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PRELIMINARY INVESTIGATION OF LANSING-KANSAS CITY CARBONATE RESERVOIRS OF WESTERN KANSAS

By

Harold A. Brown

CENTRAL DIVISION GEOLOGICAL REPORT NO. 13

September, 1962

CONTENTS

PAGE

INTRODUCTION 1

PURPOSE 1

ECONOMICS 1

DISCUSSION - SUMMARY 4

PRELIMINARY STRATIGRAPHIC STUDIES 5

NATURE OF SEDIMENTATION THROUGHOUT PENNSYLVANIAN TIME 5

CYCLES OF SEDIMENTATION WITHIN PENNSYLVANIAN SYSTEM 6

EXAMINATION OF "J" ZONE 6

REFERENCES 7

ENCLOSURES

1. MAP SHOWING DISTRIBUTION OF LANSING-KANSAS CITY PRODUCTION
2. FIELD PRODUCTION CURVES
3. FIELD PRODUCTION CURVES
4. PERCENTAGE OF FIELDS VERSUS CUMULATIVE PRODUCTION
5. CROSS SECTION A-A'
6. CROSS SECTION B-B'
7. STRUCTURE MAP - EUBANK FIELD, HASKELL COUNTY, KANSAS, TOP LANSING-KANSAS CITY "J" ZONE
8. BLOCK DIAGRAM OF A PORTION OF EUBANK FIELD, HASKELL COUNTY, KANSAS
9. BARRELS RECOVERED PER WELL VERSUS ACRES DRAINED PER WELL

TABLE I - PRODUCTION AND ECONOMIC DATA CHART

PRELIMINARY INVESTIGATION OF LANSING-KANSAS CITY CARBONATE RESERVOIRS OF WESTERN KANSAS

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INTRODUCTION

In Kansas, the hydrocarbon productivity of the Lansing-Kansas City groups has been established for many years. It was probably in Butler County, during the year 1914, that the first extensive Lansing-Kansas City production was discovered. It was during that year that the Augusta Oil Field was discovered, followed the next year by the discovery of the El Dorado Field, also in Butler County.

Since the early days of exploration, Lansing-Kansas City production has been established at various points throughout the western two-thirds of the state. It is in north central Kansas, in the area of the Central Kansas Uplift, that the Lansing-Kansas City along with other horizons has been the most prolific. However, in the last ten years it has become increasingly apparent in western Kansas that the Lansing-Kansas City has significant productive potential.

For many years much of the oil industry believed Lansing-Kansas City production to be controlled largely if not entirely by structure. There is a need to establish whether or not this concept is true or even partly true, particularly in the relatively undeveloped western portion of Kansas.

PURPOSE

The purpose of this preliminary report is twofold:

(1) To investigate and evaluate the economic aspect of Lansing-Kansas City production in terms of present day drilling costs, crude oil prices, and past production performance.

(2) It is also the purpose of this report to describe and gain a better understanding of the factors which control production from the Lansing-Kansas City in the Eubank Field, Haskell County, Kansas.

ECONOMICS

Carbonate reservoirs in Lansing-Kansas City rocks of Pennsylvanian age are characterized by thin pay zones which occasionally are of very limited areal extent. In spite of this fact, however, the Lansing-Kansas City has yielded an impressively large amount of oil. As of January 1, 1960, the cumulative oil production in Kansas was placed at 3-1/4 billion barrels (Goebel et al, 1960). Oil production from Pennsylvanian carbonate rocks (Lansing-Kansas City and Marmaton) has been estimated at 683,832,127 barrels, or 21% of the cumulative Kansas oil production. Only the Arbuckle-Reagan exceeds this figure, having produced approximately 1-1/2 billion barrels or 45% of the cumulative total.

In the western two-thirds of the state (west of the red line on Exhibit No. 1), 1474 oil fields were actually counted (derived from production data given by Goebel et al, 1960). Of this total there are 760 oil fields producing from Pennsylvanian carbonate reservoirs (colored in green or yellow on Exhibit No. 1). This represents 52% of the total oil fields in western Kansas. It should be noted that many of the Pennsylvanian oil fields are also productive from other horizons such as Arbuckle or Mississippian rocks.

Of these 760 oil fields, there are 334 fields which produce from Lansing-Kansas City rocks only. Data from these 334 fields are shown on Exhibit No. 4 where the number of fields (expressed in percentage of the total) is plotted against cumulative production. It is shown here that 62% of these fields have recovered less than 100,000 barrels per field. Ninety-four per cent of these fields are class E (less than 1,000,000 barrels). Six per cent are class D (1-10,000,000 barrels of oil). The largest known field is the Laton Field in Rooks County which has produced slightly over 6,000,000 barrels of oil to date.

Data pertaining to all of the Central Division indicate that 82% of all oil fields are class E, while 18% of all fields are class D or larger.

Detailed analysis of individual field performances have given much information as to the economic feasibility of Lansing-Kansas City production. Thirty-three fields listed on Table I were selected for evaluation for the following reasons:

(1) The selected fields produce from only the Lansing-Kansas City horizon. (Production data reported by Vance Rowe Oil Reports in Kansas is given by field or lease without respect to the amount of oil from a certain horizon. Therefore, in fields with multiple pay horizons it is impossible to evaluate the Lansing-Kansas City accurately).

(2) The fields range in size from small volume to large volume reservoirs. Correspondingly, the number of wells also range from a few (two) to many (175).

(3) Wide geographic representation.

(4) The fields selected are older fields ranging in age from nearly seven years to 35 years. Production from fields drilled in the last few years has not declined sufficiently to enable an accurate prediction of the expected life or ultimate recovery from the fields.

In addition to the listing on Table I, annual production curves for eleven of the fields are shown on Exhibits Nos. 2 and 3. Data shown on these enclosures have been extracted from a variety of sources which are: Vance Rowe Oil Reports; Kansas Corporation Commission; Goebel et al, 1961; Pan American Base Maps; Sterling, 1959; Oil Scouts Yearbook.

The three production curves on Exhibit No. 2 are plotted on identical vertical scales. This was done so that one field performance may be compared to another. The fields on this exhibit each have more than 50 wells, while the field production curves on Exhibit No. 3 each have less than 50 wells. The curves on Exhibit No. 3 are also shown on identical scales with the exception of the Sun City Field which had a very high average annual production per well.

Commonly, the annual production curve reaches a peak during the first few years of the life of the field and then declines rather sharply to a point where the decline becomes nearly horizontal. This type of curve seems to be characteristic of a reservoir with gas solution drive.

In several instances, on Exhibits Nos. 2 and 3, additional wells were drilled in certain fields after the annual production curve had started to decline. In nearly all cases neither production curve illustrated was raised significantly because of the additional wells drilled. It is probable that the area drained by the newly drilled wells was being drained by a previously existing well or wells.

Therefore, the wells were drilled too close together and the expense of additional wells was not necessary to achieve maximum recovery. Sun City, Rosedale, Prairie View (Exhibit No. 3) and Adell and Huffstutter fields (Exhibit No. 2) illustrate this point very well. Obviously the ultimate ROI would be significantly reduced in these cases.

Although information is generally inconclusive, secondary water flooding increases Lansing-Kansas City recoveries by factors ranging from 52% of the primary recovery in Hall-Gurney Field in Russell County (Sterling, 1959) to 75% of primary recovery in Fairport Field in Ellis County (personal communication with Division Production Department). A discussion of Lansing-Kansas City secondary recovery potential is outside the scope of this report; however, it is interesting to note that all of the data presented on Table I pertain to primary recovery and that ultimate recoveries could be raised by the factors mentioned above.

The data presented under Column 1, Table I, represent the estimated area drained by each field. This includes total area inside the delineating dry holes.

Column 2 shows the cumulative production for each field up to January 1, 1962. In the cases where the field is under water flood, secondary recovery is included in this figure. Fifteen of the fields shown are class D fields, while the remainder are class E fields. The mean cumulative production per field is 1,432,000 barrels.

Column 3 shows the cumulative primary production for each field. In the cases where certain fields are not under flood the total primary production is the same as the cumulative total shown under Column 2. The figure shown under Column 3 is the value used to compute all of the data under succeeding columns presented on Table I.

Column 4 shows the primary field recovery per acre. The values vary quite widely ranging from 710 barrels per acre up to 3900 barrels per acre. Gas-oil ratio, crude gravity, water saturation, type and amount of reservoir porosity and net feet of pay are all responsible for this variation. Some of the reservoir properties will be delved into later in this and following reports. The mean field recovery is 1685 barrels per acre.

Column 5 shows the mean primary recovery per well in each field. It is interesting to note that most of the small recoveries per well are confined to the fields that are apparently draining less than 40 acres per well. The mean recovery per well in these fields is 42,215 barrels. Conversely, the mean recovery per well in the fields where the wells are apparently draining 40 acres or more (indicated by #) is 70,107 barrels of oil. In addition to the previous discussion of the field production curves (Exhibits Nos. 2 and 3), it is again apparent that a large portion of the wells are not allowed to drain a large enough area.

Column 6 shows the maximum number of producing wells that have been drilled in each field. The number of wells presently producing in each field are shown on Exhibits Nos. 2 and 3 and may be considerably less than shown under Column 6. Also shown is the average area drained per well in each field.

Column 7 shows the estimated cost of drilling a well to the depth indicated. Estimates are based on Pan American's current drilling experience in western Kansas.

Column 8 shows the calculated field ROI. For comparison purposes the fields are again separated into the closely spaced fields (less than 40 acres per well) and the widely spaced fields (40 acres or more). The closely spaced fields have an indicated ROI ranging from .16 up to 5.3 with most of them closer to 1 or less. The mean ROI for these fields is 1.59.

Since it has been shown that the more widely spaced fields recover more oil per well, the ROI would naturally be vastly improved. The ROI listed under Column 8, for the widely spaced fields, indicates a mean ROI of 2.9 which will yield almost twice the monetary return as the closely spaced fields.

Column 9 shows the estimated ROI for each field if that field were actually draining 40 acres per well. All of the closely spaced fields become much more attractive if developed on wider spacing. The average estimated ROI for these fields is 3.0 which seems to be corroborated by the fact that the fields that actually are draining about 40 acres per well have an ROI of 2.9.

