Geology and Ground-Water Resources of Reno County, Kansas

By

C. K. BAYNE

With a geologic map by O. S. Fent and C. K. Bayne

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By C. K. BAYNE
(State Geological Survey of Kansas)
With a geologic map by O. S. FENT and C. K. BAYNE

Prepared by the State Geological Survey of Kansas and the United States Geological Survey, with the cooperation of the Division of Sanitation of the Kansas State Board of Health, and the Division of Water Resources of the Kansas State Board of Agriculture.

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By C. K. Bayne

With a geologic map by O. S. Fent and C. K. Bayne

ABSTRACT

This report describes the geography, geology, and ground-water resources of Reno County, Kansas. The hydrologic and geologic information was obtained in the field during the summers of 1949 and 1950. The county has an area of about 1,255 square miles and in 1950 had a population of 54,058. The area lies principally in the Great Bend lowland physiographic division. A small area in the southwestern part of the county is in the High Plains section of the Great Plains province and a small area in the south-central part of the county is in the Red Hills division. The area is drained by Arkansas River and its tributaries. The normal annual precipitation is 28.53 inches and the mean anual temperature is 56.1°F. Farming is the principal occupation, wheat being the main crop. Petroleum and salt are important mineral products.

All the exposed rocks in Reno County are of sedimentary origin; they range in age from Permian to Quaternary. A map showing the surface geology, and cross sections and maps showing the distribution of the unconsolidated deposits are included in the report. Four major cycles of erosion and deposition are recorded in the Pleistocene rocks.

The unconsolidated sand and gravel deposits of Pleistocene age form the most important aquifer in the area. These deposits reach a maximum thickness of about 300 feet and yield water to wells for all public and industrial and most domestic supplies. The water is hard in most of the area, and water of high chloride content is found in the deep Pleistocene channels.

Hydrologic and geologic data on which this report is based include records of 241 wells, logs of 94 test holes and wells, and analyses of 154 samples of water.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

An investigation of the geology and ground-water resources was begun in Reno County in the summer of 1949 by the United States Geological Survey and the State Geological Survey of Kansas, with the cooperation of the Division of Sanitation of the Kansas State Board of Health and the Division of Water Resources of the Kansas State Board of Agriculture.

Ground water is a principal natural resource of Reno County. At the present rate of withdrawal, the danger of seriously depleting the ground-water supply in Reno County is very slight. But an adequate understanding is needed of the quantity and quality of the available supply, and of measures necessary to safeguard it so that water supplies for rapidly increasing municipal, industrial, and agricultural uses can be developed orderly.

LOCATION AND EXTENT OF THE AREA

Reno County, in south-central Kansas, is bounded on the north by Rice and McPherson Counties, on the west by Stafford and Pratt Counties, on the south by Kingman County, and on the east by Harvey and Sedgwick Counties. The county comprises 35 townships and contains about 1,255 square miles (Fig. 1).

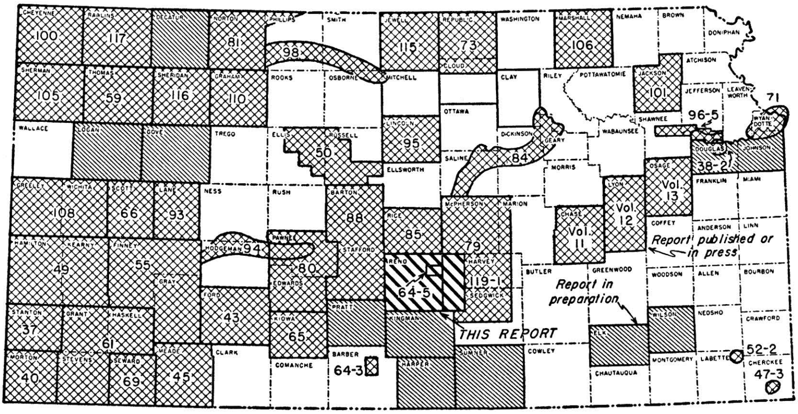

FIG. 1.—Map showing area covered by this report, and other areas in Kansas for which cooperative ground-water reports have been published or are in preparation.

PREVIOUS INVESTIGATIONS

A detailed study of the geology and ground-water resources of Reno County has not been made previously. Brief references to the geology and ground water of parts of the county have been made in several reports, however. Haworth (1897) discussed the regional geology and ground water of western Kansas including Reno County. In 1913 Haworth discussed ground water in Reno County in a report on well waters in Kansas. Lohman (1942) discussed the availability of ground water in the Arkansas River valley below Hutchinson and in the buried McPherson channel north and west of Halstead. The ground water in Reno County was discussed by Lohman and others (1942) in a report on ground water available for national-defense industries. Williams (1946) discussed the geology and ground water in the vicinity of Hutchinson, and Williams and Lohman (1949) discussed the geology and ground water of a part of Reno County in a report on the geology and ground-water resources of a part of south-central Kansas. Fent (1950) described the geology and ground-water resources of Rice County, and Latta (1950) described the geology and ground-water resources of Barton and Stafford Counties.

METHODS OF INVESTIGATION

Field work was begun in Reno County in June 1949 and continued until December 1949. Additional field work was done during the spring of 1950. Data were collected on 241 wells including the depth of the well and the depth to water level in the well (Pl. 2). Data concerning well yields and water-bearing materials were obtained from well owners. The stage of Arkansas River was measured at 42 points along the river to aid in preparing the water-table contour map (Pl. 1). Samples of water were collected from 152 wells (154 samples) and 22 points (22 samples) along the streams and were analyzed by Howard Stoltenberg, Chemist, in the Water and Sewage Laboratory of the Kansas State Board of Health.

Forty-nine test holes were drilled in the county to determine the thickness and character of the Quaternary deposits. The test holes were drilled with the hydraulic-rotary drilling machine owned by the State Geological Survey and operated by W. T. Connor and Max Yazza. Drill cuttings were collected in the field and later examined microscopically in the laboratory. The altitudes of measuring points of the wells and test holes were determined by means of a plane-table and alidade by Rex Huff and Virgil Young.

Highway maps prepared by the State Highway Commission of Kansas were used in the field for mapping and were used in the office as base maps in preparing Plates 1 and 2. The roads were corrected and the drainage of Reno County was delineated from aerial photographs obtained from the Agricultural Adjustment Administration, United States Department of Agriculture. The locations of wells within the section, shown on Plate 2, were determined by means of an odometer.

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, and quarter-quarter section. If two or more wells are in a 40-acre tract, they are numbered serially according to the order in which they were inventoried. The quarter sections and the quarter-quarter sections are designated a, b, c, or d in a counterclockwise direction beginning in the northeast quarter of the section. For example, well 22-9-7bb (Fig. 2) is in the NW¼ NW¼ sec. 7, T. 22 S., R. 9 W.

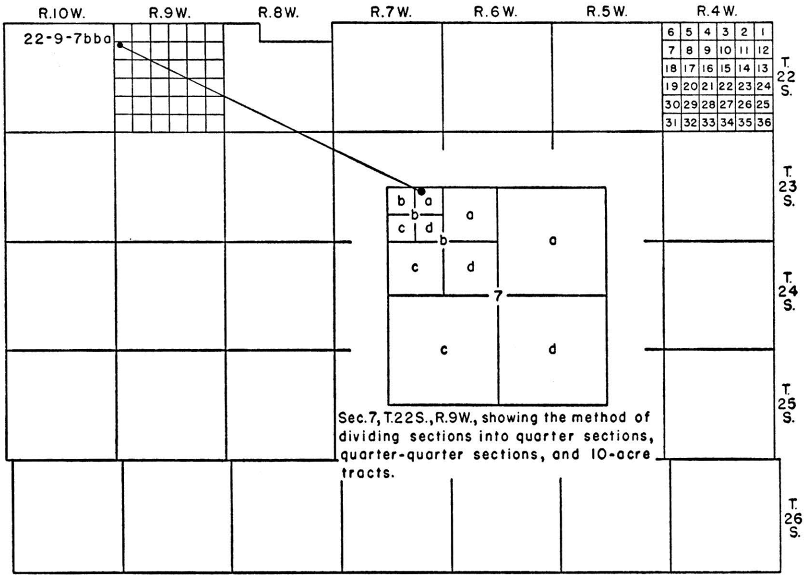

FIG. 2.—Map of Reno County illustrating the well-numbering system used in this report.

ACKNOWLEDGMENTS

Thanks and appreciation are expressed to the many residents who supplied information on their wells and aided in collecting field data. Special acknowledgment is made to the officials of the cities who furnished information regarding city water supplies and to officials of the Hutchinson Water Company who provided information on the Hutchinson water supply. Acknowledgment is made to the drillers who supplied information and logs on wells and test holes in the county.

The manuscript of this report has been reviewed by members of the U. S. Geological Survey and the State Geological Survey of Kansas; by R. V. Smrha, Chief Engineer, and George S. Knapp, Engineer, of the Division of Water Resources of the Kansas State Board of Agriculture; and by Dwight F. Metzler, Director, and Willard O. Hilton, Geologist, of the Division of Sanitation of the Kansas State Board of Health.

GEOGRAPHY

Topography and Drainage

Reno County is in the Great Bend lowland physiographic division as designated by Adams (1903), except for a small area in the southwest part of the county that is in the High Plains section of the Great Plains province and a small area in the south-central part of the county that is in the Red Hills division (Fig. 3). The Great Bend lowland division is nearly flat in most places but in some areas has slight relief. The belt of sand dunes along the north side of the Arkansas River valley, the sand dunes in the west part of the county, and the area underlain by the Ninnescah shale adjacent to Ninnescah River provide the only prominent relief.

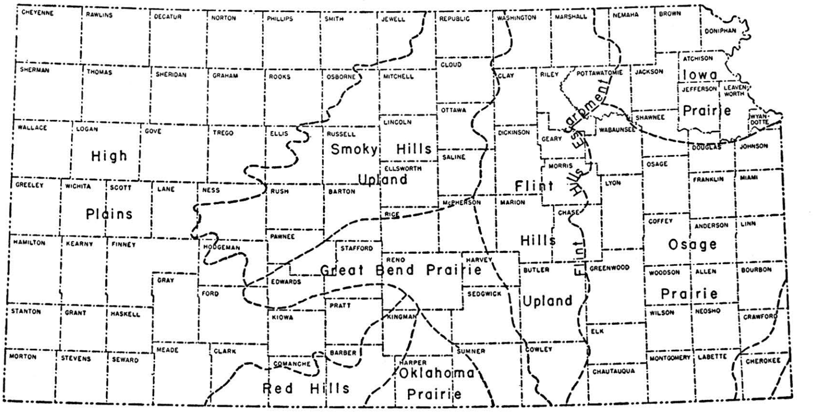

FIG. 3.—Map showing physiographic provinces in Kansas

The highest points in the county are in the sand dunes in the western part of the county. The altitude of some of the points in the sand dunes is about 1,800 feet above sea level. The lowest points in the county are about 1,380 feet above sea level and occur along Arkansas River and Ninnescah River where they leave the county.

Reno County is drained by Arkansas River and its tributaries. The south part of the county is drained by North Fork of Ninnescah River, which joins Arkansas River in eastern Sumner County near

Oxford. The northeast part of the county is drained by Little Arkansas River, which joins Arkansas River in Sedgwick County at Wichita. The major tributaries to Ninnescah River are Silver Creek, Goose Creek, and Red Rock Creek. The major tributaries of Arkansas River in Reno County are Cow Creek, Salt Creek, and Peace Creek.

CLIMATE

The climate of Reno County is subhumid and is characterized by moderate precipitation, a wide range of temperature, and moderately high average wind velocity. The summer days and many of the nights are generally hot. The winters are moderately cold, but are generally free from excessive snowfall.

The climatic data in this report are compiled from the records of the U. S. Weather Bureau. The normal monthly mean temperatures at Hutchinson range from a low in January of 31°F to a high in July of 80.2°F. The annual mean temperature is 56.1°F. The highest temperature recorded was 116°F on July 31, 1934; the lowest temperature recorded was —27°F on February 13, 1905. The average date of the last killing frost in the spring is April 17, and the average date of the first killing frost in the fall is October 18. Thus the average growing season is 184 days. Killing frosts have occurred as late as May 15 and as early as September 20, however. The longest growing season recorded was 223 days and the shortest was 145 days.

The normal annual precipitation at Hutchinson based on a 56-year record is 28.53 inches; the normal at Medora is 28.61. The lowest annual precipitation at Hutchinson was 15.40 inches in 1952 and the highest annual precipitation at Hutchinson was 46.97 inches in 1944. The annual precipitation at Hutchinson and the cumulative departure from normal are shown graphically in Figure 4. Data for Medora are shown in Figure 5.

Precipitation in Reno County seems to follow irregular cycles in which periods of excessive rainfall are followed by periods of deficient rainfall. About 70 percent of the annual precipitation falls as rain during the growing season from April to September. January has the lowest normal monthly precipitation, 0.72 inch, and May has the highest normal monthly precipitation, 4.45 inches

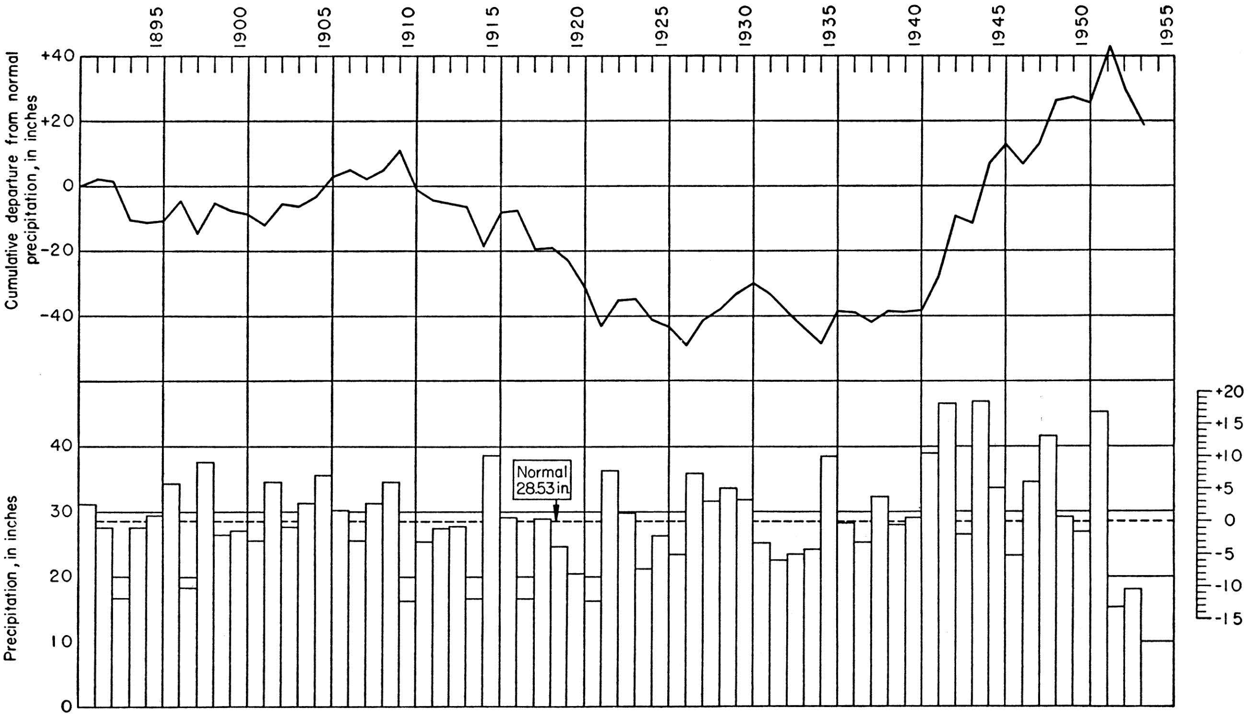

FIG. 4.—Annual precipitation and cumulative departure from normal precipitation at Hutchinson.

(Fig. 6). Much of the precipitation in Reno County falls in heavy rains; many of these storms are followed by periods of deficient rainfall. The greatest rainfall in a day recorded at Hutchinson was 4.75 inches on July 4, 1895.

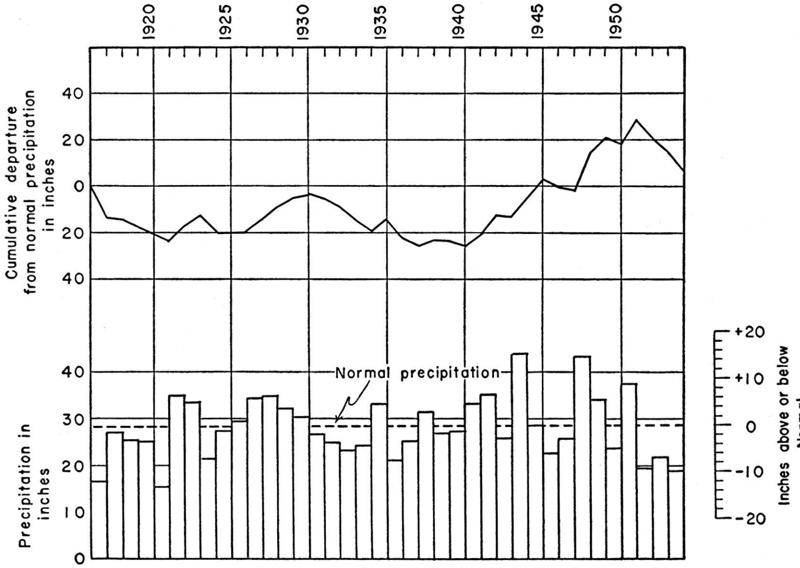

FIG. 5.—Annual precipitation and cumulative departure from normal precipitation at Medora.

POPULATION

Reno County was organized in 1872. In 1950 the county had a population of 54,058 and ranked fourth in the state in population. Hutchinson, the largest city and the county seat, had a population of 33,575. Other communities and their 1950 populations are South Hutchinson, 1,045; Nickerson, 1,013; Buhler, 750; Haven, 720; Turon, 632; Sylvia, 496; Pretty Prairie, 484; Arlington, 405; Partridge, 221; Plevna, 200; Langdon, 120; and Abbyville, 99.

TRANSPORTATION

Reno County is served by the main lines of the Atchison, Topeka, and Santa Fe Railway Company and the Chicago, Rock Island and Pacific Railway, and by branch lines of the Missouri Pacific Railroad Company and the St. Louis and San Francisco Railroad. Each of

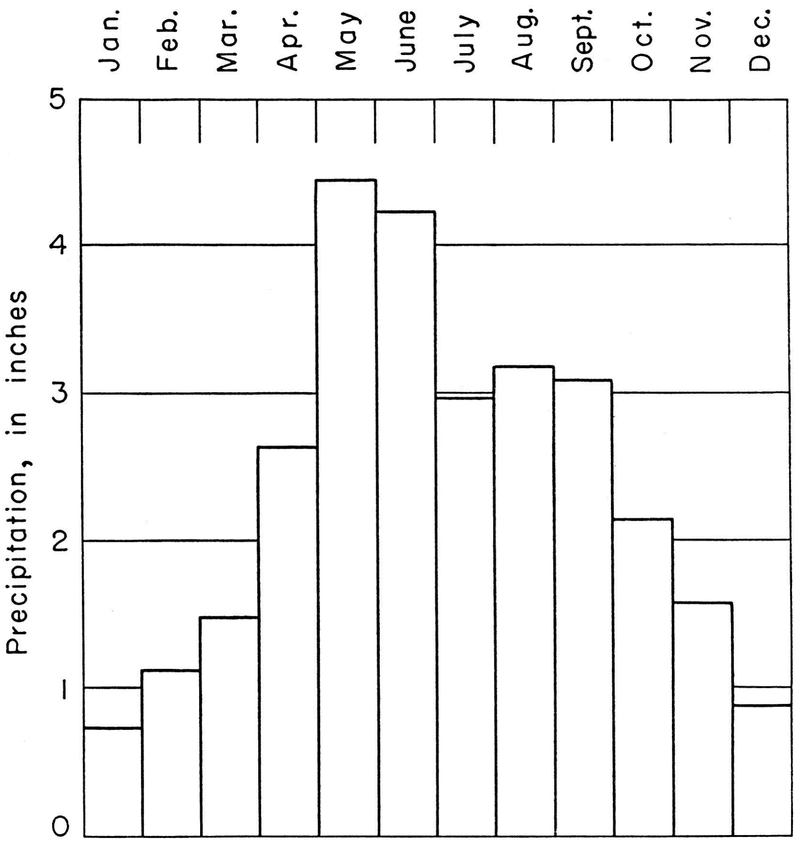

FIG. 6.—Monthly distribution of precipitation at Hutchinson.

the communities named above is served by one or more of these lines.

Improved State and Federal highways in Reno County amount to about 152 miles. U. S. Highway 50S crosses the county east to west; Kansas Highway 61 crosses the county from northeast to southwest; Kansas Highway 17 crosses the eastern part of the county from north to south; and Kansas Highway 14 crosses the county from north to south through the center of the county. These highways are hard surfaced. County and township roads are in good condition most of the year, and roads on most of the section lines are open except in parts of the sand-dune areas.

AGRICULTURE

Reno County has 3,058 farms. According to the State Board of Agriculture, a total of 510,481 acres was under cultivation in 1950. The acreage of all principal crops grown in 1950 is shown in Table 1.

TABLE 1.—*Acreage of principal crops grown in Reno County in 1950.*

Crop	Acreage
Wheat	362,000
Sorghums	82,120
Hay	31,170
Barley	16,200
Oats	14,200
Corn	7,800
Rye	2,820

MINERAL RESOURCES

Mineral resources of Reno County include oil, gas, salt, sand, gravel, and volcanic ash.

Oil and Gas

Reno County is among the most important oil-producing counties in the state. As early as 1878 test wells were drilled in the vicinity of Hutchinson, but these wells were less than a thousand feet deep and did not produce oil or gas. The first well in the county to produce oil was completed in January 1927 in what is now the Abbyville pool. This well initially produced 325 barrels a day from the Kansas City group of Pennsylvanian age. In 1956, Reno County has 16 producing fields. Producing zones in Reno County are the Lansing-Kansas City group, Mississippian "chat", Hunton formation, and Viola limestone. The cumulative production, the number of wells, the producing zones, and the depth of production for all fields are detailed in the annual reports of the Geological Survey of Kansas on oil and gas developments.

Salt

The salt deposits of the Wellington formation in Reno County were discovered during drilling for oil and gas in the vicinity of Hutchinson in 1887. These deposits of salt were laid down in Permian seas that probably were partly cut off from the ocean. The beds extend eastward from a line between eastern Gove County and eastern Seward County to a line extended along the east line of Reno County. The eastern edge of the salt beds is only a few miles west of the outcrop of the Wellington shales. The salt beds originally extended farther east but were removed by circulating ground water. North and east of the present limits of the salt beds in the vicinity of Hutchinson the Wellington formation thins, and the removal of salt by circulating ground water has caused slumping.

Near Hutchinson the salt beds, interstratified with some thinner shale beds, are as much as 450 feet thick (Taft, 1946). Jewett (Jewett and Schoewe, 1952) estimated the salt reserves of Kansas to be about 5,000 billion tons.

Kansas ranks sixth in the United States in production of salt, and Reno County produces about 75 percent of the salt mined in Kansas. Three of the five plants producing salt in Kansas are in Reno County at Hutchinson. One shaft mine 650 feet deep produces salt used mainly for stock and industrial purposes. Salt is also obtained at two plants by evaporation of brines formed by pumping water down through wells and this salt is refined for use in meat-packing plants and other establishments that prepare foods.

Sand and Gravel

Sand and gravel are obtained in Reno County from Pleistocene deposits in the Arkansas River valley. The gravel and sand are used for road surfacing and for concrete aggregate.

Volcanic Ash

Volcanic ash is mined from two pits in Reno County. One pit was opened in 1948 in the SE¼ NE¼ sec. 1, T. 25 S., R. 7 W. The other pit, which likewise has been worked for several years, is situated in the center of sec. 14, T. 25 S., R. 8 W. The ash is used by the county road department as a component in road-surfacing material.

GENERAL GEOLOGY

SUMMARY OF STRATIGRAPHY *

The rocks that crop out in Reno County are of sedimentary origin and range in age from Paleozoic to Cenozoic (Pl. 1). The oldest rocks that crop out in the county are a part of the Ninnescah shale of the Leonardian Series, Permian System. The Ninnescah shale crops out in the northeastern and southeastern parts of the county

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* This report is a cooperative product of the U. S. Geological Survey and the State Geological Survey of Kansas. The classification and nomenclature of the rock units accord for the most part with those of the two surveys but differ somewhat from those of the U. S. Geological Survey.

and along the valley of Ninnescah River in the southern part of the county where the river has cut through younger deposits. The Stone Corral dolomite crops out in northern Reno County and along the Ninnescah River valley in south-central Reno County. The youngest rocks of Permian age exposed in the county are rocks classified as the Harper sandstone, which crop out along the valley of Ninnescah River west of the outcrop of the Stone Corral dolomite. Cenozoic deposits of the Pleistocene Series ranging in age from the Blanco formation of the Nebraskan glacial stage to Recent alluvium unconformably overlie the Permian rocks over most of Reno County. These include unconsolidated deposits of sand and gravel in both the valleys and most of the upland area, and eolian silt occurring principally in the upland area. Information on the unexposed rocks that lie beneath the surface in Reno County has been obtained from test holes and from logs of oil wells drilled in the county.

A generalized section of the outcropping rocks in Reno County is given in Table 2. The configuration of the pre-Pleistocene surface and the locations of the test holes in the county are shown in Figure 7, and the geologic cross sections based on these test holes are shown on Plate 3.

GEOLOGIC HISTORY

Paleozoic Era

Over the basement igneous and metamorphic rocks were deposited marine rocks of Paleozoic (Cambrian and Ordovician) age. Silurian and Devonian rocks were probably deposited over the area and later removed by erosion after the pre-Mississippian uplift of the Ellis arch, known also as the Central Kansas arch. This ancestral arch extended from Chautauqua County northwestward through Ellis County. Rocks of Mississippian age were deposited over the arch and lie unconformably on the Cambro-Ordovician rocks. Post-Mississippian folding raised these rocks in Reno County, and parts of the upper Mississippian strata were eroded. Subsequent to this erosional period the area was submerged again and Pennsylvanian and Permian rocks totaling about 3,500 feet in thickness were deposited. After the deposition of the Permian rocks there was another long period of erosion.

Mesozoic Era

The Mesozoic Era in Kansas is represented by rocks of the Triassic, Jurassic, and Cretaceous systems. Reno County was probably a part of the land area during Triassic and Jurassic time;

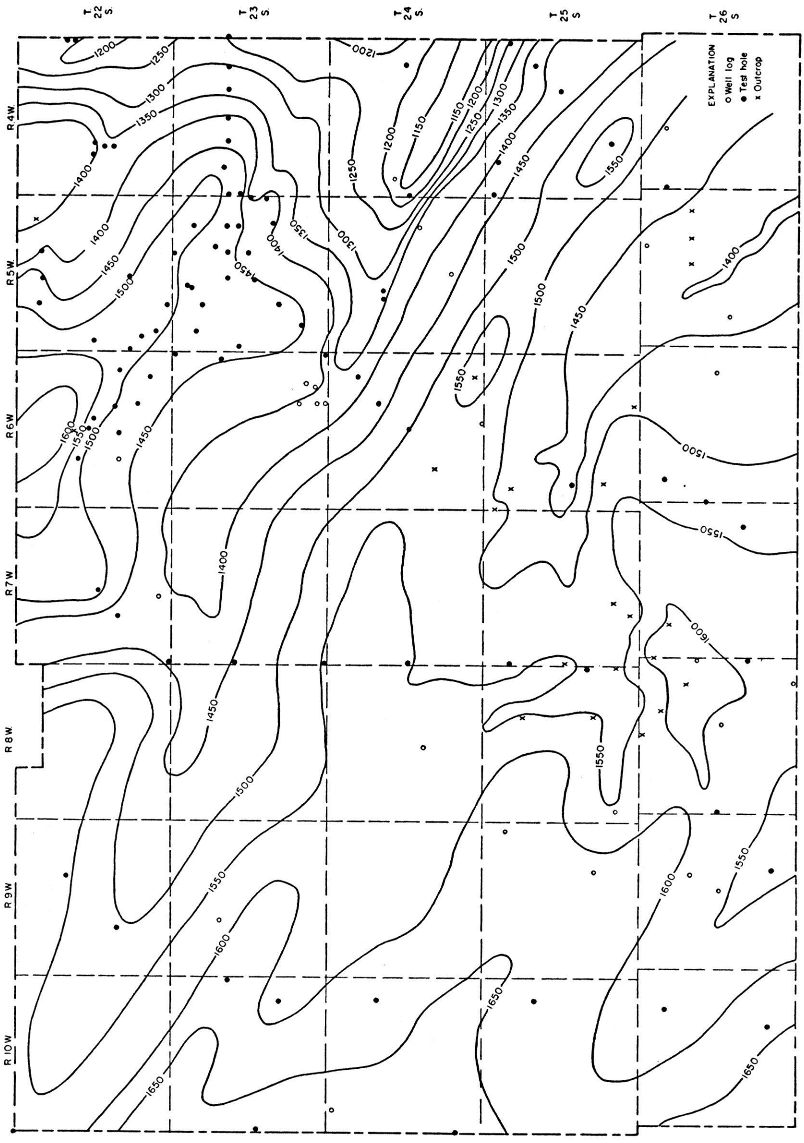

FIG. 7.—Configuration of bedrock surface and location of test holes.

TABLE 2.—*Generalized section of the geologic formations of Reno County, Kansas* *

System	Series	Subdivision			Thickness	Physical character	Water supply
		Stage	Formation	Member			
Quaternary	Pleistocene	Recent	Alluvium		0–60	Silt, sand, and gravel in stream valleys.	Yields large supplies of water of poor quality to many wells.
			Dune sand		0–120	Medium and fine sand in upland areas.	Yields small supplies of water of good quality to wells.
		Wisconsinan	Sanborn	Peoria silt	0–15	Eolian silt.	Lies above water table; yields no water to wells.
				Wisconsinan terrace deposits	0–130	Silt, sand, and gravel.	Yields large supplies of water of good quality to wells.
		Illinoian		Loveland silt	0–15	Eolian and water-laid silt.	Lies above water table; yields no water to wells.
				Crete sand and gravel	0–40	Silt, sand, and gravel.	Lies in part above the water table; yields moderate supplies of water of good quality to wells where below water table.
		Kansan	Meade	Sappa silt	0–40	Silt and very fine sand; contains Pearlette volcanic ash lentil.	Lies above water table in part of area; yields little or no water to wells in area.
				Grand Island sand and gravel	0–100	Sand and gravel and minor amounts of silt.	Yields large supplies of water of good to fair quality to many wells.
		Nebraskan	Blanco	Fullerton silt	0–30	Silt and clay and minor amounts of sand.	Yields no water to wells in area.
				Holdrege sand and gravel	0–110	Sand and gravel and minor amounts of silt and clay.	Yields moderate supplies of water of good quality to wells in upland areas where present. Water highly mineralized in channel areas.

TABLE 2.—*Generalized section of the geologic formations of Reno County, Kansas*—CONCLUDED

System	Series	Subdivision			Thickness	Physical character	Water supply
		Stage	Formation	Member			
Permian	Leonardian		Harper sandstone		0–200	Red siltstone and very fine silty sandstone.	Yields small supplies of highly mineralized water to wells in area of outcrop.
			Stone Corral dolomite		0–20	White and light-gray anhydrite and dolomite.	Yields no water to wells in area.
			Ninnescah shale		0–300	Red and green-gray shale, siltstone, and very fine silty sandstone.	Yields small supplies of highly mineralized water in area of outcrop.
			Wellington formation		0–700	Gray to blue-gray shale and thin interbedded calcareous zones; contains thick Hutchinson salt member.	Yields no water to wells in area.

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* The stratigraphic nomenclature is that of the State Geological Survey of Kansas.

deposition in the county was renewed during Cretaceous time. No Cretaceous rocks crop out or were penetrated in the test drilling, but these rocks are present only a few miles west in Stafford County and to the north in Rice County. A considerable thickness of Cretaceous rocks probably was deposited in Reno County and later removed by erosion during early Tertiary time.

Cenozoic Era

Reno County was probably subjected to erosion during most of Tertiary time. No Tertiary deposits were found in the county during this investigation, but Ogallala rocks have been identified in Rice County. Thin deposits of the Ogallala formation probably were laid down in Reno County and later removed by erosion. In late Tertiary time Reno County was an area of low relief, but renewed erosion in early Pleistocene time dissected the land surface and cut deep valleys into the Permian beds. These valleys were later filled with alluvial deposits. Four major periods of erosion and deposition in the Pleistocene are evident in the county. Climatic changes during the four major glacial epochs effected the four major periods of erosion and deposition in Reno County.

HISTORY OF DRAINAGE

At the close of the Tertiary the surface of Reno County was an area of low relief. During the Nebraskan stage of Pleistocene time, streams traversing the county increased their rate of cutting and deepened their channels. The maximum relief in the county at the close of this cutting was about 160 feet.

Three main early Nebraskan valleys enter Reno County. One channel enters southwestern Reno County near the center of the west line of Township 26 South and extends eastward along this tier of townships nearly two-thirds the distance across the county. A second channel enters the county near the northwest corner and extends eastward about halfway across the county, where it is joined by the third—the Chase channel (Fent, 1950). From this junction the main channel trends southeastward and leaves the county near the center of the east county line.

After the period of valley cutting in Nebraskan time, a period of valley filling took place. The deposits, the Blanco formation of the Nebraskan stage, range in thickness from a few feet along the flanks of the valleys to more than 100 feet in the channel entering the county at the northwestern corner. Figure 8 shows the areas in Reno County in which the Blanco formation of the Nebraskan stage crops out or is buried in the subsurface.

During the Kansan stage of Pleistocene time, the streams eroded laterally and the downcutting was less than that during the Nebraskan stage. A part of the Blanco formation of the Nebraskan stage was removed in the downcutting interval of the Kansan stage; the channels were then refilled with deposits of the Meade formation of the Kansan stage. As the channels of these streams became filled they shifted laterally. Figure 9 shows the areas in Reno County in which the Meade formation of Kansan age crops out or is buried in the subsurface. At the close of the Kansan stage of Pleistocene time the entire area of the county probably was mantled by the Meade formation. From the blank areas shown in Figure 9, it was removed later by erosion.

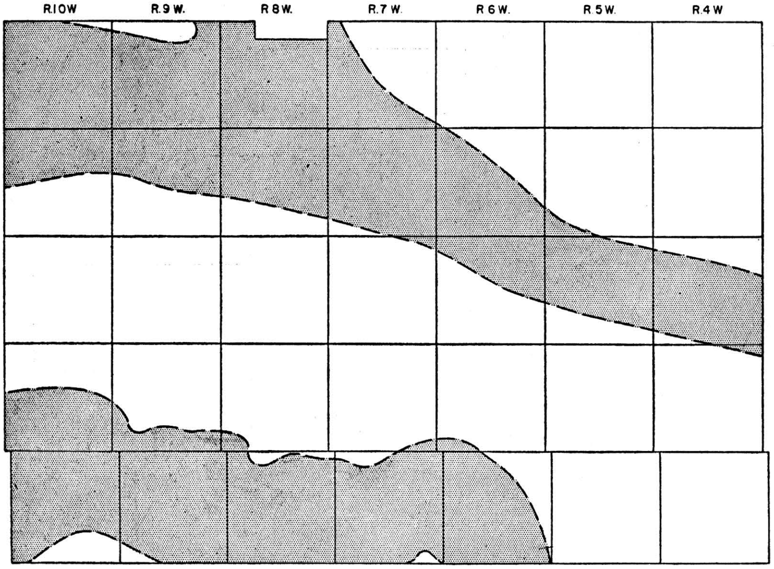

FIG. 8.—Map of Reno County showing areas in which Blanco formation crops out or is buried in the subsurface.

During the early part of the Illinoian stage of Pleistocene time there was another cycle of downcutting and deposition in the county. The downcutting was much less extensive than that during the Kansan stage. Deposition followed approximately the same pattern as in the Kansan stage, although these deposits are generally thinner than the Meade deposits of Kansan age. The early Illinoian deposits comprise the Crete sand and gravel member of the Sanborn formation. The areal distribution of the Crete sand and gravel member in Reno County is shown in Figure 10. The Crete sand and gravel member of the Sanborn formation probably was deposited over most of the county, but later Pleistocene erosion removed the member in the present major stream valleys.

After early Illinoian time the streams were more or less stable and the upland areas were covered by eolian deposits. The streams remained stable until the Wisconsinan stage of Pleistocene time, when the major streams, which by then were in approximately their present locations, became more active.

