

OILFIELD RESEARCH LABORATORIES

536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

July 17, 1967

18-24-10E

Eugene A. Roberts, Jr.
134 Suburban Building
5526 Dyer Street
Dallas, Texas 75206

Dear Sir:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Cantrell Lease, Well No. W-1, Woodson County, Kansas, and submitted to our laboratory on July 11, 1967.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:rf

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Cantrell W-1

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company	E. A. Roberts, Jr.	Lease	Cantrell	Well No.	W-1
Location	East Line, N/2, NW/4				
Section	18	Twp	24S	Rge.	16E
County	Woodson			State	Kansas
Name of Sand					Squirrel
Top of Core					1076.0
Bottom of Core					1100.0
Top of ^{Pay} Sand					1081.9
Bottom of ^{Pay} Sand					1095.9
Total Feet of Permeable Sand					22.0
Total Feet of Floodable Sand					12.1
Distribution of Permeable Sand:					
Permeability Range Millidarcys	Feet		Cum. Ft.		
0 - 10	3.5		3.5		
10 - 25	3.9		7.4		
25 - 50	9.1		16.5		
50 - 75	2.9		19.4		
75 & above	2.6		22.0		
Average Permeability Millidarcys					40.8
Average Percent Porosity					19.3
Average Percent Oil Saturation					50.0
Average Percent Water Saturation					42.5
Average Oil Content, Bbls./A. Ft.					758.
Total Oil Content, Bbls./Acre					18,216.
Average Percent Oil Recovery by Laboratory Flooding Tests					23.4
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.					371.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre					4,308.
Total Calculated Oil Recovery, Bbls./Acre					3,473.
Packer Setting, Feet					
Viscosity, Centipoises @					
A. P. I. Gravity, degrees @ 60 °F					
Elevation, Feet					

A fresh water mud was used as a circulating fluid in the coring of the sand in this well. The core was submitted to our laboratory by Mr. E. A. Roberts, Jr.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, <u>Feet</u>	<u>Description</u>
1076.0 - 1079.0	Light brown, fine grained sandstone.
1079.0 - 1081.9	Alternate thin layers of sandstone and shale.
1081.9 - 1091.0	Dark, fine grained sandstone.
1091.0 - 1092.0	Alternate thin layers of sandstone and shale.
1092.0 - 1093.0	Gray, laminated, sandy shale.
1093.0 - 1095.9	Dark, fine grained sandstone.
1095.9 - 1100.0	Dark brown, fine grained sandstone.

Coring was started at a depth of 1076.0 feet in light brown, fine grained sandstone and completed at 1100.0 feet in dark brown, fine grained sandstone. This core shows a total of 19.1 feet of sandstone. For the most part, the pay is made up of dark, fine grained sandstone.

PERMEABILITY

For the sake of distribution, the core was divided into three sections. The weighted average permeability of the upper, middle and lower sections is 18.1, 53.5 and 31.9 millidarcys respectively; the overall average being 40.8 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a very

irregular permeability profile. The permeability of the sand varies from Imp. to a maximum of 119. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a very good weighted average percent oil saturation, namely, 50.0. The weighted average percent oil saturation of the upper, middle and lower sections is 23.8, 58.4 and 58.8 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 66.9, 36.4 and 35.6 respectively; the overall average being 42.5 (See Table III). This gives an overall weighted average total fluid saturation of 92.5 percent.

The weighted average oil content of the upper, middle and lower sections is 335, 913 and 846 barrels per acre foot respectively; the overall average being 758. The total oil content, as shown by this core, is 18,216 barrels per acre of which 12,776 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

Part of the sand in this core responded very well to laboratory flooding tests, as a total recovery of 4,308 barrels of oil per acre was obtained from 11.6 feet of sand. The weighted average percent oil saturation was reduced from 61.2 to 37.8, or represents an average recovery of 23.4 percent. The weighted average effective permeability of the samples is 2.07 millidarcys, while the average initial fluid production pressure is 16.0 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 24 samples tested, 19 produced water and 12 oil. This indicates

that approximately 50 percent of the sand represented by these samples is floodable pay sand. The tests also show that the pay sand section extends from a depth of 1081.9 to 1095.9 feet.

