Geology and Ground-Water Resources of Kingman County, Kansas

By

CHARLES W. LANE

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By CHARLES W. LANE
(U. S. Geological Survey)

Prepared by the United States Geological Survey and the State Geological Survey of Kansas, with the co-operation 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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GEOLOGY AND GROUND-WATER RESOURCES OF KINGMAN COUNTY, KANSAS

By Charles W. Lane

ABSTRACT

Kingman County, which covers about 864 square miles in the south-central part of Kansas, lies in the High Plains and Red Hills sections of the Great Plains physiographic province. The population of the county in 1955 was 10,857, of which 69 percent was rural. Small-grain farming and livestock raising are the principal occupations. The climate of the county is subhumid, the normal annual rainfall being 29.28 inches and the annual mean temperature 57.9° F.

The rocks that crop out in the county are sedimentary and range in age from Permian to Recent. The Ninnescah Shale of Permian age is the oldest rock cropping out in the county. Most of the county is underlain by unconsolidated deposits of silt, sand, and gravel of Pleistocene age, which were deposited by southeastward-flowing streams. Deposits of the four major stages of the Pleistocene are present in the county. A list of early Pleistocene fossil mollusks collected at two localities in the county is given.

Ground water is one of the most important natural resources of Kingman County. All domestic, municipal, industrial, and most stock and irrigation water supplies in the county are derived from ground water. Withdrawal of ground water for all uses in the county is estimated to be about 5,600 acre-feet per year. The principal aquifer in the county is the Holdrege Formation of late Nebraskan age. The Grand Island Formation of late Kansan age is capable of yielding large water supplies in the western part of the county and is utilized in that area. In the eastern part of the county, where Permian rocks are near the surface, small water supplies for stock and domestic use are generally available from the weathered zone in these rocks. The ground water in the county is moderately hard but satisfactory for most uses, except where water containing excessive sodium chloride infiltrates the aquifer from South Fork of Ninnescah River and where, in the extreme southeastern corner of the county, water from the Permian rocks contains much chloride and sulfate.

The ground-water reservoir in the county is recharged by precipitation within the county and by subsurface inflow along the western and northwestern borders of the county. The general direction of ground-water movement is eastward but toward the major streams. Ground water is discharged principally by evaporation and transpiration in the stream valleys and by seepage into the streams. Discharge by wells and subsurface outflow account for only a small part of the ground-water discharge.

The field data upon which this report is based include records of 79 wells, chemical analyses of water from 21 wells, 2 springs, and 2 rivers, and logs of 247 test holes, 7 wells, and 30 oil-well tests.

INTRODUCTION

Purpose and Scope of Investigation

The investigation upon which this report is based is part of a continuing program of ground-water investigations in Kansas begun in 1937 by the United State Geological Survey and the State Geological Survey of Kansas in co-operation with the Division of Sanitation of the Kansas State Board of Health and the Division of Water Resources of the Kansas State Board of Agriculture. The present status of the program is shown in Figure 1.

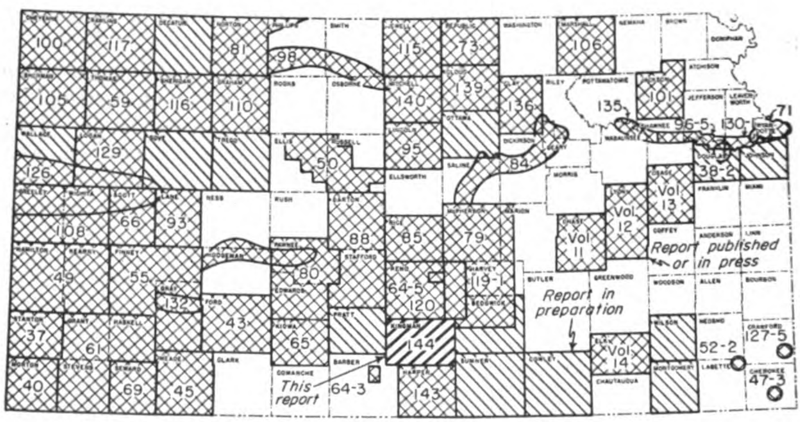

Fig. 1.—Index map of Kansas showing area discussed in this report and other areas for which ground-water reports have been published or are in preparation.

The investigation of the geology and ground-water resources of Kingman County was made to determine the availability and quality of ground water for domestic, stock, municipal, industrial, and irrigation use and to determine the geologic and hydrologic factors that control the occurrence of ground water in the county. Ground water is one of the county's principal natural resources, and though supplies are adequate in most of the county at the present withdrawal rate, there is a need for better understanding of the quantity and quality of the available water supply to meet anticipated population increases and expanding use by industry and agriculture.

Location and Extent of Area

Kingman County, in south-central Kansas, is bounded on the north by Reno County, on the east by Sedgwick and Sumner Counties, on the south by Harper and Barber Counties, and on the west by Pratt

County. It includes 24 townships and has an area of about 864 square miles. The location of the county is shown in Figure 1.

Previous Investigations

A detailed study of the Quaternary geology and ground-water resources of Kingman County has not been made previously. Williams and Lohman (1949), described the geology and ground-water resources of an adjacent part of south-central Kansas. Carey and others (1952) reported the occurrence of volcanic ash in the county. Frye and Leonard (1952) reported the occurrence of early Pleistocene sediments in the county and described fossil mollusks from these deposits. Hibbard (1956, 1957) and Tihen (1955) described vertebrate fossils from these deposits. The geology and ground-water resources of bordering Reno County were described by Bayne (1956), Sumner County by Walters (in preparation), and Harper County by Bayne (1960).

The Permian rocks of south-central Kansas, including Kingman County, were described by Norton (1939) and Swineford (1955). Moore (1920), Moore and Landes (1937), Lee (1949), and Moore and others (1951) described parts of the general geology of south-central Kansas.

Methods of Investigation

Field work was begun in Kingman County in April 1955. Additional field work was done during the spring and summer of 1956. Data were collected on 79 wells and included the depth of the well and depth to water in the well. Data concerning yield, adequacy of the supply, and quality of the water were obtained from well owners. A total of 235 test holes were drilled in the county to determine the thickness and character of the Quaternary deposits. Of the test holes, 36 were drilled with a hydraulic rotary drilling machine and 199 with a jeep-mounted power auger, both owned by the State Geological Survey of Kansas. Samples of drill cuttings were collected and examined in the field and later examined microscopically in the laboratory. Well contractors operating in the county provided logs of 12 test holes and 7 wells. Locations of wells and test holes within the sections were determined by means of an odometer, and the altitudes of measuring points of wells and test holes were determined with a plane table and alidade.

The stage of South Fork of Ninnescah River and its tributaries was measured at 14 points and of Chikaskia River and its tributaries at

11 points to aid in the preparation of the water-table contour map of the county (Pl. 3).

Samples of water were collected from 21 wells, from 2 springs, and from 1 point on South Fork of Ninnescah River and 1 on Chikaskia River and were analyzed by Howard A. Stoltenberg, chemist, in the Water and Sewage Laboratory of the Kansas State Board of Health.

Geologic mapping was done on aerial photographs obtained from the Agricultural Adjustment Administration, U. S. Department of Agriculture, and later transferred to base maps using a focalmatic projector for reduction. The base maps used for Plates 1, 2, and 3 were compiled from maps prepared by the Soil Conservation Service. The roads were corrected in the field, and the drainage was delineated from aerial photographs.

Well-Numbering System

The well numbers used in this report show the location of each well according to General Land Office surveys of the area, in accordance with the following formula: Township, range, section, quarter section, quarter-quarter section, and quarter-quarter-quarter section (10-acre tract). When two or more wells fall within the same 10-acre tract they are numbered serially according to the order in which

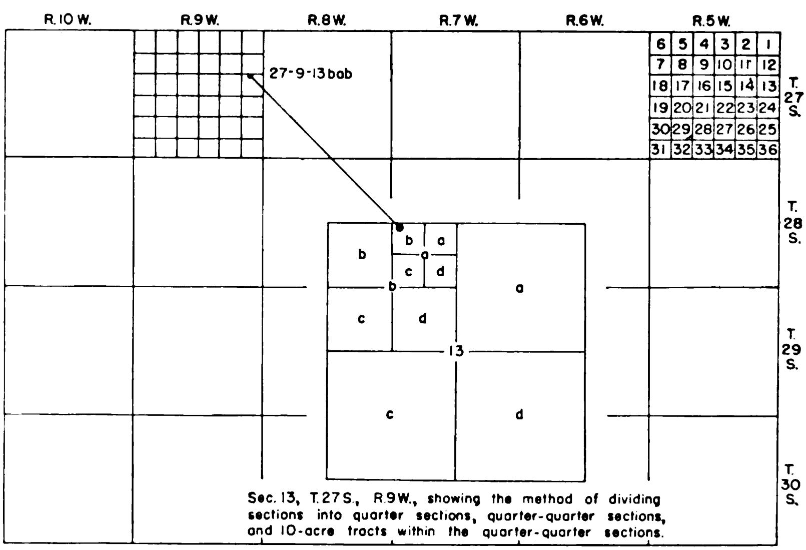

Fig. 2.—Outline map of Kingman County illustrating well-numbering system used in this report.

they were inventoried. The quarter sections, quarter-quarter sections, and 10-acre tracts are designated a, b, c, and d in a counterclockwise direction, beginning in the northeast quarter. For example, well 27-9-13bab (Fig. 2) is in the NW¼ NE¼ NW¼ sec. 13, T. 27 S., R. 9 W.

Acknowledgments

Thanks and appreciation are expressed to the many residents who supplied information on their wells and to those who allowed access to their property for the study of rock exposures, to the officials of cities who provided information concerning city water supplies, and to the drilling contractors who supplied logs of wells and test holes drilled in the county. Special acknowledgment is made to Dr. Claude W. Hibbard, Curator of Vertebrates, University of Michigan Museum of Paleontology, for his assistance in the collection and preparation of fossils from Kingman County and for his identification of the vertebrates; and to Dr. Dwight W. Taylor, of the U. S. Geological Survey, for his identification of the fossil mollusks.

The manuscript of this report has been reviewed by members of the U. S. Geological Survey and the State Geological Survey of Kansas; by Messrs. 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 Messrs. Russell L. Culp, Chief, Water Supply Section, and Willard O. Hilton, Geologist of the Division of Sanitation, of the Kansas State Board of Health.

GEOGRAPHY

Topography and Drainage

Kingman County is at the southeast edge of the Kansas portion of the Great Plains physiographic province as designated by Schoewe (1949). Approximately the western half is in the High Plains and Dissected High Plains sections. The eastern half is within the Red Hills division of the Dissected High Plains (Fig. 3). The general slope of the land surface is toward the southeast and averages 10 feet per mile. The highest points in the county are at the center of the western border and in the sand-dune area in the southwest corner. The altitude in these areas is about 1,800 feet above sea level. The lowest points in the county are where South Fork of Ninnescah River and Chikaskia River leave the county in the east-central and southeastern parts of the county and are about 1,340 feet above sea level.

Topographic relief in the county results from dissection by South Fork of Ninnescah River, which flows eastward across the northern third of the county, and by Chikaskia River, which parallels South Fork in the southern third of the county. The intervening terrain, ranging in width from 10 to 13 miles, forms a gently sloping divide across the county, which is dissected by many short tributary creeks near the rivers.

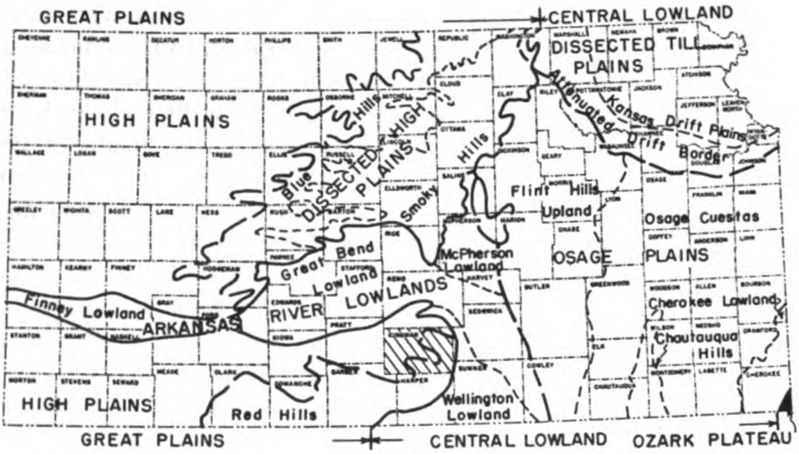

FIG. 3.—Map of Kansas showing physiographic divisions. (From Schoewe, 1949).

A second ridge extends southeastward from the northwestern part of the county to a narrow termination near the town of Murdock and forms the divide between South Fork of Ninnescah River and Smoots Creek, one of its major tributaries. In the northeastern corner of the county a poorly defined ridge forms the divide between Smoots Creek and North Fork of Ninnescah River. Along the southern border of the county on the south side of Chikaskia River is another ridge, which rises abruptly from the valley and reaches a crest about on the county line. This ridge forms the divide between Chikaskia River and Bluff Creek, one of its major tributaries, which drains most of Harper County.

Surface drainage of most of the county is good. A few square miles along the northern boundary northeast of the city of Kingman is flat and has poor surface drainage, and some land bordering the rivers is waterlogged. South Fork of Ninnescah River drains nearly all of the northern half of the county. Its main tributaries are Smoots Creek, which joins near the center of the eastern border of the county, and Painter Creek, which joins the main stream near the town of Calista. North Fork of Ninnescah River crosses the extreme northeast corner of the county but drains only a few sections in the county. Chikaskia River drains the southern half of the county; its major tributary is Sand Creek, which flows along the southern boundary of the county in the southwest corner and joins the main stream near the town of Spivey.

Climate

The climate of Kingman County is subhumid and is characterized by moderate precipitation, reasonably mild winters, and fairly hot summers. A large percentage of the winter days are clear, but snow flurries are common. Ordinarily snow remains on the ground only a short time. The weather during spring and fall is mild and very pleasant, but summers are generally hot, and strong southerly winds are common.

The climatic data in this report are compiled from records of the U. S. Weather Bureau. The normal annual precipitation at Norwich, based on a 62-year record, is 29.28 inches. The lowest annual precipitation of record at Norwich was 12.40 inches in 1956 and the highest of record was 48.84 inches in 1915. About 70 percent of the annual precipitation falls as rain during the growing season from April through September. January has the lowest normal monthly precipitation, 0.70 inch, and May has the highest, 4.51 inches. Much of the precipitation in Kingman County falls in relatively short, heavy thunderstorms. The greatest rainfall ever recorded at Norwich in a 24-hour period was 5.77 inches on April 8, 1927.

The normal annual temperature at Norwich is 57.9°F. The normal monthly temperature ranges from 33.3°F in January to 81.5°F in July. The highest temperature recorded was 117°F on August 12, 1936; the lowest temperature recorded was —21°F on February 13, 1905. The average date of the last killing frost in the spring is April 14, and the average date of the first killing frost in the fall is October 25. Killing frosts have occurred as late as May 15 and as early as September 20. The growing season averages 194 days but has been as long as 225 days and as short as 152 days.

Population

Kingman County was organized from parts of Harper and Reno Counties on February 27, 1874, and had fewer than 20 settlers. In 1955 the county had a population of 10,857, of which 31 percent was urban. Kingman, the largest town and the county seat, had a population of 3,741 in 1955. Other communities and their 1955 population are Norwich, 413; Spivey, 137; Cunningham, 587; Penalosa, 71; Nashville, 143; and Zenda, 183.

Transportation

Kingman County is served by about 110 miles of surfaced federal and state highways. U. S. Highway 54 crosses the northern half of the county from east to west, and Kansas Highway 42 crosses the southern half of the county from east to west. Kansas Highway 14 crosses the county from north to south near the center, and Kansas Highway 17 enters the county near the northeast corner and terminates at U. S. Highway 54. The southeast corner of the county is crossed by Kansas Highway 2. In addition, the county is served by about 120 miles of surfaced county roads. Most section-line roads in the county are open and are in good condition most of the year.

Transportation facilities provided by branch lines of the Atchison, Topeka and Santa Fe Railway and the Missouri Pacific Railroad are good. These railroads pass through almost all the towns, and few farms in the county are more than 7 miles from the nearest railroad.

Agriculture

According to the State Board of Agriculture, the number of farms in Kingman County in 1955 was 1,320 and the total acreage under cultivation was about 282,000, mostly devoted to the production of grain. The acreages of the principal crops harvested in 1955 are shown in Table 1.

Table 1.—*Acreage of principal crops harvested in Kingman County in 1955*

Crop	Acreage harvested
Wheat	114,000
Sorghums	59,100
Hay	22,300
Oats	13,000
Barley	10,000
Corn	2,400
Rye	2,000

Livestock raising also is an important agricultural pursuit in Kingman County. In 1955 the livestock on farms included 6,200 cows, 44,200 other cattle, and 5,650 hogs.

Mineral Resources

The mineral resources of Kingman County include oil, gas, helium, salt, sand, gravel, and volcanic ash.

Oil and gas.—Oil and gas are important mineral resources in Kingman County. Oil was discovered in the county in January 1926 in sec. 6, T. 27 S., R. 7 W., when a well 3,853 feet deep was completed in the uppermost part of the "Mississippi lime" for an initial production of 120 barrels a day. Development in the county has continued and in 1958 oil and gas were being produced from twenty-seven fields, which had yielded 14.3 million barrels of oil and 35.4 billion cubic feet of gas. The cumulative production, the number of wells, the producing zones, and the depth of production for all fields in the county are given in annual reports by the State Geological Survey of Kansas on oil and gas developments.

Helium.—Helium is present in small quantities in natural gas produced from the Cunningham pool in western Kingman County and eastern Pratt County. During World War II an extraction plant was built by the U. S. Government near Cunningham to help meet the wartime demand for helium. The plant began operation on January 17, 1944, and operating continuously until July 9, 1945, produced 43 million cubic feet of helium. The extraction plant was dismantled shortly thereafter, and helium is not currently being produced in the county.

Salt.—Salt deposits of the Wellington Formation of Permian age underlie all of Kingman County and range in thickness from about 250 feet in the eastern part of the county to 450 feet in the southwestern part. The salt beds are interstratified with thin beds of shale, anhydrite, and limestone, but many beds of minable thickness are present. These deposits of salt underlie most of south-central Kansas and were laid down in Permian seas that were partly cut off from the ocean.

During the early days of the salt-producing industry in Kansas, two mines were in operation at Kingman. The first mine began operation in 1889 but closed about 2 years later. A second mine was opened shortly thereafter but ceased operation in 1893. Huge salt reserves are present but salt is not being produced in the county.

Sand and gravel.—Sand and gravel are obtained in Kingman County from Pleistocene deposits in the valleys of South Fork of Ninnescah River and Chikaskia River. Extensive deposits of sand and gravel are also available in the uplands in much of the county.

The sand and gravel are used for concrete aggregate and for road surfacing.

Volcanic ash.—Two small deposits of volcanic ash are known in Kingman County. A 2-foot bed of ash caps a small rise in the NW¼ NE¼ sec. 16, T. 29 S., R. 10 W., about a quarter of a mile west of St. Leo. Another deposit of unknown size is reported in the SW¼ NW¼ sec. 30, T. 28 S., R. 7 W. Both deposits are too small to be of commercial value but may be useful locally as a ceramic material. Other deposits of volcanic ash may be present in the uplands of the western part of the county but probably would require much prospecting to locate.

GENERAL GEOLOGY

Summary of Stratigraphy *

The rocks that crop out in Kingman 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 part of the Ninnescah Shale of the Leonardian Series, Permian System. The Ninnescah Shale crops out in the eastern part of the county and is exposed along the valleys of South Fork of Ninnescah River and Chikaskia River where these streams have cut through younger deposits. The formation has one member, the Runnymede Siltstone, which occurs at the top. Above the Ninnescah is the Stone Corral Dolomite, which is a prominent marker bed in the subsurface to the west of Kingman County and is exposed in the north-central part of the county. In the southern part of the county the Stone Corral Dolomite is not recognizable, and its stratigraphic position is occupied by red dolomitic shale that cannot be distinguished from similar rocks below and above. The Harper Siltstone crops out in the central part of the county along South Fork of Ninnescah River and Chikaskia River, where it forms steep bluffs. The formation has two members, the Chikaskia Siltstone and the Kingman Siltstone. The youngest rocks of Permian age exposed in the county are part of the Salt Plain Siltstone and are poorly exposed near Chikaskia River in the southwestern part of the county.

Unconsolidated deposits of silt, sand, and gravel believed to be a part of the late Pliocene Ogallala Formation of the Tertiary System unconformably overlie Permian rocks in the upland north and east of the city of Kingman. These rocks are poorly exposed along

* The classification and nomenclature of the rock units used in this report are those of the State Geological Survey of Kansas and differ somewhat from those of the U. S. Geological Survey.

the valley walls of Smoots Creek and South Fork of Ninnescah River and are not known to be present in other parts of the county.

Cenozoic deposits of the Pleistocene Series unconformably overlie the Permian rocks in much of the county. These deposits range in age from the Holdrege Formation of the Nebraskan glacial stage to Recent alluvium and consist of unconsolidated clay, silt, sand, and gravel. They are present in the river valleys and mantle most of the upland surface of the county.

A generalized section of the outcropping rocks in Kingman County is given in Table 2. The configuration of the Permian bedrock surface is shown by means of contours in Figure 4, and geologic cross sections of the county are shown on Plate 2.