Column 10 shows the estimated field ROI if that field were actually draining 80 acres per well. In this case the field ROI ranges from 2.1 up to 17. The mean of these values is 7.

Column 11 shows the year that secondary water flooding projects were started in each field.

DISCUSSION - SUMMARY

It has been shown that a large portion of Lansing-Kansas City fields in Kansas was drilled by spacing development wells too close together. Nearly all of these wells are capable of draining a much larger area than permitted to drain. Hence, the recovery per well and the ROI is proportionately lower.

The 33 points plotted on Exhibit No. 9 represent the same 33 fields listed on Table I. The mean curve (representing the mean field recovery of 1685 barrels per acre) demonstrates that a well draining 40 acres will recover twice as much oil as an identical well draining 20 acres. Obviously, the monetary return would be increased significantly due to the reduced drilling costs.

In view of this evidence it seems very desirable to space the wells as far apart as practical. Projection of the mean curve up to 80-acre drainage indicates that a well could be expected to recover about 132,104 barrels of oil. The ROI in this case could be expected to vary as high as 17 which is highly desirable (Table I, Column 10).

The current practice in western Kansas is to drill Lansing-Kansas City fields on the wider 80-acre pattern. None of this production is old enough to establish a reliable production decline curve. However, according to the Central Division Production Department, an 80-acre block drained by one well will yield about 2% less oil than if it were drained by eight wells spaced on ten acres per well. Compared to the sharply decreased drilling cost, the 2% loss in ultimate recovery is insignificant.

In recent years, per well allowables set by the Kansas Corporation Commission have encouraged wider spacing.

The evidence indicates that the probability of finding large reserves in a single field is small. However, considering the Lansing-Kansas City in general, a very large amount of the oil in Kansas has been extracted from this horizon. Obviously this large amount of oil has been extracted from relatively smaller but very numerous fields.

Since the Lansing-Kansas City underlies nearly all of western Kansas, it seems logical to reason that a large amount of oil remains to be found in the less well developed areas.

Therefore, with more knowledge and better exploration tools, these smaller but numerous oil reservoirs should be economic and continue to account for a very large amount of the oil produced in Kansas.

PRELIMINARY STRATIGRAPHIC STUDIES

Lithologies strongly indicate deposition in very shallow water shelf type, marine carbonate environment not dissimilar to such modern day carbonate environments as Great Bahama Bank, Florida Bay and the coastal areas of Cuba. By comparison to these modern carbonate environments it is amazing that these conditions prevailed during Lansing-Kansas City time to the extent of covering many thousands of square miles. Northward, the Lansing-Kansas City maintains its shallow water characteristics well into Nebraska and perhaps much farther. Westward these same characteristics are carried well into the Colorado subsurface where the entire Pennsylvanian system systematically loses its identity in the arkosic facies of the Fountain conglomerate.

To the south, dipping into the Anadarko Basin, the Lansing-Kansas City rather abruptly changes facies from light colored shelf type carbonate deposits to dark shale and dark basin type carbonates. This line of change lies slightly south of the Kansas-Oklahoma line and runs about West-Northwest to East-Southeast across Beaver, Woodward, and Major counties in Oklahoma.

Extensive electric log correlation work was done throughout most of the Hugoton Embayment area in western Kansas. Descending the section from the top of the Missourian, each carbonate zone is designated A, B, C and so on to the base of the R zone which probably represents the base of the Marmaton group and the top of the Cherokee group (left margin of Exhibits Nos. 5 and 6). A similar zonation system was devised by Morgan (1952) in the area of the Central Kansas Uplift. A regional cross section revealed that there is no correlation between the two areas.

Surprisingly, electric log correlations will carry each zone for moderately long distances. However, later sample work revealed that varied lithologies existed in each zone and that certain facies could be carried laterally very short distances. This observation seems to indicate the distinct possibility of stratigraphic accumulation of hydrocarbons in the Lansing-Kansas City groups.

NATURE OF SEDIMENTATION THROUGHOUT PENNSYLVANIAN TIME

It is apparent that vertical movement of the Anadarko Basin and surrounding areas continued in a single direction during Pennsylvanian time. With variable rates of subsidence of the trough floor and surrounding areas, the sea maintained its general tendency to deepen, and lithologic variations result from variations in the rate of trough subsidence and the rate of sediment deposition. When sinking predominates there is transgression, and when sedimentation prevails there is regression and regressive deposits are the result (Sears et al, 1941). Since sedimentation prevails during regression, the basin and shelf areas are slowly becoming filled with sediments; thus forcing the sea to retreat. Under conditions of basin filling, the rocks at the base of a given interval would naturally be deposited in relatively deeper water than the rocks at the top of the interval. In western Kansas this phenomenon is recognized in the overall interval from the top of the "Morrow" to the top of the "B" zone (Lansing). Dark colored shale and carbonate rocks were deposited at the base of this interval. Ascending the section, the depositional environments systematically alternate between relatively deeper to very shallow. However, the general upward trend is for the rocks to become much lighter in color with white chalk, oolitic and bioclastic zones representing the shallowest environments.

The criteria for establishing environments are based primarily on rock color, texture and fabric. Faunal assemblages being not well defined or limited to any particular type of rock are of limited value. However, the deeper water rocks generally contain more crinoid remains while the shallower water rocks reveal more brachiopod-pelecypod fragments. Fusulinids and possibly algae are found mostly in the chalky, white colored rocks.

CYCLES OF SEDIMENTATION WITHIN PENNSYLVANIAN SYSTEM

Detailed work with cores and drill cuttings has been done in Haskell, Seward and Finney counties in western Kansas. It is in this area that four major cycles of sedimentation are discernable within the interval from the top of the "Morrow" to the top of the Lansing. The stratigraphic positions of these cycles are indicated in the left margin of Exhibits Nos. 5 and 6. The rocks at the base of each cycle were deposited in relatively deeper water than the rocks at the top of each cycle. This depositional pattern is similar to the overall sequence previously described. The rocks at the base of each cycle are brown to gray micrites, dense (lithographic) and rarely porous. The shales throughout the section are black to dark gray. Gradually upward the carbonate rocks become lighter colored through shades of brown, tan and white. The lighter colored rocks are also less indurated.

The sediments near the top of each cycle were deposited above wave base representing the shallowest depositional environment. It is in these zones that oolites, occasionally mixed with various amounts of bioclastic debris, are found. It is also from these high energy zones that the vast majority of production has been found.

EXAMINATION OF "J" ZONE

Each zone within a sedimentary cycle probably represents a minor regression. Following the same pattern previously described, the rock at the base of each zone was deposited in deeper water than rock at the top.

In the Eubank Field, 28S-34W, Haskell County, Kansas, the "J" zone (top of second cycle) is productive in several locations indicated on Exhibits Nos. 7 and 8. Because cores in this zone are available, most detailed stratigraphic work to date has been confined to this area.

Oolite grain size varies vertically as well as laterally, as shown on Exhibits Nos. 5 and 6. The larger oolites were found at the top of the zone with a gradual decrease in size toward the bottom. This is further evidence that the top of the zone was deposited in shallower water (in higher wave energy) than the bottom of the zone. Individual grain size also varies in a lateral direction with the coarser particles being deposited gradually to the southwest. This indicates that as the sea floor slowly became shallower the sea was forced to retreat to the southwest. Hence the depositional strike of this zone was from northwest to southeast. This zone is interpreted as a marine bank with oolites deposited at the top where the sea floor is the shallowest.

It is interesting to note that the oil occurs in the thickest part of the "J" zone (Exhibit No. 8). The production also occurs in the oolitic zone of intermediate particle size and not the larger size as might be expected. Data plotted on Exhibit No. 5 indicate an increase in permeability toward the isopach thick. Visual inspection of cores reveal that the oolite grains are tightly cemented southwest of the thick trend, but fair to good interparticle porosity is found in the thick trend. Considering this information, it is somewhat apparent that the hydrocarbons were in place very shortly after burial. The block diagram (Exhibit No. 8) shows in three dimensions the thickness of the "J" zone which represents the structure on this horizon very shortly after burial. It can be seen that the gas accumulated in the thickest area with the oil appropriately accumulating "down-dip" from the gas. All of the wells which found the "J" zone less than about 45 feet thick encountered small amounts of water, and in a few cases small amounts of oil.

During Laramide time the Pennsylvanian strata underlying western Kansas ~~was~~ were tilted from west dip to what is seen today as easterly regional dip. Accompanying this movement many of the pre-Pennsylvanian structures such as Eubank were rejuvenated and tilted slightly.

If the oolites in the "J" zone became tightly cemented sometime after the hydrocarbons were in place and prior to Laramide time, it is entirely logical that trapped hydrocarbons would not shift position during low order structural tilting or rejuvenation.

If hydrocarbon accumulations did not shift, it is easily understood why the gas well in NW NE Section 20 (Exhibit No. 7) is five feet low to the oil well in SE SW Section 21. It is also pointed out that many of the wells to the west in Sections 20 and 29 are flat to slightly high to the producing wells but are nonproductive from the "J" zone.

Although the above inferences are made on data that in some cases are inconclusive, it is nevertheless apparent that Lansing-Kansas City production, in many areas at least, can be vitally controlled by adequate porosity rather than simple structural development only.

Work on the Lansing-Kansas City is still being done with the following objectives.

(1) To understand more completely the factors controlling lateral development of oolitic areas within certain zones. These factors should be understood more thoroughly to accurately predict an occurrence of these marine banks in less well developed areas.

(2) Inferences made in Eubank Field should be applied in other productive areas to determine their validity.

(3) Porosity and permeability occurrences as related to grain size and hydrocarbon accumulation must be more thoroughly understood.

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EXHIBIT 1 OF 9

MAP SHOWING DISTRIBUTION OF LANSING-KANSAS CITY PRODUCTION

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CENTRAL DIVISION

GEOLOGICAL CONSULTING GROUP
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INFORMATION SOURCE

VANCE-ROWE ; OIL SCOUTS YEARBOOK ; KANSAS CORP. COMM.