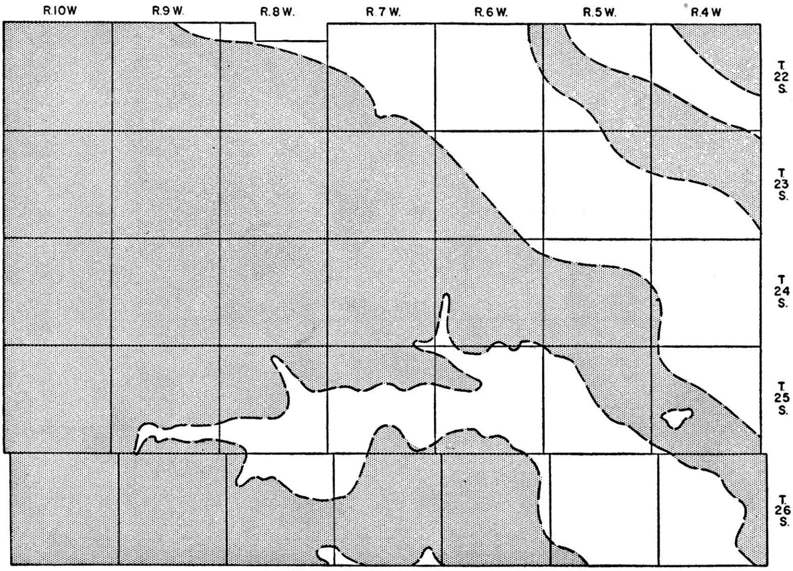

FIG. 9.—Map of Reno County showing areas in which Meade formation crops out or is buried in the subsurface.

Late Wisconsinan downcutting by the streams removed the Crete sand and gravel member of the Illinoian stage and the Meade formation from the valleys; subsequent filling produced younger Wisconsinan terrace deposits. In the Ninnescah River valley the stream cut into Permian rocks as much as 100 feet below the base of the Meade formation. Since the deposition of the Late Wisconsinan terrace deposits the streams have remained in the same channels, and stream activity has consisted of minor downcutting and filling. Prominent low terraces in the valleys of the major streams are remnants of the Wisconsinan surface. The present Arkansas River has a braided channel. The channel be-

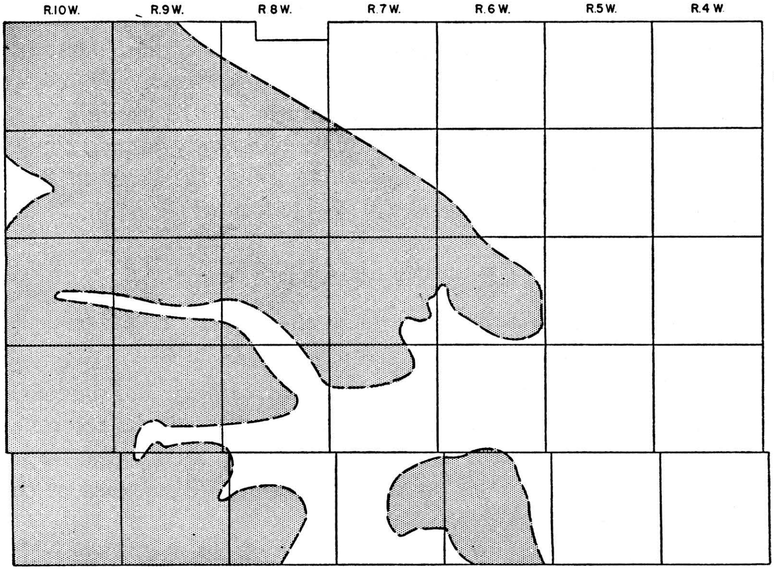

FIG. 10.—Map of Reno County showing areas in which Crete member of Sanborn formation crops out or is buried in the subsurface.

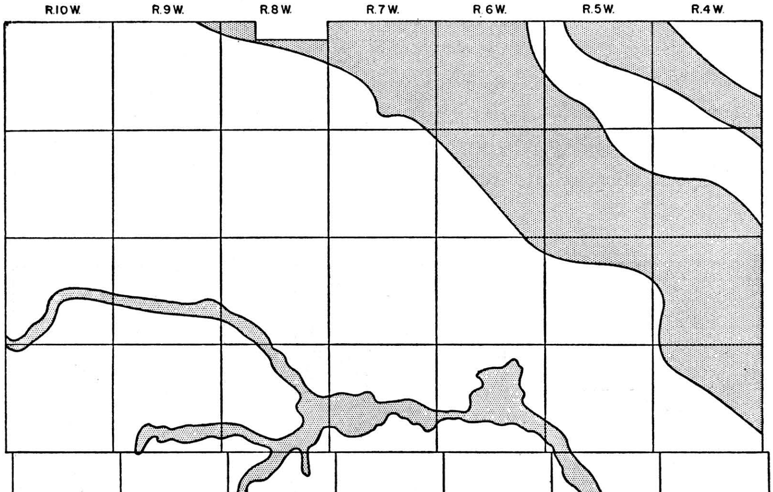

FIG. 11.—Map of Reno County showing areas in which Wisconsinan and Recent alluvial deposits are exposed.

comes choked with sand and gravel during times of flood, and in low-water stages the stream flows through, rather than over, the pervious material making up much of the stream bed. Ninnescah River, in a part of its course, and its tributaries are eroding their channels fairly rapidly, as indicated by the relatively rugged topography bordering these streams. Figure 11 shows the areas in Reno County in which Wisconsinan and Recent alluvial deposits are found.

GROUND WATER

PRINCIPLES OF OCCURRENCE

The fundamental principles of the occurrence and movement of ground water have been given by Meinzer (1923), and a general discussion of the occurrence of ground water with special reference to Kansas has been given by Moore (1940). The reader is referred to these publications for a more detailed discussion of the occurrence of ground water.

The rocks that make up the outer crust of the earth generally are not solid but have numerous openings, called voids or interstices. The number, size, and shape of these openings depend upon the character of the rocks; therefore, the occurrence of ground water in any region is determined by the geology of that region.

The interstices or voids in rocks range in size from microscopic openings in clay to huge caverns in limestones. The openings generally are connected so that water may move from one void to another, but in some rocks the voids are isolated so that there is little or no movement of the water. Several common types of interstices or voids, and the relation of texture to porosity, are shown in Figure 12.

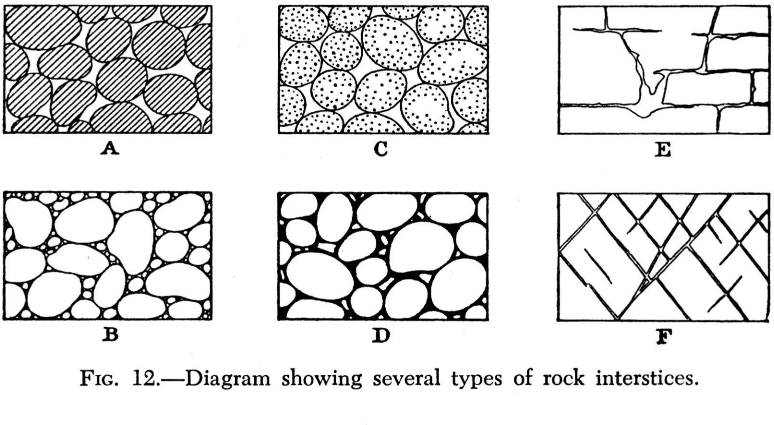

FIG. 12.—Diagram showing several types of rock interstices.

Below a certain level in the earth's crust the rocks generally are saturated with water and are said to be in the zone of saturation (Fig. 13). The upper surface of the zone of saturation is called the ground-water table or the water table. The rocks above the water table are in the zone of aeration. This zone generally consists of three parts: the belt of soil water at the top, the intermediate vadose zone, and the capillary fringe at the bottom.

The belt of soil water lies just below the land surface and normally contains water held by molecular attraction. During periods of ground-water recharge this zone contains water in excess of the amount that can be held by molecular attraction, and the excess percolates downward to the water table. The thickness of the belt

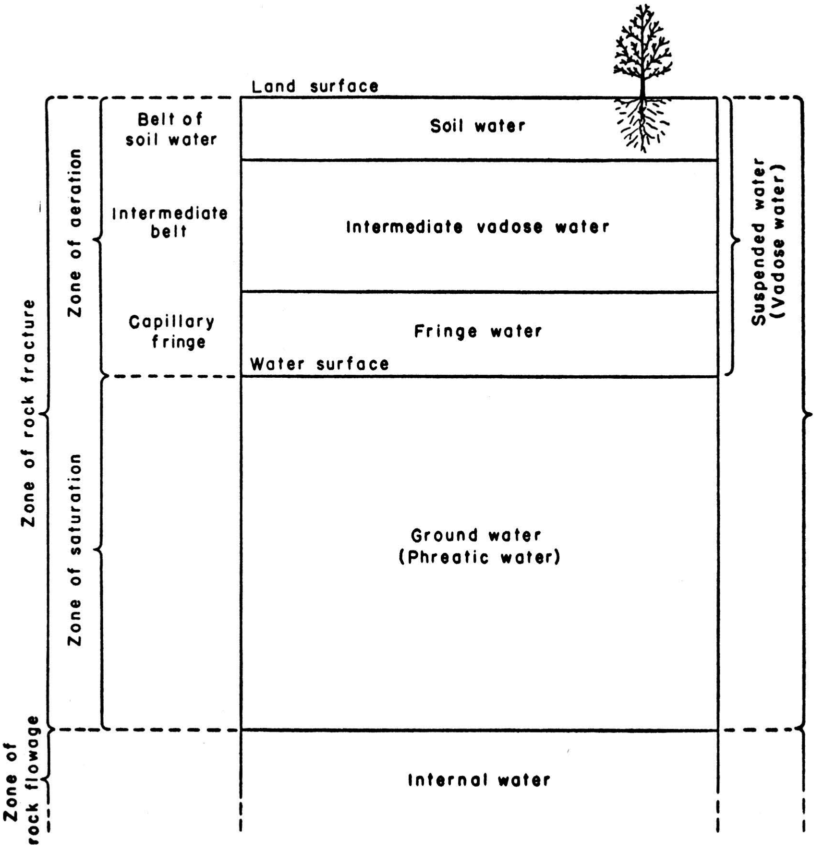

FIG. 13.—Diagram showing divisions of subsurface water.

of soil water depends upon the soil, the precipitation, and the vegetation.

The intermediate belt of vadose water lies between the soil belt and the capillary fringe. In this zone the interstices in the rocks contain water held by molecular attraction, and at times of ground-water replenishment they contain also water that is moving downward to the water table. The intermediate zone may be absent or may be several hundred feet thick, depending on the local geology, topography, and climate. In Reno County the intermediate zone is absent in some areas and is nowhere more than 60 feet thick.

The capillary fringe lies directly below the intermediate belt and over the water table and is formed of water held up from the zone of saturation by capillary force. The water in this zone is not available to wells, which must be deepened to the zone of saturation to obtain water. The capillary fringe may be absent or very thin in coarse-grained materials, but it may be several feet thick in fine-grained materials.

The porosity of a rock aggregate is its property of containing interstices. Porosity is expressed as the percentage of the total volume occupied by the interstices.

The moisture equivalent of a water-bearing material is expressed as a ratio of (1) the weight of water that the material, after saturation, will retain against a centrifugal force 1,000 times greater than the force of gravity, to (2) the weight of the dry material. To convert this figure to percentage of volume, the moisture equivalent is multiplied by the apparent specific gravity of the dry material.

The specific retention of a rock or soil, with respect to water, is the ratio of (1) the volume of water which, after being saturated, it will retain against the pull of gravity to (2) its own volume. It is stated as a percentage and may be expressed by the formula $R = 100\ (r/v)$, where R is the specific retention, r is the volume of water retained by the rock or soil against the pull of gravity, and v is the volume of the rock or soil.

The specific yield of a water-bearing formation is the ratio of the volume of water a saturated material will yield to gravity in proportion to its own volume (Meinzer, 1923, p. 28). The specific yield is equal to the porosity minus the specific retention. The specific yield of a formation is needed to estimate the quantity of water available to wells and to estimate the quantity of water represented by a rise or decline in the water table during periods of recharge or discharge.

PHYSICAL AND HYDROLOGIC PROPERTIES OF WATER-BEARING MATERIALS

The quantity of water an aquifer will yield to wells depends upon the physical and hydrologic properties of the materials composing the aquifer. Geologic descriptions of the materials penetrated by test holes and wells are useful in making estimates of the quantity of water an aquifer will yield. A more precise estimate of the amount of water that an aquifer will yield can be obtained from field or laboratory tests of the water-bearing materials.

Samples of water-bearing materials were collected for analysis in the hydrologic laboratory of the Geological Survey in Lawrence. These studies included mechanical (particle-size) analyses and permeability determinations. Some of the samples were collected in the fall of 1945 during an investigation of the ground water in the Arkansas River valley in the vicinity of Hutchinson (Williams, 1946). In November 1949, samples were collected from 6 test holes that were drilled in the county, and mechanical analyses and permeability determinations were made on a part of these samples (Table 3).

Mechanical Analysis

A mechanical, or particle-size, analysis of materials consists of separating into groups the grains of different size and determining the percentage by weight of each size group. Results of the analyses are shown in Table 3.

Laboratory determinations of porosity and specific yield were not made on any of the samples from test holes in Reno County, but such determinations were made on some well cuttings from wells in the Wichita well field, which is a few miles east of Reno County. The porosity ranged from 24.1 to 60.2 percent. The specific yield averaged 26.8 percent (Williams and Lohman, 1949). The water-bearing materials near Hutchinson in Reno County in the Arkansas River valley are very similar to those in the Wichita well field and probably have about the same porosity and specific yield.

Permeability

The permeability of water-bearing material generally is expressed as a coefficient of permeability. The coefficient of permeability is defined as the number of gallons of water a day at a temperature of 60°F that will be conducted through each mile of the water-bearing bed under investigation, measured at right angles to the direction of flow, for each foot of thickness of the

TABLE 3.—*Physical properties of water-bearing material from test holes in Reno County*

Test hole number	Depth of sample (feet)	Mechanical analysis (percent by weight)								Coefficient of permeability (gpd/ft.²)
		Gravel (larger than 4 mm)	Fine gravel (4.0–2.0 mm)	Very coarse sand (2.0–1.0 mm)	Coarse sand (1.0–0.50 mm)	Medium sand (0.50–0.25 mm)	Fine sand (0.25–0.125 mm)	Very fine sand (0.125–0.062 mm)	Silt and clay (less than 0.062 mm)	
22–5–19ab...	0–2	...	...	...	...	31.3	49.0	11.7	8.0	...
	2–14	...	...	...	0.4	34.6	51.4	7.6	6.0	...
	14–16	...	...	...	.9	23.9	37.8	10.0	27.4	...
	16–28	...	...	...	.4	36.8	50.0	6.4	6.4	...
	28–38	...	...	...	.9	27.1	35.8	11.8	24.5	...
	66–92	...	...	...	7.1	58.0	27.5	2.9	4.5	110
22–5–28ad...	0–29	...	...	...	2.3	48.1	43.0	4.7	1.9	...
	29–34	...	...	...	1.0	40.4	42.0	8.3	8.3	...
	34–65	...	...	...	2.4	25.7	28.5	15.3	28.1	...
	65–85	...	...	...	3.4	28.8	34.2	10.3	23.3	50
	85–116	...	...	...	4.8	54.8	32.7	3.8	3.9	110
22–5–30dc...	0–3	...	...	...	3.9	35.3	39.8	10.5	10.5	...
	12–18	20.3	26.4	30.0	15.9	4.8	1.3	.4	.9	...
	18–25	3.2	11.2	27.1	28.2	21.1	6.4	1.2	1.6	1,400
	25–31	7.9	22.2	27.5	19.9	13.9	6.4	1.1	1.1	2,800
	31–34	5.0	14.9	29.0	25.6	16.0	7.3	1.1	1.1	750
22–5–29dd...	0–4	.4	.4	3.5	8.8	26.4	34.8	10.2	15.5	...
	16–31	6.7	24.2	36.4	21.1	8.5	1.8	.4	.9	3,200
22–6–26cb...	0–3	...	...	...	.8	11.1	10.3	16.1	61.7	...
	10–20	3.6	17.0	28.9	26.8	11.6	4.9	2.7	4.5	120
	20–25	6.6	17.1	32.3	23.2	12.3	3.8	1.9	2.8	810
	25–68	19.2	27.4	33.6	13.5	3.8	1.0	.5	1.0	2,400

23-4-18cb...	0-6	...	...	1.3	11.5	54.1	27.4	3.8	1.9	...
	10-43	15.7	34.2	29.9	12.8	5.5	1.1	.4	.4	1,500
23-5-3aa....	0-5	...	...	...	1.0	44.7	43.6	7.1	3.6	...
	5-16	...	...	.4	5.9	55.4	26.6	4.7	7.0	40
	16-28	...	...	...	1.5	49.3	42.6	5.1	1.5	190
	28-31	...	...	.4	8.4	59.3	21.3	4.4	6.2	...
	31-41	...	...	...	3.6	56.2	33.7	4.1	2.4	140
	41-47	...	...	...	4.2	58.3	30.9	4.2	2.4	210
	47-57	...	...	1.1	15.4	49.2	17.7	6.3	10.3	30
	57-98	...	...	...	5.9	47.4	23.0	7.9	15.8	10
	98-107	...	...	...	6.4	44.6	36.2	6.4	6.4	...
	107-109	...	...	...	13.8	55.2	20.0	3.8	7.2	80
	109-123	...	...	...	2.3	33.7	32.7	10.6	20.7	...
23-5-8aa....	0-3	...	...	...	1.6	10.6	15.7	13.3	28.8	...
	3-5	...	...	...	...	1.8	7.8	12.1	78.3	...
	5-23	3.6	9.1	14.6	18.7	33.4	17.4	2.3	.9	...
	23-30	20.9	25.4	28.8	15.2	6.2	2.3	.6	.6	4,400
	30-42	8.8	13.6	25.3	26.6	16.3	8.2	.7	.7	1,090
	42-57	33.2	20.1	21.6	15.1	6.5	2.0	1.0	.5	...
	57-62	13.8	13.8	19.6	25.0	21.3	5.5	.5	.5	1,200
23-5-14da...	0-4	...	...	.9	8.2	56.4	28.9	3.9	1.7	...
	4-7	.7	2.9	5.8	16.1	33.6	26.6	6.6	11.7	...
	7-42	21.5	25.2	29.0	19.4	4.1	.8	...	...	2,200
	42-47	10.2	19.6	34.5	28.0	5.8	1.1	.4	.4	950
23-5-23dd...	0-2	...	.5	3.8	7.5	19.8	30.4	18.2	19.8	...
	4-46	24.5	31.1	25.2	11.9	4.6	1.3	.7	.7	2,300
	46-50	5.2	19.1	36.4	26.0	9.8	2.3	.6	.6	650
	50-97	42.6	35.9	14.8	3.6	1.4	.9	.4	.4	...
23-6-1aa....	0-3	...	...	...	3.8	18.1	33.1	16.7	28.3	...
	11-70	26.6	34.9	22.3	9.7	4.0	1.4	.4	.7	2,120

TABLE 3.—*Physical properties of water-bearing material from test holes in Reno County—Concluded*

Test hole number	Depth of sample (feet)	Mechanical analysis (percent by weight)								Coefficient of permeability (gpd/ft.^{2})
		Gravel (larger than 4 mm)	Fine gravel (4.0–2.0 mm)	Very coarse sand (2.0–1.0 mm)	Coarse sand (1.0–0.50 mm)	Medium sand (0.50–0.25 mm)	Fine sand (0.25–0.125 mm)	Very fine sand (0.125–0.062 mm)	Silt and clay (less than 0.062 mm)	
23-6-36dd	0–3	...	...	...	2.8	23.5	16.6	13.9	43.2	...
	20–64	24.3	28.8	19.2	13.5	7.4	3.4	1.1	2.3	3,400
	74–79	1.6	4.0	19.8	37.1	23.8	8.1	2.4	3.2	50
	89–124	8.5	34.8	24.2	20.3	7.6	2.5	.8	1.3	3,800
	124–136	3.1	30.7	32.5	14.2	9.3	5.3	1.8	3.1	2,400
24-6-12bb	0–3	...	...	1.6	16.8	39.8	16.7	7.3	17.8	...
	20–29	...	1.3	9.4	37.1	34.6	8.2	3.1	6.3	380
	29–40	.6	8.1	19.1	45.0	22.0	3.5	.6	1.1	140
	46–72	2.2	27.7	35.4	19.7	7.7	2.9	1.5	2.9	540
	80–152	6.2	19.0	24.4	23.4	14.2	5.7	2.7	4.4	90
23-5-2dd	32–58	...	...	...	...	...	...	...	...	50
23-5-24da	9–69	...	...	...	...	...	...	...	...	1,900
22-9-20dd	40–80	...	...	...	...	...	...	...	...	430
	80–119	...	...	...	...	...	...	...	...	230
	160–180	...	...	...	...	...	...	...	...	400
	193–212	...	...	...	...	...	...	...	...	2,400
23-10-19bcb	17–78.5	...	...	...	...	...	...	...	...	2,200
25-10-12cc	30–48.5	...	...	...	...	...	...	...	...	140
	51–85	...	...	...	...	...	...	...	...	460
26-10-20dd	20–54.5	...	...	...	...	...	...	...	...	50

bed and for each foot per mile of hydraulic gradient (Meinzer's coefficient, or meinzer).

The quantity of water that will percolate through a given cross section of water-bearing material under a known hydraulic gradient is directly proportional to the coefficient of permeability. Thus, to compute the quantity of water that will percolate into or out of a given area the permeability must be determined.

Coefficients of permeability have a wide range in value. Clay and silt, which are fine grained, may have high porosity, but very low permeability; a coarse-grained sand may have a lower porosity, but a high permeability, owing to the greater ability of the coarse-grained material to transmit water. Coefficients of permeability of less than 100 are considered low, coefficients of 100 to 1,000 are medium, and those more than 1,000 are considered high.

Permeability tests were made on samples of water-bearing materials collected near Hutchinson in Reno County. The permeability ranged from 10 for fine sand mixed with silt to 4,400 for coarse and medium gravel. The permeability of most samples ranged from 1,000 to 3,000, except in the sand-dune area (Table 3). Permeability of the silts and clays was not tested, but generally the permeability of these materials is very low.

THE WATER TABLE AND MOVEMENT OF GROUND WATER

The upper surface of the zone of saturation in ordinary permeable soil or rock has been termed the ground-water table, or simply the water table. Where the upper surface is intersected by impermeable material, the water table is interrupted, and artesian conditions are said to exist. The water table is not a plane surface but has irregularities comparable with and related to those of the land surface, although the water table is less rugged. The water table does not remain in a stationary position, but fluctuates up and down. The irregularities are caused chiefly by local differences in geology and topography, and the fluctuations are due to gain or loss of water.

The shape of the water table in Reno County is shown on Plate 1 by contour lines drawn on the water table. All points along a contour line have the same altitude, and the lines show the shape and slope of the surface of the water table as the land surface is shown on a topographic map. The water moves down slope in a direction at right angles to the contours. In general, the shape of the water table in Reno County conforms to the surface of the land. The water table is high in the dune-sand area, in areas north and east of Hutchinson, and in local areas in the western part of the county. The water table is near the surface in these areas because the surface material is relatively permeable and admits large quantities of water.

North Fork of Ninnescah River, Cow Creek, and Little Arkansas River are effluent streams throughout most of their courses in Reno County; that is, they are perennial streams, the channels of which have been cut below the water table and the streams are thereby gaining water from the zone of saturation. This movement of water from the underground reservoir to the channels of these streams has caused troughs to be formed in the water table that follow the courses of these streams, as indicated by the upstream flexure of the contours. The water-table contours cross Arkansas River approximately at right angles, which indicates an apparent balance between the level of water in the stream and the adjacent water table, the stream neither gaining nor losing water. At times of low water, however, Arkansas River will gain water from the ground-water reservoir and at times of high water the river will lose water to the ground-water reservoir.

GROUND-WATER RECHARGE

Recharge is the addition of water to the ground-water reservoir. Precipitation is the original source of all ground-water recharge, although in a particular area the ground-water reservoir may be recharged in several ways. The principal source of recharge in Reno County is precipitation. At times of high water the streams, especially Arkansas River and parts of Cow Creek, contribute water to the ground-water reservoir. The amount of water contributed by the streams is only a small part of the total amount of recharge. Water moves into Reno County from the west and also from the north. Williams (1946) estimated that about 500 acre-feet of water a year moves across each mile of border area into the sandhills north of Hutchinson. He estimated also that about half the precipitation in the sandhills region becomes ground-water recharge.

The sand, soil, and topography in the sandhill area north of Hutchinson and in western Reno County are favorable for ground-water recharge. Many undrained basins hold the precipitation, and the sandy soil and subsoil allow it to percolate downward to the water table.

The sandy soil and flat topography of the terrace deposits and the alluvium in the Arkansas River valley are favorable to recharge.

East of Reno County in Sedgwick and Harvey Counties, wells drilled in deposits similar to those in the Arkansas River valley in Reno County were equipped with automatic water-stage recorders and have been observed since 1938. A study of these records indicates that about 20 percent of the annual precipitation reaches the water table (Williams and Lohman, 1949). The deposits described by Williams and Lohman are continuous with those in the Arkansas River valley in Reno County, so that probably about 20 percent of the annual precipitation in the valley in Reno County also reaches the water table; 20 percent of the precipitation would amount to about 300 acre-feet or about 100 million gallons on each square mile. Figure 14 shows the hydrographs of three wells in the Arkansas River valley, the monthly precipitation, and the cumulative departure from normal precipitation. The period of measurements is short, but the fluctuations of the water levels correlate fairly well with the precipitation.

In the upland areas in central and southern Reno County the slopes are steeper and the soil is not as sandy as in the valley plain. Hence a larger fraction of the water runs off the upland surface and there is much less recharge than in the valley.

In the areas underlain by Permian shales, the soils are compact and have a very low permeability. In these areas the recharge is much less than in either the upland areas or the Arkansas River valley.

GROUND-WATER DISCHARGE

Ground-water discharge is the water discharged from the zone of saturation or the capillary fringe and may take place by flow directly into streams, from springs and seeps, or by evaporation and transpiration. Discharge of water by these methods is called natural discharge. Discharge of water by pumping from wells or infiltration galleries is artificial discharge.

Before wells were drilled in Reno County, the water table was in approximate equilibrium; that is, the annual discharge by evaporation, transpiration, and discharge into streams was approximately equal to the annual recharge from precipitation and seepage from streams. At the present time water is discharged into Ninnescah River, Little Arkansas River, and Peace Creek. Arkansas River is in approximate equilibrium with the water table and does not add water to or receive water from the ground-water body in most of its course through Reno County (Pl. 1).

Transpiration is the process by which water is taken into the roots of plants and is evaporated into the atmosphere. The depth

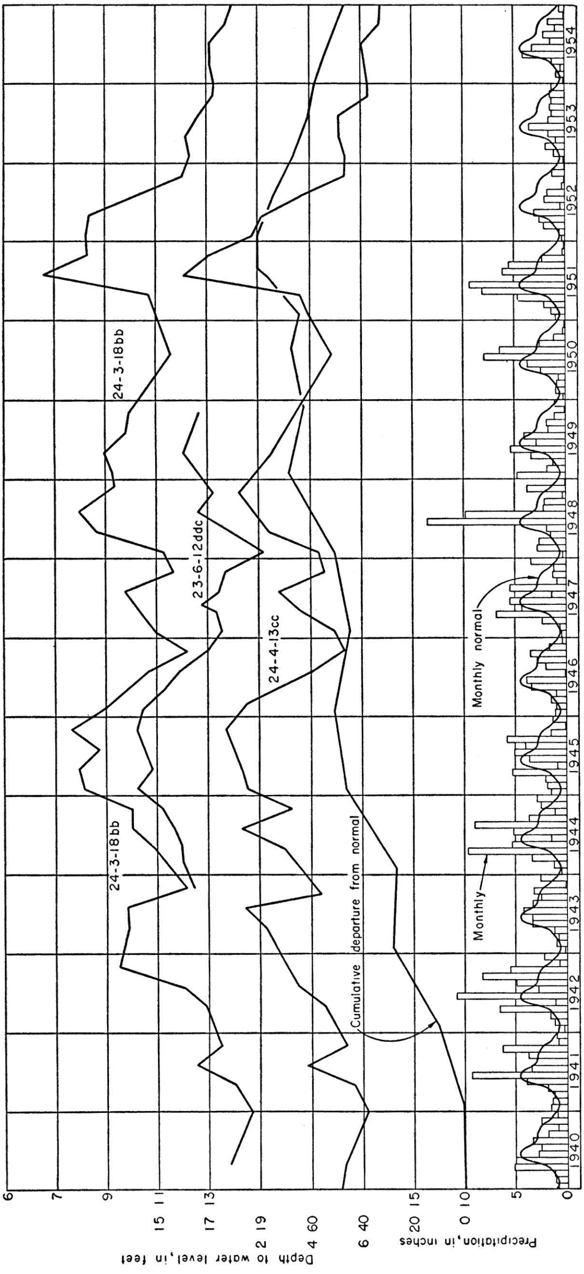

FIG. 14.—Hydrographs showing fluctuations of water levels in three wells in the Arkansas River valley, monthly precipitation, and cumulative departure from normal precipitation.

from which plants will obtain their water from the water table varies with the plant species and type of soil. Ordinary grasses and field crops will not send their roots more than a few feet in the search for water, but alfalfa and certain desert plants may send their roots to a depth of as much as severel tens of feet to reach the water table (Meinzer, 1923).

Discharge of ground water by transpiration and evaporation is relatively great in Reno County, owing to the shallow depth to the water table in much of the county. The greatest discharge by transpiration and evaporation probably is in the Arkansas River valley, where the water table is shallow. The quantity of ground water discharged in Reno County by evaporation and transpiration is probably much greater than the amount discharged by all other means.

The discharge of water from wells in Reno County is now one of the principal means of discharge of ground water. The average pumpage of water for industrial, municipal, and farm use is about 15,000 acre-feet annually, which is probably between 5 and 10 percent of the total recharge in the county.

RECOVERY

Principles of Recovery

When water is pumped from a well, a difference of head exists between the water in the well and the water outside the well for some distance from the well. The water table for some distance surrounding the well develops a cone of depression (Fig. 15). In any given well, the greater the rate of pumping, the greater the drawdown in the well and throughout the cone of depression. The character and thickness of the water-bearing materials have a direct bearing on the yield and drawdown of a well. Inasmuch as the specific capacity of a well is defined as the yield in gallons a minute per foot of drawdown, the character and thickness of the material surrounding a well have a direct bearing on its specific capacity. A well in coarse material will have a higher specific capacity than a well in fine-grained, poorly sorted material.

Types of Wells

Dug wells.—Dug wells are excavated with pick and shovel or by machinery. Dug wells generally range in diameter from about 2 to 5 feet although they may have a larger diameter—for example, the well in Greensburg, Kiowa County, which has a diameter of

40 feet. Dug wells generally extend only a short distance below the water table.

Bored wells.—Bored wells are made by augers or post-hole diggers in unconsolidated materials and generally are made in areas where the water table is shallow. Many wells in Reno County are constructed by this method.

Driven wells.—Driven wells are wells constructed in unconsolidated material by driving a 1¼- or 1½-inch pipe, equipped at the bottom with a screened drive point, below the water table. Wells generally can be driven only where the water-bearing material is sufficiently permeable to permit water to flow freely into the pipe, where the material is unconsolidated enough to permit a pipe to be driven, and where the depth to the water is not more than 20 feet or so below land surface. In Reno County where the depth

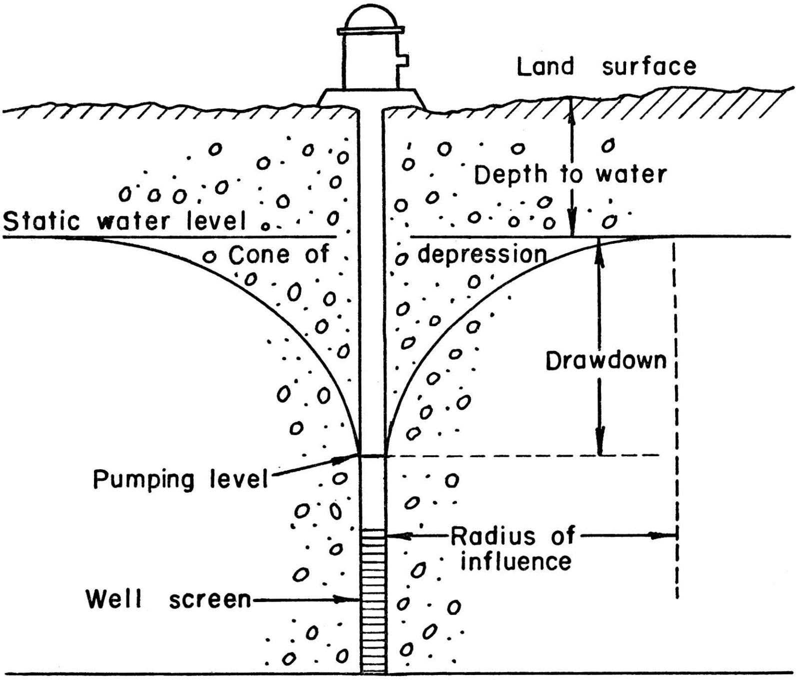

Fig. 15.—Diagrammatic section of a well that is being pumped, showing its drawdown, cone of depression, and radius of influence.

to water exceeds 20 feet, the well generally is dug part way so that the distance from the pump cylinder, at the bottom of the dug part of the well, to the water table is less than 20 feet.

Drilled wells.—Drilled wells are wells made by percussion or rotary machines and may be drilled either in consolidated or unconsolidated material. Generally, drilled wells in Reno County are 4 to 6 inches in diameter, but many public-supply wells and industrial wells are begun as holes 30 to 60 inches in diameter and finished as gravel-walled wells having a casing 12 to 20 inches in diameter. Most drilled wells in unconsolidated rocks are cased to the bottom of the well, the last few feet of casing being slotted to admit the water into the well. Wells in consolidated rocks generally have casing only to the top of the consolidated rock or in that part of the well that will not remain open without casing. Where large supplies of water are needed, the well should penetrate all the good water-bearing material, and the casing should be perforated so that water will enter the well as fast as the surrounding material will yield it.

UTILIZATION OF WATER

During the course of the investigation, data were obtained on 241 wells in Reno County (Table 11). The wells listed in Table 11 include 150 domestic and stock wells, 16 public-supply wells, 9 industrial wells, 3 irrigation wells, and 63 not in use or used only for observing water levels.

Domestic and Stock Supplies

Most domestic and stock water supplies in Reno County are obtained from wells. In a few places ponds are used to supply stock water. The ground water in this area generally is suitable for domestic use except for an area in the southeastern part of the county where the water comes from Permian rocks and is very hard. There, a few families use cistern water for drinking and washing but others use the well water even though it is not desirable. In a few local areas the ground water has become polluted from industrial wastes. In Reno County the supply of ground water available is generally sufficient for all domestic uses.

Public Water Supplies

Eight communities in Reno County have public water supplies. Descriptions of the water systems and wells in these communities are given below, and additional information may be found in the table of well records at the end of this report (Table 11).

TABLE 4.—*Monthly and annual pumpage of water for the City of Hutchinson, in millions of gallons*
(Data provided by the Hutchinson Water Co.)

Month	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954
Jan.....	82.0	68.0	74.8	81.7	71.0	81.0	92.7	83.0	81.5	79.5	88.4	94.2	100.1	118.4
Feb.....	75.5	61.7	67.8	72.5	64.3	75.1	83.0	78.6	75.3	73.3	80.7	84.5	90.1	108.4
Mar....	68.1	68.9	77.8	73.2	73.2	84.1	91.9	82.5	84.5	85.9	90.1	89.8	106.6	120.9
Apr.....	59.5	65.4	82.4	66.3	69.5	93.5	95.3	92.6	88.8	98.6	87.4	91.3	131.4	142.7
May....	68.6	77.5	81.3	74.6	80.8	95.3	102.3	111.6	88.8	109.0	98.0	113.3	156.0	134.4
June....	78.2	70.4	91.4	95.8	81.2	127.5	100.3	111.5	106.3	137.4	99.2	198.3	208.2	188.5
July....	106.6	93.6	103.4	91.3	100.2	175.2	154.5	114.6	131.6	109.7	117.3	200.5	183.1	265.4
Aug.....	89.7	78.0	114.3	90.6	100.4	147.2	167.3	116.8	123.7	98.8	136.8	168.3	201.6	242.8
Sept....	78.0	71.9	83.1	76.2	95.1	121.4	142.4	113.3	93.5	95.1	112.6	169.2	181.0	213.4
Oct.....	68.9	71.5	81.6	64.2	80.0	102.0	113.1	89.3	91.7	97.8	98.1	141.6	148.8	140.3
Nov....	65.3	63.1	79.1	68.8	76.7	88.4	107.6	77.5	80.6	86.9	90.5	106.8	113.7	115.1
Dec.....	64.7	68.2	85.8	71.3	82.1	86.7	82.6	79.2	80.4	87.2	90.6	106.0	116.1	107.9
Annual..	905.1	858.2	1,022.8	926.5	974.5	1,277.4	1,333.0	1,150.5	1,126.7	1,159.2	1,189.7	1,563.8	1,736.7	1,898.2

Hutchinson.—Hutchinson, the largest city in Reno County (population 33,575), is supplied water by the privately owned Hutchinson Water Co. from eight gravel-walled wells in the city. These wells obtain water from the alluvium and Wisconsinan deposits and range in depth from 50 to 75 feet. Yields of the wells range from 750 to 2,000 gallons a minute. Water is pumped directly into the distribution system and the required pressure is maintained by varying the number of wells pumping. The pumps of six wells are controlled from a central station to facilitate the maintenance of pressure. Two wells (23-6-1bdc and 23-6-12cd) are used continuously and provide most of the water. At times of peak loads additional wells are used. The average daily use of water is about 3 million gallons. The monthly and annual pumpage is given in Table 4. The quality of water varies from well to well. The wells providing the water of poorest quality are pumped only during periods of peak loads or for emergency use. The water at Hutchinson is very hard and is not treated except by chlorination at the wells (Table 5).