GEOLOGIC HISTORY

Paleozoic Era

During Paleozoic time marine rocks of Cambrian and Ordovician age were deposited in central Kansas over the igneous and metamorphic basement rocks. Rocks of Silurian and Devonian age were probably deposited over these older rocks and later removed by erosion after the pre-Mississippian uplift of the Ellis Arch (Central Kansas Arch). This ancestral arch extended from Chautauqua County on the Oklahoma line northwestward through Ellis County. Rocks of Mississippian age were deposited over the arch and lie unconformably on the Cambrian and Ordovician rocks. After deposition of Mississippian rocks the area was again raised and parts of the Upper Mississippian strata were deeply eroded. After this period of erosion the area was again submerged, forming the Sedgwick Basin where Pennsylvanian and Permian rocks about 3,500 feet thick were deposited. After the Permian rocks were deposited the area was again uplifted and subjected to a long period of erosion.

Mesozoic Era

The Mesozoic Era in Kansas is represented by rocks of the Triassic, Jurassic, and Cretaceous Systems. Central Kansas, including Kingman County, was probably a land area during Triassic and Jurassic time and no deposits of these periods are known in the area. Deposition was resumed in the area in Cretaceous time and a considerable thickness of Cretaceous rocks probably was deposited in Kingman County and removed by later erosion. No Cretaceous rocks crop out in the county or were penetrated in test

TABLE 2.—*Generalized section of geologic formations in Kingman County * and their water-bearing characteristics*

System	Series	Subseries	Stage	Stratigraphic unit	Member	Maximum thickness	Physical character	Water supply
Quaternary	Pleistocene	Upper Pleistocene	Recent	Alluvium		30 ±	Silt, sand, and gravel in channels of major streams. Small areal extent.	Moderate to large water supplies may be obtained along rivers by induced filtration.
				Dune sand		30 ±	Fine to medium sand and some silt.	Generally lies above the water table and yields no water to wells.
			Wisconsinan	Terrace deposits		49	Silt, sand, and gravel beneath terraces along present streams.	Moderate water supplies available for domestic and stock use.
				Peoria(?) Formation		3	Wind-deposited silt and fine sand occurring locally on upland divides.	Lies above the water table and yields no water to wells.
				Colluvium Recent to Illinoisan		23	Silt, sand, and some gravel deposited on slopes by sheet wash.	Yields small water supplies for domestic and stock use in small areas in eastern part of county.
			Sangamonian and Illinoisan	Crete(?) Formation		50	Silt, sand, and gravel containing some caliche where on uplands. Forms terraces in eastern part of county.	Yields moderate water supplies for domestic and stock use where it forms terraces.
		Lower Pleistocene	Yarmouthian and Kansan	Sappa Formation	Pearlette Ash bed	150 ±	Silt, clay, sand, and gravel; locally contains volcanic ash.	Yield large water supplies adequate for irrigation in western part of county, moderate supplies for domestic and stock use in central part.
				Grand Island Formation				
			Aftonian and Nebraskan	Fullerton Formation		162	Si't, clay, sand, and gravel; underlie Kansan deposits in western half of county.	Yield large water supplies where sufficient saturated thickness is present.
				Holdrege Formation				
Tertiary	Pliocene			Ogallala(?) Formation		26	Silt, sand, and gravel, locally derived.	Yields small water supplies for domestic and stock use in small area in county.

		(Group)	Salt Plain Siltstone		265	Reddish-brown siltstone, thin sandy siltstone, and fine-grained sandstone.	Buried beneath younger water-bearing deposits in most of western part of county and is not known to yield water to wells.
		Nippewalla	Harper Siltstone	Kingman Siltstone	80	Brownish-red argillaceous siltstone and silty shale and a few thin beds of silty sandstone.	Yields small water supplies for domestic and stock use from weathered zone in central part of county. Wells often fail in drought periods.
				Chikaskia Siltstone	130		
Permian	Leonardian		Stone Corral Dolomite		0.4	Grayish-buff coarse-textured dolomite; occurs only in north-central part of county.	Yields no water to wells.
		Sumner	Ninnescah Shale	Runnymede Siltstone	4	Brownish-red calcareous and dolomitic silty clay shale; some gray-green beds. Some thin beds of silty dolomite, limestone, and siltstone.	Yields small water supplies for domestic and stock use from deeply weathered zone in eastern part of county.
					400		

* The classification is that of the State Geological Survey of Kansas.

drilling, but they are present to the west in Barber, Pratt, and Stafford Counties.

CENOZOIC ERA

Tertiary Period

Uplift in the Rocky Mountain area and tilting of older rocks in adjacent areas at the close of the Mesozoic Era started a long period of erosion in which were removed all the Cretaceous and a part of the Permian sedimentary rocks from Kingman County and the surrounding area. Erosion was active until late Tertiary time, when deposits of the Pliocene Series were laid down. In Kingman County, silt, sand, and gravel, derived from Cretaceous and Permian rocks probably to the west and north, were deposited by streams on the gently sloping surface of the Permian rocks. These deposits are lithologically similar to the Pliocene rocks of McPherson County formerly called the "Delmore Formation" (Williams and Lohman, 1949) and are probably equivalent to them. Sediments of the late Pliocene Ogallala Formation may have been deposited over most of Kingman County and later removed by erosion. The Tertiary period ended with renewed but minor uplift in the Rocky Mountain area.

Quaternary Period—Pleistocene Epoch

After the physical disturbance that marked the end of the Tertiary Period there was a gradual climatic change in North America, which resulted in the formation of the great continental ice sheets and mountain glaciers that distinguish the Pleistocene Epoch. Four major ice sheets invaded the northern midcontinent region but did not reach as far south as south-central Kansas. The climatic changes that accompanied the ice invasions, however, resulted in erosion and deposition by streams fed in part by meltwater from the continental and mountain glaciers. These streams were responsible for the sculpturing of the present land surface over most of the state.

Nebraskan and Aftonian Stages

The surface of Kingman County at the beginning of Pleistocene time probably was a flat plain sloping gently to the southeast and mantled by thin Tertiary deposits. The climatic change that accompanied the formation and advance of the Nebraskan ice sheet into the midcontinent brought a cooler and moister climate to south-central Kansas than exists there today. Increased precipitation

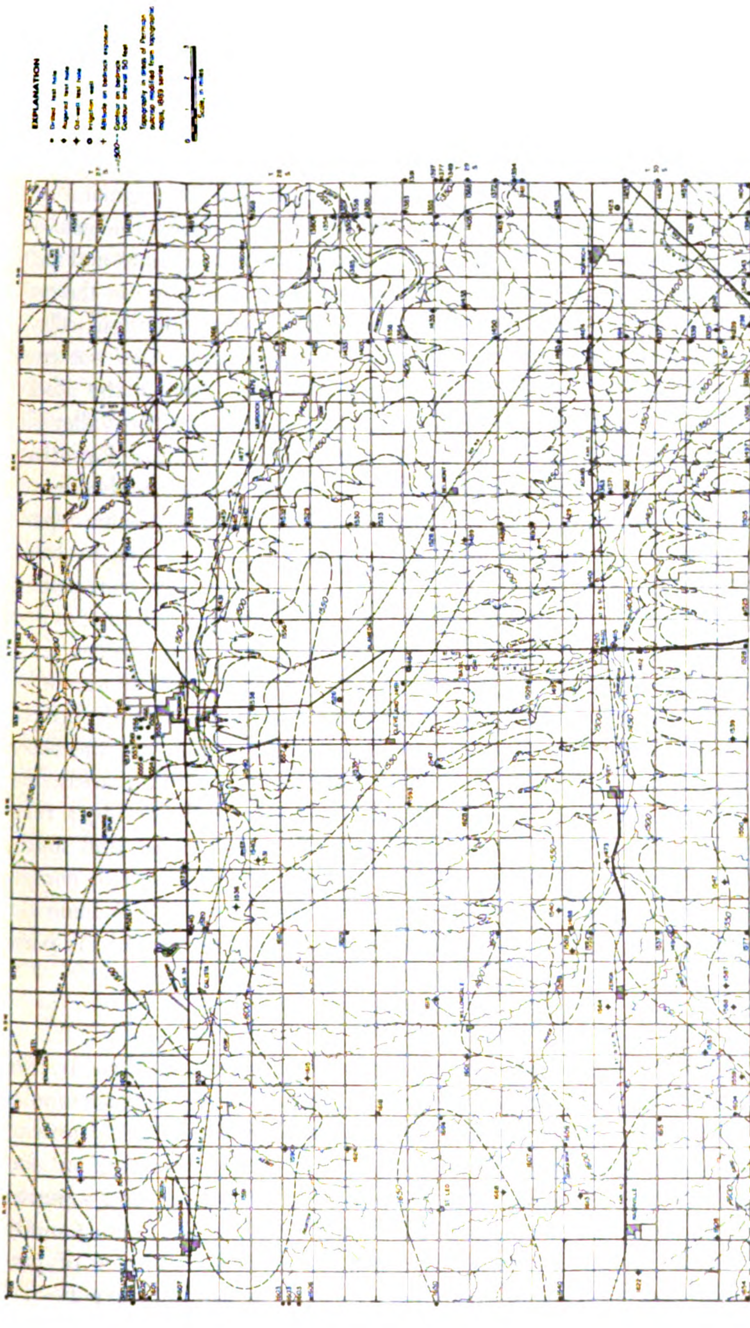

FIG. 4.—Map of Kingman County showing configuration of Permian bedrock surface.

caused a period of downcutting by streams, and in Kingman County Nebraskan streams removed most of the Tertiary sediments and cut valleys as much as 100 feet into the Permian bedrock. By the time the Nebraskan ice sheet was at its maximum these streams were probably at base level and had gradients somewhat less than those of present major streams. The course of the Nebraskan streams in Kingman County can be delineated in a general way from the bedrock contour map (Fig. 4) and from the geologic cross-sections (Pl. 2). A trend toward a warmer climate and melting of the Nebraskan ice sheet brought about a change in the regimen of the Nebraskan streams, and they began to fill their valleys. Through drainage from the Rocky Mountain area did not cross south-central Kansas in Nebraskan time, and hence the Rocky Mountain area could not have been the source for the valley fill. Just west of Kingman County, however, the Ogallala Formation provided a readily available source of sediment in the headwater regions of the Nebraskan streams. The reasons for stream deposition at this time are not definitely known, but it seems probable that a decrease in precipitation resulted in decreased transporting power of the streams, and coupled with low stream gradients, caused widespread alluviation of the stream valleys. This process continued until the valleys were filled and many former divides were buried. As the Nebraskan ice front retreated from the midcontinent region and a milder climate returned to central Kansas, the once-powerful streams probably shifted laterally over wide areas, depositing progressively finer grained sediments and leaving a relatively flat, featureless plain sloping gently to the east and south. A long period of surface stability followed, and during this period, the Aftonian interglacial stage, soil formation was the dominant geologic process. Remnants of the Aftonian soil are present in parts of Kingman County.

Kansan and Yarmouthian Stages

The Aftonian interglacial stage was brought to a close by the return of a cooler, moister climate accompanied by the accumulation and advance of the Kansan ice sheet into the midcontinent region and heavy glaciation of the Rocky Mountain region. Increased precipitation caused a rejuvenation of streams and a period of downcutting in the major stream valleys. In Kingman County and much of the surrounding area there is little evidence of pronounced downcutting at this time, and the area may have been a low divide between major streams to the northeast and southwest. Through drainage by way of a stream originating in the Rocky Mountains probably was established in south-central Kansas by late Kansan time. The stream, heavily laden with outwash, rapidly filled its valley and, shifting laterally on its alluvial fill, topped the low divides and spread a thick sheet of alluvial material over most of the area. As the Kansan ice disappeared from the midcontinent and Rocky Mountain areas the stream carrying outwash into south-central Kansas from the mountains was shifting over an agradational plain of low gradient, depositing progressively finer material. As the Kansan Stage drew to a close with return of a milder climate, south-central Kansas was again a relatively flat plain sloping gently to the south and east, but at a higher altitude than existed at the close of the Aftonian (interglacial) Stage. A long period of surface stability followed during the Yarmouthian (interglacial) Stage, and soil formation again was the dominant geologic process. Remnants of the soil are preserved in extreme western Kingman County.

Illinoisan and Sangamonian Stages

Illinoisan time was begun by a return to a cooler climate and the accumulation and advance of the Illinoisan ice sheet into the northern midcontinent region and accumulation of glaciers in the Rocky Mountain area. The Illinoisan ice sheet did not extend farther south than southeastern Iowa, but the climatic changes accompanying continental glaciation were probably far reaching and caused the rejuvenation of streams in most of the midcontinent region. Major streams in northern Kansas once again deepened their valleys, but in most of south-central Kansas available evidence does not indicate that an integrated drainage system existed at the beginning of Illinoisan time west of the major stream flowing through the McPherson valley and the ancestral Arkansas River. Headward erosion of tributaries to the ancestral Arkansas River probably reached well into Kingman County during this time, establishing the pattern of the present drainage system in the county. With the melting of the Illinoisan ice and a return to a milder climate, outwash from the Rocky Mountains was again transported into south-central Kansas by a large stream. The stream shifted laterally, depositing a thin sheet of alluvial material over western Kingman County and the area farther west. This laterally shifting stream may have been captured by the headwaters of the ancestral Arkansas River during this time, establishing that river as the master stream in the area. A drainage adjustment of this nature would have far-reaching effects, and adjustment of the master stream to an increased volume of water and sediment would have renewed headward erosion of its tributaries at a time when streams in other parts of the state were alluviating their valleys. A major drainage change of this nature could account for the anomalous distribution of sediments tentatively dated as late Illinoisan, and for the drainage pattern, which does not yet seem to be stable.

During late Illinoisan time and early in the Sangamonian (interglacial) Stage that followed, eolian activity became effective in modifying the surface over much of Kansas. Strong winds began moving sand and silt from uplands where these materials were at the surface and not protected by vegetation and from stream valleys where annual floods probably spread fine material over flood plains. Sand was blown into dunes, which probably migrated short distances, and silt was carried many miles from its source and deposited as loess. Loess deposits of late Illinoisan age are not known to be present in Kingman County. A concentration of coarse gravel and pebbles a few inches thick overlying sediments of Kansan and Nebraskan age and underlying recent wind-blown material in some upland areas of the county indicate that Kingman County may have been a source area for loess deposited in surrounding areas at this time.

Surface stability prevailed over much of Kansas during much of Sangamonian time, and soil formation was the dominant geologic process. Remnants of the Sangamonian soil were not recognized in Kingman County. Surface conditions in the area may have precluded the development of a mature soil, or one may have been formed and later removed by erosion.

Wisconsinan Stage

The Wisconsinan is the youngest of the first-rank glacial stages and included several periods of glacial advance and retreat. Deposits of this stage, being younger than those of earlier stages, are better preserved and more extensively exposed and thus accessible for detailed study. The Bradyan (interglacial) Substage divides the Wisconsinan into two distinct periods in most of Kansas and is represented in much of the state by the Brady soil.

The Wisconsinan ice sheet advanced no farther south than central Iowa and northeastern Nebraska, but the change to a cooler and a moister climate that accompanied the accumulation and advance of the ice was far reaching and started a period of downcutting in most Kansas valleys. The major streams established in Kingman County in late Illinoisan time deepened their valleys and extended their drainage areas by headward erosion. When the return of a milder climate caused retreat of the early Wisconsinan ice, the streams were no longer able to transport their sediment load and alluviated their valleys. The Bradyan (interglacial) Substage that followed was a period of surface stability and soil formation. The Brady soil was not recognized in Kingman County but may be present near the surface of the stream terraces that are underlain by early Wisconsinan alluvium.

The return of a continental ice sheet to the northern mid-continent region in late Wisconsinan time resulted in deepening of most Kansas stream valleys. The major streams in Kingman County deepened their valleys about 25 feet below the level of the early Wisconsinan streams. With the retreat of the late Wisconsinan ice front and return of a more moderate climate, streams again alluviated their valleys. In Kingman County, as in much of Kansas, the deposits of early and late Wisconsinan age underlie terrace surfaces at two distinct levels adjacent to present streams. Eolian activity in early and late Wisconsinan time resulted in the deposition of loess on upland areas in much of Kansas. Thin deposits of sandy silt occur locally on upland divides in Kingman County and may in part be equivalent to the early Wisconsinan Peoria Formation.

Recent Stage

The Recent Stage represents the time since the late Wisconsinan ice sheet ceased to be an active force and includes about the last 10,000 years. The geologic processes responsible for the deposition of Recent sediments in Kingman County are those active in the area at the present time.

GROUND WATER

Principles of Occurrence

The fundamental principles governing the occurrence and movement of ground water were described by Meinzer (1923), and as they apply to Kansas were summarized by Moore (1940). These principles will be discussed only briefly here; for a more detailed discussion the reader is referred to the reports by Meinzer and by Moore.

Figure 5 is a diagram of the hydrologic cycle adapted by S. W.

Lohman of the U. S. Geological Survey and depicts the part of ground water in the circulation of water near the surface of the earth. Ground water is derived chiefly from water that falls as rain or snow. A part of this water runs off directly in streams to the sea, a part evaporates, a part is transpired by plants, and a part sinks through pore spaces in the soil and underlying rocks to become

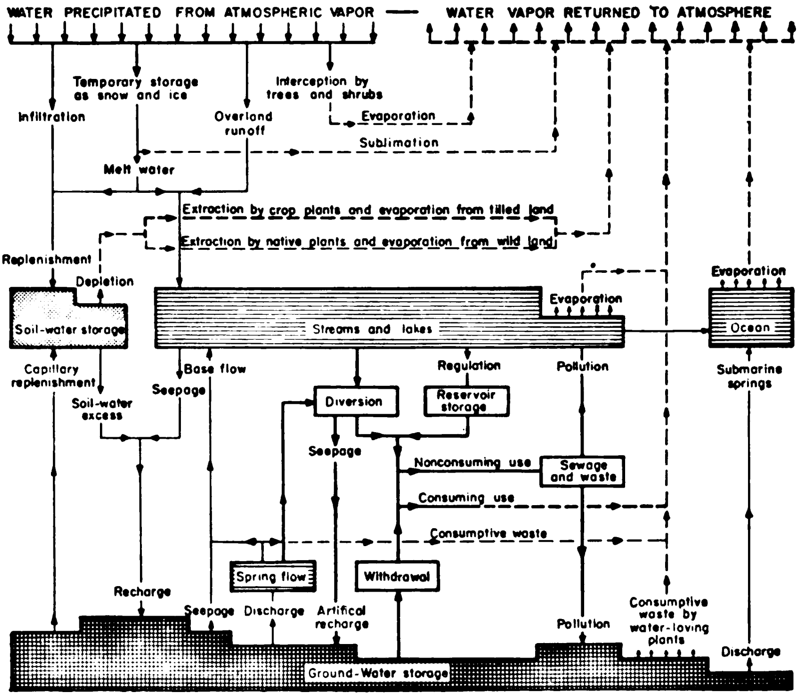

FIG. 5.—Diagram of the hydrologic cycle (From Lohman, 1953). Solid flow lines indicate movement of water as a liquid, broken lines, movement as vapor. Heavy flow lines indicate man's principal changes in the natural cycle.

subsurface water. Figure 6 depicts graphically the divisions of subsurface water as they generally occur.

Subsurface water can be divided into two zones, the zone of areation, or vadose zone, and the zone of saturation. Within the zone of aeration are three belts, the belt of soil water, the intermediate belt, and the capillary fringe. The belt of soil water is that part, directly below the surface, from which water is discharged into the atmosphere by plants or by direct evaporation from the soil. The water in this belt is of great importance to the agriculturist, for it is the water near enough to the surface to be available to plant roots. The capillary fringe is a belt that overlies the zone of saturation and contains pores some or all of which are filled with water that is continuous with the zone of saturation but is held above that

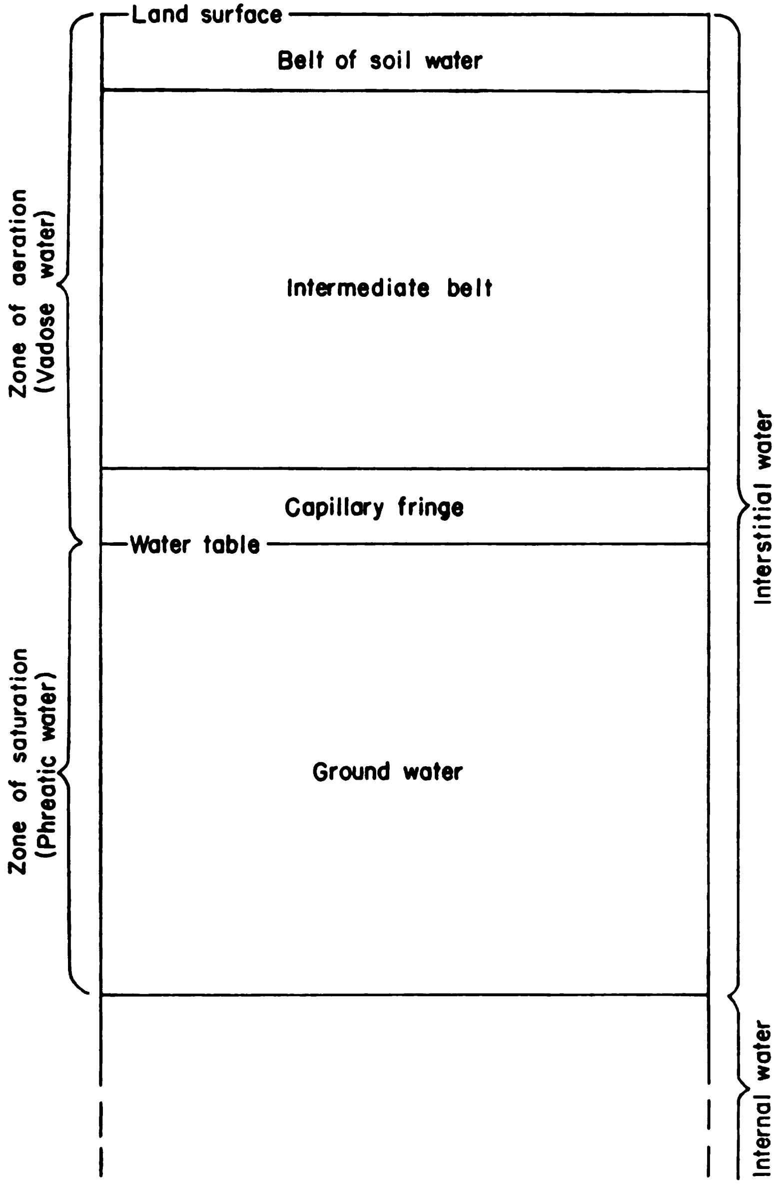

Fig. 6.—Diagram showing divisions of subsurface water. (From Meinzer, 1923b).

zone by capillarity acting against gravity. The thickness of the capillary fringe depends upon the texture of the rock or soil in which it occurs, being greatest in fine-grained material having small pores. The water in the capillary fringe is called fringe water. The intermediate belt of the zone of aeration is the part that lies between the belt of soil water and the capillary fringe. Water that sinks into this belt is either drawn downward by gravity to the zone of saturation, is retained within the belt by molecular attraction as a coating on individual grains or a meniscus at grain contacts, or returns to the surface by capillary or vapor flow. Water in the intermediate belt is called intermediate vadose water. Both the belt of soil water and the capillary fringe are limited in thickness by local conditions, such as the character of vegetation and texture of rock or soil, but the intermediate belt is not thus limited and may be absent or may be several hundred feet thick.

