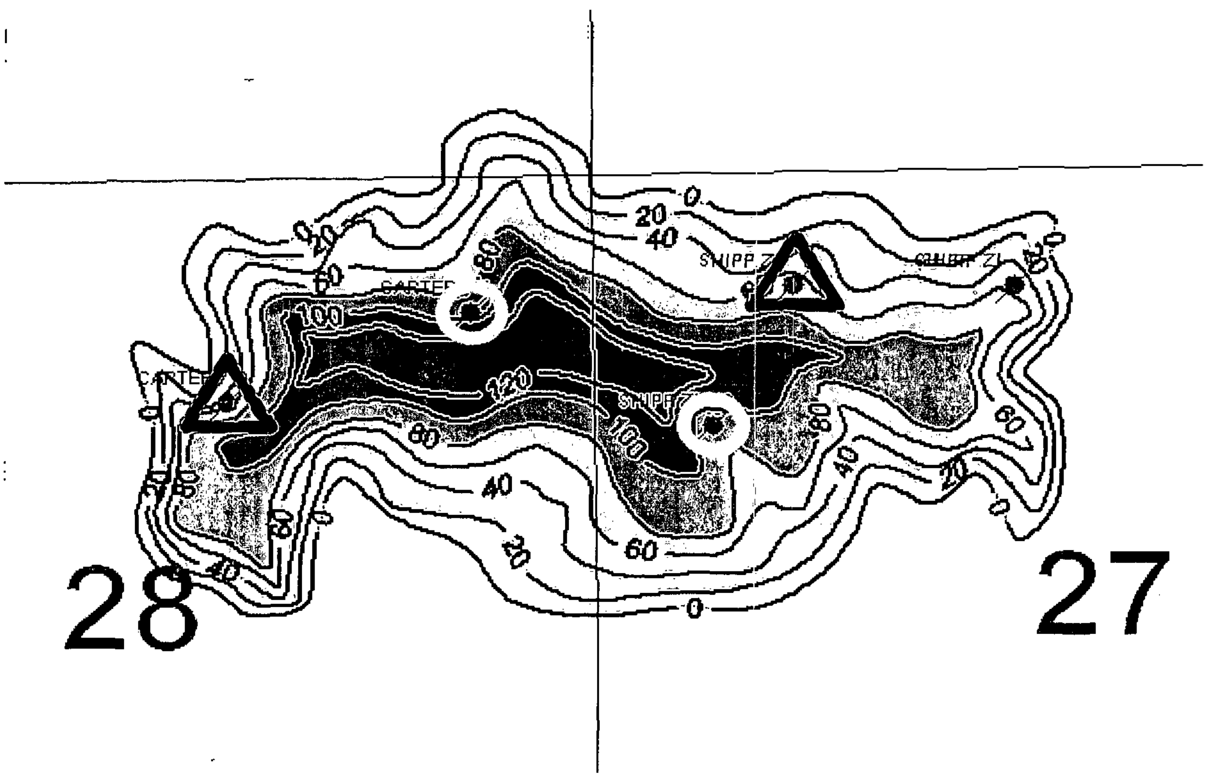
Feasibility Study

For the Proposed

Carter-Shipp Strawn Unit



Lea County, New Mexico

T16S-R37E Sec 21SESE, 27NW4, and 28NE4

May 2009

Proposed Carter-Shipp Strawn Unit

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Proposed Carter-Shipp Strawn Unit
Executive Summary

Background and Overview

In Pennsylvanian times a series of phylloid algal bioherms (Strawn mounds) developed along the northwest flank of the Central Basin Platform. These mounds underlie an area of present day northwest Lea County, NM, near the town of Lovington. The average depth is 11,400 ft and the features are generally small, elongated porosity mounds of from a few acres up to several hundred acres and from 20 to 180 ft in thickness. The mounds are generally separated and sealed by tight lime mudstones.

Chesapeake proposed to unitize a mound and conduct waterflood operations in order to prevent the waste of secondary reserves. The location is T16S-R37E SESE Sec 21, NW4 Sec 27 and NE4 Sec 28, which is in the southeast corner of what is now designated part of the Lovington NE Field. The proposed unit will contain 360 acres of which 244 acres are productive. Average thickness is 58.5 feet, average porosity is 8.3 percent, and water saturation is 36 percent. The drive mechanism is solution gas, and there is no evidence of the formation of a secondary gas cap nor of a significant water drive. This is an appropriate candidate for waterflood operations. The OOIP was 4.446 MMBO. The reservoir has produced 1.463 MMBO from 5 completions. All wells are depleted and now plugged. We plan to re-enter four wells and complete two for production and two for injection. The secondary recovery estimate is 355 MBO. The total recovery efficiency will be 40.9 percent, and 0.24 is the anticipated secondary-to-primary ratio for this flood. Capital costs are estimated at $2.8 million, resulting in a net finding cost of $8.46/BO to the working interest owners.

Findings:

1. The OOIP is 4.446 million barrels.
2. Primary recovery was 1.463 million barrels from five completions.
3. Primary recovery efficiency calculates to be 33 percent.
4. The unit will have a positive mobility ratio for 0.686
5. The secondary recovery will be 355,268 barrels of oil.
6. The secondary to primary ratio is 0.24
7. The secondary recovery efficiency is 8 percent.
8. The total recovery efficiency is 41 percent.
9. The capital investment is $2.8 million.
10. The finding cost for the working interest owners is $8.46/BO.

Conclusions:

1. The field is a waterflood candidate.
2. The absence of a flood will result in the loss of 355 MBO.
3. There is strong economic incentive to flood this mound.

Recommendations:

1. Unitize the Carter-Shipp Strawn Unit.
2. Implement the flood plan.

Proposed Carter-Shipp Strawn Unit

Summary:
Geologic, Fluid, Production and Engineering Data

Formation	Strawn	
Lithology	Limestone	
Trap	Algal bioherm	
Drive Energy	Solution Gas	
Unit Area	360	Acres
Net Productive Area	244	Acres
Depth	11,465	ft.
Temperature	162	°F
Net Thickness, Avg.	58.49	ft.
Porosity, Avg	8.3	%
Permeability	8.5	md
Water Saturation, Avg.	36	%
Initial Reservoir Pressure	5,441	psi
Oil Gravity	42.5	°API
Gas Gravity	0.61	Ratio
Initial Gas/Oil Ratio	690	Cu. ft./BO
Bubble Point Pressure	2,950	Psi
Oil form. Vol. factor, Init.	1.325	BO/STB
Original Oil in Place	4,445,892	STB
Primary Production	1,462,892	STB
Primary Rec. Efficiency	32.90	%
Abandonment Pressure	350	psi
Oil Form. Vol. factor, Aband.	1.09	BO/STB
Secondary Reserves	355,268	BO
Sec. Rec. Efficiency	8.0	%
Total EUR	1,818,160	BO
Total Rec. Efficiency	40.9	%
Sec. to Prim. Ratio	0.24	Ratio
Capital Investment	2,806,400	$

General Geology

The Lovington Strawn is situated locally in eastern central Lea County, New Mexico and regionally on the Northwest Shelf of the Delaware basin. The Strawn is Pennsylvanian (Desmoinesian) age, which unconformably overlies Atoka-age shale and shallow marine sand and is overlain by clastics of Missourian age. Strawn at Lovington produces oil and gas from phylloid algal bioherms within the lower Strawn limestone. These Strawn carbonates were deposited along the northwest flank of the Central Basin Platform axis in a low energy, middle to outer ramp setting. Growth of algal bioherms developed into elongated, steep-sided, loaf-shaped buildups in a dip direction separated by tight lime mudstones. The average depth of Strawn mounds is 11,400 feet, and thickness ranges from 40 to 180 ft, while average areal extent is 1.5 long by 0.5 to 1 mile wide. Within the mound facies, porosity ranges from 4 to 14 percent. Intermound facies of nonporous lime mudstones form the vertical and lateral seals for the porous bioherms. Basinal black shale overlies the Strawn limestone across the play fairway and possibly provides a source for Strawn oil.

Field Discovery and History

The field known as Lovington Northeast has now had 81 well completions in 22 sections and contains roughly 11,000 to 12,000 acres. The field lies southwest of the town of Lovington in Lea County, New Mexico. An orientation map is attachment 1. The first well to produce in the Lovington Northeast Strawn Field was the H.T. Montieth "A" No. 1 in Section 20M-T16S-R37E. This well was completed by the Tide Water Associated Oil Company on August 12, 1952, and flowing 754 BOD of 42.2 °API oil from perforations at 11,256' – 11,316' in the Strawn member of the Pennsylvanian. The well is still active and has cumulative production of 1,311,500 BO, 1,639,000 Mcf, and 207,800 BW. The well is 97 percent depleted. The most recent well drilled in this field was the Shoofly 9 State 1 completed in July 2008 by Chesapeake Energy.

The Lovington Northwest field is not a single reservoir but a grouping of separate, discrete, sealed porous units. The long development life, 56 years, numerous dry holes, and the many development wells found to be at virgin pressure all attest to the discontinuous nature of many of the mounds in this area. Thus, we are proposing to unitize and waterflood a single mound.

Reservoir of Interest

The single mound that Chesapeake proposes to unitize is in the far southeast corner of the Lovington Northeast field. This area has had five wells, drilled in 1984 and 1985. These wells are located on the base map at attachment 2. A cross-section, showing each well with perforations, is attachment 3. The cross-section is located in the plastic sleeve at the end of this report. The cross-section shows good continuity between wells. There is little or no stratification in the central core of the mound, but stratification does occur in the northeast area as seen in the Shipp 1 and Shipp 2. A structure map, attachment 4, on top of the Strawn formation shows very shallow dip,

dip, approximately one degree, to the east-northeast. The structure of the Strawn does not play a role in trapping; rather it is the development of algal bioherms that provides the basis of the reservoir. A table of well data is attachment 5 and has date of first production, production totals, perforations, discovery pressure, oil gravity, log derived porosity and water saturation, and oil formation volume factor.

Mound History and Production Data: The mound was drilled and completed in a 15 month period from July 1985 to October 1986. The first well drilled, the Shipp ZI 1, has 54 feet of pay but was initially perforated in only the top stringer of pay, which contains only six net feet. This thin zone performed poorly and after 6 months of production was abandoned for an uphole zone. The Strawn was never recompleted in this well, and the recovery was only 0.3 MBO. The other four wells in the mound have an average EUR of 365.7 MBO per well, and the total mound recovery was 1.463 million barrels of oil and 1.792 MMcf of gas. A performance curve of the combined mound and of each well is attachment 6-1 through 6-6. Essentially all of this recovery occurred over a 15 year life from December 1984 through November 1998.

Reservoir Rock and Fluid Characteristics: The reservoir is a phylloid algal bioherm that has experienced weathering. Weathering led to grain dissolution and significant vug development and contributed to brecciation and initial fracture development. Core work and Formation Micro-Imager work on the Alston 1-8 and numerous routine core studies of mounds in the area indicate that fracture and other secondary pores are important reservoir characteristics. General standard porosity logs are pessimistic and may miss vuggy porosity that is not developed entirely around the borehole. In the Carter-Shipp mound, Neutron-Density crossplot porosity averages 8.3 percent, when a cut-off of 4 percent was applied. No attempt has been made to adjust for the fractured, vuggy nature of the rock. The water saturation calculates to be 36.5 percent. The porosity and water saturations may both be pessimistic.

The initial pressure in this mound was 5,440 psi, which is equivalent to the field discovery pressure, despite being drilled 32 years after field discovery. We do not have a PVT study on this mound, but Lasater's correlation (Frick Petroleum Handbook, pg 19-9) indicates the bubble point pressure is approximately 2,950 psi. The reservoir temperature is 162 °F, initial GOR was 0.7 Mcf/Bbl, and the oil gravity is 42.48 °API. By correlation, the oil formation volume factor is 1.325 STB/Res Bbl.

We do not have core data from this particular mound but do have routine core analysis of the Strawn formation taken from the Alston 1-8. The porosity to permeability relationship is fairly strong and shows that for porosity of 8%, the permeability is about 10 md. The relationship of horizontal to vertical permeability is also shown, and vertical permeability is about 56% of horizontal permeability, which suggests we can expect fairly good vertical fluid movement. These relationships are shown on attachment 7. The Alston 1-8 core permeability distribution is shown on attachment 8 and this data show the 50 percentile to also be 10 md. The Dykstra-

Parsons coefficient of permeability variation is 0.83. Most reservoirs fall between 0.6 and 0.9; therefore, the Strawn is fairly heterogeneous but, based on the cross section, not particularly stratified.

Reservoir Size and Original Oil in Place: Studies of multiple cores in closely spaced wells conducted in T16S-R37E indicate mounds rarely correlate over long distances. We believe three-dimensional (3D) seismic data analysis is critical in determining the location and shape of individual mounds. Log data, presented in attachment 5, and (3D) seismic analysis were used to develop the ϕh isopach map at attachment 9. The mound is 1 mile long, 0.56 miles wide, runs east-west, and has a productive area of 244 acres. The maximum reservoir thickness is 120+ feet, and the average thickness is 58.5 feet. Porosity averages 8.3 percent, and water saturation averages 36 percent from Neutron-Density crossplot calculations. The cut-off for pay was 4 percent. Core studies from wells in other Strawn mounds, discussed above, indicate the log derived values may be pessimistic. The oil formation volume factor is 1.325 STB/Bbl. Using average porosity and water saturations for the mound, the original oil in place (OOIP) is 4,445,882 STB. The OOIP calculation is presented in the Waterflood Calculation sheet, attachment 10-1.

