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Geohydrology of Grant and Stanton Counties, Kansas

By Stuart W. Fader, Edwin D. Gutentag,
David H. Lobmeyer, and Walter R. Meyer

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BULLETIN 168

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Geohydrology of Grant and Stanton Counties, Kansas

By Stuart W. Fader, Edwin D. Gutentag,
David H. Lobmeyer, and Walter R. Meyer

Prepared by the United States Geological Survey and the State Geological Survey of Kansas with the co-operation of the Environmental Health Services of the Kansas State Department of Health, and the Division of Water Resources of the Kansas State Board of Agriculture.

Printed by authority of the State of Kansas
Distributed from Lawrence
DECEMBER, 1964

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DAVID H. LOBMEYER
WALTER R. MEYER
U. S. Geological Survey, Lawrence, Kansas

Geohydrology of Grant and Stanton Counties, Kansas

ABSTRACT

A study of the geohydrology of Grant and Stanton counties, comprising 1, 260 square miles, is contained in this report. The principal cities are Ulysses, in Grant County, and Johnson, in Stanton County. Normal annual precipitation is 17.24 inches at Ulysses and 15.03 inches at Johnson.

The rocks in the two counties range in age from Permian to Recent. Unconsolidated deposits of Neogene age (Pliocene and Pleistocene) underlie most of the area and contain aquifers that annually supply about 250,000 acre-feet of water for irrigation. The Pleistocene deposits reach a maximum thickness of 455 feet in the southeastern part of the area. The areal extent, thickness, and water yields of sandstone aquifers of Cretaceous and Triassic age are given. The coefficients of transmissibility and storage of the Pliocene and Pleistocene aquifers were determined by tests at 26 sites. The data thus obtained were used to estimate the hydrologic characteristics at localities where adequate well logs were available. The extrapolated transmissibility data were used to analyze the movement of ground water.

Approximately 58 mgd (million gallons per day) of ground water is flowing into Stanton County from the west, and approximately 86 mgd is flowing out of Grant County to the southeast. This difference is due to the addition of lateral flow from the adjacent counties to the north and south and from precipitation within the area. The recharge from precipitation was computed to be about 0.3 inches per year or 2 percent of the average annual precipitation. Inflow and outflow in the area were approximately the same in 1940 as in 1960. Therefore, most of the water pumped for irrigation since 1940 has been removed from storage.

Analyses of the six water-level contour maps indicates that the weighted-average water level declined 8 feet between 1939-42 and 1960 and 18 feet between 1939-42 and 1963. Prediction of future water levels based on these data was not attempted because of the close relationship of water level to the annual pumping rate, which varies considerably.

The two counties contain 55 million acre-feet of ground water in storage of which about 39 million is in the unconsolidated aquifers and 16 million in the sandstone aquifers. However, from a practical standpoint, not more than about half this amount of water can be recovered for irrigation use.

Résumé

Une étude de la géohydrologie de Grant et de Stanton Counties, qui comprennent 3,260 kilometers carrés, se trouve dans ce rapport. Les villes principales sont Ulysses dans Grant County, et Johnson dans Stanton County. L'annuelle précipitation normale est 43.8 centimeters à Ulysses et 38.2 centimeters à Johnson.

Les roches dans les deux "counties" varient en âge du Permien au Récent. Des dépôts inconsolidés de l'age néogène (pliocène et pléistocène) sont sous la plupart de la région et contiennent des aquifères qui produisent annuellement environ 308,000,000 metres cubes d'eau pour l'irrigation. Les dépôts pléistocènes sont d'une épaisseur de 139 metres au maximum dans la partie sud-est de la région. On donne l'étendue régionale, l'épaisseur, et les rendements d'eau des aquifères gréseux des âges crétacé et triasique. On a déterminé les coefficients de transmissibilité et d'emmagasinage des aquifères pliocènes et pléistocènes par des essais à 26 emplacements. On a employé les données ainsi obtenues pour estimer les caractéristiques hydrologiques aux localités où de suffisantes coupes de sondages étaient disponibles. On a employé les données sur la trans-

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missibilité inférée pour analyser le movement de la nappe superficielle.

A peu près 219,000 metres cubes par jour de nappe superficielle coulent dans Stanton County de l'Ouest, et à peu pres 325,000 metres cubes par jour coulent dehors de Grant County au Sud-Est. L'addition de l'écoulement latéral des "counties" adjacents au Nord et au Sud et de la précipitation dans la région cause cette différence. On a calculé que l'addition continuelle de la précipitation est à peu pres 8 mm. annuellement ou 2 pour cent de la moyenne précipitation annuelle. La venue et la sortie d'eau dans la région étaient à peu près de la même quantité en 1940 qu'en 1960. Ainsi, on a enlevé d'emmagasinage la plupart de l'eau épuisée pour l'irrigation depuis 1940.

Les analyses des six cartes en courbe de niveau pour le plan d'eau indiquent que la moyenne pondérée plan d'eau a diminué par 2.4 metres de 1939-1942 à 1960 et 5.5 metres de 1939-1942 à 1963. On n'a pas entrepris la prédiction des niveaux d'eau futurs basée sur ces données à cause des rapports proches du niveau d'eau au taux d'épuisement, qui varie considérablement.

Les deux "counties" contiennent 68 km. cubes de nappe superficielle en emmagasinage delaquelle à peu près 48 km. cubes sont dans les aquifères inconsolidés et 20 km. cubes sont dans les aquifères gréseux. Au point de vue pratique, cependant, on ne peut pas récupérer probablement plus qu'à peu près la moitié de cette quantité d'eau dans le but d'irrigation.

Resumen

Este trabajo contiene un estudio hidrogeológico de los condados de Grant y Stanton, que abarcan 3,260 Km caudrados. Las ciudades principales son Ulysses, en el condado de Grant y Johnson, en el condado de Stanton. La precipitación anual normal es 43,8 cm en Ulysses y 38,2 en Johnson.

Las rocas de los dos condados se originaron entre el Pérmico y el Reciente. Depósitos inconsolidados de edad Neogena (Pliocena y Pleistocena) forman la mayor parte del área y contienen acuíferos que suministran anualmente alrededor de 308 millones de m cúbicos de agua para irrigación. Los depósitos Pleistocenos tienen un espesor máximo de 139 m en la parte sudeste del área. El trabajo contiene información acerca de la extensión areal, el espesor y el rendimiento de los acuíferos Cretácicos y Triásicos. Los coeficientes de transmisibilidad y almacenamiento de los acuíferos Pliocenos y Pleistocenos se determinaron con pruebas de bombeo en 26 localidades. Los datos de las pruebas se usaron para estimar las características hidrológicas en las localidades donde se dispuso de adecuados registros de pozos. Los datos de transmisibilidad extrapolados se usaron para analizar el movimiento del agua subterránea.

Aproximadamente 219 mil m cúbicos de agua subterránea percolan diariamente hacia el condado de Stanton desde el oeste y aproximadamente 325 mil m cúbicos percolan diariamente desde el condado de Grant hacia el sudoeste. Esta diferencia se debe a la adición de flujo lateral desde los condados adyacentes al norte y al sur, y a la precipitación que recibe el área. La recarga de la precipitación se calculó en aproximadamente 0,76 cm anuales, que es el 2 por ciento de la precipitación anual en promedio. La percolación hacia adentro y hacia afuera del área fue aproximadamente la misma en 1940 y en 1960. Por lo tanto la mayor parte del aguabombeada para irrigación desde 1940 ha sido obtenida del almacenamiento.

Los análisis de seis mapas de superficie freática indican que el nivel de agua promedio disminuyó 2,4 m entre 1939-42 y 1960, y 5,5 m entre 1939-42 y 1963. No se intenta una predicción de los futuros niveles de agua en base a estos datos debido a la estrecha relación de los niveles de agua con la intensidad del bombeo anual, que puede variar considerablemente.

Los dos condados contienen 68 mil millones de m cúbicos de agua subterránea almacenada, de los cuales aproximadamente 48 mil millones de m cúbicos están en los acuíferos inconsolidados y 20 mil millones de m cúbicos están en las areniscas acuíferas. Sin embargo, desde un punto de vista práctico, probablemente no más de la mitad de esta cantidad de agua puede ser extraída para irrigación.

Zusammenfassung

Die vorliegende Abhandlung befasst sich mit der Hydrogeologie der Counties Grant und Stanton, die zusammen eine Fläche von 3 263,4 Quadratkilometern einnehmen. Die bedeutendsten Städte sind Ulysses in Grant County und Johnson in Stanton County. Der jährliche Niederschlag im langjährigen Mittel beträgt in Ulysses 438 Millimeter und in Johnson 382 Millimeter.

Die Gesteine in den beiden "Counties" datieren vom Perm bis zur Neuzeit. Lose Gesteinsablagerungen aus dem Neogen (Pliozän and Pleistozän) unterliegen den grössten Teil des Gebietes. Sie enthalten wasserführende Schichten, die jährlich etwa 308 375 000 Kubikmeter Wasser zu Bewässerungszwecken liefern. Die Ablagerungen aus dem Pleistozän erreichen im südöstlichen Teil des Gebietes eine Maximalstärke von 139 Metern. Regionale Ausdehnung, Mächtigkeit und Wasserertrag wasserführenden Sandsteins aus der Kreide- und Triaszeit sind bekannt. Durch Untersuchungen an 26 Orten wurden die Koeffizienten Leitungs- und Speicherungsfähigkeit der wasserführenden Schichten aus dem Pliozän und Pleistozän bestimmt. Die auf diese Weise erhaltenen Angaben verwandte man, um die hydrologischen Besonderheiten an Orten zu beurteilen, für die entsprechende Bohrberichte vorlagen. Die extrapolierten Angaben über die Leitungsfähigkeit benutzte man, um die Grundwasserbewegung zu analysieren.

Ungefähr 220 Millionen Liter Grundwasser fliessen pro Tag von Westen her in das Stanton County, ungefähr 326 Millionen Liter pro Tag fliessen nach Südosten aus dem Stanton County ab. Diese Differenz entsteht durch zusätzlichen Seitenfluss aus den nördlich und südlich angrenzenden "Counties" und durch Niederschlag in dem Gebiet selbst. Berech-

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nungen ergaben, dass die Wiederauffüllung durch Niederschlag etwa 7,6 Millimeter pro Jahr oder zwei Prozent des durchschnittlichen jährlichen Niederschlags beträgt. Zufluss und Abfluss in dem Gebiet waren 1940 und 1960 annähernd gleich. Deshalb ist der grösste Teil des Wassers, das man seit 1940 für Bewässerungszwecke gepumpt hat, dem Wasservorrat entnommen worden.

Die Analyse der sechs Wasserspiegelkonturkarten zeigt an, dass der durchschnittliche Wasserspiegel in dem Zeitraum zwischen 1939/42 und 1960 2,44 Meter und zwischen 1939/42 und 1963 5,49 Meter gesunken ist. Der Versuch, mit Hilfe dieser Angaben eine Vorhersage über die Höhe zukünftiger Wasserspiegel zu machen, unterblieb wegen der engen Beziehung zwischen Wasserspiegel und jährlicher Pumprate, die beträchtlich variiert.

Die beiden "Counties" verfügen über einen Grundwasservorrat von 67 843 Millionen Kubikmetern. Davon befinden sich etwa 48 107 Millionen Kubikmeter in den losen wasserführenden Gesteinsschichten und 9 736 Millionen Kubikmeter in den wasserführenden Sandsteinschichten. Von einem praktischen Standpunkt aus betrachtet kann jedoch wahrscheinlich nicht mehr als etwa die Hälfte dieser Wassermenge für Bewässerungszwecke nutzbar gemacht werden.

INTRODUCTION

Purpose and Scope of the Investigation

Large quantities of ground water are available in western Kansas for agricultural, municipal, domestic, and industrial purposes. In 1960, 131,000 acre-feet of ground water was withdrawn in Grant County and 128,000 acre-feet was withdrawn in Stanton County for all purposes. About 98 percent of the water was used for irrigation.

A reconnaissance of the water levels in southwestern Kansas by the Kansas Water Resources Board in January 1958 showed a considerable decline of water levels since 1944 in small localized areas. The reconnaissance indicated that a more comprehensive study of the geology and hydrology of the area was needed to provide adequate information for the future development of the area and to provide a basis for sound planning for future use.

A study of the ground-water resources of southwestern Kansas was begun in August 1958. Because the area is vast and the hydrologic and geologic problems are complex, it was decided to limit the study to Grant and Stanton counties (the most intensively developed areas) for the first report. Objectives of the investigation included: a geologic study of the water-bearing materials, a study of the hydrologic properties of the water-bearing materials, information on water levels, water-level contour maps, movement of ground water, an estimate of the amount of water in storage, data on the chemical quality of the ground water, and information on phreatophytes.

This investigation is a part of a systematic study of the ground-water resources of Kansas begun in 1937. This cooperative program is being conducted by the U. S. Geological Survey, the State Geological Survey of Kansas, the Division of Water Resources of the Kansas State Board of Agriculture, and the Environmental Health Services of the Kansas State Department of Health. The water programs in Kansas are coordinated by the Water Resources Board. The present status of the ground-water investigations in Kansas is shown in Figure 1, and the numbers on the map correspond to the bulletin numbers of the State Geological Survey.

Description of the Area

Grant and Stanton counties are in the southwestern part of the State (Fig. 1). The combined area of the two counties is 1,260 square miles. The population of Grant and Stanton counties combined was 7,361 in 1960, according to the U. S. Census Bureau. The area is in the Cimarron Unit, as described by the Kansas Water Resources Board in their State Water Plan Studies (1958).

Previous Investigations

The geology and ground water of southwestern Kansas was briefly discussed by St. John (1887) and by Hay (1890). A more detailed study was made by Haworth (1897a, 1897b, and 1897c), with emphasis on ground

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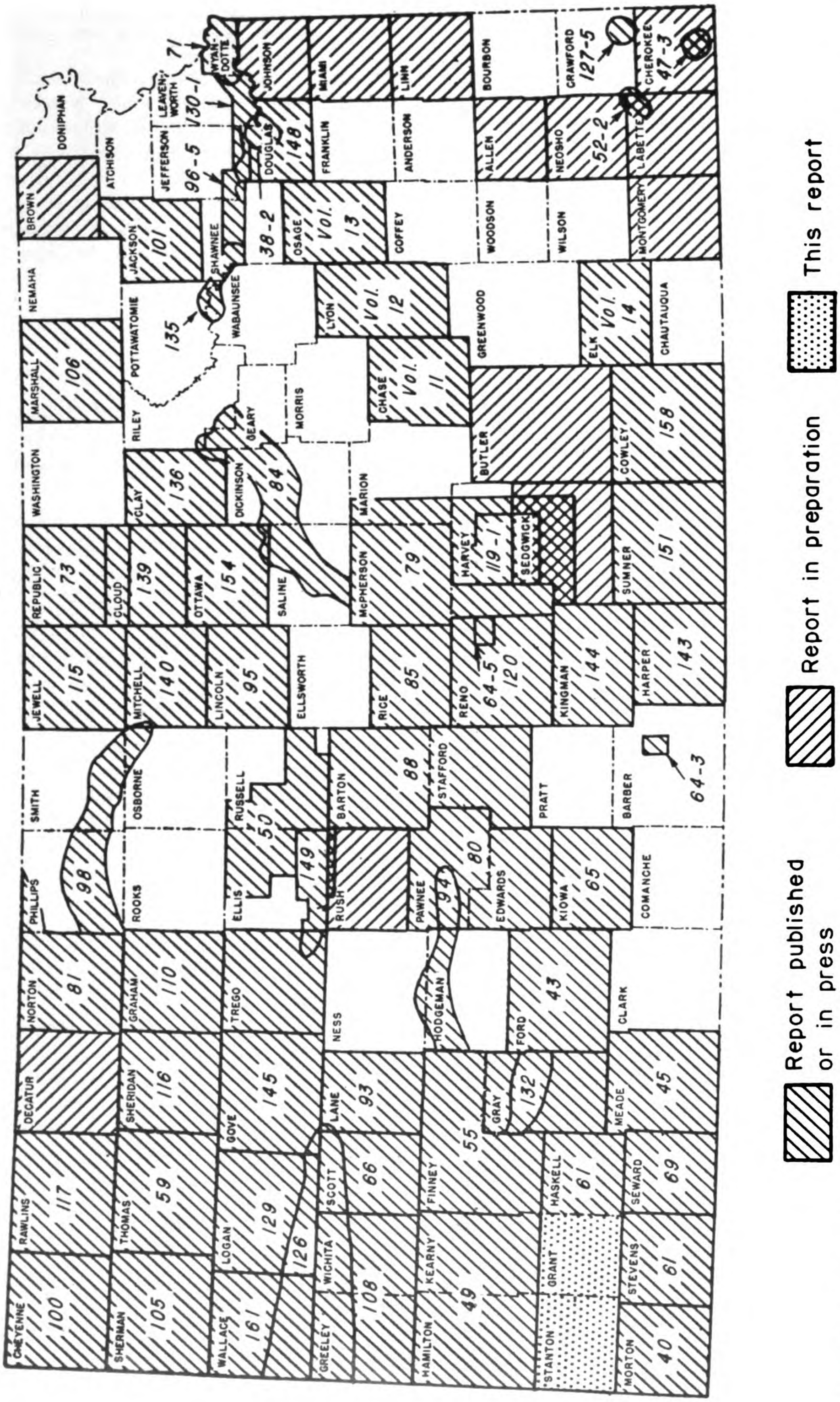

FIGURE 1.—Location of area described in this report and areas for which ground-water reports have been published as bulletins by the State Geological Survey of Kansas.

water in the Dakota and younger formations. Johnson (1901, 1902) made special reference to the source, availability, and use of ground water in western Kansas. The ground-water conditions in the area were briefly described by Parker (1911) in a report on the chemical quality of water supplies in Kansas. Additional ground-water studies were made by Haworth (1913).

The first detailed studies of the geology and ground-water resources of this area, which included the northern parts of Grant and Stanton counties, were by Darton (1920). The geology of Hamilton County and the northern part of Stanton County was described by Bass (1926). Theis, Burleigh, and Waite (1935) made a reconnaissance of the ground-water resources of the High Plains. A study of the Neogene geology of southwestern Kansas was made by Smith (1940).

The cooperative studies of the ground-water resources of southwestern Kansas which were started in 1937 were published as bulletins by the State Geological Survey of Kansas as follows: Latta (1941), McLaughlin (1942, 1943, 1946), and Frye and Fishel (1949). Frye and Leonard (1952) made a study of the Pleistocene geology of Kansas and outlined the Pleistocene drainage patterns. Merriam and Frye (1954) investigated the Cenozoic of western Kansas and included a map showing the areal geology and topography of the surface below the Cenozoic deposits. Merriam (1957) made a correlation of the Mesozoic rocks in Kansas which included a cross section through Stanton County. The Kansas Water Resources Board studied the water resources of the area (KWRB, 1958) as part of their preliminary appraisal of Kansas water problems.

Prior to 1956, water-level measurements in selected observation wells throughout the State were published annually in water-supply papers published by the U. S. Geological Survey. Since that time, water-level data have been published annually in bulletins of the State Geological Survey of Kansas.

Methods of Investigation

The collection of field data on which this report is based was begun in August 1958 and was continuous through July 1960. Intermittent field work was continued until January 1963. Previous geologic maps were used as a guide to map the surface geology.

The study of the subsurface geology utilized the samples from 94 test holes and 342 drillers' logs. Logs of the test holes were prepared in the field and revised as the cuttings were examined in the office. Samples of cuttings from test holes and wells were glued onto strip logs for easy comparison of the lithology. Electric or radioactivity logs when available were traced on the strip logs to supplement and to compare with the sample logs. All the electric and radioactivity logs in the files of the State Geological Survey obtained from oil and gas tests in the Grant-Stanton area were examined. Most of these logs did not show the geologic section above the Permian rocks. However, 47 of these logs which did show some or all of the section above the Permian were used in the geologic study. Fossils from 14 wells and 2 outcrops were studied for use in the geologic correlations.

Information was obtained during the inventory of 814 wells concerning the depth to water, depth of the well, diameter, use, and interval perforated. The drillers' logs of these wells were obtained when available. All altitudes were determined by and tied into bench marks of the U. S. Geological Survey and the U. S. Coast and Geodetic Survey.

Aquifer tests were made at 26 well sites to determine the hydrologic characteristics of the water-bearing materials. All tests utilized an irrigation well as the pumped well and, where available, other irrigation wells were used as observation wells. Observation wells were drilled at six sites to obtain drawdown information. All the pumped wells for these tests were perforated in more than one aquifer. The data obtained from these tests were used to analyze the water-level contour maps.

Twenty-six samples of water were collected from representative wells. The samples were analyzed in the Sanitary Engineering Laboratory of the Kansas State Department of Health under the direction of Howard A. Stoltenberg, Chief Chemist. In addition, complete analyses of water from 63 wells have been retabulated

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from previous reports. Two hundred five partial analyses of water samples from wells are also included. These analyses were examined in an attempt to correlate water quality with the various aquifers.

Well-Numbering System

The well and test-hole numbers used in this report give the location of wells and test holes according to the General Land Office Surveys and according to the following formula: township, range, section, quarter section, quarter-quarter section, and quarter-quarter-quarter section (10-acre tract). The subdivisions of a section are designated *a*, *b*, *c*, and *d* in a counter-clockwise direction beginning in the northeast quarter. If several wells or test holes are in a 10-acre tract, they are numbered serially after the above letters and in the order in which they were inventoried. (Fig. 2.)

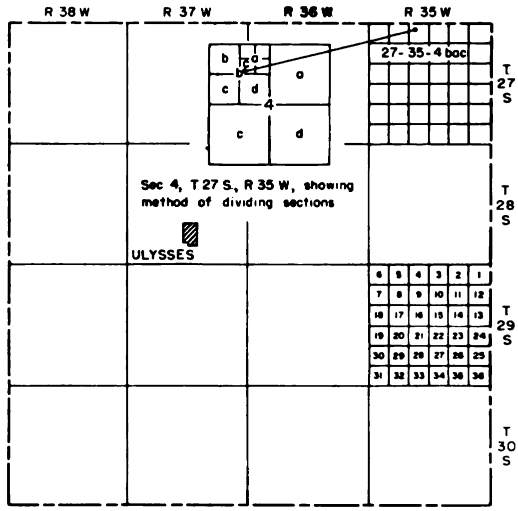

FIGURE 2.—Map of Grant County illustrating well-numbering system based on land-classification system.

Acknowledgments

The writers wish to thank the owners of the wells for their cooperation and especially those who permitted the use of their wells for aquifer tests. Acknowledgment is given Guy Vincent, Water Commissioner, Division of Water Resources, Kansas State Board of Agriculture, and his staff for their cooperation in supplying well information and water levels, and for help in conducting aquifer tests. W. N. Lockwood, U. S. Geological Survey, was assigned to this project from its inception until June 1960 and did much of the preliminary geologic field work. Well logs and other information were supplied by the following well drillers and drilling companies: Juel Water Well Drilling Company; Ray Stevenson; Henkle Drilling and Supply Company, Inc.; Kenny Minter; C. K. Minter Drilling Company; Swearengen Water Well Company; Loucks Brothers Drilling Service; Western Drilling Company; Ray Stagner; Arnold Drilling Company; and Dreiling Drilling Company. The Liberal Geological Society and oil and gas companies in the area cooperated in furnishing deep-well information and allowing access to their test holes during drilling. Some altitudes were determined by a field party headed by D. R. Lee, Topographic Division; others were determined by a party headed by E. L. and C. L. Reavis. E. A. Waddell and W. A. Long compiled the tables of chemical analyses and well records.

Acknowledgment is given to A. B. Leonard and Tong-yun Ho, Zoology Department, University of Kansas, for identifying the fossil mollusks, and to C. W. Hibbard, Curator of Vertebrates, University of Michigan, for identifying the micro-vertebrates.

The manuscript of this report has been reviewed critically by several members of the Federal and State Geological Surveys; by R. V. Smrha, Chief Engineer, and Harris Mackey, Engineer, Division of Water Resources, Kansas State Board of Agriculture; by W. O. Hilton, Geologist, Environmental Health Services, Kansas State Department of Health; by D. F. Metzler, Executive Secretary, Kansas Water Resources Board; and by R. L. Smith, Professor, School of Engineering, University of Kansas.

GEOGRAPHY

Topography and Drainage

The Grant-Stanton area is a relatively flat plain which lies in the High Plains Physiographic Province (Fenneman, 1931; Schoewe,

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1949). The plain has an upward slope of about 8 feet per mile from the Crooked Creek area in Meade County to a point near Johnson in Stanton County. The slope of the plain increases from 8 to 22 feet per mile near Johnson and maintains this slope to the Colorado line. Narrow, shallow, flat-bottomed valleys extend from Colorado on the west to the more level plain east of Johnson.

The area is drained by Bear Creek and the Cimarron River and its tributaries, the North Fork Cimarron River, Sandy Arroyo, and Lakin Draw (Pl. 1). The Cimarron River and all its tributaries are intermittent throughout Grant and Stanton counties. Small springs south of Ulysses flow during wet periods.

The main Bear Creek channel contains water throughout the year in its upper reaches in western Stanton County. Throughout the rest of its course in Kansas, Bear Creek is an ephemeral stream, as is Little Bear Creek.

The southern part of Grant County is deeply dissected by the Cimarron and North Fork Cimarron rivers. Bluffs from 120 to 180 feet above the flood plain extend along both sides of the Cimarron River and are dissected by numerous deep, short draws.

The lowest point in the area is on the Cimarron River where it flows out of Grant County and is 2,820 feet above sea level. The highest point is near the junction of U. S. Highway 160 and the Colorado line and is 3,700 feet above sea level.

The sand dunes in northeastern Grant County are the southern edge of an extensive dune complex along the south side of the Arkansas River (Pl. 1). One of the major dune belts extends for about 19 miles along the south side of Bear Creek in central Stanton County (Latta, 1941). The dunes are relatively stable at the present time, and most of them are covered with some type of vegetation.

Several small undrained areas are found in the counties. One of these depressions is in sec. 32, T. 28 S., R. 38 W. in Grant County.

Climate

The climate of the Grant-Stanton area is semiarid, characterized by low precipitation and low relative humidity, with wide diurnal and seasonal ranges in temperature. The normal annual precipitation is 17.24 inches at Ulysses and 15.03 inches at Johnson. Most of the precipitation occurs during the summer. The annual precipitation for the period 1890-1960 is shown in Figure 3. Grant County is usually frost-free from about April 27 to October 16 and Stanton County from April 28 to October 19.

Agriculture

There were 388,000 acres of farm crops harvested in the area in 1960. The principal crops as reported by the Kansas State Board of Agriculture were wheat and grain sorghums. Beef cattle are raised in the area, and the pasturing of cattle and sheep on winter wheat and fallow land is a major secondary source of income to the farmers. Some cattle are fattened for market in farm feed lots, but no large commercial lots are operating in the two counties. Grant County farmers harvested about 173,450 acres of crops in 1960, of which about 81,000 acres were irrigated. About 214,560 acres were harvested in Stanton County, of which about 68,000 were irrigated. Essentially all of the water used for irrigation in both counties was supplied from ground water.

Mineral Resources

Except for the large quantities of ground water pumped for irrigation, natural gas is the principal mineral resource. Parts of Grant and Stanton counties are within the Hugoton Gas Field. About 115 billion cubic feet of natural gas was produced in 1960. Total crude oil production for both counties was 41,000 barrels in 1960. The initial production of crude oil in Stanton County was in 1954 and that in Grant County was in 1959.

Sand and gravel pits in deposits of Pleistocene age are found throughout the area (Pl. 1). Production from these pits varies with the local demand and is used for road metal, concrete aggregate, and for gravel packing in water wells. Volcanic ash is mined from open pits for use as fines in asphalt paving mix aggregate.

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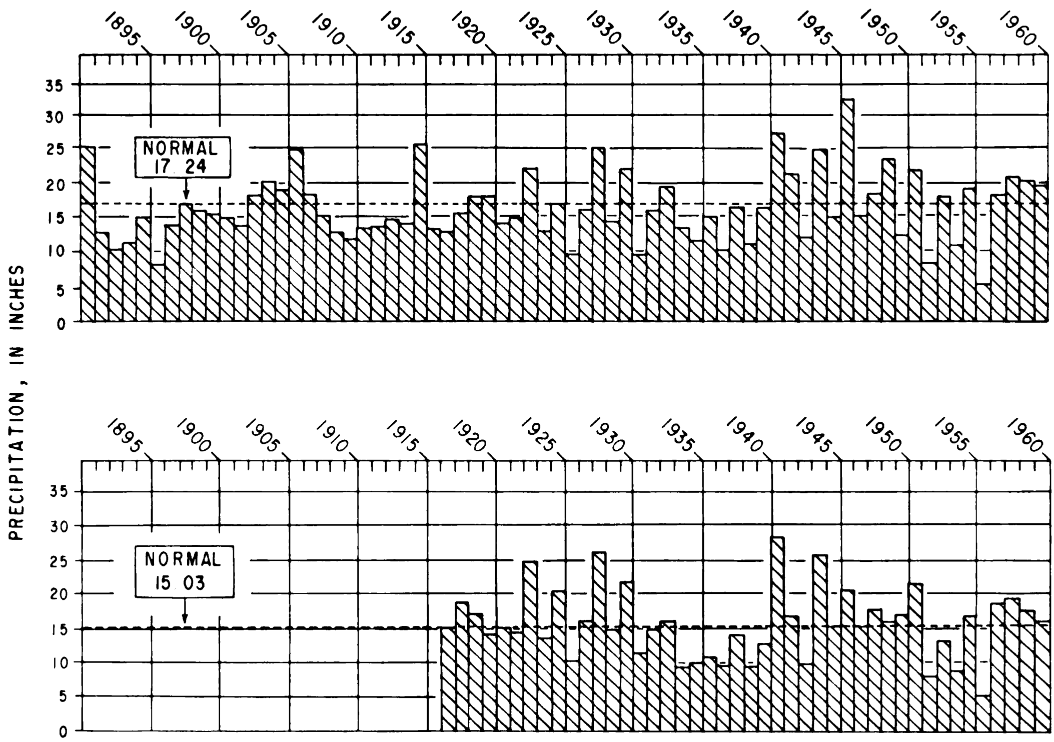

FIGURE 3.—Annual precipitation (in inches) at Ulysses, Grant County, (upper graph) and Johnson, Stanton County, (lower graph). Data from Weather Bureau, U. S. Department of Commerce.

GEOLOGY

General Geology

SUMMARY OF STRATIGRAPHY [1]

The rocks that crop out in Grant and Stanton counties range in age from Lower Cretaceous to Recent. Large expanses of the older deposits are masked by a thin mantle of dune sand and loess (eolian silt) of Recent age. The surficial geology is shown on Plate 1. The geologic formations of the Grant-Stanton area and their water-bearing properties are given in Table 1.

All deposits that yield water of a chemical quality suitable for irrigation lie above the Permian red beds. These deposits are of sedimentary origin and are composed of consolidated and unconsolidated materials which range in age from Triassic(?) to Recent. The pre-Pliocene surface and the Pliocene (Ogallala) drainage pattern developed on this surface are shown on Plate 2,A. The general drainage pattern of the early Pleistocene streams and the eroded surface of the Ogallala Formation and, in places, the pre-Ogallala surface are shown on a contour map (Pl. 2,B). The buried stream valleys shown on the maps contain deposits that are coarser grained and thicker than those in the interstream areas. Wells which yield large quantities of water are obtained from the channel phase of these buried-valley deposits.

Geologic cross sections (Pl. 3-7) show the stratigraphic units and the depth of erosion. The configuration of the top of the bedrock

1. The classification and nomenclature of the rock units described in this report follow that of the State Geological Survey of Kansas and differ somewhat from the usage by the U. S. Geological Survey.

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TABLE 1.—Geologic formations and their water-bearing properties, Grant-Stanton area.

System	Series	Subseries	Stage	Strati-graphic unit	Thick-ness, feet	Character	Water Supply
Neogene	Pleistocene	Upper(?) Pleistocene	Recent Wisconsinan Sangamonian Illinoisan	Undiffer-entiated eolian and alluvial deposits	0 to 270 ±	Soil, loess, dune sand, alluvium on surface. Clay, silt, sand, and gravel in subsurface.	Where saturated, known to yield 750 gpm from sand and gravel; higher yields may be possible. (Most deposits lie above water table and yield no water to wells.)
		Lower Pleistocene(?)	Yarmouthian Kansan Aftonian Nebraskan	Undiffer-entiated alluvial deposits	0 to 300 ±	Coarse sand and gravel deposits in channel fill; silt, fine sand, and clay in backwater and inter-stream deposits.	Wells screened only in Lower Pleistocene(?) deposits yield up to 2,000 gpm.
	Pliocene			Ogallala Formation	0 to 200 ±	Silt, clay, sand, and gravel. (Sand and gravel lenses may contain large amounts of inter-bedded silt and clay.)	Yields up to 1,000 gpm obtained in areas of coarse channel-fill deposits.
		(disconformity)					
Cretaceous	Lower			Dakota Formation (L. ? Cret.)	0 to 135 ±	Fine- to medium-grained sandstone with shale beds.	Yields small supplies of water for stock and domestic wells. Yields water to multiple-aquifer irrigation wells.
				Kiowa Shale	0 to 150 ±	Gray to black silty shale; may contain some thin sandstone beds.	Yields little or no water to wells.
				Cheyenne Sandstone	0 to 120 ±	White to yellow fine to coarse quartzose sandstone.	Yields up to 500 gpm possible. Yields water to multiple-aquifer irrigation wells.
		(disconformity)					
Triassic(?)	Upper			Dockum Group (undivided in Kansas)	0 to 130 ±	Fine to medium gravel, quartzose sandstone. Contains red sandstone and siltstone.	Yields up to 1,000 gpm reported. Yields water to multiple-aquifer wells.
Permian	Upper			Big Basin Formation	160 ±	Dark-red mudstone and orange-red siltstone beds.	No information available.

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(Permian to Cretaceous) and the top of the Ogallala Formation (Pliocene) between wells shown on the cross sections was derived from Plates 2A and 2B. Offset wells were added to the sections in some places to show the approximate depths of the sandstone aquifers.

STRUCTURAL GEOLOGY

The Grant-Stanton area is on the eastern flank of the broad, regional Las Animas Arch (Lee and Merriam, 1954). The Syracuse Anticline (Darton, 1918), the dominant structural feature in this area, is only a minor flexure upon the regional arch. This local flexure is a southeast - northwest - trending faulted fold which extends from Kearny County, Kansas, through northwestern Grant County and across the northeastern part of Stanton County into Hamilton County. Bass (1926) modified Darton's generalized structure map for Hamilton County and further described the flexure.

From a study of the physiographic data, Smith (1940) concluded that the rectilinear pattern of the north branch of Bear Creek indicated the presence of a fault on the southern margin of the Syracuse flexure. This fault was mentioned by Latta (1941) as being present in Stanton County, and it was mapped by McLaughlin (1943) in Kearny and Hamilton counties.

The prominent fault or fault system in Grant and Stanton counties (T. 27 S., R. 37-40 W.) is shown on Plates 2,A and 2,B and on the geologic cross sections (Pl. 5-7). The throw of the fault ranges from 100 to 200 feet. The exact structural relationships of the pre-Tertiary rocks are not clear from existing data. Along a northeast-southwest-trending fault in T. 30 S., R. 42-43 W. outcrops of the Dakota Formation occur at the same elevation as those of the Ogallala Formation. Minor faults also are found in the surface and subsurface, but information is not available to locate them precisely.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Paleozoic Rocks

PERMIAN SYSTEM—UPPER PERMIAM SERIES

Big Basin Formation

In the subsurface of Grant and Stanton counties the red beds below the last known usable water-bearing sandstone are correlated with the Upper Permian Big Basin Formation (Norton, 1939, p. 13; O'Connor, 1963, p. 1875-1877). Merriam (1957, fig. 6) shows a geologic map of the inferred areal geology in pre-Triassic time. A basin is indicated by successively older beds outcropping away from the center of the structure.

Distribution and thickness.—Both Grant and Stanton counties were shown to be underlain by the Big Basin Formation (Merriam, 1957). Moore and others (1951, p. 34) discussed Upper Permian rocks in the subsurface in nearby Morton County and gave a thickness of 160 feet for the Big Basin (Taloga) Formation. The lower boundary of the Big Basin Formation was not delineated in this study.

Character.—M. R. Mudge recognized the Big Basin (Taloga) Formation in southeastern Colorado and northwestern Oklahoma (McKee and others, 1959). He stated (p. 2): "This formation consists largely of dark-red mudstones with some beds of orange-red siltstone. Locally it contains some fine-grained sandstone and sandy mudstone."

The contact between the Big Basin Formation and the Upper Triassic(?) Dockum Group can be placed with accuracy by use of drill-hole samples and radioactivity logs. Without drill-hole samples, the upper contact of the Big Basin is less certain, and the greater radioactivity of the red beds of the Big Basin is the criterion used for the separation of the Big Basin from the overlying Dockum Group.

During Neogene time streams eroded through the Cretaceous and Triassic rocks in southeastern Grant County, and in this area the unconsolidated Neogene alluvium lies di-

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rectly upon the Big Basin Formation. This contact can be determined from electric and radioactivity logs with the aid of drill-hole samples. The cross sections on Plates 3, 5, and 7 show this upper contact of the Big Basin.

Water supply.—No wells obtain water from the Big Basin Formation.

Mesozoic Rocks

TRIASSIC SYSTEM—UPPER TRIASSIC SERIES

Dockum Group

Rocks assigned to the Dockum Group, of Upper Triassic age, are found in the subsurface throughout most of the Grant-Stanton area below Cretaceous and Neogene rocks (Pl. 3-7). The nearest outcrops of the Dockum Group are to the south along the Cimarron River in Morton County (McLaughlin, 1942; Merriam, 1963) and in Baca County, Colorado (McLaughlin, 1954). Sandstone and siltstone samples collected from drill holes in the Grant-Stanton area were correlated with the samples from outcrops at Point of Rocks, Morton County, on the basis of similar lithology. Latta (1941, p. 66) recognized the occurrence of Triassic sedimentary rocks in Stanton County, stating, "The subsurface evidence in Stanton County and the relative nearness of areas of outcrop indicate that Triassic(?) beds are probably present beneath most or all of the county." Further indication of this occurrence is shown by the geologic cross sections (Pl. 3-7) and Table 2 of this report. The base of the combined sandstone sequence normally indicates the base of the Dockum Group.

A large basin in eastern New Mexico and western Texas with its eastern edge lying in southwestern Kansas is shown on an interpretative map by McKee and others (1959, pl. 9). This map shows clearly a westward thickening of Triassic sediments in the Grant-Stanton area.

What is classified in this report as Dockum may include deposits of Jurassic age equivalent to the Entrada Sandstone and the Morrison Formation.

Distribution and thickness.—The Dockum Group underlies most of the Grant-Stanton area. The maximum known thickness of the Group is 130 feet in western Stanton County. The average thickness, as shown by radioactivity logs, is 90 feet. The depth of occurrence of the sandstone sequence of the Dockum Group is shown on Table 2. The base of the sandstone beds in most places represents the base of the Dockum Group. In southeastern and in parts of eastern Grant County, Pliocene and/or Lower Cretaceous deposits rest upon the Permian Big Basin Formation.

Character. — The sandstones are yellow, white, pink, and tan, fine- to medium-grained, generally quartzose, and loosely cemented with calcium carbonate. Some thin beds are cemented with silica and would be classified as orthoquartzites. Red siltstone and mudstone are interbedded with the sandstone. Where drill-hole samples were available, the siltstone, mudstone, and sandstone beds of the Dockum Group can be differentiated from those in the overlying Cheyenne Sandstone of Early Cretaceous age and from the underlying Big Basin Formation. As previously mentioned, with the aid of drill-hole samples from test wells, rocks of the Dockum Group can be identified on electric and radioactivity logs.

Water supply.—The Dockum Group yields water to wells in parts of Grant and Stanton counties. One well, in sec. 24, T. 29 S., R. 42 W., was reported to produce 1,000 gpm. This well is screened in both the Cheyenne Sandstone and the Dockum Group; therefore, the yield of the individual formations is not known. Other wells in northern Grant and Stanton counties probably are deriving part of their production from the Dockum Group (Tables 16 and 17).

CRETACEOUS SYSTEM—LOWER CRETACEOUS SERIES

Cheyenne Sandstone

The Cheyenne Sandstone of Early Cretaceous age does not crop out in the Grant-Stanton area. The nearest outcrop is in Baca County, Colorado (McLaughlin, 1954), where the Cheyenne is the lower member of the Purgatoire Formation. Latta (1946) dis-

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TABLE 2.—Summary of geologic information from logs of gas and oil tests.

Company	Well name	Location	Type of log (1)	Age of bedrock present (2)	Altitude of lsd, feet	Sandstone		Base of Pliocene		Base of Pleistocene	
						Thickness, feet	Depth to base, feet	Depth, feet	Altitude, feet	Depth, feet	Altitude, feet
		T. 27 S., R. 36 W.									
W. B. Osborn	Phelps No. 1	Center sec. 6	E	Kc or TRd	3,089		705				
Columbian Fuel Corp.	Lizzie Hoffman "B" No. 2	SE NW sec. 16	GR	Kd?, Kk, Kc, TRd?	3,130	130	750				
		T. 27 S., R. 37 W.									
Northern Natural Gas Producing Co.	Thorp "C" No. 1	SW NE sec. 5	GR	Kk, Kc, TRd	3,079	170	665				
do	Waechter "A" No. 2	NE SW sec. 6	GR	Kd?, Kk, Kc, TRd	3,075	150	680				
		T. 27 S., R. 38 W.									
Western Natural Gas Co.	Dora D. Wright A-U No. 1	NW SE sec. 5	GR	Kd, Kk, Kc, TRd	3,178	170	515				
do	R. E. Cox Unit No. 1	SW NE sec. 24	S	Unknown	3,086		640				
		T. 27 S., R. 39 W.									
Stanolind Oil and Gas Co.	Fegan No. 1	Center sec. 3	S	Kd, Kk, Kc, TRd	3,244	280	620			70	3,174
		T. 27 S., R. 40 W.									
Graham Michaelis Dr. Co.	Plummer "C" No. 1	SE NE sec. 10	GR	Kd, Kk, Kc, TRd	3,221	250	685	275	2,946		
do	Plummer "A" No. 1	SE NW sec. 11	GR	Kd?, Kk, Kc, TRd	3,226	140	605				
do	Plummer "B" No. 1	NE SE sec. 15	GR	Kd?, Kk, Kc, TRd	3,217	140	630	325	2,892		
United Producing Co.	Baughman No. 2	SE SE sec. 16	GR	Kk, Kc, TRd	3,255	140	630				
do	Winger No. 1	SE SE sec. 20	E	Kd, Kk, Kc, TRd	3,268	170	620				
		T. 27 S., R. 41 W.									
do	M. G. Raney No. 1	NW SE sec. 24	E	Kk, Kc, TRd	3,284	160	620				
do	Carl Lane No. 1	SW NE sec. 25	GR	Kk, Kc, TRd	3,321	200	640				
		T. 27 S., R. 43 W.									
Van Grisso Oil Co.	Wilson No. 1	SE SE sec. 11	E	Kd, Kk, Kc, TRd	3,529	380	750	265	3,264	175	3,354
		T. 28 S., R. 35 W.									
Columbian Fuel Corp.	Beaver No. 1	SW SE sec. 15	S	Kk, Kc		120	740				
do	Kennedy A-2	SE NW sec. 17	GR,E	Kk, Kc, TRd	3,082	130	755				
W. B. Osborn	Coke No. 1	SW NE sec. 36	E	Kk, Kc	3,027	30	690	550	2,477		
		T. 28 S., R. 38 W.									
Stanolind Oil and Gas Co.	Fletcher No. 1	Center sec. 20	GR	Kd, Kk, Kc, TRd	3,118	190	620	370	2,748		
		T. 28 S., R. 40 W.									
Graham Michaelis Dr. Co.	Plummer "D" No. 1	NE NE sec. 5	GR	Kd, Kk, Kc, TRd	3,290	200	625	345	2,945		
Ed Swearer	Plummer No. 1	NE SW sec. 10	GR	Kd, Kk, Kc, TRd	3,250	200	595	310	2,940		
		T. 28 S., R. 41 W.									
Musgrove Dr. Co.	Craig No. 1	Center SW sec. 10	GR	Kk, Kc, TRd		140	575				
		T. 29 S., R. 35 W.									
United Producing Co.	J. W. Baughman No. 1	SW NE sec. 13	GR	Kc, or TRd	3,017	60	670	590	2,427	500?	2,517?
do	C. N. King No. 3	SE NW sec. 19	GR	Kc or TRd	3,017	40	635	585	2,432	510	2,507
do	R. R. King No. 1	NE SW sec. 22	GR	Kc or TRd	2,999	20	655	630	2,569	470	2,529

Hugoton Production Co.	Eichenberger No. 2	T. 29 S., R. 37 W. SE NW sec. 27	GR	P	3,053	0	555	555	2,498		
Stanolind Oil and Gas Co.	Sullivan "B"	T. 29 S., R. 38 W. SW NE sec. 1	GR	Trd?	3,086	90?	550	450	2,637		
do	McGannon-Snow Inc. No. 1	Center sec. 5	E	Trd?	3,119	90?	610				
Kansas-Nebraska Natural Gas	Ray No. 1	T. 29 S., R. 40 W. SW SE sec. 17	E	Trd	3,307	120	600	470?	2,837		
do	Jones No. 1	NW SE sec. 26	E	Trd	3,251	130	600	445	2,806		
Coronet Oil Co.	Troutman No. 1	T. 29 S., R. 42 W. NE NE sec. 22	E	Kd?, Kk, Kc, Trd	3,495	260	610				
Sun Ray Mid-Continent Oil Co.	Santa Fe No. 1	NW NW sec. 31	E	Kd?, Kk, Kc, Trd	3,566	230	565				
Anderson-Pritchard Oil Corp.	Stewart Unit "E" No. 1	T. 29 S., R. 43 W. NW NE sec. 28	E	Kd?, Kk, Kc, Trd	3,567	250	500				
United Producing Co.	Brollier No. 1	T. 30 S., R. 35 W. NE SW sec. 5	GR	P	2,919	0	510	510	2,409	300	2,619
do	F. H. Truesdale No. 1	SE NW sec. 12	GR	P	2,986	0	580	580	2,406	436	2,550
do	D. Julian No. 1	NW NE sec. 26	GR	P	2,845	0	412	412	2,433	250	2,595
do	L. L. Gilbert No. 1	SW NE sec. 31	GR	P	2,928	0	440	440	2,488	250	2,675
do	C. Koenig No. 2	T. 30 S., R. 36 W. NE SW sec. 11	GR	P	3,001	0	595	595	2,406	300	2,701
do	H. H. Thurow No. 1	SE NW sec. 20	GR	P	2,999	0	580	580	2,419	305	2,694
Hugoton Production Co.	R. G. Dunne No. 7	T. 30 S., R. 37 W. NW SE sec. 13	S	P	3,040	0	517	517	2,523		
Saturn Oil and Gas Co.	Brollier No. A-1	SW NE sec. 25	GR,S	P	3,005	0	514	514	2,491	350	2,655
Anadarko Production et al.		NE NE sec. 32	GR,S	Trd	3,071	75	540	465	2,606	345	2,726
Hugoton Production Co.	Bell No. 1	T. 30 S., R. 38 W. NE SW sec. 21	GR	Trd	3,124	115	525	410	2,714		
Stanolind Oil and Gas Co.	Citizens State Bank Unit No. 1	T. 30 S., R. 39 W. SW NE sec. 26	GR	Trd	3,134	100	475	366	2,768	315	2,819
Kansas Natural Gas, Inc.	Plummer No. 1	T. 30 S., R. 40 W. SW NE sec. 2	E,S	Kc, Trd	3,216	110	590	450	2,811	210	3,006
do	Peppercorn No. 1	NE SW sec. 3	E	Kc, Trd	3,274	180	590				
Petroleum, Inc.	Newsome No. 1	NW SE sec. 9	E	Trd	3,289	?	500?				
Wm. Greenewald	Tucker No. 1	T. 30 S., R. 41 W. SE SE sec. 29	S	Kk, Kc, Trd	3,421	240	530	195	3,226	105	3,216
Huber Corp.	Kilgore No. 2	T. 30 S., R. 42 W. NE SW sec. 5	S	Kd, Kk, Kc, Trd		240	510				
Killman-Hurd and Sun Oil Co.	Rorick Unit No. 1	SW SW sec. 18	S	Kd, Kk, Kc, Trd		250	550				
Huber Corp.	Sparks No. 1	NE NE sec. 34	S	Kd, Kk, Kc, Trd		250	550				
Shell and Sohio	Hume Unit No. 1	T. 30 S., R. 43 W. SE SE sec. 23	S	Kd, Kk, Kc, Trd	3,570	230	480	110	3,460		

1. E, electrical log; GR, Gamma-ray log; S, sample log.
2. Kd, Dakota Formation; Kk, Kiowa Shale; Kc, Cheyenne Sandstone; Trd, Dockum Group; P, Permian.

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cussed the Cheyenne Sandstone at its type locality in the Belvidere area, Kiowa County.

Distribution and thickness.—The thickness of the Cheyenne Sandstone is variable, owing to its deposition upon an uneven pre-Cretaceous erosional surface. In the Grant-Stanton area, the thickness of the formation, where it has not been eroded by Neogene streams, ranges from 40 to more than 120 feet (Pl. 3-7). The Cheyenne Sandstone and the sandstones in the Dockum Group (Upper Triassic), although differing in age, have similar hydrologic characteristics and are considered a single hydrologic unit. The sandstone beds of the Dakota Formation [L.(?) Cretaceous] are separated stratigraphically from the Cheyenne by a dark-gray to black silty shale believed to be the Kiowa Shale. The combined thicknesses of the sandstones (Dakota, Cheyenne, and Dockum Group) were interpreted from electric and radioactivity logs (Table 2).

Character.—The Cheyenne Sandstone, as described from well cuttings from Grant and Stanton counties, consists of white to rust colored, fine- to coarse-grained quartzose sandstone. The sandstone locally is poorly cemented with calcium carbonate and limonite. Pyrite is disseminated in some of the sandstone beds. The black silty shale lenses which are commonly interbedded with the sandstone make separation of the Cheyenne from the overlying Kiowa Shale difficult.

Water supply.—Many wells that produce from the Cheyenne Sandstone are multiple-screened and produce water from the unconsolidated Pliocene and Pleistocene deposits as well as from the Lower(?) Cretaceous Dakota Formation and the Lower Cretaceous Cheyenne Sandstone. In some areas of Stanton County multiple-screened wells produce water from the Cheyenne Sandstone and the sandstone beds of the Dockum Group. Where the Cheyenne Sandstone consists predominately of sandstone beds, well yields up to 500 gpm are possible. In adjacent Baca County, Colorado, yields in excess of 1,000 gpm from the Cheyenne Sandstone Member were reported by McLaughlin (1954, p. 98).

Kiowa Shale

The Kiowa Shale does not crop out in Grant or Stanton counties. It is exposed along major stream valleys in southwestern and northwestern Baca County, Colorado (McLaughlin, 1954), where it is the upper member of the Purgatoire Formation of Early Cretaceous age. The Kiowa Shale at the type locality in Kiowa County, Kansas, has been described in detail by Latta (1946). The term Kiowa, as used in this report, refers to the black shale interval separating a thick sandstone believed to be Cheyenne from an overlying thick sandstone assigned to the Dakota Formation.

Distribution and thickness.—The Kiowa Shale underlies most of the Grant-Stanton area. In southern and eastern Grant County, the Kiowa has been eroded by Pliocene and Pleistocene streams and is missing in some localities.

The maximum thickness of the Kiowa Shale is approximately 150 feet, as illustrated by cross sections on Plates 3-7.

Character.—The Kiowa Shale consists of a dark-gray to black silty shale containing calcareous shale lenses and interbedded sandy siltstone, fine sandstone, and "soft," tan calcareous shale. Interpretations of electric and gamma-ray logs show that the Kiowa consists of shale with a few siltstone and sandstone beds. Where the Kiowa Shale consists predominantly of sandstone beds, it is difficult to distinguish from the underlying Cheyenne Sandstone or the overlying sandstone beds of the Dakota Formation.

Water supply.—The Kiowa Shale yields little water to wells in the area. In some localities sandstone beds in the Kiowa are screened in some multiple-aquifer wells.

Dakota Formation

The Dakota Formation of Early(?) Cretaceous age is the oldest rock exposed in the Grant-Stanton area (Pl. 1). The formation crops out in western Stanton County along the South Fork of Bear Creek in T. 29 S., R. 43 W. and along Sandy Arroyo in T. 30 S., Rs. 42-43 W. (Pl. 8A). An angular un-

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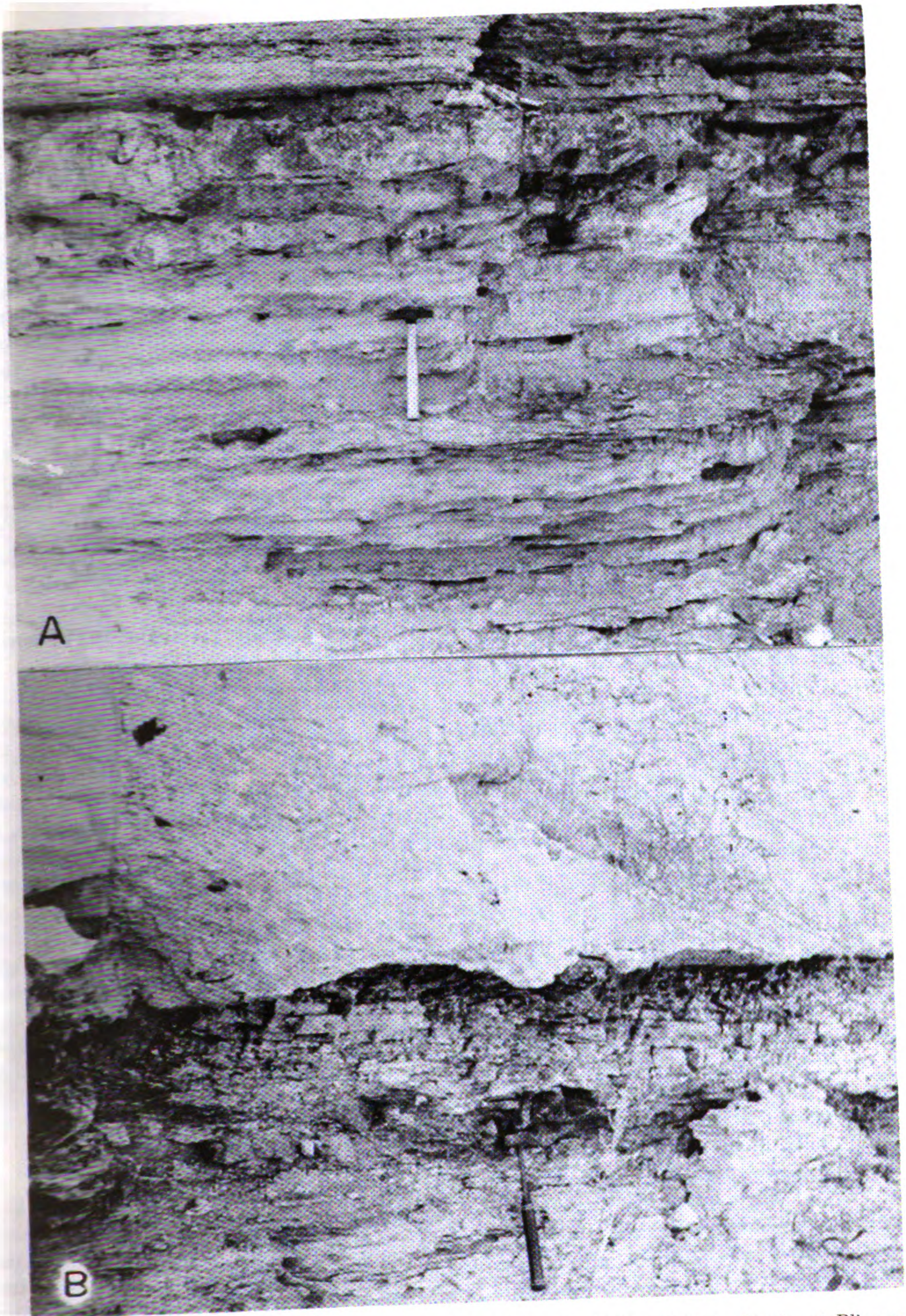

PLATE 8.—A, Dakota Formation in SE¼ sec. 15, T. 29 S., R. 43 W.; B, Unconformity at Pliocene (?)-Dakota contact in SW¼ sec. 15, T. 29 S., 43 W., Stanton County.

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conformity at the Pliocene(?)—Dakota contact in Stanton County is exposed in the SW¼ sec. 15, T. 29 S., R. 43 W. (Pl. 8,B). Latta (1941) introduced the name "Cockrum Sandstone" for the rocks exposed in these localities. The Cockrum Sandstone was considered as the upper formation of a proposed Dakota Group. The lower formations were to be the Kiowa Shale and the Cheyenne Sandstone. Waite in 1942 (p. 135-137) discussed the reasons for further use of the Dakota Formation as a valid stratigraphic unit. Plummer and Romary (1942) considered the Cockrum Sandstone to be equivalent in part to the Dakota Formation of central Kansas.

Merriam (1957), in a subsurface study in Kansas, used the term "Omadi Formation" (of Condra and Reed, 1943) in place of the Dakota Formation. In the Nebraska portion of the Denver basin, the Omadi Formation is divided into Cruise Sandstone (lower), Huntsman Shale, and Gurley Sandstone (upper) members. Merriam recognized three divisions of the Omadi Formation in the subsurface and correlated them with the named members in Nebraska.

Insufficient subsurface data are available to confirm correlation of the Dakota Formation in Grant and Stanton counties with the Omadi Formation as defined by Condra and Reed (1943) and as adopted by Merriam (1957). The term "Dakota Formation," which is well established by local usage, therefore, is retained. The age of the Dakota Formation is placed as latest Early(?) Cretaceous (Table 2) as given by Jewett (1959). McLaughlin (personal communication, 1962) reported that mollusks of Early Cretaceous age similar to those found in the Duck Creek of Texas were collected near the west line of sec. 20, T. 29 S., R. 44 W., Baca County, Colorado, approximately 20 miles west of the Stanton County line. Although fossils were not found in beds of the Dakota Formation in the area of this report, the proximity to the fossiliferous outcrop in Baca County indicates that an Early Cretaceous age is probable for rocks assigned to the Dakota Formation in Stanton County.

Distribution and thickness.—The Dakota Formation underlies all of Stanton County and the western half of Grant County, but it is absent in eastern Grant County. The Dakota Formation is thickest in the western half of Stanton County and on the upthrown (north) side of the Bear Creek Fault in Grant and Stanton counties (Pl. 3-7). The thickness (as indicated by sample logs) ranges from 60 to 135 feet.

Character.—The Dakota Formation in most areas consists of fine- to medium-grained reddish-brown to yellowish-brown ferruginous standstone, containing yellow and gray silty shale beds. The predominance of hydrous iron oxide as the primary cementing agent is a distinguishing feature of the Dakota Formation in Grant and Stanton counties. Minor amounts of calcium carbonate and silica cement are present. The most distinctive markers are the interbedded thin ironstone layers, which form small resistant ledges on the outcrops of the Dakota Formation.

As stated previously, the Dakota Formation can be separated from the Kiowa Shale in the subsurface by use of samples and electric and radioactivity logs; however, some sandstone classed in this report as Dakota actually may be Kiowa. The Dakota Formation has been eroded and redeposited by Neogene streams, forming sediments that in some localities are difficult to differentiate from the Dakota Formation in the subsurface. However, rounded ironstone pebbles from beds in the Dakota, when associated with material from other sources, differentiates the secondarily derived material from the Dakota Formation. Smith, who first reported this problem, stated: "Pebbles of Dakota ironstone, for example, occur well up in the Ogallala so that the presence of ferruginous chips in cuttings does not necessarily indicate that the drill has reached the Dakota Formation."

Water supply.—No irrigation wells are screened solely in the Dakota, as yields from this formation range only from 50 to 100 gpm. Many wells are screened in more than one aquifer and usually obtain water from the unconsolidated Pleistocene and Pliocene deposits and from the Dakota Formation, the Cheyenne Sandstone, and the sandstones of the Dockum Group. However, there are many

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stock and domestic wells screened in the Dakota Formation in northwestern Grant and northern and western Stanton counties.

Cenozoic Rocks

NEOGENE SYSTEM

Summary of Pliocene and Pleistocene Investigations

Thick deposits of Pliocene and Pleistocene age are widespread in southwestern Kansas, and they are particularly well developed in the Grant-Stanton area. The Pliocene deposits have not been divided in this report (Fig. 4), and the term "Ogallala Formation" has been used for all deposits of Pliocene age penetrated by drilling. Semicontinuous lithologic units in the Ogallala Formation have been recognized, but these units have not been successfully correlated over the entire area. In Meade County where the Pliocene deposits crop out, they have been divided on the bases of lithology and fossil content (Hibbard, 1953, 1958; Hibbard and Taylor, 1960) into three units which, in ascending order, are: Laverne Formation, Ogallala Formation, and Rexroad Formation (Fig. 4).

In northwestern Kansas the Ogallala Formation has been divided into three members which, in ascending order, are: Valentine, Ash Hollow, and Kimball (Frye and others, 1956). This division was first applied by Lugn (1939) to the Pliocene of Nebraska, in which the Ogallala was considered as a group with these members as formations. No subsurface correlations have been made between the divisions of the Ogallala Formation in the Grant-Stanton area and in northwestern or southwestern Kansas.

The Pleistocene deposits have been divided in this report into two major units, using sub-

This report				Meade County (after Hibbard, 1953, 1958, and Hibbard and Taylor, 1960)			
Cenozoic Era	Neogene System	Pleistocene Series	Upper Pleistocene	Recent			
				Wisconsinan	Sanborn Group	Vanhem Formation	
				Sangamonian		Kingsdown Formation	
				Illinoisan			
			(Pearlette ash bed) Lower Pleistocene	Yarmouthian	Meade Group	Crooked Creek Fm.	Atwater Member
				Kansan			(Pearlette ash lentil) Stump Arroyo Member
				Aftonian		Ballard Formation	Missler Member
				Nebraskan			Angell Member
		Pliocene Series	Ogallala Formation	Upper	Rexroad Formation X I Member		
				Middle	Ogallala Formation		
				Lower	Laverne Formation		

FIGURE 4.—Classification of Neogene deposits in Grant and Stanton counties as compared with classification used in Meade County.

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surface data. The upper unit, Upper(?) Pleistocene Subseries, includes deposits ranging in age from Recent to Illinoisan. The lower unit, Lower Pleistocene(?) Subseries, includes deposits ranging in age from Yarmouthian to Nebraskan. These units have the same age boundaries as the Meade and Sanborn groups in Meade County, Kansas, as defined by Hibbard (1958). To divide the Pleistocene into more than two units in the Grant-Stanton area does not seem feasible at this time.

Prior to this study, much of the unconsolidated sediment above the stream-dissected bedrock surface had been considered as undifferentiated Pleistocene and Ogallala Formation (Pliocene).

Darton (1920) stated that what he mapped as Ogallala might include deposits of Pleistocene age. Smith (1937) believed that he could differentiate the Pleistocene gravels and the Ogallala gravels in the Arkansas Valley.

Smith (1940) differentiated the exposed Pliocene and Pleistocene deposits in Meade and Clark counties. Latta (1941), in Stanton County, and McLaughlin (1943), in Hamilton and Kearny counties, recognized the gross lithologic differences between the Ogallala and Pleistocene deposits, but did not separate them in the subsurface. Latta (1944) differentiated the Pleistocene and Pliocene deposits in the subsurface in parts of Finney County.

Frye (1945) stated that 80 to 90 percent of the surface area of southwestern Kansas is underlain by deposits of Pleistocene age. McLaughlin (1946) reported that deposits of the Meade Formation [now Lower Pleistocene(?) Subseries] underlie in part all the counties of southwestern Kansas.

Frye and Leonard (1952) and Merriam and Frye (1954) described the Pleistocene drainage patterns in southwestern Kansas.

As indicated above, previous investigators had recognized a difference between the Pliocene and Pleistocene deposits in many places in southwestern Kansas, but they had insufficient data to justify their separation over a large area. On the basis of the subsurface data available for this study, the Pliocene (Ogallala Formation) was separated from the Lower Pleistocene(?) Subseries in the Grant-Stanton area. The coarse arkosic sand and gravel deposits of the Pleistocene can, in most instances, be differentiated from the Ogallala Formation on the basis of lithology. With the aid of fossil mollusks the Pleistocene-Pliocene boundary can be determined as well as the Upper-Lower Pleistocene boundary. Ostracodes also can be used to establish the Pleistocene-Pliocene boundary.

Pliocene Series

OGALLALA FORMATION

The Ogallala Formation crops out locally along Sandy Arroyo and Bear Creek in western Stanton County. A typical outcrop of the Ogallala is shown on Plate 9A. The Ogallala lies upon a surface of stream-dissected rocks that range in age from Permian to Cretaceous (Fig. 5A).

The Ogallala, as used in this report, includes all known deposits of Pliocene age identified in the subsurface in the Grant-Stanton area. Divisions of the Ogallala that have been applied elsewhere could not be applied to stratigraphic units in the area under study. Units comparable to the lower Pliocene Laverne Formation and the middle Pliocene Ash Hollow Member of the Ogallala Formation are indicated by sample logs, but additional study is necessary before correlation of these units is certain.

Distribution and thickness.—The Ogallala Formation, which underlies most of the Grant-Stanton area, ranges from 0 feet in western Stanton County to approximately 200 feet in parts of eastern Grant County. A pre-Ogallala bedrock high is present in western Stanton County, and, consequently, the Ogallala may be thin or absent. Differential erosion during Pleistocene time is a further cause for the range in thickness in other parts of the area. Geologic cross sections (Pl. 3-7) illustrate the variation in thickness of the Ogallala and the relationship of Pleistocene stream erosion upon the Ogallala surface.

Character.—The Ogallala Formation consists of individual and mixed layers of stream-deposited silt, clay, sand, and gravel. Caliche and "mortar bed" (caliche-cemented sand and

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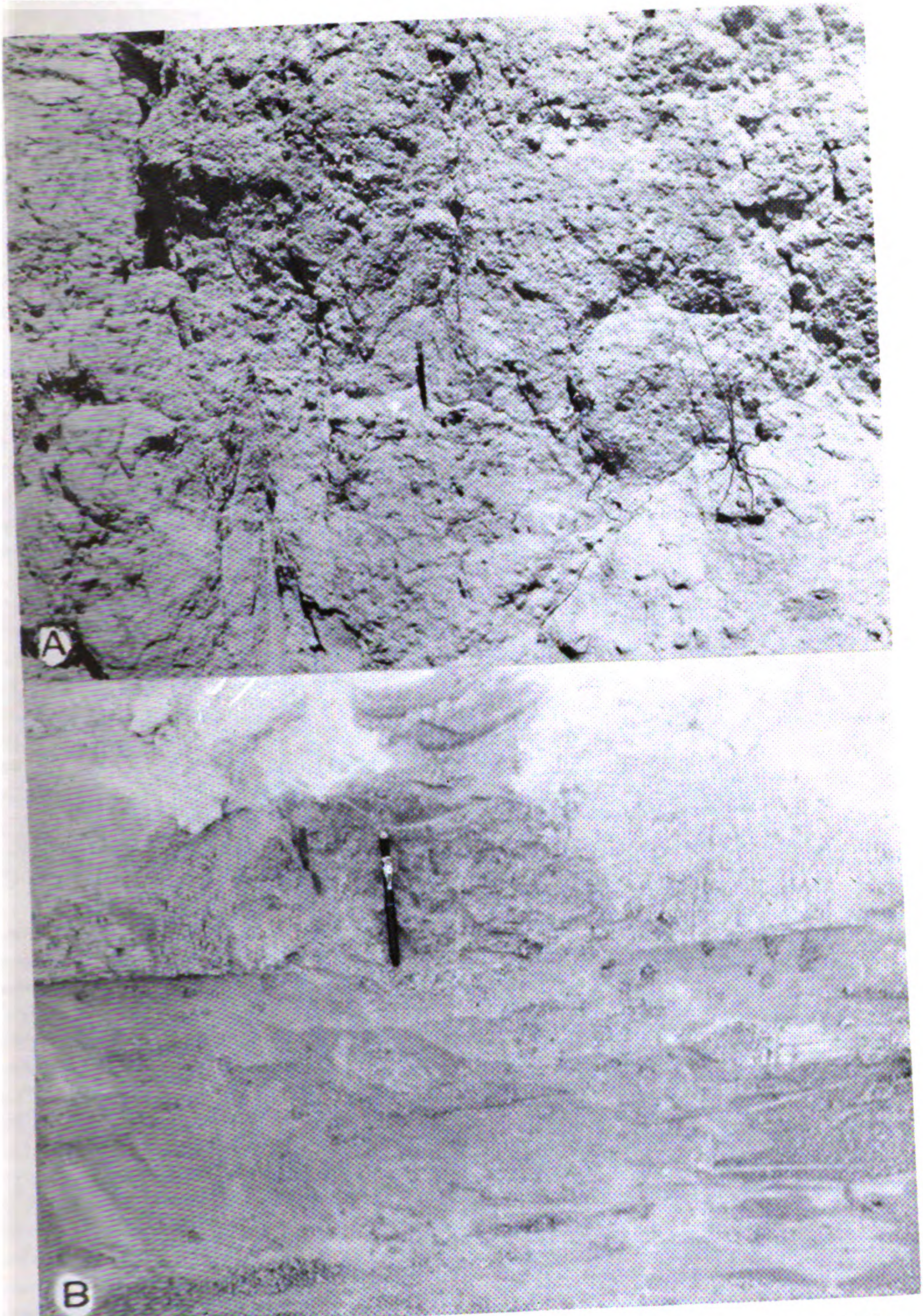

PLATE 9.—A, Ogallala Formation in SE¼ sec. 12, T. 34 S., R. 43 W., Morton County; B, Lower Pleistocene stream deposits in NW¼ NW¼ SE¼ sec. 28, T. 29 S., 43 W., Stanton County.

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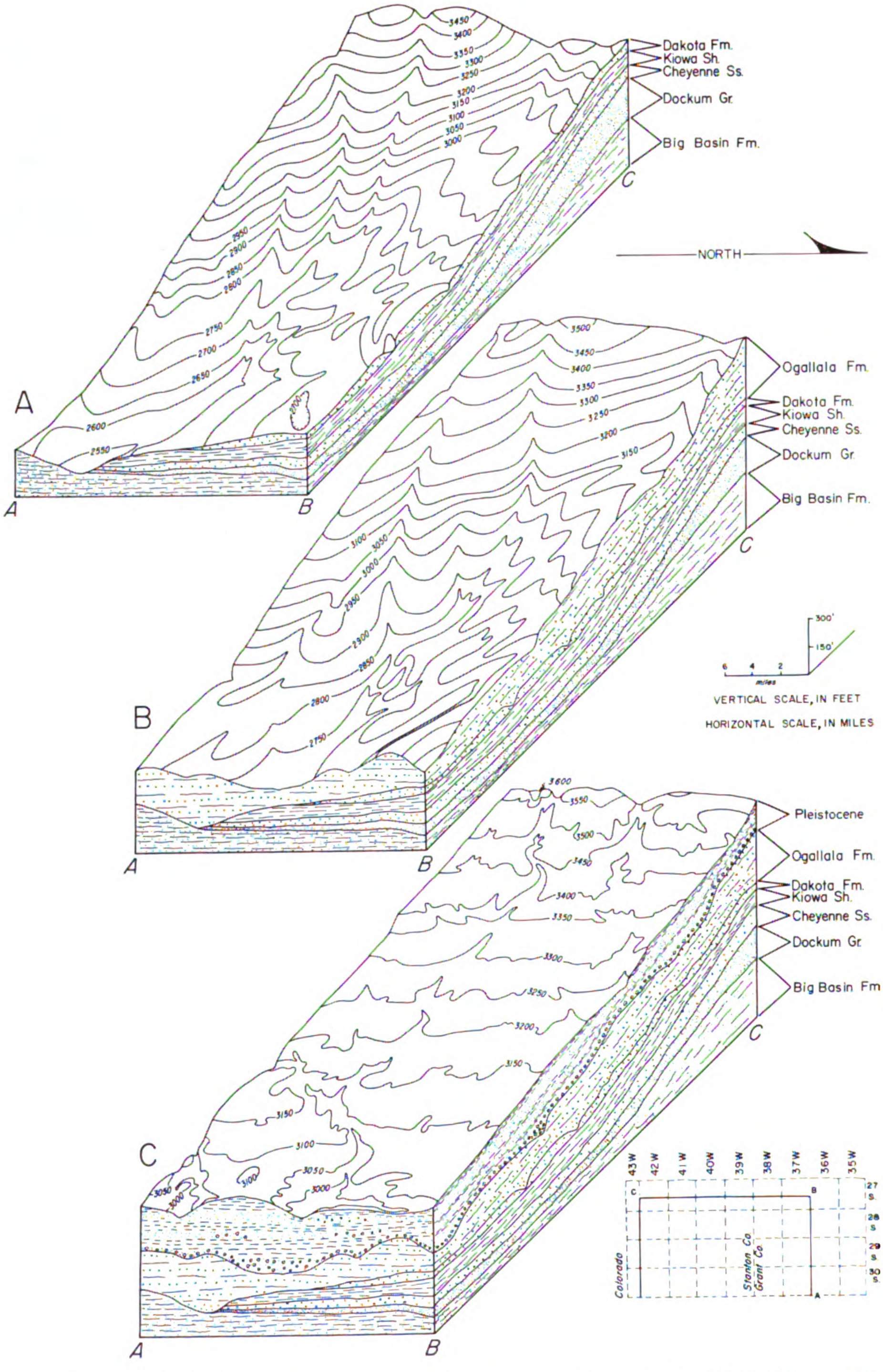

FIGURE 5.—Block diagram showing the topography and geology of the Grant-Stanton area. A, Pre-Neogene surface dissected by Pliocene streams; B, Pre-Pleistocene surface dissected by Pleistocene streams; C, Present areal geology. (Contour interval 50 feet.) (Prepared by W. N. Lockwood.)

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gravel) zones occur at several horizons throughout the formation. The presence of caliche is not by itself evidence of the presence of the Ogallala because thick caliche zones are prevalent in the Pleistocene deposits of Meade County (Hibbard and Taylor, 1960) and in other areas in southwestern Kansas.

In the Ogallala Formation, most of the sand and gravel beds lie above the basal chalky silt beds and below the upper silt and clay beds. The sand samples recovered from rotary drilling are predominantly quartz grains and particles of reworked Dakota rocks. The gravel is composed primarily of phenoclasts of reworked Dakota rocks. Ironstone and sandstone phenoclasts derived from the Dakota Formation are recognized in well cuttings. The relatively rapid rate of penetration of the Ogallala by the rotary drill, as well as the lithology of the drill-hole samples, precludes misidentification of the reworked material as bedrock. The sand and gravel of the Ogallala contain a greater amount of interbedded silt and clay lenses and are more well sorted than are similar deposits in the Pleistocene.

In most areas the lower part of the Ogallala contains yellow, chalky, silty, sand beds that were considered in the past as possibly belonging to the Dakota Formation. This chalky unit is found at the base of the Ogallala in the areas of deepest fill. "Red beds" found in association with this chalky member were considered by Smith (1940, p. 50) to be reworked material from Permian and Triassic deposits. In most instances the Ogallala can be differentiated from the underlying Cretaceous, Triassic, or Permian bedrock by its heterogeneous alluvial nature.

The upper surface of the Ogallala was modified by erosion in Pleistocene time. In northwestern Kansas the so-called "Algal limestone" at the top of the Kimball Member (uppermost Ogallala) is considered as the top of the Pliocene Series (Frye and others, 1956). Because this member is missing or unrecognizable in the subsurface in the Grant-Stanton area, the Pliocene-Pleistocene contact is accordingly more difficult to differentiate. The distinctive granitic-arkosic lithofacies of the Lower Pleistocene deposits can be differentiated from the Ogallala Formation on fossil evidence over most of the area. In western Stanton County the Pliocene and Pleistocene deposits are undifferentiated.

Water supply.—The Ogallala Formation is one of the principal aquifers in the Grant-Stanton area. Sand and gravel beds in the Ogallala, because of admixed silt and clay, generally do not yield as much water as comparable thicknesses of lower Pleistocene sand and gravel. In western Stanton County the Ogallala is only partly saturated or may lie above the water table.

Wells are usually perforated opposite all the water-bearing zones in areas where the Ogallala is saturated, and, hence, the yield from individual zones is not easily determined. The production of wells screened only in the Ogallala in Stanton County ranges from 450 gpm (well 28-42-6db) to 900 gpm (well 28-42-35ba). Probably no irrigation well in Grant County is screened only in the Ogallala, but yields up to 1,000 gpm in areas of thick sand and gravel may be possible. The geologic cross sections (Pl. 3-7) can be used to determine the approximate base of the Ogallala Formation and should prove helpful as a guide to well depth.

Pleistocene Series

LOWER PLEISTOCENE(?) SUBSERIES

The Lower Pleistocene deposits, as defined in this report, include all known deposits of Nebraskan, Aftonian, Kansan, and Yarmouthian Age that have been recognized in the Grant-Stanton area.

Lower Pleistocene deposits crop out as a valley fill best observed in NW¼ NW¼ SE¼ sec. 28, T. 29 S., R. 43 W., in western Stanton County (Pl. 9,B), and this deposit was dated as early Pleistocene (Kansan) by means of the contained molluscan fauna. In southwestern Grant County, Lower Pleistocene deposits crop out along the Cimarron River valley. The Pearlette ash bed (late Kansan) crops out in sec. 1, T. 30 S., R. 36 W., Grant County (Pl. 10A). Although the Pearlette ash bed is stratigraphically important, it is not continuous, and at short distances from

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the outcrops augering did not penetrate the ash. An outcrop of Lower Pleistocene gravel in nearby Kearny County is shown on Plate 10B. The geologic map (Pl. 1) shows the outcrop area of Lower Pleistocene deposits.

In the Grant-Stanton area the subsurface deposits[1] identified as being of Early Pleistocene Age are divided into two categories:

(1) Coarse sand and gravel deposits containing phenoclasts of granite, pink feldspar (orthoclase), quartz, quartzite, and rock fragments from other igneous and metamorphic rocks. Minor amounts of water-worn pebbles of caliche and chalcedony occur in the gravel and sand.

(2) Silt, very fine silty sand, caliche, and clay deposits that in many localities contain thin beds of coarse sand and gravel near the base. Fossiliferous blue clayey silts and silty clays are found in these fine-grained deposits in parts of the area.

Because these two major depositional units are distributed throughout much of the area, multiple working hypotheses were used to determine the relationship between them and the recognized major depositional sequences.

(1) The first hypothesis is that course deposits of Pliocene age were eroded by streams which later deposited fine sediments. This hypothesis was rejected because the depositional environment of the coarse deposits is more typical of conditions that are believed to have existed during Pleistocene time rather than Pliocene (Ogallala) time. The Ogallala Formation was deposited in Kansas by broad, shallow, low-gradient aggrading streams which were transporting relatively fine material. Moore (1960, p. 221) in a discussion of Cenozoic history in the "Gangplank Area" of Wyoming and Colorado, with reference to the Ogallala deposits at the mountain front, reported that coarser arkosic deposits are found closer to the mountain source areas while some of the finer materials were reworked and deposited eastward on the plains. He also stated that Pleistocene erosion effected the dissection of the Tertiary mantle. It is believed that in southwestern Kansas much of the arkosic materials are reworked Ogallala sands and gravels deposited on the Plains area by Pleistocene streams.

Frye, Leonard, and Swineford (1956, p. 50-51) stated: "The earliest post-Ogallala sediments of the central Great Plains are coarser than those of the upper Ogallala, and Pleistocene materials subsequently transported eastward from the Rocky Mountains to western Kansas are considerably coarser than any of the Ogallala materials."

(2) The second hypothesis is that coarse sediment was deposited by streams in channels eroded into fine deposits of pre-Pleistocene age. The initial erosion by the Lower Pleistocene streams was into the Ogallala Formation, and the alluvial deposits of some of the small valleys in northwestern Stanton County are in a geologic setting that may lend support to this hypothesis. Subsequent erosion and deposition has obliterated much of the original Ogallala surface, leaving low hills as remnants. Fossils of Pleistocene age found at depth in fine deposits at numerous localities in Grant and Stanton counties indicate that much of the fine deposits are Pleistocene.