The top of the zone of saturation is marked by the water table, below which all connected pore spaces are filled with water under hydrostatic pressure. Water within this zone is free to move under the force of gravity, and it is only from the zone of saturation that wells are able to derive water. The water in the zone of saturation is called ground water.

Below the zone of saturation is the zone of rock flowage, in which temperature and pressure are such that pores or openings cannot exist in the rocks. In this zone, far below the earth's surface, subsurface water exists only in the molecular structure of the rocks and is called internal water.

Physical and Hydrologic Properties of Water-Bearing Materials

The physical and hydrologic properties of water-bearing materials discussed in this section include grain size, porosity, moisture equivalent, specific retention, specific yield, permeability, transmissibility, and storage. The specific capacity of wells, which is related to these properties, also is discussed. Determination of these properties of water-bearing materials is necessary in any area where a quantitative estimate of the amount of ground water available for use is desired, such as for the development of an extensive well field or as a legal guide for the orderly development of the resource. Most of these properties can be determined approximately in the laboratory from samples of the water-bearing material collected in the field. Laboratory determinations, however, have inherent errors resulting from spot sampling of the material and from disturbance of the material as it occurs in its natural state, but are useful as a check against determinations made in the field.

Hydrologic properties of an aquifer can be determined in the field by means of carefully controlled pumping tests on wells, involving observation of the effects of pumping on the ground-water levels in the area surrounding the well. Pumping tests have the advantage of sampling the hydrologic properties of an aquifer over a relatively large area and of smoothing out differences in these properties caused by local changes in lithology. In the interpretation of the results of pumping tests, several basic assumptions concerning the physical properties of the aquifer must be made. The assumed conditions are rarely fulfilled completely in nature. Divergence from these assumptions introduces errors in the values of hydrologic properties obtained in pumping tests, but the errors are generally within acceptable limits, and in some cases the divergences can be compensated mathematically. A detailed discussion of pumping-test analysis is beyond the scope of this report, but several references on the subject are included at the end of this report (Cooper and Jacob, 1946; Theis, 1935, 1938; Wenzel, 1942).

Grain Size

Mechanical (particle-size) analysis of granular water-bearing material consists of separating into groups the grains of different sizes and determining what percentage of the total, by weight, each size group constitutes. Mechanical analysis of grain size will show the degree of homogeneity of an aquifer and make possible comparisons with granular material from different aquifers or from different locations in the same aquifer. Also, methods are available for making indirect determinations of certain other physical properties from mechanical analyses and are useful as checks against other methods.

Porosity

The rocks that make up the outer crust of the earth are generally not solid but have many openings called voids or interstices. This property of having voids or interstices is called porosity. The size, shape, and number of these openings depend upon the character of the rocks, and the presence of ground water in any region is in part determined by the character and structure of the rocks—that is, the geology. The voids in rocks range from microscopic openings in clay to large caverns in limestone. The openings generally are connected so that water can move from one void to another, but in some rocks the openings are isolated or so minute that there is little or no movement of water. Figure 7 shows several common types of voids or interstices and the relation of texture to porosity. Porosity is expressed as the percentage of the total volume occupied by interstices.

Moisture Equivalent, Specific Retention, and Specific Yield

The moisture equivalent of a water-bearing material is the ratio of the weight of water that the material, after saturation, will retain against a centrifugal force 1,000 times the force of gravity, to the weight of dry material. The moisture equivalent by volume is computed by multiplying the moisture equivalent by weight by the apparent specific gravity of the material. The moisture-equivalent determinations are used in estimating the specific retention of the

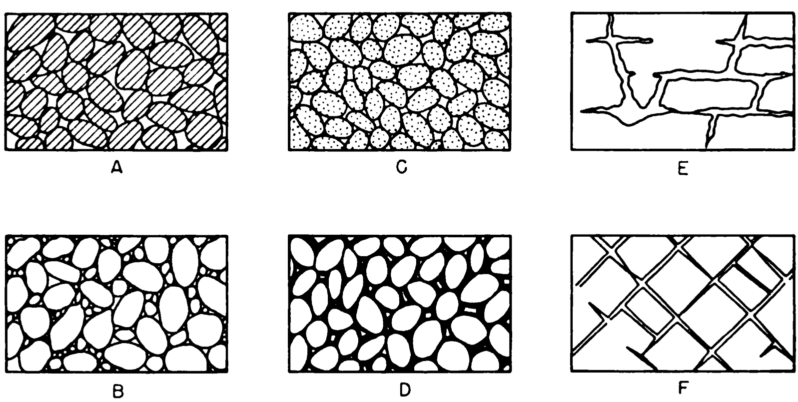

FIG. 7.—Diagram showing several types of rock interstices and relation of rock texture to porosity. (From Meinzer, 1923a). **A,** Well-sorted sedimentary deposit having high porosity; **B,** poorly sorted sedimentary deposit having low porosity; **C,** well-sorted sedimentary deposit consisting of pebbles that are themselves porous, so that the deposit as a whole has a very high porosity; **D,** well-sorted sedimentary deposit whose porosity has been diminished by the deposition of mineral matter in the interstices; **E,** rock rendered porous by solution; **F,** rock rendered porous by fracturing.

water-bearing material. The specific retention is the quantity of water that a soil or rock will retain against the pull of gravity if it is drained after being saturated. Specific retention is expressed as the ratio of the retained water to the total volume of material.

The specific yield of a water-bearing formation is defined as the ratio of the volume of water that a saturated aquifer will yield by gravity to its own volume. The specific yield of a material is equal to the porosity minus specific retention.

Permeability, Transmissibility, and Storage

The permeability of a water-bearing rock is an expression of the capacity of the rock to transmit water under pressure and is related to the size and interconnection of the pore spaces. Permeability is generally expressed as a coefficient of permeability and is defined as the number of gallons of water a day, at 60°F, that is conducted laterally through each mile of the water-bearing bed measured at right angles to the direction of flow, for each foot of thickness of the formation and for each foot per mile of hydraulic gradient. The unit of permeability, gallon per day per square foot, is also called the Meinzer's unit, or meinzer.

The transmissibility, generally expressed as a coefficient of transmissibility, is defined as the number of gallons of water a day, at the prevailing temperature, that is transmitted through each mile of the formation under a hydraulic gradient of 1 foot per mile. It is the average coefficient of permeability taken at the prevailing temperature (field coefficient of permeability) multiplied by the saturated thickness of the aquifer, in feet.

The storage capacity of a water-bearing material, usually expressed as the coefficient of storage, may be defined as the volume of water it releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. Underwater-table conditions the coefficient of storage is practically equal to the specific yield.

Specific Capacity

Specific capacity is a term applied to a well producing ground water, and is expressed as the number of gallons a minute that a well will yield for each foot of drawdown. It has been demonstrated that this is not a linear relationship and is only approximate, but it is useful nevertheless in estimating relative efficiencies and permeabilities of water-bearing formations. The specific capacities of 11 wells in Kingman County are given in Table 3.

TABLE 3.—*Specific capacity of selected wells in Kingman County and their water-bearing formation*

Well number	Specific capacity, in gallons per minute per foot of drawdown	Water-bearing formation
27-5-33abb	18	Crete(?) Formation
27-8-15ddb	15	Holdrege Formation
27-10-31ccd	17	Holdrege Formation
27-10-31cca	20	Holdrege Formation
27-10-32dcc1	25	Grand Island Formation
27-10-32dcc2	22	Grand Island Formation
28-7-6dab	22	Alluvium
28-8-6ccc	33	Holdrege Formation
28-10-5dbb	44	Grand Island Formation
29-7-9baa	39	Holdrege Formation
30-5-12cca	31	Holdrege Formation

WATER TABLE AND MOVEMENT OF GROUND WATER

The upper surface of the zone of saturation in permeable rock or soil is called the water table. Where the water table is intersected by relatively impermeable material, the water table is interrupted, the ground water is confined, and artesian conditions exist. If the relatively impermeable bed confining water under artesian pressure is penetrated by a well, the water will rise above the level at which it was encountered. The imaginary surface representing the level to which water under artesian pressure would rise is called a piezometric surface, each artesian aquifer having its own piezometric surface.

Shape and Slope of Water Table

The water table is not a flat surface but has irregularities that are related to the topography, geology, and hydrology of the area. The shape of the water table in Kingman County is shown on Plate 3 by means of 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 water table as the land surface is shown on a topographic map. The shape of the water table is very similar to the surface topography of the county but is less rugged.

In central and eastern Kingman County, where Permian rocks are at or near the surface (Pl. 1) and form steep slopes, the water table may be discontinuous or absent and in this area the inferred position of the water table is shown by dashed contours. Ground water, where not confined, moves toward areas of discharge in response to gravity, and the direction of movement is down the slope of the water table at right angles to the water-table contours. The movement of ground water is slow compared to the movement of surface water, and in unconsolidated materials such as are found in Kingman County, the rate may range from a fraction of an inch per day in silt and clay to several feet per day in well-sorted sand and gravel.

Fluctuations of Water Table

The water table is not a stationary surface but fluctuates up and down in response to additions to or withdrawals from the ground-water reservoir. Fluctuations of the water table can be determined by periodic measurements of the depth to water in wells, and if the specific yield of the aquifer is known, changes in storage within the aquifer can be calculated. The depth to water has been measured periodically in one well (27-9-9bbb1) in Kingman County since

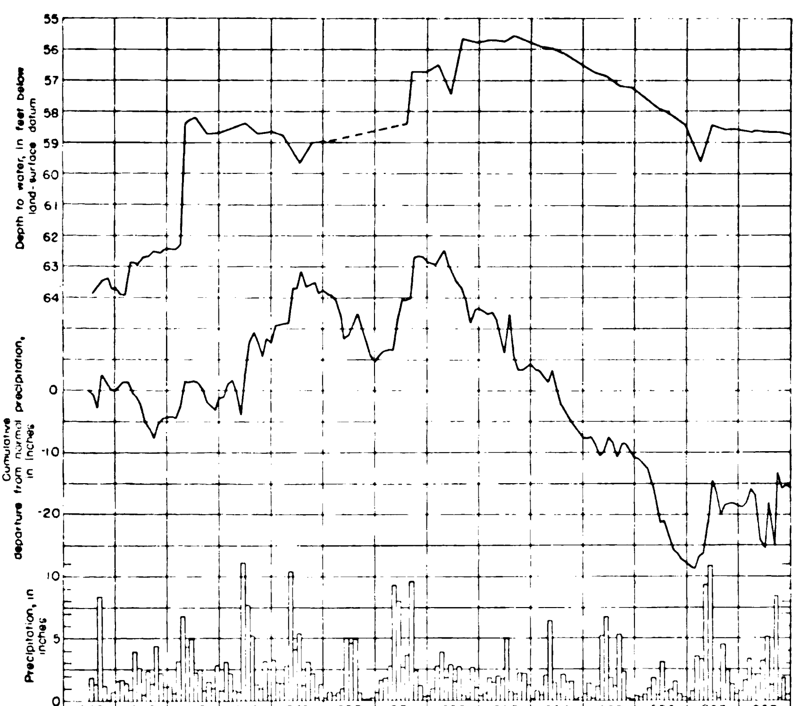

Fig. 8.—Hydrograph showing fluctuations of water level in well 27-9-9bbb1, monthly precipitation, and cumulative departure from normal precipitation at Kingman.

1945 and the results have been published annually by the U. S. Geological Survey through 1955 (see "References") and thereafter by the Kansas Geological Survey (Fishel and Mason, 1957, 1958). Figure 8 is a hydrograph showing fluctuations of the water level in this well, monthly precipitation, and cumulative departure from normal precipitation at Kingman.

Ground-Water Recharge

Recharge is the addition of water to the ground-water reservoir and may occur in several ways. The original source of all recharge is precipitation; however, in addition to direct infiltration of precipitation through the soil and subsoil, a ground-water reservoir may be recharged locally by the infiltration of water from streams, by return of irrigation water applied on the surface, or by subsurface inflow of water from adjacent areas. In Kingman County irrigation is not widely practiced, so that recharge by return of irrigation water is negligible. The annual quantity of recharge in Kingman County is not known, but it is believed to be a small percentage of the total precipitation that falls in the county. Nevertheless, recharge must amount to several tens of thousands of acre-feet per year.

Infiltration of Precipitation in Upland Areas

For the purpose of this discussion the "upland areas" of Kingman County include the relatively flat divide areas between major streams where not deeply dissected by tributary streams. Upland areas occupy less than a fifth of the total area of the county. Recharge in the uplands results chiefly from percolation of precipitation that falls on the area, but there is some subsurface inflow from Pratt County on the west. In those areas in the western half of the county that are underlain by deposits of Nebraskan and Kansan age (Pl. 1), the beds of silt and clay that lie above the water table retard the downward percolation of water. The rate of recharge in this area, therefore, is controlled by the vertical permeability of these beds. The shape of the water table (Pl. 3) shows, however, that recharge does occur in these areas, as the movement of ground water toward points of discharge starts in the divide areas. In the uplands in the eastern half of the county, silt and clay beds are not extensive in the subsurface, and the rate of recharge is probably greater.

Influent Seepage from Streams

South Fork of Ninnescah River and its main tributaries (Smoots and Painter Creeks) and Chikaskia River and its main tributary (Sand Creek) are all effluent streams—that is, they have cut their channels below the water table throughout their courses in Kingman County and thus generally receive water from rather than add water to the zone of saturation. Deposits adjacent to the channels are recharged during flood stages on these streams, but the water represents temporary "bank" storage and returns to the stream soon after the flood. The smaller tributaries to these streams, however, which head near the upland divides, lie above the water table in their upper reaches. Where these tributaries have cut their channels into beds of permeable sand and gravel, the ground-water reservoir is recharged when surface runoff is available in the streams.

Subsurface Inflow

Subsurface inflow to an area results from the movement of ground water downgradient toward areas of discharge. Ground water moves into Kingman County along the western border of the county and locally along the eastern part of the northern border. The quantity of subsurface inflow to the county is not known but is estimated to be on the order of 100 acre-feet per day (1 acre-foot equals 325,850 gallons).

Ground-Water Discharge

When water derived from precipitation or other sources reaches the zone of saturation it immediately starts moving down the slope of the water table toward a point of discharge. The water remains a part of the ground-water body until discharged by natural or artificial means. Water may be discharged from an aquifer by evaporation, by transpiration, by seepage into streams or drains, through springs, or by pumping from wells. Over a period of years or a climatic cycle under natural conditions the amount of water discharged from an aquifer is approximately equal to the quantity of recharge.

Transpiration and Evaporation

Ground water may be taken up by the roots of plants directly from the zone of saturation, or from the capillary fringe above it, and discharged into the atmosphere by the process of transpiration. The depth from which plants will lift ground water differs with the plant species and the type of soil in which it grows. Most grasses and cultivated crops will not lift water more than a few feet; however, alfalfa and some desert plants have been known to extend their roots to depths of 60 feet or more to reach the water table. Where the water table is near the surface, ground water may be discharged directly by evaporation.

Significant quantities of ground water are discharged in Kingman County by evaporation and transpiration in the valleys of the major streams where the depth to water is generally less than 10 feet. The quantity of ground water discharged in this manner is difficult to determine but probably exceeds the discharge by all other means combined. After the first killing frost in the fall, when evaporation and transpiration generally cease, South Fork of Ninnescah River and Chikaskia River show an appreciable increase in flow, which can be accounted for only by increased discharge to these streams of ground water ordinarily discharged by plant transpiration and evaporation.

Springs and Seeps

Streamflow at low stages in South Fork of Ninnescah River, Chikaskia River, and their major tributaries is maintained by ground-water discharge. Water is discharged into these streams mainly as seeps along stream channels, but there are many springs along the valley walls where the stream channels intercept the water table and also at the contact of unconsolidated water-bearing material and the relatively impermeable Permian redbeds. Many of the seeps and springs in Kingman County continue to discharge ground water even during periods of drought, and the shallow ground water along the streams supports a heavy growth of vegetation. Whenever the supply of ground water is greater than the amount required by vegetation along the stream courses, the excess contributes to the flow of the stream. The amount of discharge through seeps and springs in Kingman County is not known but is believed to be large.

Wells

Ground water is pumped for municipal, domestic, stock, irrigation, and industrial use in Kingman County. The total withdrawal of water from wells in Kingman County is estimated to be about 5,600 acre-feet per year. Natural discharge of ground water in Kingman County greatly exceeds withdrawal from wells.

Subsurface Outflow

Subsurface outflow of ground water occurs near the west end of the north border and along the east edge of Kingman County. The areas where ground water is discharged in this manner are small and the quantity discharged is not believed to be significant. Thus, ground water is discharged from the county mainly by evapotranspiration and by effluent flow into streams that leave the county.

Recovery of Ground Water

When water is pumped from a well, the head becomes lower in the well than outside, and water moves toward the well. The water table or piezometric surface for some distance surrounding the pumped well is lowered, assuming the approximate shape of an inverted cone whose apex is at the well. This is called the cone of depression (Fig. 9). The size and shape of the cone of depression surrounding a pumped well are determined by the transmissibility of the water-bearing formation, and the extent to which the

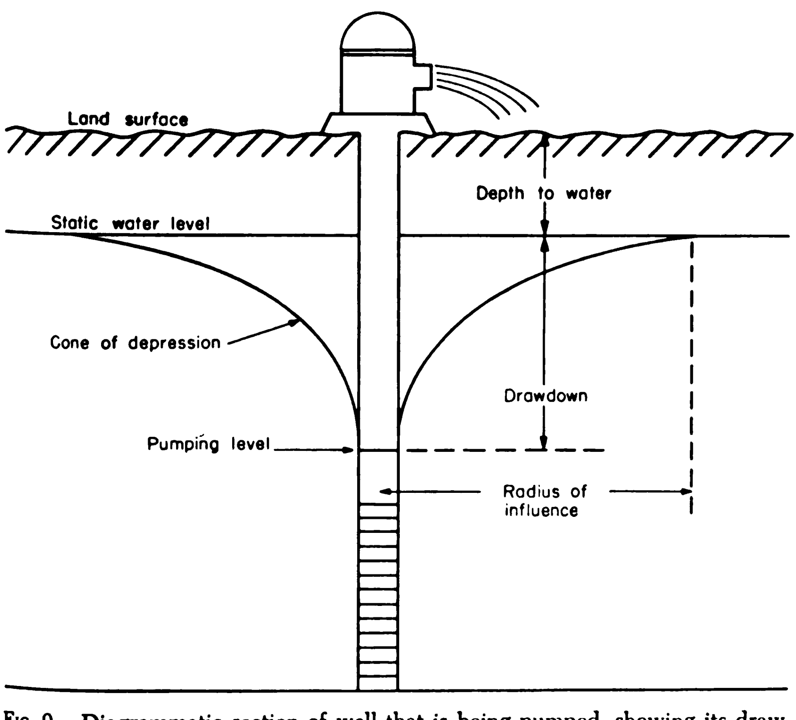

Fig. 9.—Diagrammatic section of well that is being pumped, showing its drawdown, cone of depression, and radius of influence.

well penetrates the formation, the rate at which water is being pumped, and the length of time that the well is pumped. The cone of depression around a pumped well will increase in depth and area until it intercepts enough recharge or reduces natural discharge by an amount sufficient to supply the demand of the well. The distance from the pumped well to a point where the drawdown of the water level on the cone of depression is zero is called the radius of influence of the well. If pumping from the well is stopped, water will continue to move toward the well, and the cone of depression created by pumping will be filled. For a short time after pumping is stopped, while the slope of the cone of depression is near the maximum, the movement of water into the

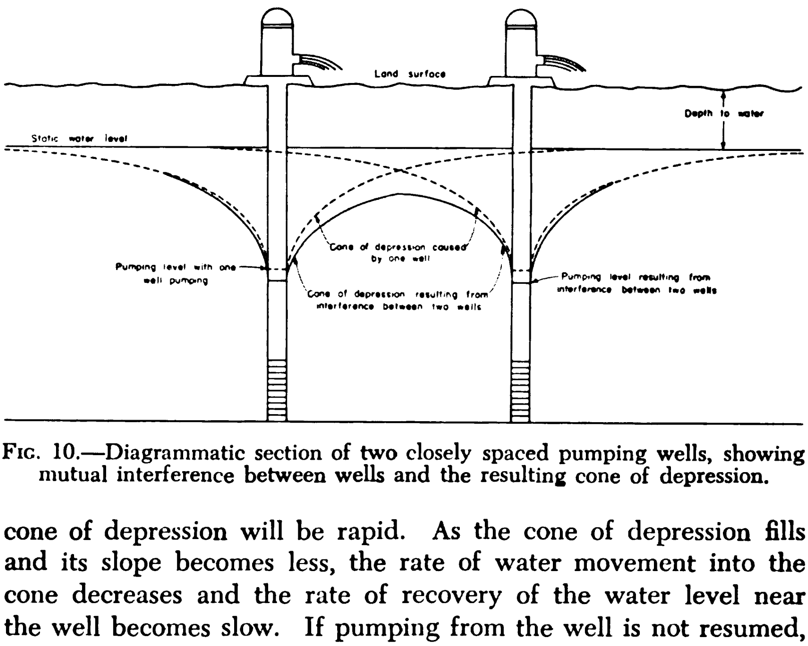

FIG. 10.—Diagrammatic section of two closely spaced pumping wells, showing mutual interference between wells and the resulting cone of depression.

cone of depression will be rapid. As the cone of depression fills and its slope becomes less, the rate of water movement into the cone decreases and the rate of recovery of the water level near the well becomes slow. If pumping from the well is not resumed, the water table or piezometric surface surrounding the well will in time return to its original position.

