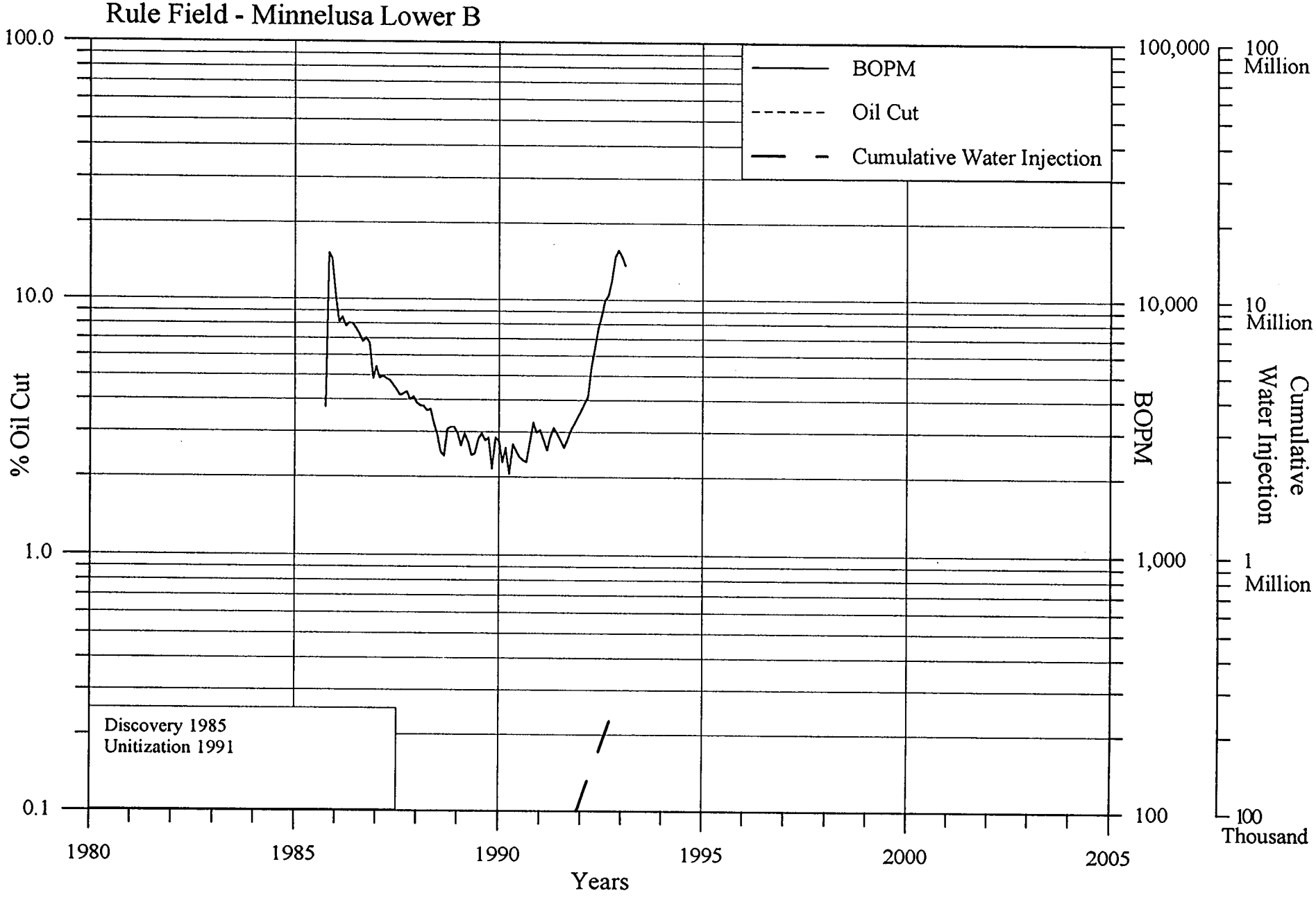
⊹	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⧫	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
⚷	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		

RULE AREA
CAMPBELL COUNTY, WYOMING

RULE FIELD
MINNELUSA LB
ISOPACH:NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH

8/93


Rule Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1985
Unitization 1991
1980
1985
1990
1995
2000
2005
Years

Semlek Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Section 27
Drive Mechanism:	Water Drive
Discovered:	1962
Unitized:	n.a.

Current Production – 1/1 to 12/31/92	
Oil, bbls	44,841
Water, bbls	320,062

Cumulative Production – thru 12/31/92	
Oil, Mbbls	3,224
Water, Mbbls	5,010
Injection, Mbbls	n.a.

Current Rates	
Oil, bopd	123
Oil Cut, %	12.3%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	
Estimated Decline	
Proj. Ultimate Recovery, Mbbls	3,411
Proj. Remaining Reserves, Mbbls	188
Estimated Remaining Life, Years (from 1/93)	5.8
OOIP: Pore Volume	0.702
Ultimate Recovery: Pore Volume	0.322
Remaining O.I.P.: Pore Volume	0.380

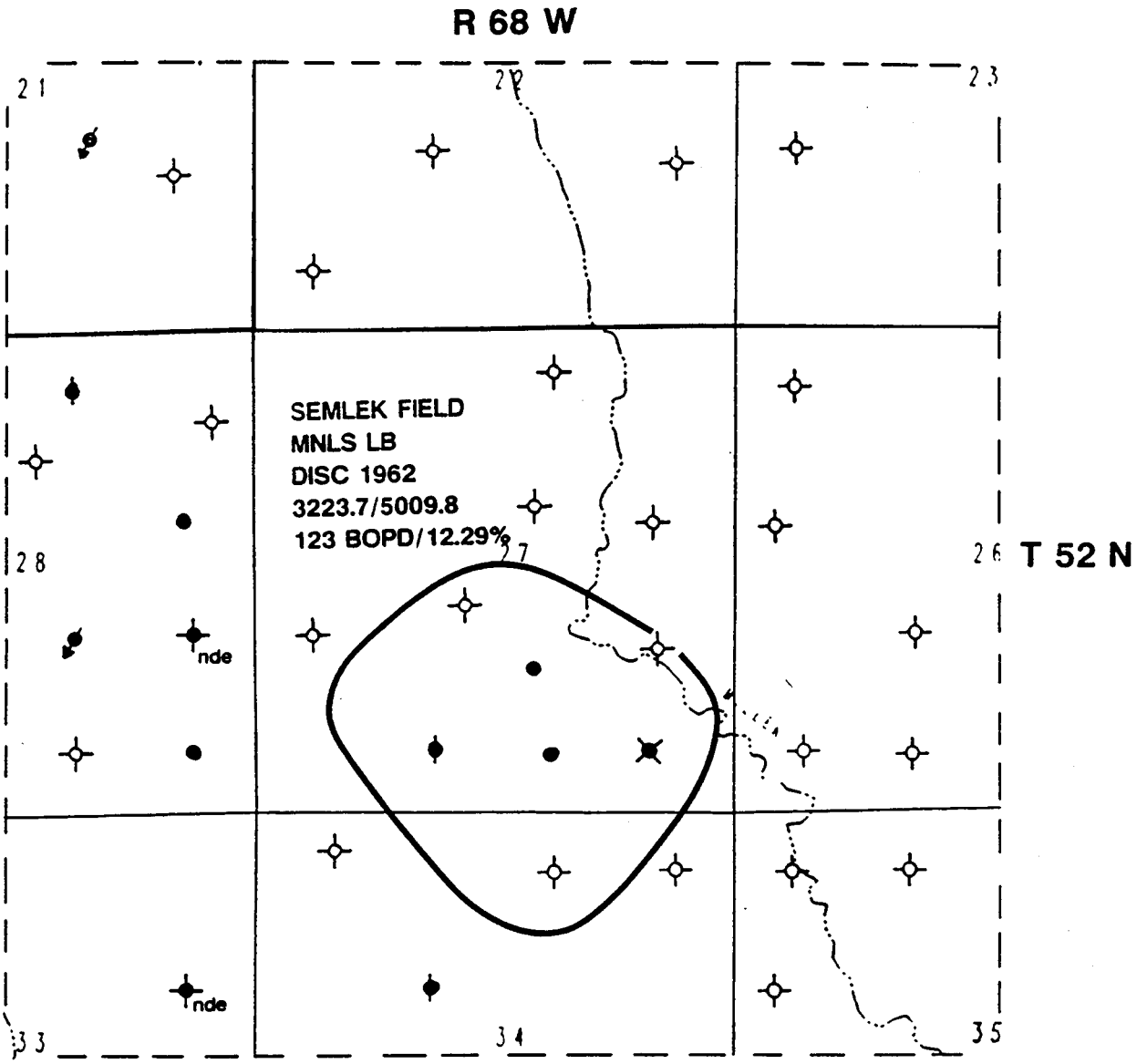
Oil Gravity	22.6
Oil Viscosity, cp	
Water Viscosity, cp	
Depth, feet	6,968
Formation Temperature, degrees F	110
Rw @ Formation Temperature	0.15

Reservoir Properties	
Volume, acre feet	6,438
Area, acres	253
Average Net Pay, feet	25.4
Average Porosity	21.2%
Average S_w	27.0%
FVF Factor	1.040
Pore Volume, Mbbls	10,588
Oil in Place, Mbbls	7,432
Est. Ult. Recovery Factor, %OOIP	45.9%
Current Recovery Factor %OOIP	43.4%
Current Depletion Factor %	94.5%

Primary Deline Analysis	
Economic Cutoff	
Oil Cut	5.0%
End of Primary Decline	09/98
Estimated Decline	15.0%
Projected Ult. Recovery, Mbbls	3,411
Primary Recovery Factor %OOIP	45.9%
Cumulative Oil: Pore Volume	0.304
Cumulative Water: Pore Volume	0.473
Cumulative Injection: Pore Volume	n.a.
Production – Injection Difference: PV	n.a.

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSE 27–52–68	Mellott #1–B	1,618,877	17,817,750	Pump–Oil
SESW 27–52–68	Semlek #1–F	1,369,214	1,434,019	TA–Oil
SWSE 27–52–68	Semlek #2–F	289,055	1,442,675	Pump–Oil
SESE 27–52–68				SWD

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

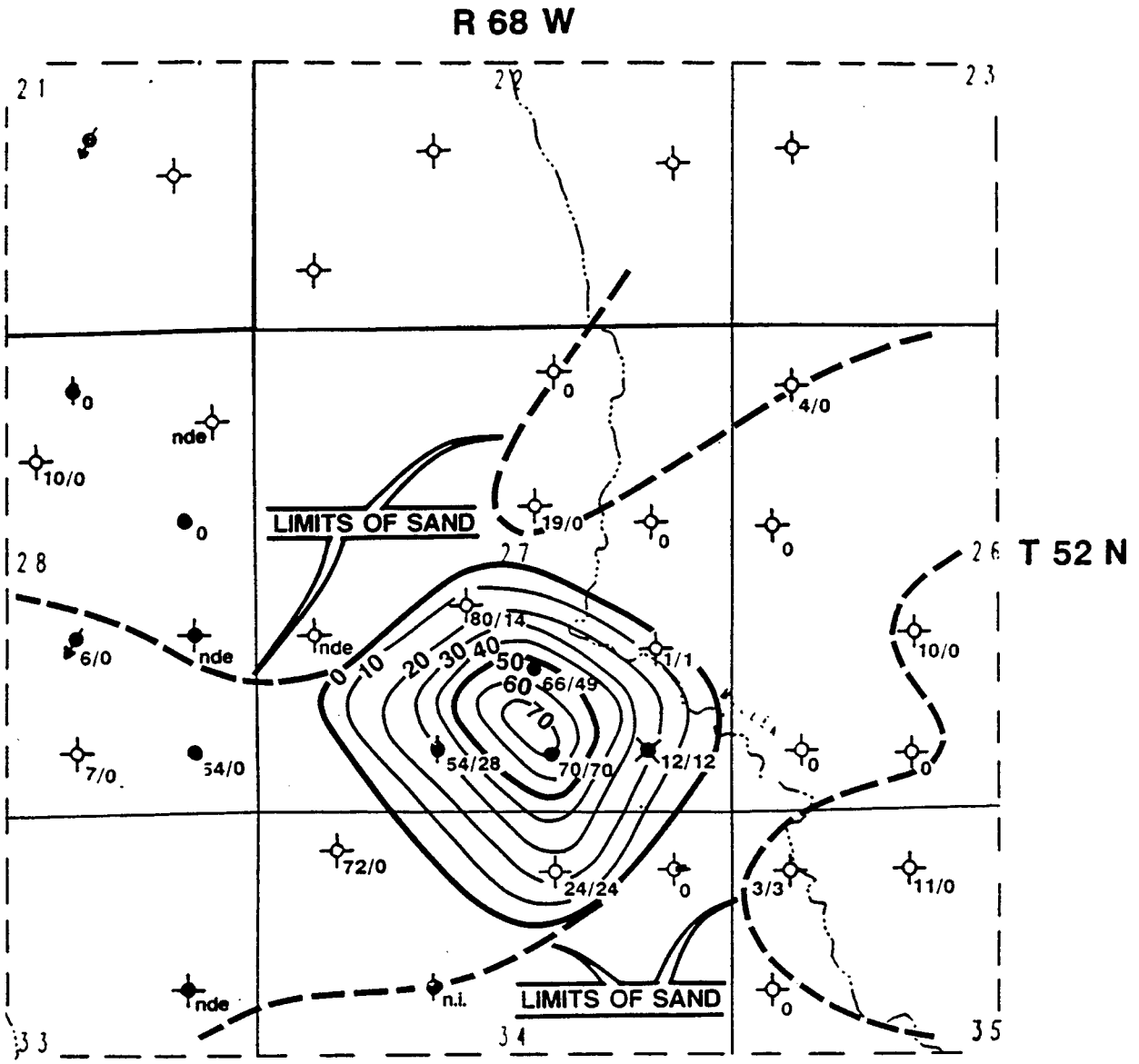
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