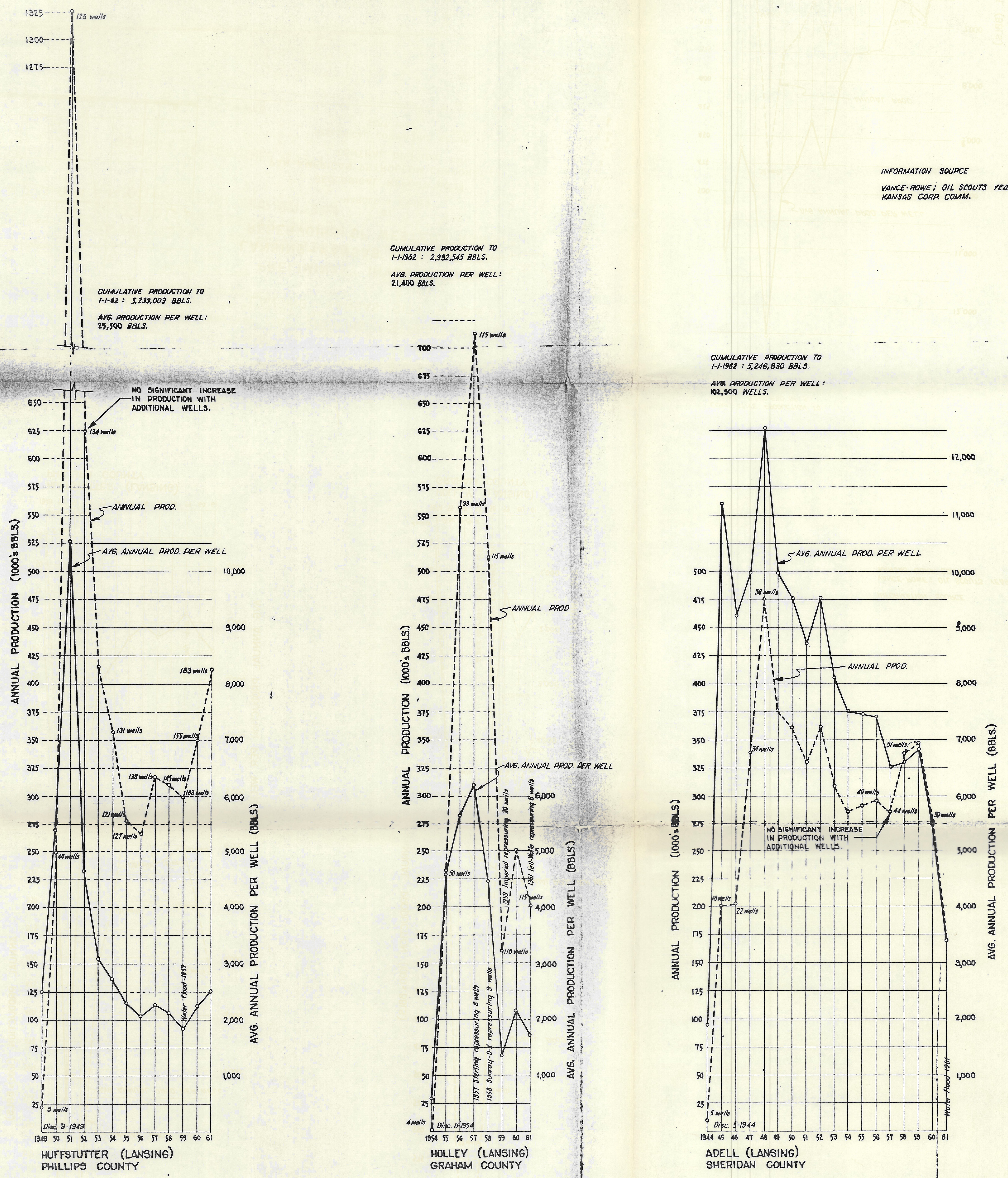

EXHIBIT 2 OF 9

FIELD PRODUCTION CURVES

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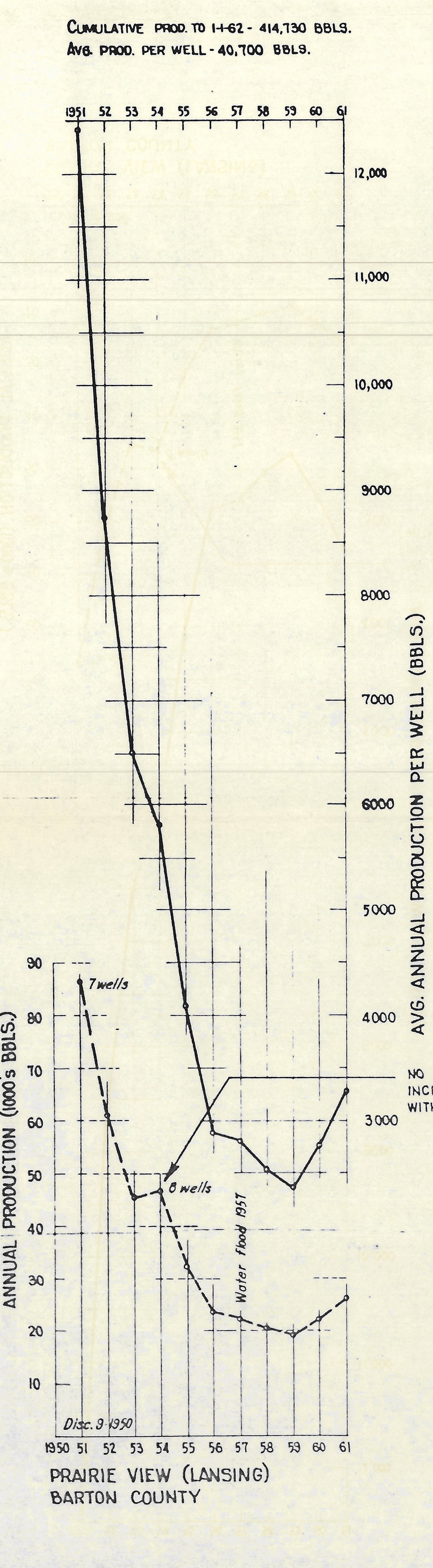
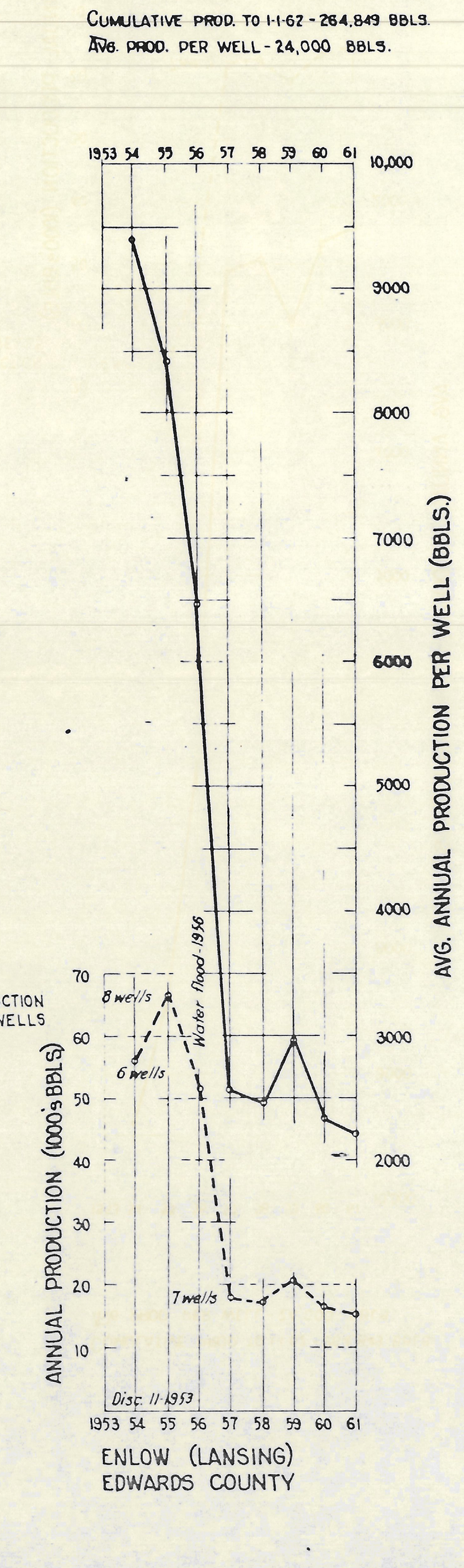
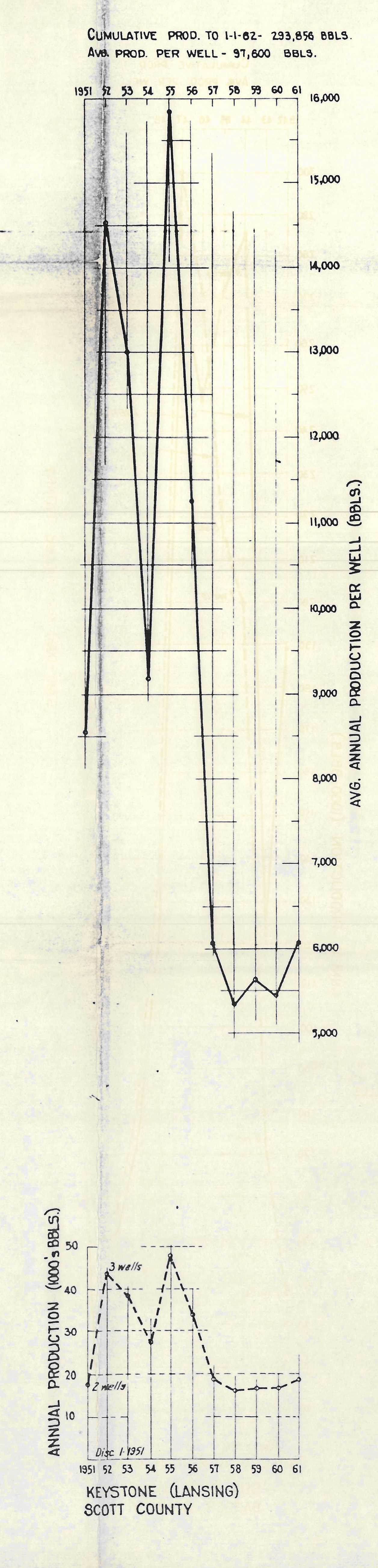
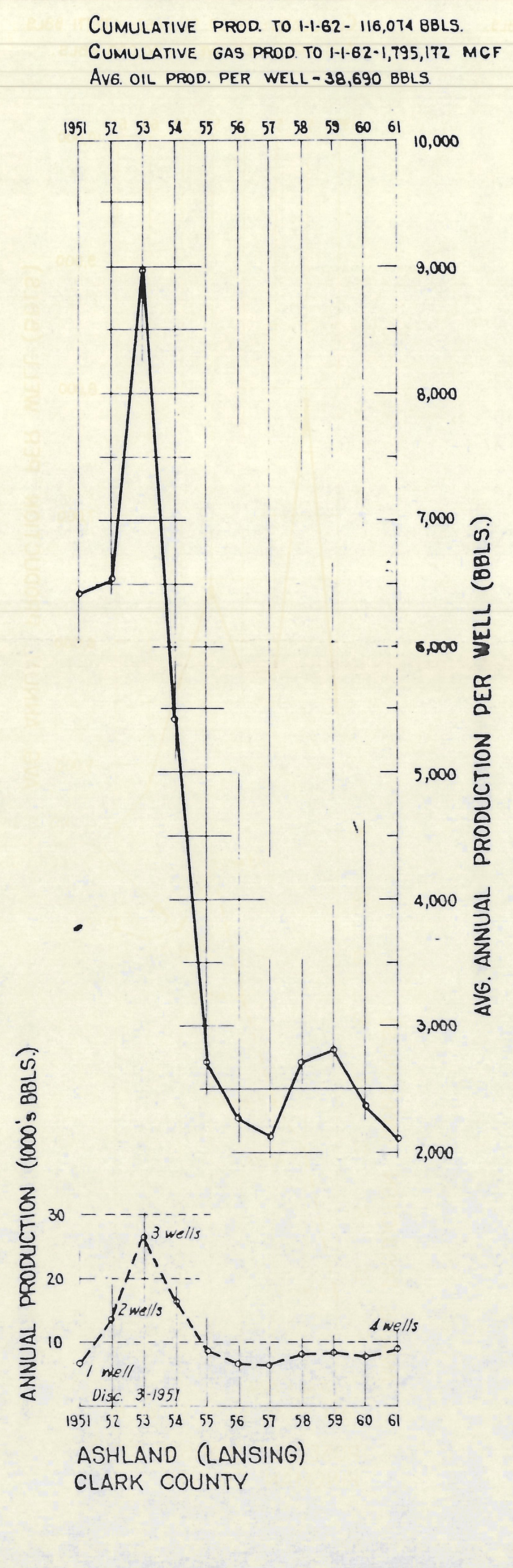
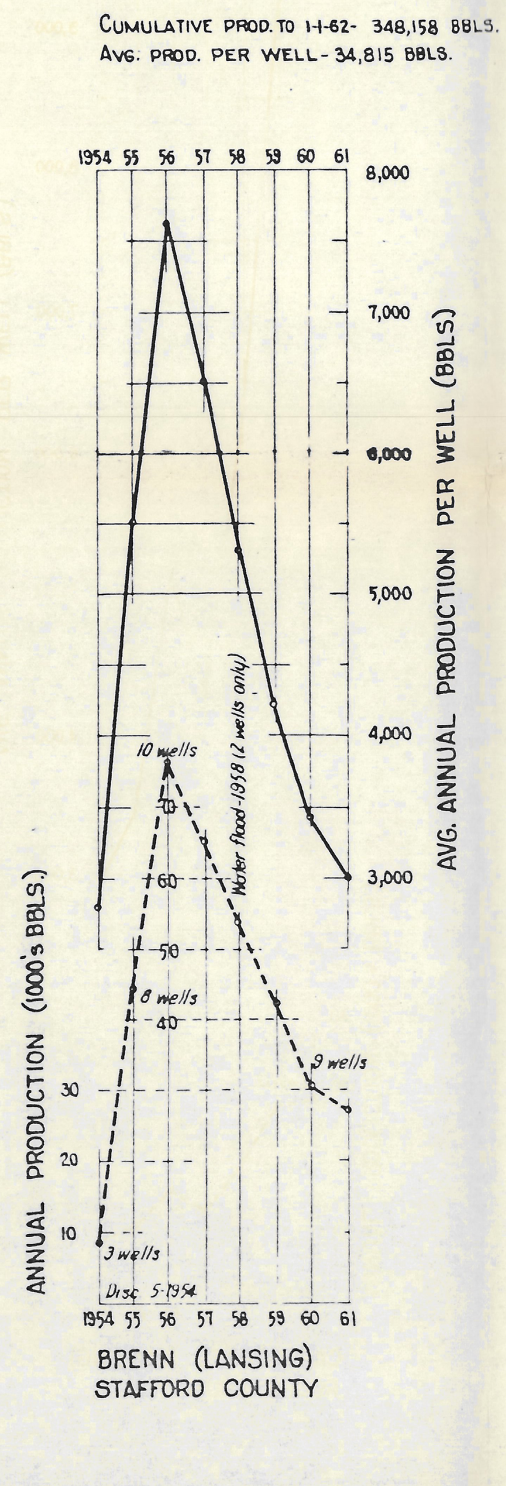