CONCLUSION

From a study of the above data, we estimate that approximately 3,473 barrels of oil per acre or an average of 287 barrels per acre foot can be recovered from the area, represented by this core, by efficient primary and water flood operations. The following data and assumptions were used in calculating the above oil recovery value:

Original formation volume factor	1.05
Present formation volume factor	1.01
Irreducible water saturation, percent	23.0
Average porosity, percent	20.6
Oil saturation after flooding, percent	37.8
Performance factor	0.50
Net floodable pay sand, feet	12.1

This core shows a rather clean pay sand section (1081.9 to 1095.9 feet) having a good porosity, a very good oil saturation, a fairly low water saturation and an average permeability.

That part of the cored section extending from a depth of 1076.0 to 1081.9 feet is not oil productive but will take water.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company E. A. Roberts, Jr. Lease Cantrell Well No. W-1

Sample No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbbls. / A Ft.	Perm., Mill.	Feet of Sand		Total Oil Content	Perm. Capacity Ft. X md.
			Oil	Water	Total			Ft.	Conn. Ft.		
1	1076.5	19.1	18	72	90	267	31.	1.0	1.0	267	31.00
2	1077.5	18.8	21	71	92	306	6.8	1.0	2.0	306	6.80
3	1078.4	18.6	30	57	87	419	4.1	0.5	2.5	209	2.05
F-3	1078.6	20.3	18	-	-	284	-	0.5	3.0	142	-
4	1079.5	20.4	23	73	96	364	32.	1.0	4.0	364	32.00
5	1080.5	16.0	24	62	86	298	5.5	1.0	5.0	298	5.50
6	1081.5	16.5	34	61	95	435	23.	0.9	5.9	392	20.70
7	1082.5	22.3	40	54	94	692	108.	1.1	7.0	762	118.80
8	1083.5	21.2	52	42	94	855	59.	1.0	8.0	855	59.00
9	1084.5	20.8	47	43	90	758	24.	1.0	9.0	758	24.00
10	1085.5	19.9	57	39	96	880	48.	1.0	10.0	880	48.00
11	1086.5	20.8	61	37	98	984	30.	1.0	11.0	984	30.00
12	1087.5	20.4	70	27	97	1,108	46.	1.0	12.0	1,108	46.00
13	1088.5	20.2	72	26	98	1,128	37.	1.0	13.0	1,128	37.00
14	1089.5	20.1	69	24	93	1,076	42.	1.0	14.0	1,076	42.00
15	1090.4	22.4	73	25	99	1,268	119.	0.5	14.5	634	59.50
F-15	1090.6	17.9	70	-	-	972	-	0.5	15.0	486	-
16	1091.5	16.8	53	41	94	691	1.7	1.0	16.0	691	1.70
17	1092.5	12.6	25	71	96	244	Imp.	1.0	17.0	244	0.00
18	1093.5	21.3	69	24	93	1,140	62.	1.0	18.0	1,140	62.00
19	1094.5	20.1	67	23	90	1,044	78.	1.0	19.0	1,044	78.00
20	1095.5	21.1	67	25	92	1,096	70.	0.9	19.9	986	63.00
21	1096.5	19.4	49	47	96	738	49.	1.1	21.0	812	53.90
22	1097.5	20.8	58	33	97	936	42.	1.0	22.0	936	42.00
23	1098.5	18.3	60	33	93	852	20.	1.0	23.0	852	20.00
24	1099.5	16.1	63	22	91	862	15.	1.0	24.0	862	15.00
								Total		18,216	

SUMMARY OF PERMEABILITY & SATURATION TESTS

Company	Lease	Well No.	W-1
E. A. Roberts, Jr.	Cantrell		

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
1076.0 - 1081.9	5.4	18.1	98.05
1081.9 - 1095.9	12.5	53.5	669.00
1095.9 - 1100.0	4.1	31.9	130.90
1076.0 - 1100.0	22.0	40.8	897.95

Depth Interval, Feet	Feet of Core Analyzed	Average Percent Porosity	Average Percent Oil Saturation	Average Percent Water Saturation	Average Oil Content Bbl./A. Ft.	Total Oil Content Bbls./Acre
1076.0 - 1081.9	5.9	18.4	23.8	66.9	335	1,978
1081.9 - 1095.9	14.0	19.8	58.4	36.4	913	12,776
1095.9 - 1100.0	4.1	18.6	58.8	35.6	846	3,462
1076.0 - 1100.0	24.0	19.3	50.0	42.5	758	18,216