SEMLEK AREA

CROOK COUNTY, WYOMING

SEMLEK FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH	
	8-93



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⊕	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
☼	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		

SEMLEK AREA

CROOK COUNTY, WYOMING

SEMLEK FIELD

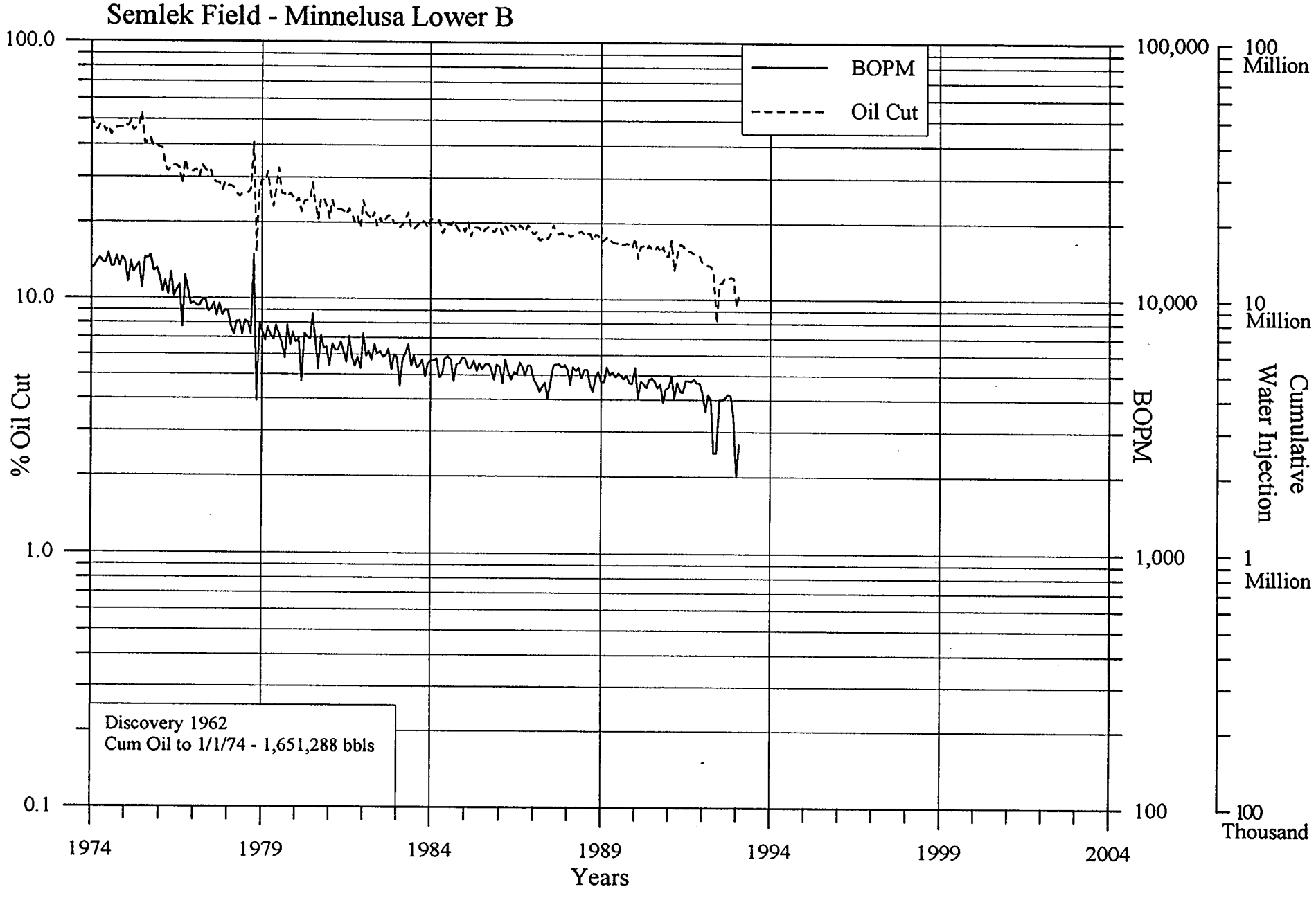
MINNELUSA LB

ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L. GRIFFITH

8/93


Semlek Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1962
Cum Oil to 1/1/74 - 1,651,288 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Semlek North Field

Producing Zone:	Minnelusa Lower B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 16, & 21
Drive Mechanism:	Polymer Waterflood
Discovered:	1962
Unitized:	1988

Current Production – 1/1 to 12/31/92	
Oil, bbls	51,661
Water, bbls	118,919

Cumulative Production – thru 12/31/92	
Oil, Mbbls	1,438
Water, Mbbls	492
Injection, Mbbls	889

Current Rates	
Oil, bopd	142
Oil Cut, %	30.3%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	40.0%
Proj. Ultimate Recovery, Mbbls	1,526
Proj. Remaining Reserves, Mbbls	88
Estimated Remaining Life, Years (from 1/93)	5.0
OOIP: Pore Volume	0.654
Ultimate Recovery: Pore Volume	0.304
Remaining O.I.P.: Pore Volume	0.350

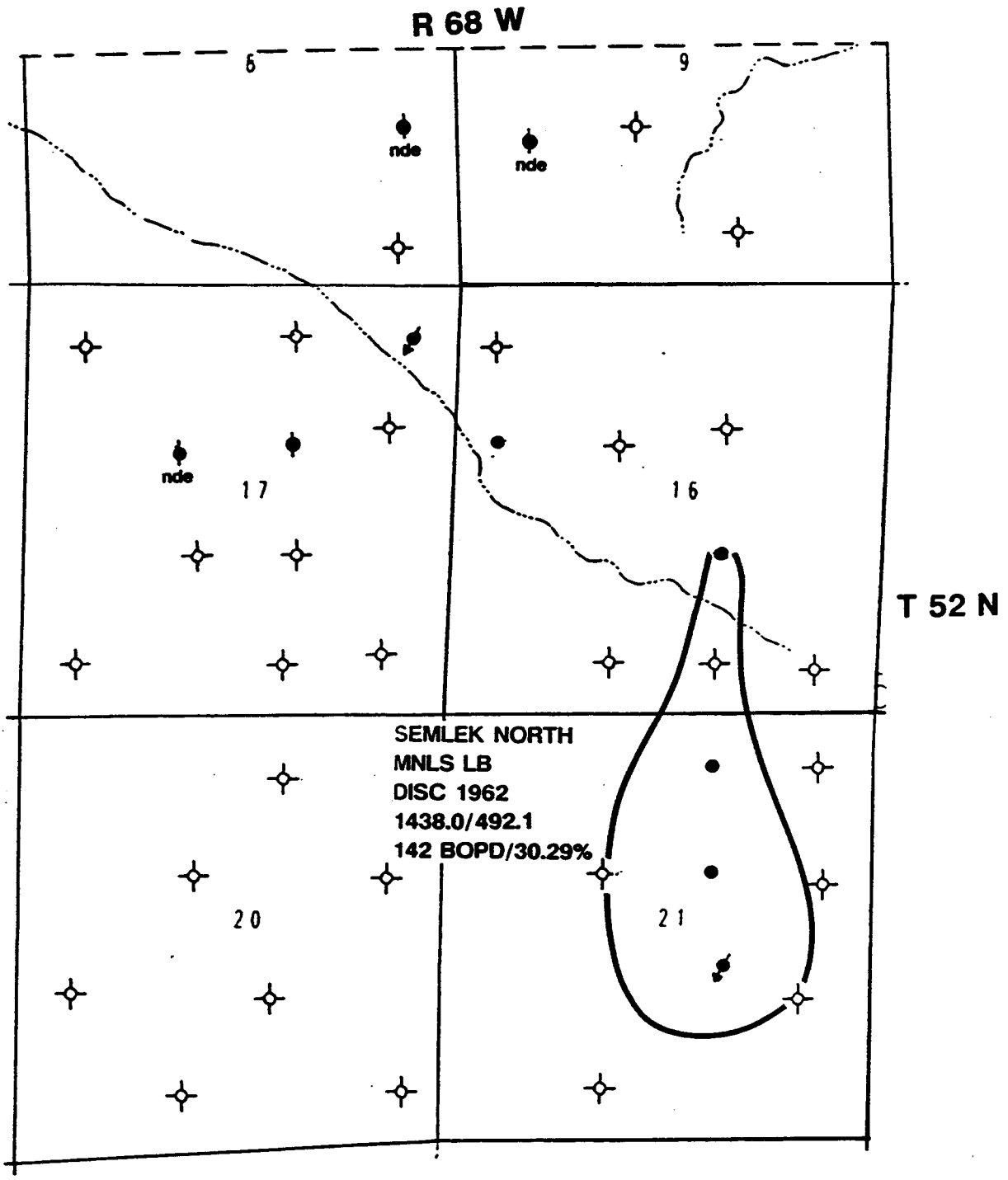
Oil Gravity	22.6
Oil Viscosity, cp	12.3
Water Viscosity, cp	0.5
Depth, feet	7,230
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.15

Reservoir Properties	
Volume, acre feet	3,846
Area, acres	207
Average Net Pay, feet	18.6
Average Porosity	16.8%
Average S_w	32.0%
FVF Factor	1.040
Pore Volume, Mbbls	5,016
Oil in Place, Mbbls	3,280
Est. Ult. Recovery Factor, %OOIP	46.5%
Current Recovery Factor %OOIP	43.8%
Current Depletion Factor %	94.2%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	01/88
Estimated Decline	10.0%
Projected Ult. Recovery, Mbbls	1,051
Primary Recovery Factor %OOIP	32.0%
Cumulative Oil: Pore Volume	0.287
Cumulative Water: Pore Volume	0.098
Cumulative Injection: Pore Volume	0.177
Production – Injection Difference: PV	–0.208

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWSE 16–52–68	Terra–State #1	42,231	3,245	Pump–Oil
NWNE 21–52–68	Govt Heath #1–21	917,921	59,109	Pump–Oil
SWNE 21–52–68	Govt Heath #5–21	311,499	337,687	Pump–Oil
NWSE 21–52–68	Federal #1	62,828	39,500	Injection

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NWSE 21–52–68	Federal #1	185,468	88,838	Injection



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

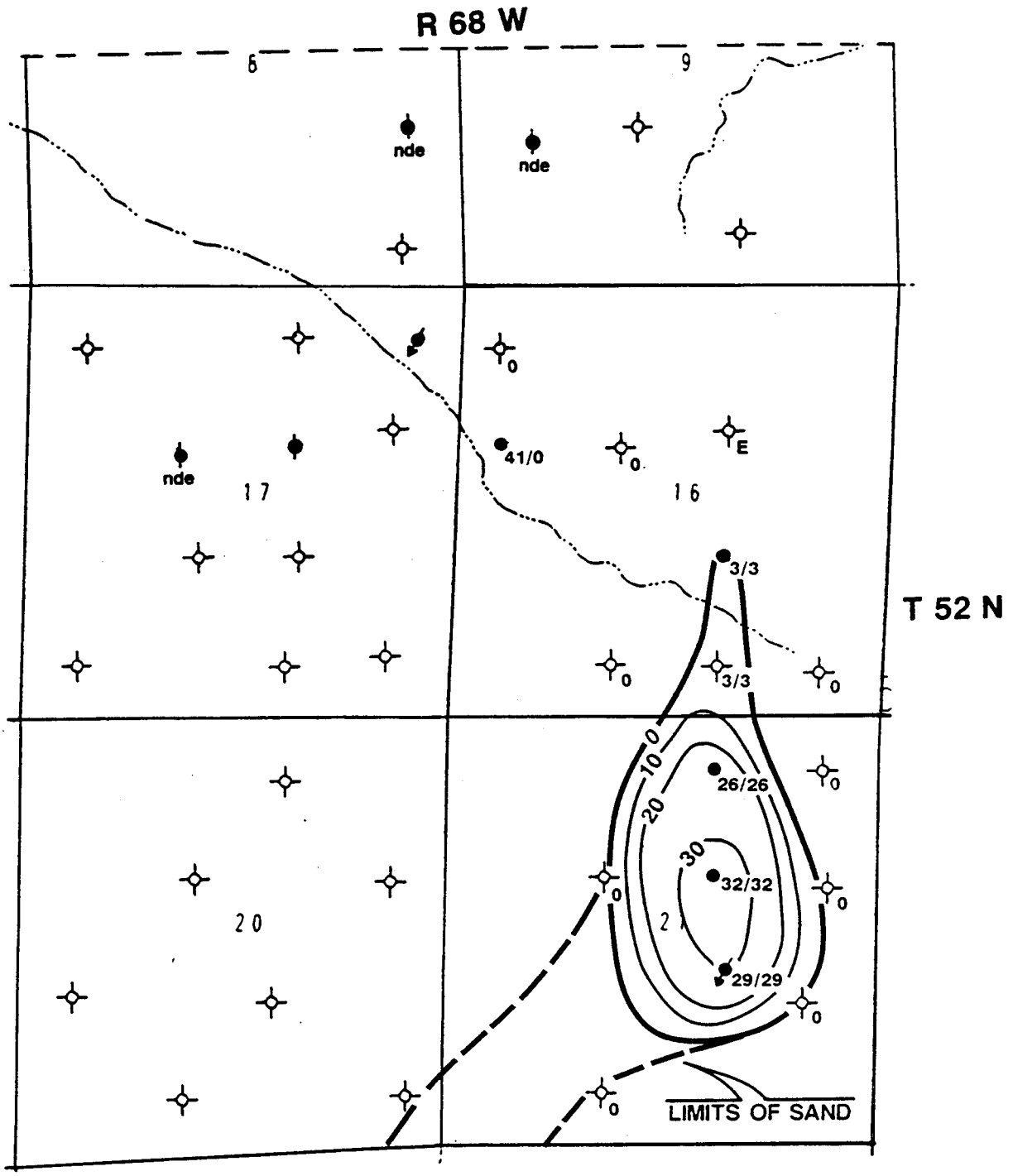
SEMLEK NORTH AREA

CROOK COUNTY, WYOMING

SEMLEK NORTH FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8'93



LEGEND

⊁	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⊁	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
⊁	ABDN. OIL WELL	E	Production Zone Eroded
⊁	WATER INJECTOR	n.i.	No Well Information
⊁	WATER DISPOSAL		