Waterflood Recovery

Primary Drive Mechanism: The production behavior is indicative of solution gas drive. The reservoir initially produced about 0.7 Mcf/Bbl. The GOR of the various wells reached a maximum range of only 2 to 2.6 Mcf/Bbl. There is no indication of the formation of a secondary gas cap. The formation produced relatively small amounts of water that decreased over time, and there is no indication of water drive support.

Primary Recovery Efficiency: The waterflood calculations for this project are shown on Attachment 10-1 through 10-4. The OOIP is 4.446 million STB, and the primary recovery was 1.463 million barrels, for a primary recovery efficiency of 33 percent. We recognize that this is an unusually high efficiency for a solution drive reservoir. A review of primary efficiencies of mounds in this area indicates that between 15 and 22 percent is the norm. Strawn well log data for other area mounds indicates that the average porosity is 9 percent, and the average water saturation is 19 percent. The log values in this mound are below average. They may be pessimistic and if so, the OOIP calculation is pessimistic, resulting in a primary efficiency that is erroneously high.

Mobility Ratio: The mobility ratio is 0.686, and the calculation is at attachment 10-2. This ratio is one of the most important single characteristics of a flood and a ratio of less than one implies that the water bank is less mobile than the oil bank and, hence, high volumetric sweep efficiencies are possible.

The calculation of the mobility ratio requires information about the relative permeability of the formation. Because we did not have core data in this mound and had no special core analysis from any Strawn well in the mound area, we used special core analysis from similar carbonate core from the Abo formation, which we waterflooded in the Trinity-Burrus Unit in Lea County, New Mexico. For completeness, that relative permeability curve is shown on attachment 11.

Waterflood Recovery: Waterflood recovery calculations use terminal oil saturations at flood out, and these are generally between 25 to 30 percent. The Abo core reference above had a terminal saturation of 30 percent, and similar values are available in numerous texts. The fractional flow curve from the Trinity-Burrus Unit is on attachment 12. Volumetric sweep efficiency calculates to 86 percent for this flood, which represents a recovery of 355.3 MBO. However, an endpoint of 25% residual oil indicates recovery of 668.8 MBO. Hence, the range of reasonable recovery is fairly broad for this mound. Chesapeake based planning and economic expectation on the smaller recovery of 355.3 MBO, which represents a secondary efficiency of 8%, a total recovery of 41%, and 0.24 Secondary-to-Primary ratio (S:P).

Interference, Fill-up and Response: Time to interference and fill-up are also estimated in calculations of attachment 10-3. The fillup volume is 2.6 million barrels, and at 1600 BWID, discussed below, fillup will be reached in about 4.5 years. Initial response will occur at 50 to 60 percent of full fillup, or at about 2.2 years. With start of injection at November 2009, the first response will be around January 2012 and the peak at January 2014. The peak rate used here is 400BOD, which is about 40% of the combined initial peak rate under primary recovery of the two wells scheduled as producers in the waterflood. Total flood life is 18 to 20 years. Timing events and peak rate calculations are at attachment 13. The anticipated waterflood performance curve is shown on attachment 14.

Water Source

Water supply needs are based on injecting 800 BWID into two injection wells, for a total water requirement of 1,600 BWID. Strawn wells in this area report high initial rates, often in the 600 to 700 BTFD rate. The Chesapeake operated Easley No. 1 produces in an area where there are higher water saturations; having been on for 12 years, this well still yields 940 BTFD. Also, extensive treating experience leads to a subjective belief that 800 BWID is a reasonable sustained injection rate.

There are several options for make-up water in this area. Water is available from Devonian producers in the area, from Strawn producers to the north, from Wolfcamp production to the northwest, and possibly effluent water from the Lovington Waste Water Treatment Plant. Unfortunately, all of these sources require a supply line of 6 to 8 miles, as shown on attachment 15. Of the three options, the preferred is the Wolfcamp water from the wells in Section 11-T16S-R36E. These two wells, the Chipshot 1 and 2, produce 2000 BWD, are operated by Chesapeake, and have a projected life of 37 years. In the event additional water is needed, a 2.5 mile line may be laid to the Easley 6-1, Chesapeake operated, for an additional 750 BWD.

The Chipshot wells are also in the vicinity of Lovington's effluent line; should additional water be needed, the effluent water is another possibility.

The line cost will be approximately $50,000 per mile. The maximum line distance is about 8 miles. With tankage, valves, controls, and transfer pump, the cost is estimated to be $500,000 for the water supply system.

Capital Cost Estimate

A review of each wellbore in this field leads us to the opinion that each well can be re-entered and equipped for use in the waterflood. We plan to use two wells for injection and two for production. The map on attachment 16 shows the proposed pattern and the costs associated with the development of this flood. Total gross costs are estimated to be $2,806,400. This cost and the anticipated secondary recovery of 414.5 MBOE gross, 331.6 MBOE net, represents a finding cost of $8.46/BOE net.

Unitization

We propose to unitize this entire porosity mound for secondary recovery operations. There is no primary rate or reserve, all primary production has ceased, and all wells have been plugged. The tract participation will be based solely upon its estimated contribution to secondary reserve and the wellbores to capture those reserves.

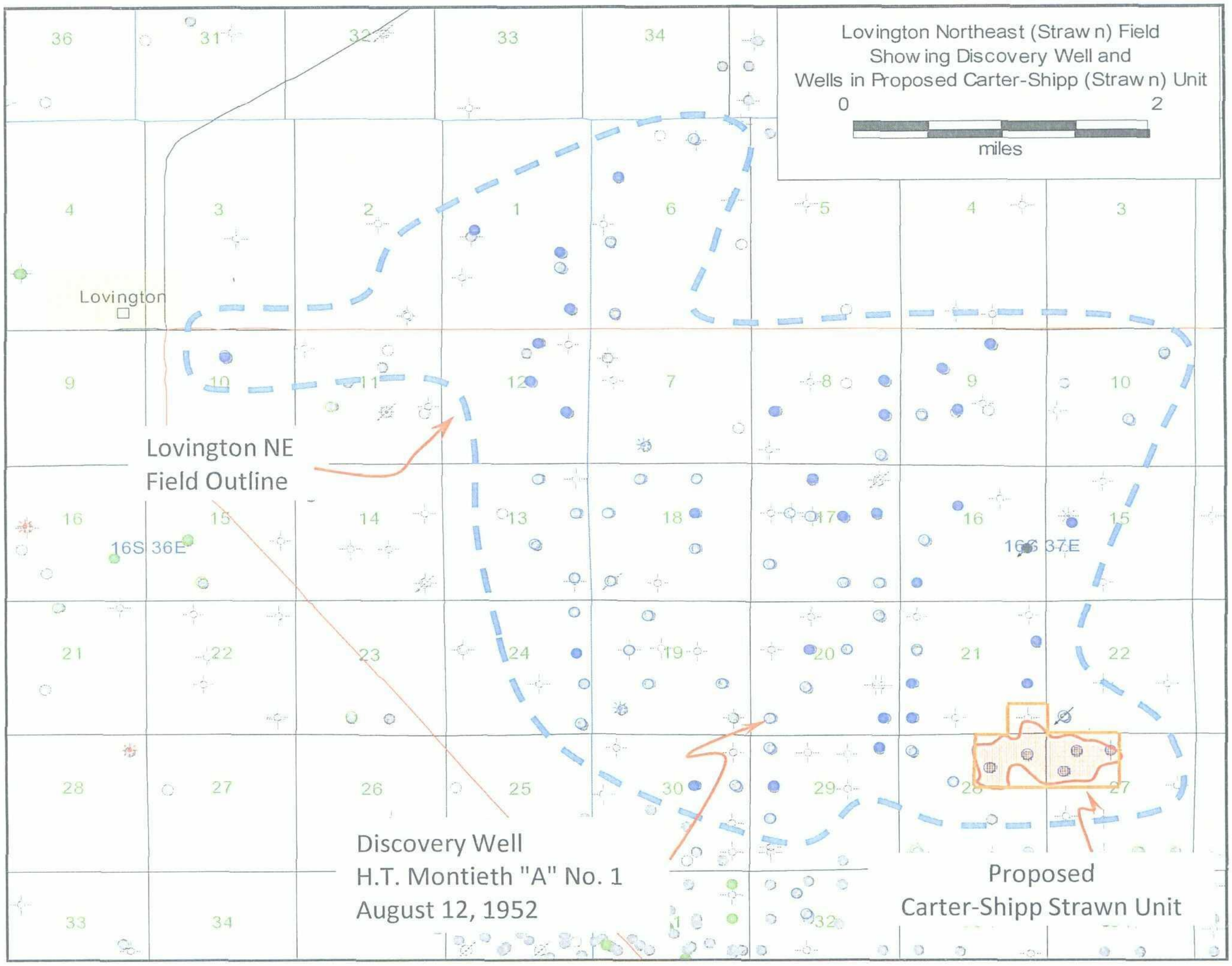
At this depth, 11,000 ft, drilling costs have a tremendous impact upon project economics and can determine whether or not an attempt will be made to flood the reservoir. For this unitization, a 10 percent factor is assigned to the existence of a wellbore that we believe can be and will be re-entered and used in the flood.

Because secondary oil is an absolute requirement for a successful flood, we put this component at 90 percent of the tract factor. The secondary reserve each tract contributes is reflected by both the original oil in place and the primary recovery of each tract. As primary is reflective of numerous factors that may not be in play during secondary recovery—such as date drilled, number of wells drilled, completion efficiencies, competitive drainage—we have placed primary recovery of 40 percent and OOIP at 50 percent of the tract factor.

The Unit Participation Factors, by tract, are presented in a table at attachment 17. The equation below is the proposed tract participation equation for each tract in this unit:

$$\text{Tract Factor} = \left\{0.1 \times \left(\frac{\text{Tract Usable Wellbores}}{\text{Unit Usable Wellbores}}\right)\right\} + \left\{0.4 \times \left(\frac{\text{Tract Primary EUR}}{\text{Unit Primary EUR}}\right)\right\} + \left\{0.5 \times \left(\frac{\text{Tract OOIP}}{\text{Unit OOIP}}\right)\right\}$$

Proposed Carter-Shipp Strawn Unit
Orientation Map



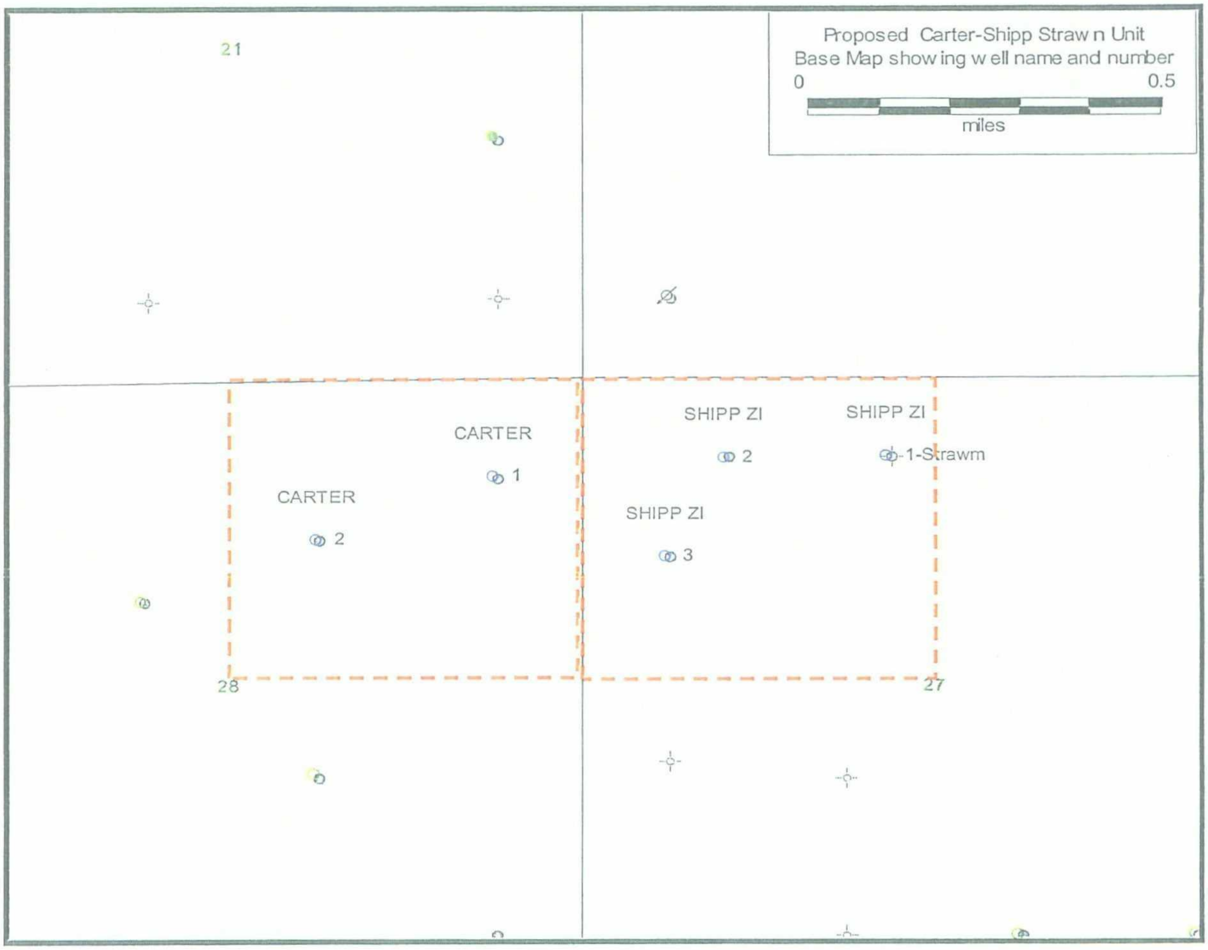
The group of Strawn wells known as the Lovington Northeast Field is shown above. The field contains roughly 81 Strawn completions in 22 sections. *The field lies generally to the southeast* of Lovington, New Mexico.