(3) The third hypothesis is that younger Pleistocene deposits were deposited in channels in the fine deposits of an older Pleistocene deposition cycle. Remnants of deposits of earlier Pleistocene stages are found in many stream valleys in central Kansas. This indicates that the streams have gone through alternating phases of cutting and filling, which correspond to climatic changes. Frye and Leonard (1954) gave an excellent discussion of the problems encountered in mapping and interpreting outcropping terrace deposits. Because of downcutting by streams, the younger terrace deposits are topographically lower than older deposits. During the Upper Pleistocene, cycles of erosion and deposition resulted in terrace formation.

The occurrence of coarse gravel and sand deposits in close proximity to the fossiliferous, fine-grained deposits is possible under conditions of this hypothesis. Dalquest (1962) found that similar conditions existed during

1. In this report all references to subsurface Lower Pleistocene deposits are followed by a question mark. This query is used to indicate that, although several types of geologic evidence (similar lithology, fossil dating, and electric and radioactivity logging) were used to resolve the problem, the boundaries of the Pleistocene units are subject to revision until proven by detailed work in surrounding areas.

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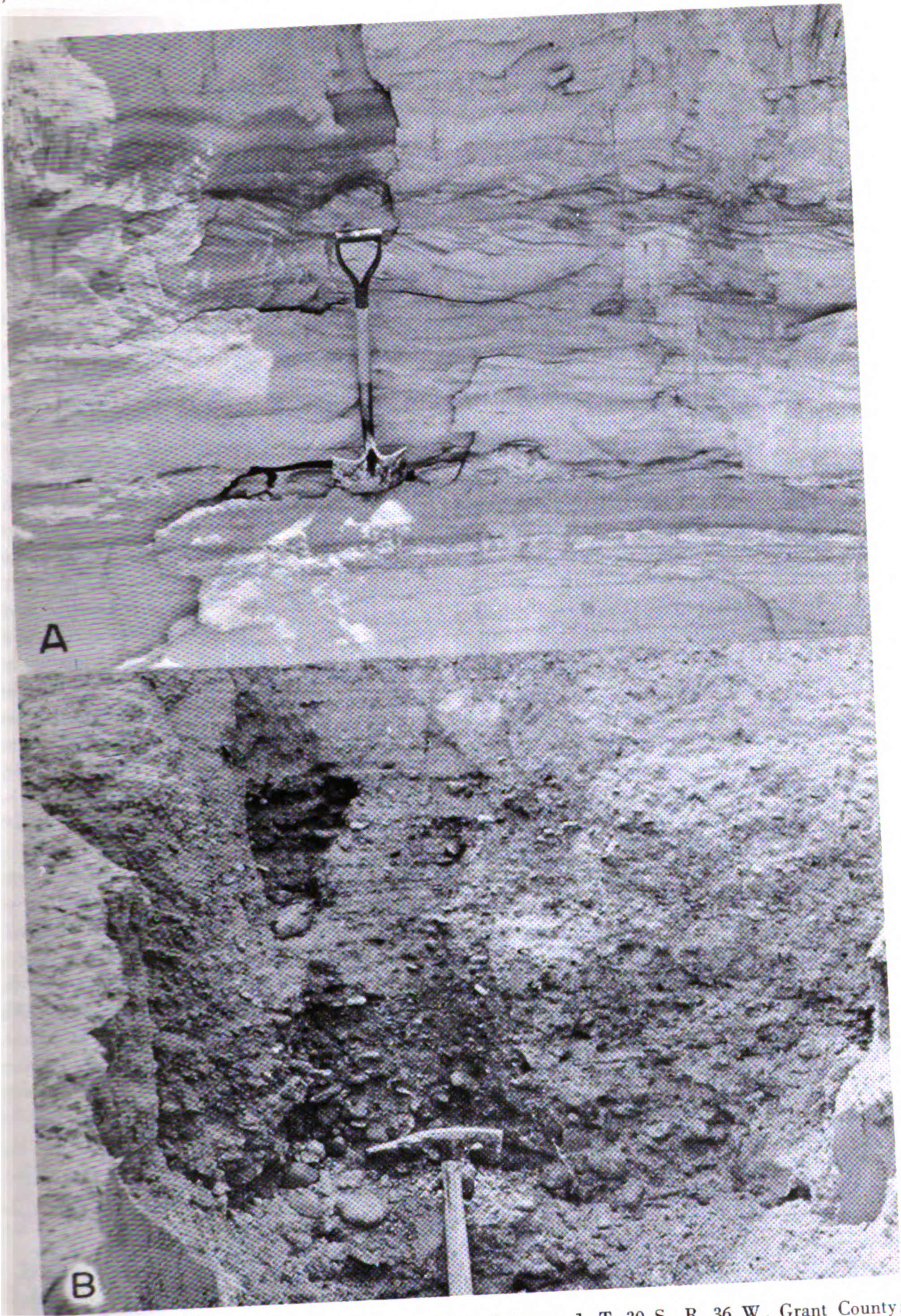

PLATE 10.—A, Lower Pleistocene Pearlette ash bed in sec. 1, T. 30 S., R. 36 W., Grant County; B, Lower Pleistocene gravel in NW¼ sec. 20, T. 26 S., R. 37 W., Kearny County.

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deposition of the fossiliferous late Pleistocene Good Creek Formation of West Texas. In Texas fossiliferous blue-clay deposits were eroded by a somewhat later channeling, followed by deposition of coarse sand and gravel.

(4) The fourth hypothesis is that coarse channel deposits are contemperaneous with finer interstream and backwater deposits, with the former representing a coarser fluviatile phase of the later. Evidence from data collected in the Grant-Stanton area supports this hypothesis. The examination of sample logs indicates that many of the gravel zones can be correlated laterally. The basal part of the sequence of fine silt and clay, which probably was deposited in the interstream and backwater areas, contains thin beds of coarse sand and gravel. Fossils collected from the blue-gray silty clay material of the finer deposits have been studied and are diagnostic of early Pleistocene age. The thicker deposits of the coarse-grained channel-phase sediments are found in the deeper parts of the valleys, while the thinner deposits are located on the flanks.

Pleistocene deposition was controlled by climatic changes which resulted in cycles of erosion, alluviation, eolation, and soil formation. These cycles have been correlated with those of the classic glaciated region of the Mississippi Valley (Frye and Leonard, 1952, p. 52; Hibbard, 1958, p. 55).

The major consequent streams during early Pleistocene time generally followed the late Pliocene water courses (Pl. 2,B). After the onset of climatic and tectonic changes in the source areas, the streams became entrenched. Increased stream flow produced a concomitant increase in capacity and competency, which in turn caused a readjustment of stream gradients. After grade was established, the streams were capable of increased lateral planation which produced broad valleys. A subsequent change in climatic conditions started a period of alluviation. The streams then filled their valleys and overlapped and spread sediment over the divides. Condra, Reed, and Gordon (1950, p. 9) in a study of the Pleistocene deposits in Nebraska describe a similar condition.

From the available data, it seems that the streams were slowly aggrading and laterally migrating, and, as the channel shifted from side to side, a layer of channel sand was deposited at almost the same altitude across each of the individual valleys. However, at times the rate of sedimentation increased and the streams rapidly aggraded their channels. This may account for backwater deposits not being eroded. The fine flood-plain or backwater deposits contain fossiliferous beds. The swift-flowing, load-laden water of the channels did not as readily allow the preservation of fossils as did the quiet waters in the backwater areas.

After deposition of the alluvium, the climate changed, and the cycle of eolation and soil formation was completed. This was followed by another cycle or epicycle of erosion and alluviation.

The occurrence of fossiliferous blue clay in relation to coarse sand and gravel deposits in the Grant-Stanton area can be explained by hypotheses (3) and (4). Most likely both types of conditions occurred in the area. Additional data from nearby areas under study may lend support to these hypotheses.

Paleontologic age determination is the most important tool in the differentiation of the Pleistocene and Pliocene deposits. Fossil mollusks from the blue-gray silt and clay deposits were identified by A. B. Leonard and Tong-yun Ho, Zoology Department, University of Kansas (Table 3). The adequacy of the fossil data should be commented upon. A limited number of specimens are obtained from rotary drill cuttings. Because the type section specimens to which the subsurface specimens have been compared are greater in number and variety of species, adequate comparison is impossible. Leonard (personal communication) is reasonably sure of the Pliocene, Pleistocene, and Early-Late Pleistocene faunal age boundaries. His recognition of Pleistocene stages is based upon the number and percentage of species present. The fossil occurrences (Table 3) are assigned to specific Pleistocene stages but because of the inconsistencies of the fossil record, the data are used only to indicate the Early-Late Pleistocene boundary.

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The micro-vertebrates collected from the fossil zones were identified by C. W. Hibbard, Curator of Vertebrates, Museum of Paleontology, University of Michigan. Much of the micro-vertebrate material was fragmentary and not of stratigraphic use as guide fossils. The following resumé of the stratigraphically important micro-vertebrate fauna was given by Dr. Hibbard:

27-39-18bbb, Stanton County, 100-110 feet; *Citellus* sp., lower molar M 1 or M 2; probable age post-Rexroad (late Pliocene) and pre-Butler Spring and Berends local faunas (Illinoisan).

28-38-34bbb, Grant County, 40-44 feet; part of microtine tooth; this type of tooth is known from the base of the Pearlette Ash Bed to Recent (primary Wisconsinan deposits).

The fresh-water ostracodes (Table 4) found in the fossiliferous zones were examined by E. D. Gutentag. These ostracodes are similar to those in the Pleistocene fauna from Meade County described by Gutentag and Benson (1962). The ecology and fossil distribution of the fresh-water ostracode faunas are not well enough known to date glacial and interglacial stages of the Pleistocene, but *Candona nyensis* Gutentag and Benson, so far as it is known, is restricted to deposits of Pleistocene age in southwestern Kansas.

Distribution and thickness.—Deposits of early Pleistocene age underlie most of the Grant-Stanton area. The thickness ranges from 0 feet in southwestern Stanton County to 275 feet in southeastern Grant County. The average thickness for the eastern two-thirds of the area is approximately 170 feet.

The configuration and drainage pattern of Lower Pleistocene streams on the Ogallala surface are shown on Plate 2,B. Geologic cross sections (Pl. 3-7) show the thickness of the Pleistocene deposits. Upper Pleistocene deposits have not been differentiated from the Lower Pleistocene deposits on the cross sections because when saturated they compose a hydrologic unit. The Pliocene Ogallala Formation is not differentiated from the Pleistocene deposits in western Stanton County.

Character.—Lower Pleistocene channel deposits consist of thick sequences of gravel and coarse sand. Thin beds of coarse deposits underlie the fine-grained backwater deposits throughout most of the area. The phenoclasts in these beds consists of granite, pink feldspar (orthoclase), quartz, quartzite, and fragments of igneous and metamorphis rocks. Minor amounts of water-worn pebbles of caliche and chalcedony are found interspersed in the gravel and sand.

The gray, silty, fossiliferous facies occur in backwater deposits. These beds are generally continuous, but fossils are found in some samples only. The Pearlette ash bed, which is a lower Pleistocene stratigraphic marker bed, was reported in 1939 from test hole 28-39-2ccc at a depth of 80 to 94 feet, but it has not been found in other test holes.

In the upper part of the Lower Pleistocene deposits, beds of reddish-brown and tan silt, fine sand, and clay are found overlying the lower valley fill and backwater deposits. Massive beds and thin stringers of caliche are common in these deposits.

Water supply.—Most of the water pumped in the area is probably from Lower Pleistocene aquifers. Most irrigation wells screened in both Pleistocene and Pliocene deposits receive the larger part of their yields from the Lower Pleistocene deposits. Wells screened only in Lower Pleistocene deposits are reported to yield as much as 2,000 gpm. However, yields from 3,000 to 5,000 gpm are possible.

UPPER PLEISTOCENE SUBSERIES

The Upper Pleistocene deposits, as defined in this report, include deposits of Illinoisan, Sangamonian, Wisconsinan, and Recent Age that have been recognized in the Grant-Stanton area. Upper Pleistocene deposits mantle most of the present surface (Fig. 5,C). The Upper-Lower Pleistocene contact indicated on some well logs and the geologic cross sections is not differentiated throughout the area. Until further evidence is available from areas adjacent to the Grant-Stanton area, the assignment of beds to the Upper Pleistocene Subseries is subject to revision and is indicated by a query (?) on the well logs.

Deposition of Upper Pleistocene sediments was characterized by cycles and epicycles of

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TABLE 3.—Occurrence of Pleistocene fossil mollusks in the Grant-Stanton area, Kansas. (Identification by A. B. Leonard and Tong-yun Ho.)

Species	Well number and depth interval: 27–35–4bbb, 10′–20′	27–37–34cc, 110′–120′	27–39–18bbb, 70′–110′	28–36–17bbb, 230′–240′	28–37–5bc, 200′–210′	do 210′–220′	28–37–21daa1, 110′–120′	do 120′–170′	28–37–26ac, outcrop	28–37–26bcc, 40′–50′	do 160′–180′	28–37–26dcc, 0′–20′	do 20′–30′	do 130′–140′	do 140′–150′	do 150′–160′	28–39–13cbb, 220′–260′	29–36–2ccb, 180′–200′	29–36–7dcc, 10′–20′	29–36–21cdc, 30′–40′	29–43–28abb, outcrop	30–36–24ccc, 20′–30′	30–37–2cd2, 200′–210′
Age*	4?	2	2	1	5	1?	1?	1	3	3	1	2?3?	2	2	1	1?	1?	5	4	2	2	2?	1
Calipyrgula tumida Leonard																	?						
Deroceras aenigma Leonard								X							X								
Ferrissia sp.															X								
Gastrocopta armifera (Say)									X														
Gastrocopta cristata Pilsbry & Vanatta								X						X									
Gasrocopta paracristata Franzen & Leonard											X												
Gastrocopta procera (Gould)			X								X									X		X	
Gastrocopta tappaniana (Adams)																					X		
Gyraulus crista (Linné)			X																				
Gyraulus labiatus Leonard			X																		X		
Gyraulus similaris Baker									X			X	X							X			
Gyraulus sp.																							X
Hawaiia minscula (Binney)						X			X		X			X						X	X		
Helicodiscus eigenmanni Pilsbry									X														
Helicodiscus parallelus (Say)																				X			
Helicodiscus singleyanus Pilsbry																			X	X			
Helisoma antrosa (Conrad)								X														X	
Helisoma sp.																				X			
Helisoma trivolvis (Say)																		?					
Lymnaea bulimoides Lea																					X		
Lymnaea caperata (Say)																				X	X		
Lymnaea diminuta Leonard							X	X							X								
Lymnaea macella Leonard															X								
Lymnaea palustris Muller			X																		X		
Lymnaea parexilis Leonard								?			?				?		?						
Lymnaea parva Lea									X				X										
Lymnaea reflexa Say		X	X										X	X						X			
Lymnaea turritella Leonard											X												X
Menetus kansasensis Baker				X		X		X			X				X								
Menetus pearlettei Leonard																				X	?		
Physa anatina Lea			X		X			X			X												
Physa hawnii Lea																	X						
Physa sp.	X			X		X		X			X				X	X	X	X		X		X	X
Pisidium compressum Prime																				X			

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Pisidium sp.								X			X				X		X						
Promenetus blancoensis Leonard								X															X
Promenetus umbilicatellus (Cockerell)			X																				
Pupilla muscorum (Linné)	X		X											X					X	X	X		
Pupoides albilabris (Adams)									X			X		X						X			
Retinella electrina (Gould)									X														
Strobilops sparsicostata Baker											X												
Succinea avara Say			X																				
Succinea grosvenori Lea	X								X			X	X						X	X	X		
Succinea sp.												X		X	X		X					X	
Vallonia gracilicosta Reinhardt	X		X						X	X									X	X	X		
Valvata tricarinata (Say)		X																					
Vertigo milium (Gould)								X			X			X									
Vertigo ovata Say											X		X								X		
Total number species	4	2	10	2	1	3	1	11	9	1	12	4	5	7	9	1	6	2	4	15	11	4	4

* 1, Nebraskan; 2, Kansan; 3, Illinoisan; 4, Wisconsinan; 5, Pleistocene undifferentiated.

TABLE 4.—Occurrence of Pleistocene fresh-water ostracodes in the Grant-Stanton area. (Identification by E. D. Gutentag.)

Well number	Depth interval, in feet	Species
27–36–1bba	225–311	*Candona nyensis* Gutentag and Benson *Cyprideis littoralis* Brady *Cyclocypris* of *C. ovum* Miller
27–38–25aaa	150–160	*Candona nyensis* Gutentag and Benson *Candona* sp.
27–39–18bbb	70–100	*Candona nyensis* Gutentag and Benson
29–35–19dc	320–330	*Candona nyensis* Gutentag and Benson *Cyprideis littoralis* Brady *Cyclocypris* of *C. ovum* Miller *Candona* sp.
29–35–28aa	205–215	*Candona nyensis* Gutentag and Benson *Candona* of *C. crogmaniana* Turner *Candona* sp. *Cyclocypris* of *C. ovum* Miller *Limnocythere* sp.
do	230–240	*Candona nyensis* Gutentag and Benson *Candona* of *C. crogmaniana* Turner *Candona* sp. *Cyclocypris* of *C. ovum* Miller
29–36–21cdc	130–140	*Candona nyensis* Gutentag and Benson *Candona* sp.

erosion, alluviation, eolation, and soil formation comparable to those of the Lower Pleistocene. Cycles of erosion and subsequent alluviation are indicated in well 27-35-4bbb, where the base of the 49-foot coarse gravel bed at 142 feet lies upon the finer deposits of early Pleistocene age. The coarse gravel represents an alluvial cycle, which aggraded a valley that was previously cut into the Lower Pleistocene deposits. Mollusks recovered from this test hole (Table 3) at a depth interval of 10 to 20 feet were assigned an early Pleistocene age (probably Wisconsinan). This fossil-bearing interval may represent a loess deposit between the finer fossil-bearing sandy silt and the coarse gravel. Fossils of Illinoisan Age (late Pleistocene) (Table 3) were recovered from a silty sand deposit in a pit east of Ulysses in Grant County in the SW¼ NE¼ sec. 26, T. 28 S., R. 37 W., at an altitude of approximately 2,990 feet. At a nearby test hole in the SW¼ SW¼ NW¼ sec. 26, at an altitude of 3,038 feet, Illinoisan fossils were found at a depth interval of 40-50 feet. Fossils of Nebraskan Age where identified at a depth of 160-180 feet in this test hole (Table 3). The lithologic break between the Upper and Lower Pleistocene is at 50 feet. Therefore, the interval between 50 and 180 feet can be placed with some degree of certainity as Lower Pleistocene.

Distribution and thickness.—Upper Pleistocene deposits that crop out in the Grant-Stanton area consist of loess, dune sand, and alluvium. These deposits extend over a wide area, as shown by the geologic map (Pl. 1). The Upper Pleistocene deposits, which have been tentatively differentiated in the subsurface, range in thickness from 10 to 270 feet. The average thickness is approximately 110 feet.

Character.—The gravel and coarse sand deposits are representative of channel fills and are coarser than their equivalents in the Lower Pleistocene deposits. The phenoclasts consist of quartz, quartzite, granite, basalt, fine-grained acid igneous rocks, and metamorphic rocks. Sandstone locally derived from the Dakota Formation may be common. The finer materials consist of clay, silt, sandy silt, and fine sand. Caliche horizons are developed in some of these deposits.

Water supply.—Upper Pleistocene deposits lie above the water table in most of the Grant-Stanton area. Along the major streams, the deposits are saturated and are reported to yield as much as 750 gpm to wells. Saturated deposits of late Pleistocene age, together with the Lower Pleistocene deposits, are considered as a hydrologic unit because they exhibit similar hydrologic characteristics. Dune sand in the Grant-Stanton area lies above the water table and yields no water to wells, but it may form a catchment area for precipitation and may facilitate recharge to the Pleistocene aquifers.

HYDROLOGY

Hydrologic Properties of Water-Bearing Materials

The quantity of ground water that an aquifer will yield to wells depends upon the hydrologic properties of the aquifer. The ability of an aquifer to transmit water is measured by its coefficient of transmissibility. The coefficient of transmissibility (T) of an aquifer is defined as the number of gallons of water that will move in 1 day through a vertical strip of aquifer 1 foot wide and the full thickness of the aquifer, under a hydraulic gradient of 100 percent, or 1 foot per foot, at the prevailing temperature of the water. The coefficient of permeability (P) is expressed as the rate of flow of water, in gallons per day, through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot. The coefficient of permeability can be computed by dividing the coefficient of transmissibility by the thickness (m) of the aquifer. The coefficient of storage (S) of an aquifer is defined as the volume of water it releases or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. Under water-table conditions the coefficient of storage is practically equal to the specific yield, which is defined as the ratio of the volume of water a saturated material will yield to gravity in proportion to its own volume.

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PURPOSE OF AQUIFER TESTS

The hydrologic properties described above are determined from aquifer tests. Hydrologic coefficients resulting from aquifer tests are used in conjunction with the water-level contour maps to estimate the quantity of ground water moving laterally through the water-bearing formations. They are used to estimate the quantity of water being removed or returned to storage and the amount of local recharge. These tests also give an indication of the type and areal extent of the water-bearing materials.

METHODS OF ANALYSES AND TEST RESULTS

Aquifer tests were made at 26 sites in Grant and Stanton counties. The tests were analyzed by the nonequilibrium method (Theis, 1935) or by the modified nonequilibrium method (Cooper and Jacob, 1946). These methods of analyses are also shown in U. S. G. S. WSP1536-E. The results of these tests are summarized in Table 5. The basic data for one of these tests are plotted in Figure 6. The coefficients of transmissibility obtained from these tests are plotted on Plate 11,B in parentheses to distinguish them from the estimated coefficients to be described later.

The values for T obtained from these tests were reduced to the field coefficients of permeability ($P = T/m$). The value used for m is not the total saturated thickness of the formations, but is the aggregate of effective thickness of the sand and gravel beds in the formation, based on the driller's and authors' interpretations of the well logs.

Because tests were made using wells screened opposite more than one aquifer, a trial and error method was used to determine

TABLE 5.—Results of aquifer tests, Grant and Stanton counties.

Well number	Geologic source (a)	Coefficient of transmissibility, gpd/ft	Coefficient of storage, dimensionless
	GRANT COUNTY		
27-36-15dd	Npl, No	153,000	0.00014
27-37-29cc	Npl, No	52,100	.00012b
27-38-15da	Npl, No	63,400	.00023b
27-38-19cd	Npl, No	590,000	.0048
27-38-22cb	Npl, No	159,000	.00035
27-38-23ca	Npl, No	71,000	.00021
27-38-32bb	Npl, No	188,000	.0024
28-36-11ba	Npl, No	215,000	.00022
28-38-12cb	Npl, No	50,600	.00028
28-38-15cb	Npl, No	119,000	.00060
28-38-27ba	Npl, No	125,000	.00021
29-35-15ab	Npl	134,000	.00038b
29-38-35db	Npl, No	45,000	.00094b
30-37-2ba2	Npl, No	29,600	.00014b
30-37-19aa2	Npl	56,000	.00029b
30-37-26da	Npl, No	145,000	.0032
30-38-30ac	Npl, No	337,000	.00044c
	STANTON COUNTY		
27-39-13ac	Kd, Kc	45,800	
27-40-25cb	Npl, No	137,000	.0048
28-39-12ac	Npl	40,500	.00011
28-39-20bd	Npl, No	188,000	.00095
28-39-24cc2	Npl, No	465,000	.0094
28-41-14aa	Npl, No	352,000	.059
29-39-24dd	Npl, No	58,000	.0011b
30-40-24cd	Npl, No, Kd	97,500	.0013
30-41-13cc	No, Kd	137,000	.044

a. Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone.
b. Pumped well may be partially penetrating.
c. See Figure 7.

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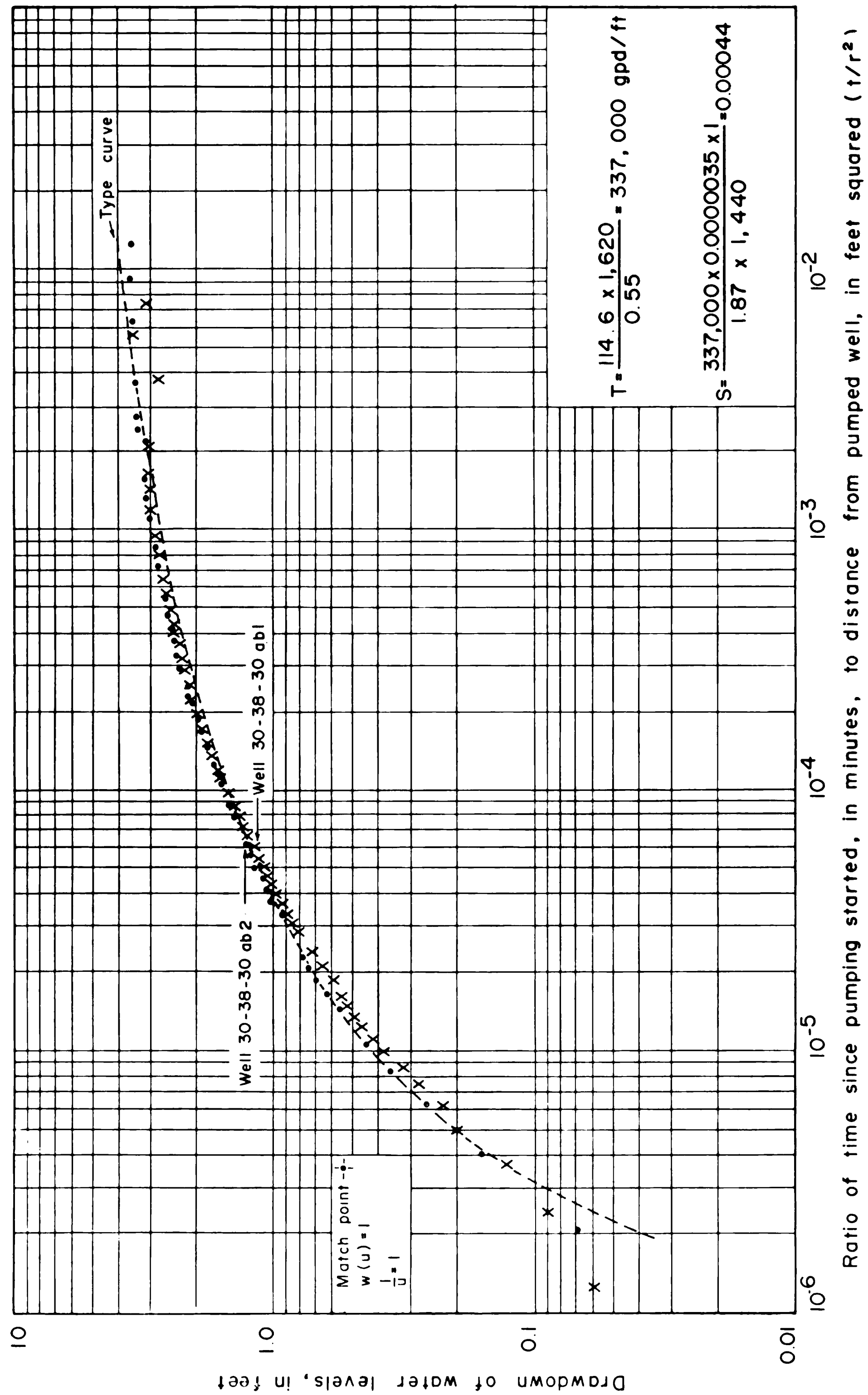

FIGURE 6.—Drawdown of water level in observation wells during 30-38-30ac aquifer test July 27-31, 1960.

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P for each aquifer. Trial values of P were assigned to the sand of each aquifer, then multiplied by the aggregate thickness to obtain T. A trial T for the complete saturated sand section was then obtained by adding the individual values for T for each aquifer. This value for T was then compared with that obtained from the aquifer test. The process was continued until a permeability (P) was assigned to each aquifer that when combined with the aggregate thickness of the aquifers at each test site resulted in coefficients of transmissibility that were approximately the same as the coefficients obtained from aquifer tests. Using this method, the average coefficient of permeability was 2,200 gpd/ft^2 for the Pleistocene aquifer and 1,250 gpd/ft^2 for the Pliocene aquifer.

The coefficients (P) were then extended to other areas and used in conjunction with the drillers' logs to estimate the coefficients (T) as shown for well 27-35-4bbb. In this well there is a saturated section of 112 feet of sand and or gravel in the Pleistocene deposits and 33 feet of Pliocene sand. Thus: $(112 \times 2.200) + (33 \times 1,250) = 287,000$ gpd/ft which is the coefficient (T) for the well site. The estimated transmissibilities obtained by this method are shown in brackets on Plate 11,B.

The thickness of the sand and gravel used in the above estimates is not the total thickness of sand and gravel in the well described by the drillers. In many of the logs, the drillers, on the basis of their experience, assigned a yield number to each sand and gravel section of the aquifer. If a 10-foot section of aquifer contained clean sand and gravel and the material drilled easily, the driller probably would assign it a thickness of 10 feet. However, if the 10-foot section contained thin layers of silt or fine sand, the driller might assign it a thickness of 5 feet. In other words, the numbers shown in parentheses on the drillers' logs are the drillers' estimates of the yield from the intervals logged. The drillers total these numbers for the well and multiply by a coefficient to obtain the estimated yield of a well in gallons per minute. Where these estimates were not included in the drillers' logs, the equivalent thicknesses were estimated by the authors. The estimates of the authors were not included in the published logs but are computed as part of the coefficients of transmissibility on Plate 11,B.

Because of the reasons discussed on page 49 of this report, the coefficients of storage obtained from the foregoing tests were not used in the quantitative computations. However, the coefficients did indicate that artesian conditions existed during the pumping tests.

Water Levels

HISTORY OF WATER LEVELS

Very little is known about the water levels in the area prior to 1940. During the field work in the early 1940's, observation wells were established in the area, and periodic measurements have been made since that time. As shown by the hydrographs (Fig. 7), the water levels remained approximately at the same level or trended slightly upward through the period 1940-52, then declined at a slow rate. After 1952, the effect of pumping for irrigation is reflected on the hydrographs and masks the effect of precipitation in the area.

Most of the water levels measured during and since 1957 have been in irrigation wells that obtain water from unconsolidated aquifers. These are gravel-walled wells which are perforated opposite all water-bearing materials penetrated in the well. Thus, these measurements are of the composite water levels for all the formations penetrated in each well (Tables 16, 17, 18).

Few wells in the area are perforated only in the sandstone aquifers. A few scattered wells were perforated both in the unconsolidated and the sandstone aquifers to the bottom of the Cheyenne Sandstone. The water levels in these wells, cased through the sandstone aquifers including the Cheyenne Sandstone, were compared with water levels in nearby wells screened only in the unconsolidated materials. The water levels in these two types of wells were at approximately the same level; hence, it was assumed that the 1960 water levels throughout the area were at approximately the same level in wells screened in both the unconsolidated and consolidated

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aquifers throughout the Cheyenne Sandstone. Little is known about the water levels in the Triassic sandstone, but they probably are comparable with those in the unconsolidated aquifers of the area. However, in northeastern Grant County, the flow in the Triassic sandstones is probably toward the east or northeast as compared with the southeasterly flow in the unconsolidated materials, and there may be some difference in water levels in this area.

During most years, pumping for irrigation causes considerable decline of water levels during the summer months, but some recovery

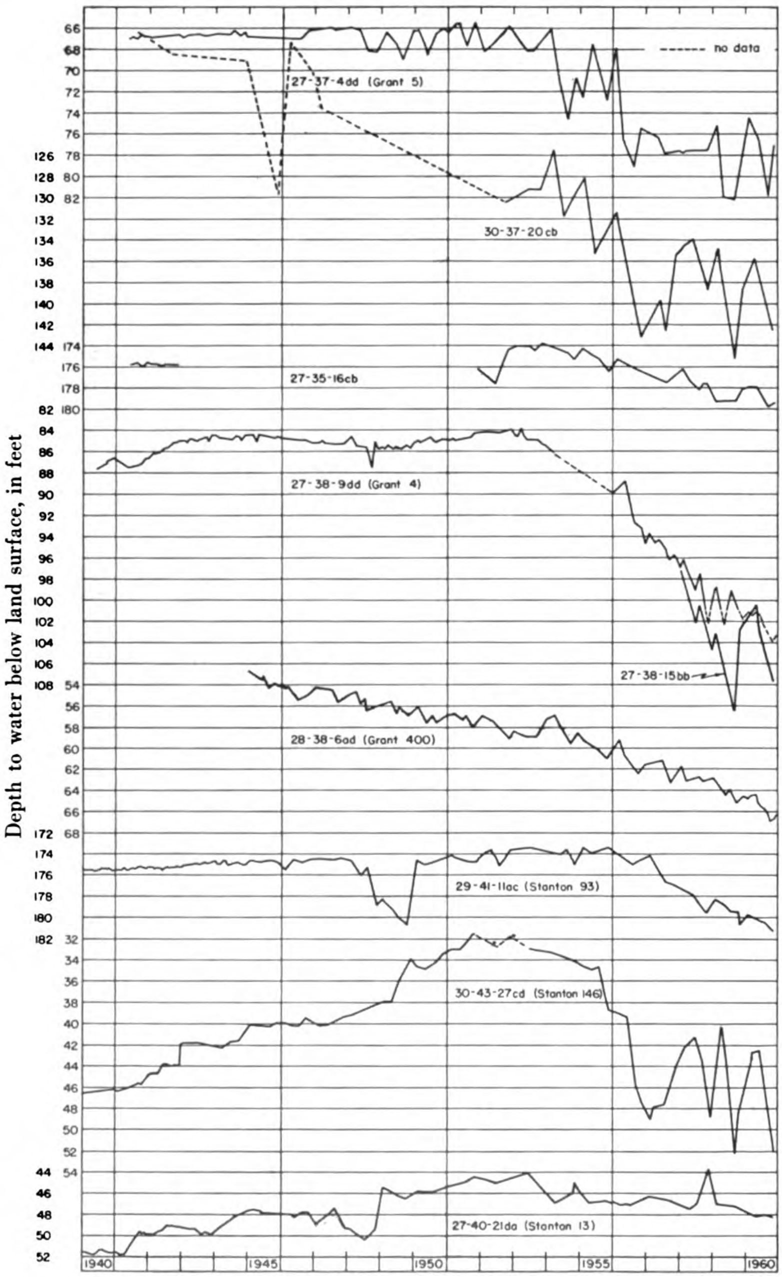

FIGURE 7.—Hydrographs of wells in Grant-Stanton area.

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of water levels is noted during the late winter and early spring months. An example of this is shown by fluctuations in well 28-38-8bc. Water levels in this well were as follows: during the late summer of 1959, 180 feet reported; March 21, 1960, 79.7 feet; and January 22, 1963, 110 feet. Pumping for irrigation in 1959 was mostly during the summer months, but in 1962, pumping was continued through December in addition to the summer months. The above well was not measured in 1962, but fluctuations in well 28-38-27ca can be used as an example. Water levels in this well were: March 30, 1960, 81.7 feet; Sept. 6, 1962, 150.7 feet; Oct. 11, 1962, 138.5 feet; Nov. 1, 1962, 123.6 feet; and Jan. 22, 1963, 103.7 feet.

The change in water levels in much of Grant and Stanton counties from about 1940 to Jan. 22, 1963, is shown in Figure 9. Figure 9 was prepared from Plate 11,A which shows the water level as of 1939-42 and from an unpublished map which shows the water level for Jan. 22, 1963. Plate 11,A was superimposed over the 1963 map and contours drawn through points of equal change. A map showing the change from about 1939-42 to March-April 1960 was given by Broeker and Fishel (1962, p. 31). If Figure 9 is compared with the acreage irrigated (Pl. 12), the close correlation between decline in water level and the areal distribution of pumping for irrigation may be noted.

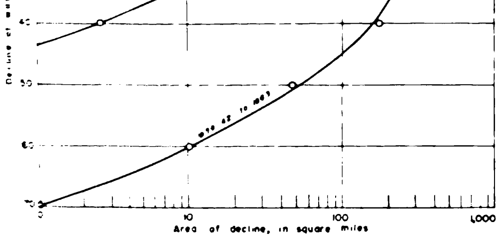

FIGURE 8.—Decline of water level in Grant-Stanton area.

The areal decline of water level from 1939-42 to 1960 and from 1939-42 to 1963 is shown graphically in Figure 8. The water level declined (1939-42 to 1963) 70 feet or more in an area of less than 1 square mile, 60 feet or more in 10 square miles, 40 feet or more in 174 square miles, 20 feet or more in 420 square miles, and 10 feet or more in 662 square miles.

Withdrawals of Ground Water

by CARL E. NUZMAN, *Engineer*,
Division of Water Resources,
Kansas State Board of Agriculture

The Geological Surveys' open file well records first reported the use of wells for irrigation in this area in 1940. As of that date, there were 4 irrigation wells in Stanton County and 8 in Grant County. The publication, "United States Census of Irrigation—Kansas 1940," listed 319 acres irrigated in Stanton County but did not mention Grant County. A report to the Governor of Kansas in 1944 listed 330 acres irrigated in Stanton County and 1,178 acres in Grant County. A report for 1948 by the Extension Service of Kansas State University listed 7,520 acres irrigated in Stanton County and 12,500 acres irrigated in Grant County. The Kansas Water Resources Board furnished reports of water usage for the period 1950 through 1957. The withdrawals for 1958 through 1960 (Table 6, 7) are compilations of the data furnished directly to the Division of Water Resources. In 1960 an estimated 68,000 acres were irrigated in Stanton County and 81,000 acres were irrigated in Grant County. The information obtained from the above sources is summarized in Figure 10, which demonstrates the growth of irrigation in the area.

An examination of the records indicates that in 1960 less than 4,000 acre-feet per year was pumped for municipal, rural, and industrial use. As this is less than 2 percent of the total use, or within the limit of error in estimation of irrigation use, only the irrigation use is shown in Figure 10 and Tables 6 and 7.

In 1958, those water users in Grant County who reported used 72 percent of their authorized appropriation. Thus, if the total authorized for Grant County was 158,300 acre-feet,

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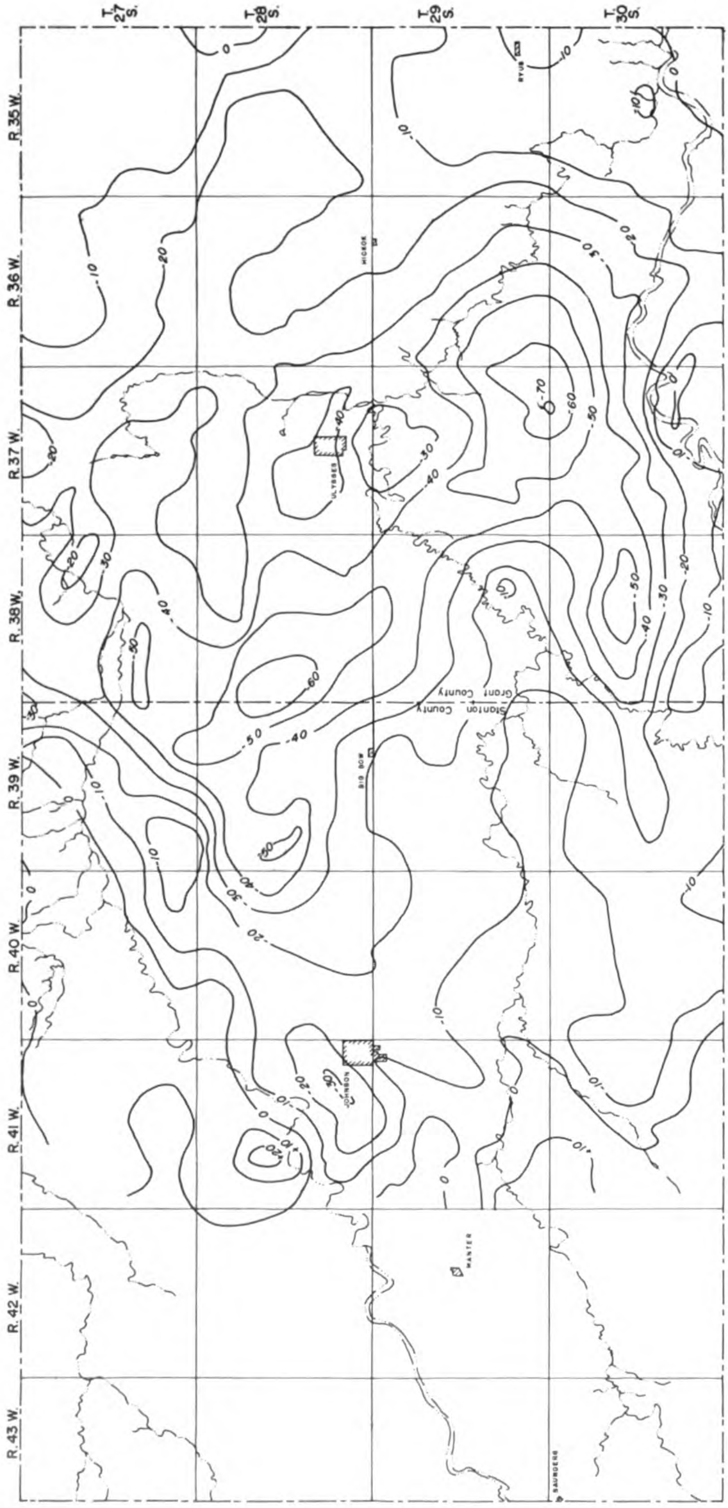

FIGURE 9.—Change of water level in Grant and Stanton counties from 1939-42 to January 22, 1963.

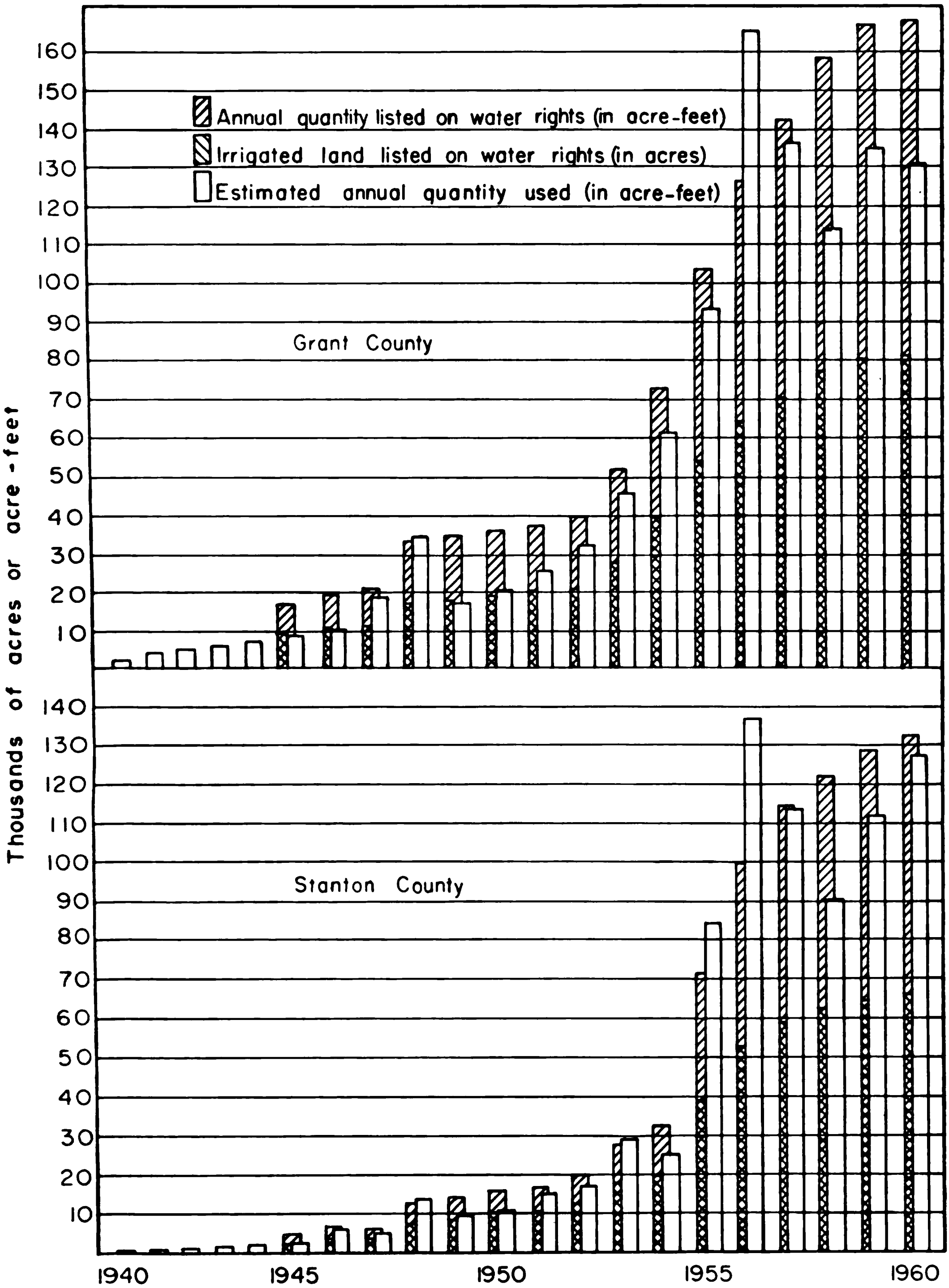

FIGURE 10.—Irrigation growth and withdrawals of ground water in the Grant-Stanton area. (Prepared by Carl Nuzman.)

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TABLE 6.—Reported pumpage from irrigation wells (acre-feet) in Grant County, 1958-1960.

Well number	1958	1959	1960	Well number	1958	1959	1960
27–35–10cc	640	674	616	27–38–31ba		516	
27–35–17ad		810	432	27–38–31dd2		826	1,261
27–35–24ac		1,406		27–38–32bb			1,524
27–35–27ca	1,810	2,570	1,175	27–38–32bc			
27–35–29ba		865	788	27–38–32cc		405	545
27–35–33bb		880	344	27–38–33cb			
27–36–13ad	804	240		28–35–5bc			566
27–36–14cc			1,369	28–35–5dc	666	662	
27–36–15dd				28–35–6ba	1,420	1,199	1,192
27–36–15cc		997	1,148	28–35–8bb			1,335
27–36–18dc	636	436	532	28–35–9aa	994	1,290	551
27–36–21dc				28–35–10bb			182
27–36–23dc				28–35–15cb		267	305
27–36–25aa		716		28–35–20ab	870	985	905
27–36–25cc	517	716		28–35–21bb	445	691	395
				28–35–22ac		336	258
27–37–3bd				28–35–22bb	363	398	407
27–37–3dd				28–35–23bd		325	
27–37–4ab				28–35–27bb			
27–37–11ab		352	344	28–35–27bc		940	
27–37–14ba		1,044	625	28–35–29bc		1,326	1,237
27–37–16bb	141	409	380	28–35–30bb	811	624	
27–37–19db		716	1,363	28–35–31cd1			5
27–37–20cd	684	1,249	1,326	28–35–31cd2			61
27–37–25cb	811	402	459	28–35–35dc		994	690
27–37–26bc	392	1,231	1,194	28–35–36ab	476	649	759
27–37–28cb			186				
27–37–29cb				28–36–2ba		420	492
27–37–29cc	772	1,190	1,274	28–36–2cd			420
27–37–30bd	681	955	1,243	28–36–11ba		625	1,095
27–37–33cc	263	394	398	28–36–13ac	254	744	423
27–37–34bc1							
27–37–34da	257	292	454	28–37–2bb		182	
27–37–35dc	456		168	28–37–2bc		177	
27–37–36cc			302	28–37–4ac	122	269	244
				28–37–6bb	374	239	
27–38–1da	106		354	28–37–7cb	134	428	530
27–38–6cb		320		28–37–9ac			
27–38–12ad				28–37–9bb	363	444	613
27–38–12dd	361		276	28–37–9cc	272	431	
27–38–13ab	299		229	28–37–10bc	412		
27–38–13cc	157	155	158	28–37–17cb			848
27–38–14cd	99	238	265	28–37–20cd2			530
27–38–15bb	252	241	253	28–37–22ab		177	
27–38–15da	88	292	353	28–37–27cc1			
27–38–19bc		270	967	28–37–27cc2	158		
27–38–19db		112		28–37–27cd		490	
27–38–20bd		333		28–37–28dc	500	398	276
27–38–20cb		219		28–37–28dd1	200	155	94
27–38–21cb				28–37–28dd2	500	471	446
27–38–22cb		860	661	28–37–30bb		923	1,147
27–38–22cc		859	1,115	28–37–31aa1			
27–38–23ca		717	728	28–37–31aa2		107	107
27–38–23cb2		587	317				
27–38–24cc	532		666	28–38–4bb		293	
27–38–25bb				28–38–4cc		420	
27–38–26bb	367	516	545	28–38–5ac		536	
27–38–27aa		1,032		28–38–5bd		658	1,946
27–38–27bb		251	332	28–28–5dc	1,400	420	
27–38–28cb3	709	1,216	927	28–38–6bc			
27–38–29ac	1,080		1,524	28–38–6cb			
27–38–30ca		875	1,105	28–38–7ab	321	243	
27–38–30cb			825	28–38–7bb			

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TABLE 6.—Reported pumpage from irrigation wells (acre-feet in Grant County, 1958-1960.—*Continued*

Well number	1958	1959	1960
28-38-8bb2	1,236	1,503	1,095
28-38-8bc	348	265	203
28-38-9ca	795	1,105	1,050
28-38-9cb		6	7
28-38-10ab			
28-38-10bb			1,247
28-38-12bc			
28-38-12cb	308	864	1,166
28-38-15cb			
28-38-16ab			
28-38-16bb		928	176
28-38-16cb			407
28-38-16db1			231
28-38-16db3			
28-38-17ab		828	1,574
28-38-17bb		608	1,193
28-38-17cb		862	1,432
28-38-18bb	1,079	1,538	1,263
28-38-18db			
28-38-18dc		309	795
28-38-19bc	862	1,314	888
28-38-19bd	994	726	650
28-38-20dc1	495	840	322
28-38-20dc2		435	371
28-38-27ba			
28-38-27ca		1,784	958
28-38-27cb			
28-38-28da		1,200	1,505
28-38-30cb	640	159	
28-38-30cc		482	
28-38-31db	786		628
28-38-33ba2			
28-38-33bd			
28-38-35bc	663	942	
29-35-6ba		490	582
29-35-7bc1			
29-35-7bc2			
29-35-7cb1			
29-35-7cb2		422	
29-35-12dd		130	141
29-35-13ac	868	835	
29-35-15ab	561		
29-35-24ba	817		
29-35-24bc		2,298	1,390
29-35-25dc1			
29-35-25dc2			
29-35-25dc3			
29-35-25dd2			
29-35-25dd3		101	
29-36-19bc			
29-36-30bc			62
29-36-30dc			
29-36-31db	269	221	316
29-37-8cb	362		636
29-37-19db		1,031	550
29-37-21bc		998	
29-37-22aa			
29-37-22cc2	610	949	43
29-37-26cc	823		
29-37-28bb	132	707	321
29-37-28cb		919	687
29-37-29bb	561	497	
29-37-32bd		577	450
29-37-32cc1			364
29-37-32db		390	
29-37-34bd		486	318
29-37-35ac			
29-37-35cc	566		
29-37-35cd			
29-38-1bb	790		954
29-38-1ca			530
29-38-3ba		960	1,467
29-38-4cc		531	550
29-38-5aab			
29-38-5aac	406	403	430
29-38-7da		1,114	1,230
29-38-8cc	1,127		921
29-38-22bb		344	440
29-38-22cb	728	808	529
29-38-25ba	367	171	330
29-38-27ad	380	456	474
29-38-31dc			
29-38-35ac2	68	212	143
29-38-35cd	126	180	744
29-38-35db	180	305	116
30-35-2db	118	308	210
30-35-19bc1	219	373	586
30-36-5bb2			5
30-36-5cb			55
30-36-6bb	693	370	397
30-36-6bd	491	440	375
30-36-7aa	45	379	643
30-36-7ab		176	595
30-36-7cb			
30-36-8cd		512	338
30-36-9bb			
30-36-9dc			
30-36-16da1		270	
30-36-32bb	736		254
30-37-1ab			
30-37-2ba2	149		221
30-37-6dc			
30-37-8cc		490	516
30-37-9cc			688
30-37-10ab			
30-37-10bb2			
30-37-10bb3	42	28	27
30-37-10dc	850		759
30-37-11db		1,202	1,166
30-37-15cb2			678
30-37-16da			543
30-37-17bc		1,259	644
30-37-19aa2		871	
30-37-20cb	207	341	
30-37-20cc		760	
30-37-21bd		333	397
30-37-21cc	324	213	344
30-37-25dd2		331	292
30-37-26cc	66		221
30-37-26da			

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TABLE 6.—Reported pumpage from irrigation wells (acre-feet) in Grant County, 1958-1960.—*Concluded*

Well number	1958	1959	1960	Well number	1958	1959	1960
30-37-35bd	465	590	592	30-38-11dd	236	210	230
30-37-36bc	358	496	466	30-38-12cc	964	1,062	1,155
				30-38-13cc	1,237	1,011	1,363
30-38-2ab				30-38-14ac		1,114	1,224
30-38-2cb	615	110		30-38-15db		684	1,610
30-38-2cc				30-38-26da		914	660
30-38-3dc	383	615	1,074	30-38-30ac			
30-38-5bb		633	540	30-38-34bc		1,170	575
30-38-6bc		160		30-38-35db			728
30-38-6cc		1,988		30-38-36bb			
30-38-10ab	645	728	944				
30-38-10bc			360				
30-38-11bc3				Totals.......	50,759	102,734	101,905

TABLE 7.—Reported pumpage from irrigation wells (acre-feet) in Stanton County, 1958-1960.

Well number	1958	1959	1960	Well number	1958	1959	1960
27-39-13ac	274	468	493	28-39-8ac			1,268
27-39-21ac		1,415	980	28-39-8bb	243	843	1,213
27-39-22db	728			28-39-8bc	257	948	1,386
27-39-23ac2	376	525	462	28-39-8db			
27-39-23cc				28-39-9ab		219	281
27-39-25bb	939	900		28-39-11aa			
27-39-25cb				28-39-11bc			647
27-39-26ab	130	275	265	28-39-12ac			
27-39-26bc				28-39-12bb			
27-39-26db				28-39-11bd			
27-39-27ad1				28-39-12cc			
27-39-27bb	100	363	435	28-39-14bb2			
27-39-27cb	98	127	414	28-39-15ac	663	661	644
27-39-28ba	694	613		28-39-16dc	400	1,051	1,035
27-39-33bd				28-39-17bc		610	692
27-39-34cc			1,063	28-39-17db			595
27-39-34dd	1,293	1,367		28-39-18bb	1,240	414	441
27-39-35ab				28-39-18bd	1,176	840	682
27-39-35cb			1,124	28-39-20ac		888	1,062
				28-39-20bb	1,240	883	
27-40-22da			4	28-39-20bd			
27-40-25cb				28-39-21cc			249
27-40-26ba		795	552	28-39-22ac	863	477	464
27-40-35ab1				28-39-22db	456	517	707
27-40-36ba		240		28-39-23aa		392	331
				28-39-23dd	381	354	456
27-41-2db				28-39-24cc2			
27-41-10ac		619	618	28-39-26ac	760		715
27-41-31ac	919	768	715	28-39-26cd	690	461	646
27-41-31cc2		667	1,325	28-39-27bd			716
27-41-35cc	368	258	195	28-39-28ac			580
				28-39-28cc			274
27-42-11db				28-39-29cb			663
27-42-31cc		178	276	28-39-29cc			663
				28-39-29cd			663
28-39-1bb	560	545		28-39-30cc	1,240	886	
28-39-1dd				28-39-31ab	704	970	
28-39-2ab				28-39-31bc	520	424	
28-39-2cb			615	28-39-31cc		298	
28-39-2dc			662	28-39-33dc		640	690
28-39-3bb		933	880	28-39-36ab		676	
28-39-5bb2							
28-39-6dc			748	28-40-2ab			

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Table 7.—Reported pumpage from irrigation wells (acre-feet) in Stanton County, 1958-1960.—*Continued*

Well number	1958	1959	1960
28-40-2cb		1,262	830
28-40-3ab		221	
28-40-3cb			
28-40-3cc			
28-40-4cc		618	259
28-40-9ac		250	251
28-40-15cc	524	613	680
28-40-17cb			532
28-40-19dc			
28-40-20bc			
28-40-21cc	666	738	954
28-40-23ac		632	499
28-40-25cc2			
28-40-25dc			
28-40-26bc		1,326	
28-40-27cc	884	795	884
28-40-28cb		1,031	
28-40-29ab		1,053	
28-40-29bc	688	919	783
28-40-30cb	662		
28-40-31bb		1,312	
28-40-32bd	530	634	602
28-40-32cc	1,000		
28-40-36cb		866	
28-41-5bb		943	
18-41-6ab		950	894
28-41-11bc	948	1,497	
28-41-12bb		398	
28-41-14aa		882	
28-41-19dc	384		876
28-41-25ab			
28-41-31bd	151	191	381
28-41-36db	180	204	537
28-41-36dc			
28-41-36dd		2	2
28-42-6db		109	
28-42-8cc	109	1	
28-42-14bc			711
28-42-16cd1		442	
28-42-16cd2		795	
28-42-16dc		637	
28-42-20dd			
28-42-21ab		461	
28-42-22ba	1,034	892	
28-42-23db	837	872	
28-42-24dc			
28-42-25aa			
28-42-26aa	257	563	
28-42-32bb	46		9
28-42-35ba			
28-42-35bb			
29-39-1bb			
29-39-2dc			
29-39-6bc		1,197	1,577
29-39-6cc	779	1,195	
29-39-8ac	537		1,186
29-39-9dd2		785	
29-39-10cc			
29-39-11ac			
29-39-15ac	370	749	
29-39-15bb		732	699
29-39-17bc			1,365
29-39-18ac			
29-39-20bc			
29-39-21db		371	371
29-39-24dd	410	421	237
29-39-26bd	335	305	729
29-39-27cc			
29-40-1cc	682	1,304	
29-40-3bc		416	704
29-40-3db			
29-40-4cd	364		362
29-40-6db	277	858	
29-40-11bb	962	816	1,197
29-40-11cb	913	958	1,001
29-40-12bb	640	1,447	
29-40-15db		596	927
29-40-16ba		265	132
29-40-25dc	371	446	224
29-40-26bb		345	689
29-40-31db	276		
29-40-33ac	419	204	289
29-40-34bb	392	333	535
29-40-35dd		286	545
29-41-3da			
29-41-11bd		147	
29-41-13ac		400	1,259
29-41-23db	398	199	93
29-41-24ac			
29-41-31cb		71	
29-42-8cd	378	401	378
29-42-11dc		13	
29-42-24cc			20
29-43-3db			
30-39-2ab	873	724	721
30-39-2bb		529	430
30-39-2cb	900	777	
30-39-4dc			
30-39-12cc			
30-39-13cb	1,299	1,140	1,286
30-39-18bb	1,000	1,389	604
30-39-20da	506		915
30-39-22ac	507	520	1,054
30-39-23bb	625	626	644
30-39-23cb	736	357	589
30-39-32da	475	619	636
30-39-36bd		803	914
30-40-2cb			
30-40-5ca	722		
30-40-8ab	262		
30-40-9dc	266		
30-40-22cb			
30-40-24cc1	72		
30-40-24cc2			
30-40-24cd			
30-40-25dc	378		
30-40-27ac			
30-40-33cc			
30-40-34ac			

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Table 7.—Reported pumpage from irrigation wells (acre-feet) in Stanton County, 1958-1960.—*Concluded*

Well number	1958	1959	1960	Well number	1958	1959	1960
30-40-35bb				30-43-27cc	634	619	972
30-40-36ac			18	30-43-28ab	74	110	88
				30-43-28dd	398	465	
30-41-13cc				30-43-29a		238	
				30-43-34bb	184	198	
30-42-12ac		119		30-43-35bb	1,100	1,738	2,210
30-42-16bd	125	254	395				
30-43-26dd	1,183	1,342	1,213	Totals.......	47,034	74,444	66,481

72 percent of this value or 114,000 acre-feet was the estimated water pumped (Fig. 10). In 1959, 81 percent of the authorized amount of 167,000 acre-feet was reported, and 135,000 acre-feet was the estimated total used. In 1960 the estimated quantity used was 131,000 acre-feet.

In Stanton County irrigators reported the use of 72 percent of their authorized quantity in 1958 and 80 percent in 1959. Thus, the estimated total used in Stanton County was 91,000 acre-feet in 1958 and 113,000 acre-feet in 1959. In 1960, the estimated quantity used was 128,000 acre-feet.

The differences between Tables 6 and 7 and Figure 10 are due to the differences in reported pumpage and actual use. The acreage for which applications for water rights have been filed with the Division of Water Resources and the location of irrigation wells are shown on Plate 12.

Perched Zones of Saturation

There are several perched zones of saturation in the area. The northwest quarter of Grant County and part of Stanton County contains a perched zone. The water level in wells screened in the perched zone is generally 50 to 65 feet below the land surface. The zone is intercepted by the Lakin Draw and several seeps discharge at the bottom of the draw during prolonged wet periods.

Two perched zones are above the major aquifer in the Hickok area. Water levels in wells about 130 feet deep are 85 feet below the land surface. Another thin aquifer occurs between 150 and 200 feet below the surface in the Hickok area. The water level is not known but probably is near 130 feet. The principal aquifer is about 20 feet thick and is from 350 to 370 feet below the surface. The water level associated with this aquifer is near 182 feet.

Another perched zone is present along the Cimarron River south of Ulysses. Little is known about the water levels in this area, but springs discharge along the river bottom during wet periods. Wagon Bed Springs is in this area but is dry most of the time.

The water level in the small gravel-filled valley in the southwest corner of Stanton County stands slightly above that in wells screened in the underlying sandstone aquifers. Local well drillers are careful not to penetrate the thin clay layer separating the two aquifers when drilling shallow wells, as the water in the shallow aquifer will drain into the sandstone. Irrigation wells screened in the shallow aquifer are reported to yield as much as 3,000 gallons per minute.

Water-Level Contour Maps And Their Analysis

Water-level contour maps were prepared for the water levels measured during the periods: 1939-42 (Pl. 11A); the winter of 1957-58 (Pl. 11,B); the spring of 1959 (Pl. 11,C); October 1959 (Pl. 12); the spring of 1960 (Pl. 11,D); and Jan. 22, 1963 (unpublished). Water levels were measured in about 270 wells. These maps show water levels in the aquifers

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tapped by nearly all the irrigation wells in Grant and Stanton counties, but excludes any of the perched zones discussed above. [The datum is mean sea level, and the contours join points of equal altitude on the piezometric surface (pressure head or water level) at the time of measurement.]

Water-level contour maps indicate water levels with respect to a known datum, the direction of ground-water movement, areas of recharge and discharge, and the effects of pumping. They can be used with other hydrologic data to compute the rate of movement of water, and successive maps can be used to compute changes in ground-water storage. A practical use of the maps is in determining the depth to water below the land surface in any locality if the altitude of the land surface is known. For example, the depth to water below land surface, 163 feet, is the difference between the altitude of the land surface at Johnson (about 3,342 feet above sea level) and the altitude of the water surface (about 3,179 feet) shown on the 1939-42 map.

COMPUTATION OF FLOW

Ground water moves at right angles to the water-level contours or from areas of high to low head. The water-level contour maps indicate that the movement of water in the area is predominantly eastward. Most of the ground water enters Stanton County from the west through the unconsolidated and sandstone aquifers, then flows eastward through Stanton and Grant counties into southwestern Haskell County. Some water enters the two-county area from Morton, Stevens, Hamilton, and southwestern Kearny counties, and more enters northeastern Grant County from Kearny County.

The quantity of flow eastward can be computed from the contour maps by application of the formula

$$Q = TIL$$

where: Q is the quantity of water flowing per unit of time,
T is the transmissibility, as previously defined,
I is the hydraulic gradient obtained from the contour map, and
L is the length of the segment through which the water moves, measured normal to the direction of flow.

The quantity of ground-water flow was computed for the 1939-42 water-level contour map (Pl. 11,A) and summarized in Table 8. To make these computations, the following assumptions were made:

1. The water level was static during the period, and no water was removed from or added to storage in the aquifers.

2. Pumpage was negligible and did not influence the shape of the water-level contours at the segments used for computations.

3. Sufficient data were collected on the hydrologic properties of the unconsolidated aquifers so that the calculations made are in the right order of magnitude.

4. Any increase in quantity of flow between the contours used for the computation was from the sandstone aquifers that are in contact with the unconsolidated aquifers in the subsurface or from recharge by precipitation.

5. The lateral boundaries, ADGJM and CFILN, are drawn perpendicular to the contour lines on Plate 11,A, showing that no water flows across these boundaries.

Using these assumptions, the northernmost segment of flow across the 3,240-foot contour in northwestern Stanton County was computed. As an example, the coefficient of transmissibility in that area is 90,000 gpd/ft, from Plate 11,B. The hydraulic gradient (I) averages 10.7 feet per mile between the 3,230- and 3,250-foot contours on Plate 11,A, normal to the direction of flow. Thus: $Q = 90{,}000 \times 10.7 \times 1.58 = 1.54$ mgd. The flow across the rest of the 3,240-foot contour was computed in this way, as was the flow across the 3,160-, 3,090-, 3,000-, and 2,830-foot contours. The results of these computations were tabulated in Table 8, along with an estimate of the flow through the underlying sandstones.

Data available on the water levels and hydrologic properties of the sandstone aquifers were insufficient to make more than an estimate of the flow through the sandstones.

Recharge from Precipitation

As the water flowed eastward through the unconsolidated aquifers, the flow increased about 14 mgd between the 3,240- and the 2,830-foot contours and within the boundaries

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TABLE 8.—Summary of ground-water flow eastward across Grant and Stanton counties (in million gallons per day), 1939-42.[1]

Contour	Flow into area from	Calculated flow in Npl and No	Increase in Npl and No from sandstone	Increase in Npl and No from rainfall	Estimated flow in SS aquifers	Total flow Npl, No and SS aquifers
3240	Colorado and western Stanton County (A–C)	20.8			30.0	
	Southwestern Hamilton County	1.5			2.0	
	Northwestern Morton County	1.5			2.0	
	sub-totals	23.8			34.0	57.8
3160	Colorado and western Stanton County (D–F)	23.3	1.3	1.2	29.7	
	Southwestern Hamilton County	3.0			3.9	
	Northwestern Morton County	1.2			3.4	
	sub-totals	27.5			37.0	64.5
3090	Colorado and Stanton County (G–I)	27.8	2.5	2.0	27.6	
	Southern Hamilton County	1.1			3.5	
	Northern Morton and southern Stanton Counties	9.8			3.4	
	sub-totals	38.6			34.5	73.1
3000	Colorado, Stanton and western Grant Counties (J–L)	30.9	1.1	2.0	24.5	
	Southern Hamilton and Kearny Counties	2.3			2.3	
	Northern Morton and southern Stanton and Grant Counties	6.5			0.5	
	sub-totals	39.7			27.3	67.0
2830	Colorado, Grant and Stanton Counties (M–N)	35.2	2.1	2.2	22.8	
	Southern Hamilton and Kearny Counties	5.9			2.3	
	Southern Kearny County (Arkansas River valley?)	8.9				
	Northern Morton and Stevens Counties	11.2				
	sub-totals	61.2			25.1	86.3

1. Segments A to M and C to N shown on Plate 11A; Npl, Pleistocene deposits; No, Ogallala Formation; SS, sandstone in pre-Pliocene rocks.

of ADGJM and CFILN (Pl. 11,A). Some of this increase was from the sandstone aquifers that are in contact in the subsurface, and some was from precipitation within the area. The area DEKJ (Pl. 11,A) was selected to make an estimate of the recharge from precipitation because the sandstones were not in contact in the subsurface and did not increase the eastward flow within this area. The inflow across the 3,160-foot contour and between points D and E was 13 mgd. The outflow across the 3,000-foot contour between the points J and K was 15 mgd. Assuming that this increase of 2.0 mgd is all from precipitation in the area of 160 square miles, the recharge rate was about 0.013 mgd/sq. mi. or about 0.3 inch per year, which is about 2 percent of the annual precipitation. This recharge rate was applied to the rest of the area, and the recharge from precipitation was separated from the flow contributed to the unconsolidated aquifers by the sandstones.

Small amounts of water seep from Bear Creek into the ground-water reservoir throughout the year in western Stanton County. During flood stages the stream is believed to contribute large amounts of its flow to ground water throughout its total reach. However, these floods occur only at about 10-year intervals, and the total area flooded is less than 10 percent of the combined areas of Grant and Stanton counties.

Summary of Flow

Plate 11,A and Table 8 indicate that about 58 mgd was flowing eastward into the area

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from Colorado and southwestern Hamilton and northwestern Morton counties. About 24 mgd flows through the unconsolidated aquifers and 34 mgd flows through the sandstone aquifers. As this water moves eastward, some of the flow is transferred from the sandstone aquifers to the unconsolidated aquifers. If the amount of 0.013 mgd/sq. mi. as calculated for the recharge from precipitation is correct, then the total recharge from precipitation within the AMNC polygon (an area of 530 sq. mi.) was about 7 mgd. The remaining increase of 7 mgd in the unconsolidated aquifers and within the polygon was assumed to be contributed by the sandstone aquifers. There is some doubt that the recharge is uniformly distributed over the area as assumed above. The recharge may be confined to gravel or sand areas of the streams and their flood plains. If this is true, the recharge within the AMNC polygon would be less than 7 mgd and the increase from the sandstone aquifers would be between 7 and 14 mgd.

The outflow of 86 mgd across the 2,830-foot contour and the eastern Grant County line north of the 2,830-foot contour in eastern Grant County includes 61 mgd flowing eastward in the unconsolidated aquifers and about 25 mgd flowing in the sandstone aquifers. About 58 mgd of this was continuous flow from the most westerly areas of Stanton County, 13 mgd possibly was recharge from precipitation within the area east of the 3,240 contour (977 square miles), 6 mgd was lateral inflow from the adjacent counties to the north and south, and 9 mgd was the flow southeastward from eastern Kearny County across the northeast corner of Grant County. The 9 mgd probably is inflow from the Arkansas River drainage.

The foregoing analyses were made on the 1939-42 map because pumping in the area was negligible at that time and thus had very little effect on the shape of the water-level contours. Pumping in the area since that time has caused considerable decline of the water levels near the center of the area. However, the 1939-42 and 1960 maps indicate that there has been very little change in the hydraulic gradients across the 3,240- and 2,830-foot contours, and the water-level near these contours has not changed appreciably. Thus it may be assumed that T, I, and L have not changed appreciably, and the flow into and out of the area was approximately the same in 1960 as in 1939-42. As the saturated thickness (and consequently I) is reduced in the future and I changes, the flow into and out of the area will also change.

On Jan. 22, 1963, the water-level contours in the outflow area had changed slightly, but the inflow was estimated to be about the same as in 1939-42. Pumping in the outflow area within a month of the time of measurements on Jan. 22, 1963, had changed the hydraulic gradients so that an outflow comparable to 1939-42 could not be computed. The saturated thickness had been reduced about 2 percent and thus the outflow was probably reduced also by at least 2 percent.

REDUCTION IN STORAGE OF GROUND WATER

Weighted-Average Water Level

The withdrawal of ground-water throughout the years has caused a decline of water level in the area, and in some areas concentrated pumping has caused considerable decline. In order to determine the average decline for the period 1939-42 to 1960, a weighted-average water level was computed from all the water-level contour maps, except the 1957-58 maps (the 1957-58 map was incomplete for part of the area). To compute the weighted-average, the volume of the ground-water reservoir between the highest and lowest water-level contours was computed for each map by use of the trapezoidal formula as adapted from Fader (1957, p. 5):

$$V_t = h\,[\tfrac{1}{2}(A_o + A_n) + A_1 + A_2 + A_3 + \ldots + A_{n-1}]$$

in which: V_t is the volume between the highest and lowest contour,

h is the contour interval in feet,

A_o is the area in square miles embraced by the initial or highest contour,

A_1, A_2 . . . are the areas embraced by the next successive lower contours in square miles,

A_n is the area embraced by the lowest contour in square miles (Fig. 11). A sketch showing the symbols used in the computation of the weighted-average water level is shown in Figure 11.

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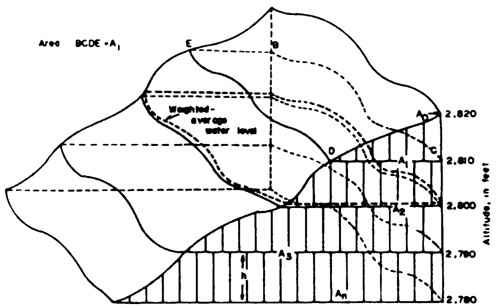

FIGURE 11.—Block diagram illustrating symbols used in computation of weighted-average water level.

The areas for each contour were obtained by a planimeter and are given in Table 9 for the 1939-42 map as an example. Substituting the values in the above formula and simplifying:

$$V_t = 10\left[\frac{977}{2} + 24{,}858\right] = 253{,}480 \text{ square-miles-feet}$$

Dividing this figure by the total planimetered area of 977 square miles, the result is 259.4 feet, which is the weighted-average water level above the 2,780-foot contour. Thus, the altitude of the weighted-average water level computed by this method was:

1939-42	3,039 ft.
Spring, 1959	3,031 ft.
Fall, 1959	3,028 ft.
Spring, 1960	3,031 ft.
January 22, 1960	3,021 ft.

This is a drop of 8 feet between 1939-42 and spring 1960, most of which probably occurred after 1955. The weighted-average declined 10 feet between spring 1960 and January 1963 or an average of 3 feet per year.

The areas considered in the above computations included all of both counties east of the 3,240-foot contour on Plate 11,A. This 3,240-foot contour was plotted on subsequent maps so that the same area was compared each time. These boundaries were chosen because of their geographic convenience, because detailed water-level data were not collected outside these boundaries, and because water-level decline due to pumping was approximately zero in 1960 at these boundaries on all the maps. If these conditions were strictly true and the water levels could all be measured on the same day, the weighted-average water level should not have risen between the spring of 1959 and spring of 1960. The reason that the spring 1959 average was lower is that most of the later levels in the area of concentrated pumping in northwestern Grant County were measured in February, whereas the levels in the rest of the area were measured in late April and early May. Therefore,

TABLE 9.—Areas used in computation of weighted-average water level, 1939-42.

Contour	A	Area, square miles	
		A_0+A_n	$A_1+A_2+\ldots$
3,240	A_0	0	
30	A_1		18.8
20	A_2		37.7
10	A_3		57.1
3,200	A_4		79.2
3,190	A_5		103.5
80	A_6		127.1
70	A_7		154.7
60	A_8		189.8
50	A_9		229.9
40	A_{10}		262.7
30	A_{11}		292.8
20	A_{12}		321.5
10	A_{13}		349.3
3,100	A_{14}		374.8
3,090	A_{15}		405.2
80	A_{16}		434.9
70	A_{17}		460.9
60	A_{18}		486.5
50	A_{19}		509.2
40	A_{20}		532.3
30	A_{21}		554.5
20	A_{22}		574.0
10	A_{23}		593.5
3,000	A_{24}		612.7
90	A_{25}		631.5
80	A_{26}		650.3
70	A_{27}		670.7
60	A_{28}		688.5
50	A_{29}		705.9
40	A_{30}		727.5
30	A_{31}		747.8
20	A_{32}		766.1
10	A_{33}		786.2
2,900	A_{34}		806.3
2,890	A_{35}		826.5
80	A_{36}		844.5
70	A_{37}		861.2
60	A_{38}		877.5
50	A_{39}		891.6
40	A_{40}		904.4
30	A_{41}		917.0
20	A_{42}		928.2
10	A_{43}		940.6
2,800	A_{44}		951.9
2,790	A_{45}		970.8
80	A_{46}	976.8	
Totals		976.8	24,858.0

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the water had time to move into the area of concentrated pumping, and the water levels outside the area of concentrated pumping consequently were lowered, resulting in a slightly low weighted-average. If weather and pumping conditions had allowed all the measurements to be made at one time, the spring 1959 weighted-average probably would have been about 0.5 foot above that for the spring 1960.

Computation of Areal Drawdown Coefficient

The highest coefficient of storage (S) obtained from the aquifer tests (Table 8) was 0.059. The value of S for the remainder of the tests was 0.01 or less. The longest test was for 2 weeks, and, hence, the silt, fine sand, and clay in the overlying aquicludes had a relatively short time to drain during the test compared with the 10 to 20 years since pumping started in the area. Therefore, an areal drawdown coefficient was computed for the period 1939-42 to 1960. The areal drawdown coefficient is here defined as the ratio of the quantity of water pumped in the area, in feet, to the decline of the weighted-averaged water level, in feet, during the period of removal. The areal drawdown coefficient might be called a "long term" coefficient of storage in places where the water is removed from within an area bounded by a zero drawdown contour (the lateral boundaries are at zero drawdown) and if corrected for recharge and discharge, should approach the specific yield of the materials being dewatered. Where part of the water is being removed from storage outside the area being considered, the areal drawdown coefficient will be larger than for the total area.

From 1939 through 1959, the weighted-average water level declined 8 feet (page 48). The quantity of water pumped during the 20-year period was estimated from Figure 10 to be about 1,620,000 acre-feet for the total area of Grant and Stanton counties. About 5 percent, or 87,000 acre-feet, of the pumping took place west of the area for which the decline of water level was computed. Therefore, the total pumpage was reduced to 1,540,000 acre-feet for the area considered. This withdrawal was then reduced to feet of water by dividing by the area, as follows:

$$\frac{1{,}540{,}000 \text{ acre-feet}}{977 \times 640 \text{ acres}} = 2.47 \text{ feet.}$$

The areal drawdown coefficient then would be 2.47/8 or 0.31.

The above areal drawdown coefficient can be further adjusted to approach the specific yield by correcting for recharge by precipitation over the 20-year period and for possible over-reporting of the pumpage. Assuming that the recharge rate of 0.013 mgd / sq. mi. (page 46) is correct, the recharge over the 977 square miles should be $0.013 \times 20 \times 977 \times 365 \times 3.07 = 280{,}000$ acre-feet. This recharge was subtracted from the total pumpage and compared with the weighted-average decline as follows:

$$\frac{1{,}260{,}000 \text{ acre-feet}}{977 \times 640 \text{ acres}} = 2.01 \text{ feet.}$$

The areal drawdown coefficient adjusted for recharge from precipitation would be 2.01/8 or 0.25.

State and Federal personnel working on water resources of southwestern Kansas are of the opinion that pumping rates reported by irrigators are maximum rates rather than the rate actually used. Although there are insufficient data at present to determine the amount of over-reporting, it is estimated to be as much as 20 percent which would reduce the areal drawdown coefficient to 0.20 (adjusted for recharge from precipitation and estimated over-reported pumpage).

Future Water-Level Decline

The areal drawdown coefficient was computed for the purpose of estimating future water-level decline. Because the rate of annual withdrawal is unpredictable, estimates of future declines were not attempted. The weighted-average water level for the area east of the 3,240-foot contour on Plate 11,A declined 8 feet between 1955 and 1960 (see page 48) and 10 feet between 1960 and 1963. It can be assumed that the weighted-average will decline considerably in the future if the present high rate of withdrawal continues. Because the weighted-averaged water level is an average, 8 or 10 feet decline would not

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be expected in all areas and some areas of high withdrawals will have more decline than other areas of low withdrawals, as shown on Figure 9. Well owners may obtain past declines for their individual well sites from Figure 9 and estimate future declines for their own use.

Availability of Ground Water

WATER IN STORAGE

The saturated water-bearing materials in the Neogene deposits in Grant and Stanton counties range in thickness from 0 to more than 400 feet (Fig. 12). The contour line in Figure 12, showing zero thickness, represents the line of contact where the water table passes from the Pliocene or Pleistocene deposits into the underlying Cretaceous rocks.

In Grant and Stanton counties there are approximately 39 million acre-feet of water in storage between the water table and the base of the unconsolidated aquifers. There is probably another 16 million acre-feet in the sandstone below. These estimates are based on a coefficient of storage of 0.20, the total thickness of the saturated materials in the unconsolidated aquifers, and the thickness of the sandstone in the consolidated aquifers. The volume of the unconsolidated materials was measured by planimetering the spring 1960 water-level contour and the bedrock contour maps (Pl. 2,A and 11,D). The weighted-average altitude was computed for each map and the difference multiplied by the total area to obtain the volume of the unconsolidated material. The volume of water in the sandstones was estimated on the meager information available from electric and radioactivity logs of oil tests, a few geologic test holes, and six drillers' logs.