Haven.—The town of Haven (population 720) is supplied by three gravel-walled wells on the west edge of town. The wells obtain water from the Meade formation and Wisconsinan deposits south of Arkansas River. Two of the wells are equipped with centrifugal pumps and yield about 250 gallons a minute each. The third well is equipped with a turbine pump and also yields about 250 gallons a minute. The water is pumped directly into the mains, and the system is equipped with a 55,000-gallon elevated steel tank for storage and pressure maintenance. The daily consumption of water varies from 60,000 gallons to 100,000 gallons. The water is hard and is not treated (Table 5).

Buhler.—Prior to 1938 the water supply for Buhler was obtained from three wells in the Little Arkansas River valley. These wells were abandoned because of low yield and infiltration of fine sand. In 1938 two wells (22-4-12dd1 and 22-4-12dd2) were drilled in the Meade formation 4 miles east of the city. These wells are 88 and 98 feet deep and are on the west edge of the McPherson Valley. Well 22-4-12dd1 had a yield of 269 gallons a minute and a drawdown of 7.7 feet; well 22-4-12dd2 had a yield of 201 gallons a minute and a drawdown of 2 feet. The wells are gravel packed and are equipped with turbine pumps. For many years water was pumped directly into the distribution system, but in 1949 a treatment plant was built and the water has been treated since then. The water from the wells is high in carbon dioxide and thus is corrosive. The untreated water has a hardness of 461 parts per million, of which about two-thirds is of the carbonate type. The water is softened to a hardness of about 130 parts per million. The daily consumption of water averages about 35,000 gallons. The system includes an elevated steel storage tank having a capacity of 50,000 gallons.

Nickerson.—The water supply for Nickerson is obtained from two wells that penetrate the alluvium of the Arkansas River valley in the center of the city. The wells are equipped with turbine pumps and have a combined yield of about 900,000 gallons a day. The average daily use of water is about 100,000 gallons. The water is pumped directly into the mains, and the system is equipped with a 50,000-gallon elevated steel tank for storage and pressure maintenance. The water is hard and is not treated (Table 5).

Arlington.—The water supply for Arlington is obtained from two drilled wells in the Meade formation at the west edge of the city. The wells are equipped with turbine pumps that pump the water directly into the distribution system. The capacity of the two wells is about 170,000 gallons a day, and the average consumption is about 30,000 gallons a day. An elevated steel tank having a capacity of 50,000 gallons is used for storage. The water has a hardness of 141 parts per million and is not treated.

Sylvia.—The water supply for Sylvia is obtained from two wells tapping the Meade formation and the Crete member of the Sanborn formation in the northwestern part of town. The wells are equipped with turbine pumps. When tested, each well had a yield of about 250 gallons a minute and a drawdown of 1 foot. The total capacity of the 2 wells as equipped is about 720,000 gallons a day and the consumption is about 20,000 gallons a day. Water is pumped to an elevated steel storage tank having a capacity of 50,000 gallons. The water has a hardness of 136 parts per million and is not treated.

Turon.—The town of Turon obtains its water supply from two wells penetrating gravel of the Meade formation and the Crete member of the Sanborn formation in the northwestern part of town. Well 26-10-5dd1 is equipped with a turbine pump, which discharges water into an elevated steel storage tank having a capacity of 50,000 gallons. Well 26-10-5dd2 is equipped with a centrifugal pump and is used only in an emergency. Well 26-10-5dd2 yields an estimated 50 gallons a minute and well 26-10-5dd1 yields 125 gallons a minute. The average daily use is about 20,000 gallons. The water has a hardness of 196 parts per million and is chlorinated.

Pretty Prairie.—The Pretty Prairie water supply is obtained from two wells penetrating the Meade formation and gravel of Blancan age in the western part of town. The wells are equipped with turbine pumps, which discharge water to an elevated storage tank having a capacity of 40,000 gallons. The water has a hardness of 129 parts per million (Table 5).

Industrial Supplies

Many industrial wells are in use in Reno County, principally in and near Hutchinson. The largest users of water are the Central Fiber Products Co., the Kansas Power and Light Co., the Carey Salt Co., and the Atchison, Topeka and Santa Fe Railway Co. Water from industrial wells is used for cooling, washing, ice manufacturing, and air conditioning, and by meat-packing plants, creameries, and foundries.

The Central Fiber Products Co. is supplied by four wells ranging in depth from 62 to 68 feet. Water is obtained from terrace deposits near the foot of the sandhills in the NE cor. sec. 8, T. 23 S., R. 5 W. The combined yield of the wells is 2,500 to 3,000 gallons a minute. The Atchison, Topeka and Santa Fe Railway Co. is supplied by two wells in the NE¼ SE¼ sec. 4, T. 23 S., R. 5 W. These wells are 40 feet deep and obtain water from terrace deposits near the foot of the sandhills. The yield from each well is 215 gallons a minute, and the annual pumpage is about 54 million gallons. In the fall of 1949 the Kansas Power and Light Co. had three wells drilled in the SE¼ SW¼ sec. 4, T. 23 S., R. 5 W. These wells are 50 to 55 feet deep and obtain water from terrace deposits of Wisconsinan age. Well 23-5-4cda was pumped at the rate of 1,600 gallons a minute for 4 hours and had a drawdown of 17 feet. The other wells were not tested, but an examination of samples of the gravel penetrated by the wells indicates that the yields from these wells should be almost as great as that of the well tested. About 300 gallons a minute is pumped from each well. The water from these wells is used to cool the condensers in the powerplant northeast of Hutchinson.

Not all industrial wells in Reno County were inventoried, so the total amount of water pumped from industrial wells is not known; however, the amount unquestionably exceeds the pumpage of the Hutchinson Water Co.

TABLE 5.—*Analyses of water from typical wells and test holes in Reno County*

Analyzed by H. A. Stoltenberg. Dissolved constituents given in parts per million [a]

Well number	Depth (feet)	Geologic source	Date of collection	Temperature (°F)	Dissolved solids	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)	Hardness as $CaCO_3$		
																Total	Carbonate	Noncarbonate
22-4-4aad	33.0	Meade formation	4-25-50	60	1,580	21	0.13	190	69	244	451	424	242	0.5	168	758	370	388
22-4-7ccd	54.0	Meade formation and Ninnescah shale	2- 2-50	......	......	......	......	......	......	......	......	......	54	......	12	......	......	......
22-4-12dd	98.0	Meade formation	2- 2-50	......	468	17	.09	27	15	105	89	186	62	.4	1.7	129	73	56
22-4-14dda	37.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	98	......	53	......	......	......
22-4-25ad	135.0	do.	......	......	......	......	......	......	......	......	......	......	13	......	.0	......	......	......
22-4-28cb	20.0	do.	4-25-50	58	403	13	.10	96	9.0	43	383	7.8	20	.4	25	276	276	0
22-4-34cb	42.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	179	......	394	......	......	......
22-5-3aad	18.0	Alluvium	......	......	......	......	......	......	......	......	......	......	37	......	146	......	......	......
22-5-5cd	24.5	Dune sand and Meade formation	4-25-50	59	270	15	.42	63	8.2	25	242	23	12	.3	4.3	190	190	
22-5-11cb	26.0	Alluvium	......	......	......	......	......	......	......	......	......	......	15	......	31	......	......	......
22-5-19ab	52-55	Dune sand and Meade formation	11- 6-45	59	172	28	24	36	4.2	11	122	2.9	6.5	.2	22	107	100	7
22- 5-20cc	46.0	do.	10-31-45	60	......	......	.54	......	......	......	......	22	47	......	......	......	......	......
22- 5-27dc	35.8	do.	11- 1-45	58	......	......	17	......	......	......	......	14	29	......	......	......	......	......
22-5-28bb	34.8	do.	10-31-45	58	......	......	.34	......	......	......	......	8.2	16	......	......	......	......	......
22-5-30cb	30-34	Wisconsinan terrace deposits	11-29-45	60	234	22	3	34	9.2	32	149	48	14	.3	1.1	123	122	1
22-5-30dc	29-33	do.	11-28-45	60	212	31	6	24	7.8	32	110	38	18	.3	7.1	92	90	2
22-5-31ad	30-34	do.	11-28-45	60	254	18	4.3	38	10	37	171	51	15	.4	1.0	136	136	0
22-5-32dd	27-31	do.	11-28-45	60	335	18	12	69	10	34	215	62	26	.3	10	213	176	37
22-5-33cb	16.7	Dune sand and Meade formation	11- 1-45	60	......	......	.32	......	......	......	......	1.6	5	......	......	......	......	......
22-5-34cc	26.5	do.	11- 1-45	59	......	......	3.3	......	......	......	......	44	35	......	......	......	......	......
22-5-36cb	10.4	do.	11- 7-45	60	......	......	.10	......	......	......	......	4.2	7	......	......	......	......	......
22-6-9dcd	29.5	Wisconsinan terrace deposits	11- 2-45	58	......	......	2.3	......	......	......	......	14	19	......	......	......	......	......
22-6-15ccb	44-48	do.	11-30-45	60	294	23	1.0	56	12	29	222	37	15	.3	13	189	182	7
22-6-15cd	33-37	Wisconsinan terrace deposits	11-30-45	59	289	16	1.9	64	11	22	232	25	10	.3	27	204	190	14
22-6-17ad	61-65	do.	11-30-45	59	692	14	.60	92	22	131	337	1.2	137	.8	9.7	320	276	44
22-6-21dd	65-69	do.	12- 1-45	60	779	15	.34	104	23	149	303	124	209	.7	5.3	354	248	106
22-6-22ad	52-56	do.	11-29-45	59	296	20	.84	59	12	29	229	36	19	.3	8	196	188	8

22-6-24ccd	33-35	do.	10-24-45	61	2[illegible]	20	1.5	43	8.8	28	149	30	15	.4	38	144	122	22
22-6-26cb	66-68	do.	12- 1-45	61	726	14	1.9	94	22	142	317	117	174	.7	6.6	325	260	65
22-6-36bb	48-52	do.	12- 3-45	60	669	18	.40	100	23	110	322	118	134	.7	6.2	344	264	80
22-7-15bb*l*	40.0	do.	3-15-49	......	1,443	17	0	148	33	294	281	361	368	.6	32	504	230	274
22-8-11ccd	90.0	Dune sand and Meade formation	12- 3-49	59	479	19	.22	124	8.2	30	337	24	33	.1	75	343	276	67
22-8-19cc	50.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	70	......	4.9	......	......	......
22-8-33ccd	27.2	do.	12- 1-49	......	......	......	......	......	......	......	......	......	237	......	120	......	......	......
22-8-34ad	51.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	56	......	41	......	......	......
22-9-7bba	38.5	do.	12- 1-49	......	......	......	......	......	......	......	......	......	27	......	115	......	......	......
22-9-12dd	52.0	do.	12- 1-49	......	......	......	......	......	......	......	......	......	346	......	15	......	......	......
22-9-20dd	207-212	Blanco formation	11-18-49	60	18,200	18	1.3	390	165	6,360	318	1,230	9,880	.4	1.3	1,650	261	1,390
22-9-30aad	35.0	Dune sand and Meade formation	4-25-50	59	252	15	.22	37	4.2	46	139	14	44	.3	23	110	110	00
22-10-7dcd	18.0	Dune sand	12- 1-49	......	......	......	......	......	......	......	......	......	1,140	......	106	......	......	......
22-10-10aa	8.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	870	......	1.8	......	......	......
22-10-29cb	18.0	do.	......	......	......	......	......	......	......	......	......	......	400	......	20	......	......	......
22-10-35cd	26.0	do.	......	......	......	......	......	......	......	......	......	......	143	......	53	......	......	......
23-4-1aab	30.0	Dune sand and Meade formation	......	......	......	......	......	......	......	......	......	......	5.5	......	.0	......	......	......
23-4-7cc	20.0	do.	10-26-45	58	......	......	.40	......	......	......	......	3.2	4.0	......	......	......	......	......
23-4-11dab	35.0	do.	4-26-50	59	788	22	.68	147	29	98	142	21	395	.2	5.3	486	116	370
23-4-12bb	25.0	Dune sand and Meade formation	2- 2-50	......	......	......	......	......	......	......	......	......	24	......	20	......	......	......
23-4-13ad	22.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	10	......	35	......	......	......
23-4-18ccb	33-36	Wisconsinan terrace deposits	10-26-45	58	213	18	4.1	22	6.4	40	127	40	9	.2	14	82	82	0
23-4-19cc	12.0	do.	11- 7-45	61	......	......	.08	......	......	......	......	44	39	......	......	......	......	......
23-4-21ccb	16.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	11	......	.0	......	......	......
23-4-22ad	16.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	9	......	8.4	......	......	......
23-4-24ad	21.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	203	......	23	......	......	......
23-4-35aac	29.0	do.	2- 2-50	......	......	......	......	......	......	......	......	......	450	......	.0	......	......	......
23-5-2dda	69-73	Dune sand and Meade formation	12- 8-45	57	152	63	8.6	14	5	42	60	2.1	4.5	.2	23	56	49	7
23-5-2dca	21.0	do.	11- 3-45	58	......	......	1.3	......	......	......	......	5.8	10	......	......	......	......	......
23-5-4bbd	40.5	Wisconsinan terrace deposits	8- 3-45	59	344	21	.06	62	10	25	161	84	14	.3	12	196	132	64
23-5-6dd	62-66	do.	11-27-45	59	352	16	15	57	15	52	260	44	38	.7	1.5	204	204	0
23-5-8aa	68.0	do.	3- 1-38	......	396	18	2.5	80	15	26	198	123	.2	.0	......	261	162	99
23-5-11cb	31-33	do.	10-24-45	59	240	16	4.3	34	7.8	37	137	63	12	.3	1.4	117	112	5
23-5-13dd	33-36	do.	10-25-45	58	194	16	5.9	24	6.6	31	102	53	10	.3	2	87	84	3
23-5-13dd	130-133	do.	10-25-45	57	193	17	2.7	29	7	26	120	40	11	.3	2.2	102	98	4
23-5-14da	42-45	do.	10-27-45	58	241	28	2.1	21	6.2	49	127	61	11	.4	.7	78	78	0
23-5-15dd	52-54	do.	10-23-45	59	14,500	43	25	3,270	445	1,420	152	79	9,120	.0	.0	9,980	125	9,860
23-5-16aa	50-54	do.	11-27-45	59	944	20	7.2	139	27	162	243	158	316	.3	1.3	458	199	259
23-5-18bcd	80.0	do.	6- 6-38	......	1,830	16	0	185	32	383	271	192	694	.6	31	593	222	371
23-5-20aa	19.6	do.	10-30-45	60	......	......	.09	......	......	......	......	222	840	......	......	......	......	......
23-5-21aa	55-58	do.	10-30-45	59	13,700	23	14	1,880	274	2,900	283	230	8,250	.4	93	5,820	232	5,580

TABLE 5.—*Analyses of water from typical wells and test holes in Reno County*—*Continued*

Well number	Depth (feet)	Geologic source	Date of collection	Temperature (°F)	Dissolved solids	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)	Hardness as $CaCO_3$		
																Total	Carbonate	Noncarbonate
23-5-23dd	94-97	Wisconsinan terrace deposits	10-29-45	59	2,960	19	2.4	417	104	539	273	102	1,640	0.4	4.4	1,470	224	1,240
23-5-24ad	57-60	do	12- 8-45	58	236	17	3.6	42	9	29	183	39	9	.5	.7	142	142	0
23-5-27bb	24.2	do	10-29-45	60			42					90	490					
23-5-29aa	35-38	Alluvium	10-30-45	59	1,240	14	6.3	87	19	353	260	137	495	.6	8	295	213	82
23-5-30aa	15.8	do	10-30-45	62			1.8					214	355					
23-5-32bb	53-56	do	10-31-45	58	3,940	16	6.7	285	67	1,100	222	307	2,040	.4	5.8	986	182	804
23-6-1aa	64-68	Wisconsinan terrace deposits	12- 4-45	60	458	17	.58	86	20	52	283	67	74	.6	2	296	232	64
23-6-2cc	19.7	Alluvium	10-19-45	62			.27					46	37					
23-6-12ad	58.0	Wisconsinan terrace deposits	6- 6-38		726	15	.05	102	19	137	310	192	161	.9	18	333	254	79
23-6-12bbd	60.0	do	3-27-44		576	15	0	88	17	87	242	96	119	.6	13	290	198	92
23-6-12cc	65.0	Alluvium	6- 6-38		1,200	15	0	148	25	220	237	135	429	.3	13	473	194	279
23-6-12cd	73.0	do	6- 6-38		662	16	0	101	18	98	256	119	134	.8	20	326	210	116
23-6-14bd	21.0	do	10-26-45	60			.86					428	320					
23-6-36dd	133-136	Wisconsinan terrace deposits	11- 1-45	59	426	20	3.5	52	8.8	93	311	32	43	.2	21	166	166	0
23-7-2ad	20.8	do	2- 2-50										400		88			
23-7-6aab	34.5	Dune sand and Meade formation	2- 2-50										170		164			
23-7-13ab	56.9	Meade formation	2- 2-50										1,580		10			
23-7-15bb	25.8	do	12- 4-49		853	19	.54	80	11	233	368	33	290	.4	5.8	244	244	0
23-7-17bbc	45.0	Dune sand and Meade formation	2- 2-50										518		14			
23-7-18dc	26.0	do	2- 2-50										240		19			
23-7-22ba	18.0	Meade formation	2- 2-50										131		13			
23-7-28dd	57.0	do	2- 2-50										650		111			
23-7-30cc	30.0	do	2- 2-50										370		71			
23-7-30dd	22.7	Meade formation	12- 1-49										375		53			
23-8-6bb	36.0	Dune sand and Meade formation	2- 2-50										108		33			
23-8-18cc	38.0	do	12- 3-49	59	405	21	.11	78	6	65	327	8.6	50	.3	15	219	219	0
23-8-27dd	22.0	Meade formation	2- 2-50										190		8.4			

23-8-33dad	50.0	do.	12- 1-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	155	.....	9.3	.....	.....	.....
23-8-36cc	28.0	do.	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	147	.....	.0	.....	.....	.....
23-9-6aa	47.0	Dune sand and Meade formation	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	274	.....	15	.....	.....	.....
23-9-18ba	77.5	Crete member of Sanborn form. and Meade form.	12- 1-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	181	.....	8.4	.....	.....	.....
23-9-26cc	26.0	do.	12- 1-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	14	.....	15	.....	.....	.....
23-10-6aa	11.6	Dune sand	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	237	.....	84	.....	.....	.....
23-10-23dc	108.0	Dune sand and Crete member of Sanborn formation	11-22-49	61	315	15	.09	56	8.6	52	283	9.5	29	.2	5.8	175	175	0
23-10-25bb	139-143	Crete member of Sanborn formation	11-17-49	60	8,530	21	.58	165	60	3,020	284	601	4,520	.4	.9	658	233	425
23-10-25bb	174-176	Meade formation	11-17-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,620	.....	.9	.....	.....	.....
23-10-31ccd	19.5	Dune sand	11-17-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	28	.....	29	.....	.....	.....
24-4-5aa	22.0	Wisconsinan terrace deposits	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	186	.....	13	.....	.....	.....
24-5-1dda	21.5	do.	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	420	.....	26	.....	.....	.....
24-5-3ab	27.1	Alluvium	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	520	.....	.0	.....	.....	.....
24-5-6bbc	42.0	Wisconsinan terrace deposits	4-27-50	58	369	15	.07	70	9.6	50	276	25	40	.2	27	214	214	0
24-5-20dc	53.0	Meade formation	4-27-50	58	376	14	.15	78	8	53	346	16	21	.2	16	228	228	0
24-5-25cb	53.0	Wisconsinan terrace deposits	4-27-50	59	1,140	14	.15	221	27	122	455	47	184	.1	305	662	373	289
24-6-4ab	36.0	Meade formation	4-25-50	57	344	18	.17	68	8.2	48	264	16	48	.2	7.5	203	203	0
24-6-8cdc	92.0	Ninnescah shale	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	78	.....	80	.....	.....	.....
24-6-11cc	22-25	Meade formation	12- 5-45	57	386	15	3.3	65	11	65	333	21	25	.7	19	207	207	0
24-6-12cc	22.4	do.	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	12	.....	35	.....	.....	.....
24-6-12bb	145-148	Blanco formation	11- 2-45	59	268	19	9.7	46	5.2	42	212	19	16	.2	14	136	136	0
24-6-22bb	24-27	Meade formation	12- 7-45	59	361	17	4.0	80	13	38	334	10	32	.7	6.2	253	253	0
24-7-10bb	36.0	Crete member of Sanborn form. and Meade form.	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	58	.....	217	.....	.....	.....
24-7-22dd	20.0	do.	4-25-50	60	347	17	.61	67	11	39	224	30	37	.3	36	212	184	28
24-8-21dad	37.0	do.	12- 1-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	137	.....	8	.....	.....	.....
24-8-24aa	68.0	do.	12- 3-49	60	750	15	.78	114	15	142	344	41	205	.3	49	364	282	64
24-8-36bc	76.0	do.	12- 1-49	.....	.....	.....	.....	.....	.....	.....	.....	.....	49	.....	97	.....	.....	.....
24-9-10bc	36.0	do.	4-25-50	59	266	17	.15	58	5.4	19	139	14	18	.2	66	166	114	52
24-9-12dd	32.0	do.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	201	.....	14	.....	.....	.....
24-9-31bcb	68.0	do.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	55	.....	20	.....	.....	.....
24-10-1bc	31.0	do.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	17	.....	2.3	.....	.....	.....
24-10-15cab	55.0	do.	3-10-49	.....	253	15	.03	45	5.8	32	157	14	28	.2	27	136	129	7
25-4-5cab	55.0	Wisconsinan terrace deposits	10-28-37	59	411	.....	.0	88	14	51	390	14	28	.4	5	277	277	0
25-4-9dd	39.0	do.	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	18	.....	58	.....	.....	.....
25-4-33ba	37.5	Ninnescah shale	2- 2-50	.....	.....	.....	.....	.....	.....	.....	.....	.....	69	.....	274	.....	.....	.....
25-5-8aa	34.5	do.	4-25-50	60	369	12	7.9	101	13	22	378	2.9	25	.4	6.6	306	306	0
25-6-8bab	16.0	Alluvium	4-25-50	59	265	28	.09	49	8.8	16	112	27	10	.4	71	158	92	66

TABLE 5.—*Analyses of water from typical wells and test holes in Reno County—Concluded*

Well number	Depth (feet)	Geologic source	Date of collection	Temperature (°F)	Dissolved solids	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)	Hardness as $CaCO_3$		
																Total	Carbonate	Noncarbonate
25-7-16aa	18.8	Meade formation	4-25-50	59	261	15	0.52	68	5	18	222	9.1	11	0.3	26	190	182	8
25-8-10abc1	...	do	1-21-50	...	352	15	.12	47	5.8	64	134	16	91	.2	31	141	110	31
25-8-11ab	18.0	do	12-3-49	...	...	...	...	...	...	...	...	...	6	...	12	...	...	...
25-8-26cba	38.0	Wisconsinan terrace deposits	2-2-50	...	...	...	...	...	...	...	...	...	105	...	403	...	...	...
25-8-26bbd	54.0	Harper sandstone	2-2-50	...	...	...	...	...	...	...	...	...	69	...	36	...	...	...
25-9-1dcd	32.0	Crete member of Sanborn formation	12-3-49	60	190	15	.16	27	7	18	66	13	11	.2	66	96	54	42
25-10-16dd	29.5	do	12-3-49	60	227	9.6	3.3	30	6	34	102	18	13	.2	66	100	84	16
25-10-19cc	48.0	do	...	...	...	...	...	...	...	...	...	...	14	...	26	...	...	...
26-4-2dd	31.3	Meade formation	4-25-50	60	410	15	.21	88	23	30	376	13	18	.2	38	314	308	6
26-5-20ab	22.0	Ninnescah shale	4-25-50	60	361	7.6	.14	65	24	25	237	44	16	.3	62	260	194	66
26-6-18cdb2	40.0	Meade formation and Blanco formation	3-2-49	...	219	17	.03	40	7	28	173	7.4	12	.2	29	129	129	0
26-6-26da	20.0	do	4-25-50	59	188	10	.17	30	5.6	27	132	6.6	10	.3	34	98	98	0
26-8-13aa	36.0	Harper sandstone	4-25-50	50	510	17	.15	119	12	47	305	12	104	.3	49	346	250	96
26-8-32cb	38.0	Meade formation and Blanco formation	4-25-50	59	236	8.6	.43	30	8	31	71	22	21	.2	80	108	58	50
26-9-4bba	38.0	do	12-3-49	60	314	16	.37	57	6.8	34	154	15	21	.3	88	170	126	44
26-9-13cbb	57.0	do	12-3-49	...	...	...	...	...	...	...	...	...	91	...	447	...	...	...
26-9-33aa	50.0	Meade formation	12-3-49	...	...	...	...	...	...	...	...	...	19	...	6.2	...	...	...
26-10-5dd1	60.0	do	11-14-49	...	459	17	.05	67	6	92	234	36	100	.2	27	192	192	0
26-10-7abd	28.0	Dune sand and Crete member of Sanborn formation	11-22-49	59	562	20	.12	110	12	69	300	28	95	.2	80	324	246	78
26-10-20aa	33.0	Crete member of Sanborn form. and Meade form.	11-22-49	...	...	...	...	...	...	...	...	...	9	...	26	...	...	...
26-10-23add	30.0	do	11-22-49	...	...	...	...	...	...	...	...	...	30	...	42	...	...	...

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.

Irrigation Supplies

During the drought period from 1930 to 1939, some irrigation wells were drilled in parts of Reno County. Most of these wells have been abandoned, and at the time of the report no large plants were in operation. Water from several small wells was used for irrigating gardens and orchards, but an inventory was not made of the amount of water pumped in 1949. The total pumpage for irrigation was small in comparison with other uses, however, even before the larger wells were abandoned.

CHEMICAL CHARACTER OF WATER

The chemical character of the water in Reno County is shown by analyses of 154 samples of water collected from 152 test holes and wells. The results of the analyses are given in Table 5. Partial analyses were made of 78 samples and more detailed analyses were made of 76 samples. In general, the analyses do not indicate the sanitary condition of the water. The analyses were made by Howard A. Stoltenberg, Chemist, in the Water and Sewage Laboratory of the Kansas State Board of Health.

Chemical Constituents in Relation to Use

Dissolved solids.—When water is evaporated the residue consists mainly of the mineral constituents given in the table of analyses (Table 5). In addition to the mineral constituents, the residue generally includes small quantities of organic materials and a small amount of water of crystallization. Water containing less than 500 parts per million of dissolved solids is suitable generally for domestic use, except for difficulties resulting from hardness or the presence of iron in excessive amounts. Water containing more than 1,000 parts per million is likely to contain enough of certain constituents to cause noticeable taste or otherwise to make the water undesirable or unsuitable for use.

The dissolved solids in 76 samples collected in Reno County ranged from 152 to 18,200 parts per million; 13 of these samples contained between 500 and 1,000 parts per million and 12 samples contained more than 1,000 parts. Seven of these samples were from test holes and were taken directly above shale bedrock, which fact in part accounts for the high concentration of dissolved solids. Test holes 23-5-21aa, 23-5-15dd, and 23-5-23dd probably are affected by local contamination from industrial wastes.

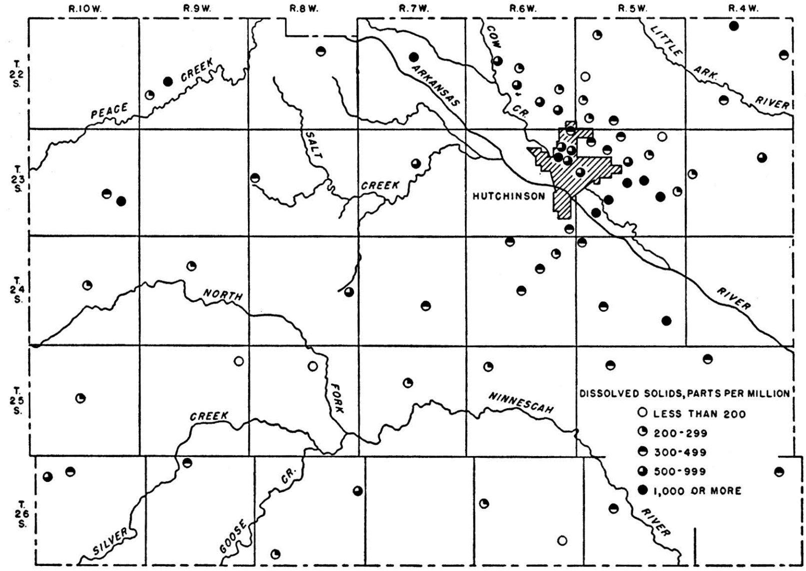

FIG. 16.—Dissolved solids in samples of water from wells and test holes.

Figure 16 shows the range in dissolved solids in the water from wells in Reno County. Samples of water from four wells contained more than 5,000 parts per million of dissolved solids. Two of these are Hutchinson municipal wells drilled in the alluvium of Arkansas River and two are domestic wells drilled into or near to the Permian shales.

The water samples from about two-thirds of the wells and test holes contained less than 500 parts per million of dissolved solids (Table 6).

TABLE 6.—*Dissolved solids in samples of water from wells and test holes in Reno County.*

Dissolved solids (parts per million)	Number of samples
Less than 200	6
201 to 300	21
301 to 500	24
501 to 750	9
751 to 1,000	4
1,001 to 5,000	8
5,001 to 15,000	3
More than 15,000	1
Total	76

Hardness.—The hardness of water, the property that generally receives the most attention, is most commonly recognized by its effect when soap is used with the water. Calcium and magnesium cause nearly all the hardness of ordinary water. These constituents also are the active agents in the formation of scale in steam boilers and in other containers in which water is heated or evaporated.

The total hardness, the carbonate hardness, and the noncarbonate hardness of the water samples from Reno County are given in Table 5 and Figures 17 and 18. The carbonate hardness, or "temporary hardness", is caused by calcium and magnesium bicarbonates and can be removed almost entirely by boiling. The noncarbonate hardness, or "permanent hardness", is caused by sulfates and chlorides of calcium and magnesium and other salts and cannot be removed by boiling. Carbonate and noncarbonate hardness

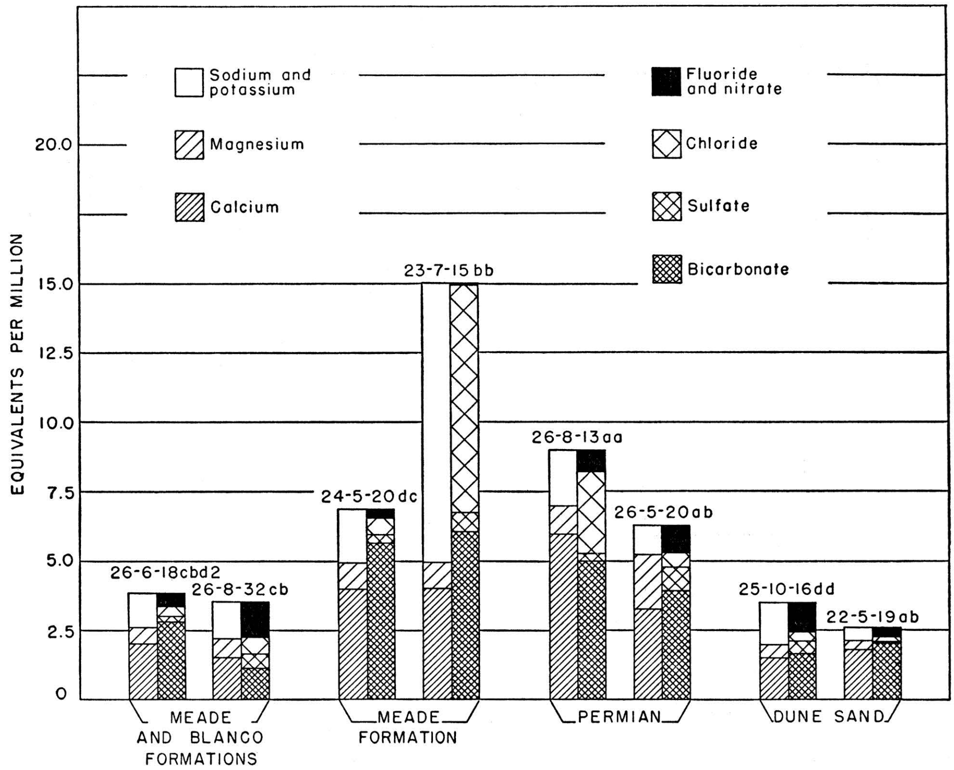

FIG. 17.—Analyses of water from the principal water-bearing formations.

react in the same manner in relation to the use of soap. Generally, water having noncarbonate hardness forms a harder scale in boilers than water having only carbonate hardness.

Water having a hardness of less than 50 parts per million is rated as soft, and treatment for removal of hardness under ordinary cir-

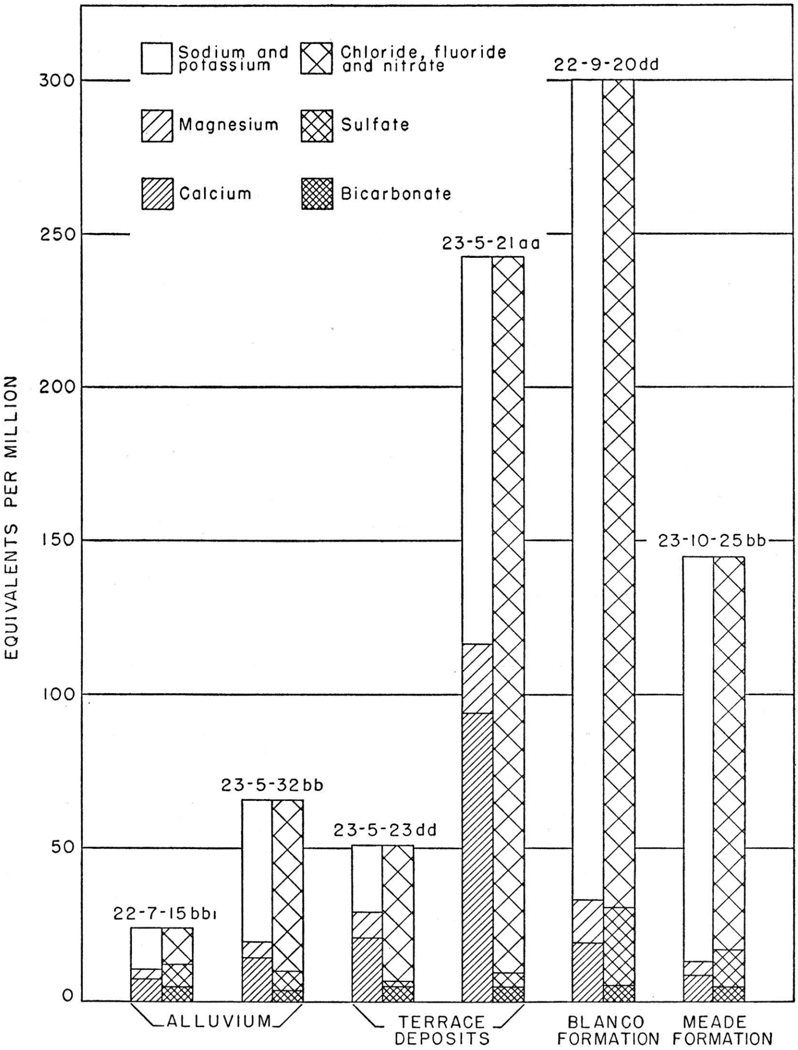

FIG. 18.—Analyses of water from principal water-bearing formations.

cumstances is not necessary. Hardness between 50 and 150 parts per million does not seriously interfere with the use of water for most purposes, but it does increase the consumption of soap; laundries and other industries using large quantities of soap, or to which hardness is objectionable in some way other than through excessive soap consumption, may profitably soften such water. Water of this range of hardness will form scale in steam boilers and generally is softened before being used. Hardness of more than 150 parts per million is noticeable by almost everyone, and if it is much higher than 150 parts per million the water may be softened. (Rain water stored in cisterns may be used for domestic supply.) When municipal water is softened, generally the hardness is decreased to about 100 parts per million, depending to some extent upon the original hardness of the water. The advantages of further softening a municipal supply may not be economically justified.

The hardness of water samples collected in Reno County ranged from 56 to 9,990 parts per million. Twenty-two of the samples had a hardness of less than 150 parts per million (Table 7). Most of the water from the Arkansas River valley had a hardness of more than 300 parts per million. The softest waters were those from the sandhills area north of Hutchinson and from the southern part of the county (Fig. 19). The hardest water was from test holes penetrating deposits just above the Permian shales. Some test holes south and east of Hutchinson show local contamination by industrial wastes (hardest waters shown in Fig. 19).