SEMLEK NORTH AREA

CROOK COUNTY, WYOMING

SEMLEK NORTH FIELD

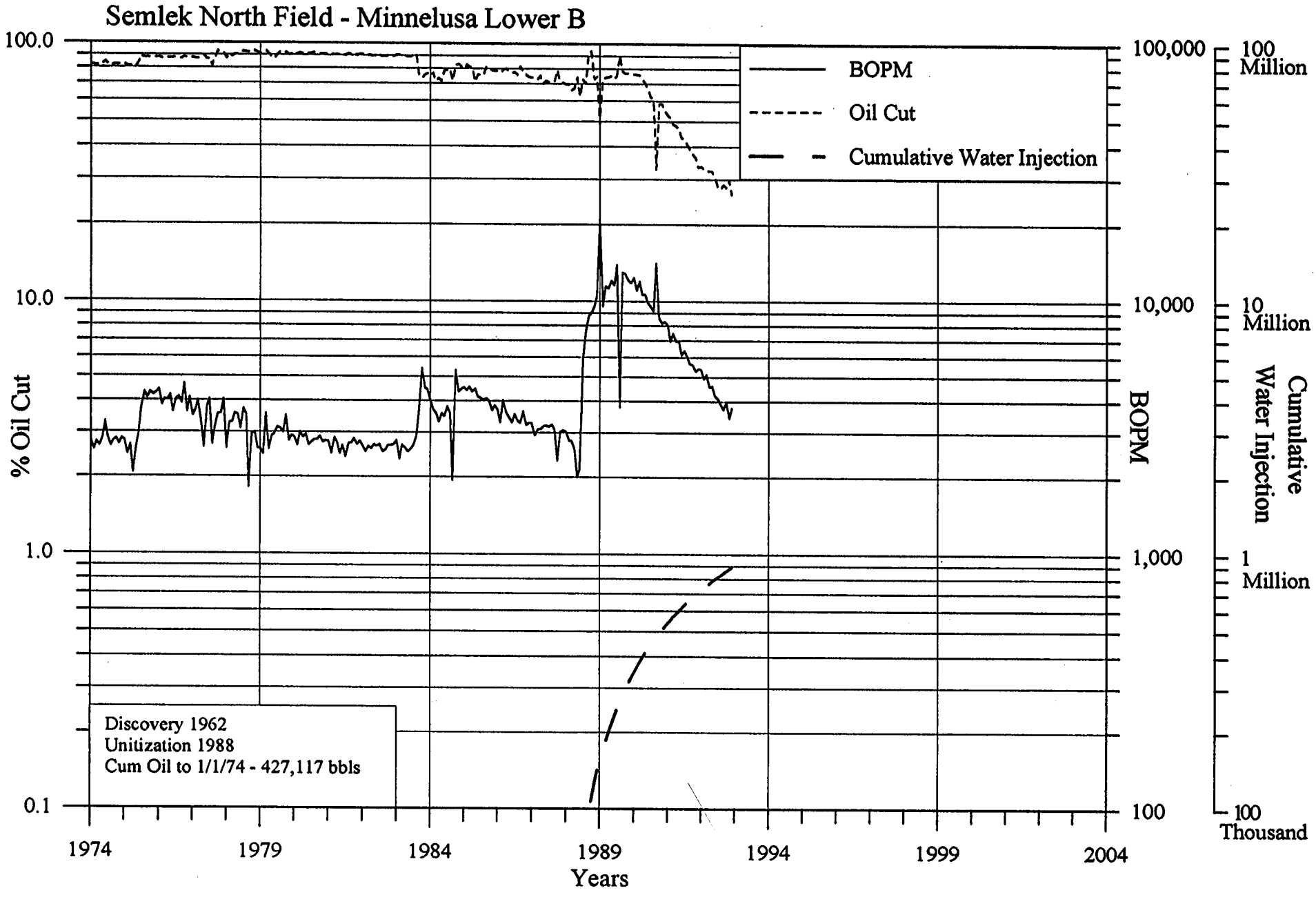
MINNELUSA LB

ISOPACH:NET OIL PAY

C.I.=10'

GEOLOGY: L.GRIFFITH

8'93


Semlek North Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1962
Unitization 1988
Cum Oil to 1/1/74 - 427,117 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Semlek West Field

Producing Zone:	Minnelusa Upper B
Location:	Crook County, Wyoming
	TWP 52N – RGE 68W
	Sections 28 & 29
Drive Mechanism:	Waterflood
Discovered:	1963
Unitized:	1973

Oil Gravity	23.0
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	7,267
Formation Temperature, degrees F	115
Rw @ Formation Temperature	0.26

Current Production – 1/1 to 12/31/92	
Oil, bbls	128,646
Water, bbls	1,285,470

Cumulative Production – thru 12/31/92	
Oil, Mbbls	5,791
Water, Mbbls	15,637
Injection, Mbbls	12,369

Current Rates	
Oil, bopd	352
Oil Cut, %	9.1%

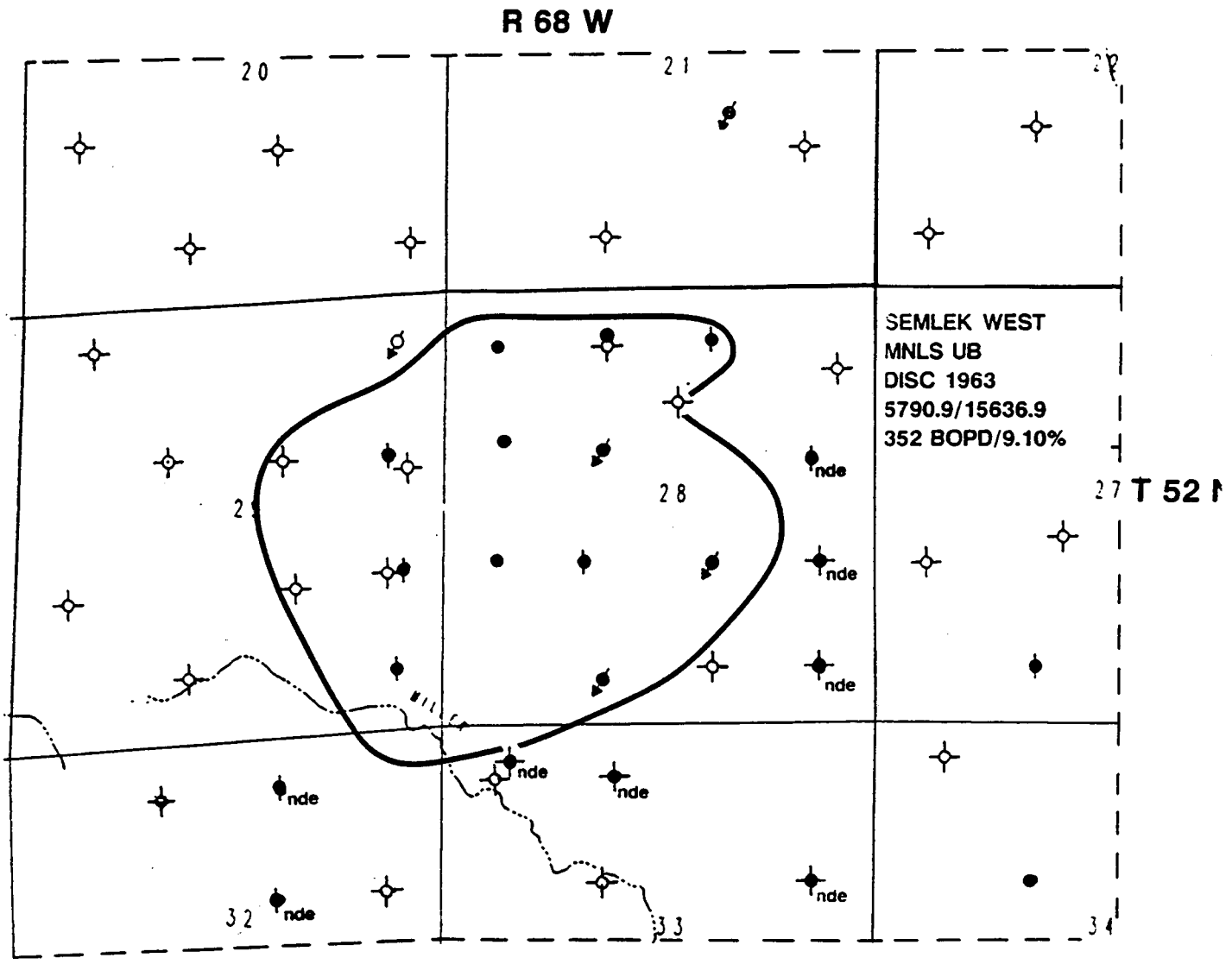
Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	20.0%
Proj. Ultimate Recovery, Mbbls	6,047
Proj. Remaining Reserves, Mbbls	256
Estimated Remaining Life, Years (from 1/93)	2.8
OOIP: Pore Volume	0.625
Ultimate Recovery: Pore Volume	0.272
Remaining O.I.P.: Pore Volume	0.353

Reservoir Properties	
Volume, acre feet	15,284
Area, acres	574
Average Net Pay, feet	26.6
Average Porosity	18.7%
Average S_w	35.0%
FVF Factor	1.040
Pore Volume, Mbbls	22,209
Oil in Place, Mbbls	13,881
Est. Ult. Recovery Factor, %OOIP	43.6%
Current Recovery Factor %OOIP	41.7%
Current Depletion Factor %	95.8%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	120
End of Primary Decline	10/72
Estimated Decline	5.0%
Projected Ult. Recovery, Mbbls	5,297
Primary Recovery Factor %OOIP	38.2%
Cumulative Oil: Pore Volume	0.261
Cumulative Water: Pore Volume	0.704
Cumulative Injection: Pore Volume	0.557
Production – Injection Difference: PV	–0.408

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNE 28–52–68	Munoz #5–28			TA–Oil
NENW 28–52–68	Unit #7–28	404,683	82,910	Pump–Oil
NWNW 28–52–68	Unit #48–28	548,112	1,086,690	Pump–Oil
SWNW 28–52–68	Unit #9–28	157,296	1,297,480	Pump–Oil
SENW 28–52–68	Munoz #2–28	932,349	1,117,828	Injection
NWSE 28–52–68	Dunning #3–28	174,089	0	Injection
NESW 28–52–68	Unit #11–28	49	750	SI–Oil
NWSW 28–52–68	Munoz #6–28	1,727,001	8,193,921	Pump–Oil
SESW 28–52–68	Dunning #1–28	1,459,686	2,688,531	Pump–Oil
NENE 29–52–68	Unit #1–29	51	227	Injection
SENE 29–52–68	Rausdep #1–A			TA–Oil
NESE 29–52–68	Highwater #31–29	739	2,788	SI–Oil
SESE 29–52–68	Govt #44–29	147,974	33,556	SI–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NWSE 28–52–68	Dunning #3–28	79,388	8,661,259	Injection
NENE 29–52–68	Unit #1–29	36,378	873,415	Injection
SWSE 28–52–68	Unit #8–29	0	528,507	SI–Inj
SENW 28–52–68	Munoz #2–28	420,582	2,306,217	Injection