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company		E. A. Roberts, Jr.		Lease		Cantrell		Well No.		W-1	
Sample No.	Depth, Feet	Effective Porosity Percent	Original Oil Saturation		Oil Recovery		Residual Saturation		Volume of Water Recovered cc*	Effective Permeability Millidarcys**	Initial Fluid Production Pressure Lbs./Sq./In.
			%	Bbls./A. Ft.	%	Bbls./A. Ft.	% Oil	% Water	Bbls./A. Ft.		
1	1076.5	19.5	19	287	0	0	19	72	287	2.55	10
2	1077.5	18.5	19	273	0	0	19	78	273	0.300	40
3	1078.6	20.3	18	284	0	0	18	74	284	2.55	10
4	1079.5	20.9	20	324	0	0	20	78	324	19.00	10
5	1080.5	15.7	22	268	0	0	22	68	268	Imp.	-
6	1081.5	16.8	31	404	0	0	31	66	404	1.10	15
7	1082.5	22.9	40	711	6	107	34	65	604	9.46	10
8	1083.5	21.2	52	856	18	296	34	61	560	4.27	10
9	1084.5	20.5	47	747	9	143	38	56	604	0.880	20
10	1085.5	19.8	57	876	19	292	38	59	584	1.17	20
11	1086.5	20.3	61	960	23	362	38	60	598	0.500	25
12	1087.5	20.0	70	1087	31	481	39	61	606	0.500	20
13	1088.5	19.8	72	1106	38	584	34	65	522	0.805	15
14	1089.5	20.3	69	1086	31	488	38	61	598	0.805	15
15	1090.6	17.9	70	972	28	389	42	55	583	0.514	20
16	1091.5	16.5	50	640	0	0	50	47	640	Imp.	-
17	1092.5	13.0	23	232	0	0	23	75	232	Imp.	-
18	1093.5	21.7	69	1162	35	590	34	60	572	2.36	10
19	1094.5	20.5	67	1065	28	445	39	56	620	1.10	15
20	1095.5	21.4	67	1112	19	315	48	52	797	0.950	20
21	1096.5	19.8	45	691	0	0	45	52	691	1.35	15
22	1097.5	20.6	36	895	0	0	56	42	895	Imp.	-
23	1098.5	18.5	58	832	0	0	58	40	832	0.220	50
24	1099.5	15.8	70	858	0	0	70	23	858	Imp.	-

Notes: cc—cubic centimeter.

*—Volume of water recovered at the time of maximum oil recovery.

**—Determined by passing water through sample which still contains residual oil.

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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company	E. A. Roberts, Jr.	Lease	Cantrell	Well No.
				W-1
Depth Interval, Feet	1081.9 - 1095.9			
Feet of Core Analyzed	11.6			
Average Percent Porosity	20.6			
Average Percent Original Oil Saturation	61.2			
Average Percent Oil Recovery	23.4			
Average Percent Residual Oil Saturation	37.8			
Average Percent Residual Water Saturation	59.5			
Average Percent Total Residual Fluid Saturation	97.3			
Average Original Oil Content, Bbls./A. Ft.	975.			
Average Oil Recovery, Bbls./A. Ft.	371.			
Average Residual Oil Content, Bbls./A. Ft.	604.			
Total Original Oil Content, Bbls./Acre	11,324.			
Total Oil Recovery, Bbls./Acre	4,308.			
Total Residual Oil Content, Bbls./Acre	7,016.			
Average Effective Permeability, Millidarcys	2.07			
Average Initial Fluid Production Pressure, p.s.i.	16.0			

NOTE: Only those samples which recovered oil were used in calculating the above averages.

AIR PERMEABILITY, MILLIDARCYs
 --- EFFECTIVE PERMEABILITY, MILLIDARCYs

8 16 24 32 40 48 56 64 72 80 88 96
 0.8 1.6 2.4 3.2 4.0 4.8 5.6 6.4 7.2 8.0 8.8 9.6