If wells are spaced close together, as in a well field or an intensively irrigated area, the cone of depression created by each well may overlap those of adjacent wells, causing mutual interference among the wells (Fig. 10). When mutual interference occurs the drawdown at any point within the radius of influence of the wells is the sum of the drawdowns caused by each individual well at that point. Thus, when wells interfere, the pumping lift in each well is increased and the discharge is decreased. Also, to maintain a constant discharge from the wells the drawdown caused by pumping each well must be greater and the volume of the cone of depression for each well will be greater. In areas where many wells are pumping from the same aquifer, the large cone of depression resulting from mutual interference may not have sufficient time to recover between pumping periods and the water level may decline persistently.

Utilization of Ground Water

Domestic and Stock Supplies

Most domestic and stock water supplies in Kingman County are obtained from wells. Ponds are used in some places to supply stock water, but most of the ponds that provide a perennial water supply are constructed on small streams fed by springs and, therefore, represent ground water. The ground water in the county generally is suitable for domestic use, although adjacent to South Fork of Ninnescah River the water in the alluvial fill has been polluted by water containing much sodium chloride (common salt) from the river, which drains an area of salt marshes in Pratt County. Few if any domestic supplies are obtained from this source, however, and the water is suitable for live stock. The supply of ground water available in Kingman County is adequate for all domestic and stock use, except in small areas where Permian rocks are at the surface and form steep slopes.

Public Water Supplies

Three communities in Kingman County have public water supplies. Descriptions of the water systems in these communities follow, and additional information may be found in the table of well records at the end of this report.

Kingman.—Kingman, the largest city in Kingman County, is supplied with water from three springs about 3 miles west of the city and from five wells in terrace deposits of South Fork of Ninnescah River in the city. The springs west of the city issue at the contact between Pleistocene sand and gravel and the underlying Permian rocks. Each spring is equipped with a concrete collecting box from which tile collectors radiate. The three springs have a combined yield of about 200 gpm (gallons per minute) in years of normal precipitation and about 300 gpm in wet years. The water is piped to the city by gravity flow and is stored in an underground reservoir of 0.5-million-gallon capacity. The spring supply is not adequate during periods of peak demand and is supplemented with water from the five wells in the city. Two of the five city wells are 3-inch driven wells pumped with a single centrifugal pump and have a combined yield of about 190 gpm. Three of the wells are drilled gravel-walled wells equipped with electric turbine pumps and each has an average yield of about 275 gpm. The wells produce water that has an objectionable chloride content and the water is mixed with that from the city springs before distribution. The water is not treated except for chlorination and is pumped directly into the mains, the excess going to a 70,000-gallon elevated storage tank. Water use by the city ranges from about 0.3 million gpd (gallons per day) in March to about 1.2 million gpd in July.

Norwich.—The city of Norwich is supplied with water from two gravel-walled wells 98 feet deep. One well pumping about 100 gpm is adequate to meet the demand and the second well is normally used as a standby. The water is chlorinated and pumped directly into the mains, the excess going to a 50,000-gallon elevated storage tank. Use of water by the city is reported to range from about 30,000 to 140,000 gpd.

Cunningham.—The city of Cunningham is supplied with water from two gravel-walled wells 59 and 60 feet deep. The wells yield about 200 gpm; one normally meets the demand and the second is used as a standby. The water is chlorinated and pumped directly into the mains, the excess going to a 50,000-gallon elevated storage tank. Use of water by the city is reported to range from about 15,000 to 75,000 gpd.

Industrial Supplies

Kingman County is not an industrialized area, and only two industrial wells currently in operation were inventoried during the investigation for this report. A gas compressor station owned by the Drillers Gas Co. in the NW¼ NW¼ NE¼ sec. 33, T. 27 S., R. 5 W., is supplied with cooling water from a well 65 feet deep in terrace deposits bordering Smoots Creek. The well is reported to yield 350 gpm and is pumped continuously. A gas compressor station owned by the Kansas Power and Light Co. in the SW¼ SW¼ SW¼ sec. 6, T. 28 S., R. 8 W., is supplied with water from a gravel-walled well 82 feet deep in sand and gravel of Pleistocene age. The well is reported to yield 200 gpm.

Irrigation Supplies

Irrigation with ground water was not practiced in Kingman County prior to the drought beginning in 1952. By the end of 1956 there were in operation 14 irrigation plants utilizing ground water, and 6 additional irrigation wells have been installed in the county since completion of field work for this report. Information on 11 of these irrigation plants is reported in the well tables at the end of this report.

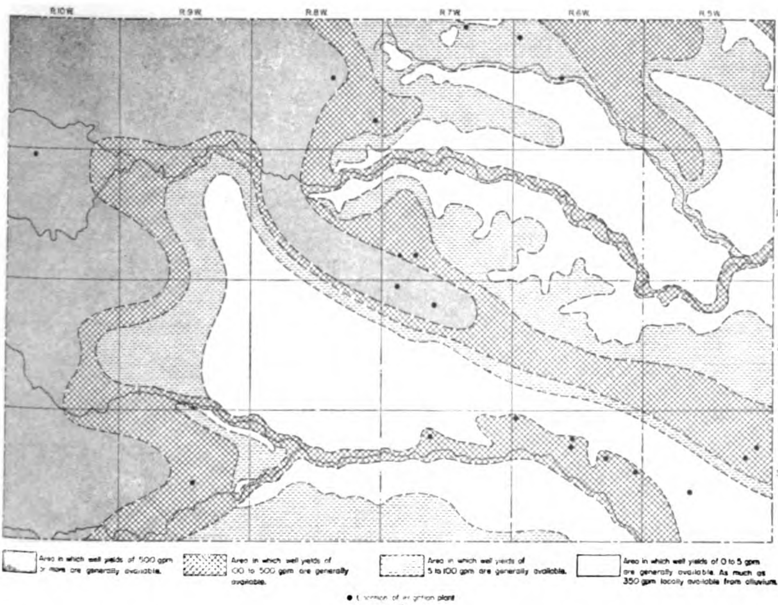

FIG. 11.—Outline map of Kingman County showing location of irrigation plants using ground water, and yields generally available from wells in the county.

The yields of irrigation wells in the county range from about 100 to 700 gpm. Sprinkler irrigation is used throughout the county, as the topography of much of the county and the quantity of water available generally are not suitable for ditch irrigation. Figure 11 shows the locations of ground-water irrigation plants in the county, including those not included in Table 7, and, by patterns, the quantity of water generally available from wells in the county. Some irrigation plants producing water from relatively thin terrace deposits along Smoots Creek and Chikaskia River, in the eastern part of Kingman County, use multiple-well systems because yields of in-

Table 4.—*Analyses of water from wells, springs, and rivers in Kingman County*

Analyzed by Howard A. Stoltenberg. Dissolved constitutents given in parts per million [a]

Well no.	Location	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
	T. 27 S., R. 5 W.																		
27-5-3ccc	SW SW SW sec. 3	37	Holdrege Formation	10-21-55	61	198	24	0.18	40	5.4	20	167	4.1	9.0	0.2	13	122	122	0
27-5-36aab	NW NE NE sec. 36	42	Ninnescah Shale	10-21-55	62	302	16	.77	55	19	24	237	36	9.0	.3	26	215	194	21
	T. 27 S., R. 6 W.																		
27-6-6ccd	SE SW SW sec. 6	30	Crete (?) Formation	10-18-55	64	604	27	1.6	86	29	58	89	322	34	.4	3.6	334	73	261
	T. 27 S., R. 7 W.																		
27-7-3adc	SW SE NE sec. 3	55	Crete (?) Formation	10-18-56	61	343	20	.08	68	13	35	279	19	15	.4	35	223	223	0
	T. 27 S., R. 8 W.																		
27-8-15ddb	NW SE SE sec. 15	50	Holdrege Formation	10-12-56	63	287	21	.10	69	4.9	24	228	7.8	18	.2	30	192	187	5
27-8-31cca	NE SW SW sec. 31	66	do	10-12-56	59	274	20	.03	49	4.9	40	176	13	38	.1	22	142	142	0
	T. 27 S., R. 9 W.																		
27-9-18dcc	SW SW SE sec. 18	82	do	10-10-56	63	262	18	.05	65	4.9	15	191	20	8.0	.3	42	182	148	34
	T. 27 S., R. 10 W.																		
27-10-32dcd	SW SW SE sec. 32	60	Grand Island Formation	1956	......	261	19	.15	66	6.7	14	222	7.0	11	.4	19	192	182	10
	T. 28 S., R. 6 W.																		
28-6-12cdd	SE SE SW sec. 12	67	Ninnescah Shale	10-20-55	62	497	13	.30	84	39	29	305	21	50	.4	111	370	250	120
28-6-25bbc	SW NW NW sec. 25	....	Ninnescah River	10-15-56	......	1,200	7.0	.35	64	14	377	183	70	575	.4	1.8	217	150	67
	T. 28 S., R. 7 W.																		
28-7-30ddd	SE SE SE sec. 30	65	Holdrege Formation	10-13-56	......	152	24	.19	23	6.5	13	88	4.1	8.0	.2	30	84	72	12
	T. 28 S., R. 8 W.																		
28-8-2ccc	SW SW SW sec. 2	....	do	10-15-56	62	202	20	.43	37	6.2	19	124	14	12	.2	32	118	102	16
	T. 28 S., R. 10 W.																		
28-10-5dbb	NW NW SE sec. 5	96	Grand Island Formation	10-11-56	64	231	20	.05	61	5.4	12	194	7.0	15	.3	15	174	159	15
	T. 29 S., R. 7 W.																		
29-7-9baa	NE NE NW sec. 9	132	Holdrege Formation	10-9-56	64	267	23	.09	61	4.9	29	249	2.5	16	.2	7.5	172	172	0

29-7-10abb	NW NW NE sec. 10	33	do	8- 9-56	60	197	22	.08	35	8.9	13	107	9.5	14	.1	42	124	88	36
29-7-24dba	NE NW SE sec. 24	34	do	8- 4-56	62	254	19	2.9	56	6.5	27	210	13	27	.2	1.9	166	166	0
29-7-26abb	NW NW NE sec. 26	....	Ninnescah Shale	8- 4-56	61	296	22	.08	56	11	37	259	16	24	.2	2.4	184	184	0
	T. 29 S., R. 9 W.																		
29-9-35ccb	NW SW SW sec. 35	....	Chikaskia River	10-13-56	......	262	19	.37	66	7.7	18	244	12	12	.4	6.2	196	196	0
	T. 29 S., R. 10 W.																		
29-10-24bc	SW NW sec. 24	40	Grand Island Formation	8- 2-56	60	208	20	.09	41	4.8	21	144	13	11	.2	26	122	118	4
	T. 30 S., R. 5 W.																		
30-5-3cdd1	SE SE SW sec. 3	100	Holdrege Formation	1956	......	196	21	.06	30	6.1	13	68	21	13	.2	38	100	44	56
30-5-12cca	NE SW SW sec. 12	63	do	9-29-55	62	232	24	.54	39	6.9	28	168	7.0	11	.3	33	126	126	0
30-5-30aaa2	NE NE NE sec. 30	14	Colluvium	9-29-55	68	225	15	.12	42	14	16	174	13	17	.2	22	162	142	20
30-5-35cbb	NW NW SW sec. 35	60	Ninnescah Shale	10- 9-56	64	1,920	13	.11	278	76	225	156	1,035	190	.5	26	1,010	128	878
	T. 30 S., R. 6 W.																		
30-6-21cda	NE SE SW sec. 21	35	Harper Siltstone	10-20-55	62	481	12	.74	74	39	37	298	120	24	.6	27	345	244	101
	T. 30 S., R. 9 W.																		
30-9-22db	NW SE sec. 22	....	Holdrege Formation	10-13 56	......	263	24	.54	66	5.7	18	232	11	9.0	.2	15	188	188	0

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.

dividual wells are not adequate. Where multiple-well systems are used in thin aquifers, the spacing between wells should be sufficient to reduce mutual interference between wells to a minimum.

Chemical Character of Ground Water

The chemical character of the water in Kingman County is indicated by analyses of 25 samples of water collected from 21 wells, 2 springs, and 2 rivers. The results of the analyses are given in Table 4. The analyses were made by Howard A. Stoltenberg, Chemist, in the Water and Sewage Laboratory of the Kansas State Board of Health. In general, the analyses do not indicate the sanitary condition of the water.

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 4). In addition to the mineral constituents, the residue generally includes small quantities of organic matter and a small amount of water of crystallization. Water containing less than 500 ppm (parts per million) of dissolved solids is suitable for domestic use, except for difficulties resulting from hardness or the presence of iron in excessive amounts. Water containing more than 1,000 ppm of dissolved solids is likely to contain enough of certain constituents to cause noticeable taste or otherwise make the water undesirable or unsuitable for use. The dissolved solids in 25 water samples collected in Kingman County ranged from 152 to 1,920 ppm; 22 of these samples contained between 152 and 497 ppm, one contained 604 ppm, and two samples contained more than 1,000 ppm. One of the samples (28-6-25bbc) high in dissolved solids was a surface-water sample from South Fork of Ninnescah River. The river water has a high concentration of dissolved solids during low flow because of natural inflow of salt water.

Hardness.—The hardness of water is most commonly recognized by its effect when soap is used with the water. Salts of 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 the other containers in which water is heated or evaporated.

The total hardness, carbonate hardness, and noncarbonate hardness of the water samples from Kingman County are given in Table 4. The carbonate hardness, or "temporary hardness", is caused by calcium and magnesium bicarbonates and can be almost entirely removed by boiling the water. 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 hardness and noncarbonate hardness react in the same manner in the relation to the use of soap. When used in boilers, water having noncarbonate hardness forms a harder scale than water having only carbonate hardness.

Water having a hardness of less than 50 ppm is classified as soft, and treatment for reduction of hardness is not necessary for ordinary uses. Hardness between 50 and 150 ppm does not seriously interfere with the use of water for most purposes, but does increase the consumption of soap. Laundries and other industries using large quantities of soap, or to which hardness is objectionable in other ways, 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 ppm is noticeable by almost everyone.

The hardness of water samples collected in Kingman County ranged from 84 to 1,010 ppm. Eight of the samples had a hardness of less than 150 ppm, ten a hardness between 151 and 200 ppm, six a hardness between 201 and 400 ppm, and one a hardness of more than 1,000 ppm.

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, even in the same aquifer. If the water contains more than 0.3 ppm of iron in solution, the iron upon oxidation may settle out as a reddish sediment. Iron, if present in sufficient quantity, gives a disagreeable taste to water, stains clothing, cooking utensils, and plumbing fixtures, and is objectionable in the preparation of foods and beverages. Iron generally can be removed by aeration and filtration, but some waters require chemical treatment for removal of iron.

The iron content of water samples collected in Kingman County ranged from 0.03 to 2.9 ppm. Sixteen of the samples contained 0.3 ppm or less and nine contained more than 0.3 ppm.

Manganese has similar properties except that the stain is black. Iron and manganese are considered together in evaluating the usefulness of water.

Chloride.—Chloride salts are very abundant in nature. They are found in quantity in sea water and 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 or corrosive. The removal of chloride from water is difficult and too costly for most water uses.

The chloride content of water samples collected in Kingman County ranged from 8 to 575 ppm. The chloride content was highest, 575 ppm, in water from South Fork of Ninnescah River. Of the 23 ground-water samples analyzed only one (30-5-35cbb) had a chloride concentration greater than 100 ppm. All other samples had chloride concentrations of 50 ppm or less.

Fluoride.—Fluoride is present in ground water only in small quantities, but a knowledge of the fluoride content of water is important because the use of water containing fluoride in excess of 1.5 ppm by children during the formation of permanent teeth may cause mottling of the tooth enamel. If the fluoride content is as much as 4 ppm, about 90 percent of the children using the water may have mottled tooth enamel (Dean, 1936). Although too much fluoride has a detrimental effect, investigations indicate that a fluoride concentration of about 1 ppm in drinking water lessens the incidence of tooth decay (Dean and others, 1941). The fluoride concentration in samples of water collected in Kingman County ranged from 0.1 to 0.6 ppm.

Nitrate.—Investigations in the last two decades on the effect of nitrate in drinking water have shown that large concentrations of nitrate in water may cause cyanosis in infants (blue babies) when the water is used for drinking and in the preparation of formulas for feeding. Infant cyanosis is usually not fatal if diagnosed in time but may be fatal with continued use of water containing excessive nitrate. Water that contains more than 90 ppm of nitrate is regarded by the Kansas State Board of Health as likely to cause infant cyanosis (Metzler and Stoltenberg, 1950). Moderate nitrate concentrations are seemingly not harmful to older children or adults. Nitrate cannot be removed from water by boiling. The nitrate concentration in samples of water collected in Kingman County ranged from 1.8 to 111 ppm. Of the 25 samples, 24 had a nitrate concentration of 42 ppm or less and only 1 sample (28-6-12cdd), having a nitrate concentration of 111 ppm, would be regarded as unsafe for feeding to infants.

Chemical Constituents in Relation to Irrigation

The following discussion of the suitability of water for irrigation use is adapted from Agriculture Handbook 60 of the U. S. Department of Agriculture (U. S. Salinity Laboratory Staff, 1954).

The development and maintenance of successful irrigation projects involve not only supplying irrigation water to the land but also control of salt and alkali in 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 solution and transportation of soluble salts by water moving 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 mineral matter will accumulate at that point. 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 water for irrigation 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 to plants; 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 a 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 an approximation of the electrical conductivity can be obtained by multiplying the total

TABLE 5.—*Factors for converting parts per million of mineral constituents to equivalents per million*

CATION	Conversion factor	Anion	Conversion factor
Ca^{++}	0.0499	HCO_3^-	0.0164
Mg^{++}	.0822	SO_4^{--}	.0208
Na^+	.0435	Cl^-	.0282
		NO_3^-	.0161
		F^-	.0526

equivalents per million (epm) of calcium, magnesium, sodium, and potassium by 100, or by dividing the dissolved solids in parts per million by a factor of 0.6 to 0.7 (Table 5). 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 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 places 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)—the percent sodium, so called. According to the U. S. Department of Agriculture the sodium-adsorption ratio (SAR), used to express the relative activity of sodium ions in exchange reactions with soil, is a better measure of suitability of water for irrigation with respect to the sodium (alkali) hazard. The sodium-adsorption ratio may be determined by the formula

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

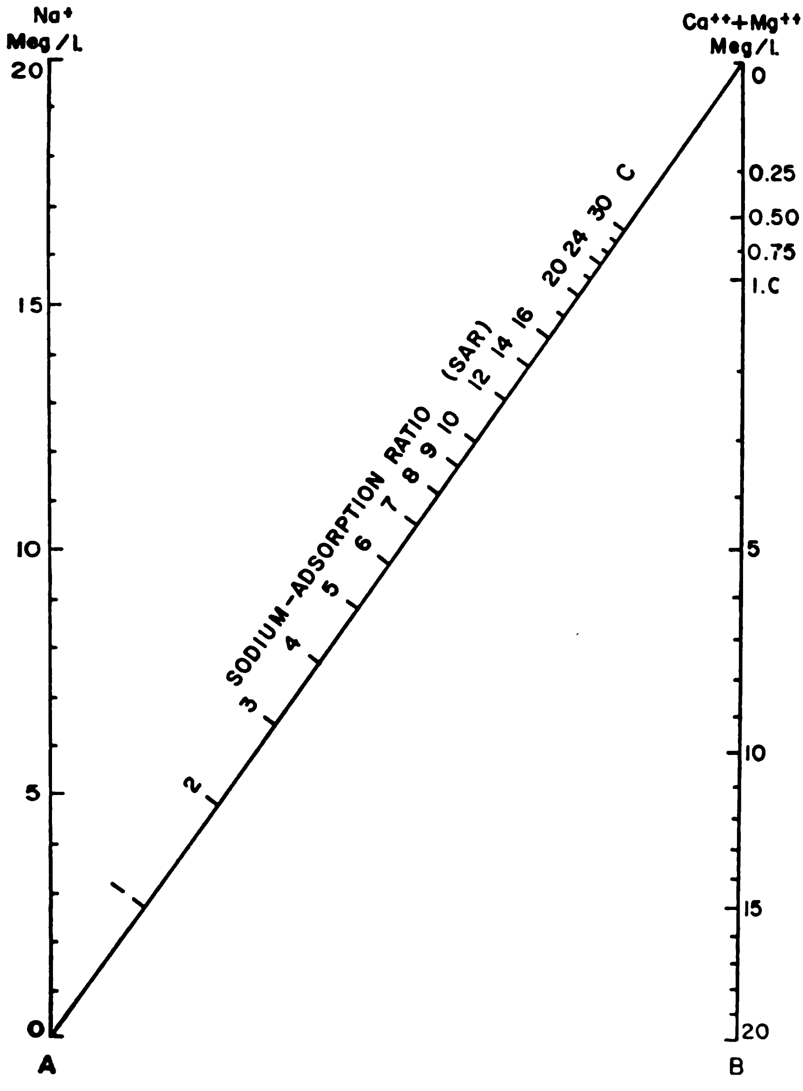

Fig. 12.—Nomogram used to determine sodium-adsorption ratio of water.

