



# OILFIELD RESEARCH LABORATORIES

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

July 20, 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. 31, Bourbon County, Kansas, and submitted to our laboratory on July 13, 1966.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

*Benjamin R. Pearman*  
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BRP:rf

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

# Oilfield Research Laboratories

## GENERAL INFORMATION & SUMMARY

Company CRA, Incorporated Lease Woodward Well No. 31

Location 1200' NSL & 1400' EWL, NW $\frac{1}{4}$

Section 13 Twp. 25S Rge. 21E County Bourbon State Kansas

Name of Sand	-	Bartlesville
Top of Core	-	633.0
Bottom of Core	-	659.2
Top of Sand	(Analyzed)	633.0
Bottom of Sand	(Analyzed)	659.2
Total Feet of Permeable Sand	-	22.9
Total Feet of Floodable Sand	-	15.1

**Distribution of Permeable Sand:**  
Permeability Range  
Millidarcys

	Feet	Cum. Ft.
5 - 20	3.8	3.8
20 - 50	6.6	10.4
50 - 100	7.1	17.5
100 & above	5.4	22.9

Average Permeability Millidarcys	-	61.4
Average Percent Porosity	-	19.7
Average Percent Oil Saturation	-	33.9
Average Percent Water Saturation	-	39.4
Average Oil Content, Bbls./A. Ft.	-	518.
Total Oil Content, Bbls./Acre	-	11,876.
Average Percent Oil Recovery by Laboratory Flooding Tests	-	14.1
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	-	222.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	-	3,348.
Total Calculated Oil Recovery, Bbls./Acre	(Primary & Secondary)	5,940.
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:

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

633.0 - 639.8	Light brown, laminated, shaly sandstone.
639.8 - 648.0	Brown, laminated, slightly shaly sandstone.
648.0 - 649.0	Laminated sandstone and shale.
649.0 - 654.3	Brown, laminated, slightly shaly sandstone.
654.3 - 656.6	Laminated sandy shale.
656.6 - 659.0	Brown, slightly shaly sandstone.
659.0 - 659.2	Dark, slightly carbonaceous sandstone.

Coring was started at a depth of 633.0 feet in light brown sandstone and completed at 659.2 feet in dark carbonaceous sandstone. This core shows a total of 22.9 feet of sandstone. For the most part, the pay is made up of brown, 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 68.9 and 58.1 millidarcys respectively; the overall average being 61.4 (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 5.4 to a maximum

of 141. millidarcys.

#### PERCENT SATURATION & OIL CONTENT

The sand in this core shows a good weighted average percent oil saturation, namely, 33.9. The weighted average percent oil saturation of the upper and lower sections is 16.6 and 41.1 respectively. The weighted average percent water saturation of the upper and lower sections is 62.6 and 30.2 respectively; the overall average being 39.4 (See Table III). This gives an overall weighted average total fluid saturation of 73.3 percent. This low total fluid saturation indicates considerable fluid was lost during coring most of which probably was oil.

The weighted average oil content of the upper and lower sections is 242 and 636 barrels per acre foot respectively; the overall average being 518. The total oil content, as shown by this core, is 11,876 barrels per acre of which 9,656 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 3,348 barrels of oil per acre was obtained from 15.1 feet of sand. The weighted average percent oil saturation was reduced from 40.7 to 26.6, or represents an average recovery of 14.1 percent. The weighted average effective permeability of the samples is 4.51 millidarcys, while the average initial fluid production pressure is 20.6 pounds per square inch (See Table V).

By observing the data given in Table IV, you will note that of the 24 samples tested, 22 produced water and 16 oil. This indicates

that approximately 67 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 5,940 barrels of oil per acre or an average of 394 barrels per acre foot from the 15.1 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	20.2
Oil saturation after flooding, percent	26.6
Performance factor, percent	50.0
Net floodable pay sand, feet	15.1

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.