The first Strawn completion in this field was the H.T. Montieth "A" No. 1 in section 20M-T16S-R37E, completed by the Tide Water Associated Oil Company on August 12, 1952.

The proposed Carter-Shipp (Strawn) Unit is located at the southeast corner of the Lovington NW Field. This proposed unit is seven miles southwest of Lovington, New Mexico.

Proposed Carter-Shipp Strawn Unit

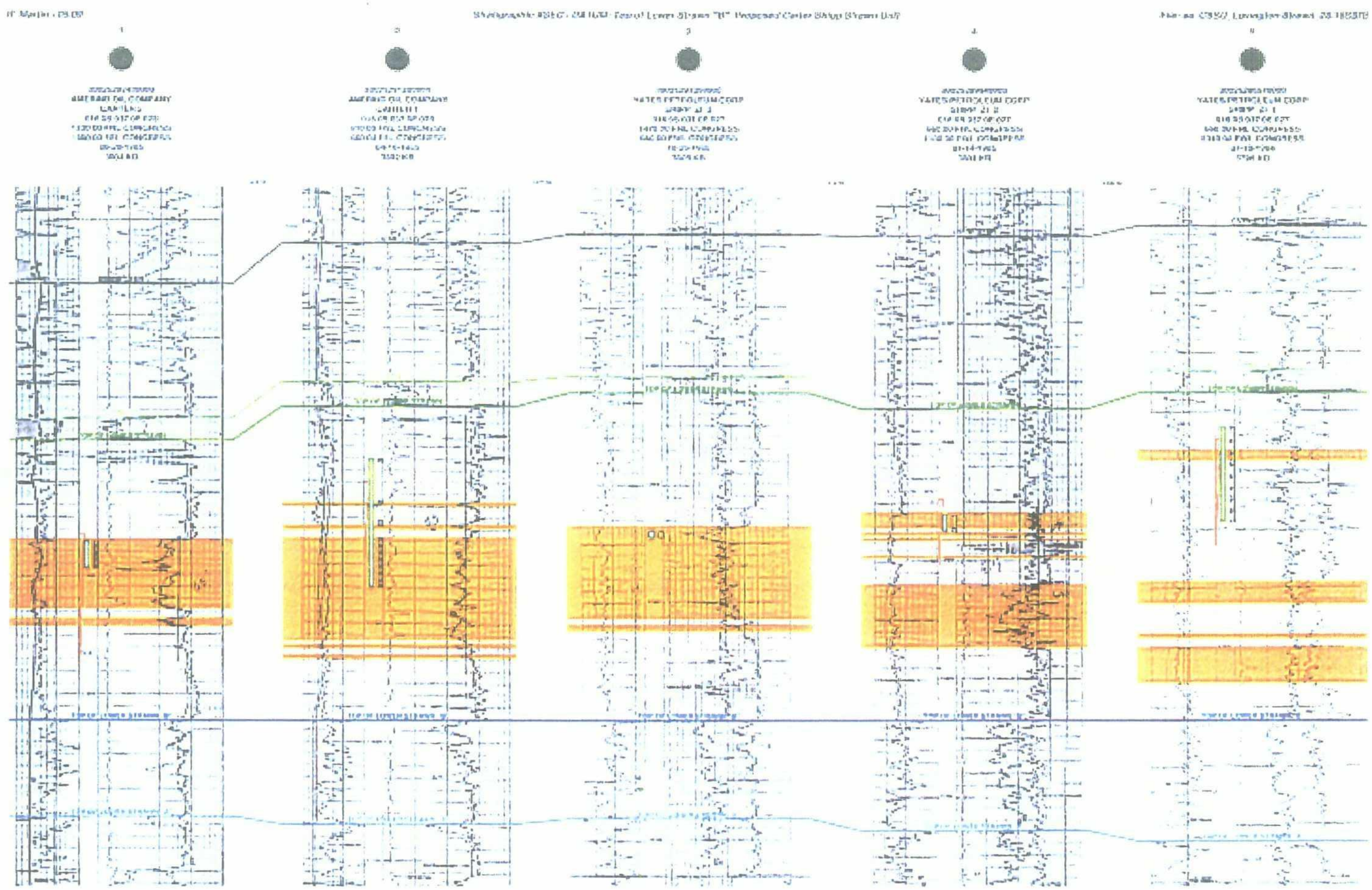
Base Map showing wells



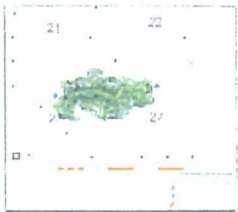
Attachment 2

Proposed Carter-Shipp Strawn Unit

X-Section



A larger version of this cross-section is folded and enclosed in the plastic sleeve at the back of this report.



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Carter-Shipp Strawn Unit

X-Section

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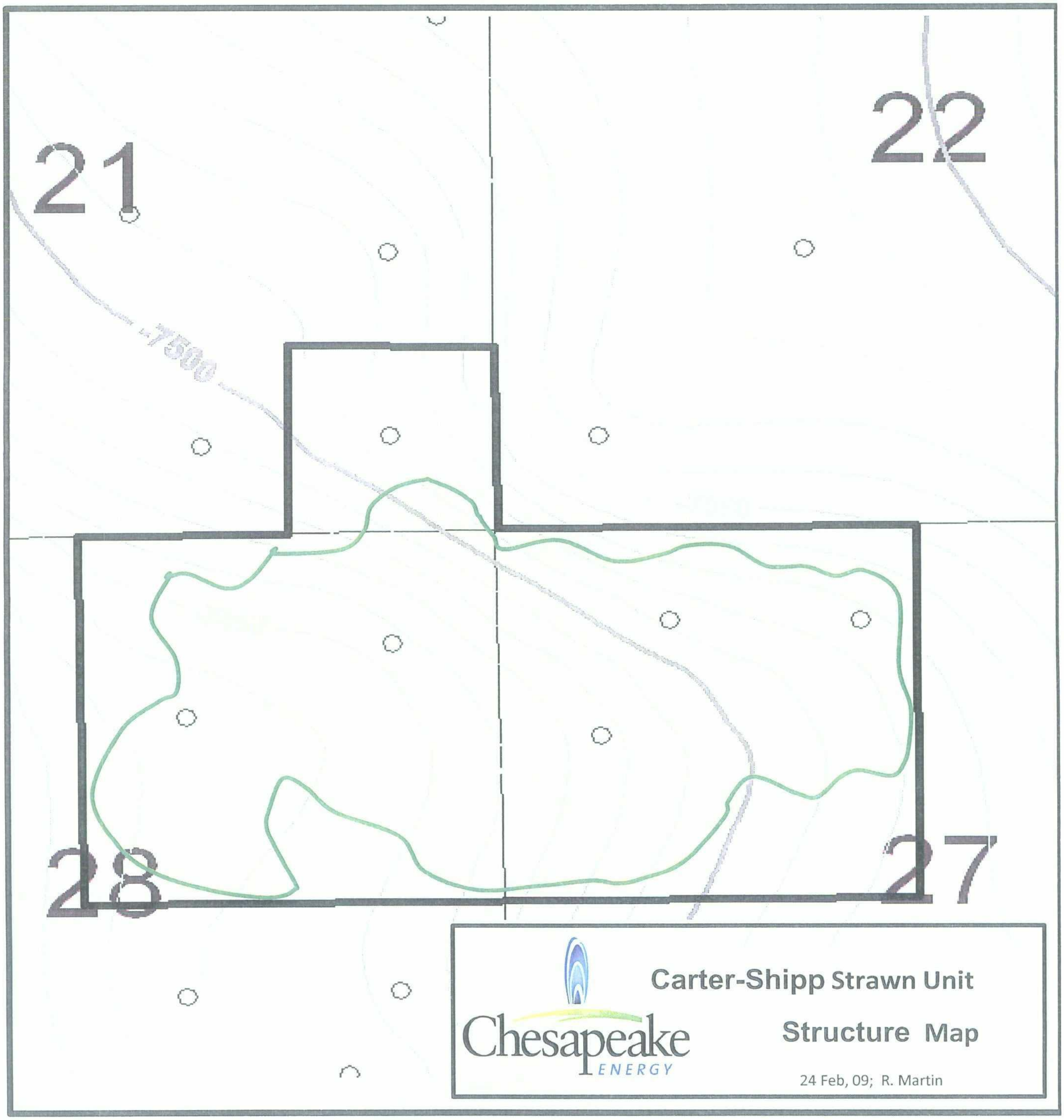
Attachment 3

Attachment 3

Proposed Carter-Shipp Strawn Unit

Structure Map



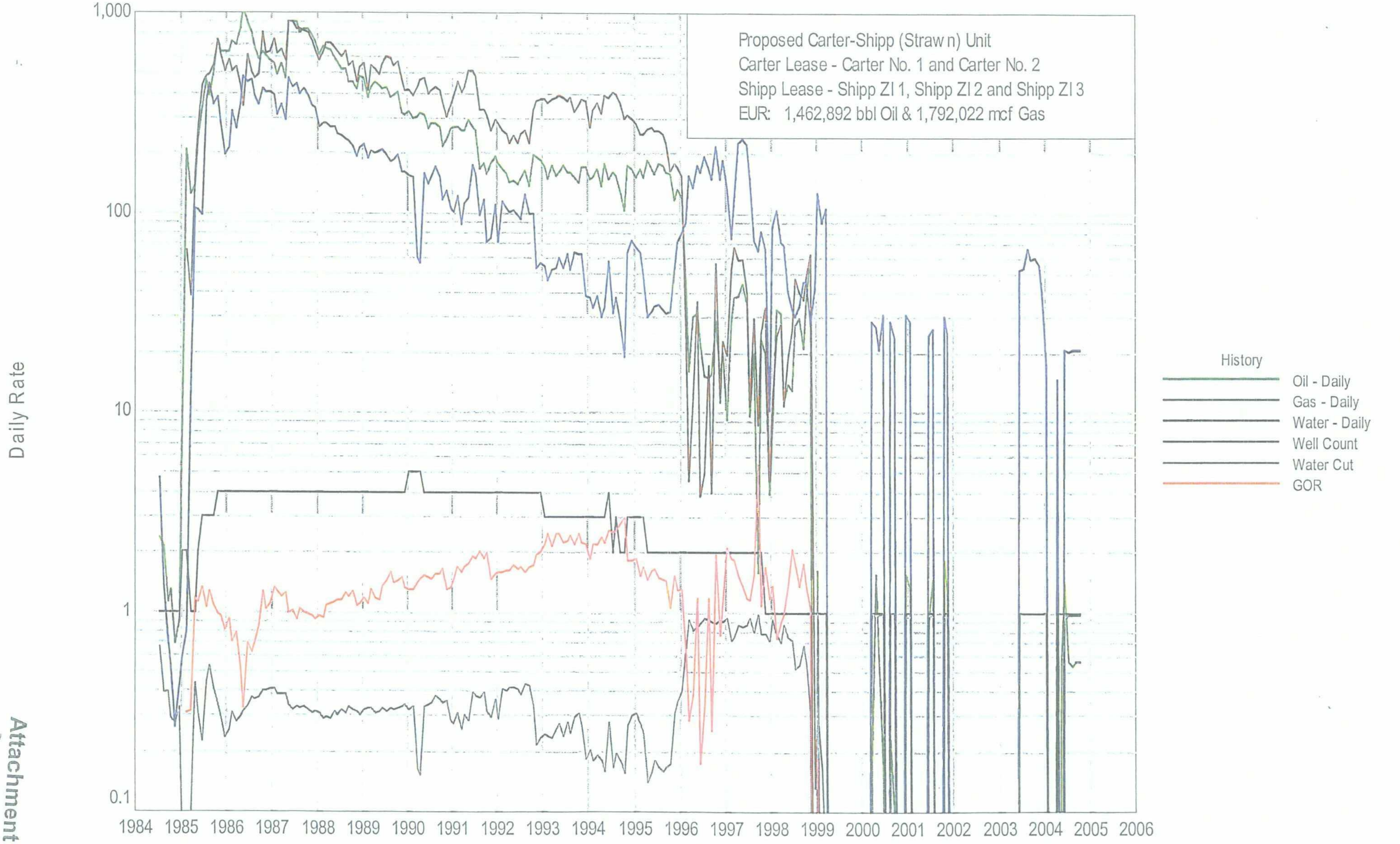
The structure map shows the shallow dip, approximately 100 ft per mile (1 degree), toward the northeast. The proposed unit outline is shown, and within the unit the productive area of the mound is highlighted in light green.