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 12. In using the nomogram to determine the sodium-adsorption ratio of water, the concentration of sodium expressed in equivalents per million is plotted on the left-hand scale, and the concentration of calcium plus magnesium

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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 indicates 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 plotting these values on the diagram shown in Figure 13. Table 6 gives the

TABLE 6.—*Sodium-adsorption ratio (SAR) and approximate conductivity of water samples that are plotted on Figure 13 and for which analyses are given in Table 4.*

Well number	Sodium-adsorption ratio	Conductivity (micromhos) 100 x (Ca + Mg + Na)
27-5-3ccc	0.8	330
27-5-36aab	.6	535
27-6-6ccd	1.4	920
27-7-3adc	.9	660
27-8-15ddb	.7	490
27-8-31cca	1.5	455
27-9-18dcc	.4	430
27-10-32dcc1	.4	445
28-6-12cdd	.6	865
28-6-25bbc	11.1	2,070
28-7-30ddd	.6	225
28-8-2ccc	.7	320
28-10-5dbb	.4	400
29-7-9baa	.9	470
29-7-10abb	.4	305
29-7-24dba	.9	450
29-7-26abb	1.1	530
29-9-35ccb	.5	470
29-10-24bc	.7	335
30-5-3cdd1	.5	255
30-5-12cca	.8	375
30-5-30aaa2	.5	395
30-5-35cbb	3.1	2,990
30-6-21cda	.9	850
30-9-22db	.5	455

sodium-adsorption ratio and approximate electrical conductivity of water samples that are plotted on Figure 13 and for which analyses are given in Table 4. Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of developing 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 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 addition of organic matter. Very high sodium water (S4) is generally unsatisfactory for irrigation unless special action is taken, such as addition of gypsum to the soil.

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 can be irrigated

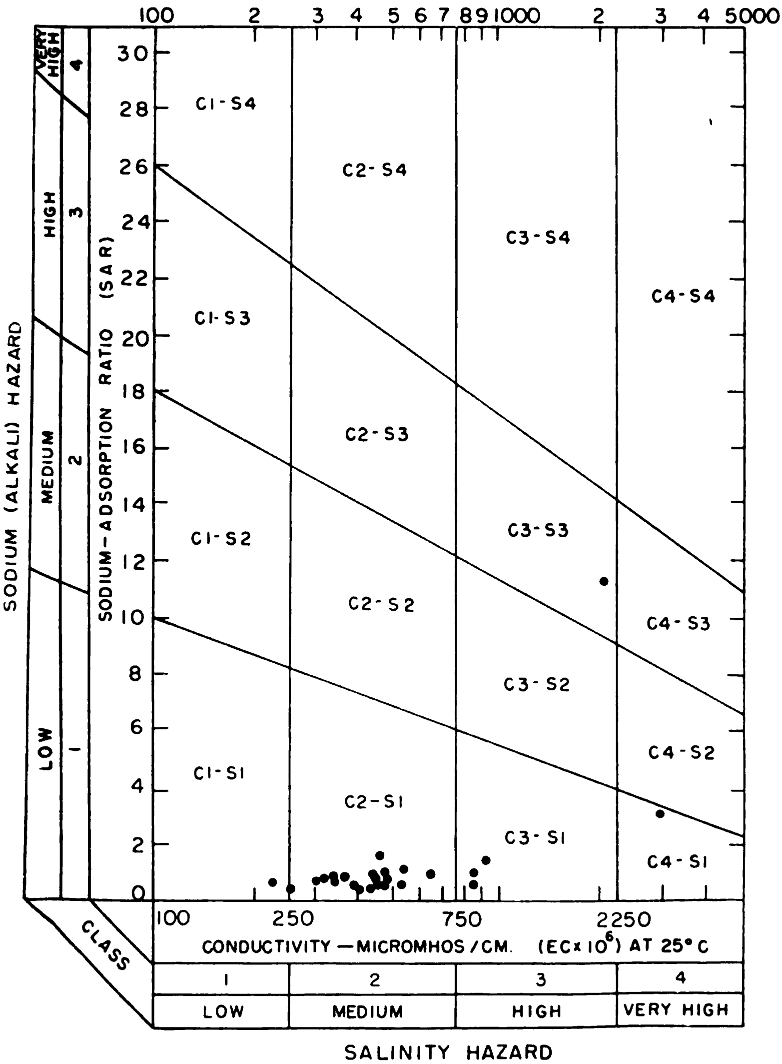

FIG. 13.—Diagram showing suitability of water for irrigation.

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 water under ordinary circumstances. It can be used only on crops that are very tolerant for salt 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 crops ordinarily grown in Kansas are not adversely affected by boron concentrations of less than 1 ppm.

In water having a high concentration of bicarbonate, there is a tendency for calcium and magnesium to precipitate as the water in the soil becomes more concentrated as a result of evaporation and plant transpiration. 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 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 (meq) per liter or equivalents per million (epm).

On the basis of limited data and using the concept of residual sodium carbonate described above, it is concluded by the Department of Agriculture that water having more than 2.5 epm of residual sodium carbonate is not suitable for irrigation. Water containing 1.25 to 2.50 epm of residual sodium carbonate is marginal, and water containing less than 1.25 epm is safe.

In appraising the quality of an irrigation water, first consideration must be given to salinity and alkali hazards by reference to Figure 13. Then consideration should be given to other characteristics such as content of boron and other toxic elements and of 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 Conditions

The analyses of water given in Table 4 show only the amounts of dissolved mineral matter in the water and do not indicate the sanitary quality of the water. An abnormal amount of certain chemical constituents, such as nitrates, may indicate pollution of the water.

The cities in Kingman County that are served by municipal water supplies use carefully constructed wells, which meet the requirements of and are periodically examined by the Division of Sanitation of the State Board of Health. Most of the population of the county, however, is dependent on private water supplies, and every precaution should be taken to protect these supplies from pollution. A well should not be located near possible sources of pollution, such as barnyards, privies, and cesspools, and well casings should be sealed tightly down to a level somewhat below the water table. As a general rule, dug wells are relatively vulnerable to contamination by surface water because they generally are not effectively cased or sealed at the surface.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Permian System

Leonardian Series

The Permian rocks of Kingman County are a part of the Leonardian Series and are divided into two groups, the lower of which is the Sumner Group and the upper, the Nippewalla Group (Table 2). The outcropping rocks of the Sumner Group include the Ninnescah Shale, in which the Runnymede Siltstone member forms the upper part, and the Stone Corral Dolomite, which is the top formation of the Sumner Group. The rocks of the Nippewalla Group cropping out in Kingman County include two formations, the Harper Siltstone and the Salt Plain Siltstone. The Harper Siltstone is divided into two members, the Chikaskia Siltstone and the Kingman Siltstone.

The distribution of the Permian rocks is shown on the geologic map (Pl. 1) by the approximate position of the contact of the Sumner and Nippewalla Groups. The general character of the individual formations is apparent in the field, and they are discussed separately in the section that follows. However, the lithology of the rock units is so similar that formation contacts cannot be identified with certainty away from the type areas of the formations.

Ninnescah Shale

The Ninnescah Shale, the oldest formation exposed in Kingman County, was named by Norton (1939, p. 1767) from exposures on North and South Forks of Ninnescah River in Reno and Kingman

Counties. The formation is composed of alternating beds of brownish-red shale, silty shale, and siltstone, and a few thin beds of gray-green silty shale.

The Ninnescah Shale crops out along South and North Forks of Ninnescah River and Chikaskia River and their tributaries in the eastern third of the county and forms a surface of low relief. The formation attains a maximum thickness of about 400 feet along the south edge of the county. The Runnymede Siltstone member, 7 to 8 feet thick, forms the top of the formation. Norton (1939, p. 1767-74) and Swineford (1955) have described the character and thickness of the Ninnescah Shale in detail.

The Ninnescah Shale yields water to many stock and domestic wells in the eastern part of the county where not overlain by younger water-bearing beds. Little is known of the hydrologic properties of the formation, but it is believed to yield water only from the weathered part. The water from the Ninnescah Shale is of good quality in most of its area of outcrop in the county, except in the southeast corner where the water is strongly mineralized.

Stone Corral Dolomite

The Stone Corral Dolomite was named by Norton (1939, p. 1775) from exposures in Rice County. The formation is chiefly anhydrite in the subsurface and is a key marker bed. The Stone Corral Dolomite is exposed along the valley of Smoots Creek in the north-central part of Kingman County, where it is represented by 0.4 foot of dense grayish-buff dolomite. Farther south in the county the Stone Corral is represented by reddish dolomitic silty shale and cannot be distinguished from the shales of the Ninnescah below and the Harper above. The Stone Corral Dolomite yields no water to wells in the county.

Harper Siltstone

The Harper Siltstone was named by Cragin (1896) from exposures in Harper County, Kansas. Norton (1939, p. 1782) removed the Ninnescah Shale and Stone Corral Dolomite from Cragin's Harper Formation and restricted the unit to the beds above the Stone Corral Dolomite and below the Salt Plain Siltstone.

The Harper Siltstone in Kingman County consists of about 210 feet of brownish-red argillaceous siltstone and silty shale and a few beds of silty sandstone. The formation is divided into two members, the Chikaskia Siltstone in the lower part, and the overlying Kingman Siltstone. The formation is well exposed along the valleys of South

Fork of Ninnescah River and Chikaskia River in central Kingman County, where the beds form steep valley walls. Swineford (1955, p. 49-57) has described the formation in detail.

The Harper Siltstone yields small supplies of water for stock and domestic use in the central part of Kingman County. The water is believed to occur only in the weathered part of the formation, and the wells commonly fail during drought periods. Younger water-bearing formations overlie the Harper Siltstone in much of the county.

Salt Plain Siltstone

The Salt Plain Siltstone underlies younger water-bearing deposits in much of western Kingman County. The formation crops out in a small area along Chikaskia River north of the town of Zenda. Swineford (1955, p. 57-60) has described the formation in detail. The Salt Plain Siltstone is not known to yield water to wells in Kingman County.

Tertiary System

Pliocene Series

Ogallala(?) Formation

Rocks believed to be equivalent to a part of the Ogallala Formation occur in a small upland area north and east of the city of Kingman. The deposits are lithologically similar to the Delmore Formation described by Williams and Lohman (1949, p. 57-59) in McPherson County and correlated with the Ash Hollow Member of the Ogallala Formation by Frye, Leonard, and Swineford (1956, p. 57). The deposits are composed principally of material derived locally from Cretaceous and Permian rocks. The rocks were probably deposited by a tributary flowing eastward toward a major stream flowing south through a depressional area in McPherson, Harvey, and Sedgwick Counties.

Character.—The Ogallala(?) Formation is composed of brown to red-brown calcareous silt, fine- to coarse-grained sand, and fine to coarse gravel and cobbles. Locally, the basal gravel and cobbles are cemented with calcium carbonate. Exposures of the formation are poor but are found in road cuts and pit silos in the area.

Coarse, well-rounded pebbles and cobbles of quartz, ironstone, sandstone, weathered granite, and quartzite in part derived from Cretaceous rocks that are no longer present in place in the county, are concentrated locally at the unconformable contact of the

Ogallala(?) on older rocks. The sand beds in the formation are composed of fine to coarse grains of iron-stained quartz and some feldspar, mica, and other minerals. The silt is predominantly red brown but in part brown. On the outcrop the formation is characteristically dark reddish brown.

Distribution and thickness.—The Ogallala(?) Formation crops out in north-central Kingman County, capping the upland divide between South Fork of Ninnescah River and Smoots Creek. The western boundary of the formation is shown on Plate 1 by a dashed line, as exposures in the area are poor and younger sediments overlie the formation in this area. Test drilling in the area west of the mapped boundary did not reveal sediments typical of the Ogallala(?) Formation, but they are present in adjacent areas of Reno County. The maximum thickness of the formation as determined by test drilling was about 26 feet in test hole 27-6-28ccc.

Age and correlation.—The deposits in Kingman County tentatively assigned to the Ogallala(?) Formation are lithologically distinct from the younger Pleistocene deposits in adjacent areas and are in part overlain by the oldest Pleistocene deposits present in the area. The deposits are lithologically similar to middle Pliocene deposits in McPherson County (Delmore Formation), being composed of material derived locally from Cretaceous and Permian rocks but lacking the chert pebbles, derived from Permian limestones to the east, that are common in the McPherson County deposits. Only one fossil is known from the deposits in Kingman County, an upper molar of the Pliocene mastodon *Amebelodon* (Kansas University Museum of Natural History No. 9967) recovered from a pit silo in the SE¼ sec. 16, T. 27 S., R. 7 W. Although not conclusive, the foregoing evidence points to a Pliocene age for the deposits, and they are tentatively assigned to the Ogallala Formation.

Water supply.—The deposits of the Ogallala(?) Formation are relatively thin and of small areal extent and yield small supplies of water for stock and domestic use to only a few wells in the county.

Quaternary System—Pleistocene Series

The Pleistocene Series in Kansas is divided into four main stages related to continental glaciation, and three interglacial stages. Events during each of the stages of continental glaciation followed a similar pattern. The cycle in the belt marginal to the glaciated area is characterized by downcutting in stream valleys and some local deposition of sediments during the advance of the glacial ice, then deposition of clastic material, which became progressively finer grained as the glacial front retreated, and finally the development of soil over large areas as surface stability was established.

Although deposits representing all the glacial stages are present in Kingman County and can be recognized in the field and in logs of test holes, some of these units are of such small areal extent or so thin that they are not shown on the geologic map (Pl. 1). Deposits of the Crete(?) Formation (Illinoisan) in isolated areas of the uplands in western Kingman County are mapped with the Grand Island and Sappa Formations, although they are shown separately on the well logs. Deposits believed to be in part equivalent to the Peoria Formation occur locally on most upland divides in the county but are so thin that they are not shown on the geologic map. The terrace deposits representing Wisconsinan deposition and the Recent alluvium, although readily separable in the field, are shown together on the geologic map because of their small areal extent, but they are discussed separately in the section that follows.

Lower Pleistocene Subseries

Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages

Late Nebraskan and Aftonian time in Kingman County is represented by deposits of clay, silt, sand, and gravel of the Holdrege and Fullerton Formations, which unconformably overlie rocks of Permian age. The contact between the Holdrege and Fullerton Formations is not sharp and is arbitrarily placed where the sand and gravel typical of the Holdrege Formation give way to sandy silt. In much of Kingman County where the Holdrege and Fullerton Formations are overlain by younger sediments, the Fullerton Formation contains, in its upper part, a heavy accumulation of caliche and a clay-enriched zone believed to represent remnants of the Afton soil. The Holdrege and Fullerton Formations are shown on the geologic map (Pl. 1) as a single unit, although the Fullerton is absent in part of the area so mapped.

Character.—The material composing the Holdrege Formation was deposited by streams that headed in the area west of Kingman County. The material consists of fine to coarse sand and fine to coarse gravel and some sandy silt and clay. The gravel generally is found near the base of the formation and contains pebbles of material derived from Cretaceous rocks, such as ironstone and sandstone. The sand and gravel consists predominantly of quartz grains but contains much feldspar, some mica, and a few dark minerals. The silt beds in the Holdrege Formation are generally thin, are very sandy, and in many places contain a small amount of clay. The silt is generally pinkish tan but some tan and gray silt is present. Thin zones of lime-cemented sand are found locally in the upper part of the formation.

The Fullerton Formation consists predominantly of tan to gray sandy silt and locally contains thin zones of silty sand. In much of central and western Kingman County where the Fullerton Formation is overlain by younger sediments and thus protected from erosion the upper part of the formation contains much clay and a zone of heavy caliche accumulation believed to be a remnant of a well-developed Afton soil.

Distribution and thickness.—The Holdrege and Fullerton Formations are present over most of Kingman County except where removed by erosion in the valleys of Chikaskia and Ninnescah Rivers in the central and eastern parts of the county. These formations probably formed a coalescent sheet over the county during Aftonian time except in an area of high bedrock in the southwestern part of the county (Section A-A′, Pl. 2). Younger sediments later buried the Nebraskan sediments. Erosion by streams of steeper gradient during late Pleistocene time cut deeply into the Nebraskan and younger sediments and the underlying Permian bedrock, exposing these formations along present valleys in the county. Overlying younger sediments and the Fullerton Formation and part of the Holdrege Formation were removed in eastern Kingman County, and the relative topographic position of the Nebraskan sediments was changed. In western and central Kingman County the Nebraskan sediments fill buried valleys of low gradient, top low divides in the Permian bedrock, and remain buried by younger sediments in much of the area. In the eastern part of the county, present streams have cut below the level of the Nebraskan valleys, and remnants of the Nebraskan valley fills form the highest topographic elements in the area. The combined thickness of the Holdrege and Fullerton Formations ranges from 0 in parts of Kingman County to a maximum of about 162 feet in test hole 27-9-6bbb.

Age and correlation.—A late Nebraskan and early Aftonian age for the Holdrege and Fullerton Formations in Kingman County is indicated by vertebrate and invertebrate fossils collected at three localities in the county and by their stratigraphic position, which places them as the oldest Pleistocene rocks in the county.

The fossils collected in Kingman County were taken from sediments of the Fullerton Formation and were associated with or were below the zone of caliche accumulation believed to be a part of the Afton soil profile. The sites of the fossil collections are in the NW¼ SW¼ sec. 23, T. 30 S., R. 9 W., known as the Swingle locality; in the SW¼ sec. 12, T. 29 S., R. 8 W., known as the Dixon locality; and in the SE¼ NE¼ sec. 23, T. 30 S., R. 5 W., known as Dixon locality 2.

The vertebrate fossils from the Dixon locality were identified and described by Hibbard (1956) and Tihen (1955) and the invertebrates by Frye and Leonard (1952). The vertebrates from Dixon locality 2 were identified by Hibbard (1957). No vertebrates were recovered at the Swingle locality. The invertebrates recovered at Dixon locality 2 and the Swingle locality were identified by Dr. Dwight W. Taylor and are listed below. The species name is followed by the University of Michigan Museum of Zoology catalog number, and the number of specimens in parentheses.

Fossil mollusks from Swingle locality, SW¼ SW¼ sec. 23, T. 30 S., R. 9 W.

Fresh-water clams:	
Sphaerium sp.	191477(1), 191479(1)
Pisidium compressum Prime	191478(24)
Fresh-water snails:	
Lymnaea caperata Say	191480(33)
Gyraulus parvus (Say)	191481(11)
G. circumstriatus (Tryon)	191482(2)
Helisoma trivolvis (Say)	191483(1)
Promenetus umbilicatellus (Cockerell)	191484(3)
Physa sp.	191485(1)
Land snails:	
Gastrocopta armifera (Say)	191486(4)
G. cristata (Pilsbry and Vanatta)	191487(8)
G. pellucida hardeacella (Pilsbry)	191488(42)
G. tappaniana (Adams)	191489(5)
Pupoides albilabris (Adams)	191490(4)
Vertigo milium (Gould)	191491(5)
V. ovata Say	191492(6)
Vallonia gracilicosta Reinhardt	191493(5)
V. parvula Sterki	191494(3)
V. sp. (young of one or both of the above two species)	191495(6)
cf. *Succinea*	191496(44)
Helicodiscus parallelus (Say)	191497(6)
H. singleyanus (Pilsbry)	191498(2)
Deroceras aenigma Leonard	191499(1)
Hawaiia minuscula (Binney)	191500(55)

Fossil mollusks from Dixon locality 2, SE¼ NE¼ sec. 23, T. 30 S., R. 5 W.