LEGEND

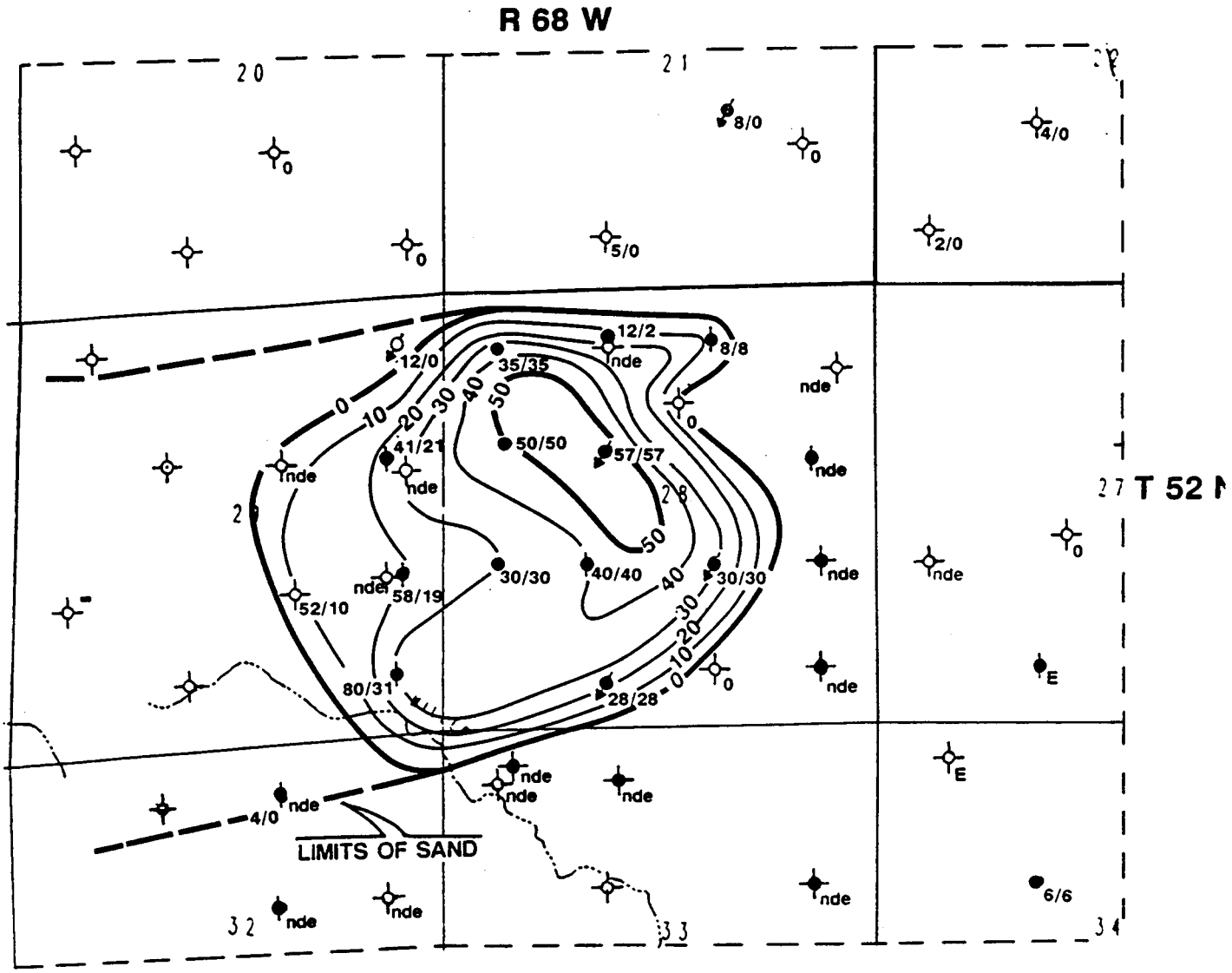
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

SEMLEK WEST AREA

CROOK COUNTY, WYOMING

SEMLEK WEST FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH	
	8/93



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
♦	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
☍	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		

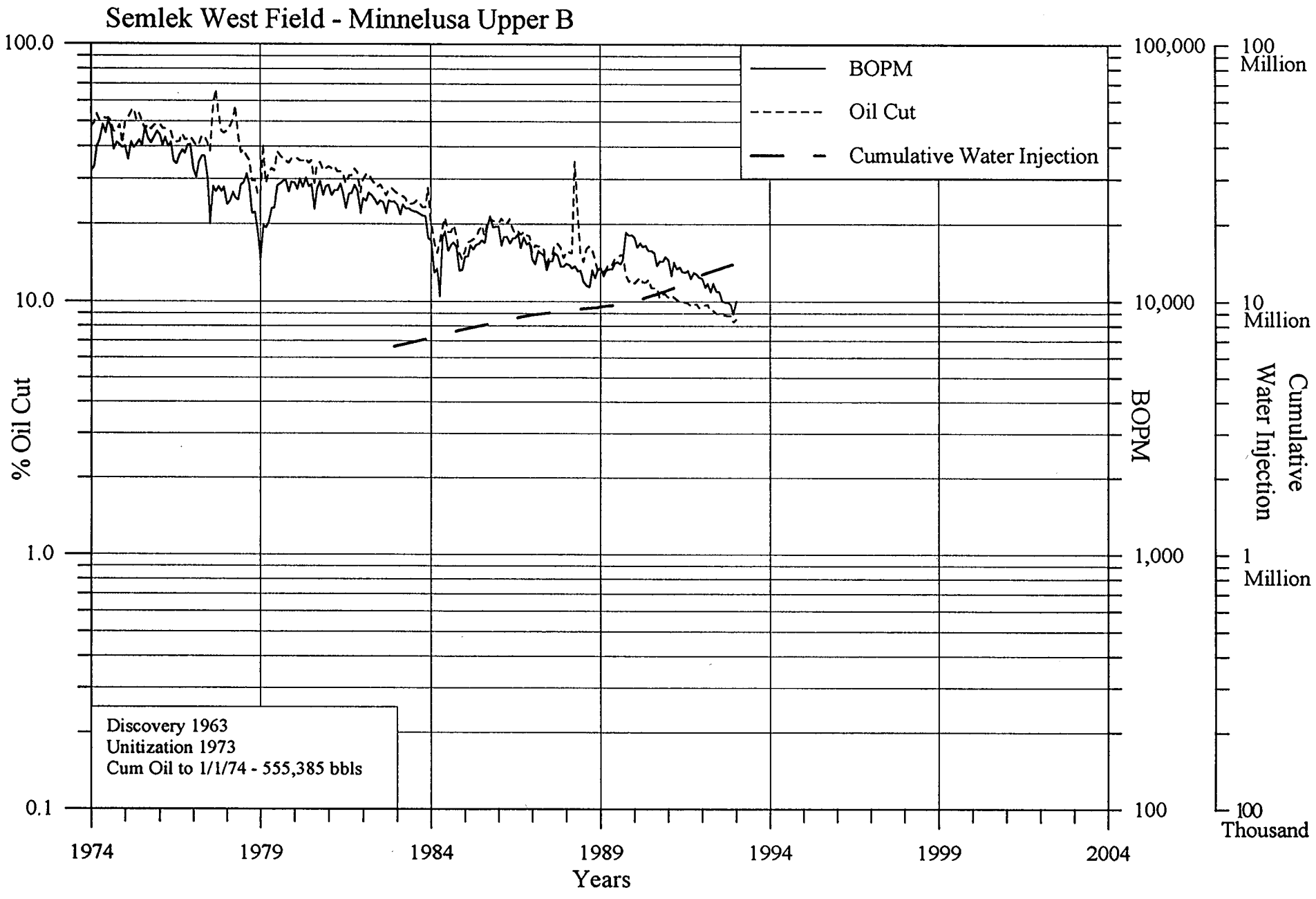
SEMLEK WEST AREA

CROOK COUNTY, WYOMING

SEMLEK WEST FIELD
MINNELUSA UB
ISOPACH:NET OIL PAY
C.I.=10'

GEOLOGY: L. GRIFFITH

8/93


Semlek West Field - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1963
Unitization 1973
Cum Oil to 1/1/74 - 555,385 bbls
1974
1979
1984
1989
1994
1999
2004
Years

Simpson Ranch Field

Producing Zone:	Minnelusa Upper B
Location:	Campbell County, Wyoming
	TWP 51 – RGE 69W
	Section 15
Drive Mechanism:	Polymer Waterflood
Discovered:	1977
Unitized:	1990

Current Production – 1/1 to 12/31/92	
Oil, bbls	21,741
Water, bbls	242,655

Cumulative Production – thru 12/31/92	
Oil, Mbbls	792
Water, Mbbls	1,891
Injection, Mbbls	2,749

Current Rates	
Oil, bopd	60
Oil Cut, %	8.2%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	10.0%
Proj. Ultimate Recovery, Mbbls	871
Proj. Remaining Reserves, Mbbls	79
Estimated Remaining Life, Years (from 1/93)	7.6
OOIP: Pore Volume	0.619
Ultimate Recovery: Pore Volume	0.236
Remaining O.I.P.: Pore Volume	0.383

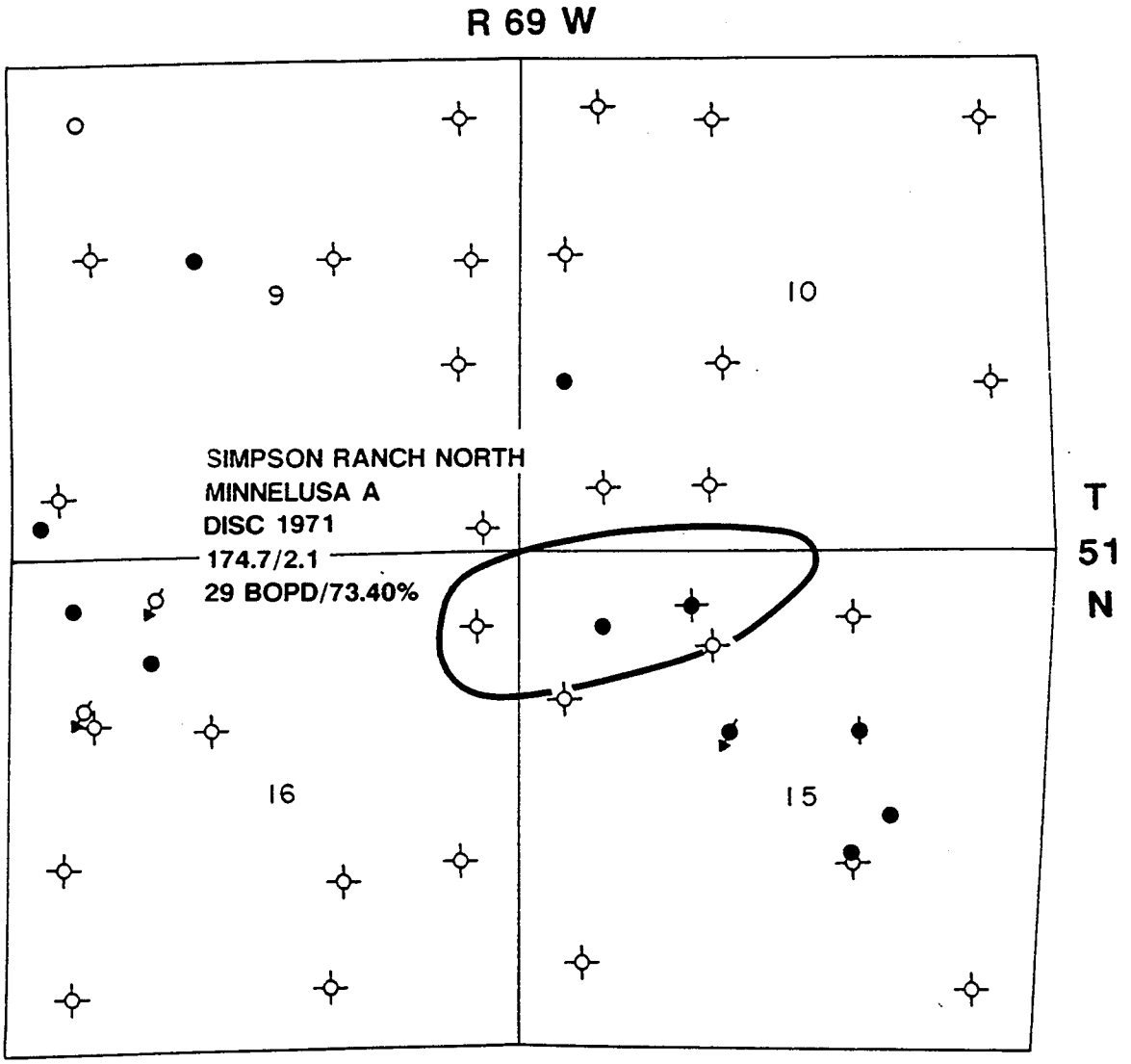
Oil Gravity	21.0
Oil Viscosity, cp	15.7
Water Viscosity, cp	0.4
Depth, feet	7,883
Formation Temperature, degrees F	120
Rw @ Formation Temperature	0.20

Reservoir Properties	
Volume, acre feet	2,633
Area, acres	183
Average Net Pay, feet	14.4
Average Porosity	18.0%
Average S_w	35.0%
FVF Factor	1.050
Pore Volume, Mbbls	3,682
Oil in Place, Mbbls	2,280
Est. Ult. Recovery Factor, %OOIP	38.2%
Current Recovery Factor %OOIP	34.7%
Current Depletion Factor %	90.9%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	20
End of Primary Decline	04/79
Estimated Decline	45.0%
Projected Ult. Recovery, Mbbls	130
Primary Recovery Factor %OOIP	5.7%
Cumulative Oil: Pore Volume	0.215
Cumulative Water: Pore Volume	0.514
Cumulative Injection: Pore Volume	0.747
Production – Injection Difference: PV	0.018

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SENW 15–51–69	Hilda #3	4,864	72	Injection
SWNE 15–51–69	Hilda #1	330,443	369,115	TA–Oil
NWSE 15–51–69	Hamm Twin–Fed #2	314,613	853,103	Pump–Oil
NENWSE 15–51–69	Unit #4	144,935	673,601	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
SENW 15–51–69	Hilda #3	243,195	2,749,033	Injection