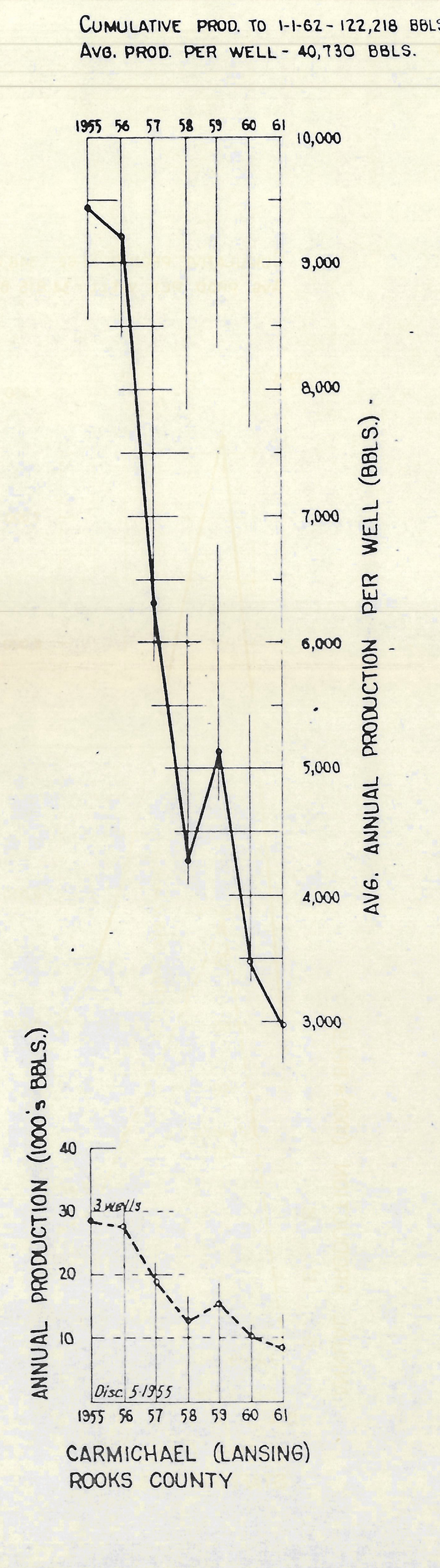


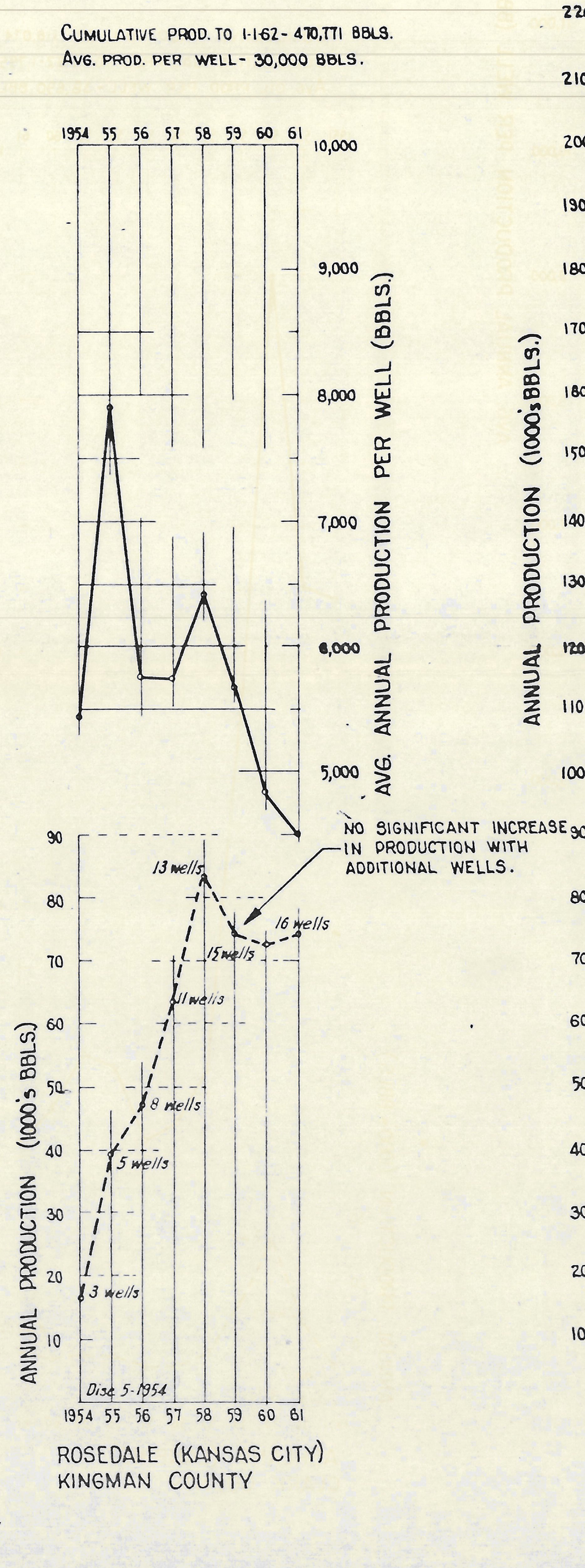




INFORMATION SOURCE :
VANCE ROWE; OIL SCOUTS YEARBOOK; KANSAS GEOLOGICAL SURVEY, OIL & GAS INVESTIGATIONS NO. 24-1960; KANSAS CORP. COMM.







