OILFIELD RESEARCH LABORATORIES

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

December 5, 1967

16-25-10E

TEC Drilling Company, Inc.
P. O. Box 693
El Dorado, Kansas 67042

Gentlemen:

Enclosed herewith is the report of the analysis of the Rotary core taken from the Coffield Lease, Well No. 3, Woodson County, Kansas, and submitted to our laboratory on November 28, 1967.

Your business is greatly appreciated.

Very truly yours,

OILFIELD RESEARCH LABORATORIES

Carl L. Pate

CLP:bjo

5 c. - El Dorado, Kansas

Coffield 3

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

Location SW, SW, SW,

Section 16 Twp. 25S Rge. 16E County Woodson State Kansas

Name of Sand	Upper Squirrel
Top of Core	870.0
Bottom of Core (Recovered)	892.1
Top of Pay Sand	871.5
Bottom of Sand (Recovered)	892.1
Total Feet of Permeable Sand	19.0
Total Feet of Floodable Sand	11.5

Distribution of Permeable Sand: Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 5	5.4	5.4
5 - 10	6.1	11.5
10 - 20	1.6	13.1
20 & above	5.9	19.0

Average Permeability Millidarcys	14.8
Average Percent Porosity	17.8
Average Percent Oil Saturation	55.6
Average Percent Water Saturation	23.7
Average Oil Content, Bbls./A. Ft.	771.
Total Oil Content, Bbls./Acre	14,642.
Average Percent Oil Recovery by Laboratory Flooding Tests	9.9
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	143.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	1,649.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	2,830.
Packer Setting, Feet	
Viscosity, Centipoises @	
A. P. I. Gravity, degrees @ 60 °F	
Elevation, Feet	

Oilfield Research Laboratories

GENERAL INFORMATION & SUMMARY

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

Location SW, SW, SW

Section 16 Twp. 25S Rge. 16E County Woodson State Kansas

Name of Sand	Lower Squirrel
Top of Core	914.0
Bottom of Core	934.0
Top of Sand (Cored)	914.0
Bottom of Sand	926.5
Total Feet of Permeable Sand (Analyzed)	7.9
Total Feet of Floodable Sand	5.6

Distribution of Permeable Sand:

Permeability Range Millidarcys	Feet	Cum. Ft.
0 - 25	1.7	1.7
25 - 50	3.0	4.7
50 - 100	1.2	5.9
100 & above	2.0	7.9

Average Permeability Millidarcys	73.6
Average Percent Porosity	19.2
Average Percent Oil Saturation	62.2
Average Percent Water Saturation	13.6
Average Oil Content, Bbls./A. Ft.	952.
Total Oil Content, Bbls./Acre	8,005.
Average Percent Oil Recovery by Laboratory Flooding Tests	11.2
Average Oil Recovery by Laboratory Flooding Tests, Bbls./A. Ft.	172.
Total Oil Recovery by Laboratory Flooding Tests, Bbls./Acre	966.
Total Calculated Oil Recovery, Bbls./Acre (Primary & Secondary)	1,680.
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. This well was drilled in a virgin area. The cores were sampled and sealed in tin cans by an employee of Oilfield Research Laboratories.

FORMATION CORED

The detailed log of the formation cored is as follows:

Depth Interval, Feet	Description

UPPER SQUIRREL SAND

870.0 - 871.0 - Sandy shale.

871.0 - 871.5 - Light brown shaly sandstone.

871.5 - 882.0 - Dark brown slightly laminated shaly sandstone.

882.0 - 883.6 - Gray calcareous sandstone.

883.6 - 889.0 - Dark brown slightly laminated shaly sandstone.

889.0 - 892.1 - Dark carbonaceous sandstone.

892.1 - 910.0 - Loss.

LOWER SQUIRREL SAND

914.0 - 915.2 - Dark carbonaceous sandstone.

915.2 - 916.5 - Laminated shaly sandstone.

916.5 - 916.9 - Sandy shale.

916.9 - 917.6 - Laminated shaly sandstone.

917.6 - 919.6 - Dark carbonaceous sandstone.

919.6 - 920.5 - Dark laminated shaly sandstone.

