

OILFIELD RESEARCH LABORATORIES

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

August 11, 1966

CRA, Incorporated
P.O. Box 98
Wellington, Kansas 67152

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Woodward Lease, Well No. 32, Bourbon County, Kansas, and submitted to our laboratory on August 4, 1966.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES


Benjamin R. Pearman

BRP:rf

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GENERAL INFORMATION & SUMMARY

Company	CRA, Incorporated	Lease	Woodward	Well No.	32
Location	1145' EWL & 595' NSL, NW $\frac{1}{4}$				
Section	13	Twp.	25S	Rge.	21E
		County	Bourbon		State Kansas
Name of Sand	-				Bartlesville
Top of Core	-				632.0
Bottom of Core	-				658.4
Top of Sand	(Analyzed) -				632.0
Bottom of Sand	(Analyzed) -				654.6
Total Feet of Permeable Sand	-				18.5
Total Feet of Floodable Sand	-				7.4
Distribution of Permeable Sand:					
Permeability Range Millidarcys	Feet		Cum. Ft.		
0 - 10	2.6		2.6		
10 - 50	6.4		9.0		
50 - 100	7.9		16.9		
100 & above	1.6		18.5		
Average Permeability Millidarcys - - - - -					
					51.0
Average Percent Porosity - - - - -					
					19.5
Average Percent Oil Saturation - - - - -					
					25.0
Average Percent Water Saturation - - - - -					
					53.1
Average Oil Content, Bbls./A. Ft. - - - - -					
					371.
Total Oil Content, Bbls./Acre - - - - -					
					6,859.
Average Percent Oil Recovery by Laboratory Flooding Tests - - - - -					
					7.8
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft. - - - - -					
					122.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre - - - - -					
					901.
Total Calculated Oil Recovery, Bbls./Acre - (Primary & Secondary) -					
					2,060.
Packer Setting, Feet - - - - -					
Viscosity, Centipoises @ - - - - -					
A. P. I. Gravity, degrees @ 60 °F - - - - -					
Elevation, Feet - - - - -					

Fresh water mud was used as the circulating fluid while taking this core. The core was sampled and the samples sealed in cans by a representative of Oilfield Research Laboratories. The well was drilled in virgin territory.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Description
<u>Feet</u>

632.0 - 639.0 - Light brown, slightly shaly sandstone.
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639.0 - 640.1 - Shale.

640.1 - 647.0 - Brown, slightly shaly sandstone.
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647.0 - 648.0 - Brown, laminated, shaly sandstone.
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648.0 - 651.0 - Alternate layers of sandstone and shale.
--

651.0 - 654.6 - Brown, laminated, shaly sandstone.
--

654.6 - 658.4 - Alternate layers of sandstone and shale.
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Coring was started at a depth of 632.0 feet in sandstone and completed at 658.4 feet in laminated sandstone and shale. For the most part, the pay is made up of brown, shaly sandstone.

PERMEABILITY

For the sake of distribution, the core was divided into two sections. The weighted average permeability of the upper and lower sections is 59.0 and 45.6 millidarcys respectively; the overall average being 51.0 (See Table III). By observing the data given on the coregraph, it is noticeable that the sand has a rather irregular permeability profile. The permeability of the sand varies

from 0.78 to a maximum of 169. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a fairly low weighted average percent oil saturation, namely, 25.0. The weighted average percent oil saturation of the upper and lower sections is 11.8 and 34.0 respectively. The weighted average percent water saturation of the upper and lower sections is 60.3 and 48.2 respectively; the overall average being 53.1 (See Table III). This gives an overall weighted average total fluid saturation of 78.1 percent. This low total fluid saturation indicates considerable fluid was lost during coring most of which was probably oil.

The weighted average oil content of the upper and lower sections is 186 and 496 barrels per acre foot respectively; the overall average being 371. The total oil content, as shown by this core, is 6,859 barrels per acre of which 4,095 barrels are in the pay sand section (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 901 barrels of oil per acre was obtained from 7.4 feet of sand. The weighted average percent oil saturation was reduced from 34.8 to 27.0, or represents an average recovery of 7.8 percent. The weighted average effective permeability of the samples is 3.07 millidarcys, while the average initial fluid production pressure is 21.4 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that

of the 19 samples tested, 15 produced water and 7 oil. This indicates that approximately 37 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sand has a wide variation in effective permeability to water.