Fresh-water clams:
Sphaerium partumeium (Say) .... 191501(109), 191502(17)

Fresh-water snails:
Valvata tricarinata (Say) form
perconfusa Walker .... 191503(33)
Viviparidae, indet .... 191504(1)
Lymnaea palustris (Müller) .... 191505(250)
L. caperata Say .... 191506(41)
L. dalli Baker .... 191507(2)
L. megasoma Say .... 191508(15)
Gyraulus parvus (Say) .... 191509(300)
Helisoma anceps (Menke) .... 191510(1)
H. trivolvis (Say) .... 191511(72)
Planorbula armigera (Say) .... 191512(200)
Promenetus kansasensis (Baker) .... 191513(150)
P. umbilicatellus (Cockerell) .... 191514(6)
Ancylus coloradensis Henderson .... 191515(1)
Ferrissia pumila Sterki .... 191516(43)
Physa elliptica Lea .... 191517(65)
P. skinneri Taylor .... 191518(22)

Land snails:
Gastrocopta cristata (Pilsbry and Vanatta) .... 191519(2)
G. procera (Gould) .... 191520(11)
G. pellucida hardeacella (Pilsbry) .... 191521(3)
G. n. sp. .... 191522(6)
G. tappaniana (Adams) .... 191523(32)
Pupoides albilabris (Adams) .... 191524(16)
Vertigo milium (Gould) .... 191525(25)
V. ovata Say .... 191526(4)
cf. *Succinea* .... 191527(12)
Oxyloma ref. *O. haydeni* (Binney) .... 191528(27)
Helicodiscus parallelus (Say) .... 191529(18)
H. singleyanus (Pilsbry) .... 191530(400)
Deroceras aenigma Leonard .... 191531(6)
Hawaiia minuscula (Binney) .... 191532(150)

According to Dr. Taylor (written communication), "the collection from SE¼ NE¼ sec. 23, T. 30 S., R. 5 W., is so similar to the already known Dixon local fauna that I am including it in that assemblage as Dixon locality 2. . . . The climate when the Dixon local fauna was living was certainly different from that of Kingman County today. Apparently the summers were not much different, but winter precipitation was probably much greater. Such conditions could result in much more surface water than now persists through the summer, but in a climate with summers like those of today. This climate is believed to be very late glacial rather than interglacial, and the Dixon local fauna very late Nebraskan. The collection from NW¼ SW¼ sec. 23, T. 30 S., R. 9 W. (Swingle site), is probably interglacial rather than glacial. There are not many species and I can't be too sure of correlation. The fauna shows that summers were not quite as hot and dry as they are in southern Kansas today, but winters were no colder. It is possible that this assemblage is of the same age as the Dixon local fauna, and differs only because of local habitat. I believe, however, that it is more probably Aftonian than even very late Nebraskan. The fauna may be correlative with the Aftonian Sanders local fauna [Hibbard, 1956] of Meade County, but the mollusks can't prove this. I can ascribe it only to some unknown part of the varied Aftonian interglacial."

Water supply.—The Holdrege Formation is the principal source of ground water in Kingman County. The quantity of water that may be obtained from the Holdrege Formation is different from place to place, owing to differences in the thickness and physical character of the sand and gravel in the formation. Supplies of water adequate for domestic and stock use are available in most of the area underlain by the formation. In parts of Kingman County the saturated thickness of the formation is adequate for large water supplies for municipal, irrigation, and industrial use. The water from the Holdrege Formation is moderately hard but is satisfactory for most uses.

The Fullerton Formation is composed principally of sandy silt and clay and does not readily yield water to wells. In parts of Kingman County the Fullerton Formation lies below the water table, and wells penetrating sandy zones in the formation might yield small water supplies adequate for stock and domestic use.

Grand Island and Sappa Formations—Kansan and Yarmouthian Stages

Kansan and Yarmouthian time in Kingman County is represented by stream-deposited clay, silt, sand, and gravel of the Grand Island and Sappa Formations. The Grand Island Formation rests unconformably on the Fullerton Formation and locally on Permian rocks, and grades upward into sandy silt and clay of the Sappa Formation. The contact between the Grand Island and Sappa Formations is not sharp and is arbitrarily placed where the rock changes from sandy to predominantly silty. A heavy accumulation of caliche and a clay-enriched zone in the upper part of the Sappa Formation in parts of western Kingman County are believed to represent remnants of the Yarmouth soil. The Grand Island and Sappa Formations are shown on the geologic map (Pl. 1) as a single unit, although the Sappa is absent in part of the area so mapped.

Character.—The Grand Island Formation consists of fine to coarse sand and fine to coarse gravel and minor amounts of silt. The sand of the Grand Island Formation is mostly quartz but contains much feldspar and other minerals typical of igneous rocks. Gravel is found throughout the formation but is most common near the base. The gravel is coarser than that in the Holdrege Formation and contains rock types common to the Rocky Mountain area; locally derived gravel of the kind common in the Holdrege Formation is not found in the Grand Island Formation. These facts may indicate that through drainage from the Rocky Mountains first reached central Kansas in late Kansan time. Silt beds in the Grand Island Formation are thin, contain much sand, and are tan.

The Sappa Formation consists of gray to tan sandy silt, which becomes clayey in the upper part of the formation. In extreme western Kingman County the Sappa Formation contains a heavy zone of caliche in the clay-enriched zone, which is believed to represent a remnant of the Yarmouth soil. A lenticular bed of volcanic ash, the Pearlette Ash bed (Carey and others, 1952), is found in the stratigraphic position of the Sappa Formation at widely distributed locations throughout the midcontinent region from Texas to South Dakota and from Colorado to Iowa and is an important stratigraphic marker in the Pleistocene of the region (Frye and Leonard, 1952). Two deposits of the Pearlette Ash bed are known in Kingman County. A small deposit about 2 feet thick crops out in the NW¼ NE¼ sec. 16, T. 29 S., R. 10 W., and a deposit of unknown extent, buried under Recent slope deposits, is present in the NW¼ sec. 30, T. 28 S., R. 7 W.

Distribution and thickness.—Valley cutting, which was common in Nebraskan time, does not seem to have been extensive in Kingman County during Kansan time. The Grand Island and Sappa Formations seem to have been deposited by streams that shifted laterally over a relatively flat eastward-sloping surface. The formations may have formed a coalescent sheet over the entire area of Kingman County during Yarmouthian time. Erosion during late Pleistocene time removed the formations from most of eastern Kingman County (Pl. 1), and the deposits now are found only on the upland divides in the central and western parts of the county. The Sappa Formation has been removed in the central part of the county except in isolated areas on the crests of divides. In extreme western Kingman County all but the upper part of the Sappa Formation remains intact and underlies the surface in that area. The Grand Island and Sappa Formations are thickest along the western border of the county. Although the thickness is not definitely known, it is estimated to be as much as 150 feet. Eastward, the formations have been thinned by erosion to a featheredge in the central part of the county.

Age and correlation.—A late Kansan to early Yarmouthian age for the Grand Island and Sappa Formations is indicated by the stratigraphic position of the Grand Island, which unconformably overlies deposits of late Nebraskan to Aftonian age, and by the occurrence of the late Kansan Pearlette Ash bed in the Sappa silts overlying the Grand Island Formation. No fossils were found in the Grand Island and Sappa Formations in Kingman County.

Water supply.—The Grand Island lies above the water table in most of its area of occurrence in Kingman County, and where it does it yields no water to wells. In the extreme western part of the county, where the formation is thickest it is the principal aquifer supplying water to domestic and stock wells. The formation in that area is capable of yielding large water supplies adequate for municipal, irrigation, and industrial use. The city of Cunningham is supplied from two wells finished in the Grand Island Formation; and irrigation well 28-10-5dbb, which also is in the Grand Island Formation, is reported to have yielded 1,000 gpm during a pumping test. The water from the Grand Island Formation is moderately hard but suitable for most uses. The Sappa Formation lies above the water table and does not yield water to wells in Kingman County.

Upper Pleistocene Subseries

Crete(?) Formation—Illinoisan Stage

Deposits of silt, sand, and gravel believed to be the Crete Formation of late Illinoisan age are present at scattered localities in western Kingman County, form terraces adjacent to Smoots Creek in the northeastern part of the county, and fill a buried valley in the east-central part of the county. The anomalous distribution of the Crete(?) Formation suggests the occurrence of a major change in the master stream of the area, and resulting adjustments in its tributaries, in late Illinoisan time.

In western Kingman County isolated deposits of the Crete(?) Formation consisting of arkosic sand and gravel lie unconformably on the Sappa Formation and locally fill small channels cut into that formation. In other parts of western Kingman County the Crete(?) Formation forms a thin veneer of coarse gravel resting on the Sappa Formation. The maximum thickness of the Crete(?) Formation in the western part of the county is not known, but 12 feet of sand and gravel overlying the Sappa Formation was penetrated by test hole 29-9-6bbb. Deposits of the Crete(?) Formation in the western part of the county are so small and scattered that they are not shown on the geologic map (Pl. 1).

Deposits of silt, sand, and gravel believed to be the Crete(?) Formation form a terrace on the northeast side of Smoots Creek in northeastern Kingman County. These deposits occupy a broad channel cut into the Permian bedrock, but its floor is at a higher altitude than bedrock under the present Smoots Creek (Section E-E′, Pl. 2). Erosion has removed the Crete(?) Formation near South Fork of Ninnescah River. Southeast from the northward bend in T. 29 S., R. 5 W., a buried valley, which has been traced by test drilling, leaves Kingman County, crosses the corner of Sedgwick County, and joins the Slate Creek valley in Sumner County. The silt, sand, and gravel filling this buried valley are believed to be the Crete Formation, and the valley may be a continuation of the late Illinoisan(?) valley adjacent to Smoots Creek. The maximum thickness of the Crete(?) Formation in eastern Kingman County as determined by test drilling was 50 feet in test hole 27-5-29ccc.

Water supply.—In western Kingman County the Crete(?) Formation lies above the water table and thus does not yield water to wells. Permeable sand and gravel of the Crete(?) Formation adjacent to Smoots Creek are capable of yielding moderately large water supplies adequate for small-scale irrigation and industrial use. Industrial well 27-5-33abb is reported to yield 350 gpm continuously; and irrigation well 27-6-6ccd, a battery of eight closely spaced small-diameter wells, is reported to yield 260 gpm. The Crete(?) Formation in the buried channel in T. 29 S., R. 5 W., supplies water for domestic and stock use. The water from the Crete(?) Formation is moderately hard but is satisfactory for most uses.

Terrace Deposits—Wisconsinan Stage

There are low terraces at two distinct levels in the valleys of South Fork of Ninnescah River, Chikaskia River, and their principle tributaries in Kingman County. The deposits underlying the upper terrace, which are not continuous, contain fossil mollusks that have been dated as early Wisconsinan (Frye and Leonard, 1952). A late Wisconsinan age is assumed for the more widespread lower terrace because of local traces of abandoned meanders on its surface and because of its position above the Recent alluvium of the streams and below the early Wisconsinan terrace surface. The materials underlying the terraces consist principally of silt, sand, and gravel derived from older Pleistocene deposits. Where the deposits are entrenched in Permian rocks, they contain abundant pebbles of Permian shale. The deposits are limited to the floors of the major valleys and average about ¾ mile in width. The maximum thickness of the terrace deposits penetrated by test drilling was 49 feet in test hole 30-8-6bcb, but the average is about 40 feet. The Wisconsinan terrace deposits and the Recent alluvium are shown as a single unit on the geologic map (Pl. 1).

Water supply.—The sand and gravel of the Wisconsinan terrace deposits is capable of yielding moderately large water supplies, particularly adjacent to the rivers where induced filtration of river water by pumping will readily recharge the aquifer. The city of Kingman supplements its municipal water supply with five wells in terrace deposits of South Fork of Ninnescah River. Of these, three are capable of producing 250 to 300 gpm each, and two small-diameter wells are capable of producing about 90 gpm each. Irrigation well 30-6-9dac in terrace deposits along Chikaskia River is reported to yield about 300 gpm. The water in the terrace deposits adjacent to South Fork of Ninnescah River is of poor quality, containing an excessive amount of chloride derived from the river water. In the terrace deposits away from the river the water is moderately hard but is low in chloride and is satisfactory for most uses. The water in the terrace deposits along Chikaskia River is moderately hard.

Colluvium

Deposits of silt, containing some sand and gravel, overlie Permian rocks in large areas of central and eastern Kingman County. The deposits are on gentle slopes adjacent to major streams and are the result of mass movement of debris from the bordering uplands toward the major drainages by sheet wash and soil creep. The colluvial deposits in Kingman County are particularly well developed on the Ninnescah Shale, which is easily eroded and forms gentle slopes. Where widespread, the deposits have the general appearance of a broad alluvial terrace and in many places blend imperceptibly with the terrace deposits bordering the streams. The age of the colluvial deposits is uncertain but some may in part be as old as late Illinoisan and some are still being deposited at the present time. The maximum thickness of colluvium penetrated by test drilling was 23 feet in test hole 30-5-29ddd. The deposits lie above the water table generally but where below the water table and where sufficiently thick and permeable are capable of yielding small supplies of water.

Dune Sand

Several areas in Kingman County are underlain by deposits of fine to medium sand containing some silt and displaying a typical dune topography. The largest area of sand dunes in the county is in the southwest corner, in T. 30 S., R. 10 W., and is an extension of a larger tract of dunes in Pratt County to the west. The dunes in this area generally are stabilized by vegetation, but blowouts are common when the vegetative cover is removed. There is another large tract of dunes along the north side of Chikaskia River in T. 30 S., R. 6 W. Some dunes adjacent to the river are active, but those away from the river generally are subdued and have a cover of vegetation. Other isolated areas in eastern Kingman County are underlain by gently rolling sand dunes (Pl. 1) and are successfully cultivated in years of normal rainfall. The maximum thickness of the dune sand probably does not exceed 30 feet, and in the areas of gently rolling subdued dunes the thickness does not exceed 6 feet. The age of the dune sand is uncertain, but the sand movement may have begun as early as late Wisconsinan time and in isolated areas bordering the major streams is still going on. The dune sand lies above the water table and thus does not supply water to wells in the county.

Alluvium

Deposits of Recent alluvium are present in and adjacent to the channels of South and North Forks of Ninnescah River, Chikaskia River, and their major tributaries in Kingman County. The alluvium is confined to a narrow belt adjacent to the present stream channels and is not more than 200 feet wide, except in a few places. The surface of the Recent alluvium generally lies 2 to 4 feet below the late Wisconsinan terrace, and the stream channels, commonly box shaped, are incised 2 to 6 feet in the alluvial fill. The alluvium is composed of silt, sand, and fine gravel derived from older Pleistocene deposits and, where adjacent to Permian bedrock, contains abundant fragments of these rocks. The thickness of the alluvium is not definitely known, but the 30 feet of alluvium penetrated in test hole 28-5-35ada is believed to be about average. So far as is known no wells in Kingman County penetrate alluvium of the major streams, as the flood plain it forms is periodically flooded. However, wells could be located on the flood plain if they were constructed so as to prevent flood damage, and they should yield large quantities of water by induced infiltration of river water. Wells on the adjacent terrace should have similar yields.

RECORDS OF WELLS, TEST HOLES, AND SPRINGS

Information pertaining to 358 wells, test holes, and springs in Kingman County is tabulated in the following pages (Table 7). The types and numbers of wells, test holes, and springs are summarized as follows:

Type of well or test hole	Number
Drilled test holes	48
Augered test holes	199
Domestic and stock wells	53
Irrigation wells	11
Industrial wells	4
Public-supply wells	10
Oil-well tests	30
Observation wells	1
Springs	2
Total	358
Test holes by private contractors	12
Auger test holes by State Geological Survey	199
Hydraulic-rotary test holes by State Geological Survey	36
Total number of wells	79
Total number of test holes (includes oil-well tests)	277
Total number of wells and test holes	356
Total number of springs	2
	358

The well-numbering system used in this report is described on page 10.

Table 7.—*Records of wells, test holes, and springs in Kingman County*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 26 S., R. 11 W.															
26-11-36ddd	SE SE SE sec. 36	....	Dr	160	4	N	Silt, sand, and gravel	Pleistocene (undifferentiated)	N	N	Land surface	0	1,759.9	....	....	T. H. by USGS and KGS.
	T. 27 S., R. 5 W.															
27-5-1bbb	NW NW NW sec. 1	....	B	13	4	N	do	Colluvium	N	N	do	0	1,403.8	8.2	6-16-55	do.
•27-5-3ccc	SW SW SW sec. 3	Peter Halsig	Dr	37	6	S	Sand and gravel	Holdrege Formation	J, E	D, S	do	0	1,497.2	5.0	9-7-55	
27-5-6aaa	NE NE NE sec. 6	....	Dr	60	4	N	do	do	N	N	do	0	1,509.6	8.6	6-16-55	T. H. by USGS and KGS.
27-5-6ddd	SE SE SE sec. 6	....	B	50	4	N	do	do	N	N	do	0	1,525.1	29.9	6-16-55	do.
27-5-7ddd	SE SE SE sec. 7	....	B	50	4	N	do	do	N	N	do	0	1,507.1	14.0	6-16-55	do.
27-5-12bbb	NW NW NW sec. 12	....	B	25	4	N	do	do	N	N	do	0	1,459.8	13.9	7-23-55	do.
27-5-14aaa	NE NE NE sec. 14	....	B	50	4	N	do	do	N	N	do	0	1,479.8	16.7	5-10-55	do.
27-5-16ddd	SE SE SE sec. 16	Art Busch	Dr	16	6	GI	do	do	N	N	Top of casing	0	1,491.5	11.1	9-7-55	
27-5-18ddd	SE SE SE sec. 18	....	B	20	4	N	do	do	N	N	Land surface	0	1,492.0	3.5	6-16-55	T. H. by USGS and KGS.
27-5-19ddd	SE SE SE sec. 19	....	B	46	4	N	do	Crete(?) Formation	N	N	do	0	1,465.8	23.5	6-16-55	do.
27-5-23aaa	NE NE NE sec. 23	....	B	40	4	N	do	Holdrege Formation	N	N	do	0	1,472.2	8.8	7-23-55	do.
27-5-23dcc	SW SW SE sec. 23	Emma Klinker	Dr	37	6	GI	do	do	N	N	do	0	1,505.2	33.9	9-7-55	
27-5-24cdc	SW SE SW sec. 24	Mort Isaacs	Dr	....	6	GI	do	do	Cy, H	D	Top of casing	2.0	1,486.2	22.9	9-7-55	
27-5-26aaa	NE NE NE sec. 26	....	B	40	4	N	do	....	N	N	Land surface	0	1,503.5	Dry	6-15-55	T. H. by USGS and KGS.
27-5-29ccc	SW SW SW sec. 29	....	Dr	52	4	N	do	Crete(?) Formation	N	N	do	0	1,449.8	16.5	6-15-55	do.
27-5-31cdc	SW SE SW sec. 31	K. Beat	Dr	49	6	GI	do	do	Cy, H	D	do	0	1,418.0	12.0	9-10-55	Depth and SWL reported.
27-5-31ddd	SE SE SE sec. 31	....	B	25	4	N	do	Colluvium	N	N	do	0	1,421.0	5.4	6-15-55	T. H. by USGS
27-5-33abb	NW NW NE sec. 33	Drillers Gas Co.	Dr	65	12	S	do	Crete(?) Formation	T, E	Ind	do	0	1,451.4	38.5	9-7-55	Depth to water is pumping level. Reported yield 350.

27-5-34aab	NW NE NE sec. 34	Terry's Station and Cafe	Dr	26	6	GI	do	do	J, E	D	Top of casing	0.5	1,445.7	13.2	9- 7-55	
*27-5-36aab	NW NE NE sec. 36	Kansas Highway Commission	Dr	41	7	S	Shale	Ninnescah Shale	Cy, H	PS	do	2.0	1,421.5	16.2	9- 7-55	Well pumped recently.
	T. 27 S., R. 6 W.															
27-6-5aaa	NE NE NE sec. 5		Dr	56	4	N	Sand and gravel	Crete(?) Formation	N	N	Land surface	0	1,510.1	9.3	6-16-55	T. H. by USGS and KGS.
*27-6-6ccd	SE SW SW sec. 6	Kenneth Kautser	Dr	30	5.5	GI	do	do	Ce, B	I	do	0	1,500.2	10.0	10-18-56	Battery of 8 wells pumped with one pump. Reported yield 260.
27-6-9bbb	NW NW NW sec. 9		B	40	4	N	do	do	N	N	do	0	1,503.1	14.2	6-17-55	T. H. by USGS and KGS.
27-6-12bbb	NW NW NW sec. 12		B	14	4	N	do	do	N	N	do	0	1,508.5	11.4	7-17-56	do.
27-6-14ddd	SE SE SE sec. 14		B	15	4	N	do	do	N	N	do	0	1,465.5	10.8	7-17-56	do.
27-6-16bbb	NW NW NW sec. 16		B	18	4	N	do	do	N	N	do	0	1,478.7	12.1	6-17-55	do
27-6-21bbb	NW NW NW sec. 21		B	13	4	N	Silt and sand	Colluvium	N	N	do	0	1,475.8	9.8	6-17-55	do.
27-6-28bbb	NW NW NW sec. 28		B	5	4	N	Silt		N	N	do	0	1,507.6	Dry	6-17-55	do.
27-6-28ccc	SW SW SW sec. 28		B	30	4	N	Silt, sand, and gravel	Ogallala(?) Formation	N	N	do	0	1,558.4	16.9	6-17-55	do.
27-6-30bbb	NW NW NW sec. 30		B	12	4	N	do		N	N	do	0	1,575.9	Dry	7-22-56	do.
	T. 27 S., R. 7 W.															
27-7-1bbb	NW NW NW sec. 1		B	7	4	N	Silt and sand		N	N	do	0	1,544.6	Dry	7-12-56	do.
*27-7-3adc	SW SE NE sec. 3	Merle Young	Dr	55	12	S	Sand and gravel	Crete(?) Formation	T, E	I	do	0	1,545.1	20.0	10-18-56	Depth of well and depth to water are reported. Reported yield 100.
27-7-4aab	NW NE NE sec. 4		B	12	4	N	do	do	N	N	do	0	1,574.6	6.5	7-12-56	T. H. by USGS and KGS.
27-7-5bbb	NW NW NW sec. 5		B	50	4	N	do	do	N	N	do	0	1,579.3	32.5	7-22-55	do.
27-7-7aaa	NE NE NE sec. 7		B	15	4	N	do	do	N	N	do	0	1,555.8	7.0	7-22-55	do.
27-7-12ddd	SE SE SE sec. 12		B	12	4	N	do	Terrace deposits	N	N	do	0	1,499.3	8.1	7-12-56	do.
27-7-18ddd	SE SE SE sec. 18		B	12	4	N	Silt, sand, and gravel		N	N	do	0	1,575.4	Dry	7-22-55	do.
27-7-22aaa	NE NE NE sec. 22		B	8	4	N	do	Ogallala(?) Formation	N	N	do	0	1,566.5	Dry	7-12-56	do.
27-7-29bba	NE NW NW sec. 29		B	40	4	N	Sand and gravel	Holdrege Formation	N	N	do	0	1,602.4	17.9	7-22-55	do.
27-7-30bcd	SE SW NW sec. 30	City of Kingman	Dr	38	4	N	do	do	N	N	do	0	1,596	8.0	10- 1-57	T. H. by Dal Wells Drilling Co.
27-7-30ccd	SE SW SW sec. 30	do	Dr	45	4	N	do	do	N	N	do	0	1,593	13.0	10- 1-57	T. H. by Layne-Western Co.
27-7-30dab	NW NE SE sec. 30	do	Dr	25	4	N	do	do	N	N	do	0	1,586	4.0	8-10-50	do.

