NEIL H. WILLS ET AL

PRELIMINARY WATER FLOOD SURVEY

RUSSELL POOL
EDDY COUNTY, NEW MEXICO

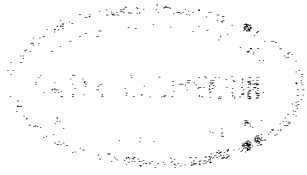

TABLE OF CONTENTS

TELEPHONE - 3-2167

PETROLEUM ENGINEERS
CABLE ENGINEERING
WICHITA FALLS, TEXAS

POST OFFICE BOX - 2249

WICHITA FALLS, TEXAS

December 5, 1952.

Mr Neil H. Wills Et Al,
P. O. Box 529,
Carlsbad, New Mexico.

Dear Mr Wills:

Pursuant to your request, we submit herewith a preliminary water flood survey of your oil producing properties in the Russell Pool, Eddy County, New Mexico.

We have examined all available data including core analysis, well logs, production records, isopach and structure maps, and repressuring history.

Our conclusions are as follows:

1) The ultimate recoverable oil from all leases by present producing methods will be approximately 990,208 gross barrels. The future recoverable oil by present producing methods as of November 1, 1952 will be approximately 163,500 gross barrels.

2) From production history, the Russell Pool appears to be adaptable to water flooding if old gas input wells are not used for water injection.

3) Pilot flooding is the most feasable method of determining the floodability of the field.

4) If pilot flooding is succesful, the entire field should yield approximately 900,000 gross barrels of water flood oil in addition to the ultimate recovery by present producing methods.

Our recommendations are as follows:

1) The George Turner No. 5 well should first be recompleted in the 900-foot limestone as a source of flood water.

2) A pilot flood should be initiated as described in this report at a cost of $ 24,241.00.

3) If pilot flooding proves sufficiently beneficial, a complete flood should be initiated at an additional cost of $ 59,231.00.

We will be pleased to discuss this report with you at your convenience.

Yours very truly,

CABLE ENGINEERING,

Roger Lewis

Roger Lewis.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

PURPOSE

The purpose of this report is to determine the most feasable pilot water flood program for the Russell Pool, Eddy County, New Mexico.

LOCATION

The Russell Pool is located in the Southeast quarters of sections 12 and 14 and in section 13, Township 20 South, Range 28 East, Eddy County, New Mexico, approximately twelve miles northwest of Carlsbad.

HISTORY & GENERAL INFORMATION

The Russell Pool was discovered in March 1945 with the completion of Wills et al Number 1 in the southwest quarter of Section 13 for an initial production of 29 barrels per day. This lease is also designated as the South Battery lease. The productive formation, Yates Sand, was topped at 786 feet and casing set at 737 feet.

The pool has been developed rather slowly because pipe line facilities were lacking in this area. The Artesia Pipe Line Company completed a gathering system in 1946. The last well producing was completed in August 1948.

The field has been gas repressured since July 1949 with success as can be seen from individual lease decline curves. The average gas-oil ratio at the inception of gas repressuring was 1200-1400 cubic feet per barrel and at the

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

HISTORY & GENERAL INFORMATION (Cont'd)

present time is approximately 3000 cubic feet per barrel.

The Yates sand, Permian in age, is penetrated at approximately 800 feet in depth. The structural features controlling the accumulation of oil is primarily a monocline with a small closure near the center of Section 13. The gross thickness of the producing sand ranges from zero to approximately 40 feet, but averages approximately 20 feet.

The gravity of the oil ranges from 36 to 38 degrees API and has a viscosity of 5.7 centipoise at 92 degrees Fahrenheit. This viscosity is favorable for flooding.