TABLE 7.—*Hardness of samples of water from wells and test holes in Reno County*

Hardness (parts per million)	Number of samples
Less than 100	8
101 to 150	14
151 to 200	11
201 to 300	18
301 to 500	15
501 to 1,000	6
1,001 to 10,000	4
Total	76

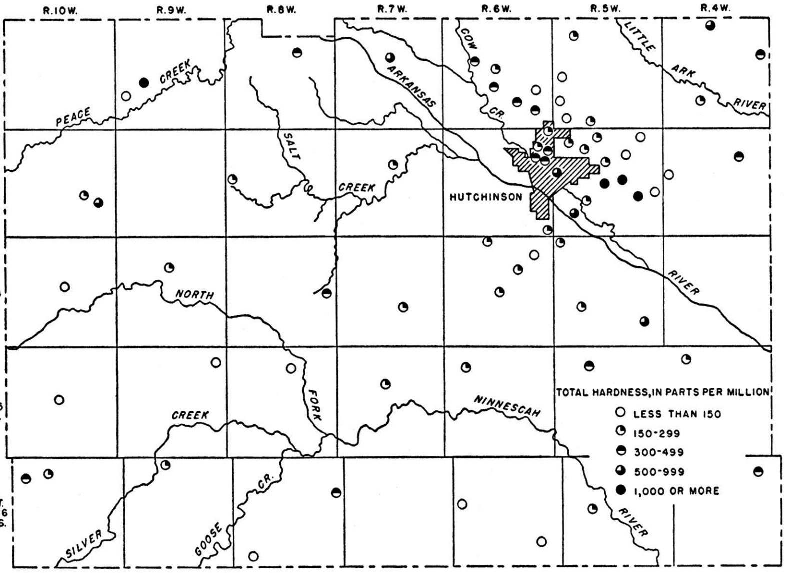

FIG. 19.—Hardness of samples of water from wells and test holes.

Iron.—Next to hardness, iron is the constituent in natural waters that generally is the most objectionable. The quantity of iron in water may differ greatly from place to place although the water is obtained from the same formation. If the water contains more than 0.3 part per million of iron in solution, the iron upon oxidation may settle out as a reddish sediment. Iron, present in sufficient quantity, gives a disagreeable taste to water, stains cooking utensils and plumbing fixtures, and is objectionable in the preparation of foods and beverages. Generally, iron may be removed by aeration followed by settling, or filtration, but some waters require treatment with lime or other chemicals. Samples of water from 91 wells

TABLE 8.—*Iron in samples of water from wells and test holes in Reno County.*

Iron (parts per million)	Number of samples
0.0 to 0.10	19
.11 to .3	16
.31 to 1.5	22
1.6 to 5.0	20
5.1 to 10.0	8
10.1 to 20.0	3
More than 20.0	3
Total	91

and test holes in Reno County were analyzed for iron. Table 8 shows the number of samples in certain concentration ranges of iron. Fifty-six samples contained more than 0.3 part per million.

The highest concentration of iron in water is found in the sandhills area north and east of Hutchinson (Fig. 20).

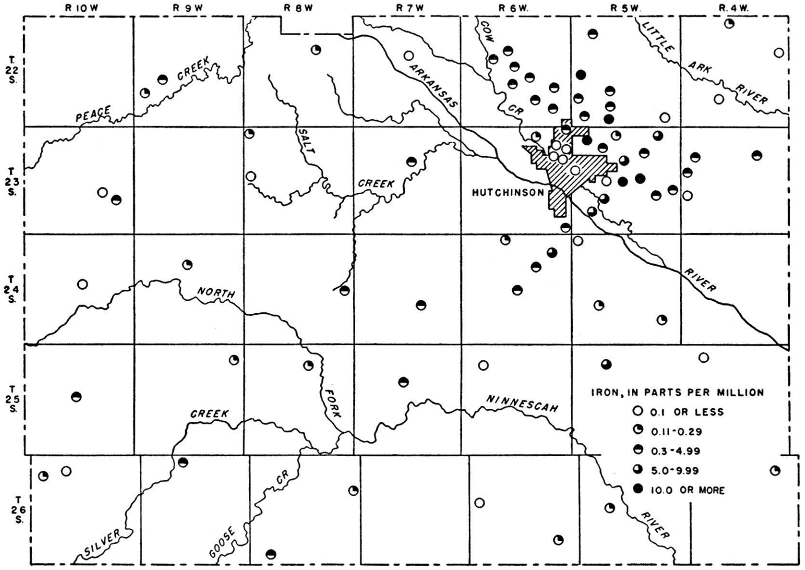

FIG. 20.—Iron content of samples of water from wells and test holes.

Chloride.—Chloride salts are found in nature in abundance. They are found in sea water and in oil-field brines and are dissolved in small quantities from many rock materials. Chloride has little effect on the suitability of water for ordinary use unless present in such concentration as to make the water unpotable. Water high in chloride content may be corrosive if used in steam boilers. The removal of the chloride ion from water is difficult and expensive.

Analyses for chloride were made for 153 samples of water from wells and test holes in Reno County (Table 5). The chloride content of the samples analyzed ranged from 4 to 9,870 parts per million. Table 9 shows the number of samples in various ranges of concentration of chloride. The five samples containing more than 2,500 parts were from test holes.

The greatest concentration of chloride is in water from the Arkansas River valley, along Salt Creek, and in the northwestern part of the county. The source of the chloride in the northwestern part of Reno County is probably the marsh area in Stafford County. The high chloride in the area south and east of Hutchinson is probably due to local contamination by industrial wastes.

TABLE 9.—*Chloride in samples of water from wells and test holes in Reno County*

Chloride (parts per million)	Number of samples
Less than 50	78
51 to 250	39
251 to 500	21
501 to 2,500	10
More than 2,500	5
Total	153

Fluoride.—Fluoride in water occurs only in small quantities, but a knowledge of the fluoride content of water used by children is important because of the effect the fluoride has on the permanent teeth. The use of water containing fluoride in excess of 1.5 parts per million may cause mottling of the tooth enamel. If the fluoride content is as high as 4 parts per million, about 90 percent of the children may have mottled teeth (Dean, 1936). Although too much fluoride has a detrimental effect, investigations indicate that concentrations of fluoride of about 1 part per million in drinking water lessen the incidence of tooth decay (Dean and others, 1941). The concentration of fluoride in the samples of water collected from wells in Reno County was less than 0.9 part per million.

Nitrate.—Recent investigations have caused considerable interest in the amount of nitrate in drinking water. Large amounts of nitrate in water may cause cyanosis in infants when the water is used for drinking and in the preparation of formulas in feeding. Infant cyanosis may be fatal if water containing a high concentration of nitrate is used continually. Water that contains more than 90 parts per million of nitrate is considered by the Kansas State Board of Health likely to cause infant cyanosis (Metzler and Stoltenberg, 1950). Water containing less than 45 parts of nitrate is generally regarded as safe. In Reno County the nitrate content of the samples of water collected from wells ranged from 0 to 447 parts per million. Thirteen samples contained more than 100 parts per million.

Chemical Constituents in Relation to Irrigation

This discussion of the suitability of water for irrigation use is adapted from Agriculture Handbook 60 of the U. S. Department of Agriculture.

The development and maintenance of successful irrigation projects involve not only supplying of irrigation water to the land but also control of the salinity and alkalinity of the soil. The quality of irrigation water, irrigation practices, and drainage conditions are involved in salinity and alkali control. Soil that was originally nonsaline and nonalkali 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.

In areas of sufficient rainfall and ideal soil conditions the soluble salts originally present in the soil or added to the soil with water are carried downward by the water and ultimately reach the water table. The process of dissolving and transporting soluble salts by the movement of water through the soil is called leaching. If the amount of water applied to the soil is not in excess of the amount needed by plants, there will be no downward percolation of water below the root zone and an accumulation of mineral matter will form at that point. Likewise, impermeable soil zones near the surface can retard the downward movement of water, resulting in waterlogging of the soil and deposition of salts. Unless drainage is adequate, attempts at leaching may not be successful, because leaching requires the free passage of water through and away from the root zone.

The characteristics of an irrigation water that seem to be most important in determining its quality are: (1) total concentration of soluble salts; (2) relative proportion of sodium to other principal cations (magnesium, calcium, and potassium); (3) concentration of boron or other elements that may be toxic; and (4) under some conditions, the bicarbonate concentration as related to the concentration of calcium plus magnesium.

The total concentration of soluble salts in irrigation water can be adequately expressed in terms of electrical conductivity for purposes of diagnosis and classification. Electrical conductivity is the measure of the ability of the ionized inorganic salts in solution to conduct an electrical current, and is usually expressed in terms of micromhos per centimeter at 25°C. The electrical conductivity can be determined accurately in the laboratory, or a rough approximation of the electrical conductivity can be obtained by multiplying the total equivalents per million of calcium, sodium, magnesium, and potassium by 100, or by dividing the dissolved solids in parts per million by a factor of 0.6 to 0.7. In general, water having an electrical conductivity below 750 micromhos per centimeter is satisfactory for irrigation insofar as salt content is concerned, although salt-sensitive crops such as strawberries, green beans, and red clover may be adversely affected by irrigation water having an electrical conductivity in the range of 250 to 750 micromhos per centimeter. Water in the range of 750 to 2,250 micromhos per centimeter is widely used, and satisfactory crop growth is obtained under good management and favorable drainage conditions, but saline conditions will develop if leaching and drainage are inadequate. Use of water having a conductivity of more than 2,250 micromhos per centimeter is not common, and very few instances can be cited where such waters have been used successfully.

In the past the relative proportion of sodium to other cations in irrigation water usually has been expressed simply as the percentage of sodium among the principal cations (expressed in equivalents), or simply the percent sodium. According to the U. S. Department of Agriculture the sodium-adsorption ratio, used to express the relative activity of sodium ions in exchange reactions with soil, is a better measure of the suitability of water for irrigation with respect to the sodium (alkali) hazard. The sodium-adsorption ratio, or SAR, may be determined by the formula

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

where the ionic concentrations are expressed in equivalents per million. The sodium-adsorption ratio may be determined also by use of the nomogram shown in Figure 21. In using the nomogram to determine the sodium-adsorption ratio of a water, the concentration of sodium expressed in equivalents per million is plotted on the left-hand scale, and the concentration of calcium plus magnesium expressed in equivalents per million is plotted on the right-hand scale. The point at which a line connecting these two points intersects the scale for sodium-adsorption ratio determines the sodium-adsorption ratio of the water. When the sodium-adsorption ratio and the electrical conductivity of a water are known, the classification of the water for irrigation can be determined by graphically plotting these values on the diagram shown in Figure 22. Table 10 gives the index numbers for the wells plotted on Figure 22 and the sodium-adsorp-

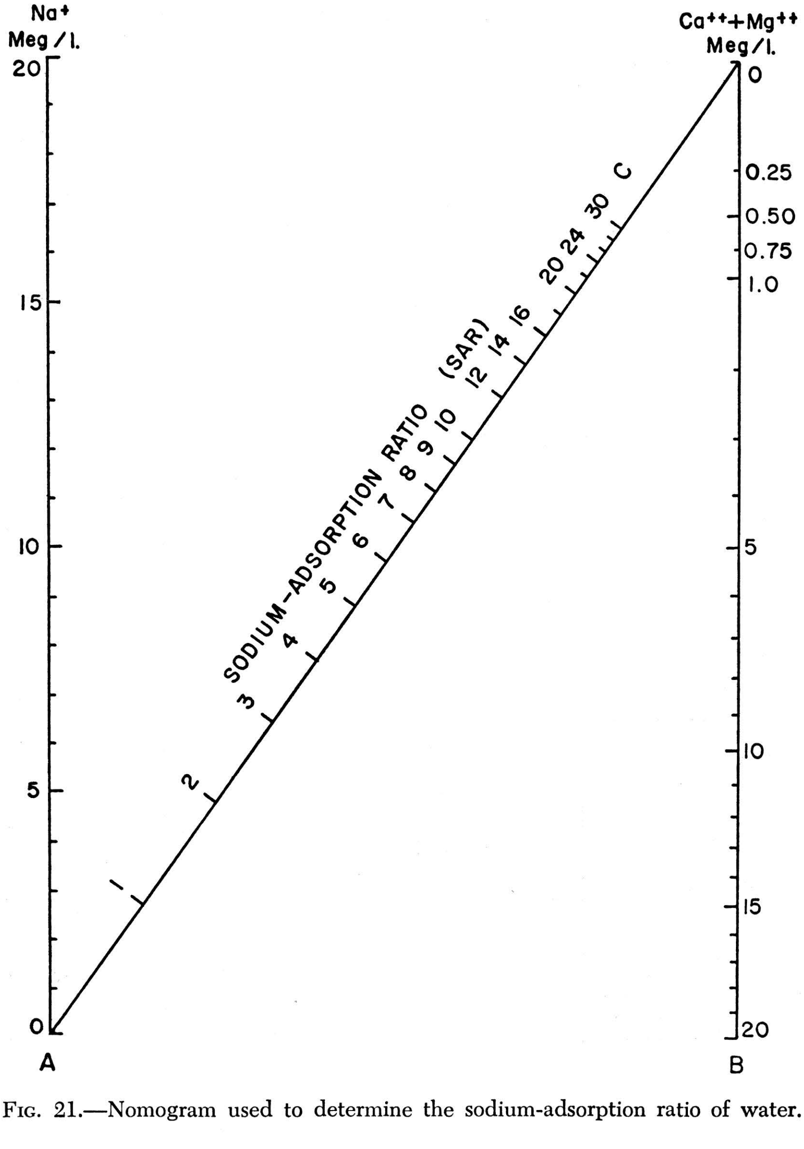

FIG. 21.—Nomogram used to determine the sodium-adsorption ratio of water.

TABLE 10.—*Index numbers of samples shown on Figure 22 and the sodium-adsorption ratio (SAR) and conductivity of water samples for which analyses are given in Table 5.*

Well number	Sodium-adsorption ratio	Conductivity (micromhos) 100 x Ca+Mg+Na	Index number (Fig. 22)
22–4–4aad	3.9	2,570	1
22–4–12dd1	4.0	710	23
22–4–28cb	1.1	740	24
22–5–5cd	.8	490	....
22–5–19ab	.3	260	2
22–5–30cb	1.2	390	....
22–5–30dc	1.5	320	25
22–5–31ad	1.4	440	....
22–5–32dd	1.0	570	26
22–6–15ccb	1.0	500	....
22–6–15cd	.5	500	3
22–6–17ad	3.1	1,210	27
22–6–21dd	3.3	1,360	28
22–6–22ad	.9	520	....
22–6–24ccd	1.1	410	....
22–6–26cb	3.8	1,270	29
22–6–36bb	2.5	1,170	30
22–7–15bb1	5.7	2,290	31
22–8–11ccd	.7	820	4
22–9–20dd	68.5	30,900	....
22–9–30aad	1.8	470	....
23–4–11dab	2.0	1,400	32
23–4–18ccb	2.0	340	5
23–5–2dca	1.1	210	33
23–5–4bbd	.8	500	....
23–5–6dd	1.6	630	....
23–5–8aa	.8	640	....
23–5–11cb	1.5	400	....
23–5–13dd	1.7	290	34
23–5–13dd	1.2	320	....
23–5–14da	2.4	370	....
23–5–15dd	6.2	26,200	....
23–5–16aa	3.3	1,620	35
23–5–18bcd	6.8	2,580	6
23–5–21aa	16	24,200	....
23–5–23dd	6.1	5,280	36
23–5–24ad	1.1	420	....
23–5–29aa	9.0	2,120	7
23–5–32bb	15	6,770	37
23–6–1aa	1.3	820	....

TABLE 10.—*Index numbers of samples shown on Figure 22 and the sodium-adsorption ratio (SAR) and conductivity of water samples for which analyses are given in Table 5.—Concluded.*

Well number	Sodium-adsorption ratio	Conductivity (micromhos) 100 x Ca+Mg+Na	Index number (Fig. 22)
23-6-12ad	3.2	1,260	....
23-6-12bdd	2.2	960	38
23-6-12cc	4.5	1,900	9
23-6-12cd	2.3	1,080	39
23-6-36dd	3.1	730	8
23-7-15bb	6.5	1,500	40
23-8-18cc	1.9	720	....
23-10-23dc	1.7	580	10
23-10-25bb	51	14,500	....
24-5-6bbc	1.5	650	....
24-5-20dc	1.6	690	....
24-5-25cb	2.1	1,850	11
24-6-4ab	1.4	610	....
24-6-11cc	2.0	700	....
24-6-12bb	1.5	460	12
24-6-22bb	1.0	670	....
24-7-22dd	1.1	580	13
24-8-24aa	3.2	1,310	....
24-9-10bc	.5	420	14
24-10-15cab	1.1	410	....
25-4-5cab	1.3	780	15
25-5-8aa	.4	710	....
25-6-8bab	.6	380	16
25-7-16aa	.4	450	17
25-8-10abc1	2.3	550	....
25-9-1dcd	.9	270	....
25-10-16dd	1.6	350	18
26-4-2dd	.7	760	19
26-5-20ab	.8	530	....
26-6-18cdb2	1.0	380	20
26-6-26da	1.0	320	....
26-8-13aa	1.1	900	....
26-8-32cb	1.2	350	21
26-9-4bba	1.1	490	....
26-10-5dd1	2.7	790	22
26-10-7abd	1.7	950	....

tion ratio and electrical conductivity of the water samples for which analyses are given in Table 5. Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. Medium-sodium water (S2) will present an appreciable sodium hazard in certain fine-textured soils, especially poorly leached ones. Such water may be

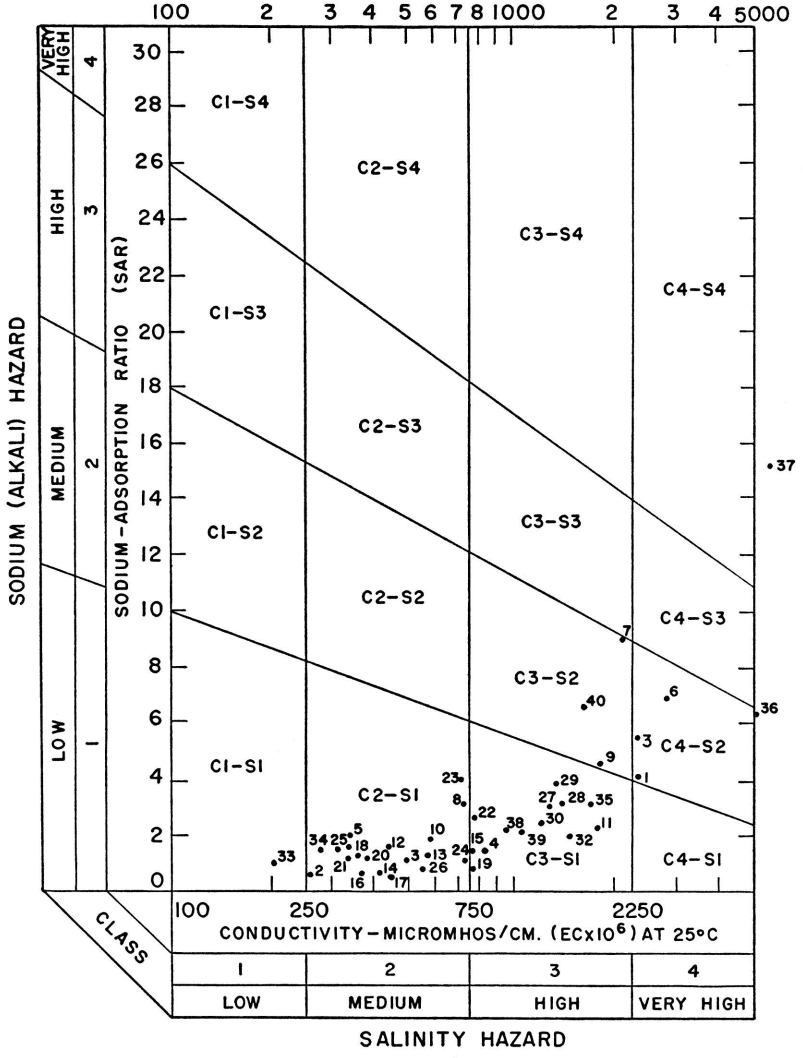

FIG. 22.—Diagram showing suitability of waters for irrigation.

used safely on coarse-textured or organic soils having good permeability. High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management such as good drainage and leaching and additional 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.

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 of restricted drainage. Very high salinity water (C4) is not suitable for irrigation under ordinary conditions. It can be used only on very salt tolerant crops and then only if special practices are followed, including a high degree of leaching.

Boron is essential to normal plant growth, but the quantity required is very small, and larger quantities are harmful. Crops vary greatly in their boron tolerance, but in general it may be said that the ordinary field crops common to Kansas are not adversely affected by boron concentrations of less than 1 part per million.

In water having high concentrations of bicarbonate, there is a tendency for calcium and magnesium to precipitate as the water in the soil becomes more concentrated. This reaction ordinarily does not go to completion, but insofar as it does proceed there is a reduction in the concentration of calcium and magnesium and therefore a relative increase in sodium. The calcium and magnesium are precipitated as the carbonates, and any residual carbonate or bicarbonate is left in solution as sodium carbonate. The potential amount of such "residual sodium carbonate" may be computed $(Na_2CO_3) = (CO_3^{--} + HCO_3^{-}) - (Ca^{++} + Mg^{++})$, where the ionic concentrations are expressed as milliequivalents per liter or equivalents per million.

On the basis of limited data and using the "residual sodium carbonate" concept described above, it is concluded by the Department of Agriculture that water having more than 2.5 equivalents per million (eq/m) or milliequivalents per liter (meq/1), of residual sodium carbonate is not suitable for irrigation purposes. Water containing 1.25 to 2.50 eq/m of residual sodium carbonate is marginal, and water containing less than 1.25 eq/m is safe.

In appraising the quality of an irrigation water, first consideration must be given to salinity and alkali hazards by reference to Figure 22. Then consideration should be given to independent characteristics such as boron and other toxic elements, and bicarbonate, any one of which may change the quality rating. The use of water of any quality must take into account such factors as drainage and management practices.

Sanitary Considerations

The analyses of water given in Table 5 show only the amounts of mineral matter in the water and do not, in general, indicate the sanitary quality of the water. An abnormal concentration of several constituents, such as more than a few parts per million of nitrate or a high concentration of chloride in an area in which the water is generally low in chloride, may indicate pollution of the water. Every precaution should be used to protect a water supply from pollution. A well should not be constructed near possible sources of pollution such as barnyards, privies, and cesspools. Every well should be sealed tightly for several feet below the surface. Dug wells are more likely to become polluted than drilled wells because of difficulty in sealing the well at the top. Drilled wells generally are properly sealed by a casing, but sometimes the casing itself is poorly sealed at the surface.

Quality of Water in Streams

In 1934 and 1935 a survey was made of the chloride content of the water of Arkansas River and its main tributaries from Great Bend to the confluence of Cow Creek and Arkansas River southeast of Hutchinson. Again in 1946 samples were collected at many of these same points (Fent, 1950), and in 1949 more samples were collected at some of the same locations. Although the analyses show a difference in the chloride concentration at the same points on the different dates of collection, a pattern seems to be established. The water in Arkansas River at Great Bend has a low chloride content and gains only a small amount of chloride as the river passes through the oilfields in western Rice County. Samples were taken at points on the river just above and below Rattlesnake Creek; the chloride content of the sample taken below the creek was double that of the sample taken above. Farther downstream, just below the mouth of Peace Creek, the chloride content increased again, and just below the sewer outlet at Hutchinson the chloride content increased still more. Below the confluence of

Cow Creek and Arkansas River the chloride content increased again. From this point to the east edge of Reno County, the chloride concentration remained about the same.

Samples were collected along Rattlesnake Creek in Stafford and Rice Counties to determine the source of the chloride in that stream. At a point just west of St. John the water is very low in chloride. The stream shows only a slight increase in chloride content above the oilfields in eastern Stafford County and no appreciable increase at a point just below the oil fields. At a point in Rice County about 2 miles east of the big marsh area in eastern Stafford County, the chloride concentration was about three times as high as at St. John. Samples were collected along Peace Creek in northwestern Reno County. Peace Creek flows nearly at right angles to the movement of the ground water from the marsh area in Stafford County. The chloride concentration in Peace Creek increases as the stream intercepts the ground water moving from the marshes. Cow Creek was sampled at a point just west of the Rice County line. The chloride content of the water at that point was moderately high. At a point just below the oilfields in northwestern Rice County the chloride content had decreased to about half the concentration at the county line. The chloride concentration continued to decrease in the stream to a point just below the salt plants at Lyons in Rice County, where an appreciable increase was noted. Below the salt plants the chloride concentration became progressively lower downstream to a point just below Hutchinson, where a large increase was noted.

The chloride content of Ninnescah River is about 250 parts per million throughout its course in the county. The chloride salts in Arkansas River and its tributaries are derived from the Permian shale in the marsh area of eastern Stafford County, as shown by the increase in chloride concentration in both Rattlesnake and Peace Creeks. Along upper Cow Creek the chloride is derived from the Cretaceous rocks. Downstream from the outcrop of the Cretaceous rocks the chloride concentration decreases except near Lyons, where a large increase occurs as the result of local contamination. The chloride content increases again below Hutchinson because of local contamination from the salt mines. The oilfields in this area seem to have little effect on the chloride concentration in the streams, as most of the oilfield wastes are injected into deep salt-water aquifers.

Pollution of Arkansas River and its tributaries in this area has been studied further by the Kansas State Board of Health (1954).

The Board of Health has concluded that: (1) The reach of Arkansas River from a point above Hutchinson to a point below Wichita is seriously polluted by brine from salt plants, by inadequately treated municipal sewage, and by organic industrial wastes. (2) Large quantities of brine from four salt plants are discharged into streams in the area. Two of these plants discharge into Cow Creek, one discharges into Salt Creek, and the other discharges into the Hutchinson industrial sewer, which empties into Arkansas River. (3) Appreciable quantities of oilfield brines are discharged into surface ponds. (4) Some of the municipal sewage-treatment plants are overloaded and sewage receives inadequate treatment. (5) None of the industries discharging process wastes into the river has adequate treatment facilities.

Until pollution is corrected there is little chance that further use can be made of Arkansas River water especially if the user requires fresh water. Chlorides and other pollutants make it unsatisfactory for use or make treatment prohibitively expensive.

There is a good possibility that if the quality of water in Arkansas River is improved it can be used in ground-water recharging projects at selected streamflows. This would permit storage for later use of much of the water now lost during higher streamflows. Improvement of quality of water in the streams should also eventually lead to an improvement in quality of water in the alluvium and low terrace deposits in the valley area.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING CHARACTERISTICS

PERMIAN SYSTEM

Leonardian Series

Permian rocks of Leonardian age are the oldest rocks exposed at the surface in Reno County. Included are the Wellington shale (not exposed), Ninnescah shale, Stone Corral dolomite, and Harper sandstone. These rocks are present in northeastern Reno County on the north side of Little Arkansas River, in the upland area of southeastern Reno County, and along Ninnescah River in south-central Reno County.

Wellington Shale

Although the Wellington shale does not crop out in Reno County, the formation underlies younger deposits in the county. Test holes in the Arkansas and Little Arkansas River valleys encountered the Wellington shale below Cenozoic deposits, and the formation underlies younger Permian and other deposits in upland areas in south-central Reno County.

The Wellington is composed chiefly of silty gray shale. The upper boundary of the formation is marked by the Milan limestone member, which is an impure limestone about 1 foot thick. The thick Hutchinson salt member lies about 300 feet below the top of the formation. The Carlton limestone member occurs a short distance below the Hutchinson salt member. Red and green shales predominate below the Carlton limestone member, and the Hollenberg limestone member lies about 35 feet above the base of the formation. The total thickness of the formation is about 700 feet. The Wellington shale yields no water to wells in Reno County.

Ninnescah Shale

The Ninnescah shale is the oldest formation exposed in the county. The formation is composed of alternating beds of red and light-gray shale, silty shale, and siltstone. Small veins of gypsum are present in a few exposures.

The Ninnescah shale conformably overlies the Wellington shale. The Ninnescah crops out in the northeastern and in the southeastern and south-central parts of the county, where erosion by small streams has resulted in dissected topography typical of the formation. The best exposures are found along the forks of Ninnescah River in Kingman and Reno Counties, from which stream the shale derives its name. The average thickness of the formation is about 280 feet in that area.

The Ninnescah shale furnishes water to domestic and stock wells in the area of its outcrop and in an area north of Ninnescah River in south-central Reno County. The formation yields water from the weathered part of the shale, from crevices in the shale, and from sandstones. Water from the Ninnescah shale generally is highly mineralized (Fig. 17).

Stone Corral Dolomite

The type locality of the Stone Corral dolomite is in sec. 11, T. 20 S., R. 6 W., Rice County, about 10 miles north of Reno County. The formation is composed of dolomite, gypsum, and anhydrite. On the outcrop the formation is about 6 feet thick, the lower part being massive and the upper part slabby. Solution of the gypsum and anhydrite has caused thinning along the outcrop; the formation thickens west of the outcrop. In Reno County the Stone Corral dolomite crops out along Ninnescah River in the south-central part of the county and in the northeastern part of the county.

The Stone Corral dolomite yields no water to wells in Reno County.

Harper Sandstone

The Harper sandstone conformably overlies the Stone Corral dolomite and is composed mainly of red siltstone and very fine grained silty sandstone. In south-central Kansas the average thickness of the formation is about 140 feet.

The Harper sandstone crops out in the south-central part of Reno County. The best exposures are in T. 25 S., R. 8 W., where the sandstone forms the hills along Ninnescah River.

In the area of outcrop the Harper sandstone yields small supplies of highly mineralized water to domestic and stock wells.

QUATERNARY SYSTEM

Pleistocene Series

The Pleistocene series in Kansas is divided into four main stages related to continental glaciation, and three main interglacial stages. Events in each of the periods of continental glaciation followed a cyclic repetition. Each of the cycles consists of a glacial and an interglacial interval or stage. The cycle in the marginal belt of a glaciated area is characterized by a period of downcutting in the valleys and some local deposition of sediments, followed by a period of deposition of coarser materials from outwash beyond the glacial limit, deposition of progressively finer-grained material as the glacier retreated, and finally the development of soil profiles over large areas where surface conditions were relatively stable.

Unconsolidated deposits of Pleistocene age unconformably overlie older deposits of Permian age in the greater part of Reno County. The deposits represent each of the four glacial stages.

Although deposits that represent all the glacial stages are present in Reno County and can be identified in the field and on logs of wells and test holes, it is difficult to map some of these units separately. On the geologic map (Pl. 1) deposits of the Meade formation and the Crete, Loveland, and Peorian members of the Sanborn formation are all mapped as the Sanborn formation undifferentiated, even though these units can be identified in isolated outcrops and in most of the test-hole logs. Figures 8-11 give additional information on the distribution of certain Pleistocene units in the county.

Blanco Formation–Nebraskan and Aftonian Stages

The Blanco formation is composed of the (lower) Holdrege sand and gravel member and the (upper) Fullerton silt member, and represents the Nebraskan stage of the Pleistocene in Reno County. The formation unconformably overlies Permian rocks. The topography of the Permian surface at the beginning of the Pleistocene was an area having little relief. In the downcutting period of the Nebraskan Stage, deep broad channels were cut into the Permian rocks. These channels were filled during the middle and later parts of the Nebraskan Stage of the Pleistocene with deposits of the Blanco formation.

Holdrege member.—Deposits of sand, gravel, and silt classified as the Holdrege member of the Blanco formation occur in deep buried channels in Reno County. One buried channel enters the area near the northwest corner of the county and trends nearly east halfway across the county, where it is joined by another buried channel from the north. From the junction of these two channels the main buried channel trends southeast and leaves the county at about the middle of the east county line. The deposits of sand and gravel range in texture from fine sand to coarse gravel and contain some silt and clay. A large part of the sand and gravel was derived from Cretaceous and Permian material. In southwestern Reno County another buried channel enters the area and trends eastward for a distance of about 10 miles and then turns south out of the county. Deposits in this channel are similar to those in the channels in northern Reno County. East of the point where the channel in southwestern Reno County trends south there is an area in which deposits of the Blanco formation crop out. These deposits lie at a higher elevation than the deposits in the channels, but consist of sand, gravel, and silt similar to the channel deposits. A few cobbles of quartzite are found, some as much as 6 inches in diameter. The Holdrege member ranges in thickness from a featheredge to as much as 110 feet.

The Holdrege member yields no water to wells in the channel areas. Large quantities of water are available, but the water is highly mineralized and not suitable for domestic or industrial use. The deposits of the Blanco formation that crop out in south-central Reno County yield water of good quality to wells. A graphic presentation of analysis of water from the principal water-bearing formations is shown in Figures 17 and 18, and the saturated thickness of the Pleistocene deposits is shown in Figure 23.

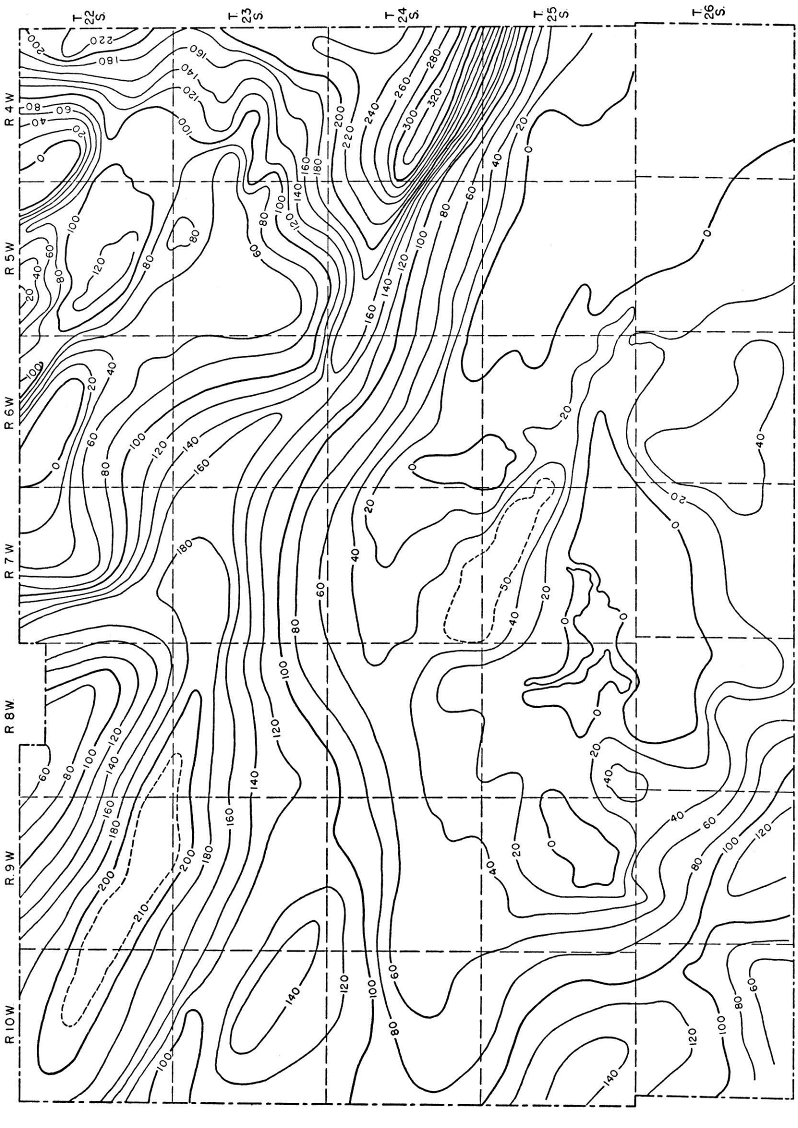

FIG. 23.—Map showing saturated thickness of Pleistocene deposits.

Fullerton member.—The Fullerton member of the Blanco formation overlies the Holdrege sand and gravel member. The Fullerton member is composed of tan alluvial silt. A zone of caliche accumulation found at many localities is suggestive of soil development during the Aftonian interglacial stage. Deposits of the Fullerton member ranging in thickness from 20 to 30 feet were penetrated in test holes in Reno County.

Wells do not produce water from the Fullerton member in Reno County, because the water is highly mineralized. Also, the Fullerton and the Holdrege members of the Blanco formation are overlain by younger Pleistocene deposits that yield large supplies of water of good quality to wells.

Meade Formation–Kansan and Yarmouthian Stages

The Meade formation in Reno County unconformably overlies the Blanco formation and Permian rocks. The formation is composed of a lower gravel member, the Grand Island member, corresponding to the late phase of Kansan glaciation, and an upper silt member, the Sappa member, corresponding to the latest Kansan phase of glaciation and in part to the Yarmouthian interglacial stage. The formation is classified as of late Kansan and Yarmouthian age.

Grand Island member.—The basal gravel member of the Meade formation, the Grand Island member, is composed of granitic gravels that were deposited over most of the area by eastward-flowing streams. The valleys of Kansan age are generally broader and less deeply cut than those of Nebraskan age. Some of the deposits of the Meade formation are made up of locally derived material. Such deposits are found in tributary channels that connect to the main trunk streams of Kansan age.

The gravel of the tributary channels is mainly composed of material derived locally from Permian rocks, but it includes many fragments of caliche. The gravel resembles the Holdrege member of the Blanco formation except for the pebbles of caliche in the Grand Island member, which probably were derived from the Fullerton member of the Blanco formation. The Grand Island member ranges in thickness from a featheredge on the uplands in the south-central part of the county to as much as 100 feet in some of the deep channels. The Grand Island member in the uplands was deposited by a laterally shifting stream or streams flowing from the west.