CONCLUSION

The results of the laboratory tests indicate that efficient primary and secondary operations in the vicinity of this well should recover approximately 2,060 barrels of oil per acre or an average of 279 barrels per acre foot from the 7.4 feet of floodable pay sand analyzed in this core. These recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.06
Reservoir water saturation, percent	35.0
Average porosity, percent	20.1
Oil saturation after flooding, percent	27.0
Performance factor, percent	50.0
Net floodable pay sand, feet	7.4

This core shows a pay sand section having a good oil saturation, a moderate water saturation and a wide variation in effective permeability to water.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Incorporated Lease Woodward Well No. 32

Sample No.	Depth, Feet	Effective Porosity Percent	Percent Saturation			Oil Content Bbls. / A Ft.	Perm., Mill.	Feet of Sand		Total Oil Content	Perm. Capacity Ft. X md.
			Oil	Water	Total			Ft.	Cum. Ft.		
1	632.1	17.3	11	67	78	148	169.	0.6	0.6	89	101.40
2	633.1	22.6	8	60	68	140	75.	1.0	1.6	140	75.00
3	634.1	22.6	10	52	62	175	51.	1.0	2.6	175	51.00
4	635.1	19.2	12	69	81	179	55.	1.0	3.6	179	55.00
5	636.1	19.2	13	61	74	194	43.	1.0	4.6	194	43.00
6	637.1	19.6	13	62	75	198	32.	1.0	5.6	198	32.00
7	638.1	20.3	13	59	72	205	30.	1.4	7.0	287	42.00
8	640.3	22.6	15	51	66	263	89.	0.5	7.5	132	44.50
9	641.1	23.7	27	50	77	496	135.	1.0	8.5	496	135.00
10	642.1	20.2	29	50	79	454	80.	1.0	9.5	454	80.00
11	643.1	19.3	26	51	77	389	58.	1.0	10.5	389	58.00
12	644.1	19.3	32	43	75	479	38.	1.0	11.5	479	38.00
13	645.1	17.6	31	48	79	423	36.	1.0	12.5	423	36.00
14	646.1	20.4	44	41	85	695	51.	1.4	13.9	972	71.40
15	647.1	16.3	35	55	90	441	2.7	1.0	14.9	441	2.70
16	651.1	16.1	29	60	89	362	0.78	0.6	15.5	217	0.47
17	652.1	18.6	44	44	88	634	6.2	1.0	16.5	634	6.20
18	653.1	18.9	38	39	77	556	12.	1.0	17.5	556	12.00
19	654.1	15.8	33	57	90	404	62.	1.0	18.5	404	62.00
								Total	-----	6,859	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Inc. Lease Woodward Well No. 32

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
632.0 - 640.6	7.5	59.0	443.90
640.6 - 654.6	11.0	45.6	501.77
632.0 - 654.6	18.5	51.0	945.67

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
632.0 - 640.6	7.5	20.4	11.8	60.3	186	1,394
640.6 - 654.6	11.0	18.9	34.0	48.2	496	5,465
632.0 - 654.6	18.5	19.5	25.0	53.1	371	6,859

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Incorporated Lease Woodward Well No. 32

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	632.1	17.3	11	148	0	0	11	85	148	369	15.28	10
2	633.1	22.8	7	124	0	0	7	90	124	203	17.50	10
3	634.1	22.7	10	176	0	0	10	83	176	249	26.25	10
4	635.1	19.0	12	177	0	0	12	84	177	140	3.90	20
5	636.1	19.5	12	182	0	0	12	80	182	184	15.00	10
6	637.1	19.5	13	197	0	0	13	80	197	297	14.80	10
7	638.1	20.0	15	232	0	0	15	80	232	241	20.80	10
8	640.3	22.8	16	283	0	0	16	80	283	312	14.20	10
9	641.1	23.4	27	489	3	54	24	68	435	272	10.50	10
10	642.1	20.0	29	450	2	31	27	70	419	64	1.70	20
11	643.1	19.1	26	385	3	44	23	75	341	181	5.50	20
12	644.1	19.7	32	489	9	137	23	68	352	69	1.80	30
13	645.1	17.8	31	428	0	0	31	50	428	0	Imp.	-
14	646.1	20.7	44	775	10	176	34	64	599	72	1.90	20
15	647.1	16.0	37	459	0	0	37	56	459	0	Imp.	-
16	651.1	16.2	29	364	0	0	29	62	364	0	Imp.	-
17	652.1	18.1	44	616	16	224	28	64	392	2	0.200	30
18	653.1	19.4	38	571	11	165	27	62	416	6	0.300	20
19	654.1	15.7	33	401	0	0	33	60	401	0	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.