Proposed Carter-Shipp Strawn Unit

Well, Reservoir Data

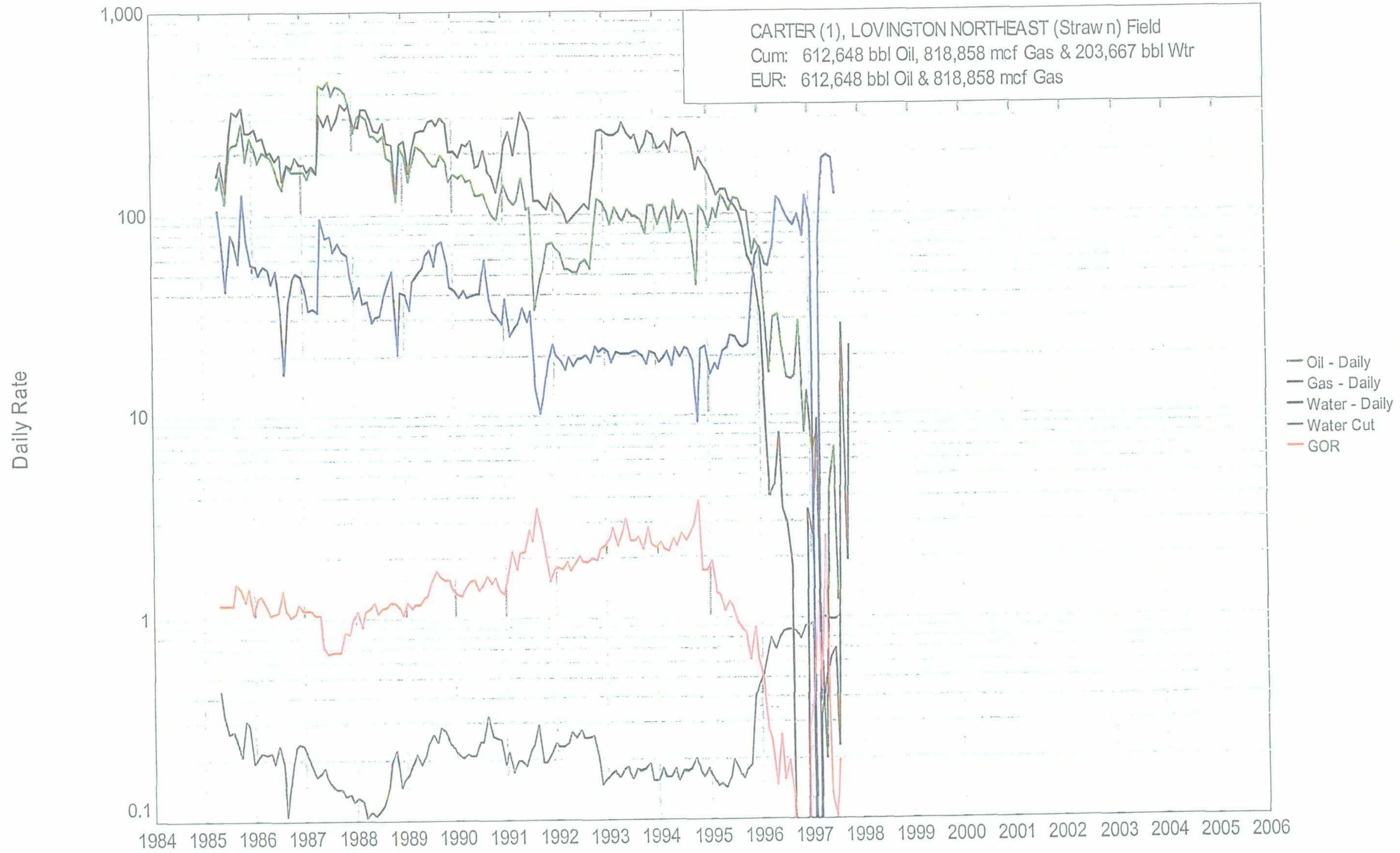
	Shipp ZI 1	Shipp ZI 2	Carter 1	Carter 2	Shipp ZI 3	Averages
1st Prod	Jul-84	Jan-85	Apr-85	Jun-85	Oct-85	
API	3002528657	3002528994	3002529138	3002529248	3002529335	
EUR Oil	266 BO	327,234 BO	612,648 BO	378,490 BO	144,254 BO	365,657 BO
EUR Gas	10 Mcf	316,618 Mcf	818,858 Mcf	559,368 Mcf	97,168 Mcf	448,000 Mcf
Initial GOR	.5 Mcf/Bbl	0.3 Mcf/Bbl	0.7 Mcf/Bbl	1.2 Mcf/Bbl	0.75 Mcf/Bbl	0.69 Mcf/Bo
Perfs	11,414' - 11,493'	11,461' - 11,475' 9 shots	11,361' - 11,469' various, 29 holes	11,371' - 11,393'	11,439' - 11,444' 10 holes	
DST Interval	11,424'-513'	11,448' - 504'	11,380'-445'	11,365' - 476'	No pressure or	DST data 3 wells
Oil Gravity	41.45 °API	Test failed.	43 °API	43 °API	fluid data found	42.48 °API
BHP	BHP 5,259 Psi		BHP 5,439 Psi	BHP 5,526 Psi	at NMOCD.	5,441 Psi
h (ft)	54	72	90	65	88	
ϕ (frac.)	0.056	0.098	0.054	0.08	0.099	0.083 **Avg. ϕ**
S_w (frac.)	0.600	0.318	0.332	0.268	0.309	0.365 **Avg. S_w**
S_o (frac.)	0.400	0.682	0.668	0.732	0.691	0.635 **Avg. S_o**
β_{oi} (bbl/bbl)	1.2823	1.1959	1.3755	1.3704	1.4	1.325 Avg. βoi