Many wells in Reno County obtain water from the Grand Island member. The water is very hard in some areas and varies in quality from good to fair. Locally the water has been contaminated and is not suitable for use.

Sappa member.—The Grand Island member of the Meade formation grades upward into the Sappa member, composed of sand, sandy silt, and silt. A lentil of volcanic ash known as the Pearlette ash is found in the lower part of the Sappa member. The Pearlette ash is present over an area extending from Iowa to Texas and is useful in identifying the Sappa member. The silt of the Sappa member is gray to tan or buff and contains many nodules of caliche in the upper part. The member ranges in thickness from a featheredge to 40 feet. The thickness is difficult to determine in much of the area because the Sappa member is overlain by the Loveland silt member of the Sanborn formation, which resembles the Sappa member very closely. During the Yarmouthian interglacial stage, a prominent soil was formed at the top of the Sappa member. This soil (Yarmouth soil) is overlain by younger eolian deposits in much of the area and is useful in identifying the upper limit of Kansan deposits. The Sappa member yields no water to wells in Reno County.

Sanborn Formation

Crete sand and gravel member—Illinoian Stage.—Sand and gravel assigned to the Crete sand and gravel member of the Sanborn formation are present in much of the western part of Reno County. These deposits have been observed above the Pearlette ash lentil of the Meade formation and below the Sangamon soil, which was developed at the top of the Loveland silt member. The Crete sand and gravel member ranges in thickness from a featheredge at the eastern edge of the deposit to as much as 40 feet in western Reno County. In part of the area the deposits are above the water table. In areas where the Crete sand and gravel member is below the water table, abundant supplies of water of good quality may be obtained.

Loveland silt member—Illinoian Stage.—Silts and clays of the Loveland silt member are present in north-central Reno County. The deposits range in thickness from a featheredge to as much as 15 feet. Thin deposits of the Loveland silt member are present in central Reno County and probably in much of the rest of the county, but where the member lies above the Sappa member of the Meade formation and where the Yarmouth soil is not present or at least is not exposed, the Loveland silt member cannot be distinguished easily from silts of the Sappa member. The Loveland silt member in Reno County is above the water table and yields no water to wells.

Terrace deposits—Wisconsinan Stage.—Terrace deposits classed as of Wisconsinan age are present in the major stream valleys in Reno County. These deposits probably represent the valley cutting and filling subphases of both early and late Wisconsinan glaciation. The terrace deposits are composed of sand, gravel, and silt, and small amounts of clay. They occupy the greater part of the valley area of the major streams and in Reno County are the principal sources of ground water. The deposits range in thickness from a featheredge along the sides of the valleys to as much as 130 feet in the valley of Arkansas River near Hutchinson. The city of Hutchinson derives water from these deposits, as do many industrial users of water. The relatively smooth topography of the terrace areas is ideal for irrigation. The water from these deposits is hard but suitable for irrigation.

Peoria silt member—Wisconsinan Stage.—The Peoria silt member of the Sanborn formation represents the retreat phase of the glacial cycle. In Reno County thin deposits of the Peoria silt member overlie the Loveland silt member in the northern part of the county and probably mantle much of the county, but the member is not recognized easily. A period of soil formation took place after the deposition of the Peoria silt member. This period, named the Bradyan substage, was an interglacial phase of the glacial cycle. The Peoria silt member where present ranges in thickness from a featheredge to as much as 15 feet, lies above the water table, and yields no water to wells in Reno County.

Dune Sand—Wisconsinan and Recent Stages

Most of the western third of Reno County and the area between Arkansas River and Little Arkansas River are underlain by dune sand. The dune sand consists of uniform fine and medium sand, moderately well rounded, and, in some areas, includes silt and clay.

Two types of dune topography are recognized in Reno County. One type consists of moderately steep, irregular grass-covered hills surrounding shallow undrained basins. This type of topography is found mainly in the area between Arkansas River and Little Arkansas River and in small areas in the extreme western part of the county. The second type of dune topography consists of broader, lower swells and swales having a thicker soil; some of these areas have a rudimentary drainage.

Smith (1940, p. 159-165) described an ideal dune cycle of two phases: (1) an active or eolian phase during which the dune is built up, and (2) an elluvial or passive phase during which vegetation prevents more growth and the dune is subdued by weathering and creep. Smith divides the passive phase into three stages: youth, maturity, and old age. In the youthful stage the soil is developed and slopes are reduced; in the mature stage the dune becomes smooth and regular and the soil becomes more stable; and in old age the hills are no longer recognizable as dunes.

Most of the dunes in Reno County are in the passive phase, although a few dunes are in the eolian or active phase. Dunes in all stages of the passive phase are present in the county. The dunes in the area between Arkansas River and Little Arkansas River are mostly in the yougthful stage, as are those in the northwestern part of the county. Boundaries between the different stages of dune sand are indistinct, as are the boundaries between the dune sand and older formations.

The thickness of the dune sand in Reno County ranges from a featheredge to as much as 120 feet.

In areas where the dune sand is not above the water table, wells obtain moderate supplies of water, the quality of which is good except that the iron content may be high (Table 5).

Alluvium—Wisconsinan and Recent Stages

Alluvium underlies the flood plain or inner valley of Arkansas River, Little Arkansas River, Ninnescah River, and Cow Creek in Reno County.

In the Arkansas River valley and the lower Cow Creek valley the alluvium occupies channels cut into deposits of the Meade formation and terrace deposits of Wisconsinan age. The alluvium is similar to these deposits, as most of it is derived from them. It consists predominantly of coarse sand and gravel. Because of the similarity of the unconsolidated deposits in the valleys, their separation is difficult without fossil evidence. The unconsolidated deposits in the valleys of Little Arkansas River and Ninnescah River are of Recent age and, possibly, in part of Late Wisconsinan age and range in thickness from a featheredge to as much as 60 feet.

Many domestic and stock wells in Reno County obtain water from the alluvium. The water differs in quality from valley to valley, but generally it is hard. Nickerson is the only city in the county that obtains its water from alluvium. The water at Nickerson is very hard. The water from the alluvium in the Arkansas River valley and the Cow Creek valley is very hard and in some areas salty to the taste. The water is of poor quality and is generally undesirable for most municipal and industrial uses. The alluvial material in the Little Arkansas River valley is finer than that of the Arkansas River valley and the quality of the water is better than in the Arkansas River valley. In the Ninnescah River valley supplies of water are limited by the thinness of the alluvium, and the quality ranges from fair to poor.

POSSIBILITIES OF DEVELOPING ADDITIONAL WATER SUPPLIES

Ground-water supplies could be developed in much of Reno County for industrial and irrigation purposes. The potentialities for use of water for irrigation depend to a large extent on the topography, the type of soil to be irrigated, and the quality of water. Much of Reno County is not suitable for irrigation because of the local topography or the type of soil. The western third of the county is covered by sand dunes not suitable for irrigation except that dunes of the old-age stage in the alluvial phase and possibly some of the dunes in the mature stage might be irrigated by sprinklers. Much of the Arkansas River valley is level and suitable for irrigation, but there the soil in many places is not suitable, and the ground water has a high concentration of sodium. Large supplies of ground water could be developed in the Arkansas River valley for industrial uses, but the quality is poor; the chloride content and hardness are generally high.

Except in the terrace area at the foot of the sandhills, industrial or irrigation supplies of water generally cannot be obtained in most of the northeastern part of the county in the sandhill area. Gardens and orchards on the Wisconsinan terraces are irrigated to some extent. Many industrial wells in the east part of Hutchinson are in the terrace area. In the future, wells should be properly spaced to minimize lowering of the water table and induced infiltration of poor-quality water from the alluvium of Arkansas River south of the sandhills. Additional wells yielding 300 to 500 gallons a minute could be developed in these terrace deposits with proper spacing.

Water of good quality is found in the uplands just south of Arkansas River. Two wells at the Hutchinson Naval Air Station southeast of Hutchinson, in the eastern part of the county were both pumped at a rate of 365 gallons a minute for 21 hours with 15 feet of drawdown. With proper spacing, many wells having yields of 300 to 500 gallons a minute can be developed in this area. The quality of the water is good. The chloride content and hardness are low. Because the thickness of the water-bearing material diminishes southward (Fig. 23), a test-drilling program should precede the drilling of large-capacity wells.

RECORDS OF WELLS

Information pertaining to 241 wells in Reno County is tabulated in the following pages (Table 11). The well-numbering system used in this report is described on page 9.

TABLE 11.—*Records of wells and springs in Reno County*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
	T. 21 S., R. 5 W.															
21-5-33dc	SW¼SE¼ sec. 33	W. E. Dilley	B	12.5	6	GI	Sand, gravel	Alluvium	N	N	Top of casing	0.0	1511.9	7.76	8-22-49	
	T. 22 S., R. 4 W.															
22-4-2aac	SW¼NE¼NE¼ sec. 2	Mutual Benefit Assn.	Dr	53.0	6	GI	do	Meade formation	J, E	D, S	Board cover over pit	0.1	1460.5	22.34	7-28-49	
*22-4-4aad	SE¼NE¼NE¼ sec. 4	J. B. Schroeder	Dr	33.0	6	GI	do	do	Cy, H	D	Base of pump	0.4	1460.9	7.98	7-28-49	
22-4-6dd	SE¼SE¼ sec. 6	Friecen	Dr	78.0	6	GI	do	do	J, E	D, S	Top of casing	0.6	1535.0	49.60	7-29-49	
*22-4-7ccd	SW¼SW¼ sec. 7	J. M. Kiazer	Du	54.0	28	R	Gravel, shale	Meade formation Ninnescah shale	Cy,H,W	D, S	Top of concrete curb	0.7	1497.2	29.00	7-29-49	
*22-4-12dd1	SE¼SE¼ sec. 12	City of Buhler	Dr	98.0	48	C	Sand, gravel	Meade formation	T, E	P	Ground surface	0.0		11.2	7-28-49	7.7 drawdown, 269 gpm
22-4-12dd2	SE¼SE¼ sec. 12	do	Dr	88.0	48	C	do	do	T, E	P	do	0.0		11.6	7-28-49	2.0 drawdown, 201 gpm
22-4-13aa	NE¼NE¼ sec. 13	A. T. Reimer	Dr	65.0	8	T	do	do	Cy, W	S	Top of casing	1.0	1443.5	17.61	7-28-49	
*22-4-14dda	NE¼SE¼SE¼ sec. 14		Dr	37.0	6	GI	do	do	Cy, W	S	do	0.7	1453.3	31.98	7-28-49	
22-4-15bb	NW¼NW¼ sec. 15	P. B. Froese	Dr	55.0	6	GI	Gravel	do	Cy, W	D, S	Ground surface	0.0	1469.9	27.0	7-28-49	
22-4-16bca	NE¼SE¼NW¼ sec. 16	H. T. Esau	Dr	76.7	6	GI	Sandy shale	Ninnescah shale	Cy, W	D	Top of casing	0.7	1482.3	27.96	7-28-49	
22-4-21cb	NW¼SW¼ sec. 21	H. D. Ratzliff	Dr	29.0	12	T	Sand, gravel	Alluvium	L, H	D	Top of platform	1.0	1462.9	9.76	7-29-49	
*22-4-25ad	SE¼NE¼ sec. 25	P. J. Penner	Dr	135.0	6	GP	do	Meade formation	J, E	D, S	Top of concrete platform	0.2	1454.7	24.48	8- 3-49	
22-4-26bb	NW¼NW¼ sec. 26		Dr	36.0	6	GI	do	do	Cy, H	S	Base of pump	1.0	1458.9	14.24	8- 3-49	
*22-4-28cb	NW¼SW¼ sec. 28	H. Unruh	B	20.0	10	T	do	do	B	D, S	Top of casing	1.7	1470.0	5.33	7-29-49	
22-4-31cdc	SW¼SE¼SW¼ sec. 31	Joe Floydd	B	14.0	8	GI	do	do	N	N	do	1.1	1559.2	7.14	8- 3-49	
*22-4-34cb	NW¼SW¼ sec. 34	H. J. Voth	B	42.0	10	T	Coarse sand	do	J, E	D, S	Base of pump	0.7	1468.6	9.24	8- 3-49	
	T. 22 S., R. 5 W.															
22-5-1ba	NE¼NW¼ sec. 1		Dr	75.0	6	GI	Shale	Ninnescah shale	J, E	D, S	Base of pump	0.8	1524.6	27.30	7-29-49	

22-5-2bb	NW¼NW¼ sec. 2	....	Du,B	32.0	5	GI	Sand, gravel	Meade formation and Alluvium	Cy, W	D, S	Top of concrete platform	0.0	1493.1	13.80	6-12-49
*22-5-3aad	SE¼NE¼NE¼ sec. 3	....	B	18.0	6	GI	do	Alluvium	Cy, H	D, S	Top of casing	1.4	1483.8	5.03	7-29-49
*22-5-5cd	SE¼SW¼ sec. 5	G. W. Zent	B	24.5	6	GI	do	Meade formation and dune sand	Cy, H	S	do	1.0	1552.9	5.72	8- 2-49
*22-5-11cb	NW¼SW¼ sec. 11	O. E. Boyle	Dr	26.0	6	GI	do	Alluvium	Cy, H	S	do	1.8	1482.9	4.70	7-29-49
22-5-12bad	SE¼NE¼NW¼ sec. 12	....	Dr	100	10	GI	Shale	Ninnescah shale	Cy, H	S	do	0.0	1520.2	40.40	6-12-49
22-5-18bb	NW¼NW¼ sec. 18	....	B	18.9	1¼	GP	Sand, gravel	Dune sand and Meade formation	P, H	D	Ground surface	0.0	1635.1	4.72	9-17-49
22-5-20aa	NE¼NE¼ sec. 20	....	Du	10.7	24	C	do	do	P, H	D, S	do	0.0	1605.2	4.52	9-20-49
*22-5-20cc	SW¼SW¼ sec. 20	C. A. Perry	Dr	46.0	5½	S	do	do	Cy, W	D, S	Top of casing	1.5	1635.6	18.10	8- 2-49
22-5-22bba	NE¼NW¼NW¼ sec.22	....	Dr	30.0	6	S	do	do	Cy, W	S	Ground surface	0.0	1551.9	7.38	9-20-49
*22-5-27dc	SW¼SE¼ sec. 27	A. I. Jackson	Dr	35.8	6	GI	do	do	Cy, W	D, S	Top of casing	0.0	1619.9	16.58	9-20-49
*22-5-28bb	NW¼NW¼ sec. 28	Eli Hochstetler	Dr	34.8	8	GI	do	do	Cy, E	D, S	do	0.2	1630.2	13.90	9-20-49
22-5-31cb	NW¼SW¼ sec. 31	....	Dr	29.8	12	GI	do	Wisconsinan terrace deposits	C, G	I	do	0.8	1541.4	10.08	9-17-49
*22-5-33cb	NW¼SW¼ sec. 33	W. Falkenrich	Dr	16.7	6	GI	do	Dune sand and Meade formation	Cy, H	D, S	Ground surface	0.0	1576.9	6.23	9-20-49
*22-5-34cc	SW¼SW¼ sec. 34	E.M. Dunsworth	Dr	26.5	6	GI	do	do	Cy, G	S	Top of concrete curb	0.8	1589.0	7.80	9-20-49
*22-5-36cb	NW¼SW¼ sec. 36	....	B	10.4	10	T	do	do	Cy, W	S	Ground surface	0.0	1582.1	4.96	9-20-49
	T. 22 S., R. 6 W.														
*22-6-9dcd	SE¼SW¼SE¼ sec. 9	Wm. Hedges	Dr	29.5	6	GI	do	Wisconsinan terrace deposits	Cy, W	S	Ground surface	0.0	1588.4	19.11	9-16-49
22-6-14ada	NE¼SE¼NE¼ sec. 19	L. D. White	Dr	33.7	8	GI	do	Dune sand and Meade formation	Cy, W	S	Top of concrete base	0.2	1627.4	16.98	9-16-49
22-6-20ba	NE¼NW¼ sec. 20	C. L. Burt	Dr	24.0	6	GI	do	Wisconsinan terrace deposits	C, E	D,S	Ground surface	0.8	1569.1	6.97	9-16-49
22-6-27bb	NW¼NW¼ sec. 27	....	Dn	23.0	1¼	GP	do	do	P, H	D	Lower pump valve	2.0	1561.3	8.86	9-16-49
22-6-29cba	NE¼NW¼SW¼ sec. 29	....	B	12.0	¾	GP	do	do	N	O	Top of pipe	0.4	1565.6	4.84	7-19-49
22-6-34ad	SE¼NE¼ sec. 34	J. V. Nelson	B	29.3	8	GI	do	do	F, E	D	Ground surface	0.0	1549.2	9.96	9-20-49
	T. 22 S., R. 7 W.														
22-7-1dd	SE¼SE¼ sec. 1	....	B	10.5	¾	GP	do	do	N	O	Top of pipe	0.3	1579.8	6.43	9-16-49
22-7-4ad	SE¼NE¼ sec. 4	M. Gregg	Dn	20.9	1¼	GP	do	do	P, H	D, S	Lower check valve	2.7	1593.5	9.75	9-29-49
22-7-10cca	NE¼SW¼SW¼ sec. 10	Buell Motor Co.	Dn	28.0	1¼	GP	do	do	P, H	O	do	2.0	1593.8	6.50	9-24-49
*22-7-15bb*1*	NW¼NW¼ sec. 15	City of Nickerson	Dr	40	......	OW	do	do	T, E	P	....	......	......	......	11- 6-49
22-7-15bb*2*	NW¼NW¼ sec. 15	do	Dr	40	......	OW	do	do	T, E	P	....	......	......	......	11- 6-49
22-7-20cdc	SW¼SE¼SW¼ sec. 20	W. S. McGongle	DD	65.0	36.6	R,GI	do	Dune sand and Meade formation	J, E	D, S	Top of cover over pit	0.1	1628.2	25.80	9-30-49
22-7-22cc	SW¼SW¼ sec. 22	R. V. Olmstead	Dn	21.0	1¼	GP	do	Wisconsinan terrace deposits	P, H	D, S	Top of pump lip	3.3	1584.1	8.65	9-30-49

TABLE 11.—*Records of wells and springs in Reno County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
	T. 22 S., R. 8 W.															
*22-8-11ccd...	SE¼SW¼SW¼ sec. 11	J. F. Justus.....	DD	90.0	48.6	C,GI	Sand, gravel..	Dune sand and Meade formation	Cy, H	D, S	Top of platform	0.2	1678.2	49.50	9-29-49	
22-8-16bb...	NW¼NW¼ sec. 16...	A. E. Snook....	Dr	72.0	10	GI	do..........	do............	Cy, H	O	Top of concrete platform.....	0.2	1697.0	45.41	9-15-49	
*22-8-19cc....	SW¼SW¼ sec. 19....	R. J. Rupp.....	Dr	50.0	6	GI	do..........	do............	J, E	D, S	Top of concrete curb.........	0.3	1709.6	31.23	9-29-49	
22-8-22cb...	NW¼SW¼ sec. 22....	W. D. Magoffin	Dr	59.0	8	GI	do..........	do............	Cy, H	D, S	Top of casing...	0.2	1679.4	23.66	9-29-49	
*22-8-33ccd..	SE¼SW¼SW¼ sec. 33	....	Dr	27.2	6	GI	do..........	do............	Cy, H	S	do............	0.6	1658.8	7.26	9-28-49	
*22-8-34ad...	SE¼NE¼ sec. 34.....	E. Wickley.....	DD	51.0	6	GI	do..........	do............	C, E	D, S	do............	-9.0	1655.8	10.22	9-29-49	
	T. 22 S., R. 9 W.															
22-9-1aad...	NE¼NE¼ sec. 1.....	P.E. Leatherman	Dn	28.0	1¼	GP	do..........	do............	C, E	D, S	Land surface....	0.0	1660.2	12.0	9-29-49	
*22-9-7bba...	NE¼NW¼NW¼ sec. 7	F. W. Drake....	Dr	38.5	6	GI	do..........	do............	J, E	D, S	Base of pump...	-5.3	1745.1	17.20	11-17-49	
*22-9-12dd...	SE¼SE¼ sec. 12.....	Jack Stubbs....	Dr	52.0	6	GI	do..........	do............	J, E	D, S	Land surface....	0.0	1679.5	24.0	9-29-49	
22-9-16bb...	NW¼NW¼ sec. 16...	....	Dr	35.0	6	GI	do..........	do............	Cy, H	D	Top of casing...	0.5	1727.8	8.56	11-16-49	
*22-9-30aad..	NE¼NE¼SE¼ sec. 30	F. E. Leslie.....	Dr	35.0	6	GI	do..........	do............	J, E	D, S	do............	0.0	1736.2	10.1	11-16-49	
22-9-35abd..	SE¼NW¼NE¼ sec. 35	....	Dn	65.8	1¼	GP	do..........	do............	N	N	Ground surface..	0.0	1707.8	9.82	11-16-49	
	T. 22 S., R. 10 W.															
*22-10-7dcd..	SE¼SW¼SE¼ sec. 7...	Lilly Starr......	Dr	18.0	6	GI	do..........	Dune sand.....	Cy, W	S	Top of well curb	0.2	1764.8	5.80	9-14-49	
*22-10-10aa...	NE¼NE¼ sec. 10....	....	B	8.0	3	......	do..........	do............	N	O	Ground surface..	0.0	1739.8	3.60	11-17-49	
*22-10-29cb...	SW¼NW¼ sec. 29....	....	Dn	18.0	1¼	GP	do..........	do............	P, H	D	....	......	....	....	4-22-50	
*22-10-35cd...	SW¼SE¼ sec. 35.....	....	B	26.0	6	GI	do..........	do............	J, E	D	....	......	....	....	4-27-50	
	T. 23 S., R. 3 W.															
23-3-19dc...	SW¼SE¼ sec. 19.....	....	B	28.0	6	GI	do..........	Wisconsinan terrace deposits	N	O	Top of casing...	1.1	1459.3	8.86	8- 4-49	
	T. 23 S., R. 4 W.															
*23-4-1aab...	NE¼NE¼NW¼ sec. 1	....	Dr	30.0	6	GI	do..........	Dune sand and Meade formation	Cy, W	D	....	......	....	....	4-26-50	

*23-4-7cc.....	SW¼SW¼ sec. 7.....	....	Dn	20	1¼	GP	do..........	do............	P, H	D	Lower check valve........	2.3	1556.1	8.35	8- 3-49	
*23-4-11dab..	NW¼NE¼SE¼ sec. 11	Barnsdall Oil Co.	B	35.0	6	GI	do..........	do............	Cy, E	D	Top of casing...	0.3	1488.1	13.38	8- 4-49	
*23-4-12bb...	NW¼NW¼ sec. 12...	....	B	25.0	6	GI	do..........	do............	Cy, H	D, S	....	.....	....	....	4-26-50	
*23-4-13ad...	NE¼SE¼ sec. 13.....	....	B	22.0	6	GI	do..........	do............	J, E	D, S	....	.....	....	....	4-26-50	
23-4-16bb...	NW¼NW¼ sec. 16...	R. F. Jones.....	B	32.0	6	GI	do..........	do............	Cy, H	S	Top of casing...	0.8	1572.4	11.10	8- 3-49	
*23-4-19cc....	SW¼SW¼ sec. 19....	S. A. Miller.....	B	12.0	1¼	GP	do..........	Wisconsinan terrace deposits	P, H	S	Ground surface..	0.0	1494.5	5.81	9-20-49	
*23-4-21ccb..	NW¼SW¼SW¼ sec. 21	J. E. Luker.....	Dn	16.0	1¼	GP	do..........	do............	P, H	S	Top of pipe coupling......	0.5	1484.3	5.40	8- 5-49	
*23-4-22ad...	SE¼NE¼ sec. 22.....	T. W. Curless...	Dn	16.0	1½	GP	do..........	do............	P, H	D, S	Lower check valve........	2.1	1470.5	6.16	8- 5-49	
*23-4-24ad...	SE¼NE¼ sec. 24.....	J. D. Saiben....	Dn	21.0	1¼	GP	do..........	do............	P, H	S	do............	2.2	1463.1	9.87	8- 4-49	
23-4-28bb...	NW¼NW¼ sec. 28...	....	B	10.5	¾	GP	do..........	do............	N	O	Top of pipe.....	0.7	1481.7	3.33	7-17-49	
*23-4-35aac...	SW¼NE¼NE¼ sec. 35	L. Kiebel.......	B	29.0	2	GP	do..........	do............	N	N	do............	0.0	1464.1	5.24	8- 4-49	
	T. 23 S., R. 5 W.															
*23-5-2dca...	NE¼SW¼SE¼ sec. 2..	....	B	21.0	8	GI	do..........	Dune sand and Meade formation	Cy, H	D, S	Ground surface..	0.0	1589.1	6.25	9-20-49	
*23-5-4bbd...	SE¼NW¼NW¼ sec. 4	A. T. and S. F. Railroad.....	Dr	40.5	10	I	do..........	Wisconsinan terrace deposits	T, E	In	do............	0.0	....	19.0	8- 3-49	2.5 drawdown, 215 gpm
23-5-4cda...	NE¼SE¼SW¼ sec. 4..	Kansas Power and Light Co.	Du	55.0	24	C	do..........	do............	N	In	Top of concrete casing........	3.4	1523.3	14.80	10-27-49	
*23-5-8aa....	NE¼NE¼ sec. 8.....	Central Fiber Products Co.	Dr	68	18	I	do..........	do............	T, E	In	Ground surface..	0.0	1528.1	23.21	9-20-49	
23-5-11cc....	SW¼W¼ sec. 11.....	Obee Grocery...	B	19.0	6	GI	do..........	do............	N	N	Top of casing...	1.0	1510.8	8.64	9-22-49	
23-5-17ba...	NE¼NW¼ sec. 17....	Hutchinson Water Co.....	Dr	59	25	C	do..........	do............	T, E	P	Ground surface..	0.0	....	14.8	....	15 drawdown, 2000 gpm
23-5-17bbc..	SW¼NW¼NW¼ sec.17	do............	Dr	....	25	C	do..........	do............	C, E	P	....	.....	....	....	....	
*23-5-18bcd..	SW¼SE¼NW¼ sec. 18	do............	Dr	80.0	25	C	do..........	do............	T, E	P	....	.....	....	....	....	1500 gpm
*23-5-20aa...	NE¼NE¼ sec. 20....	Fred Smith.....	Dr	19.6	1¼	GP	do..........	do............	P, H	S	Ground surface..	0.0	1519.0	12.38	9-20-49	
23-5-23dc...	SW¼SE¼ sec. 23.....	....	Dn	15.4	1¼	GP	do..........	do............	P, H	D	do............	0.0	1500.8	6.94	9-20-49	
23-5-26ba...	NE¼NW¼ sec. 26....	Tennant Drilling Co...	Dr	54.0	8	OW	do..........	do............	C, G	In	Top of casing...	0.3	1499.6	6.06	9-20-49	
*23-5-27bb...	NW¼NW¼ sec. 27...	R. Rayl........	Dn	24.2	1¼	GP	do..........	do............	P, H	D	Ground surface..	0.0	1515.1	12.87	9-20-49	
*23-5-30aa...	NE¼NE¼ sec. 30....	Gardner........	B	15.8	6	GI	do..........	Wisconsinan....	C, E	D	do............	0.0	1515.6	5.86	9-22-49	
	T. 23 S., R. 6 W.															
23-6-1bdc...	SW¼SE¼NW¼ sec. 1	Hutchinson Water Co.....	Dr	65.5	25	C	do..........	Wisconsinan terrace deposits	T, E	P	....	.....	....	....	....	14.7 drawdown, 2000 gpm
*23-6-2cc.....	SW¼SW¼ sec. 2.....	....	B	19.7	8	GI	do..........	Alluvium.......	P, H	S	Top of casing...	0.2	1537.9	7.59	10- 3-49	
23-6-8bbc...	SW¼NW¼NW¼ sec. 8	J. Duffin.......	B	23.5	12	GI	do..........	do............	N	N	do............	0.0	1550.8	5.65	9-21-49	
23-6-9ab....	NW¼NE¼ sec. 9.....	Emil Scheuchzer	Dr	18.2	8	GI	do..........	do............	N	N	Ground surface..	0.0	1548.4	7.37	9-20-49	

TABLE 11.—*Records of wells and springs in Reno County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
	T. 23 S., R. 6 W.															
*23-6-12ad	SE¼NE¼ sec. 12	Hutchinson Water Co.	Dr	58	25	C	Sand, gravel	Wisconsinan terrace deposits	C, E	P						1000 gpm
*23-6-12bbd	NW¼NW¼ sec. 12	do.	Dr	60	25	C	do.	do.	C, E	P						1500 gpm
*23-6-12cc	SW¼SW¼ sec. 12	do.	Dr	65	25	C	do.	Alluvium	T, E	P						1500 gpm
*23-6-12cd	SE¼SW¼ sec. 12	do.	Dr	73	25	C	do.	do.	T, E	P			1531.9			1500 gpm
23-6-12ddc	SW¼SW¼SE¼ sec. 12	do.	Dr	25	1¼	GP	do.	Wisconsinan terrace deposits	N	O	Top of pipe	0.0	1531.9	16.65	10- 3-49	
23-6-13aa	NE¼NE¼ sec. 13	Kansas Power and Light Co.	Dr	51.5	24	Bs	do.	do.	T, E	In						
*23-6-14bd	SE¼SW¼ sec. 14		Dn	21.0	1¼	GP	do.	Alluvium	P, H	S	Ground surface	0.0	1536.1	12.02	9-20-49	
23-6-15bbc	SW¼NW¼NW¼ sec. 15	Claud Paulk	B	21.2	10	GI	do.	do.	C, G	I	Top of casing	0.9	1541.2	7.10	9-20-49	
23-6-29aab	NW¼NE¼NE¼ sec. 29	H. S. Ponsler	Dr	56.0	6	GI	do.	Meade formation	Cy, H	D, S	Ground surface	0.0	1587.7	36.0	9-21-49	
23-6-35cbc	SW¼NW¼SW¼ sec. 35	Joy Mfg. Co.	Dr	167.0	1½	GP	do.	do.	N	N	Top of pipe	1.8	1550.1	22.74	9-22-49	
	T. 23 S., R. 7 W.															
*23-7-2ad	NE¼SE¼ sec. 2		Dr	20.8	6	GI	do.	Wisconsinan terrace deposits	J, E	D, S					4-28-50	
*23-7-6aab	NW¼NE¼NE¼ sec. 6	C. Calais	Dn	34.5	1¼	GP	do.	Dune sand and Meade formation	Cy, H	D, S	Top of concrete floor	0.2	1622.7	14.73	9-30-49	
*23-7-13ab	NE¼NW¼ sec. 13	D. G. Wilden	Dr	56.9	6	GI	do.	Meade formation	J, E	D, S	Top of concrete curb	0.1	1601.2	44.74	9-28-49	
*23-7-15bb	NW¼NW¼ sec. 15	C. H. Katterhorn	Dn	25.8	1¼	GP	do.	do.	P, H	D	Lower pump valve	2.2	1588.7	6.06	9-16-49	
*23-7-17bbc	SW¼SE¼SE¼ sec. 17	Schuman	Dr	45.0	8	GI	do.	Dune sand and Meade formation	N	I	Top of casing	0.5	1615.7	10.80	9-16-49	
*23-7-18dc	SW¼SE¼ sec. 18		Dn	26.0	1¼	GP	do.	do.							4-26-50	
*23-7-22ba	NE¼NW¼ sec. 22		B,Dn	18.0	6-1¼	GI,GP	do.	Meade formation	L	D, S					4-28-50	
23-7-23dcd	SE¼SW¼SE¼ sec. 23	O. M. Kent	Dr	51.0	6	GI	do.	do.	N	N	Top of casing	0.6	1608.5	45.86	10- 1-49	
*23-7-28dd	SE¼SE¼ sec. 28	Elvon Helmuth	Dr	57.0	6	GI	do.	do.	N	N	do.	0.2	1619.4	41.10	9-21-49	
*23-7-30cc	SW¼SW¼ sec. 30		B	30.0	6	GI	do.	do.	J, E	D					4-27-50	
*23-7-30dd	SE¼SE¼ sec. 30	G. A. Russell	Dr	22.7	6	GI	do.	do.	J, E	D	Ground surface	0.0	1603.9	9.50	9-30-49	

	T. 23 S., R. 8 W.														
*23-8-6bb	NW¼NW¼; ec. 6		Dr	36.0	6	GI	do.	Dune sand and Meade formation	Cy, H	S	Top of wood platform	0.5	1684.9	10.10	9-15-49
23-8-10dd	SE¼SE¼ sec. 10		Dn	31.0	1¼	GP	do.	do.	P, H	N	Lower check valve	2.3	1635.7	10.50	9-28-49
*23-8-18cc	SW¼SW¼ sec. 18	Loyd Kueck	Dn	38.0	1¼	GP	do.	do.	Cy, W	D, S	Ground surface	0.0	1690.1	28.60	10-22-49
23-8-22ddc	SW¼SE¼SE¼ sec. 22	A. C. Dunn	Dn	25.2	1¼	GP	do.	Meade formation	N	N	Top of concrete foundation	0.2	1643.5	15.58	9-30-49
*23-8-27dd	SE¼SE¼ sec. 27		Dr	22.0	6	GI	do.	do.	J, E	D					4-27-50
*23-8-33dad	SE¼NE¼SE¼ sec. 33	D. D. Conroy	Dr	50	6	GI	do.	do.	J, E	D	Top of concrete floor	0.5	1651.6	12.50	10-11-49
*23-8-36cc	SW¼SW¼ sec. 36		Dr	28.0	6	GI	do.	do.	Cy, W	S					2-27-50
	T. 23 S., R. 9 W.														
23-9-4cd	SW¼SE¼ sec. 4	E. A. Hill	Dr	60	6	GI	do.	Dune sand and Meade formation	Cy, W	S	Top of concrete curb	0.4	1738.6	15.70	10-21-49
*23-9-6aa	NE¼NE¼ sec. 6		Dr	47.0	8	OW	do.	do.	Cy, H	N	Top of casing	0.0	1737.3	4.75	6-17-49
23-9-16dd	SE¼SE¼ sec. 16	M. C. Roberts	Dn	16	1¼	GP	do.	Dune sand and Crete member of Sanborn formation	Cy, H	D, S	Top of pump	3.0	1733.2	10.50	10-22-49
*23-9-18ba	NE¼NW¼ sec. 18	H. Withroder	Dr	77.5	10	OW	do.	Crete member of Sanborn formation and Meade formation	Cy, E	D, S	Top of casing	0.2	1749.8	11.80	10-21-49
23-9-22ba	NE¼NW¼ sec. 22	Veder Drilling Co.	Dr	125.0	7	OW	do.	do.	Cy, G	In	do.	0.3	1730.0	10.11	11-21-49
*23-9-26cc	SW¼SW¼ sec. 26	J. R. Campbell	Dn	26.0	1¼	GP	do.	Crete member of Sanborn form.	Cy, W	S	Top of cover over pit	0.3	1719.1	10.40	10-22-49
23-9-32bb	NW¼NW¼ sec. 32	J. G. Nusser	Dn	28.0	1¼	GP	do.	do.	Cy, W	D, S	do.	0.9	1725.1	4.55	10-22-49
	T. 23 S., R. 10 W.														
23-10-2acc	SW¼SW¼NE¼ sec. 2	Lion Oil Co.	Dr	71.0	8	OW	do.	Crete member of Sanborn formation and Meade formation	N	O	Top of casing	0.0	1751.8	7.43	9-14-49
*23-10-6aa	NE¼NE¼ sec. 6		B	11.6	3	N	do.	Dune sand	N	N	Ground surface	0.0	1777.7	10.40	11-16-49
23-10-14bb	NW¼NW¼ sec. 14	L. A. Withroder	Du	13.5	30	C	do.	do.	P, H	D	Top of concrete curb	0.1	1764.1	1.90	9-21-49
23-10-17ba	NE¼NW¼ sec. 17	K. Schweithale	Dn	23.5	1¼	GP	Sand	Dune sand and Crete member of Sanborn form.	C, E	S	Top of reducer	2.0	1775.4	4.55	10-21-49
23-10-20dd	SE¼SE¼ sec. 20	Lion Oil Co.	Dr	82.0	10	OW	Sand, gravel	Meade formation	N	O	Top of casing	0.5	1783.7	8.88	1-10-50
*23-10-23dc	SW¼SE¼ sec. 23	T. R. Withroder	Dr	108.0	6	GI	do.	Dune sand and Crete member of Sanborn form.	J, E	D, S	Ground surface	0.0	1772.7	28.45	10-21-49
*23-10-31ccd	SE¼SW¼SW¼ sec. 31	I. C. Johnson	Du	19.5	24	R	do.	Dune sand	Cy, H	D, S	Top of cover over well	0.2	1806.8	17.47	10-21-49