DRILLING AND COMPLETION

The wells were drilled with a rotary rig and pipe set approximately 50 to 100 feet above the saturation and completed with cable tools which includes a heavy shot with subsequent cleaning out as part of the completion work. The approximate cost of drilling each well is $7,000.00

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

COMPLETION RECORDS
WILLS ET AL-NORTH AND SOUTH LEASES

Well No.	Elev.	Top Pay	Est. Sat. Thick-ness	Csg. Seat	Total Depth	Init. Produc-tion	Completion Date	Elev. Top Pay	Remarks
1	3250	786	20	737	906		3-25-42	2464	Sand
2	3244	785	24	756	810	29	4-5-42	2459	Sand
3	3253*	817	20	780	844	45	8-22-43	2436	Sand
4	3253	780		736	873		9-13-44	2473	Base Sand 810'
5	3255	836	30	770	856		1-15-45	2429	
6	3247	803	26	735	829		4-6-45	2444	Sand
7	3253	815	18	752	839		3-17-45	2438	Sand
8	3256	860	17	740	878		5-2-45	2396	Sand
9	3253	864	0	800	880		6-14-45	2389	Sand
10	3249	780	25	740	807		6-25-45	2469	Sand
11	3255	840	25	733	867	59/5 Hrs	9-21-45	2415	Sand 217' Liner Cemented
12	3248	800	23	689	825	48	2-5-46	2448	Sand
13	3242	772	21	657	797	45	2-21-46	2470	Sand
14	3240	756		655	993	Gas	7-17-46	2484	Show Oil Sat. Low
15	3241*	764	13	662	784	36	7-30-46	2477	Sand
16	3241*	795	16	681	812	45	8-16-46	2446	Sand
17	3241*	778	20	679	808	15	9-30-46	2463	Sand
18	3241*	765	16	668	782	12	8-28-46	2476	Sand
19	3252	820	26	775	849	36	6-29-47	2432	Sand
20	3253	824	21	717	847	15	7-7-47	2429	Sand
21	3254	832	16	732	854	40	7-20-47	2422	Sand
22	3256	846	21	749	870	50	7-29-47	2410	Sand
23	3258	860	23	752	883	40	8-9-47	2398	Sand

* Estimated

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

COMPLETION RECORDS
GEO. TURNER-SOUTH-MIDDLE-NORTH LEASE

Well No.	Elev.	Top Pay	Est. Sat. Thick-ness	Csg. Seat	Total Depth	Init. Production *	Completion Date	Elev. Top Pay	Remarks
1	3245	795	12	712	908	22	9-14-42	2450	Pay, Sandy Lime
2	3250	814	18	724	873	36	10-26-42	2436	Pay - Sand
3	3250	841	21	723	869	50	2-25-43	2409	Pay - Sand
4	3250	790	25	725	815	100	4-7-43	2460	Pay - Sand
5	3240	842	0	710	1028	Dry	6-3-43	2398	Water Below 855'
6	3252	826	19	732	850	50	9-4-43	2426	Sand
7	3248			714	808	50	9-23-44		Lime
8	3250	787	26	702	814	60	10-24-44	2463	Sand
9	3252	824	23	728	850	60	1-25-45	2428	Sand
10	3250	841	29	706	870	60	5-1-45	2409	Sand
11	3250	788	26	803	813	50	5-25-45	2462	Sand
12	3250	826	24	767	852	82	7-30-45	2424	Sand
13	3256	831	14	745	847	80	6-19-46	2425	Sand
14	3250	804	27	712	835	80	7-14-46	2446	Sand
15	3242	789	19	695	810	30	9-16-46	2453	Sand
16	3252	797	27	731	826	50	11-27-46	2455	Sand
17	3250	823	20	728	843	40	2-20-47	2427	Sand
18	3252	799	30	734	829	150	4-2-47	2453	Sand
19	3250	799	34	716	834	150	5-12-47	2451	Sand
20	3250	795	27	696	824	60	7-9-48	2455	Sand
21	3250	789	30	686	820	40	7-17-48	2461	Sand
22	3250	846	22	742	868	30	8-6-48	2404	Sand
23	3250	790	13	682	804	40	7-24-48	2460	Sand

* Estimated

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

COMPLETION RECORDS
CROSBY LEASE

Well No.	Elev.	Top Pay	Est. Sat. Thick-ness	Csg. Seat	Total Depth	Init. Production	Completion Date	Elev. Top Pay	Remarks
1	3256	844	37	751	881	100*	12-3-44	2412	Sand
2	3260	836	43	775	908	124*	3-23-45	2397	Water 60%
3	3260	896	6	795	900	dry	6-29-45	2364	Water 896'
4	3256	867	19	746	890	50*	6-18-48	2389	Sand