Proposed Carter-Shipp Strawn Unit
Primary Performance Curve



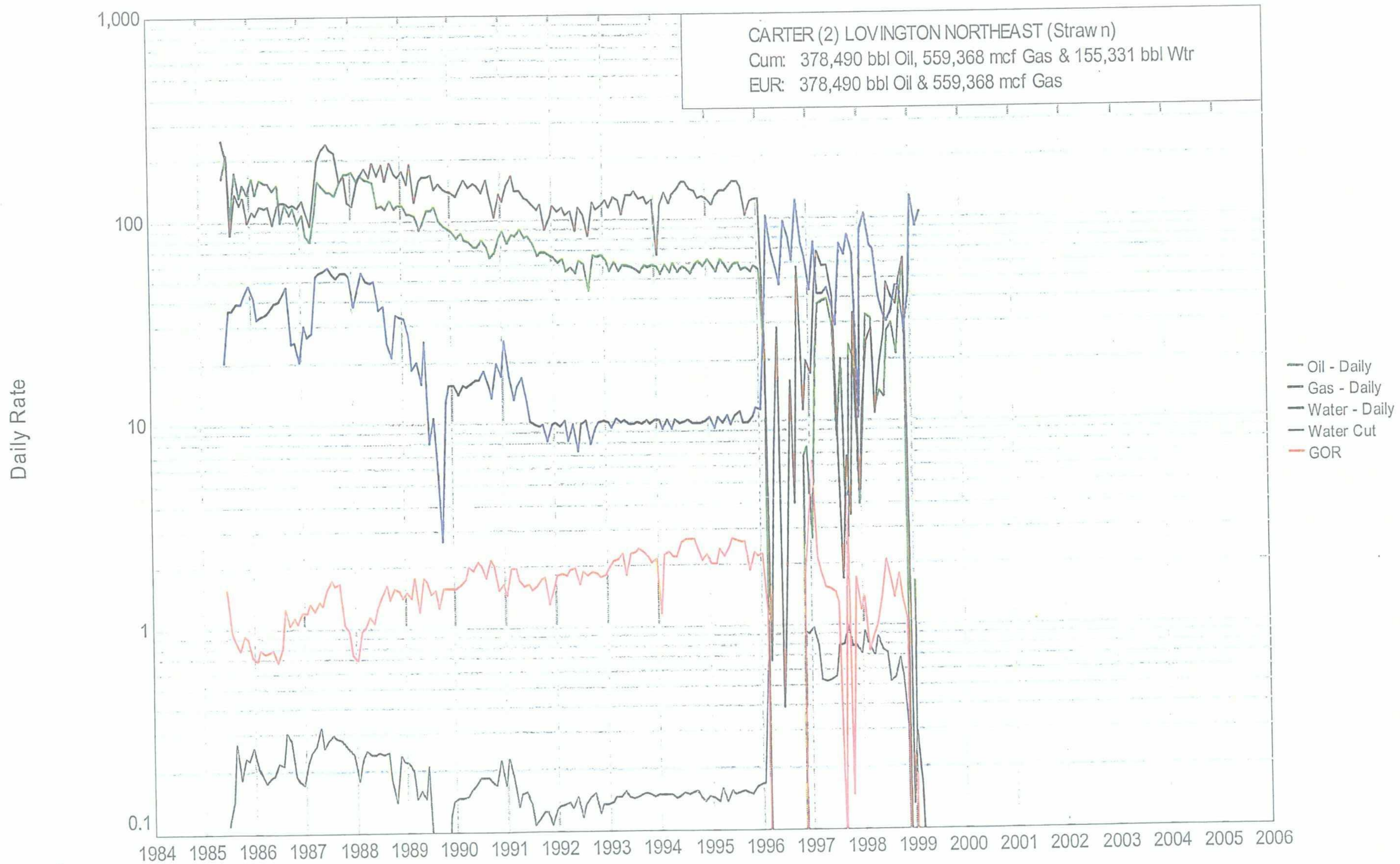
Attachment 6-1

Proposed Carter-Shipp Strawn Unit
Well Performance Curve
Carter 1



Attachment 6-2

Proposed Carter-Shipp Strawn Unit
Well Performance Curve
Carter 2

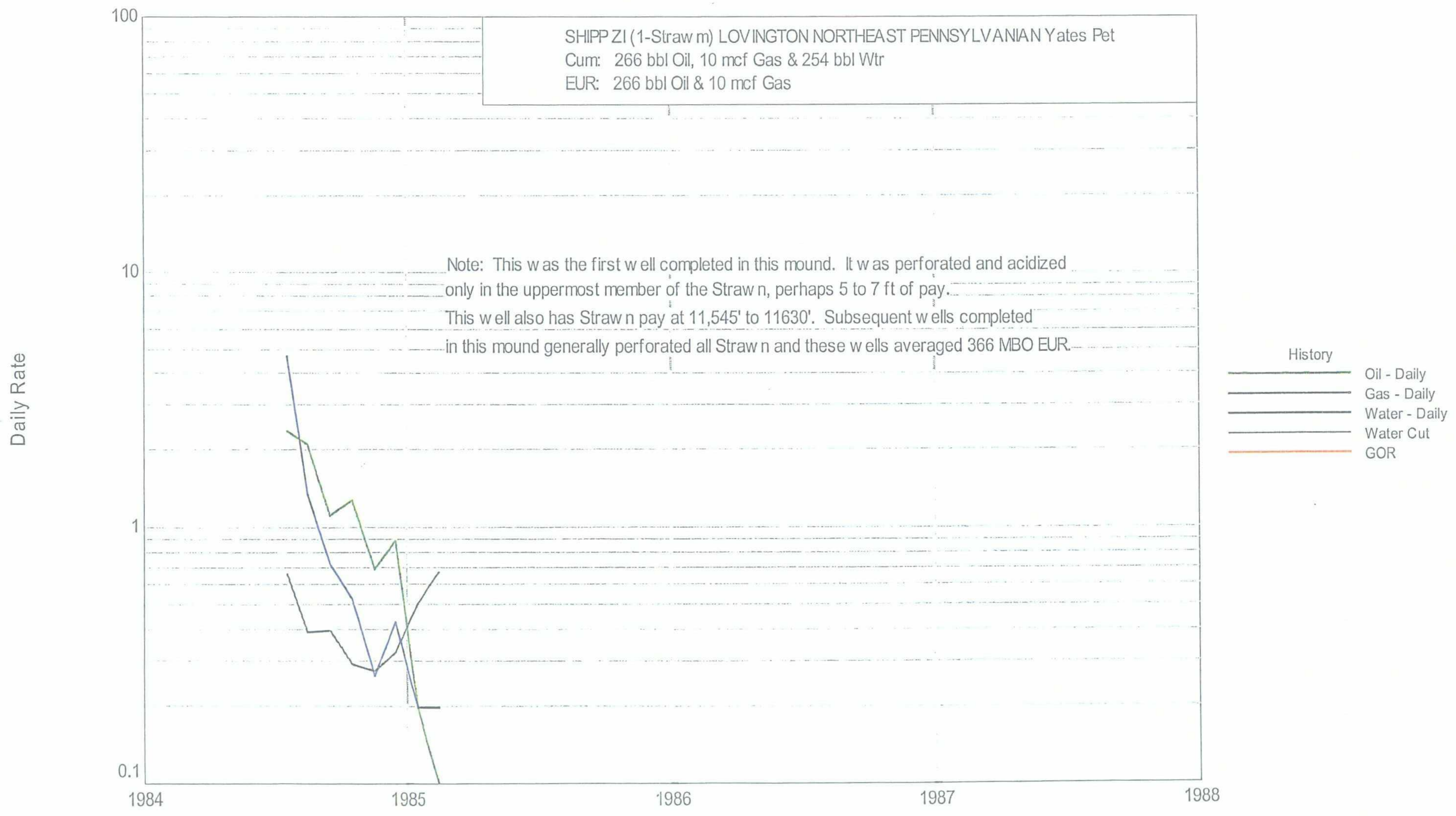


Attachment 6-3

Performance Curves.xlsx
Carter 2

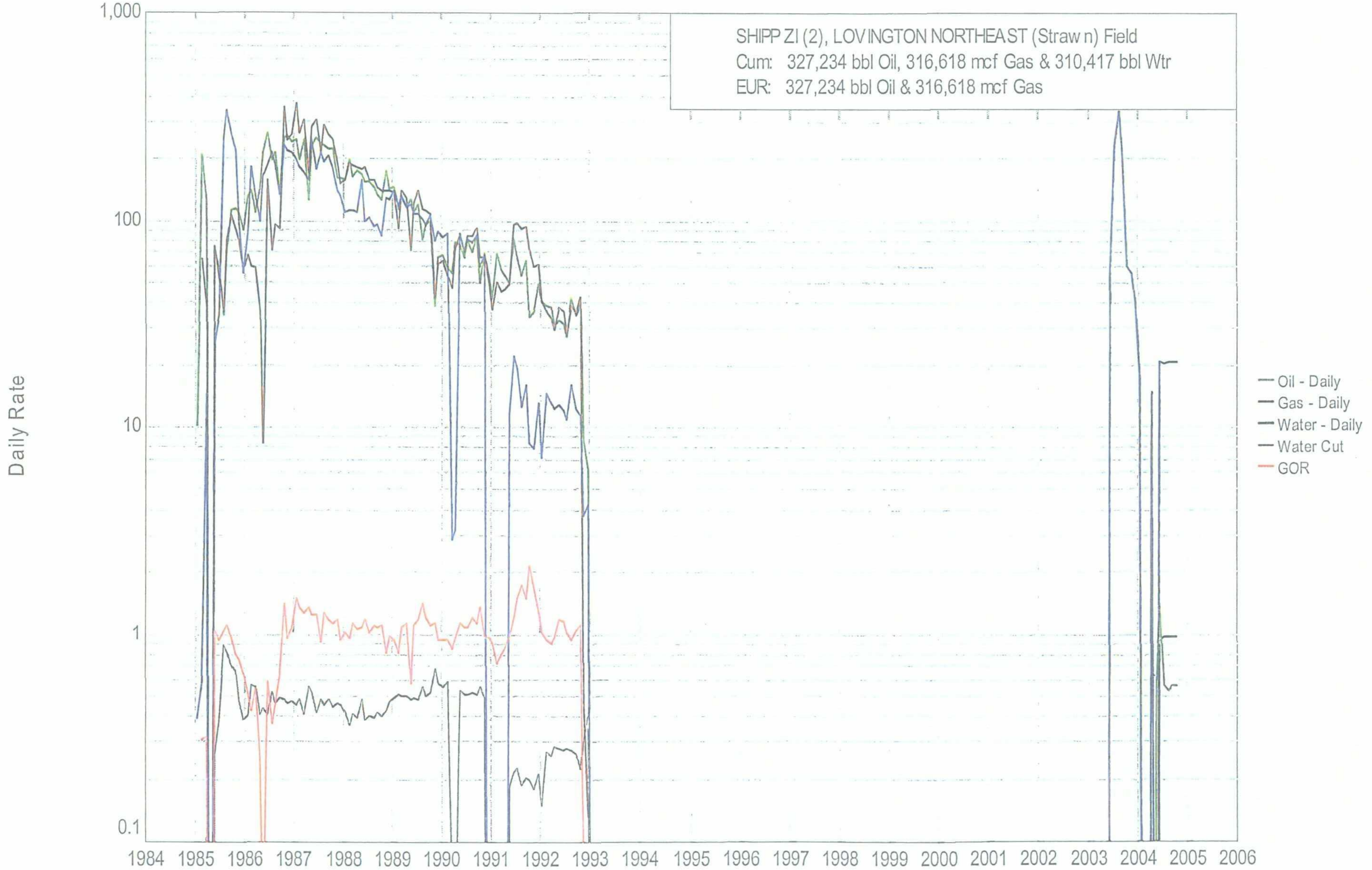
EEB
03/12/09

Proposed Carter-Shipp Strawn Unit
Well Performance Curve
Shipp Z.I. 1



Attachment 6-4

Proposed Carter-Shipp Strawn Unit
Well Performance Curve
Shipp Z.I. 2

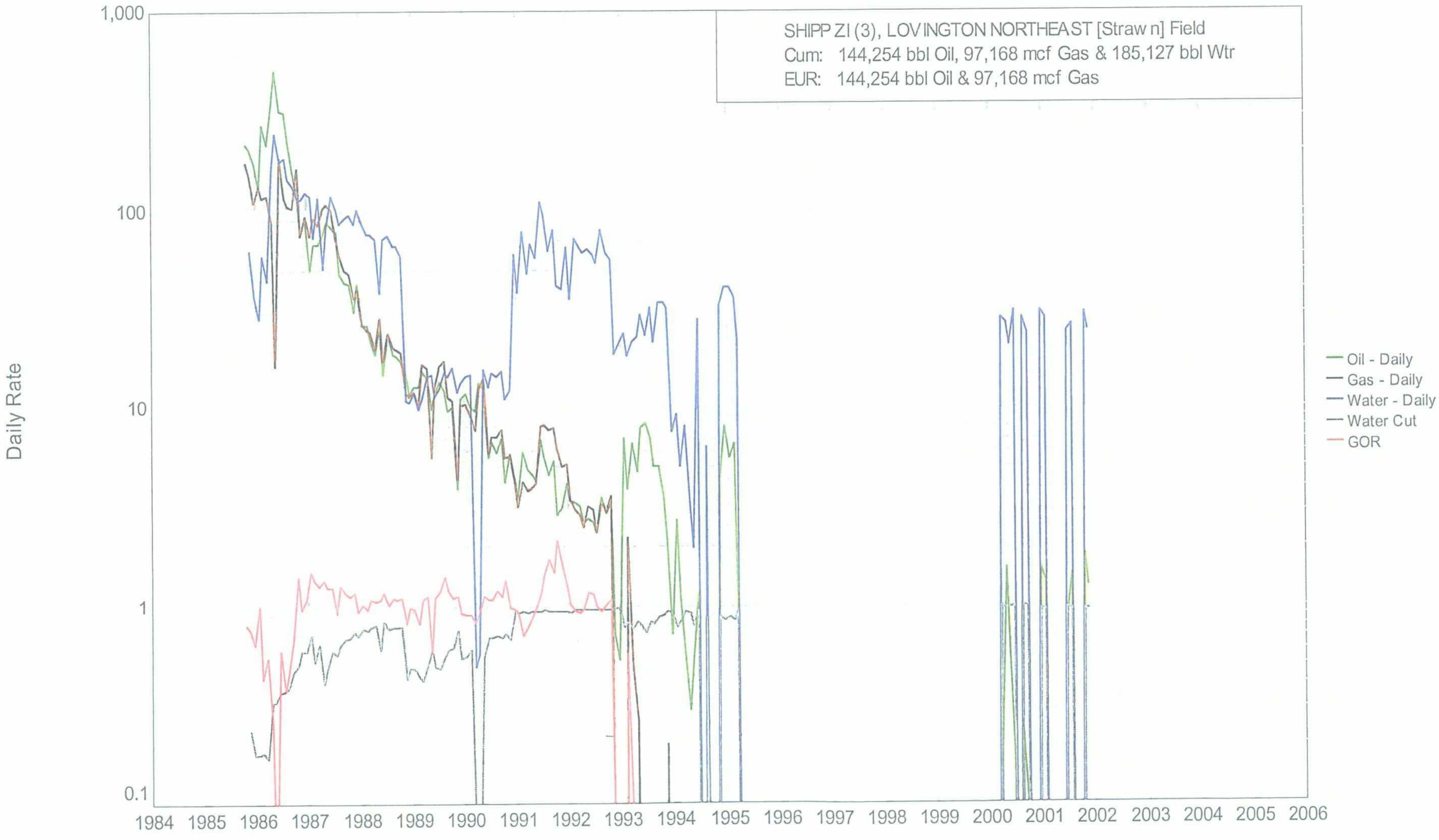


Attachment 6-5

Performance Curves.xlsx
Shipp ZI 2

EEB
03/12/09

Proposed Carter-Shipp Strawn Unit
Well Performance Curve
Shipp Z.I. 3

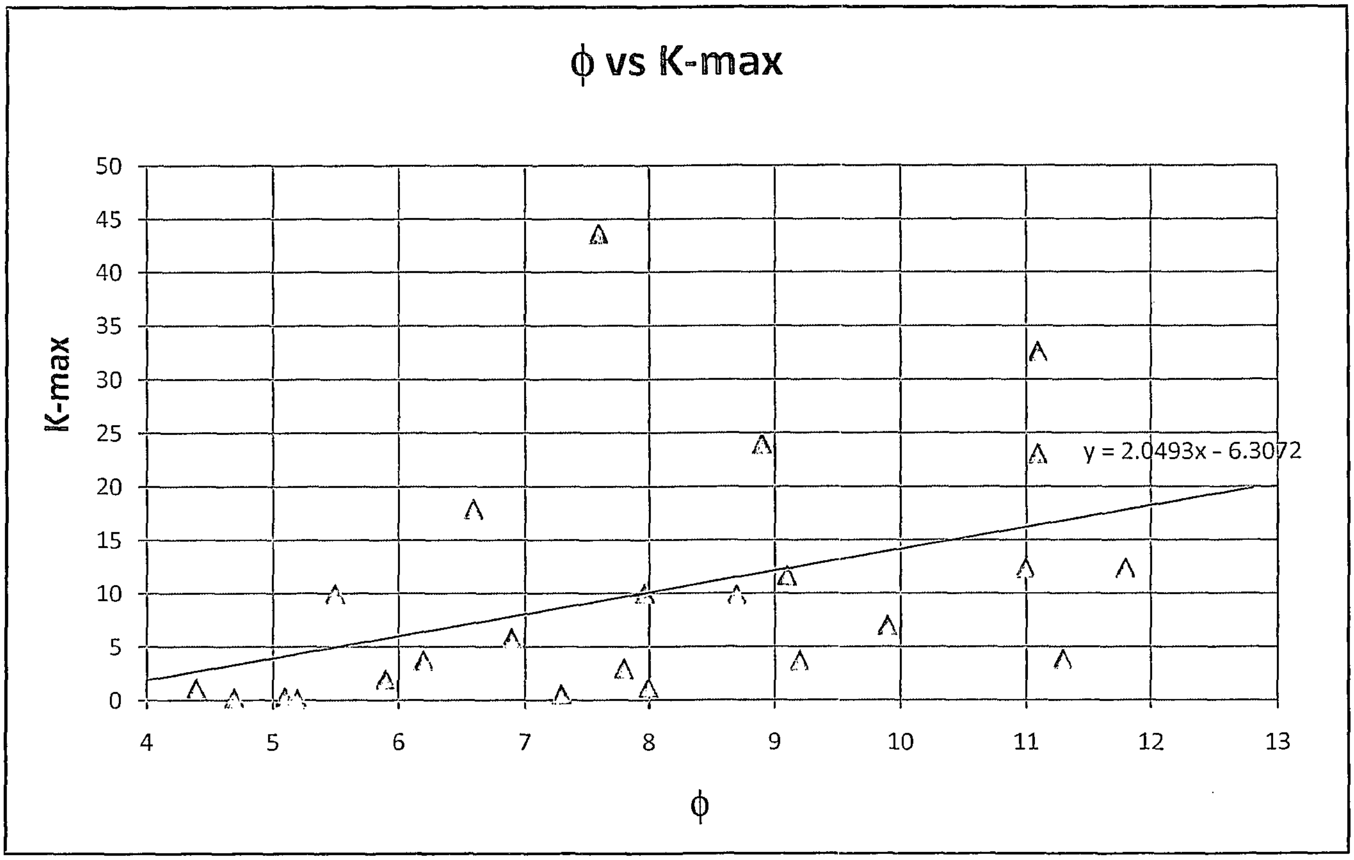


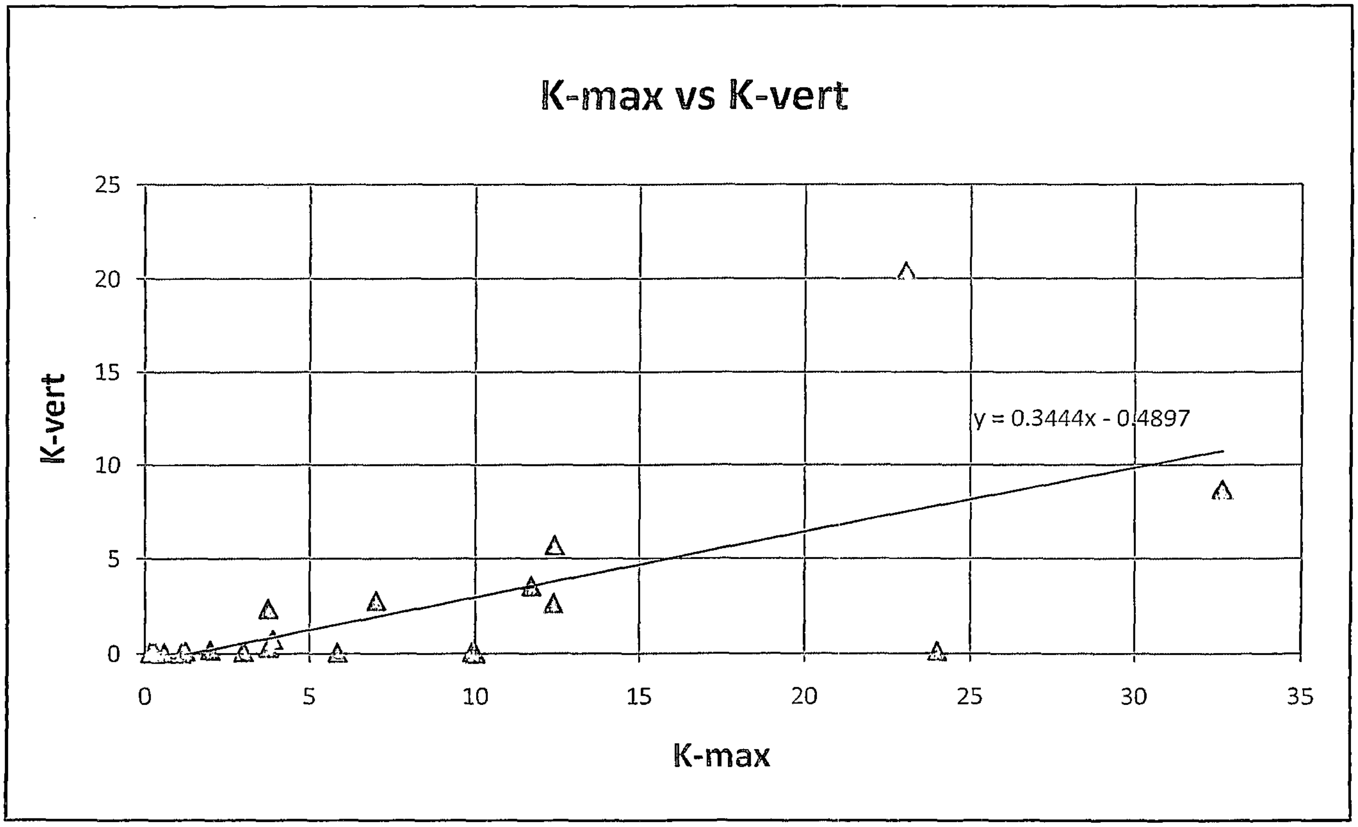
Performance Curves.xlsx
Shipp ZI 3

EEB
03/12/09

Attachment 6-6

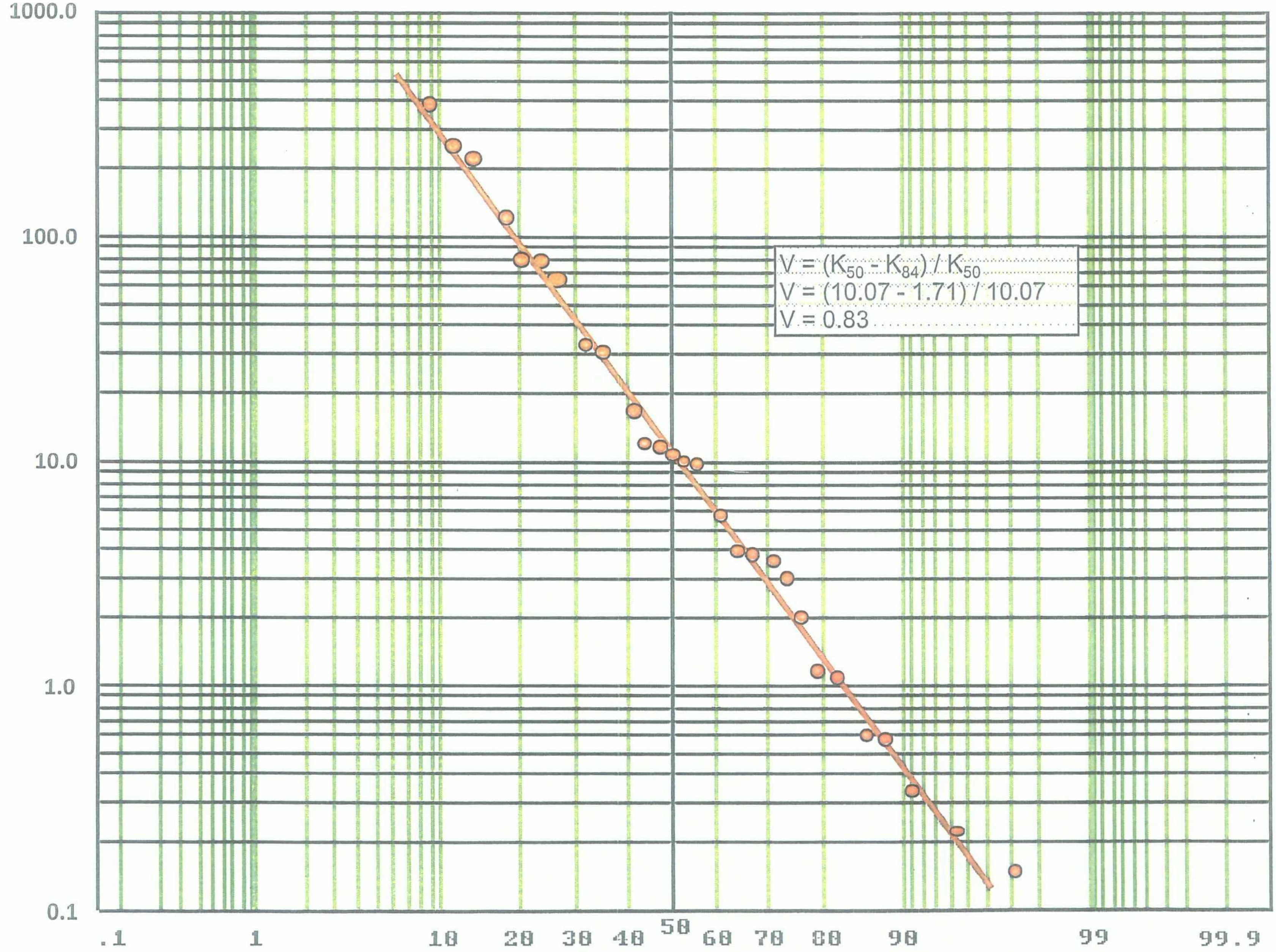
Proposed Carter-Shipp Strawn Unit
Routine Core Analysis - Strawn Formation - Alston 1-8



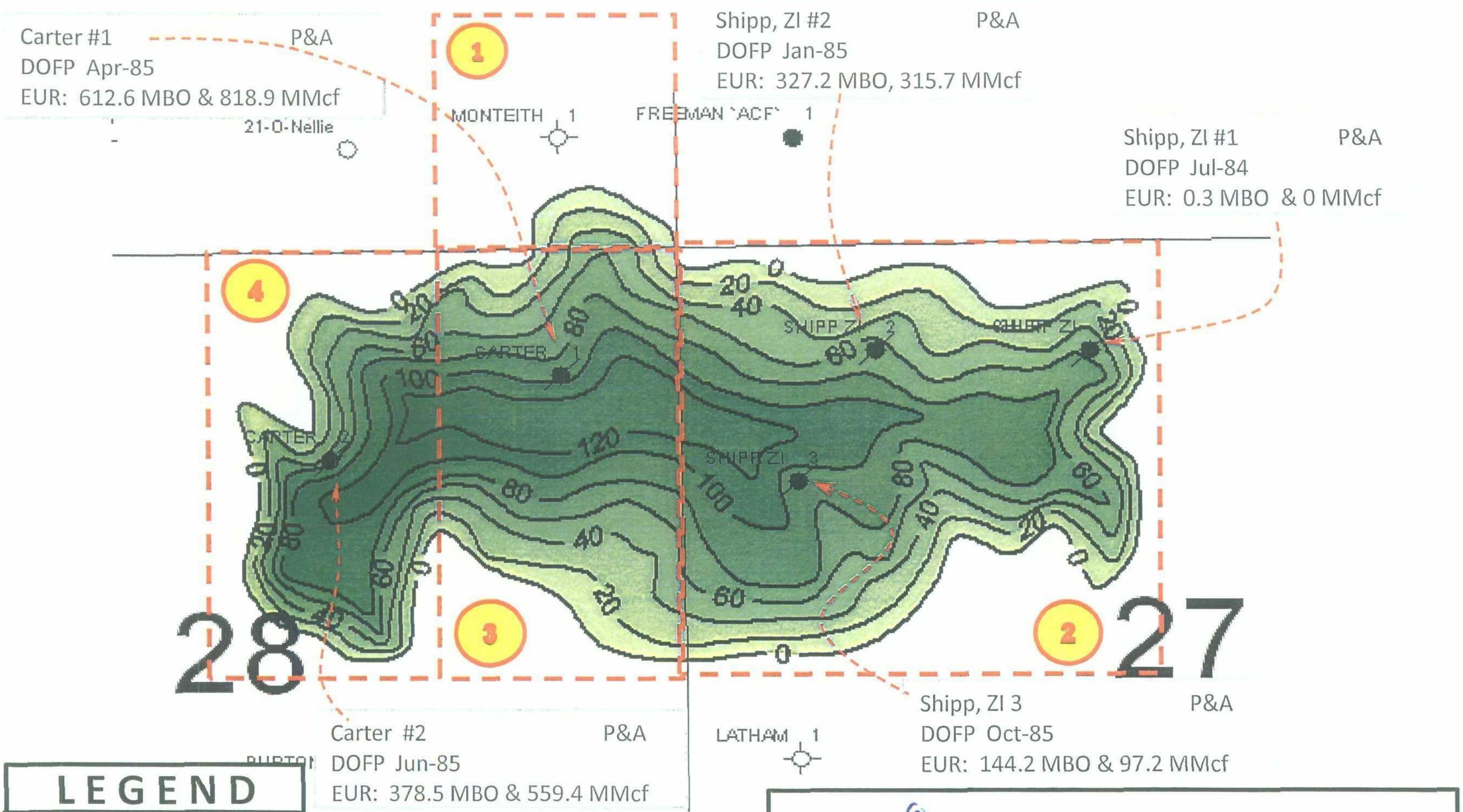


Proposed Carter-Shipp Strawn Unit

Permeability Distribution - Alston 1-8 Core Data



Proposed Carter-Shipp Strawn Unit



LEGEND

- Tract Boundary
- Tract Number

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Carter-Shipp Strawn Unit

ϕh Isopach Map

24 Feb, 09; R. Martin

Proposed Carter-Shipp Strawn Unit
Waterflood Calculations

Basic Data		
Area	244	Acres
Average		
Thickness	58.49	ft
Porosity	0.0830	This is the average of 4 wells
Initial Water Saturation	0.3600	
Oil Formation Volume Factor, initial	1.325	STB/RB,
Oil Formation Volume Factor, at depletion	1.09	STB/RB,
Initial Reservoir Pressure	5,441	Psi by DST measurement
Abandonment Pressure, end of Primary	350	Psi, or about 700' above pump.
Est. Ultimate Primary, ...	1,462,892	STB

1 . Original Oil in Place

$$OOIP = \{7758\ A\ (\phi\ h)\ (1\text{-}Sw)\} / \beta_{oi}$$

$$= 7758\,[244.4][0.08][58.49]\ [1 - 0.360] / 1.33$$

$$= 4{,}445{,}894 \quad STB$$

Present Development, based on decline curve analysis, 1,462,892 Bbls
Present primary recovery factor = 1,462,892 Bbls /4,445,894 Bbls
Present primary recovery factor = 0.32904 Bbls

3 . Oil Saturation at Depletion of Primary Pressure

$$S_{or\text{-}pri} = \{(1 - (\Delta N_p/N)\}\ (b_{or}/b_{oi})\ (1\text{-}S_w)$$

$$S_{or\text{-}pri} = \{1 - [1{,}462{,}892 / 4{,}445{,}894]\}[1.09 / 1.33]\ [1 - 0.36]$$

$$S_{or\text{-}pri} = 0.35325$$