TABLE 11.—*Records of wells and springs in Reno County*—Continued

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
24-3-18bb	*T. 24 S., R. 3 W.* NW¼NW¼ sec. 18	City of Wichita	Dr	71.3	1¼	GP	Sand, gravel	Wisconsinan terrace deposits	N	O	Top of pipe	1.2	1457.6	9.97	10-27-49	
*24-4-5aa	*T. 24 S., R. 4 W.* NE¼NE¼ sec. 5	C. M. Johnson	Dn	22.0	1¼	GP	do.	do.	P, H	S	Lower check valve	2.0	1481.8	9.60	8- 5-49	
24-4-9dd	SE¼SE¼ sec. 9	City of Wichita	Dn	66.5	1¼	GP	do.	do.	N	O	Top of pipe	1.5	1468.8	7.64	10-27-49	
24-4-13cc	SW¼SW¼ sec. 13	do.	Dn	48.0	1¼	GP	do.	do.	N	O	do.	2.0	1452.4	3.40	10-27-49	
24-4-18ad	SE¼NE¼ sec. 18	D. T. Ingling Drilling Co.	Dr	28.0	8	OW	do.	Alluvium	Cy, G	In	Top of casing	0.1	1471.7	3.50	10-27-49	
24-4-18ccd	SE¼SW¼SW¼ sec. 18	do.	Dr	36.0	10	OW	do.	do.	Cy, G	In	do.	0.3	1472.9	4.88	11-7-49	
24-4-28cc	SW¼SW¼ sec. 28	City of Wichita	Dn	13.0	1¼	GP	do.	do.	N	N	Top of pipe	1.0	1460.9	4.56	10-27-49	
24-4-36bb	NW¼NW¼ sec. 36		B	9.6	3		do.	do.	N	N	Ground surface	0.0	1446.6	5.86	1-13-50	
*24-5-1dda	*T. 24 S., R. 5 W.* NE¼SE¼SE¼ sec. 1		Dr	21.5	13	OW	do.	Wisconsinan terrace deposits	N	N	Top of board cover	0.0	1488.1	7.56	8- 5-49	
*24-5-3ab	NW¼NE¼ sec. 3	Otto Crans	Dn	27.1	1¼	GP	do.	Alluvium	P, H	S	Top of pump lip	3.6	1501.3	10.98	9-22-49	
*24-5-6bbc	SW¼NW¼NW¼ sec. 6	J. D. McNew	B	42.0	6	GI	do.	Wisconsinan terrace deposits	Cy, E	D, S	Top of casing	-5.1	1519.6	6.92	9-22-49	
24-5-16bab	NW¼NE¼NW¼ sec.16	U. S. Navy	Dr	123.0	16	OW	do.	Meade formation	T, E	P	do.	2.0	1529.7	33.0	10- 9-42	360 gpm Drawdown 14.0 pumping 360 gpm 20 hours
24-5-16ba	NE¼NW¼ sec. 16	do.	Dr	123.0	16	OW	do.	do.	T, E	P	do.	2.0	1538.3	44.89	9-16-42	
*24-5-20dc	SW¼SE¼ sec. 20	P. O. Borntrager	Dr	53.0	6	GI	do.	do.	Cy, W	D, S	do.	0.3	1550.5	42.57	11- 7-49	
24-5-22bba	NE¼NW¼NW¼ sec.22	Abe Yoder	Dr	48.0	10	OW	do.	do.	N	O	do.	0.4	1536.8	44.98	9-18-49	
*24-5-25cb	NW¼SW¼ sec. 25	Enos L. Knepp	B	53.0	6	GI	do.	Wisconsinan terrace deposits	J, E	D, S	Top of well curb	1.3	1500.5	26.67	11- 7-49	

	T. 24 S., R. 6 W.													
*24-6-4ab	NW¼NE¼ sec. 4	Eli Helmuth	B	36.0	5	GI	do.	Meade formation	J, G	D, S	Ground surface	0.0	1564.1	28.80	9-16-49
*24-6-8cdc	SE¼SW¼SE¼ sec. 8	Clyde Altenreed	Dr	92.0	3	GP	Shale	Ninnescah shale	Cy, E	D, S	....	....	....	....	4-27-50
24-6-8dd	SE¼SE¼ sec. 8	D. M. Sinn	B	22.0	6	GI	Sand, gravel	Crete member of Sanborn form.	Cy, W	N	Top of casing	0.3	1566.1	19.50	9-22-49
*24-6-12cc	SW¼SW¼ sec. 12	....	B	22.4	6	GI	do.	Meade formation	Cy, E	D	do.	-4.2	1539.5	8.64	9-22-49
24-6-19cd	SE¼SW¼ sec. 19	W. C. Pierce	B	28.0	2½	OW	Shale	Ninnescah shale	Cy, W	S	Ground surface	0.0	1531.7	3.20	9-22-49
24-6-22cc	SW¼SW¼ sec. 22	Kathie Moore	Dr	23.2	6	GI	Sand, gravel	Meade formation	Cy, H	D, S	Top of casing	0.9	1565.9	10.84	9-22-49
24-6-25bbc	SW¼NW¼NW¼ sec. 25	R. L. Jaques	Du	22.0	30	R	do.	do.	Cy, H	S, O	Top of wood cover	1.1	1555.6	5.82	9-22-49
24-6-34cdc	SW¼SE¼SW¼ sec. 34	F. A. Bells	Du	21.3	48	R	Shale	Ninnescah shale	J, E	D, S	Top of concrete curb	0.2	1549.5	11.82	11- 7-49
24-6-36cb	NW¼SW¼ sec. 36	....	Du	23.0	40	R	do.	do.	Cy, H	D, S	Top of wood cover	0.7	1570.4	12.79	11- 7-49
	T. 24 S., R. 7 W.													
*24-7-10bb	NW¼NW¼ sec. 10	J. L. Conkling	Du	36.0	30	C	Sand, gravel	Crete member of Sanborn formation and Meade formation	Cy, H	D, S	Pump base	1.0	1617.3	19.60	9-21-49
24-7-12aad	SE¼NE¼NE¼ sec. 12	L. E. Helmuth	B	42.0	6	GI	do.	do.	N	N	Ground surface	0.0	1580.0	22.00	9-15-49
24-7-19ca	NE¼SW¼ sec. 19	W. A. Love	Dr	59.0	7½	OW	do.	do.	N	N	Top of casing	0.5	1627.4	39.82	10-11-49
*24-7-22dd	SE¼SE¼ sec. 22	N. E. Terrell	B	20.0	6	GI	do.	do.	Cy, H	S	do.	0.0	1575.9	12.08	9-21-49
24-7-29bbc	SW¼NW¼NW¼ sec. 22	I. Terrell	Dr	50.5	5	GI	do.	do.	Cy, W	D,S,O	do.	0.4	1615.5	29.66	9-15-49
	T. 24 S., R. 8 W.													
24-8-9dda	NE¼SE¼SE¼ sec. 9	D. A. Waite	B	14.0	8	OW	do.	do.	N	N	do.	0.3	1648.6	12.20	9-14-49
24-8-9ddb	NW¼SE¼SE¼ sec. 9	do.	B	44.0	8	OW	do.	do.	C, G	I	Ground surface	0.0	1650.4	14.0	9-15-49
24-8-12cb	NW¼SW¼ sec. 12	....	Dr	24.6	6	GI	do.	do.	N	N	Top of concrete curb	0.6	1627.9	6.95	10-11-49
*24-8-21dad	SE¼NE¼SE¼ sec. 21	....	Dr	37.0	6	GI	do.	do.	N	N	Top of casing	0.5	1610.0	7.32	10-25-49
24-8-24aa	NE¼NE¼ sec. 24	....	Dr	68.0	6	GI	do.	do.	Cy, W	S	do.	1.2	1636.0	42.13	12- 3-49
24-8-30cac	SW¼NE¼SW¼ sec. 30	H. H. Heaps	Sp	....	....	....	do.	Terrcae deposits	N	N	....	....	....	....	....
*24-8-36bc	SW¼NW¼ sec. 36	J. H. Linshid	Dr	76	6	GI	do.	Crete member of Sanborn formation and Meade formation	Cy, H	S	Base of pump	0.5	1638.4	54.36	10-25-49
	T. 24 S., R. 9 W.													
24-9-1aa	NE¼NE¼ sec. 1	....	Dn	38.0	1¼	GP	do.	Dune sand and Crete member of Sanborn form.	Cy, H	N	do.	0.4	1690.1	5.63	10-25-49
*24-9-10bc	SW¼NW¼ sec. 10	M. D. Matley	Dn	36.0	1¼	GP	do.	Crete member of Sanborn formation and Meade formation	Cy, E	D, S	Ground surface	0.0	1709.2	29.60	10-26-49
*24-9-12dd	SE¼SE¼ sec. 12	Albert Korsler	Dn	32.0	1¼	GP	do.	do.	Cy, H	S	Base of pump	0.6	1651.8	8.38	10-25-49
24-9-18bba	NE¼NW¼NW¼ sec. 18	....	Dn	18.2	1¼	GP	do.	do.	P, H	D	Lower check valve	3.2	1698.2	15.34	10-26-49

TABLE 11.—*Records of wells and springs in Reno County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
	T. 24 S., R. 9 W.															
24-9-28aa...	NE¼NE¼ sec. 28....	....	Dn	33.4	1¼	GP	Sand, gravel..	Crete member of Sanborn form. and Meade fm.	N	N	Top of pipe.....	1.7	1680.8	16.79	11- 1-49	
*24-9-31bcb..	NW¼SW¼NW¼ sec. 31	F. E. Julien.....	Dr	68.0	8	GI	do..........	do............	J, E	D, S	Top of concrete curb.........	0.3	1734.0	31.80	11- 1-49	
24-9-33cd...	SE¼SW¼ sec. 33.....	U. W. Nickels...	Dn	38.0	1¼	GP	Sand........	do............	Cy, W	S	Ground surface..	0.0	1703.3	21.00	11- 1-49	
	T. 24 S., R. 10 W.															
*24-10-1bc...	SW¼NW¼ sec. 1.....	....	Dr	31.0	6	GI	do..........	do............	Cy, W	S	Top of pipe clamp........	2.4	1755.3	18.07	10-26-49	
24-10-4ba...	NE¼NW¼ sec. 4.....	J. Wyess.......	Du	28.0	30	C	do..........	do............	Cy, W	S	Top of well curb	0.1	1780.4	14.34	10-21-49	
*24-10-15cab*1*	NW¼NE¼SW¼ sec. 15	City of Sylvia...	Dr	55.0	18	OW	Sand, gravel..	do............	T, E	P	Airline opening in pump......	1.5	1739.8	11.58	10-26-49	Drawdown 1.0, 250 gpm
24-10-15cab*2*	NW¼NE¼SW¼ sec. 15	do............	Dr	55.0	18	OW	do..........	do............	T, E	P	do............	1.6	1738.7	10.51	10-26-49	
24-10-18dda	NE¼SE¼SE¼ sec. 18	....	Dn	26.0	1¼	GP	do..........	do............	N	N	Top of pipe.....	0.0	1761.1	7.56	10-26-49	
24-10-30da..	NE¼SE¼ sec. 30.....	....	Dn	28.0	2	GP	do..........	do............	Cy, H	N	Base of pump...	0.2	1753.6	14.38	10-26-49	
	T. 25 S., R. 4 W.															
*25-4-5cab...	NW¼NE¼SW¼ sec. 5	City of Haven...	Dr	55.0	12	......	do..........	Wisconsinan terrace deposits	C, E	P	Ground surface..	0.0	....	28.0	10-27-49	
25-4-5cac....	SW¼NE¼SW¼ sec. 5	do............	Dr	55.0	12	OW	do..........	do............	C, E	P	....	......	....	....	....	Drawdown 10, 250 gpm
25-4-5cdc....	SW¼SE¼SW¼ sec. 5..	do............	Dr	48.3	10	OW	do..........	do............	T, E	P	Pumphouse floor	2.0	1479.0	25.40	10-27-49	Drawdown 10, 200 gpm
25-4-6aa....	NE¼NE¼ sec. 6.....	....	B	40.0	10	GI	do..........	do............	Cy, W	D, S	Ground surface..	0.0	1481.1	27.65	11- 7-49	
*25-4-9dd....	SE¼SE¼ sec. 9......	D. Meyer......	Dr	39.0	8	GI	do..........	do............	N	S	Top of casing...	0.2	1479.3	31.16	9-18-49	
25-4-12bc...	SW¼NW¼ sec. 12....	....	B	21.0	1¼	GP	do..........	do............	N	S	Top of pipe.....	3.0	1451.4	11.40	1-13-50	
25-4-24dda..	NE¼SE¼SE¼ sec. 24	Emma Back....	B	47.8	6	GI	do..........	do............	Cy, E	D, S	Top of casing...	-7.4	1462.4	34.15	9-18-49	
*25-4-33ba...	NE¼NW¼ sec. 33....	C. S. Koontz....	Dr	37.5	6	GI	Shale........	Ninnescah shale	Cy, W	D, S	do............	-4.7	1555.5	13.12	9-18-49	

	T. 25 S., R. 5 W.														
25-5-2ddc...	SW¼SE¼SE¼ sec. 2...	....	Dr	33.0	6	GI	Sand, gravel..	Meade formation	Cy,H	D, S	Base of pump...	0.7	1520.8	17.64	11- 7-49
*25-5-8aa....	NE¼NE¼ sec. 8.....	S. A. Marteny...	Du	34.5	42	R	Shale........	Ninnescah shale	Cy, W	D, S	do............	0.4	1533.9	24.17	11- 7-49
	T. 25 S., R. 6 W.														
*25-6-8bab...	NW¼NE¼NW¼ sec. 8.	J. J. Kaufman..	B	16.0	6	GI	Sand.........	Alluvium.......	Cy, H	S	Top of casing...	1.9	1493.7	10.24	11- 7-49
25-6-12cd...	SE¼SW¼ sec. 12.....	....	B	17.5	6	OW	Shale........	Ninnescah shale	N	N	do............	2.5	1487.0	6.30	6-12-49
25-6-32dd...	SE¼SE¼ sec. 32.....	H. J. Graber....	B	24.5	5	GI	Sand, gravel..	Meade formation	Cy, W	S	do............	0.6	1559.1	12.18	11- 2-49
	T. 25 S., R. 7 W.														
25-7-2bb....	NE¼NE¼ sec. 2.....	Cecil Adkins....	Dr	60.0	3½	GP	Shale........	Ninnescah shale	Cy, W	S	Ground surface..	0.0	1546.5	9.00	9-21-49
25-7-11ab...	NW¼NE¼ sec. 11....	....	Dr	35.0	6	GI	Sand, gravel..	Meade formation	Cy, H	D, S	Top of casing...	0.1	1565.2	10.75	9-21-49
*25-7-16aa...	NE¼NE¼ sec. 16....	J. C. Gilmore...	B	18.3	6	GI	do..........	do............	Cy, E	D, S	do............	-4.0	1560.4	5.35	11- 3-49
25-7-19dd...	SE¼SE¼ sec. 19.....	M. Barker......	B	26.0	2½	GP	do..........	Wisconsinan terrace deposits	N	N	Top of pipe.....	3.1	1522.0	8.32	11- 2-49
25-7-26cdc...	SW¼SE¼SW¼ sec. 26	L. W. Mercer...	B	21.0	6	GI	do..........	Meade formation	Cy, H	S	Base of pump...	0.4	1541.0	10.45	11- 3-49
	T. 25 S., R. 8 W.														
25-8-4aa....	NE¼NE¼ sec. 8.....	....	Sp	......	......	......	do..........	Wisconsinan terrace deposits	......	......	....	......	1595.1	....	....
*25-8-10abc*1*	SW¼NW¼NE¼ sec. 10	City of Arlington	Dr	?	......	OW	do..........	Meade formation	T, E	P	....	......	....	....	9-25-49
25-8-10abc*2*	SW¼NW¼NE¼ sec. 10	do............	Dr	?	......	OW	do..........	do............	T, E	P	....	......	....	....	9-25-49
*25-8-11ab...	NW¼NE¼ sec. 11....	....	B	18.0	6	GI	do..........	do............	Cy, H	D	Top of casing...	0.5	1566.0	8.23	11- 3-49
25-8-15ccd..	SE¼SW¼SW¼ sec. 15	....	Sp	......	......	......	do..........	do............	......	......	....	......	1606.7	....	....
25-8-17cdb..	NW¼SE¼SW¼ sec. 17	....	Sp	......	......	......	do..........	do............	......	......	....	......	1624.3	....	....
25-8-24aa...	NE¼NE¼ sec. 24....	S. P. Burling....	Du	16.4	48	C	do..........	Wisconsinan terrace deposits	N	N	....	1.1	1574.8	9.42	11- 2-49
*25-8-26bbd..	SE¼NW¼NW¼ sec. 26	S. A. Krouse....	Du	54.0	36	R	Shale and sandstone...	Harper sandstone....	Cy, H	D, S	Base of pump...	0.6	1591.7	38.24	11- 2-49
*25-8-26cba...	NE¼NW¼SW¼ sec. 26	W. C. Layman..	Dr	38.0	6	GI	Sand, gravel..	Wisconsinan terrace deposits	J, E	D, S	Top of casing...	0.7	1568.5	16.50	11- 2-49
25-8-30cd...	SE¼SW¼ sec. 30.....	R. E. Neudigate	Du	28.4	36	R	do..........	Meade formation	Cy, W	O	Base of pump...	0.1	1622.7	23.92	11- 1-49
25-8-36bd...	SE¼NW¼ sec. 36....	R. L. Dick.....	Dn	19.6	1¼	GP	do..........	Alluvium.......	J, E	D, S	Ground surface..	0.0	1536.0	8.40	11- 2-49
	T. 25 S., R. 9 W.														
*25-9-1dcd...	SE¼SW¼SE¼ sec. 1...	H. Thayer......	Dr	32.0	6	GI	do..........	Crete member of Sanborn form.	N	N	....	0.3	1655.2	9.60	10-25-49
25-9-18bcb..	NW¼SW¼NW¼ sec.18	....	Dn	26.5	1¼	GP	Sand.........	Dune sand and Crete member of Sanborn fm.	P, H	S	Lower check valve........	2.3	1715.0	9.15	11- 1-49
25-9-22ca....	NE¼SW¼ sec. 22....	D. Scheaffer....	B	15.0	10	GI	Sand, gravel..	Crete member of Sanborn form.	Cy, E	D, S	Top of casing...	0.1	1634.3	10.41	9-15-49
	T. 25 S., R. 10 W.														
25-10-10aba	NE¼NW¼NE¼ sec. 10	I. G. Gaston....	Dr	59.6	8	T	do..........	Meade formation	Cy, H	D	do............	0.9	1755.9	29.62	11- 1-49

TABLE 11.—*Records of wells and springs in Reno County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
	T. 25 S., R. 10 W.															
*25-10-16dd	SE¼SE¼ sec. 16	Hanshaw Estate	B	29.5	6	GI	Sand, gravel	Crete member of Sanborn form.	Cy, W	S, O	Top of casing	0.4	1757.4	18.70	9-15-49	
*25-10-19cc	SW¼SW¼ sec. 19	J. Nies	Dr	48.0	8	GI	do.	do.	Cy, W	S	Bottom of pipe clamp	2.3	1805.3	35.39	11- 1-49	
25-10-25bb	NW¼NW¼ sec. 25	L. J. Potter	Dr	32.5	6	GI	do.	do.	Cy, H	D, S	Top of casing	0.6	1720.5	16.39	11- 1-49	
25-10-28cc	SW¼SW¼ sec. 28	M. J. Kitlin	B	33.0	8	T	do.	do.	Cy, W	D, S	do.	0.2	1756.9	11.95	11- 1-49	
	T. 26 S., R. 4 W.															
*26-4-2dd	SE¼SE¼ sec. 2	D. J. Smith	Dr	31.3	8	GI	do.	Meade formation	Cy, W	D	Top of casing	1.3	1519.0	16.76	9-18-49	
26-4-7dd	SE¼SE¼ sec. 7	....	Dr	35.5	6	GI	Shale	Ninnescah shale	Cy, H	D, O	do.	0.6	1466.1	14.05	9-18-49	
26-4-15bb	NW¼NW¼ sec. 15	T. R. Driesser	Dr	80.0	6	GI	do.	do.	Cy, H	N	do.	1.5	1566.8	18.83	9-18-49	
	T. 26 S., R. 5 W.															
26-5-8bc	SW¼NW¼ sec. 8	R. J. Stuckey	B	21.7	6	GI	Sand, gravel	Wisconsinan terrace deposits	N	O	do.	0.6	1435.3	8.29	9-18-49	
*26-5-20ab	NE¼NW¼ sec. 20	J. H. Graber	Dr	22.0	6	GI	Shale	Ninnescah shale	Cy, W	S	do.	0.2	1438.2	11.19	9-18-49	
	T. 26 S., R. 6 W.															
26-6-14cc	SW¼SW¼ sec. 14	Helmrick and Payne Oil Co.	Dr	33.0	10	OW	Sand, gravel	Meade formation and Blanco formation	N	N	Top of casing	0.7	1540.2	11.37	1-10-50	
26-6-18cad	SE¼NE¼SW¼ sec. 18	....	Dr	43.0	5½	GI	do.	do.	Cy, H	D, O	do.	0.0	1574.5	25.26	6-25-49	
26-6-18cdb*1*	NW¼SE¼SW¼ sec. 18	City of Pretty Prairie	Dr	40.0	......	OW	do.	do.	T, E	P	....	......	......	......	9-25-49	
*26-6-18cdb*2*	NW¼SE¼SW¼ sec. 18	do.	Dr	40.0	......	OW	do.	do.	T, E	P	....	......	......	......	9-25-49	
*26-6-26da	NE¼SE¼ sec. 26	....	B	20.0	6	GI	do.	do.	J, E	D	do.	0.5	1522.2	5.16	1-10-50	
26-6-27cc	SW¼SW¼ sec. 27	French	Dr	35.0	6	GI	do.	do.	Cy, W	D, S	Base of pump	0.0	1563.3	26.50	1-10-50	
	T. 26 S., R. 7 W.															
26-7-1ddb	NW¼SE¼SE¼ sec. 1	A. J. Stuckey	Dr	32.5	6	GI	do.	do.	Cy, W	S	do.	0.5	1573.9	23.65	11- 2-49	

26-7-4dd	SE¼SE¼ sec. 4	....	Dr	29.6	5	GI	do.	do.	N	N	Top of casing	0.4	1581.5	4.89	11- 2-49	
26-7-20cd	SE¼SW¼ sec. 20	A. J. Stuckey	B	22.6	5	GI	do.	do.	Cy, W	S	Base of pump	0.4	1614.7	10.13	11- 2-49	
26-7-22ad	SE¼NE¼ sec. 22	G. M. McClure	Dr	50.0	6	GI	do.	do.	Cy, W	S	do.	0.4	1619.6	33.22	11- 2-49	
26-7-36aad	SE¼NE¼NE¼ sec. 36	Ray Brownlee	Du	20.3	30	R	do.	do.	Cy, H	O	Top of metal opening at pump	1.8	1559.9	15.40	11- 2-49	
	T. 26 S., R. 8 W.															
26-8-6ccd	SE¼SW¼SW¼ sec. 6	F. C. Kelman	B	14.0	6	GI	do.	do.	J, E	D, S	Top of casing	-5.6	1642.2	4.20	7-26-49	
*26-8-13aa	NE¼NE¼ sec. 13	E. Hullon	Dr	36.0	12	GI	Shale	Harper sandstone	Cy, W	D, S	Top of concrete platform	0.2	1643.9	24.73	11- 6-49	
26-8-16ab	NW¼NE¼ sec. 16	C. Cole	B	16.0	6	GI	Sand, gravel	Meade formation and Blanco formation	N	N	Top of well curb	0.3	1612.5	11.40	7-26-49	
26-8-16dd	SE¼SE¼ sec. 16	....	B	36.0	6	GI	do.	do.	Cy, W	D, O	Top of casing	0.5	1642.4	22.33	7-26-49	
26-8-23cd	SE¼SW¼ sec. 23	L. Belt	B,Dn	23.0	1¼	GP	do.	do.	Cy, G	S	Base of pump	0.0	1616.8	11.50	7-26-49	
26-8-30ada	NE¼SE¼NE¼ sec. 30	F. M. Weber	Dr	64.0	3	GP	do.	do.	Cy, W	D, S	Ground surface	0.0	1673.8	34.0	7-10-49	
*26-8-32cb	NW¼SW¼ sec. 32	do.	B	38.0	6	GI	do.	do.	J, E	D, S	do.	0.0	1665.8	25.55	7-26-49	
26-8-36cc	SW¼SW¼ sec. 36	A. A. McCoullough	Dn	24.0	1¼	GP	do.	do.	P, H	S	Ground surface	0.0	1604.4	18.0	7- 1-49	
	T. 26 S., R. 9 W.															
26-9-3dd	SE¼SE¼ sec. 3	J. S. Nunnemaker	B	33.0	8	T	do.	do.	Cy, W	N	Top of casing	1.0	1685.6	27.02	7-20-49	
*26-9-4bba	NE¼NW¼NW¼ sec. 4	E. Truitt	Dr	38.0	6	GI	do.	do.	Cy, W	D, S	Base of pump	0.4	1677.3	22.33	7-23-49	
26-9-4bbb	NW¼NW¼NW¼ sec. 4	do.	SP	....	....	....	do.	do.	....	S	....	....	1637.8	....	7-23-49	
26-9-6bba	NE¼NW¼NW¼ sec. 6	Sam Sherr	B	35.0	8	GI	do.	do.	J, E	D, S	Top of casing	0.0	1677.2	3.17	7-19-49	
26-9-8cd	SE¼SW¼ sec. 8	A. B. Bradshaw	Dr	60.0	8	GI	do.	do.	J, E	D, S	do.	1.0	1675.9	18.36	7-18-49	
*26-9-13cbb	NW¼NW¼SW¼ sec. 13	B. Cole	Dr	57.0	8	GI	do.	do.	Cy, W	S	Top of casing	0.0	1669.2	30.02	7-20-49	
26-9-22bb	NW¼NW¼ sec. 22	L. N. Sheppard	Dr	66.0	10	OW	do.	Meade formation	N	N	do.	0.0	1687.2	23.03	7-20-49	
26-9-29bbc	SW¼NW¼NW¼ sec. 29	C. A. Cortts	Dr	66.0	8	GI	do.	do.	Cy, W	S	do.	3.0	1722.0	41.89	7-18-49	
*26-9-33aa	NE¼NE¼ sec. 33	G. M. Woodson	B	50.0	12	T	do.	do.	Cy, W	S	Base of pump	2.0	1711.7	40.24	7-19-49	
26-9-36aa	NE¼NE¼ sec. 36	G. E. Fornwalt	Dn	34.0	3	GP	do.	do.	Cy, W	D, S	Ground surface	0.0	1659.3	19.0	7-11-49	
	T. 26 S., R. 10 W.															
26-10-3aba	NE¼NW¼NE¼ sec. 3	F. R. Frauh	Dr	38.0	6	GI	do.	do.	Cy, W	S	Top of casing	1.0	1735.2	27.00	7-13-49	
*26-10-5dd*1*	SE¼SE¼ sec. 5	City of Turon	Dr	60.0	18	OW	do.	do.	T, E	P, S	....	....	....	....	9-25-49	Estimated yield 125 gpm
26-10-5dd*2*	SE¼SE¼ sec. 5	do.	Dr	....	....	OW	do.	do.	C, E	P, S	....	....	....	....	9-25-49	Estimated yield 50 gpm
*26-10-7abd	SE¼NW¼NE¼ sec. 7	Vera Smith	B	28.0	10	T	do.	Dune sand and Crete member of Sanborn formation	Cy, H	D, S	Top of casing	1.0	1767.7	9.50	7-13-49	
26-10-12bcc	SW¼SW¼NW¼ sec. 12	W. Snedacar	B	35.0	6	GI	do.	Crete member of Sanborn formation	J, E	S	Top of concrete curb	0.8	1676.6	2.85	7-13-49	

TABLE 11.—*Records of wells and springs in Reno County—Concluded*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in ft.)
							Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
*26-10-20aa...	*T. 26 S., R. 10 W.* NE¼NE¼ sec. 20....	G. Shanline.....	Dr	33.0	10	T	Sand.........	Crete member of Sanborn formation and Meade formation....								
*26-10-23add	SE¼SE¼NE¼ sec. 23	A. Spung.......	Dn	30.0	1¼	GP	do...........	do.............	Cy, W	D, S	Top of casing...	0.3	1755.9	13.36	7-13-49	
26-10-30aa...	NE¼NE¼ sec. 30....	....	B	22.8	8	T	do...........	Dune sand and Crete member of Sanborn formation....	P, H	D, S	Base of pump...	1.8	1681.9	4.04	7-13-49	
									N	N	Top of concrete curb.........	0.6	1759.3	4.32	7-13-49	
26-10-33daa	NE¼NE¼SE¼ sec. 33	F. M. Dunn....	Dn	22.5	1¼	GP	do...........	Crete member of Sanborn formation....	P, H	S	Lower check valve........	2.7	1705.9	3.88	7-13-49	

1. Well numbering system described in text.
2. B, bored well; DD, dug and drilled well; Dn, driven well; Dr, drilled well; Du, dug well; DuDn, dug and driven well; Sp, spring.
3. Reported depths below the land surface are given in feet; measured depths are given in feet and tenths below measuring point.
4. Bs, boiler steel; C, concrete; GI, galvanized sheet iron; GP, galvanized-iron pipe; I, iron; N, none; OW, oil-well casing; R, rock; T, vitrified tile; W, wood.
5. Method of lift: B, bucket; C, centrifugal; CY, cylinder; F, natural flow; J, jet; L, lift; N, none; P, pitcher pump; S, submersible turbine; T, turbine.
   Type of power: E, electric; G, gas engine; H, hand operated; W, wind mill.
6. D, domestic; I, irrigation; In, industrial; N, not being used; O, observation; P, public supply; S, stock.
7. Measured depths to water level are given in feet, tenths, and hundredths; reported depths to water level are given in feet.

* Chemical analysis given in Table 5.

LOGS OF WELLS AND TEST HOLES

On the following pages the logs of 94 test holes and wells in Reno County are given. Of the logs, 49 are of test holes drilled by the State Geological Survey; the other logs are of test holes and wells drilled by private drillers. Unless otherwise stated on the log, the test holes were drilled by the State Geological Survey. Samples from these test holes were collected in the field and studied in the office. The samples from the test holes drilled by Claude Price were collected in the field by C. K. Bayne and studied in the office by O. S. Fent, C. C. Williams, and James B. Cooper.

21-9-36dd.—*Sample log of test hole in the SE cor. sec. 36, T. 21 S., R. 9 W.; drilled July 1946. Surface altitude, 1,655.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, fine, and dark-gray silt	3	3
Sand, medium to fine, and buff silt	1.5	4.5
Terrace deposits		
Silt, calcareous, light gray; contains much coarse to fine sand and nodular caliche	1.5	6
Sand, coarse to fine; contains some fine to medium gravel,	22	28
Gravel, fine to medium, and sand	17.5	45.5
Blanco formation		
Silt, calcareous, buff; contains some nodular caliche	24.5	70
Sand, coarse to fine, and fine to medium gravel; contains much buff silt	8	78
PERMIAN—Leonardian		
Harper sandstone		
Shale, dark red	2	80

22-4-12dd.—*Drillers log of well at the SE cor. sec. 12, T. 22 S., R. 4 W.; drilled by Wichita Pump and Supply Company for the City of Buhler, 1938.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Silt, brown	8	8
Clay, gray	22	30
Clay, sandy, brown	17	47
Clay, gray, and fine sand	6	53
Sand, coarse to medium	11	64
Gravel and sand	1	65
Sand, coarse	6	71
Sand, medium to coarse	26	97

22-4-13aa.—*Drillers log of test hole at the NE cor. sec. 13, T. 22 S., R. 4 W.; drilled by the Wichita Pump and Supply Company for the City of Buhler, 1938.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Silt	8	8
Clay	5	13
Clay, sandy	2	15
Clay	23	38
Clay, hard	2	40
Clay, and fine sand	10	50
Sand, fine	7	57
Sand, fine to medium	7	64
Gravel	1	65
Clay, sandy, blue	10	75
Clay, sandy, gray	14	89

22-4-20abb.—*Drillers log of test hole in the NW¼ NW¼ NE¼ sec. 20, T. 22 S., R. 4 W.; drilled by Layne-Western Company for the City of Buhler, 1927. Surface altitude, 1,465.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt	5	5
Clay, jointed	10	15
Clay	25	40
Clay, sandy	3	43
Clay	3	46
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	47

22-4-20ada.—*Drillers log of well in the NE¼ SE¼ NE¼ sec. 20, T. 22 S., R. 4 W.; drilled by Layne-Western Company for the City of Buhler, 1927. Surface altitude, 1,461.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Soil	5	5
Clay	7	12
Sand, fine, brown	3	15
Clay	21	36
Sand, fine	16	52
Clay, on shale	54	106

22-4-20dda.—*Drillers log of test hole in the NE¼ SE¼ SE¼ sec. 20, T. 22 S., R. 4 W.; drilled by Layne-Western Company for the City of Buhler, 1927. Surface altitude, 1,459.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt	3	3
Clay, sandy	7	10
Sand, fine, brown	5	15

	Thickness, feet	Depth, feet
Clay, sandy	25	40
Sand, fine	6	46
Clay, sandy	11	57
Sand, fine	8	65
Clay, red	25	90
Clay, sandy	8	98
Sand, on rock	2	100

22-4-21bb.—*Drillers log of test hole in the NW cor. sec. 21, T. 22 S., R. 4 W.; drilled by Layne-Western Company for the City of Buhler, 1927. Surface altitude, 1,466.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt and clay	39	39
Clay and gravel	2	41
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	42

22-5-3dd.—*Sample log of test hole in the SE¼ SE¼ sec. 3, T. 22 S., R. 5 W.; drilled 1949. Surface altitude, 1,480.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	1	1
Alluvium		
Clay, gray to brown, sandy	1	2
Sand, fine	6	8
Clay, gray green	1	9
Clay, gray, some caliche	3	12
Sand, fine, some gray clay	17	29
Clay, dark gray	6	35
Clay, blue gray	2	37
Sand, fine, some tan clay	18	55
Clay, blue gray, shells, some Permian rubble	3	58
Clay, gray green, shells	2	60
Sand, fine, clay streaks	7	67
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue gray, soft	1	68

22-5-5dd.—*Sample log of test hole in the SE¼ SE¼ sec. 5, T. 22 S., R. 5 W.; drilled 1949. Surface altitude, 1,535.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	2	2
Dune sand		
Sand, fine, clay streaks, tan to brown	7	9
Clay, tan	4	13
Clay, buff	5	18
Silt, tan, some caliche and sand, fine	10	28

Sanborn formation	Thickness, feet	Depth, feet
Clay, tan, sandy, caliche	7	35
Clay, tan, much caliche	2	37
Silt, tan, some clay, tan	6	43
Clay, tan	2.5	45.5
Clay, buff, much caliche	9.5	55
Permian-derived gravel, some quartz gravel and tan clay,	2	57
Permian—Leonardian		
Ninnescah shale		
Shale, red	1.5	58.5

22-5-9aa.—*Sample log of test hole in the NE¼ NE¼ sec. 9, T. 22 S., R. 5 W.; drilled 1949. Surface altitude, 1,502.5 feet.*

Quaternary—Pleistocene	Thickness, feet	Depth, feet
Soil, sandy, fine	2.5	2.5
Dune sand		
Sand, medium to fine, and clay, yellow brown	2.5	5
Sand, fine	5.5	10.5
Silt, green, sandy, fine	2.5	13
Alluvium		
Silt, tan, sandy, fine	2	15
Sand, fine	13	28
Sand, fine, much Permian-derived gravel, medium to coarse. Caliche and shells	6	34
Clay, tan, much Permian rubble, caliche and shells	9	43
Clay, tan, some caliche	7	50
Clay, gray, much Permian rubble	2	52
Permian—Leonardian		
Ninnescah shale		
Shale, red, weathered at top	4	56

22-5-19ab.—*Sample log of test hole in the NW cor. NE¼ sec. 19, T. 22 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,643.8 feet.*

Quaternary—Pleistocene

Dune sand	Thickness, feet	Depth, feet
Sand, fine to medium, and brown silt	2	2
Sand, fine to medium	12	14
Sand, fine to medium, and clay, buff; contains some very fine sand	14	28
Sand, medium to very fine, and buff clay	10	38
Clay and silt, gray to brown, containing fine sand	28	66
Sand, medium to fine	26	92
Meade formation		
Clay, gray to brown; contains some caliche at base	24	116
Permian—Leonardian		
Ninnescah shale		
Shale, red	1	117

22-5-28da.—*Sample log of test hole in the NE¼ SE¼ sec. 28, T. 22 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,616.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine	29	29
Sand, medium to very fine, containing buff silt and clay	5	34
Sand, medium to fine, and tan silt and clay	31	65
Sand, fine to medium, and gray clay; contains some sand, very fine	20	85
Sand, medium to fine; grains stained red brown	31	116
Clay, gray	2	118
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	2	120

22-5-30cb.—*Sample log of test hole in the NW cor. SW¼ sec. 30, T. 22 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,544.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Soil, very sandy	3	3
Clay, gray to tan; contains some fine to medium sand	8	11
Gravel, coarse to fine; contains some coarse to medium sand	9	20
Gravel, medium to coarse, and fine gravel	3	28
Gravel, fine to coarse; contains coarse sand	4	32
Gravel, coarse to fine; contains some coarse sand	2	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green and brick red	1	35

22-5-30dc.—*Sample log of test hole in the SW cor. SE¼ sec. 30, T. 22 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,540.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Soil, very sandy, brown	3	3
Sand, fine to medium, and gray clay	5	8
Clay, gray	4	12
Gravel, fine to coarse, and coarse sand	6	18
Sand, coarse to medium, and fine to medium gravel	7	25
Gravel, fine to medium, and coarse to medium sand	6	31
Gravel, fine to medium, and coarse to fine sand; poorly sorted	3	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	1	35

