OILFIELD RESEARCH LABORATORIES
536 NORTH HIGHLAND - CHANUTE, KANSAS - PHONE HE1-2650

January 26, 1966

CRA, Incorporated
Box 445
Wellington, Kansas

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Woodward Lease, Well No. 13, Bourbon County, Kansas, and submitted to our laboratory on January 20, 1966.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

BRP:rf

2 c. - Wellington, Kansas
2 c. - Muskogee, Oklahoma
1 c. - Independence, Kansas

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company CRA, Inc. Lease Woodward Well No. 13

Location 2550' EWL & 2530' NSL, NW

Section 12 Twp. 25S Rge. 21E County Bourbon State Kansas

Name of Sand	Bartlesville
Top of Core	631.0
Bottom of Core	664.0
Top of Sand (Tested)	637.5
Bottom of Sand	663.0
Total Feet of Permeable Sand	24.5
Total Feet of Floodable Sand	19.5

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 6	5.0	5.0
40 - 100	8.5	13.5
100 - 200	9.0	22.5
200 & above	2.0	24.5

Average Permeability Millidarcys	117.8
Average Percent Porosity	19.2
Average Percent Oil Saturation	40.6
Average Percent Water Saturation	39.2
Average Oil Content, Bbls./A. Ft.	617.
Total Oil Content, Bbls./Acre	15,742.
Average Percent Oil Recovery by Laboratory Flooding Tests	16.9
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	274.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	5,351.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	7,810.
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, Feet	Description
631.0 - 634.0	Sandy shale.
634.0 - 637.5	Broken sandy shale (bleeding very little).
637.5 - 655.0	Brown, slightly laminated, slightly shaly sandstone.
655.0 - 657.6	Light brown, laminated shaly sandstone.
657.6 - 659.6	Brown, slightly shaly sandstone.
659.6 - 663.0	Brown to dark, slightly carbonaceous, shaly sandstone.
663.0 - 664.0	Gray, laminated, sandy shale.

Coring was started at a depth of 631.0 feet in sandy shale and completed at 664.0 feet also in sandy shale. This core shows a total of 25.5 feet of sandstone. For the most part, the pay is made up of brown, slightly laminated, slightly 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 156.0 and 21.2 millidarcys respectively; the overall average being 117.8 (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 impermeable to a maximum

of 636. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 40.6. The weighted average percent oil saturation of the upper and lower sections is 43.5 and 34.1 respectively. The weighted average percent water saturation of the upper and lower sections is 33.0 and 52.9 respectively; the overall average being 39.2 (See Table III). This gives an overall weighted average total fluid saturation of 79.8 percent. This low total fluid saturation indicates some fluid was lost during coring most of which was probably oil.

The weighted average oil content of the upper and lower sections is 701 and 434 barrels per acre foot respectively; the overall average being 617. The total oil content, as shown by this core, is 15,742 barrels per acre of which 13,889 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 5,351 barrels of oil per acre was obtained from 19.5 feet of sand. The weighted average percent oil saturation was reduced from 44.1 to 27.2, or represents an average recovery of 16.9 percent. The weighted average effective permeability of the samples is 8.39 millidarcys, while the average initial fluid production pressure is 15.3 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 25 samples tested, 19 produced water and oil. This indicates that approximately 76 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

Based on the results of the laboratory tests it appears that efficient primary and secondary operations in the vicinity of this well should recover approximately 7,810 barrels of oil per acre or an average of 401 barrels per acre foot from the 19.5 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	20.0
Average porosity, percent	20.8
Oil saturation after flooding, percent	27.2
Performance factor, percent	50.0
Net floodable pay sand, feet	19.5