920.5 - 921.2 - Laminated sandy shale.

921.2 - 923.5 - Dark carbonaceous sandstone.

923.5 - 926.5 - Carbonaceous sandstone.

926.5 - 934.0 - Sandy shale (Discarded).

Coring of the upper sand was started at a depth of 870.0 feet in sandy shale and completed at 910.0 feet. There was a core loss from a depth of 892.1 to 910.0 feet. This core shows a total of 21.1 feet of sandstone. For the most part, the pay is made up of dark brown slightly laminated shaly sandstone. Coring of the lower sand was started at a depth of 914.0 feet and completed at 934.0 feet (See Log). The core shows a total of 11.4 feet.

PERMEABILITY

The weighted average permeability of the upper and lower sands is 14.8 and 73.6 millidarcys respectively (See Table III). By observing the data given on the coregraph, it is noticeable that the sands have very irregular permeability profiles. The permeability of the sands vary from 2.8 to a maximum of 202.0 millidarcys.

PERCENT SATURATION & OIL CONTENT

The weighted average percent oil saturation of the upper and lower sands is 55.6 and 62.2 respectively. The weighted average percent water saturation of the upper and lower sands is 23.7 and 13.6 respectively (See Table III). This gives an overall weighted average total fluid saturation of 79.3 and 75.8 percent respectively for the upper and lower sands. This fairly low total fluid saturation indicates some fluid was lost during coring which was probably oil.

The weighted average oil content of the upper and lower sands is 771 and 952 barrels per acre foot respectively. The total oil content, as shown by the cores, is 22,647 barrels per acre of which 14,642 barrels are in the upper sand (See Table III).

LABORATORY FLOODING TESTS

The sand in the cores responded fairly well to laboratory flooding tests, as a total recovery of 2,615 barrels of oil per acre was obtained from 17.1 feet of sand. The weighted average percent oil saturation of the upper and lower sands was reduced from 56.7 and 60.2 to 46.8 and 49.0 respectively. The weighted average effective permeability of the sands is 0.30 and 8.51 millidarcys, while the average initial fluid production pressures are 40.1 and 18.1 pounds per square inch respectively (See Table V).

By observing the data given in Table IV, you will note that of the 28 samples tested, 19 produced water and 18 oil. This indicates that approximately 64 percent of the sand represented by these samples is floodable pay sand. The tests also show that the sands have high residual oil saturations.

CONCLUSION

On the basis of the above data, we estimate that approximately 4,510 barrels of oil per acre can be recovered from the area, represented by these cores, by efficient primary and waterflood operations; 2,830 barrels from the upper sand and 1,680 from the lower sand. The following data and assumptions were used in calculating the above oil recovery values:

	Upper Sand	Lower Sand
Present formation volume factor	1.07	1.07
Irreducible water saturation, percent	20.0	12.0
Primary recovery, estimated, percent	None	None
Present oil saturation, percent	74.8	82.2

Average porosity, percent	18.6	19.7
Oil saturation after flooding, percent	46.8	49.0
Performance factor	0.50	0.50
Net floodable pay sand, feet	11.5	5.6

The cores show a rather clean sand section having very good oil saturation, a low water saturation and a good porosity. The upper sand had a low permeability while the lower sand had a good permeability. In as much as the analyses indicate that the sands contain oil with a rather high viscosity, some thermal type of secondary recovery would probably be more effective.

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RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

