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

May 26, 1967

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

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Humphrey Lease, Well No. 12, Bourbon County, Kansas and submitted to our laboratory on May 20, 1967.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Benjamin R. Pearman

Benjamin R. Pearman

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Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company CRA, Incorporated Lease Humphrey Well No. 12

Location 540' EWL & 990' NSL, NE¼

Section 36 Twp. 24S Rge. 21E County Bourbon State Kansas

Name of Sand	Bartlesville
Top of Core	607.0
Bottom of Core	658.0
Top of Sand (Analyzed)	607.0
Bottom of Sand	651.0
Total Feet of Permeable Sand	38.2
Total Feet of Floodable Sand	18.8

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	9.5	9.5
5 - 10	12.1	21.6
10 - 20	5.3	26.9
20 - 50	10.3	37.2
50 & above	1.0	38.2

Average Permeability Millidarcys	16.7
Average Percent Porosity	18.9
Average Percent Oil Saturation	41.7
Average Percent Water Saturation	39.7
Average Oil Content, Bbls./A. Ft.	620.
Total Oil Content, Bbls./Acre	24,319.
Average Percent Oil Recovery by Laboratory Flooding Tests	13.7
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	212.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	3,990.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	6,960.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	1014.9

Fresh water mud was used as the circulating fluid while taking this core. The core was sampled and the samples sealed in cans and plastic bags 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
607.0 - 607.4	Grayish light brown, laminated, shaly sandstone.
607.4 - 608.3	Brown, slightly shaly sandstone.
608.3 - 609.0	Grayish light brown, laminated, shaly sandstone.
609.0 - 609.3	Gray sandy shale.
609.3 - 610.2	Brown sandstone.
610.2 - 610.4	Gray shale.
610.4 - 610.7	Grayish light brown, laminated, shaly sandstone.
610.7 - 611.1	Gray, laminated, sandy shale.
611.1 - 612.0	Brown sandstone.
612.0 - 612.8	Brown, laminated, shaly sandstone.
612.8 - 613.9	Gray shale.
613.9 - 614.9	Grayish light brown, shaly sandstone.
614.9 - 615.2	Sandy conglomerate.
615.2 - 616.0	Brown shaly sandstone.
616.0 - 617.7	Gray shale.
617.7 - 619.8	Brown sandstone.
619.8 - 620.6	Grayish brown, laminated, shaly sandstone.
620.6 - 623.5	Brown shaly sandstone.
623.5 - 626.0	Light brown, laminated, shaly sandstone.

626.0 - 629.3 - Brown sandstone.

629.3 - 630.1 - Gray, laminated, sandy shale.

630.1 - 631.5 - Brown, slightly shaly sandstone.

631.5 - 632.5 - Gray and light brown, laminated, shaly sandstone.

632.5 - 634.8 - Brown, laminated, slightly shaly sandstone.

634.8 - 635.3 - Grayish brown, laminated, shaly sandstone.

635.3 - 635.5 - Gray shale.

635.5 - 637.9 - Brown sandstone.

637.9 - 638.9 - Brown, laminated, slightly shaly sandstone.

638.9 - 640.4 - Dark carbonaceous sandstone.

640.4 - 640.8 - Light brown, laminated, slightly carbonaceous, shaly sandstone.

640.8 - 651.0 - Dark carbonaceous sandstone.

651.0 - 652.0 - Dark carbonaceous conglomerate.

652.0 - 653.3 - Gray, shaly conglomerate.

653.3 - 654.3 - Coal.

654.3 - 658.0 - Black shale.

Coring was started at a depth of 607.0 feet in sandstone and completed at 658.0 feet in shale. This core shows a total of 39.2 feet of sandstone. For the most part, the pay is made up of brown, more or less, shaly 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 16.2, 21.6 and 10.0 millidarcys respectively; the overall average being 16.7 (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 54. millidarcys.

PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 41.7. The weighted average percent oil saturation of the upper, middle and lower sections is 32.8, 41.9 and 45.5 respectively. The weighted average percent water saturation of the upper, middle and lower sections is 50.1, 40.0 and 34.5 respectively; the overall average being 39.7 (See Table III). This gives an overall weighted average total fluid saturation of 81.4 percent.

The weighted average oil content of the upper, middle and lower sections is 460, 629 and 681 barrels per acre foot respectively; the overall average being 620. The total oil content, as shown by this core, is 24,319 barrels per acre (See Table III).