Not all the water in the unconsolidated aquifers is available for irrigation. As the water table declines, the yields of the wells will decline, and a time will be reached when the yields are no longer adequate for irrigation, but the yields may continue to be adequate for stock, domestic, or other uses.

QUANTITIES AVAILABLE

Because the sand and gravel beds are thin or practically absent in small areas, water is not available in sufficient quantity for irrigation throughout the whole area. The figures in parenthese on Plate 11,B can be used as a rough guide to the availability of water. These figures are coefficients of transmissibility in thousands of gallons a day per foot. An approximate yield of a well in gallons a minute can be obtained by dividing the transmissibility by 100. Plate 11,B shows the coefficient of transmissibility divided by 1,000.

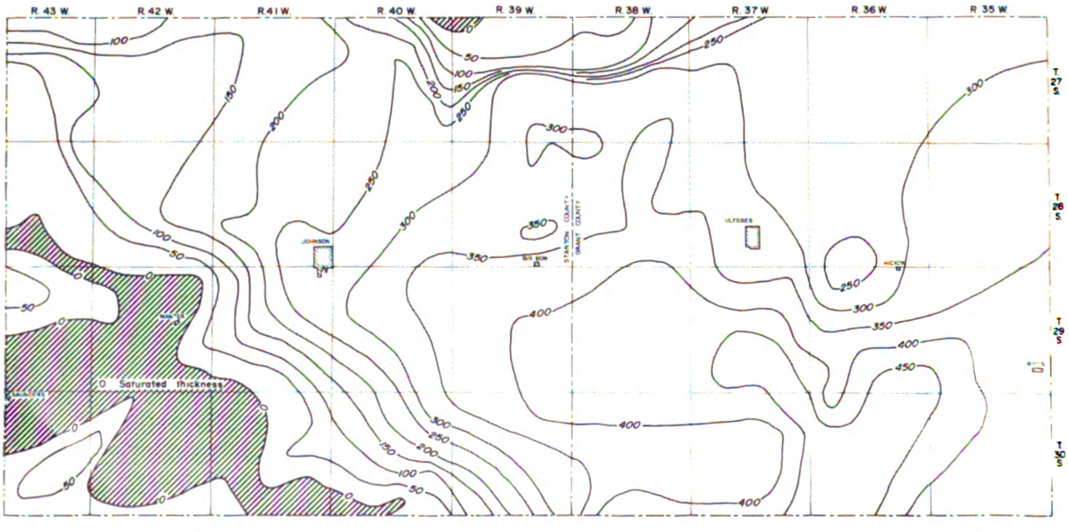

FIGURE 12.—Saturated thickness of Neogene deposits, Grant and Stanton counties, 1939-42.

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The values shown on Plate 11,B should be multiplied by 10 to obtain the approximate gallons per minute. Because these data are general over large areas, this method of estimating yields should be used with extreme caution. Also the local well drillers should be consulted and test holes should be drilled before installation of any irrigation well.

Near Manter, in western Stanton County, the irrigation wells obtain their entire supply from the sandstone aquifers (see tables of well records). Most of the domestic and stock wells in western Stanton County are screened in sandstone aquifers. In the northern half of both Stanton and Grant counties and as far east as Ulysses, several irrigation wells are perforated in both the unconsolidated and sandstone aquifers. The meager information available on the sandstone aquifers is given in Table 2 and plotted on Plate 11,C. These figures are plotted on the map as a guide for future test drilling in the area.

Chemical Quality of Water

The chemical character of the water is indicated by 89 complete and 205 partial analyses of water collected from wells in the Grant-Stanton area. The analyses (Table 11 and 12) were made by the Sanitary Engineering Laboratory of the Kansas State Department of Health. The analyses in Tables 13 and 14 were made in the field by the authors. The results of the analyses are given in parts per million, and the factors for converting parts per million of mineral constituents to equivalents per million are given in Table 10.

The dissolved solids in water samples from the Grant-Stanton area ranged from 169 ppm in well 27-35-16dd in the sand-hill area of northeastern Grant County to 1,470 ppm in shallow well 29-38-27aal along the North Cimarron River, southwest of Ulysses. Both of these water samples are from Pleistocene deposits. The average dissolved-solids content of water from the Pleistocene deposits was 439 ppm. The total hardness of water from the Pleistocene deposits ranged from 142 ppm

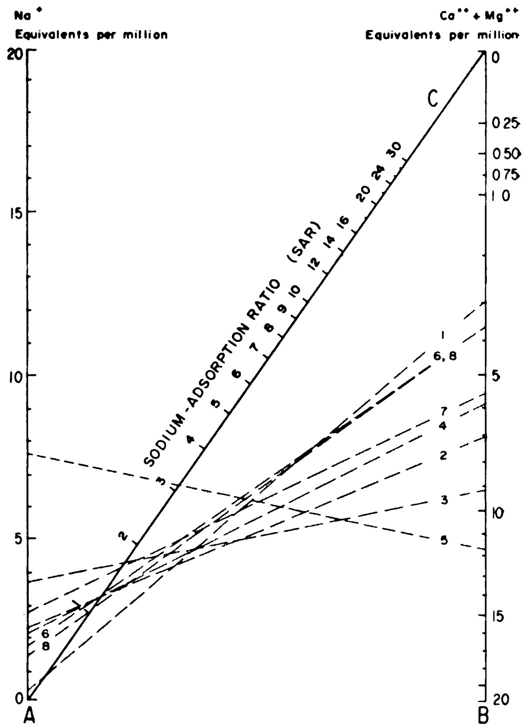

FIGURE 13.—Nomogram for determining sodium-adsorption ratio of water. (See Table 15 for well numbers.)

in well 28-42-32dd to 809 ppm in well 27-38-20ad.

The dissolved solids in water from wells screened both in the Pleistocene and Pliocene deposits ranged from 185 ppm in well 27-35-24ac in northeastern Grant County to 790 ppm in well 28-38-4cc in northwestern Grant

TABLE 10. Factors for converting parts per million of mineral constituents to equivalents per million.

Cation	Conversion factor
Ca^{++}	0.04990
Mg^{++}	.08226
NA^{+}	.04350
Anion	**Conversion factor**
HCO_3^-	.01639
SO_4^-	.02082
Cl^-	.02821
NO_3^-	.01613
F^-	.05264

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Table 11.—Analyses of water from typical wells in Grant County, Kansas.

Analyzed by Sanitary Engineering Laboratory, Kansas State Department of Health. Dissolved constituents and hardness given in parts per million.[a]

Well number	Depth, feet	Geologic source (b)	Date of collection	Temperature (°F)	Dissolved solids (evaporated at 180°C)	Specific conductance (micromhos) at 25C°	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3) (C)	Hardness as $CaCO_3$ Total	Carbonate	Noncarbonate
T. 27 S., R. 35 W.																			
27-35-6cc	135	Npl	10-28-41	60	183	....	..	.31	49	7	12	182	14	5.5	0.3	4.1	151	149	2
-16dd	170	Npl	10-28-41	58	169	....	..	.04	47	6.6	9	174	13	2.5	.3	3.9	144	142	2
-24ac	355	N	9-28-59	..	185	330	18	.04	46	8	8	178	8.2	6.0	.2	2.8	148	146	2
T. 27 S., R. 36 W.																			
27-36-23dc	416	N	9-28-59	65	265	435	19	.05	49	14	25	220	35	7.0	.8	6.6	180	180	0
T. 27 S. R. 37 W.																			
27-37-1cc	160	Npl	10-27-41	58	660	....	..	1.9	101	40	62	200	305	40	1.6	13	416	164	252
-11ab	340	N	1-31-61	..	610	1,000	24	.01	66	43	77	293	204	20	1.8	30	341	240	101
-28ad	60	Npl	10-28-41	58	720	....	..	1.0	63	43	123	295	317	16	1.5	3.5	334	242	92
T. 27 S., R. 38 W.																			
27-38-20ad	100	Npl	10-20-41	59	1,140	....	..	.06	209	70	33	229	230	106	.6	376c	809	188	621
T. 28 S., R. 35 W.																			
28-35-15bb	220	Npl	10-28-41	62	327	....	..	.68	55	12	45	190	104	11	.5	4.1	186	156	30
T. 28 S., R. 36 W.																			
28-36-3dd	200	Npl	10-28-41	61	460	....	..	1.4	60	36	56	310	137	13	1.3	0	298	254	44
-36cd	91	Npl	10-27-41	59	359	....	..	12	67	20	34	254	68	30	.6	0	249	208	41
T. 28 S., R. 37 W.																			
28-37-27cc1	290	N	8-8-41	..	507	....	..	.02	64	33	43	198	188	15	1.7	6.2	295	162	133
-35aa	165	Npl	10-27-41	61	1,050	....	..	.38	98	82	138	240	486	121	2.8	2.4	582	197	385
T. 28 S., R. 38 W.																			
28-38-4cc	285	N	7-20-59	60	790	1,215	25	.09	89	58	86	227	349	57	2.1	15	460	186	274
-4db	55	Npl	10-27-41	59	596	....	..	1.4	66	45	72	202	258	39	3.0	11	350	166	184
T. 29 S., R. 35 W.																			
29-35-12cd	234	Npl	10-27-41	59	423	....	..	1.3	72	25	41	241	140	14	.8	8.0	282	198	84
-15ab	460	Npl	5-25-60	65	491	790	23	.03	75	27	51	242	171	16	1.2	8.0	298	198	100
T. 29 S., R. 36 W.																			
29-36-4ba1	113	Npl	10-27-41	59	328	....	..	.75	62	24	22	199	79	36	.7	4.0	253	163	90
-23ddd	269	Npl	10-14-59	62	1,210	1,810	25	.19	119	72	175	283	573	99	1.3	3.3	593	232	361
-25ba	119	Npl	10-27-41	59	341	....	..	.22	47	30	40	234	45	57	2.2	2.3	240	192	48
-30bc	446	No	7-16-59	65	345	565	19	.07	41	21	42	146	129	13	.8	7.5	189	120	69
T. 29 S., R. 37 W.																			
29-37-19db	319	No	7- 9-59	63	328	530	19	.06	39	20	41	151	112	12	1.0	9.7	180	124	56
-22cc1	80	Npl	10-21-41	62	442	....	..	1.7	66	32	40	195	165	31	1.4	7.1	296	160	136
T. 29 S., R. 38 W.																			
29-38-4cc	450	No	7- 9-50	63	354	570	19	.12	52	20	38	185	112	13	1.0	7.5	212	152	60
-16aa	150	Npl	10-21-41	60	363	....	..	1.3	58	27	29	190	132	13	1.2	6.2	256	156	100
-27aa1	25	Npl	10-21-41	63	1,470	....	..	.92	139	101	195	310	725	76	2.6	80c	762	254	508

T. 30 S., R. 35 W.																			
30-35-2dc	240	Npl	10-27-41	60	234	....	..	2.1	43	20	16	210	34	7	1.1	5.3	180	172	17
T. 30 S., R. 36 W.																			
30-36-1dc	140	Npl	10-27-41	59	360	....	..	.66	57	28	32	206	95	31	1.8	12	257	169	88
-5bb1	125	Npl	10-27-41	59	410	....	..	13	53	39	32	219	128	26	2.6	7.1	292	180	112
-23dd	45	Npl	10-27-41	59	729	....	..	.25	87	45	106	368	278	25	1.8	1.6	402	302	100
T. 30 S., R. 37 W.																			
30-37-16aa	120	Npl	10-27-41	59	340	....	..	.54	63	20	30	202	103	16	2.4	4.4	239	166	73
-27bc2	25	Npl	10-27-41	60	337	....	..	1.2	49	24	39	218	97	12	1.6	4.1	220	179	41
-36bc	317	Npl	9-28-59	63	289	505	7.5	.06	36	23	34	178	86	13	1.2	.4	184	146	38
T. 30 S., R. 38 W.																			
30-39-5bb	310	No	7-16-59	..	344	535	17	.08	53	15	44	192	95	17	.9	7.5	194	158	36
-10dd	140	Npl	10-21-41	60	370	....	..	16	57	25	35	234	94	14	1.6	10	245	192	53

a. One part per million is equivalent to one pound of substance per million pounds of water or 8.33 pounds per million gallons of water.

b. N, Neogene; Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; Trd, Dockum Group.

c. In areas in which the nitrate content of water is known to exceed 45 ppm, the public should be warned of the potential dangers of using the water for infant feeding (U. S. Public Health Service, 1962, p. 7).

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TABLE 12.—Analyses of water from typical wells in Stanton County, Kansas.

Analyzed by Sanitary Engineering Laboratory, Kansas State Department of Health. Dissolved constituents and hardness given in parts per million.[a]

Well number	Depth, feet	Geologic source (b)	Date of collection	Temperature (°F)	Dissolved solids (evaporated at 180°C)	Specific conductance (micromhos) at 25°C	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3) (c)	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Carbonate	Hardness as $CaCO_3$: Noncarbonate
T. 27 S., R. 39 W.																			
27-39-2bb	96	Npl	10-21-39	60	237	....	..	.08	44	17	23	232	12	7.0	1.6	16	180	180	0
-13ac	508	Kd, Kc	4-3-59	62	622	860	31	.04	90	33	53	242	231	17	1.1	5.2	360	198	162
-13bda	160	No	11-17-59	61	515	825	21	.07	61	23	76	178	212	25	2.0	6.6	246	146	100
-29da	80	Npl	10-21-39	59	427	....	..	.76	66	30	33	177	177	16	1.4	12	295	145	150
T. 27 S., R. 40 W.																			
27-40-1cd	150	Kd	10-21-39	59	232	....	..	.04	54	13	16	215	26	6.0	1.1	8.8	188	176	12
-17bc	71	Npl	10-21-39	59	397	....	..	1.5	71	22	33	185	156	11	1.0	8.8	270	152	118
-26ba	343	N	5-24-60	63	415	690	22	.04	78	20	30	201	139	17	.8	8.9	276	165	111
-35ab1	182	Npl	10-25-39	60	340	....	..	.03	66	19	24	174	122	9.0	.9	12	243	143	100
-35ab2	620	No, Kd, Kc	8-25-60	63	401	645	31	.19	66	18	37	188	134	11	.8	10	238	154	84
T. 27 S., R. 41 W.																			
27-41-3cc	117	Npl	10-30-39	59	410	....	..	.10	76	23	30	181	167	12	1.1	10	284	148	136
-15dc	123.5	Npl	10-24-39	60	355	....	..	.18	66	20	28	172	120	18	1.0	16	247	141	106
-31cc1	172	Npl	10-24-39	60	268	....	..	.20	52	13	25	172	75	7.0	.7	8.8	184	141	43
T. 27 S., R. 42 W.																			
27-42-8aa	138	Npl	10-25-39	60	352	....	..	.39	64	20	29	178	129	12	.8	8.0	242	146	96
-11db	252	No	8-23-60	62	386	610	25	.20	68	17	34	193	126	11	.6	8.9	240	158	82
-31cc	400	No, Kd, Kc?	5-24-60	..	272	485	14	.04	51	18	16	173	69	11	.8	7.1	201	142	59
T. 27 S., R. 43 W.																			
27-43-15ad	190	No	10-20-39	61	255	....	..	1.7	50	13	24	185	56	7.0	.8	9.7	182	152	30
-33aa	130.5	No	10-20-39	61	278	....	..	11	49	14	26	161	79	9.0	.9	8.4	200	132	68
T. 28 S., R. 39 W.																			
28-39-3da	65.5	Npl	10-25-39	59	595	....	..	5.0	75	39	67	189	278	25	2.0	9.2	357	155	202
-8bc	290	No	5-24-60	61	354	580	19	.03	63	20	27	193	105	15	1.0	9.3	239	158	81
-8cd	79.5	Npl	10-21-39	59	427	....	..	1.3	73	30	35	256	139	14	1.3	4.9	308	210	98
T. 28 S., R. 40 W.																			
28-40-35bb	102	Npl	10-25-39	59	306	....	..	3.5	55	17	27	167	93	16	.9	10	214	137	77
T. 28 S., R. 41 W.																			
28-41-1bb	117	Npl	10-24-39	60	267	....	..	1.3	51	17	23	232	28	3.0	.9	27	200	190	10
-19dc	270	No	5-24-60	63	223	395	21	.03	41	20	6.0	179	35	5.0	1.0	5.8	184	147	37
-23ca	195	Npl	10-25-39	61	247	....	..	1.6	46	13	25	183	50	7.0	.6	12	172	150	22
-36db	223	Npl	6- -39	..	317	....	..	.0	50	18	26	181	81	10	1.0	11	199	148	51
T. 28 S., R. 42 W.																			
28-42-9cb	248.5	No	10-25-60	62	256	....	..	.87	53	13	18	148	77	8.5	.7	11	187	121	66
-13cc	213	Npl	10-20-39	59	280	....	..	4.2	46	19	27	190	72	9.0	.9	7.1	201	156	45
-32dd	68	Npl	10-20-39	59	183	....	..	.04	47	5.8	12	154	25	3.5	.5	12	142	126	16
T. 28 S., R. 43 W.																			
28-43-12bb	173	No	10-20-39	62	253	....	..	2.4	51	12	23	181	59	7.0	.6	7.1	181	148	33
-27dc	213	No	10-20-39	61	297	....	..	13	35	19	42	183	74	12	2.0	8.0	180	150	39

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T. 29 S., R. 39 W.																		
29–39–2cd2	330	Npl	10–25–39	61	349	....	..	.0	58	21	33	176	123	12	1.0	13	231	144	87
–5cd	92	Npl	10–25–39	59	327	....	..	.53	59	18	30	188	103	9.0	.7	13	222	154	68
–30bb	94	Npl	10–25–39	60	296	....	..	3.3	42	20	35	188	83	8.0	1.3	9.7	193	154	39
T. 29 S., R. 40 W.																		
29–40–4cd	411	No	5–24–60	62	311	530	22	.04	53	17	27	193	81	9.0	.8	6.2	202	158	44
T. 29 S., R. 41 W.																		
29–41–11dd	201	Npl	10–24–39	61	214	....	..	.30	43	12	19	173	38	3.0	1.3	11	158	142	16
–35da	209	No	10–21–39	63	268	....	..	.68	48	20	21	198	58	7.5	1.6	12	203	162	41
T. 29 S., R. 42 W.																		
29–42–11dc	435	Kd, Kc, TRd	5–23–60	63	494	800	15	1.8	70	26	62	234	172	28	1.3	4.4	282	192	90
–14cb	278	Kd	10– 39	..	335	....	..	.0	66	18	4	190	72	9	1.0	3.7	239	156	83
–24cc	515	Kd, Kc, TRd	8–26–60	62	419	690	27	.24	55	23	54	240	118	15	1.6	7.1	232	197	35
–34ca	215	Kd	10–21–60	62	263	....	..	.18	49	18	23	204	52	7.0	3.0	9.2	197	167	30
T. 29 S., R. 43 W.																		
29–43–14cc	108	Kd	10–24–39	58	439	....	..	.24	74	21	50	220	158	18	1.2	6.6	272	180	92
–33cc	160	Kd	10–20–39	59	561	....	..	1.9	106	27	46	229	232	27	1.0	5.3	379	188	191
T. 30 S., R. 39 W.																		
30–39–20bc	114	Npl	10–25–39	60	343	....	..	3.5	43	29	38	212	102	14	2.3	5.3	233	174	59
–23bb	405	No	7–16–59	63	266	450	18	.07	34	19	30	171	60	11	1.3	8.4	163	140	23
–25cc	81	Npl	10–25–39	59	343	....	..	.71	45	32	33	227	95	12	3.0	9.7	246	186	60
T. 30 S., R. 40 W.																		
30–40–24cd	295	No, Kd	5–25–60	62	356	630	19	.06	45	27	40	223	90	15	2.4	7.5	223	183	40
T. 30 S., R. 41 W.																		
30–41–13cc	235	No, Kd	5–23–60	62	358	615	19	.04	46	25	43	227	93	13	2.2	5.8	218	186	32
–33db	189	Kd	10–24–39	60	281	....	..	.90	32	23	39	204	60	9.0	2.8	12	176	167	9
T. 30 S., R. 42 W.																		
30–42–4cc	177.5	Kd	10–21–39	60	279	....	..	.68	46	21	26	207	66	7.0	1.8	6.6	203	170	33
–11db	207	Kd	10–24–39	61	306	....	..	.20	47	23	33	220	76	7.0	3.0	6.6	213	180	33
–16bd	220	Kd	5–23–60	61	307	535	19	.01	45	26	25	222	70	7.0	1.5	4.2	219	182	37
–29aa1	176	Kd	10–21–39	59	300	....	..	.37	44	24	32	220	74	7.0	2.3	6.6	209	180	29
–33dc	149.5	Kd	10–24–39	60	361	....	..	.96	52	28	39	234	98	15	2.6	8.8	246	192	54
T. 30 S., R. 43 W.																		
30–43–28dd	131	No?	5–23–60	..	658	1,070	19	.02	83	47	69	234	252	57	1.4	15	400	192	208

a. One part per million is equivalent to one pound of substance per million pounds of water or 8.33 pounds per million gallons of water.

b. N, Neogene; Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; TRd, Dockum Group.

c. In areas in which the nitrate content of water is known to exceed 45 ppm, the public should be warned of the potential dangers of using the water for infant feeding (U. S. Public Health Service, 1962, p. 7).

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TABLE 13.—Partial analyses of water from typical wells in Grant County, Kansas.

Well number	Depth, feet	Date of collection	Temperature (°F)	Geologic source [1]	Specific conductance (micromhos at 25°C)	Chloride (ppm)	Total hardness (ppm)
27–35–							
13cc	246	4–15–59	63	Npl	322	9	104
17ad	410	4–15–59	63	Npl, No	344	10	132
27ca	400	7–25–60		Npl, No	345	13	82
27–36–							
13ad	390	7–25–60	64	Npl, No	200	14	82
15cc	388	4–15–59	65	Npl, No	344	18	160
15dd	422	8– 4–59	65	Npl, No	255	10	108
23dc	416	9–28–59	65	Npl, No	435	7	180
27–37–							
4ab	370	5–11–59	62	Npl, No	588	33	232
20cd	288	7– 1–59	62	Npl, No	542	18	242
25cb	265	5–25–59	63	Npl	440	25	204
29cb	288	7–30–59	62	Npl, No	624	24	204
29cc	280	7–30–59	62	Npl, No	624	27	304
35dc	270	7–20–59	63	Npl, No	642	29	280
27–38–							
13cc	300	5–25–59	62	Npl, No	592	19	300
15bb	450	5–11–59	63	No, Kd, Kc, TRd	504	4	180
22cc	202	7– 1–59	62	Npl	654	22	302
23ca	260	3–24–59	61	Npl, No	714	63	376
23cb2	260	3–24–59	61	Npl, No	646	66	376
25bb	275	5–25–59	62	Npl, No	564	21	226
26bb	327	5–11–59	63	Npl, No	564	24	240
27aa	272	5–25–59	62	Npl, No	583	27	232
28cb3	303	3– 3–59	62	Npl, No		52	312
29ac	330	4– 6–59	62	Npl, No	646	33	272
31ba	300	3– 9–59		Npl, No	646	24	304
31dd2	360	4– 6–59	61	Npl, No	646	37	272
32bb	350	3– 6–59	61	Npl, No	646	39	308
32cc1	295	4–27–59	61	Npl, No	592	50	268
33cb	288	4– 6–59	61	Npl, No	611	37	288
28–35–							
10bb	402	8–10–59	64	Npl, No	218	27	120
15cb	405	8–10–59	64	Npl, No	182	13	104
20ab	410	8–10–59	65	Npl, No	233	10	122
21bb	352	8–10–59	65	Npl, No	211	10	112
29bc	405	8–10–59	65	Npl, No	353	19	176
30bb	390	8–10–59	66	Npl, No	463	26	244
35dc	400	7–28–60		Npl, No	480	14	120
28–36–							
2ba	408	8–10–59	64	Npl, No	427	26	234
13ac	438	8–10–59	64	Npl, No	360	17	184
34bc	360	7–16–59	67	Npl, No	428	30	176
28–37–							
2bb	303	7–20–59	63	Npl, No	686	29	294
2bc	474	7–20–59	63	Npl, No	660	29	284
9bb	365	7–20–59	63	Npl, No	834	36	314
9cc	365	7–20–59	64	Npl, No	598	22	242
10bc1	78	7–20–59	59	Npl	1150	103	304
10bc2	340	7–20–59	63	Npl, No		34	304
22ab	360	7–20–59	62	Npl, No	574	22	246
30bb	285	5–19–59	62	Npl, No	625	28	246
31aa2	310	5–19–59	62	Npl, No	825	48	356
36dd	360	10–19–59	63	Npl, No	609	53	499
28–38–							
4bb	317	3–30–59	60	Npl, No	1112	193	516
5bd	280	3– 6–59	61	Npl, No	703	46	328
5dc	280	3–24–59	62	Npl, No	856	45	420

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TABLE 13.—Partial analyses of water from typical wells in Grant County, Kansas.—*Continued*

Well number	Depth, feet	Date of collection	Temperature (°F)	Geologic source [1]	Specific conductance (micromhos at 25°C)	Chloride (ppm)	Total hardness (ppm)
28-38-(*Continued*)							
6bc	300	3- 3-59	62	Npl, No	653	27	300
8bb2	320	5-19-59	62	Npl, No	597	48	272
9ca	375	3-23-59		Npl, No	956	67	528
9cb	280	5-18-59	62	Npl, No	770	44	330
10ab	320	5-11-59	61	Npl, No	760	57	345
10bb	320	5-11-59	62	Npl, No	636	34	310
12bc	384	7-20-59	62	Npl, No	788	41	344
12cb	364	7-30-59	63	Npl, No	730	29	324
15cb	370	3-30-59	61	Npl, No	657	36	312
16bb	383	3-23-59	62	Npl, No	654	30	308
16cb	388	11-10-58	62	Npl, No	660	24	276
16db3	556	5-19-59	62	Npl, No	614	25	226
16db3	556	8- 5-59	61	Npl, No	572	27	218
17ab	280	5-19-59	61	Npl, No	776	44	338
17bb	396	5-19-59	61	Npl, No	700	30	246
18bb	376	5-19-59	61	Npl, No	546	18	220
27ba	410	5-19-59		Npl, No	593	20	230
31db	425	7-30-59	60	Npl, No	583	23	240
33bd	422	7-30-59	62	Npl, No	526	17	248
29-35-							
6ba	400	7-25-60		Npl, No	667	21	174
13ac	440	8-10-59	64	Npl, No	405	17	196
24ba	400	8-10-59	65	Npl	400	19	204
29-36-							
19bc	370	7-16-59	64	Npl, No	408	15	170
29-37-							
26cc	540	7-16-59	63	Npl, No	418	18	198
28bb	400	7- 9-59	63	Npl, No	430	26	144
29bb	380	7- 9-59	62	Npl, No	448	17	220
32cc1	351	7- 9-59	63	Npl, No	500	18	258
35cc	390	8- 5-59	63	Npl, No	510	28	232
35cd	540	8- 5-59	64	Npl, No	412	17	178
29-38-							
1bb	450	8- 5-59	62	Npl, No	538	24	256
1ca	400	5-19-59	61	Npl, No	563	58	298
3ba	450	5-19-59	63	Np,, No	368	18	194
7da	478	7- 9-59	62	Npl, No	406	20	230
8cc	487	7- 9-59	63	Npl, No	437	15	230
22bb	390	7- 9-59	61	Npl, No	430	20	242
22cb	180	7- 9-59	60	Npl	400	18	208
25ba	373	7- 9-59	61	Npl, No	454	20	224
35ac2	354	4-14-59		Npl, No	631	37	224
35db	417	4-14-59		Npl, No	646	34	212
30-35-							
2db	430	8- 5-59	64	Npl, No	482	23	206
19bc1	430	8- 5-59	64	Npl, No	546	27	224
30-36-							
6bb	393	7-16-59	63	Npl, No	418	17	190
7ab	425	10- 1-59	63	Npl, No	631	24	216
30-37-							
3db	558	9-28-59	65	Npl, No	391	19	210
6dc	390	4-14-59	62	Npl, No	508	18	218
8cc	510	7- 9-59	64	Npl, No	448	15	218
10ab	565	7-16-59	63	Npl, No	436	23	192
10dc	395	7-16-59		Npl, No	368	20	190
11db	350	7- 2-59	64	Npl, No	443	20	240
15cb2	360	5-18-59	62	Npl, No	378	20	160
16da	396	5-18-59	62	Npl, No	350	22	160

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TABLE 13.—Partial analyses of water from typical wells in Grant County, Kansas.—*Concluded*

Well number	Depth, feet	Date of collection	Temperature (°F)	Geologic source [1]	Specific conductance (micromhos at 25°C)	Chloride (ppm)	Total hardness (ppm)
30–37–(*Continued*)							
17bc	390	7– 9–59	62	Npl, No	443	17	214
19aa2	380	5–18–59	62	Npl	350	26	160
21cc	330	7–16–59		Npl	324	16	192
26cc	118	7– 2–59	60	Npl	438	15	194
26da	400	5–31–60		Npl, No	628	16	152
30–38–							
2ab	417	3– 3–59	62	Npl, No	704	34	232
2cb	375	3– 3–59	60	Npl	600	24	212
2cc	355	4–14–59	63	Npl	484	20	180
3dc	400	4–14–59	62	Npl, No	478	20	168
6bc	414	7–16–59		Npl, No	282	15	140
6cc	346	7–16–59		Npl, No	286	16	140
10ab	406	4–14–59	63	Npl, No	631	22	200
10ab	406	5–18–59	65	Npl, No	368	17	200
11bc3	347	7–16–59		Npl	335	15	158
12cc	440	7–16–59		Npl	332	16	160
15db	360	8– 5–59		Npl, No	332	14	154
26da	408	7– 2–59	65	Npl, No	357	12	176
30ac	380	8– 5–59		Npl, No	269	13	140
34bc	426	8– 5–59		Npl, No	283	14	140
35db	403	8– 5–59		Npl	279	13	144
36bb	390	8– 5–59		Npl	311	14	160

1. Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; Trd, Dockum Group.

County. The average for the multiple-screened wells is about 389 ppm. The total hardness ranged from 148 ppm in well 27-35-24ac to 460 ppm in well 27-38-4cc. The average total hardness was 238 ppm.

The dissolved solids in water from wells screened in the Pliocene deposits ranged from 253 ppm in well 28-43-12bb in western Stanton County to 515 ppm in well 27-39-13bda in northeastern Stanton County. The average was 303 ppm. The total hardness ranged from 181 ppm in well 28-43-12bb to 246 ppm in well 27-39-13bda. The average was 198 ppm. Comparison of the hardness of water from Pliocene and Pleistocene aquifers indicates that water from Pliocene deposits generally is softer.

In water from the sandstone aquifers the dissolved solids ranged from 232 ppm in well 27-40-1cd to 622 ppm in well 27-39-13ac. The average from the sandstones is 371 ppm. The total hardness ranges from 176 ppm in well 39-41-33db to 360 ppm in well 27-39-13ad. The average for the sandstone aquifers was 244 ppm.

The water in the Pleistocene deposits of northeastern Grant County is somewhat softer and contains less dissolved solids than water from the rest of the area. This indicates recharge from precipitation in the sand hills of the area over a long period of years. The samples were not studied in detail for possible movement between aquifers.

CHEMICAL CONSTITUENTS IN RELATION TO IRRIGATION

The suitability of water for irrigation can be determined by methods outlined in Agricultural Handbook 60 of the U. S. Department of Agriculture (U. S. Salinity Laboratory Staff, 1954).

Soil that was originally nonsaline and nonalkaline may become unproductive if excessive soluble salts or exchangeable sodium are allowed to accumulate because of improper irrigation and soil-management practices or inadequate drainage. If the amount of water applied to the soil is not in excess of the amount needed by plants, water will not percolate downward below the root zone, and mineral matter will accumulate at that depth. Likewise, impermeable soil zones near the surface can retard the downward movement of

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TABLE 14.—Partial analyses of water from typical wells in Stanton County, Kansas.

Well number	Depth, feet	Date of collection	Temperature (°F)	Geologic source [1]	Specific conductance (micromhos at 25°C)	Chloride (ppm)	Total hardness (ppm)
27-39-							
13ac	508	4- 3-59	62	Kd, Kc	647	24	284
13ac	508	5-12-59	62	Kd, Kc	618	22	250
21ac	396	5-12-59	61	Npl, No	542	22	242
25cb	418	5-12-59	62	Npl, No	542	34	252
26bc	236	5-12-59	62	Npl	534	26	234
26db	340	5-12-59	61	Npl, No	555	36	248
27bb	379	5-12-59	66	Npl, No	479	19	224
28ba	360	5-12-59	63	Npl, No	489	21	226
34dd	330	5-12-59		Npl, No	620	38	264
35ab	318	5-12-59	62	Npl, No	479	22	210
27-40-							
25cb	330	7-28-59	62	Npl, No	482	15	230
27-41-							
10ac	465	5-24-60	63	Npl, No	482	22	178
31ac	308	7-14-59	63	Npl, No	400	16	180
31cc2	346	7-14-59	64	Npl, No	359	12	154
35cc	332	7-21-60	63	Npl, No, Kd?, Kc, TRd?	841	12	226
28-39-							
1bb	626	3- 9-59	63	Npl, No, Kc	785	82	308
1bb	626	5- 2-59	63	Npl, No, Kc	598	27	232
2ab	388	5-12-59	62	Npl, No	594	24	248
2dc	340	5-12-59	61	Npl, No	594	28	252
3bb	380	5-12-59	62	Npl, No	594	21	220
5bb2	310	5-25-59	60	Npl, No	730	28	302
6dc	400	5-25-59	60	Npl, No	447	8	172
8ab	301	5-25-59	61	Npl, No	521	32	250
8bb	243	5-25-59	61	Npl	442	32	172
8bc	290	7-24-59	61	Npl, No	406	17	186
8bc	290	5-25-59	61	Npl, No	442	14	196
8db	276	5-25-59		Npl, No	434	14	172
11bc	347	5-18-59	61	Npl, No	478	18	212
12ac	270	7-20-59	63	Npl	647	31	324
12cc	330	5-12-59	62	Npl, No	583	30	250
14bb2	200	5-12-59	61	Npl	521	25	232
15ac	335	5-12-59		Npl, No	537	21	224
16dc	235	5-25-59	60	Npl	447	20	200
17bc	261	5-25-59	62	Npl	342	10	130
18bb	333	5-25-59	62	Npl, No	393	14	166
20ac	214	5-25-59	60	Npl	462	38	222
22ac	310	5-18-59	61	Npl	406	15	174
22db	425	7-23-59	61	Npl, No	448	21	204
24cc2	370	5-18-59	62	Npl, No	397	16	182
29cd	400	5-25-59	62	Npl, No	440	25	190
30cc	160	5-25-59	62	Npl	402	17	190
31bc	400	5-25-59	64	Npl, No	387	15	154
31cc	415	5-25-59	62	Npl, No	376	15	160
36ab	408	7-16-59	62	Npl, No	530	17	232
28-40-							
3cb	340	7-28-59	61	Npl, No	436	18	232
3cc	310	7-28-59	61	Npl, No	486	17	232
19dc	400	7-28-59	63	Npl, No	376	17	176
25cc2	410	7-28-59	64	Npl, No	426	16	214
26bc	435	7- 2-59	64	Npl, No	452	15	224
28-41-							
5bb	535	7-14-59	65	Npl, No, Kd, Kc, TRd	414	15	170
6ab	345	7-14-59	63	Npl, No	359	15	152
11bc	260	7-21-60	63	Npl, No	460	16	132
31bd	298	8-26-60	62	Npl, No	324	10	130

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TABLE 14.—Partial analyses of water from typical wells in Stanton County, Kansas.—*Continued*

Well number	Depth, feet	Date of collection	Temperature (°F)	Geologic source [1]	Specific conductance (microhmos at 25°C)	Chloride (ppm)	Total hardness (ppm)
28-42-							
16cd1	320	7-30-59	65	Npl, No	448	11	202
21ab		7-30-59	63	Npl, No	440	16	222
22ba	290	7-30-59	64	Npl, No	400	14	194
25aa	410	7-30-59	62	Npl, No	311	6	154
35bb	184	8-26-60	61	No	324	10	142
29-39-							
10cc	400	7-20-60	61	Npl, No	949	32	240
11ac	400	7-25-60	61	Npl, No	667	21	174
20bc	409	7-20-60	62	Npl, No	451	12	132
21db	390	7-20-60	62	Npl, No	460	15	130
26bd	410	7-20-60	63	Npl, No	454	15	140
29-40-							
6bd	380	7-20-60	62	Npl, No	677	16	186
11bb	405	7-20-60	62	Npl, No	410	16	120
12bb	421	7-20-60	62	Npl, No	438	16	120
26bb	390	8-26-60	62	Npl, No	356	14	126
33ac	326	7-21-60	63	Npl, No	405	14	182
35dd	400	7-21-60	62	Npl, No	460	23	460
29-41-							
3da	400		64	Npl, No	356	14	126
24ac	425		62	Npl, No, TRd	511	19	204
29-42-							
8cd	367		62	Kd, Kc	328	14	126
30-39-							
2bb	440	7-16-59	63	Npl, No	380	13	152
2cb	394	7-16-59	62	Npl, No	406	17	170
4dc	484	7-21-60	62	Npl	460	17	180
18bb	400	7-21-60	62	Npl, No, TRd	719	17	184
20bc	114	7-25-60	62	Npl	467	22	172
32da	250	7-21-60	62	Npl, No	808	12	224
36bd	300	7-25-60	62	Npl	660	20	176
30-40-							
8ab	233	8-26-60	62	Npl, No	396	17	142
24cc1	189	7-18-60	61	Npl, No	598	14	226
35bb	253	7-25-60	62	Kd	631	15	152

1. Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; TRd, Dockum Group.

water and cause waterlogging of the soil and consequent deposition of salts.

The characteristics of irrigation water that seem to be most important in determining its usability are the total concentration of soluble salts and the relative activity of sodium ions in exchange reactions. For diagnosis and classification, the total concentration of soluble salts can be expressed in terms of electrical conductivity, which is a measure of the ability of inorganic salts in solution to conduct an electrical current. The electrical conductivity can be determined accurately in the laboratory, or approximately, by multiplying the total equivalents per million of calcium, magnesium, sodium, and potassium by 100, or by dividing the parts per million of total dissolved solids by 0.64 (U. S. Salinity Laboratory Staff, 1954, p. 69). Water having an electrical conductivity of less than 750 micromhos per centimeter (µmho/cm) is generally satisfactory for irrigation insofar as the salt content is concerned, although salt-sensitive crops such as strawberries, green beans, and red clover may be adversely affected by water having a conductivity of more than 250 µmho/cm. Water having conductivity in the range of 750 to 2,250 is widely used, and satisfactory crop growth is obtained under good management and favorable drainage, but saline soil will develop if leaching and drainage are inadequate. Water having a conduc-

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tivity of about 2,250 µmho/cm has seldom been used successfully.

The sodium-adsorption ratio (SAR) of water, which relates to the adsorption of sodium by soil, may be determined by the formula

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

in which the ionic concentrations are expressed in equivalents per million. The SAR may be determined also by use of the nomogram shown in Figure 13. In it, the concentration of sodium expressed in equivalents per million is plotted on the left-hand scale, *A*, and the concentration of calcium plus magnesium, expressed in equivalents per million, is plotted on the right-hand scale, *B*. The point at which a line connecting these two points intersects the SAR scale, *C*, determines the SAR of the water. When the SAR and the electrical conductivity of a water are known, the suitability of water for irrigation can be determined by plotting the values on the nomogram. Table 15 lists the SAR of the 8 water samples plotted on Figures 13 and 14.

TABLE 15.—Index numbers of samples shown in Figures 13 and 14 and sodium adsorption ratio (SAR).

Well number	Number used in Figures 13 and 14	Geologic Source [1]	SAR
27–35–24ac	1	Npl, No	0.3
27–39–13ac	2	Kd, Kc	1.3
28–38– 4cc	3	Npl, No	1.7
29–35–15ab	4	Npl	1.3
29–36–23ddd	5	Npl	3.1
29–36–30bc	6	Npl, No	1.3
29–42–11dc	7	Kd, Kc, TRd	1.6
30–37–36bc	8	Npl	1.0

1. Npl, Pleistocene; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; TRd, Dockum Group.

Low-sodium water (S1) (Fig. 14) can be used for irrigation on almost all soils with little danger of developing harmful levels of exchangeable sodium. Medium-sodium water (S2) can be used safely on coarse-textured or organic soils having good permeability, but it will present appreciable sodium hazard in certain fine-textured soils, especially those not leached thoroughly. High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management, such as good drainage, thorough leaching, and addition of organic matter. Very high sodium water (S4) is generally unsatisfactory for irrigation unless special action is taken, such as addition of gypsum to the soil.

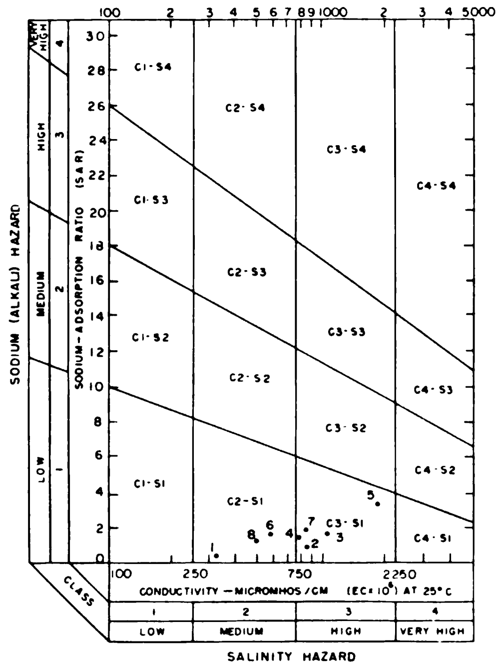

FIGURE 14.—Classification of irrigation waters from representative wells in the Grant-Stanton area. (See Table 15 for well numbers.)

Low-salinity water (C1) can be used for irrigation of most crops on most soils with little likelihood that soil salinity will develop. Medium-salinity water (C2) can be used if a moderate amount of leaching occurs. Crops of moderate salt tolerance, such as potatoes, corn, wheat, oats, and alfalfa can be irrigated with C2 water without special practices. High-salinity water (C3) cannot be used on soils with restricted drainage. Very high salinity water (C4) can be used only on certain crops and then only if special practices are followed.

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The irrigation water being used in the area is a low-sodium water, (Fig. 14) but it is medium to high in salinity.

Phreatophytes

A plant that habitually obtains its water supply from the zone of saturation, either directly or through the capillary fringe, is termed a phreatophyte (Meinzer, 1923, p. 55). The Subcommittee on Phreatophytes (1958, p. 5) states, "A phreatophyte in most cases is a mesophyte which grows in arid or semi-arid climates and which gets its water supply from ground water." The most abundant phreatophytes in this area are salt cedar (five-stamen tamarisk), willows, and cottonwoods. In some parts of the west these plants grow along valleys and flood plains and use considerable water. These plants, the tamarisk in particular, are of little or no economic value and grow thick enough in some areas to choke the stream channels, causing flooding. The tamarisk is difficult to control once growth has started, and care should be taken not to spread this plant deliberately.

Tamarisks, willows, and cottonwoods grow in abundance along the Arkansas River as far east as Dodge City, Kansas. It is not known how far they extend down the Cimarron River, but a few grow near Wagon Bed Springs south of Ulysses. Figure 15 shows the areas where tamarisks are growing in the Grant-Stanton area.

SUMMARY AND CONCLUSIONS

Thick deposits of Pleistocene and Pliocene age underlie most of Grant and Stanton counties. These deposits are the principal aquifers that furnish water for irrigation in the area. Where these deposits do not exist or are not water-bearing, sandstone aquifers may supply water for irrigation.

Previously, geologists recognized that deposits of Pleistocene age were present in the area, but the meager data available made Pleistocene and Pliocene differentiation impractical. The detailed data in this report, including the information on fossils, have made possible the delineation of Pleistocene from Pliocene throughout most of the area.

Sample, electrical, and radioactivity logs from deep water-well tests and from oil and gas tests, have permitted an approximation of the thickness and areal extent of the Cretaceous and Triassic sandstone aquifers.

In 1959 there were about 135,000 acre-feet of ground water withdrawn for irrigation purposes in Grant County and about 113,000 acre-feet withdrawn in Stanton County. These withdrawal rates probably will vary considerably in accordance with the annual pumping rate for each well, which in turn depends upon the annual precipitation.

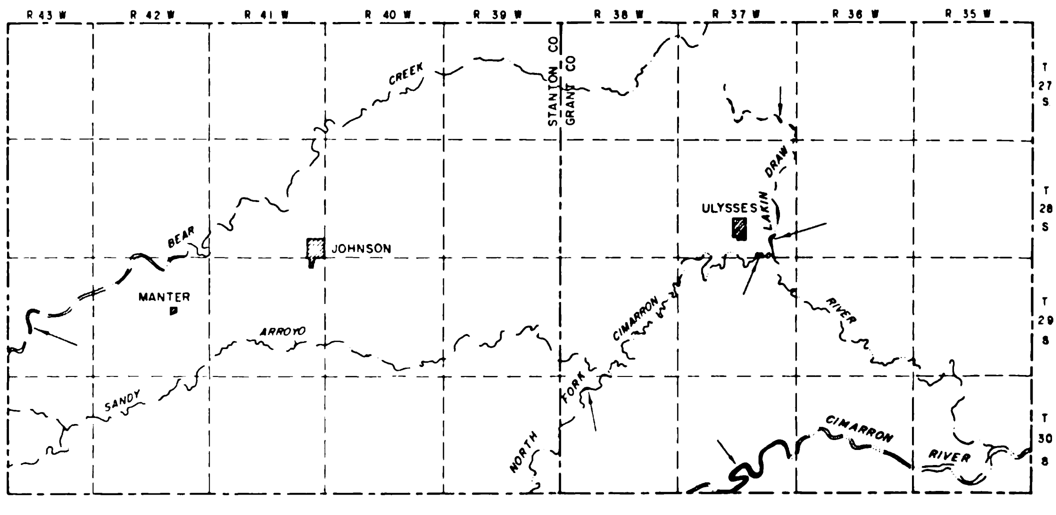

FIGURE 15.—Map showing occurrence of phreatophytes in the Grant-Stanton area. (Areas of phreatophytes shown in black and indicated by arrows.)

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The coefficients of transmissibility obtained from the aquifer tests can be applied throughout the area, provided that the geology of the aquifers is known. The coefficients of storage obtained from the aquifer tests were too low, and this is believed to reflect the short period of time that the material at the water table had to drain during the aquifer tests. An areal drawndown coefficient of 32 percent was obtained by comparing the total amount pumped between 1939-42 and 1960 and the average water-level decline. This coefficient was later corrected for recharge from precipitation and for possible over-reporting of pumpage, which reduced the coefficient to 0.20.

Water levels in some areas declined as much as 42 feet between 1939-42 and 1960 and as much as 70 feet between 1939-42 and 1963. Most of this decline probably occurred after 1955. The weighted-average water level declined 8 feet and 18 feet, respectively, during the above time intervals. Water levels in small localized areas will fluctuate considerably from pumping seasons to off seasons. In general, water levels will decline over the area as shown by Figures 8 and 9, depending upon the rate of withdrawal.

The analysis of the water-table contour map indicated that about 58 mgd of ground water was flowing into the area from the west and about 86 mgd was flowing out of the area eastward. About 13 mgd seemed to be recharge from precipitation. The remaining increase of 15 mgd was from adjacent areas to the north and south.

Because the hydraulic gradients at the 3,240 and 2,830 water-table contours have not changed appreciably between 1939-42 and 1960 and because water levels in these areas have declined only slightly, the inflow and outflow of the area is assumed to be approximately the same in 1960 as in 1939-42; however, some change in the outflow was noted in January 1963. Therefore, it can be assumed that the amount of ground water pumped within the area during the last 20 years is predominantly from the storage within the area. This is further indicated by the decline of the weighted-average water level.

The recharge from precipitation was computed to be 0.013 mgd per square mile or 0.3 inches per year. This is about 2 percent of the annual precipitation or less than 10 percent of the present reported annual pumping rate.

In Grant and Stanton counties there is about 55 million acre-feet of ground water in storage. About 39 million acre-feet is in the unconsolidated aquifers, and 16 million acre-feet is in the consolidated aquifers. However, probably not more than half of this water can be economically recovered. The time that any well or well field would last should be considered on an individual basis.

The authors were unable to determine the geologic source of the water from various wells by the chemical constituents of the water. However, the chemical-quality program was useful in determining the suitability of water for irrigation.

Phreatophytes grow along the Cimarron River, North Fork Cimarron River, and Lakin Draw. These plants are difficult to control and use much water that might possibly be used more beneficially.

RECORDS OF WELLS AND WATER LEVELS

Information about the depth, diameter, use of water, water level, and geologic source of of the water for 814 wells is given in Tables 16 and 17. The well-numbering system is explained in the introduction of this report (under the heading "Well-numbering System"). The depths of the wells are given by the driller or reported by the owner. The geologic source was determined by the authors. Reported depths to water are given in feet; measured depths to water are given in feet and tenths. The yield of the wells was measured by the authors or by the members of the Division of Water Resources, Kansas State Board of Agriculture; those yields followed by the capital letter "R" are reported by the owner or tenant. The drawdowns given under "Remarks" are all reported by the owner or tenant and generally were measured by the driller during the testing of the well.

Water levels in wells for which more than one measurement was available are given in Table 18.

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TABLE 16.—Records of wells in Grant County, Kansas.

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 27 S., R. 35 W.													
27-35-3ca	Liman Smith and Son	Dr	133	5	I	Sd	Npl.	Cy, W	S	121.8	7-18-41	3,035		
-3cd	C. L. Ladner	Dr	125	6	I	Sd	Npl	Cy, W	S	120.9	10-15-59	3,030		
-5ad	C. L. Dew	Dr	149	4	I	Sd	Npl	Cy, W	D, S	144.4	3-25-60	3,061		
-6cc*	Jasper Smith	Dr	141	4½	I	Sd	Npl	Cy, E	D, S	134.4	3-28-60	3,055		
-10cc	Henry L. Trafton	Dr	385	16	I	Sd, Gr	Npl, No	T, G	I	149.3	3-25-60	3,052	1,800 R	
-13cc	A. E. Alexander	Dr	246	6	I	Sd, Gr	Npl	T, G	I	148	10-15-59	3,035	240 R	Drawdown 24.
-16cb	Mrs. Craig Howard	Dr	182	6	I	Sd	Npl	Cy, W	S	179.3	11-18-60	3,084		
-16dd*		Dr	170	6	I	Sd	Npl	Cy, W	S					
-17ad	Herman E. Meyer	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	180.1	2-25-60	3,086	1,085	Drawdown 8 after 5 hr.
-17cc	Cecil W. Sturgeon	Dr	184	4	I	Sd	Npl	Cy, H	D	175.2	7-24-41	3,091		
-22db	S. H. Kells	Dr	181	4	I	Sd	Npl	Cy, W	D, S	172.7	7-28-41	3,070		
-24aa	W. E. Moody	Dr	160	5	I	Sd	Npl	Cy, W	S	144.8	7-18-41	3,028		
-24ac*	W. E. Moody	Dr	355	16	I	Sd, Gr	Npl, No	T, G	I	172.4	3-25-60	3,055	2,150	
-27ca	J. E. and D. M. Rixon	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	189.5	3-25-60	3,078	1,730	Drawdown 11.
-29ba	V. N. Roberts	Dr	400	30	I	Sd, Gr	Npl, No	T, G	I	194.0	3-25-60	3,093	2,250 R	
-33bb	Charles E. Ladner	Dr	400	30	I	Sd, Gr	Npl, No	T, G	I	190.0	3-25-60	3,078	2,500 R	
	T. 27 S., R. 36 W.													
27-36-2ad	R. H. Tate Estate	Dr	137	4	I	Sd	Npl	Cy, W	D, S	126.7	7-24-41	3,070		
-3cd	Mary S. Lewis	Dr	176	5	I	Sd	Npl	Cy, W, H	D, S	163.9	1-28-60	3,108		
-4aa	Lenora V. Tate	Dr	187	5	I	Sd	Npl	Cy, W	D, S	155.6	7-24-41	3,112		Found plugged at 20 feet in 1959.
-5bb	Mrs. I. L. Puckett	Dr	163	4½	I	Sd	Npl	Cy, W	D, S	119.5	10-24-39	3,091		
-7aa	J. H. Lindsay	Dr	176	6	I	Sd	Npl	Cy, W	S	141.8	3-28-60	3,109		
-8bb	R. H. Tate Estate	Dr	138	5	I	Sd	Npl	Cy, W	D, S	126.6	7-14-41	3,093		Found destroyed 1959.
-13ad	Clifford Fort	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	182.5	3-28-60	3,097	1,830	Drawdown 11 ft. after 6 wks. pumping.
-14cc	Mrs. B. M. Corley	Dr	406	16	I	Sd, Gr	Npl, No	T, G	I	192.2	3-28-60	3,115	2,000 R	
-15cc	C. E. Hoffman	Dr	388	16	I	Sd, Gr	Npl, No	T, G	I	188.2	3-28-60	3,121	2,180	
-15dd	Mrs. B. M. Corley	Dr	422	16	I	Sd, Gr	Npl, No	T, G	I	188	12-10-54	3,117	2,460	Drawdown 22 ft. after 6 hrs. pumping.
-17dd	R. A. Phelps	Dr	160	6	I	Sd	Npl	Cy, H	D	153.9	7-23-41	3,102		Abandoned 1959.
-18ab	E. B. Petro	Dr	144	5	I	Sd	Npl	Cy, W	S	121.1	7-22-41	3,088		
-18dc	William H. Meyer	Dr	393	26	I	Sd, Gr, SS	Npl, No	T, G	I	107.0	3-28-60	3,065	1,340	
-21dc	C. W. McCauley	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	201.8	3-28-60	3,130	2,800 R	
-23dc*	Martin Long	Dr	416	16	I	Sd, Gr	Npl, No	T, G	I	200.9	3-28-60	3,114	2,000 R	
-25aa	Blanche Smith	Dr	440	..	I	Sd, Gr	Npl, No	T, G	I	221.9	3-28-60	3,126	1,800 R	
-25cc	do	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	231.5	3-31-60	3,134	1,800 R	
-32bb	Carl Moyer	Dr	255	4	I	Sd, Gr	Npl	Cy, W, E	D, S	....	....	....		
-32dd	Ernest Kephart	Dr	235	5	I	Sd, Gr	Npl	Cy, W	D, S	....	....	....		
-34ad	R. V. Lightly	Dr	194	5	I	Sd	Npl	Cy, W	N	182.5	7-17-41	3,104		Abandoned 1941.
	T. 27 S., R. 37 W.													
27-37-1cc*	Mary E. Shapland	Dr	160	..	I	Sd	Npl	Cy, W	D, S	104.6	2-11-58	3,087		Abandoned 1958.
-3bd	Edward F. Judge	Dr	326	16	I	Sd, Gr	Npl, No	T, G	I	80	1960	3,080	800 R	
-3dd	do	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	125.9	3-28-60	3,106	1,180 R	
-4ab	C. L. Jury, Jr.	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	74.2	3-28-60	3,080	1,270 R	Drawdown 90.

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-4dd	C. L. Jury, Sr.	Dr	158	6	I	Sd, Gr	Npl	Cy, W	S	77.1	11-18-60	3,070		
-11ab*	Robert A. Moore	Dr	340	16	I	Sd, Gr	Npl, No	T, G	I	116.6	3-28-60	3,093	990	
-14ba	Erdene Corley	Dr	415	16	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	107.2	3-28-60	3,088	1,800 R	
-16bb	Ruth M. Gall	Dr	300?	16	I	Sd, Gr	Npl, No	T, G	I	57.6	3-28-60	3,058	1,100 R	
-18cb	Hattie E. Anderson	Dr	86	4	I	Sd	Npl	Cy, W, H	D, S	48.0	7-21-41	3,091		
-19db	M. E. Radebaugh and Ida Smith	Dr	300?	16	I	Sd, Gr	Npl, No	T, G	I	52.4	1-30-59	3,081	1,800 R	
-20cd	Flora D. Nutter	Dr	288	16	I	Sd, Gr	Npl, No	T, G	I	52.8	3-30-60	3,072	1,520	
-22bb	Russell Bechtelheimer	Dr	365	16	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	68	10- 59	3,055		
-25bc	Elvin H. Metherd	Dr	121	5	I	Sd	Npl	Cy, H	D	78.5	7-18-41	3,059		Plugged in 1959.
-25cb	do	Dr	265	16	I	Sd, Gr	Npl	T, G	I	87.9	3-30-60	3,060	910 R	
-26bc	J. H. Siebert	Dr	595	16 to 12	I	Sd, Gr, SS	Npl, No, Kd, Kc	T	I	70.6	3-30-60	3,054	2,200 R	
-28cb	A. G. Redinger	Dr	352	30	I	Sd, Gr	Npl, No	T, G	I	57.8	3-30-60	3,068	810	
-28ad*	do	Dr	60	..	I	Sd	Npl	Cy, W, H	D, S	40	10-28-41	3,046		
-29cb	Frank and Jake Wiebe	Dr	288	16	I	Sd, Gr	Npl, No	T, G	I	59.1	3-30-60	3,079	1,520	
-29cc	Earl B. Williams	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,079	2,100	
-30bd	do	Dr	342	16	I	Sd, Gr	Npl, No	T, G	I	64.2	3-30-60	3,090	1,350 R	
-30dd	F. C. Williams	Dr	57	6	I	Sd	Npl	Cy, W	S	42.0	2-15-48	3,077		Found destroyed 1948.
-33cc	Ray Lighty	Dr	361	16	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	60.6	3-30-60	3,070	1,200 R	
-34da	Keith M. Puckett	Dr	397	16	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	88.1	3-30-60	3,075	800 R	
-35dc	Elvin H. Metherd	Dr	270	12	I	Sd, Gr	Npl, No	T, G	I	104.6	1-27-59	3,080	590	
-36cc	Oscar F. Barnes	Dr	272	16	I	Sd, Gr	Npl, No	T, G	I	89.5	3-30-60	3,059	1,180 R	
	T. 27 S., R. 38 W.													
27-38-1ad	O. F. Waechter	Dr	57	4	I	Sd	Npl	Cy, W	S	41.7	7-23-41	3,085		
-1da	L. C. Waechter	Dr	300	16 to 14	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	56.7	3-28-60	3,083	1,200	Drawdown 70 after 24 hr.
-6cb	Ray Shaffer	Dr	568	16	I	SS	Kd, Kc	T, G	I	130.2	3-28-60	3,219	1,200 R	
-9dd	Flossie J. Andes	Dr	101	8	I	Sd	No	Cy, W	S, D	101 dry	8-23-60	3,149		Well dry at times, 1958.
-12ad	L. C. Waechter	Dr	280	16	I	Sd, Gr	Npl, No	T,G	I	33.6	3-28-60	3,076	1,200 R	
-12dd	Allen S. Anderson	Dr	310	16	I	Sd, Gr	Npl, No	T, G	I	72.6	9-18-58	3,101	940 R	
-13ab	do	Dr	324	16	I	Sd, Gr	Npl, No	T, G	I	70.6	3-28-60	3,106	910	
-13cc	J. J. Anderson	Dr	300	16	I	Sd, Gr	Npl, No	T, G	I	60.1	3-28-60	3,096	1,600 R	
-14cd	Rider Bros. Co.	Dr	270	16	I	Sd, Gr	Npl, No	T, G	I	59.7	1-15-58	3,095	2,500 R	
-15bb	Mrs. Charles Andes	Dr	450	16	I	Sd, SS	No, Kd, Kc, TRd	T, G	I	107.7	11-18-60	3,149	900 R	
-15dad	U.S.G.S.	Dr	275	1¼	I	Sd	No	N	O	65.2	10-27-59	3,101		Casing Removed November 1959.
-15dd	Rider Bros. Co.	Dr	260	16	I	Sd, Gr	Npl, No	T, G	I	64.3	1-25-60	3,101	2,000	
-17dd	Mrs. Robert Waldie	Dr	56	5	I	Sd	Npl	Cy, W	S	33.9	7-16-41	3,112		Well found destroyed 1958.
-19bc	Peter Kistner	Dr	200	18	I	Sd, Gr	Npl	T, G	I	66.7	1-30-59	3,137	1,450	
-19cd	L. E. Annis	Dr	344	18	I	Sd, Gr	Npl, No	T, G	I	75.0	3-30-60	3,137	2,900 R	
-19db	do	Dr	360	16	I	Sd, Gr	Npl, No	N	N	74.5	5- 4-59	3,134	2,000 R	
-20ad*	Mrs. Robert Waldie	Dr	100	..	I	Sd	Npl	Cy, W	S, D	60.8	9-18-58	3,121		
-20bd	do	Dr	270	16	I	Sd, Gr	Npl, No	T, G	I	70.5	1-15-58	3,125	2,000 R	
-20cb	do	Dr	300	16	I	Sd, Gr	Npl, No	T, G	I	71.6	1-15-58	3,131	2,000 R	
-21cb	H. F. Zimmett	Dr	270	16	I	Sd, Gr	Npl, No	T, G	I	68.2	3-28-60	3,120	2,000 R	
-22cb	L. F. Hohner	Dr	287	16	I	Sd, Gr	Npl, No	T, G	I	65.4	1-15-58	3,110	1,550	
-22cc	do	Dr	202	16	I	Sd, Gr	Npl	T, G	I	63.2	2-16-59	3,111	2,460	
-23ca	do	Dr	260	16	I	Sd, Gr	Npl, No	T, G	I	66.9	1-15-58	3,098	1,320	
-23cb1	do	Dr	234	16	I	Sd, Gr	Npl	N	N	72.3	12-14-60	3,105		
-23cb2	do	Dr	260	16	I	Sd, Gr	Npl, No	T, G	I	69.3	1-15-58	3,104	1,050	52 ft. drawdown after 272 hrs.
-24cc	Mrs. Margret Flummer Felt	Dr	288	16	I	Sd, Gr	Npl, No	T, G	I	67.5	1-15-58	3,094	1,710	
-25bb	Mrs. Dorothy L. Gall	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	62.5	3-28-60	3,096	1,100 R	
-26aa	Charles Shorter	Dr	60	6	I	Sd, Gr	Npl	Cy, W	D, S	46.0	5-14-41	3,096		Found destroyed 1958.
-26bb	do	Dr	327	16	I	Sd, Gr	Npl, No	T, G	I	74.4	1-16-58	3,105	1,160	
-27aa	do	Dr	272	16	I	Sd, Gr	Npl, No	T, G	I	50	1-15-54	3,107		
-27bb	Mrs. Tillie H. Clowe	Dr	230	16	I	Sd, Gr	Npl, No	T, G	I	64.8	3-28-58	3,112	1,230	Drawdown 23.
-28cb1	Cecil Puckett	Dr	250?	16	..	Sd, Gr	Npl	N	N	77.1	3-30-60	3,130		
-28cb2	do	Dr	250?	6	I	Sd, Gr	Npl	Cy, W	D	75.7	2-12-58	3,130		
-28cb3	do	Dr	303	16	I	Sd, Gr	Npl, No	T, G	I	....	3- 3-59	3,130	1,070	

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TABLE 16.—Records of wells in Grant County, Kansas.—*Continued.*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 27 S., R. 38 W.													
29ac	G. M. Coffey	Dr	330	16	I	Sd, Gr	Npl, No	T, G	I	81.0	3- 6-59	3,132	1,370	
29da	do	Dr	252	6	I	Sd, Gr	Npl	....	..	....	....	...	....	
-30ca	Ray Stevenson	Dr	360?	16	I	Sd, Gr	Npl, No	T, G	I	98.0	1-17-58	3,135	1,300 R	
-30cb	do	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	97	1-17-58	3,148	3,000 R	
-31ba	Joe Jungferman	Dr	300	16	I	Sd, Gr	Npl, No	T, G	I	80.4	3-30-60	3,133	1,900	
-31dd1	do	Dr	317	16	I	Sd, Gr	Npl, No	T, G	I	89.8	3- 3-59	3,138	1,180	Drawdown 24.
-31dd2	do	Dr	360	18 to 14	I	Sd, Gr	Npl,No	T, G	I	114.1	1-17-58	3,137	1,800	
-32bb	G. M. Coffey	Dr	350	16	I	Sd, Gr	Npl, No	T, G	I	92.4	1-17-58	3,130	1,550	
-32bc	do	Dr	300	16	I	Sd, Gr	Npl, No	N	N	78.7	3-21-60	3,130		
-32cc1	J. L. Murphy	Dr	295	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,134	1,120	Drawdown 27.5 after 3 hr
-32cc2	do	Dr	260	6	I	Sd, Gr	Npl	Cy, W	D	90.6	2-12-58	3,133		
-33cb	W. L. Puckett	Dr	288	16	I	Sd, Gr	Npl, No	T, G	I	71.6	3-30-60	3,124	970	
-34aa	O. P. Williams	Dr	55	6	I	Sd, Gr	Npl	Cy, W	D, S	47.4	7-21-41	3,111		Unlocated 1960.
	T. 28 S., R. 35 W.													
28-35-1cb	L. O. Stanley	Dr	267	6	I	Sd	Npl	Cy, W	D, S	217.7	3-25-60	3,080		
-5bc	C. L. Dew	Dr	443	16	I	Sd, Gr	Npl, No	T, G	I	240	9- 56	3,117	1,150	
-5dc	Glenn E. Dew	Dr	425	16	I	Sd, Gr	Npl, No	T, G	I	243	8-12-58	3,124	1,100 R	
-6ba1	F. W. Stever	Dr	242	4	I	Sd, Gr	Npl	N	N	231.1	7-24-41	3,124		Found plugged 1959.
-6ba2	do	Dr	435	16	I	Sd, Gr	Npl, No	T, G	I	246.5	3-31-60	3,127	1,800 R	
-8bb	G. L. Meeker	Dr	420	16	I	Sd, Gr	Npl, No	T, G	I	247.6	3-25-60	3,117	1,708	
-9aa	Max Hand	Dr	397	16	I	Sd, Gr	Npl, No	T, G	I	241.8	3-25-60	3,100	1,800 R	
-10bb	C. L. Dew	Dr	402	16	I	Sd, Gr	Npl, No	T, G	I	249.6	2-13-58	3,104	900 R	
-15bb*	V. S. Higginbothom	Dr	220	4½	I	Sd	Npl	Cy, W	D, S	212	10-28-41	3,069		
-15cb	C. R. DaVatz	Dr	405	16	I	Sd, Gr	Npl, No	T, G	I	225.6	3-25-60	3,064	650	
-16cc	Fern Ulsh	Dr	242	5	GI	Sd	Npl	Cy, H	D, S	215.1	7-25-41	3,074		
-20ab	C. N. King	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	242.1	3-25-60	3,089	1,800 R	
-21bb	Henry A. Koehn	Dr	352	16	I	Sd, Gr	Npl, No	T, G	I	234	10- 59	3,073	1,100 R	Drawdown 34.
-22ac	Pete J. Harms	Dr	430	16	I	Sd, Gr	Npl, No	T, G	I	200	1958	3,042	870	
-22bb	Ralph A. Fry	Dr	385	16	I	Sd, Gr	Npl, No	T, G	I	190	5- 56	3,058	800	
-23bd	C. R. DaVatz	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	224.6	3-25-60	3,042	590	
-24cd	A. C. Kaufman	Dr	220	4½	I	Sd	Npl	Cy, W	D, S	211.8	7-19-41	3,033		
-27bb	R. G. Ulsh	Dr	325	16	I	Sd,, Gr	Npl	T, G	I	213.3	3-25-60	3,041	1,720 R	
-27bc	do	Dr	265	16	I	Sd, Gr	Npl	T, G	I	216.3	8-17-60	3,038	1,150	Drawdown 23 after 5.5 hr.
-29bc	Leslie D. King	Dr	405	16	I	Sd, Gr	Npl, No	T, G	I	237.6	10-19-59	3,063	2,630	
-30bb	R. G. Ulsh	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	227.0	3-31-60	3,072	1,730	
-31cd1	Magnolia Petroleum Co.	Dr	383	12	I	Sd, Gr	Npl, No	T, E, G	Ind	235.9	11-10-60	3,055	280	Drawdown 64 after 4 hr.
-31cd2	do	Dr	384	12	I	Sd, Gr	Npl, No	T, E	Ind	240.4	1-17-58	3,055	250	
-35dc	J. B. Ungles	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	221.0	3-25-60	3,032	1,490	
-36ab	M. E. Britten	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	222.8	3-25-60	3,032	1,760	
	T. 28 S., R. 36 W.													
28-36-2ba	Hollis Bullock	Dr	408	16	I	Sd, Gr	Npl, No	T, G	I	233.2	3-30-60	3,132	960	
-2cd	R. R. Hampton	Dr	449	16	I	Sd, Gr	Npl, No	T, G	I	226.2	2-22-59	3,111	1,000 R	
-3dd*	G. M. Hampton	Dr	200	5	I	Sd	Npl	Cy, W	D, S	192	10-28-41	3,107		
-7cb	F. M. Barnes	Dr	51	6	I	Sd	Npl	Cy, N	D, S	41.1	7-14-41	3,007		
-11ba	A. G. Dyck	Dr	437	16	I	Sd, Gr	Npl, No	T, G	I	220.2	3-30-60	3,103	1,240	Drawdown 18 after 1.5 hr.

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-13ac	C. R. DaVatz	Dr	438	16	I	Sd, Gr	Npl, No	T, G	I	227.6	3-31-60	3,091	1,150	Drawdown 17.
-15aa	Connie Hampton	Dr	285	5	I	Sd, Gr	No	Cy, W	D, S	197.4	7-17-41	3,090		
-17bbb	U.S.G.S.	Dr	320	1¼	I	Sd	No	N	O	152.5	3-30-60	3,088		
-25aa	A. Fry, Jr.	Dr	214	4	I	Sd	Npl	Cy, W	D, S	159	7-19-41	3,074		
-31bc	Ralph L. Teeter	Dr	430	4	N	Sd	No	N	N	146	10-1-60	3,060		
-34bc	Columbian Carbon Co.	Dr	360	6	I	Sd	Npl, No	Cy, E	I				....	
-36cd*	Ethel W. Hoffman	Dr	91	6	I	Sd	Npl	Cy, W	S	82.1	5-27-41	3,041		Found plugged 1958.
	T. 28 S., R. 37 W.													
28-37-2bb	R. R. Bechtelheimer	Dr	303	16	I	Sd, Gr	Npl, No	T, D	I	108.2	10-26-59	3,087	650	Drawdown 52
-2bc	do	Dr	474	14 to 10	I	Sd, Gr, SS	Npl, No, Kc	T, G	I	96.4	3-30-60	3,081	500	
-2cc	do	Dr	90	5	I	Sd	Npl	Cy, W	D, S	80.1	7-18-41	3,078		
-4ac	Philip Shorter	Dr	310	16	I	Sd, Gr, SS	Npl, No	T, G	I	....	....	3,079	690	
-5dc	J. T. Smith Estate	Dr	300	16	I	Sd, Gr	Npl, No	N	N	52.0	11-29-40	3,073		Found plugged 1958.
-6bb	R. R. Bechtelheimer	Dr	225	16	I	Sd, Gr	Npl	T, G	I	53.3	3-30-60	3,029	1,350 R	
-7cb	W. C. Reeves	Dr	357	16	I	Sd, Gr	Npl, No	T, G	I	52.7	3-30-60	3,082	1,100 R	
-9ac	Gearold L. Gray	Dr	387	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,066	450 R	
-9bb	Dale Stevenson	Dr	365	16	I	Sd, Gr	Npl, No	T, G	I	40	6-22-53	3,071	710	
-9cc	do	Dr	365	16	I	Sd, Gr	Npl, No	T, G	I	61.0	3-30-60	3,070	730	
-10cb1	Keith M. Puckett	Dr	78	6	I	Sd	Npl	Cy, W	D, S	54.2	2-11-58	3,057		
-10cb2	do	Dr	340	16 & 12	I	Sd, Gr	Npl, No	T, G	I	62.2	3-30-60	3,057	690	
-14da1	C. F. Patterson	Du, Dr	35	..	..	Sd	Npl	Cf, N	I	9.3	7-18-41	2,983		
-14da2	do	Dr	160	..	..	Sd	Npl	Cy, W	S	....	1951	2,980	1.25	Flowing artesian; not flowing 1958.
-17cb	J. D. Sullivan	Dr	392	16	I	Sd, Gr	Npl, No	T, G	I	70.0	3-30-60	3,089		
-18cc	C. Burnham	Dr	139	7	I	Sd	Npl	N	Ind	41.4	10-10-41	3,078		
-20dc1	J. D. Sullivan	Dr	66	6	I	Sd	Npl	Cy, W	D, S	45.5	1-28-59	3,077		
-20dc2	do	Dr	310	16 & 12	I	Sd, Gr	Npl, No	T, G	I	72.8	3-30-60	3,079	920	
-22ab	R. R. Bechtelheimer	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	63.8	3-30-60	3,052	1,500 R	
-22dc	L. T. Helmly	Dr	132	6	I	Sd	Npl	N	Ind	45.6	8-25-41	3,040		
-27ca1	B. G. Robinson	Dr	77	6	I	Sd	Npl	N	N	72.3	5-28-41	3,053		
-27cc1*	City of Ulysses	Dr	290	12	I	Sd, Gr	Npl, No	T, G	P	57	8-8-41	3,054	200	Drawdown 28.
-27cc2	do	Dr	290	12	I	Sd, Gr	Npl, No	T, G	N	83.2	3-30-60	3,055		
-27cd	A.T. & S.F. Railway Co.	Dr	289	12 & 8	I	Sd, Gr	Npl, No	Cy, E	Ind	50	11-23-22	3,047	78	Measured in 1922.
-28dc	City of Ulysses	Dr	289	16	I	Sd, Gr	Npl, No	T, G	P	65	2-13-59	3,059		
-28dd1	do	Dr	280	12	I	Sd, Gr	Npl, No	T, E	P	....	....	3,052		
-28dd2	do	Dr	285	16	I	Sd, Gr	Npl, No	T, E	P	85	2-13-59	3,055	410 R	Drawdown 120.
-30bb	Robert R. Hickok	Dr	285	16	I	Sd, Gr	Npl, No	T, G	I	75.9	3-30-60	3,097	885	
-31aa1	Pioneer Co-op Assn., Inc.	Dr	300	..	I	Sd, Gr	Npl, No	T, E	Ind	70.8	3-30-60	3,074	200 R	
-31aa2	do	Dr	310	16	I	Sd, Gr	Npl, No	T, E	Ind	85	10-59	3,075	200 R	
-35aa*	C. A. Smith Estate	Dr	165	4½	I	Sd	Npl	Cy, W, H	D, S	10.3	11-1-58	2,979		
-36dd	Ulysses Cemetery Assn.	Dr	360	8, 7	I	Sd, Gr	Npl, No	T, E	I	110.4	3-30-60	3,057	30 R	
	T. 28 S., R. 38 W.													
28-38-4bb	Herman Cockerham	Dr	317	16	I	Sd, Gr	Npl, No	T, G	I	86	1-15-58	3,118	990	Drawdown 42 after 3 hr.
-4cc*	do	Dr	285	15½	I	Sd, Gr	Npl, No	T, G	I	60.9	3-21-60	3,112	1,070	
-4db*	do	Dr	55	4½	I	Sd	Npl	Cy, W, H	D, S	45	10-27-41	3,094		
-5ab	do	Dr	285	16	I	Sd, Gr	Npl, No	T, G	I	52.6	10-12-42	3,125	1,400 R	Drawdown 17. Found destroyed 1959.
-5ac	do	Dr	330	16	I	Sd, Gr	Npl, No	T, G	I	80	1-53	3,124	850	
-5bd	do	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,125	1,350	
-5dc	do	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	72.6	3-30-60	3,122	810	
-6ad	State of Kansas	Dr	100	12	I	Sd, Gr	Npl	N	O	66.4	12-14-60	3,130		
-6bc	O. P. Williams	Dr	300	16 & 12	I	Sd, Gr	Npl, No	T, G	I	100.4	1-17-58	3,039	610	
-6cb	do	Dr	332	16	I	Sd, Gr	Npl, No	T, G	I	101.7	1-17-58	3,142	930	
-6dc1	do	Dr	65	5	I	Sd	Npl	Cy, W	S	58.6	2-12-58	3,133		
-6dc2	do	Dr	260	6	I	Sd, Gr	Npl	Ts, E	D, S	150	8-9-60	3,133		
-7ab	Dale Williams	Dr	373	16	I	Sd, Gr	Npl, No	T, G	I	95.8	2-3-59	3,131	600	
-7bb	Delila Pinegar	Dr	284	16	I	Sd, Gr	Npl, No	T, G	I	89.7	11-18-60	3,135	600 R	
-8bb1	A. G. Dyck	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	51.8	8-23-40	3,127		Found destroyed 1958.
-8bb2	do	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	79.8	1-17-59	3,128	1,200	
-8bc	do	Dr	398	16	I	Sd, Gr	Npl, No	T, G	I	79.7	3-21-60	3,124	375	

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TABLE 16.—Records of wells in Grant County, Kansas.—*Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 28 S., R. 38 W.													
-8dc	do	Dr	52.0	6	I	Sd	Npl	Cy, W	S	45.6	5-14-41	3,119		
-9ca	Ray Stevenson	Dr	375	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,110	890	
-9cb	do	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	92.0	1-15-58	3,114	300 R	
-10ab	D. R. Young	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	47.2	3-30-60	3,100	1,000 R	
-10bb	do	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	80	7- 53	3,102	1,200 R	
-12bc	J. D. Sullivan	Dr	384	16	I	Sd, Gr	Npl, No	T, G	I	48.6	3-30-60	3,087	1,000 R	Drawdown 52.
-12cb	do	Dr	364	16	I	Sd, Gr	Npl, No	T, G	I	64.2	2-12-58	3,091	980	Drawdown 58.
-13dd	W. O. Newby Estate	Dr	68	4	I	Sd	Npl	Cy, W, H	D	60.4	10-10-41	3,097		
-15cb	Mrs. Edna McLaughlin	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,101	1,000	
-16ab	Ray Stevenson	Dr	384	14	I	Sd, Gr	Npl, No	Cy, E	D, S	59.0	2-22-59	3,107		Formerly irrigation; well caved.
-16bb	do	Dr	383	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,112	1,330	
-16cb	Mrs. T. M. Halliday	Dr	388	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,112	1,350	
-16db1	do	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	83.4	11-17-60	3,107		Abandoned 1959.
-16db3	do	Dr	556	16	I	Sd, Gr, SS	Npl, No, Kc	T, G	I	84.5	2-22-59	3,103	1,330	
-17ab	Ray Stevenson	Dr	280	16	I	Sd, Gr	Npl, No	T, G	I	110+	1-16-58	3,120	1,600 R	
-17bb	do	Dr	396	16	I	Sd, Gr	Npl, No	T, G	I	110+	1-16-58	3,120	1,600 R	
-17cb	do	Dr	375	16	I	Sd, Gr	Npl, No	T, G	I	114.1	1-16-58	3,121	1,800 R	
-18bb	E. A. Dyck	Dr	376	16	I	Sd, Gr	Npl, No	T, G	I	84.5	3-21-60	3,130	2,000 R	
-18db	Ray Stevenson	Dr	342	14 & 12	I	Sd, Gr	Npl, No	T, G	I	84.2	3-30-60	3,125	1,200 R	
-18dc	do	Dr	382	16	I	Sd, Gr	Npl, No	T, G	I	80+	1-16-58	3,127	1,200 R	
-19bc	A. B. Williams	Dr	368	16	I	Sd, Gr	Npl, No	T, G	I	140	12- 55	3,135	500 R	
-19bd	do	Dr	376	16	I	Sd, Gr	Npl, No	T, G	I	91.1	1-25-60	3,133	1,500 R	
-20dc1	Lyle Morris	Dr	352	16	I	Sd, Gr	Npl, No	T, G	I	82.6	3-30-60	3,122	1,350 R	
-20dc2	do	Dr	375	16	I	Sd, Gr	Npl, No	T, G	I	98.0	10-27-59	3,125	1,200 R	
-26cd	H. Toohey	Dr	69	4	I	Sd	Npl	Cy, H	N	47.2	5-28-41	3,102		Found destroyed 1958.
-27ba	W. A. Leigh	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	117.6	2-18-58	3,117	1,930	
-27ca	do	Dr	418	16	I	Sd, Gr	Npl, No	T, G	I	81.7	3-30-60	3,117	1,990	
-27cb	do	Dr	420	16	I	Sd, Gr	Npl, No	T, G	I	153.5	5-18-59	3,124	1,940	
-27dd	do	Dr	57	..	I	Sd	Npl	Cy, W	D, S	55.4	1-28-59	3,101		
-28ccc	Cities Service Gas Co.	Dr	253	12	I	Sd, Gr	Npl	T, E	Ind	102	12-11-59	3,117	200	Drawdown 15 after 8 hr.
-28ccd	do	Dr	293	12	I	Sd, Gr	Npl	T, E	Ind, D	120	7- 51	....	280	Drawdown 14 after 8 hr.
-28da	Cecil W. Sturgeon	Dr	490	16	I	Sd, Gr, SS	Npl, No, Kc	T, G	I	60	5- 56	3,124	2,000 R	
-30bb	J. T. Klepper	Dr	55	4?	I	Sd	Npl	Cy, W	D, S	46.5	7-23-41	3,137		
-30cb	W. T. Haley	Dr	406	16	I	Sd, Gr	Npl, No	T, G	I	70.5	1-16-58	3,137	1,600 R	
-30cc	do	Dr	408	16	I	Sd, Gr	Npl, No	T, G	I	70.4	1-28-59	3,137	1,310	
-31db	V. T. Klepper	Dr	428	16	I	Sd, Gr	Npl, No	T, G	I	76.3	3-30-60	3,138	2,020	
-32dcc	Stanolind Oil & Gas Co.	Dr	522	2	I	Sd, Gr, SS	Npl, No, Kd?, Kc	N	O	119	5-17-60	3,126		
-33ba1	W. J. Hemphill	Dr	66	4	I	Sd	Npl	N	D	64.0	1-15-58	3,128		
-33ba2	do	Dr	430	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,098	1,600 R	
-33bd	do	Dr	422	16	I	Sd, Gr	Npl, No	T, G	I	91.3	3-30-60	3,128	1,300 R	
-35ba	John Hiebert	Dr	93	6	I	Sd	Npl	Cy, W	D	57.3	1-28-59	3,100		
-35 bc	do	Dr	382	16	I	Sd, Gr	Npl, No	T, G	I	71.5	3-30-60	3,103	1,100 R	
	T. 29 S., R. 35 W.													
29-35-3aa	Cities Service Gas Co.	Dr	378	12	I	Sd, Gr	No	T, E	Ind	....	....	....	....	
-3ad	do	Dr	390	11	I	Sd, Gr	No	T, E	Ind	....	....	....		