* Estimated.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

24-HR INDIVIDUAL WELL TESTS

Original Owner & Well Number		Oil Bbls	Water Bbls	Gas Cu Ft	Gas/Oil Ratio	Csg. H. Pres.
Neil H. Wills Et Al	4	No Tests				
	5	4.5	0	16,000	3555	12
	6	2.0	0	5,000	2500	10
	7	2.0	0	13,000	6500	12
	8	4.5	0.5	4,000	888	10
	10	2.5	0	7,500	3000	10
	11	2.5	0	6,500	2600	11
	12	3.5	0	7,000	2000	12
	13	2.0	0	8,000	4000	9
	15	4.0	0	8,500	2125	10
	16	3.0	0	7,500	2500	10
	17	2.0	0	2,000	1000	10
	18	1.0	0	5,000	5000	10
	19	2.5	0	6,000	2400	10
	20	3.5	0	4,000	1142	10
	21	3.0	0	5,000	1666	10
	22	4.0	0	7,000	1750	10
	23	4.5	0.5	17,000	3777	10
Total		51.0	1.0	129,000	2554	
George Turner	7	1.0	0	4,700	4700	-
	8	3.0	0	10,500	3500	-
	9	1.5	0	4,500	3000	10
	10	2.0	0	22,000	11000	10
	11	2.0	0	12,500	6250	-
	12	4.0	0	10,500	2625	-
	13	1.0	0	4,500	4500	10
	14	4.0	0	7,500	1875	15
	15	2.0	0	5,500	2750	-
	16	4.0	0	28,000	7000	-
	17	1.2	0	4,700	3916	12
	18	3.5	0	18,000	5142	-
	19	3.5	0	10,000	2857	-
	20	No Test				
	21	5.5	0	4,700	854	-
	22	2.5	0	5,800	2320	14
	23	0.5	0	3,000	6000	-
George Turner Crosby Lease	1	2.0	0	4,700	2350	-
	2	2.0*	52.0*	2,000*	1000	-
	4	1.5	0	4,000	2800	-
Total		46.7	52.0	167,100	3578	
Field Total		97.7	53.0	299,100	3077	

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

PRODUCTION RECORDS

Year	Month	Wills South	Wills North	Turner North, South & Middle	Turner Crosby	Total	Cumulative Total
1942		4615		320		4935	4935
1943		11259		18454		29713	34648
1944		17796		25953	450	44199	78847
1945		15996	29891	44153	10277	100317	179164
1946		20838	24650	47423	8972	101883	281047
1947		33079	38592	67900	9748	149319	430366
1948		25229	40543	57781	8189	131742	562108
1949		15441	29150	44470	6037	95098	657206
1950	Jan.	1047	2892	3555	436	7930	665136
	Feb.	860	2248	2932	312	6352	671488
	Mar.	952	2861	3294	493	7600	679088
	Apr.	1005	2822	3205	377	7409	686497
	May.	1462	2868	2953	411	7694	694191
	Jun.	1362	2886	2315	428	6991	701182
	Jul.	1368	2571	2411	278	6628	707810
	Aug.	1218	2351	2161	389	6119	713929
	Sep.	1142	2201	2229	278	5850	719779
	Oct.	1257	2254	2564	337	6412	726191
	Nov.	1207	2083	2103	301	5694	731885
	Dec.	1249	2110	2020	345	5724	737609
		14129	30147	31742	4385	80403	

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

PRODUCTION RECORDS (Cont'd)