**Oilfield Research Laboratories**

**RESULTS OF SATURATION & PERMEABILITY TESTS**

**TABLE 1-B**

Company CRA, Inc. Lease Woodward Well No. 31

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	633.1	18.0	27	55	82	377	5.4	0.6	0.6	226	3.24
2	634.1	20.4	15	65	80	237	82.	1.0	1.6	237	82.00
3	635.1	20.2	12	67	79	188	12.	1.0	2.6	188	12.00
4	636.1	21.4	10	76	86	166	127.	1.0	3.6	166	127.00
5	637.1	22.4	15	52	67	260	135.	1.0	4.6	260	135.00
6	638.1	20.8	16	61	77	258	88.	1.0	5.6	258	88.00
7	639.1	13.7	24	60	84	255	18.	1.2	6.8	306	21.60
8	640.1	20.4	36	30	66	569	62.	0.8	7.6	455	49.60
9	641.1	19.2	29	38	67	431	22.	1.0	8.6	431	22.00
10	642.1	19.6	37	37	74	562	44.	1.0	9.6	562	44.00
11	643.1	22.1	37	32	69	634	21.	1.0	10.6	634	21.00
12	644.1	21.2	38	35	73	624	141.	1.0	11.6	624	141.00
13	645.1	16.9	40	34	74	524	30.	1.0	12.6	524	30.00
14	646.1	16.9	46	33	79	602	27.	1.0	13.6	602	27.00
15	647.1	18.8	34	34	68	495	30.	1.4	15.0	693	42.00
16	649.1	20.1	47	29	76	732	62.	0.6	15.6	440	37.20
17	650.1	20.8	44	26	70	709	19.	1.0	16.6	709	19.00
18	651.1	19.2	45	25	70	670	57.	1.0	17.6	670	57.00
19	652.1	21.2	46	27	73	756	106.	1.0	18.6	756	106.00
20	653.1	19.7	44	29	73	671	82.	1.0	19.6	671	82.00
21	654.1	20.4	45	27	72	711	55.	0.7	20.3	498	38.50
22	657.1	21.1	47	25	72	769	62.	1.0	21.3	769	62.00
23	658.1	21.2	46	23	69	756	107.	1.4	22.7	1,059	149.80
24	659.1	18.5	48	27	75	689	39.	0.2	22.9	138	7.80
								Total-----		11,876	

**Oilfield Research Laboratories**

**SUMMARY OF PERMEABILITY & SATURATION TESTS**

**TABLE III**

Company CRA, Incorporated Lease Woodward Well No. 31

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
633.0 - 639.8	6.8	68.9	468.84
639.8 - 659.2	16.1	58.1	935.90
633.0 - 659.2	22.9	61.4	1,404.74

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
633.0 - 639.8	6.8	19.5	16.6	62.6	242	1,641
639.8 - 659.2	16.1	19.9	41.1	30.2	636	10,235
633.0 - 659.2	22.9	19.7	33.9	39.4	518	11,876

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## RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company CRA, Incorporated Lease Woodward Well No. 31

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	633.1	18.3	26	369	0	0	26	63	369	46	1.60	10
2	634.1	20.4	16	253	0	0	16	72	253	186	12.30	10
3	635.1	20.0	12	186	0	0	12	80	186	119	10.72	10
4	636.1	21.6	10	168	0	0	10	86	168	111	9.56	10
5	637.1	22.0	17	290	0	0	17	82	290	407	48.10	10
6	638.1	20.6	15	239	0	0	15	84	239	113	7.13	30
7	639.1	13.6	26	274	0	0	26	59	274	0	Imp.	-
8	640.1	20.0	36	558	6	93	30	63	465	66	1.30	30
9	641.1	19.6	29	441	3	46	26	62	395	170	4.70	20
10	642.1	19.5	37	559	9	136	28	69	423	77	2.80	30
11	643.1	21.9	37	628	10	170	27	67	458	407	10.00	20
12	644.1	21.6	38	636	11	184	27	70	452	169	15.70	20
13	645.1	16.7	40	518	15	194	25	64	324	8	0.200	40
14	646.1	16.6	47	604	0	0	47	35	604	0	Imp.	-
15	647.1	19.2	34	506	8	119	26	71	387	50	1.20	20
16	649.1	20.0	47	729	24	372	23	73	357	169	3.21	10
17	650.1	21.2	44	723	19	312	25	71	411	32	0.800	20
18	651.1	19.3	45	673	19	284	26	66	389	98	3.00	20
19	652.1	21.6	46	771	16	268	30	56	503	147	4.60	10
20	653.1	20.0	44	682	19	294	25	70	388	107	2.11	10
21	654.1	20.4	45	711	19	300	26	69	411	119	3.10	20
22	657.1	20.6	47	750	19	303	28	63	447	45	1.30	20
23	658.1	20.9	46	746	20	324	26	68	422	275	11.00	20
24	659.1	18.8	48	699	10	146	38	53	553	117	3.80	20

Notes: cc—cubic centimeter.