LABORATORY FLOODING TESTS

The sand in this core responded to laboratory flooding tests, as a total recovery of 3,990 barrels of oil per acre was obtained from 18.8 feet of sand. The weighted average percent oil saturation was reduced from 42.5 to 28.8, or represents an average recovery of 13.7 percent. The weighted average effective permeability of the samples is 1.13 millidarcys, while the average initial fluid production pressure is 27.6 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 42 samples tested, 22 produced water and 19 oil. This indicates that approximately 45 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 operations in the vicinity of this well should recover approximately 2,270 barrels of oil per acre or an average of 65 barrels per acre foot from 35.0 feet of pay sand. An additional 4,690 barrels of oil per acre or an average of 249 barrels per acre foot can be recovered by efficient waterflooding operations. These recovery values were calculated using the following data and assumptions:

Original formation volume factor	1.06
Reservoir water saturation, percent	30.0
Expected primary recovery, estimated, percent (607.0 - 638.9)	6.0
Expected primary recovery, estimated, percent (638.9 - 651.0)	2.0
Average porosity, percent	18.8 - 19.4
Oil saturation after flooding, percent	28.8
Performance factor, percent	50.0
Net floodable pay sand, feet	18.8

This core shows a pay sand section (616.0 - 638.9) having a good oil saturation, a moderate water saturation and a wide variation in effective permeability to water. The lower zone (638.9 - 651.0) is carbonaceous sand that will probably respond to primary efforts, but will not respond to water-flooding.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Incorporated Lease Humphrey Well No. 12

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	607.1	15.8	29	56	85	355	3.7	0.4	0.4	142	1.48
2	608.1	20.4	37	42	79	586	6.4	0.9	1.3	529	5.76
3	609.4	18.2	42	43	85	593	50.	0.9	2.2	534	45.00
4	610.5	13.6	22	72	94	232	3.9	0.3	2.5	70	1.17
5	611.4	19.3	38	49	87	569	23.	0.9	3.4	511	20.70
6	612.1	17.9	30	52	82	417	6.2	0.8	4.2	334	4.96
7	614.1	17.8	23	51	74	318	9.7	1.0	5.2	318	9.70
8	615.3	16.2	32	54	86	402	10.	0.8	6.0	322	8.00
9	618.1	20.6	48	31	79	767	46.	0.9	6.9	690	41.40
10	619.1	20.3	53	30	83	835	33.	1.2	8.1	1,008	39.60
11	620.1	16.2	29	52	81	364	7.6	0.8	8.9	292	6.08
12	621.1	21.4	55	27	82	913	27.	1.0	9.9	913	27.00
13	622.1	18.5	36	43	79	517	5.8	1.0	10.9	517	5.80
14	623.1	15.9	44	44	88	543	15.	0.9	11.8	489	13.50
15	624.1	18.5	36	43	79	517	4.0	1.1	12.9	569	4.40
16	625.1	17.6	38	45	83	519	4.3	1.4	14.3	726	6.02
17	626.1	20.5	51	40	91	811	15.	0.6	14.9	486	9.00
18	627.1	21.3	49	28	77	810	54.	1.0	15.9	810	54.00
19	628.1	19.9	49	36	85	757	46.	1.7	17.6	1,288	78.20
20	630.2	19.4	34	43	77	512	19.	0.4	18.0	205	7.60
21	631.1	19.5	38	39	77	575	7.0	1.0	19.0	575	7.00
22	632.1	15.3	29	55	84	344	Imp.	1.0	20.0	344	0.00
23	633.1	16.0	31	53	84	385	4.5	1.1	21.1	424	4.95
24	634.1	17.0	36	51	87	474	4.7	1.2	22.3	569	5.64

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company CRA, Inc. Lease Humphrey Well No. 12

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.		
25	635.1	18.0	45	42	87	628	1.2	0.5	22.8	314	0.60
26	636.1	21.1	42	40	82	687	41.	1.0	23.8	687	41.00
27	637.1	21.4	49	32	81	812	41.	1.3	25.1	1,058	53.30
28	638.1	21.1	40	33	73	654	7.6	1.0	26.1	654	7.60
29	639.1	20.5	48	27	75	762	12.	0.7	26.8	534	8.40
30	640.1	20.8	49	31	80	790	8.3	0.8	27.6	632	6.64
31	641.1	21.8	48	24	72	811	15.	0.7	28.3	569	10.50
32	642.1	20.1	42	32	74	654	8.2	1.0	29.3	654	8.20
33	643.1	19.0	45	34	79	663	4.4	1.0	30.3	663	4.40
34	644.1	18.6	42	37	79	605	5.1	1.0	31.3	605	5.10
35	645.1	19.3	41	34	75	613	7.4	1.0	32.3	613	7.40
36	646.1	20.3	46	33	79	724	6.1	1.0	33.3	724	6.10
37	647.1	17.7	45	37	82	617	0.95	1.0	34.3	617	0.95
38	648.1	20.1	50	31	81	779	11.	1.0	35.3	779	11.00
39	649.1	20.1	52	33	85	810	15.	1.0	36.3	810	15.00
40	650.1	20.0	41	32	73	636	31.	1.4	37.7	890	43.40
41	651.1	16.6	63	34	97	809	3.0	1.0	38.7	809	3.00
42	652.1	9.9	11	84	95	84	0.78	0.5	39.2	42	0.39
								Total	-------	24,319	

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company CRA, Inc. Lease Humphrey Well No. 12

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
607.0 - 616.0	6.0	16.2	96.77
617.7 - 638.9	19.1	21.6	412.69
638.9 - 652.5	13.1	10.0	130.48
607.0 - 652.5	38.2	16.7	639.94