Year	Month	Wills South	Wills North	Turner North, South & Middle	Turner Crosby	Total	Cumulative Total
1951	Jan.	1167	1946	1852	281	5246	742855
	Feb.	932	1674	1875	283	4764	747619
	Mar.	1113	1718	2080	270	5181	752800
	Apr.	1016	1690	1799	353	4858	757658
	May.	920	1674	1889	229	4712	762370
	Jun.	902	1522	1856	243	4523	766893
	Jul.	863	1435	1771	244	4313	771206
	Aug.	792	1370	1812	242	4216	775422
	Sep.	734	1323	1704	219	3980	779402
	Oct.	866	1329	1723	190	4108	783510
	Nov.	770	1367	1780	187	4104	787614
	Dec.	813	1293	1708	225	4039	791653
		10888	18341	21849	2966	54044	
1952	Jan.	814	1191	1693	221	3919	795572
	Feb.	732	1164	1599	194	3689	799261
	Mar.	754	1172	1696	206	3828	803089
	Apr.	666	1127	1594	197	3584	806673
	May.	731	1168	1579	183	3661	810334
	Jun.	669	1071	1451	184	3375	813709
	July	603	1031	1557	207	3398	817107
	Aug.	613	998	1380	217	3208	820315
	Sep.	642	946	1361	203	3152	823467
	Oct.	697	897	1459	188	3241	826708
		6921	10765	15369	2000	35055	
Grand Total		398270		375414	53024	826708	

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

ESTIMATE OF RECOVERABLE OIL by PRESENT PRODUCING METHODS

The estimate of recoverable oil by present producing methods was made by the production decline method. The total field production was plotted and the resulting curve was extrapolated on logarithmic paper to an estimated economic limit. We estimate the total future recovery by present producing methods from the Russell Pool to be 163,500 gross barrels as of November 1, 1952. The total ultimate recovery by present producing methods for the field will be approximately 990,208 gross barrels. The estimated future and ultimate recovery by leases is tabulated in the recapitulation.

The average recovery from the Russell Pool as of November 1, 1952 is 97.1 barrels per acre-foot. The Wills north battery has recovered 109.7 barrels per acre-foot while the other areas of the field have recovered approximately 90 barrels per acre-foot. The present and ultimate recoveries per acre-foot by present producing methods for the Wills-North, Wills-South, Turner-North, South and middle, and Turner-Crosby leases are shown in the recapitulation. These recoveries were based on gross rather than net sand volume and therefore seem quite low for sand production.

Our original estimate of recoverable oil by primary production and repressuring which was made in 1948 during

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

ESTIMATE OF RECOVERABLE OIL
by
PRESENT PRODUCING METHODS (Cont'd)

flush production was 1,151,167 gross barrels. The estimate made at this time of 990,208 gross barrels incorporating the production history since 1948 is more reliable.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

ESTIMATE OF RECOVERABLE OIL by WATER FLOODING

An important item of information necessary in planning a large scale water flood and predicting the recovery therefrom is core analysis data. Sufficient core analysis data are lacking in this field to make predictions which will be of great value. The single core analysis from the Wills et al No. 26 well, which was cored with oil base mud to determine the existing water saturation in the sand. The analysis showed the core to have an average water saturation of 47.4 percent. This water saturation is higher than ordinarily exists in sands which can be succesfully flooded. However, this core showed some shale which may have given up some water when heated to retort temperature.

A pilot flood will be the most reliable method of determining the floodability of this field and for obtaining an idea of what additional recovery can be expected. It is not uncommon in succesful water flooding to recover as much oil as was possible by all other methods of production.

As no significant volume of water has been produced to date, the high water saturation reported by core analysis could easily be in error. If this flood is succesful, the additional recovery by water flooding should be approximately 900,000 gross barrels.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

RECAPITULATION OF RECOVERABLE OIL

	Oil Prod. as of 11-1-52	Est. Future Recv. by Pres. Prod. Methods as of 11-1-52	Ult. Recv. by Present Producing Methods	Sand Vol. Ac. Ft.	Prod. Area Acres	Recovery as of 11-1-52 Bbl/Ac.	Recovery as of 11-1-52 Bbl/AcFt	Ult. Recovery Pres. Prod. Methods. Bbl/Ac.	Ult. Recovery Pres. Prod. Methods. Bbl/Ac.Ft.
Russell Pool	826,708	163,500	990,208	8511	442	1870	97.1	2240	116.3
Wills-North	242,281	48,381	290,662	2209	113	2144	109.7	2572	131.5
Wills-South	155,989	33,241	189,230	1729	102	1529	90.3	1855	109.6
Turner-North, South and Middle,	375,414	71,524	446,938	3965	192	1955	94.7	2328	112.7
Turner-Crosby	53,024	10,354	63,378	610	34.4	1541	86.9	1842	103.9