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-6ba	P. M. Hampton	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	223.9	3-31-60	3,051	1,110	
-7bc1	Columbian Carbon Co.	Dr	346	8	I	Sd, Gr	Npl, No	T, E	Ind	160	6- 45	3,038		
-7bc2	do	Dr	352	12	I	Sd, Gr	Npl, No	T, E	Ind	....	....	3,038		
-7cb1	do	Dr	350	12	I	Sd, Gr	Npl, No	T, E	Ind	163	1945	3,037	300	
-7cb2	do	Dr	350	10¾	I	Sd, Gr	Npl, No	T, E	Ind	....	....	3,037	300	
-7cc	do	Dr	146	5	I	Sd, Gr	Npl	Cy, W	S	133.0	8- 7-41	3,032		Found destroyed 1959.
-12cd*	W. B. Miller Estate	Dr	234	5	I	Sd, Gr	Npl	Cy, W	D	226	10-27-41	3,026		
-12dd	Guy T. Miller	Dr	406	16	I	Sd, Gr	Npl	T, G	I	233.2	3-25-60	3,209	1,700 R	
-13ac	Elwin E. Anthony	Dr	440	16	I	Sd, Gr	Npl, No	T, G	I	210	2- 55	3,038	1,620	Drawdown 12 after 10 hr.
-15ab*	Carl Epps	Dr	460	16	I	Sd, Gr	Npl	T, G	I	219.5	3-25-60	3,027	1,650 R	
-15aba	U.S.G.S.	Dr	315	1¼	I	Sd, Gr	Npl	N	O	224.8	3-25-60	3,032		
-15baa	do	Dr	300	1¼	I	Sd, Gr	Npl	N	O	212.0	3-25-60	3,020		
-18aa	Bryce Cantrell	Dr	317	4	I	Sd	Npl	Cy, W	D	228.1	3-31-60	3,049		
-22cb	Roy R. King	Dr	385	6	I	Sd, Gr	Npl, No	Ts, E	D, S	197.4	5- 3-60	2,995		
-24ba	G. D. Blackwelder Estate	Dr	400?	16	I	Sd, Gr	Npl	T, G	I	243.1	3-25-60	3,035	2,000 R	
-24bb	do	Dr	258	6	I	Sd, Gr	Npl	N	Ind	231.6	8-25-41	3,032		
-24bc	do	Dr	407	16	I	Sd, Gr	Npl	T, G	I	235	12- 58	3,037	2,000 R	
-25dd1	United Carbon Co.	Dr	367	12	I	Sd, Gr	Npl	N	Ind	237.0	7- 8-41	3,030		Well now abandoned and capped. Five wells of similar depth at this site.
-27cc	Wayne Lakey	Dr	100	3	I	Sd, Gr	Npl	Cy, W	D, S	85	10- 59			
-28ac	do	Dr	250	7	I	Sd, Gr	Npl	Cy, W	S	173.8	3-25-60	2,971		
-33ab	E. A. Stuart	Dr	77	4	I	Sd, Gr	Npl	N	S	59.0	5-27-41	2,953		Found plugged 1958
	T. 29 S., R. 36 W.													
29-36-2bb	Gano Grain Corp.	Dr	115	6	I	Sd	Npl	Cf, E	D	82.8	1-28-59	3,055		
-4ba1*	Hollis Bullock	Dr	113	4	I	Sd	Npl	Cy, W	D	87.1	2-26-59	3,058		
-4ba2	do	Dr	380	6	I	Sd	No	Ts, E	D	161.9	3-30-60	3,058		
-5ab	M. O. Nuss	Dr	119	4	I	Sd	Npl	N	N	106.6	5-30-41	3,063		
-11dd	E. M. Johnson	Dr	58+	4	I	Sd	Npl	Cy, W	D, S	58.3	1-15-58	3,037		
-18cc	Mrs. Lloyd Keller	Dr	37	4½	I	Sd	Npl	Cy, H	D	32.6	7-12-41	2,986		Found destroyed 1958.
-19bc	do	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	56.1	3-31-60	2,995	1,652	
-21cdc	U.S.G.S.	Dr	120	2	Plastic	Sd, Gr	Npl	N	N	34.6	3-31-60	2,942		
-23cb1	G. H. Wood	Dr	179	4	I	Sd	Npl	N	N	58.6	3-31-60	2,971		
-23cb2	do	Dr	365	6 & 4	I	Sd	Npl, No	Ts, E	D, S	58.5	2- 9-60	2,972		
-23ddd*	U.S.G.S.	Dr	269	1¼	I	Sd	Npl	N	O	109.2	3-31-60	3,023		Casing removed 1960.
-24bd	A. F. Stevenson	Dr	206	7	I	Sd	Npl	N	N	108.9	8-26-41	3,021		
-25ba*	O. T. Deyoe	Dr	119	..	I	Sd	Npl	Cy, W	D, S	97	10-27-41	2,928		
-27ab	O. O. Strickling	Dr	35	5	I	Sd	Npl	N	D, S	13.8	7-30-41	2,935		Found destroyed 1959.
-29ba	Ernest Keller	Dr	62	4	I	Sd	Npl	Cy, W	S	47.8	7-28-41	3,001		
-30bc*	Keith Schwein	Dr	446	16	I	Sd, Gr	Npl, No	T, G	I	139.7	3-31-60	3,072	1,500 R	
-30dc	do	Dr	465	16	I	Sd, Gr	Npl, No	T, G	I	159.6	10-23-59	3,064	1,500 R	
-31db	Jesse E. Limper	Dr	450	16	I	Sd, Gr	Npl, No	T, G	I	135.6	3-31-60	3,071	890 R	
-36bb1	Glenn Carter	Dr	163	4	I	Sd	Npl	N	D	48.6	2- 9-60	2,926		
-36bb2	do	Dr	34	6	I	Sd	Npl	Cf, E	D	23.7	1-18-58	2,925		
-36db	do	Dr	330	6⅝	I	Sd	Npl, No	N	N	73.0	3-31-60	2,938		
	T. 29 S., R. 37 W.													
29-37-3bb	T. Brewer	Dr	27	4½	I	Sd	Npl	Cy, W	D, S	13.7	7-11-41	2,992		
-8cb	Dan C. Sullivan	Dr	300	16	I	Sd, Gr	Npl	T, G	I	65.5	4- 1-60	3,065	1,800 R	
-14cd	Frank Thomason	Dr	100	4	I	Sd	Npl	Cy, W	D, S	77.4	7-28-41	3,064		
-18ad	John Neufeld	Dr	90	4½	I	Sd	Npl	Cy, H	D, S	72	8- 4-41	3,100		
-19db*	Ralph E. Winger	Dr	392	16	I	Sd, Gr	Npl, No	T, G	I	120.9	2- 5-59	3,114	1,500 R	
-20cd	G. E. Gano	Dr	82	4	I	Sd	Npl	N	N	74.1	5-30-41	3,091		
-21cc	Arthur Campbell	Dr	80	4	I	Sd	Npl	Cy, W, H	D	71.7	8- 7-41	3,086		
-22aa	Earl Steen	Dr	280	16 & 12	I	Sd, Gr	Npl	T, G	I	55.0	3-31-60	3,039	900 R	
-22cc1*	Walter Eichenberger	Dr	80	..	I	Sd	Npl	Cy, W	D, S	60	10-21-41	3,039		
-22cc2	do	Dr	490	16	I	Sd, Gr	Npl, No	T, G	I	82.1	3-31-60	3,058	1,530	
-26cc	H. H. Caldwell	Dr	540	16	I	Sd, Gr	Npl, No	T, G	I	124.9	3-31-60	3,088	1,800 R	
-28bb	Owen C. Steen	Dr	400	16	I	Sd, Gr	Npl, No	T, E	I	74	5-17-46	3,087	1,000 R	
-28cb	do	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	124.5	10-26-59	3,087	1,100 R	

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TABLE 16.—Records of wells in Grant County, Kansas.—*Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 29 S., R. 37 W.													
-29bb	Eugene F. Swindler	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	104.2	3-31-60	3,094	880	
-32ab	Vernal Lattimore	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	....	....	....	....	
-32bd	do	Dr	310	16	I	Sd, Gr	Npl	T, G	I	112	4-23-54	3,087	750	
-32cc1	Jesse J. Ford	Dr	351	16	I	Sd, Gr	Npl, No	T, G	I	103.0	3-31-60	3,098	740	
-32db	do	Dr	351	16	I	Sd, Gr	Npl, No	T, G	I	122.8	10-27-59	3,096	1,200 R	
-34bc	H. M. Johnson	Dr	76	5	I	Sd	Npl	Cy, W, H	D, S	67.3	7-11-41	3,067		
-34bd	Verle E. Johnson	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	80	8- 46	3,096	1,200 R	
-35ac	Glenn Jarvis	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	169.0	10-23-59	3,105	1,500 R	
-35cc	Edna Herschel	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	160.4	2-13-58	3,105	1,200 R	
-35cd	E. N. Halladay	Dr	540	16	I	Sd, Gr	Npl, No	T, G	I	161.6	11-30-59	3,103	1,100 R	
	T. 29 S., R. 38 W.													
29-38-1bb	Dan C. Sullivan	Dr	450	16	I	Sd, Gr	Npl, No	T, G	I	77.9	1-27-60	3,094	2,000 R	
-1ca	Sullivan Bros.	Dr	400	18	I	Sd, Gr	Npl, No	T, G	I	78.0	3-31-60	3,094		
-3ba	Dan Sullivan, Jr.	Dr	459	16	I	Sd, Gr	Npl, No	T, G	I	99.5	10-28-59	3,113	2,000 R	
-4cc*	Marshall A. Brewer	Dr	450	16	I	Sd, Gr	Npl, No	T, G	I	91.6	4- 1-60	3,134	1,050	
-5aab	Stanolind Oil & Gas	Dr	464	12	I	Sd, Gr	Npl, No	T, E	Ind	139.4	1-17-58	3,151	750 R	
-5aac	do	Dr	467	12	I	Sd, Gr	Npl, No	T, E	Ind	139.9	1958	3,151	750 R	
-5acb	do	Dr	422	2	I	Sd, Gr	Npl, No	N	O	164.0	9- 9-60	3,132		
-7da	R. H. Goertzen	Dr	478	16	I	Sd, Gr	Npl, No	T, G	I	80.6	2- 5-59	3,148	1,520	
-8cc	James T. Klepper	Dr	487	16	I	Sd, Gr	Npl, No	T, G	I	87.8	4- 1 60	3,154	1,970	
-16aa*	A. G. Redinger	Dr	150	4	I	Sd	Npl	Cy, W, H	D, S	60	10-21-41	3,113		
-18dd	L. A. Smith	Dr	76	4	I	Sd	Npl	Cy, W	S	63.6	7-14-41	3,146		
-19cb	U.S.G.S.	Dr	250	1¼	I	Gr	Npl	N	N	68.4	7-12 60	3,152		
-20cd	J. W. Siebert	Dr	550	16	I	Sd, Gr, SS	Npl, No, Trd	T, G	I	....	....	3,137		
-22bb	do	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	58	9-16-58	3,113	1,100 R	
-22cb	E. G. Zonker	Dr	180	14	I	Sd, Gr	Npl	T, G	I	60.2	4- 1-60	3,113	1,410	
-25ba	Isaac Harms	Dr	373	16	I	Sd, Gr	Npl, No	T, G	I	89.3	4- 1-60	3,109	800 R	
-26ba	J. R. Hickok	Dr	40	6	I	Sd	Npl	Cy, H	D	29.4	8- 4-41	3,073		
-27aa1*	Frank Siebert	Dr	25	6	I	Sd	Npl	Cy, H	D, S	20	10-21-41	3,063		
-27aa2	do	Dr	160	6	I	Sd	Npl	Cy, E	D, S	30	2- 60	3,063		
-27ad	do	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	47.8	10-27-59	3,094	750 R	
-29cb	H. W. Loewer	Dr	63	5	I	Sd	Npl	Cy, W	D, S	30.1	8- 5-41	3,115		
-30bc	A. M. Williams	Dr	93	6	I	Sd	Npl	Cy, H	D, S	67.4	8- 9-39	3,158		
-31dc	Elmer L. Johnson	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	53	1-16-53	3,139	2,100 R	
-35ac1	Ray R. Kepley	Dr	240	12	I	Sd, Gr	Npl	T, D	I	70.3	9-22-42	3,116		Found abandoned 1959.
-35ac2	do	Dr	354	16	I	Sd, Gr	Npl, No	T, G	I	83.8	3-30-59	...	700 R	
-35cd	do	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	100.2	4- 1-60	3,133	713	Drawdown 71 after 2 hrs.
-35db	do	Dr	417	16	I	Sd, Gr	Npl, No	T, G	I	93.8	10-27-59	3,117	1,000 R	
	T. 30 S., R. 35 W.													
30-35-2db	Clifford Willett	Dr	430	16	I	Sd, Gr	Npl, No	T, G	I	230.5	3-25-60	3,022	740	
-2dc*	do	Dr	40	5	I	Sd, Gr	Npl	Cy, W	D, S	225	10 27-41	3,017		
-3dd	L. M. Stubbs, et al	Dr	196	5	I	Sd, Gr	Npl	Cy, W	D, S	192.8	7-11-41	2,987		
-4db	E. H. Hockett	Dr	165	7	I	Sd, Gr	Npl	N	N	86.3	3-25 60	2,888		
-4dc	do	Dr	69	5	I	Sd	Npl	Cy, W	D, S	66.3	7 16 41	2,905		Found plugged 1959.
-7dd	Mrs. M. Allmon	Dr	195	6	I	Sd, Gr	Npl	Cy, W	S	179.3	10-10 59	2,998		

-13ab	E. E. Correll, et al	Dr	190	7	I	Sd, Gr	Npl	Cy, G	S	183.4	8-26-41	2,971		
-16bb	Riverview State Bank	Dr	86	5	I	Sd, Gr	Npl	Cy, W	S	76.1	7-17-41	2,881		
-19bc1	Eual P. Brewer	Dr	130	16	I	Sd, Gr	Npl, No	T, G	I	145.4	3-23-60	3,004	1,600 R	
-19bc2	U.S.G.S.	Dr	400	1¼	I	Sd	No	N	N	143.3	11-23-59	3,001		Casing removed 1959.
-19bc3	do	Dr	380	1¼	I	Sd	No	N	N	140.2	11-18-59	2,997		Casing removed 1959.
-20ba1	G. G. Feight	Dr	177	5	I	Sd, Gr	Npl	Cy, W	D, S	155.5	7-16-41	2,999		
-20ba2	do	Dr	300	4	I	Sd, Gr	Npl	Cy, W	S	155.4	3-31-60	2,999		
-22cc	Hugh Hooper	Dr	70	4	I	Sd, Gr	Npl	Cy, W	S	55.0	8- 7-41	2,878		Found destroyed 1959.
-23cb	E. Gosshardt	Dr	260	3	I	Sd, Gr	Npl, No	N	N	56.3	10-16-59	2,854		Casing removed 1959.
-24ca	L. A. Watson	Dr	68	5	I	Sd, Gr	Npl	N, W	D, S	62.9	7-11-41	2,850		
-24cb	do	Dr	100	7½	I	Sd, Gr	Npl	Cy, W	S	81.5	3-25-60	2,872		
-35cc	W. Lahey	Dr	140	5	I	Sd, Gr	Npl	Cy, W	D, S	125.6	7-17-41	2,915		
	T. 30 S., R. 36 W.													
30-36-1dc*	A. J. Walters	Dr	140	7?	I	Sd, Gr	Npl	Cy, W	D, S	130	10-27-41	2,999		
-2bb	J. E. Alford	Dr	48	4	I	Sd, Gr	Npl	Cy, W	D, S	41.5	7-21-41	2,951		
-5bb1*	J. W. Alford	Dr	125	..	I	Sd	Npl	Cy, W, H	D, S	115	10-27-41	3,057		
-5bb2	do	Dr	404	7	I	Sd, Gr	Npl, No	T, G	I	120	8-12-58	3,057		Unused 1960.
-5cb	do	Dr	540	16	I	Sd, Gr	Npl, No, Trd?	T, G	I	....	....	....	1,000 R	
-6bb	Mrs. Dorothy Boldt	Dr	393	16	I	Sd, Gr	Npl, No	T, G	I	134.8	3-31-60	3,073	1,200 R	
-6bd	W. R. McClaren	Dr	371	16	I	Sd, Gr	Npl, No	T, G	I	121	8-24-49	3,061	1,200 R	
-7aa	Nora A. Christian	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	135.9	10-23-59	3,057	700 R	
-7ab	do	Dr	425	16	I	Sd, Gr	Npl, No	T, G	I	120	7- 2-54	3,061	400	
-7cb	Geneva Blake Curtis	Dr	340	16	I	Sd, Gr	Npl, No	T, G	I	139.6	3-31-60	3,068	620	
-8cd	Nora A. Christian	Dr	425	16	I	Sd, Gr	Npl, No	T, G	I	121.3	3-31-60	3,038	1,530	
-9bb	John W. Alford	Dr	500	16	I	Sd, Gr	Npl, No	T, G	I	131.5	3-31-60	3,043	1,510	
-9dc	Wilma Jennings	Dr	325	16	I	Sd, Gr	Npl	T, G	I	118.3	10-23-59	3,024	730	
-10cc	J. W. Teeter	Dr	168	6	I	Sd	Npl	Cy, W	S	119.5	7-30-41	3,027		
-16da1	Nora A. Christian	Dr	356	16	I	Sd, Gr	Npl, No	T, G	I	121.1	3-31-60	3,027	1,380	
-23dd*	J. W. Teeter	Dr	45	5	I	Sd, Gr	Npl	Cy, N	S	21.4	10-23-59	2,909		
-24cc	do	Dr	55	6	I	Sd, Gr	Npl	N	S	23.6	8-25-58	2,910		
-25ca	Eual P. Brewer	Dr	124	6	I	Sd, Gr	Npl	Cy, W	S	27.5	3-31-60	2,905		
-26ba	C. E. Gordon	Dr	21	5	I	Sd, Gr	Npl	Cy, W	D	13.3	8- 1-41	2,912		
-27ba	R. and O. Thurow	Dr	136	..	..	Sd, Gr	Npl	N	D, S	96.3	7-30-41	3,025		
-31dc	F. G. Stoner	Dr	112	..	..	Sd, Gr	Npl	Cy, W	D, S	95.7	7-30-41	3,059		
-32bb	Mrs. Fannie Brollier	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	112.9	3-21-60	3,064	1,000 R	
	T. 30 S., R. 37 W.													
30-37-1ab	Glenn Jarvis	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,081		
-1bb	J. Limper	Dr	118	15	I	Sd, Gr	Npl, No	Cy, W	D, S	113.2	7-28-41	3,083		
-2ba1	Lawrence Steen	Dr	300	16 & 12	I	Sd, Gr	Npl	T, G	I	175	5- 7-59	3,101		Unused 1960.
-2ba2	do	Dr	480	16	I	Sd, Gr	Npl, No	T, G	I	153.7	3-31-60	3,101	980	Drawdown 120 after 20 hrs.
-3db	Earl Steen	Dr	558	16	I	Sd, Gr	Npl, No	T, G	I	149.1	3-31-60	3,104	1,000	
-4ab	W. H. Hildenbrand	Dr	88	5	I	Sd	Npl	Cy, H, W	D, S	85.0	7-11-41	3,087		
-6dc	V. V. Lattimore	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	122.6	3-31-60	3,122	1,140	
-8cc	Wayne Jarvis	Dr	510	16	I	Sd, Gr	Npl, No	T, G	I	137.7	3-31-60	3,125	1,000 R	
-9cc	R. W. Tuttle	Dr	345	16	I	Sd, Gr	Npl, No	T, G	I	137.4	10-27-59	3,102	1,500 R	
-10ab	Tacy Marie Halliday	Dr	565	16	I	Sd, Gr	Npl, No	T, G	I	108	3- 54	3,103	660	
-10bb1	Kansas Power and Light	Dr	308	8⅝	I	Sd, Gr	Npl	T, E	Ind	115	5- 52	3,102	50 R	Abandoned 1954.
-10bb2	do	Dr	290	10	I	Sd, Gr	Npl	T, E	Ind	120	5- 52	3,104	170 R	
-10bb3	do	Dr	283	10	I	Sd, Gr	Npl	T, E	Ind	123	6- 54	3,100	100 R	Drawdown 94 after 4 hrs.
-10bb4	do	Dr	378	10¾	I	Sd, Gr	Npl, No	T, E	D, Ind	....	....	3,104	100 R	
-10bb5	do	Dr	366	10	I	Sd, Gr	Npl, No	T, E	D, Ind	132	10- 52	3,105	100 R	
-10dc	Tacy Marie Halliday	Dr	395	16 & 12	I	Sd, Gr	Npl, No	T, G	I	147.7	3-31-60	3,096	1,030	
-11db	Verle E. Johnson	Dr	350	16	I	Sd, Gr	Npl, No	T, G	I	150.4	10-23-59	3,083	1,300 R	
-15cb1	R. W. Tuttle	Dr	289	18	I	Sd, Gr	Npl	T, G	D, S	165.9	8-27-58	3,101	850 R	Abandoned irrigation well.
-15cb2	do	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	171.1	8-27-58	3,100		
-16aa*	do	Dr	120	..	I	....	Npl	Cy, W	D, S	94	10-27-41	3,108		
-16da	do	Dr	396	16	I	Sd, Gr	Npl, No	T, G	I	122	5-17-46	3,102	1,400 R	
-17bc	E. Wayne Jarvis	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	143.7	2- 5-59	3,130	1,085	

TABLE 16.—Records of wells in Grant County, Kansas.—*Concluded*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 30 S., R. 37 W.													
-19aa1	Harold A. Drake	Dr	350	16	I	Sd, Gr	Npl	N	N	139.3	3-31-60	3,127	1,500 R	
-19aa2	do	Dr	380	16	I	Sd, Gr	Npl	T, G	I	135.7	10-27-59	3,127	1,300	
-20cb	John H. Lewis	Dr	335	16	I	Sd, Gr	Npl	T, G	I	135.8	2-25-60	3,124	800 R	
-20cc	do	Dr	400	16	I	Sd, Gr	Npl	T, G	I	142.2	10-27-59	3,131	800 R	
-21bd	Earl Anderson	Dr	540	16	I	Sd, Gr, SS	Npl, No, Trd	T, G	I	....	....	3,095	1,100 R	
-21cc	Thomas E. Joyce	Dr	330	18	I	Sd, Gr	Npl	T, G	I	124.1	3-31-60	3,104	700 R	
-21db	do	Dr	194	6	I	Sd, Gr	Npl	N	Ind	102.2	8-25-41	3,093		
-23aa	R. W. Tuttle	Dr	111	7	I	Sd, Gr	Npl	Cy, W	S	57.9	3-31-60	2,998		
-24cb	F. W. Hoffman	Du	25±	..	..	Sd	Npl	Cy, H	D	21.6	7-30-41	2,970		
-25dd1	G. V. Brollier	Dr	123	..	..	Sd, Gr	Npl	Cy, W	D, S	105.4	7-30-41	3,053		
-25dd2	do	Dr	382	16	I	Sd, Gr	Npl, No	T, G	I	93.5	3-21-60	3,061	1,080	
-26cc	M. F. Frederick	Dr	118	16	I	Sd, Gr	Npl	T, G	I	12.4	3-31-60	2,978	750 R	
-26da	I. R. Parsons	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	110	8- 59	3,071	1,200 R	
-26db1	do	Dr	260	16	I	Sd, Gr	Npl	N	N	114.8	3-21-60	3,079		Abandoned 1958.
-27bc1	R. H. Joyce	Dr	16	6	I	Sd, Gr	Npl	N	N	11.5	5-28-41	2,984		
-27bc2*	do	Dr	25	8	I	Sd, Gr	Npl	Cy, W	D, S	23.2	2- 6-59	2,996		
-31cc	R. W. Tuttle	Dr	41	6	I	Sd, Gr	Npl	Cy, W	D, S	33.0	8- 5-41	3,051		
-33aa	M. T. Joyce	Dr	34	5	I	Sd, Gr	Npl	Cy, W	D, S	18.5	8- 2-41	3,000		
-33db	J. F. Parsons	Dr	72	8	I	Sd, Gr	Npl	Cy, W, G	S	22.3	8- 2 41	3,108		
-35bd	G. E. Candless	Dr	371	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,088	1,400 R	
-36bc*	R. H. Joyce	Dr	317	12	I	Sd, Gr	Npl	T, G	I	89.9	3-21-60	3,063	1,000 R	Drawdown 13.
	T. 30 S., R. 38 W.													
30-38-2ab	R. D. Kepley	Dr	417	16	I	Sd, Gr	Npl, No	T, G	I	160	1956	3,021	450	
-2cb	do	Dr	375	16	I	Sd, Gr	Npl	T, B	I	90	1947	3,139	670	
-2cc	do	Dr	355	16	I	Sd, Gr	Npl	T, G	I	100.8	2- 5-59	3,135	1,500 R	
-3dc	Clyde H. Ball	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	115.9	10-27-59	3,146	1,450 R	
-5bb*	Edward B. Kepley	Dr	310	16	I	Sd, Gr	Npl, No	T, G	I	51.8	4- 1-60	3,131		
-6bc	L. W. Bailey	Dr	414	16	I	Sd, Gr	Npl, No	T, G	I	60.6	4- 1-60	3,151	2,700 R	
-6cc	do	Dr	346	16	I	Sd, Gr	Npl, No	T, G	I	75.6	8-26-58	3,159	2,500 R	
-9ad	E. Mills	Dr	137	5	I	Sd	Npl	Cy, W, H	D	85.6	7-15-41	3,148	1,800 R	
-10ab	Elmer Hennigh	Dr	406	16	I	Sd, Gr	Npl, No	T, D	I	90	6- 48	3,149	1,350 R	
-10bc	Mrs. R. H. Thomason	Dr	355	16	I	Sd, Gr	Npl, No	T, G	I	....	....	3,148	1,350 R	
-10dd*	Elmer Hennigh	Dr	140	4½	I	Sd	Npl	Cy, W	D, S	92	10-21-41	3,130		
-11bc3	Marion Hennigh	Dr	347	16	I	Sd, Gr	Npl	T, G	I	107.6	4- 1-60	3,138	1,240 R	Drawdown 110 after 60 hrs.
-11dd	Elmer Hennigh	Dr	351	16	I	Sd, Gr	Npl	T, G	I	118.8	10-27-59	3,131	1,500 R	
-12cc	R. W. Hennigh	Dr	440	16	I	Sd, Gr	Npl	T, G	I	97	1- 7-55	3,130	1,260	
-13cc	Lawrence R. Hennigh	Dr	560	16	I	Sd, Gr	Npl, No, Trd?	T, G	I	126.1	4- 1-60	3,142	1,300 R	
-14ac	do	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	100	1955	3,137	1,430	
-15ab	F. B. Schartz	Dr	97	..	..	Sd	Npl	Cy, W	S	83.9	7-15-41	3,139		
-15db	do	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	102.8	4- 1-60	3,146	880	
-26da	G. P. Witt	Dr	408	16	I	Sd, Gr	Npl, No	T, G	I	131.3	4- 1-60	3,154	1,490	
-30ab1	U.S.G.S.	Dr	214	1¼	I	Sd, Gr	Npl	N	O	71.5	5-19-60	3,153		Casing removed 1960.
-30ab2	do	Dr	250	1¼	I	Sd, Gr	Npl	N	O	70.9	5-19-60	3,154		Casing removed 1960.

-30ac	Clarence B. Collins	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	71.5	4-1-60	3,156	1,620
-33aa	Ella Petty	Dr	112	..	..	Sd	Npl	Cy, W	D, S	90.8	8-2-41	3,152	
-34bc	G. P. Witt	Dr	426	16	I	Sd, Gr	Npl, No	T, G	I	101.0	4-1-60	3,158	2,000 R
-34dc	do	Dr	119	..	..	Sd	Npl	Cy, W	D, S	101.5	8-2-41	3,152	
-35db	R. W. Tuttle	Dr	400?	16	I	Sd, Gr	Npl	T, G	I	111.1	4-1-60	3,145	
-36bb	Glenn E. Jarvis	Dr	380	16	I	Sd, Gr	Npl	T, G	I	129	12-28-55	3,147	1,470

1. An asterisk (*) after a well number indicates that analysis of water is given in Table 10.
2. A, augerhole; Du, dug well; Dr, drilled well.
3. Depths below land surface are given in feet.
4. I, iron; GI, galvanized iron; T, tile; S, stone.
5. Sd, sand; Gr, gravel; SS, sandstone.
6. Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; TRd, Dockum Group.
7. Type of pump: Cf, centrifugal; Cy, cylinder; N, none; T, turbine; Ts, submersible turbine.
8. Type of power: B, butane; D, diesel; E, electric; G, gas engine; H, hand operated; W, windmill.
9. I, irrigation; N, none; O, observation; P, public; S, stock; D, domestic; Ind, industry.
10. Measured depths to water level are given in feet, tenths; reported depths to water level are given in feet.
11. 1,800 R, reported yield; 2,180, measured yield.

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Table 17.—Records of wells in Stanton County, Kansas.

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 27 S., R. 39 W.													
27-39-2bb*	Van Trussel	Dr	96	6	I	Sd	Npl	Cy, W	D, S	95.6	1-16-58	3,217		
-9dc	J. M. and R. Platt	Dr	109	8	I	Sd	No	Cy, W	N	54.7	4- 1-60	3,171		
-13ac*	Frank A. Snell	Dr	508	16 & 12	I	SS	Kd, Kc	T, G	I	87.0	4- 1-60	3,177	900	
-13bda*	State Geol. Survey	Dr	150	¼	I	Sd	No	N	O	112.2	9-17-59	3,180		
-14bb	V. S. Congdon	Dr	81	6	I	Sd	No	Cy, W	S	69.4	4- 1-60	3,175		
-17dd	Olen Warner	Dr	65	5½	I	Sd	Npl	Cy, W	N	50.4	1-17-58	3,175		
-20bd	Charles H. Helmle	Dr	355	16	I	Sd, Gr	Npl, No	T, G	I	62.4	9-27-60	3,191	1,500 R	Drawdown 113 after 8 hr.
-21ac	C. M. Helmle	Dr	396	16	I	Sd, Gr	Npl, No	T, G	I	85.6	4- 1-60	3,190	1,800 R	
-22db	Olen Warner	Dr	412	20	I	Sd, Gr	Npl, No	T, G	I	85.8	1-16-58	3,178	3,250	
-23ac1	Leslie L. Mater	Dr	69	6	Tile	Sd	Npl	Cy, H	D	44.2	8- 5-39	3,144		
-23ac2	do	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	57.1	4- 1-60	3,144	2,000 R	
-23cc	Olen Warner	Dr	420	16	I	Sd, Gr	Npl, No	T, G	I	69.1	1-26-60	3,152		
-25bb	R. E. Hurst	Dr	295	14	I	Sd, Gr	Npl, No	T, G	I	101.2	1-17-58	3,170	1,440 R	
-25cb	R. L. Arnold	Dr	418	13	I	Sd, Gr, SS	Npl, No, Kd?	T, G	I	100.6	4- 1-60	3,165	1,500 R	
-26ab	R. S. Molz	Dr	235	16	I	Sd, Gr	Npl	T, G	I	93.8	1-16-58	3,163	1,280	
-26bc	D. K. Molz	Dr	236	16	I	Sd, Gr	Npl	T, G	I	94.6	1-17-58	3,159	1,500 R	
-26db	R. L. Arnold	Dr	340	16	I	Sd, Gr	Npl, No	T, G	I	76	9- -48	3,168	2,000 R	
-27ad1	M. P. Molz	Dr	83	18	I	Sd, Gr	Npl	N	N	56	9- 9-39	3,156	450 R	Abandoned 1958; dry at times in 1960.
-27bb	do	Dr	379	16	I	Sd, Gr	Npl, No	T, G	I	83.2	4- 1-60	3,175	900 R	
-27cb	do	Dr	312	16	I	Sd, Gr	Npl, No	T, G	I	92.8	1-17-58	3,178	800 R	
-28ba	Vincent E. Peery	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	78.7	4- 1-60	3,192	940	
-29da*	Felix Edmisson	Dr	80	6	I	Sd, Gr	Npl	Cy, W	D, S	58.1	1-17-58	3,185		
-33bd	Vincent E. Peery	Dr	335	16	I	Sd, Gr	Npl	T, G	I	50	4- -53	3,165	400 R	
-34dd	Earl H. Moore	Dr	330	16	I	Sd, Gr	Npl, No	T, G	I	89.0	4- 1-60	3,153	1,500 R	
-35ab	Mrs. Faye Collingwood	Dr	318	16	I	Sd, Gr	Npl, No	T, G	I	70	1- -57	3,159	1,000 R	
-35cb	Mrs. Alma Arnold	Dr	330	16	I	Sd, Gr	Npl, No	T, G	I	120	7- -57	3,147	2,000 R	
	T. 27 S., R. 40 W.													
27-40-1cd*	Mrs. G. R. Oliver	Dr	150	4	I	SS	Kd	Cy, W	D, S	110	9-2-39	3,263		
-5cd	J. W. Dimmitt, Jr.	Dr	71	6	I	Sd	Npl	Cy, W	D, S	41.4	4- 1-60	3,255		
-15cb	D. R. Wilson	Dr	68	6	I	Sd	Npl	Cy, W	S	47.9	4- 1-60	3,241		
-17bc*	G. R. Carrithers	Dr	71	5½	I	Sd	Npl	Cy, W	D, S	55.2	8-22-39	3,259		
-21da	C. R. Winger	Dr	55	6	I	Sd	Npl	Cy, W	S	48.0	4- 1-60	3,235		
-22da	do	Dr	136	8	I	Sd	Npl	N	I	47	10- -48	3,227		
-24aa	Molz Bros.	Dr	51	6	I	Sd	Npl	Cy, W	D, S	43.2	2- 8-60	3,197		
-24dc	J. A. Floyd	Dr	100?	6	I	Sd	Npl	Cy, W	D	83.6	1-17-58	3,231		
-25cb	Clarence Winger	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	71.4	4- 1-60	3,228	1,410	
-25cc	do	Dr	240	6	I	Sd	Npl, No	Cy, W	S	79.3	9-17-60	3,228		
-26ba*	Thomas R. Winger	Dr	343	16	I	Sd, Gr	Npl, No	T, G	I	70.0	4- 1-60	3,238	1,200 R	
-26dd	Clarence Winger	Dr	75?	6	I	Sd	Npl	Cy, W	S	59.4	8-19-39	3,223		
-29dd	Mary C. Williamson	Dr	105	6	I	Sd	Npl	Cy, W	D, S	65.1	8-19-39	3,260		
-30bb	O. E. Josserand	Dr	93	6	I	Sd	Npl	Cy, W	S	87.8	8-22-39	3,294		
-32cc	J. L. Cross	Dr	120	6	I	Sd	Npl	Cy, W	D, S	114.7	9- 6-39	3,307		
-35ab1*	Clarence Winger	Dr	182	16	I	Sd, Gr	Npl	T, G	I	74.9	11-17-60	3,232	800 R	
-35ab2*	do	Dr	620	16	I	Sd, SS	Npl, No, Kd, Kc	T, G	I	—	—	3,232	1,170	
-36ba	Walter D. Winger	Dr	204	10	I	Sd, Gr	Npl, No	T, G	I	—	—	3,210	605	

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	T. 27 S., R. 41 W.													
27-41-3cc*	C. A. Floyd	Dr	117	6	I	Sd	Npl	Cy, W	S	75.6	8-22-39	3,317		
-10ac	James W. Raney	Dr	465	16	I	Sd, Gr, SS	Npl, No, Kd, Kc, Tnd	T, B	I	71.7	4-1-60	3,314	1,200 R	
-15dc*	Ida Raney	Dr	124	6	I	Sd	Npl	Cy, W	S	98.6	9-6-39	3,329		
-17dd	A. G. Raney	Dr	122	6	I	Sd	Npl	Cy, W	S	117.6	8-22-39	3,351		
-30da	Nellie Yinger	Dr	156	6	I	Sd	Npl	Cy, W	N	141.2	8-30-39	3,388		
-31ac	Mrs. R. L. Ball	Dr	308	16	I	Sd, Gr	Npl, No	T, B	I	180	4- -56	3,397	1,250 R	
-31cc1*	Mrs. Ada I. Mack	Dr	172	6	I	Sd, Gr	Npl	Cy, W	D, S	161	9-5-39	3,402		
-31cc2	do	Dr	346	16	I	Sd, Gr	Npl, No	T, G	I	173.0	3-29-60	3,402	2,000 R	
-33ad	Harry Payne	Dr	141	6	I	Sd	Npl	Cy, N	D	124.6	8-18-39	3,351		
-35cc	Seyb Bros.	Dr	610	16	I	Sd, Gr, SS	Npl, No, Kd?, Kc, Tnd	T, G	I	131.5	3-29-60	3,340	500 R	Well reported deepened in 1960.
	T. 27 S., R. 42 W.													
27-42-8aa*	E. E. Reynolds	Dr	138	6	I	Sd	Npl	Cy, W	D, S	123.0	8-25-39	3,461		
-10dc	M. L. Gillum	Dr	148	6	I	Sd	Npl	Cy, W	D, S	115.6	9-6-39	3,428		
-11db*	William M. Hoff	Dr	252	16 & 12	I	Sd, Gr	Npl, No	T, B	I	118.1	3-29-60	3,397	800	Drawdown 23 after 3 hr.
-11dd	do	Dr	128	6	I	Sd	Npl	Cy, W	N	116.8	9-6-39	3,390		
-12ad	B. D. Frigon	Dr	130	5½	I	Sd	Npl	N	O	95.0	11-3-58	3,375		
-21ad	D. E. Cockrum	Dr	194	6	I	Sd	Npl, No	Cy, W	D, S	157.4	9-5-39	3,470		
-31cc*	Earl R. Anderson	Dr	400	16	I	Sd, Gr	Npl, No, Kd, Kc?	T, B	I	190.4	3-29-60	3,534	1,000 R	
-33cd	Faye McCune	Dr	174	6	I	Sd	Npl	Cy, W	D	168.8	9-5-39	3,477		
-36cc	W. H. Teas	Dr	203	6	I	Sd	Npl, No	N	N	189.9	8-25-39	3,440		
	T. 27 S., R. 43 W.													
27-43-5dd	L. W. Bailey	Dr	221	6	I	Sd	No	Cy, W	N	212.6	8-31-39	3,613		
-15ad*	R. L. Schmidt	Dr	190	6	I	Sd	No	Cy, W	D, S	181.0	10-29-59	3,558		
-26da	H. J. Payne	Dr	236	5½	I	Sd, SS	No, Kd	N	N	178.6	7-29-59	3,542		
-27ba	Emma C. Berkley	Dr	200	6	I	Sd	No	Cy, W	D, S	186.3	8-31-39	3,595		
-33aa*	C. E. Gilgore	Dr	130	6	I	Sd	No	Cy, W	D, S	125.9	9-13-39	3,588		
-34ad	D. Dody	Dr	117	6	I	Sd	No	Cy, W	D, S	114.7	9-13-39	3,560		
	T. 28 S., R. 39 W.													
28-39-1bb	Dale Williams	Dr	626	16 & 12	I	Sd, Gr, SS	Npl, No, Kc	T, G	I	85.4	4-1-60	3,143	1,145	
-1dd	Delia H. Pinegar	Dr	284	16	I	Sd, Gr	Npl	T, G	I	110	—	3,145		
-2ab	Faye Collingwood	Dr	388	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,147	800	
-2cb	Mrs. Alma Arnold	Dr	357	16	I	Sd, Gr	Npl, No	T, G	I	120	7- -57	3,152	1,700 R	
-2da	M. Romersi	Dr	316	16	I	Sd, Gr	Npl, No	N	N	84.5	12-12-58	3,146		Casing removed 1959.
-2dc	do	Dr	340	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,143	1,200	
-3bb	E. H. Moore	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,170	1,200 R	
-3da*	Vivian Glenn	Dr	65	6	I	Sd	Npl	Cy, H	D	53.4	8-31-39	3,153		
-4cc	do	Dr	310	16	I	Sd, Gr	Npl	T, G	I	—	—	3,177		
-5ab	do	Dr	58	6	I	Sd	Npl	Cy, W	S	44.9	8-10-39	3,177		
-5bb1	do	Dr	160	18	I	Sd	Npl	T, N	I	52	10-25-39	3,187		Well plugged at 38 feet.
-5bb2	do	Dr	310	16	I	Sd, Gr	Npl, No	T, G	I	53.4	4-1-60	3,187	250 R	
-6dc	Alma Arnold	Dr	400	16	I	Sd, Gr, SS	Npl, No, Kd?	T,G	I	—	—	3,206		
-8ab	Vivian Glenn	Dr	301	16	I	Sd, Gr	Npl, No	T, G	I	56	11- -48	3,187		
-8bb	do	Dr	243	16	I	Sd, Gr	Npl	T, G	I	80	5- -55	3,200	1,200	
-8bc*	do	Dr	290	16	I	Sd, Gr	Npl, No	T, G	I	95.2	4-1-60	3,200	1,660	
-8cd*	do	Dr	80	6	I	Sd, Gr	Npl	Cy, W	D, S	63.7	8-31-39	3,191		
-8db	do	Dr	276	16	I	Sd, Gr	Npl, No	T, G	I	100	9- -59	3,186		
-9ab	do	Dr	330	16	I	Sd, Gr	Npl, No	T, G	I	77.1	4-1-60	3,176	380 R	
-11aa	D. H. Pinegar	Dr	356	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,141		
-11bc	Dale Steele	Dr	347	16	I	Sd, Gr	Npl, No	T, G	I	75	8- -48	3,156	700 R	
-12aa	D. H. Pinegar	Dr	56	6	I	Sd, Gr	Npl	N	N	55.3	8-31-39	3,141		
-12ac	do	Dr	270	16	I	Sd, Gr	Npl	T, G	I	—	—	3,144	350	
-12bb	do	Dr	270?	16	I	Sd, Gr	Npl	T, G	I	—	—	3,144		
-12bd	do	Dr	270	16	I	Sd, Gr	Npl	T, G	I	130.0	7-20-59	3,139		
-12cc	Max B. Ainsworth	Dr	330	16 & 12	I	Sd, Gr	Npl, No	T, G	I	99.1	4-1-60	3,148	890	Drawdown 50.
-14bb1	Herbert Campbell, Jr.	Dr	419	16	I	Sd, Gr	Npl, No	N	N	85.9	11-16-60	3,158		
-14bb2	do	Dr	200	16	I	Sd, Gr	Npl	T, G	I	85.2	2-3-59	3,156	500	
-14cc	Eyman and Kearny	Dr	52	5½	I	Sd?	Npl	N	N	46.1	8-5-39	3,151		

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TABLE 17.—Records of wells in Stanton County, Kansas.—*Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 28 S., R. 39 W.													
28-39-15ac	Herbert Campbell, Sr.	Dr	335	16	I	Sd, Gr	Npl, No	T, G	I	75	1- -55	3,177	1,200 R	
-16dc	Vivian Glenn	Dr	235	16	I	Sd, Gr	Npl	T, G	I	76.5	3-31-60	3,170	1,600 R	
-17bc	do	Dr	261	16	I	Sd, Gr	Npl	T, G	I	100	9- -59	3,200	920	
-17db	do	Dr	356	16	I	Sd, Gr	Npl	T, G	I	60	1948	3,185		
-18bb	Homer Richard	Dr	333	16 & 12	I	Sd, Gr	Npl, No	T, G	I	94.8	3-31-60	3,223	1,750 R	
-18db	Andrew C. Anderson	Dr	325	16	I	Sd, Gr	Npl, No	T, G	I	83	1955	3,212	1,140	
-20ac	Vivian Glenn	Dr	214	16	I	Sd, Gr	Npl	T, G	I	—	—	3,184	1,410	
-20bb	Carl Levens	Dr	160	10	I	Sd, Gr	Npl	T, G	I	89.5	3-31-60	3,198	2,000 R	
-20bd	do	Dr	317	16	I	Sd, Gr	Npl, No	T, G	I	105	9- -60	3,188		
-21cc	E. Kendrick	Dr	393	16	I	Sd, Gr	Npl, No	T, G	I	—	—	—	1,400 R	
-22ac	M. E. Eyman	Dr	310	18	I	Sd, Gr	Npl	T, G	I	93.9	3-31-60	3,178	1,700	
-22db	Melvin S. Wilson	Dr	425	16	I	Sd, Gr	Npl, No	T, G	I	100.5	7-23-59	3,182	1,560	
-23aa	R. E. Foresman	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	80	4- -56	3,156	990 R	
-23dd	Marjorie C. Romersi	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	92.2	3-31-60	3,164	1,200 R	
-24cc1	J. L. Foresman	Dr	120	6	I	Sd, Gr	Npl	Cy, W	S	91.7	2-12-58	3,155		
-24cc2	do	Dr	370	13	I	Sd, Gr	Npl, No	T, G	I	83.8	2-12-58	3,155	850	
-26ac	B. L. Dubois	Dr	280	16	I	Sd, Gr	Npl	T, G	I	96.8	2-23-59	3,169	1,320	
-26cd	Melvin S. Wilson	Dr	280	16	I	Sd, Gr	Npl	T, G	I	103.5	3-31-60	3,184	1,200 R	
-27bd	Vivian Glenn	Dr	452	16	I	Sd, Gr	Npl, No	T, G	I	70	11- -48	3,189	1,100 R	
-27cc	J. G. Neufeldt	Dr	119	6	I	Sd, Gr	Npl	Cy, H	N	77.9	8- 7-39	3,190		
-28ac	Elmer Kendrick	Dr	316	16	I	Sd, Gr	Npl	T, G	I	—	—	3,081		
-28cc	do	Dr	420	16	I	Sd, Gr	Npl, No	T, G	I	70	1955	3,192	2,000 R	
-29bb	Vivian Glenn	Dr	66	5½	I	Sd, Gr	Npl	Cy, W	N	62.4	8- 3-39	3,192		
-29cb	do	Dr	350	16	I	Sd, Gr	Npl, No	T, G	I	87.9	1-28-58	3,204	900 R	
-29cc	do	Dr	350±	16	I	Sd, Gr	Npl, No	T, G	I	79	1948	3,210	900 R	
-29cd	do	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	97.5	11-16-60	3,201	1,100 R	
-30cc	Carl Levens	Dr	160	10	I	Sd, Gr	Npl	T, G	I	97.5	1-28-58	3,228	1,500 R	
-31ab	R. C. Eastin	Dr	415	16	I	Sd, Gr	Npl, No	T, G	I	95	5- -55	3,220	950	
-31bc	Stanley Julian	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	99.1	3-31-60	3,232	2,000 R	
-31cc	Herschel Howry	Dr	415	16	I	Sd, Gr	Npl, No	T, G	I	89	1955	3,231	2,000 R	
-33ac	E. Wetzler	Dr	430	16 & 12	I	Sd, Gr	Npl, No	T, G	I	95.0	3-31-60	3,201	1,710 R	
-35ab	Southwestern College	Dr	88	5½	I	Sd, Gr	Npl	N	N	70.6	7-25-39	3,165		
-35cc	Big Bow School Dist.	Dr	310?	6?	I	Sd, Gr	Npl	—	P	—	—	3,175		
-36ab	Fred Shore	Dr	408	16	I	Sd, Gr	Npl, No	T, G	I	75.0	3-31-60	3,145	1,800 R	
	T. 28 S., R. 40 W.													
28-40-2ab	Melvin Winger	Dr	250	16	I	Sd, Gr	Npl, No	T, G	I	72.9	4- 1-60	3,230	2,000 R	
-2cb	Grover C. Dotzour	Dr	320	16	I	Sd,Gr,SS?	Npl, No	T, G	I	—	—	3,240	2,380 R	
-3ab	Wilma N. Winger	Dr	305	16	I	Sd, Gr	Npl, No	T, G	I	78.3	4- 1-60	3,245	1,200 R	
-3cb	Clarence E. Winger	Dr	340	16	I	Sd, Gr	Npl, No	T, G	I	80	8- -56	3,261	600 R	
-3cc	do	Dr	310	16	I	Sd, Gr	Npl, No	T, G	I	80	8- -56	3,252	1,200 R	
-4cc	Eugene Floyd	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	104.7	4- 1-60	3,289	2,500 R	
-9ac	do	Dr	304	16	I	Sd, Gr	Npl, No	T, G	I	90	1954	3,272	1,000	
-12dd	Homer Richard	Dr	300	6	I	Sd, Gr	Npl, No	T, G	I	—	—	—		
-13ad	W. Richard	Dr	97	5½	I	Sd, Gr	Npl	Cy, W	N	77.8	7-28-39	3,223	50 R	
-15cb	C. H. Beckett	Dr	99	5½	I	Sd, Gr	Npl	Cy, H	N	91.0	8-10-39	3,259		

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-15cc	do	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	101.6	3-31-60	3,250	1,050 R	
-17cb	Bruce E. Josserand	Dr	335	16	I	Sd, Gr	Npl, No	T, G	I	151.3	3-31-60	3,321	1,000	
-19dc	Forest Walker	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,325	2,070	
-20bc	do	Dr	370	16	I	Sd, Gr	Npl, No	T, G	I	152.5	11-18-58	3,313		
-21cc	J. A. Ramsay	Dr	402	16	I	Sd, Gr	Npl, No	T, G	I	133.8	3-31-60	3,201	1,180	
-21dc1	do	Dr	131	6	I	Sd, Gr	Npl	Cy, H	D, S	115.8	9- 6-39	3,280		
-21dc2	do	Dr	300	6	I	Sd, Gr	Npl, No	Cy, E	D, S	125	7- -59	3,280		
-23ac	Felix R. Edmisson	Dr	295	16	I	Sd, Gr	Npl	T, G	I	106.4	3-31-60	3,254	1,070	
-25cc1	O. E. Josserand	Dr	150	12	I	Sd, Gr	Npl	T, E	I	85	1958	3,247	400 R	North well of two.
-25cc2	do	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	104.2	3-31-60	3,247	1,400 R	
-25dc	do	Dr	360	16 & 12	I	Sd, Gr	Npl, No	T, G	I	—	—	3,233	1,200 R	
-26bc	Ivan Josserand	Dr	435	16	I	Sd	Npl, No	T, G	I	—	—	3,265		
-27cc	W. R. Puyear	Dr	440	16	I	Sd	Npl, No	T, G	I	134.5	3-31-60	3,285	2,000 R	
-28cb	Max I. Ramsay	Dr	405	16	I	Sd, Gr	Npl, No	T, G	I	125	3- -52	3,294	1,750	
-29ab	Samuel Plummer Estate	Dr	377	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,305		
-29bc	John Lewis	Dr	396	16	I	Sd, Gr	Npl, No	T, G	I	149	5- -57	3,314	2,500 R	
-30cb	Forest Walker	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	159.0	3-29-60	3,322	2,180	
-30dd	R. H. Trostle	Dr	158	5½	I	Sd, Gr	Npl	Cy, W	D, S	144.1	8-19-39	3,317		
-31bb	P. E. Plummer	Dr	393	16	I	Sd, Gr	Npl, No	T, G	I	160	1- -59	3,333	2,000 R	
-32bd	D. S. Ray	Dr	413	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,306	2,400 R	
-32cc	R. M. Speck	Dr	393	16	I	Sd, Gr	Npl, No	T, G	I	154.0	3-30-60	3,317	2,000 R	
-33ab	do	Dr	146	6	I	Sd, Gr	Npl	Cy, W	D, S	131.0	8-16-39	3,296		
-33ba	Kansas-Colorado Utilities	Dr	204	8	I	Sd, Gr	Npl	T, E	Ind, D	—	—	3,290		Total use about 500 gpd.
-35bb*	B. Wolfe	Dr	102	5½	I	Sd, Gr	Npl	Cy, W	D, S	81	1939	3,265		
-35ca	Elmer Martin	Dr	435	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,265		
-36ba	Milo G. York	Dr	190	5½	I	Sd, Gr	Npl	Cy, W	N	121.0	1-28-59	3,252		
-36cb	do	Dr	430	16	I	Sd, Gr	Npl, No	T, G	I	118.2	3-31-60	3,260	2,000	
	T. 28 S., R. 41 W.													
28-41-1bb*	E. H. Tallman	Dr	117	6	I	Sd	Npl	Cy, W	S	81.0	8-30-39	3,304		
-3dd	H. Witt	Dr	177	6	I	Sd	Npl	Cy, H	N	143.7	9- 6-39	3,343		
-5bb	LeRoy Cockrum	Dr	535	16	I	Sd, Gr, SS	Npl, No, Kd, Kc, TRd	T, G	I	146.1	3-29-60	3,382	1,400 R	
-6ab	C. R. Peterson	Dr	346	16	I	Sd, Gr	Npl, No	T, G	I	150	5- -55	3,394	1,500	
-11bc	Mrs. Nellie Craig	Dr	260	16	I	Sd, Gr	Npl, No	T, G	I	140	7- -56	3,332	2,150 R	
-12bb	J. W. Dimmitt	Dr	200?	16	I	Sd, Gr	Npl?	T, G	I	138.2	2-29-60	3,314	750	
-13ab	I. Josserand	Dr	164	6	I	Sd, Gr	Npl	Cy, W	N	150.0	7-24-39	3,335		
-14aa	Mrs. Nellie Craig	Dr	302	16	I	Sd, Gr	Npl, No	T, G	I	155.4	7-23-60	3,331	1,420	
-14aad	U. S. G. S.	Dr	295	1½	I	Sd, Gr	No	N	O	160.3	7-23-60	3,339		
-16dd	M. E. Craig	Dr	207	6	I	Sd, Gr	Npl	Cy, W	S	189.3	9- 5-39	3,386		
-17dc	Mrs. Grace E. Bearman	Dr	165?	—	—	Sd, Gr	Npl	Cy, W	S	152.6	8-30-39	3,363		
-19dc*	M. R. McKinney	Dr	270	16	I	Sd, Gr	Npl, No	T, G	I	177.0	3-30-60	3,429	830	
-23ca*	Mrs. Grace E. Bearman	Dr	195	6	I	Sd, Gr	Npl	Cy, W	D, S	183.3	8-30-39	3,369		
-25ab	E. Ruth Archer	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	174.1	2- 3-59	3,144		
-26db	O. M. Cockreham	Dr	435	16	I	Sd, Gr	Npl, No	T, G	I	203.4	3-30-60	3,374	2,500 R	
-26dd	do	Dr	186	5½	I	Sd, Gr	Npl	Cy, W	D, S	182.3	8-18-39	3,350		
-29cc	M. E. McKinney	Dr	156	6	I	Sd, Gr	Npl	Cy, W	N	140.5	7-22-39	3,392		
-31bd	Marlin McKinney	Dr	298	16	I	Sd, Gr	Npl, No	T, G	I	141.5	3-30-60	3,411	1,300 R	
-36ab	City of Johnson	Dr	—	—	I	Sd, Gr	Npl, No	T, E	D?	170	1960	—		
-36db*	do	Dr	223	12 & 10	I	Sd, Gr	Npl	T, E	P	163.1	8-16-39	3,342	115 R	
-36dc	do	Dr	200	12	I	Sd, Gr	Npl	T, E	P	171	12-29-58	3,342	270 R	
-36dd	R. H. Trostle	Dr	240	8	I	Sd, Gr	Npl	T, E	I	160	6- -49	3,340	50 R	
	T. 28 S., R. 42 W.													
28-42-6db	E. M. Farrar	Dr	300	16	I	Sd	No	T, B	I	170	6- -53	3,527	450	
-8cc	Mrs. Ruby Hutchinson	Dr	300	16	I	Sd, SS	No, Kd	T, B	I	223.6	3-29-60	3,538	1,000 R	
-9cb*	W. S. Scrivner	Du, Dr	249	6	I	Sd	No	Cy, W	D, S	244.3	9- 7-39	3,542		
-13cc*	J. S. Wartman	Dr	213	6	I	Sd	Npl	Cy, W	D, S	186.4	9-11-39	3,449		
-14bc	Robert Scrivner	Dr	370	16	I	Sd, Gr	Npl, No	T, B	I	—	—	3,480	1,980 R	
-16cd1	Lester Stanton	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	220	3- -56	3,535	1,000 R	
-16cd2	do	Dr	320	16	I	Sd, Gr	Npl, No	T, G	I	225.7	3-29-60	3,529	1,200 R	
-16dc	do	Dr	310	16	I	Sd, Gr	Npl, No	T, G	I	223.6	7-30-59	3,535	1,000 R	
-20dd	do	Dr	460	12 & 8	I	Sd, Gr, SS	Npl, No, Kd?, Kc	T, E	D, S	205	8- -50	3,536	150 R	

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TABLE 17.—Records of wells in Stanton County, Kansas.—*Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in. (4)	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 28 S., R. 42 W.													
28-42-21ab	Fred Walkemeyer	Dr	260	16	I	Sd, Gr	Npl, No	T, G	I	216	—	—	800 R	
-22ba	do	Dr	290	16	I	Sd, Gr	Npl, No	T, G	I	231.6	3-30-60	3,522	1,500 R	
-23db	Emily A. Wartman	Dr	395	16	I	Sd, Gr	Npl, No	T, G	I	198	11- -55	3,475	1,600 R	
-24dc	Ennis Figgins	Dr	350	16	I	Sd, Gr	Npl, No	T, G	I	179.4	3-30-60	3,439	1,600 R	
-24dd	do	Dr	115	5½	I	Sd, Gr	Npl, No	Cy, W	D, S	94.1	8-26-39	3,434		
-25aa	do	Dr	375	16	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	175	1- -56	3,436	1,800 R	
-26aa	J. S. Wartman	Dr	281	16	I	Sd, Gr	Npl, No	T, G	I	166.8	4- 9-60	3,451	1,190 R	
-27ba	F. M. Walkemeyer	Dr	232	6	I	Sd, Gr	Npl, No	Cy, W	D, S	207	8-25-39	3,500		
-29cc	R. J. Shetlar	Dr	169	5½	I	Sd, Gr	Npl	N	N	137.7	7-29-39	3,545		
-32bb	Mabel Nichols	Dr	443	16	I	Sd, Gr, SS	Npl, No, Kc, TRd	T, B	I	212.2	3-30-60	3,540	550 R	Drawdown 175 after 24 hr.
-32dd*	R. P. Nichols	Dr	68	6	I	Sd, Gr	Npl	N	N	60.2	9- 7-39	3,489		
-35ba	Hal Hale	Dr	184	16	I	Sd, Gr	No	T, G	I	126.6	3-30-60	3,449	900 R	
-35bb	do	Dr	184	16	I	Sd, Gr	No	T, G	I	118.9	11- 3-58	3,470	800 R	
-35bc	do	Dr	137	6	I	Sd, Gr	No	Cy, W	D, S	119.0	8-25-39	3,449		
	T. 28 S., R. 43 W.													
28-43-12bb*	Faye Collingwood	Dr	173	—	—	Sd, Gr	No	Cy, W	D, S	169.6	9- 7-39	3,570		
-13ab	H. Cockreham	Dr	223	6	I	Sd, Gr	No	N	N	189.2	8-31-39	3,575		
-15cc	C. Williams	Dr	244	6	I	Sd, Gr, SS	No, Kd	Cy, W	D, S	193.1	8-31-39	3,638		
-27dc*	Fern Tressner	Dr	213	6	I	Sd, Gr	No	Cy, W	D	207.9	8-25-39	3,630		
	T. 29 S., R. 39 W.													
29-39-1bb	Carl Dahlquist	Dr	435	—	—	Sd, Gr	Npl, No	T, G	I	47	7- -46	3,141		
-2cd1	A. P. Kliewer	Dr	74	5½	I	Sd	Npl	Cy, H	N	57.0	8- 3-39	3,158		
-2cd2*	do	Dr	330	—	I	Sd, Gr	Npl	T, D	I	66.6	3-31-60	3,158		
-4dd	Marie E. Spires	Dr	84	6	I	Sd	Npl	Cy, W	D, S	80	8-23-39	3,192		
-5cd*	J. B. Spires	Dr	92	5½	I	Sd, Gr	Npl	Cy, W	D, S	75.8	8- 7-39	3,211		
-6cb	T. J. Julian	Dr	105	6	I	Sd, Gr	Npl	Cy, W	S	93.6	8-23-39	3,237		
-6cc	do	Dr	435	16	I	Sd, Gr	Npl, No	T, G	I	105.7	3-31-60	3,236	500 R	
-8ac	Harriet McBurney	Dr	466	16	I	Sd, Gr	Npl, No	T, G	I	98.8	3-31-60	3,225	1,950 R	
-9dd1	R. P. Dotzour	Dr	88	5½	I	Sd, Gr	Npl	Cy, W	S	81.2	8-23-39	3,199		
-9dd2	do	Dr	390	16	I	Sd, Gr	Npl, No	T, G	I	92.2	2- 4-59	3,201	1,350 R	
-10cc	do	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,198		
-11ac	A. P. Kliewer	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	90	4- -56	3,166		
-15ac	Roger C. Jones	Dr	428	16	I	Sd, Gr	Npl, No	T, G	I	84.9	3-31-60	3,188	2,000 R	
-15bb	James B. Malone	Dr	436	16	I	Sd, Gr	Npl, No	T, G	I	94.2	1-29-58	3,199	1,600 R	
-17bc	J. D. Burkham	Dr	460	16	I	Sd, Gr	Npl, No	T, G	I	108.5	3-31-60	3,238		
-18dd	Charles F. Gray	Dr	101	—	—	Sd, Gr	Npl	Cy, W	D	93.3	8- 7-39	3,231		
-20bc	Leon Kilgore	Dr	409	16	I	Sd, Gr	Npl, No	T, G	I	103.8	2-11-60	3,233		
-21db	Charles E. Garey	Dr	390	14 & 12	I	Sd, Gr	Npl, No	T, G	I	65.9	3-31-60	3,183	1,120	
-23cb	R. C. Jones	Dr	61	—	—	Sd, Gr	Npl, No	Cy, W	N	56.9	7-21-39	3,165		
-24dda	U. S. G. S.	Dr	300	1¼	I	Sd, Gr	Npl	N	N	70.4	7-12-60	3,154		
-24dd	V. E. Ruth	Dr	314	16	I	Sd, Gr	Npl	T, G	I	67.6	3-31-60	3,153	960	
-26bd	Melvin S. Wilson	Dr	410	16	I	Sd, Gr	Npl, No	T, G	I	80.0	3-31-60	3,184	1,150 R	
-30bb*	W. C. Jones	Dr	94	5½	I	Sd, Gr	Npl	Cy, W	D, S	86.7	8-18-39	3,228		

	T. 29 S., R. 40 W.													
29-40-1cc	Stanley A. Julian	Dr	120	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,251	2,500 R	
-3bc	Hester J. Clark	Dr	397	16	I	Sd, Gr	Npl	T, G	I	127	1957	3,281	2,300 R	
-3db	Lysle A. Davidson	Dr	407	--	I	Sd, Gr	Npl, No	T, G	I	115	1955	3,275		
-4cd*	H. Royce Fiss	Dr	411	16	I	Sd, Gr	Npl, No	T, G	I	148.1	3-30-60	3,299	2,000 R	
-6db	Glen V. Arnold	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	159.5	3-30-60	3,320	2,000 R	
-6dc	do	Dr	188	6	I	Sd, Gr	Npl	Cy, W	D	118.6	8-23-39	3,316		
-11bb	R. H. Trostle	Dr	405	18	I	Sd, Gr	Npl, No	T, G	I	130.1	3-31-60	3,274	2,700 R	
-11cb	do	Dr	430	18	I	Sd, Gr	Npl, No	T, G	I	115	2- -52	3,266	2,340	
-12bb	Stanley A. Julian	Dr	421	16	I	Sd, Gr	Npl, No	T, G	I	105	1955	3,255	2,500 R	
-15db	E. M. Farrar	Dr	300	16	I	Sd, Gr	Npl	T, G	I	70	4- -56	3,271	1,500 R	Drawdown 30.
-16ba	Elmer Martin	Dr	385	16	I	Sd, Gr	Npl, No	T, B	I	140.2	3-30-60	3,292	1,000 R	
-19dc	O. F. Ramsey	Dr	158	—	—	Sd, Gr	Npl	Cy, W	D, S	153.1	8-23-39	3,311		
-22bb	C. O. Dye	Dr	132	5½	I	Sd, Gr	Npl	Cy, W	N	122.9	8-18-39	3,278		
-25dc	Earl E. Whipple	Dr	380	16	I	Sd, Gr	Npl, No	T, G	I	100.2	3-31-60	3,234	1,800 R	
-26ac	Harold Jones	Dr	112	6	I	Sd	Npl	Cy, W	D, S	105.6	9-12-39	3,242		
-26bb	do	Dr	400	16	I	Sd, Gr	Npl, No	T, B	I	117.8	3-31-60	3,260	1,300 R	
-31db	F. M. Simpson	Dr	348	16	I	Sd, Gr	Npl, No	T, G	I	172.3	3-31-60	3,333	1,600 R	
-33ac	Harry Teeter	Dr	326	16	I	Sd, Gr	Npl, No	T, G	I	131.0	3-31-60	3,282	1,500 R	
-33cc	C. E. Morris	Dr	193	6	I	Sd, Gr	Npl	Cy, W	D	153.6	8- 9-39	3,308		
-34bb	Harry Teeter	Dr	360	16	I	Sd, Gr	Npl, No	T, G	I	120	7- -55	3,270	1,500 R	
-35dd	Warren W. Plummer	Dr	460	16	I	Sd, Gr	Npl, No	T, G	I	125.1	3-31-60	3,261	1,980 R	
	T. 29 S., R. 41 W.													
29-41-3da	Donald Jones	Dr	400	16	I	Sd	Npl, No	T, G	I	207.6	3-30-60	3,385		
-9cc	C. O. Dye	Dr	238	5½	I	Sd, Gr	Npl	Cy, W	D	210.9	8-23-39	3,418		
-11ac	Glen Arnold	Dr	234	8	I	Sd	Npl	N	N	179.8	2-25-60	3,349		
-11bd	do	Dr	308	16	I	Sd	Npl, No	T, G	I	187.9	3-30-60	3,363	400 R	
-11dd*	do	Dr	201	6	I	Sd, Gr	Npl	Cy, W	D, S	184.2	8-24-39	3,356		
-13ac	C. D. Kendrick	Dr	423	16	I	Sd, Gr	Npl, No	T, G	I	178.9	3-30-60	3,344	1,600 R	
-20dd	H. L. Cullens	Dr	188	6	I	Sd	Npl	Cy, W	N	173.8	8-28-39	3,384		
-23db	Harold D. Cullens	Dr	310	16	I	Sd, Gr	Npl, No	T, G	I	204.4	3-31-60	3,372	900 R	
-24ac	R. J. Shetlar	Dr	425	16	I	Sd, Gr, SS	Npl, No, TRd	T, G	I	—	—	3,348	1,500 R	
-25bb	H. R. Fiss	Dr	172	6	I	Sd, Gr	Npl	Cy, W	D	152.5	8-24-39	3,323		
-31cb	Clifford Harmon	Dr	307	16	I	SS	Kd	T, B	I	226.6	3-30-60	3,477	800 R	
-32ab	Roy Harmon	Dr	400	16	I	Sd, Gr, SS	No, Kd, Kc?	T, N	I	215.6	11- 3-59	3,446		
-35da*	H. L. Cullens	Dr	209	5½	I	Sd, Gr	No	Cy, W	D	201.9	8-24-39	3,375		
	T. 29 S., R. 42 W.													
29-42-2bc	J. S. Wartman	Dr	85	6	I	Sd	Npl, No	Cy, W	D, S	78	9- 4-39	3,445		
-4ac	H. L. Tucker	Dr	37	6	I	Sd	Npl	Cy, W	D, S	28	9- 4-39	3,459		
-8cd	C. H. and Harry Bilbery	Dr	367	16	I	SS	Kd, Kc	T, G	I	184.3	3-30-60	3,517	900 R	
-10da	H. H. Hoopingarner	Dr	182	6	I	SS	Kd	Cy, W	N	152.3	8-23-39	3,513		
-11dc*	L. W. Bailey	Dr	435	16	I	SS	Kd, Kc, TRd	T, G	I	210.6	3-30-60	3,486	1,000 R	
-14cb*	City of Mantor	Dr	278	12	I	SS	Kd	T, E	P	240	9- 1-39	3,488	100 R	
-14cc	A. T. & S. F. R. R.	Dr	475	12.5&8	I	SS	Kd, Kc, TRd	Cy, E	Ind	211	9-14-39	3,493		
-18da	C. H. Bilbery	Dr	140	6	I	Sd, Gr, SS	No, Kd	N	N	97.2	8-25-39	3,555		
-24cc*	Lloyd Batterton	Dr	515	16 & 12	I	SS	Kd, Kc, TRd	T, B	I	222.1	3-30-60	3,484	1,000 R	
-27cc	J. L. Patterson	Dr	252	—	—	SS	Kd	Cy, W	D	241.5	9- 9-39	3,512		
-27dd	M. C. Graber	Dr	256	6	I	SS	Kd	Cy, W	D, S	250.0	8- 9-39	3,504		
-30da	Rena M. Burchfield	Dr	227	6	I	SS	Kd	Cy, W	D	224.4	7-20-39	3,553		
-34ca*	E. S. DeSelms	Dr	215	6	I	SS	Kd	Cy, W	D, S	203	9- 9-39	3,493		
	T. 29 S., R. 43 W.													
29-43-3db	W. O. Bearce	Dr	434	16	I	SS	Kd, Kc, TRd	T, B	I	165.6	3-30-60	3,609	1,000 R	
-9db	Cora Conrad	Du	21	36	Stone	Sd, Gr	Npl	Cy, W	D, S	19.8	8-26-39	3,588		
-10ad	W. O. Bearce	Dr	99	6	I	Sd?, SS	No?, Kd	Cy, W	D, S	83.2	8-25-39	3,597		
-14ac	J. B. Cockrum	Dr	19	6	I	Sd, Gr	Npl	N	N	11.4	8-26-39	3,514		
-14cc*	do	Dr	108	5½	GI	SS	Kd	Cy, W	D, S	28.2	8-25-39	3,533		
-15ba	W. O. Bearce	Dr	73	—	I	SS	Kd	Cy, W	D, S	60.9	8-26-39	3,577		
-15cc	Stanton Co.	Dr	63	6	GI	SS	Kd	N	N	40.3	8-25-39	3,572		
-21db	E. L. Delaney	Dr	16	—	—	Sd, Gr	Npl	N	N	12.5	8-29-39	3,556		

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TABLE 17.—Records of wells in Stanton County, Kansas.—*Concluded*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed: Character of material (5)	Principal water-bearing bed: Geologic source (6)	Method of lift (7, 8)	Use of water (9)	Depth to water level below land surface, feet (10)	Date of measurement	Height of land surface above mean sea level, feet	Yield, gpm (11)	Remarks (Drawdown in feet)
	T. 29 S., R. 42 W.													
29-42-29ab	L. W. Bailey	Dr	300	16	I	SS	Kd, Kc	N	N	64.7	3-30-60	3,630		
-33cc*	Virgil Stewart and Son	Dr	160	6	I	SS	Kd	Cy, W	D	125	8-28-39	3,656		
-33cd	do	Dr	300	11	I	SS	Kd, Kc	T, G	I	99.8	3-30-60	3,654	300 R	
	T. 30 S., R. 39 W.													
30-39-2ab	Milton Julian	Dr	444	16	I	Sd, Gr	Npl, No	T, G	I	73.9	4- 1-60	3,184	2,000 R	
-2bb	do	Dr	440	16	I	Sd, Gr	Npl, No	T, G	I	—	—	3,187	1,500 R	
-2cb	Fred Shore	Dr	394	16	I	Sd, Gr	Npl, No	T, G	I	90	8- -56	3,185	2,000 R	
-4cd	do	Dr	91	5½	I	Sd	Npl	N	N	80.3	8- 4-39	3,202		
-4dc	R. J. Shetlar	Dr	484	16	I	Sd, Gr	Npl, No	T, G	I	87.6	4- 1-60	3,203		
-6ab	O. R. Swindler	Dr	109	5½	I	Sd, Gr	Npl	Cy, W	N	95.5	8- 2-39	3,229		
-12cc	Albert A. Stewart	Dr	180	10	I	Sd, Gr	Npl	T, G	I	65.2	2-11-60	3,161	340	
-13cb	Earl C. Warnock	Dr	375	16	I	Sd, Gr	Npl, No	T, G	I	67.6	2-11-60	3,162	2,790	Drawdown 17.
-14ba	W. and Y. Nicholas	Dr	78	6	I	Sd, Gr	Npl	Cy, W	D, S	63.9	7-20-39	3,172		
-18aa	E. C. Highfill	Dr	103	6	I	Sd, Gr	Npl	Cy, N	N	91.5	8- 4-39	3,219		
-18bb	Walter J. Schwieterman	Dr	400	16	I	Sd, Gr, SS	Npl, No, Trd	T, G	I	108.8	4- 1-60	3,237	2,000 R	
-20bc*	Maud Collingwood	Dr	114	6	Tile	Sd, Gr	Npl	Cy, W	D, S	78.1	8-18-39	3,208		
-20da	Mrs. G. A. Delay	Dr	360	16	I	Sd, SS?	Npl, No	T, G	I	93.4	4- 1-60	3,207	1,800 R	
-22ac	Ralph W. Allen	Dr	301	16	I	Sd, Gr	Npl, No	T, G	I	75	10- -52	3,179	1,800	
-22cb	R. W. Allen	Dr	93	6	I	Sd, Gr	Npl	Cy, W	D	72.9	8- 4-39	3,184		
-23bb*	Florence Shore	Dr	405	16	I	Sd, Gr	Npl, No	T, G	I	77.4	4- 1-60	3,176	2,000 R	Drawdown 22 after 4 hr.
-23cb	Charles W. Lucas	Dr	400	16	I	Sd, Gr	Npl, No	T, G	I	81.9	1-28-58	3,176	2,000 R	
-24bc	C. E. Warnock	Dr	92	6	I	Sd, Gr	Npl	Cy, W	S	56.6	8- 4-39	3,156		
-25cc*	C. R. Lucas	Dr	81	6	I	Sd	Npl	Cy, W	D	72.1	8- 4-39	3,170		
-32da	Ed Logue	Dr	250	16	I	Sd	Npl, No	T, G	I	107.2	4- 1-60	3,226	1,500	Drawdown 40 after 8 hr.
-32dd	Merle Logue	Dr	111	6	I	Sd	Npl	Cy, W	N	101.1	8- 2-39	3,227		
-36bd	Carl Lucas	Dr	300	16	I	Sd, Gr	Npl	T, G	I	92.8	4- 1-60	3,180	1,600 R	
	T. 30 S., R. 40 W.													
30-40-2cb	James B. Malone	Dr	286	16	I	Sd, Gr	Npl, No	T, G	I	122.9	11-17-60	3,278		
-3dd	M. Staker	Dr	146	6	I	Sd, Gr	Npl	Cy, W	D	137.7	7-28-39	3,283		
-5ca	Martin Dunklau	Dr	270	16	I	Sd, Gr	Npl	T, G	I	167.6	4- 4-60	3,324	2,000 R	
-8ab	Mrs. Teresa McDowell	Dr	233	16	I	Sd, Gr	Npl, No	T, G	I	157	1- -57	3,314	1,300 R	
-9dc	O. E. Newsome	Dr	240	16	I	Sd, Gr	Npl, No	T, G	I	145.9	4- 4-60	3,294	1,000 R	
-14dd	A. L. Powell	Dr	115	6	I	Sd	Npl	N	N	106.2	8-24-39	3,244		
-17bb	R. H. Moore	Dr	166	5½	I	Sd	Npl	Cy, W	N	152.3	8-24-39	3,314		
-22cb	John Shore	Dr	300	16	I	Sd, Gr, SS	Npl, No, Kc?	T, G	I	148.0	4- 1-60	3,292	1,200 R	
-24cc1	do	Dr	189	16	I	Sd, Gr	Npl, No	T, G	I	120	10- -48	3,247	465	Drawdown 65.
-24cc2	do	Dr	190	10	I	Sd, Gr	Npl, No	T, G	I	114.7	2-12-60	3,247	20 R	
-24cd*	do	Dr	295	16	I	Sd, Gr, SS	Npl, No, Kd	T, G	I	105.1	4- 1-60	3,236	1,210 R	
-25dc	do	Dr	190	16	I	Sd, Gr	Npl, No	T, G	I	120	10- -48	3,240	950 R	
-27ac	Walter Herrick	Dr	235	16	I	Sd, Gr, SS	No, Kd	T, G	I	135	11- -55	3,260	1,200 R	
-33cc	do	Dr	245	16	I	SS	Kd	T, G	I	155.5	4- 1-60	3,309	100 R	
-34ac	do	Dr	235	16	I	SS	Kd	T, G	I	135	1955	—	1,200 R	
-35bb	do	Dr	253	16	I	SS	Kd	T, G	I	132.3	4- 1-60	3,270	1,100	
-36ab	John Shore	Dr	125	5½	I	Sd, Gr	Npl, No	Cy, W	D	108.4	8- 4-39	3,244		
-36ac	do	Dr	299	16	I	Sd, Gr, SS	No, Kd	T, G	I	124.5	4- 1-60	3,258	1,500 R	

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	T. 30 S., R. 41 W.													
30-41-8dc	A. J. Doughty	Dr	195	5½	I	Sd, Gr	No	Cy, W	D	181.5	7-28-39	3,406		
-11da	W. H. Smoot	Dr	217	6	I	Sd, Gr	No	Cy, W	D, S	184.0	2-4-59	3,364		
-13cc*	J. N. Beauchamp	Dr	235	16	I	Sd, Gr, SS	No, Kd	T, G	I	167.6	4-4-60	3,346	900 R	
-13da	do	Dr	228	16	I	Sd, Gr, SS	No, Kd	T, G	I	158	1948		250 R	
-13dc	do	Dr	210	8	I	Sd, Gr	No	T, G	D,S,I	155	11- -59	—	250 R	
-14dd	U. S. G. S.	Dr	225	1¼	I	Sd, Gr, SS	No, Kd	N	Test	171.0	5-25-60	3,347		
-18bc	S. Eliz. Davis	Dr	142	6	I	Sd, Gr	No	N	N	139.0	8-28-39	3,452		
-21ad	E. Hilty	Dr	206	6	I	Sd, Gr	No	Cy, W	D, S	200.3	9-7-39	3,409		
-23aa	U. S. G. S.	Dr	200	1¼	I	Sd, Gr	No	N	Test	166.9	5-25-60	3,342		
-23bc	J. N. Beauchamp	Dr	187	6	I	Sd, Gr	No	Cy, W	D, S	170.8	8-3-39	3,372		
-30bc	D. H. Reed	Dr	207	6	I	Sd, Gr	No, Kd	Cy, W	D, S	188.1	9-7-39	3,447		
-32ba	Carl Dewell	Dr	235	16	I	SS	Kd	T, B	I	191.9	4-4-60	3,433	300 R	
-33db*	L. Tucker	Dr	189	6	GI	SS	Kd	Cy, W	D, S	181.4	8-30-39	3,406		
-35da	J. J. Johns	Dr	196	6	GI	SS	Kd	Cy, W	D, S	194	9-11-39	3,378		
	T. 30 S., R. 42 W.													
30-42-4cc*	Guy Rorick	Dr	178	6	I	SS	Kd	Cy, W	D, S	165.3	9-7-39	3,511		
-9dd	W. D. Rorick	Dr	195	6	I	SS	Kd	Cy, W	D	181.0	8-28-39	3,514		
-11db*	Milt C. Graber	Dr	207	6	I	SS	Kd	Cy, W	D	193.3	9-7-39	3,481		
-12ac	Clifford Harmon	Dr	410	16	I	SS	Kd, Kc, TRd?	T, G	I	183.7	4-4-60	3,456	900 R	Drawdown 41 after 80 hr.
-16bd*	Harvey Bitner	Dr	220	16	I	SS	Kd	T, B	I	171.4	4-4-60	3,524	750 R	Drawdown 70 after 6 hr.
-29aa1*	Madeen Heyen	Dr	176	6	I	SS	Kd	Cy, W, H	D	154.9	9-11-39	3,542		Replaced 1959.
-29aa2	do	Dr	240	6	I	SS	Kd	—	D, S	180	11- -59	—		
-29db	do	Dr	360	12	I	SS	Kd, Kc, TRd	N	N	174.8	4-4-60	3,565		
-33dc*	Lester Sparks	Dr	150	6	I	SS	Kd	Cy, W	D, S	117.9	8-30-39	3,532		
	T. 30 S., R. 43 W.													
30-43-2cd	V. E. Wendf	Dr	162	6	I	SS	Kd	Cy, W	D, S	152.6	7-19-39	3,644		
-13db	W. D. Rorick	Dr	85	5½	I	SS	Kd?	Cy, W	D	66.8	8-28-39	3,542		
-20da	C. F. Royce	Dr	72	6	I	Sd, Gr	N	Cy, W	D	64.4	8-29-39	3,668		
-22aa	L. W. Bailey	Dr	62	6	I	Sd, Gr	N	Cy, W	S	51.1	8-28-39	3,596		
-24dd	M. H. Hume	Dr	96	6	I	Sd, Gr	N	N	N	76.9	9-11-39	3,579		
-25cc	do	Dr	86	14	I	Sd, Gr	N	N	N	45	3- -56	3,598		
-26dd	do	Dr	98	16	I	Sd, Gr	N	T, G	I	40	1954	—	1,350 R	
-27cc	Fred Bryan	Dr	105	16	I	Sd, Gr	N	T, B	I	—	—	3,622	2,800 R	
-27dc	do	Dr	55	5½	I	Sd, Gr	N	Cy, W	D	—	—	3,615		Dry at 52 feet.
-28ab	Calvin O. Davis	Dr	100	16	I	Sd, Gr	N	T, G	I	46.8	4-4-60	3,629	600 R	
-28dd*	Perry E. Israel	Dr	131	16	I	Sd, Gr	N	T, G	I	—	—	—	2,500 R	
-34bb	W. T. Lawman	Dr	103	16	I	Sd, Gr	N	T, B	I	52.8	11-16-60	3,621	1,490	
-35bb	M. H. Hume	Dr	112	16	I	Sd, Gr	N	T, B	I	35	3- -56	3,604	2,700 R	
-36bb	do	Dr	500	14	I	Sd, Gr, SS	N, Kc, TRd	T, E	S, I	57.6	4-4-60	3,595	400 R	

1. An asterisk (*) after a well number indicates that analysis of water is given in Table 11.
2. A, auger hall; Du, dug well; Dr, drilled well.
3. Depths below land surface are given in feet.
4. I, iron; GI, galvanized iron; T. tile; S, stone.
5. Sd, sand; Gr, gravel, SS, sandstone.
6. N, Neogene; Npl, Pleistocene deposits; No, Ogallala Formation; Kd, Dakota Formation; Kc, Cheyenne Sandstone; TRd, Dockum Group.
7. Type of pump: Cf, centrifugal; Cy, cylinder; N, none; T, turbine.
8. Type of power: B, butane; D, diesel; E, electric; G, gas engine; H, hand operated; W, windmill.
9. I, irrigation; N, none; O, observation; P, public; S, stock; D, domestic; Ind, industry.
10. Measured depths to water level are given in feet, tenths; reported depths to water level are given in feet.
11. 1,800 R, reported yield; 2,180, measured yield.