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

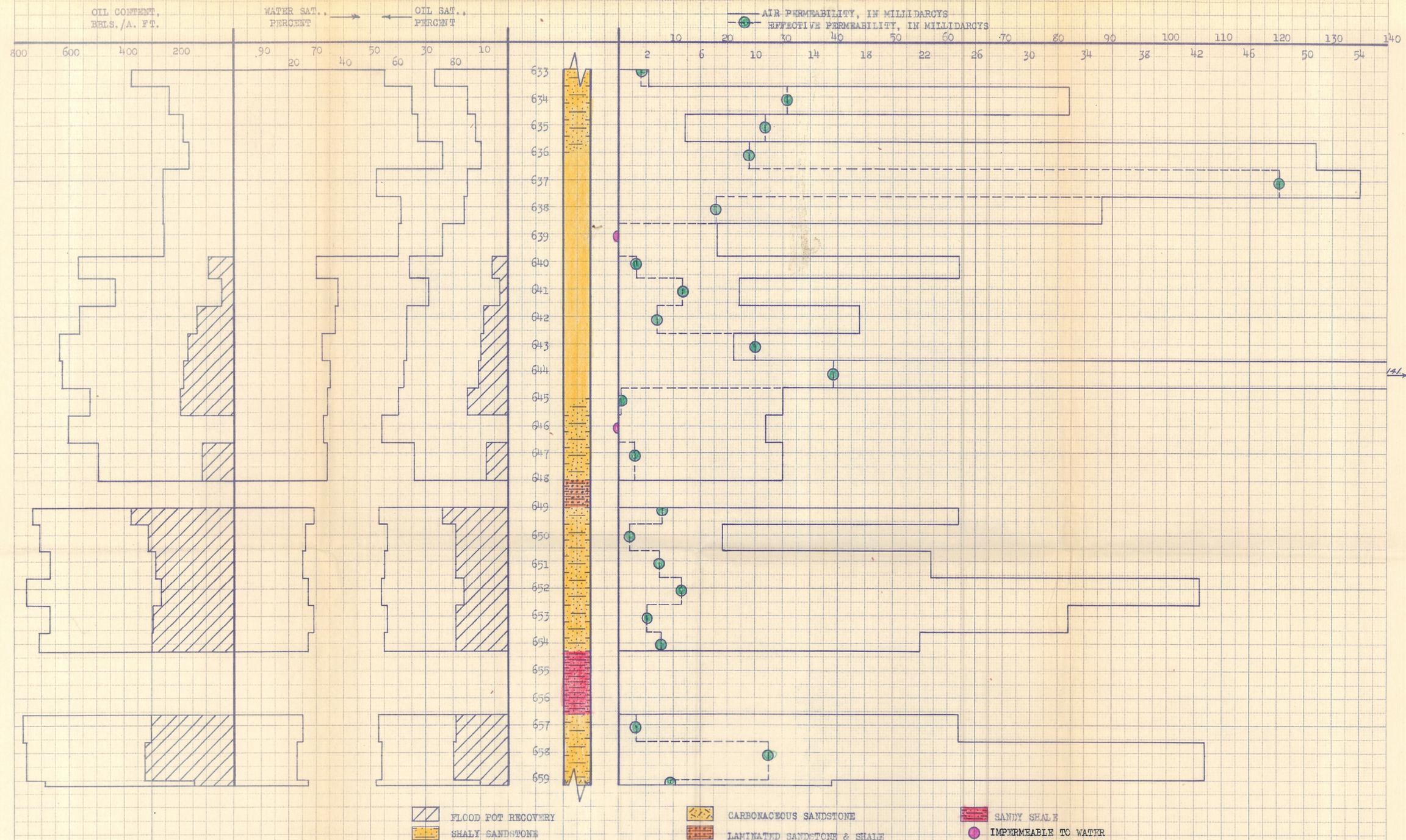
\*\*—Determined by passing water through sample which still contains residual oil.

**Oilfield Research Laboratories**  
**SUMMARY OF LABORATORY FLOODING TESTS**

**TABLE V**

Company	CRA, Incorporated	Lease	Woodward	Well No.	31
Depth Interval, Feet	639.8 - 659.2				
Feet of Core Analyzed	15.1				
Average Percent Porosity	20.2				
Average Percent Original Oil Saturation	40.7				
Average Percent Oil Recovery	14.1				
Average Percent Residual Oil Saturation	26.6				
Average Percent Residual Water Saturation	66.6				
Average Percent Total Residual Fluid Saturation	93.2				
Average Original Oil Content, Bbls./A. Ft.	640.				
Average Oil Recovery, Bbls./A. Ft.	222.				
Average Residual Oil Content, Bbls./A. Ft.	418.				
Total Original Oil Content, Bbls./Acre	9,656.				
Total Oil Recovery, Bbls./Acre	3,348.				
Total Residual Oil Content, Bbls./Acre	6,308.				
Average Effective Permeability, Millidarcys	4.51				
Average Initial Fluid Production Pressure, p.s.i.	20.6				

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



**C. R. A., INC.**

WOODWARD LEASE WELL NO. 31  
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
633.0 - 639.8	6.8	19.5	16.6	62.6	242	1,641	68.9	
639.8 - 659.2	16.1	19.9	41.1	30.2	636	10,235	58.1	
633.0 - 659.2	22.9	19.7	33.9	39.4	518	11,876	61.4	5,940 (Primary & Secondary)

OILFIELD RESEARCH LABORATORIES  
CHANUTE, KANSAS  
JULY, 1966

STANDARD CROSS SECTION  
MILLIMETER

KEIFFEL & ESSER CO.  
MADE IN U.S.A.