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

RECOMMENDED PILOT FLOOD PROGRAM

As the character of the Yates sand is different in the southern part of the Russell Pool than in the central and northern part, it will be advantageous to test the floodability of both areas by pilot injection. We believe that a 20 acre 5-spot will be the most profitable pattern as no additional wells will have to be drilled for input purposes. Although this pattern is quite wide for flooding a sand only 800 feet deep, it has two distinct advantages in this particular field. First, a 20 acre 5-spot pattern will minimize the danger of water channeling through streaks of high gas saturation that have contributed to the abnormally high gas-oil ratio history. Second, this pattern will allow the gas injection wells to remain in service while water flooding which could not be done on the closer 10 acre 5-spot pattern. Due to the high gas-oil ratios in this field, the present gas injection contributes as much reservoir energy as will be possible to gain by water flooding. Of course, gas has not the oil displacing ability that water has, but from a standpoint of maintaining pressure and thereby reducing the volume of water necessary, it is just as valuable. The chief disadvantage to the wide spacing is that less water can be injected because fewer input wells will be incorporated. This disadvantage may be overcome by drilling producing wells in the virgin areas between water

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

RECOMMENDED PILOT FLOOD PROGRAM (Cont'd)

input wells if the flooding progress proves to be too slow. Drilling additional producing wells between water input wells will alter the pattern to a 10 acre 5-spot, but will not necessitate injecting water into old gas injection wells. We recommend that the flood be begun on the wider spacing which is 660 feet between unlike wells and 933 feet between like wells. This will result from converting alternate producing wells to water input wells.

As a pilot injection project we recommend converting the following six producing wells to water input wells as shown on the field map: Wills et al Nos. 6, 10, and 17 and George Turner Nos. 8, 12, and 14. Thus, two complete 20 acre 5-spot will be obtained with the Wills No. 12 and the Turner No. 19 being the producing wells which will be affected by a 4-way drive. The Wills No. 12 is a typical well in the southern portion of the field which is the less prolific area, and the Turner No. 19 is a typical well in more prolific area which includes the central and northern portions of the field. During the flush production of 1948 the Wills No. 12 and the Turner No. 19 produced 7 and 13 barrels per day respectively. At the present time these two wells each produce approximately 3 barrels per day.

The current gas injection program should be continued during either pilot or complete flooding as long as there is gas available.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

RECOMMENDED PILOT FLOOD PROGRAM (Cont'd)

A reasonably long pilot injection period can be expected due to the wide spacing recommended. We estimate that a maximum injection period of one year will be necessary before a production increase will be noted. This estimation is based on the assumption that an injection rate of 1000 barrels per day is maintained during the pilot flood. If an increase in production does come relatively late, it will be a good indication that channeling will not be excessive.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

WATER FLOOD FACILITIES

It is quite probable that an open injection system will be necessary due to the high concentration of hydrogen sulphide which is commonly found in the 900 foot lime in this area. The cost estimate and plant design in this report are for an open system.

The pilot plant will be so constructed that expansion to a capacity sufficient for fieldwide flooding will be possible with a minimum of additions and alterations. It will be necessary to install additional water pumping, filtering, and storage capacity for plant expansion, but the basic plant layout will remain the same. The high pressure water mains extending northeast and southwest from the plant will remain the same. The injection lines should be cement lined seamless pipe and the water return lines should be cement lined or plastic pipe. The proposed location of these lines are shown on the field map. Water return lines will not be necessary in the pilot flood and therefore were not included in the pilot flood cost estimate.

It will be advantageous to operate the water source well or wells on electric power and the high pressure pumping equipment with gas power. Gas power gives greater flexibility which is needed to regulate the injection rate but is

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

WATER FLOOD FACILITIES(Cont'd)

not greatly needed in the source well power when using an open system. The long range, overall economy of the two power sources do not differ greatly.

Heater gun barrels will eventually be needed on all batteries if water flooding is found to be practical. These heaters may be of the atmospheric-type except on the Wills et al south battery. This battery should be equipped with a pressure-type heater because the elevation is too low for produced water to flow by gravity to the injection plant.

The converted water input wells should each be capable of taking approximately 150 barrels per day without exceeding the breakdown pressure of the formation. Therefore, the pilot injection plant is designed with a capacity of 1000 barrels per day and full scale plant should have a capacity of approximately 3500 barrels per day.