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Table 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
				GRANT COUNTY								
27–35–												
3ca	Leman Smith and Son	7–18–41	121.8	—	—	—	—	—	—	—	—	—
3cd	C. L. Ladner	—	—	—	—	—	—	10–15–59	120.9	—	—	dry
5ad	C. L. Dew	7–25–41	142.8	—	—	—	—	10–15–59	144.1	3–25–60	144.4	dry
6cc	Jasper Smith	10–28–41	r120	—	—	—	—	10– 8–59	134.0	3–28–60	134.4	
10cc	Henry L. Trafton	—	—	—	—	—	—	10–15–59	149.4	3–25–60	149.3	150.82
13cc	A. E. Alexander	—	—	—	—	—	—	10–15–59	r148	—	—	—
17ad	Herman E. Meyer	—	—	9–30–58	179.6	—	—	10–15–59	180.1	2–25–60	180.1	180.52
				11–30–58	179.3							
				12– 9–58	179.4							
17cc	Cecil W. Sturgeon	7–24–41	175.2	—	—	—	—	—	—	—	—	—
22db	S. H. Kells	7–28–41	172.7	—	—	—	—	—	—	—	—	—
24aa	W. E. Moody	7–18–41	144.8	—	—	—	—	—	—	—	—	—
24ac	W. E. Moody	—	—	2–13–58	171.0	4–15–59	171.6	10–15–59	173.4	3–25–60	172.4	174.98
27ca	J. E. and Della M. Rixon	—	—	—	—	—	—	10–15–59	190.7	3–25–60	189.5	193.95
29ba	Vivian N. Roberts	—	—	—	—	—	—	10–15–59	194.2	3–25–60	194.0	196.80
33bb	Charles E. Ladner	—	—	—	—	—	—	10–15–59	190.7	3–25–60	190.0	185.81
27–36–												
2ad	R. H. Tate Estate	7–24–41	126.7	—	—	—	—	—	—	—	—	—
3cd	Mary S. Lewis	7–17–41	161.2	—	—	—	—	10– 8–59	163.7	1–28–60	163.9	163.27
4aa	Lenora V. Tate	7–24–41	155.6	—	—	—	—	—	—	—	—	—
7aa	J. H. Lindsay	—	—	—	—	—	—	10– 8–59	141.6	1–28–60	141.5	141.85
										3–28–60	141.8	
8bb	R. H. Tate Estate	7–14–41	126.6	—	—	—	—	—	—	—	—	—
13ad	Clifford Fort	—	—	2–13–58	181.1	4–15–59	181.8	10–19–59	182.7	3–28–60	182.5	185.65
14cc	Bessie M. Corley	—	—	—	—	—	—	8– 4–59	197.0	3–28–60	192.2	197.66
								10–19–59	193.5			
15cc	C. E. Hoffman	—	—	2–11–58	189.2	—	—	10–19–59	189.2	1–28–60	188.6	193.71
										3–28–60	188.2	
17dd	R. A. Phelps	7–23–41	153.9	—	—	—	—	—	—	—	—	—
18ab	E. B. Petro	7–22–41	121.1	—	—	—	—	—	—	—	—	—
18dc	William H. Meyer	—	—	—	—	—	—	10– 8–59	111.5	2– 5–60	107.8	111.77
										3–28–60	107.0	
23dc	Martin Long	—	—	—	—	—	—	10–19–59	202.2	3–28–60	200.9	—
25aa	Blanche Smith	—	—	—	—	1–27–59	221.1	10–19–59	222.7	3–28–60	221.9	228.59
25cc	Blanche Smith	—	—	—	—	1–27–59	230.8	10–19–59	233.1	3–31–60	231.5	236.04
32bb	Carl Meyer	—	—	—	—	—	—	10– –59	r120	—	—	—
32dd	Earnest Kephart	—	—	—	—	—	—	10– –59	r183	—	—	—
34ad	R. J. Lighty	7–17–41	182.5	—	—	—	—	—	—	—	—	—
27–37–												
1cc	Mary E. Shapland	10–27–41	r110	2–11–58	104.6	—	—	—	—	—	—	—
3dd	Edward F. Judge	—	—	—	—	—	—	10–26–59	128.5	1–27–60	127.2	133.83
										3–28–60	125.9	
11ab	Robert A. Moore	—	—	—	—	1–30–59	122.2	10–26–59	119.3	1–27–60	118.0	123.58
										3–28–60	116.6	
14ba	Erdene Corley	—	—	—	—	—	—	10–26–59	112.2	1–27–60	109.2	119.45
										3–28–60	107.2	
16bb	Ruth M. Gall	—	—	—	—	1–30–59	58.1	10–26–59	62.8	1–26–60	59.3	73.13
										3–28–60	57.6	
18cb	Hattie E. Anderson	7–21–41	48.0	—	—	—	—	—	—	—	—	—
19db	Mrs. Ida Smith	—	—	—	—	1–30–59	52.4	—	—	—	—	—
20cd	Walter Ford	—	—	2–11–58	72.4	—	—	10–26–59	62.3	3–30–60	52.8	77.04
22bb	Russell Bechtelheimer	—	—	—	—	—	—	10– –59	r 68	—	—	82.47
25bc	Elvin H. Metherd	7–18–41	78.5	—	—	—	—	—	—	—	—	—

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25cb	Elvin H. Metherd			2-11-58	91.6	1-27-59	89.3	10-26-59	92.7	1-27-60	89.7	102.44
										3-30-60	87.9	
26bc	J. H. Siebert			2-20-57	r 71	1-30-59	73.0	10-26-59	79.0	1-27-60	73.3	95.02
										3-30-60	70.6	
28cb	A. G. Redinger			9-17-58	107.6			10-26-59	66.1	1-27-60	61.4	80.50
										3-30-60	57.8	
29cb	Frank and Jake Wiebe			2-12-58	80.2					4-22-60	59.1	77.88
30bd	Earl B. Williams							10-26-59	71.3	1-26-60	67.5	84.10
										3-30-60	64.2	
30dd	F. C. Williams	5-14-41	44.4									
33cc	Ray Lighty			2-11-58	73.3	1-27-59	63.9	10-26-59	68.6	1-27-60	64.0	81.60
34da	Keith Puckett			2-11-58	95.1			10-26-59	95.8	1-27-60	90.9	108.93
										3-30-60	88.1	
35dc	Elvin H. Metherd					1-27-59	104.6					117.23
36cc	Oscar F. Barnes							10-26-59	94.3	1-27-60	91.2	108.00
										3-30-60	89.5	
27-38-												
1ad	O. and F. Waechter	7-23-41	41.7									
1da	L. C. Waechter			1-16-58	58.6			10-3-59	59.6	2-8-60	57.4	71.30
										3-28-60	56.7	
6cb	Ray Shaffer			1-16-58	148.4	5-12-59	173.6	10-27-59	136.4	3-28-60	130.2	164.80
12ad	L. C. Weachter			1-16-58	65.9			10-26-59	45.5	2-8-60	43.9	61.72
										3-28-60	33.6	
12dd	Allen S. Anderson			1-15-58	70.9							
				9-18-58	72.6							
13ab	Allen S. Anderson			1-15-58	69.7	1-30-59	69.7	10-26-59	74.1	1-26-60	71.9	77.13
				9-18-58	77.7					3-28-60	70.6	
13cc	J. J. Anderson			1-15-58	62.1			10-26-59	64.7	1-26-60	62.0	79.49
				9-18-58	76.2					3-28-60	60.1	
14cd	Rider Bros.			1-15-58	59.7							72.68
15dad	U. S. G. S.							10-27-59	65.2			
15dd	Rider Bros.			1-15-58	59.2					1-25-60	64.3	72.18
17dd	Mrs. Robert Waldie	7-16-41	33.9									
19bc	L. E. Annis			10-15-58	72.2	1-30-59	66.7					89.80
19cd	L. E. Annis							10-27-59	79.0	1-25-60	77.0	101.00
										3-30-60	75.0	
19db	L. E. Annis					5-4-59	74.5					
20ad	Mrs. Robert Waldie	10-20-41	r 40	2-12-58	59.6							
				9-18-58	60.8							
20cb	Harry Caldwell			1-15-58	71.6							93.11
				9-18-58	75.4							
20bd	Mrs. Robert Waldie			1-15-58	70.5							
21cb	H. E. Zimmet			1-15-58	66.0	1-30-59	66.2	10-27-59	70.5	1-25-60	70.4	89.37
										3-28-60	68.2	
22cb	L. F. Hohner			1-15-58	65.4							87.55
22cc	L. F. Hohner			1-15-58	67.2	2-16-59	63.2					
				9-18-58	74.5							
23ca	L. F. Hohner			1-15-58	66.9							
23cb2	L. F. Hohner			1-15-58	69.3							
24cc	I. and R. Flummerfelt and F. and E. Kistner			1-15-58	67.5							
25bb	Mrs. Dorothy L. Gall			1-16-58	69.1			10-26-59	67.9	1-26-60	65.2	81.70
										3-28-60	62.5	
26aa	Charles Shorter	5-14-41	46.0									
26bb	Charles Shorter			1-16-58	74.4							
27bb	Mrs. T. H. Clowe			9-18-58	72.8	2-16-59	61.2	10-27-59	67.0	1-25-60	66.3	
28cb1	Cecil Puckett					2-16-59	75.9	10-27-59	81.6	1-25-60	79.9	99.50
28cb2	Cecil Puckett			2-12-58	75.7							
29ac	Dr. G. M. Coffey			1-17-58	83.5	3-6-59	81.0					94.80
30ca	Ray Stevenson			1-17-58	98.0							
31ba	Joe Jungferman			1-17-58	87.3	3-3-59	83.5	10-27-59	88.5	1-25-60	83.2	99.48
										3-30-60	80.4	

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TABLE 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).—*Continued*

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
27–38–												
31dd2	Joe Jungferman	—	—	1-17-58	114.1	—	—	—	—	—	—	—
32bb	Dr. G. M. Coffey	—	—	1-17-58	92.4	—	—	—	—	—	—	—
32cc2	J. L. Murphy	—	—	2-12-58	90.6	—	—	—	—	—	—	—
33cb	W. L. Puckett	8-29-40 11-25-40	r 40 43.8	—	—	3- 3-59 3- 6-59	85.8 89.1	10-27-59	76.9	1-25-60 3-30-60	75.2 71.6	83.00
34aa	O. P. Williams	7-21-41	47.4	—	—	—	—	—	—	—	—	—
28–35–												
1cb	L. O. Stanley	7-19-41	215.7	—	—	—	—	10-15-59	217.6	3-25-60	217.7	218.82
6ba1	F. W. Stever	7-24-41	231.1	—	—	—	—	—	—	—	—	—
6ba2	F. W. Stever	—	—	—	—	2- -59	r240	10-19-59	248.3	3-31-60	246.5	249.77
8bb	George L. Meeker	—	—	—	—	1-27-59	248.0	10-19-59	250.1	3-24-60	247.6	258.70
9aa	Max Hand	—	—	—	—	—	—	10-15-59	246.2	3-25-60	241.8	246.52
10bb	C. L. Dew	—	—	2-13-58	249.6	—	—	—	—	—	—	—
15cb	C. R. Davatz	—	—	1-18-58	223.0	—	—	10-15-59	229.5	3-25-60	225.6	233.12
16cc	Fern Ulsh	7-25-41	215.1	—	—	—	—	—	—	—	—	—
20ab	C. N. King	—	—	—	—	—	—	10-19-59	243.9	3-25-60	242.1	249.20
21bb	Henry F. Koehn	—	—	5- -56	r220	—	—	10- 5-59	r234	—	—	—
23bd	C. R. DaVatz	—	—	—	—	—	—	10-15-59	225.7	3-25-60	224.6	234.01
24cd	A. C. Kaufman	7-19-41	211.8	—	—	—	—	—	—	—	—	—
27bb	R. G. Ulsh	—	—	—	—	—	—	10-15-59	216.0	3-25-60	213.3	219.22
27bc	R. G. Ulsh	—	—	—	—	—	—	8-17-59	216.3			
29bc	Leslie D. King	—	—	—	—	—	—	10-19-59	237.6	—	—	238.11
30bb	R. G. Ulsh	—	—	—	—	—	—	10-19-59	228.4	3-31-60	227.0	—
31cd1	Magnolia Petroleum Corp.	—	—	1-17-58 5-28-58	237.5 221.9	2- 4-59	228.8	11-13-59	224.4	2-25-60	225.5	—
31cd2	Magnolia Petroleum Corp.	—	—	1-17-58	240.2	—	—	—	—	—	—	—
35dc	J. B. Ungles	—	—	9-16-58 10-22-58 11-21-58	220.6 224.3 220.6	1-26-59	219.9	10-15-59	221.5	3-25-60	221.0	227.20
36ab	M. E. Britten	—	—	—	—	—	—	10-15-59	223.2	3-25-60	222.8	231.25
28–36–												
2ba	Hollis Bullock	—	—	2-13-58	233.0	—	—	10-19-59	234.5	3-30-60	233.2	240.80
2cd	R. R. Hampton	—	—	1-17-58	225.9	2-22-59	226.2	—	—	—	—	—
7cb	F. M. Barnes	7-14-41	41.1	—	—	—	—	—	—	—	—	—
11ba	A. G. Dyck	—	—	—	—	—	—	10-19-59	222.4	3-30-60	220.2	228.14
13ac	C. R. DaVatz	—	—	1-18-58	226.4	—	—	10-19-59	229.0	3-31-60	227.6	233.92
15aa	Connie Hampton	7-17-41	197.4	—	—	—	—	—	—	—	—	—
17bbb	U. S. G. S.	—	—	—	—	—	—	10-15-59	164.4	1-28-60 3-30-60	155.6 152.5	—
36cd	Ethel Hoffman	5-27-41	82.1	—	—	—	—	—	—	—	—	—
28–37–												
2bb	R. R. Bechtelheimer	—	—	—	—	—	—	10-26-59	108.2	—	—	—
2bc	R. R. Bechtelheimer	—	—	—	—	—	—	9-21-59 9-29-59 10-26-59	110.7 117.2 103.2	1-27-60 3-30-60	98.9 96.4	115.55
2cc	R. R. Bechtelheimer	7-18-41	80.1	—	—	—	—	—	—	—	—	—
5dc	R. C. Hammond	11-29-40	52.0	—	—	—	—	—	—	—	—	—
6bb	R. R. Bechtelheimer	—	—	2-12-58	63.9	1-27-59	55.0	10-26-60	59.4	1-26-60 3-30-60	56.2 53.3	71.56
7cb	M. L. Reeves	—	—	1-17-58	55.4	2- 5-59	54.5	10-26-59	61.1	1-26-60 3-30-60	55.1 52.7	73.25

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9cc	Dale Stevenson	—	—			1-27-59	66.0	10-26-59	73.3	1-27-60 3-30-60	65.4 61.0	87.12
10bc1	Keith M. Puckett	—	—	2-11-58	51.2	—	—	—	—	—	—	—
10bc2	Keith M. Puckett	—	—	2-11-58	60.8	—	—	10-26-59	71.7	1-27-60 3-30-60	65.6 62.2	77.42
14da1	C. F. Patterson	7-18-41	9.3	—	—	—	—	—	—	—	—	—
14da2	C. F. Patterson	4-26-43	*	8-26-58	**	—	—	—	—	—	—	—
17cb	J. D. Sullivan	—	—	—	—	—	—	10-26-59	86.4	1-27-60 3-30-60	72.3 70.0	—
18cc	C. Burnham	10-10-41	41.4	—	—	—	—	—	—	—	—	—
20dc1	J. D. Sullivan	7-14-41	50.9	9-17-58	45.4	1-28-59	45.5	—	—	—	—	—
20dc2	J. D. Sullivan	—	—	9-17-58 11-21-58	113.7 97.6	1-28-59	75.6	10-26-59	87.8	1-27-60 3-30-60	77.7 72.8	109.00
22ab	R. R. Bechtelheimer	—	—	2-11-58	73.1	2-22-59	66.1	10-23-59	78.8	1-27-60 3-30-60	68.8 63.8	91.77
22dc	L. T. Helmly	8-25-41	45.6	—	—	—	—	—	—	—	—	—
27ca1	B. G. Robinson	5-28-41	72.3	—	—	—	—	—	—	—	—	—
27cc1	City of Ulysses	8-8-41	r 57	—	—	—	—	—	—	—	—	—
27cc2	City of Ulysses	8-8-41	r 57	—	—	2-6-59	84.0	10-26-59	97.1	1-27-60 3-30-60	87.1 83.2	101.84
30bb	Robert R. Hickok	—	—	—	—	1-28-59	78.0	10-26-59	89.3	1-26-60 3-30-60	80.2 75.9	100.44
31aa1	Pioneer Co-op Assn.	—	—	—	—	—	—	10-26-59	83.8	1-27-60 3-30-60	74.1 70.8	—
35aa	C. A. Smith Estate	10-15-41	r 13	10-1-58	10.3	—	—	—	—	—	—	10.95
36dd	Ulysses Cemetery Assn.	—	—	9-30-58 11-10-58	137.8 128.8	1-28-59	116.1	10-19-59	130.5	1-28-60	115.6	—
28-38-												
4bb	Herman Cockerham	11-29-40	43.8	—	—	—	—	—	—	—	—	—
4cc	Herman Cockerham	7-24-41	42.1	1-15-58	91.6	1-27-59	68.4	10-27-59	67.3	1-25-60 3-21-60	67.6 60.9	79.50
4db	Herman Cockerham	10-27-41	r 45	—	—	—	—	—	—	—	—	—
5ab	Herman Cockerham	10-12-42 3-9-43	52.6 53.6	—	—	—	—	—	—	—	—	—
5dc	Herman Cockerham	—	—	1-15-58	81.6	—	—	10-27-59	79.6	1-25-60 3-30-60	79.2 72.6	—
6bc	O. P. Williams	—	—	1-17-58	100.4	—	—	—	—	—	—	—
6cb	O. P. Williams	—	—	1-17-58	101.7	—	—	—	—	—	—	108.30
6dc1	O. P. Williams	—	—	2-12-58	58.6	—	—	—	—	—	—	—
7ab	Dale H. Williams	—	—	1-17-58	115.5	2-3-59	95.8	—	—	—	—	143.60
8bb1	A. G. Dyck	8-23-40	51.8	—	—	—	—	—	—	—	—	—
8bb2	A. G. Dyck	—	—	—	—	1-17-59	79.8	—	—	—	—	—
8bc	A. G. Dyck	—	—	1-15-58	109.9	2-3-59	92.5	10-27-59	91.5	1-25-60 3-21-60	86.2 79.7	110.90
8dc	A. G. Dyck	5-14-41	45.6	—	—	—	—	—	—	—	—	—
9cb	Ray Stevenson	3-9-43	45.4	1-15-58	92.0	—	—	—	—	—	—	—
10ab	D. R. Young	—	—	—	—	—	—	10-27-59	51.8	1-25-60 3-30-60	52.3 47.2	66.40
12bc	J. D. Sullivan	—	—	—	—	—	—	8-25-59 10-26-59	77.6 54.6	1-26-60 3-30-60	51.7 48.6	68.28
12cb	J. D. Sullivan	—	—	2-12-58	64.2	—	—	—	—	—	—	—
13dd	W. O. Newby Estate	10-10-41	60.4	—	—	—	—	—	—	—	—	—
16ab	Ray Stevenson	—	—	11-12-58	54.5	1-27-59 2-22-59	58.4 59.0	—	—	—	—	—
16db3	Mrs. T. M. Halliday	—	—	—	—	1-27-59 2-22-59	73.0 84.5	—	—	—	—	—
17cb	Ray Stevenson	—	—	1-16-58	114.1	—	—	—	—	—	—	—
18bb	E. A. Dyck	—	—	—	—	—	—	—	—	3-21-60	84.5	—
18db	Ray Stevenson	—	—	10-21-58 12-12-58	89.7 87.1	2-3-59 4-15-59	84.5 97.9	10-27-59 12-31-59	90.8 95.9	1-25-60 3-30-60	87.5 84.2	106.40
19bd	A. B. Williams	—	—	1-16-58	117.8	—	—	10-27-59	96.0	1-25-60	91.1	111.30

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TABLE 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).—*Continued*

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
28–38–												
20dc1	Lyle Morris	—	—	1-17-58	119.0	1-31-59	96.1	—	—	1-25-60	85.6	103.70
										3-30-60	82.6	
20dc2	Lyle Morris	—	—	—	—	—	—	10-27-59	98.0	—	—	—
26cd	H. Toohey	5-28-41	47.2	—	—	—	—	—	—	—	—	—
27ba	W. A. Leigh	—	—	2-12-58	117.6	—	—	—	—	—	—	—
27ca	W. A. Leigh	—	—	1-15-58	125.1	—	—	10-27-59	97.3	1-26-60	84.1	103.70
										3-30-60	81.7	
27cb	W. A. Leigh	—	—	1-15-58	125.3	1-28-59	93.8	—	—	—	—	—
						5-18-59	153.5					
27cd	W. A. Leigh	5-28-41	44.0	1-15-58	47.4	1-28-59	55.4	—	—	—	—	—
				9-9-58	dry at 57							
30bb	J. T. Klepper	7-23-41	46.5	—	—	—	—	—	—	—	—	—
30cb	W. T. Haley	—	—	1-16-58	70.5	—	—	—	—	—	—	—
30cc	W. T. Haley	—	—	1-16-58	70.9	1-28-59	70.4	—	—	—	—	—
31db	J. T. Klepper	—	—	—	—	—	—	10-22-59	83.2	1-26-60	78.8	92.60
										3-30-60	76.3	
33ba	W. J. Hemphill	—	—	1-15-58	64.0	—	—	—	—	—	—	—
33bd	W. J. Hemphill	—	—	—	—	—	—	7-9-59	133.5	1-26-60	93.9	110.09
								10-27-59	107.9	3-30-60	91.3	
35ba	John Hiebert	—	—	1-15-58	57.3	—	—	—	—	—	—	—
35bc	John Hiebert	—	—	9-16-58	120.4	1-28-59	70.8	10-27-59	85.1	1-26-60	74.0	89.40
				10-21-58	86.1					3-30-60	71.5	
				11-21-58	86.2							
29–35–												
6ba	P. M. Hampton	—	—	—	—	—	—	7-20-59	227.7	3-30-60	223.9	—
								10-19-59	231.8			
7cc	Columbian Carbon	8-7-41	133.0	—	—	—	—	—	—	—	—	—
12dd	Guy T. Miller	—	—	1-18-58	232.4	—	—	10-15-59	234.0	3-25-60	233.2	238.68
15ab	Carl Epps	—	—	1-18-58	218.0	—	—	10-15-59	220.1	3-25-60	219.5	224.46
15aba	U. S. G. S.	—	—	—	—	—	—	12-3-59	225.8	1-4-60	226.2	—
										1-8-60	225.8	
										3-25-60	224.8	
15baa	U. S. G. S.	—	—	—	—	—	—	—	—	1-4-60	211.9	—
										3-25-60	212.0	
18aa	Bryce Cantrell	—	—	—	—	—	—	10-19-59	228.2	3-31-60	228.1	234.95
22cb	Roy R. King	—	—	—	—	—	—	—	—	5-3-60	197.4	—
24ba	G. D. Blackwelder Estate	—	—	1-18-58	242.1	2-6-59	241.7	10-15-59	244.9	3-25-60	243.1	249.08
24bb	G. D. Blackwelder Estate	8-25-41	231.6	—	—	—	—	—	—	—	—	—
25dd1	United Carbon Co.	7-8-41	237.0	—	—	—	—	—	—	—	—	—
28ac	Wayne Lahey	—	—	—	—	—	—	10-19-59	175.4	3-25-60	173.8	178.45
33ab	E. A. Stuart	5-27-41	59.0	—	—	—	—	—	—	—	—	—
29–36–												
2bb	Gano Grain Corp.	—	—	10-1-58	84.1	1-28-59	82.8	—	—	—	—	—
4ba1	Hollis Bullock	7-15-41	93.1	10-1-58	87.2	2-6-59	87.1	—	—	—	—	—
4ba2	Hollis Bullock	—	—	—	—	—	—	—	—	3-30-60	161.9	183.35
5ab	M. O. Nuss	5-30-41	106.6	—	—	—	—	—	—	—	—	—
11dd	E. M. Johnson	—	—	1-18-58	58.3	—	—	—	—	—	—	—
18cc	Mrs. Lloyd Keller	7-12-41	32.6	—	—	—	—	—	—	—	—	—
19bc	Mrs. Lloyd Keller	—	—	—	—	2-6-59	62.4	10-19-59	80.4	2-9-60	60.6	95.48
										3-31-60	56.1	
21cdc	U. S. G. S.	—	—	—	—	—	—	10-14-59	56.8	2-9-60	39.8	dry
								10-19-59	56.0	3-31-60	34.6	

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23cb1	G. H. Wood	—	—	—	—	2-22-59	58.6	10-14-59	59.7	2-9-60	58.0	—
										3-31-60	58.6	
23cb2	G. H. Wood	—	—	—	—	—	—	—	—	2-9-60	58.5	—
23ddd	U. S. G. S.	—		—	—	—	—	10-19-59	109.6	1-4-60	109.7	—
										2-9-60	109.2	
										3-31-60	109.2	
24bd	A. E. Stevenson	8-26-41	108.9	—	—	—	—	—	—	—	—	—
27ab	O. O. Strickling Estate	7-30-41	13.8	—	—	—	—	—	—	—	—	—
29ba	Ernest Keller	7-28-41	47.8	—	—	—	—	—	—	—	—	—
30bc	Keith S. Schwein	—	—	2-13-58	153.7	2-6-59	146.2	10-19-59	163.8	3-31-60	139.7	179.61
30dc	Keith Schwein	—	—	—	—	—	—	10-23-59	159.6	—	—	—
31db	Jesse E. Limper	—	—	2-13-58	151.7	—	—	10-23-59	152.4	3-31-60	135.6	179.30
36bb1	Glenn Carter	—	—	1-18-58	49.5	—	—	10-14-59	49.0	2-9-60	48.6	—
36bb2	Glenn Carter	—	—	1-18-58	23.7	—	—	—	—	—	—	—
36db	Glenn Carter	—	—	—	—	—	—	10-14-59	87.4	2-9-60	76.2	99.85
										3-31-60	73.0	
29-37-												
3bb	T. Brewer	7-11-41	13.7	—	—	—	—	—	—	—	—	—
8cb	Dan C. Sullivan	—	—	—	—	2-6-59	68.0	10-26-59	80.4	1-27-60	69.9	90.38
										4-1-60	65.5	
14cd	Frank Thomason	7-28-41	77.4	—	—	—	—	—	—	—	—	—
19db	Ralph E. Winger	—	—	—	—	2-5-59	120.9	—	—	—	—	—
20cd	G. E. Gano	5-30-41	74.1	—	—	—	—	—	—	—	—	—
21cc	Arthur Campbell	8-7-41	74.7	—	—	—	—	—	—	—	—	—
22aa	Earl Steen	—	—	—	—	2-27-59	57.4	10-23-59	72.3	1-27-60	59.9	82.41
										3-31-60	55.0	
22cc2	Walter Eichenberger	—	—	1-29-58	99.7	2-6-59	86.9	10-26-59	102.4	1-27-60	88.0	116.40
										3-31-60	82.1	
26cc	H. H. Caldwell	—	—	—	—	—	—	10-23-59	138.8	3-31-60	124.9	159.97
28cb	Owen Steen	—	—	—	—	—	—	10-26-59	124.5	—	—	127.41
29bb	Eugene F. Swindler	—	—	—	—	—	—	10-26-59	115.2	1-27-60	107.7	126.45
										3-31-60	104.2	
32cc1	Jesse J. Ford	—	—	—	—	2-5-59	103.5	—	—	3-31-60	103.0	120.54
32db	Jesse J. Ford	—	—	2-13-58	125.6	—	—	10-27-59	122.8	—	—	—
34bc	H. M. Johnson	7-11-41	67.3	—	—	—	—	—	—	—	—	—
35ac	Glenn Jarvis	—	—	—	—	—	—	10-23-59	169.0	—	—	—
35cc	Edna N. Halladay	—	—	2-13-58	160.4	—	—	—	—	—	—	—
35cd	Clifford Fort, Jr.	—	—	4-22-57	r160	—	—	11-30-59	161.6	—	—	—
29-38-												
1bb	Dan C. Sullivan	—	—	—	—	—	—	—	—	1-27-60	77.9	—
1ca	Sullivan Bros.	—	—	—	—	2-6-59	79.8	10-27-59	107.9	3-31-60	78.0	96.74
3ba	Dan Sullivan, Jr.	—	—	—	—	—	—	10-28-59	99.5	—	—	104.02
4cc	Marshall A. Brewer	—	—	—	—	2-5-59	95.0	10-26-59	114.7	1-27-60	96.3	106.50
										4-1-60	91.6	
5aab	Stanolind Oil and Gas	—	—	1-17-58	139.4	—	—	—	—	—	—	—
5aac	Stanolind Oil and Gas	—	—	1-17-58	139.9	—	—	—	—	—	—	—
7da	P. H. Goertzen	—	—	—	—	2-5-59	80.6	—	—	—	—	—
8cc	James T. Klepper	—	—	1-29-58	101.4	—	—	10-28-59	107.1	2-8-60	89.4	106.49
										4-1-60	87.8	
18dd	L. A. Smith	7-14-41	63.6	—	—	—	—	—	—	—	—	—
19cb	U. S. G. S.	—	—	—	—	—	—	—	—	7-12-60	68.4	—
22cb	E. Guy Zonker	—	—	—	—	2-5-59	61.7	—	—	2-8-60	61.3	68.15
										4-1-60	60.2	
25ba	Isaac Harms	—	—	—	—	—	—	10-28-59	97.1	2-8-60	90.7	100.08
										4-1-60	89.3	
26ba	J. R. Hickok	8-4-41	29.4	—	—	—	—	—	—	—	—	—
27ad	Frank Siebert	—	—	—	—	—	—	10-27-59	47.8	—	—	52.98
29cb	H. W. Loewer	8-5-41	30.1	—	—	—	—	—	—	—	—	—
31bc	A. M. Williams	8-9-39	67.4	—	—	—	—	—	—	—	—	—
35ac1	Ray R. Kepley	9-22-42	70.3	—	—	—	—	—	—	—	—	—
35ac2	Ray R. Kepley	—	—	—	—	3-30-59	83.8	—	—	—	—	—
35cd	Ralph D. Kepley	—	—	1-29-58	113.4	2-5-59	101.5	—	—	4-1-60	100.2	—
35db	Ray R. Kepley	—	—	—	—	3-30-59	90.2	10-27-59	93.8	—	—	—

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TABLE 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).—*Continued*

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
30–35–												
2db	Clifford Willett	—	—	8–25–58	230.5	2– 6–59	229.5	10–16–59	230.8	3–25–60	230.5	236.73
3dd	L. M. Stubbs Et al	7–11–41	192.8	—	—	—	—	—	—	—	—	—
4db	E. H. Hockett	—	—	—	—	—	—	10–15–59	86.1	3–25–60	86.3	88.72
4dc	E. H. Hockett	7–16–41	66.3	—	—	—	—	—	—	—	—	—
7dd	Mrs. M. Allman	—	—	—	—	—	—	10–10–59	179.3	—	—	186.75
13ab	E. E. Correll, Et al	8–26–41	183.4	—	—	—	—	—	—	—	—	—
16bb	Riverview State Bank	7–17–41	76.1	—	—	—	—	—	—	—	—	—
19bc2	U. S. G. S.	—	—	—	—	—	—	11–23–59	143.3	—	—	—
19bc3	U. S. G. S.	—	—	—	—	—	—	11–18–59	140.2	—	—	—
20ba1	G. G. Feight	7–16–41	155.5	—	—	—	—	—	—	—	—	—
20ba2	G. G. Feight	—	—	—	—	2–23–59	154.4	10–15–59	159.0	3–31–60	155.4	—
22cc	Hugh Hopper	8– 7–41	55.0	—	—	—	—	—	—	—	—	—
23cb	E. Gosshardt	—	—	—	—	—	—	10–16–59	56.3	—	—	—
24ca	L. A. Watson	7–11–41	62.9	—	—	—	—	—	—	—	—	—
24cb	L. A. Watson	—	—	—	—	2–23–59	79.3	10–16–59	80.7	2–25–60	81.5	85.53
35cc	W. Lahey	7–17–41	125.6	—	—	—	—	—	—	—	—	—
30–36–												
2bb	J. E. Alford	7–21–42	41.5	—	—	—	—	—	—	—	—	—
6bb	Mrs. Dorothy Boldt	—	—	2–13–58	153.6	2– 6–59	148.3	10–23–59	148.4	3–31–60	134.8	176.95
7aa	Nora A. Christian	—	—	10– 1–58	148.2	—	—	10–23–59	135.9	—	—	—
7cb	Geneva Blake Curtis	—	—	—	—	2– 6–59	141.1	10–23–59	146.9	3–31–60	139.6	—
8cd	Nora A. Christian	—	—	—	—	2– 6–59	122.1	10–23–59	128.1	3–31–60	121.3	—
9bb	John W. Alford	—	—	—	—	—	—	10–23–59	143.8	3–31–60	131.5	—
9dc	Wilma Jennings	—	—	2–13–58	117.1	—	—	10–23–59	118.3	—	—	135.71
10cc	J. W. Teeter	7–30–41	119.5	—	—	—	—	—	—	—	—	—
16da1	Nora A. Christian	—	—	9–30–58	129.1	2–23–59	121.0	10–23–59	127.7	3–31–60	121.1	—
23dd	J. W. Teeter	10–27–41	r 20	—	—	—	—	10–23–59	21.4	—	—	—
24cc	J. W. Teeter	7–11–41	21.0	8–25–58	23.6	—	—	—	—	—	—	—
25ca	Eual P. Brewer	—	—	—	—	—	—	11–18–59	28.2	3–31–60	27.5	30.10
26ba	G. E. Gordon	8– 1–41	13.3	—	—	—	—	—	—	—	—	—
27ba	R. and O. Thurow	7–30–41	96.3	—	—	—	—	—	—	—	—	—
31dc	F. G. Stoner	7–30–41	95.7	—	—	—	—	—	—	—	—	—
32bb	Mrs. Fannie Brollier	—	—	—	—	—	—	—	—	1– 4–60	115.0	118.25
30–37–												
1bb	J. Limper	7–28–41	113.2	—	—	—	—	—	—	—	—	—
2ba1	Lawrence Steen	—	—	—	—	5–7–59	r175	—	—	—	—	—
2ba2	Lawrence Steen	—	—	2–13–58	175.7	—	—	10–23–59	167.0	3–31–60	153.7	192.50
3bd	Earl Steen	—	—	—	—	—	—	10–23–59	162.1	3–31–60	149.1	178.30
4ab	W. H. Hilderbrand	7–11–41	85.0	—	—	—	—	—	—	—	—	—
6dc	V. V. Lattimore	—	—	2–13–58	124.1	—	—	10–27–59	125.3	3–31–60	122.6	133.64
8cc	Wayne Jarvis	—	—	2–13–58	137.8	—	—	10–27–59	141.8	3–31–60	137.7	—
9cc	R. W. Tuttle	—	—	—	—	—	—	10–27–59	137.4	—	—	148.24
10dc	Tacy M. Halliday	—	—	2–13–58	150.7	2– 6–59	149.8	10–23–59	153.3	3–31–60	147.7	—
11db	Verle E. Johnson	—	—	—	—	—	—	10–23–59	150.4	—	—	162.55
15cb1	R. W. Tuttle	8–29–41	119.4	8–27–58	165.9	—	—	—	—	—	—	—
15cb2	R. W. Tuttle	—	—	8–27–58	171.1	—	—	—	—	—	—	—
17bc	E. Wayne Jarvis	—	—	9–30–58	146.0	2– 5–59	143.7	—	—	—	—	—
19aa1	C. E. Eagle	—	—	—	—	—	—	7– 1–59	146.9	3–31–60	139.3	—
20cc	John Lewis	—	—	—	—	—	—	10–27–59	142.2	—	—	150.92
21cc	Thomas E. Joyce	—	—	8–27–58	124.6	—	—	10–27–59	126.3	3–31–60	128.1	133.30
21db	Thomas E. Joyce	8–25–41	102.2	—	—	—	—	—	—	—	—	—
23aa	R. W. Tuttle	—	—	—	—	—	—	10–23–59	59.5	3–31–60	57.9	67.50

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24cb	F. W. Hoffman	7-30-41	21.6	—	—	—	—	—	—	—	—	—
25dd1	G. V. Brollier	7-30-41	105.4	—	—	—	—	—	—	—	—	—
25dd2	G. V. Brollier	—	—	1-29-58	97.0	—	—	—	—	3-21-60	93.5	—
26cc	M. F. Frederick	—	—	—	—	—	—	10-27-59	13.3	3-31-60	12.4	—
26db1	I. R. Parsons	—	—	—	—	4-27-59	117.2	10-27-59	116.3	3-21-60	114.8	104.00
27bc1	R. H. Joyce	5-28-41	11.5	—	—	—	—	—	—	—	—	—
27bc2	R. H. Joyce	10-27-41	r 15	—	—	2-6-59	23.2	—	—	—	—	—
31cc	R. W. Tuttle	8-5-41	33.0	—	—	—	—	—	—	—	—	—
33aa	M. T. Joyce	8-2-41	18.5	—	—	—	—	—	—	—	—	—
33db	J. F. Parsons	8-2-41	22.3	—	—	—	—	—	—	—	—	—
36bc	R. H. Joyce	7-11-41	80.7	—	—	—	—	—	—	1-4-60	92.0	—
										3-21-60	89.9	
30-38-												
2cc	Ralph D. Kepley	—	—	—	—	2-5-59	100.8	—	—	—	—	—
3dc	Clyde H. Ball	—	—	—	—	—	—	10-22-59	115.9	—	—	123.88
5bb	Edward B. Kepley	—	—	8-26-58	55.7	—	—	10-22-59	53.2	2-8-60	51.6	61.87
										4-1-60	51.8	
6cc	L. W. Bailey	—	—	8-26-58	75.6	—	—	—	—	—	—	—
9ad	E. Mills	7-15-41	85.6	—	—	—	—	—	—	—	—	—
11bc3	Marian Hennigh	—	—	—	—	4-14-59	113.7	—	—	4-1-60	107.6	—
11dd	Elmer Hennigh	—	—	—	—	—	—	10-22-59	118.8	—	—	132.51
13cc	Lawrence Hennigh	—	—	3-7-57	r225	—	—	10-27-59	129.4	4-1-60	126.1	111.58
15ab	F. N. Schartz	7-15-41	83.9	—	—	—	—	—	—	—	—	—
15db	F. N. Schartz	—	—	1-29-58	106.4	2-5-59	106.2	10-27-59	105.1	4-1-60	102.8	150.53
26da	G. P. Witt	—	—	—	—	—	—	10-27-59	131.5	4-1-60	131.3	142.07
30ac	Clarence B. Collins	—	—	—	—	2-5-59	71.4	10-27-59	71.7	4-1-60	71.5	75.77
33aa	Ella Petty	8-2-41	90.8	—	—	—	—	—	—	—	—	—
34bc	G. P. Witt	—	—	8-27-58	105.5	—	—	10-27-59	104.7	4-1-60	104.0	109.93
34dc	G. P. Witt	8-2-41	101.5	—	—	—	—	—	—	—	—	—
35db	R. W. Tuttle	—	—	—	—	—	—	10-27-59	114.5	4-1-60	114.1	121.26
				STANTON COUNTY								
27-39-												
2bb	Van Trussel	8-10-39	87.5	1-16-58	95.6	—	—	—	—	—	—	—
9dc	J. M. and R. Platt	—	—	—	—	—	—	—	—	2-8-60	54.7	60.49
										4-1-60	54.7	
13ac	Frank A. Snell	—	—	—	—	1-12-59	87.3	10-17-59	92.8	1-26-60	94.9	115.09
										4-1-60	87.0	
13bda	U. S. G. S.	—	—	—	—	—	—	9-17-59	111.2	—	—	—
14bb	V. S. Congden	8-31-39	68.2	—	—	—	—	—	—	1-26-60	69.2	75.43
										4-1-60	69.4	
17dd	Olen Warner	7-25-39	54.9	1-17-58	50.4	—	—	—	—	—	—	57.19
21ac	C. M. Helmle	—	—	—	—	—	—	10-28-59	86.5	2-8-60	82.2	95.25
										4-1-60	85.6	
22db	Olen Warner	—	—	1-16-58	85.5	—	—	—	—	—	—	—
23ac1	Leslie L. Mater	8-5-39	44.2	—	—	—	—	—	—	—	—	—
23ac2	Leslie L. Mater	—	—	1-16-58	64.7	—	—	10-27-59	60.6	4-1-60	57.1	70.74
23cc	Olen Warner	—	—	1-16-58	67.9	—	—	—	—	1-26-60	69.1	—
25bb	R. E. Hurst	—	—	1-17-58	101.2	—	—	—	—	—	—	—
25cb	R. L. Arnold	—	—	—	—	—	—	10-17-59	105.2	4-1-60	100.6	115.47
26ab	Pete Molz	—	—	1-16-58	93.8	—	—	—	—	—	—	—
26bc	Donald K. Molz	—	—	1-17-58	94.6	—	—	—	—	—	—	—
27cb	M. P. Molz	—	—	1-17-58	92.8	—	—	—	—	—	—	—
28ba	Vincent E. Peery	—	—	1-17-58	86.77	—	—	10-28-59	81.3	1-26-60	78.2	88.24
										4-1-60	78.7	
29da	Felix Edmisson	8-31-39	62.7	1-17-58	58.1	—	—	—	—	—	—	—
34dd	Earl H. Moore	—	—	—	—	2-3-59	84.2	10-27-59	93.5	1-26-60	87.7	105.29
										4-1-60	89.0	

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TABLE 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).—*Continued*

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
27–40–												
5cd	J. W. Dimmitt, Jr.	8-22-39	52.0	1-17-58	42.1	—	—	11-24-59	41.4	4-1-60	41.4	—
15cb	D. R. Wilson	9-2-39	56.7	—	—	—	—	11-21-59	47.2	4-1-60	47.9	46.98
17bc	G. R. Carrithers	8-22-39	55.2	—	—	—	—	—	—	—	—	—
21aa	Molz Bros.	—	—	—	—	—	—	10-28-59	43.8	2-8-60	43.2	45.40
21dc	J. A. Floyd	8-10-39	81.2	1-17-58	83.6	—	—	—	—	—	—	—
25cb	C. Winger and R. D. Floyd	—	—	—	—	—	—	10-28-59	77.0	2-8-60 4-1-60	72.6 71.4	82.95
26ba	Thomas R. Winger	—	—	—	—	1-30-59	68.9	10-26-59	70.6	2-8-60 4-1-60	69.0 70.0	72.90
26dd	C. Winger	8-19-39	59.4	—	—	—	—	—	—	—	—	—
29dd	Mary Williamson	8-19-39	65.1	—	—	—	—	—	—	—	—	—
30bb	O. E. Josserand	8-22-39	87.8	—	—	—	—	—	—	—	—	—
32cc	J. L. Cross	9-6-39	114.7	—	—	—	—	—	—	—	—	—
35ab1	Clarence Winger	10-25-39	r 63	1-17-58	82.1	—	—	—	—	4-1-60	89.8	77.50
27–41–												
3cc	C. A. Floyd	8-22-39	75.6	—	—	—	—	—	—	—	—	—
10ac	James W. Raney	—	—	—	—	2-3-59	70.9	10-29-59	74.3	4-1-60	74.7	71.50
15dc	Ida Raney	9-6-39	98.6	—	—	—	—	—	—	—	—	—
17dd	A. G. Raney	8-22-39	117.6	—	—	—	—	—	—	—	—	—
30da	Nellie Yinger	8-30-39	141.2	—	—	—	—	—	—	—	—	—
31cc2	Mrs. Ada I. Mack	—	—	—	—	—	—	10-29-59	167.0	3-29-60	173.0	163.4
33ad	Harry Payne	8-18-39	124.6	—	—	—	—	—	—	—	—	—
35cc	Seyb Bros.	—	—	—	—	—	—	10-28-59	138.2	3-29-60	131.5	—
27–42–												
8aa	E. E. Reynolds	8-25-39	123.0	—	—	—	—	—	—	—	—	—
10dc	M. L. Gillum	9-6-39	115.6	—	—	—	—	—	—	—	—	—
11db	William M. Hoff	—	—	—	—	—	—	10-29-59	116.0	3-29-60	118.1	122.53
11dd	William M. Hoff	9-6-39	116.8	—	—	—	—	—	—	—	—	—
12ad	B. D. Frigon	7-24-39	100.3	11-3-58	95.0	—	—	—	—	—	—	—
21ad	Darius E. Cockrum	9-5-39	157.4	—	—	—	—	—	—	—	—	—
33cd	Faye McCune	9-5-39	168.8	—	—	—	—	—	—	—	—	—
36cc	W. H. Teas	8-25-39	189.9	—	—	—	—	—	—	—	—	—
27–43–												
5dd	L. W. Bailey	8-31-39	212.6	—	—	—	—	—	—	—	—	—
15ad	R. L. Schmidt	8-31-39	182.4	—	—	—	—	10-29-59	181.0	—	—	—
26da	H. J. Payne	7-29-39	178.6	—	—	—	—	—	—	—	—	—
27ba	Emma C. Berkley	8-31-39	186.32	—	—	—	—	—	—	—	—	—
33aa	C. E. Gilgore	9-13-39	125.9	—	—	—	—	—	—	—	—	—
34ad	D. Dody	9-13-39	114.7	—	—	—	—	—	—	—	—	—
28–39–												
1bb	Dale Williams	—	—	—	—	1-12-59	83.3	10-27-59	90.8	1-25-60 4-1-60	85.4 85.4	—
3da	Vivian C. Glenn	8-31-39	53.4	—	—	—	—	—	—	—	—	—
5ab	Vivian C. Glenn	8-10-39	44.9	—	—	—	—	—	—	—	—	—
5bb2	Vivian C. Glenn	—	—	—	—	2-3-59	53.8	10-28-59	53.6	2-8-60 4-1-60	53.2 53.4	55.65
8bc	Vivian C. Glenn	—	—	—	—	—	—	10-28-59	100.8	2-8-60 4-1-60	97.3 95.2	116.40
8cd	Vivian C. Glenn	8-31-39	63.7	—	—	—	—	—	—	—	—	—

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9ab	Vivian C. Glenn	—	—	—	—	—	—	10-28-59	78.0	2-8-60	76.9	—
										4-1-60	77.1	
12aa	Mrs. Delia H. Pinegar	8-31-39	55.3	—	—	—	—	—	—	—	—	—
12bd	Mrs. Delia H. Pinegar	—	—	—	—	—	—	7-20-59	130.0	—	—	—
12cc	Max B. Ainsworth	—	—	—	—	—	—	10-27-59	100.7	1-25-60	98.5	113.40
								12-1-59	102.2	4-1-60	99.1	
14bb1	Herbert Campbell, Jr.	—	—	—	—	—	—	10-27-59	84.5	3-31-60	82.0	90.10
14bb2	Herbert Campbell, Jr.	—	—	—	—	2-3-59	85.2	—	—	—	—	—
14cc	Eyman and Kearny	8-5-39	46.1	—	—	—	—	—	—	—	—	—
16dc	Vivian C. Glenn	—	—	—	—	2-3-59	71.4	10-28-59	77.0	2-8-60	76.6	87.24
										3-31-60	76.5	
18bb	Homer Richard	—	—	—	—	2-3-59	96.0	10-28-59	100.1	2-8-60	95.1	—
										3-31-60	94.8	
20bb	Carl Levens	—	—	—	—	—	—	10-28-59	97.4	2-8-60	91.6	119.85
										3-31-60	89.5	
22ac	M. E. Eyman	—	—	—	—	—	—	7-23-59	96.9	1-26-60	94.5	104.05
								10-27-59	96.0	3-31-60	93.9	
22db	Melvin S. Wilson	—	—	—	—	—	—	7-23-59	100.5	—	—	—
23dd	Marjorie Cole Rumersi	—	—	—	—	—	—	10-27-59	97.0	1-26-60	93.9	104.14
										3-31-60	92.2	
24cc1	J. L. Foresman	—	—	2-12-58	91.7	—	—	—	—	—	—	—
24cc2	J. L. Foresman	—	—	2-12-58	83.8	—	—	—	—	—	—	—
26ac	Melvin S. Wilson	—	—	—	—	2-23-59	96.8	—	—	—	—	—
26cd	Melvin S. Wilson	—	—	—	—	1-29-59	102.7	7-22-59	107.4	1-26-60	104.2	112.92
								10-22-59	105.2	3-31-60	103.5	
27cc	J. G. Neufeldt	8-7-39	77.9	—	—	—	—	—	—	—	—	—
29bb	Vivian C. Glenn	8-3-39	62.4	—	—	—	—	—	—	—	—	—
29cb	Vivian C. Glenn	—	—	1-28-58	87.9	—	—	—	—	—	—	—
30cc	Carl Levens	—	—	1-28-58	97.5	—	—	—	—	—	—	—
31bc	Stanley Julian	—	—	—	—	—	—	10-28-59	105.6	3-31-60	99.1	114.46
33ac	E. Wetzler	—	—	—	—	—	—	10-28-59	98.4	2-8-60	95.1	—
35ab	Southwestern College	7-25-39	70.6	—	—	—	—	—	—	3-31-60	95.0	—
36ab	Fred Shore	—	—	—	—	—	—	10-27-59	79.7	1-26-60	76.4	91.27
										3-31-60	75.0	
28-40-												
2ab	Melvin Winger	—	—	—	—	—	—	10-28-59	75.8	4-1-60	72.9	80.77
3ab	Wilma N. Winger	—	—	1-17-58	79.8	1-30-59	78.0	10-28-59	81.0	4-1-60	78.3	84.78
4cc	Eugene Floyd	—	—	—	—	—	—	10-28-59	107.9	4-1-60	104.7	108.40
13ad	W. Richard	7-28-39	77.8	—	—	—	—	—	—	—	—	—
15cb	C. H. Beckett	8-10-39	91.0	—	—	—	—	—	—	—	—	—
15cc	C. H. Beckett	—	—	—	—	1-30-59	100.9	10-28-59	103.9	3-31-60	101.6	110.25
17cb	Bruce E. Josserand	—	—	—	—	—	—	10-14-59	153.8	3-31-60	151.3	—
20bc	Forest Walker	—	—	1-18-58	152.5	—	—	—	—	—	—	—
21cc	J. A. Ramsay	—	—	1-18-58	136.5	—	—	10-2-59	133.2	3-31-60	133.8	139.30
21dc1	J. A. Ramsay	9-6-39	115.8	—	—	—	—	—	—	—	—	—
23ac	Felix R. Edmisson	—	—	—	—	1-30-59	106.0	10-28-59	114.2	3-31-60	106.4	120.56
25cc2	O. E. Josserand	—	—	1-28-58	102.4	—	—	10-28-59	107.4	3-31-60	104.2	116.24
27cc	W. R. Puyear	—	—	—	—	1-28-59	131.5	10-28-59	135.0	3-31-60	134.5	144.27
30cb	Forest Walker	—	—	—	—	—	—	10-28-59	160.9	3-29-60	159.0	171.77
30dd	R. H. Trostle	8-19-39	144.1	—	—	—	—	—	—	—	—	—
32cc	R. M. Speck	—	—	—	—	—	—	10-28-59	155.1	3-30-60	154.0	161.18
33ab	R. M. Speck	8-16-39	131.0	—	—	—	—	—	—	—	—	—
36ba	Milo G. York	7-21-39	102.6	—	—	1-28-59	121.0	—	—	—	—	—
36cb	Milo G. York	—	—	—	—	—	—	10-28-59	120.2	3-31-60	118.2	130.60
28-41-												
1bb	E. H. Tallman	8-30-39	81.0	—	—	—	—	—	—	—	—	—
3dd	H. Witt	9-6-39	143.7	—	—	—	—	—	—	—	—	—
5bb	LeRoy Cockrum	—	—	—	—	2-3-59	144.6	—	—	3-29-60	146.1	—
12bb	J. W. Dimmitt	1-16-40	84.3	1-18-58	129.2	2-3-59	121.2	—	—	3-29-60	138.2	122.20
13ab	I. Josserand	7-24-39	150.0	—	—	—	—	—	—	—	—	—

TABLE 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).—*Continued*

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
28-41-												
14aa	Mrs. Nellie Craig	—	—	1-18-58	151.7	2-3-59	152.4	10-28-59	154.2	3-29-60	154.5	158.94
16dd	M. E. Craig	9-5-39	189.2	—	—	—	—	—	—	—	—	—
17dc	Mrs. Grace E. Bearman	8-30-39	152.6	—	—	—	—	—	—	—	—	—
19dc	Marvin Ray McKinney	—	—	—	—	—	—	10-29-59	179.4	3-30-60	177.0	191.93
23ca	Mrs. Grace E. Bearman	8-30-39	183.3	—	—	—	—	—	—	—	—	—
25ab	E. Ruth Archer	—	—	—	—	2-3-59	174.1	—	—	—	—	—
26dd	D. M. Cockreham	8-18-39	182.3	—	—	—	—	—	—	—	—	—
26db	D. M. Cockreham	—	—	—	—	—	—	10-18-59	203.8	3-30-60	203.4	218.10
29cc	M. E. McKinney	7-22-39	140.5	—	—	—	—	—	—	—	—	—
31bd	Marlin McKinney	—	—	—	—	—	—	10-29-59	141.9	3-30-60	141.5	150.82
36db	City of Johnson	8-16-39	163.1	—	—	—	—	—	—	—	—	—
28-42-												
8cc	Mrs. Ruby Hutchinson	—	—	—	—	—	—	10-29-59	223.5	3-29-60	223.6	227.06
9cb	W. S. Scrivner	9-7-39	244.3	—	—	—	—	—	—	—	—	—
13cc	J. S. Wartman	9-11-39	186.4	—	—	—	—	—	—	—	—	—
16cd2	Lester Stanton	—	—	—	—	—	—	10-29-59	226.8	3-29-60	225.7	—
22ba	Fred Walkemeyer	—	—	—	—	—	—	10-29-59	232.4	3-30-60	231.6	239.50
24dc	Ennis Figgins	—	—	—	—	—	—	10-29-59	182.0	3-30-60	179.4	190.10
24dd	Ennis Figgins	8-26-39	94.1	—	—	—	—	—	—	—	—	—
26aa	John S. Wartman	—	—	—	—	—	—	—	—	4-9-60	166.8	174.95
29cc	R. J. Shetlar	7-29-39	137.7	—	—	—	—	—	—	—	—	—
32bb	Mabel Nichols	—	—	—	—	—	—	10-29-59	211.8	3-30-60	212.2	212.95
32dd	R. P. Nichols	9-7-39	60.2	—	—	—	—	—	—	—	—	—
35bb	Hal Hale	—	—	11-3-58	118.9	—	—	—	—	—	—	—
28-43-												
12bb	Faye Collingwood	9-7-39	169.6	—	—	—	—	—	—	—	—	—
13ab	H. Cockreham	8-31-39	189.2	—	—	—	—	—	—	—	—	—
15cc	C. Williams	8-31-39	193.1	—	—	—	—	—	—	—	—	—
27dc	Fern Tressner	8-25-39	207.9	—	—	—	—	—	—	—	—	—
29-39-												
2cd1	A. P. Kliewer	8-3-39	57.0	—	—	—	—	—	—	—	—	—
2cd2	A. P. Kliewer	—	—	—	—	2-4-59	67.4	10-28-59	67.3	3-31-60	66.6	73.24
5cd	J. B. Spires	8-7-39	75.8	—	—	—	—	—	—	—	—	—
6cb	T. J. Julian	8-23-39	93.6	—	—	—	—	—	—	—	—	—
6cc	T. J. Julian	—	—	—	—	5-25-59	112.6	10-28-59	108.6	3-31-60	105.7	113.49
8ac	Harriet McBurney	—	—	—	—	—	—	10-28-59	101.3	3-31-60	98.8	108.01
9dd1	R. P. Dotzour	8-23-39	81.2	—	—	—	—	—	—	—	—	—
9dd2	R. P. Dotzour	—	—	1-29-58	94.3	2-4-59	92.2	—	—	—	—	—
15ac	Roger C. Jones	—	—	—	—	—	—	10-28-59	88.9	2-8-60	85.4	98.16
										3-31-60	84.9	
15bb	James B. Malone	—	—	1-29-58	94.2	—	—	—	—	—	—	—
17bc	J. D. Burkham	—	—	—	—	2-4-59	107.4	10-28-59	110.0	2-11-60	109.0	116.67
										3-31-60	108.5	
18dd	Chas. F. Gray	8-7-39	93.3	—	—	—	—	—	—	—	—	—
20bc	Leon Kilgore	—	—	—	—	—	—	—	—	2-10-60	103.7	—
21db	Charles E. Garry	—	—	—	—	—	—	—	—	2-12-60	66.3	72.98
								10-28-59	84.0	3-31-60	65.9	
23cb	R. C. Jones	7-21-39	56.9	—	—	—	—	—	—	—	—	—

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24dd	V. E. Ruth	—	—	11- -57 1- -58 3 58 4-15-58 6- 8-58 9-30-58	r 66 r 67 r 67 r 66 r 66 r 66	5- 1-59	r 67	8-10-59 10-28-59	r 66 67.8	2- 8-60 3-31-60	68.0 67.6	75.84
26bd	Melvin S. Wilson	—	—	—	—	—	—	10-29-59	81.2	2- 8-60 3-31-60	80.3 80.0	86.78
30bb	W. C. Jones	8-18-39	86.7	—	—	—	—	—	—	—	—	—
29-40-												
4cd	Royce Fiss	—	—	—	—	2- 4-59	147.0	10-28-59	149.2	2-12-60 3-30-60	148.6 148.1	156.39
6db	Glen Arnold	—	—	—	—	—	—	7- 1-59	159.6	3-30-60	159.5	170.89
6dc	Glen Arnold	8-23-39	148.6	—	—	—	—	10-28-59	160.2	—	—	—
11bb	R. H. Trostle	—	—	—	—	2- 5-59	127.4	10-28-59	130.5	3-31-60	130.1	137.96
16ba	Elmer Martin	—	—	—	—	—	—	7- 1-59 10-29-59	139.9 140.3	2-12-60 3-30-60	140.7 140.2	—
19dc	O. F. Ramsey	8-23-39	153.1	—	—	—	—	—	—	—	—	—
22bb	C. O. Dye	8-18-39	122.9	—	—	—	—	—	—	—	—	—
25dc	Earl Whipple	—	—	—	—	2- 4-59	98.7	10-29-59	99.6	3-31-60	100.2	103.74
26ac	Harold Jones	9-12-39	105.6	—	—	—	—	—	—	—	—	—
26bb	Harold Jones	—	—	—	—	—	—	10-29-59	124.1	2-12-60 3-31-60	125.8 117.8	—
31db	F. M. Simpson	—	—	—	—	—	—	—	—	2-12-60 3-31-60	172.7 172.2	176.01
33ac	Harry Teeter	—	—	—	—	—	—	10-29-59	131.2	2-12-60 3-31-60	131.1 131.0	134.54
33cc	C. E. Morris	8- 9-39	153.6	—	—	—	—	—	—	—	—	—
35dd	Warren W. Plummer	—	—	—	—	—	—	11- 2-59	125.2	2-12-60 3-31-60	125.2 125.1	129.59
29-41-												
3da	Donald Jones	—	—	—	—	—	—	11- 3-59	208.1	3-30-60	207.6	—
9cc	C. O. Dye	8-23-39	210.9	—	—	—	—	—	—	—	—	—
11bd	Glen Arnold	—	—	—	—	2- 4-59	187.2	11- 2-59	188.4	3-30-60	187.9	189.92
11dd	Glen Arnold	8-24-39	184.2	—	—	—	—	—	—	—	—	—
13ac	C. D. Kendrick	—	—	—	—	—	—	10-29-59	179.4	3-30-60	178.9	182.21
20dd	H. L. Cullers	8-28-39	173.8	—	—	—	—	—	—	—	—	—
23db	Harold D. Cullers	—	—	—	—	—	—	11- 2-59	204.7	3-31-60	204.4	206.58
25bb	H. R. Fiss	8-24-39	152.5	—	—	—	—	—	—	—	—	—
31cb	Clifford Harmon	—	—	—	—	—	—	11- 3-59	226.4	3-30-60	226.6	231.28
32ab	Roy Harmon	—	—	—	—	—	—	11- 3-59	215.6	—	—	—
35da	H. L. Cullers	8-24-39	201.9	—	—	—	—	—	—	—	—	—
29-42-												
8cd	C. H. and Harry Bilberry	—	—	—	—	—	—	11- 3-59	186.0	3-30-60	184.3	184.53
10da	H. H. Hoopingarner	8-23-39	152.3	—	—	—	—	—	—	—	—	—
11dc	L. W. Bailey	—	—	—	—	—	—	11- 3-59	210.8	3-30-60	210.6	215.74
14cb	City of Manter	9- 1-39	r240	—	—	—	—	—	—	—	—	—
18da	C. H. Bilberry	8-25-39	97.2	—	—	—	—	—	—	—	—	—
24cc	Lloyd Batterton	—	—	—	—	—	—	—	—	3-30-60	222.1	—
27cc	J. L. Patterson	9- 9-39	241.5	—	—	—	—	—	—	—	—	—
27dd	M. C. Graber	8- 9-39	250.0	—	—	—	—	—	—	—	—	—
30da	Rena M. Burchfield	7-20-39	224.4	—	—	—	—	—	—	—	—	—
29-43-												
3db	W. O. Bearce	—	—	—	—	—	—	—	—	3-30-60	165.6	—
9db	Cora Conrad	8-26-39	19.8	—	—	—	—	—	—	—	—	—
10ac	W. O. Bearce	8-25-39	83.2	—	—	—	—	—	—	—	—	—
11ac	J. B. Cockrum	8-26-39	11.4	—	—	—	—	—	—	—	—	—

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TABLE 18.—Water levels in feet and tenths below land surface measured in wells screened in the principal sands of Grant-Stanton area (For location of wells see Pl. 12).—*Concluded*

Well number	Owner	1939–44		1957–58		Spring 1959		Fall 1959		Spring 1960		Jan. 22, 1963
29–43–												
14cc	J. B. Cockrum	8–25–39	28.2	—	—	—	—	—	—	—	—	—
15ba	W. O. Bearce	8–26–39	60.9	—	—	—	—	—	—	—	—	—
15cc	Stanton Co.	8–25–39	40.3	—	—	—	—	—	—	—	—	—
21db	E. L. Delaney	8–29–39	12.5	—	—	—	—	—	—	—	—	—
29ab	L. W. Bailey	—	—	—	—	—	—	11– 5–59	64.8	3–30–60	64.7	63.78
33cd	Virgil Stewart and Son	—	—	—	—	—	—	11–11–59	99.7	3–30–60	99.8	102.00
30–39–												
2ab	Milton Julian	—	—	—	—	2– 4–59	72.6	10–29–59	75.8	2–11–60	74.3	80.54
										4– 1–60	73.9	
4cd	Fred Shore	8– 4–39	80.3	—	—	—	—	—	—	—	—	—
4dc	R. J. Shetlar	—	—	—	—	—	—	10–29–59	89.2	2–12–60	87.8	90.75
										4– 1–60	87.6	
6ab	O. R. Swindler	8– 2–39	95.5	—	—	—	—	—	—	—	—	—
12cc	Albert A. Stewart	—	—	—	—	—	—	10–29–59	65.8	2–11–60	65.2	74.15
13cb	Earl C. Warnock	—	—	—	—	—	—	—	—	2–11–60	67.6	—
14ba	W. and Y. Nicholas	7–20–39	63.9	—	—	—	—	—	—	—	—	—
18aa	E. C. Highfill	8– 4–39	91.5	—	—	—	—	—	—	—	—	—
18bb	Walter J. Schwieterman	—	—	—	—	—	—	10–29–59	116.3	2–11–60	109.2	112.90
										4– 1–60	108.8	
20bc	Maud Collingwood	8–18–39	78.1	—	—	—	—	—	—	—	—	—
20da	Mrs. G. A. Delay	—	—	—	—	—	—	10–29–59	97.8	2–11–60	93.9	105.47
										4– 1–60	93.4	
22cb	R. W. Aller	8– 4–39	72.9	—	—	—	—	—	—	—	—	—
23bb	Florence Shore	—	—	1–28–59	76.2	2– 4–59	76.7	10–29–59	78.1	2–11–60	77.6	81.87
										4– 1–60	77.4	
23cb	Charles W. Lucas	—	—	1–28–58	81.9	—	—	—	—	—	—	—
24bc	C. E. Warnock	8– 4–39	56.6	—	—	—	—	—	—	—	—	—
25cc	C. R. Lucas	8– 4–39	72.1	—	—	—	—	—	—	—	—	—
32da	Ed Logue	—	—	12– 4–58	107.0	3– 9–59	111.2	10–29–59	108.2	2–12–60	107.5	110.90
										4– 1–60	107.2	
32dd	Merle Logue	8– 2–39	101.1	—	—	—	—	—	—	—	—	—
36bd	Carl Lucas	—	—	—	—	—	—	10–29–59	93.3	2–12–60	93.2	96.93
										4– 1–60	92.8	
30–40–												
3dd	M. Staker	7–28–39	137.7	—	—	—	—	—	—	—	—	—
5ca	Martin Dunklau	—	—	—	—	—	—	—	—	2–12–60	167.7	169.40
										4– 4–60	167.6	
9dc	O. E. Newsome	—	—	—	—	2– 4–59	145.9	11– 2–59	146.6	2–12–60	146.0	149.50
										4– 4–60	145.9	
14dd	A. L. Powell	8–24–39	106.2	—	—	—	—	—	—	—	—	—
17bb	P. H. Moore	8–24–39	152.3	—	—	—	—	—	—	—	—	—
22cb	John Shore	—	—	—	—	—	—	11– 2–59	148.7	2–12–60	148.5	159.49
										4– 1–60	148.0	
24cc2	John Shore	—	—	—	—	—	—	11– 2–59	115.7	2–12–60	114.7	—
24cd	John Shore	—	—	—	—	—	—	8–25–59	107.1	2–12–60	105.4	—
								11– 2–59	105.8	4– 1–60	105.1	
33cc	Walter Herrick	—	—	—	—	—	—	11– 2–59	155.8	2–12–60	155.9	159.38
										4– 1–60	155.5	
35bb	Walter Herrick	—	—	—	—	—	—	—	—	2–12–60	134.0	138.49
										4– 1–60	132.3	
36ab	John Shore	8– 4–39	108.4	—	—	—	—	—	—	—	—	—
36ac	John Shore	—	—	—	—	—	—	10–29–59	124.9	2–12–60	121.9	125.15
										4– 1–60	124.5	

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30-41-												
8dc	A. J. Doughty	7-28-39	181.5	—	—	—	—	—	—	—	—	—
9ab	R. Harmon	8-29-39	141.2	—	—	—	—	—	—	—	—	—
13cc	J. N. Beauchamp	—	—	—	—	—	—	11- 2-59	168.4	2-12-60	168.7	117.65
										4- 4-60	167.6	
										5-25-60	171.0	
14dd	U. S. G. S.	—	—	—	—	—	—	—	—			
18bc	S. Eliz. Davis	8-28-39	139.0	—	—	—	—	—	—	—	—	—
21ad	E. Hilty	9- 7-39	200.3	—	—	—	—	—	—	—	—	—
23aa	U. S. G. S.	—	—	—	—	—	—	—	—	5-25-60	166.9	—
23bc	J. N. Beauchamp	8- 3-39	170.8	—	—	—	—	—	—	—	—	—
30bc	D. H. Reed	9- 7-39	188.1	—	—	—	—	—	—	—	—	—
32ba	Carl Dewell	—	—	—	—	3- 2-59	191.9	11- 2-59	191.6	4- 4-60	191.9	191.27
33db	L. Tucker	8-30-39	181.4	—	—	—	—	—	—	—	—	—
30-42-												
4cc	Guy Rorick	9- 7-39	165.3	—	—	—	—	—	—	—	—	—
9dd	W. D. Rorick	8-28-39	181.0	—	—	—	—	—	—	—	—	—
11db	Milt C. Graber	9- 7-39	193.3	—	—	—	—	—	—	—	—	—
12ac	Clifford Harmon	—	—	—	—	4- 2-59	183.2	11- 3-59	183.0	4- 4-60	183.7	182.39
16bd	Harvey Bitner	—	—	—	—	—	—	11- 3-59	173.2	4- 4-60	171.4	172.82
29aa1	Madeen Heyen	9-11-39	154.9	—	—	—	—	—	—	—	—	—
29db	Madeen Heyen	—	—	—	—	—	—	11- 3-59	176.8	4- 4-60	174.8	—
33dc	Lester Sparks	8-30-39	117.9	—	—	—	—	—	—	—	—	—
30-43-												
2cd	V. E. Wendf	7-19-39	152.6	—	—	—	—	—	—	—	—	—
13db	W. D. Rorick	8-28-39	66.8	—	—	—	—	—	—	—	—	—
20da	C. F. Royce	8-29-39	64.4	—	—	—	—	—	—	—	—	—
22aa	L. W. Bailey	8-28-39	51.1	—	—	—	—	—	—	—	—	—
24dd	M. H. Hume	9-11-39	76.9	—	—	—	—	—	—	—	—	—
28ab	Calvin D. Davis	—	—	12- 4-58	43.9	—	—	11- 2-59	46.1	4- 4-60	45.2	52.38
34bb	W. T. Lawman	—	—	12- 4-58	45.7	—	—	11- 2-59	50.6	4- 4-60	47.0	57.49
36bb	M. H. Hume	—	—	—	—	—	—	11- 2-59	58.7	4- 4-60	57.6	63.79

r Reported depth to water.

* Artesian Well. Flowing 1¼ GPM.

** Not flowing.

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TABLE 19.—Depth in feet below land surface to top of Permian rocks and to base of other geologic formations, from driller logs, Grant County, Kansas.