UPPER SAND

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	872.1	17.7	45	27	72	618	9.9	1.1	1.1	680	10.89
2	873.1	18.4	58	22	80	828	8.3	1.0	2.1	828	8.30
3	874.1	18.4	53	26	79	756	13.	1.0	3.1	756	13.00
4	875.1	17.5	49	28	77	665	9.0	1.0	4.1	665	9.00
5	876.1	18.1	60	23	83	843	4.4	1.0	5.1	843	4.40
6	877.1	18.0	53	27	80	740	8.8	1.0	6.1	740	8.80
7	878.1	15.5	53	34	87	637	4.9	1.0	7.1	637	4.90
8	879.1	17.3	58	26	84	778	4.3	1.0	8.1	778	4.30
9	880.1	17.6	53	22	75	724	23.	1.0	9.1	724	23.00
10	881.1	16.0	57	24	81	708	2.8	1.4	10.5	991	3.92
11	884.1	17.4	56	29	85	756	5.5	1.0	11.5	756	5.50
12	885.1	16.5	55	27	82	704	4.2	1.0	12.5	704	4.20
13	886.1	18.6	49	22	71	707	23.	1.0	13.5	707	23.00
14	887.1	15.9	59	27	86	728	8.3	1.0	14.5	728	8.30
15	888.1	19.0	66	16	82	973	22.	1.4	15.9	1362	30.80
16	889.1	19.8	62	15	77	952	19.	0.6	16.5	571	11.40
17	890.1	19.9	62	16	78	957	38.	1.0	17.5	957	38.00
18	891.1	19.7	53	18	71	810	46.	1.5	19.0	1215	69.00

Oilfield Research Laboratories

RESULTS OF SATURATION & PERMEABILITY TESTS

TABLE 1-B

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

LOWER SAND

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	914.1	15.8	58	9	67	711	95.	0.6	0.6	427	55.00
2	915.1	18.4	57	14	71	814	81.	0.6	1.2	488	48.60
3	916.1	19.2	57	13	70	849	30.	1.3	2.5	1103	39.00
4	917.0	19.4	70	18	88	1053	2.3	0.2	2.7	211	0.46
F-4	917.2	19.0	63	-	-	933	-	0.5	3.2	466	-
5	918.1	20.2	63	16	79	987	202.	1.0	4.2	987	202.00
6	919.1	21.5	60	12	72	1002	158.	1.0	5.2	1002	158.00
7	920.1	20.8	55	17	72	888	15.	0.9	6.1	799	13.50
8	921.4	20.2	66	17	83	1034	20.	0.6	6.7	621	12.00
9	922.1	22.0	66	12	78	1127	26.	0.8	7.5	901	20.80
10	923.1	18.6	77	11	88	1112	36.	0.9	8.4	1000	32.40

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SUMMARY OF PERMEABILITY & SATURATION TESTS

TABLE III

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

Depth Interval, Feet	Feet of Core Analyzed	Average Permeability, Millidarcys	Permeability Capacity Ft. x Md.
	UPPER SQUIRREL SAND		
871.5 - 879.6	8.1	7.8	63.59
879.6 - 892.1	10.9	19.9	217.12
871.5 - 892.1	19.0	14.8	280.71
	LOWER SQUIRREL SAND		
914.0 - 923.5	7.9	73.6	581.76

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
			UPPER SQUIRREL SAND			
871.5 - 879.6	8.1	17.6	53.5	26.6	732	5,927.
879.6 - 892.1	10.9	18.0	56.2	21.6	799	8,715.
871.5 - 892.1	19.0	17.8	55.6	23.7	771	14,642.
			LOWER SQUIRREL SAND			
914.0 - 923.5	8.4	19.2	62.2	13.6	952	8,005.

Oilfield Research Laboratories

RESULTS OF LABORATORY FLOODING TESTS

TABLE IV

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

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.			
						UPPER SQUIRREL SAND						
1	872.1	17.2	42	561	0	0	42	34	561	0	Imp.	-
2	873.1	17.9	58	806	14	194	44	50	612	8	0.22	45
3	874.1	18.5	53	761	11	158	42	54	603	16	0.30	40
4	875.1	17.9	49	680	6	83	43	53	597	9	0.22	40
5	876.1	17.7	60	824	17	233	43	56	591	3	0.15	45
6	877.1	17.5	55	747	0	0	55	30	747	0	Imp.	-
7	878.1	15.8	50	613	0	0	50	42	613	0	Imp.	-
8	879.1	17.0	55	726	0	0	55	32	726	0	Imp.	-
9	880.1	18.0	53	740	9	126	44	53	614	23	0.37	30
10	881.1	15.7	54	658	0	0	54	32	658	0	Imp.	-
11	884.1	17.0	54	712	0	0	54	35	712	0	Imp.	-
12	885.1	16.8	52	678	0	0	52	34	678	0	Imp.	-
13	886.1	18.8	49	715	5	73	44	56	642	19	0.37	40
14	887.1	16.3	59	746	2	25	57	35	721	2	0.07	50
15	888.1	19.2	66	984	22	328	44	56	656	20	0.37	40
16	889.1	20.3	62	977	14	221	48	49	756	33	0.60	30
17	890.1	20.2	62	972	9	141	53	45	831	39	0.60	30
18	891.1	20.1	53	827	1	16	52	41	811	6	0.15	45