A general diagram of the pilot water injection plant is included in this report.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

CONVERSION OF PRODUCING WELLS TO INPUT WELLS

After rods and tubing have been removed from the wells being converted, the wells should be cleaned out as well as possible. Each input well should be gravel packed from bottom to a heighth of about 10 feet into the casing to prevent exposed shale from heaving into the well. Well washed, coarse gravel (1/2-inch) should be placed opposite the sand filling the shot hole and well washed, medium sized (1/4-inch) gravel should be used to cover the exposed shale. To assure that the proper amount of each size gravel is placed in the well, a baler should be run to bottom periodically during the gravel packing operation to determine the heighth to which the hole is being filled. Gravel should stand about 10 feet into the casing, but excess gravel will cause excessive flow friction.

COMPLETION OF SOURCE WELLS

One well completed in the 900-foot limestone should provide ample water for the pilot flood operation. The top of the lime section should be cored to determine the presence of oil saturation. Any non-commercial oil production with the flood water would be most troublesome and should be cased off.

The Turner No. 5 well which was dry in the Yates, but has casing set at 710 feet. This well may be deepened to the

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

COMPLETION OF SOURCE WELLS (Cont'd)

water bearing strata and completed with a liner cemented from 710 feet to bottom. A liner will reduce the turbidity of the water and will eliminate oil production from the Yates or the 900-foot lime.

The well should be treated with 1000 to 2000 gallons of acid depending on the thickness penetrated and the natural productivity of the well. The well should be swabbed for several hours after completion to determine its producing capacity prior to selecting pumping equipment.

Other dry holes having casing set are the Wills et al No. 9 and the Crosby No. 3 which may also be recompleted as water producing wells later if needed.

The Turner No. 5 should be recompleted as a water source well as the initial step in the proposed pilot flood program. This is necessary as an analysis of the water is necessary before construction of the water plant can be begun.

REMEDIAL WORK ON PRODUCING WELLS

After water production becomes significant, some trouble may occur from caving due to the interval of exposed shale between the casing shoe and the top of the sand. If this occurs, it may be necessary to set liners

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

REMEDIAL WORK ON PRODUCING WELLS (Cont'd)

in producing wells where this trouble is excessive. Producing wells to be converted to input wells should be gravel packed through the exposed shale section.

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

FACILITIES AND COST ESTIMATE FOR PILOT FLOOD

6 - Input wells cleaned out and gravel packed, @ $300.00 each	$ 1,800.00
1 - Water source well recompleted in the 900-foot limestone and equipped to pump 750-1000 barrels of water per day	9,250.00
1 - Gaso injection pump and 25 HP multiple cylinder engine packaged unit	2,400.00
1 - 500-barrel Redwood tank equipped with galvanized hoops	1,551.00
1 - 250-barrel Redwood tank equipped with galvanized hoops	940.00
2 - Concrete tank foundation blocks @ 150.00	300.00
1 - Water filter, 6' x 5', packed with anthrafilt or filtering sand	650.00
1 - Centrifugal backwash pump and electric motor, 300 gal per minute capacity	565.00
1 - Centrifugal pickup pump and electric motor, 150 gal per minute capacity	325.00
1 - Dry chemical feeder	300.00
1 - Wooden aereator, 15' x 10' x 15'	100.00
Earthen aereation pit, 150' x 150' x 10'	250.00
High pressure injection lines	1,650.00
Well-head equipment for six input wells including meters, valves and gages @ 160.00/well	960.00
Miscellaneous valves and connections	400.00
Labor	1,000.00
Engineering and contingencies	1,800.00
	$ 24,241.00