LEGEND

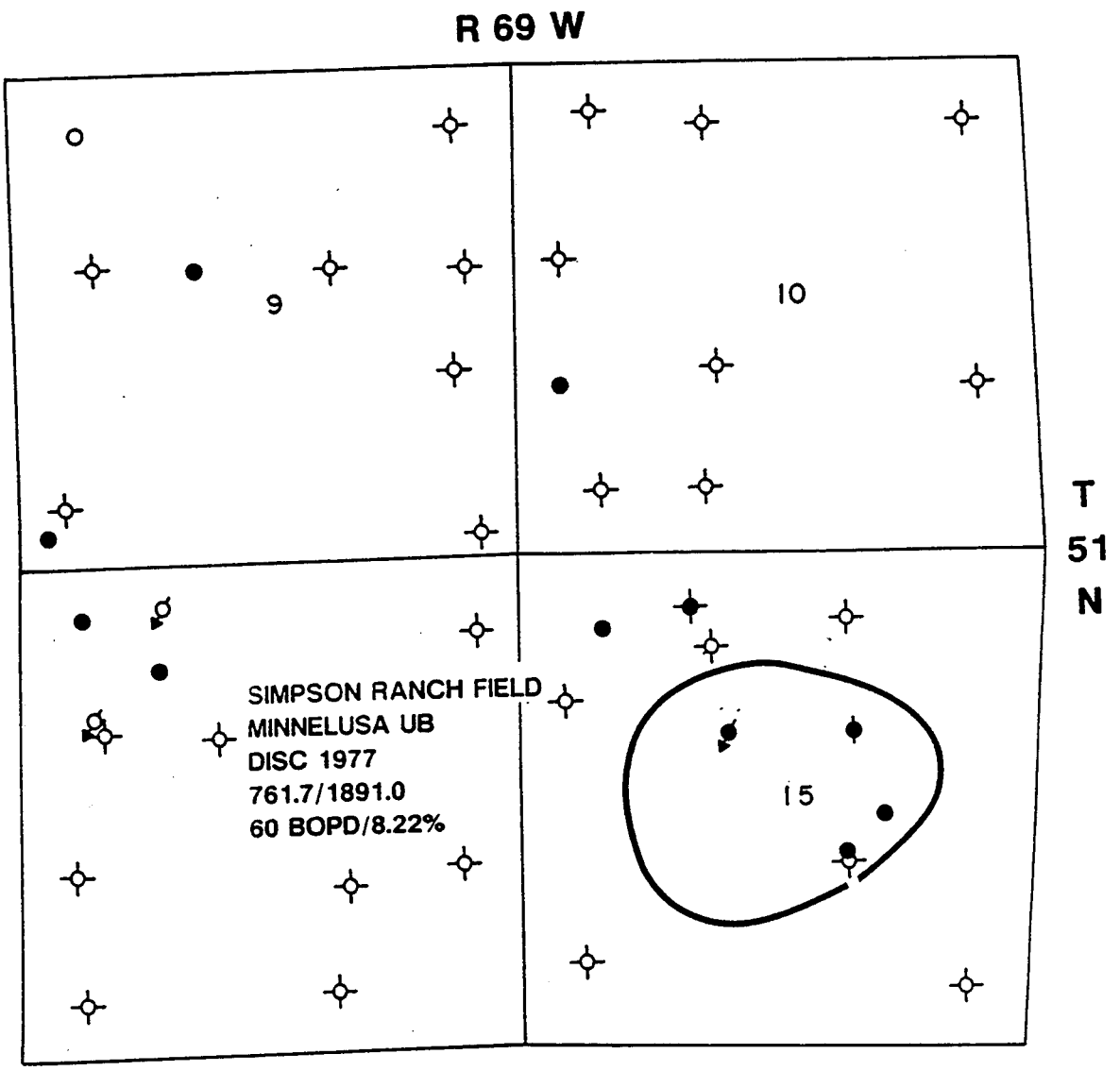
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992
LOCATION	

SIMPSON RANCH AREA

CAMPBELL COUNTY, WYOMING

SIMPSON RANCH NORTH FIELD
MINNELUSA A
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH	
	9-93



LEGEND

- DRY HOLE
- PRODUCING OIL WELL
- SHUT IN OIL WELL
- ABDN. OIL WELL
- WATER INJECTOR
- WATER DISPOSAL
- LOCATION

FIELD NAME
PRODUCING ZONE(S)
DISCOVERY DATE
CUM OIL/WATER Mbbls thru 1992
AVG DAILY RATE/AVG OIL CUT
IN 1992

SIMPSON RANCH AREA

CAMPBELL COUNTY, WYOMING

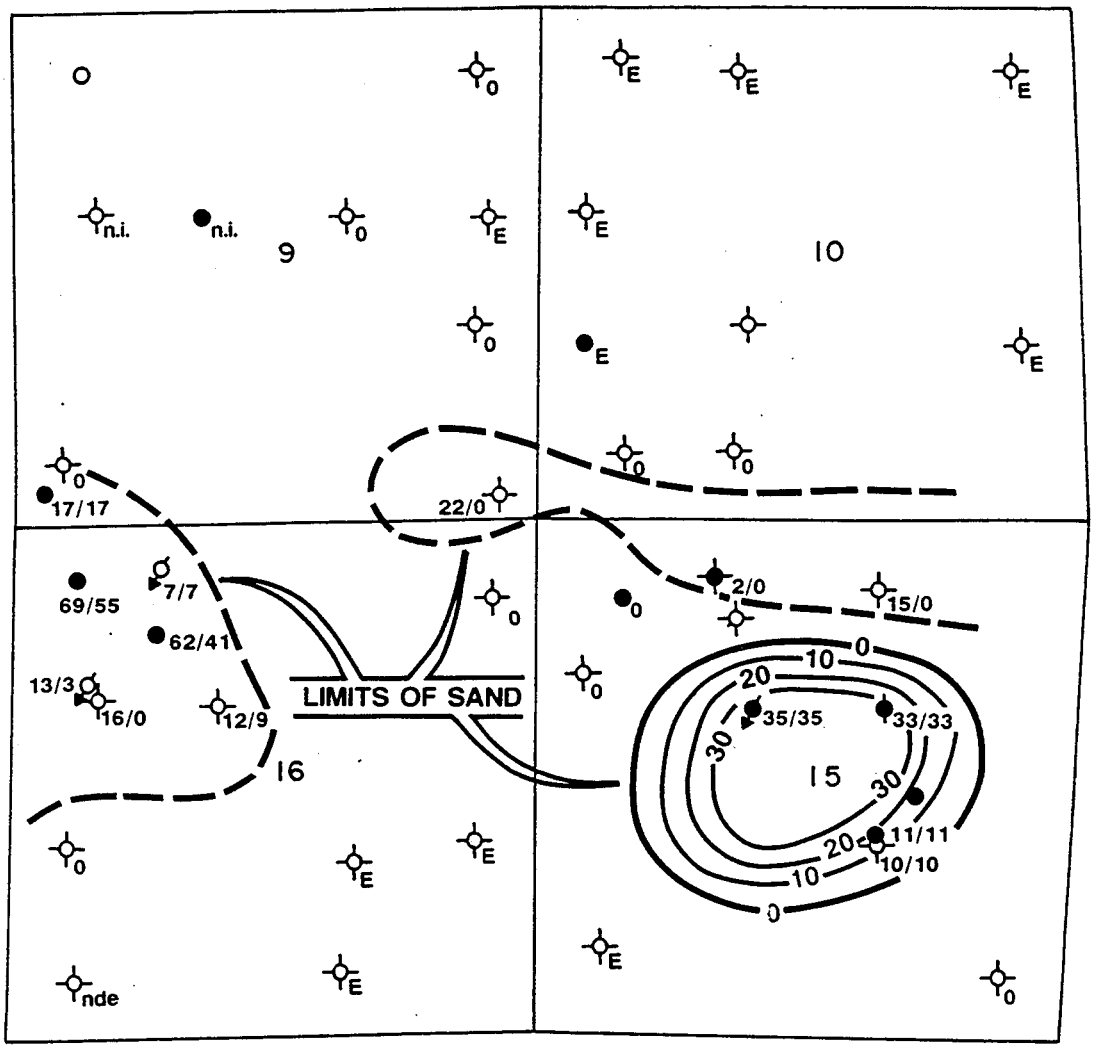
SIMPSON RANCH FIELD

MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH

9/93

R 69 W



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
♦	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
⚷	WATER INJECTOR	n.i.	No Well Information
⌑	WATER DISPOSAL		
○	LOCATION		

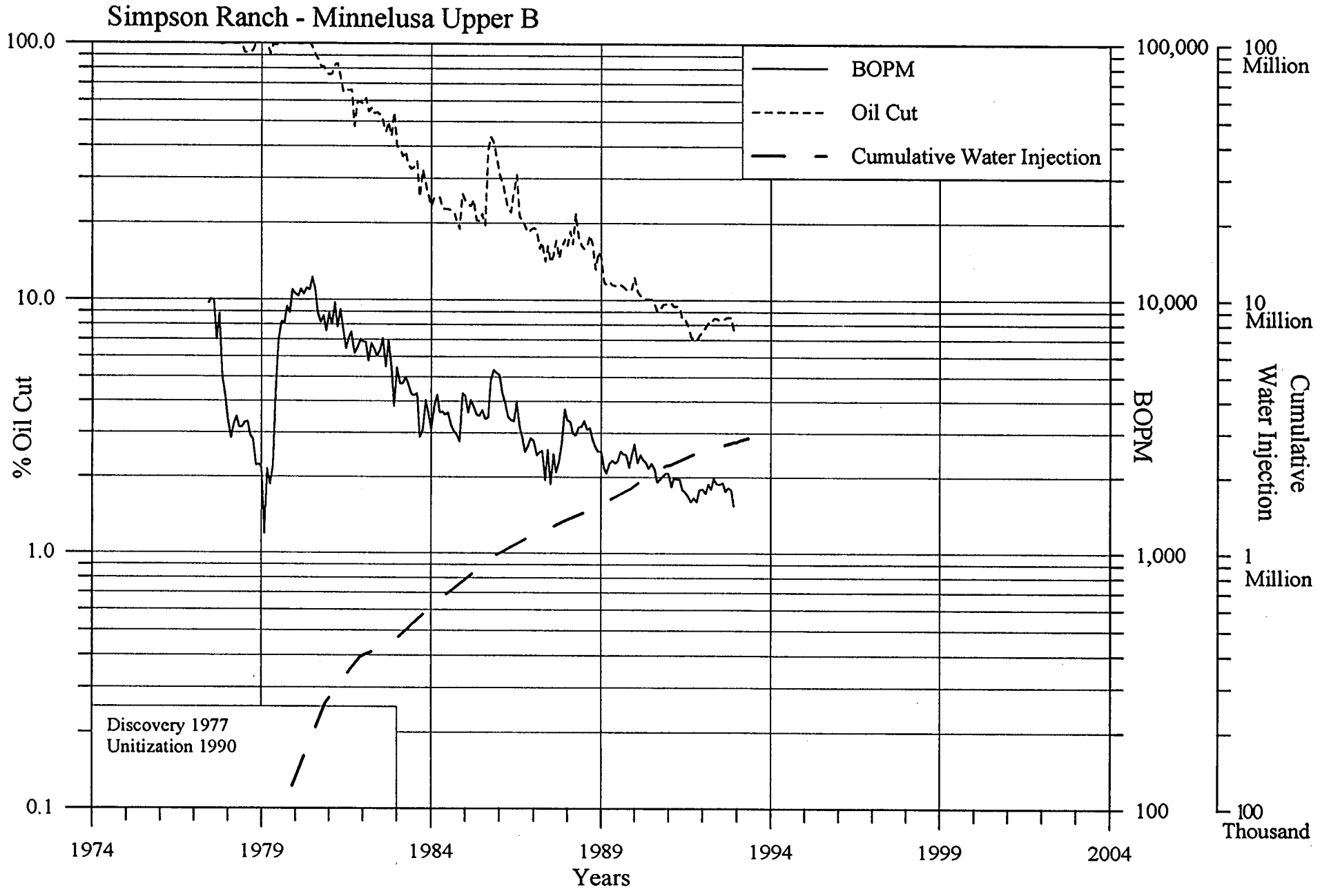
SIMPSON RANCH AREA

CAMPBELL COUNTY, WYOMING

SIMPSON RANCH FIELD
MINNELUSA UB
ISOPACH:NET OIL PAY
C.I.=10'