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
607.0 - 616.0	6.0	17.9	32.8	50.1	460	2,760
617.7 - 638.9	20.1	19.1	41.9	40.0	629	12,618
638.9 - 652.5	13.1	19.2	45.5	34.5	681	8,941
607.0 - 652.5	39.2	18.9	41.7	39.7	620	24,319

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RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Humphrey Well No. 12

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	607.1	16.2	30	377	0	0	30	64	377	8	0.300	40
2	608.1	20.0	37	573	7	108	30	59	465	42	1.10	25
3	609.4	18.7	42	609	13	188	29	66	421	112	3.70	20
4	610.5	14.0	26	282	0	0	26	73	282	5	0.200	45
5	611.4	19.0	38	559	2	30	36	53	529	28	0.800	25
6	612.1	17.5	30	406	0	0	30	68	406	24	0.800	30
7	614.1	18.1	23	322	0	0	23	66	322	4	0.200	45
8	615.3	16.0	33	409	0	0	33	55	409	0	Imp.	-
9	618.1	21.0	48	781	24	391	24	60	390	87	2.70	20
10	619.1	20.0	53	821	27	418	26	73	403	37	1.50	25
11	620.1	16.5	29	371	3	38	26	73	333	4	0.200	35
12	621.1	21.7	55	924	24	403	31	68	521	48	1.80	20
13	622.1	18.0	36	502	12	168	24	67	334	10	0.400	30
14	623.1	16.4	44	560	16	204	28	69	356	31	0.900	20
15	624.1	18.7	36	521	0	0	36	45	521	0	Imp.	-
16	625.1	17.5	36	488	0	0	36	46	488	0	Imp.	-
17	626.1	20.6	51	814	16	256	35	64	558	10	0.400	25
18	627.1	20.9	49	794	21	340	28	71	454	52	1.60	20
19	628.1	19.7	49	749	24	367	25	74	382	61	2.10	20
20	630.2	19.3	34	509	7	105	27	71	404	8	0.334	25
21	631.1	19.7	38	581	5	76	33	64	505	4	0.200	40
22	632.1	15.1	29	690	0	0	29	56	690	0	Imp.	-
23	633.1	16.4	31	394	3	38	28	67	356	2	0.100	45
24	634.1	17.3	36	483	5	67	31	59	416	0	0.025	35

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.

Oilfield Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Inc. Lease Humphrey Well No. 12

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.			
25	635.1	17.7	46	631	0	0	46	43	631	0	Imp.	-
26	636.1	21.2	42	691	14	230	28	62	461	48	1.20	30
27	637.1	20.9	49	794	15	243	34	57	551	34	1.10	30
28	638.1	20.8	40	645	9	145	31	65	500	10	0.334	35
29	639.1	20.8	50	806	0	0	50	26	806	0	Imp.	-
30	640.1	20.8	49	789	0	0	49	32	789	0	Imp.	-
31	641.1	21.5	48	800	0	0	48	27	800	0	Imp.	-
32	642.1	20.3	44	691	0	0	44	31	691	0	Imp.	-
33	643.1	18.7	45	651	0	0	45	37	651	0	Imp.	-
34	644.1	18.7	41	594	0	0	41	39	594	0	Imp.	-
35	645.1	19.0	42	619	0	0	42	35	619	0	Imp.	-
36	646.1	20.3	47	739	0	0	47	36	739	0	Imp.	-
37	647.1	17.4	45	606	0	0	45	36	606	0	Imp.	-
38	648.1	20.1	50	779	0	0	50	33	779	0	Imp.	-
39	649.1	20.0	51	790	0	0	51	33	790	0	Imp.	-
40	650.1	20.0	43	666	0	0	43	33	666	0	Imp.	-
41	651.1	16.6	61	786	0	0	61	37	786	0	Imp.	-
42	652.1	10.1	12	94	0	0	12	85	94	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.

Oilfield Research Laboratories

SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company CRA, Inc. Lease Humphrey Well No. 12

Depth Interval, Feet	607.0 - 616.0	617.7 - 638.9	607.0 - 638.9
Feet of Core Analyzed	2.7	16.1	18.8
Average Percent Porosity	19.2	19.4	19.4
Average Percent Original Oil Saturation	38.9	43.1	42.5
Average Percent Oil Recovery	7.3	14.7	13.7
Average Percent Residual Oil Saturation	31.6	28.4	28.8
Average Percent Residual Water Saturation	59.4	59.5	59.4
Average Percent Total Residual Fluid Saturation	91.0	87.9	88.2
Average Original Oil Content, Bbls./A. Ft.	581.	661.	649.
Average Oil Recovery, Bbls./A. Ft.	109.	230.	212.
Average Residual Oil Content, Bbls./A. Ft.	472.	431.	437.
Total Original Oil Content, Bbls./Acre	1,567.	10,646.	12,213.
Total Oil Recovery, Bbls./Acre	293.	3,697.	3,990.
Total Residual Oil Content, Bbls./Acre	1,274.	6,949.	8,223.
Average Effective Permeability, Millidarcys	1.87	1.01	1.13
Average Initial Fluid Production Pressure, p.s.i.	23.3	28.4	27.6

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