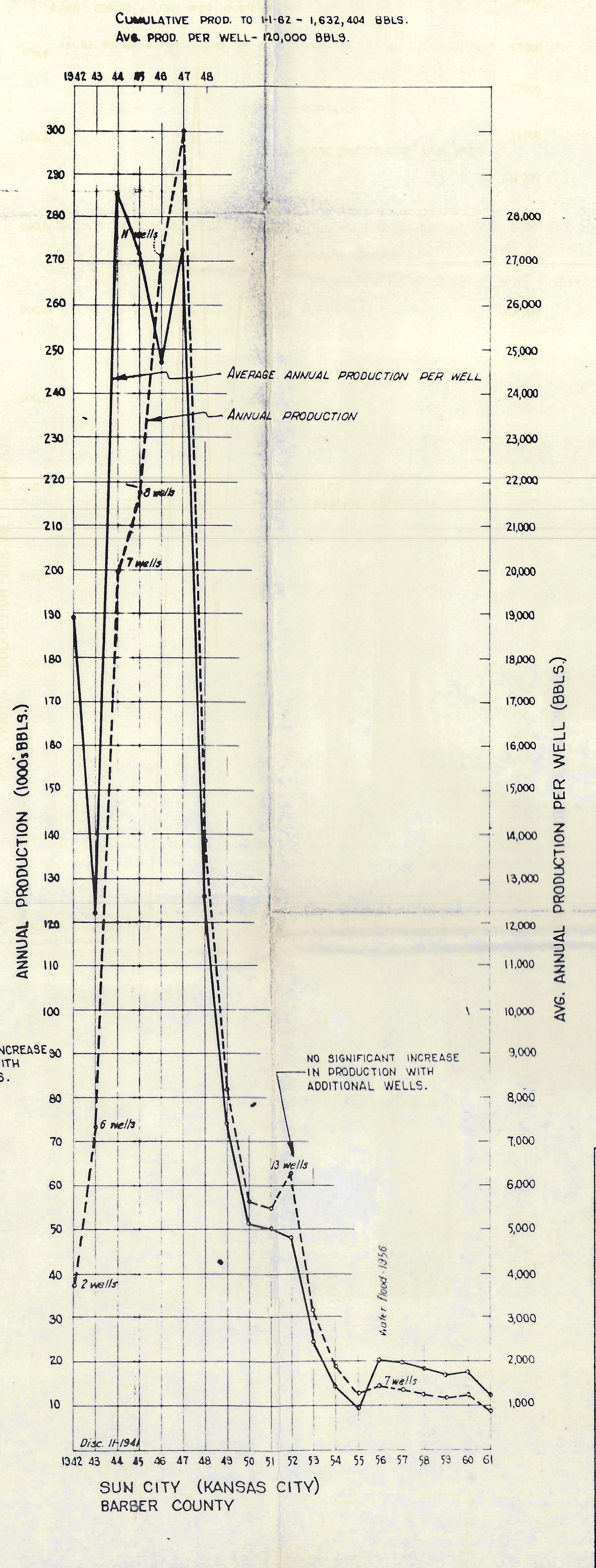


EXHIBIT 3 OF 9

FIELD PRODUCTION CURVES

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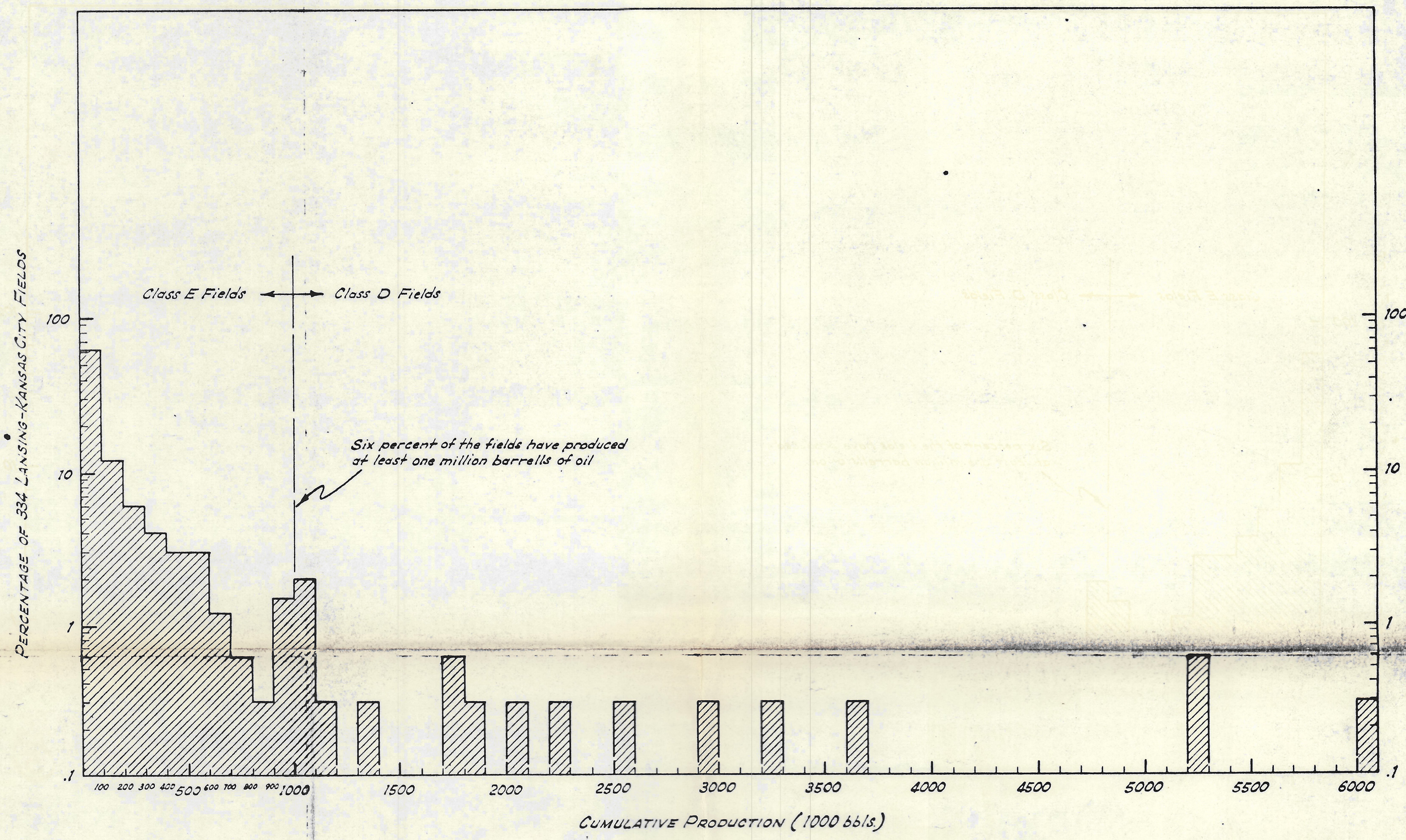