GEOLOGY: L. GRIFFITH

9/93

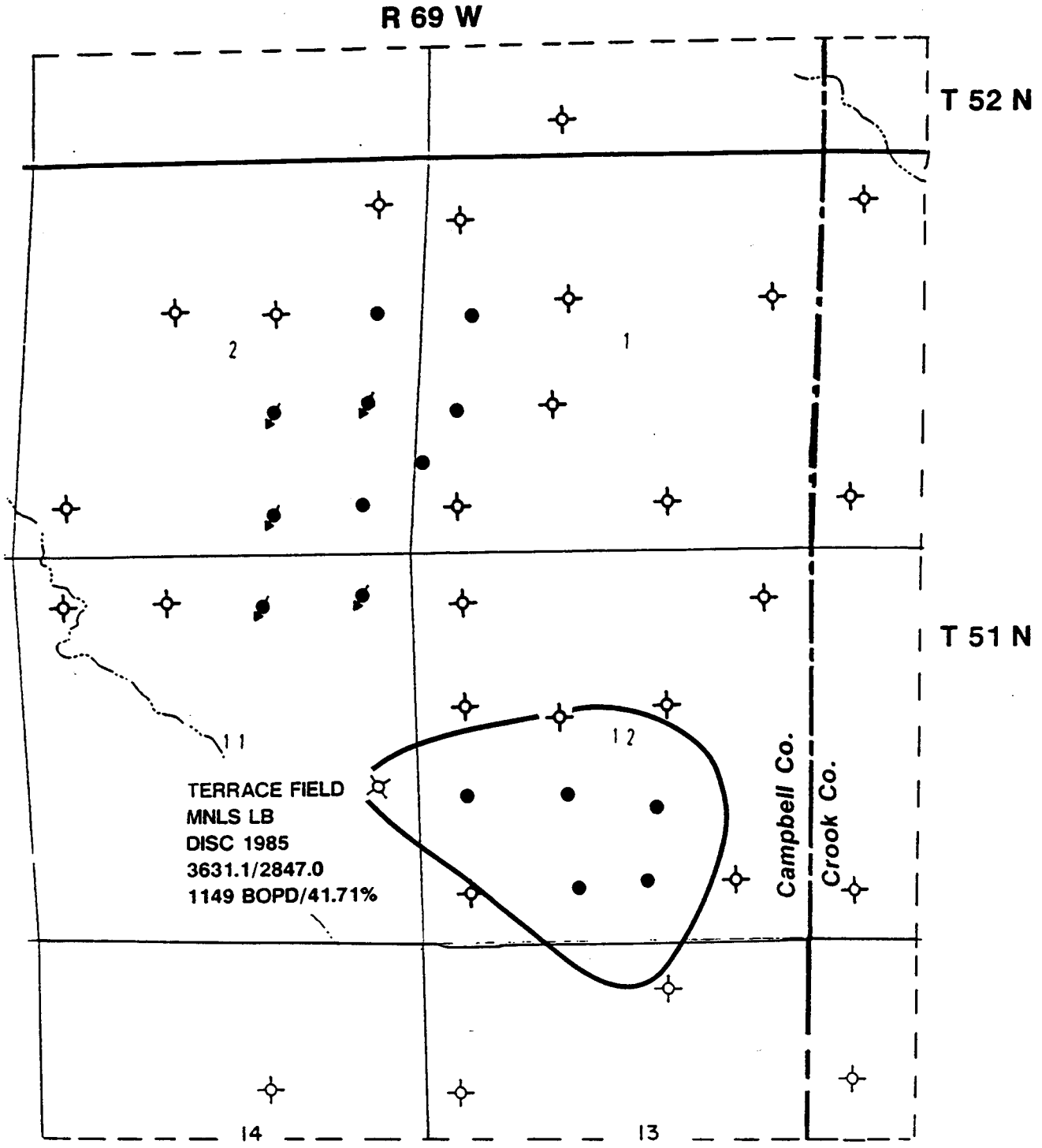

Simpson Ranch - Minnelusa Upper B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1977
Unitization 1990
1974
1979
1984
1989
1994
1999
2004
Years

Terrace Field

Producing Zone:	Minnelusa Lower B	Oil Gravity	21.0
Location:	Campbell County, Wyoming	Oil Viscosity, cp	
	TWP 51N – RGE 69W	Water Viscosity, cp	
	Sections 11 & 12	Depth, feet	7,576
Drive Mechanism:	Water Drive	Formation Temperature, degrees F	140
Discovered:	1985	Rw @ Formation Temperature	0.18
Unitized:	n.a.		
		Reservoir Properties	
Current Production – 1/1 to 12/31/92		Volume, acre feet	8,886
Oil, bbls	419,311	Area, acres	268
Water, bbls	585,989	Average Net Pay, feet	33.2
		Average Porosity	23.5%
Cumulative Production – thru 12/31/92		Average S_w	23.0%
Oil, Mbbls	3,631	FVF Factor	1.050
Water, Mbbls	2,847		
Injection, Mbbls	n.a.	Pore Volume, Mbbls	16,213
		Oil in Place, Mbbls	11,890
Current Rates		Est. Ult. Recovery Factor, %OOIP	48.7%
Oil, bopd	1,149	Current Recovery Factor %OOIP	30.5%
Oil Cut, %	41.7%	Current Depletion Factor %	62.7%
Waterflood Decline Analysis		Primary Deline Analysis	
Economic Cutoff		Economic Cutoff	
Oil, bopd		Oil, bopd	100
Oil Cut		End of Primary Decline	03/06
Estimated Decline		Estimated Decline	15.0%
Proj. Ultimate Recovery, Mbbls	5,792	Projected Ult. Recovery, Mbbls	5,792
Proj. Remaining Reserves, Mbbls	2,161	Primary Recovery Factor %OOIP	48.7%
Estimated Remaining Life, Years (from 1/93)	12.3		
		Cumulative Oil: Pore Volume	0.224
		Cumulative Water: Pore Volume	0.176
OOIP: Pore Volume	0.733	Cumulative Injection: Pore Volume	n.a.
Ultimate Recovery: Pore Volume	0.357	Production – Injection Difference: PV	n.a.
Remaining O.I.P.: Pore Volume	0.376		

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NESE 11–51–69	Simpson #43–11			SWD
NWSE 12–51–69	Simpson #33–12	318,899	620,901	Pump–Oil
NESW 12–51–69	Simpson #23–12	1,977,931	60,026	Pump–Oil
NWSW 12–51–69	Simpson #1–12	319,107	1,030,098	Pump–Oil
SESW 12–51–69	Simpson #24–12	416,692	762,070	Pump–Oil
SWSE 12–51–69	Simpson #34–12	597,390	367,990	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

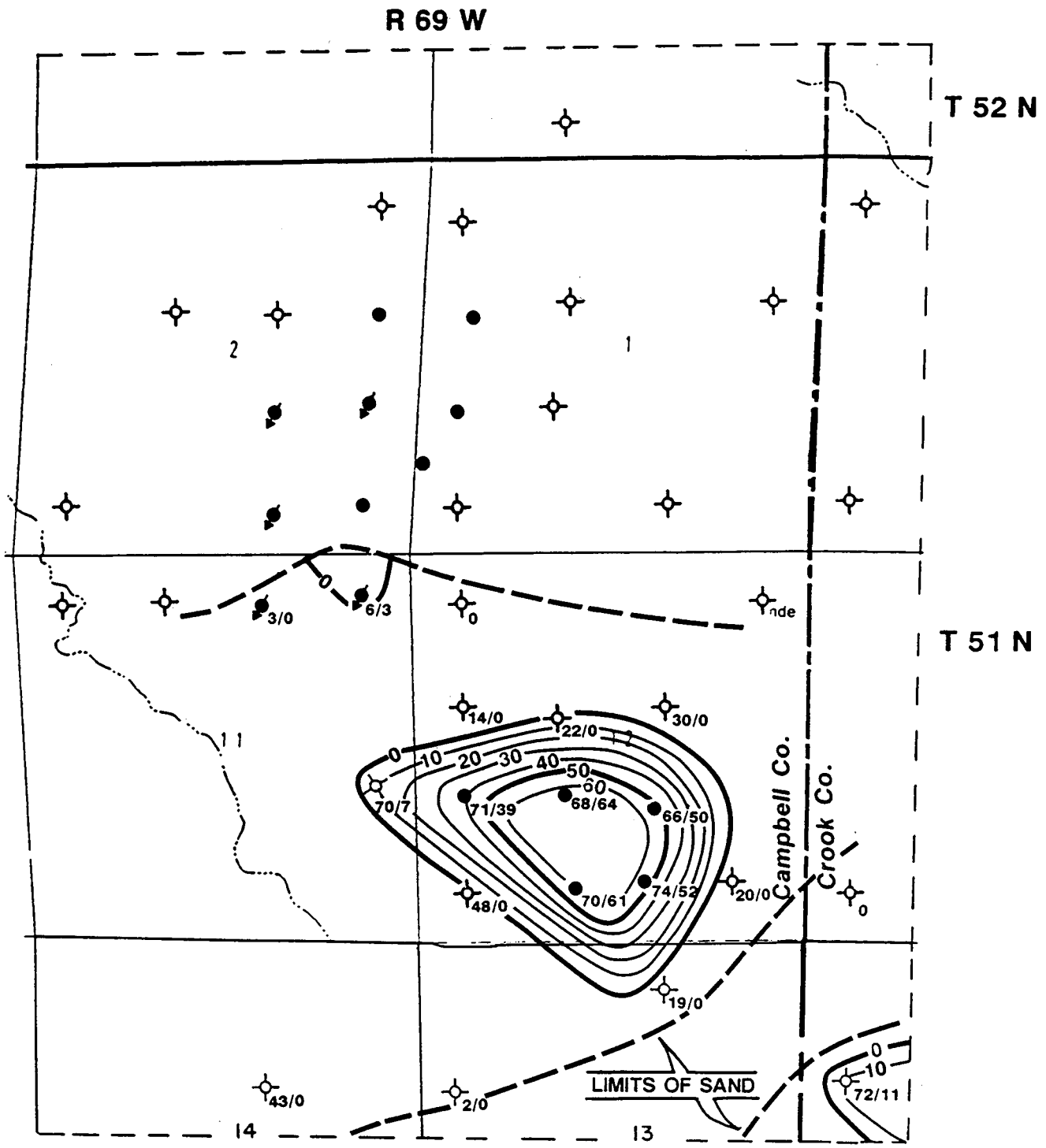
ALPHA AREA

CAMPBELL AND CROOK COUNTIES, WYOMING

TERRACE FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH

8'93



LEGEND

✧	DRY HOLE	70/65	Net Porosity/Net Oil Pay
●	PRODUCING OIL WELL	nde	Not Deep Enough
⊕	SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
✦	ABDN. OIL WELL	E	Production Zone Eroded
⊘	WATER INJECTOR	n.i.	No Well Information
⊠	WATER DISPOSAL		

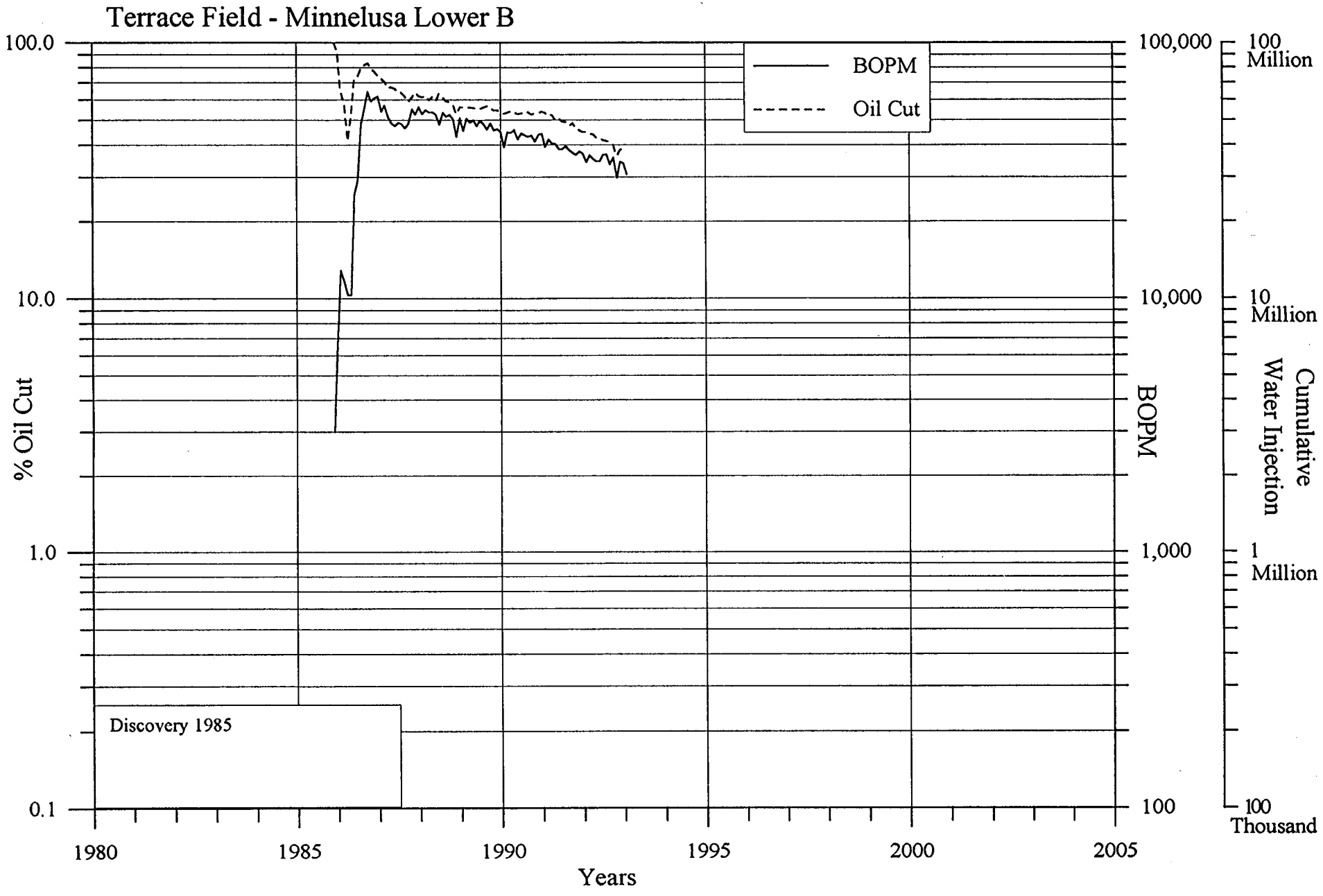
ALPHA AREA

CAMPBELL AND CROOK COUNTIES, WYOMING

TERRACE FIELD
MINNELUSA LB
ISOPACH:NET OIL PAY
C.I.=10'

GEOLOGY: L.GRIFFITH

8-93


Terrace Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Discovery 1985
1980
1985
1990
1995
2000
2005
Years