Gas Saturation = Oil Saturation initial - Oil saturation at Abandonment.

= (1 - 0.360) - 0.353

= 0.287 Average in reservoir

4 . Relative Permeability and Fractional Flow

We have no relative permeability data on this project.
We looked at relative permeability data from similar rock such as Abo and Wolfcamp.
We know the oil saturation is initially 30% and the fraction flow of water at 98% is at 70 to 75 % water saturation, 25 to 30% oil saturation

Proposed Carter-Shipp Strawn Unit
Waterflood Calculations

Mobility = $\lambda = k_r/\mu$

Mobility of the water in the water bank

The fractional flow curve from similar rock shows the average water saturation in the water bank is about 67 percent. At this water saturation the adjusted relative permeability curve shows the k_{rw} to be and similar crude (Abo at Trinity-Burrus Unit) at 25%..

$\lambda_w = 0.25 / 0.51 = 0.4902$

Mobility of the oil in the oil bank

In the oil bank the relative mobility to oil is 100 percent.
Crude is 42.5 °API Gravity.
Oil Viscosity is 2.7 cp at 100°F per Beals Correlation, Fig 19-39, Frick Handbooks, Vol. II, pg 19-38.
Reservoir temperature is 165 °F
Oil Viscosity is 1.4 cp at 165°F per Beals etal, Fig 19-40, Frick Handbooks, Vol. II, page 19-39

$\lambda_o = k_{ro}/\mu_o = 1.0/1.4 = 0.71$

Mobility Ratio = $M = \lambda_\omega/\lambda_o$
Mobility Ratio = $M = 0.49 / 0.714$
Mobility Ratio = M = 0.6863
M is less than 1 and is favorable for waterflooding.

5 . Permeability Variation

$V = (k_{50} - k_{84})/k_{50} = 0.83$
Core data, Alston 1-8, Strawn Reservoir.

6 . Volumetric Sweep Effieciency

The favorable mobility ratio will provide good areal sweep.
Empirical correlation with 100 layer Higgins-Leighton streamtube model show
WOR = 25, E_v = .76 and at WOR = 50, E_v = .79 0.79

Refer to fig 6.22 and 6.23, Page 206, Whillhite's SPE Text Vol. 3.

7 . Waterflood Recovery

Secondary Reserves = $7758\ A\ h\ \phi\ (S_{or\text{-}pri} - S_{or})\ E_V / \beta_{oa\text{-}pri}$

Secondary Reserves = $7758\ (244)(58.5)(0.083)(0.35 - 0.30)\ 0.79 / 1.09$

Secondary Reserves = 355,268 BO

Secondary Recovery Factor = 355,268 / 4,445,894 = 0.0799

Total Recovery Efficiency = 0.3290 + 0.0799 = 0.4090

Secondary : Primary Ratio = 355,268 / 1,462,892 = 0.243

NOTE: If the endpoint of S_w is 75% is used, rather than 70% then S_{or} would be 25% rather than 30% and the secondary would be 688,840 BO & RE would be 50.4 percent.