Well number (1)	Owner	Driller	Altitude of land surface (2)	Lower Pleistocene Subseries	Ogallala Formation	Dakota Formation (3)	Kiowa Shale (3)	Cheyenne Sandstone (3)	Triassic Sandstone, Dockum Group (3)	Top of Permian	Remarks
T. 27 S., R. 35 W.											
27-35-4bbb*	U. S. G. S.	K. G. S.	3,060	362	397+						Base Upper Pleistocene at 142′
27-35-10cc	H. F. Tafton	Henkle Drilling & Supply Co.	3,052	350	390+						
27-35-17ad	H. C. Mayer	Juel Water Well Drilling Co.	3,086	374	400+						
27-35-27ca	H. E. Dixon	do	3,078	355	400+						
27-35-29ba	V. N. Roberts	do	3,093	340	440+						
27-35-33bb	C. E. Ladner	do	3,078	353	420+						
T. 27 S., R. 36 W.											
27-36-1bba*	Mobil Oil Co.	Mobil Oil Co.	3,079	372	403+						
27-36-13ad	Clifford Fort	Western Drilling Co.	3,098	388	400+						
27-36-14cc	Dale Corley	Kenny Minter Water Wells	3,115	357	461+						
27-36-15cc	C. E. Hoffman	do	3,122	348	440+						
27-36-16dc	do	do	3,125	360	440	450+					
27-36-18dc	W. H. Meyer	Juel Water Well Drilling Co.	3,065	300	385	390+					
27-36-21dc	C. W. McCauley	Western Drilling Co.	3,130	350	420+						
27-36-23dc	Martin Long	C. K. Minter Drilling Co.	3,114	366	420+						
27-36-25aa	Blanche Smith	Western Drilling Co.	3,126	389	470+						
27-36-25cc	C. A. Kennedy	Kenny Minter Water Wells	3,134	367	450+						
27-36-32bb	Carl Moyer	Ray Stevenson	3,061	260+							
27-36-32dd	Earnest Kephart	do	3,115	250+							
T. 27 S., R. 37 W.											
27-37-11ab	R. A. Moore	Ray Stevenson	3,093	262	368	390	400+				
27-37-14ba	Dale Corley	do	3,088	280	354	415	460+				
27-37-20cd	Walter Ford	Juel Water Well Drilling Co.	3,073	242	300+						
27-37-22bb	Russell Bechtelheimer	do	3,055	237	318	365	470	604	640+		
27-37-25cb	Alvin Metherd	do	3,060	262	300+						
27-37-26bc	J. H. Siebert	Ray Stevenson	3,053	255	330	365	457	590+			
27-37-26ca*	Mobil Oil Co.	Mobil Oil Co.	3,069	267	315+						
27-37-28cb	A. C. Redinger	Juel Water Well Drilling Co.	3,068	190	340	355+					
27-37-33cc	Ray Lighty	Ray Stevenson	3,070	179	330	385+					
27-37-34ccc*	U. S. G. S.	K. G. S.	3,068	200	300+						
27-37-34da	Keith Puckett	Ray Stevenson	3,076	195	310	399+					
27-37-35dc	Alvin Metherd	Juel Water Well Drilling Co.	3,081	210	320	406	495	600+			
27-37-36cc	Oscar Barnes	Ray Stevenson	3,059	173	280+						
T. 27 S., R. 38 W.											
27-38-6cb	Ray Shaffer	Dreiling Drilling Co.	3,219	70	145	320	415	565	568+		
27-38-12ad	L. C. Waechter	Ray Stevenson	3,076	229	280+						
27-38-12dd	A. S. Anderson	Juel Water Well Drilling Co.	3,101	243	340+						
27-38-13ab	do	do	3,106	234	320+						
27-38-15bb	Mrs. Chas. Andes	E. R. Rexroat	3,149	82	155	290	390	475	485+		
27-38-15dad*	U. S. G. S.	K. G. S.	3,101	221	373	463	475+				
27-38-16ba	Mrs. Robert Waldie	Ray Stevenson	3,167	90	153	200+					
27-38-16bc	do	do	3,124	74	143	200+					
27-38-16db	do	do	3,151	113	173	180+					
27-38-16cc	do	do	3,114	217	333	340+					
27-38-19cd	L. E. Annis	do	3,139	262	360+						
27-38-19db*	do	Juel Water Well Drilling Co.	3,134	248	342	360+					

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27-38-20bd	Mrs. Robert Waldie	Ray Stevenson	3,128	245	357	360+				
27-38-22cc	L. F. Hohner	Juel Water Well Drilling Co.	3,110	225	260+					
27-38-24cc	Flummerfelt & Kistner	do	3,094	236	291+					
27-38-25aaa*	U. S. G. S.	K. G. S.	3,081	220	401	465	530	560+		
27-38-26bb	Charles Shorter	Ray Stevenson	3,105	226	330+					
27-38-27aa	do	Juel Water Well Drilling Co.	3,106	246	280+					
27-38-27bb	Tillie Clowe	do	3,112	222	230+					
27-38-28cb3	Cecil Puckett	Ray Stevenson	3,130	255	300+					
27-38-29da	G. M. Coffey	do	3,126	252	260+					
27-38-30ca	Ray Stevenson	do	3,135	270	360	405+				
27-38-30cb	do	do	3,147	287	380+					
27-38-31ba	Joe Jungferman	do	3,131	260	310+					
27-38-31dd	do	do	3,137	282	317+					
27-38-32bb	G. M. Coffey	do	3,130	246	350+					
27-38-32cc1	J. L. Murphy	do	3,132	264	295+					
27-38-32ddd*	U. S. G. S.	K. G. S.	3,121	254	370	absent ?	520	590	600+	
T. 28 S., R. 35 W.										
28-35-5dc	C. E. Dew	Juel Water Well Drilling Co.	3,122	360	406+					
28-35-8bb	George Meeker	Henkle Drilling & Supply Co.	3,117	363	470+					
28-35-9aa	Max Hand	Kenny Minter Water Wells	3,100	362	440+					
28-35-10bbd*	C. L. Dew	Juel Water Well Drilling Co.	3,102	355	595	absent	634	648+		
28-35-12bb	C. R. Da Vatz	Kenny Minter Water Wells	3,078	357	495+					
28-35-12bd	do	do	3,071	369	510+					
28-35-13ba	do	do	3,065	368	460+					
28-35-15cb	P. J. Harms	do	3,064	358	448+					
28-35-21bb	Henry Koehn	do	3,072	319	420+					
28-35-22bb	do	do	3,056	322	460+					
28-35-23bd	P. J. Harms	do	3,042	345	444+					
28-35-27bb*	Rolla Ulsh	Juel Water Well Drilling Co.	3,041	320	453+					
28-35-29bc	L. D. King	Kenny Minter Water Wells	3,063	295	400+					
28-35-31cd1	Magnolia Petroleum Co.		3,055	305	383+					
28-35-31cd2	do		3,055	310	384+					
28-35-34bb	Henry Koehn	Kenny Minter Water Wells	3,035	305	441+					
28-35-35dc	J. B. Ungles	Juel Water Well Drilling Co.	3,033	380	410+					
T. 28 S., R. 36 W.										
28-36-2ba	Hollis Bullock	Kenny Minter Water Wells	3,132	314	408+					
28-36-2bbb*	U. S. G. S.	K. G. S.	3,119	318	480	490+				
28-36-11ba	Hollis Bullock	Kenny Minter Water Wells	3,103	342	409+					
28-36-13ac	C. R. DaVatz	Loucks Bros. Drilling Co.	3,091	322	434+					
28-36-17bbb*	U. S. G. S.	K. G. S.	3,087	257	420	430 ?	450+			
28-36-31bc	Ralph Teeter	Juel Water Well Drilling Co.	3,060	310	420	430+				
28-36-35ccc*	U. S. G. S.	K. G. S.	3,052	345	420+					
T. 28 S., R. 37 W.										
28-37-1ba	Oscar Barnes	Ray Stevenson	3,012	130	290	300+ ?				
28-37-1bd	do	do	3,002	120	268	270+				
28-37-2bc	Russell Betchelhiemer	Juel Water Well Drilling Co.	3,081	?	332	371	500	560+		
28-37-4ac	Philip Shorter	Ray Stevenson	3,078	213	290	310+				
28-37-5bcc*	C. E. Hoffman	Juel Water Well Drilling Co.	3,072	260	330+					
28-37-9ac	Gerald Gray	do	3,065	285	377	387+				
28-37-10bc2	Keith Puckett	Ray Stevenson	3,057	265	340	350+				
28-37-17cb*	E. M. Farrar	Red Swearengen	3,087	280	386	absent	476	545+		
28-37-21daa1*	City of Ulysses	Juel Water Well Drilling Co.	3,056	260	300+					
28-37-21db1*	do	do	3,060	245	350+					
28-37-22ab	Russell Bechtelhiemer	do	3,052	260	361+					
28-37-26bcc*	City of Ulysses	do	3,039	250	305+					
28-37-26dcc*	U. S. G. S.	K. G. S.	2,975	228	300+					Upper Pleistocene at 50′
28-37-27cd	Santa Fe Railway Co.	———	3,047	268	289+					Upper Pleistocene at 10′

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Table 19.—Depth in feet below land surface to top of Permian rocks and to base of other geologic formations, from driller logs, Grant County, Kansas.—*Continued*

Well number (1)	Owner	Driller	Altitude of land surface (2)	Lower Pleistocene Subseries	Ogallala Formation	Dakota Formation (3)	Kiowa Shale (3)	Cheyenne Sandstone (3)	Triassic Sandstone, Dockum Group (3)	Top of Permian	Remarks
T. 28 S., R. 37 W.											
28-37-28cd	Fred Maxwell	Ray Stevenson	3,058	222	225+						
28-37-30bb	R. R. Hickok	Juel Water Well Drilling Co.	3,097	294	390+						
28-37-31aa2	Pioneer Coop. Assn. Inc.	Ray Stevenson	3,075	283	310+						
28-37-34ccc*	U. S. G. S.	K. G. S.	2,996	233	330+						
28-37-36dd	Grant Co. Cem. Assn.	Juel Water Well Drilling Co.	3,057	315	358+						
T. 28 S., R. 38 W.											
28-38-4ca	Earl Brookover	Ray Stevenson	3,095	260	390	absent ?	398+ ?				
28-38-6cb	O. P. Williams	do	3,142	246	325	340+					
28-38-6dc2*	do	Arnold Drilling Co.	3,133	258	260+						
28-38-7ab	Dale Williams	Ray Stevenson	3,131	253	405	absent	430+ ?				
28-38-8bc	A. G. Dyck	do	3,124	240	395	absent	400+				
28-38-9ca	Ray Stevenson	do	3,110	254	380+						
28-38-15cb	Edna McLaughlin	do	3,101	234	372	absent	420+				
28-38-16ab	Ray Stevenson	do	3,106	246	400	absent	410+				
28-38-16bb	do	do	3,112	250	385+						
28-38-16cb	Mrs. T. M. Halliday	do	3,111	245	400	absent	410+				
28-38-16db3*	do	Juel Water Well Drilling Co.	3,103	233	370	absent	440	530	570+		
28-38-17ab	Ray Stevenson	Ray Stevenson	3,119	240	414	absent ?	450+ ?				
28-38-17bb	do	do	3,119	284	410	absent ?	440+ ?				
28-38-17cb	do	do	3,121	263	375	absent ?	400+ ?				
28-38-18db	do	do	3,125	285	380+						
28-38-18dc	do	do	3,126	280	300+						
28-38-19bc	A. B. Williams	Western Drilling Co.	3,134	280	300+						
28-38-19bd	do	Ray Stevenson	3,133	288	373	absent ?	377+ ?				
28-38-20dc1	Lyle Morris	Juel Water Well Drilling Co.	3,122	265	355+						
28-38-24bbb*	U. S. G. S.	K. G. S.	3,082	282	394+						
28-38-27ba	William Leigh	Ray Stevenson	3,117	274	411	absent ?	420+ ?				
28-38-27ca	do	do	3,117	286	420+						
28-38-28da	C. W. Sturgeon	Juel Water Well Drilling Co.	3,124	310	415	absent ?	absent ?	472+ ?			
28-38-28ccc	Cities Service Gas Co.	Layne-Western	3,117	295+							
28-38-28ccd	do	do	3,118	285	357+						
28-38-30cb	William Haley	Ray Stevenson	3,137	315	410	absent	416+				
28-38-32bbb*	U. S. G. S.	K. G. S.	3,109	230	400	absent ?	440+ ?				
28-38-32dc	Pan-American Oil Co.	Layne-Western	3,127	350	410	absent	470	522+			
28-38-33ba2	W. J. Hemphill	Juel Water Well Drilling Co.	3,098	270	423	absent ?	480+ ?				
28-38-33bd	do	do	3,128	332	423	absent	460+				
28-38-35bc	John Hiebert	Western Drilling Co.	3,103	295	397+						
T. 29 S., R. 35 W.											
29-35-1aaa*	U. S. G. S.	K. G. S.	3,013	375	570	absent	689	absent	absent	689	
29-35-3aa	Cities Service Gas Co.	Layne-Western	3,032	284	378+						
29-35-3ad	do	do	3,032	287	401+						
29-35-6ba	P. M. Hampton	Kenny Minter Water Wells	3,054	299	400+						
29-35-7bc	Columbian Carbon Co.	Layne-Western	3,038	280	351+						
29-35-7cb2	do	Juel Water Well Drilling Co.	3,037	285	400+						
29-35-12dd	G. T. Miller	Henkle Drilling & Supply Co.	3,029	440+							
29-35-14db*	E. H. Miller	C. K. Minter Drilling Co.	3,049	435+							
29-35-15aba*	U. S. G. S.	K. G. S.	3,032	455	470+						
29-35-19dc*	do	K. G. S.	3,027	390	530+						
29-35-21bc*	Howard Miller	Juel Water Well Drilling Co.	3,037	407+							
29-35-28aa*	U. S. G. S.	K. G. S.	2,988	410+							

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T. 29 S., R. 36 W.										
29-36-2ccb*	Mobil Oil Co.	Young Drilling Co.	3,015	305+						
29-36-4ba2	Hollis Bullock	C. K. Minter Drilling Co.	3,058	298	380+					
29-36-7dcc*	U. S. G. S.	K. G. S.	2,998	260	350	absent ?	390+ ?			
29-36-9bb	M. O. Nuss	Kenny Minter Water Wells	3,052	300	403	absent	420+			
29-36-19bc	Earnest Keller	Western Drilling Co.	2,995	250	350+					
29-36-20cd	George Hagerman	Ray Stagner	2,960	220	400+					
29-36-21cdc*	U. S. G. S.	K. G. S.	2,943	215	360+					
29-36-23ddd*	do	do	3,023	340	350+					
29-36-30aaa*	do	do	3,043	310	440+					
29-36-30dc	Keith Schwein	Ray Stagner	3,064	332	470+					
29-36-31db	J. C. Limper	do	3,071	324	460+					
29-36-35ccc*	U. S. G. S.	K. G. S.	2,933	240	512	absent	absent	absent	520+ ?	
T. 29 S., R. 37 W.										
29-37-8cb	D. C. Sullivan, Sr.	Juel Water Well Drilling Co.	3,065	299	430	absent ?	430+ ?			
29-37-16ddd*	U. S. G. S.	K. G. S.	3,038	310	360+					
29-37-22aa	Earl Stein	Ray Stevenson	3,039	280+						
29-37-22cc2	Walter Eichenberger	Juel Water Well Drilling Co.	3,058	300	500+					
29-37-25cd	J. C. Limper	Ray Stagner	3,082	307	450+					
29-37-25dd	do	do	3,091	350	450+					
29-37-26cc	H. H. Caldwell	Ray Stevenson	3,088	300	590—	absent	absent	absent	absent	590+ ?
29-37-28bb	Earl Stein	do	3,087	309	400+					
29-37-29bb	Eugene Swindler	Juel Water Well Drilling Co.	3,094	330	390+					
29-37-32ab	V. V. & V. L. Lattimore	Henkle Drilling & Supply Co.	3,055	306	492+					
29-37-32cc1	Jesse Ford	Juel Water Well Drilling Co.	3,097	330	380+					
T. 29 S., R. 38 W.										
29-38-1bb	Dan Sullivan, Jr	Ray Stevenson	3,094	301	450+					
29-38-3ba	do	Juel Water Well Drilling Co.	3,113	301	459+					
29-38-4aa	C. I. Barnes	Kenny Minter Water Wells	3,112	295	478	absent	480+ ?			
29-38-4cc	M. A. Brewer	Juel Water Well Drilling Co.	3,135	330	450+					
29-38-5acb	Pan-American Oil Co.	Layne-Western	3,132	344	422+					
29-38-6dc	C. D. Jennings	Ray Stevenson	3,142	315	440+					
29-38-8cc	J. T. Klepper	Juel Water Well Drilling Co.	3,154	320	478	absent	485+			
29-38-8da	C. D. Jennings	Ray Stevenson	3,139	310	460	absent	absent	460+ ?		
29-38-20cd	J. W. Siebert	Dreiling Drilling Co.	3,137	330	505	absent	absent	absent	550+ ?	
29-38-21bcb*	U. S. G. S.	K. G. S.	3,126	320	500+					
29-38-22bb	J. W. Seibert	Western Drilling Co.	3,113	297	400+					
29-38-23cc*	U. S. G. S.	K. G. S.	3,055	248	440+					
29-38-24ddd*	do	do	3,114	330	400+					
29-38-25da	Jake Karber	Kenny Minter Water Wells	3,123	318	510	absent	absent ?	590+		
29-38-31dc	E. L. Johnson	Juel Water Well Drilling Co.	3,138	275	335+					
29-38-33bbb*	U. S. G. S.	K. G. S.	3,115	280	450+					
29-38-35ac1	E. A. Kepley	Buell Scott	3,116	307	322+					
29-38-35cd	Ralph Kepley	Juel Water Well Drilling Co.	3,133	340	520	absent	absent ?	545+		
29-38-35db	Ray Kepley	Ray Stagner	3,118	310	420+					
T. 30 S., R. 35 W.										
30-35-3ad	United Production Co.	Rine Drilling Co.	2,985	405	550	absent	absent	absent	absent	550
30-35-4dd*	U. S. G. S.	K. G. S.	2,916	308	400+					
30-35-19bc1	E. P. Brewer	Kenny Minter Water Wells	3,004	338	430+					
30-35-21aa*	U. S. G. S.	K. G. S.	2,873	208	360+					
30-35-34cc*	do	do	2,878	186	320+					
T. 30 S., R. 36 W.										
30-36-5bc	J. W. Alford	Juel Water Well Drilling Co.	3,057	345	385+					
30-36-5cb	do	C. K. Minter	3,056	335	500	absent	absent	absent	540+ ?	
30-36-7aa	Willis Christian	Juel Water Well Drilling Co.	3,057	311	420+					
30-36-9dc	Mrs. W. Jennings	do	3,024	315+						
30-36-16da1	Willis Christian	do	3,027	300	450+					
30-36-16da2	do	do	3,020(e)	294	410+					
30-36-24ccc*	U. S. G. S.	K. G. S.	2,902	228	300+					

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TABLE 19.—Depth in feet below land surface to top of Permian rocks and to base of other geologic formations, from driller logs, Grant County, Kansas.—*Concluded*

Well number (1)	Owner	Driller	Altitude of land surface (2)	Lower Pleistocene Subseries	Ogallala Formation	Dakota Formation (3)	Kiowa Shale (3)	Cheyenne Sandstone (3)	Triassic Sandstone, Dockum Group (3)	Top of Permian	Remarks
T. 30 S., R. 36 W.											
30-36-32bb	Mrs. Fannie Brollier	Juel Water Well Drilling Co.	3,064	365	430+						
30-36-35aaa*	U. S. G. S.	K. G. S.	2,897	70+							
30-36-35ddd*	do	do	2,954	190	270+						
T. 30 S., R. 37 W.											
30-37-1ab	Glen Jarvis	Ray Stagner	3,080	295	400						
30-37-2cd2*	Lawrence Steen	Juel Water Well Drilling Co.	3,089	310	550	absent	absent	absent	570+		
30-37-3bbb*	U. S. G. S.	K. G. S.	3,074	310	520	absent	absent	absent	530+ ?		
30-37-3da*	Lawrence Steen	Juel Water Well Drilling Co.	3,101	340	550	absent	absent	absent	570+		
30-37-6dc	V. V. Lattimore	Ray Stagner	3,122	204	420+						
30-37-10ab	Earl Brookover	Ray Stevenson	3,101	310	430+						
30-37-10bb4	Hugoton Production Co.	Layne-Western Co.	3,104	306	382+						
30-37-10dc	Mrs. T. M. Halladay	Ray Stevenson	3,096	295	420+						
30-37-11db	Verle Johnson	Juel Water Well Drilling Co.	3,083	310	370+						
30-37-15cb2	Ralph Tuttle	do	3,100	350	490+						
30-37-19aa2	H. A. Drake	do	3,127	368	400+						
30-37-20cc	John Lewis	do	3,131	400	410+						
30-37-21bd	Earl Anderson	Dreiling Drilling Co.	3,095	360	410	absent	absent	435	540+		
30-37-21cc	T. E. Joyce	Ray Stevenson	3,104	350+							
30-37-23dd*	U. S. G. S.	K. G. S.	2,971	239	300						
30-37-25ac*	Saturn Oil & Gas Co.	—	3,005	350	514	absent	absent	absent	absent	514	
30-37-26cc	M. F. Frederick	Juel Water Well Drilling Co.	2,978	120+							
30-37-26db2*	U. S. G. S.	K. G. S.	3,077	374	400+						
30-37-30dd*	do	do	3,067	319	334+						
30-37-32aa*	Anadarko Pro. Co.	Garvey Drilling Co.	3,071	345	462	absent	absent	absent	540	540	
30-37-35bd	G. E. McCandless	Juel Water Well Drilling Co.	3,088	346	350+						
T. 30 S., R. 38 W.											
30-38-2ab	Ralph Kepley	Ray Stagner	3,120	344	440+						
30-38-2cb	do	Juel Water Well Drilling Co.	3,139	360	518	absent	absent	absent	550+		
30-38-2cc	do	do	3,135	350	500+						
30-38-5ba	Edward Kepley	—	3,126(e)	288	450+						
30-38-6cc	L. W. Bailey	Tweedy Drilling Co.	3,159	335	364+						
30-38-10ab	Elmer Hennigh	Ray Stevenson	3,149	340	420+						
30-38-10cb*	do	do	3,149	335	390+						
30-38-11ba*	Marion Hennigh	do	3,135	344	405+						
30-38-11bc1*	do	do	3,138	330	460+						
30-38-11dd	Elmer Hennigh	do	3,131	341	370+						
30-38-14ac	Lawrence Hennigh	Ray Stagner	3,155(e)	347	380+						
30-38-15aa	F. M. Schartz	Ray Stevenson	3,140(e)	320	380+						
30-38-19ddd*	U. S. G. S.	K. G. S.	3,146	366	380+						
30-38-26da	G. P. Witt	C. K. Minter	3,154	397	410+						
30-38-30ab1*	U. S. G. S.	K. G. S.	3,153	357	400+						
30-38-32ddd*	do	do	3,173	436	540	absent	absent	absent	560+		
30-38-34bc	G. P. Witt	Henkle Drilling & Supply Co.	3,158	425	432+						
30-38-35db	Ralph Tuttle	Juel Water Well Drilling Co.	3,146	403+							

1. *—Following well number indicates descriptive log included in this report.
2. (e)—Denotes estimated.
3. ?—Available data inadequate for definite identification.

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TABLE 20.—Depth in feet below land surface to top of Permian rocks and to base of other geologic formations, from drillers logs, Stanton County, Kansas.

Well number (1)	Owner	Driller	Altitude of land surface (2)	Lower Pleistocene Subseries	Ogallala Formation	Dakota Formation (3)	Kiowa Shale (3)	Cheyenne Sandstone (3)	Triassic Sandstone, Dockum Group (3)	Top of Permian	Remarks
T. 27 S., R. 39 W.											
27-39-13ac	F. A. Snell	Ray Stevenson	3,177	70	160	305	415	510+			
27-39-13bda*	U. S. G. S.	K. G. S.	3,180	69	190	330	440	537	545+		
27-39-18bbb*	do	do	3,187	100	190+						
27-39-19ab	L. L. Hull	Juel Water Well Drilling Co.	3,193	204	260+						
27-39-19ac	do	do	3,195	210	272	280+					
27-39-20bd	C. H. Helmle	do	3,191	200	350	382+					
27-39-21ac	do	do	3,190	225	415	420+					
27-39-22db	Olin Warner	do	3,178	210	421+						
27-39-23ac2	L. L. Mater	do	3,144	225	370	375+					
27-39-25cb	R. L. Arnold	Sleymeyer Drilling Co.	3,165	258	375	420+					
27-39-26ab	Raymond Molz	Ray Stevenson	3,163	260	350+						
27-39-27bb	M. P. Molz	Kenny Minter Water Wells	3,173	247	380+						
27-39-28baa	V. E. Perry	do	3,189	248	410+						
27-39-28bc	do	do	3,184	250	365+						
27-39-29bb	J. H. Mayhew	do	3,202	185	345	390+					
27-39-30aa	C. H. Helmle	Juel Water Well Drilling Co.	3,210	190	340	365+					
27-39-31db	J. H. Mayhew	Kenny Minter Water Wells	3,190	207	309+						
27-39-31dd	do	do	3,189	198	350	360+					
27-39-32ab	do	do	3,183	240	311	358+					
27-39-33bd	V. E. Perry	Ray Stevenson	3,165	222	350	360+ ?					
27-39-34dd	E. H. Moore	————	3,153	241	330+						
27-39-35ab	Faye Collingwood	————	3,159	245	380+						
T. 27 S., R. 40 W.											
27-40-17dcc*	U. S. G. S.	K. G. S.	3,267	132	310	350+ ?					
27-40-18cc	O. E. Josserand	Kenny Minter Water Wells	3,276	159	240+						
27-40-25cb	Clarence Winger	Juel Water Well Drilling Co.	3,228	203	328	340+ ?					
27-40-26ba	T. R. Winger	Ray Stevenson	3,228	156	358	absent	359+ ?				
27-40-35ab2	Clarence Winger	Juel Water Well Drilling Co.	3,232	180	310	375	435	620+			
T. 27 S., R. 41 W.											
27-41-1bbb*	U. S. G. S.	K. G. S.	3,265	169	226	289	356	412	617+		
27-41-2dd	Buell Scott	Buell Scott	3,291	211+							
27-41-10ac	J. W. Raney	Dreiling Drilling Co.	3,314	175	260	310 ?	370	450	465+		
27-41-13bbb*	U. S. G. S.	K. G. S.	3,274	190	228	240+					
27-41-31ac	Mrs. R. L. Ball	Henkle Drlg. & Sup. Co., Inc.	3,397	250	320+						
27-41-31cc2	James Peterson	do	3,401	249	360+						
27-41-35cc	Thomas and Lawrence Seyb	Kenny Minter Water Wells	3,340	236	380+						
27-41-35cc2	do	Dreiling Drilling Co.	3,340	235	370	absent ?	430 ?	500 ?	610+ ?		
T. 27 S., R. 42 W.											
27-42-11db	William Hoff	Henkle Drlg. & Sup. Co., Inc.	3,397	144	250	260+ ?					
27-42-24cc*	U. S. G. S.	K. G. S.	3,410	181	270+						
27-42-31cc	Jim Scrivner	Ray Stevenson	3,534	152	298	310+ ?					
T. 27 S., R. 43 W.											
27-43-1ccc*	U. S. G. S.	K. G. S.	3,521	136	380+						
27-43-4cc	David Weaver	Dreiling Drilling Co.	3,603	155	370	absent ?	450	520+			
27-43-23aaa*	U. S. G. S.	K. G. S.	3,527	116	200+						

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TABLE 20.—Depth in feet below land surface to top of Permian rocks and to base of other geologic formations, from drillers logs, Stanton County, Kansas.—*Continued*

Well number (1)	Owner	Driller	Altitude of land surface (2)	Lower Pleistocene Subseries	Ogallala Formation	Dakota Formation (3)	Kiowa Shale (3)	Cheyenne Sandstone (3)	Triassic Sandstone, Dockum Group (3)	Top of Permian	Remarks
T. 28 S., R. 39 W.											
28-39-1bb	O. P. Williams	Ray Stevenson	3,143	247	395	absent	522	626+			
28-39-2ab	Faye Collingwood	do	3,147	272	395+						
28-39-2ccc*	U. S. G. S.	K. G. S.	3,152	266	350+						
28-39-2da	M. C. Romersi	Juel Water Well Drilling Co.	3,146	270	400+						
28-39-2dc*	do	do	3,143	250	318	371 ?	483	580+			
28-39-3bb	E. H. Moore	Ray Stevenson	3,170	254	377	absent ?	390+ ?				
28-39-4cc	Vivian Glenn	Juel Water Well Drilling Co.	3,177	?	360	absent	425	575	640+		
28-39-5bb1	Charles Winger	Buell Scott	3,187	235+							
28-39-8bc	Vivian Glenn	Ray Stevenson	3,200	250	290+						
28-39-8db	do	Juel Water Well Drilling Co.	3,186	250	310+						
28-39-9ab	do	do	3,176	250	380+						
28-39-12bd	D. H. Pinegar	Ray Stevenson	3,139	270	400+						
28-39-13cbb*	U. S. G. S.	K. G. S.	3,143	300	365+						
28-39-14bb1	Herbert Campbell, Jr.	Henkle Drlg. & Sup. Co., Inc.	3,158	274	360+						
28-39-14bb2	do	do	3,156	266	400+						
28-39-15ac	Herbert Campbell, Sr.	do	3,177	278	390						
28-39-17bc	Vivian Glenn	Juel Water Well Drilling Co.	3,200	240	320+						
28-39-18bb	Homer Richards	Henkle Drlg. & Sup. Co., Inc.	3,223	263	370+						
28-39-19aaa*	U. S. G. S.	K. G. S.	3,198	250	400+						
28-39-20ac	Vivian Glenn	Juel Water Well Drilling Co.	3,184	?	310+						
28-39-20bd	Carl Levins	Henkle Drlg. & Sup. Co., Inc.	3,188	249	325+						
28-39-22db	Melvin Wilson	Juel Water Well Drilling Co.	3,182	290	424	absent ?	424+ ?				
28-39-23aa	R. E. Foresman	Ray Stagner	3,156	290	410+						
28-39-26ac	Bert Dubois	Juel Water Well Drilling Co.	3,169	290	415+						
28-39-28ac	Elmer Kendrick	Dreiling Drilling Co.	3,180	285	405	465 ?	520 ?	570 ?	600 ?	600	
28-39-28cc	do	Kenny Minter Water Wells	3,192	297	391	400+ ?					
28-39-31ab	K. C. Easton	Juel Water Well Drilling Co.	3,220	345	425+						
28-39-31bc	Stanley Julian	Kenny Minter Water Wells	3,232	330	440+						
28-39-33ac	E. Wetzler	Ray Stevenson	3,201	359	430+						
28-39-34cb	Fred Maxwell	do	3,202	350	430+						
28-39-35cc	Big Bow School District	Dreiling Drilling Co.	3,175	315	320+ ?						
28-39-36ab	Fred Shore	Juel Water Well Drilling Co.	3,145	330	412	absent	420+ ?				
T. 28 S., R. 40 W.											
28-40-2cb	Grover Dotzour	do	3,239	230	320+						
28-40-3cc	C. E. Winger	do	3,252	243	330+						
28-40-4cc	Eugene Floyd	do	3,289	274	360+						
28-40-15cc	C. H. Beckett	do	3,259	287	375+						
28-40-17cb	B. E. Josserand	Schleymeyer	3,321	260	380 ?	absent ?	380+ ?				
28-40-19dc	Forest Walker	Dreiling Drilling Co.	3,325	280	385	absent ?	395+ ?				
28-40-21cc	Alfred Ramsey	Kenny Minter Water Wells	3,291	284	415+						
28-40-21dc2*	J. A. Ramsey	Juel Water Well Drilling Co.	3,280	250	300+						Sample log.
28-40-25cc2	O. E. Josserand	Kenny Minter Water Wells	3,247	312	440	absent	445+				
28-40-25dc	do	Henkle Drilling & Supply Co.	3,232	296	390+						
29-40-26bc	Ivan Josserand	Dreiling Drilling Co.	3,265	295	425	absent ?	450+ ?				
28-40-27cc	W. R. Puyear	Juel Water Well Drilling Co.	3,285	?	465+						Undiff. Pleistocene and Pliocene.
28-40-29ab	P. E. Plummer	Juel Water Well Drilling Co.	3,305	?	390+						do
28-40-31bb	do	do	3,333	280	410+						
28-40-32cc	R. M. Speck	Kenny Minter Water Wells	3,314	351	450+						

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28-40-33ba	Kan. Colo. Utilities	Juel Water Well Drilling Co.	3,290	?	400+					Undiff. Pleistocene and Pliocene.
28-40-35bd	W. R. Puyear	do	3,267	315	450+					
28-40-35ca	Elmer Martin	do	3,265	270	450+					
28-40-36cb	M. G. York	Kenny Minter Water Wells	3,260	316	440+					
T. 28 S., R. 41 W.										
28-41-5bb	LeRoy Cockrum	Dreiling Drilling Co.	3,382	230	330	absent	420	485	535+ ?	
28-41-6ab	C. R. Peterson	Henkle Drlg. & Sup. Co., Inc.	3,394	217	353	absent ?	354+ ?			
28-41-9ccc*	U. S. G. S.	K. G. S.	3,376	224	368	absent ?	370+ ?			
28-41-11bc	Nellie Craig	Juel Water Well Drilling Co.	3,332	180	260+					
28-41-14aa	do	do	3,333	210	345	absent	360+			
28-41-14aad*	U. S. G. S.	K. G. S.	3,339	194	294+					
28-41-25ab	Ruth Archer	Juel Water Well Drilling Co.	3,344	295	405+					
28-41-25cb	P. E. Plummer	do	3,345	290	390+					
28-41-31bd	Marlin McKinney	Ray Stagner	3,411	225	280+					
28-41-35aaa*	U. S. G. S.	K. G. S.	3,347	316	438	absent	410+ ?			
T. 28 S., R. 42 W.										
28-42-2ddd*	do	do	3,434	190	318	absent ?	330+ ?			
28-42-10cc	W. S. Scrivner	Dreiling Drilling Co.	3,495	220	320	absent	340+			
28-42-14bc	Robert Scrivner	do	3,479	230	370	absent ?	370+?			
28-42-16dc	Lester Stanton	Tony Dreiling	3,535	210	345	absent	400+			
28-42-23db	E. A. Wortman	Ray Stagner	3,475	265	390	absent ?	400+ ?			
28-42-24dc	Ennis Figgins	do	3,439	212	335	absent ?	340+ ?			
28-42-25aa	do	do	3,436	260	380+					
28-42-32bb	Mabel Nichols	Great Plains Drilling Co.	3,540	60	145	absent	280	412	445+	
28-42-35ba	Hal Hale	Ray Stagner	3,449	120	184+					
28-42-35bb	do	do	3,472	100	180+					
R. 28 S., T. 43 W.										
28-43-13bbb*	U. S. G. S.	K. G. S.	3,593	145	191	214+				
28-43-16ddd*	do	do	3,643	156	209	220+				
T. 29 S., R. 39 W.										
29-39-1bb	Carl Dahlquist	Western Drilling Co.	3,141	277	320+					
29-39-2ab	Francis Krone	Ray Stevenson	3,163	315	435	absent	450+			
29-39-2cd2	H. H. Brown	W. H. Smoot	3,158	320+						
29-39-6cc	T. J. Julian	Kenny Minter Water Wells	3,236	345	460+					
29-39-8ac	Harriet McBurney	Juel Water Well Drilling Co.	3,225	370	485+					
29-39-15ac	Roger Jones	do	3,188	315	435+					
29-39-17bc	Vivian Glenn	do	3,238	315	460+					
29-39-18ac	T. J. Julian	Kenny Minter Water Wells	3,238	310	480+					
29-39-24dd	V. E. Ruth	Schlemeyer Drilling Co.	3,153	301	314+					
29-39-24dda*	U. S. Geological Survey	Kansas Geological Survey	3,154	308	380+					
29-39-26bd	Melvin Wilson	Juel Water Well Drilling Co.	3,184	311	440+					
29-39-27aaa*	U. S. Geological Survey	Kansas Geological Survey	3,174	282	410+					
29-39-30bb*	do	do	3,228	269	470+					
29-39-32dc	F. M. Simpson	Kenny Minter Water Wells	3,212	342	460+					
T. 29 S., R. 40 W.										
29-40-1cc	S. A. Julian	do	3,251	372	440+					
29-40-3bd	H. J. Clark	Juel Water Well Drilling Co.	3,281	400	410+					
29-40-3db	L. A. Davidson	Kenny Minter Water Wells	3,275	376	420+					
29-40-6db	G. V. Arnold	Juel Water Well Drilling Co.	3,321	373	450+					
29-40-11bb	R. H. Trostle	do	3,274	370	450+					
29-40-11cb	do	Ray Stevenson	3,266	345	430+					
29-40-12bb	S. A. Julian	Kenny Minter Water Wells	3,255	380	446+					
29-40-16ba	Elmer Martin	Juel Water Well Drilling Co.	3,292	296	385+					
29-40-21ddd*	U. S. Geological Survey	Kansas Geological Survey	3,272	291	410+					
29-40-25dc	E. E. Whipple	Juel Water Well Drilling Co.	3,234	312	450+					
29-40-31db	F. M. Simpson	Kenny Minter Water Wells	3,333	237	342	absent	absent ?	354+ ?		

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TABLE 20.—Depth in feet below land surface to top of Permian rocks and to base of other geologic formations, from drillers logs, Stanton County, Kansas.—*Concluded*

Well number (1)	Owner	Driller	Altitude of land surface (2)	Lower Pleistocene Subseries	Ogallala Formation	Dakota Formation (3)	Kiowa Shale (3)	Cheyenne Sandstone (3)	Triassic Sandstone, Dockum Group (3)	Top of Permian	Remarks
T. 29 S., R. 40 W.											
29-40-33ac	Harry Teeter	Ray Stevenson	3,282	243	360+						
29-40-34bb	do	do	3,270	240	360+						
29-40-35dd	W. W. Plummer	Juel Water Well Drilling Co.	3,261	221	460+						
T. 29 S., R. 41 W.											
29-41-3da	Donald Jones	Dreiling Drilling Co.	3,385	230	460	absent	absent	490	605+		
29-41-11bd	G. V. Arnold	Juel Water Well Drilling Co.	3,363	280	470+						
29-41-12cc	Clifton Dye	Kenny Minter Water Wells	3,342	249	460+						
29-41-13ac	C. D. Kendrick	do	3,342	248	415+						
29-41-23db	H. D. Gullers	Juel Water Well Drilling Co.	3,372	255	375+						
29-41-24ac	R. J. Shetlar	Dreiling Drilling Co.	3,348	250	405	absent	absent	425+ ?			
29-41-28bbb*	U. S. Geological Survey	Kansas Geological Survey	3,380	128	246	absent	260+				
T. 29 S., R. 42 W.											
29-42-1bb	H. F. McKinney	————?	3,420	?	130	210+					Undiff. Pleistocene and Pliocene.
29-42-8cd	C. H. Bilberry	Great Plains Drilling Co.	3,517	?	75	240	295	361	363+		do
29-42-11dc	L. W. Bailey	do	3,486	?	150	258	324	410	415+		do
29-42-19ca	C. H. Bilberry	————?	3,564(e)	?	104	278	352	401	403+		do
29-42-24cc*	G. A. Wilcox	Dreiling Drilling Co.	3,484	137	260	297	360	410	515+		
T. 29 S., R. 43 W.											
29-43-3db	W. O. Bearce	Great Plains Drilling Co.	3,609	?	145	285	375	416	550+		Undiff. Pleistocene and Pliocene.
29-43-23ccc*	U. S. Geological Survey	Kansas Geological Survey	3,588	?	40+						do Auger hole.
29-43-29ab	L. W. Bailey	Great Plains Drilling Co.	3,630	?	55	170	253	305	310+		Undiff. Pleistocene and Pliocene.
29-43-33cd	Virgil Stewart	Dreiling Drilling Co.	3,654	?	55	155	240	330	510	510	do
T. 30 S., R. 39 W.											
30-39-2bbb*	U. S. Geological Survey	Kansas Geological Survey	3,188	318	420+						
30-39-2cb	Fred Shore	Juel Water Well Drilling Co.	3,186	330	410+						
30-39-4dc	R. J. Shetlar	do	3,203	345	485	absent	absent	absent	500+		
30-39-18bb	W. J. Schwieterman	do	3,237	304	380+						
30-29-20da	Mrs. G. A. Delay	do	3,209	246	330+						
30-39-23bb	Lewis Shore	Henkle Drlg. & Sup. Co., Inc.	3,176	365	404	absent	absent	absent	420+		
30-39-23cb	C. W. Lucas	Kenny Minter Water Wells	3,176	329	393	do	do	do	420+		
30-39-32da	Ed Logue	Henkle Drlg. & Sup. Co. Inc.	3,226	234	260+						
30-39-36bd	Carl Lucas	Kenny Minter Water Wells	3,179	340	415	absent	absent	absent	420+		
T. 30 S., R. 40 W.											
30-40-2cb	J. B. Malone	Juel Water Well Drilling Co.	3,278	240	410+						
30-40-5ca	Martin Dunklau	do	3,324	235	310+						
30-40-8ab	Teresa McDowell	Kenny Minter Water Wells	3,314	211	281	absent	290+				
30-40-22cb	John Shore	Dreiling Drilling Co.	3,292	185	260	absent	?	320+			Undiff. Kiowa and Cheyenne.
30-40-24cc1	do	Fred Sweazy	3,247	130	185	221	244+				
30-40-24cd	do	————?	3,236	142	195	285	296+				

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30-40-27ca	Walter Herrick	Dreiling Drilling Co.	3,260	?	150	225+					Undiff. Pleistocene and Pliocene.
30-40-33cc	do	do	3,309	?	115	220	250+				do
30-40-35bb		do	3,270	?	120	255	265+				do
30-40-36ac	John Shore	Great Plains Drilling Co.	3,258	?	175	290+					do
T. 30 S., R. 41 W.											
30-41-1bbb*	U. S. Geological Survey	Kansas Geological Survey	3,359	97	217	240+					
30-41-12cc	W. E. Smoot	Central Drilling Co.	3,357(e)	80?	240	255	300+				
30-41-14dd*	U. S. Geological Survey	Kansas Geological Survey	3,347	70	220	225+					
30-41-30bcc*	do	do	3,416	134	195	absent	230+				Undiff. Pleistocene and Pliocene.
30-41-32a	T. F. Shumate	——?	3,430(e)	?	195	absent	197+ ?				
T. 30 S., R. 42 W.											
30-42-29aa3	Huber Oil Co.	——?	3,560	?	80	195	255	380	540	540	Sample Log Undiff. Pleistocene and Pliocene.
T. 30 S., R. 43 W.											
30-43-5ad	Virgil Stewart	Dreiling Drilling Co.	3,666	?	45	165	250	320	505+		do Auger.
30-43-9dad*	U. S. Geological Survey	Kansas Geological Survey	3,643	?	34	34+					do
30-43-25cc	M. H. Hume	——?	3,598	?	86+						do
30-43-26dd	do	Cy Campus	——?	?	98+						do
30-43-28ab	C. O. Davis	Holt	3,627	?	100+						do
30-43-28add*	U. S. Geological Survey	Kansas Geological Survey	3,590	?	46	46+					do Auger.
30-43-33aaa*	do	do	3,623	?	70+						do Auger.
30-43-35bb	M. H. Hume	——?	3,605	?	112+						do
30-43-36bb	do	——?	3,595	?	100	absent	220	350	500+		do

1. *—Following well number indicates descriptive log included in this report.
2. (e)—Denotes estimated.

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LOGS OF WELLS AND TEST HOLES

The following are logs of 95 test holes drilled in Grant and Stanton counties. Sixty-nine of these test holes were drilled by the State and Federal Geological Surveys and are headed "Sample log of test hole in . . ." These tests were logged by the authors during drilling and supplemented by studying the formation samples. Twenty-six of the test holes were drilled by commercial well drillers for individual land owners, and formation samples were collected; these are headed "Sample logs of test holes drilled by . . ." These 26 test holes were logged by the personnel of the Geological Survey from the formation samples and the descriptions may differ somewhat from that of the drillers.

In addition, 342 test holes drilled and logged by commercial well drillers are summarized in Tables 19 and 20. An asterisk after the well number in Tables 19 and 20 indicates that a descriptive log is also included in this report, and an "e" after the altitude means that the altitude was estimated. Table 2 presents similar information from electrical and radioactivity logs.

GRANT COUNTY

27-35-4bbb.—Sample log of test hole drilled in NW NW sec. 4, T. 27 S., R. 35 W., 20 feet south and 20 feet east of NW cor. sec. 4; January 15, 1959; altitude of land surface, 3,060 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, sandy	20	20
Sand, fine to medium, silty; contains coarse grains	50	70
Sand, medium to very coarse, silty	10	80
Sand, very coarse, and fine gravel	13	93
Gravel, fine to coarse, and very coarse sand	49	142
Sand, fine to medium, silty	47	187
Silt, sandy, brown	9	196
Sand, fine to coarse, silty, and fine gravel	52	248
Sand, fine to coarse, silty; contains thin brown clay layers	25	273
Sand, fine to coarse, and fine gravel	26	323
Clay, silty, brown	7	330
Sand, fine to coarse, and fine gravel	8	338
Silt, sandy, brown	5	343
Sand, fine to coarse, and fine gravel	19	362
Pliocene		
Ogallala Formation		
Silt, clayey, tan-buff	2	364
Sand, fine to coarse	3	367
Sand, fine to medium; contains some coarse grains	13	380
Sand, fine to medium, and fine gravel; contains thin brown silt layers	17+	397

27-36-1bba.—Sample log of test hole drilled by Mobil Oil Co. for shot hole test in NE NW NW sec. 1, T. 27 S., R. 36 W., 0.22 mile east and 35 feet south of NW cor. sec. 1; February 5, 1960; altitude of land surface, 3,079 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	3	3
Sand, fine to medium, silty, brown	12	15
Sand, fine to coarse	15	31
Sand, fine to medium; contains thin silt beds	15	46
Sand, medium to coarse, brown.	16	62
Sand, silty, brown	10	72
Sand, medium to coarse; contains fine gravel	5	77
Clay, silty, yellow	5	82
Sand, coarse; contains fine gravel	5	87
Sand, medium to coarse; contains pea gravel	21	108
Gravel, course; contains very coarse sand	20	128
Sand, coarse; contains fine to medium gravel	26	154
Clay	3	157
Clay, silty, tan; contains fine sand strips	10	167
Sand, medium to coarse; contains fine gravel and thin tan clay strips	10	177
Gravel, fine to medium; contains coarse sand	13	190
Clay, silty, yellow; contains beds of medium gravel and coarse sand	16	206
Gravel, fine to medium, and coarse sand	8	214
Clay, blue-gray	33	247
Sand, medium to coarse	8	255
Clay, blue-gray	8	263
Sand, coarse to medium	5	268
Clay, blue-gray	2	270
Sand, fine to medium; with a few blue clay layers	10	280
Clay, blue; with thin fine sand layers	15	295
Clay, blue-gray	10	305
Clay, tan; interbedded blue-gray clay	2	307
Sand, fine to medium	4	311
Clay, tan; interbedded blue-gray clay layers and thin fine sand layers	8	319
Sand, medium to coarse, and fine gravel; interbedded gray and tan silt	53	372

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	Thickness, feet	Depth, feet
Pliocene		
Ogallala Formation		
Sand, fine to medium; with thin tan clay layers	12	384
Sand, coarse to medium	10	394
Clay, tan-gray	9+	403

27-37-26ca.—Sample log of test hole drilled for Mobil Oil Co. in NE SW sec. 26, T. 27 S., R. 37 W., about 650 feet south and 650 feet west of center of sec. 26; 1959; altitude of land surface, 3,069 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Topsoil and tan silt	15	15
Clay and silt, brown	30	45
Clay, sandy, brown	15	60
Silt, sandy, brown	13	73
Sand, fine, brown	7	80
Clay, hard, tan	25	105
Silt, tan, and gray clay strips	15	120
Silt, tan, and very fine sand	10	130
Silt, tan, and fine sand strips	20	150
Sand, very fine, silty, tan; contains a few thin brown clay strips	38	188
Sand, very fine, silty, gray	15	203
Sand, very fine, tan	17	220
Sand, fine, and caliche	15	235
Sand and fine gravel; contains caliche strips	15	250
Gravel	17	267
Pliocene		
Ogallala Formation		
Clay and caliche	8	275
Sand, coarse	5	280
Sand and fine gravel	7	292
Clay and caliche	23+	315

27-37-34ccc.—Sample log of test hole drilled in SW SW sec. 34, T. 27 S., R. 37 W. at SW cor. sec. 34; 1942; altitude of land surface, 3,068 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Soil, compact, silty, sandy, tan and brown	1	1
Silt, compact, sandy, gray and brown; contains caliche	9	10
Sand, fine, silty, brown	3	13
Silt and fine sand, brown; contains caliche	5	18
Silt, tan; contains caliche and sand layers	19	37
Sand, coarse	3	40
Clay, compact, tan; contains silt and fine sand	10	50
Silt and clay, compact, sandy, tan	20	70
Silt, sandy, gray and green	10	80
Sand, very fine; contains brown silt	20	100
Silt, sandy, tan; contains caliche	10	110
Clay, gray; and brown, fine sand	10	120
Sand, fine, silty, tan	10	130
Silt, sandy, brown	10	140
Sand, very fine, silty, tan	20	160
Sand, very fine, silty, tan; contains clay layers	15	175
Sand, fine to medium; contains clay strips	15	190
Silt, very sandy, and gray clay,	10	200
Pliocene		
Ogallala Formation		
Sand, fine, silty, tan	13	213
Sand, fine to coarse, brown	7	220
Silt and fine sand; contains caliche	10	230
Sand, coarse, brown	8	238
Sand and fine gravel	27	265
Gravel, fine to coarse, sandy; contains brown silt	5	270
Silt, sandy, yellow; contains caliche	15	285
Clay and silt; contains weathered fragments of sandstone	15+	300

27-38-15dad.—Sample log of test hole drilled in SE NE SE sec. 15, T. 27 S., R. 38 W., 0.3 mile north and 25 feet west of SE cor. sec. 15; September 25, 1959; altitude of land surface 3,101 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Silt, gray-brown	10	10
Silt, gray-brown, and fine to medium sand	10	20
Silt, brown-gray, and fine sand,	10	30
Silt, clayey, tan, and fine sand,	30	60
Sand, fine to medium, silty	52	112
Clay, tan; interbedded with buff, sandy silt	20	132
Sand, fine to medium, silty, tan,	5	137
Silt, clayey, blue-gray	25	162
Sand, medium to coarse	21	183
Caliche	3	186
Silt, sandy, brown	8	194
Sand, medium to very coarse, and fine to medium gravel	27	221
Pliocene		
Ogallala Formation		
Silt, clayey, brown	9	230
Sand, fine to medium; contains caliche	10	240
Silt, clayey, brown	13	253
Sand, fine to coarse	29	282
Clay, silty, tan	13	295
Silt, clayey, tan; contains thin layers of silty sand and caliche	78	373
Cretaceous		
Lower Cretaceous		
Dakota Formation [Lower(?) Cretaceous]		
Sandstone, brown to yellow, and brown shale	48	421
Sandstone, red-brown; contains thin layers of dark-brown shale	26	447
Shale, brown-red	3	450
Sandstone, brownish-red to gray,	13	463
Kiowa Shale		
Shale, hard, blue	12+	475

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27-38-19db.—Sample log of test hole drilled by Juel Water Well Drilling Co. for L. E. Annis in NW SE sec. 19, T. 27 S., R. 38 W., 0.26 mile north of S¼ cor. sec. 19; November 11, 1958; altitude of land surface, 3,134 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Sand, fine to meduim, silty, dark-gray	10	10
Sand, fine to coarse; some light-gray silt	10	20
Sand, very coarse, and fine gravel	40	60
Gravel, fine to medium, and very coarse sand	30	90
Sand, very coarse, and fine to very fine gravel	10	100
Silt, sandy, gray-brown; caliche-cemented	20	120
Sand, fine to coarse, and buff-tan silt	32	152
Sand, medium to coarse, and fine to medium gravel	13	165
Silt, sandy, brown	4	169
Sand, fine to coarse, silty, tan	10	179
Sand, fine to medium; with silt; caliche-cemented	16	195
Sand, very coarse to medium, and fine gravel; with some caliche-cemented beds	37	232
Sand, medium to coarse, interbedded with brown-tan silt	16	248
Pliocene		
Ogallala Formation		
Sand, fine, silty, buff-tan	20	268
Silt, very sandy, buff-tan; caliche-cemented	15	283
Sand, fine to medium; some coarse quartz grains, and buff-tan silt; some caliche-cemented layers	34	317
Silt, buff-tan, and fine to medium sand	11	328
Sand, fine to medium, and buff-tan silt	13	342
CRETACEOUS		
Lower(?) Cretaceous		
Dakota Formation		
Shale, gray to yellow-brown; fine-grained sandstone, iron cemented	28+	360

27-38-25aaa.—Sample log of test hole drilled in NE NE sec. 25, T. 27 S. R. 38 W., 25 feet west and 40 feet south of NE cor. sec. 25; September 16, 1959; altitude of land surface, 3,084 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, gray	10	10
Sand, brown	5	15
Sand, brown, and silt	5	20
Silt, brown	60	80
Silt, sandy, light-brown, and caliche	10	90
Silt, sandy, brown and gray	20	110
Silt, gray and brown	20	130
Silt, brown	10	140
Silt, brown, and very fine sand,	10	150
Silt, blue and brown	20	170
Silt, hard, brown, and fine sand,	17	187
Sand, fine	3	190
Sand, fine to coarse	10	200
Sand, fine to coarse, and brown silt	10	210
Sand, fine; contains a little brown clay	10	220
Pliocene		
Ogallala Formation		
Gravel, fine	10	230
Sand and gravel	55	285
Silt, pink	2	287
Sand	3	290
Sand and gravel	8	298
Caliche, hard	12	310
Silt, hard, brown and gray	27	337
Clay, red	1	338
Silt, hard, brown and gray	12	350
Silt, hard, brown; and some ironstone and sandstone chips,	30	380
Silt, hard, brown, and ironstone chips	21	401
CRETACEOUS		
Lower Cretaceous		
Dakota Formation [Lower(?) Cretaceous]		
Sandstone, hard, dark-brown	3	404
Shale, hard, brown and green streaks	11	415
Sandstone, hard, brown	1	416
Shale, brown	7	423
Sandstone, gray-brown	2	425
Shale, sticky, tan	2	427
Shale, hard, tan	2	429
Shale, very hard, tan	0.5	429.5
Shale, hard, black and brown	10.5	440
Shale, hard, brown and blue	16	456
Shale, sticky	1	457
Shale, hard, blue and brown streaks	8	465
Kiowa Shale		
Shale, hard, dry, brown, blue, and white	2	467
Shale, hard, dry, brownish-yellow	8	475
Shale, soft, brown and blue streaks	8	483
Shale, hard, blue	5	488
Sandstone and shale streaks, hard	6	494
Sandstone, fine to coarse, friable	4	498
Shale, hard, blue	10	508
Shale, soft, blue	2	510
Shale, soft, sticky, blue	20	530
Cheyenne Sandstone		
Sandstone, fine-grained, soft, white	20	550
Sandstone, fine-grained, granular, friable, limonitic, tan	10+	560

27-38-32ddd.—Sample log of test hole drilled in SE SE SE sec. 32, T. 27 S., R. 38 W., SE cor. sec. 32; 1942; altitude of land surface, 3,121 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, silty, gray	1	1

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	Thickness, feet	Depth, feet
Silt, sand, buff; containing gravel, sand, and clay	13	14
Clay, silty, compact, buff to tan,	6	20
Silt, fine, sandy, buff to tan	13	33
Silt, sand, and gravel; poorly sorted; gray to gray-green, tan, and buff	33	66
Silt, sandy, gray to brown, containing caliche	4	70
Silt, sandy, gray and white, containing fine gravel	7	77
Silt, sandy, compact, buff, containing a little caliche	33	110
Sand and gravel, fine to coarse, light gray to buff, containing silt	30	140
Silt, fine, sandy, buff to gray, containing gravel and a little clay	40	180
Silt, compact, dark-tan to brown, containing fragments of charcoal	10	190
Gravel, fine to coarse; containing buff to brown silt and fine sand	40	230
Silt, buff to tan, and fine gravel, containing sand	24	254
Pliocene		
Ogallala Formation		
Clay, compact, blocky, dark-tan to brown; contains silt and a little charcoal	28	282
Silt, sandy to clayey, compact, dark tan, containing caliche	2	290
Silt, white to buff, and medium to coarse gravel; contains sand, caliche, and clay	10	300
Sand, fine to very fine, semiconsolidated, red-brown to yellow; contains much silt and clay	10	310
Clay, in part sand, dark-tan to brown and red; contains fragments of yellow-brown sandstone and ironstone	30	340
Sand, fine to coarse, partially cemented, yellow-brown to dark rusty brown; contains a little silt and clay	10	350
Clay, silty, compact, gray to tan, contains fragments of fine sandstone and ironstone	10	360
Clay, silty, yellow; contains a few fine sandstone fragments,	10	370
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Shale, silty, soft, dark-brown	15	385
Shale, sandy, soft, gray	15	400
Shale, clayey, fissile, soft, gray to dark-gray, containing fragments of pyrite and charcoal,	50	450
Shale, fine sandy, gray	30	480
Shale, fissile, soft, dark-gray to black, containing streaks of white sandstone	22.5	502.5
Shale, clayey to fine sandy, soft, light-gray and gray	7.5	510
Shale, clayey, dark-gray to black	10	520
Cheyenne Sandstone		
Sandstone, fine to coarse, friable	10	530
Sandstone, fine, friable, white	33	563
Shale, clayey, soft, light-gray and light-green	7	570
Sandstone, fine, friable, white	20	590
TRIASSIC		
Upper Triassic		
Dockum Group		
Sandstone, very fine, hard, white	1.5	591.5
Shale, silty to clayey, soft, light-gray and green, containing streaks of hard sandstone	6.5	598
Siltstone, soft, red	2+	600

28-35-10bbd.—Sample log of test hole drilled by Juel Water Well Drilling Co. for C. L. Dew in NW NW sec. 10, T. 28 S., R. 35 W., 0.2 mile south and 0.2 mile east of NW cor. sec. 10; September 1959; altitude of land surface, 3,102 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil and gray silt	10	10
Silt, brown, and caliche	10	20
Silt, light grayish-brown	10	30
Silt, caliche and coarse sand	20	50
Silt, brown and gray	20	70
Sand, fine to medium	10	80
Sand, fine to coarse	30	110
Sand and fine gravel	10	120
Sand, coarse	18	138
Clay, silty, brown	10	148
Sand, coarse, and fine gravel	16	164
Sand, fine, and brown silt	5	169
Clay, brown	9	178
Sand, medium to coarse	14	192
Clay, silty, brown	5	197
Sand, medium, silty, brown-tan,	38	235
Clay, silty, brown	20	255
Sand, medium to coarse, and fine gravel	30	285
Clay, hard, brown	13	298
Clay, silty, brown	47	345
Sand, fine, brown	10	355
Pliocene		
Ogallala Formation		
Clay, silty, sandy, brown, containing fine sand strips	53	408
Clay, hard, silty, brown	37	445
Clay and light-gray silt strips	10	455
Clay, sandy, silty, containing fine to coarse sand strips	55	510
Clay, hard, silty, brown, containing fine sand strips	85	595
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Shale, hard, blue-gray	39	634
Cheyenne Sandstone		
Sandstone and shale, hard (Drilled for ½ hour at 648 feet; fishtail bit would not penetrate.)	14+	648

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28-35-27bb.—Sample log of test hole drilled by Juel Water Well Drilling Co. for Rolla Ulsh in NW NW sec. 27, T. 28 S., R. 35 W., 95 feet south and 100 feet east of NW cor. sec. 27; November 13, 1958; altitude of land surface, 3,041 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, gray, fine sand, and white caliche	13	13
Silt, brown, fine sand, and white caliche	10	23
Sand, fine to medium, reddish-brown	10	33
Sand, medium to coarse	10	43
Sand, medium to coarse, and fine gravel	10	53
Sand, medium to coarse, and fine to medium gravel	10	63
Sand, fine to coarse	10	73
Sand, fine to coarse, and fine to medium gravel	10	83
Sand, medium to coarse, and fine to medium gravel	10	93
Sand, medium to coarse, and fine to coarse gravel	20	113
Sand, medium to coarse, and fine gravel	10	123
Silt, sandy, brownish-gray	10	133
Sand, fine, and gray to brown silty clay	10	143
Clay, silty, gray to brown, and brown silt	5	148
Sand, very coarse, and fine gravel	15	163
Clay, silty, gray to brown, and brown silt	10	173
Silt, sandy, brown	10	183
Silt, sandy, brown, and gray to brown clay	10	193
Sand, fine to coarse	11	204
Gravel, very coarse	13	217
Silt, sandy, brown	6	223
Sand, coarse, and fine to medium gravel	20	243
Clay, gray to limonite-brown	9	252
Gravel, coarse to very coarse, quartz and red granite pebbles	21	273
Clay, gray to brown, and fine sand	10	283
Sand, medium to coarse, caliche-cemented	10	293
Sand, fine to coarse	10	303
Sand, very coarse, and fine gravel	17	320
Pliocene		
Ogallala Formation		
Clay, silty, brown	18	338
Sand, coarse, and fine to coarse gravel	6	344
Clay, sandy, dark-brown to gray,	9	353
Clay, brown, greenish-gray to light-gray, and very fine sand	10	363
Sand, fine to medium, and caliche	30	393
Clay, brown to gray; contains sandstone fragments	10	403
Sand, fine, loose	10	413
Clay, sandy, dark-brown	10	423
Clay, dark-brown to gray, containing sandstone fragments	20	443
Sand, fine to medium, loose	10+	453

28-36-2bbb.—Sample log of test hole drilled in NW NW sec. 2, T. 28 S., R. 36 W.; 1942; altitude of land surface, 3,119 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, fine, sandy, black	2	2
Silt, fine, brown; some caliche,	12	14
Silt, sandy, gray and tan, and fine sand	29	43
Silt, sandy, tan; contains sand and caliche	19	62
Sand, coarse, and fine gravel	18	80
Gravel, fine to very coarse	11	91
Sand, coarse, cemented	2	93
Silt, soft, sandy, gray and yellow	17	110
Sand, fine to coarse; contains silt	10	120
Sand, coarse; some fine gravel	10	130
Sand, coarse, tan-white	17	147
Caliche and clay, hard, light-gray and white	3	150
Silt, soft, varicolored; some sand	10	160
Sand, coarse, and fine gravel	7	167
Silt and clay, white-gray	23	190
Sand, coarse to fine gravel	24	214
Sand, coarse, and soft, sandy, red, tan, and yellow-brown silt	8	222
Silt, sandy, tan and light-gray, containing coarse sand	18	240
Sand, coarse	8	248
Silt, hard, sandy, gray, containing coarse sand	7	255
Sand, coarse, red-brown and white	25	280
Silt, soft, blue-gray to tan and yellow-brown	20	300
Sand, fine gravel, and soft gray-tan and yellow-brown clay	18	318
Pliocene		
Ogallala Formation		
Sand, fine to medium, cemented,	4	322
Sand, coarse, containing some silt	18	340
Sand, coarse, and fine gravel	28	368
Sand, coarse, tan; some silt	20	388
Silt, soft, sandy, tan	8	396
Sand, coarse	10	406
Clay, brown, containing limonite	3	409
Silt, hard, sandy, tan to white	21	430
Silt, clayey, tan	10	440
Silt, clayey, tan; some sand	10	450
Silt, sandy, tan; fragments of caliche	20	470
Silt, hard, clayey	10	480
CRETACEOUS		
Lower(?) Cretaceous		
Dakota Formation		
Siltstone, fine, sandy, varicolored, and hard yellow-brown sandstone, containing fragments of sandstone	10+	490

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28-36-17bbb.—Sample log of test hole drilled in NW NW sec. 17, T. 28 S., R. 36 W., 33 feet south and 70 feet east of NW cor. sec. 17; 1959; altitude of land surface, 3,087 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Sand, fine, brown; dune sand	10	10
Silt, gray-brown	10	20
Silt, tan, and caliche	35	55
Sand, coarse, brown, red, and pea gravel	15	70
Silt, sandy, brown; with fine to medium sand strips	17	87
Sand, coarse, tan	8	95
Silt, sandy, brown	3	98
Sand, limey, tan	5	103
Silt, sandy, brown, and fine sand,	25	128
Sand, very fine, tan, with clay strips	27	155
Silt, brown, and clay	10	165
Sand, fine, brown, with few coarse grains	15	180
Silt, sandy, brown and gray	26	206
Clay, brown and gray	6	212
Silt, sandy, brown and gray	15	227
Clay, silty, blue, brown, and gray	25	252
Sand, fine to coarse, gray	5	257
Pliocene		
Ogallala Formation		
Clay, silty, brown and gray	20	277
Sand, silty, brown and gray	10	287
Sand, fine to medium, brown; some caliche	20	307
Clay, silty, brown	3	310
Sand, fine to medium; some coarse sand strips	25	335
Sand, silty, brown-tan	12	347
Silt and clay, brown	5	352
Sand, fine, brown	20	372
Clay, brown	5	377
Sand, fine to coarse, tan and white	33	410
Sand, coarse, brown, containing sandstone fragments	10	420
CRETACEOUS		
Lower Cretaceous		
Dakota Formation [Lower(?) Cretaceous]		
Siltstone and sandstone, blue-gray	10	430
Kiowa Shale		
Shale, hard, blue	20+	450

28-36-35ccc.—Sample log of test hole drilled in SW SW sec. 35, T. 28 S., R. 36 W., at SW cor. sec. 35; 1912; altitude of land surface, 3,052 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, fine, sandy, black	3	3
Silt, soft, gray-brown	5	8
Silt, hard, blocky, gray-green	2	10
Silt, soft, yellow-brown; with some caliche	17	27
Silt, soft, sandy, red-brown, with some caliche	16	43
Sand, coarse, and gravel; contains clayey gray-brown silt	17	60
Sand, coarse, and gravel	21	81
Clay, hard, tan	19	100
Silt, soft, sandy, light-tan	24	124
Sand, medium to coarse	7	131
Silt, hard, blocky, tan and buff to gray	68	199
Silt, soft, clayey, tan-gray	11	210
Silt, hard, blocky, gray to brown, containing some fine sand	42	252
Clay, hard, tan and green	28	280
Silt, fine, sandy, light-brown	20	300
Silt, clayey to sandy, light-gray and brown, containing a little sand	30	330
Silt, sandy, tan	10	340
Sand, coarse, and small gravel,	5	345
Pliocene		
Ogallala Formation		
Sand, coarse, and gravel; with light-gray silt strips	15	360
Sand, fine, brown; with silt and caliche strips	16	376
Clay, hard, laminated, gray-green	4	380
Sand, fine to medium, containing hard gray silt	20	400
Clay, soft, varicolored, containing sandstone and ironstone fragments	20+	420

28-37-5bcc.—Sample log of test hole drilled by Juel Water Well Drilling Co. for C. E. Hoffman in SW NW sec. 5, T. 28 S., R. 37 W., 10 feet north and 200 feet east of W¼ cor. sec. 5; September 1959; altitude of land surface, 3,072 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, silt, and clay	34	34
Clay	8	42
Sand, fine	5	47
Clay, silty, brown; fine sand	13	60
Clay, silty, gray; fine sand	5	65
Sand, fine to brown	10	75
Clay, brown	17	92
Sand, fine, silty, brown	12	104
Clay, gray	18	122
Sand, fine to medium, brown	6	128
Clay, silty, brown	6	134
Silt, sandy; some clay strips	23	157
Clay, gray	3	160
Sand, fine, brown to gray	14	174
Clay and silt strips, brown	26	200
Clay, gray; fine sand strips	7	207
Sand, fine, brown, and caliche	5	212
Sand, fine, brown	8	220
Sand, medium, brown	13	233
Sand, fine, brown, and silt strips	12	245
Sand and coarse gravel	15	260
Pliocene		
Ogallala Formation		
Clay, silt, fine sand, and caliche strips	12	272
Clay, silty, brown	10	282
Sand, fine, brown; some caliche,	15	297
Clay, silty	4	301

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	Thickness, feet	Depth, feet
Sand, coarse, and fine gravel	10	311
Clay and silt	5	316
Sand, fine, silty, brown	6	322
Clay, brown	8+	330

28-37-17cb.—Sample log of test hole drilled by Red Swearengen for E. M. Farrar (V. D. Sullivan) in NW SW sec. 17, T. 28 S., R. 37 W., 0.25 mile east of W¼ cor. sec. 17; November 1958; altitude of land surface, 3,089 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, silty, gray	10	10
Sand, fine, silty, brown	23	33
Clay, brown	3	36
Sand, fine, silty, brown	8	44
Clay, hard, brown; silty sand strips	16	60
Sand, coarse, brown; mostly quartz	15	75
Clay, brown	10	85
Sand, fine, brown, and clay strips	23	108
Clay, sandy, brown	15	123
Clay, hard, gray	12	135
Clay, silt, and fine brown sand strips	30	165
Clay, hard, brown	13	178
Clay, sandy, gray	9	187
Sand, fine, silty, gray	13	200
Clay, blue; brown silt strip	10	210
Clay, brown and gray; fine sand strips	18	228
Clay, silty, brown	17	245
Sand, fine to medium; some silty clay strips	15	260
Sand, coarse, and fine gravel	20	280
Pliocene		
Ogallala Formation		
Sand, fine, clay and caliche strips	20	300
Sand, fine, brown	6	306
Clay, silty, gray	14	320
Sand, fine, brown; some caliche,	8	328
Sand and fine gravel	17	345
Clay, silty, brown	10	355
Sand, fine, brown; some clay	15	370
Sand, coarse, and fine gravel	16	386
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Shale, blue	40	426
Shale, blue, and sandstone strips	50	476
Cheyenne Sandstone		
Shale and sandstone strips	69+	545

28-37-21daa1.—Sample log of test hole drilled by Juel Water Well Drilling Co. for the City of Ulysses in NE SE sec. 21, T. 28 S., R. 37 W., near E¼ cor. sec. 21; 1959; altitude of land surface, 3,056 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Sand, fine to medium, brown; some clay strips	20	20
Clay, silty, brown, and fine sand strips	27	47
Clay, hard, brown-tan	7	54
Sand, silty, brown	6	60
Clay, hard, brown	20	80
Clay, hard, gray, and caliche	10	90
Clay, silty, gray	10	100
Clay, gray, and silt	10	110
Clay, gray, and very fine sand	15	125
Sand, fine to medium, gray	10	135
Clay; brown and gray strips	10	145
Sand, fine to coarse, brown	15	160
Sand, silty	10	170
Sand, very fine, gray	10	180
Sand, fine, brownish-red	10	190
Sand, fine to medium; some caliche	10	200
Clay and silt, brown; thin strips of fine sand	15	215
Sand, fine, brown	20	235
Clay, silty, brown	5	240
Sand and gravel	20	260
Pliocene		
Ogallala Formation		
Clay, silty, brown	10	270
Clay, silt, and caliche	10	280
Clay, fine sand, and caliche	10	290
Clay, brown	10+	300

28-37-21db1.—Sample log of test hole drilled by Juel Water Well Drilling Co. for City of Ulysses in NW SE sec. 21, T. 28 S., R. 37 W., 0.4 mile west and 25 feet south of E¼ cor. sec. 21; 1959; altitude of land surface, 3,060 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
No log	100	100
Clay, gray	11	111
Clay, hard, blue	18	129
Clay, silty, gray; some fine sand strips	19	148
Sand, fine to medium, brown; some caliche	17	165
Sand, medium to coarse, brown,	17	182
Sand, fine sand, silt, and caliche	13	195
Sand, very fine, brown	5	200
Sand, fine, silty, brown; few thin clay strips	15	215
Sand, coarse, brown	8	223
Clay, silty, brown	7	230
Sand and fine gravel	15	245
Pliocene		
Ogallala Formation		
Clay, silty, brown; some fine sand and caliche	23	268
Sand, fine, brown	10	278
Sand, fine, brown, and caliche strips	12	290
Sand, medium to coarse, and fine gravel	22	312
Clay, silty, brown	2	314
Sand, coarse, and fine gravel	8	322
Clay, hard, tan-yellow	4	326
Clay, silty, tan-yellow	12	338
Clay, hard, tan	12+	350

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28-37-26bcc.—Sample log of test hole drilled by Juel Water Well Drilling Co. for the City of Ulysses in SW NW sec. 26, T. 28 S., R. 37 W., 10 feet north and 150 feet east of W¼ cor. sec. 26; 1959; altitude of land surface, 3,039 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Upper Pleistocene(?)		
Topsoil and silt, gray	10	10
Sand, fine, silty, brown	20	30
Sand, fine brown	10	40
Sand and fine gravel, silty	10	50
Lower Pleistocene(?)		
Clay, hard, gray	10	60
Clay, silty, brown	40	100
Silt and fine sand, brown	15	115
Sand, fine to medium, brown	15	130
Clay, silty, gray-brown	20	150
Clay, silty, gray; some fine gray sand	30	180
Sand, fine to medium, brown	20	200
Clay, hard, brown	20	220
Clay, silty, brown	20	240
Sand and fine gravel	10	250
Pliocene		
Ogallala Formation		
Clay, fine sand, and caliche	20	270
Sand, fine to medium, brown	10	280
Sand, medium, and clay strips	10	290
Clay, caliche and silt	10	300
Clay, brown; some sandstone and ironstone fragments	5+	305

28-37-26dcc.—Sample log of test hole drilled in SW SE sec. 26, T. 28 S., R. 37 W., 0.4 mile west and 25 feet north of SE cor. sec. 26; September 1959; altitude of land surface, 2,975 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Upper Pleistocene(?)		
Clay and silt, gray	10	10
Lower Pleistocene(?)		
Silt and fine sand, brown	10	20
Sand, fine, silty, brown	10	30
Sand, coarse, brown, and fine gravel	10	40
Clay, brown, and silt	5	45
Silt, brown, and fine sand	20	65
Clay, silty, gray	4	69
Silt, brown, and fine sand	11	80
Clay and silty sand; gray	15	95
Clay, brown	13	108
Sand, fine to coarse	20	128
Clay, silty	4	132
Sand, fine, silty, brown	6	138
Clay, brown	4	142
Silt, sandy, gray	6	148
Clay, blue	11	159
Sand, fine, brown	6	165
Clay, brown	7	172
Sand, medium to coarse	13	185
Sand, fine, silty, and thin silt strips	13	198
Clay, brown	8	206
Sand, coarse, and small gravel	12	218
Clay, silty, brown	3	221
Sand, coarse, and gravel	7	228
Pliocene		
Ogallala Formation		
Clay, silty, brown; some caliche,	13	241
Sand, medium to coarse, brown,	49	290
Clay, silt, and caliche	10+	300

28-37-34ccc.—Sample log of test hole drilled in SW SW sec. 34, T. 28 S., R. 37 W., near SW cor. sec. 34; 1942; altitude of land surface, 2,996 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, sandy, brown-black	3	3
Gravel, fine to medium, and fine sand	5	8
Silt, compact, light tan to gray, containing fine sandy clay	2	10
Sand, fine to medium, tan	2	12
Silt, compact, light-tan and buff, containing fine sand and clay,	18	30
Sand, fine to coarse, red-brown, containing buff silt	3	33
Silt, sandy, compact, containing buff clay	7	40
Silt, sandy, buff, and fine to coarse sand; contains fine to coarse gravel	19	59
Sand, fine to coarse, containing fine gravel and buff silt	41	100
Silt, light-gray, and brown fine to coarse sand	10	110
Sand, fine to coarse, brown	6	116
Silt, sandy, compact, gray to tan	44	160
Silt, clayey, compact, tan, containing sand	45	205
Gravel and sand, fine to coarse, containing silt and caliche	28	233
Pliocene		
Ogallala Formation		
Silt, sandy, compact, gray and yellow-tan; contains sand, fine to coarse gravel, and caliche	7	240
Gravel, fine to coarse and fine sand; contains red-tan silt	10	250
Silt, sandy, light-gray to tan, containing caliche	40	290
Silt, clayey, compact, gray-green and dark tan, containing caliche	11	301
Gravel, fine to medium, containing fine sand, silt, and caliche,	18	319
Silt, clayey, yellow-tan, containing fragments of ironstone and sandstone	11+	330

28-38-6dc2.—Sample log of test hole drilled by Arnold Drilling Co. for O. P. Williams in SW SE sec. 6 T. 28 S., R. 38 W., 1,650 feet west and 125 feet north of SE cor. sec. 6; 1960; altitude of land surface, 3,133 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, gray	5	5
Silt, tan, and caliche	10	15

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	Thickness, feet	Depth, feet
Silt, gray-brown	15	30
Sand, fine to medium	10	40
Silt, brown	62	102
Sand, very fine, brown	3	105
Silt, brown	37	142
Sand, fine, brown	3	145
Clay, brown	5	150
Sand, fine, brown	15	165
Silt, brown	20	185
Sand, fine to medium, brown	22	207
Silt, brown	3	210
Silt, brown, and caliche	20	230
Sand, coarse	10	240
Sand, coarse, and medium gravel	8	258
Pliocene		
Ogallala Formation		
Silt, brown	2+	260

28-38-16db3.—Sample log of test hole drilled by Juel Water Well Drilling Co. for Mrs. T. M. Halliday in NW SE sec. 16, T. 28 S., R. 38 W., 0.49 mile west and 0.36 mile north of SE cor. sec. 16; November 11, 1958; altitude of land surface, 3,103 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Sand, fine to medium, silty, buff-tan	20	20
Sand, fine to medium; with thin layers of buff-tan silty clay	54	74
Sand, coarse to medium, and buff-tan clayey silt	9	83
Sand, coarse to medium; with some buff-tan silt	12	95
Sand, coarse to very coarse; with buff-tan silt	7	102
Sand, very coarse to medium; with buff-tan silt	16	118
Sand, very coarse to coarse	4	122
Sand, coarse to very coarse; with light-tan silt	11	133
Silt, sandy, clayey, tan-brown	7	140
Clay, silty, gray	25	165
Silt, sandy, tan-brown	25	190
Sand, very coarse to medium	22	212
Silt, sandy, brown	12	224
Gravel and very coarse sand	9	233
Pliocene		
Ogallala Formation		
Silt, sandy, red-brown	7	240
Silt, sandy, caliche-cemented, buff-tan	9	249
Silt, sandy, red-brown	22	271
Silt, sandy, caliche-cemented, buff-tan	11	282
Silt, clayey, sandy, tan	9	291
Silt, clayey, tan	14	305
Sand, very coarse to coarse	13	318
Silt, tan	10	328
Silt, fine sandy, buff-tan	13	341
Sand, very coarse, and fine gravel	9	350
Gravel, medium to coarse, and very coarse sand	14	364
Gravel, medium to coarse, very silty, and fine to coarse sand	6	370
Cretaceous		
Lower Cretaceous		
Kiowa Shale		
Shale, silty, dark-gray to black,	30	400
Sandstone, medium to fine, silty, clayey, friable, light-brown; interbedded with thin black shale layers	9	409
Shale, silty, sandy, dark-gray to black	11	420
Sandstone, medium to fine, silty, clayey, friable, light-brown; interbedded with thin black shale layers	9	429
Shale, silty, dark-gray to black	11	440
Cheyenne Sandstone		
Sandstone, very fine to coarse, friable; interbedded with a dark-gray silty sandstone	11	431
Sandstone, fine to medium; with limonite cement and very fine to coarse friable sandstone which is interbedded with a dark-gray silty sandstone	79	530
Triassic		
Upper Triassic		
Dockum Group		
Sandstone, fine to medium, silty, pink-tan	40+	570

28-38-24bbb.—Sample log of test hole drilled in NW NW sec. 24, T. 28 S., R. 38 W., 70 feet south and 15 feet east of NW cor. sec. 24; June 1960; altitude of land surface, 3,082 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Topsoil, sandy (dune sand)	6	6
Clay, brown-tan	10	16
Sand, fine, brown, and sandy clay	3	19
Clay, brown	8	27
Sand, fine, brown	7	34
Clay, sandy, brown, and gray, fine sand strips	10	44
Sand, fine to coarse, white-tan; some caliche and clay strips	18	62
Sand, fine, and brown clay strips	10	72
Sand, fine, brown; thin clay and sandy clay strips	10	82
Sand, fine to medium, brown	6	88
Clay, sandy	2	90
Sand, medium, brown	10	100
Clay, sandy, and thin strips of fine sand	7	107
Clay, gray	16	123
Sand, fine, sandy clay and clay strips	6	129
Clay, hard, brown; thin strips of fine sand	14	143
Clay, hard, gray	5	148
Clay, brown, and gray strips; thin strips of fine brown sand,	38	186
Clay, sandy, brown, and medium sand strips	17	203
Clay, brown and tan; thin strips of sandy clay	8	211

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	Thickness, feet	Depth, feet
Clay, sandy, brown	8	219
Clay, sandy, brown; thin layers of fine sand	13	232
Sand, fine, brown, and caliche	3	235
Sand	2	237
Clay, sandy, brown	3	240
Sand, medium, hard (cemented?), brown	7	247
Sand and fine gravel	35	282
Pliocene		
Ogallala Formation		
Clay, sandy, brown	3	285
Sand, coarse, and fine gravel; brownish-red	11	296
Clay, sandy, brown	4	300
Sand and fine gravel	8	308
Clay, brown; blue and tan strips; thin strips of sandy clay and fine sand	27	335
Sand, fine, gray	3	338
Clay, brown	4	342
Sand, fine, brown, and clay strips	14	356
Sand, fine, loose, brown	5	361
Sand, fine to coarse; a few thin clay strips	9	370
Sand, coarse, brown-tan; few thin clay strips	15	385
Clay, brown, blue, and yellow; thin strips of sandy clay	8+	394

28-38-32bbb.—Sample log of test hole drilled in NW NW NW sec. 32, T. 28 S., R. 38 W., 0.1 mile south and 30 feet east of NW cor. sec. 32; October 1959; altitude of land surface, 3,109 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Clay, gray, and brown silt	10	10
Clay, silty, brown-gray	15	25
Sand, medium to fine	10	35
Silt, clayey, sandy, gray; caliche zones	9	44
Sand, medium to fine	3	47
Silt, sandy, brown	3	50
Silt, sandy, brown, and sand streaks	10	60
Sand, fine to very fine	10	70
Sand, fine to medium; with brown silt	20	90
Sand, fine to medium	12	102
Clay, tan-brown; with some fine sand layers	18	120
Sand, fine to medium; with brown silt	7	127
Silt, clayey, brown; with sand strips	10	137
Clay, brown	3	140
Silt, clayey, brown; with thin sand strips	20	160
Clay, silty, gray-brown	30	190
Sand, coarse to medium	15	205
Clay, silty, brown, light-brown; with some clay layers and thin sand layers	25	230
Pliocene		
Ogallala Formation		
Sand, fine to medium, silty, tan-buff; cemented with caliche,	30	260
Sand, fine to medium, silty, tan-buff; some beds cemented with caliche	30	290
Sand, fine to coarse; with layers of buff-tan clayey silt	30	320
Sand, medium to coarse; with layers of brown silt	40	360
Sand, medium to fine; with layers of brown silt	20	380
Sand, coarse to very coarse; with fine to medium gravel	20	400
Cretaceous		
Lower Cretaceous		
Kiowa Shale		
Shale, gray and brown; contains very fine to medium sandstone streaks	40+	440

29-35-1aaa.—Sample log of test hole drilled in NE NE sec. 1, T. 29 S., R. 35 W., near NE cor. sec. 1; 1942; altitude of land surface, 3,013 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene(?)		
Silt, compact, sandy; contains blue-gray clay	10	10
Silt, soft, sandy, light-brown; contains some caliche	33	43
Sand, fine to coarse; contains some silt and caliche	7	50
Sand, coarse, and gravel	15	65
Sand, coarse	45	110
Sand, coarse, and large gravel	28	138
Silt, sandy, tan; contains some clay	32	170
Clay, compact, gray	10	180
Clay, compact, brown, and interbedded gray clay layers	90	270
Sand, coarse, and some fine gravel	40	310
Clay and silt, tan	10	320
Sand, coarse, and fine to coarse gravel	55	375
Pliocene		
Ogallala Formation		
Silt, compact, sandy, brown; contains some clay and caliche	5	380
Sand, fine to coarse	10	390
Sand, coarse, and fine gravel	30	420
Clay and silt, varicolored; contains fragments of sandstone and ironstone	20	440
Clay and interbedded coarse sand strips	11	451
Silt, compact, dark-brown	9	460
Clay, soft, yellow and white; contains hard yellow-brown sandstone fragments	40	500
Clay, fine sandy, hard, gray; contains yellow-brown siltstone fragments	20	520
Silt, clayey, gray, sand and fine gravel; contains weathered Dakota fragments	50	570

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	Thickness, feet	Depth, feet
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Shale, clayey, dark-gray to black; contains sandy shale	52	622
Shale, soft, clayey, gray	21	643
Shale and fine-grained sandstone, white to gray	46	689
PERMIAN		
Cimarronian		
Big Basin Formation		
Siltstone, soft, clayey, brick-red,	11+	700

29-35-14db.—Sample log of test hole drilled by C. K. Minter Drilling Co. for E. H. Miller in NW SE sec. 14, T. 29 S., R. 35 W., 0.48 mile west and 0.4 mile north of SE cor. sec. 14; August 20, 1960; altitude of land surface, 3,049 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil; consists of sandy silt	3	3
Sand, medium to very fine, tan, brown	32	35
Silt, clayey, brown; with very fine sand	10	45
Silt, clayey, buff-tan, containing caliche	7	52
Silt, sandy, brown, containing caliche and thin tan clay layers	18	70
Silt and medium to fine sand, containing thin caliche layers,	15	85
Sand, medium to fine, containing thin silty clay layers and thin layers of caliche	35	120
Sand, medium to coarse, with thin silty caliche layers	10	130
Gravel, fine to medium, and very coarse sand	10	140
Sand, very coarse, and fine gravel	20	160
Silt, clayey. yellow, and caliche; contains fine sand layers	10	170
Gravel, fine; with very coarse to coarse sand	20	190
Gravel, fine to medium; with very coarse to coarse sand	20	210
Clay, silty, blue-gray	20	230
Silt, clayey, tan; with strips of fine sand and blue-gray clay,	40	270
Sand, very fine to medium, silty,	10	280
Clay, silty, tan; with strips of blue-gray clay	13	293
Sand, very coarse; with some fine gravel	7	300
Clay, tan; with strips of blue-gray clay	10	310
Sand, fine to medium, silty	10	320
Clay, tan	5	325
Sand, very coarse to coarse and fine gravel	25	350
Gravel, fine to medium, and very coarse sand	10	360
Gravel, fine, and very coarse sand	10	370
Gravel, fine to medium, and very coarse sand	19	389
Silt, tan-brown, with strips of gray clay and fine sand	31	420
Gravel, fine, and fine to medium sand; with strips of tan clay,	15+	435

29-35-15aba.—Sample log of test hole drilled in NE NW NE sec. 15, T. 29 S., R. 35 W., 25 feet south and 0.3 mile west of NE cor. sec. 15; December 2. 1959; altitude of land surface, 3,032 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil and sandy silt; contains organic matter	8	8
Silt, sandy, buff-brown	4	12
Silt, sandy; with caliche	8	20
Silt and fine sand, buff-brown; with caliche	9	29
Sand, fine, and silt; buff-brown; with caliche	7	36
Sand, fine, silty, buff-brown	16	52
Caliche	3	55
Sand, fine to medium, silty, brown; with small caliche strips	25	80
Sand, fine to medium, silty, brown	12	92
Silt, sandy, buff-brown	10	102
Sand, fine to medium, silty, buff-brown	6	108
Sand, medium to coarse	4	112
Sand, very coarse to medium, and fine to medium gravel	18	130
Gravel, fine to medium, and coarse to very coarse sand	20	150
Gravel, large to fine, and very coarse sand	20	170
Gravel, fine to large; with some coarse sand	8	178
Gravel, medium to large, and coarse sand; drilled hard in layers	7	185
Gravel, fine to medium, and coarse sand; with thin sandy clay layers	7	192
Gravel, fine to medium, and coarse sand	19	211
Silt, sandy, buff-brown; with brown clay layers	12	223
Silt, sandy, buff-brown; with fine sand strips	19	242
Sand, fine to medium, silty	8	250
Silt, tan	3	253
Sand, fine, brown	2	255
Silt, tan	3	258
Silt, sandy, tan; with tan clay layers	7	265
Sand, medium to very coarse; with tan silt	10	275
Sand, medium to coarse, silty	13	288
Sand, medium to coarse; with a few thin sandy clay strips	17	305
Clay, silty, buff-brown	3	308
Sand, coarse to very coarse, and fine to medium gravel	17	325
Clay, silty, buff-brown	4	329
Sand, coarse to very coarse, and gravel	6	335

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	Thickness, feet	Depth, feet
Silt, tan; drilled easy	30	365
Sand, medium to fine, slightly cemented with caliche	3	368
Silt, sandy, buff-brown; drilled easy	4	372
Sand, medium to fine, silty	7	379
Sand, medium to coarse, with fine gravel	6	385
Gravel, fine to medium, and medium to very coarse sand	70	455
Pliocene		
Ogallala Formation		
Silt, sandy, buff-tan	11	466
Clay, hard, brown	4+	470

29-35-19dc.—Sample log of test hole drilled in SW SE sec. 19, T. 29 S., R. 35 W., 30 feet north and 0.48 mile west of SE cor. sec. 19; May 2, 1960; altitude of land surface, 3,027 feet.