Wagonspoke Field

Producing Zone:	Minnelusa Lower B
Location:	Campbell County, Wyoming
	TWP 52 & 53N – RGE 69W
	Sections 3; 34
Drive Mechanism:	Waterflood
Discovered:	1972
Unitized:	1978

Current Production – 1/1 to 12/31/92	
Oil, bbls	36,635
Water, bbls	1,192,634

Cumulative Production – thru 12/31/92	
Oil, Mbbls	2,916
Water, Mbbls	7,467
Injection, Mbbls	13,640

Current Rates	
Oil, bopd	100
Oil Cut, %	3.0%

Waterflood Decline Analysis	
Economic Cutoff	
Oil, bopd	
Oil Cut	5.0%
Estimated Decline	25.0%
Proj. Ultimate Recovery, Mbbls	2,825
Proj. Remaining Reserves, Mbbls	(91)
Estimated Remaining Life, Years (from 1/93)	0.0
OOIP: Pore Volume	0.724
Ultimate Recovery: Pore Volume	0.295
Remaining O.I.P.: Pore Volume	0.429

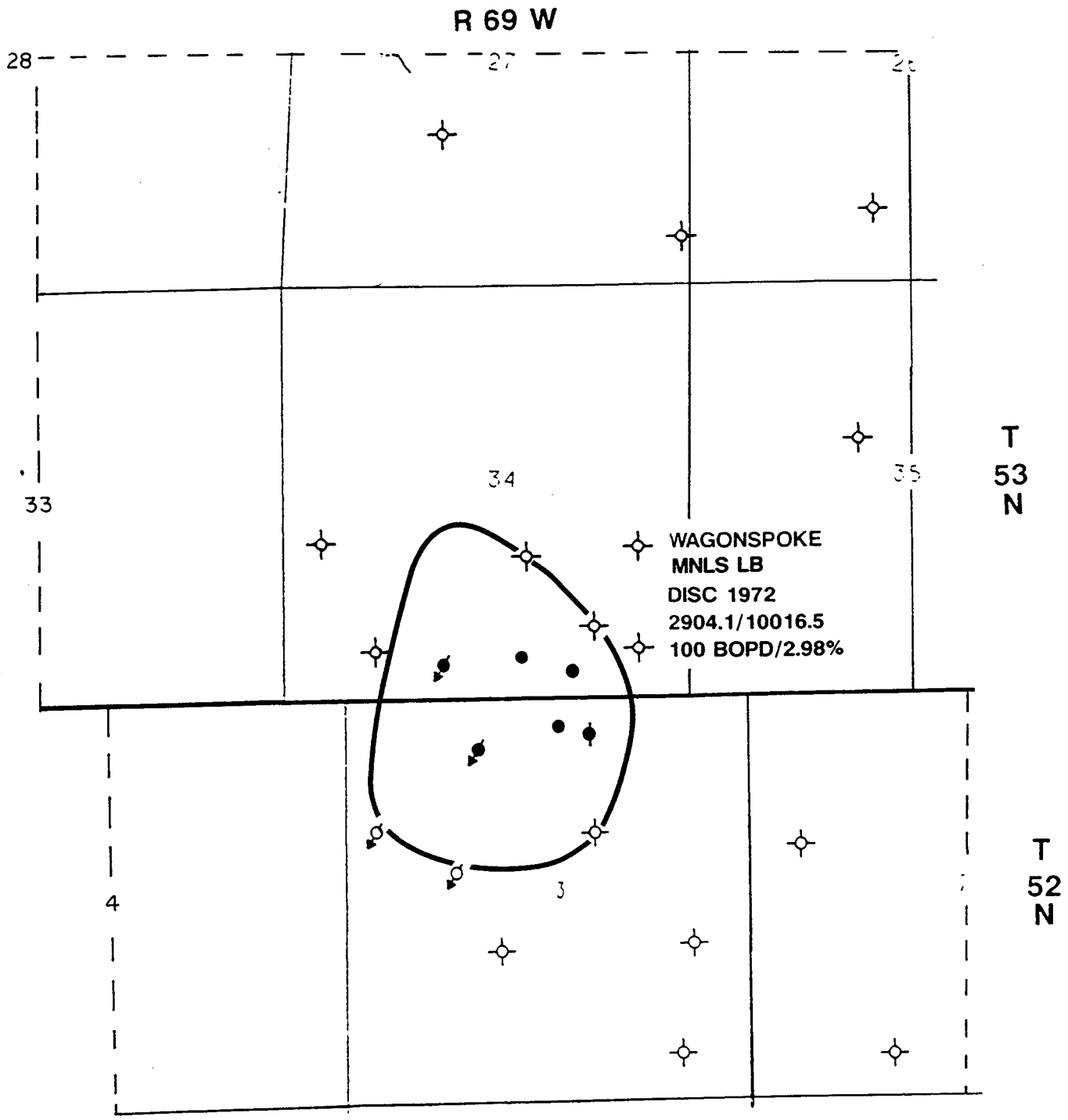
Oil Gravity	28.0
Oil Viscosity, cp	n.i.
Water Viscosity, cp	n.i.
Depth, feet	7,348
Formation Temperature, degrees F	128
Rw @ Formation Temperature	0.05

Reservoir Properties	
Volume, acre feet	6,296
Area, acres	258
Average Net Pay, feet	24.5
Average Porosity	19.6%
Average S_w	24.0%
FVF Factor	1.050
Pore Volume, Mbbls	9,573
Oil in Place, Mbbls	6,929
Est. Ult. Recovery Factor, %OOIP	40.8%
Current Recovery Factor %OOIP	42.1%
Current Depletion Factor %	103.2%

Primary Deline Analysis	
Economic Cutoff	
Oil, bopd	30
End of Primary Decline	03/78
Estimated Decline	30.0%
Projected Ult. Recovery, Mbbls	1,124
Primary Recovery Factor %OOIP	16.2%
Cumulative Oil: Pore Volume	0.305
Cumulative Water: Pore Volume	0.780
Cumulative Injection: Pore Volume	1.425
Production – Injection Difference: PV	0.340

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
NWNE 03–52–69	Federal #2			TA–Oil
NWNWNE 03–52–69	P–4	558,836	3,184,345	Pump–Oil
NENW 03–52–69	Burke–Fed #3–3	277,915	140,028	Injection
SESW 34–53–69	Duncan–Fed #24–34	258,143	164,104	Injection
SWSWSE 34–53–69	Vaughn–Fed #15–34	1,577,165	3,976,670	Pump–Oil
SWSE 34–53–69	Federal #P–6	1,625	540	Pump–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NENW 03–52–69	Burke–Fed #3–3	504,867	4,873,021	Injection
SWNW 03–52–69	Ashnar–Fed #5–3	0	3,227,088	SI–Inj
SENW 03–52–69	Unit #I–2	0	484,585	SI–Inj
SESW 34–53–69	Duncan–Fed #24–34	597,874	5,163,485	Injection



LEGEND

DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

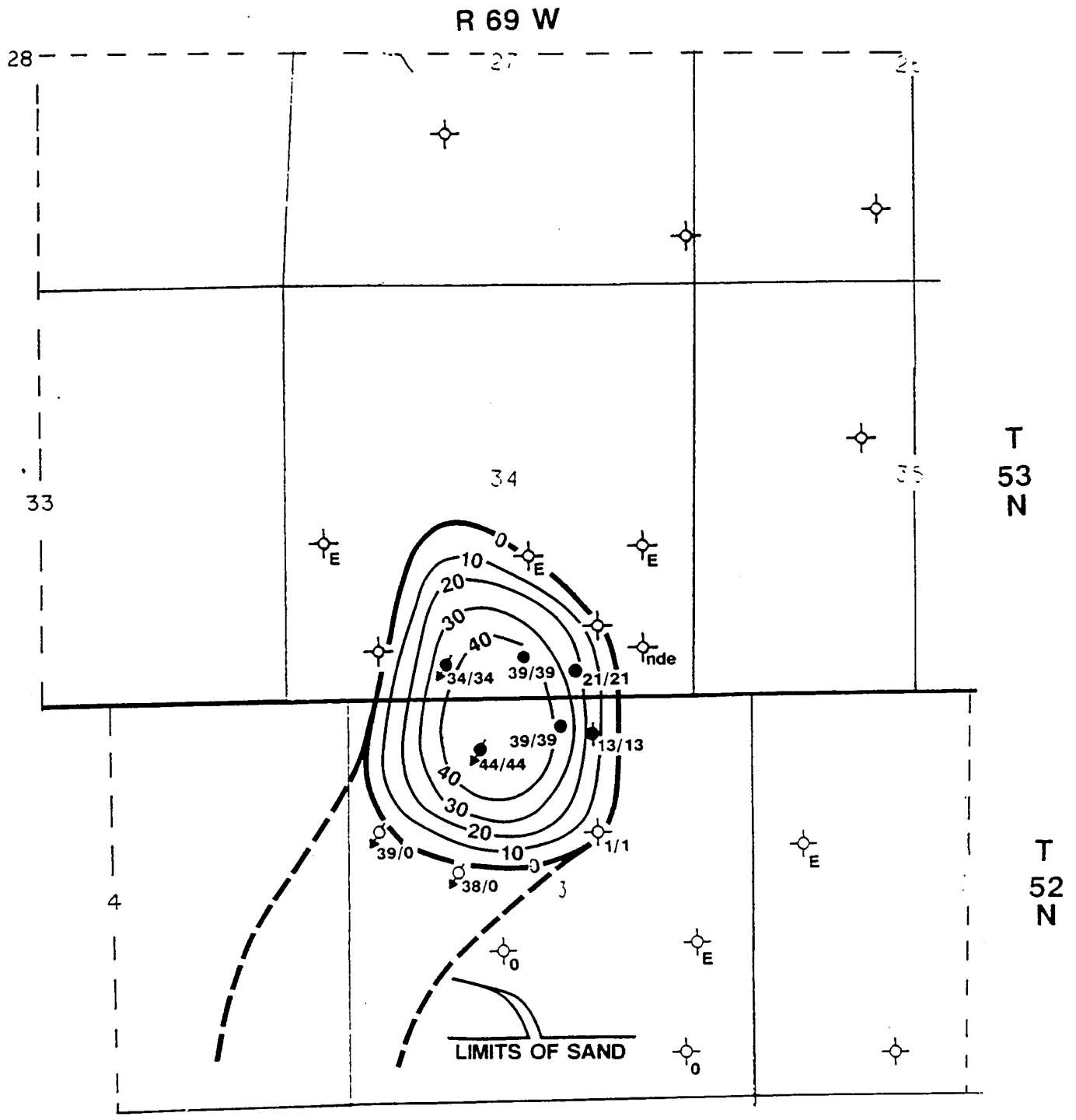
WAGONSPOKE AREA

CAMPBELL COUNTY, WYOMING

WAGONSPOKE FIELD
MINNELUSA LB
PRODUCTION PLAT

GEOLOGY: L. GRIFFITH

8 93



LEGEND

DRY HOLE	70/65	Net Porosity/Net Oil Pay
PRODUCING OIL WELL	nde	Not Deep Enough
SHUT IN OIL WELL	n.p.	Production Zone Not Penetrated
ABDN. OIL WELL	E	Production Zone Eroded
WATER INJECTOR	n.i.	No Well Information
WATER DISPOSAL		

WAGONSPOKE AREA

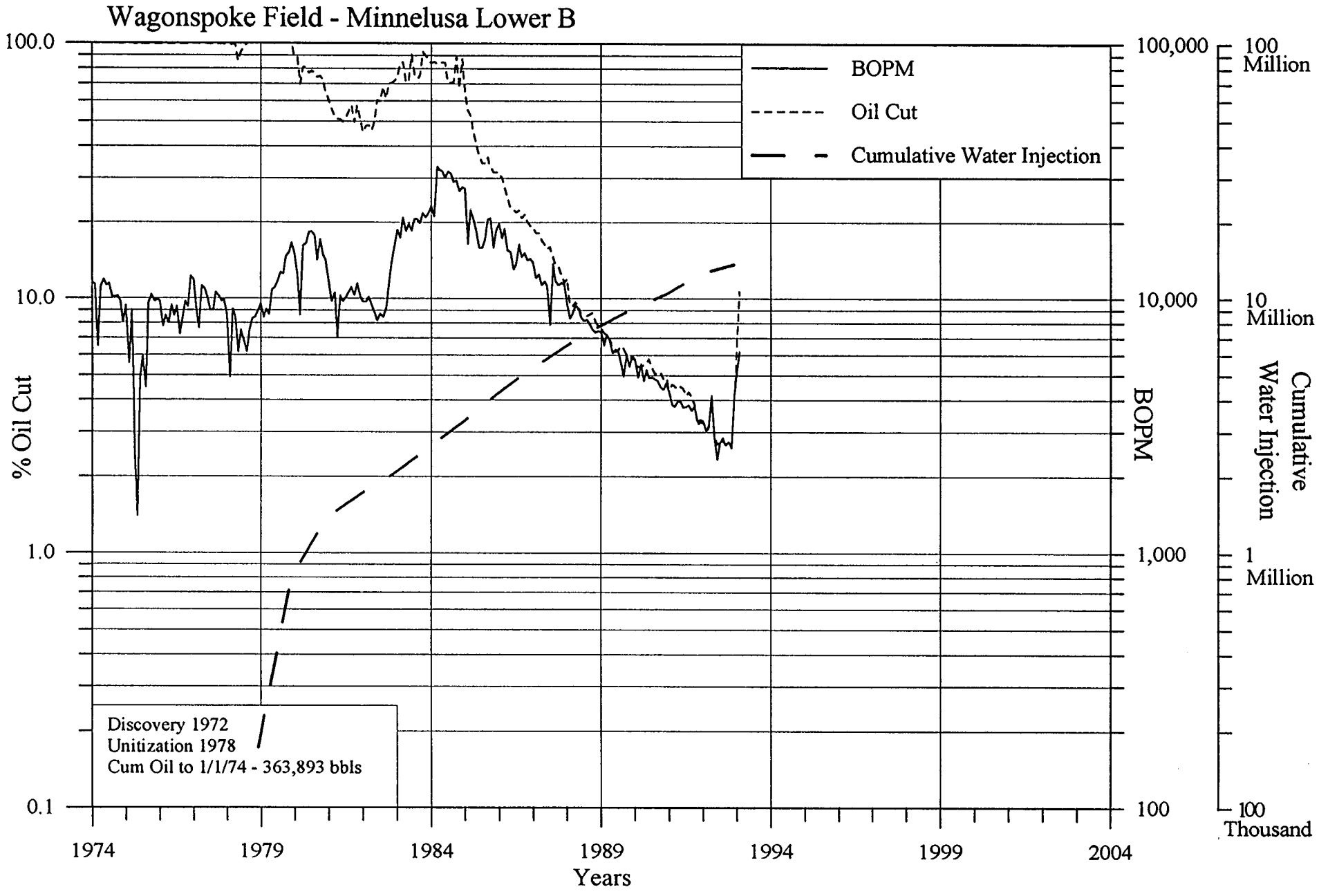
CAMPBELL COUNTY, WYOMING

WAGONSPOKE FIELD
MINNELUSA LB
ISOPACH : NET OIL PAY

C.I.=10'