Proposed Carter-Shipp Strawn Unit
Waterflood Calculations

Summary, Reserve Estimate

1 . OOIP is 4,445,894 Stock Tank Barrels.
2 . Primary recovery is 1,462,892 Stock Tank Barrels.
3 . Primary recovery efficency is 33 percent.
4 . Secondary Target is 355,268 Bbls.
5 . Total Recovery Efficiency = Primary + Secondary = 0.329 + 0.0799 = 0.4090
6 . Secondary : Primary = 0.0799 0.3290 = 0.2429

8 . Water Injection Volume at Interference

The distance between injectors and producers:

From Shipp ZI 2 to Shipp ZI 3	=	823 ft	1,633 ft, average
From Shipp ZI 2 to Carter 1	=	1,721 ft	
From Carter 2 to Carter 1	=	1,406 ft	
From Carter 2 to Shipp ZI 3	=	2,583 ft	

In repeating patterns we frequently see the fill-up calculation based on the average size pattern. However, in this mound the patterns do not repeat, spacing is irregular and the reservoir border is a no-flow boundary. All flow is contain and flow streams will trend toward the producers at the initial expense of the reservoir contained at the extremities. Hence, the timing below may be of little use in this flood.

$W_{ii} = \pi h \phi S_{gc} r_{ei}^2 / 5.61$, where r_e = 1633 ft

$[3.1416][58.49][0.08][0.287][1633^2]/5.61$

2,078,936 Bbls Assuming 800 BWID/Injection Well.

Estimated time to interference is 3.6 years, 43 months .

9 . Water Injection at Fillup

$W_{if} = 7758.4\, A\, \phi h\, S_{gc}$

= 7758 244.37 0.083 58.494 0.287 Full Reservoir Basis

= 2,639,473 Bbls Estimate time to fillup at 4.52 years

I would normally expect first response to occur at about 60% of fill-up, however in this situation, given odd patterns and variable spacing I believe we will see first response at about the 50% point, or about 2 years 3 months.

10 . Water Injection at Breakthrough:

$W_{ibt} = 7758.4\, A\, \phi h\, E_a\, (S_{wbt} - S_{wc}) =$

$= 7758\, [244][0.083][58.49][0.890][0.700 - 0.360]$

= 4,177,873 Bbls [Unit Basis]

W_{ibt} = 2,088,936 Bbls [Injection Well Basis]

Estimated time to water breakthrough is 6.4 years. Assuming 800 BWID/Well and uniform spacing.

Since spacing varies, the average is 1633 ft but is as small as 823 ft between some well pares, I expect to se water breakthrough in three years or less.

Proposed Carter-Shipp Strawn Unit
Waterflood Calculations

11. Waterflood Life:

Estimateed to be the time to inject 1.25 pore volumes

The pore volume is = 7758 * Area * thickness * porosity

= 7758 * 244 * 58.49 * 0.083 = 9,204,390 Bbls

Time to inject 1.25 pore volues at 1600 bbls/day

= 1.25 9,204,390 1600 365 = 19.7 years

Other "Rules-of-Thumb" some times seen for quick estimates are:

Time to interference

Estimated to be 0.104 times project life

2.0 years, about 24 months, which is significantly shorter than calculated above.

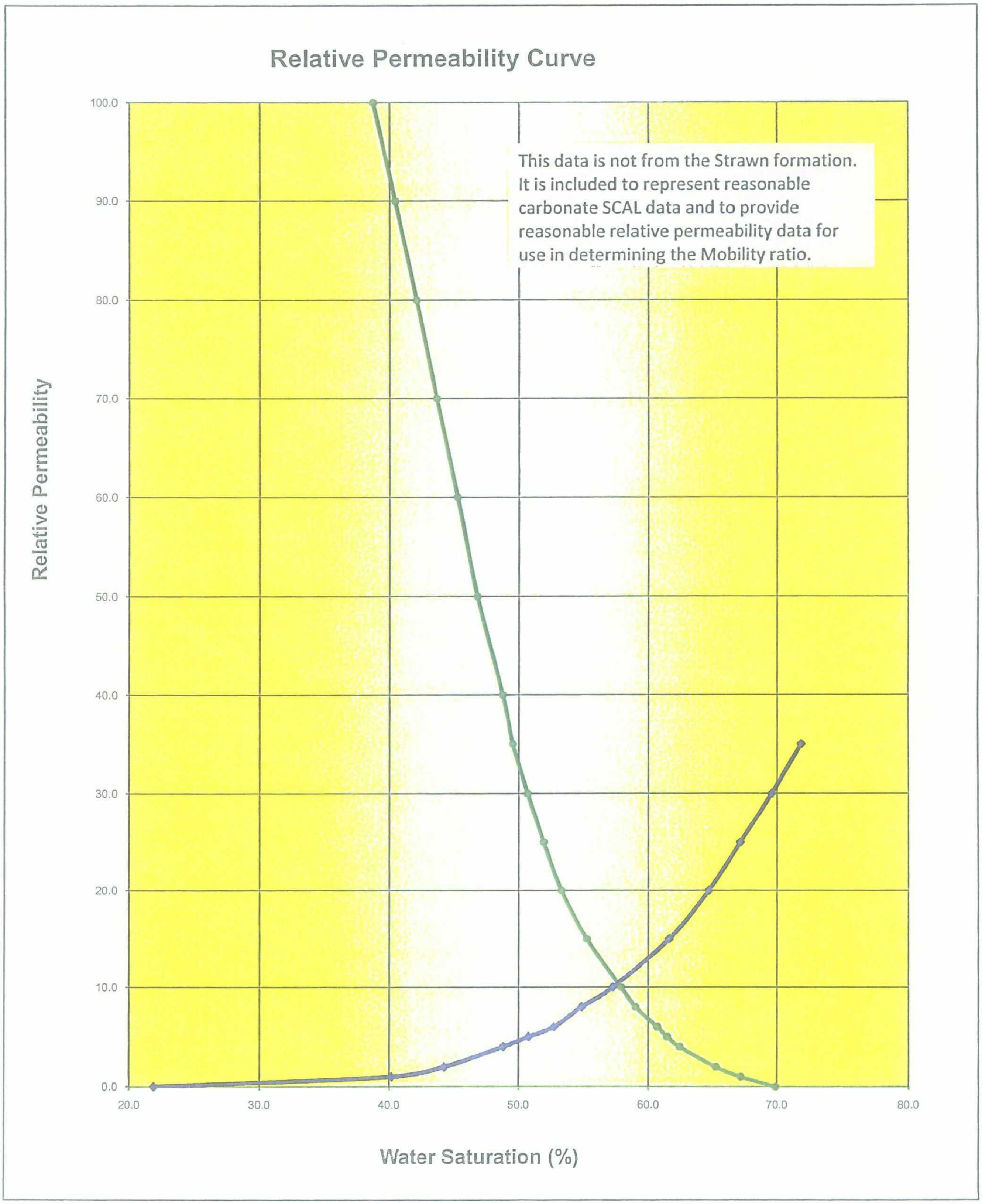
Time to peak response:

Estimated to be 0.23 * waterflood life or 4.5 years

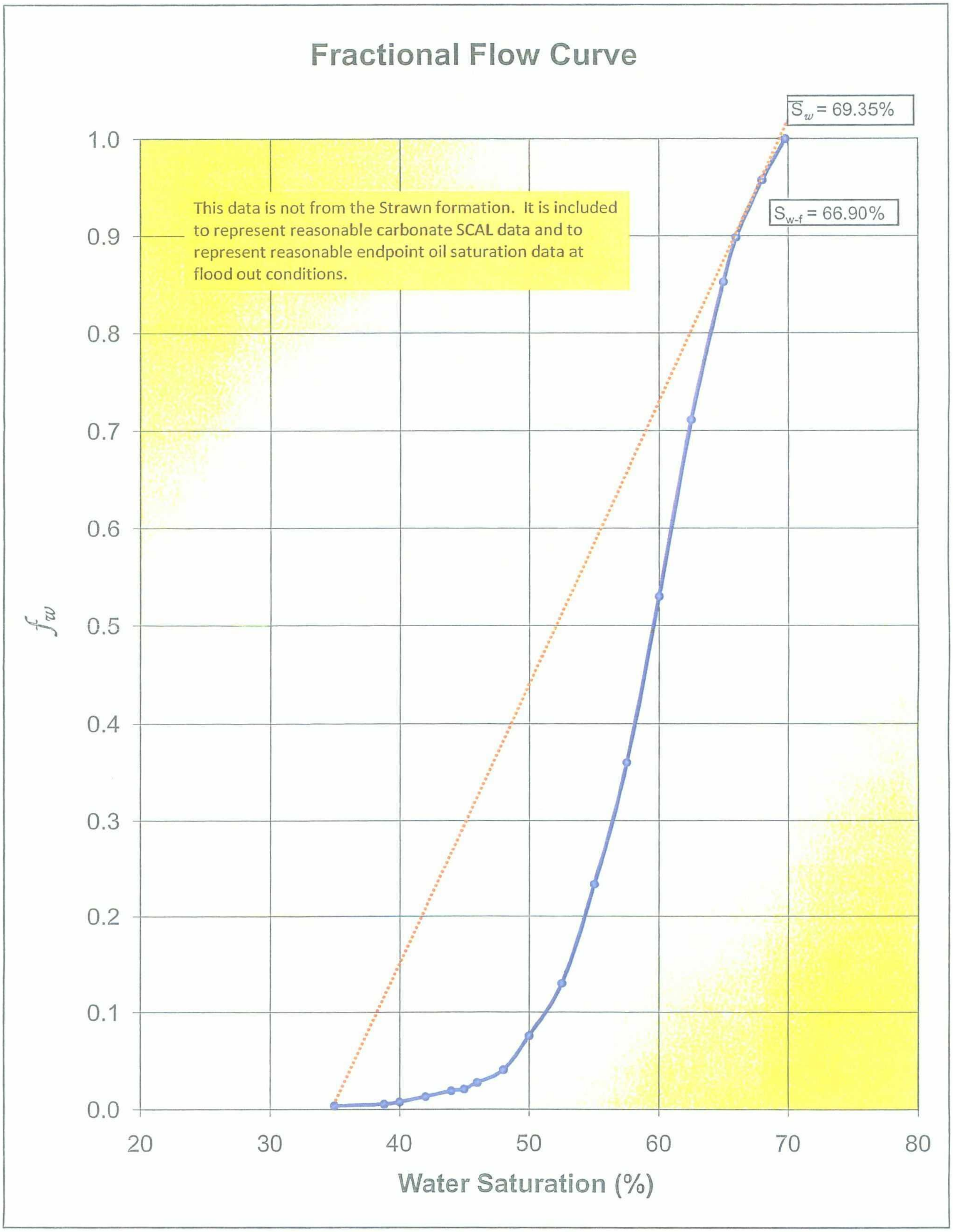
Proposed Carter-Shipp Strawn Unit

Burrus 5 SCAL Data - Trinity (Abo) Field

Averaged and Normalized Data



Proposed Carter-Shipp Strawn Unit
SCAL Data from Burrus 5 - Trinity (Abo) Field



Proposed Carter-Shipp Strawn Unit

First Response and Peak - Timing

Start of Injection

Starting injection about October or November 2009.

Fill-up

Fill-up calculates to be about 3.8 years and

First Response

I expect 1st response to be at about 50 to 60 % of fill-up.
That puts first response in 23 to 28 months.
Response at 1-1-2012.

Peak Rate - Time

Peak will occur at about 2 additional years after first response.