Table 7.—*Records of wells, test holes, and springs in Kingman County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 27 S., R. 7 W.															
27-7-30dbb	NW NW SE sec. 30	City of Kingman	Dr	45	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,601	12.0	9-30-57	T. H. by Dal Wells Drilling Co.
27-7-30dcb	NW SW SE sec. 30	do	Dr	34	4	N	do	do	N	N	do	0	1,587	7.3	8-10-50	T. H. by Layne-Western Co.
	T. 27 S., R. 8 W.															
27-8-1bbb	NW NW NW sec. 1		B	15	4	N	do	do	N	N	do	0	1,600.4	9.7	7-13-56	T. H. by USGS and KGS.
27-8-4bbb	NW NW NW sec. 4		B	15	4	N	do	do	N	N	do	0	1,635.6	7.2	7-13-56	do.
27-8-9ccc	SW SW SW sec. 9		B	25	4	N	do	do	N	N	do	0	1,651.5	24.6	7-13-56	do.
27-8-15aaa	NE NE NE sec. 15		B	15	4	N	do	do	N	N	do	0	1,626.2	7.5	7-13-56	do.
*27-8-15ddb	NW SE SE sec. 15	Cleo Sallee	Dr	50	14	S	do	do	T, Ng	I	do	0	1,632.6	16.0	10-12-56	14-inch well in 30-inch gravel pack. Reported yield 500.
27-8-25aaa	NE NE NE sec. 25	City of Kingman	Dr	30	4	N	do	do	N	N	do	0	1,603	9.5	10- 2-57	T. H. by Dal Wells Drilling Co.
27-8-25bbb	NW NW NW sec. 25		B	30	4	N	do	do	N	N	do	0	1,628.7	27.1	7-13-56	T. H. by USGS and KGS.
27-8-25daa	NE NE SE sec. 25	City of Kingman	Dr	57	4	N	do	do	N	N	do	0	1,607	....	9-30-57	T. H. by Dal Wells Drilling Co.
27-8-25dbb	NW NW SE sec. 25	do	Dr	51	4	N	do	do	N	N	do	0	1,606	11.5	10- 2-57	do.
27-8-25dcc	SW SW SE sec. 25	do	Dr	35	4	N	do	do	N	N	do	0	1,589	4.8	10- 2-57	do.
27-8-28abb	NW NW NE sec. 28		B	25	4	N	do	do	N	N	do	0	1,623.3	21.4	7-24-56	T. H. by USGS and KGS.
27-8-30bbb	NW NW NW sec. 30		Dr	122	4	N	do	do	N	N	do	0	1,645.6	32.5	10- 1-55	do.
*27-8-31cca	NE SW SW sec. 31	Louis Keeling	Dr	66	8	S	do	do	F	S, I	do	0	....	+4.0	10-12-56	Flow estimated 75 at land surface.
27-8-33ccc	SW SW SW sec. 33		B	43	4	N	do	do	N	N	do	0	1,616.0	33.0	7-24-56	T. H. by USGS and KGS.

	T. 27 S., R. 9 W.															
27-9-2aaa	NE NE NE sec. 2		Dr	102	4	N	do	do	N	N	do	0	1,675.6	26.7	10- 1-55	do.
27-9-6bbb	NW NW NW sec. 6		Dr	187	4	N	do	do	N	N	do	0	1,700.8		10- 2-55	do.
27-9-9bbb1	NW NW NW sec. 9	N. Lawson	Dn	73.2	2	S	do	do	N	N	Top of pump	3.0	1,730.6	58.2	9-20-56	USGS observation well.
27-9-9bbb2	NW NW NW sec. 9		Dr	154	4	N	do	do	N	N	Land surface	0	1,721.0		12-23-50	T. H. by USGS and KGS.
27-9-12ddd	SE SE SE sec. 12		B	28	4	N	do	do	N	N	do	0	1,660.0	26.0	7-16-56	do.
27-9-14bba	NW NW NE sec. 14		B	49	4	N	do	do	N	N	do	0	1,689.1	41.8	7-16-56	do.
27-9-16ccc	SW SW SW sec. 16		B	20	4	N	do	Grand Island Formation	N	N	do	0	1,685.1	16.6	7-16-56	do.
27-9-18bbb	NW NW NW sec. 18		B	30	4	N	do	do	N	N	do	0	1,742.3	18.5	7-16-56	do.
*27-9-18dcc	SW SW SE sec. 18	Clifford Hansen	Dn	82	2	S	do	Holdrege Formation	Cy	D	do				10-10-56	
27-9-19aba	NE NW NE sec. 19	do	Dr	160	4	N	do	do	N	N	do	0		80	2- 4-57	T. H. by Layne-Western Co. Water level reported.
27-9-19ada	NE SE NE sec. 19	do	Dr	155	4	N	do	do	N	N	do	0		75	2- 5-57	do.
27-9-23ccc	SW SW SW sec. 23		B	39	4	N	do	do	N	N	do	0	1,646.9	23.9	7-16-56	T. H. by USGS and KGS.
27-9-29bbb	NW NW NW sec. 29		Dr	130	4	N	do	do	N	N	do	0	1,720.9		10- 2-55	do.
27-9-32aaa	NE NE NE sec. 32		B	69	4	N	do	do	N	N	do	0	1,719.8	65.0	7-18-56	do.
	T. 27 S., R. 10 W.															
27-10-2aaa	NE NE NE sec. 2		B	59	4	N	Sand	Pleistocene (undifferentiated)	N	N	do	0	1,690.1		7-18-56	do.
27-10-5aaa	NE NE NE sec. 5		B	25	4	N	do	Grand Island Formation	N	N	do	0	1,726.2	11.0	7-18-56	do.
27-10-7ccd	SE SW SW sec. 7		B	69	4	N	Sand and gravel	do	N	N	do	0	1,767.1	54.6	7-18-56	do.
27-10-8aad	SE NE NE sec. 8	E. H. Adair Oil Co.											1,762.0			Oil-well test. Depth to bedrock 175 feet.
27-10-10ccc	SW SW SW sec. 10		B	69	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,739.0	46.1	7-18-56	T. H. by USGS and KGS.
27-10-13bcc	SW SW NW sec. 13	Lion Oil Co.											1,750			Oil-well test. Depth to bedrock 170 feet.
27-10-15add	SE SE NE sec. 15	Amerada Petroleum Corp.											1,750			Oil-well test. Depth to bedrock 175 feet.
27-10-26aaa	NE NE NE sec. 26		B	44	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,703.4	37.0	7-18-56	T. H. by USGS and KGS.
27-10-30bcc	SW SW NW sec. 30		Dr	70	4	N	do	Pleistocene (undifferentiated)	N	N	do	0	1,667.1			do.
27-10-30cbc	SW NW SW sec. 30		Dr	75	4	N	do	do	N	N	do	0	1,666.7			do.
27-10-31cbc	SW NW SW sec. 31		Dr	109.5	4	N	do	do	N	N	do	0	1,722.0			do.

TABLE 7.—*Records of wells, test holes, and springs in Kingman County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 27 S., R. 10 W.															
27-10-31cca	NE SW SW sec. 31..	Formerly U. S. Bureau of Mines	Dr	118	13	S	Sand and gravel	Pleistocene (undifferentiated)	N	N	Land surface	0	....	31.0	7-11-43	Well now abandoned. 13-inch casing in 30-inch gravel pack. Drawdown 29 after 6 hrs. at 500.
27-10-31ccd	SE SW SW sec. 31...	do..........	Dr	109	13	S	do........	do............	N	N	do..........	0	....	32.0	7-13-43	Well now abandoned. 13-inch casing in 30-inch gravel pack. Drawdown 25 after 6 hrs. at 503.
27-10-32dcc1	SW SW SE sec. 32...	City of Cunningham	Dr	60	......	S	do........	Grand Island Formation	T, E	PS	....	......	....	......	....	Reported yield 200; 8 ft. drawdown after 36 hrs.
27-10-32dcc2	SW SW SE sec. 32...	do..........	Dr	59	......	S	do........	do............	T, E	PS	....	......	....	......	....	Reported yield 200; 9 ft. drawdown after 36 hrs.
	T. 27 S. R. 11 W.															
27-11-25aad	SE NE NE sec. 25...	....	Dr	114	4	N	do........	Pleistocene (undifferentiated)	N	N	Land surface	0	1,694.3	......	....	T. H. by USGS and KGS.
	T. 28 S., R. 5 W.															
28-5-1dda...	NE SE SE sec. 1....	Roy Baxter...	Dr	47	8	S	Shale.....	Ninnescah Shale	Cy, E	S	Top of concrete platform	.8	1,410.5	20.3	9-12-55	

28-5-2aaa	NE NE NE sec. 2		B	20	4	N	Silt, sand, and gravel	Colluvium	N	N	Land surface	0	1,435.7	Dry	5-21-55	T. H. by USGS and KGS.
28-5-3ada	NE SE NE sec. 3	Addie Goode	Dr	18.1	6	GI	Shale	Ninnescah Shale	Cy, H	N	Top of concrete platform	1.0	1,431.2	8.6	9-12-55	
28-5-6dad	SE NE SE sec. 6		B	40	4	N	Sand and gravel	Terrace deposits	N	N	Land surface	0	1,408.1	11.5	6-15-55	T. H. by USGS and KGS.
28-5-6ddd	SE SE SE sec. 6		B	39	4	N	do	do	N	N	do	0	1,405.1	9.9	6-15-55	do.
28-5-11ccb	NW SW SW sec. 11	R. S. Brown	Dr	33.8	6	GI	Shale	Ninnescah Shale	Cy, H	N	Top of concrete platform	.5	1,407.1	13.1	9-10-55	
28-5-14aaa	NE NE NE sec. 14		B	22	4	N	Silt, sand, and gravel	Colluvium	N	N	Land surface	0	1,387.9	6.8	5-28-55	T. H. by USGS and KGS.
28-5-16aba	NE NW NE sec. 16	F. J. Schemach	Dr	35	6	GI	Shale	Ninnescah Shale	Cy, W	S	Top of casing	.5	1,406.3	15.3	9-10-55	
28-5-18ddd	SE SE SE sec. 18		B	5	4	N			N	N	Land surface	0	1,413.0	Dry	6-15-55	T. H. by USGS and KGS.
28-5-19ddd	SE SE SE sec. 19		B	10	4	N			N	N	do	0	1,431.2	Dry	6-14-55	do.
28-5-20cbc	SW NW SW sec. 20	Emma Althouse	Du	20	36	R	Shale	Ninnescah Shale	Cy, E	D	do	0	1,434.1	17.0	9-12-55	
28-5-23bba	NE NW NW sec. 23	E. C. Lindholm	Dr	35	6	GI	do	do	Cy, W	S	Top of concrete tank	1.5	1,392.6	17.3	9-12-55	
28-5-24aaa	NE NE NE sec. 24	Sam Bolinger	Dr	40	6	GI	do	do	Cy, H	D	Top of concrete platform	0	1,370.4	12.2	9-12-55	
28-5-26aaa	NE NE NE sec. 26		B	5	4	N			N	N	Land surface	0	1,384.1	Dry	5-28-55	T. H. by USGS and KGS.
28-5-26dda	NE SE SE sec. 26		B	10	4	N	Silt, sand, and gravel	Colluvium	N	N	do	0	1,362.6	6.9	5-28-55	do.
28-5-30ddd	SE SE SE sec. 30		B	6	4	N			N	N	do	0	1,438.4	Dry	6-14-55	do.
28-5-31ddd	SE SE SE sec. 31		B	5	4	N			N	N	do	0	1,407.0	Dry	6-14-55	do.
28-5-32bad	SE NE NW sec. 32	Flora E. Calhoun	Dr	49	4	N	Shale	Ninnescah Shale	N	N	do	0		22.0	11-23-55	T. H. by City of Wichita.
28-5-32dcd	SE SW SE sec. 32	A. R. Laurie	Dr	30.5	6	GI	do	do	Cy, H	S	Pump base	.5	1,419.1	25.6	9-12-55	
28-5-34bcc	SW SW NW sec. 34	F. Bennett	Dr	30	6	GI	do	do	Ce, G	S	Top of casing	.3	1,385.0	10.2	9-12-55	
28-5-35aaa	NE NE NE sec. 35		B	32	4	N	Sand and gravel	Terrace deposits	N	N	Land surface	0	1,361.4		5-29-55	T. H. by USGS and KGS.
28-5-35ada	NE SE NE sec. 35		B	33	4	N	do	do	N	N	do	0	1,362.0	6.1	5-29-55	do.
28-5-35daa	NE NE SE sec. 35		B	15	4	N			N	N	do	0	1,367.9	Dry	5-29-55	do.
28-5-35dcc	SW SW SE sec. 35	A. R. Dildine	Dr	38	6	GI	Shale	Ninnescah Shale	Cy, W	S	do	0	1,381.8	22.2	9-13-55	
28-5-35ddd	SE SE SE sec. 35		B	15	4	N	Sand and gravel		N	N	do	0	1,392.3	Dry	5-29-55	T. H. by USGS and KGS.
	T. 28 S., R. 6 W.															
28-6-2daa	NE NE SE sec. 2	L. L. Strubble	Dr	48	6	GI	Shale	Ninnescah Shale	Cy, W	S	Top of concrete platform	.5	1,478.6	40.6	10-20-55	Well pumped recently.
28-6-4aaa	NE NE NE sec. 4	F. Rufkowski	Dr	87.4	6	GI	do	do	Cy, W	S	Top of casing	1.0	1,537.4	42.8	10-20-55	

Table 7.—Records of wells, test holes, and springs in Kingman County—Continued

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 28 S., R. 6 W.															
28-6-5bbb	NW NW NW sec. 5	....	B	18	4	N	Silt, sand, and gravel	Ogallala (?) Formation	N	N	Land surface	0	1,546.8	8.4	6-18-55	T. H. by USGS and KGS.
28-6-7daa	NE NE SE sec. 7	....	B	42	4	N	Sand and gravel	Terrace deposits	N	N	do.	0	1,457.3	1.5	6-20-55	do.
28-6-8bbc	SW NW NW sec. 8	....	B	25	4	N	do.	do.	N	N	do.	0	1,475.2	12.4	6-18-55	do.
28-6-8ccc	SW SW SW sec. 8	....	B	31	4	N	do.	do.	N	N	do.	0	1,472.7	16.6	6-20-55	do.
28-6-10cdc	SW SE SW sec. 10	E. W. Schuman	Dr	40.3	6	GI	Shale	Ninnescah Shale	J, E	D, S	Top of concrete pit	.4	1,484.3	9.8	10-20-55	
*28-6-12cdd	SE SE SW sec. 12	Peter J. Hilger	Dr	67.2	6	GI	do.	do.	J, E	D, S	do.	.5	1,476.1	52.8	10-20-55	
28-6-20bbb	NW NW NW sec. 20	....	B	30	4	N	....	....	N	N	Land surface	0	1,560.2	Dry	6-18-55	T. H. by USGS and KGS.
28-6-20ccc	SW SW SW sec. 20	....	B	37	4	N	Sand and gravel	Holdrege Formation	N	N	do.	0	1,566.0	21.5	6-18-55	do.
28-6-32bcb	NW SW NW sec. 32	....	B	10	4	N	do.	....	N	N	do.	0	1,538.4	Dry	6-20-55	do.
28-6-34cdc	SW SE SW sec. 34	C. E. Calk	Dr	19.3	6	GI	do.	Holdrege Formation	Cy, W	S	Top of concrete platform	.5	1,546.3	14.8	10-19-55	
28-6-35aac	SW NE NE sec. 35	C. Kostner	Dr	52.3	6	GI	Shale	Ninnescah Shale	N	N	Top of casing	0	1,433.9	19.4	10-20-55	
	T. 28 S., R. 7 W.															
28-7-5bcb1	NW SW NW sec. 5	City of Kingman	Dr	50	3	S	Sand and gravel	Terrace deposits	Ce, E	PS	Land surface	0	....	15	....	Reported yield 105. Water level reported.
28-7-5bcb2	NW SW NW sec. 5	do.	Dr	50	3	S	do.	do.	Ce, E	PS	do.	0	....	15	....	Reported yield 85. Water level reported.
28-7-5bdb	NW SE NW sec. 5	do.	Dr	49	12	S	do.	do.	T, E	PS	do.	....	....	....	....	12-inch casing 10-ft. screen, in 42-inch gravel pack. Reported yield 300.

28-7-6aca	NE SW NE sec. 6	do.	Dr	42	12	S	do.	do.	T, E	PS	do.	0	...	11.3	5-12-54	12-inch casing, 10-ft. screen, in 42-inch gravel pack. Reported yield 240.
28-7-6dab	NW NE SE sec. 6	do.	Dr	44	12	S	do.	do.	T, E	PS	do.	0	...	6.0	4-24-53	12-inch casing, 10-ft. screen, in 42-inch gravel pack. Reported yield 300. Specific capacity 22 gpm/ft.
28-7-11bab	NW NE NW sec. 11	...	B	48	4	N	do.	do.	N	N	do.	0	1,479.4	7.6	7-19-56	T. H. by USGS and KGS.
28-7-17bba	NE NW NW sec. 17	...	B	50	4	N	do.	Holdrege Formation	N	N	do.	0	1,587.6	16.9	6-23-55	do.
28-7-17cdc	SW SE SW sec. 17	...	B	40	4	N	do.	...	N	N	do.	0	1,628.6	Dry	6-23-55	do.
28-7-22aaa	NE NE NE sec. 22	...	B	32	4	N	do.	Holdrege Formation	N	N	do.	0	1,588.3	27.5	7-18-56	do.
28-7-29bab	NW NE NW sec. 29	...	B	40	4	N	do.	do.	N	N	do.	0	1,593.2	21.8	6-23-55	do.
28-7-29dcc	SW SW SE sec. 29	A. B Brown	Dr	75.6	16	S	do.	do.	T, B	I	Lower edge of 1¼-inch measuring pipe	0	1,601.0	30.2	10- 9-56	
*28-7-30ddd	SE SE SE sec. 30	Harold Schmidt	Dr	65	5	S	do.	do.	Ce, G	I	...	...	1,580.2	...	10-13-56	5-inch casing in 12-inch gravel pack. Reported yield 400.
28-7-32ddd	SE SE SE sec. 32	...	B	40	4	N	do.	do.	N	N	Land surface	0	1,635.1	...	6-23-55	T. H. by USGS and KGS.
28-7-33bbb	NW NW NW sec. 33	...	B	40	4	N	do.	do.	N	N	do.	0	1,588.3	17.7	6-23-55	do.
28-7-35bbb	NW NW NW sec. 35	...	B	70	4	N	do.	do.	N	N	do.	0	1,596.4	33.1	8- 9-56	do.
	T. 28 S., R. 8 W.															
28-8-2bbb	NW NW NW sec. 2	...	B	15	4	N	do.	do.	N	N	do.	0	1,584.3	13.5	7-18-56	do.
*28-8-2ccc	SW SW SW sec. 2	City of Kingman	Sp	...	...	...	do.	do.	...	PS	...	...	...	...	10-15-56	Group of 3 contact springs, each with radial tile collectors and concrete collector boxes. Total yield 200.
28-8-6cbb	NW NW SW sec. 6	...	Dr	40	4	N	do.	Terrace deposits	N	N	Land surface	0	1,558.2	...	7-28-55	T. H. by USGS and KGS.
28-8-6ccc	SW SW SW sec. 6	Kansas Power and Light Co.	Dr	81.8	8	S	do.	Holdrege Formation	T, E	Ind	do.	0	...	35.0	6-30-50	Gravel packed well, 10-ft. screen. Drawdown 6 ft. after 8 hrs. at 200.
28-8-7dab	NW NE SE sec. 7	National Coop Refining Association	...	...	...	...	...	...	...	...	...	...	1,576	...	...	Oil-well test. Depth to bedrock 40 feet.
28-8-13bab	NW NE NW sec. 13	...	B	10	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,545.6	9.0	7-18-56	T. H. by USGS and KGS.