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 TEC Drilling Company, Inc. Lease Coffield Well No. 3

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.			
						LOWER SQUIRREL SAND						
1	914.1	15.3	58	688	5	59	53	41	629	34	0.73	25
2	915.1	18.7	57	827	14	203	43	54	624	345	26.13	10
3	916.1	19.6	57	867	11	167	46	52	700	96	2.00	20
4	917.2	19.0	63	933	9	133	54	45	800	44	1.03	25
5	918.1	20.5	63	1002	19	302	44	54	700	295	7.92	20
6	919.1	22.0	60	1024	8	137	52	43	887	241	19.53	10
7	920.1	21.2	53	872	0	0	53	40	872	14	0.29	35
8	921.4	20.6	66	1055	9	144	57	43	911	72	1.61	20
9	922.1	21.6	63	1056	0	0	63	20	1056	0	Imp.	-
10	923.1	18.3	73	1037	0	0	73	20	1037	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

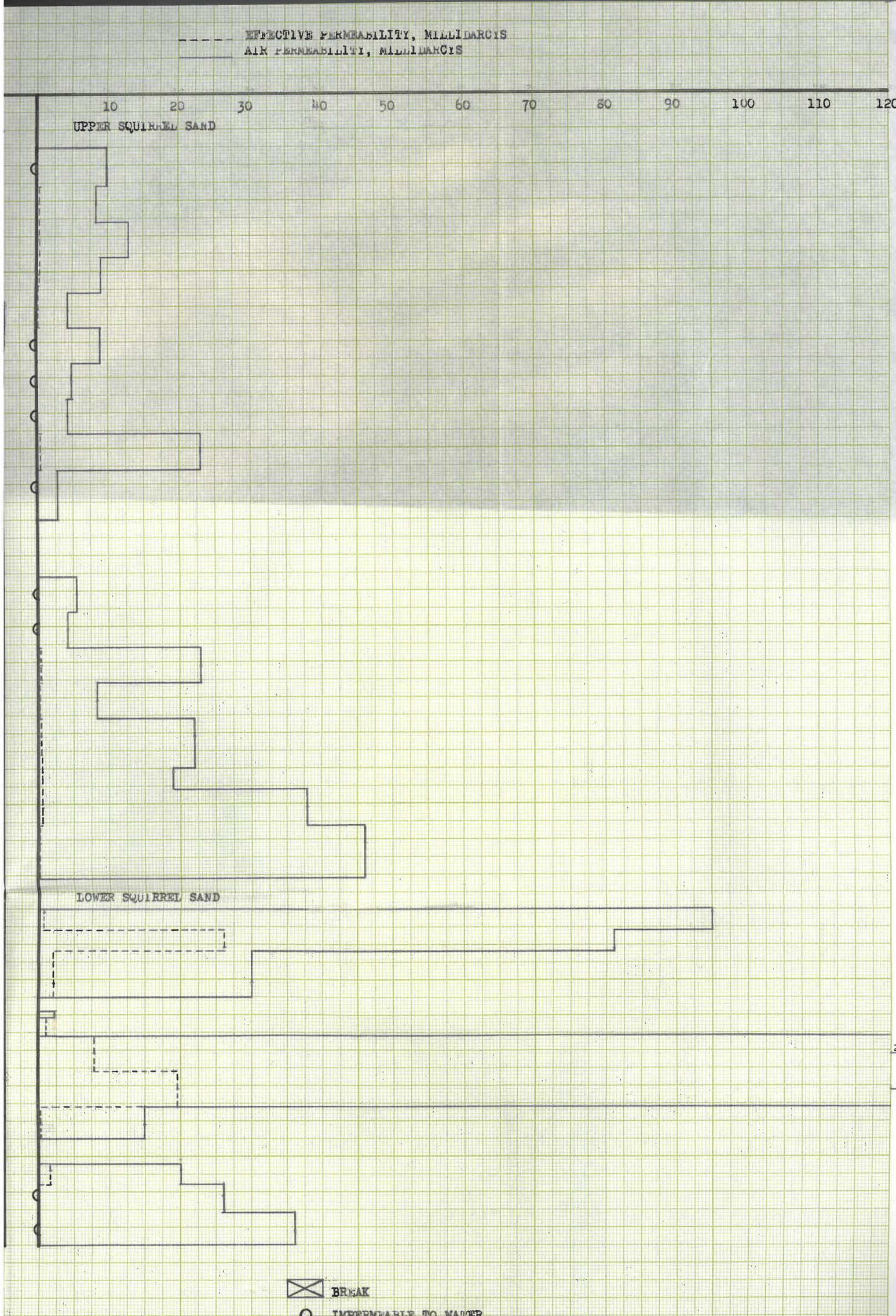
SUMMARY OF LABORATORY FLOODING TESTS

TABLE V

Company TEC Drilling Company, Inc. Lease Coffield Well No. 3

	UPPER SAND			LOWER SAND
Depth Interval, Feet	871.5 - 879.6	879.6 - 892.1	871.5 - 892.1	914.0 - 923.5
Feet of Core Analyzed	4.0	7.5	11.5	5.6
Average Percent Porosity	18.0	19.0	18.6	19.7
Average Percent Original Oil Saturation	55.0	57.7	56.7	60.2
Average Percent Oil Recovery	12.0	8.8	9.9	11.2
Average Percent Residual Oil Saturation	43.0	48.9	46.8	49.0
Average Percent Residual Water Saturation	53.2	47.8	49.6	48.2
Average Percent Total Residual Fluid Saturation	96.2	96.7	96.4	97.2
Average Original Oil Content, Bbls./A. Ft.	768.	850.	821.	921.
Average Oil Recovery, Bbls./A. Ft.	167.	131.	143.	172.
Average Residual Oil Content, Bbls./A. Ft.	601.	719.	678.	749.
Total Original Oil Content, Bbls./Acre	3,071.	6,377.	9,448.	5,160.
Total Oil Recovery, Bbls./Acre	668.	981.	1,649.	966.
Total Residual Oil Content, Bbls./Acre	2,403.	5,396.	7,799.	4,194.
Average Effective Permeability, Millidarcys	0.22	0.33	0.30	8.51
Average Initial Fluid Production Pressure, p.s.i.	42.5	38.9	40.1	18.1

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



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

COMPANY, INC.