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. 13

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	638.1	22.2	39	38	77	671	42.	1.1	1.1	738	46.20
2	639.1	22.1	53	24	77	908	133.	1.0	2.1	908	133.00
3	640.1	20.6	50	32	82	798	130.	1.0	3.1	798	130.00
4	641.1	17.9	43	39	82	596	97.	1.0	4.1	596	97.00
5	642.1	18.9	29	46	75	424	53.	1.0	5.1	424	53.00
6	643.1	22.3	39	30	69	674	72.	1.0	6.1	674	72.00
7	644.1	20.6	41	38	79	654	357.	1.0	7.1	654	357.00
8	645.1	19.6	53	31	84	804	52.	1.0	8.1	804	52.00
9	646.1	19.3	40	40	80	599	113.	1.0	9.1	599	113.00
10	647.1	23.4	51	24	75	925	181.	1.0	10.1	925	181.00
11	648.1	20.1	50	28	78	779	102.	1.0	11.1	779	102.00
12	649.1	21.5	40	29	69	666	636.	1.0	12.1	666	636.00
13	650.1	23.3	48	28	76	866	189.	1.0	13.1	866	189.00
14	651.1	20.4	50	28	78	791	184.	1.0	14.1	791	184.00
15	652.1	20.3	48	37	85	757	194.	1.0	15.1	757	194.00
16	653.1	19.1	44	36	80	651	109.	1.0	16.1	651	109.00
17	654.1	20.2	29	33	62	454	60.	1.4	17.5	635	84.00
18	655.1	16.9	41	33	74	536	0.29	0.6	18.1	322	0.17
19	656.1	15.8	40	57	97	490	Imp.	1.0	19.1	490	0.00
20	657.1	15.9	34	47	81	419	5.2	1.0	20.1	419	5.20
21	658.1	19.3	44	32	76	659	74.	1.0	21.1	659	74.00
22	659.1	17.3	53	44	97	710	62.	1.0	22.1	710	62.00
23	660.1	15.3	16	63	79	190	1.0	1.0	23.1	190	1.00
24	661.1	15.0	44	44	88	511	1.5	1.0	24.1	511	1.50
25	662.1	13.5	12	83	95	126	3.1	1.4	25.5	176	4.34
								Total------		15,742	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Incorporated Lease Woodward Well No. 13

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
637.5 - 655.0	17.5	156.0	2,732.20
655.0 - 663.0	7.0	21.2	148.21
637.5 - 663.0	24.5	117.8	2,880.41

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
637.5 - 655.0	17.5	20.7	43.5	33.0	701	12,265
655.0 - 663.0	8.0	15.9	34.1	52.9	434	3,477
637.5 - 663.0	25.5	19.2	40.6	39.2	617	15,742

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Incorporated Lease Woodward Well No. 13