GEOLOGY: L. GRIFFITH

8/93


Wagonspoke Field - Minnelusa Lower B
100.0
10.0
1.0
0.1
% Oil Cut
100,000
10,000
1,000
100
BOPM
100 Million
10 Million
1 Million
100 Thousand
Cumulative Water Injection
BOPM
Oil Cut
Cumulative Water Injection
Discovery 1972
Unitization 1978
Cum Oil to 1/1/74 - 363,893 bbls
1974
1979
1984
1989
1994
1999
2004
Years

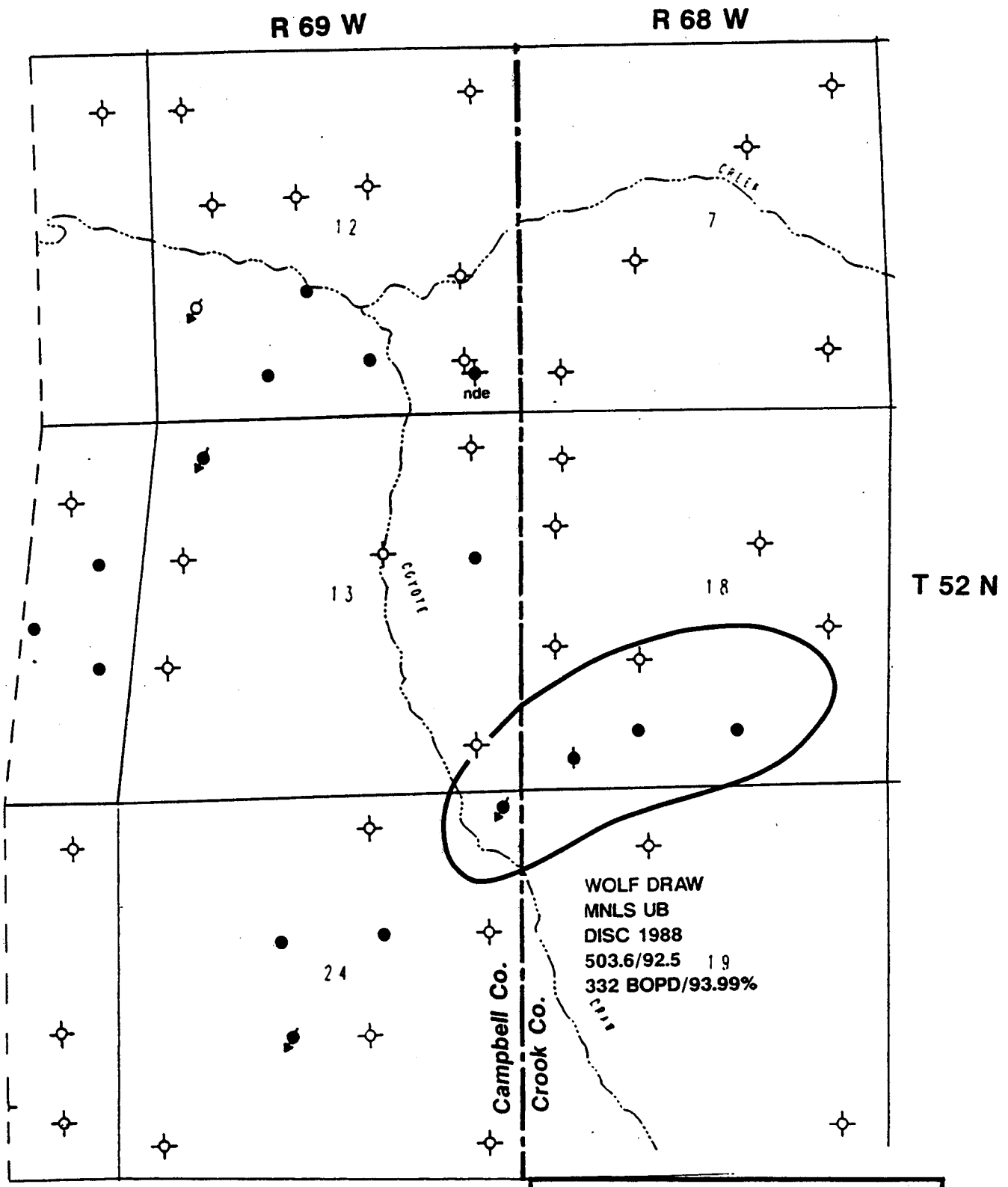
Wolf Draw Field

Producing Zone:	Minnelusa Upper B	Oil Gravity	21.5
Location:	Campbell–Crook Counties, Wy	Oil Viscosity, cp	n.i.
	TWP 52N – RGE 68 & 69W	Water Viscosity, cp	n.i.
	Sections 18; 24	Depth, feet	7,243
Drive Mechanism:	Polymer Waterflood	Formation Temperature, degrees F	130
Discovered:	1988	Rw @ Formation Temperature	0.65
Unitized:	1992		
		Reservoir Properties	
Current Production – 1/1 to 12/31/92		Volume, acre feet	4,436
Oil, bbls	121,299	Area, acres	269
Water, bbls	7,752	Average Net Pay, feet	16.5
		Average Porosity	17.3%
Cumulative Production – thru 12/31/92		Average S_w	23.0%
Oil, Mbbls	504	FVF Factor	1.050
Water, Mbbls	93		
Injection, Mbbls	516	Pore Volume, Mbbls	5,958
		Oil in Place, Mbbls	4,369
Current Rates		Est. Ult. Recovery Factor, %OOIP	28.6%
Oil, bopd	332	Current Recovery Factor %OOIP	11.5%
Oil Cut, %	94.0%	Current Depletion Factor %	40.3%
Waterflood Decline Analysis		Primary Deline Analysis	
Economic Cutoff		Economic Cutoff	
Oil, bopd		Oil, bopd	20
Oil Cut		End of Primary Decline	02/92
Estimated Decline		Estimated Decline	65.0%
Proj. Ultimate Recovery, Mbbls	1,251 *	Projected Ult. Recovery, Mbbls	461
Proj. Remaining Reserves, Mbbls	747	Primary Recovery Factor %OOIP	10.5%
Estimated Remaining Life, Years (from 1/93)	9.5 *		
		Cumulative Oil: Pore Volume	0.085
OOIP: Pore Volume	0.733	Cumulative Water: Pore Volume	0.016
Ultimate Recovery: Pore Volume	0.210	Cumulative Injection: Pore Volume	0.087
Remaining O.I.P.: Pore Volume	0.523	Production – Injection Difference: PV	–0.014

		to 1/93		
Production Location	Name	Cum Oil, bbls	Cum Wtr, bbls	Status
SWSW 18–52–68	Federal #14–18	257,479	92,464	Pump–Oil
SESW 18–52–68	Federal #24–18	200,059	0	Pump–Oil
SWSE 18–52–68	Federal #34–18	45,744	0	SI–Oil

		1992 Year	to 1/93	
Injection Location	Name	Curr Inj, bbls	Cum Inj, bbls	Status
NENE 24–52–69	Federal #41–24	515,628	515,628	Injection

* Ultimate recovery and remaining field life from unit engineering report



LEGEND

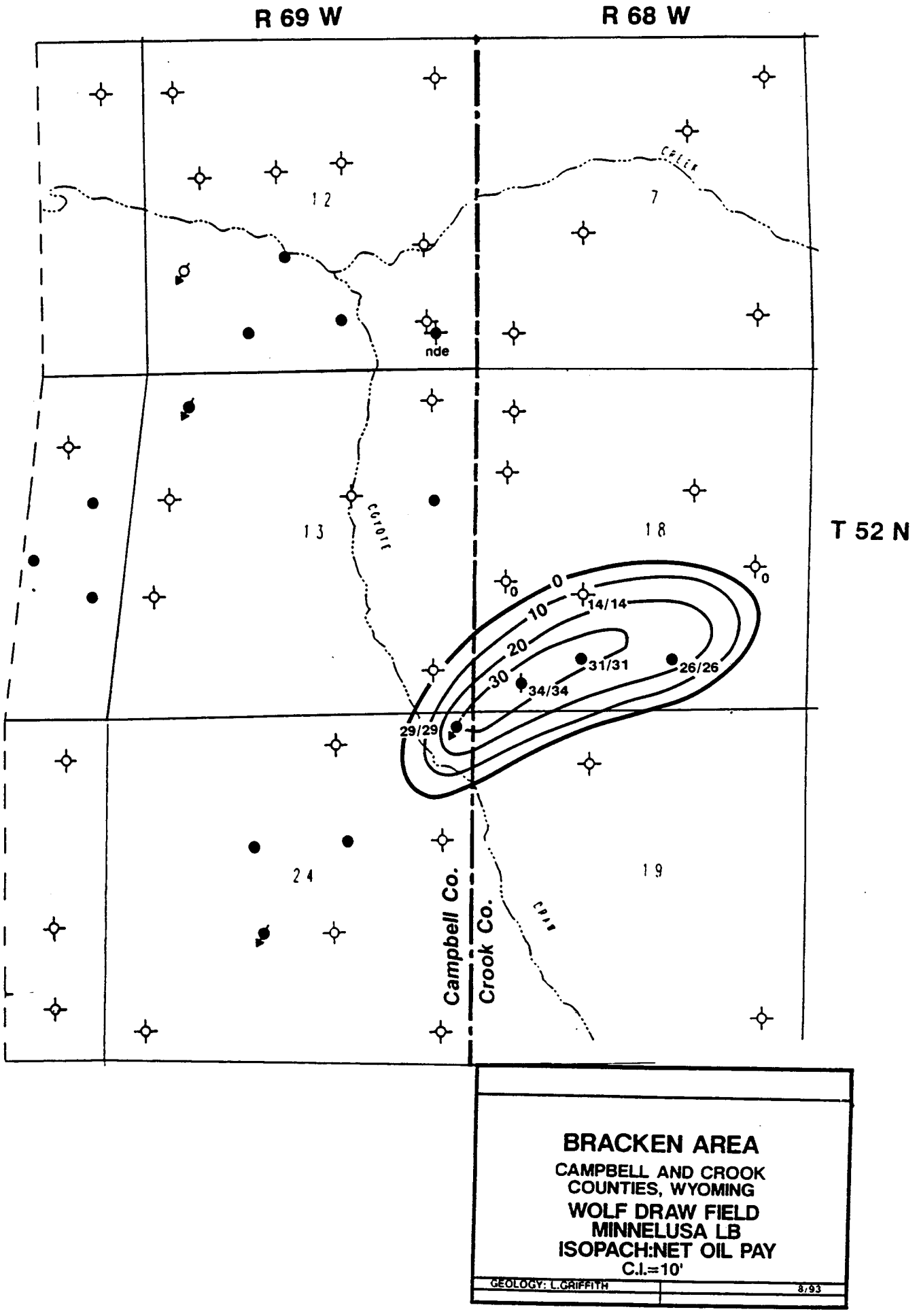
DRY HOLE	FIELD NAME
PRODUCING OIL WELL	PRODUCING ZONE(S)
SHUT IN OIL WELL	DISCOVERY DATE
ABDN. OIL WELL	CUM OIL/WATER Mbbls thru 1992
WATER INJECTOR	AVG DAILY RATE/AVG OIL CUT
WATER DISPOSAL	IN 1992

BRACKEN AREA

CAMPBELL AND CROOK
COUNTIES, WYOMING

WOLF DRAW FIELD
MINNELUSA UB
PRODUCTION PLAT

GEOLOGY: L.GRIFFITH | 8/93


R 69 W
R 68 W
T 52 N
12
7
13
18
24
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nde
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10
20
30
14/14
31/31
26/26
34/34
29/29
Campbell Co.
Crook Co.
BRACKEN AREA
CAMPBELL AND CROOK
COUNTIES, WYOMING
WOLF DRAW FIELD
MINNELUSA LB
ISOPACH:NET OIL PAY
C.I.=10'
GEOLOGY: L.GRIFFITH
8/93