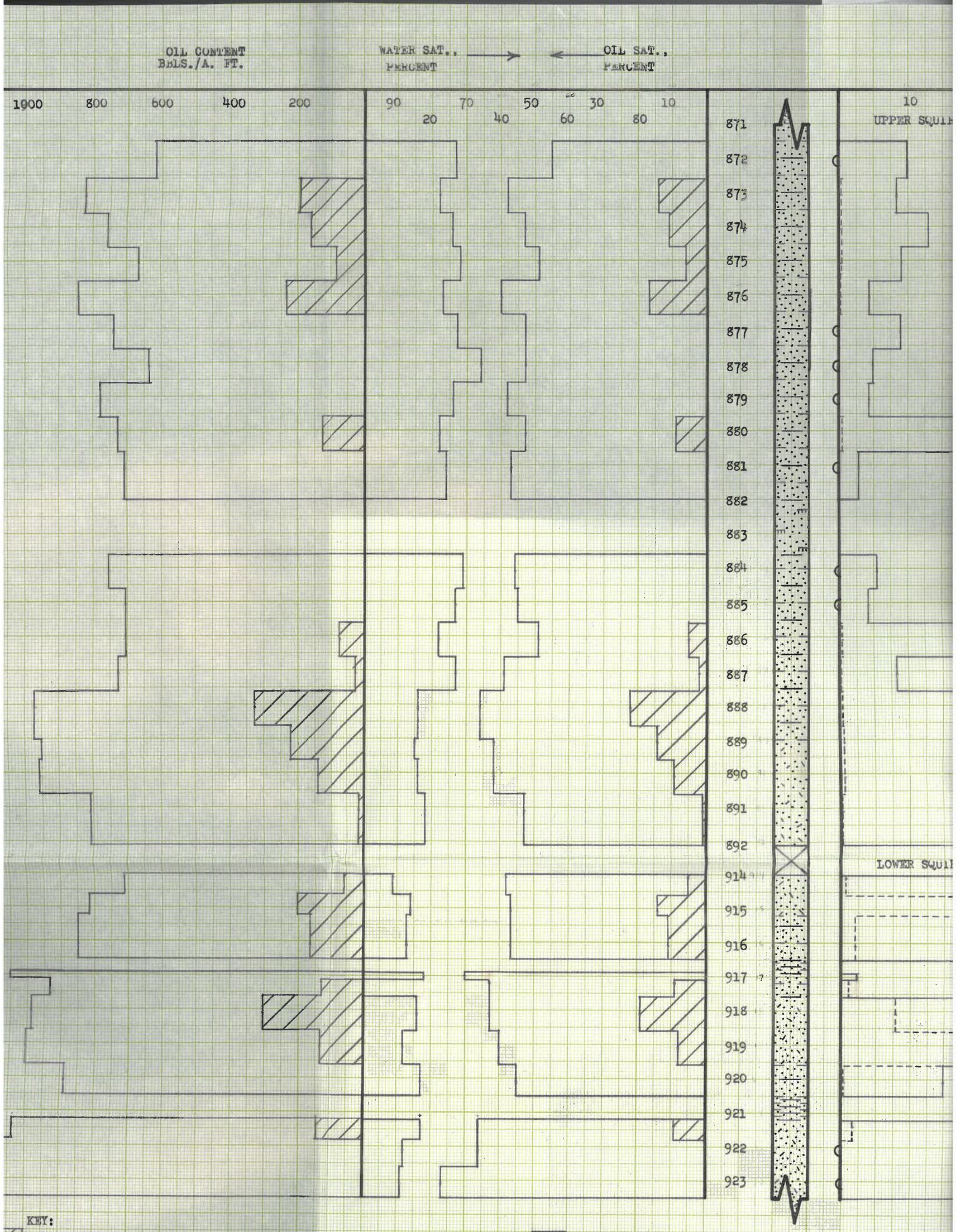
WELL NO. 3

TY, KANSAS

AVG. OIL CONTENT BBLS./A. FT.	TOTAL OIL CONTENT BBLS./ACRE	AVG. AIR PERMEABILITY MILLIDARCYS	CALCULATED OIL RECOVERY BBLS./ACRE

KEUFFEL & ESSER CO. STANDARD CROSS SECTION MILLIMETER

IRREL SAND



KEY:

- FLOOD POT RECOVERY
- CARBONACEOUS SANDSTONE
- SHALY SANDSTONE
- CALCAREOUS SANDSTONE
- SANDY SHALE

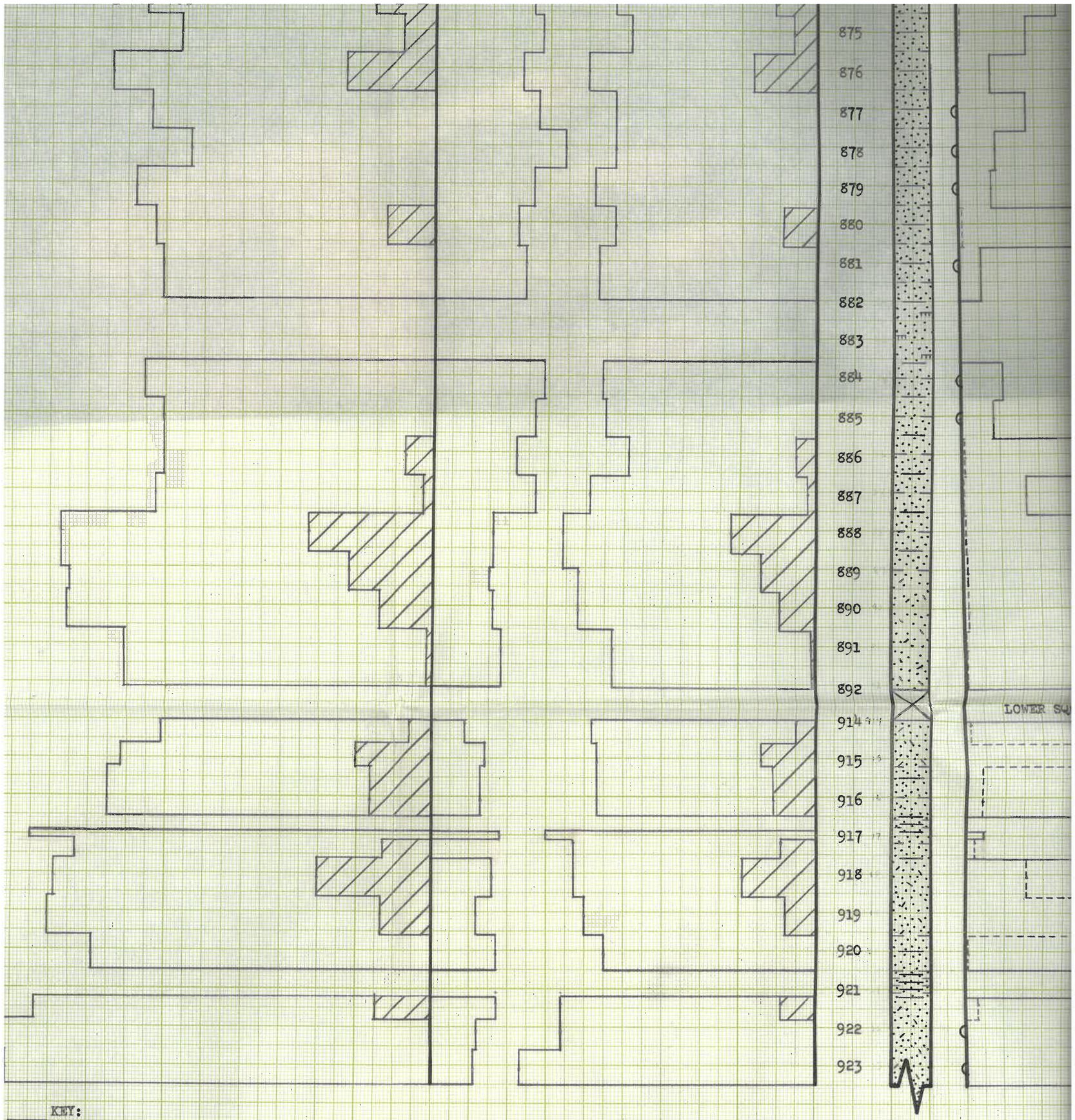
TEC DRILLING COMPA

COFFIELD LEASE WELL NO. 3

WOODSON 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.	TO CO BBL

UPPER SQUIRREL SAND



KEY:

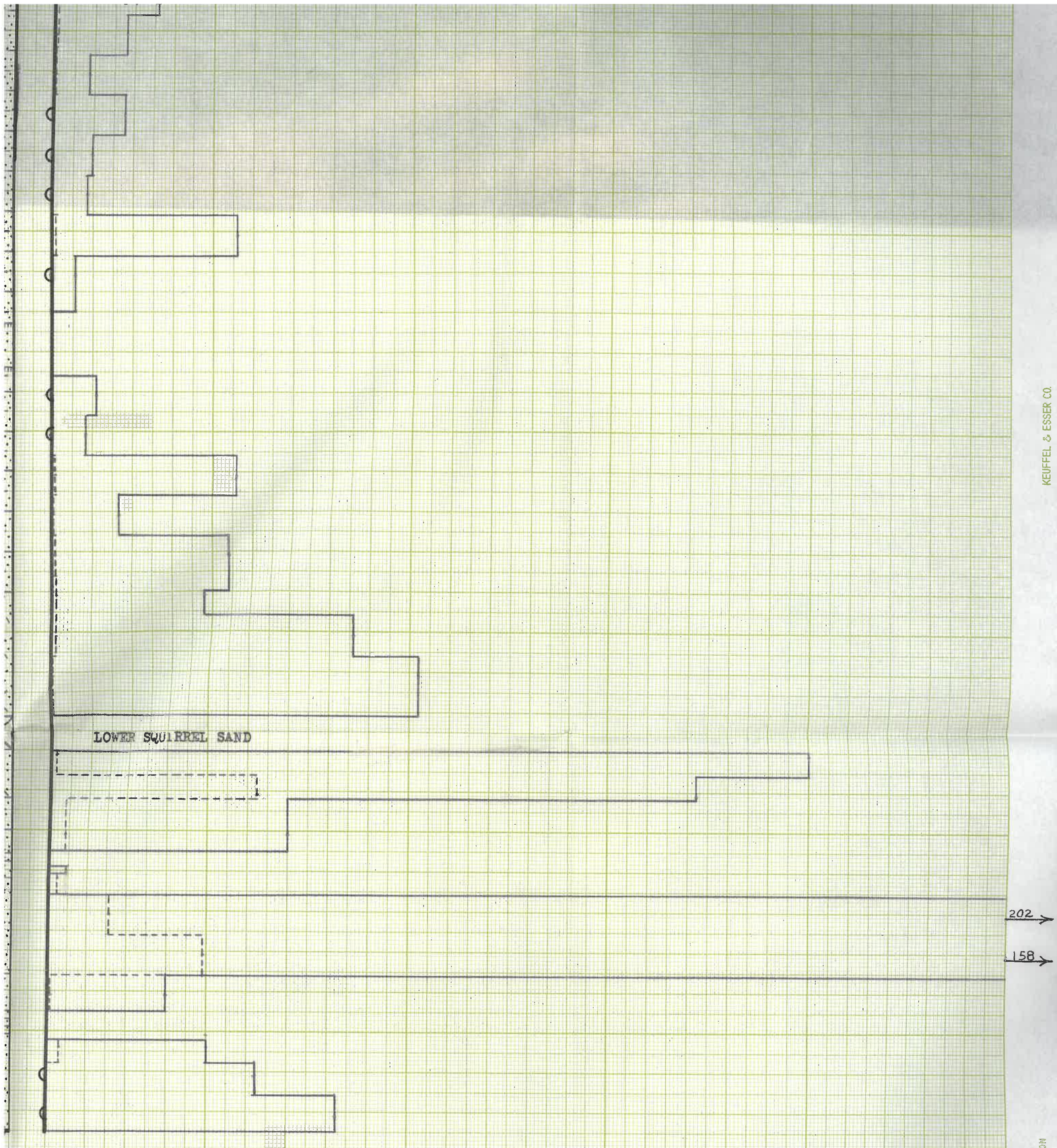
- FLOOD POT RECOVERY
- CARBONACEOUS SANDSTONE
- SHALY SANDSTONE
- CALCAREOUS SANDSTONE
- SANDY SHALE

TEC DRILLING COMPA

COFFIELD LEASE WELL NO.

WOODSON 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.
				UPPER SQUIRREL SAND	
871.5 - 879.6	8.1	17.6	53.5	26.6	732
879.6 - 892.1	10.9	18.0	56.2	21.6	799
871.5 - 892.1	19.0	17.8	55.6	23.7	771
				LOWER SQUIRREL SAND	
914.0 - 923.5	8.4	19.2	62.2	13.6	952



COMPANY, INC.

WELL NO. 3

TY, KANSAS

	AVG. OIL CONTENT BBLS./A. FT.	TOTAL OIL CONTENT BBLS./ACRE	AVG. AIR PERMEABILITY MILLIDARCYS	CALCULATED OIL RECOVERY BBLS./ACRE
IRREL SAND				
	732	5,927	7.8	
	799	8,715	19.9	
	771	14,642	14.8	2,830 (Primary & Secondary)
IRREL SAND				
	952	8,005	73.6	1,680 (Primary & Secondary)

OILFIELD RESEARCH LABORATORIES
CHANUTE, KANSAS
DECEMBER, 1967