19.00

108

119

INTERMEDIATE LAYERS SANDSTONE & SHALE

SANDY SHALE

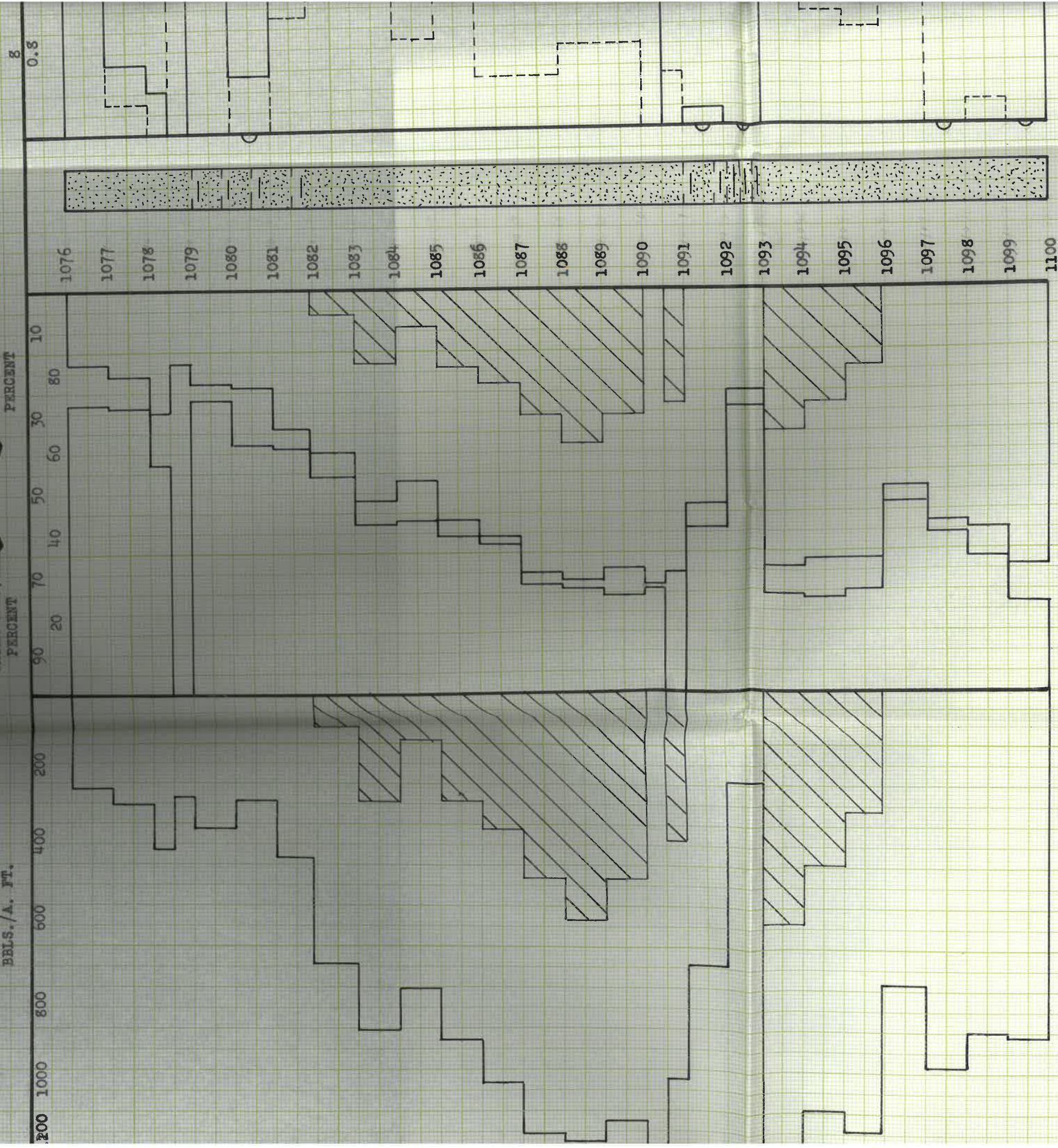
○ IMPERMEABLE TO AIR

○ IMPERMEABLE TO WATER

JR.

D. W-1

NO	AVG. OIL CONTENT BBLs./A. FT.	TOTAL OIL CONTENT BBLs./ACRE	AVG. AIR PERMEABILITY, MILLIDARCYs	CALCULATED OIL RECOVERY, BBLs./ACRE
335	1.978	18.1	53.5	31.9
913	12.776	40.8	18.1	3.473
846	3.462			
758	18,216			

OIL CONTENT,
BBL./A. FT.WATER SAT.,
PERCENTOIL SAT.,
PERCENT

FLOOD POT RECOVERY

SANDSTONE

ALTERNATE LAYER

E. A. ROBERTS, JR.

CANTRELL LEASE
WOODSON COUNTY, KANSAS
WELL NO. W-1

DEPTH INTERVAL, FEET	FEET OF CORE ANALYZED	AVERAGE POROSITY, PERCENT	AVG. OIL SATURATION PERCENT	AVG. WATER SATURATION PERCENT	AVG. O CONTE BBL./A
1076.0 - 1081.9	5.9	18.4	23.8	66.9	335
1081.9 - 1095.9	14.0	19.8	58.4	36.4	913
1095.9 - 1100.0	4.1	18.6	58.8	35.6	846
1076.0 - 1100.0	24.0	19.3	50.0	42.5	758