Neogene	Thickness, feet	Depth, feet
Undifferentiated Pleistocene(?)		
Topsoil, silty, sandy; contains organic material	3	3
Sand, fine to medium, silty, brown	22	25
Sand, very fine to medium, silty, brown	7	32
Sand, fine to medium, light-brown	8	40
Sand, fine, silty, light-brown; with caliche	10	50
Silt, sandy, light-brown	12	62
Silt, buff-brown; with thin coarse sand strips	3	65
Silt, sandy, buff-brown	7	72
Silt, tan	8	80
Clay, silty, brown	15	95
Sand, medium to coarse	12	107
Clay, tan; drilled easy	63	170
Clay, dark brown; with some small strips of gray clay	38	208
Clay, dark brown, hard; with some soft gray clay strips	20	228
Clay, brown; with thin strips of sandy clay	22	250
Clay, brown; with thin strips of very sandy tan clay and some soft blue-gray clay	14	264
Sand, coarse	1	265
Clay, brown; with thin strips of loose, coarse sand	15	280
Sand, coarse to medium; with thin brown clay strips	12	292
Clay, tan-gray, soft	5	297
Clay, brown	10	307
Clay, sandy, brown	2	309
Silt, clayey, gray; with fine sand and sandy clay strips	16	325
Clay, blue, hard	5	330
Clay, sandy, brown; with blue clay strips	8	338
Clay, blue, and thin sand and sandy clay strips	17	355
Clay, tan-brown, hard; with sandy clay and fine sand strips	15	370
Sand, coarse to medium; with hard, brown clay strips	15	385
Sand, coarse to medium; drilled easy	5	390
Pliocene		
Ogallala Formation		
Silt, sandy; drilled easy	10	400
Clay; with sandy clay strips	5	405
Sand, fine to coarse; with fine gravel	25	430
Sand, coarse to very coarse and fine to medium gravel	47	477
Clay, silty, yellow	3	480
Sand, coarse to medium, slightly cemented by caliche; drilled hard	10	490
Clay, brown to gray; drilled easy	25	515
Clay, gray, and strips of tan clay; drilled hard	10	525
Sand, fine silty, brown; drilled easy	5+	530

29-35-24bc.—Sample log of test hole drilled by Juel Water Well Drilling Co. for H. Miller in SW NW sec. 24, T. 29 S., R. 35 W., 0.2 mile east and 0.4 mile south of NW cor. sec. 24; December 1958; altitude of land surface, 3,037 feet.

Neogene	Thickness, feet	Depth, feet
Undifferentiated Pleistocene		
Surface, topsoil	10	10
Silt, clayey, buff-tan; with strips of caliche	43	53
Sand, fine to medium, silty, buff-tan	11	64
Silt, clayey; with silty sand strips	21	85
Silt, clayey, light-brown, with fine sand strips	10	95
Silt, clayey, and fine sand	15	110
Sand, fine to medium	10	120
Sand, medium to coarse	20	140
Sand, medium to fine	10	150
Sand, coarse to very coarse; with fine gravel	30	180
Silt, clayey, light-brown; with silty sand strips	15	195
Gravel, fine, and coarse to very coarse sand	12	207
Silt, sandy, light-brown	6	213
Sand, fine to medium; with gravel	11	224
Silt, sandy, light-brown	6	230
Sand, fine to medium, and fine gravel	20	250
Silt, light-brown, and caliche	5	255
Silt, clayey, gray	7	262
Sand, medium to coarse, and fine gravel	16	278
Silt, clayey, gray-tan	2	280
Sand, medium to coarse, and fine gravel	13	293
Silt, clayey, gray-tan	2	295
Sand, medium to coarse, and fine gravel	7	302
Clay, silty, gray	5	307
Gravel, fine to medium, and coarse to very coarse sand	85	392

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	Thickness, feet	Depth, feet
Clay, silty, tan	2	394
Sand, coarse to medium; with some fine gravel	11	405
Clay, silty, tan	2+	407

29-35-28aa.—Sample log of test hole drilled in NE NE sec. 28, T. 29 S., R. 35 W., 100 feet west and 35 feet south of NE cor. sec. 28; May 30, 1960; altitude of land surface, 2,988 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Topsoil, sandy, silty; contains organic material	2	2
Caliche	1	3
Silt, soft, rust-brown	6	9
Sand, very fine to fine, silty, light-brown	6	15
Sand, fine to medium, silty, brown	2	17
Sand, fine to medium, silty, and caliche	8	25
Sand, fine to medium, and a strip of tan silt	5	30
Clay, silty, tan	3	33
Clay, hard, brown	13	46
Clay, brown, and thin strips of fine sand	6	52
Sand, fine, and brown clay strips	8	60
Sand, medium to coarse, and brown clay strips and gravel	6	66
Clay, silty, gray	3	69
Sand, medium to coarse, and thin clay strips	5	74
Sand, coarse	4	78
Clay, silty, tan	4	82
Sand, medium to coarse, and fine gravel	6	88
Clay, silty, gray-tan	4	92
Sand, fine to medium, reddish-brown, and thin tan clay and caliche strips	11	103
Silt, clayey, tan; drilled easy	12	115
Silt, clayey, tan, and a thin strip of fine sand	10	125
Sand, fine to medium, and brown silt	5	130
Sand, medium to coarse, and fine gravel; contains one thin clayey silt strip	8	138
Clay, gray, and thin brown and reddish-tan clay strips	11	149
Sand, fine	1	150
Sand, fine to coarse, reddish-brown, and thin clay strips	22	172
Clay, silty, blue-green, and strips of fine sand	8	180
Clay, silty, blue-gray	12	192
Sand, medium to coarse	13	205
Clay, silty, blue-gray, and tan clay strips	10	215
Sand, medium to coarse, silty	8	223
Clay, blue-gray, and strips of tan clay	19	242
Sand, medium to coarse, and thin tan clay strips	8	250
Sand, medium to coarse, and fine gravel; contains thin blue-gray clay strips	15	265
Clay, silty, blue-gray, and strips of tan clay	17	282
Sand, fine to coarse, and fine gravel	18	300
Sand, medium to coarse, and fine to medium gravel	27	327
Silt, brown, and coarse sand and fine gravel strips	5	332
Gravel, fine, and very coarse sand; contains thin blue-gray clay strips	6	338
Clay, hard, tan	4	342
Clay, gray-tan, and strips of brown clay	10	352
Sand, fine, silty	3	355
Sand, medium to coarse, and fine gravel	3	358
Clay, gray, and strips of tan clay	35	393
Clay, brown, and thin hard strips of fine to medium sand,	17+	410

29-36-2ccb.—Sample log of test hole drilled by Young Drilling Co. for Mobil Oil Co. in NW SW SW sec. 2, T. 29 S., R. 36 W., 40 feet east and 0.14 mile north of SW cor. sec. 2; October 22, 1959; altitude of land surface, 3,045 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil and brown, fine to coarse, silty sand	15	15
Sand, fine to coarse, silty, brown; contains a little caliche	15	30
Sand, fine to coarse, silty, brown; contains a little fine gravel	15	45
Gravel, fine to coarse; contains sand, silt, and caliche	15	60
Sand, very fine to coarse, silty, limy, light brown	30	90
Silt, gray and red-brown	15	105
Silt, tan	45	150
Silt, sandy, light gray and tan	15	165
Silt, gray and tan	15	180
Silt, sandy, dark gray	15	195
Silt, sandy, gray and brown	15	210
Silt, gray-brown and brown	15	225
Silt, sandy, brown	65	290
Silt, sandy, brown to gray, and fine to coarse sand	15+	305

29-36-7dcc.—Sameple log of test hole drilled in SW SW SE sec. 7, T. 29 S., R. 36 W., 10 feet north and 0.4 mile west of SE cor. sec. 7; 1959; altitude of land surface, 2,998 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Sand, fine to coarse, and caliche,	10	10
Sand, very fine to medium, brown; contains gastropod shells	10	20
Sand, fine, and brown silt	10	30

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	Thickness, feet	Depth, feet
Sand, very fine, and brown silt	10	40
Silt, sandy, limy, brown	10	50
Silt, tan	20	70
Sand, very fine, tan	10	80
Silt, yellow	10	90
Silt, tan	10	100
Silt, pink	10	110
Silt, gray, some limonite stain	10	120
Silt, sandy, pink	10	130
Silt, very sandy, gray to brown	10	140
Sand, very fine to coarse, silty, brown	10	150
Silt, sandy, tan	10	160
Sand, fine to coarse, very silty, brown	10	170
Silt, tan	50	220
Silt, sandy, brown	10	230
Silt, tan	10	240
Sand, fine to coarse, silty	20	260
Pliocene		
Ogallala Formation		
Silt, sandy, limy, tan	10	270
Silt, tan	20	290
Sand, fine to coarse, silty	10	300
Silt, sandy, tan	20	320
Sand, fine to very coarse, and caliche	20	340
Clay, tan; contains some ironstone	10	350
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Sandstone, very fine, dark brown to dark gray	20	370
Shale, black	20+	390

29-36-21cdc.—Sample log of test hole drilled in SW SE SW sec. 21, T. 29 S., R. 36 W., 0.34 mile east of SW cor. sec. 21; October 12, 1959; altitude of land surface, 2,943 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	3	3
Sand, silty, brown	5	8
Sand, fine, brown	7	15
Sand, coarse	12	27
Silt, gray; contains a few mollusk shells	6	33
Sand, fine, gray; and thin, soft gray silt streaks	7	40
Sand, fine to coarse and fine gravel	9	49
Silt, brown-tan	9	58
Silt, clayey, blue-gray	1	59
Silt, gray-tan	13	72
Silt, clayey, blue-gray; contains small fragments of lignite	9	81
Silt, gray-tan; and tan silt streaks	4	85
Silt, gray-tan	5	90
Silt, clayey, blue; contains small fragments of lignite and mollusk shells	6	96
Sand, coarse, gray	3	99
Silt, clayey, hard, blue; contains small fragments of lignite and mollusk shells	8	107
Silt, clayey, sticky, blue; contains small fragments of lignite	2	109
Silt, clayey, blue; contains small fragments of lignite and mollusk shells	15	124
Sand, blue-gray	1	125
Silt, clayey, blue; contains small fragments of lignite and mollusk shells	20	145
Silt, clayey, blue; with white silt strips	9	154
Sand, fine to coarse, blue and white, and fine gravel	6	160
Gravel, fine to medium, blue and white	10	170
Gravel, fine, brown and coarse sand; with thin brown silt strips	10	180
Sand, medium to coarse, and fine to medium gravel	35	215
Pliocene		
Ogallala Formation		
Silt, tan, and fine sand	2	217
Sand, fine to coarse, and fine gravel; contains a little caliche	3	220
Sand, fine to coarse, and fine gravel	5	225
Caliche and brown sandy silt	5	230
Caliche, soft, sandy	13	243
Silt, limy, tan	27	270
Sand, very fine to coarse	10	280
Sand, very fine to coarse, and caliche	10	290
Sand, fine to coarse, and brown and gray clay strips	10	300
Sand, fine to coarse	20	320
Sand, fine to coarse, and fine to medium gravel; contains rounded fragments of gray and brown sandstone and ironstone	20	340
Sand, fine to coarse; contains sandstone and ironstone	10	350
Sand, fine, iron-cemented, red-brown	10+	360

29-36-23ddd.—Sample log of test hole drilled in SE SE SE sec. 23, T. 29 S., R. 36 W., 10 feet north and 10 feet west of SE cor. sec. 23; October 7, 1959; altitude of land surface, 3,023 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, gray	10	10
Silt, sandy, gray-brown; contains a little caliche	10	20
Silt, sandy, light-brown, and caliche	20	40
Sand, fine to coarse, and fine gravel	14	54
Silt, brown	36	90
Silt, tan	10	100
Silt, sandy, tan	12	112
Sand, fine, light-brown	8	120
Silt, sandy, tan	50	170

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	Thickness, feet	Depth, feet
Sand, fine to medium, silty, brown	20	190
Silt, light-brown	30	220
Silt, light-brown to gray	20	240
Silt, sandy, light-brown	10	250
Sand, fine to coarse, silty, light-brown; contains a little fine gravel	20	270
Silt, brown	20	290
Sand, fine to coarse, and fine to medium gravel; contains much silt	50	340
Pilocene		
Ogallala Formation		
Silt, sandy, brown; contains caliche	10+	350

29-36-30aaa.—Sample log of test hole drilled in NE NE NE sec. 30, T. 29 S., R. 36 W., 50 feet south and 50 feet west of NE cor. sec. 30; October 14, 1959; altitude of land surface, 3,043 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil; contains reddish-brown sandy silt	10	10
Sand, fine to medium, and brownish-red silt	10	20
Sand, very fine to medium, caliche-cemented	20	40
Clay, silty, tan and gray	10	50
Sand, fine to medium; contains tan and gray clayey silt	10	60
Silt, clayey, tan	10	70
Silt, red-brown, and very fine sand	30	100
Sand, fine to medium; contains reddish-brown silt	10	110
Silt, clayey, brownish-tan	30	140
Silt, clayey, gray; interbedded with tan clayey silt	20	160
Sand, fine to medium; contains tan clayey silt	10	170
Silt, clayey, light-gray; interbedded with tan clayey silt	10	180
Silt, clayey, light-brown; interbedded with gray clayey silt layers and fine sand layers	30	220
Silt, clayey, dark-brown; interbedded with light-gray, clayey silt layers and a few thin fine sand layers	70	290
Sand, fine to coarse; contains thin, brown silty clay layers	20	310
Pliocene		
Ogallala Formation		
Silt, brown; interbedded with sand and caliche layers	90	400
Silt, brown; interbedded with medium to coarse quartzose sand and thin caliche strips	37	437
Clay, brown and gray	3+	440

29-36-35ccc.—Sample log of test hole drilled in SW SW sec. 35, T. 29 S., R. 36 W., SW cor. sec. 35; 1912; altitude of land surface, 2,933 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, fine, sandy, gray-brown	1	1
Silt; contains nodules of caliche	4	5
Silt, soft, dark-gray	2	7
Silt, compact, blocky, grayish-green to greenish-brown	3	10
Sand, fine to coarse, brown	17	27
Sand, fine to coarse, partially cemented, brown; and fine to medium gravel; contains brown and light buff silt and caliche	13	40
Sand, coarse to fine, dark-brown,	3	43
Silt, compact, buff; contains caliche	3	46
Clay, compact, buff to white and pink; contains silt and a little sand	34	80
Volcanic ash (?), brittle, partly indurated, white to gray and pink-brown	7	87
Clay, compact, gray-green and brown	4	91
Clay, silty to fine sandy, gray to dark-buff; contains caliche	21	112
Sand, silt and clay, compact, gray and tan	8	120
Silt, sandy, pink and gray-green; silty clay	10	130
Clay, silty to fine sandy, buff; contains clay, fine gravel, and caliche	28	158
Sand, silt and clay, compact, tan and gray to brown	12	170
Silt, coarse sandy, soft, buff to gray; contains hard blocky gray-green clay	20	190
Silt, compact, tan and brown; medium to fine sand	10	200
Sand, coarse to fine, brown, and tan to white compact silt	20	220
Gravel, coarse to fine, and buff to white fine sandy to clayey silt; contains caliche	20	240
Pliocene		
Ogallala Formation		
Silt, clayey, buff to gray and green-gray; contains sand, gravel and caliche	10	250
Caliche and gray to buff sandy silt; contains sand and gravel,	10	260
Sand, medium, and light-buff to tan and gray-green silt; contains caliche	30	290
Silt, sandy, soft, light buff to gray-green and tan; contains caliche	10	300
Clay, compact, blocky, green-brown	11	311
Sand, medium to fine, partially cemented	15	326
Clay, compact, blocky, dark tan,	24	350
Silt, tan; contains fine gravel and fine to coarse sand	10	360
Sand, coarse to medium, gray-brown; contains light tan silt,	61	421
Sand, very fine to very coarse, partially cemented, and very		

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	Thickness, feet	Depth, feet
fine to fine gravel; contains fragments of ironstone and sandstone	91	512
TRIASSIC(?)		
Upper Triassic(?)		
Dockum(?) Group		
Shale, silty, brick-red	8+	520

29-37-16ddd.—Sample log of test hole drilled in SE SE sec. 16, T. 29 S., R. 37 W., near SE cor.; October 14, 1959; altitude of land surface, 3,038 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	3	3
Silt, sandy, brown	6	9
Sand, fine, brown	4	15
Caliche and brown, fine sand	6	21
Sand, fine to coarse, brown, and caliche streaks	6	27
Silt, tan, and caliche streaks	2	29
Sand, fine, brown, and caliche streaks	7	36
Silt, gray-tan	17	53
Sand, fine, brown	5	58
Silt, tan	2	60
Sand, fine to coarse; contains a little tan silt	30	90
Silt, sandy, gray-tan to brown	30	120
Sand, fine to coarse, brown	10	130
Silt, sandy, tan to light gray	20	150
Sand, fine to medium, tan	10	160
Silt, sandy, tan to brown	20	180
Silt, sandy, brown to gray, and caliche	10	190
Silt, sandy, limy, gray to tan	20	210
Sand, very fine to very coarse, brown	10	220
Silt, sandy, gray, and fine to coarse sand; contains caliche,	10	230
Caliche, very soft; contains coarse sand	10	240
Sand, very fine to very coarse, brown; contains a little very fine gravel	20	260
Silt, tan to gray; contains much caliche	10	270
Sand, medium to coarse, brown, and fine to medium gravel	40	310
Pliocene		
Ogallala Formation		
Silt, tan, and caliche	20	330
Clay, silty, yellow, tan, gray, and brown; contains fine to coarse sand	30+	360

29-38-21bcb.—Sample log of test hole drilled in NW SW NW sec. 21, T. 29 S., R. 38 W., 0.26 mile south and 35 feet east of NW cor. sec. 21; May 17, 1960; altitude of land surface, 3,126 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, brownish-gray	12	12
Silt, sandy, brown	8	20
Clay, sandy, buff-tan	10	30
Clay, buff	5	35
Sand, fine to medium, light-brown	4	39
Silt, buff-tan; with layers of buff-tan clay	11	50
Silt, sandy, buff-tan; with layers of buff-tan clay	10	60
Sand, fine to very coarse, light-brown; and fine gravel	10	70
Silt, sandy, tan	10	80
Sand, fine to medium, and thin layers of tan sandy silt	20	100
Clay, tan	4	104
Sand, fine to coarse, light-brown,	4	108
Clay, tan	2	110
Sand, fine to coarse, light-brown,	25	135
Clay, tan	5	140
Clay, tan; with layers of tan sandy silt	12	152
Sand, fine to coarse, light-brown,	11	163
Silt, sandy, tan	3	166
Sand, fine, light-brown	4	170
Silt, sandy, tan	10	180
Sand, fine to very coarse, light-brown	10	190
Sand, very fine, silty, tan	30	220
Silt, very fine to medium, sandy,	15	235
Sand, fine, light-brown	5	240
Sand, very fine, silty, tan; with caliche cement	20	260
Sand, fine to coarse, and tan clay	10	270
Sand, fine to medium, and tan hard clay	20	290
Clay, tan	10	300
Sand, fine to coarse; with thin clay layers	10	310
Sand, coarse to fine, light-brown	10	320
Pliocene		
Ogallala Formation		
Clay, buff, and thin beds of fine to medium sand	10	330
Sand, fine to coarse; with thin beds of tan clay	10	340
Clay, tan, and fine silty sand cemented with caliche	10	350
Sand, fine to medium; with thin beds of buff-tan clay	20	370
Sand, fine; with beds of limonite-brown silty clay	30	400
Clay, silty, buff; with thin beds of fine sand	50	450
Clay, silty, buff; with fine caliche-cemented sand	10	460
Clay, silty, buff; with fine sand,	30	490
Silt, clayey, buff; with fine sand,	10+	500

29-38-23cc.—Sample log of test hole drilled in SW SW sec. 23, T. 29 S., R. 38 W., 0.08 mile north and 35 feet east of SW cor. sec. 23; May 16, 1960; altitude of land surface, 3,055 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Sand, fine, gray-brown	8	10
Silt, sandy, brown, and brown fine sand streaks	17	27

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	Thickness, feet	Depth, feet
Silt, brown-tan	3	30
Silt, hard, brown-tan	17	47
Silt, sandy, brown-tan	3	50
Sand, fine to very coarse, loose, brown; with thin, sandy silt streaks	25	75
Silt, hard, brown-tan	7	82
Silt, brown-tan; with thin very fine sand streaks	8	90
Sand, fine to medium; with brown very fine sand streaks	9	99
Silt, brown-tan; brown sandy silt and fine sand streaks	15	114
Sand, fine, brown; with thin silt streaks	11	125
Sand, fine, brown, and silt streaks	5	130
Sand, fine, brown; with thin silt streaks	15	145
Sand, fine to very coarse; with thin silt streaks	7	152
Sand, fine to medium, brown; with silt and sandy silt streaks	55	207
Sand, fine to very coarse, brown,	13	220
Sand, coarse, brown; with a little fine to medium gravel	16	236
Sand, coarse, brown; with fine to medium gravel and thin streaks of sandy caliche	12	248
Pliocene		
Ogallala Formation		
Sand, fine to coarse, brown	34	282
Silt, sandy, pink; caliche and fine sand streaks	6	288
Silt, brown, and sandy silt	17	305
Sand, fine to coarse	4	309
Silt, hard, clayey, brown and blue; with thin streaks of fine sand	29	338
Sand, fine, loose, brown; with thin brown clay and sandy clay layers	27	365
Sand, fine to medium, brown; with very few thin clay streaks,	11	376
Sand, medium, brown; with a few very thin clay streaks	39	415
Sand, medium to coarse, brown; with brown clay streaks	10	425
Sand, coarse, loose, and fine gravel; contains a little ironstone	7	432
Sand, coarse, loose, and brown clays streaks	4	436
Clay, hard, brown	4+	440

29-38-24ddd.—Sample log of test hole drilled in SE SE SE sec. 24, T. 29 S., R. 38 W., SE cor sec. 24; October 20, 1959; altitude of land surface, 3,114 feet.

NEOGENE	Thickness, feet	Depth, feet
Undifferentiated Pleistocene(?)		
Silt, gray and brown	10	10
Silt, brown, fine to coarse sand and caliche	10	20
Silt, sandy, brown	30	50
Sand, fine, silty, red-brown	10	60

	Thickness, feet	Depth, feet
Silt, sandy, limy, tan	10	70
Sand, fine to coarse, and brown silt	30	100
Silt, limy, tan	18	118
Sand, fine to medium	2	120
Silt, brown, and fine to medium sand	10	130
Sand, fine to coarse, tan, limy silt and caliche	20	150
Silt, sandy, brown	10	160
Sand, fine to coarse	10	170
Sand, coarse, and clay streaks	20	190
Sand, fine to coarse, and brown silt	20	210
Silt, brown	20	230
Silt, brown-tan and gray-brown,	10	240
Silt, gray-brown	10	250
Clay, silty, blue-gray	10	260
Silt, gray-brown and tan	10	270
Silt, gray-brown, tan, and gray,	10	280
Silt, brown and dark-gray	10	290
Silt, dark-gray and tan	10	300
Sand, fine to very coarse; with a little fine to medium gravel and tan silt	30	330
Pliocene		
Ogallala Formation		
Clay, silty, gray-brown and tan	10	340
Clay, silty, brown; with a little gray clay and some sand	10	350
Clay, brown and blue; with coarse sand strips	30	380
Clay, sandy, pink, and fine sand,	20+	400

29-38-33bbb.—Sample log of test hole drilled in NW NW NW sec. 33, T. 29 S., R. 38 W., NW cor. sec. 33; 1942; altitude of land surface, 3,115 feet.

NEOGENE	Thickness, feet	Depth, feet
Undifferentiated Pleistocene		
Silt, sandy, gray	2	2
Silt, sandy, gray to tan; some caliche cement	11	13
Silt, clayey, tan	5	18
Silt, clayey, tan and gray; molluscan fauna	8	26
Silt, clayey, tan	4	30
Sand, fine to coarse; with gravel and light-gray silt	10	40
Silt, sandy; with caliche cement,	3	43
Gravel, fine to medium, and coarse to medium sand	5	48
Silt, clayey, tan	12	60
Silt, sandy, tan-gray	8	68
Sand, very coarse to medium; with fine to medium gravel; contains buff-tan silt	17	85
Silt, sandy, tan	15	100
Silt, sandy, tan-gray; with caliche cement	10	110
Silt, clayey, tan	30	140
Silt, tan	12	152
Gravel, fine to medium, and coarse to fine sand	22	174
Silt, sandy, tan-white; with caliche cement	6	180
Silt, sandy, and tan clay; with some thin sand beds	40	220

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	Thickness, feet	Depth, feet
Silt, sandy, clayey, tan, and coarse sand; with some caliche-cemented layers	30	250
Sand, very coarse, and fine gravel	20	270
Gravel, fine to medium, and very coarse sand	10	280
Pliocene		
Ogallala Formation		
Sand, fine to medium, red-brown; with caliche cement	10	290
Sand, medium to coarse, and fine gravel	40	330
Sand, medium to coarse, silty	12	342
Sand, fine; with red-tan silty clay; some layers of caliche-cemented material composed of alternate soft clay and loose sand layers	30	372
Sand, fine to coarse and fine to medium gravel; containing tan silt	8	380
Silt, sandy; contains coarse sand and fine gravel layers	30	410
Silt, fine sandy, gray to yellow,	13	423
Gravel, medium to coarse, and medium to coarse sand; contains fragments of sandstone,	5	428
Gravel, medium to coarse and medium to coarse sand; contains thin yellow clay layers and is composed mainly of weathered sandstone and iron-stone fragments	22+	450

30-35-4dd.—Sample log of test hole drilled in SE SE sec. 4, T. 30 S., R. 35 W., 0.2 mile north of SE cor. sec. 4 on section line; May 5, 1960; altitude of land surface, 2,916 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene(?)		
Topsoil silty, light-brown	1	1
Sand, fine, silty, tan-brown	2	3
Clay, silty, tan-brown	5	8
Sand, medium to coarse	2	10
Clay, silty, yellow-brown	4	14
Sand, fine to medium and yellow-brown silty clay	6	20
Clay, silty, yellow-brown	8	28
Sand, medium to coarse and fine to medium gravel; contains thin tan clay strips	80	108
Clay, silty, tan	5	113
Sand, medium to coarse and fine to medium gravel	25	138
Silt, clayey, buff-brown	24	162
Sand, fine to medium	6	168
Silt, sandy, tan-brown	15	183
Sand, medium to coarse and fine gravel; contains silty clay strips	50	233
Clay, silty, tan-brown and blue-gray interbedded clay strips	7	240
Sand, medium to coarse and fine gravel	10	250
Clay, tan and blue-gray interbedded clay strips	5	255
Sand, medium to coarse and fine to medium gravel	18	273
Clay, silty, brown	4	277
Sand, medium to coarse and fine to medium gravel	21	298
Sand, medium to coarse and thin gray and brown clay strips	10	308
Pliocene		
Ogallala Formation		
Clay, silty, gray and brown; contains some sandy clay strips	17	325
Clay, silty, gray and brown interbedded clay and sandy clay strips	31	356
Sand, medium to coarse	11	367
Clay, silty, gray and tan interbedded clay	5	372
Sand, medium to coarse and brown thin clay strips	16	388
Clay, hard, brown	12+	400

30-35-21aa.—Sample log of test hole drilled in NE NE sec. 21, T. 30 S., R. 35 W., 70 feet south and 40 feet west of NE cor. sec. 21; May 9, 1960; altitude of land surface, 2,873 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene(?)		
Topsoil; consists of brown sandy silt	1	1
Clay, silty, brown, and caliche	2	3
Sand, fine to coarse, and fine gravel	23	26
Silt, soft, clayey, brown	2	28
Sand, fine to coarse, and fine gravel; contains a thin brown fine silty sand streak	7	35
Sand, medium to coarse, and fine gravel	28	63
Clay, soft, silty, tan	2	65
Sand, medium to coarse, and fine gravel; contains thin tan soft silty clay layers	15	80
Sand, medium to coarse, and fine gravel	8	88
Clay, sandy, pink-tan	5	93
Sand, fine to medium	11	104
Clay, silty, tan	6	110
Sand, fine to medium, reddish-brown; contains thin layers of tan soft sandy clay	8	118
Clay, silty, tan; contains interbedded gray silty clay	37	155
Clay, silty, tan; some fine sand streaks	8	163
Sand, fine, silty; contains thin layers of blue silty clay	12	175
Clay, silty, blue	7	182
Sand, fine to medium, contains tan sandy clay and thin blue silty clay layers	20	202
Sand, medium to coarse, and fine gravel	6	208
Pliocene		
Ogallala Formation		
Clay, tan	3	211
Silt, hard, brown	3	214

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	Thickness, feet	Depth, feet
Sand, fine to coarse; contains brown clay and thin gray clay streaks	24	238
Clay, hard, silty, tan, interbedded with gray clay; contains thin layers of fine sand	22	260
Clay, soft, silty, gray and tan; contains thin, hard layers of fine sand	20	280
Clay, silty, brown and gray; contains thin layers of fine sand	10	290
Silt, sandy, brown, interbedded with thin, gray, hard clay layers; containing thin layers of brown fine silty sand	17	307
Sand, very fine to medium, silty, brown	7	314
Silt, clayey, tan	8	322
Sand, medium to coarse, silty, brown	16	338
Clay, hard, silty, brown	4	342
Sand, medium to coarse, caliche cement	5	347
Silt, soft, clayey	7	354
Clay, hard, silty	3	357
Silt, hard, clayey, gray	3+	360

30-35-34cc.—Sample log of test hole drilled in SW SW sec. 34, T. 30 S., R. 35 W., 30 feet north and 140 feet east of SW cor. sec. 34; May 1960; altitude of land surface, 2,878 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Sand, fine, silty, brown	2	2
Sand, fine to medium, silty, brown	4	6
Sand, fine to medium	3	9
Sand, medium to very coarse, and fine to medium gravel	26	35
Sand, coarse to very coarse, and fine to medium gravel; contains thin caliche layers	11	46
Silt, clayey, brown	6	52
Silt, clayey, tan; interbedded with gray silty clay	8	60
Sand, fine to medium; contains thin brown clay layers	4	64
Sand, medium to very coarse, and fine gravel	6	70
Sand, coarse to very coarse, and fine to medium gravel	20	90
Clay, hard, tan; interbedded with brown sandy clay	3	93
Sand, fine to medium, silty, tan,	3	96
Silt, sandy, tan; contains thin fine sand layers	5	101
Sand, fine to medium, silty, tan,	7	108
Clay, hard, brown	2	110
Sand, very fine to medium; contains thin brown sandy clay layers	7	117
Sand, medium to coarse, and fine gravel	18	135
Sand, medium to coarse, and fine gravel; contains thin tan silt and caliche layers	5	140
Silt, clayey, tan, and thin gray silty clay layers	11	151
Sand, fine to coarse, and fine gravel	2	153
Clay, hard, silty, brown	2	155
Sand, medium to coarse, and fine to medium gravel	9	164
Clay, hard, silty, brown	2	166
Sand, medium to coarse, and fine to medium gravel	3	169
Clay, hard, silty, brown	2	171
Sand, medium to coarse, and fine to medium gravel	3	174
Clay, hard, silty, brown	2	176
Sand, very coarse to medium, and fine to medium gravel	10	186
Pliocene		
Ogallala Formation		
Silt, clayey, tan, brown; contains thin fine sand strips	29	215
Sand, fine to medium; contains thin tan sandy clay layers	23	238
Silt, sandy, brown, and thin fine sand layers	7	245
Sand, fine to medium; contains thin tan sandy clay layers	16	261
Silt, hard, brown, interbedded with tan-gray clay	10	271
Sand, coarse to medium, and fine gravel	11	282
Silt, sandy, tan	7	289
Silt, clayey, brown	5	294
Sand, fine to very fine, tan	3	297
Silt, sandy, with thin layers of soft brown clay	7	304
Sand, fine to medium, silty, reddish-tan	3	307
Silt, sandy, tan	3	310
Clay, hard, silty	10+	320

30-36-24ccc.—Sample log of test hole drilled in SW SW sec. 24, T. 30 S., R. 36 W., 200 feet north and 50 feet east of SW cor. sec. 24; November 1959; altitude of land surface, 2,902 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Sand and fine gravel	15	15
Clay, silty, brown	13	28
Sand, coarse, and fine gravel	11	39
Clay, brown	3	42
Sand, coarse, and fine gravel	14	56
Clay, silt, fine sand and caliche strips	14	70
Clay, silty, brown	18	88
Sand, medium to coarse	12	100
Sand, coarse	10	110
Sand, coarse, and fine gravel	8	118
Clay, sandy, gray and brown; contains sand layers	22	140
Sand, fine to medium, silty, brown	10	150
Sand, coarse	10	160
Sand, coarse, and fine gravel	30	190
Sand, fine	6	196
Sand, coarse, and gravel	12	208
Clay, brown	2	210
Sand, coarse, and gravel	18	228

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	Thickness, feet	Depth, feet
Pliocene		
Ogallala Formation		
Clay, brown	12	240
Clay, brown; contains a few fine sand strips	10	250
Sand, medium to coarse	10	260
Clay, caliche and fine sand strips; contains red weathered sandstone fragments	40+	300

30-36-35aaa.—Sample log of test hole drilled in NE NE sec. 35, T. 30 S., R. 35 W., near NE cor. sec. 35; 1942; altitude of land surface, 2,897 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
Road fill	5	5
Silt, fine sandy to clayey, compact, dark-buff	3	8
Sand, fine to coarse and fine gravel	3	11
Silt, fine sandy, dark-gray to black	3	14
Silt, clayey, brownish-gray	5	19
Sand, fine to coarse, and grayish-brown sandy clay; containing fine gravel and caliche	31	50
Gravel, fine to coarse, brown; containing clay and nodules of caliche	4	54
Clay, compact, yellow-buff to gray and tan; containing fine sand	16+	70

30-36-35ddd.—Sample log of test hole drilled in SE SE sec. 35, T. 30 S., R. 36 W., near SE cor. sec. 35; 1942; altitude of land surface, 2,954 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene(?)		
Soil, sandy, gray-brown	1.5	1.5
Silt, sandy, red-brown; contains caliche	5.5	7
Silt, sandy to clayey, light gray-green, and caliche	3	10
Silt and clay, compact, sandy, gray-green and brown; contains caliche	16	26
Clay, compact, buff-pink	2	28
Silt, red, and fine to coarse sand; contains buff-pink compact clay	2	30
Silt, sandy to clayey, buff-pink; contains caliche	14	44
Silt, compact, gray and buff; contains gravel and caliche	6	50
Gravel, fine, slightly cemented, and gray-green to yellow and brown	18	68
Sand and gravel, cemented with caliche	2	70
Gravel, fine, and coarse sand; contains gray-buff to tan silt and caliche	20	90
Clay, compact, yellow-gray and tan	20	110
Clay and silt; tan and blue; contains caliche	16	126
Silt, compact, gray-brown and tan-green to blue; contains caliche	34	160
Sand, coarse; contains clayey silt	10	170
Sand, coarse, and fine gravel	20	190
Pliocene		
Ogallala Formation		
Silt, sandy, gray and brown; contains some sand	10	200
Sand, coarse, and some fine gravel; contains silt and clay,	20	220
Silt, compact, clayey, tan and blue; contains caliche	30	250
Silt, compact, varicolored; contains clay and weathered sandstone fragments	20+	270

30-37-2cd2.—Sample log of test hole drilled by Juel Water Well Drilling Co. for Lawrence Stein in SE SW sec. 2, T. 30 S., R. 37 W., 300 feet north and 100 feet west of south ¼-cor. sec. 2; May 1, 1959; altitude of land surface, 3,089 feet.

	Thickness, feet	Depth, feet
Neogene		
Undifferentiated Pleistocene		
No log	100	100
Sand, fine to coarse; contains a little tan silt and caliche	10	110
Silt, tan	20	130
Sand, very fine, silty, tan	10	140
Sand, very fine, silty, brown	20	160
Caliche, soft, and fine sand	10	170
Sand, very fine to fine, silty, brown	10	180
Silt, sandy, gray-green, brown and yellow; contains a little caliche	10	190
Sand, very fine to very coarse; contains much gray and brown silt	10	200
Silt, sandy, clayey, gray-green	10	210
Lignite	10	220
Sand, fine, silty, gray-green; contains a little gray-green clay	10	230
Silt, clayey, sandy, brown	10	240
Silt, limy, sandy, tan	20	260
Sand, fine to very coarse; contains fine gravel and brown silt	10	270
Caliche, sand and silt, tan	20	290
Sand, fine to very coarse, and brown silt	20	310
Pliocene		
Ogallala Formation		
Silt, sandy, limy, brown-tan	10	320
Silt, sandy, brown, and caliche,	20	340
Silt, clayey, brown	20	360
Silt, sandy, red-brown	10	370
Silt, sandy, tan, green and red-brown	10	380
Sand, fine to very coarse, and brown silt	10	390
Silt, sandy, red-brown, green and tan	10	400

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	Thickness, feet	Depth, feet
Sand, fine to very coarse, and fine gravel; contains predominantly quartz grains	10	410
Sand, very fine, hard, brown, white and red; contains ironstone and limestone fragments,	10	420
Silt, very sandy, red-brown	10	430
Silt, sandy, red-brown to brown,	10	440
Silt, brown, and white to pink clay	10	450
Sand, very fine, silty, tan, green, and yellow to dark-brown	10	460
Silt, clayey, tan	20	480
Silt, sandy, tan, red-brown, gray-brown, and green	20	500
Sand, very fine, limy	10	510
Silt, sandy, light-brown; contains a little caliche	10	520
Silt, gray-green, tan, and brown,	10	530
Silt, clayey, pinkish-tan	20	550
TRIASSIC		
Upper Triassic		
Dockum Group		
Siltstone, red and tan	20+	570

30-37-3bbb.—Sample log of test hole drilled in NW NW NW sec. 3, T. 30 S., R. 37 W., in NW cor. sec. 3; 1942; altitude of land surface, 3,074 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, sandy, black	3	3
Silt, fine sandy, gray-brown; contains caliche	3	6
Sand and gray-brown to tan silt; contains caliche	13	19
Sand, medium to fine, partially consolidated	6	25
Silt, compact, tan and white; contains caliche	15	40
Silt, sandy, light-tan to tan; contains caliche	10	50
Silt, clayey, compact, tan; contains fine sand and caliche	70	120
Silt, clayey, compact, buff	18	138
Gravel, coarse to medium	5	143
Silt, sandy, and gravel	13	156
Gravel, medium to fine, and coarse to fine sand; contains pink and buff, sandy, soft silt,	27	183
Silt, soft, sandy, gray	2	185
Gravel, coarse to fine, and coarse to medium sand; contains caliche	13	198
Silt, soft, sandy, buff to gray; contains sand and gravel	12	210
Silt, compact, clayey to sandy, buff	15	225
Sand, coarse to fine; contains coarse gravel and buff, sandy, compact silt	25	250
Gravel and coarse to fine sand; contains a little caliche and silt	60	310
Pliocene		
Ogallala Formation		
Silt, sandy, tan and gray; contains a little gravel	10	320
Gravel, coarse, and tan to gray sandy silt	10	330
Silt, sandy, tan and gray; contains a little coarse gravel	20	350
Sand, fine, and white and light-gray to buff sandy silt; contains caliche	18	368
Sand, fine, partially indurated, yellow to brown; contains gray-green and blue-gray silt,	22	390
Clay, varicolored, and yellow to red slightly indurated sand	10	400
Sand, fine, slightly indurated, yellow; contains fine sandy silt and varicolored clay	10	410
Silt, light blue-gray and brick-red; sand and clay; contains ironstone	10	420
Sand, fine, slightly indurated, white to yellow and brown; contains varicolored clay	100	520
TRIASSIC		
Upper Triassic		
Dockum (?) Group		
Shale, clayey, brick-red	10+	530

30-37-3da.—Sample log of test hole drilled by Juel Water Well Drilling Co. for Lawrence Steen in NE SE sec. 3, T. 30 S., R. 37 W., 0.35 mile north and 300 feet west of SE cor. sec. 3; May 1, 1959; altitude of land surface, 3,101 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
No log	100	100
Silt, sandy, tan	10	110
Sand, fine to coarse	10	120
Silt, brown to tan; contains caliche	20	140
Silt, sandy, tan; contains a little caliche	50	190
Silt, sandy, tan; contains abundant caliche	10	200
Caliche, soft, white	10	210
Sand, very fine to fine, silty, light-green	10	220
Silt, sandy, gray	10	230
Silt, clayey, blue-gray	10	240
Silt, blue-gray	10	250
Silt, sandy, gray	10	260
Sand, very fine to fine, silty, gray-green	15	275
Sand, very fine to coarse, silty, limy, light red-brown	15	290
Sand, very coarse, and fine to medium gravel	10	300
Silt, brown, and caliche	15	315
Sand, fine to coarse; contains streaks of brown silt	25	340
Pliocene		
Ogallala Formation		
Silt, sandy, red-brown; contains streaks of gray clay and fine sand	20	360
Silt, sandy, red	25	385
Silt, reddish-tan, and caliche	15	400
Sand, fine to medium, silty, limy, reddish-tan	30	430

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	Thickness, feet	Depth, feet
Silt, sandy, red-brown, green and yellow	40	470
Sand, very fine to coarse, predominently round fragments of brown very fine sandstone; contains thin streaks of pink and green silty clay	80	550
TRIASSIC		
Upper Triassic		
Dockum Group		
Siltstone, sandy, red and tan; with a trace of gypsum	20+	570

30-37-23db.—Sample log of test hole drilled in NW SE sec. 23, T. 30 S., R. 37 W., 100 feet south and 400 feet east of center sec. 23; May 12, 1960; altitude of land surface, 2,971 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Road fill	3	3
Sand, fine, brown	12	15
Silt, sandy, brown	3	18
Caliche and sandy silt	1	19
Sand, fine, brown	3	22
Silt, sandy, brown, and silt streaks	8	30
Silt, soft, gray-brown	9	39
Sand, fine to medium, loose, white to tan	11	50
Sand, medium to coarse, loose, tan-brown	15	65
Sand, coarse, loose, tan-brown, and some fine gravel	3	68
Silt, sandy, brown	2	70
Sand, fine, brown-red; contains thin sandy silt streaks	9	79
Sand, coarse, gray	2	81
Silt, hard, brown-tan	12	93
Silt, gray and tan streaks	12	105
Sand, coarse, red-brown	3	108
Silt, brown-tan	4	112
Silt, sandy, brown-tan; contains thin fine sand streaks	7	119
Silt, moderately hard, tan-brown	19	138
Sand, fine, brown	2	140
Silt, tan-brown	8	148
Sand, fine, brown	3	151
Silt, sandy, brown	4	155
Sand, fine to medium, brown	8	163
Sand, fine to medium, brown, and sandy silt streaks; contains some clay streaks	6	169
Silt, hard, clayey, brown; contains tan silt streaks	9	178
Sand, fine to medium, loose, brown	6	184
Silt, sandy, brown	2	186
Sand, fine to medium, brown	3	189
Sand, medium to coarse, brown; contains a little very fine gravel	17	206
Silt, soft, interbedded tan and brown layers; contains a few sandy silt streaks	16	222
Silt, soft, tan, and hard brown streaks; contains a little blue clay	12	234
Sand, fine to coarse, brown-red,	5	239
Pliocene		
Ogallala Formation		
Silt, hard, brown and tan; contains thin brown fine sand streaks	9	248
Silt, very hard, brown	4	252
Silt, brown, and fine sand streaks	11	273
Sand, fine, brown	3	276
Silt, sandy silt and thin fine sand streaks	9	285
Sand, tan-orange	2	287
Silt, hard, clayey, tan-brown	9	296
Sand, red	1	297
Silt, hard, clayey, tan-brown	3+	300

30-37-25ac.—Sample log of test hole drilled for Saturn Oil and Gas Co. *et al.* in SW NE sec. 25, T. 30 S., R. 37 W.; April 25, 1961; altitude of land surface, 3,005 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Silt, sandy, tan to brown	13	13
Caliche, hard	4	17
Silt, sandy, brown; with a little clay and fine gravel	27	44
Caliche, very hard	4	48
Silt, brown	7	55
Sand, fine to coarse, silty; with fine to medium gravel	16	71
Caliche, soft	2	73
Silt, sandy, brown	57	130
Sand, fine to coarse, and fine gravel	22	152
Caliche, hard	2	154
Silt, sandy, brown	21	175
Sand, fine to coarse, and fine gravel	6	181
Caliche	2	183
Sand, fine to coarse, silty	15	198
Caliche	4	202
Sand, fine, silty, brown	48	250
Clay, silty, brown	20	270
Sand, fine, silty, brown	13	283
Sand, fine to medium	22	305
Sand, fine to coarse; with little fine gravel	26	331
Clay, sandy, red	5	336
Sand, fine to coarse; with a little fine gravel	14	350
Pliocene		
Ogallala Formation		
Clay, sandy, red	6	356
Clay, tan; interbedded with brown silt, and sand to fine gravel	29	385
Sand, fine to coarse, silty, brown	39	424
Clay, brown, silty	6	430
Sand, fine, lime-cemented, tan	13	443
Clay, silty, red	4	447
Sand, fine, limonite-yellow	17	464

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	Thickness, feet	Depth, feet
Sand, very fine to fine, moderately hard, silty, limonite-yellow; contains thin red beds	50	514
PERMIAN		
Cimarronian		
Undifferentiated red beds		
Sandstone, very fine, hard, silty, red; with streaks of red shale and gypsum beds	286+	800

30-37-26db2.—Sample log of test hole drilled in NW SE sec. 26, T. 30 S., R. 37 W., 0.28 mile north and 0.35 mile west of SE cor. sec. 26; May 11, 1960; altitude of land surface, 3,077 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	3	3
Silt, tan-brown	3	6
Sand, fine, silty, brown	2	8
Silt, tan-gray	3	11
Sand, fine, silty, brown	4	15
Silt, tan, and caliche	2	17
Silt, tan-brown	5	22
Sand, fine; contains silt and caliche in thin streaks	5	27
Silt, sandy, tan, and caliche	18	45
Silt, brown and fine silty sand,	27	72
Sand, fine, brown	2	74
Silt, brown	5	79
Caliche, sandy; brown silt and fine sand in thin streaks	14	93
Sand, fine to coarse, and fine gravel; cemented with caliche	5	98
Sand, coarse, loose, gray-red, and fine gravel	11	109
Silt, brown, and caliche; contains thin, hard coarse sand streaks	6	115
Silt, hard, brown-tan	17	132
Sand, fine to medium, brown	12	144
Silt, tan	2	146
Sand, fine to medium, brown	11	157
Caliche, hard	1	158
Sand, fine to medium, brown	2	160
Sand, medium to coarse, brown,	8	168
Sand, very fine, brown; interbedded with thin tan silt strips	17	185
Sand, medium to coarse, loose, broken	30	215
Sand, coarse, loose, brown; contains a little fine gravel	17	232
Sand, hard, coarse, brown	9	241
Sand, fine to medium, hard, brown; contains very thin tan silt and caliche streaks	9	250
Silt, hard, brown	12	262
Sand, fine, hard, brown; interbedded with layers of brown silt	11	273
Sand, fine to medium, brown	7	280
Silt, brown, and fine sand streaks	3	283
Sand, fine, brown, and thin silt streaks	9	292
Sand, fine, brown	6	298
Silt, brown and tan; with a few thin sand layers	11	309
Sand, fine to medium, brown; with an occasional brown silt layer	11	320
Sand, medium to coarse, brown; with a few silt streaks	22	342
Silt, brown, and fine sand streaks	10	352
Sand, medium to coarse, loose, brown	8	360
Sand, coarse, loose, brown, and some fine gravel	14	374
Pliocene		
Ogallala Formation		
Silt, hard; contains a little ironstone	4	378
Sand, coarse, brown	10	388
Silt, hard, brown and tan; contains small sandstone fragments	12+	400

30-37-30dd.—Sample log of test hole drilled in SE SE sec. 30, T. 30 S., R. 37 W., 85 feet north and 25 feet west of SE cor. sec. 30; May 12, 1960; altitude of land surface, 3,067 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Sand, fine to medium, loose, brown	12	14
Silt, tan, and caliche	2	16
Sand, coarse, loose, and fine to medium gravel	6	22
Caliche, sandy, hard, pink	34	56
Silt, hard, brown	6	62
Sand, coarse	3	65
Silt, hard, brown	2	67
Sand, coarse, hard, lime-cemented, gray-brown; fine to coarse gravel, and thin caliche streaks	8	75
Sand, coarse, loose, gray-brown,	10	85
Lignite	4	89
Sand, fine, brown; with thin brown silt and sandy silt streaks	16	105
Sand, coarse, brown, and caliche streaks	11	116
Sand, coarse, loose, brown; contains a little fine gravel	21	137
Caliche and sand	2	139
Sand, coarse, loose, red-brown	18	157
Sand, fine to coarse, hard, red-brown; contains a little caliche	13	170
Sand, loose, brown-red	14	184
Clay, hard, sticky, brown	5	189
Sand, coarse; with silt and sandy silt streaks	13	202
Sand, fine, hard, brown	2	204
Silt, hard, brown; with thin fine sand streaks	20	224
Sand, fine, hard, brown; with thin silt streaks	8	232

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	Thickness, feet	Depth, feet
Sand, fine to coarse, brown; with silt streaks	5	237
Sand, fine to coarse, silty, hard, brown	17	254
Sand, fine to medium, loose, brown	5	259
Sand, fine to medium, brown; with pink-brown sandy silt streaks	9	268
Silt, soft, brown	8	276
Sand, coarse, loose, brown, and very fine gravel	3	279
Silt, soft, brown	4	283
Sand, coarse, loose, brown, and very fine gravel	12	295
Sand, coarse, loose, brown; and fine gravel	9	304
Silt, brown	2	306
Sand, coarse, loose, brown; with a little fine gravel	6	312
Sand, coarse; with thin brown silt streaks	3	315
Sand and gravel, loose	4	319
Pliocene		
Ogallala Formation		
Sand, tan-orange, and caliche	1	320
Sand, silt, and clay in thin hard streaks	10	330
Sand, very hard, and hard clay,	4+	334
Sand, fine to medium, silty, and caliche	25	345
Pliocene		
Ogallala Formation		
Clay, hard, red	4	349
Sand, fine, cemented, tan	4	353
Clay, gray and tan	7	360
Sand, hard, silty, tan	27	387
Clay, hard, red	4	391
Sand, fine to coarse; contains a little fine gravel	7	398
Clay, hard, red	2	400
Silt, hard, tan, and gray sandy clay; with red clay streaks	62	462
TRIASSIC		
Upper Triassic		
Dockum Group		
Sandstone, fine, moderately hard, yellow, gray and white; interbedded with yellow, gray, and white sandy siltstone	45	507
Siltstone, hard, sandy, tan to red; with very hard fine sandstone streaks	33	540
PERMIAN		
Cimarronian		
Big Basin Formation		
Sandstone, very hard, silty, dark-red; with a few soft streaks	65+	605

30-37-32aa.—Sample log of test hole drilled by Garvey Drilling Co. for Anadarko Production *et al.* in NE NE sec. 32, T. 30 S., R. 37 W., 0.12 mile south and 0.12 mile west of NE cor. sec. 32; May 6, 1961; altitude of land surface, 3,071 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Silt, clayey, tan to red-brown; contains a little caliche and fine sand	50	50
Silt, sand, tan, and caliche; contains a few fine sand streaks,	12	62
Sand, fine to medium, silty, brown	11	73
Sand, coarse, brown	22	95
Sand, medium to coarse, and fine to medium gravel; contains a few caliche and silt streaks	10	105
Sand, medium to coarse, silty, and fine to medium gravel	50	155
Gravel, fine to coarse, and coarse sand	70	225
Clay, brown	8	233
Gravel, coarse to fine, and coarse sand	7	240
Silt, tan; with gravel and sand streaks	45	285
Clay, silty, gray	8	293
Silt, tan; with gravel and sand streaks	9	302
Gravel, fine to medium, and coarse sand; with tan, silty clay layers	18	320

30-38-10cb.—Sample log of test hole drilled by Ray Stevenson for Elmer Hennigh in NW SW sec. 10, T. 30 S., R. 38 W., 300 feet south and 0.2 mile east of W¼ cor. sec. 10; December 1958; altitude of land surface, 3,149 feet estimated.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, sandy, brown	28	28
Clay, tight, brown	10	38
Sand, medium to coarse	7	45
Clay, tight, and caliche	25	70
Sand, medium to coarse	5	75
Clay, brown	15	90
Clay, silty, and caliche strips	20	110
Sand, fine, brown	10	120
Clay, tan-brown, and caliche	15	135
Sand, fine	15	150
Sand, coarse, and gravel	15	165
Clay, fine; brown sand	15	180
Sand, coarse, and gravel	30	210
Sand; few clay strips	78	288
Gravel	12	300
Clay and sand strips	10	310
Sand, coarse, and gravel; some thin clay strips	25	335
Pliocene		
Ogallala Formation		
Clay, brown, and sand strips	20	345
Clay, caliche and fine sand strips	15	360
Silt, clay and fine, brown sand	15	375
Clay, gray; contains sandstone fragments	15+	390

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30-38-11ba.—Sample log of test hole drilled by Ray Stevenson for Marion Hennigh in NE NW sec. 11, T. 30 S., R. 38 W., 0.1 mile south and 0.3 mile east of NW cor. sec. 11; 1958; altitude of land surface, 3,135 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, brown, and fine sand	12	12
Clay, silt, fine sand and caliche, tan	18	30
Sand, fine, silty, brown; some caliche	15	45
Clay, silty, brown	15	60
Silt, sandy, brown-tan	18	78
Clay, silty, brown	9	87
Clay, fine sand and caliche	20	107
Sand, very fine, silty, brown	17	124
Clay, silty, brown	14	138
Sand, fine to medium, brown	7	145
Clay, brown, and caliche strips	31	176
Sand, fine to medium, gray-brown	20	196
Sand, medium to coarse, brown,	26	222
Sand, coarse, and caliche	5	227
Sand, fine to medium; few clay strips	26	253
Sand, fine to medium, brown	20	273
Clay	3	276
Sand and fine gravel	12	288
Clay, fine sand and caliche	12	300
Sand, coarse	22	322
Sand and fine gravel	8	330
Clay, caliche and fine gravel strips	14	344
Pliocene		
Ogallala Formation		
Clay, hard, brown	20	364
Sand, fine, silty and clay	12	376
Sand, very fine, pink-brown	14	390
Clay, tan and white; contains weathered sandstone fragments	15+	405

30-38-11bc1.—Sample log of test hole drilled by Ray Stevenson for Marion Hennigh in SW NW sec. 11, T. 30 S., R. 38 W.. 40 feet north and 0.2 mile east of W¼ cor. sec. 11; altitude of land surface, 3,138 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Sand, fine, silty, brown	12	12
Clay, tan, and caliche strips	8	20
Sand, fine, silty, brown	25	45
Clay, caliche and fine sand strips	45	90
Sand, very fine, silt and caliche strips	45	135
Clay, brown, and caliche	18	153
Sand, coarse, and fine gravel	9	162
Clay, sandy, brown	6	168
Sand, coarse, and fine gravel	34	202
Clay, silty, brown	6	208
Clay, silty, gray, and fine sand	10	218
Clay, hard, brown	9	229
Sand, fine, brown	18	247
Clay, silty, brown	10	257
Sand, silty, brown	13	270
Sand, medium to very coarse, and fine to medium gravel	28	298
Clay, sandy	7	305
Sand, coarse, and silty clay strips	5	310
Sand, medium to very coarse, and fine to medium gravel	20	330
Pliocene		
Ogallala Formation		
Clay, hard, brown	15	345
Clay, fine sand and caliche strips,	13	358
Clay, hard, gray, and sandstone chips	4	362
Clay, gray; siltstone; and fine, brown sand strips	28	390
Sand, fine, tan; some clay	15	405
Clay, gray; some fine sand	15	420
Sand, fine, silt and clay strips	35	455
Sand, fine, and clay	5+	460

30-38-19ddd.—Sample log of test hole drilled in SE SE sec. 19, T. 30 S., R. 38 W., 90 feet north and 15 feet west of SE cor. sec. 19; October 23, 1959; altitude of land surface, 3,146 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, gray	10	10
Silt, sandy, tan	10	20
Silt, sandy; cemented with white-tan caliche; contains fine quartz grains	15	35
Clay, silty, brown-tan	5	40
Silt, sandy; cemented with white-tan caliche; contains fine quartz grains	10	50
Silt, sandy; cemented with white-tan caliche; contains coarse quartz grains	10	60
Sand, fine to coarse, light-brown,	10	70
Sand, coarse, and fine gravel	38	108
Silt, sandy, brown	22	130
Sand, coarse, and fine gravel	28	158
Silt, brown	4	162
Sand, medium to coarse; with brown silt	8	170
Sand, fine to very coarse, and fine gravel	16	186
Silt, sandy, brown; thin silt and caliche strips	14	200
Silt, and brown, fine to medium sand	10	210
Silt, sand, and caliche strips, brown	10	220
Silt and fine sand; with caliche strips	12	232
Sand, medium to coarse	20	252
Clay, silty, brown-tan	28	280
Sand, coarse, and fine gravel	20	300
Sand, very coarse, and fine gravel	30	330
Sand, medium to coarse, and fine gravel	16	366
Pliocene		
Ogallala Formation		
Clay, hard, brown-gray; contains weathered ironstone fragments	14+	380

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30-38-30ab1.—Sample log of test hole drilled in NW NE sec. 30, T. 30 S., R. 38 W., 0.17 mile south and 0.32 mile west of NE cor. sec. 30; May 1960; altitude of land surface, 3,153 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Clay, tan; and topsoil	11	11
Clay, caliche, and fine sand, tan,	9	20
Clay, brown; fine sand, silt, and caliche strips	37	57
Sand, fine, and caliche	6	63
Sand, coarse, brown; some fine gravel	10	73
Clay, brown; and sandy clay strips	10	83
Sand, medium, and clay strips,	7	90
Sand, medium to coarse	13	103
Clay, brown; brown coarse sand strips	7	110
Sand, fine, brown; clay strips	14	124
Sand, coarse, brown; some fine gravel	12	136
Sand, coarse, and pea gravel	28	164
Clay, brown	4	168
Sand, coarse	10	178
Clay, tan	6	184
Sand, coarse, and gravel	91	275
Clay, brown	2	277
Sand, coarse, and fine gravel	53	330
Sand, fine to medium	27	357
Pliocene		
Ogallala Formation		
Clay and strips of medium sand,	12	369
Clay, hard, varicolored; contains weathered fragments of sandstone	15	384
Sand, fine, brown	8	392
Sandstone, red	3	395
Sandstone, yellow; drilled easy,	5+	400

30-38-32ddd.—Sample log of test hole drilled in SE SE sec. 32, T. 30 S., R. 38 W.; 1942; altitude of land surface, 3,173 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Silt, brown and gray; contains caliche	3	3
Silt, sandy, tan	7	10
Silt, sandy, tan; contains medium sand	8	18
Silt, very sandy, tan to gray; with caliche	12	30
Silt, sandy, buff-tan; sand fraction is fine to coarse	10	40
Silt, sandy, buff-tan; some caliche-cemented layers	54	96
Silt, sandy, red-buff; with caliche cement	17	113
Silt, sandy, brown; some caliche cement	17	130
Sand, coarse, and fine gravel	70	210
Silt, sandy, white-tan; with caliche cement	25	235
Sand, coarse, and fine gravel	5	240
Sand, coarse, and medium gravel	10	250
Sand, coarse, and fine gravel	10	260
Sand, coarse, and medium gravel	12	272
Clay, silty, gray	11	283
Silt, sandy, reddish-tan	7	290
Silt, very sandy, tan	10	300
Sand, coarse, and fine gravel	10	310
Sand, medium to coarse, and fine gravel	10	320
Sand, coarse, and medium gravel	10	330
Sand, coarse, and fine gravel; with some caliche strips	10	340
Sand, very coarse	10	350
Sand, coarse, and fine gravel	40	390
Gravel, medium, and very coarse sand	10	400
Sand, coarse; and fine gravel	20	420
Sand, coarse; some silt strips	16	436
Pliocene		
Ogallala Formation		
Clay and silt, brown-tan; contains sandstone chips	14	450
Clay, blue-gray	10	460
Clay, caliche and silt strips	10	470
Clay, tan silt and very fine sand strips	30	500
Clay, yellow and gray; contains caliche and ironstone	30	530
Clay, varicolored; containing yellow sandstone and ironstone fragments	10	540
TRIASSIC		
Upper Triassic		
Dockum Group		
Siltstone, red	20+	560

STANTON COUNTY

27-39-13bda.—Sample log of test hole drilled in NE SE NW sec. 13, T. 27 S., R. 39 W., 0.3 mile south and 25 feet west of N¼ cor. sec. 13; September 3, 1959; altitude of land surface, 3,180 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Silt, gray	5	5
Silt, brownish-gray	5	10
Silt, sandy, caliche-cemented, light-gray	20	30
Sand, fine to medium, caliche-cemented, buff-tan	5	40
Sand, very coarse, and fine to medium gravel	10	50
Sand, very coarse; and fine to medium gravel (probably occurring in thin beds)	19	69
Pliocene		
Ogallala Formation		
Clay, silty, tan-brown	6	75
Sand, fine to coarse; predominantly quartz	5	80
Sand, fine, and tan-brown silt; silt occurs as thin beds	15	95
Silt, buff-tan; with fine to medium sand; caliche-cemented,	15	110

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	Thickness, feet	Depth, feet
Sand, fine to coarse, predominantly quartz; with buff-tan silt	13	123
Silt, buff-tan; with fine sand	17	140
Sand, medium to very coarse; predominantly quartz; with buff-tan silt	15	155
Silt, buff-tan; with fine to medium sand	35	190
CRETACEOUS		
Lower Cretaceous		
Dakota Formation [Lower (?) Cretaceous]		
Sandstone, fine, friable, red-brown	23	213
Sandstone, fine, friable, iron-cemented, red-brown	17	230
Shale, silty, and red-brown, friable sandstone	30	260
Shale, silty, and brown, friable sandstone	70	330
Kiowa Shale		
Shale, silty, brownish-gray; interbedded hard and soft streaks	110	440
Cheyenne Sandstone		
Sandstone, friable, whitish-gray; interbedded with gray-blue shale	60	500
Shale, very hard, black	3	503
Sandstone, friable, thin bedded; with gray-blue shale	34	537
TRIASSIC		
Upper Triassic		
Dockum Group		
Sandstone, fine, red	8+	545

27-39-18bbb.—Sample log of test hole drilled in NW NW NW sec. 18, T. 27 S., R. 39 W., 10 feet south and 50 feet east of NW cor. sec. 18; October 26, 1959; altitude of land surface, 3,187 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, gray-brown, and clayey silt,	10	10
Silt, dark-brown	18	28
Sand, fine to coarse, and fine to medium gravel	8	36
Silt, gray	4	40
Sand, fine to coarse, and gray silt	10	50
Silt, clayey, gray; with thin hard streaks	10	60
Sand, fine, brown, and gray silt,	10	70
Silt, clayey, fossiliferous, blue to dark-gray	20	90
Silt, sandy, fossiliferous, gray	10	100
Pliocene		
Ogallala Formation		
Clay, gray and brown	10	110
Sand, fine to coarse, silty	30	140
Sand, fine to coarse, silty, and fine gravel	25	165
Caliche, soft	1	166
Sand, fine to coarse, silty, and fine gravel	11	177

	Thickness, feet	Depth, feet
Sand, fine to coarse, fine to coarse gravel, and yellow to white clay; predominantly brown sandstone fragments	13+	190

27-40-17dcc.—Sample log of test hole drilled in SW SW SE sec. 17, T. 27 S., R. 40 W., 45 feet north and 30 feet east of SW cor. sec. 17; June 22, 1960; altitude of land surface, 3,267 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Silt, sandy, tan; with caliche streaks	45	47
Silt, sandy, brown	18	65
Sand, fine to coarse, brown; contains a little fine gravel	12	77
Clay, sandy, tan	10	87
Volcanic ash, unweathered, white	3	90
Silt, sandy, brown	15	105
Sand, fine to medium, brown	5	110
Sand, fine to coarse, brown; contains silt streaks and a little fine gravel	22	132
Pliocene		
Ogallala Formation		
Silt, sandy, tan	15	147
Sand, fine to coarse, brown	5	152
Silt, sandy, brown	26	178
Sand, fine to medium, brown	14	192
Silt, brown; with sand streaks and caliche	52	244
Clay, hard, gray and brown streaks	12	256
Clay, pink; contains a little ironstone	2	258
Clay, hard, brown and gray; contains a few sandstone and ironstone fragments	42	300
Clay, silty, yellow-tan	10	310
CRETACEOUS		
Lower (?) Cretaceous		
Dakota (?) Formation		
Shale, sandy, green	15	325
Shale, dark-gray; with a few hard sandy streaks	25+	350

27-41-1bbb.—Sample log of test hole drilled in NW NW NW sec. 1, T. 27 S., R. 41 W., in NW cor. sec. 1; 1940; altitude of land surface, 3,265 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, fine sandy, tan to gray	25	25
Silt, fine sandy and clayey, gray,	11	36
Sand, gray to brown, and gravel,	8	44
Silt, sandy, light-brown	26	70
Sand, medium to coarse, tan, and fine to coarse gravel	10	80
Silt, tan, sand, and gravel	10	90
Sand, fine to coarse, tan, and fine to medium gravel	11	101
Silt, light-gray and brown, and clay	9	110

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	Thickness, feet	Depth, feet
Silt and clay, blue-gray	10	120
Silt, fine sandy, brown	4	124
Sand, fine to coarse, tan	16	140
Sand, fine to coarse, tan, and fine to coarse gravel	10	150
Sand, coarse, tan, and fine to coarse gravel	19	169
Pliocene		
Ogallala Formation		
Silt, sandy, brown	16	185
Sand, coarse, tan, and fine to coarse gravel	18	203
Silt and clay, sandy, brown	14	217
Sand, medium to coarse, tan, and fine to medium gravel	9	226
CRETACEOUS		
Lower Cretaceous		
Dakota Formation [Lower(?) Cretaceous]		
Sandstone, yellow-brown and red-brown	4	230
Shale, soft, light-gray and blue,	2.5	232.5
Sandstone, light-brown, yellow- and red-brown	5	237.5
Sandstone, red-brown, and alternating yellow and gray shale,	6.5	244
Shale, yellow, gray, and blue	6	250
Sandstone, soft, yellow to light-brown	20	270
Shale, sandy, gray-green and yellow	19	289
Kiowa Shale		
Shale, clayey, blue-gray	16	305
Shale, sandy, hard, blue-gray	10	315
Shale, clayey, soft, blue-gray	15	330
Shale, hard, blue-gray	26	356
Cheyenne Sandstone		
Sandstone, fine to medium, gray,	14	370
Shale, clayey, blue-gray, and fine, hard sandstone	24	394
Sandstone, soft, light-gray	10	404
Sandstone, hard, buff	8	412
TRIASSIC		
Upper Triassic		
Dockum Group		
Shale, red and light-gray	5	417
Sandstone, buff	2	419
Shale, red, and yellow-brown, soft sandstone	5	424
Shale, red and light-gray	3	427
Sandstone, hard, light-brown to buff	14	441
Shale, red-brown and light-gray,	22	463
Sandstone, light-gray to buff	30	493
Siltstone, hard, red	5	498
Shale, gritty, light-gray to white,	6.5	504.5
Sandstone, light-brown to buff	5.5	510
Shale, silty, red-brown, light-gray, and gray-green	13	523
Sandstone, buff to gray-brown	65	588
Sandstone, hard, fine, buff, blue-green, and gray	25	613
Shale, silty, light-gray and blue-gray	4+	617

27-41-13bbb.—Sample log of test hole drilled in NW NW NW sec. 13, T. 27 S., R. 41 W.; altitude of land surface, 3,274 feet.

NEOGENE	Thickness, feet	Depth, feet
Undifferentiated Pleistocene		
Road fill	4	4
Soil, silty, brown to black	4	8
Silt, limy, gray	5	13
Sand, medium, tan	6	19
Silt, limy, gray	8	27
Silt, sandy, brown, and fine sand	12	39
Sand, fine to coarse, tan, and fine to coarse gravel	3.5	42.5
Silt, sandy, light-brown	7.5	50
Sand, fine to coarse, tan	7	57
Clay, silty, brown and gray	9	66
Sand and gravel, poorly sorted, tan	42.5	108.5
Silt, sandy, brown to gray	24.5	133
Sand, medium to coarse, tan, and fine gravel	1.5	134.5
Silt, sandy, tan, and some caliche	35.5	170
Sand, medium to coarse, tan, and fine to coarse angular gravel	20	190
Pliocene		
Ogallala Formation		
Sand and gravel and silt in alternating beds	10	200
Silt, sandy, limy, brown, and caliche	5	205
Sand, medium to coarse, and fine to coarse gravel; poorly sorted	9	214
Silt, sandy, tan, and some caliche	6	220
Gravel, fine to coarse, poorly sorted; contains abundant pebbles of Dakota sandstone,	8	228
CRETACEOUS		
Lower(?) Cretaceous		
Dakota Formation		
Shale, sandy and silty, yellow to brown	5	233
Shale, sandy, yellow, and red-brown very fine sandstone	7+	240

27-42-24cc.—Sample log of test hole drilled in SW SW sec. 24, T. 27 S., R. 42 W., SW cor. sec. 24; June 23, 1960; altitude of land surface, 3,410 feet.