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	638.1	21.8	39	659	11	186	28	55	473	57	1.78	20
2	639.1	22.0	53	904	28	477	25	71	427	272	11.10	10
3	640.1	21.0	50	814	23	374	27	67	440	304	9.40	20
4	641.1	18.1	43	604	15	210	28	58	394	315	12.80	10
5	642.1	19.4	29	436	2	30	27	57	406	89	2.60	20
6	643.1	22.0	39	665	12	204	27	69	461	386	14.40	20
7	644.1	23.0	41	731	16	285	25	57	446	386	25.20	10
8	645.1	20.0	53	821	29	449	24	62	372	128	3.60	10
9	646.1	19.7	40	611	11	168	29	67	443	141	4.10	20
10	647.1	23.8	51	941	21	388	30	65	553	247	18.40	10
11	648.1	20.6	50	798	23	367	27	58	431	71	2.50	20
12	649.1	22.0	40	682	14	239	26	63	443	188	24.00	10
13	650.1	23.4	48	870	23	417	25	62	453	343	12.40	10
14	651.1	20.9	50	810	25	405	25	60	405	84	2.80	20
15	652.1	20.7	48	770	21	337	27	52	433	186	6.00	10
16	653.1	19.6	44	669	15	228	29	61	441	173	5.50	10
17	654.1	20.5	29	461	3	48	26	58	413	37	0.999	20
18	655.1	17.1	42	557	0	0	42	35	557	0	Imp.	-
19	656.1	15.7	40	487	0	0	40	58	487	0	Imp.	-
20	657.1	16.1	33	411	0	0	33	50	411	0	Imp.	-
21	658.1	19.8	44	675	15	230	29	63	445	81	2.20	20
22	659.1	17.5	53	719	20	271	33	64	448	107	3.10	20
23	660.1	15.0	17	198	0	0	17	64	198	0	Imp.	-
24	661.1	15.0	42	488	0	0	42	47	488	0	Imp.	-
25	662.1	13.1	14	142	0	0	14	84	142	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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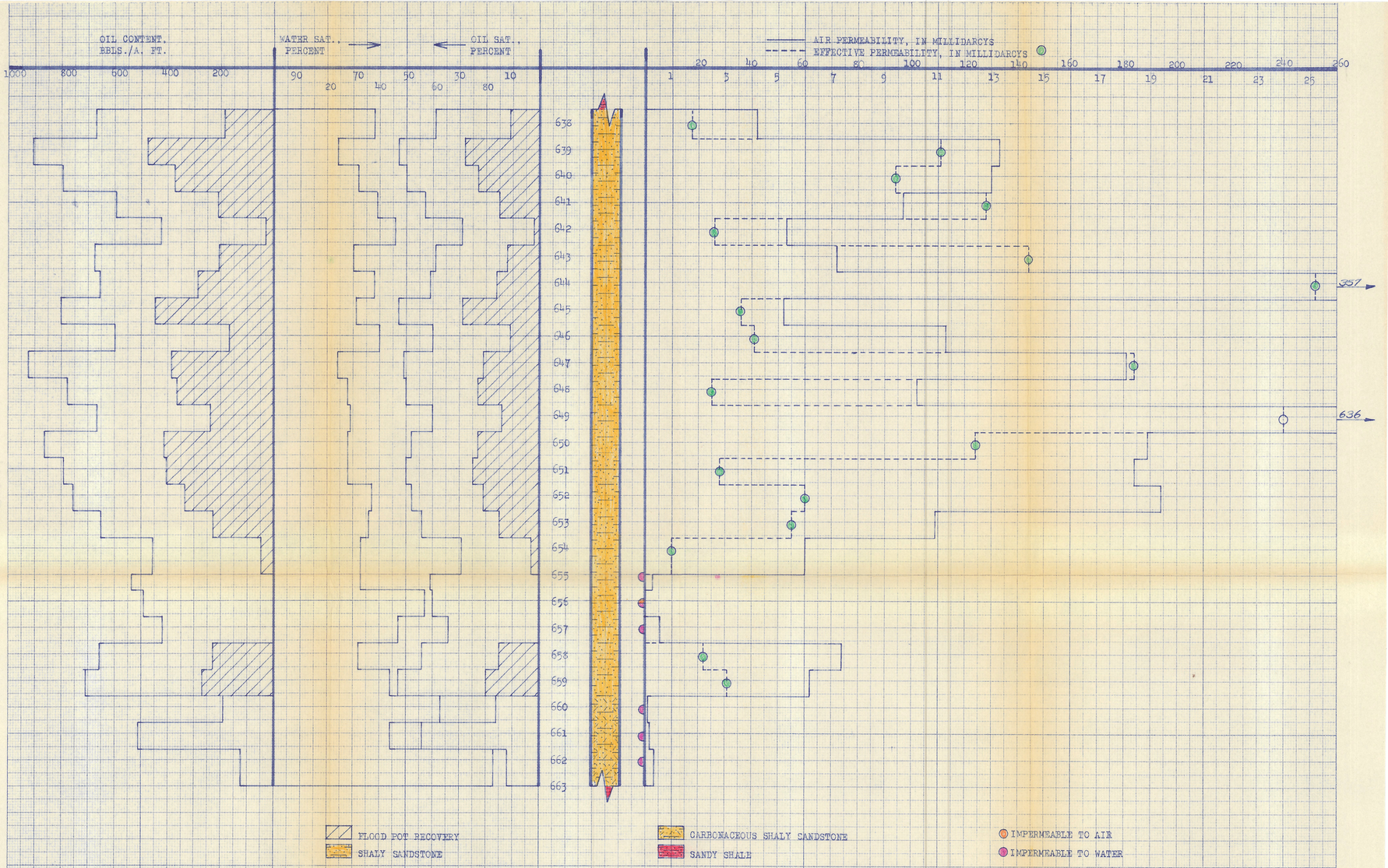
SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company CRA, Incorporated Lease Woodward Well No. 13

Depth Interval, Feet	637.5 - 655.0	655.0 - 663.0	637.5 - 663.0
Feet of Core Analyzed	17.5	2.0	19.5
Average Percent Porosity	21.1	18.7	20.8
Average Percent Original Oil Saturation	43.5	48.5	44.1
Average Percent Oil Recovery	16.8	17.5	16.9
Average Percent Residual Oil Saturation	26.7	31.0	27.2
Average Percent Residual Water Saturation	61.3	63.5	61.4
Average Percent Total Residual Fluid Saturation	88.0	94.5	88.6
Average Original Oil Content, Bbls./A. Ft.	713.	698.	711.
Average Oil Recovery, Bbls./A. Ft.	277.	251.	274.
Average Residual Oil Content, Bbls./A. Ft.	436.	447.	437.
Total Original Oil Content, Bbls./Acre	12,495.	1,394.	13,889.
Total Oil Recovery, Bbls./Acre	4,850.	501.	5,351.
Total Residual Oil Content, Bbls./Acre	7,645.	893.	8,538.
Average Effective Permeability, Millidarcys	9.05	2.65	8.39
Average Initial Fluid Production Pressure, p.s.i.	14.7	20.0	15.3

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



CRA, INC.

WOODWARD LEASE WELL NO. 13
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
637.5 - 655.0	17.5	20.7	43.5	33.0	701	12,265	156.0	
655.0 - 663.0	8.0	15.9	34.1	52.9	434	3,477	21.2	
637.5 - 663.0	25.5	19.2	40.6	39.2	617	15,742	117.8	7,810 (Primary & Secondary)

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CHANUTE, KANSAS
JANUARY, 1966