Peak Rate - Amount

The peak rates of the two wells scheduled to be producers:

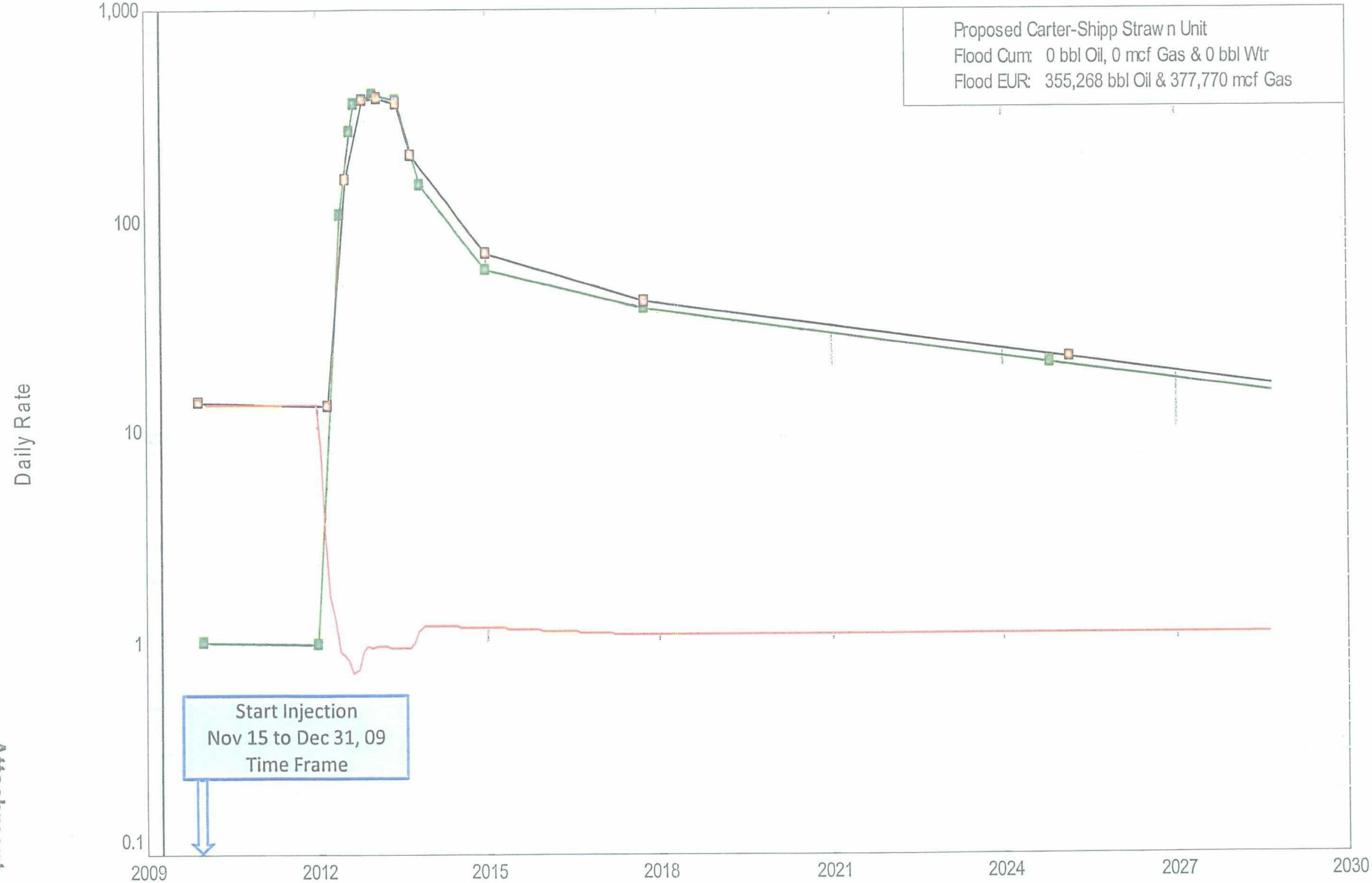
Carter No. 1	282 BOD
Shipp ZI No. 3	454 BOD
Average Peak	368 BOD per well
Two well Peak	736 BOD for the Unit

Use 54% of this maximum peak
400 BOD

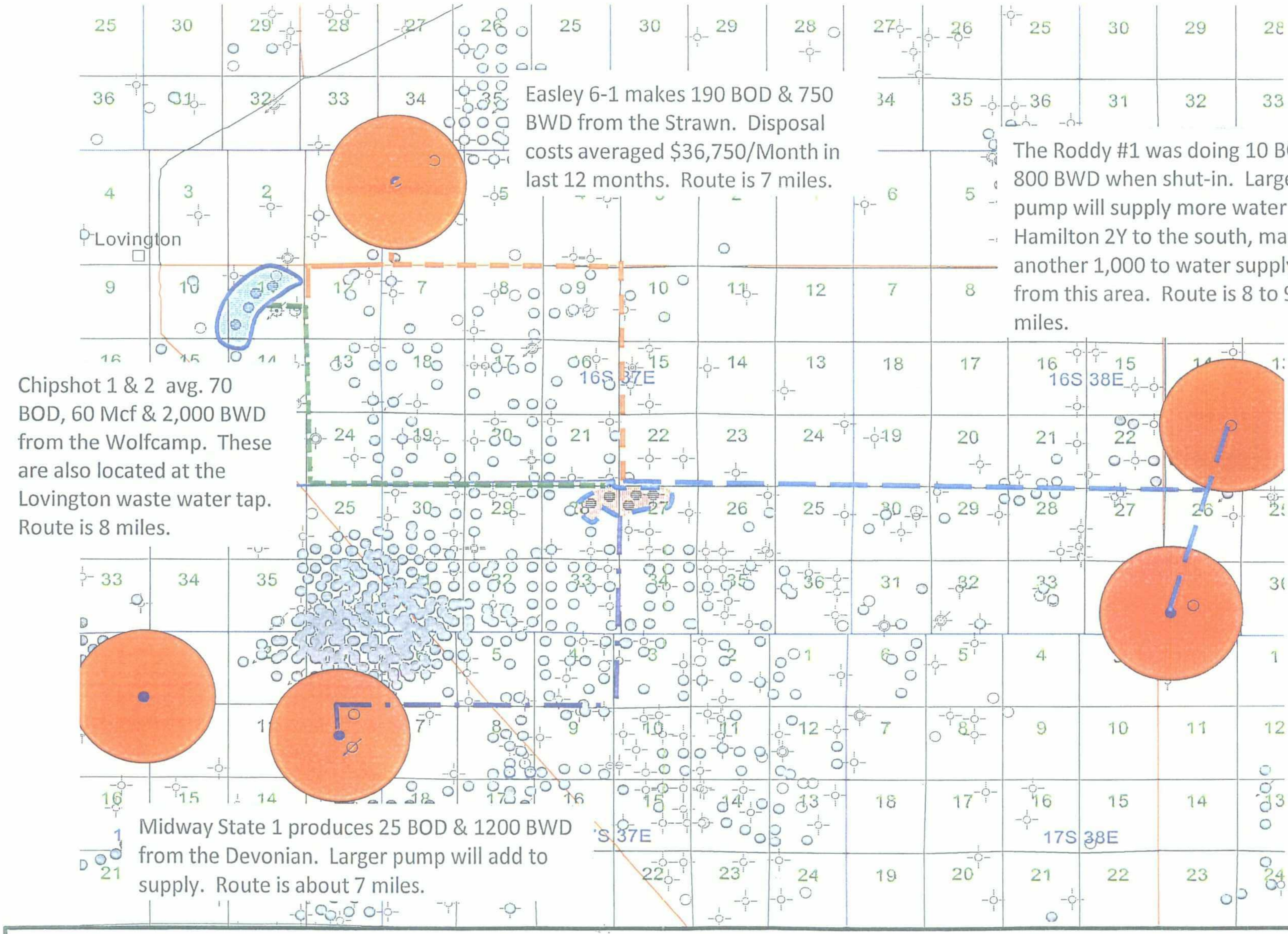
The two producers will not feel the pressure from the two injectors at the same time. Hence, the peak will be at a lower rate but will be generally sustain for several years. I scheduled the peak at 400 BOD, which is 54% of the average primary peak.

Proposed Carter-Shipp Strawn Unit

Waterflood Performance Curve



Proposed Carter-Shipp Strawn Unit
Water Supply Options



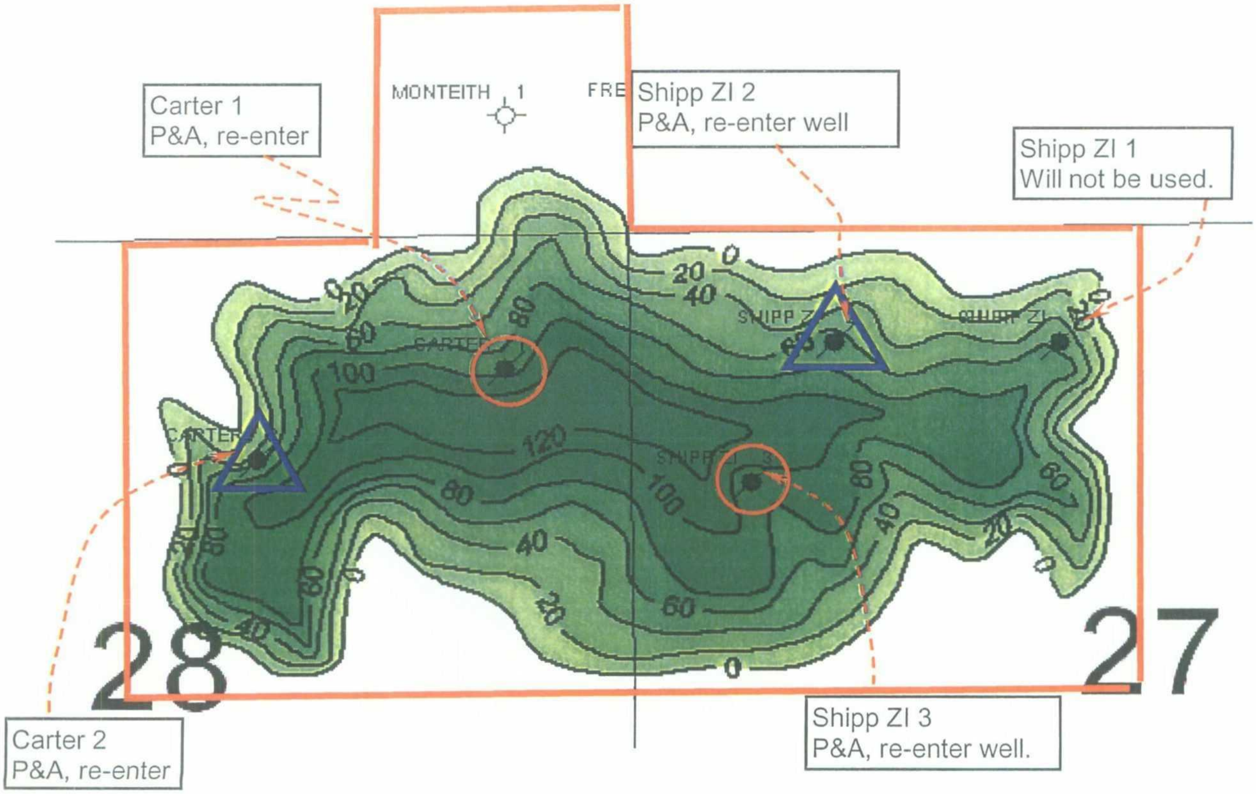
Of these options we prefer to bring the water in from the Chipshot area. This may later be augmented with water from Easley 6-1 and effluent water from the Lovington waste treatment plant.

Proposed Carter-Shipp Strawn Unit
Capital Cost Estimate

Well Work - Summary	
Carter 1	Drilled 2/85 and Plugged 11/97. Cut and pulled 5.5" casing at 4875'. Bottom of 8-5/8" casing is 4,200'. There is 675ft of exposed formation, will repair casing.
Carter 2	Drilled 5/85. P&A 11/99. Cut & pulled 5.5" cng at 4,480 ft. Bottom of 8-5/8 is 4,200 ft. There is 280ft of exposed formation, will repair casing.
Shipp ZI 2	Drilled 1/85 and Plugged 11/04. No casing pulled. We plan to re-enter well and use as an injection well.
Shipp ZI 1	Drilled 7/84, 1st well, completed in top 5-8 ft of pay. Performed poorly & abandoned after 1 year. Well has parted casing and we do not anticipate using this well in the pilot.
Shipp ZI 3	Drilled 10/85. EUR 144 MBO. P&A 11/03. Did not pull casing. Does have 47' of $2^7/_8$ tubing 11315'-362'.

Costs

1)	Re-enter Shipp ZI 3, fish 47' tubing, acidize and equip producer.	$	404,800
2)	Re-enter Shipp ZI 2, patch casing, acidize and equip as an injector.		461,900
3)	Re-Enter Carter 1, acidize and equip as an producer.		456,900
4)	Re-enter Carter 2, acidize and equip as a injector.		447,800
5)	Injection facility		285,000
6)	Water Supply System		500,000
7)	Production facility		250,000
	Total Project Cost		2,806,400



Proposed Carter-Shipp (Strawn) Unit
T16S-R37E Sec 27-28

Unitization Parameters

This mound is depleted of primary reserve.
Tract participation will be based on estimated secondary recovery and the wellbores to recover it.

Parameters for TPF:

Parameters for TPF:	**Primary Recover**	**0.40**
	Oil in Place	**0.50**
	Well bores	**0.10**
		1.00

Well Name	Tract	Loc	Primary EUR					OOIP		Wellbores		TPF			
			EUR by Well			Tract		Tract	Tract	Tract	Tract				
			Oil	Gas	Wtr	(BOE)	(Frac)	(Bbls)	(Frac.)	(Count)	(Frac.)	EUR	OOIP	Well	Total
	1	21 P	0	0	0	0	0.0000	33,715	0.0076	0	0	0.0000	0.0038	0.0000	0.003792
SHIPP ZI 1		27 C	266	10	0										
SHIPP ZI 2	2	27 D	327,234	316,618	310,417	540,720	0.3070	2,238,741	0.5036	2	0.5	0.1228	0.2518	0.0500	0.424559
SHIPP ZI 3		27 E	144,254	97,168	185,127										
CARTER 1	3	28 A	612,648	818,858	203,667	749,124	0.4253	1,360,102	0.3059	1	0.25	0.1701	0.1530	0.0250	0.348067
CARTER 2	4	28 G	378,490	559,368	155,331	471,718	0.2678	813,324	0.1829	1	0.25	0.1071	0.0915	0.0250	0.223583
			1,462,892	1,792,022	854,542	1,761,562	1.0000	4,445,882	1.0000	4	1	0.4000	0.5000	0.1000	1.000000

The Tract Participation Formula:

$$\text{Tract Factor} = \left\{0.1 \times \left(\frac{\text{Tract Usable Wellbores}}{\text{Unit Usable Wellbores}}\right)\right\} + \left\{0.4 \times \left(\frac{\text{Tract Primary EUR}}{\text{Unit Primary EUR}}\right)\right\} + \left\{0.5 \times \left(\frac{\text{Tract OOIP}}{\text{Unit OOIP}}\right)\right\}$$

Carter-Shipp Strawn Unit.xls
TPF

EEB
02/05/08
11/07/08