EXHIBIT 4 OF 9

PERCENTAGE OF FIELDS VERSUS CUMULATIVE PRODUCTION

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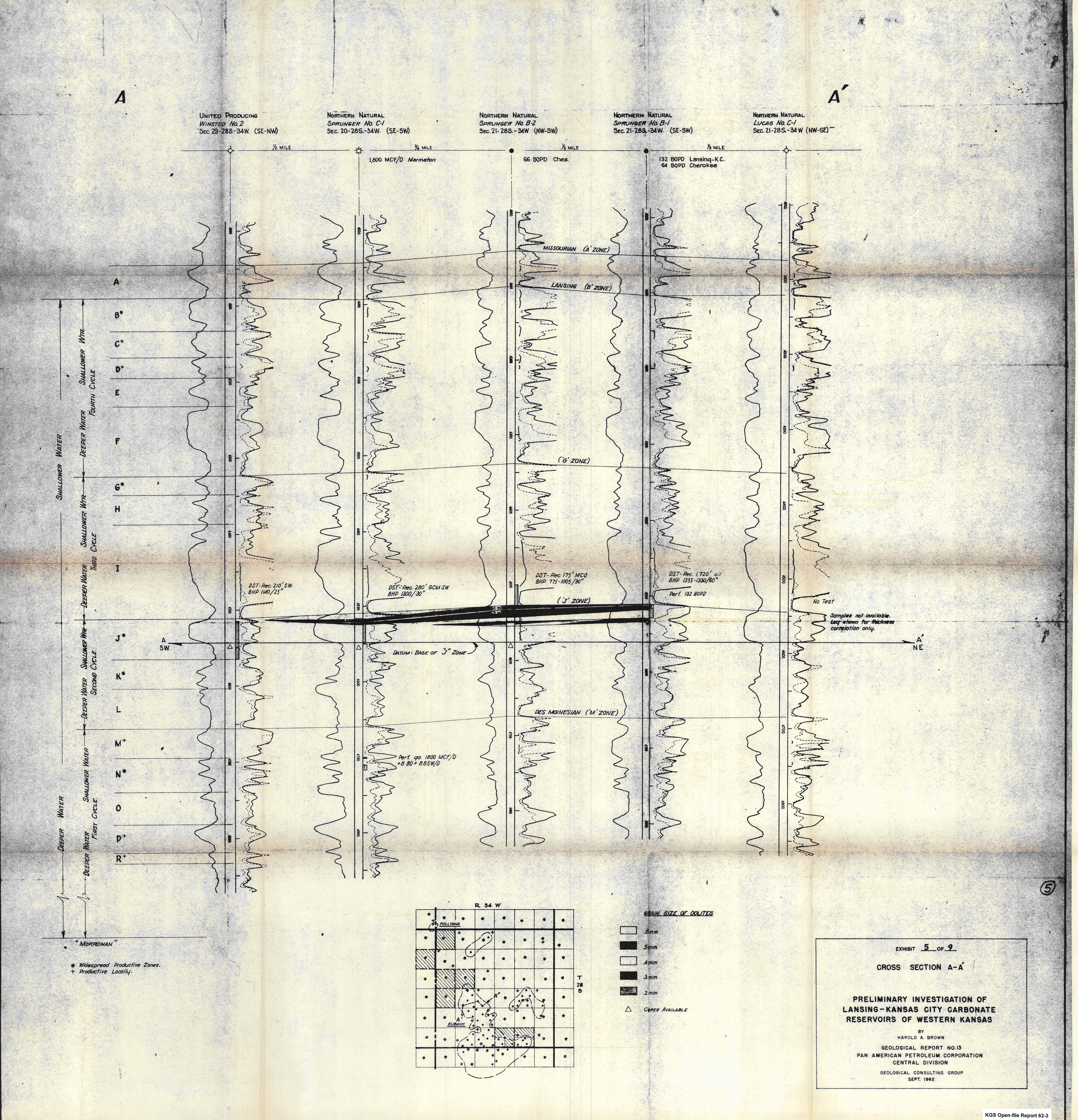
A
A′
United Producing
Winsted No. 2
Sec. 23-28S.-34W. (SE-NW)
Northern Natural
Sprunger No. C-1
Sec. 20-28S.-34W. (SE-SW)
Northern Natural
Sprunger No. B-2
Sec. 21-28S.-34W (NW-SW)
Northern Natural
Sprunger No. B-1
Sec. 21-28S.-34W. (SE-SW)
Northern Natural
Lucas No. C-1
Sec. 21-28S.-34W (NW-SE)
½ MILE
¾ MILE
⅓ MILE
⅓ MILE
1,800 MCF/D Marmaton
66 BOPD Ches.
132 BOPD Lansing-K.C.
64 BOPD Cherokee
MISSOURIAN ('A' ZONE)
LANSING ('B' ZONE)
('G' ZONE)
('J' ZONE)
DES MOINESIAN ('M' ZONE)
A
B*
C+
D+
E
F
G*
H
I
J*
K*
L
M+
N*
O
D+
R+
SHALLOWER WATER
DEEPER WATER
SHALLOWER WTR. DEEPER WATER FOURTH CYCLE
SHALLOWER WTR. DEEPER WATER THIRD CYCLE
SHALLOWER WTR. DEEPER WATER SECOND CYCLE
SHALLOWER WATER DEEPER WATER FIRST CYCLE
"MORROWAN"
DST-Rec. 210' SW. BHP 1140/25"
DST-Rec. 280' GCM SW BHP 1300/30"
DST-Rec. 175' MCO BHP 775-1005/30"
DST-Rec. 1,720' oil BHP 1355-1330/60"
Perf. 132 BOPD
No Test
Samples not available. Log shown for thickness correlation only.
A SW
A′ NE
DATUM: BASE OF "J" ZONE
Perf. ga. 1800 MCF/D + 8 BO + 8 BSW/D
* Widespread Productive Zones.
+ Productive Locally.
R. 34 W
POLLYANNA
EUBANK
T 28 S
GRAIN SIZE OF OOLITES
.6mm
.5mm
.4mm
.3mm
.2mm
CORES AVAILABLE
EXHIBIT 5 OF 9
CROSS SECTION A-A′
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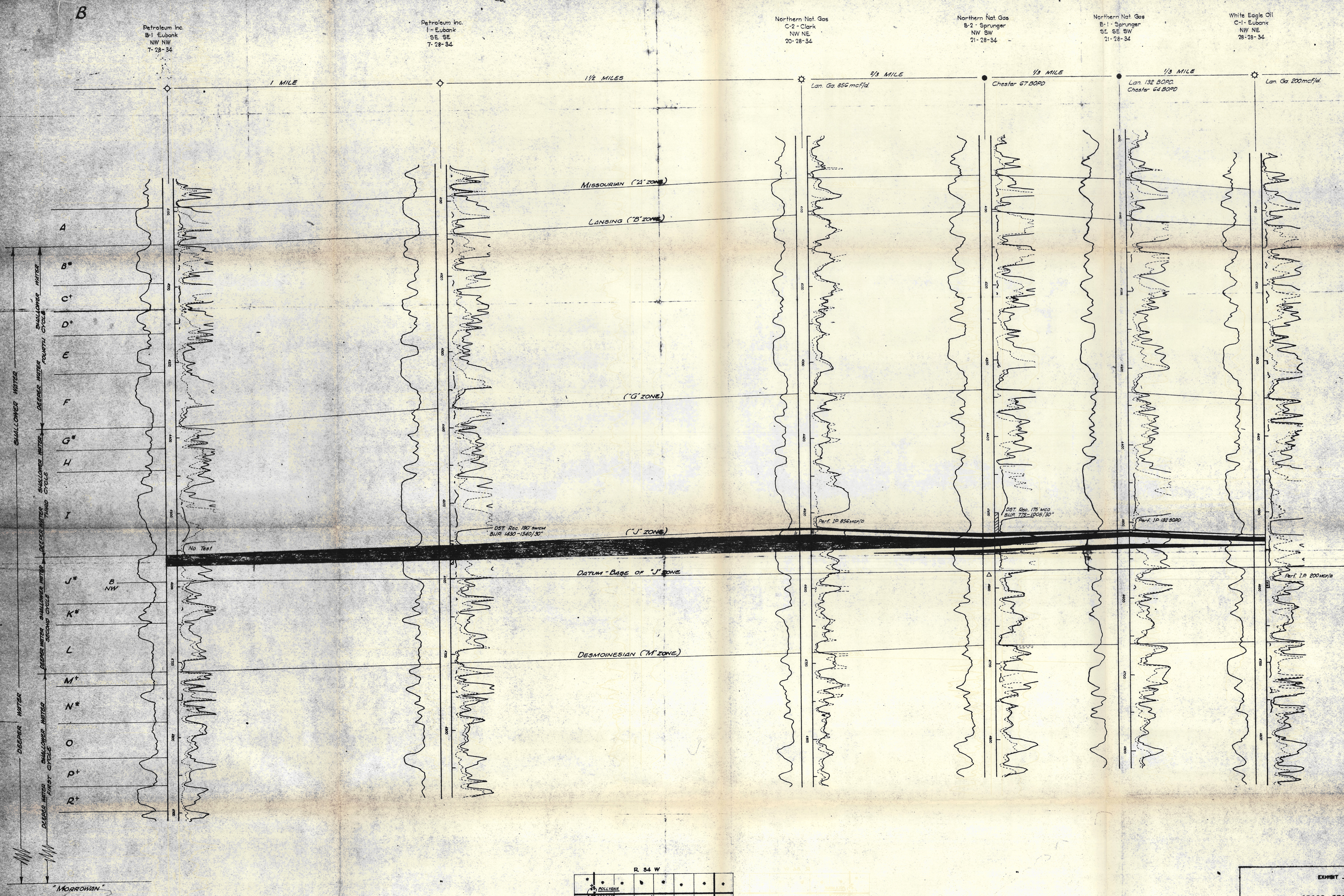
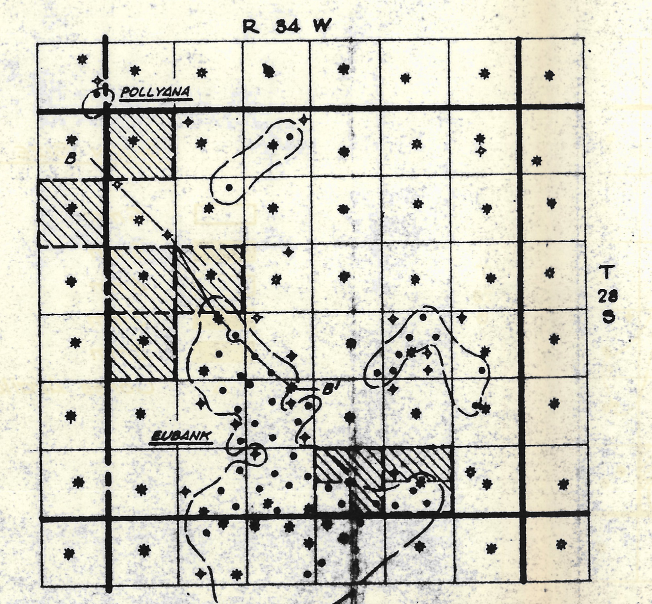
SEPT. 1962
5



* Widespread Productive Zones

\+ Productive Locally



GRAIN SIZE OF OOLITES

- .6mm
- .5mm
- .4mm
- .3mm
- .2mm
- △ Cores Available

EXHIBIT 6 OF 9

CROSS SECTION B-B'