22-5-31da.—*Sample log of test hole in the NE cor. SE¼ sec. 31, T. 22 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,536.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Soil, very sandy	3	3
Silt and clay; contains fine to medium sand	3	11
Sand, medium to fine; contains some gravel and silt; very poorly sorted	3	14
Gravel, fine to medium, and coarse to fine sand	6	20
Gravel, coarse to fine; contains some coarse to medium sand	14	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	35

22-5-32dd.—*Sample log of test hole in the SE cor. sec. 32, T. 22 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,533.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Soil, very sandy, brown	4	4
Clay and silt, gray to tan; contains fine sand	4	8
Clay and silt, gray to blue gray; contains thin layer of fine sand	8	16
Gravel, fine to medium, and coarse sand	15	31
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green and brick red	2	33

22-6-15ccb.—*Sample log of test hole in the NW cor. SW¼ SW¼ sec. 15, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,566.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Sand, fine to medium	5	5
Sand, coarse to fine, and fine to medium gravel	7	12
Gravel, coarse to fine; contains some very coarse materials; very permeable	36	48
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	2	50

22-6-15cd.—*Sample log of test hole in the SE cor. SW¼ sec. 15, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,564.0 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Terrace deposits		
Sand, fine to medium; contains very fine sand and tan silt	8	8
Clay and silt, brown to gray	4	12
Sand, medium to coarse	8	20
Gravel, fine to medium, and coarse sand	24	44
Permian—Leonardian		
Ninnescah shale		
Shale, green gray	1	45

22-6-17ad.—*Sample log of test hole in the SE¼ NE¼ sec. 17, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,569.1 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Dune sand		
Soil, dark brown; composed of sandy silt	4	4
Terrace deposits		
Silt and clay, gray to tan; contains some fine sand	3	7
Gravel, coarse to fine; contains coarse sand	5	12
Sand, medium to coarse, and fine gravel	6	18
Gravel, coarse to fine; contains some coarse sand	20	38
Gravel, medium to fine; contains coarse gravel and coarse sand	18	56
Gravel, fine to medium, and coarse sand	10	66
Permian—Leonardian		
Ninnescah shale		
Shale, brick red	1	67

22-6-21dd.—*Sample log of test hole in the SE cor. sec. 21, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,558.9 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Dune sand		
Soil, sandy, dark brown	4	4
Terrace deposits		
Clay and silt, gray	4	8
Gravel, fine to medium, and coarse to medium sand	4	12
Gravel, fine to coarse, and coarse to medium sand	6	18
Gravel, coarse to fine, contains coarse sand	26	44
Clay and silt, gray to tan	4	48
Gravel, very coarse	4	52
Gravel, coarse to fine, contains coarse sand	17	69
Permian—Leonardian		
Ninnescah shale		
Shale, red brown	1	70

22-6-22ad.—*Sample log of test hole in the SE cor. NE¼ sec. 22, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,555.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, fine to medium, contains very fine sand and brown silt	4	4
Terrace deposits		
Clay and silt, gray to tan	3	7
Sand, medium to fine, contains gravel and silt; very poorly sorted	5	12
Gravel, fine to coarse, and coarse sand	37	49
Sand, coarse to medium, and fine gravel	13	62
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green and brick red	2	64

22-6-24ccd.—*Sample log of test hole in the SE¼ SW¼ SW¼ sec. 24, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,552.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Soil, sandy, brown	3	3
Terrace deposits		
Silt and clay, tan; contains some fine sand	5	8
Clay and silt, tan to gray	4	12
Gravel, medium to fine; contains coarse sand and coarse gravel	23	35
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	1	36

22-6-26cb.—*Sample log of test hole in the NW cor. SW¼ sec. 26, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,553.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Soil, brown; contains some sand	3	3
Terrace deposits		
Clay and silt, gray to brown	7	10
Gravel, fine to medium, and coarse to medium sand	10	20
Gravel, fine to coarse, and coarse to medium sand	5	25
Gravel, fine to coarse; contains some coarse sand	46	71
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red brown	2	73

22-6-36bb.—*Sample log of test hole in the NW cor. sec. 36, T. 22 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,546.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Soil, sandy, brown	2	2
Terrace deposits		
Clay, gray	13	15
Gravel, coarse to fine; contains some coarse sand, material uniform throughout	56	71
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and gray green	1	72

22-7-20dd.—*Sample log of test hole in the SE¼ SE¼ sec. 20, T. 22 S., R. 7 W.; drilled 1949. Surface altitude, 1,623.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	1	1
Dune sand		
Sand, medium to fine, and brown silt	3	4
Sanborn formation		
Silt, buff, and very fine to medium sand; contains much caliche	16	20
Meade formation		
Silt, cream color; contains much fine to medium sand, and nodular caliche	3	23
Sand, fine to medium	2	25
Silt and clay, buff grading downward to greenish gray; contains some fine to coarse sand	4	29
Sand, fine to medium, some coarse sand	4	33
Silt and clay, greenish gray and brown, partly cemented; contains much fine to medium sand	10	43
Gravel, medium to fine, and red sand	14	57
Gravel, medium to fine, and coarse sand, light-gray silt, and clay	13	70
Gravel, medium to fine, and coarse sand, light-gray silt, and clay	20	90
Sand, medium to coarse, and much light-gray silt, some fine to medium gravel	10	100
Gravel, fine to coarse, and sand; some light-gray silt and clay	10	110
Gravel, medium to fine, and sand; some light-brown clay, non-sandy	10	120
Gravel, medium to fine, and sand, interbedded with light-brown silt	3	128
Sand, medium, brown	10	138
Sand, coarse to fine, some fine to medium gravel	11	149

	Thickness, feet	Depth, feet
Blanco formation		
Silt and clay; contains much very fine sand; buff, grading downward to blue gray; slightly cemented	10	159
Silt and clay, dark gray; contains much fine sand and few sandstone pebbles	6	165
Silt, buff; contains much medium to fine sand	7	172
Gravel, fine to medium, and sand, interbedded with buff silt	8	180
Gravel, fine to medium, and sand	10	190
Gravel, medium to fine, and sand, some coarse gravel	10.5	200.5
Permian—Leonardian		
Ninnescah shale		
Siltstone, red and light gray green	1.5	202

22-7-21aad.—*Sample log of test hole in the SE¼ NE¼ NE¼ sec. 21, T. 22 S., R. 7 W.; drilled 1949. Surface altitude, 1,588.2 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Alluvium		
Silt, dark gray brown; contains much medium to fine sand	3	3
Gravel, fine to medium, and sand; much coarse gravel	7	10
Gravel, coarse to fine, and sand	10	20
Gravel, medium to fine, and sand; some coarse gravel	10	30
Gravel, fine, and sand; some medium gravel	10	40
Gravel, medium to fine, and sand	10	50
Permian—Leonardian		
Harper sandstone		
Shale, very hard, red brown and gray green	2	52

22-7-31ccc.—*Sample log of test hole in the SW¼ SW¼ SW¼ sec. 31, T. 22 S., R. 7 W.; drilled 1949. Surface altitude, 1,632.6 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Dune sand		
Sand, fine to medium, and tan silt	7	7
Sanborn formation		
Clay and silt, dark gray to gray	8	15
Clay and silt, light greenish gray; contains much coarse to fine sand	3	18
Clay and silt, light greenish gray and pink; contains much sand, fine to coarse; much brown ironstain	8	26
Sand, fine to medium, and buff and blue-gray silt, partly loosely iron cemented	8	34
Sand, fine to coarse, fine to medium gravel, and gray and yellow-brown silt	3	37
Gravel, medium to fine, and sand; some coarse gravel	6	43
Meade formation		
Silt, yellow gray, grading downward to gray and gray-white silt; contains much fine to coarse sand and some caliche. Sand increasing downward	11	54

	Thickness, feet	Depth, feet
Gravel, fine to medium, and sand	16	70
Gravel, fine, and sand, some medium gravel	17	87
Gravel, fine to coarse, and sand; some yellow-gray silt	3	90
Gravel, medium to fine, and sand	22	112
Blanco formation		
Silt and clay, light gray grading downward to dark gray,	8	120
Silt and clay, light greenish gray; contains some caliche	8	128
Sand, coarse to fine, some fine gravel	22	150
Gravel, fine to medium, and sand	36	186
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, red brown and gray green	4	190

22-9-10ddd.—*Sample log of test hole in the SE¼ SE¼ SE¼ sec. 10, T. 22 S., R. 9 W.; drilled 1949. Surface altitude, 1,700.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	1	1
Dune sand		
Sand, medium to fine, and buff silt	2	3
Sanborn formation		
Silt and clay; yellow buff and light greenish gray; contains some sand, medium to fine. Some gravel, medium to fine, and sand in silt at 7 to 10 feet	11	14
Gravel, fine to medium, and sand; silty at top	13	27
Meade formation		
Silt and clay, light gray green and light brown, mottled; contains much coarse to fine sand and fine to coarse gravel. Some caliche at 36 to 38 feet	11	38
Silt and clay, light gray; contains much fine to medium sand and caliche	6	44
Sand, fine to coarse, silty at top; some fine to medium gravel	6	50
Gravel, fine to medium, and sand; some coarse gravel	10	60
Gravel, fine to medium, and sand; some coarse gravel. Clay, blue, green, and yellow at 66 to 67.5 feet	10	70
Gravel, medium to fine, and sand; some coarse gravel	19	89
Blanco formation		
Silt, light gray and light buff; contains much sand, fine	7	96
Gravel, medium to fine, and sand; some coarse gravel	4	100
Gravel, coarse to fine, and sand	5.5	105.5
Clay, dull bluish gray	4.5	110
Gravel, fine, and sand; some medium gravel	28	138
PERMIAN—Leonardian		
Harper sandstone		
Shale, dull red	2	140

22-9-20ddd.—*Sample log of test hole in the SE¼ SE¼ SE¼ sec. 20, T. 22 S., R. 9 W.; drilled 1949. Surface altitude, 1,716.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	2	2
Sanborn formation		
Silt and clay, light brown and gray; contains much medium to fine sand	7	9
Sand, coarse to fine, some fine to medium gravel	9.5	18.5
Meade formation		
Silt, buff; contains much coarse to fine sand. Some caliche at 27 to 32 feet	17.5	36
Sand, coarse to fine, and buff silt, some fine gravel	4	40
Gravel, fine, and sand. Much silt and caliche at 46 to 47.5 feet	7.5	47.5
Gravel, fine to medium, and sand	12.5	60
Sand, coarse to fine, some fine to medium gravel and buff silt	20	80
Gravel, fine to medium, and sand; some buff silt	20	100
Gravel, fine to medium, and sand	10	110
Gravel, fine to medium, and sand; some buff and yellow-gray silt	9	119
Blanco formation		
Silt, yellow gray and light gray; contains much medium to fine sand	11	130
Silt and clay, light gray; contains much very fine sand	7	137
Silt, blue gray, and sand, very fine to fine	9	146
Sand, very fine, and light-gray silt	14	160
Gravel, fine to medium, and sand, partly iron cemented	10	170
Gravel, medium to fine, and sand; some green and blue-gray silt	10	180
Gravel, medium to fine, and sand	9	189
Silt, pink to buff	4	193
Gravel, fine to medium, and sand	19	212
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, sandy, red	1	213

23-3-18bb.—*Sample log of test hole in the NW cor. sec. 18, T. 23 S., R. 3 W., Harvey County; drilled 1939. Surface altitude, 1,467.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Soil, sandy	2	2
Sand, medium to fine	6	8
Sand, fine to coarse; contains fine gravel	7	15
Meade formation		
Gravel, fine to coarse	3	18
Sand, fine to medium; contains gray silt	6	24
Sand, very fine, and gray to buff silt	6	30
Sand, medium to fine	8	38

	Thickness, feet	Depth, feet
Sand, medium to coarse	2	40
Sand, medium to fine	50	90
Sand, medium to fine, and some coarse sand	25	115
Sand, fine, and gray to buff silt; contains small nodules of calcium carbonate	10	125
Sand, medium to coarse; contains nodules of calcium carbonate	17	142
Sand, coarse to medium; many grains stained with limonite	11	153
Sand, medium to coarse	17	170
Sand, very fine to medium, and calcareous gray silt; contains coarse sand and nodules of calcium carbonate	11	181
Silt, calcareous, gray; contains very fine to medium sand and nodules of calcium carbonate	24	205
Silt, calcareous, buff	10	215
Sand, coarse to fine, and buff silt; contains nodules of calcium carbonate and fragments of shale	12	227
PERMIAN—Leonardian		
Wellington formation		
Shale, gray and maroon	13	240

23-4-8cc.—*Sample log of test hole in the SW cor. sec. 8, T. 23 S., R. 4 W.; drilled 1945. Surface altitude, 1,580.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine	22	22
Silt, light gray to buff, and medium to fine sand	19	41
Sand, medium to fine; contains some buff silt	25	66
Silt, light gray to buff; contains some medium to fine sand	14	80
Sand, medium to fine, and yellow-buff silt	3	83
Meade formation		
Silt, buff; contains some medium sand and nodules of calcium carbonate	7	90
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and gray green	2	92

23-4-14aa.—*Sample log of test hole in the NE cor. sec. 14, T. 23 S., R. 4 W.; drilled 1945. Surface altitude, 1,480.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine; contains buff to light-gray silt	27	27
Meade formation		
Silt, light gray, yellow, and buff; contains medium to fine sand	10	37
Sand, medium to fine, and gray to green-gray silt	29	66
Silt, light gray; contains some medium to fine sand	9	75

	Thickness, feet	Depth, feet
Sand, medium to fine, and dark- to light-gray silt	13	88
Silt, light gray to buff; contains medium to fine sand	12	100
Sand, medium to fine, and tan to light-gray silt	26	126
Silt, light gray to tan; contains sand, medium to fine, and nodules of calcium carbonate	34	160
Silt, tan; contains ironstone gravel and nodules of calcium carbonate	6	166
PERMIAN—Leonardian		
Wellington formation		
Shale, light gray, calcareous	9	175

23-4-14bb.—*Sample log of test hole in the NW cor. sec. 14, T. 23 S., R. 4 W.; drilled 1939. Surface altitude, 1,498.9 feet.*

QUATERNARY—Pleistocene

Dune sand	Thickness, feet	Depth, feet
Soil, very sandy	2	2
Sand, medium to very fine; contains tan silt	7	9
Sand, medium to fine; many grains stained tan by limonite	17	26
Meade formation		
Sand, very fine to fine, and buff to tan silt	11	37
Silt, tan, and very fine to fine sand	2	39
Sand, medium to very fine, and buff silt	3	42
Sand, medium to fine	8	50
Sand, medium	5	55
Sand, medium to fine, and buff silt	7	62
Sand, medium to fine	10	72
Sand, fine to very fine, and gray silt and clay	8	80
Sand, medium to fine	4	84
Sand, medium to very fine; contains buff silt	6	90
Sand, medium to fine	11	101
Sand, medium to fine; contains some very fine sand and buff silt	11	112
Sand, medium to coarse; contains some fine sand, many grains stained by limonite	18	130
Silt, buff; contains some very fine to fine sand	10	140
Silt, buff; contains some very fine to fine sand and many nodules of calcium carbonate	35	175
PERMIAN—Leonardian		
Wellington formation		
Shale, greenish gray and red	15	190

23-4-16aa.—*Sample log of test hole in the NE cor. sec. 16, T. 23 S., R. 4 W.; drilled 1945. Surface altitude, 1,529.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine; contains some light-gray to buff silt	60	60
Meade formation		
Silt, light gray to buff; contains medium to fine sand	17	77
Sand, medium to fine; contains light-gray to tan silt	15	92
Silt, light gray to buff; contains medium to fine sand	11	103
Sand, medium to fine, and gray to buff silt	2	105
Silt, light gray to buff; contains some medium to fine sand, and nodules of calcium carbonate	11	116
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green gray	12	128

23-4-16bb.—*Sample log of test hole in the NW cor. sec. 16, T. 23 S., R. 4 W.; drilled 1945. Surface altitude, 1,570.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine; contains small amount of light-gray silt	26	26
Silt, light gray to buff	4	30
Sand, medium to fine, and light-gray, yellow, and buff silt	38	68
Meade formation		
Silt, light gray to buff; contains medium to fine sand	37	105
Silt, gray; contains some fine to medium sand	28	133
Silt and clay, tan to buff	6	139
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green gray	1	140

23-4-18bb.—*Sample log of test hole in the NW cor. sec. 18, T. 23 S., R. 4 W.; drilled December 1944. Surface altitude, 1,546.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine; contains some dark-gray silt	6	6
Sand, coarse to fine; contains nodules of limonite	5	11
Silt, light gray, and medium to fine sand	5	16
Sand, medium to fine, and light-gray silt	12	28
Sand, medium to fine	3	31
Meade formation		
Silt, gray to tan	9	40
Silt, buff; contains nodules of calcium carbonate	11	51
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red and green gray	6	57

23-4-18ccb.—*Sample log of test hole in the NW¼ SW¼ SW¼ sec. 18, T. 23 S., R. 4 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,500.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Sand, medium to fine; contains some coarse sand and brown silt	6	6
Clay, tan to gray	4	10
Gravel, medium to fine; contains coarse gravel and coarse sand	33	43
Clay, blue gray	3	46
PERMIAN—Leonardian		
Ninnescah shale		
Shale, hard, red	1	47

23-5-2dda.—*Sample log of test hole in the NE cor. SE¼ SE¼ sec. 2, T. 23 S., R. 5 W.; drilled December 1945. Surface altitude, 1,601.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Silt, red brown, and fine sand	7	7
Silt, light gray; contains fine sand	21	28
Sand, fine to medium	4	32
Silt, brown, and fine to medium sand	26	58
Sand, fine to very fine	16	74
Meade formation		
Silt, light brown to gray	13	87
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red brown, gray, and blue green	3	90

23-5-3aa.—*Sample log of test hole at the NE cor. sec. 3, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,624.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, fine to medium	5	5
Sand, medium to very fine, and blue-gray silt and clay	11	16
Sand, medium to fine	12	28
Sand, medium to fine, and blue-gray silt and clay	3	31
Sand, medium to fine	10	41
Sand, medium to fine; grains stained red brown	6	47
Sand, medium to fine; contains some coarse sand and tan clay	10	57
Sand, medium to very fine; contains gray silt and clay	41	98
Sand, medium to fine, and gray clay	9	107
Sand, medium to fine; contains some coarse sand	2	109
Sand, medium to very fine, and gray to tan clay	14	123
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue gray and red	1	124

23-5-4cda.—*Drillers log of well at the NE cor. SE¼ SW¼ sec. 4, T. 23 S., R. 5 W.; drilled by the Layne-Western Co. for the Kansas Power and Light Co., October 1949. Surface altitude 1,523.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, brown, fine sandy	2	2
Terrace deposits		
Gravel, fine, and fine to very coarse sand	36	38
Clay, blue gray	1	39
Gravel, coarse to fine, and fine to coarse sand	15.5	54.5
PERMIAN—Leonardian		
Ninnescah shale		
Shale, light brown	0.5	55

23-5-4dbb.—*Drillers log of well at the NW¼ NW¼ SE¼ sec. 4, T. 23 S., R. 5 W.; drilled by the Atchison, Topeka and Santa Fe Railway Co., June 1944. Surface altitude, 1,528.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Sand, fine	12	12
Sand, medium to coarse	3	15
Gravel, fine, and sand, dirty	4	19
Sand and gravel, clean, sharp	4	23
Sand, coarse	2	25
Gravel, fine	1	26
Gravel and sand, coarse	14	40

23-5-6dd.—*Sample log of test hole in the SE cor. sec. 6, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,528.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Soil, sandy, dark brown	4	4
Silt and clay, gray to brown; contains fine sand	7	11
Gravel, coarse to fine, and coarse sand; contains some very coarse gravel	29	40
Gravel, coarse to fine	8	48
Gravel, medium to fine; contains coarse gravel and coarse sand; grains and pebbles stained red brown	18	66
PERMIAN—Leonardian		
Ninnescah shale		
Shale, soft, gray green	2	68

23-5-8aa.—*Sample log of test hole at the NE cor. sec. 8, T. 23 S., R. 5 W.; drilled by the Layne-Western Co. for the Central Fibre Products Co., June 1943. Surface altitude, 1,528.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, brown	3	3
Terrace deposits		
Silt, brown, and very fine sand	2	5
Sand, medium to coarse; contains fine gravel and fine sand	18	25

	Thickness, feet	Depth, feet
Gravel, fine to coarse, and coarse sand	7	30
Sand, coarse to medium, and fine to coarse gravel	12	42
Gravel, coarse to fine; contains coarse sand	15	57
Sand, coarse to medium, and fine to coarse gravel	5	62
PERMIAN—Leonardian		
Ninnescah shale		
Shale, micaceous, light brown	1	63

23-5-11cb.—*Sample log of test hole in the NW¼ SW¼ sec. 11, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,515.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Soil, brown, very sandy	3	3
Sand, medium to fine; contains coarse sand	7	10
Gravel, coarse to fine; contains some very coarse gravel	16	26
Gravel, coarse to fine	10	36
PERMIAN—Leonardian		
Ninnescah shale		
Shale, green	1	37

23-5-13dd.—*Sample log of test hole at the SE cor. sec. 13, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,499.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Sand, medium to fine	6	6
Clay, gray; contains fine sand	4	10
Gravel, coarse to fine; contains coarse sand; grains stained red brown	18	28
Gravel, fine to coarse, and coarse sand	13	41
Silt, tan, soft	12	53
Gravel, fine to medium, and coarse to medium sand	48	101
Gravel, medium to fine, and coarse sand	36	137
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue gray	2	139

23-5-14aa.—*Sample log of test hole in the NE cor. sec. 14, T. 23 S., R. 5 W.; drilled 1945. Surface altitude, 1,520.5 feet.*

	Thickness, feet	Depth feet
QUATERNARY—Pleistocene		
Terrace deposits		
Sand, medium to fine	3	3
Silt, blue gray, interbedded with medium to fine sand, limonitic	14	17
Silt, brown; contains much organic material	3	20
Gravel, coarse to fine, and coarse sand	10	30
Gravel, medium to fine, and coarse sand	4	34
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	2	36

23-5-14da.—*Sample log of test hole in the NE cor. SE¼ sec. 14, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,503.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Sand, medium to fine; contains some coarse sand	4	4
Sand, medium to fine; contains tan silt and clay and some coarse sand	3	7
Gravel, fine to coarse, and coarse sand	35	42
Gravel, fine to medium, and coarse sand	5	47
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and blue gray	2	49

23-5-15aa.—*Sample log of test hole in the NE cor. sec. 15, T. 23 S., R. 5 W.; drilled 1945. Surface altitude, 1,511.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Soil, very sandy, brown	2	2
Silt, yellow gray; contains fine gravel and coarse to fine sand	4	6
Gravel, fine to coarse, and coarse to medium sand	4	10
Sand, coarse to fine; contains some fine to medium gravel	10	20
Gravel, medium to fine, and coarse sand; includes a few thin beds of green clay	33	53
PERMIAN—Leonardian		
Ninnescah shale		
Shale, thin bedded, brick red, some green	4	57

23-5-15dd.—*Sample log of test hole in the SE cor. sec. 15, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,507.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, brown, sandy	3	3
Terrace deposits		
Clay, gray to tan	5	8
Gravel, fine to coarse, and coarse sand	6	14
Gravel, coarse to fine	4	18
Gravel, coarse to fine, and coarse sand	27	45
Clay, green to tan	1	46
Gravel, fine to coarse, and coarse sand	13	59
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red brown	1	60

23-5-16aa.—*Sample log of test hole in the NE cor. sec. 16, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,517.5 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Soil, brown, sandy	3	3
Terrace deposits		
Clay, tan to gray	7	10
Gravel, coarse to fine; contains some coarse sand	8	18
Gravel, very coarse to fine	17	35
Gravel, coarse to fine, and coarse sand	11	46
Clay, tan	2	48
Gravel, coarse to fine	15	63
Permian—Leonardian		
Ninnescah shale		
Shale, brick red and gray green	1	64

23-5-18cba.—*Drillers log of city-supply (Cleveland St.) well in the NE cor. NW¼ SW¼ sec. 18, T. 23 S., R. 5 W.; drilled for United Gas, Water, and Electric Co. (now owned by Hutchinson Water Co.), June 1922. Surface altitude, 1,531.0 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Terrace deposits		
Sand and gravel	10	10
Gravel and clay balls	18	28
Clay balls and gravel	20	48
Good, clean sand	13	61
Fine sand	17	78

23-5-21aa.—*Sample log of test hole in the NE cor. sec. 21, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,514.4 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Soil, brown, very sandy	2	2
Terrace deposits		
Clay, buff to tan	9	11
Gravel, very coarse to fine	24	35
Gravel, coarse to fine; contains thin layers of clay in lower part	25	60
Permian—Leonardian		
Ninnescah shale		
Shale, red	2	62

23-5-23dd.—*Sample log of test hole in the SE cor. sec. 23, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,498.1 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Soil, very sandy, brown	2	2
Terrace deposits		
Clay, soft, tan	2	4

	Thickness, feet	Depth, feet
Gravel, coarse to fine, and coarse sand	42	46
Gravel, fine to medium, and coarse to medium sand; grains stained red brown	4	50
Gravel, coarse to fine	47	97
PERMIAN—Leonardian		
Ninnescah shale		
Shale, blue green	3	100

23-5-24ad.—*Sample log of test hole in the SE cor. NE¼ sec. 24, T. 23 S., R. 5 W.; drilled December 1945. Surface altitude, 1,495.0 feet.*

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
Soil, brown	4	4
Terrace deposits		
Silt and clay, plastic, light gray	5	9
Gravel, fine to medium, and coarse to medium sand; contains some gray silt	59	68
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and blue green	3	71

23-5-29aa.—*Sample log of test hole in the NE cor. sec. 29, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,515.5 feet.*

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
Soil, sandy, brown to gray	2	2
Terrace deposits		
Clay, gray	5	7
Clay and silt, gray to tan; contains fine sand	4	11
Gravel, fine to coarse, and coarse sand	24	35
Gravel, fine to coarse, and coarse sand	12	47
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	3	50

23-5-32bb.—*Sample log of test hole in the NW cor. sec. 32, T. 23 S., R. 5 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,512.1 feet.*

QUATERNARY—Pleistocene

Alluvium and terrace deposits	Thickness, feet	Depth, feet
Soil, sandy, dark gray to brown	2	2
Gravel, coarse to fine; contains clay balls near middle	31	33
Gravel, coarse to fine	25	58
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green	2	60

23-6-1aa.—*Sample log of test hole in the NE cor., sec. 1, T. 23 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,539.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, sandy, brown	3	3
Terrace deposits		
Clay, tan to gray	8	11
Gravel, coarse to fine; contains coarse sand; material uniform throughout	59	70
PERMIAN—Leonardian		
Ninnescah shale		
Shale, brick red	2	72

23-6-12dcd.—*Drillers log of city-supply (Main St.) well in the SE¼ SW¼ SE¼ sec. 12, T. 23 S., R. 6 W.; drilled for United Gas, Water and Electric Co. (now owned by Hutchinson Water Co.), July 1922.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium and terrace deposits		
Sand and gravel	16	16
Good gravel	18	34
Gravel and sand	12	46
Sand, some clay balls	9	55
Fine, clean sand	20	75

23-6-36dd.—*Sample log of test hole in the SE cor. sec. 36, T. 23 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, October 1945. Surface altitude, 1,523.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, sandy, brown	3	3
Terrace deposits		
Clay, buff; contains fine sand	6	9
Clay, buff, and fine sand; partly cemented zone at 19 feet	11	20
Gravel, coarse to fine, and coarse to medium sand	44	64
Blanco formation		
Gravel, coarse to fine sand, and gray to buff clay	10	74
Sand, coarse to medium, and fine gravel	5	79
Clay, buff, and fine sand	10	89
Gravel, medium to fine, and coarse to medium sand	35	124
Gravel, medium to fine, and course to medium sand; contains some buff clay and fragments of shale	12	136
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and gray	2	138

23-7-18bcb.—*Sample log of test hole in the NW¼ SW¼ NW¼ sec. 18, T. 23 S., R. 7 W.; drilled 1949. Surface altitude, 1,622.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Sanborn formation		
Soil, medium sandy, black	1	1
Clay and silt, gray green; contains much fine to medium sand	2	3
Silt and clay, tan, mottled gray green; contains much medium to fine sand	3	6
Silt, buff; contains much medium to fine sand and caliche	7	13
Silt, light brown; contains much fine to coarse sand and caliche	5.5	18.5
Gravel, fine, and sand, grading downward to gravel	6.5	25
Meade formation		
Clay, blue gray mottled yellow; contains much caliche in large nodules	4	29
Gravel, medium to fine, and black sand, stained at top	6.5	35.5
Clay and silt, brownish gray; contains much medium to fine sand	2	37.5
Clay and silt, dark gray	2.5	40
Clay, blue gray mottled yellow	7	47
Gravel, medium to fine, and sand	8.5	55.5
Clay, light gray mottled yellow brown	2	57.5
Gravel, fine, and sand, grading downward to medium gravel	12.5	70
Sand, coarse to fine, and fine gravel, some medium gravel	15.5	85.5
Silt, yellow and gray, sandy	1.5	87
Sand, coarse to fine, some fine to medium gravel	13	100
Blanco formation		
Clay, gray grading downward to blue gray and light greenish brown, thinly laminated at top; interlaminated with sand, very fine, yellow brown, slightly cemented	8	108
Sand, fine to coarse, interbedded with yellow-brown silt at 109 to 115 feet	12	120
Sand, coarse to fine, and some fine gravel	8	128
Clay and silt, tan, compact; contains some caliche	9	137
Silt and clay, tan; contains much fine to coarse sand	4	141
Silt, red to tan; interbedded with medium to fine sand; contains some caliche	11	152
Sand, fine to coarse, some fine to medium gravel	8	160
Gravel, fine to medium, and sand	10	170
PERMIAN—Leonardian		
Harper sandstone		
Shale, silty, red brown and gray green	3	173

23-7-31ccc.—*Sample log of test hole in the SW¼ SW¼ SW¼ sec. 31, T. 23 S., R. 7 W.; drilled 1949. Surface altitude, 1,606.7 feet.*

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
Road fill	2	2
Sanborn formation		
Silt and clay, black and gray, alternating; contains some nodular caliche and much fine to coarse sand in lower part	5	7
Silt and clay, light gray green; contains much fine to medium sand	4	11
Sand, coarse to fine	1	12
Meade formation		
Silt and clay, gray green; contains some medium to fine sand and caliche at 15 to 21 feet	9	21
Sand, fine to coarse	4.5	25.5
PERMIAN—Leonardian		
Harper sandstone		
Shale, silty, thin bedded, red brown	1.5	27

23-10-13aaa.—*Sample log of test hole in the NE¼ NE¼ NE¼ sec. 13, T. 23 S., R. 10 W.; drilled 1949. Surface altitude, 1,747.1 feet.*

QUATERARY—Pleistocene

Dune sand	Thickness, feet	Depth, feet
Sand, silty, medium fine	4	4
Sanborn formation		
Clay, gray grading downward to light gray. Iron stained at base	4	8
Silt, light brown; contains much medium to fine sand	6.5	14.5
Sand, fine to coarse, some fine to medium gravel	12.5	27
Meade formation		
Silt and clay, light gray green and light brown; contains much coarse to fine sand	10.5	37.5
Sand, coarse to fine, some gravel, fine to medium, and light-gray and brown silt	12.5	50
Gravel, fine to medium, and sand	10	60
Gravel, medium to fine, and sand; much coarse gravel	17	77
Silt, yellow gray; contains much very fine to fine sand	5	82
Gravel, medium to fine, and sand	35	117
Blanco formation		
Silt, light brown; grades downward to sandy; contains caliche at 127 to 135 feet; some fine sand, thin bedded, slightly cemented	18	135
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, light green and red brown	1	136

23-10-19bcb.—*Sample log of test hole in the NW¼ SW¼ NW¼ sec. 19, T. 23 S., R. 10 W.; drilled 1949. Surface altitude, 1,792.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	2	2
Dune sand		
Silt, dark buff; contains much fine to medium sand, especially at 5 to 8 feet	6	8
Meade formation		
Silt and clay, buff; contains some fine to medium gravel	9	17
Gravel, fine to coarse, and sand; some medium to coarse gravel	7	24
Sand, coarse to fine, and buff silt; some fine gravel	6	30
Gravel, fine to medium, and coarse sand and yellow-gray silt	20	50
Gravel, coarse to fine, and sand; some yellow-gray silt; few pebbles	20	70
Gravel, fine, and sand	8.5	78.5
Blanco formation		
Clay and silt, light gray and yellow; contains much medium to fine sand	3.5	82
Clay, thin bedded, yellow and light gray	2	84
Sand, coarse to fine, some fine to medium gravel and gray-green clay	28	112
PERMIAN—Leonardian		
Harper sandstone		
Shale, red brown	1.5	113.5

23-10-25bbb.—*Sample log of test hole in the NW¼ NW¼ NW¼ sec. 25, T. 23 S., R. 10 W.; drilled 1949. Surface altitude, 1, 756.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine, and gray silt	3	3
Sanborn formation		
Silt, dark gray brown (A zone), grading downward to light-brown clay	2	5
Silt, buff; contains much medium to fine sand increasing downward	13	18
Sand, fine to medium, slightly cemented, and brown silt; some fine gravel	5	23
Meade formation		
Clay, bentonitic, green, and light-brown silt; contains much coarse to fine sand, much caliche at 28 to 32.5 feet	9.5	32.5
Sand, fine to coarse	7.5	40
Sand, fine to coarse; some fine gravel	10	50
Silt and clay, light brown; contains much fine to coarse sand	4	54
Sand, coarse to fine, grading downward to fine to medium gravel and sand, much light-brown silt	6	60

	Thickness, feet	Depth, feet
Gravel, fine to medium, and sand, grading downward to coarse to fine gravel and sand	10	70
Gravel, medium to fine, and sand; some coarse gravel	10	80
Gravel, fine to medium, and sand; some light-gray clay	10	90
Gravel, fine to medium, and sand	20	110
Sand, coarse to fine, some fine to medium gravel	20	130
Gravel, fine to medium, and sand	10	140
Blanco formation		
Silt, light gray, fine to coarse sand, and fine to coarse gravel	10	150
Sand, coarse to fine, some fine gravel, and light-gray gravel	10	160
Gravel, fine to coarse, and sand	12	172
Clay, gray to green	2	174
Gravel, coarse to fine, and sand	2	176
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, red brown	1	177

24-4-13cc.—*Drillers log of test hole in the SW cor. sec. 13, T. 24 S., R. 4 W.; drilled by Layne-Western Co. for the City of Wichita, 1939. Surface altitude, 1,451.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Silt, dark brown, and fine sand	9	9
Sand and gravel	16	25
Silt, clay, and fine sand	3	28
Sand and gravel	17	45
Sand	21	66
Silt and clay, blue green	36	102
Sand and gravel	33	135
Silt and clay	3	138
Sand and gravel	77	215
Silt and clay, sandy, tan	10	225
PERMIAN—Leonardian		
Ninnescah shale		
Shale, green	5	230

24-4-19bbb.—*Sample log of test hole in the NW cor. NW¼ NW¼ sec. 19, T. 24 S., R. 4 W.; drilled 1949. Surface altitude, 1,475.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, gray to brown, fine, sandy	3.5	3.5
Gravel, fine to coarse, and sand	22	25.5
Sanborn formation		
Silt and clay, yellow gray and buff; contains much fine sand; much hard, nodular caliche at 30 to 36 feet	10.5	36
Clay and silt, light gray grading downward to gray green; contains some nodular caliche	4	40
Silt and clay, light gray green	10	50

	Thickness, feet	Depth, feet
Silt and clay, blue to blue gray; interbedded with some fine gravel and sand	10	60
Silt and clay, blue gray	8	68
Silt, gray, and very fine to medium sand	7	75
Silt, buff; contains much medium to fine sand	5	80
Gravel, fine to medium, and sand	14	94
Meade formation		
Silt and clay, gray white; contains much caliche	10	104
Silt and clay, blue gray	5	109
Gravel, fine, and sand	3	112
Silt and clay, blue gray	5	117
Silt, gray white and lavender brown; contains much coarse to fine sand; many cemented nodules	8	125
Gravel, fine to medium, and sand	38	163
Blanco formation		
Silt and clay, pink buff and light gray green; contains much coarse to fine sand, and caliche	3	166
Gravel, fine, and sand	6	172
Silt and clay, brown and light brown; contains much fine to medium sand	8	180
Silt and clay, buff; contains much coarse to fine sand	5	185
Gravel, fine to medium, and sand; some buff and greenish-gray silt	8	193
Silt and clay, buff and greenish gray, sandy	4	197
Gravel, fine to medium, and sand	11	208
Clay and silt, gray white, sandy	4.5	212.5
Gravel, fine, and sand; some medium gravel	47.5	260
Gravel, fine to medium, and sand	31	291
Clay and silt, light brown; some caliche	4	295
Gravel, fine to medium, and sand	12	307
PERMIAN—Leonardian		
Wellington formation		
Shale, thin bedded, blue; few thin calcite veins	3	310