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

FACILITIES AND COST ESTIMATE FOR FLOOD EXPANSION

14 -	Additional input wells cleaned out and gravel packed @ 300.00 each	$ 4,200.00
2 -	Additional water source wells recompleted in the 900-foot limestone and equipped to pump 750-1000 barrels of water per day, @ 9,250.00 each	18,500.00
1 -	Aldrich direct flow 3" x 2½" triplex plunger pump, equipped with porcelain plungers, and Insuroch valves	3,900.00
1 -	50 HP 3-phase electric motor, reduced voltage starting box, and water level pilot circuit	1,850.00
1 -	500-barrel Redwood tank equipped with galvanized hoops	1,551.00
1 -	250-barrel Redwood tank equipped with galvanized hoops	940.00
2 -	Concrete tank foundation blocks @ 150.00	300.00
2 -	Water filters, 6' x 5' packed with anthrafilt or filtering sand @ 650.00	1,300.00
	Additional high pressure injection lines	4,450.00
	Water return lines,	4,000.00
	Well-head equipment for 14 additional input wells @ 160.00/well	2,240.00
	Additional valves and connections	1,000.00
1 -	Pressure-type oil treater for Wills South Battery	2,500.00
4 -	Atmospheric type oil treaters @ 2,000.00	8,000.00
	Additional Labor	1,500.00
	Engineering and contingencies	3,000.00
		$ 59,231.00
	Cost of Pilot Flood	24,241.00
	Cost of Complete Flood	$ 83,472.00

NEIL H. WILLS ET AL
RUSSELL POOL
EDDY COUNTY, NEW MEXICO

PRODUCED WATER ANALYSIS FROM CROSBY LEASES

pH Value	8.6	Turbidity	20 ppm
Alkalinity P	100 ppm as $CaCO_3$	Alkalinity M	3580 ppm as $CaCO_3$
Hardness, Soap	7000 ppm as $CaCO_3$	Hardness, Soda	7000 ppm as $CaCO_3$
Soluble Iron	.5 ppm as Fe	Total Iron	.5 ppm as Fe
Soluble Silicia	10 ppm as SiO_2	Hydrogen Sulfide	3037 ppm as H_2S
Free Carbon Dioxide	0 ppm as CO_2	Dissolved Oxygen	0 ppm as O
Dissolved Solids	39110 ppm	Total Solids	39130 ppm

Calcium Carbonate Stability

Requirement	3220 ppm $CaCO_3$ at pH 9.9
Content	3580 ppm $CaCO_3$ at pH 8.6
Super Sat.	360 ppm

PRINCIPAL CONSTITUENTS

		ppm	(+) epm	(-) epm	Ionic ppm	
Calcium	as $CaCO_3$	4800	96.00		1920	ppm as Ca
Magnesium	as $CaCO_3$	2200	44.00		537	ppm as Mg
Hydroxide	as $CaCO_3$	0				
Carbonate	as $CaCO_3$	100*				
Bicarbonates	as $CaCO_3$	3580		71.60	4368	ppm as HCO_3
Sulfate	as SO_4	3283		68.40	3283	ppm as SO_4
Chloride	as Cl	17600		495.44	17600	ppm as Cl
Sodium & Potassium	as Na		495.44		11395	ppm as Na
			635.44	635.44		

Barium 0

*All Carbonates converted to Bicarbonates in hypothetical combinations.

HYPOTHETICAL COMBINATION

Calcium Bicarbonate	5799.6 ppm
Calcium Sulfate	1739.2 ppm
Magnesium Sulfate	2648.8 ppm
Sodium Chloride	28983.0 ppm

CORE ANALYSIS SERVICE
WICHITA FALLS, TEXAS

COMPANY: Neil H. Wills Et Al
WELL: Government Lease No. 26 (March 15, 1951)

GENERAL DATA:

CORED FROM	824	TO	844	20	FEET
RECOVERED				18	FEET
ZONE ANALYZED	824	TO	844	20	Samples
OIL BEARING				20	FEET
OIL BEARING & HORIZONTALLY PERMEABLE				20	FEET

ANALYSIS SUMMARY: (For Oil Bearing & Horizontally Permeable Zone)

AVEREAGE PERMEABILITY	6.8	VERTICAL-MILLIDARCYS
	30.5	HORIZONTAL-MILLIDARCYS
AVERAGE POROSITY	19.7	PER CENT
PRODUCTIVE FORMATION CAPACITY	610	MILLIDARCY-FEET
FORMATION VOLUME FACTOR (Actual or Estimated)	1.15	
RESERVOIR GAS-OIL RATIO (Calculated & Theoretical) (1)		CU. FT./BBL.