PRELIMINARY INVESTIGATION OF LANSING-KANSAS CITY CARBONATE RESERVOIRS OF WESTERN KANSAS

BY
HAROLD A. BROWN

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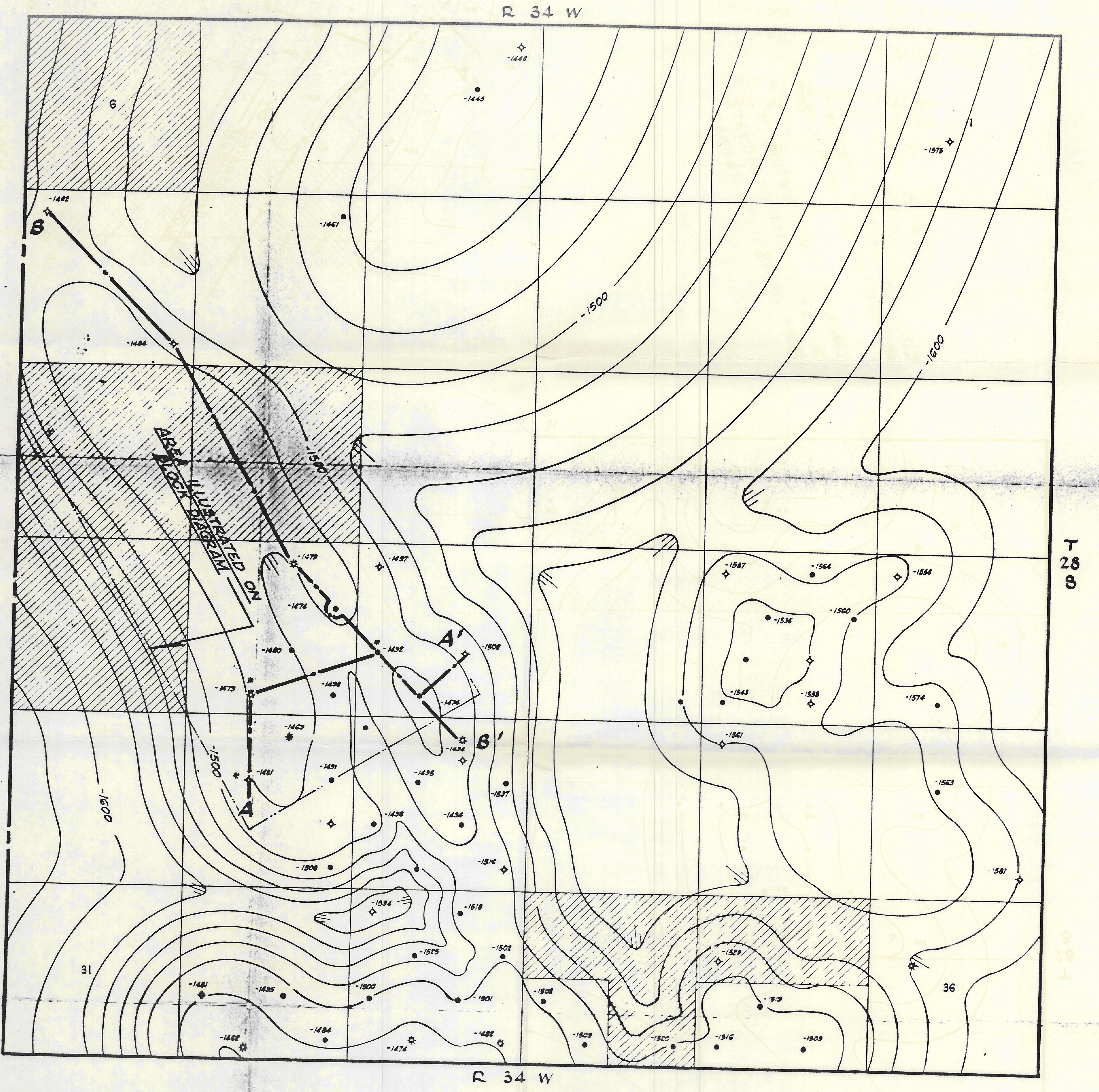
SEPT. 1962



CONTOUR INTERVAL = 20 FEET

—·— Line of Cross Section (Exhibits 5&6)

* Cores Available.

• Wells producing from "J" Zone.

EXHIBIT 7 OF 9

STRUCTURE MAP-EUBANK FIELD
HASKELL COUNTY, KANSAS
TOP LANSING-KANSAS CITY "J" ZONE

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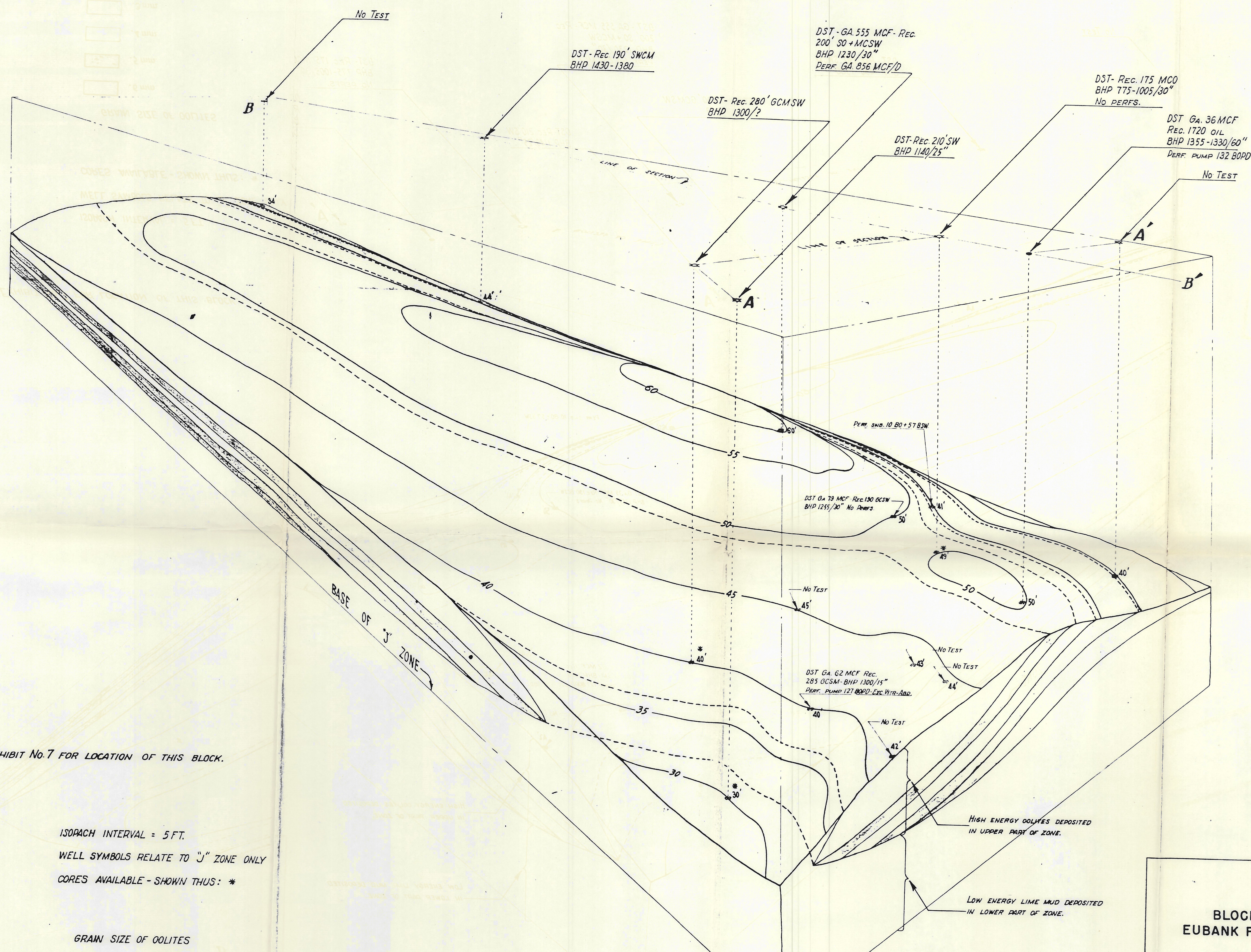

NOTE: See Exhibit No. 7 for location of this block.

ISOPACH INTERVAL = 5 FT.

WELL SYMBOLS RELATE TO "J" ZONE ONLY

CORES AVAILABLE - SHOWN THUS: *

GRAIN SIZE OF OOLITES

- .6 mm.
- .5 mm.
- .4 mm.
- .3 mm.
- .2 mm.

EXHIBIT 8 OF 9

BLOCK DIAGRAM OF A PORTION OF EUBANK FIELD, HASKELL COUNTY, KANSAS

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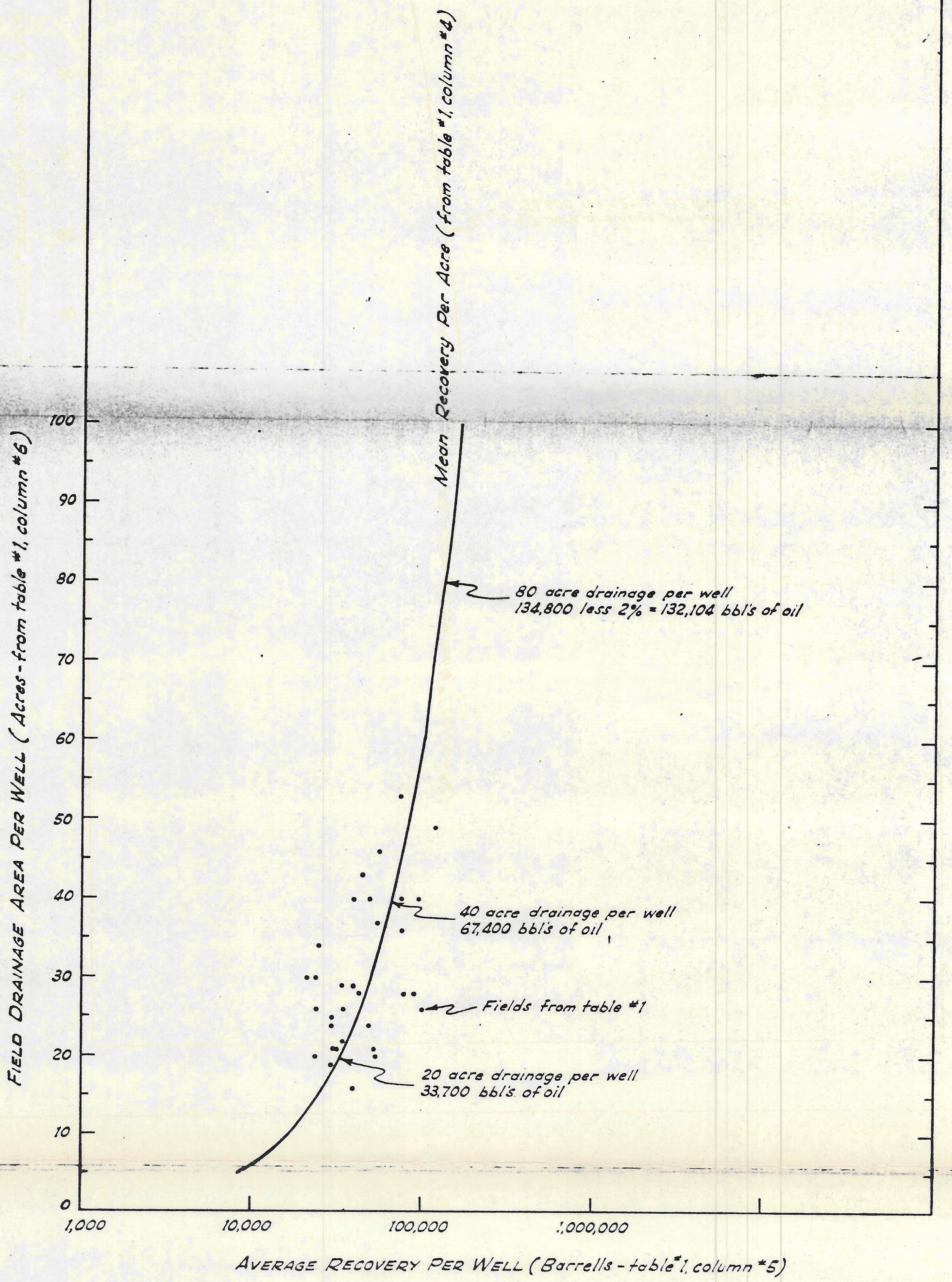
8