24-5-16baa.—*Drillers log of test hole in the NE¼ NE¼ NW¼ sec. 16, T. 24 S., R. 5 W.; drilled by Layne-Western Co. for U. S. Navy, 1942.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Clay	41	41
Sand, fine	9	50
Sand, medium to coarse	16	66
Clay and sand	6	72
Sand, medium to coarse, silty	28	100
Clay, gray	7	107
Sand, silty	11	118
Sand, medium to coarse, and gravel	9	127
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	128

24-5-16bab.—*Drillers log of well in the NW¼ NE¼ NW¼ sec. 16, T. 24 S., R. 5 W.; drilled by Layne-Western Co. for U. S. Navy, 1942.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Meade formation		
Silt	3	3
Clay, sandy	17	20
Sand, fine	15	35
Sand, medium	10	45
Sand, coarse	7	52
Clay, yellow	13	65
Sand, coarse	17	82
Sand, coarse, and gravel	14	96
Sand, medium to coarse	29	125
PERMIAN—Leonardian		
Ninnescah shale		
Shale	1	126

24-6-11cc.—*Sample log of test hole in the SW cor. sec. 11, T. 24 S., R. 6 W.; drilled December 1945. Surface altitude, 1,547.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Sanborn formation		
Soil, dark gray	3	3
Silt, light gray	4	7
Meade formation		
Silt, light brown, iron stained; contains some fine sand	8	15
Gravel, fine, and fine to coarse sand	28	43
Gravel, fine, fine to medium sand, and buff silt	6	49
Silt, dark tan	12	61
Blanco formation		
Silt, brown, and fine to coarse sand; contains some caliche	9	70
Sand, fine to medium, and fine gravel; contains some gray to brown silt	11	81
Silt, tan, interbedded with fine sand	9	90
Silt and clay, gray to red brown; plastic	13	103
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red and light blue	3	106

24-6-12bb.—*Sample log of test hole in the NW cor. sec. 12, T. 24 S., R. 6 W.; drilled by Claude Price for the City of Hutchinson, November 1945. Surface altitude, 1,545.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Sanborn formation		
Soil, sandy, dark gray	3	3
Clay, buff to tan; contains fine sand	11	14
Meade formation		
Clay, blue gray	6	20
Sand, coarse to fine; contains some fine gravel	9	29
Sand, coarse to medium, and fine gravel	11	40

	Thickness, feet	Depth, feet
Clay, gray, hard	6	46
Gravel, fine to medium, and coarse to medium sand	26	72
Blanco formation		
Clay, gray	8	80
Gravel, fine to medium, and coarse to fine sand, very poorly sorted	72	152
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green	1	153

24-6-22bb.—*Sample log of test hole in the NW cor. sec. 22, T. 24 S., R. 6 W.; drilled December 1945. Surface altitude, 1,558.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road material	2	2
Sanborn formation		
Silt, gray	5	7
Meade formation		
Silt, light gray; contains nodules of calcium carbonate	5	12
Silt, tan	5	17
Sand, fine to very fine; contains tan silt	10	27
Silt, tan to red brown; contains some fine sand	18	45
Silt, brown; contains nodules of calcium carbonate	4	49
Silt, gray and red brown	10	59
PERMIAN—Leonardian		
Ninnescah shale		
Shale, soft, red and blue green	3	62

24-7-19bbb.—*Sample log of test hole in the NW cor. NW¼ NW¼ sec. 19, T. 24 S., R. 7 W.; drilled 1949. Surface altitude, 1,630.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, sandy, dark gray	1	1
Sanborn formation		
Clay and silt, compact, dull green gray; contains much fine to coarse sand and fine gravel	2.5	3.5
Silt and clay, yellow buff; contains much fine to coarse sand and some fine gravel	4.5	8
Sand, fine to coarse, some fine gravel and yellow-buff silt,	2	10
Meade formation		
Clay, blocky, yellow gray	1	11
Gravel, fine to medium, some coarse gravel	9	20
Gravel, fine to coarse, and sand	22	42
Gravel, fine to medium, and sand; interbedded with silt and gray and buff clay, few pebbles	5	47
Gravel, fine to medium, and sand	23	70
Gravel, medium to fine, and sand, grading downward to coarse to fine gravel	5	75
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, thin bedded, brick red	2	77

24-10-12ccc.—*Sample log of test hole in the SW cor. SW¼ SW¼ sec. 12, T. 24 S., R. 10 W.; drilled 1949. Surface altitude, 1,720.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	1	1
Sanborn formation		
Clay, light green; contains some nodular caliche; sandy at 1 to 5 feet	6	7
Gravel, fine to medium, and sand	6	13
Gravel and sand, coarse to fine, yellow brown, and green clay	11.5	24.5
Meade formation		
Silt and clay, gray green grading downward to pink brown; contains much coarse to fine sand and few pebbles, some caliche	11.5	36
Sand, fine to coarse	5	41
Silt, buff and yellow brown, slightly cemented; contains much fine gravel and sand	9	50
Gravel, fine, and sand; some medium to coarse gravel, and buff silt, slightly cemented	40	90
PERMIAN—Leonardian		
Harper sandstone		
Shale, silty, red brown	1	91

25-3-7bb.—*Sample log of test hole in the NW cor. sec. 7, T. 25 S., R. 3 W., Sedgwick County; drilled 1939. Surface altitude, 1,433.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium and terrace deposits		
Soil, sandy, brown	4	4
Clay and silt, red brown	2	6
Sand and gravel	3	9
Sand	24	33
Sand; contains clay balls	2	35
Sand and gravel	12	47
Gravel	4	51
Sand, coarse, interbedded with coarse gravel	129	180
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	20	200

25-4-5bbd.—*Drillers log of test hole in the SE¼ NW¼ NW¼ sec. 6, T. 25 S., R. 4 W.; drilled by Wichita Pump and Supply Co., for Panhandle Eastern Co., 1936. Surface altitude, 1,475.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Silt, sandy	3	3
Clay, sandy, soft	57	60
Clay, sandy	7	67
Sand, fine	2	69
Clay, sandy	8	77

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah shale		
Shale, soft, red	9	86
Shale, red	14	100
Shale, red	2	102
Shale, red and gray	23	125
Shale, gray	10	135

25-4-5bdc.—*Drillers log of test hole in the SW¼ SE¼ NW¼ sec. 5, T. 25 S., R. 4 W.; drilled by Wichita Pump and Supply Co., for Panhandle Eastern Co., 1936. Surface altitude, 1,479.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Silt and clay, hard	23	23
Silt and sand, fine	2	25
Silt and clay	2	27
Clay and sand	15	42
Clay, gray	8	50
Sand, coarse, and gravel	8	58
Clay, soft, red	6	64
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	1	65

25-4-12cc.—*Sample log of test hole in the SW cor. sec. 12, T. 25 S., R. 4 W.; drilled 1939. Surface altitude, 1,455.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Soil, sandy, brown	2	2
Terrace deposits		
Silt, red brown	6	8
Clay and silt, sandy, tan to gray	12	20
Sand	3	23
Gravel	7	30
Sand	10	40
Gravel	5	45
Sand	7	52
Sand, contains fragments of green shale	3	55
PERMIAN—Leonardian		
Wellington formation		
Shale, gray	5	60

25-4-14cc.—*Sample log of test hole in the SW cor. sec. 14, T. 25 S., R. 4 W.; drilled 1939. Surface altitude, 1,483.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Terrace deposits		
Silt, sandy, red brown	8	8
Clay and silt, sandy, gray to brown; contains fragments of shale	2	10
Clay and silt, sandy, dark brown	6	16
Clay and silt, red brown	26	42

	Thickness, feet	Depth, feet
Clay and silt, yellow to greenish gray	8	50
Sand and gravel	17	67
Gravel	1	68
Permian—Leonardian		
Ninnescah shale		
Shale, brick red and green	12	80

25-4-28cc.—*Sample log of test hole in the SW cor. sec. 28, T. 25 S., R. 4 W.; drilled 1939. Surface altitude, 1,564.0 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Meade formation		
Silt, dark brown	2	2
Silt, tan	2	4
Silt, buff to tan; contains nodules of calcium carbonate	4	8
Sand, coarse to fine; contains fragments of green shale	2	10
Sand, medium; contains fragments of shale	4	14
Permian—Leonardian		
Ninnescah shale		
Shale, tan and greenish gray	3	17
Shale, brick red	3	20

25-6-20bc.—*Sample log of test hole in the SW¼ NW¼ sec. 20, T. 25 S., R. 6 W.; drilled 1949. Surface altitude, 1,469.9 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Alluvium		
Soil, sandy, fine	4	4
Sand, fine to coarse, and fine to coarse gravel	4	8
Gravel, fine to coarse, fine to coarse sand, some clay	1	9
Gravel, fine to coarse, and fine to coarse sand	2	11
Sand, fine to coarse, some fine to coarse gravel	9	20
Gravel, fine to coarse, some fine to coarse sand, much Permian-derived gravel, some red and brown clay	17	37
Permian—Leonardian		
Ninnescah shale		
Shale, red	2	39

25-7-6ccc.—*Sample log of test hole in the SW cor. SW¼ SW¼ sec. 6, T. 25 S., R. 7 W.; drilled 1949. Surface altitude, 1,604.2 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Soil, sandy, dark gray	2	2
Sanborn formation		
Sand, coarse to fine, some fine to medium gravel	8	10
Meade formation		
Silt, yellow gray; contains much fine to coarse sand	4	14
Gravel, fine, and sand, some medium gravel and yellow-gray silt	16	30
Gravel, medium to fine, and sand; some coarse gravel, and yellow-gray silt	40	70
Gravel, fine to medium, and sand	4.5	74.5

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, fine sandy, brick red	1.5	76

25-8-24ddd.—*Sample log of test hole in the SE cor. SE¼ SE¼ sec. 24, T. 25 S., R. 8 W.; drilled 1949. Surface altitude, 1,541.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine	1	1
Terrace deposits		
Silt, tan, and fine to coarse sand	2	3
Gravel, medium to fine, and sand	4	7
PERMIAN—Leonardian		
Harper sandstone		
Shale and siltstone, fine to sandy, red brown	1	8

25-10-12ccc.—*Sample log of test hole in the SW cor. SW¼ SW¼ sec. 12, T. 25 S., R. 10 W.; drilled 1949. Surface altitude, 1,733.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, medium to fine	5	5
Sanborn formation		
Clay, light gray green and light brown; contains much sand and fine gravel	8	13
Gravel, fine, and sand and yellow-brown silt; few pebbles,	7	20
Gravel, fine to medium, and sand; few pebbles	10	30
Gravel, fine to coarse, and sand	5	35
Gravel, fine to medium, and sand	13.5	48.5
Meade formation		
Silt, light brown; contains much fine to coarse sand	2.5	51
Gravel, fine, and sand; some light-brown and light-gray silt	19	70
Gravel, fine to coarse, and sand	15	85
Silt, light brown; contains much thin-bedded fine sand	9.5	94.5
Gravel, fine to medium, and sand; few pebbles	5	99.5
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, red	0.5	100

26-4-6cc.—*Sample log of test hole in the SW cor. sec. 6, T. 26 S., R. 4 W.; drilled 1939. Surface altitude, 1,434.2 feet.*

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah shale		
Silt and clay, brown (weathered shale)	2	2
Shale, brick red, blocky	1	3
Shale, soft, calcareous, light gray	2	5
Shale, blocky, brick red	5	10
Shale, brick red and greenish gray	10	20

26-6-6ddd.—*Sample log of test hole in the SE cor. SE¼ SE¼ sec. 6, T. 26 S., R. 6 W.; drilled 1949. Surface altitude, 1,575.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Road fill	1	1
Sanborn formation		
Silt, tan and buff, sand and fine gravel	5	6
Gravel, fine to coarse, and sand	5	11
Silt and clay, yellow gray; contains much fine sand	2	13
Meade formation		
Sand, fine to coarse, grading downward to fine gravel and sand	7	20
Sand, coarse to fine, some fine to medium gravel, and yellow-gray silt	20	40
Gravel, medium to fine, and sand; some light-gray silt	10	50
Gravel, fine to coarse, and sand	4	54
Blanco formation		
Clay and silt, light gray green and light tan; contains much fine to coarse sand	2.5	56.5
Gravel, fine to medium, and sand. Much gravel, coarse to pebbles	11.5	68
PERMIAN—Leonardian		
Ninnescah shale		
Shale, gray green and red brown	1	69

26-6-18cb.—*Sample log of test hole in the NW¼ SW¼ sec. 18, T. 26 S., R. 6 W.; drilled 1950. Surface altitude, 1,570.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Sanborn formation		
Silt, sandy, dark brown	4	4
Meade formation		
Sand, fine to coarse, some brown silt; some fine to coarse gravel	7	11
Sand, fine to coarse, some fine gravel	21	32
Sand, fine to coarse	9	41
Blanco formation		
Sand, fine to coarse, and few gray clay streaks	9	50
Gravel, fine to coarse, and fine to coarse sand	16	66
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red	2	68

26-7-24ccc.—*Sample log of test hole in the SW cor. SW¼ SW¼ sec. 24, T. 26 S., R. 7 W.; drilled 1949. Surface altitude, 1,602.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Sanborn formation		
Silt, tan, and fine to coarse gravel	3	3
Sand, fine to coarse, some fine gravel	7	10
Meade formation		
Gravel, medium to fine, and sand; some coarse gravel, and light-gray silt	10	20

	Thickness, feet	Depth, feet
Gravel, fine, and sand, interbedded with silt and yellow-gray clay	21	41
Silt and clay, light brown	1	42
Gravel, fine to coarse, and sand	3.5	45.5
Blanco formation		
Clay and silt, light brown and light greenish gray; contains much caliche	8.5	54
Silt and clay, light brown; contains much fine sand and few sandstone pebbles; thin bedded	7	61
Silt and clay, light gray brown; contains much fine sand; hard caliche at 61 to 62 feet	9	70
Silt and clay, light gray; contains much fine to coarse sand	6	76
Silt and clay, light gray green and light tan; contains much coarse to fine sand	8	84
Gravel, medium to fine, and sand	1	85
PERMIAN—Leonardian		
Ninnescah shale		
Shale, red brown and gray green	2	87

26-8-18cc.—*Sample log of test hole in the SW¼ SW¼ sec. 18, T. 26 S., R. 8 W.; drilled 1950. Surface altitude, 1,635.0 feet.*

QUATERNARY—Pleistocene

Sanborn formation and Meade formation	Thickness, feet	Depth, feet
Silt, brown sandy	3	3
Silt, tan to buff	3	6
Silt, buff and gray sandy, some caliche and fine gravel	7	13
Sand, medium, red-brown stain; some tan clay at 17 feet,	5	18
Blanco formation		
Clay, buff to gray; much fine sand	8	26
Sand, fine to coarse, and fine gravel, some Cretaceous-derived material	12	38
Gravel, medium to fine; some coarse to fine sand; much Cretaceous-derived gravel	2	40
PERMIAN—Leonardian		
Harper sandstone		
Shale, red	3	43

26-8-25aaa.—*Sample log of test hole in the NE cor. NE¼ NE¼ sec. 25, T. 26 S., R. 8 W.; drilled 1949. Surface altitude, 1,617.5 feet.*

QUATERNARY—Pleistocene

Meade formation	Thickness, feet	Depth, feet
Soil, dark gray grading downward to brown; contains coarse to fine gravel and sand	2	2
Gravel, medium to fine sand, and tan silt; some coarse gravel	5.5	7.5
Clay and silt, light gray; contains much coarse to fine sand and fine to medium gravel	2.5	10

Blanco formation	Thickness, feet	Depth, feet
Clay, blocky, yellow gray	3	13
Clay and silt, light gray; contains much coarse to fine sand and caliche	8	21
Clay and silt, white, light brown, and light gray green, thin bedded; contains much caliche	3	24
Gravel, medium to fine, and sand	8.5	32.5
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, fine to sandy, thin bedded, red brown	.5	33

26-9-34aaa.—*Sample log of test hole in the NE¼ NE¼ NE¼ sec. 34, T. 26 S., R. 9 W.; drilled 1950. Surface altitude, 1,672.8 feet.*

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
Soil, brown, fine sandy	3	3
Sanborn formation		
Clay, tan, much fine to coarse sand and some fine gravel,	4	7
Clay, tan, some fine to coarse sand, and fine to coarse gravel	4	11
Clay, tan to buff, fine sandy	13	24
Sand, fine to medium (red-brown stain)	1.5	25.5
Meade formation		
Clay, buff, fine sandy	9.5	35
Clay, buff; much caliche	3	38
Clay, buff, and sand; coarse and fine gravel	5	43
Sand, medium to coarse; clay streaks, buff	17	60
Sand, medium to coarse, some fine to medium gravel and buff clay streaks	20	80
Sand, medium to coarse, and fine gravel	17	97
Sand, medium to coarse, and fine gravel; buff clay streaks	9	106
Blanco formation		
Clay, dark gray, fine sandy	12	118
Sand, medium to coarse; some medium to fine gravel, some Cretaceous-derived fragments	12	130
Sand, medium to coarse, and fine to medium gravel, some Cretaceous-derived material	17	147
PERMIAN—Leonardian		
Harper sandstone		
Siltstone and red shale, alternating hard and soft layers	8	155

26-10-2cd.—*Sample log of test hole in the SE cor. SW¼ sec. 2, T. 26 S., R. 10 W.; drilled 1949. Surface altitude, 1,708.5 feet.*

QUATERNARY—Pleistocene

Sanborn formation	Thickness, feet	Depth, feet
Gravel, fine to coarse, and sand; some light-gray silt and clay	10	10
Gravel, fine, and sand; some medium gravel and buff and light-gray silt	10	20
Gravel, fine, and sand; some medium to coarse gravel and buff and light-gray silt	8.5	28.5

	Thickness, feet	Depth, feet
Meade formation		
Clay and silt, light gray, yellow brown; contains much fine to coarse sand at 30 to 36 feet and caliche at 34 feet	7.5	36
Sand, coarse to fine, some fine gravel	4	40
Sand, coarse to fine, some fine to medium gravel, some gray and buff silt	20	60
Gravel, fine to medium, and sand; some buff silt	25	85
Blanco formation		
Clay, bentonitic, light gray green and brown; contains much fine to medium sand	9	94
Clay and silt, gray brown	2	96
Silt, buff; contains much fine to coarse sand and caliche	3	99
Sand, fine to coarse, some fine gravel	10	109
Clay, light brown, partly fine sandy	8	117
Sand, fine to coarse, some fine to medium gravel; some light-gray and brown clay in lower part	13	130
Gravel, medium to fine, and sand	5	135
PERMIAN—Leonardian		
Harper sandstone		
Shale, red brown	2	137

26-10-27ddd.—*Sample log of test hole in the SE cor. SE¼ SE¼ sec. 27, T. 26 S., R. 10 W.; drilled 1949. Surface altitude, 1,690.5 feet.*

QUATERNARY—Pleistocene

	Thickness, feet	Depth, feet
Dune sand		
Sand, medium to fine, silty	3.5	3.5
Sanborn formation		
Silt and clay, brown gray; contains some fine to coarse gravel and sand	2.5	6
Silt and clay, light greenish gray and light brown; contains much coarse to fine gravel and sand	5	11
Gravel, fine to coarse, and sand	1.5	12.5
Meade formation		
Clay and silt, yellow gray, light gray, and light brown, alternating sandy and non-sandy; contains some caliche	7.5	20
Sand, coarse to fine, much fine gravel	10	30
Gravel, medium fine, and sand; some yellow-gray clay	10	40
Sand, coarse to fine, some fine gravel	10	50
Gravel, fine to medium, and sand	4.5	54.5
PERMIAN—Leonardian		
Harper sandstone		
Siltstone, hard, white and light green, and fine to very fine sandstone	5.5	60

26-11-36dd.—*Sample log of test hole in the SE cor. sec. 36, T. 26 S., R. 11 W.; Pratt County; drilled July 1951. Surface altitude, 1,759.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand and gray-black silt	1	1
Silt, clayey, red, and fine sand	6	7
Sanborn formation		
Sand, clayey, fine; contains some fine gravel	4	11
Gravel, fine to coarse; contains clay streaks	3	14
Sand, silty to clayey, fine	4.5	18.5
Sand, very fine; contains some light-gray silt	15.5	34
Sand, fine to medium; contains some yellow-brown silt	7.5	41.5
Meade formation		
Clay, tan to gray; contains fine sand	3.5	45
Sand, fine to medium, very clayey	6	51
Sand, fine to medium	9	60
Sand, coarse	3	63
Sand, fine to coarse, and fine to coarse gravel	7	70
Sand, fine to medium, silty	10	80
Sand, fine to medium, clayey	20	100
Blanco formation		
Silt, sandy, yellow brown, limy	10	110
Sand, silty, fine to medium	10	120
Sand, clayey, fine to medium	16	136
Sand, fine; contains some gray-tan clay	11	147
PERMIAN—Leonardian		
Harper sandstone		
Sandstone, pink to light red, very hard	3	150
Sandstone, red, soft	4	154
Siltstone to fine sandy shale, red, hard	6	160

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26-3102

AREAL GEOLOGY OF RENO COUNTY, KANSAS

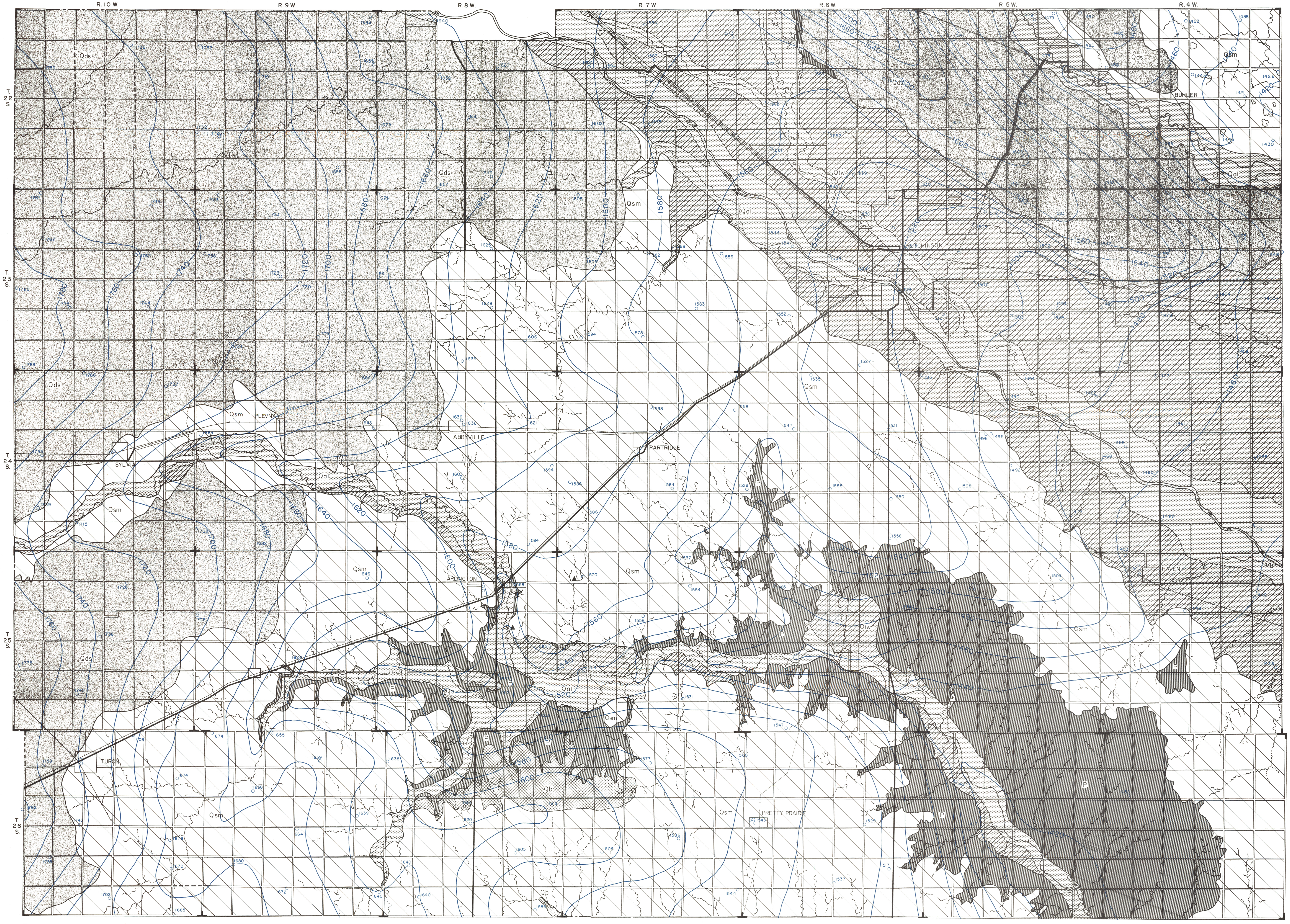
With Water-Table Contours

by O. S. Fent and C. K. Bayne

1956

State Geological Survey
of Kansas

Bulletin 120
Plate 1



Base compiled from maps prepared
by the Soil Conservation Service

Drainage from map prepared
by U. S. Dept. of Agriculture

EXPLANATION

QUATERNARY

PLEISTOCENE

Qal

Alluvium

Sand, gravel and silt along stream valleys. Yields large supplies of water in major valleys and moderate supplies in tributaries.

Qds

Dune sand

Consists of medium and fine sand. Yields small supplies of water to wells.

Qtw

Terrace Deposits

Consists of sand, gravel and silt. Yields large supplies of water to wells along major streams.

Qsm

Sanborn and Meade formation

Consists of eolian silt, sand, gravel and locally volcanic ash. Yields large supplies of good to fair quality water to wells.

Qb

Blanco formation

Consists of silt, clay, sand and gravel. Where present in upland position yields moderate supplies of good quality water to wells. Where in deeply buried channel position yields large supplies of very poor quality water.

PERMIAN

LEONARDIAN

P

Permian

Consists of shale, sandy shale, sandstone and siltstone with minor amounts of anhydrite and dolomite. Yields small supplies of highly mineralized water to wells.

○1440

Well location. Number refers to altitude of water level.

1520

Water-table contours based on instrumental levels. Contour interval 20 feet.

▲

Outcrop of Pearlette volcanic ash of Meade formation.

0 1 2 3 4

SCALE IN MILES

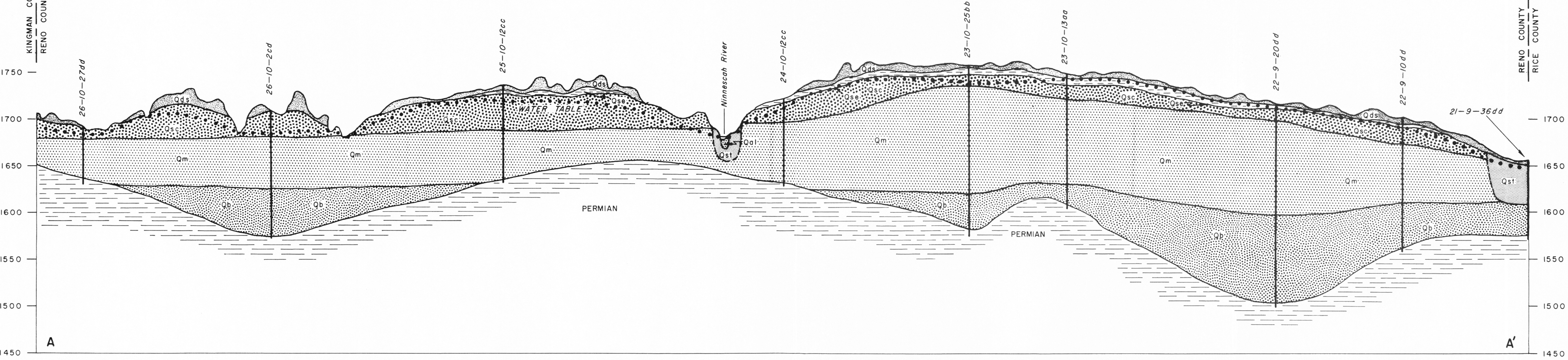
State Geological Survey of Kansas

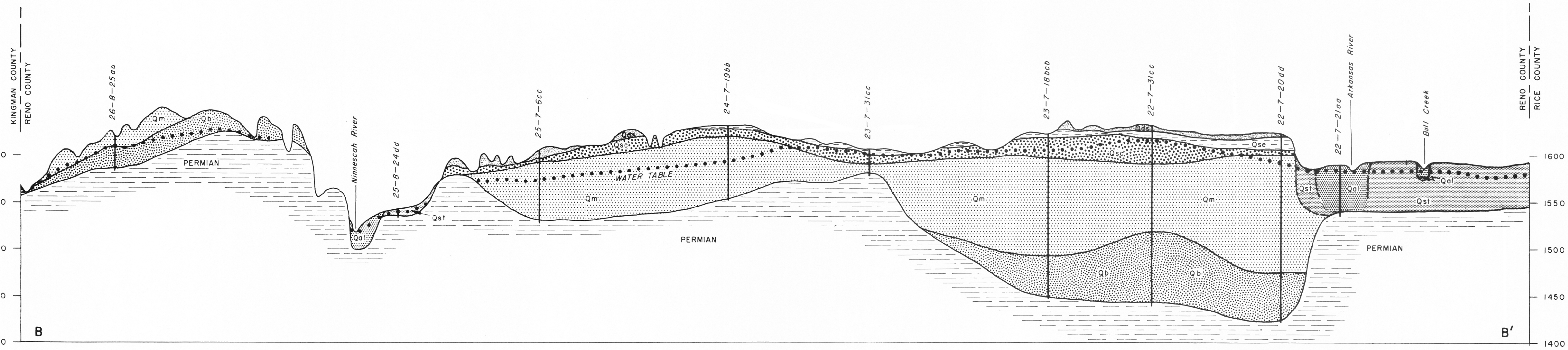
GEOLOGIC CROSS SECTIONS

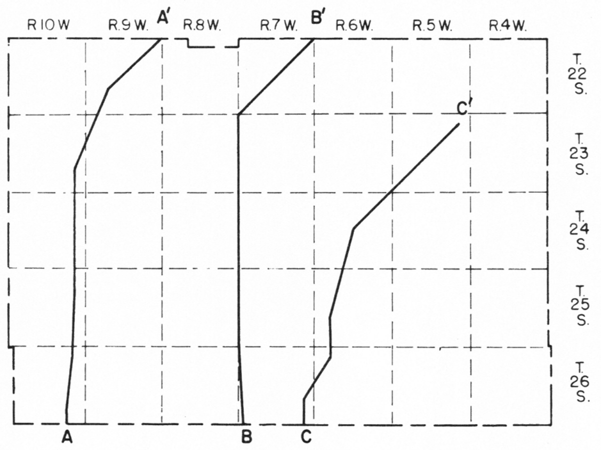
Reno County, Kansas

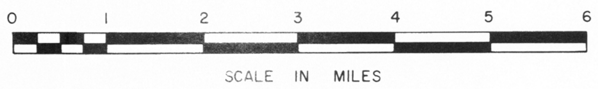
By Charles K. Bayne
1956

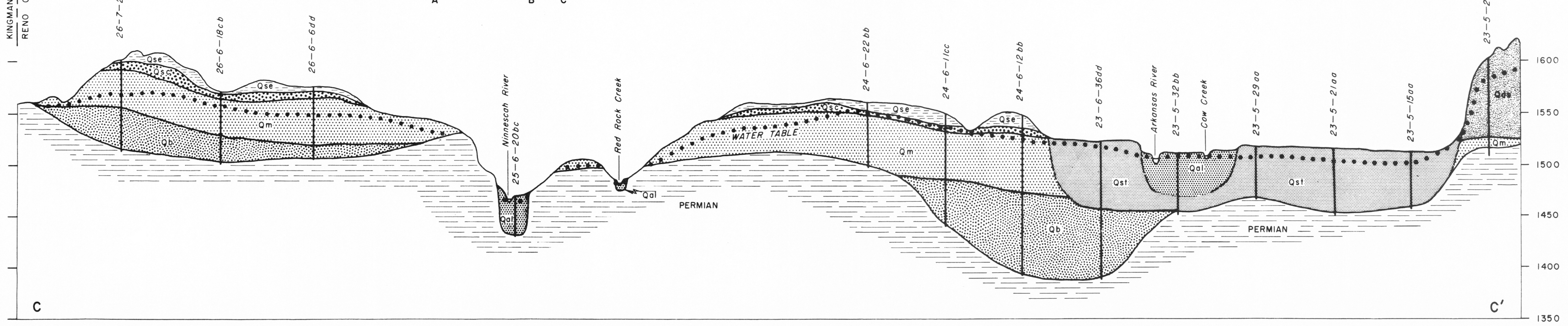
Bulletin 120
Plate 3











Symbol	Unit	Stage	Series
Qal	ALLUVIUM	RECENT AND WISCONSINAN	PLEISTOCENE SERIES
Qds	DUNE SAND		
Qst	WISCONSINAN TERRACE DEPOSITS	WISCONSINAN	
Qse	SANBORN EOLIAN DEPOSITS	WISCONSINAN AND ILLINOIAN	
Qg	CRETE SAND AND GRAVEL MEMBER		
Qm	MEADE FORMATION	KANSAN	
Qb	BLANCO FORMATION	NEBRASKAN	
P	SHALE	LEONARDIAN SERIES	PERMIAN

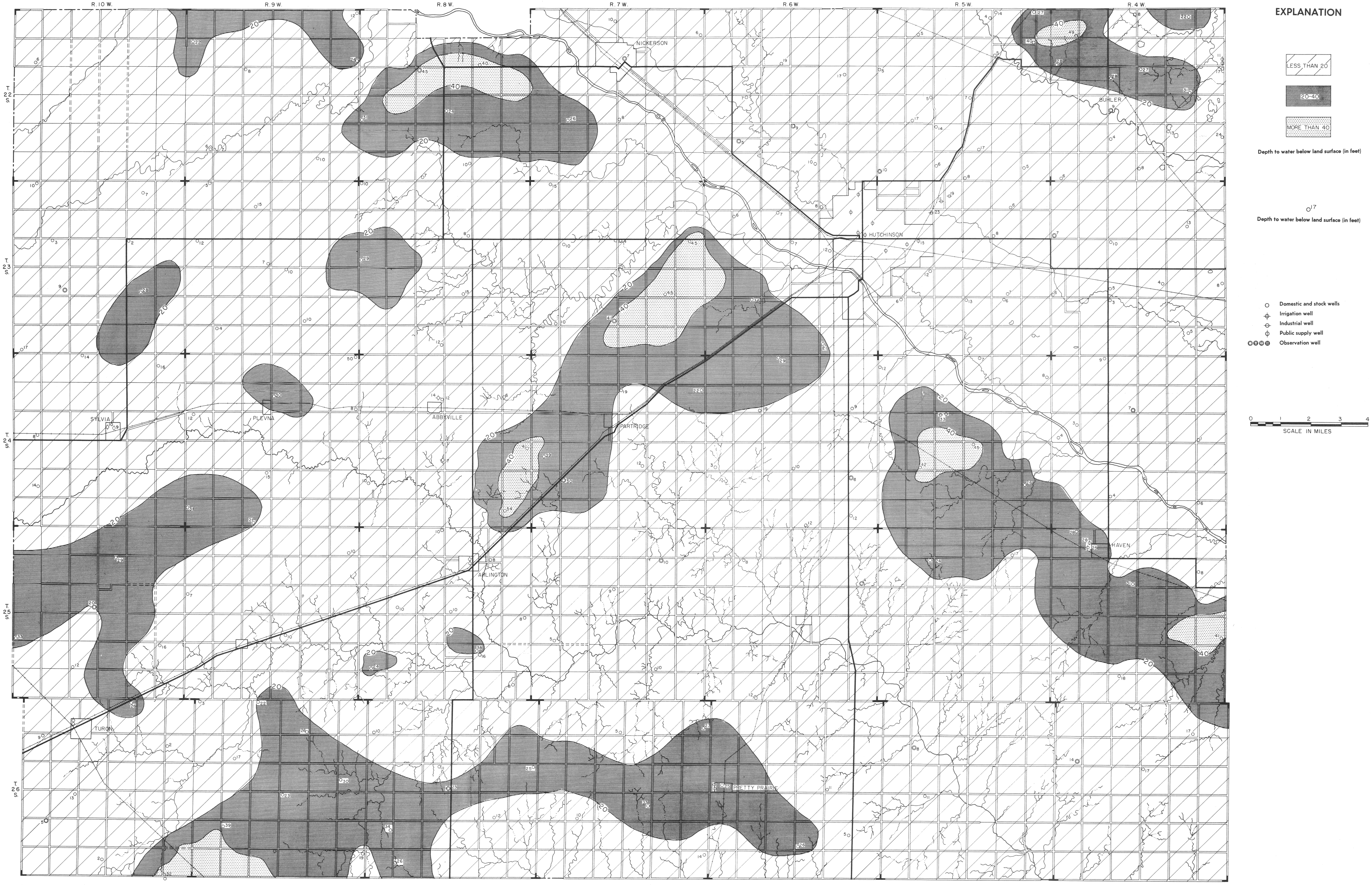
MAP OF RENO COUNTY, KANSAS

Showing the Depths to Water Level and the Location of Wells for which Records are given

State Geological Survey
of Kansas

By Charles K. Bayne
1956

Bulletin 120
Plate 2



Base compiled from maps prepared by
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