AVERAGE SATURATION:

RESIDUAL OIL	28.4	% OF PORE SPACE
CONNATE WATER	47.4	% OF PORE SPACE
TOTAL WATER	47.4	% OF PORE SPACE
OIL IN PLACE	705	BBLS./ACRE FOOT

AVERAGE RECOVERABLE OIL:

NORMAL RECOVERY (Gas Expansion) (2)	140	BBLS./ACRE FOOT
ADDITIONAL RECOVERY BY WATER DRIVE		BBLS./ACRE FOOT
GAS & WATER DRIVE RECOVERY (Complete) (3)		BBLS./ACRE FOOT
SPECIFIC PRODUCTIVITY INDEX		BBLS. OF FLUID/24 HRS./FT./ P. S. I. PRESSURE DIFFERENTIAL
FLUID PRODUCTION (No prediction shall be made unless the complete, properly secured and sealed core is submitted.)	011	

(1) Calculated for volumes of atmospheric pressure.

(2) Based on reduction of original reservoir pressure to zero p. s. i.

(3) Based on maintenance of original reservoir pressure by water drive.

NOTE: Type and amount of fluid calculated for complete isolation of zone analyzed.

POLICY: Core Analysis Service assumes no responsibility as to any predictions or data other than representing the best judgment of this organization. All observations and data secured shall remain the exclusive and confidential property of the client.

30

CORE ANALYSIS SERVICE
WICHITA FALLS, TEXAS

COMPANY: Neil H. Wills Et Al
WELL: Government Lease No. 26
ZONE: 824 To 844

CORE ANALYSIS DATA AND INTERPRETATION

Sample Number	DEPTH Feet	PERMEABILITY Millidarcys Horizontal	PERMEABILITY Millidarcys Vertical	POROSITY Per Cent	Residual Saturation % Pore Space Oil	Residual Saturation % Pore Space Total Water	Chlorides 1000 P.P.M.	PROBABLE PROD. (1)	REMARKS
1	824-825	149.0	39.5	24.6	35.4	43.3	59.6	Oil	Fine gr silty sd, loosely consolidated
2	825-826	41.2		22.7	26.7	56.5	89.5	Oil	Fine gr silty sd w/thin blue shale streaks
3	826-827	37.7	15.6	23.2	20.8	51.3	89.5	Oil	Sand, harder
4	827-828	32.6		23.7	21.6	49.6	89.5	Oil	Fine grained silty sand
5	828-829	28.2	1.4	23.8	20.5	45.3	54.7	Oil	" " " "
6	829-830	56.8		21.4	31.7	49.8	54.7	Oil	" " " "
7	830-831	3.9	1.1	20.8	32.3	48.2	54.7	Oil	" " " "
8	831-832	5.8		23.5	14.7	48.0	54.7	Oil	" " " "
9	832-833	6.4	0.8	21.6	20.0	50.0	49.7	Oil	" " " "
10	833-834	103.0		18.4	26.4	49.8	49.7	Oil	" " " "
11	834-835	7.8		16.4	33.7	47.5	39.8	Oil	" " " "
12	835-836	21.4	0	17.8	31.2	44.3	39.8	Oil	Fine gr silty sd w/occasional blue sh strks
13	836-837	35.8		16.5	44.3	38.2	39.8	Oil	" " " "
14	837-838	10.2	0	15.2	34.5	43.4	34.8	Oil	" " " "
15	838-839	3.9		16.3	26.3	42.8	39.8	Oil	Sd w/sh strks
16	839-840	54.0		16.5	30.1	41.0	39.8	Oil	" " " "
17	840-841	3.4		18.8	36.6	43.8	34.8	Oil	" " " "
18	841-842	7.0	2.5	17.0	33.7	53.5	39.8	Oil	Sand, better consolidated
19	842-843	1.0		18.3	25.7	50.4	39.8	Oil	" " " "
20	843-844	0.8	0	17.6	22.6	52.3	41.5	Oil	" " " "

NOTE: (1) Prediction Based on Complete Isolation of Zone.

POLICY: Core Analysis Service assumes no responsibility as to any predictions or data other than representing the best judgment of this organization. All observations and data secured shall remain the exclusive and confidential property of the client.