NEOGENE	Thickness, feet	Depth, feet
Undifferentiated Pleistocene		
Topsoil	2	2
Silt, brown	26	28
Sand, medium to coarse; tan silt streaks; some fine gravel	26	54
Silt, brown; caliche streaks	8	62
Sand, medium to coarse, some brown silt	23	85
Silt, tan	31	116
Silt, sandy, tan	4	120
Sand, fine; some tan silt	15	135
Silt, sandy, tan	25	160
Sand, fine to medium, brown	21	181
Pliocene		
Ogallala Formation		
Silt, brown	5	186
Sand, fine, brown	15	201

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	Thickness, feet	Depth, feet
Sand, fine, brown, and brown clay streaks	9	210
Sand, fine, brown	15	225
Silt, brown	1	226
Sand, fine to medium, brown	14	240
Sand, medium to coarse	11	251
Silt, sandy, brown	4	255
Silt, brown, and tan streaks	15+	270

27-43-1ccc.—Sample log of test hole drilled in SW SW sec. 1, T. 27 S., R. 43 W., 110 feet north and 10 feet east of SW cor. sec. 1; June 24, 1960; altitude of land surface, 3,521 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Silt, brown	12	14
Caliche, soft	4	18
Silt, brown	30	48
Sand, fine, brown	8	56
Silt, brown	1	57
Sand, fine to coarse; some fine gravel	4	61
Silt, brown; some caliche	29	90
Silt, brown, sandy	4	94
Sand, fine to coarse; some gravel	4	98
Silt, brown	20	118
Silt, brown; streaks of sand	12	130
Sand, fine	6	136
Pliocene		
Ogallala Formation		
Silt, brown	26	162
Silt, gray	5	167
Silt, tan	14	181
Silt, brown	14	195
Sand, medium	6	201
Silt, brown	8	209
Silt, brown; streaks of yellow silt and sand	31	340
Silt, brown; streaks of tan silt	12	252
Sand, fine to medium	20	272
Sand, fine to medium; streaks of silt	5	277
Silt, brown; streaks of tan silt	21	298
Sand, fine to coarse	37	335
Silt, brown to tan, sandy	33	368
Silt, brown to tan	10	378
Clay, blue	2+	380

27-43-23aaa.—Sample log of test hole drilled in NE NE NE sec. 23, T. 27 S., R. 43 W., NE cor. sec. 23; 1939; altitude of land surface, 3,527 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Road fill	2	2
Silt, limy, light-brown (loess),	2	4
Sand, fine, brown; contains caliche fragments	5	9
Silt, sandy, brown, contains a little caliche	14	23
Sand, fine, tan, and coarse, poorly sorted gravel	16	39
Silt, hard, limy, sandy, creamy-brown	3	42
Sand, medium to coarse, tan, and fine to medium gravel	3	45
Gravel, very coarse, angular, tan	9	54
Silt, light-brown	6	60
Sand, medium to coarse, tan and fine angular gravel	7	67
Silt, sandy, brown	11	78
Sand, fine to coarse, tan, and fine gravel	10	88
Silt, sandy, brown to gray-green,	12	100
Silt, sandy, tan; contains a little semiconsolidated sand and a few gastropod shell fragments	9	109
Sand, medium to coarse, tan, and fine to medium angular gravel	6.5	115.5
Pliocene		
Ogallala Formation		
Silt, sandy, hard, brown, and caliche	8.5	124
Sand, medium to coarse, tan, and fine to medium angular gravel	5	129
Silt, sandy, brown, and caliche; contains a few hard limestone fragments	4	133
Sand, fine to coarse, tan, and fine to coarse gravel	23	156
Silt, sandy, red-brown	2	158
Sand, fine to coarse, red-brown, and clay	12	170
Sand, fine to coarse, tan	5	175
Silt, clayey, sandy, brown and gray, and caliche	7	182
Clay, soft, red-buff; contains dark-brown iron nodules	2	184
Clay, soft, weathered, yellow-brown, and red	6	190
Clay, soft, varicolored; and light-gray sand	10+	200

28-39-2ccc.—Sample log of test hole drilled in SW SW sec. 2, T. 28 S., R. 39 W., near southwest cor. sec. 2; 1939; altitude of land surface, 3,152 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, tan	2	2
Soil, gray; limy strips	2	4
Silt, sandy, light-brown	10	14
Silt, sandy, brown, and red-brown loose sand	10	24
Silt, sandy, light gray, brown, and white	26	50
Sand, fine to medium, tan	5	55
Silt, sandy, limy, brown	17	72
Sand, fine to coarse, tan	8	80
Clay and volcanic ash, soft, white	14	94
Silt, light-brown and gray; some caliche	23	117
Silt, sandy, limy, brown and gray	41	158
Silt, sandy, light-brown; scattered sand, gravel, and caliche	22	180

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	Thickness, feet	Depth, feet
Clay, silty, sticky, tan	28	208
Silt, sandy, tan, and sand lenses	16	224
Silt, sandy, tan	10	234
Silt, limy, tan, light-gray and white	5	239
Gravel, medium to very coarse	27	266
Pliocene		
Ogallala Formation		
Clay, silty, sticky, tan	9	275
Sand and silt, limy, gray, interbedded	3	278
Sand, fine to coarse, tan	3	281
Silt, sandy, limy, light-brown	5	286
Sand, fine, tan and gray	5	291
Silt, sandy, limy, light-brown	4	295
Sand, fine to coarse, tan	6	301
Silt, sandy, limy, light-brown and gray	4	305
Sand, fine to coarse, and caliche,	6	311
Caliche, hard	5	316
Sand, loose, and caliche	8	324
Silt, gritty, limy, light-gray to white-tan	6	330
Clay and sandstone fragments	3	333
Clay, sandy, yellow and gray; drilled hard	17+	350

28-39-2dc.—Sample log of test hole drilled by Juel Water Well Drilling Co. for M. C. Romersi in SW SE sec. 2, T. 28 S., R. 39 W., 0.1 mile north and 0.4 mile west of SE cor. sec. 2; March 1959; altitude of land surface, 3,143 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
No sample or log	100	100
Silt, sandy, brown, tan, and thin, fine sand strips	63	163
Clay and silt strips, brown	15	178
Sand, very fine, and silt strips	34	212
Sand, fine	13	225
Gravel, medium to very coarse	25	250
Pliocene		
Ogallala Formation		
Clay and caliche	6	256
Sand, medium to coarse	14	270
Silt, sandy, brown	6	276
Clay, brown	4	280
Sand, medium, brown	7	287
Clay	3	290
Sand, medium, brown	10	300
Sand, gravel, and caliche	8	308
Sand, medium to coarse	14	322
Sand, medium, and gravel	16	338
Clay and caliche	10	348
CRETACEOUS		
Lower Cretaceous		
Dakota(?) Formation [Lower(?) Cretaceous]		
Sandstone, yellow and gray strips	23	371
Kiowa Shale		
Shale, blue	49	420
Shale and sandstone	3	423
Shale, blue and brown	19	442
Shale, blue, and sandstone strips	25	467
Shale, blue	16	483
Cheyenne Sandstone		
Sandstone; very few thin shale strips	97+	580

28-39-13cbb.—Sample log of test hole drilled in NW SW sec. 13, T. 28 S., R. 39 W., 30 feet south and 30 feet east of W¼ cor. sec. 13; June 1960; altitude of land surface, 3,143 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, gray	10	10
Sand, fine, silty, brown	10	20
Sand, fine, brown	20	40
Sand, medium, coarse	10	50
Sand, fine, silty, brown	20	70
Sand, fine to medium	10	80
Sand, fine to coarse, and clay	20	100
Clay, brown	10	110
Silt, brown, and clay strips	10	120
Sand, fine, brown	15	135
Clay, brown, and fine sand	25	160
Sand, fine to coarse, brown	15	175
Clay, light-gray and brown	20	195
Sand, fine, brown	5	200
Clay, gray-blue and brown	25	225
Clay, gray; contains fossils	33	258
Sand, coarse	12	270
Sand, coarse, and gravel strips	30	300
Pliocene		
Ogallala Formation		
Sand, coarse, and clay strips	50	350
Clay, yellow, and fine sand strips	15+	365

28-39-19aaa.—Sample log of test hole drilled in NE NE sec. 19, T. 28 S., R. 39 W., 40 feet south and 30 feet west of NE cor. sec. 19; 1959; altitude of land surface, 3,198 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, gray	5	5
Silt, brown	5	10
Silt, brown	10	20
Sand, fine, brown	15	35
Clay, and silt, brown	13	48
Sand, fine, brown	12	60
Sand, coarse, and fine gravel	14	74
Clay, brown	12	86
Sand, fine, and brown clay	5	91
Clay, gray	9	100
Clay, brown	15	115
Sand, coarse	20	135
Clay, brown, and fine sand strips	15	150
Sand, fine to coarse	10	160
Sand, coarse	14	174
Clay, gray	2	176
Clay, brown, and fine sand	14	190
Sand, fine to coarse	10	200
Sand, medium, brown, and clay strips	35	235
Sand, medium	15	250

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	Thickness, feet	Depth, feet
Pliocene		
Ogallala Formation		
Clay, brown, and fine sand strips	40	290
Sand, coarse	10	300
Clay, brown	10	310
Sand, fine, brown, and clay strips	10	320
Sand, coarse, and fine gravel	12	332
Clay and sand strips	18	350
Sand, coarse, brown	10	360
Clay, brown-tan; very fine sand strips	5	365
Clay, fine sand, and caliche strips	15	380
Clay, brown, and fine sand strips	20+	400

28-40-21dc2.—Sample log of test hole drilled by Juel Water Well Drilling Co. for J. A. Ramsey in SW SE sec. 21, T. 28 S., R. 40 W., about 0.5 mile west of SE cor. sec. 21; July 28, 1959; altitude of land surface, 3,280 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene (?)		
Topsoil and clay	18	18
Sand	42	60
Silt, tan to yellow-brown	50	110
Silt, tan, and caliche	10	120
Sand, fine to coarse, silty, brown, and fine gravel	55	175
Clay, green-tan	5	180
Silt, tan-brown	20	200
Silt, brown	10	210
Silt, sandy, brown-tan	10	220
Sand, fine to coarse, silty, tan, and fine gravel	30	250
Pliocene		
Ogallala Formation		
Silt, very sandy, tan	30+	300

28-41-9ccc.—Sample log of test hole drilled in SW SW SW sec. 9, T. 28 S., R. 41 W., 30 feet north and 30 feet east of SW cor. sec. 9; June 1960; altitude of land surface, 3,376 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Sand, fine silty, brown	3	5
Clay, silty, gray	4	9
Clay, sandy, gray	3	12
Clay, gray	3	15
Clay, sandy, yellow-brown	6	21
Clay, hard, yellow-brown	8	29
Clay, yellow-brown; contains sandy clay layers	8	37
Clay, silty, red-brown; contains red-brown sandy clay layers	18	55
Sand, fine to medium; contains a few thin, brown, sandy clay layers	19	74
Sand, medium to coarse	10	84
Sand, medium to coarse, and fine gravel	3	87
Clay, silty, olive-tan	14	101
Clay and silt, olive-tan	17	118
Sand, medium to coarse, and fine gravel; contains very few thin brown clay layers	60	178
Clay, hard, brown	4	182
Sand, fine to coarse, and fine gravel; contains thin, brown, silty clay layers	42	224
Pliocene		
Ogallala Formation		
Clay, hard, silty, and sandy clay layers	11	235
Sand, fine to medium, and brown clay layers	5	240
Sand, fine to coarse, and thin brown clay layers	12	252
Clay, brown	2	254
Sand, fine to coarse, and brown silty clay layers	5	259
Clay, brown	2	261
Sand, medium to coarse, and fine gravel; contains thin, brown, silty clay layers	94	355
Clay, brown, and thin sand layers	13	368
CRETACEOUS		
Lower Cretaceous		
Kiowa (?) Shale		
Shale, blue	2+	370

28-41-14aad.—Sample log of test hole drilled in SE NE NE sec. 14, T. 28 S., R. 41 W., 698 feet south and 104 feet west of NE cor. sec. 14; June 21, 1960; altitude of land surface, 3,339 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, silty, sandy, brown	2	2
Sand, fine, brown	6	8
Clay, tan	1	9
Sand, fine to medium, brown	18	27
Sand, coarse to medium, and fine gravel	10	37
Clay, brown	2	39
Sand, fine to medium	6	45
Clay, brown, and caliche	30	75
Sand, fine, brown	9	84
Clay, brown	2	86
Sand, fine, silty; contains brown clay layers	11	97
Sand, fine to medium	32	129
Clay, buff-tan	1	130
Sand, fine to medium	8	138
Sand, fine to medium; contains thin brown clay strips	17	155
Sand, fine to coarse, and fine gravel	12	167
Clay, buff-tan	3	170
Sand, fine to coarse	17	187
Clay, buff-tan	5	192
Sand, fine to coarse	2	194
Pliocene		
Ogallala Formation		
Clay, brown	6	200
Sand, fine to coarse	46	246
Clay, brown	2	248

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	Thickness, feet	Depth, feet
Sand, medium to coarse, and fine gravel; contains weathered ironstone and sandstone particles	34	282
Clay	1	283
Sand, medium to coarse, and fine gravel; contains weathered ironstone and sandstone fragments	11+	294

28-41-35aaa.—Sample log of test hole drilled in NE NE NE sec. 35, T. 28 S., R. 41 W., near NE cor. sec. 35; 1939; altitude of land surface, 3,347 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Road fill	2	2
Silt, sandy, gray	5	7
Silt, sandy, tan to brown, and caliche	33	40
Sand, medium to coarse	16.5	56.5
Silt, sandy, brown, and some caliche	5.5	62
Sand, fine to coarse, tan	3	65
Silt, brown; contains thin sand lenses and caliche	5	70
Sand, fine to coarse, and fine gravel; contains thin, tan silt beds	58	128
Silt, sandy, brown	18	146
Silt, limy, gray; contains caliche	9	155
Sand, fine to very coarse	6	161
Silt, sandy, brown and gray	9	170
Sand, fine to very coarse, and fine gravel	28	198
Silt, sandy, yellow	7	205
Sand, medium to coarse, and fine to medium gravel	42	247
Silt, sandy, yellow-tan	7	254
Gravel, medium to coarse, and coarse sand	62	316
Pliocene		
Ogallala Formation		
Silt, sandy, yellow-brown and gray	27	343
Sand, fine to very coarse, and fine gravel	7	350
Silt, sandy, yellow-brown	13	363
Sand, medium to coarse, and fine gravel	19	382
Silt, sandy, tan	16	398
Sand, medium to very coarse	2	400
Silt, sandy, brown	17	417
Sand, fine, brown, and yellow-brown clay	21	438
CRETACEOUS		
Lower(?) Cretaceous		
Kiowa(?) Shale		
Shale, silty, dark-gray to blue-gray	2+	440

28-42-2ddd.—Sample log of test hole drilled in SE SE SE sec. 2, T. 28 S., R. 42 W., near SE cor. sec. 2; 1939; altitude of land surface, 3,434 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, loamy, dark-brown	1.5	1.5
Silt, soft, limy, buff	7.5	9
Silt, limy, light-brown to gray	9	18
Silt, limy, light-gray to creamy-white	4	22
Silt, hard, sandy, tan	9	31
Silt, sandy, red-brown	9	40
Silt, sandy; contains caliche	5	45
Sand, fine to coarse, and fine gravel	2	47
Silt, sandy, red-brown to tan	25	72
Sand, fine to medium	4	76
Silt, sandy, tan	5	81
Sand, medium to coarse, and fine gravel	10	91
Silt, sandy, brown; contains caliche	11	102
Sand, fine to coarse, and fine gravel	31	133
Silt, light-gray	17	150
Sand, fine to coarse, and gravel	10	160
Silt, hard, brown	10	170
Silt, sandy, brown	15	185
Sand, fine to coarse, and fine gravel	5	190
Pliocene		
Ogallala Formation		
Silt, sandy, brown	10	200
Clay, silty, light-brown	16	216
Sand, fine to medium	1.5	217.5
Clay, silty, light-brown	8.5	226
Silt, sandy, limy, light-brown	21	247
Sand, fine to coarse, tan	3	250
Silt, sandy, brown	5	255
Sand, fine to medium, and tan clay	5	260
Sand, fine to medium, and fine gravel; contains sandy clay	10	270
Sand, gravel and silt, interbedded	27	297
Sand, fine to medium, brown	9	306
Clay, silty, yellow-brown	12	318
CRETACEOUS		
Lower Cretaceous		
Kiowa(?) Shale		
Shale, soft, clayey, dark-gray	8	326
Sandstone, soft, friable, red-brown	1	327
Shale, soft, clayey, dark-gray to black	3+	330

28-43-13bbb.—Sample log of test hole drilled in NW NW NW sec. 13, T. 28 S., R. 43 W., 5 feet south and 57 feet east of NW cor. sec. 13; June 27, 1960; altitude of land surface, 3,593 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, grayish-brown	10	10
Silt, sandy, brown	10	20
Silt, sandy, tan; caliche-cemented	10	30
Silt, brown	13	43
Sand, medium to coarse and fine gravel	8	51
Silt, brown and tan; thin caliche-cemented layers	29	80

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	Thickness, feet	Depth, feet
Silt, sandy, brown; some thin, brown clay layers	24	104
Sand, medium to coarse	26	130
Gravel, fine, and coarse to very coarse sand	15	145
Pliocene		
Ogallala Formation		
Silt, tan	7	152
Sand, fine to coarse, and fine gravel	8	160
Sand, medium to very coarse, and fine gravel	31	191
CRETACEOUS		
Lower(?) Cretaceous		
Dakota Formation		
Shale, silty, light-gray	23+	214

28-43-16ddd.—Sample log of test hole drilled in SE SE SE sec. 16, T. 28 S., R. 43 W., near SE cor. sec. 16; altitude of land surface, 3,643 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Silt, grayish-brown	10	10
Silt, tan-brown	4	14
Silt, sandy, tan-brown	11	25
Silt, sandy, buff-tan; caliche-cemented	10	35
Silt; caliche-cemented, sandy, tan-brown; contains medium-sized quartz grains	4	39
Clay, brown	8	47
Silt, very sandy, brown	4	51
Silt, very sandy, brown; caliche-cemented	9	60
Silt, very sandy, brown	7	67
Sand, medium to very coarse, and fine gravel	4	71
Silt, sandy, brown	5	76
Silt, very sandy, brown	9	85
Silt, sandy, brown	11	96
Clay, brown	5	101
Sand, medium to coarse	19	120
Sand, medium to very coarse	20	140
Sand, medium to very coarse; fine to medium gravel	16	156
Pliocene		
Ogallala Formation		
Clay, brown	4	160
Silt, sandy, brown	17	177
Sand, medium to very coarse; fine gravel	32	209
CRETACEOUS		
Lower(?) Cretaceous		
Dakota Formation		
Sandstone, very fine-grained; limonite-cemented	11+	220

29-39-24dda.—Sample log of test hole drilled in SE SE sec. 24, T. 29 S., R. 39 W., 700 feet north and 300 feet west of SE cor. sec. 24; July 12, 1960; altitude of land surface, 3,154 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Sand, fine, brown	5	7
Clay, tan-gray	6	13
Clay, silty, brown; with caliche streaks	9	22
Sand, fine to medium; with brown, silty clay and caliche streaks	9	31
Sand, medium to coarse; with fine gravel and thin, green-gray clay and caliche streaks,	7	38
Clay, silty, tan	5	43
Caliche and fine sand streaks	10	53
Silt, clayey, tan-red-gray; with white very fine sand	5	58
Clay, silty; with gray-green clay and fine sand	12	70
Clay, tan; with sandy clay and light-brown sand streaks	13	83
Sand, fine, brown-red; with tan clay streaks	21	104
Sand, fine, brown; with a few thin clay streaks	9	113
Sand, fine to medium, brown; with thin sandy clay streaks,	4	117
Clay, tan and gray	11	128
Clay, tan; with brown, fine sand streaks	12	140
Sand, fine to medium, brown	3	143
Sand, medium to coarse; with some fine gravel	15	158
Clay, brown and tan streaks	15	173
Sand, fine to medium, brown	3	176
Clay, tan-brown	9	185
Sand, medium, brown; with clay streaks	6	191
Sand, medium to coarse, brown,	8	199
Sand, medium, sandy clay and clay streaks	7	206
Sand, fine to coarse; with few clay streaks	19	225
Sand, coarse, brown	8	233
Sand, medium to coarse and sandy clay streaks	9	242
Clay, hard, brown-tan and gray; with some sandy clay	5	247
Sand, fine, brown, and sandy clay streaks	3	250
Clay, hard, tan and gray streaks,	6	256
Sand, fine to medium, brown	7	263
Sand, fine, brown, and clay streaks	11	274
Sand, fine, brown	5	279
Clay, brown	2	281
Sand, fine to medium, clay and sandy clay strips	6	287
Sand, medium to coarse, brown,	7	294
Clay, sandy clay and fine sand streaks	3	297
Sand, coarse, brown; with very thin clay streaks	11	308
Pliocene		
Ogallala Formation		
Clay, hard, brown	2	310
Sand, medium to coarse, brown, and thin clay streaks	8	318
Sand, coarse; with some fine gravel	11	329
Sand, fine to medium, clay and		

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	Thickness, feet	Depth, feet
sandy clay streaks (about 50 percent sand)	16	345
Clay, brown, gray, and tan streaks	11	356
Sand, medium, and clay streaks (about 50 percent sand)	6	362
Clay, brown, red, gray, and tan streaks	5	367
Sand, medium, brown; with clay streaks (about 50 percent sand)	5	372
Clay, hard, white and tan streaks; some sandy clay streaks	8+	380

29-39-27aaa.—Sample log of test hole drilled in NE NE sec. 27, T. 29 S., R. 39 W., 100 feet south and 35 feet west of NE cor. sec. 27; May 1960; altitude of land surface, 3,174 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Topsoil	2	2
Clay, silt, and sandy clay	32	34
Clay and sandy clay	10	44
Clay, sandy, brown, and caliche,	8	52
Clay, sandy, brown	12	64
Sand, medium to coarse	8	72
Sand, fine to medium, and clay streaks	10	82
Sand, medium to coarse, and thin clay streaks	9	91
Clay, sandy, brown	4	95
Sand, fine to coarse, brown	11	106
Clay, brown, and sandy clay	11	117
Sand, fine to medium; and thin, sandy clay streaks	25	142
Sand, very fine; and sandy clay streaks	13	155
Clay, fine sand, and caliche streaks	7	162
Clay, sandy, and fine sand streaks	7	169
Sand, fine to medium; and thin, sandy clay streaks	31	200
Sand, fine, brown	16	216
Sand, fine, brown, and sandy clay streaks	20	236
Sand, medium to coarse; and a few thin clay streaks	20	256
Sand, medium to coarse, and fine gravel	11	267
Sand, medium to coarse; fine gravel; and a few thin clay streaks	15	282
Pliocene		
Ogallala Formation		
Sand, coarse; clay; and a few thin caliche streaks; drilled hard	12	294
Sand, fine to medium, brown, and thin clay streaks	26	320
Sand, fine to medium	16	336
Sand, fine; and clay streaks	19	355
Sand, fine to coarse; and thin clay and silt streaks	23	378
Sand, coarse; and thin clay streaks	29	407
Sand, fine, cemented; and hard clay streaks	3+	410

29-39-30bb.—Sample log of test hole drilled in NW NW sec. 30, T. 29 S., R. 39 W., 25 feet south and 25 feet east of NW cor. sec. 30; October 1959; altitude of land surface, 3,228 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil, gray	5	5
Silt, brown, and caliche	23	28
Sand, fine, red-brown	4	32
Clay, sandy, red	13	45
Clay, sandy, pink; and caliche,	15	60
Clay, sandy, and thin fine sand streaks	20	80
Sand, fine	10	90
Sand, coarse; and fine gravel	40	130
Sand and clay streaks; with thin caliche streaks	10	140
Sand and fine gravel	48	186
Clay, red-brown	7	195
Sand, fine to coarse, and gravel,	74	269
Pliocene		
Ogallala Formation		
Clay, fine sand, and caliche	11	280
Sand, coarse	30	310
Sand, coarse, and fine gravel	79	389
Sand, fine; sandy clay; and caliche	13	402
Sand, fine to medium	37	439
Sand, coarse; and some fine gravel	11	450
Clay, hard, yellow, and fine sand	10	460
Sand, fine, cemented	10+	470

29-40-21ddd.—Sample log of test hole drilled in SE SE SE sec. 21, T. 29 S., R. 40 W., 160 feet north and 30 feet west of SE cor. sec. 21; altitude of land surface, 3,272 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Topsoil	2	2
Silt, tan; and very fine sand; contains thin layers of caliche	38	40
Sand, very fine to medium; and tan silt; contains thin layers of caliche	22	62
Silt, sandy, brown	25	87
Silt, sandy, brown; contains thin caliche layers	6	93
Sand, fine to coarse; contains thin, brown, clayey silt layers,	23	116
Sand, medium to very coarse; and fine to medium gravel	36	152
Sand, fine to medium; contains thin, brown, clayey silt layers	21	173
Sand, medium to coarse; and fine gravel; contains brown silt	16	189

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	Thickness, feet	Depth, feet
Sand, medium to coarse; and fine gravel; contains brown clayey silt layers	21	210
Clay, soft, brown; and brown sandy clay; interbedded brown silty sand layers	18	228
Sand, medium to very coarse; and fine to medium gravel; drilled loose	14	242
Silt, sandy, brown	3	245
Sand, medium to coarse, silty, brown	8	253
Sand, medium to coarse; contains thin, brown, clayey silt layers	7	260
Clay, hard, silty, brown	3	263
Sand, fine to medium, silty, brown	12	275
Sand, medium to very coarse; and fine to medium gravel	16	291
Pliocene		
Ogallala Formation		
Clay, hard, silty, yellow-brown; contains fine sand layers	8	298
Clay, hard, silty, yellow-brown	24	322
Sand, fine to medium; interbedded yellow-brown, hard silty clay layers	20	342
Clay, hard, silty, yellow-brown,	5	347
Sand, fine to coarse; interbedded yellow-brown silty clay layers	11	358
Sand, medium to coarse, and fine gravel; contains thin, yellow-brown, clayey silt strips	14	372
Sand, medium to very coarse, and fine gravel; contains thin yellow-brown clay strips,	12	384
Sand, medium to very coarse, and fine gravel	3	387
Sand, medium to very coarse, and fine gravel; contains yellow-brown silty clay layers	23+	410

29-41-28bbb.—Sample log of test hole drilled in NW NW sec. 28, T. 29 S., R. 41 W., 20 feet south and 50 feet east of NW cor. sec. 28; June 28, 1960; altitude of land surface, 3,380 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Silt, sandy, gray	10	10
Sand, fine to very coarse; and fine gravel; drilled loose; contains rounded caliche pebbles,	22	32
Silt, red-brown; interbedded with silty gray clay and fine sand layers	30	62
Sand, fine to coarse, silty, tan; contains fine to coarse gravel layers	15	77
Caliche, hard, white	4	81
Sand, fine to coarse, silty, tan	5	86
Silt, light-brown; contains caliche layer	4	90
Clay, silty, yellow-brown	12	102
Sand, fine to coarse, silty; and fine to coarse gravel	26	128
Pliocene		
Ogallala Formation		
Silt, brown	3	131
Sand, fine to medium, silty, yellow-tan	9	140
Sand, fine to very coarse; and fine gravel	20	160
Sand, fine to very coarse; and fine to coarse gravel; contains weathered pebbles of Dakota ironstone	15	175
Clay, silty, yellow-brown	10	185
Sand, fine to coarse; and fine to medium gravel; contains rounded pebbles of Dakota ironstone	20	205
Sand, very fine, and silt; contains gray clay strips and weathered fragments of Dakota ironstone	41	246
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Shale, silty, dark-gray to black,	14+	260

29-42-24cc.—Sample log of test hole drilled by Dreiling Drilling Co. for Mr. Wilcox in SW SW sec. 24, T. 29 S., R. 42 W., 400 feet north and about 300 feet east of SW cor. sec. 24; November 9, 1959; altitude of land surface, 3,484 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Topsoil	2	2
Sand, fine, brown	8	10
Sand, fine, brown; with sandy clay streaks	5	15
Sand, fine, brown	5	20
Sand, fine, brown; and caliche	10	30
Sand, fine brown; with a little clay	10	40
Sand, fine to medium, brown	10	50
Sand, medium, brown	18	68
Sand, medium coarse, brown	20	88
Sand, coarse, brown	11	99
Sand, coarse, brown, and fine gravel streaks	38	137
Pliocene		
Ogallala Formation		
Clay, sandy, yellow	3	140
Sand, fine to coarse, black, brown and white streaks; with sticky yellow clay streaks	19	159
Sand, fine to coarse; interbedded black, brown, white, and gray streaks	15	174
Sand, fine, iron-stained, brown	51	225
Clay, soft, blue	10	235
Sand, fine to coarse, brown, and gravel; predominantly fine iron-cemented sandstone particles	25	260

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	Thickness, feet	Depth, feet
CRETACEOUS		
Lower Cretaceous		
Dakota Formation [Lower(?) Cretaceous]		
Sandstone, fine; and blue shale streaks	12	272
Sandstone, fine, iron-cemented, brown	25	297
Kiowa Shale		
Shale, sticky, blue and brown streaks; with thin fine sandstone streaks	13	310
Shale, hard, blue; with very thin fine sandstone streaks	35	345
Shale, sticky, hard, blue	15	360
Cheyenne Sandstone		
Shale, blue, and fine sandstone streaks	5	365
Sandstone, fine, friable, blue	45	410
TRIASSIC		
Upper Triassic		
Dockum Group		
Sandstone, fine, red and pink	35	470
Shale, soft, red	3	473
Sandstone, fine, hard, red and tan streaks	5	478
Sandstone, fine, friable, pink and buff	37+	515

29-43-23ccc.—Sample log of test hole augered in SW SW SW sec. 23, T. 29 S., R. 43 W., 15 feet north and 15 feet east of SW cor. sec. 23; November 15, 1960; altitude of land surface, 3,588 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene and Pliocene		
Silt, dark brown, and fine to coarse sand	5	5
Silt, sandy, light-brown	5	10
Silt, sandy, clayey, light-red, and medium to very coarse sand	10	20
Sand, very coarse to fine; and light brown silt	5	25
Sand, very coarse to fine; and buff-brown silt	5	30
Sand, very coarse to fine; and light-brown silt	5	35
Caliche, sandy, silty, cream-white	5+	40

30-39-2bbb.—Sample log of test hole drilled in NW NW NW sec. 2, T. 30 S., R. 39 W., near NW cor. sec. 2; 1939; altitude of land surface, 3,188 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, loamy, gray	4	4
Silt, sandy, soft, light-brown	6	10
Silt, sandy, red-tan to light-brown	10	20
Silt, hard, light-brown	18.5	38.5
Silt, gritty, limy, tan and white; and caliche	11.5	50
Silt, gray-tan	10	60
Sand, fine; and tan-brown to yellow-brown silt	4	64
Silt, limy, brown and gray	6	70
Silt, sandy, light-brown to light-gray	15	85
Sand and gravel, poorly sorted, tan	2	87
Silt, sandy, brown and yellow-brown	7	94
Sand, fine to coarse, tan	8	102
Silt, sandy, tan	4.5	106.5
Sand, coarse; and fine to coarse gravel	3.5	110
Silt, sandy, brown to gray; contains thin caliche layer	46	156
Sand, fine to medium; and gravel	20	176
Silt, sandy, light-brown; contains thin sand lenses	8	184
Sand, fine to coarse; and fine to medium gravel	24	208
Silt, sandy, light-brown; and caliche	12	220
Sand, fine to coarse; and fine gravel	6	226
Silt, sandy, brown and yellow-brown	4	230
Sand, gravel, and sandy silt	4	234
Silt, sandy, limy; contains caliche	3	237
Sand, gravel, and interbedded tan silt	11	248
Gravel, fine to medium sand, medium to very coarse sand	48	296
Silt, hard, tan	5	301
Sand, fine to very coarse; and fine to medium gravel	17	318
Pliocene		
Ogallala Formation		
Silt, hard, tan	6	324
Sand, fine to coarse, and fine to medium gravel	26	350
Silt, hard, brown and gray	11	361
Sand, fine to coarse	22.05	383.5
Silt, sandy, red-brown	6.5	390
Sand, fine to very coarse	30+	420

30-41-1bbb.—Sample log of test hole drilled in NW NW NW sec. 1, T. 30 S., R. 41 W., in NW cor. sec. 1; 1939; altitude of land surface, 3,359 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene		
Soil, sandy, gray	4	4
Silt, soft, brown	6	10
Silt, light-brown to light-gray; contains calcareous nodules	6	16
Silt, sandy, brown	11	27
Silt, sandy, limy, tan	4	31
Sand, medium to coarse, tan	3	34
Silt, limy, tan	14	48
Sand, fine to coarse, tan; and fine to coarse gravel	6	54
Silt, sandy, brown	5	59
Silt, sandy, limy, tan; and caliche	14	73

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	Thickness, feet	Depth, feet
Silt, sandy, limy, light-gray and brown; contains a little caliche	11	84
Sand, fine to medium, brown	3	87
Silt, limy, light-gray, and caliche	7	94
Gravel, coarse, poorly sorted, brown	3	97
Pliocene		
Ogallala Formation		
Silt, sandy, limy, gray, and caliche	12	109
Silt, sandy, limy, brown, and caliche	30	139
Caliche, hard	0.5	139.5
Silt, sandy, gray, gray-green, and brown; contains a little caliche	26.5	166
Sand, fine to coarse, tan; and fine to coarse angular gravel	22	188
Silt, sandy, hard, brown	6	194
Sand, fine to coarse, tan, and fine to coarse angular gravel	5	199
Silt, sandy, brown and gray	3.5	202.5
Sand, fine to coarse, brown; and fine to coarse angular gravel	14	216.5
CRETACEOUS		
Lower(?) Cretaceous		
Dakota Formation		
Clay, sandy, light-gray and brown; contains a few thin beds of sandstone	15.5	232
Clay, gray, yellow, and red	3	235
Clay, gray; and brokn very fine-grained sandstone	5+	240

30-41-14dd.—Sample log of test hole drilled in SE SE sec. 14, T. 30 S., R. 41 W., 0.08 mile north and 45 feet west of SE cor. sec. 14; May 24, 1960; altitude of land surface, 3,347 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Topsoil	3	3
Silt, brown; and fine sand streaks	17	20
Sand, fine, brown	10	30
Sand, fine, tan; with clay streaks	10	40
Sand, coarse to fine, brown, and a little fine gravel	13	53
Silt, brown	4	57
Sand, coarse to fine, brown; and a little fine gravel	13	70
Pliocene		
Ogallala Formation		
Sand, fine to medium, brown; with thin silt streaks	20	90
Silt, hard, brown	22	112
Sand, fine, brown; and sandy silt streaks	6	118
Sand, fine to medium, loose, brown; with a few thin, brown, hard silt and sandy silt streaks	9	127
Silt, hard, and sandy silt	8	135
Sand, fine, brown	8	143
Sand, fine to medium, brown, and caliche; with a little hard silt	5	148
Silt, hard, brown; and sandy silt streaks	5	153
Sand, fine to medium, loose, brown	6	159
Sand, fine to medium, loose, brown; with brown hard silt streaks	4	163
Sand, fine to coarse, brown; with very few silt streaks	8	171
Sand, coarse to fine, loose, brown, and fine gravel; with a few thin silt streaks	16	187
Sand, fine, hard, white	5	192
Silt, hard, brown	3	195
Sand, fine, hard, white; with thin, brown, hard silt streaks,	14	209
Silt, hard, brown; with a few thin, white, fine sand streaks,	8	217
Sand, fine, tan-yellow	3	220
CRETACEOUS		
Lower(?) Cretaceous		
Dakota(?) Formation		
Sandstone, fine, hard, tan, and rusty brown streaks; with thin, brown, hard shale streaks	2	222
Sandstone, fine, hard, tan and rusty brown streaks; with thin brown and blue shale streaks	3+	225

30-41-30bcc.—Sample log of test hole drilled in SW SW NW sec. 30, T. 30 S., R. 41 W., about 0.5 mile south of NW cor. sec. 30; June 1960; altitude of land surface, 3,446 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene(?)		
Silt, dark-brown	10	10
Silt, red-tan; with caliche and fine to coarse sand	10	20
Silt, tan; and soft caliche	10	30
Silt, brown, and caliche	10	40
Silt, sandy, gray-brown; and soft caliche	10	50
Silt, gray-brown	25	75
Silt, sandy, reddish-brown	30	105
Sand, fine to coarse, brown	15	120
Sand, very fine to medium, brown	14	134
Pliocene		
Ogallala Formation		
Silt, tan	4	138
Silt, sandy, hard, brown	20	158
Silt, brown	9	167
Sand, coarse, and fine gravel	19	186
Sand, fine to coarse, partially cemented with iron, dark-brown	9	195
CRETACEOUS		
Lower Cretaceous		
Kiowa Shale		
Shale, black	29	224
Shale, black; with hard streaks,	2	226
Shale, black	4+	230

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30-42-29aa3.—Sample log of test hole drilled by Huber Oil Co. in NE NE sec. 29, T. 30 S., R. 42 W., about 0.25 mile south and 0.25 mile west of NE cor. sec. 29; 1958; altitude of land surface, 3,560 feet.

	Thickness, feet	Depth, feet
NEOGENE		
Undifferentiated Pleistocene and Pliocene		
Sand, fine to coarse; and fine gravel	30	30
Sand, fine to coarse, and gravel; predominantly sandstone fragments	50	80
CRETACEOUS		
Lower Cretaceous		
Dakota Formation [Lower(?) Cretaceous]		
Shale, sandy, gray, and dark red-brown to brown sandstone	70	150
Sandstone, fine dark-brown, and gray, sandy shale	45	195
Kiowa Shale		
Shale, black	60	255
Cheyenne Sandstone		
Sandstone, fine, gray to brown	125	380
TRIASSIC		
Upper Triassic		
Dockum Group		
Sandstone, fine, pink to red	160	540
PERMIAN		
Cimarronian		
Big Basin Formation		
Siltstone, red to tan	60+	600

30-43-9dad.—Sample log of test hole augered in SE NE SE sec. 9, T. 30 S., R. 43 W., about 0.7 mile south of NE cor. sec. 9; September 1958; altitude of land surface, 3,643 feet.

	Thickness, feet	Depth, feet
NEOGENE—Undifferintiated		
Silt, sandy, gray	5	5
Clay, very sandy, brown	10	15
Silt, very sandy, brown	15	30
Sand, very coarse; and brown clay	4	34
CRETACEOUS		
Lower(?) Cretaceous		
Dakota(?) Formation		
Sandstone, hard	?	34

30-43-28add.—Sample log of test hole augered in SE SE NE sec. 28, T. 30 S., R. 43 W., about 0.5 mile south and 10 feet west of NE cor. sec. 28; September 1958; altitude of land surface, 3,590 feet.

	Thickness, feet	Depth, feet
NEOGENE—Undifferentiated		
Sand, fine to very fine, grayish-brown	5	5
Sand, medium to fine, gray; contains coarse gravel	7	12
Sand, medium to fine, limonite-brown	3	15
Sand, coarse to fine, loose and clean, gray-brown	5	20
Sand, very coarse to fine, gray	26	46
CRETACEOUS		
Lower(?) Cretaceous		
Dakota(?) Formation		
Sandstone(?), hard	?	46

30-43-33aaa.—Sample log of test hole augered in NE NE NE sec. 33, T. 30 S., R. 43 W., in NE cor. sec. 33; September 1958; altitude of land surface, 3,623 feet.

	Thickness, feet	Depth, feet
NEOGENE—Undifferentiated		
Sand, medium to fine, gray	5	5
Silt, sandy, tan	10	15
Clay, light-tan, and sand	5	20
Silt, light-tan to white, and sand	25	45
Sand, medium to fine, brownish-gray	5	50
Sand, fine, brown	5	55
Sand, fine, very silty, brown	5	60
Sand, fine, very silty, tan	5	65
Sand, fine, very silty, gray, (Nearby irrigation well drilled to 103 feet; therefore, sand and gravel assumed from 70 to 103 feet)	5+	70

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MAP OF GRANT AND STANTON COUNTIES, KANSAS

SHOWING THE SURFACE GEOLOGY AND DRAINAGE.

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, W. R. Meyer, and W. N. Lockwood

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EXPLANATION

NEOGENE

Pleistocene

Nal — **Alluvium**
Silt, sand, and gravel in channels of major streams. Yields small to moderate water supplies to wells.

Nds — **Dune Sand**
Fine to medium sand and some silt. Lies above the water table.

Npl — **Upper Pleistocene**
Silt, clay, sand, and gravel. Most lies above water table but in some areas may yield 750 gpm.

Npl — **Lower Pleistocene**
Coarse sand and gravel deposits in channel fills. Yields as much as 2,000 gpm to wells.

Pliocene

No — **Ogallala Formation**
(Includes some younger deposits locally in western Stanton County)
Silt, clay, sand, and gravel, Yields as much as 1,000 gpm to wells.

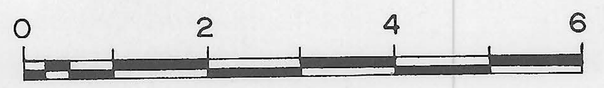
CRETACEOUS

Lower Cretaceous

Kd — **Dakota Formation**
Fine- to medium-grained sandstone containing shale. Yields some water for irrigation.

Gravel deposits or volcanic ash pit.

Fault.

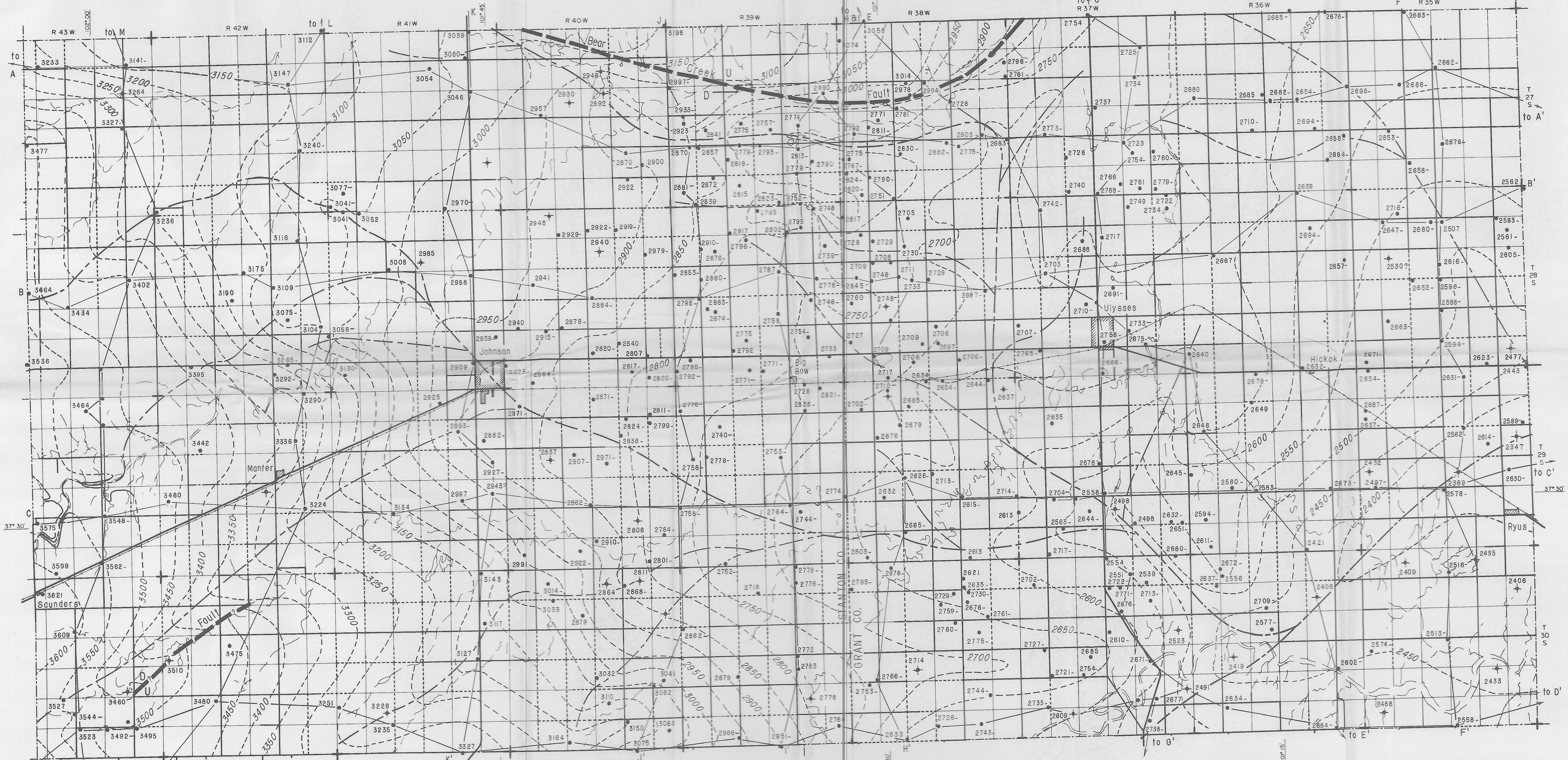


Scale, in miles.

State Geological Survey of Kansas

MAPS OF GRANT AND STANTON COUNTIES, KANSAS

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer.
1964



A. SHOWING CONTOURS ON THE BEDROCK SURFACE AND LOCATIONS OF GEOLOGIC CROSS SECTIONS.

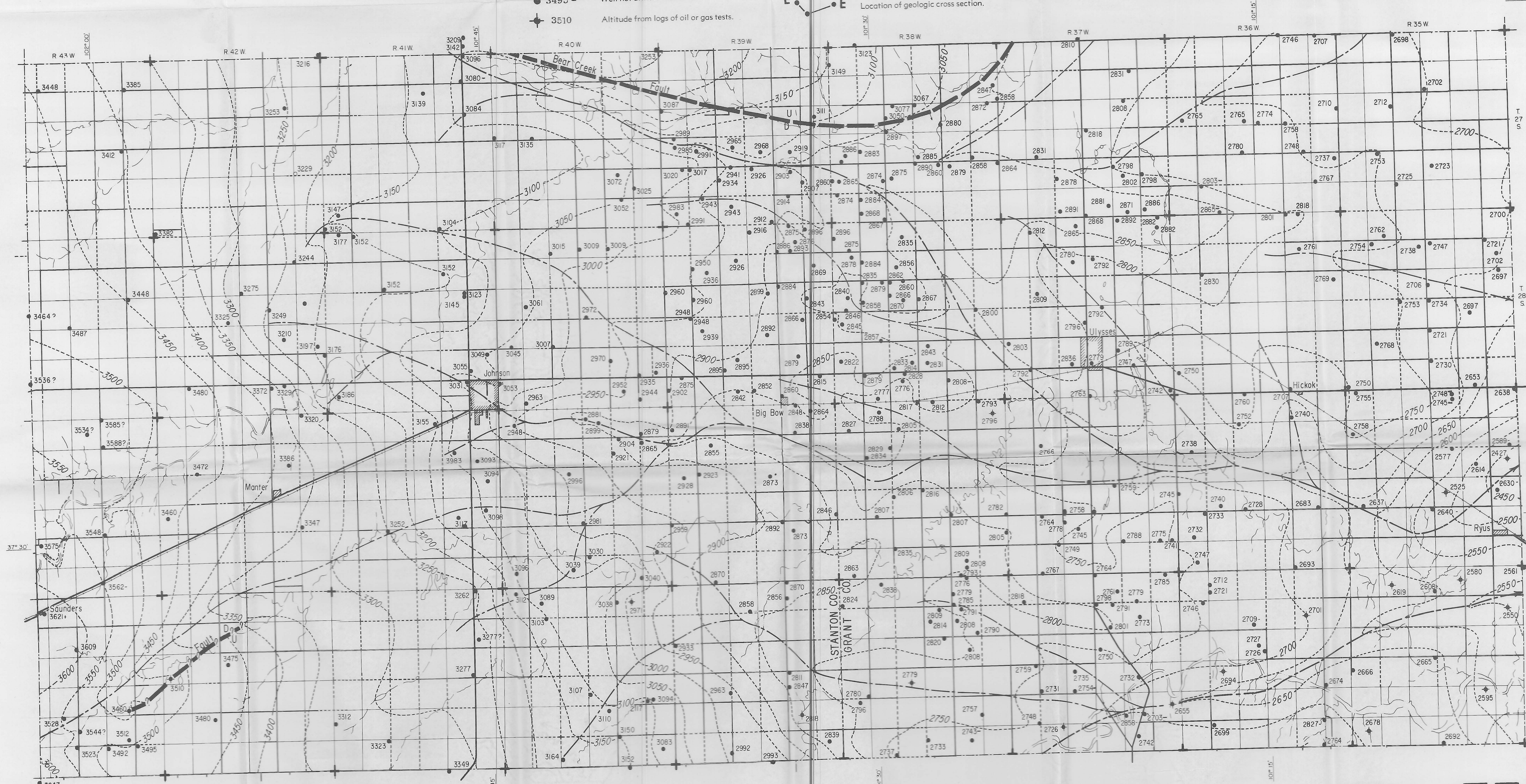
● 3235 Altitude of bedrock surface in feet above mean sea level from test holes.

● 3495 - Well not drilled to bedrock.

✦ 3510 Altitude from logs of oil or gas tests.

--- 3000 --- Contours on bedrock surface; contour interval, 50 feet.

E ⸺ E' Location of geologic cross section.



Bases compiled from maps prepared by the Soil Conservation Service

B. SHOWING CONTOURS ON THE UPPER SURFACE OF THE OGALLALA FORMATION.

● 3096 Altitude of top of Ogallala surface in feet above mean sea level.

● 3544 ? Reported data. Not positive that top of Ogallala was encountered at indicated altitude.

● 3585 - Well not drilled to base of Pleistocene deposits.

✦ 2971 Altitude from logs of oil or gas tests.

--- 3150 --- Contours on eroded surface; contour interval, 50 feet.

Drainage.

Fault.

Scale, in miles. 0 2 4 6

State Geological Survey

of Kansas

EAST-WEST GEOLOGIC CROSS SECTIONS AA′ AND BB′, GRANT-STANTON AREA.

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer

1964

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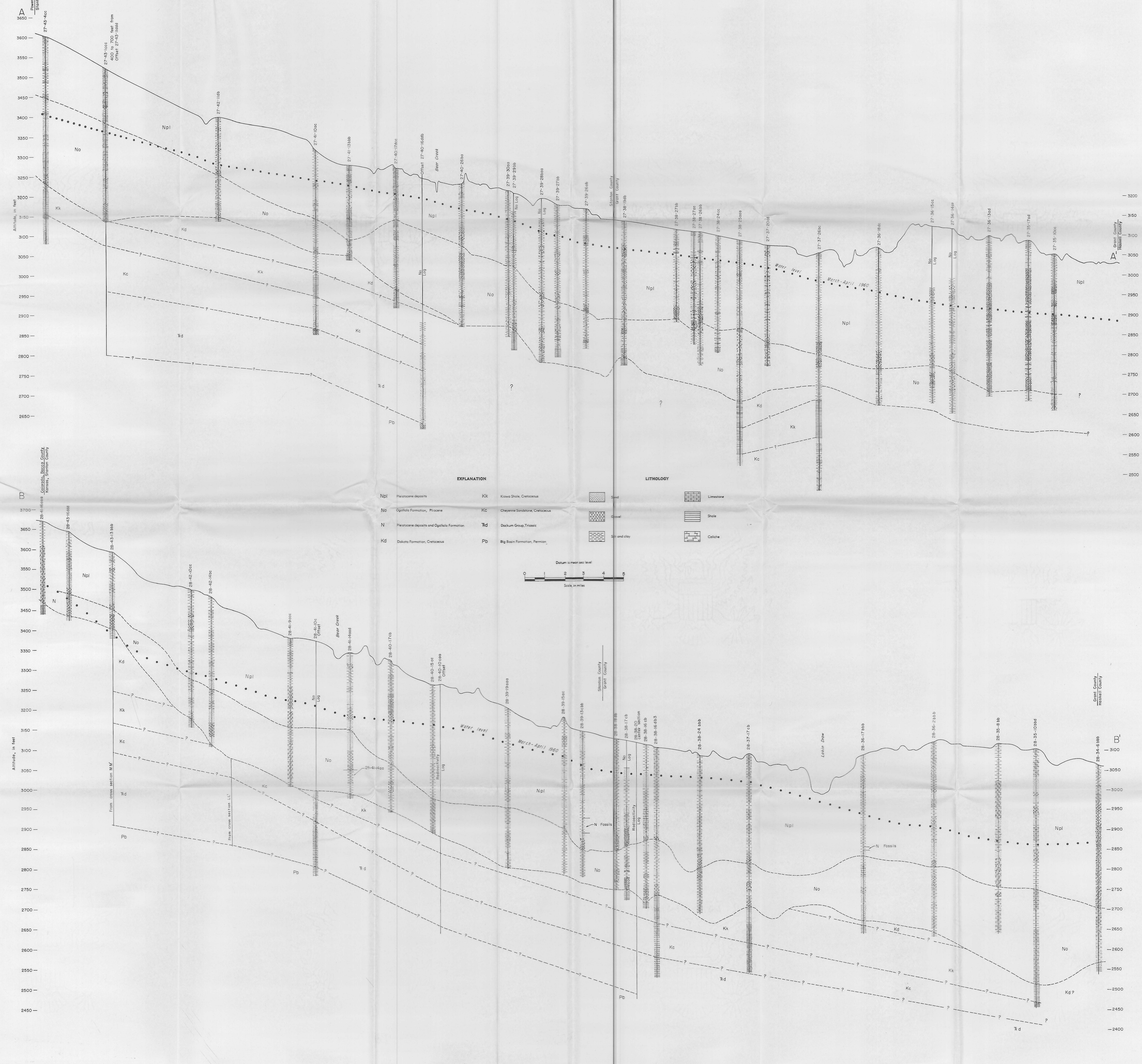
Plate 3



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EAST-WEST GEOLOGIC CROSS SECTIONS CC′ AND DD′, GRANT-STANTON AREA.

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer

1964

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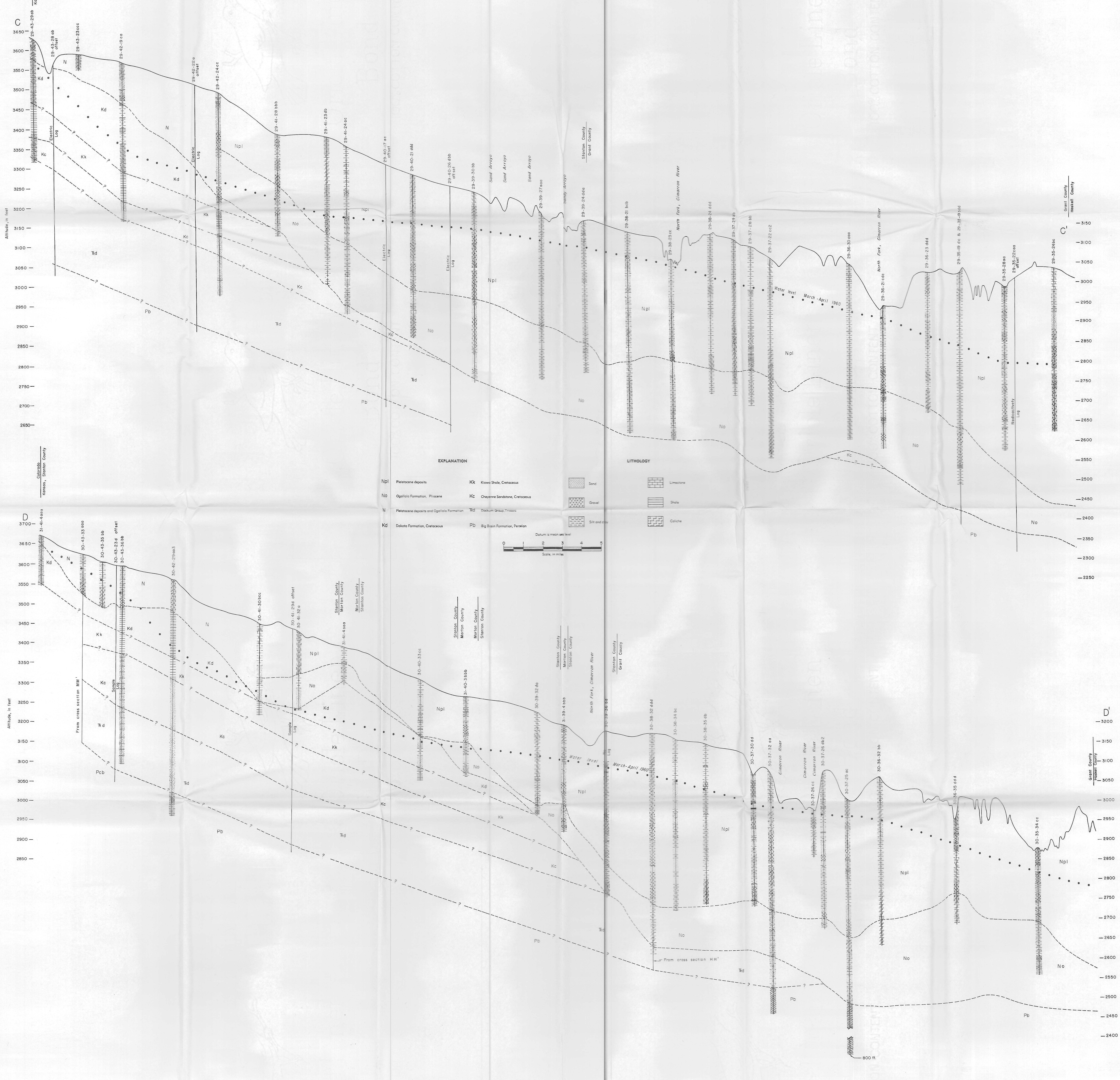
Plate 4



NORTH-SOUTH GEOLOGIC CROSS SECTIONS EE′, FF′, AND GG′, GRANT-STANTON AREA.

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Plate 5

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer

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Plate 6

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NORTH-SOUTH GEOLOGIC CROSS SECTIONS HH', II', AND JJ', GRANT-STANTON AREA.

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer

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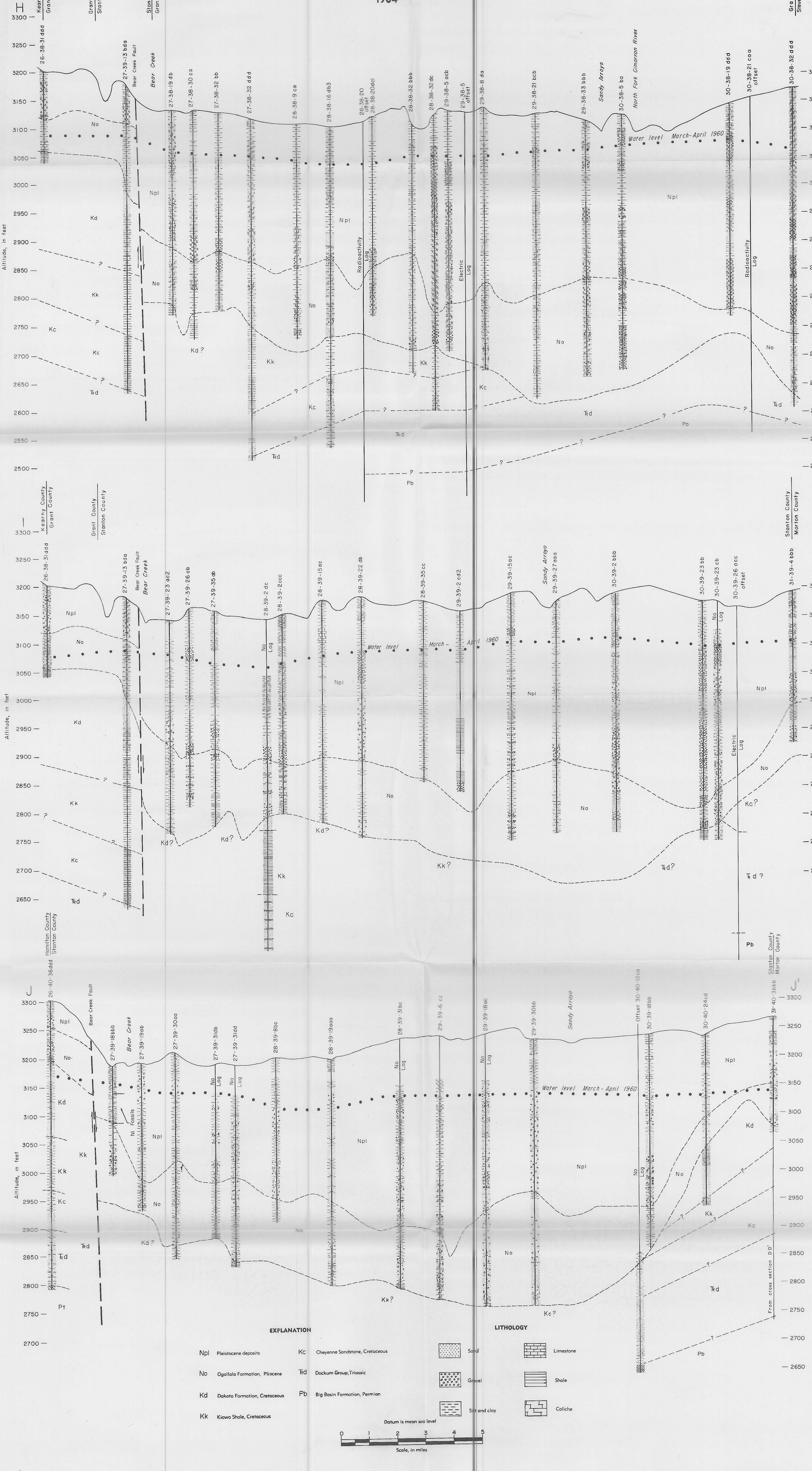

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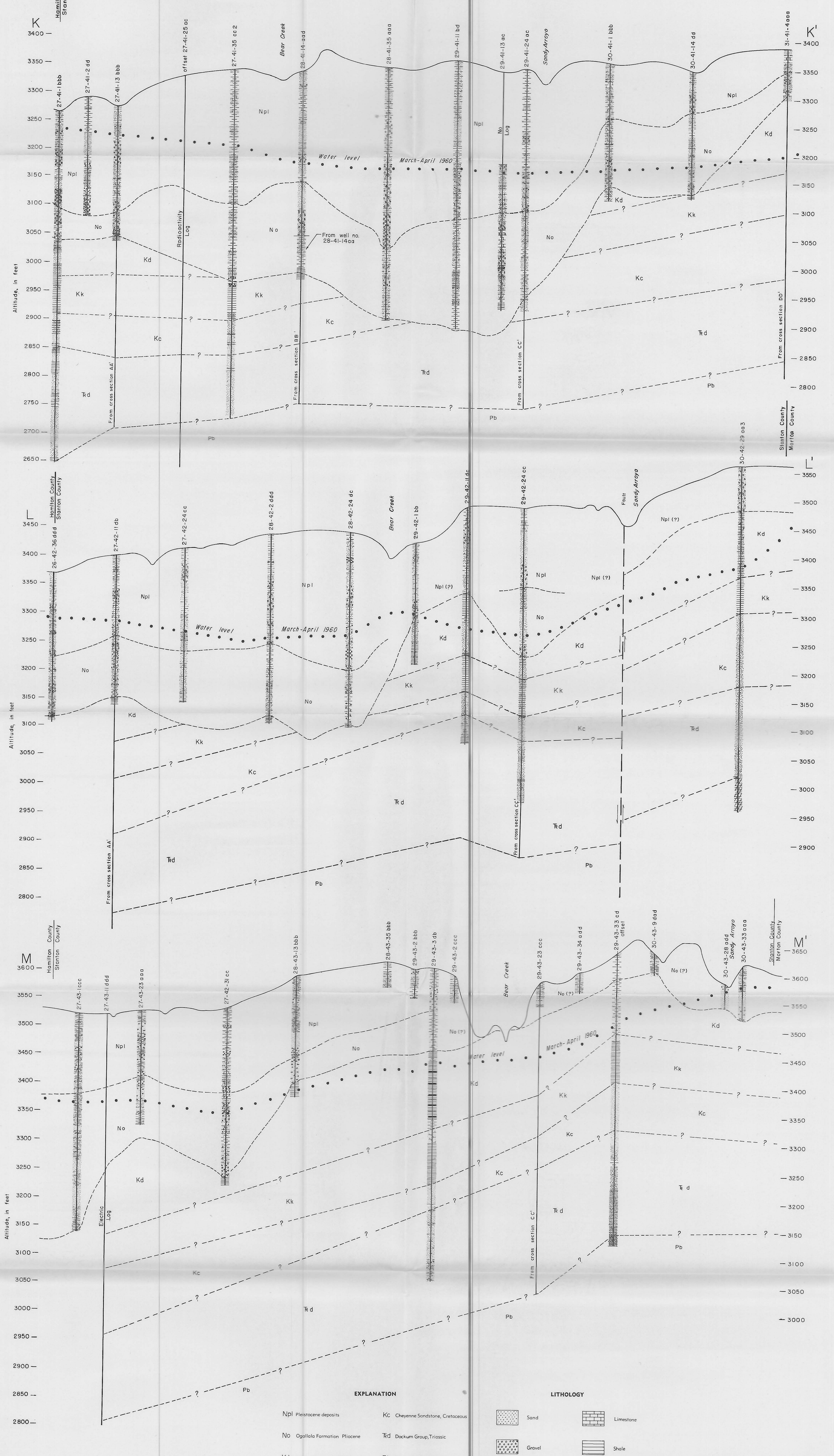
Plate 7

NORTH-SOUTH GEOLOGIC CROSS SECTIONS KK', LL', AND MM', GRANT-STANTON AREA.

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer

1964



EXPLANATION

Npl Pleistocene deposits

No Ogallala Formation Pliocene

Kd Dakota Formation, Cretaceous

Kk Kiowa Shale, Cretaceous

Kc Cheyenne Sandstone, Cretaceous

Ꞧd Dockum Group, Triassic

Pb Big Basin Formation, Permian

LITHOLOGY

Sand

Gravel

Silt and clay

Limestone

Shale

Caliche

Datum is mean sea level

0 1 2 3 4 5

Scale, in miles

State Geological Survey
of Kansas

MAPS OF GRANT AND STANTON COUNTIES, KANSAS.

By S. W. Fader, W. R. Meyer, and W. A. Long

1964

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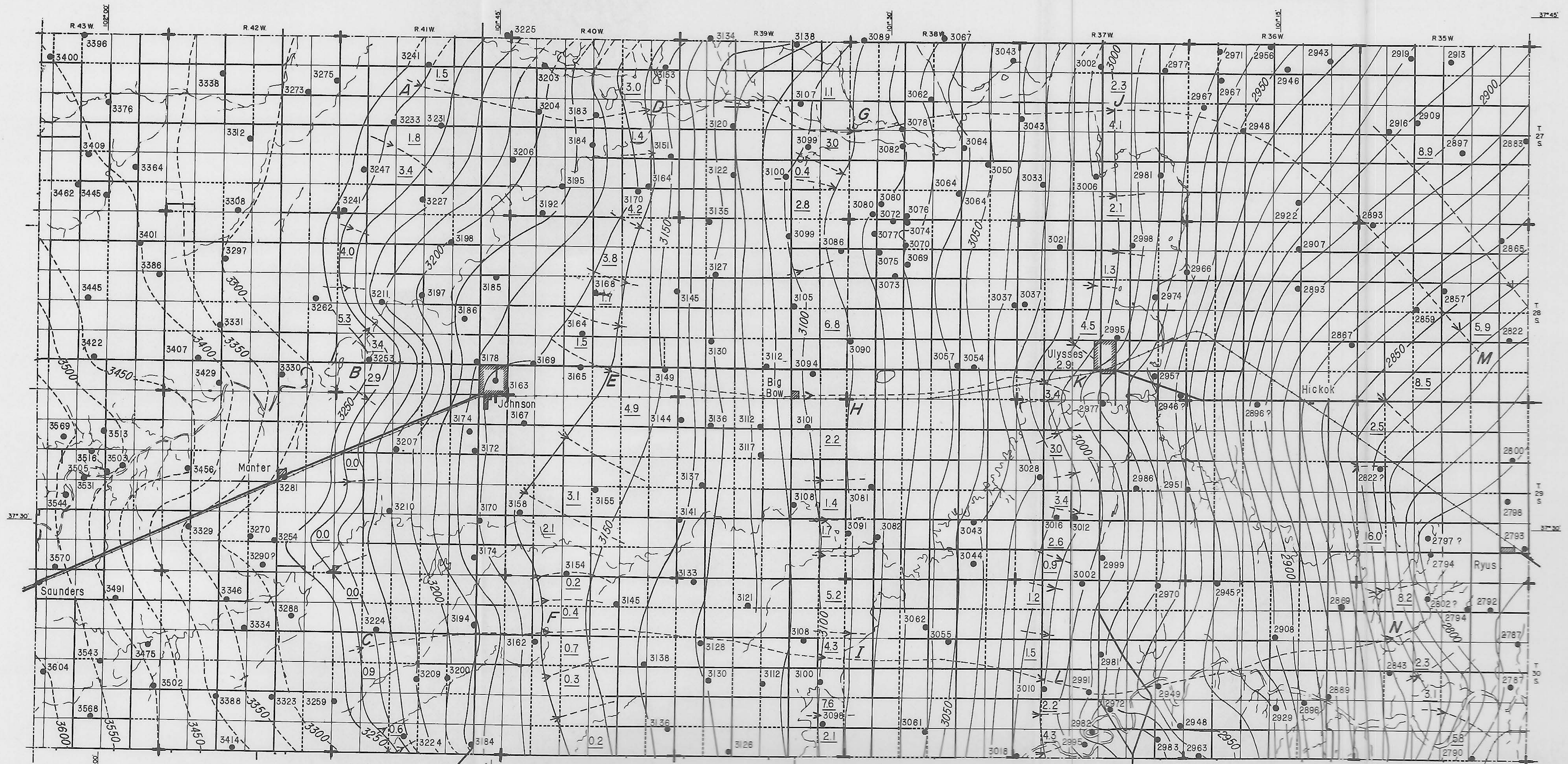
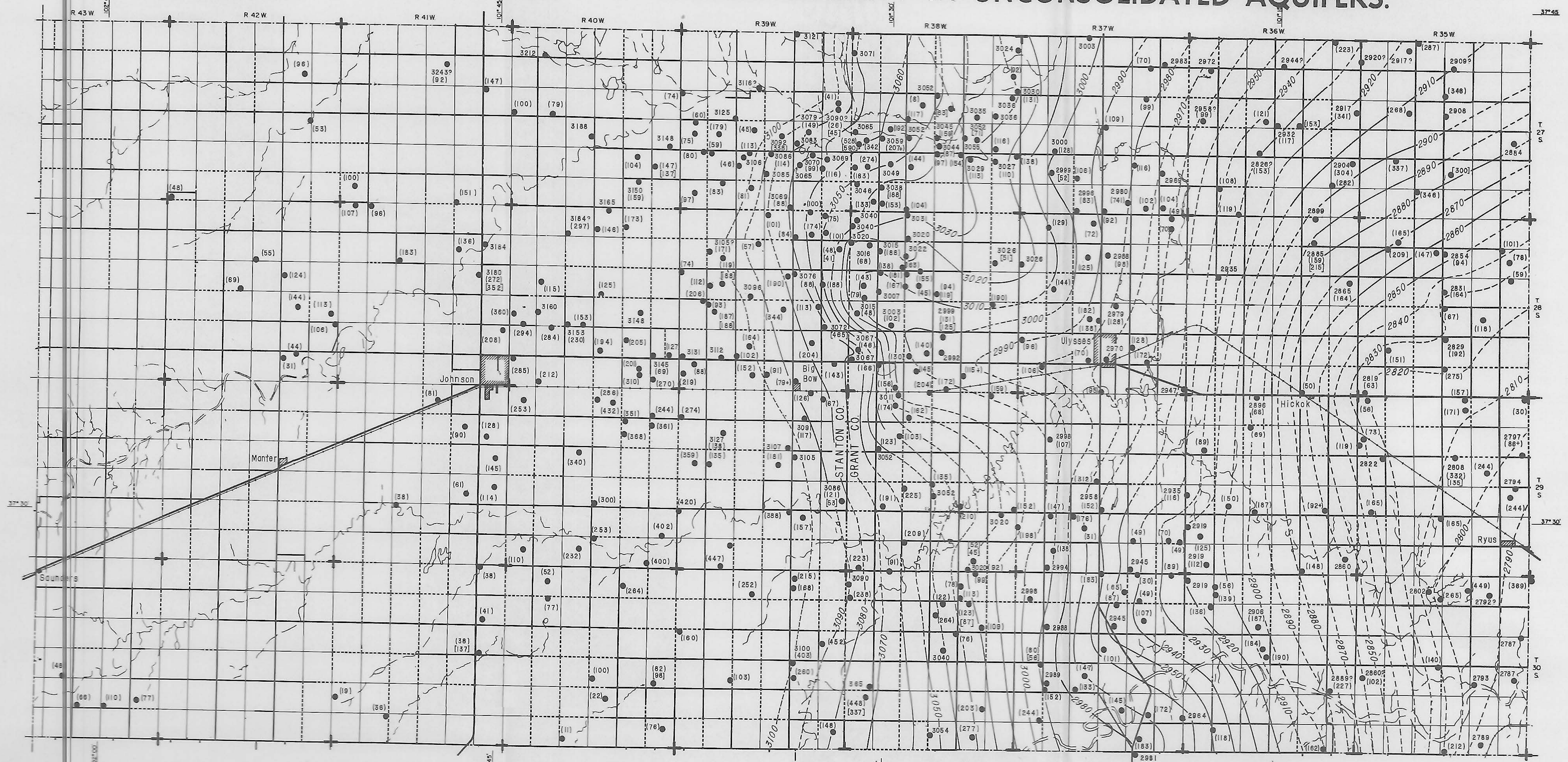
Plate 11

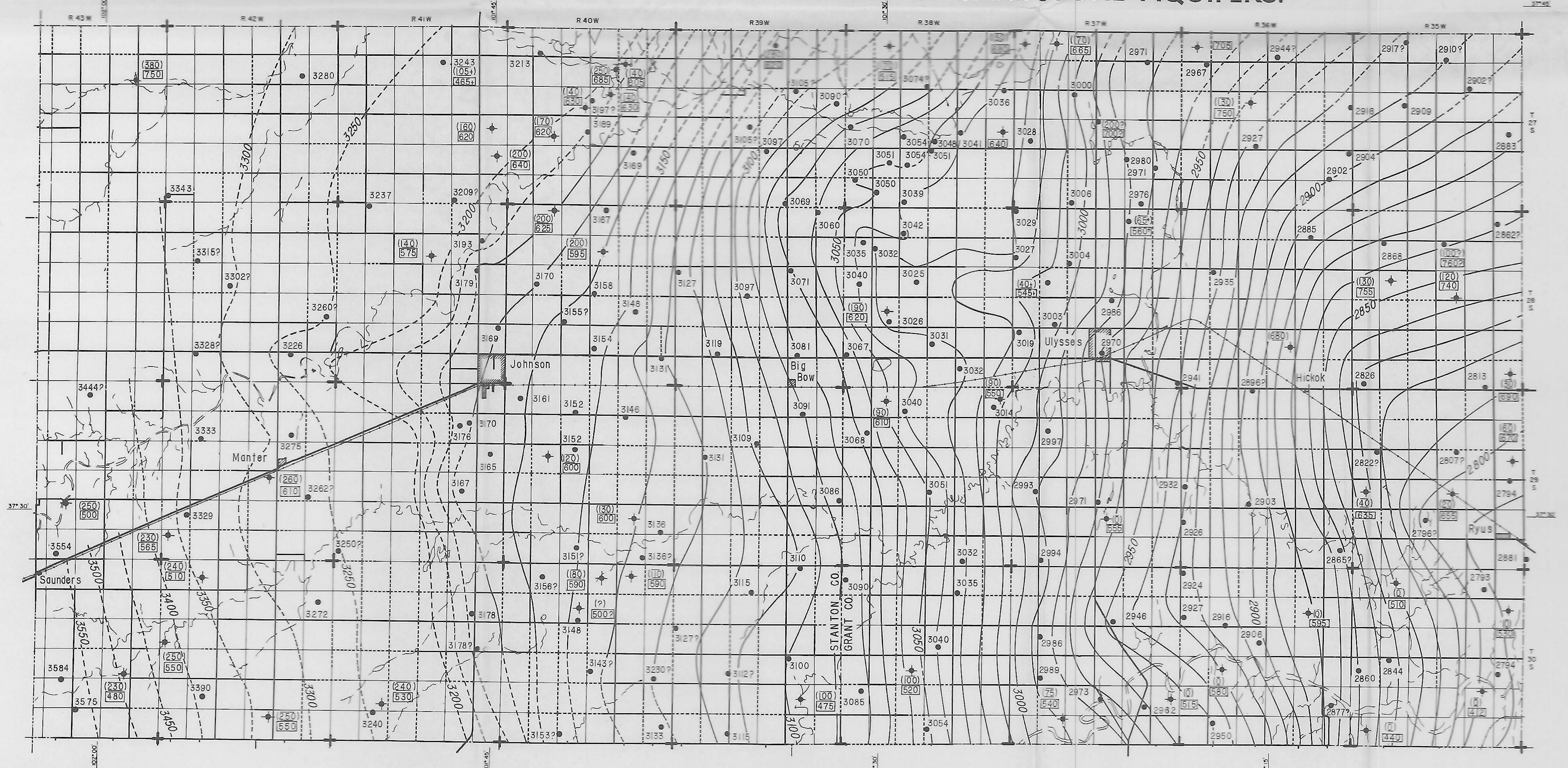
A. WATER-LEVEL CONTOURS 1939-42 AND CALCULATED FLOW OF GROUND WATER.



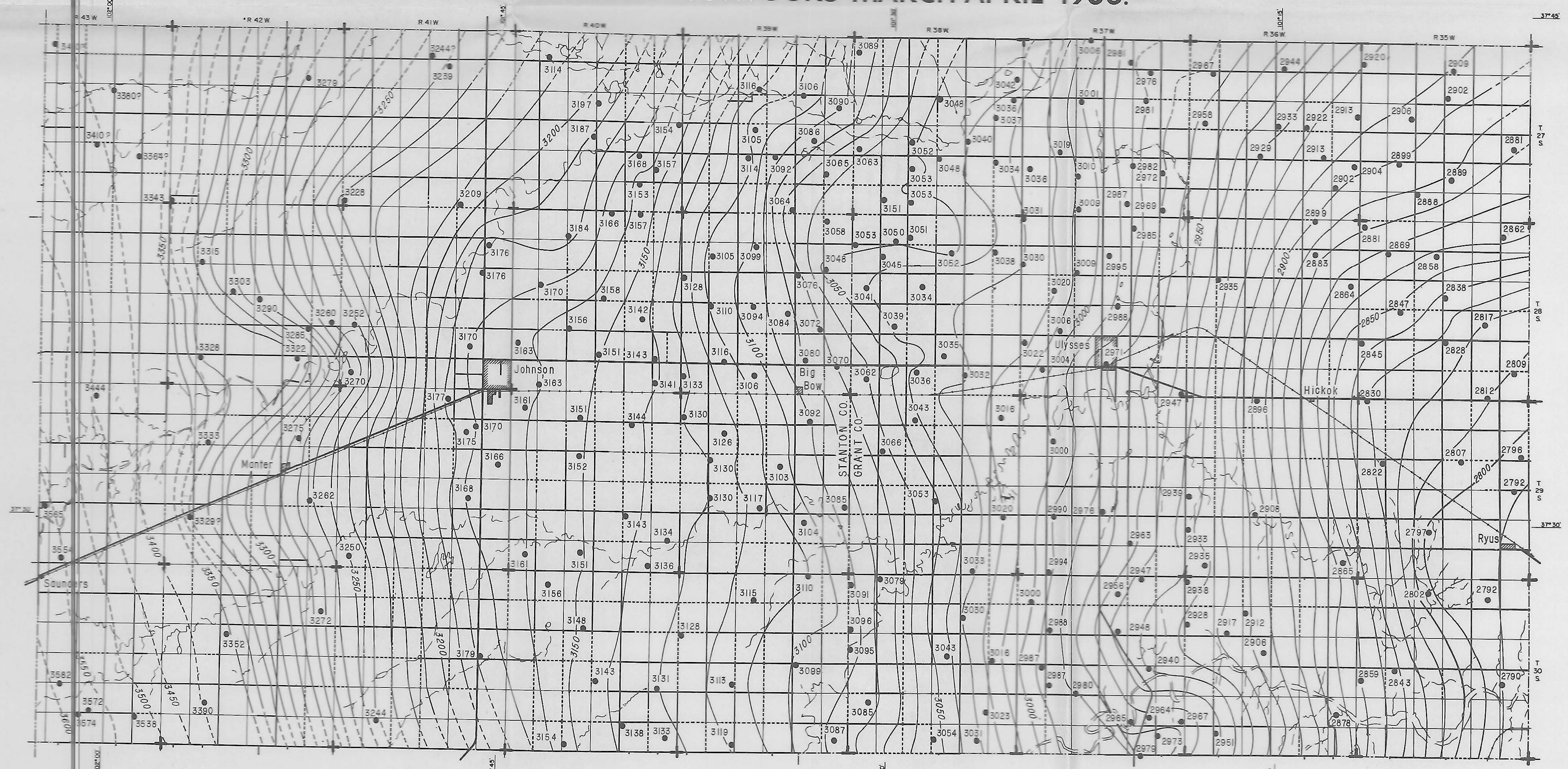
B. WATER-LEVEL CONTOURS DECEMBER 1957-JANUARY 1958 AND ESTIMATED AND CALCULATED COEFFICIENTS OF TRANSMISSIBILITY IN UNCONSOLIDATED AQUIFERS.



C. WATER-LEVEL CONTOURS FEBRUARY, MARCH, AND APRIL 1959 AND THICKNESS AND DEPTH TO THE BOTTOM OF SANDSTONE AQUIFERS.



D. WATER-LEVEL CONTOURS MARCH-APRIL 1960.



Bases compiled from maps prepared by the Soil Conservation Service.

EXPLANATION

● 2995 Altitude of water level in feet above sea level (query indicates approximate).

— 2950 — Water-level contours (dashed where approximate); contour interval 10 feet.

1.86 Calculated flow of ground water between adjacent flow lines, in millions of gallons a day.

- - -> Ground water flow lines (arrows show direction of flow).

✦ Gas or oil test hole.

(77) Estimated coefficient of transmissibility of Pliocene and Pleistocene deposits, in thousands of gallons a day per foot.

[467] Calculated coefficient of transmissibility of Pliocene and Pleistocene deposits, in thousands of gallons a day per foot.

[330] Aggregate thickness of sandstones underlying the Pliocene and Pleistocene deposits.

[465] Depth to bottom of Triassic or Cheyenne sandstones.

0 4 8 12

Scale, in miles.

State Geological Survey

of Kansas

SHOWING WATER-LEVEL CONTOURS, OCTOBER 1959, ACREAGE FOR WHICH APPLICATIONS FOR WATER RIGHTS HAVE BEEN RECEIVED, AND LOCATION OF WELLS AND TEST HOLES.

By S. W. Fader, E. D. Gutentag, D. H. Lobmeyer, and W. R. Meyer.

1964

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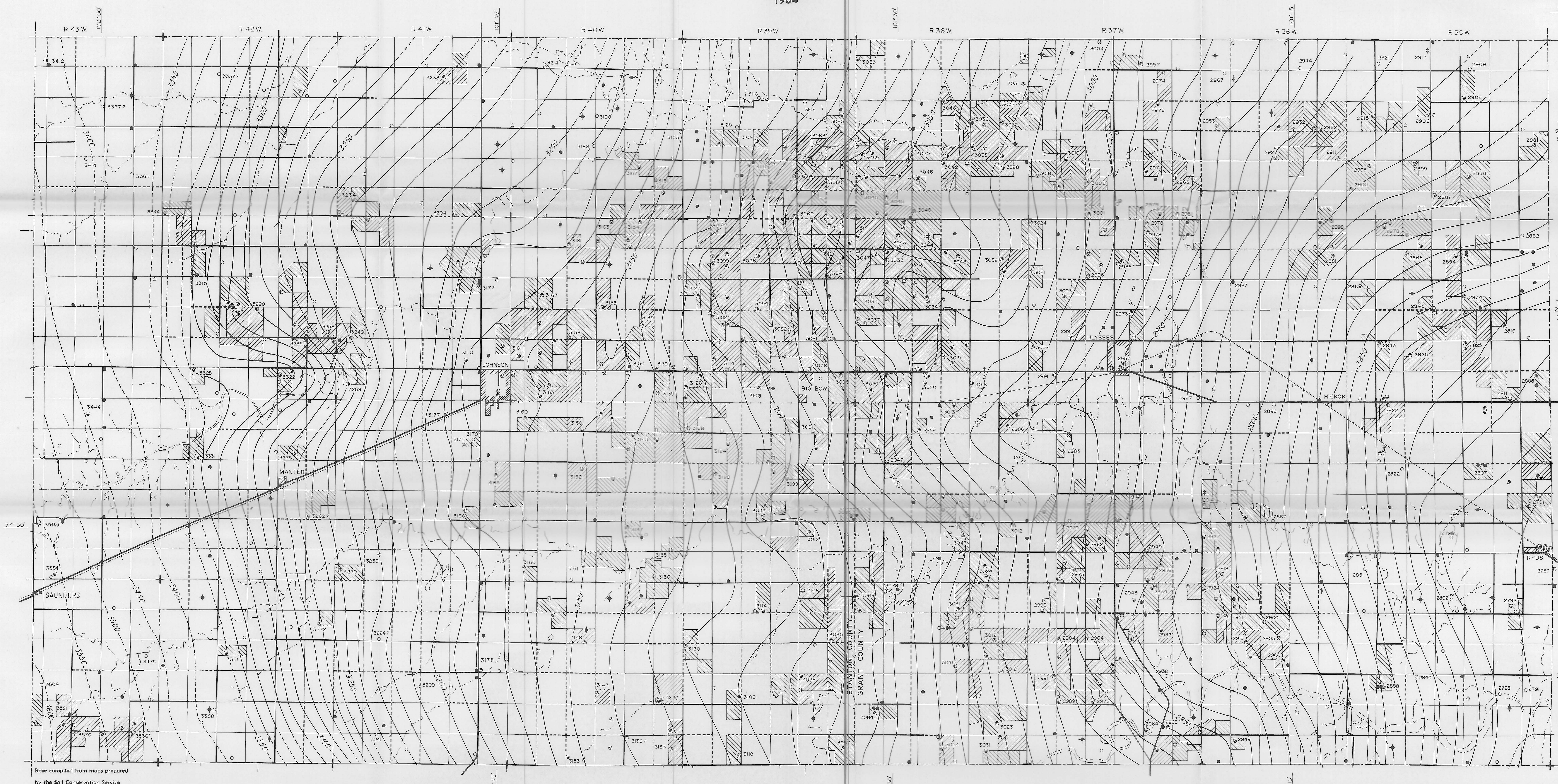
Plate 12



EXPLANATION

○2917 Altitude of water level in feet above mean sea level, October 1959 (queried where doubtful).

Domestic well.

Test hole.

Irrigation, public supply, or industrial well.

Abandoned or destroyed well.

Oil or gas test hole.

Well equipped with recording gage.

Acreage for which applications for water rights have been received.

—3150— Contour on the water table (dashed where approximate). Interval 10 feet and 50 feet.

0 2 4 6

Scale, in miles.