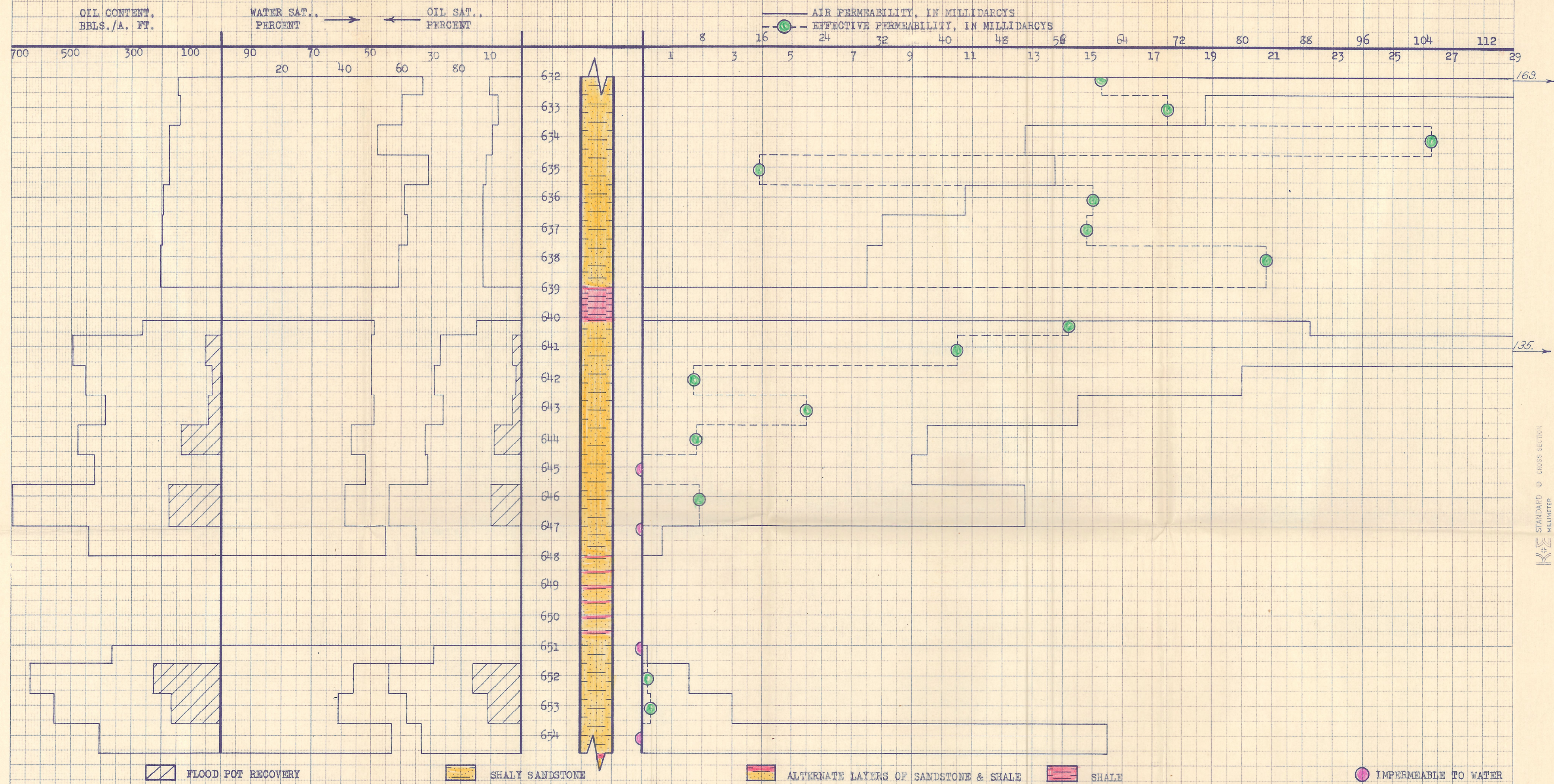
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SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company	CRA, Incorporated	Lease	Woodward	Well No.	32
Depth Interval, Feet	640.6 - 654.6				
Feet of Core Analyzed	7.4				
Average Percent Porosity	20.1				
Average Percent Original Oil Saturation	34.8				
Average Percent Oil Recovery	7.8				
Average Percent Residual Oil Saturation	27.0				
Average Percent Residual Water Saturation	67.1				
Average Percent Total Residual Fluid Saturation	94.1				
Average Original Oil Content, Bbls./A. Ft.	553.				
Average Oil Recovery, Bbls./A. Ft.	122.				
Average Residual Oil Content, Bbls./A. Ft.	431.				
Total Original Oil Content, Bbls./Acre	4,095.				
Total Oil Recovery, Bbls./Acre	901.				
Total Residual Oil Content, Bbls./Acre	3,194.				
Average Effective Permeability, Millidarcys	3.07				
Average Initial Fluid Production Pressure, p.s.i.	21.4				

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



C. R. A., INC.
WOODWARD LEASE WELL NO. 32
BOURBON COUNTY, KANSAS

DEPTH INTERVAL, FEET	FEET OF CORE ANALYZED	AVERAGE POROSITY, PERCENT	AVG. OIL SATURATION PERCENT	AVG. WATER SATURATION PERCENT	AVG. OIL CONTENT BBLs./A. FT.	TOTAL OIL CONTENT BBLs./ACRE	AVG. AIR PERMEABILITY, MILLIDARCYS	CALCULATED OIL RECOVERY, BBLs./ACRE
632.0 - 640.6	7.5	20.4	11.8	60.3	186	1,394	59.0	
640.6 - 654.6	11.0	18.9	34.0	48.2	496	5,465	45.6	
632.0 - 654.6	18.5	19.5	25.0	53.1	371	6,859	51.0	2,060 (Primary & Secondary)