9

EXHIBIT 9 OF 9

BARRELLS RECOVERED PER WELL
VERSUS ACRES DRAINED PER WELL

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PRODUCTION AND ECONOMIC DATA CHART
TABLE I

	1	2	3	4	5	6	7	8	9	10	11
FIELD NAME YEAR DISCOVERED LOCATION OF DISCOVERY WELL	FIELD AREA ACRES	CUMULATIVE PRODUCTION TO 1-1-62 BARRELS	CUMULATIVE PRIMARY PRODUCTION BARRELS	PRIMARY RECOVERY BARRELS PER ACRE	PRIMARY RECOVERY PER WELL BARRELS	MAXIMUM NO. WELLS - DRAINAGE PER WELL	COST PER WELL AVE. DEPTH	PRIMARY ROI	ROI 40 ACRE DRAINAGE	ROI 80 ACRE DRAINAGE	WATER FLOOD HISTORY
Holley+ - 1954 Graham County Sec. 3-9S-24W	3,500	2,932,545	2,481,269	710	21,400	116 30 acres	$37,000 3,900'	.16	.54	2.1	1957 - 6 wells 1958 - 9 wells 1959 - 20 wells 1961 - 6 wells
Blasier - 1955 Graham County Sec. 21-7S-25W	400	590,574	590,574	1,480	31,000	19 21 acres	$35,000 3,800'	.77	2.4	5.7	Not on flood
Diebolt - 1953 Graham and Trego Cos. Sec. 33-10S-23W	2,500	3,665,268	2,935,490	1,175	30,000	99 25 acres	$35,000 3,800'	.71	1.7	4.4	1958 - 30 wells
Roof - 1954 Graham County Sec. 9-10S-23W	640	1,557,840	1,557,840	2,430	52,000	30 21 acres	$35,000 3,800'	2.0	4.5	10.0	Not on flood
Ironclad - 1950 Graham County Sec. 23-9S-22W	500	770,900	770,900	1,540	43,000	18 28 acres	$35,000 3,800'	1.4	2.5	6.0	Not on flood
Nana - 1953 Graham County Sec. 4-8S-24W	600	1,060,174	980,000	1,580	35,000	27 22 acres	$35,000 3,800'	1.0	2.6	6.2	1959 - 3 wells
Schmied - 1952 Graham County Sec. 21-8S-25W	720	1,721,643	1,510,000	2,090	50,400	30 24 acres	$35,000 3,800'	1.9	3.8	8.5	1958 - 3 wells
Studely - 1943 Sheridan County Sec. 23-6S-26W	320	607,047	459,993	1,440	77,000#	6 53 acres	$35,000 3,800'	3.4	2.3	5.6	1958 - 5 wells
Adell+ - 1944 Sheridan County Sec. 11-6S-27W	1,320	5,246,830	5,246,830	3,900	102,900	51 26 acres	$35,000 3,700'	4.9	7.9	16.8	1961 - 50 wells
Adell NW - 1952 Decatur County Sec. 34-5S-27W	500	1,104,006	1,004,006	2,210	79,000#	14 36 acres	$35,000 3,600'	3.5	4.0	9.1	Not on flood
Huffstutter+ - 1949 Phillips County Sec. 6-2S-18W	5,880	5,239,003	4,474,672	764	25,500	175 34 acres	$30,000 3,400'	.7	1.0	3.1	1959 - 42 wells 1960 - 12 wells
Dayton - 1941 Phillips County Sec. 36-2S-19W	1,100	1,362,961	1,362,961	1,240	57,000#	24 46 acres	$30,000 3,400'	2.8	2.3	5.6	1960 - 4 wells
Carmichael+ - 1955 Rooks County Sec. 33-8S-18W	120	122,218	122,218	1,020	40,730#	3 40 acres	$29,000 3,200'	1.8	1.8	4.6	Not on flood
Dorr - 1942 Rooks County Sec. 20-9S-16W	1,000	1,868,467	1,480,000	1,480	31,500	47 21 acres	$29,000 3,200'	1.2	3.1	7.2	1952 - 26 wells
Laton - 1927 Rooks County Sec. 11-9S-16W	3,800	6,041,989	5,281,641	1,390	40,600	130 29 acres	$29,000 3,200'	1.8	2.8	6.7	1953 - 12 wells 1958 - 46 wells
Riffe - 1951 Rooks County Sec. 4-7S-19W	260	310,334	310,334	1,190	24,000	13 20 acres	$29,000 3,200'	.65	2.3	5.6	Not on flood
Prairie View+ - 1950 Barton County Sec. 20-19S-11W	140	414,730	366,257	2,610	40,700	9 16 acres	$29,000 3,100'	1.8	6.2	13.4	1957 - 9 wells
Hiss - 1936 Barton County Sec. [illegible]-13W	700	2,201,101	1,986,730	2,840	55,000	36 20 acres	$30,000 3,300'	2.7	6.5	14.2	1958 - 3 wells
Trapp - 1936 Barton & Russell Counties Sec. 23-15S-14W	280		918,400	3,280	91,840	10 28 acres	$29,000 3,000'	5.3	8.0	17.0	*
Beeching - 1943 Ellis County Sec. 34-15S-16W	300	318,793	318,793	1,060	45,400#	7 43 acres	$29,000 3,200'	2.1	2.0	4.8	Not on flood
Emmeram - 1937 Ellis County Sec. 4-13S-16W	220	386,553	350,000	1,590	58,000#	6 37 acres	$29,000 3,300'	3.0	3.4	7.8	1959 - 3 wells
Odessa - 1949 Rice County Sec. 32-18S-6W	580	724,435	652,435	1,120	34,300	19 30 acres	$29,000 3,000'	1.4	2.1	5.2	1959 - 9 wells
Jordan - 1936 Stafford County Sec. 15-2S-14W	340	1,152,327	955,147	2,800	80,000	12 28 acres	$35,000 3,800'	3.6	5.4	11.8	1956 - 10 wells
Kipp NE - 1946 Stafford County Sec. 23-25S-14W	200	380,445	380,445	1,900	76,000#	5 40 acres	$35,000 3,800'	3.3	3.3	7.7	Not on flood
Merle - 1949 Stafford County Sec. 32-33S-13W	360	342,717	342,717	950	24,400	14 26 acres	$35,000 3,700'	.39	1.2	3.3	Not on flood
Oscar W - 1952 Stafford County Sec. 22-22S-14W	640	1,035,812	812,580	1,270	30,000	27 24 acres	$35,000 3,600'	.72	1.9	4.8	1958 - 18 wells
Brenn+ - 1954 Stafford County Sec. 19-23S-13W	260	348,158	348,158	1,340	34,815	10 26 acres	$35,000 3,700'	.99	2.1	5.1	1958 - 2 wells
Sun City+ - 1941 Barber County Sec. 35-30S-15W	640	1,632,404	1,559,001	2,430	120,000#	13 49 acres	$50,000 4,300'	3.8	2.9	6.8	1956 - 7 wells
Rosedale+ - 1954 Kingman County Sec. 32-29S-6W	300	470,771	470,771	1,570	30,000	16 19 acres	$35,000 3,700'	.71	2.6	6.2	Not on flood
Enlow+ - 1953 Edwards County Sec. [illegible]-16W	240	264,849	192,352	800	24,000	8 30 acres	$35,000 3,700'	.37	.83	2.7	1956 - 5 wells
Novinger NW - 1955 Mead County Sec. 15-33S-30W	80	100,692	100,692	1,250	50,340#	2 40 acres	$50,000 4,500'	1.0	1.0	3.0	Not on flood
Ashland+ - 1951 Clark County Sec. 35-32S-23W	160	116,074 1,795,172 MCF gas	116,074 1,795,172 MCF gas	725 2,800 MCF	38,690#	3 oil 53 acres 1 gas 640 acres	$55,000 4,700'	.41 oil 3.9 gas	.06	1.1	Not on flood
Keystone+ - 1950 Scott County Sec. 25-18S-32W	120	293,856	293,856	2,400	97,600#	3 40 acres	$37,000 4,000'	4.3	4.3	9.5	Not on flood

(10)

Mean Cumulative recovery per field to 1-1-62: 1,432,000	Mean field recovery per acre: 1,685	Mean recovery per well: Close spacing: 42,215 Wide spacing: 70,107	Mean ROI per Field: Close spacing: 1.59	3.0	7.0

Mean ROI per Field — Wide spacing: 2.90

ROI determined by an assumed price of $2.00 per barrel of crude (38° to 40° gravity).

+ Annual production curves shown on Exhibits Nos. 2 and 3.

Fields that are apparently draining 40 acres per well or more

* Information from Sterling, 1959. There are 1068 wells in field. Nearly all Lansing-Kansas City wells are under water flood.

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PRODUCTION AND ECONOMIC DATA CHART

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by Harold A. Brown

CENTRAL DIVISION GEOLOGICAL REPORT NO. 13
SEPTEMBER, 1962

Sources of Information: Vance Rowe, Oil Scouts Yearbook, Kansas Corporation Commission, Kansas Geological Survey - Oil and Gas Investigations No. 24, 1960, Kansas Geological Survey, Bulletin #147, 1960; Kansas Geological Survey, Bulletin #155, 1961.