TABLE 7.—*Records of wells, test holes, and springs in Kingman County*—*Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land-surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 28 S., R. 8 W.															
28-8-16bbd	SE NW NW sec. 16	Phillips Petroleum Co.											1,556			Oil-well test. Depth to bedrock 25 feet.
28-8-16ddd	SE SE SE sec. 16		B	20	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,582.9	16.8	7-18-56	T. H. by USGS and KGS.
28-8-19bba	NE NW NW sec. 19		B	9	4	N	do.	do.	N	N	do.	0	1,583.6	4.8	7-19-56	do.
28-8-24aad	SE NE NE sec. 24	Excel Packing Co.											1,630			Oil-well test Depth to bedrock 73 feet.
28-8-25bbb	NW NW NW sec. 25		B	69	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,643.4		7-19-56	T. H. by USGS and KGS.
28-8-27ccc	SW SW SW sec. 27		B	69	4	N	do.	do.	N	N	do.	0	1,654.8		7-19-56	do.
28-8-32ccc	SW SW SW sec. 32		B	19	4	N	do.	do.	N	N	do.	0	1,632.2	13.2	7-19-56	do.
28-8-35daa	NE NE SE sec. 35	Ute Royalty Co.											1,610			Oil-well test. Depth to bedrock 75 feet.
28-8-36aad	SE NE NE sec. 36		B	25	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,589.5	14.2	8- 9-56	T. H. by USGS and KGS.
	T. 28 S., R. 9 W.															
28-9-1aaa	NE NE NE sec. 1		Dr	25	4	N	do.	Terrace deposits	N	N	do.	0	1,562.8	2.5	7-27-55	do.
28-9-5bcc	SW SW NW sec. 5		Dr	48	4	N	do.	do.	N	N	do.	0	1,599.4		8- 1-55	do.
28-9-14bbb	NW NW NW sec. 14		B	29	4	N	do.	Holdrege Formation	N	N	do.	0	1,637.3	22.6	7-23-56	do.
28-9-20cca	NE SW SW sec. 20	Nebraska-Wyoming Oil Co.											1,725			Oil-well test. Depth to bedrock 110 feet.
28-9-21bba	NE NW NW sec. 21		B	14	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,650.6	12.2	7-23-56	T. H. by USGS and KGS.
28-9-26ccc	SW SW SW sec. 26		B	49	4	N	do	do.	N	N	do.	0	1,687.8	39.5	7-23-56	do.
28-9-32aaa	NE NE NE sec. 32		B	20	4	N	do.	do.	N	N	do.	0	1,680.3	11.9	7-23-56	do.

28-9-36aaa	NE NE NE sec. 36		Dr	66	4	N	do	Holdrege Formation	N	N	do	0	1,694.0		7-27-55	do.
	T. 28 S., R. 10 W.															
28-10-3ccc	SW SW SW sec. 3		B	44	4	N	do	Grand Island Formation	N	N	do	0	1,709.3	27.0	7-23-56	do.
*28-10-5dbb	NW NW SE sec. 5	Walter Freund	Dr	96	16	S	do	do	T, Ng	I	do	0		37.0	10-11-56	Depth to water reported; yield reported 700 with 16-ft. drawdown after 8 hrs.
28-10-6ddd	SE SE SE sec. 6		B	40	4	N	do	do	N	N	do	0	1,730.1	24.9	7-24-56	T. H. by USGS and KGS.
28-10-10caa	NE NE SW sec. 10	K. Ellison Drilling Co.											1,701			Oil-well test. Depth to bedrock 110 feet.
28-10-13aaa	NE NE NE sec. 13		B	15	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,653.2	14.4	7-24-56	T. H. by USGS and KGS.
28-10-15ccc	SW SW SW sec. 15		B	34	4	N	do	Grand Island Formation	N	N	do	0	1,723.3	29.0	7-24-56	do.
28-10-19aad	SE NE NE sec. 19		B	9	4	N	do	Terrace deposits	N	N	do	0	1,724.5	4.1	7-24-56	do.
28-10-19ccc	SW SW SW sec. 19		Dr	196.5	4	N	do	Pleistocene (undifferentiated)	N	N	do	0	1,798.6			do.
28-10-23aaa	NE NE NE sec. 23	Barbara Oil Co.											1,702			Oil-well test. Depth to bedrock 112 feet.
28-10-25aaa	NE NE NE sec. 25		B	24	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,692.7	16.3	7-24-56	T. H. by USGS and KGS.
28-10-27ccd	SE SW SW sec. 27		B	19	4	N	do	do	N	N	do	0	1,729.4	17.7	7-24-56	do.
28-10-35aaa	NE NE NE sec. 35	Wakefield and Marshall Drilling Co.											1,764			Oil-well test. Depth to bedrock 140 feet.
	T. 28 S., R. 11 W.															
28-11-24aaa	NE NE NE sec. 24		Dr	145	4	N	Sand and gravel	Pleistocene (undifferentiated)	N	N	Land surface	0	1,745.3			T. H. by USGS and KGS.
28-11-24ada	NE SE NE sec. 24		Dr	139	4	N	do	do	N	N	do	0	1,738.2			do.
28-11-24daa	NE NE SE sec. 24		Dr	135.5	4	N	do	do	N	N	do	0	1,736.2			do.
	T. 29 S., R. 4 W.															
29-4-7bbb	NW NW NW sec. 7		B	12	4	N			N	N	do	0	1,390.6	Dry	8-1-57	do.
29-4-18bbb	NW NW NW sec. 18		B	11	4	N	Sand and gravel	Crete (?) Formation	N	N	do	0	1,406.5	do	7-31-57	do.
29-4-18bbc	SW NW NW sec. 18		B	31	4	N	do	do	N	N	do	0	1,406.8	24.8	8-1-57	do.
29-4-18bcc	SW SW NW sec. 18		B	58	4	N	do	do	N	N	do	0	1,405.5	20.4	7-31-57	do.
29-4-19bbb	NW NW NW sec. 19		B	38	4	N	do	do	N	N	do	0	1,405.4	18.5	7-31-57	do.
29-4-19ccc	SW SW SW sec. 19		B	26	4	N	do	do	N	N	do	0	1,397.0	3.5	8-1-57	do.
29-4-30cbb	NW NW SW sec. 30		B	21	4	N	do	do	N	N	do	0	1,414.4	13.1	8-1-57	do.
29-4-30ccb	NW SW SW sec. 30		B	6	4	N			N	N	do	0	1,416.1	Dry	8-1-57	do.

TABLE 7.—*Records of wells, test holes, and springs in Kingman County—Continued*

WELL NUMBER (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 29 S., R. 5 W.															
29-5-6daa	NE NE SE sec. 6	....	B	37	4	N	....	....	N	N	Land surface	0	1,395.1	....	9-7-55	T. H. by USGS and KGS.
29-5-8bbb	NW NW NW sec. 8	....	B	38	4	N	Sand and gravel	Terrace deposits	N	N	do	0	1,402.1	6.9	6-14-55	do.
29-5-8ddd	SE SE SE sec. 8	....	B	25	4	N	do	....	N	N	do	0	1,460.1	Dry	6-14-55	do.
29-5-9cba	NE NW SW sec. 9	R. C. Kinkaid	B	16.2	10	CT	do	Alluvium	N	N	Top of wood cover	1.8	1,393.0	1.8	9-13-55	
29-5-11ccb	NW SW SW sec. 11	S. F. Gosch	Dr	47	6	GI	do	Crete (?) Formation	Cy, H	D	Top of casing	1.0	1,422.5	17.5	9-14-55	
29-5-12bbb	NW NW NW sec. 12	....	B	10	4	N	Silt and sand	....	N	N	Land surface	0	1,391.4	Dry	7-23-55	T. H. by USGS and KGS.
29-5-14aaa	NE NE NE sec. 14	....	B	50	4	N	Sand and gravel	Crete (?) Formation	N	N	do	0	1,403.7	15.1	5-12-55	do.
29-5-16ccc	SW SW SW sec. 16	....	B	50	4	N	do	Holdrege Formation	N	N	do	0	1,479.1	22.6	6-14-55	do.
29-5-20ccc	SW SW SW sec. 20	....	B	50	4	N	do	do	N	N	do	0	1,499.3	24.1	6-14-55	do.
29-5-24bbb	NW NW NW sec. 24	....	B	25	4	N	do	Crete (?) Formation	N	N	do	0	1,425.2	12.7	7-23-55	do.
29-5-26aaa	NE NE NE sec. 26	....	B	13	4	N	do	....	N	N	do	0	1,425.2	Dry	5-12-55	do.
29-5-26bba	NE NW NW sec. 26	W. Wineinger	Dr	20.9	6	GI	do	Holdrege Formation	J, E	D	do	0	1,441.4	14.8	9-14-55	
29-5-27dcd	SE SW SE sec. 27	do	Dr	20.7	6	GI	do	do	Cy, W	S	Top of concrete platform	.5	1,458.6	7.6	9-14-55	
29-5-28cbb	NW NW SW sec. 28	V. C. Viniston	Dr	24	6	GI	do	do	Cy, G	D	do	1.0	1,479.4	9.5	9-14-55	
29-5-30cdc	SW SE SW sec. 30	Jake Graber	Dr	46	6	GI	do	do	J, E	D, S	Top of pit cover	0	1,523.7	36.2	9-14-55	
29-5-30ddd	SE SE SE sec. 30	....	B	50	4	N	do	do	N	N	Land surface	0	1,507.6	21.9	6-14-55	T. H. by USGS and KGS.
29-5-31ddd	SE SE SE sec. 31	....	B	45	4	N	do	do	N	N	do	0	1,508.1	27.5	6-14-55	do.

29-5-35ddd..	SE SE SE sec. 35....	....	B	37	4	N	do.........	do.............	N	N	do...........	0	1,462.5	9.2	5-12-55	do.
29-5-36aaa...	NE NE NE sec. 36...	W. H. Ficser..	Dr	46.5	6	GI	do.........	do.............	Cy, H	S	Top of concrete platform	.4	1,427.1	22.8	9-14-55	
	T. 29 S., R. 6 W.															
29-6-2ddd...	SE SE SE sec. 2.....	C. M. Moore	Dr	43.2	6	GI	Shale......	Ninnescah Shale	Cy, E	S	Top of casing	0	1,465.9	25.1	10-19-55	
29-6-5bbb...	NW NW NW sec. 5	....	B	15	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,546.3	5.4	6-20-55	T. H. by USGS and KGS.
29-6-7ddd...	SE SE SE sec. 7......	....	Dr	50	4	N	do.........	do.............	N	N	do...........	0	1,575.9	36.4	8- 3-55	do.
29-6-8bbb...	NW NW NW sec. 8	....	B	50	4	N	do.........	do.............	N	N	do...........	0	1,557.8	16.0	6-20-55	do.
29-6-10cdc...	SW SE SW sec. 10...	M. Kostner...	Dr	17.9	6	GI	do.........	do.............	Cy, W	S	Top of casing	2.0	1,541.3	10.7	10-19-55	
29-6-13cba...	NE NW SW sec. 13	A. R. Hedrick	Dr	42.4	6	GI	Shale......	Ninnescah Shale	Cy, W	S	Top of wood cover	1.0	1,467.2	6.3	10-19-55	
29-6-18dcc...	SW SW SE sec. 18...	Berwick and Aurora drilling Co.	......	......	......	......	....	....	....	......	....	......	1,564	....	....	Oil-well test. Depth to bedrock 75 feet.
29-6-20bbb..	NW NW NW sec. 20	....	B	50	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,561.0	31.0	6-20-55	T. H. by USGS and KGS.
29-6-21ddd..	SE SE SE sec. 21.....	E. B. Spangler	Dr	32.9	6	GI	do.........	do.............	Cy, W	S	Top of wood cover	0	1,555.0	32.8	10-19-55	
29-6-26daa..	NE NE SE sec. 26....	K. J. Kostner	Dr	44.5	6	GI	do.........	do.............	Cy, H	D	Top of pump	2.5	1,526.3	19.2	10-19-55	
29-6-29bbb..	NW NW NW sec. 29	....	B	46	4	N	do.........	do.............	N	N	Land surface	0	1,535.2	20.0	6-20-55	T. H. by USGS and KGS.
29-6-32bbb..	NW NW NW sec 32	....	B	20	4	N	do.........	do.............	N	N	do...........	0	1,507.9	12.5	6-20-55	do.
	T. 29 S., R. 7 W.															
29-7-5ddd...	SE SE SE sec. 5......	....	Dr	130	4	N	do.........	do.............	N	N	do...........	0	1,617.3	50.2	7-25-55	do.
29-7-6aca....	NE SW NE sec. 6....	Turner.......	Dr	98	16	S	do	do.............	T, B	I	Hole in pump base	0	1,627.9	56.0	10- 9-56	16-inch casing in 30-inch gravel pack. Reported yield 350.
•29-7-9baa...	NE NE NW sec. 9...	Lawrence C. Woodson	Dr	132	16	S	do.........	do.............	T, B	I	Hole in casing, west side	0	1,615.5	50.7	10- 9-56	16-inch casing in 30-inch gravel pack. Reported yield 500. Drawdown 12.7 after 3 hrs. at 500.
•29-7-10abb..	NW NW NE sec. 10	Albert Krehbiel	Dn	33	2	S	do.........	do.............	Cy	S	Land surface	0	....	15.0	8- 9-56	Depth to water reported.
29-7-11bbb..	NW NW NW sec. 11	....	B	70	4	N	do.........	do.............	N	N	do...........	0	1,588.9	28.8	8- 9-56	T. H. by UGS and KGS.S
29-7-13ccc...	SW SW SW sec. 13..	....	B	70	4	N	do.........	do.............	N	N	do...........	0	1,560.9	24.6	8- 9-56	do.
29-7-17aaa...	NE NE NE sec. 17..	....	B	40	4	N	do.........	do.............	N	N	do...........	0	1,617.8	....	6-22-55	do.
29-7-17ddd..	SE SE SE sec. 17	....	B	50	4	N	do	do.............	N	N	do...........	0	1,599.9	....	6-21-55	do.
29-7-21aab..	NW NE NE sec. 21	....	B	15	4	N	....	....	N	N	do...........	0	1,554.7	Dry	8- 9-56	do.
•29-7-24dba..	NE NW SE sec. 24..	J. J. Rockers..	Dr	33.5	8	S	Sand and gravel	Holdrege Formation	J	D	do...........	0	....	7.4	8- 4-56	

TABLE 7.—*Records of wells, test holes, and springs in Kingman County*—*Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land-surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 29 S., R. 7 W.															
*29-7-26abb	NW NW NE sec. 26	D. E. Krehbiel	Dr	......	6	S	Shale	Ninnescah Shale	F	S	Land surface	0	......	......	8- 4-56	A seismograph shot hole that was cased. Estimated flow at surface 10.
29-7-29ddd	SE SE SE sec. 29	......	B	7	4	N	......	......	N	N	do	0	1,516.3	Dry	6-21-55	T. H. by USGS and KGS.
29-7-32ddd	SE SE SE sec. 32	......	B	7	4	N	......	......	N	N	do	0	1,502.2	Dry	6-21-55	do.
	T. 29 S., R. 8 W.															
29-8-11bbb	NW NW NW sec. 11	......	B	70	4	N	Sand and gravel	Holdrege Formation	N	N	do	0	1,660.8	62.5	8- 9-56	do.
29-8-13baa	NW NE NW sec. 13	......	B	35	4	N	do	do	N	N	do	0	1,579.4	20.9	7-22-55	do.
29-8-15ddd	SE SE SE sec. 15	......	B	30	4	N	......	......	N	N	do	0	1,652.8	Dry	8- 9-56	do.
29-8-17aaa	NE NE NE sec. 17	......	B	35	4	N	Sand and gravel	Holdrege Formation	N	N	do	0	1,645.6	15.4	8- 8-56	do.
29-8-29aad	SE NE NE sec. 29	......	B	45	4	N	do	do	N	N	do	0	1,632.8	38.3	8- 8-56	do.
29-8-31dcc	SW SW SE sec. 31	Petroleum, Inc.	......	......	......	......	......	......	......	......	......	......	1,585	......	......	Oil-well test. Depth to bedrock 45 feet.
	T. 29 S., R. 9 W.															
29-9-4ccb	NW SW SW sec. 4	......	B	50	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,701.3	39.0	8- 1-56	T. H. by USGS and KGS.
29-9-6bbb	NW NW NW sec. 6	......	Dr	130	4	N	do	Holdrege Formation	N	N	do	0	1,746.1	......	8- 1-55	do.
29-9-10ddc	SW SE SE sec. 10	Magnolia Petroleum Corp.	......	......	......	......	......	......	......	......	......	......	1,700	......	......	Oil well test. Depth to bedrock 85 feet.
29-9-10ddd	SE SE SE sec. 10	......	B	60	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,701.2	47.4	8- 1-56	T. H. by USGS and KGS.

29-9-17ddd	SE SE SE sec. 17	Cities Service Oil Co.										1,661			Oil-well test. Depth to bedrock 60 feet.
29-9-24aab	NW NE NE sec. 24		B	15	4	N	Sand and gravel	Alluvium	N	N	Land surface	0	1,616.6	10.6	8- 8-56	T. H. by USGS and KGS.
29-9-24ddd	SE SE SE sec. 24		Dr	50	4	N	do.	Holdrege Formation	N	N	do.	0	1,649.5		7-27-55	do.
29-9-30aab	NW NE NE sec. 30		B	10	4	N	do.	Alluvium	N	N	do.	0	1,654.7	5.1	8- 2-56	do.
	T. 29 S., R. 10 W.															
29-10-2aad	SE NE NE sec. 2		B	70	4	N	do.	Grand Island Formation	N	N	do.	0	1,760.8	57.6	8- 1-56	do.
29-10-6bcb	NW SW NW sec. 6		B	50	4	N	do.	do.	N	N	do.	0	1,782.5	37.0	8- 1-56	do.
29-10-9bbb	NW NW NW sec. 9		B	30	4	N	do.	do.	N	N	do.	0	1,749.1	17.1	8- 1-56	do
29-10-11bbb	NW NW NW sec. 11		B	20	4	N	do.	do.	N	N	do.	0	1,721.7	11.6	8- 1-56	do.
29-10-13aaa	NE NE NE sec. 13		B	69	4	N	do.	do.	N	N	do.	0	1,733.4	43.1	8- 2-56	do.
29-10-23add	SE SE NE sec. 23		B	70	4	N	do.	do.	N	N	do.	0	1,719.7	60.0	8- 2-56	do.
*29-10-24bc	SW NW sec. 24	S. G. Adelhardt	Dn	40	2	S	do.	do.	Cy	S					8- 2-56	
29-10-26ddd	SE SE SE sec. 26		Dr	87	4	N	do.	do.	N	N	Land surface	0	1,690.5	45.4	10- 1-55	T. H. by USGS and KGS.
29-10-27abb	NW NW NW sec. 27	Carter Oil Co.											1,763			Oil-well test. Depth to bedrock 95 feet.
29-10-28aba	NE NW NE sec. 28		B	20	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,718.1	12.5	8- 1-56	T. H. by USGS and KGS.
29-10-31ccc	SW SW SW sec. 31		Dr	132	4	N	do.	Pleistocene (undifferentiated)	N	N	do.	0	1,767.4			do.
	T. 29 S., R. 11 W.															
29-11-12ddd	SE SE SE sec. 12		Dr	146.5	4	N	do.	do.	N	N	do.	0	1,789.6			do.
29-11-24ddd	SE SE SE sec. 24		B	25	4	N	do.	Grand Island Formation	N	N	do.	0	1,767.2	22.1	8- 1-56	do.
	T. 30 S., R. 4 W.															
30-4-18bbb	NW NW NW sec. 18		B	67	4	N	do.	Holdrege Formation	N	N	do.	0	1,468.6	9.1	8-16-55	do.
30-4-19bbb	NW NW NW sec. 19		B	48	4	N	do.	do.	N	N	do.	0	1,487.4	26.6	8-16-55	do.
30-4-19ccc	SW SW SW sec. 19		B	19	4	N	do.	do.	N	N	do.	0	1,475.3	14.4	8-16-55	do.
	T. 30 S., R. 5 W.															
*30-5-3cdd1	SE SE SW sec. 3	City of Norwich	Dr	92	12	S	do.	do.	T, E	PS	Top of breather pipe	2.0	1,490.8	24	10-14-55	12-in. casing in 30-in. gravel pack, 15-ft. screen. Test pumped at 150 with 12 ft. drawdown after 24 hrs.

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Table 7.—*Records of wells, test holes, and springs in Kingman County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 30 S., R. 5 W.															
30-5-3cdd2..	SE SE SW sec. 3....	City of Norwich	Dr	92	12	S	Sand and gravel	Holdrege Formation	T, E	PS	Top of breather pipe	2.0	1,490.7	24	10-14-55	75 ft. east of No. 1. SWL 31 ft. with No. 1 pumping 100.
30-5-5ccc....	SW SW SW sec. 5...	....	B	10	4	N	do.........	Colluvium......	N	N	Land surface	0	1,473.5	8.1	6-14-55	T. H. by USGS and KGS.
*30-5-12cca...	NE SW SW sec. 12..	D. I. Lowrey	Dr	63	16	S	do.........	Holdrege Formation	T, B	I	Top of breather pipe	2.0	1,485.8	24.1	9-29-55	16-in. casing in 26-in. gravel pack, 20-ft. of screen. Reported yield 500.
30-5-14aaa..	NE NE NE sec. 14..	....	Dr	75	4	N	do.........	do............	N	N	Land surface	0	1,490.2	26.7	8- 4-55	T. H. by USGS and KGS.
30-5-14aac...	SW NE NE sec. 14..	A. J. Fieser...	Dr	110	16	S	do.........	do............	T, B	I	do...........	0	1,491.1	30.0	8- 4-55	Depth of well and depth to water reported. Reported yield 500.
30-5-14ddd..	SE SE SE sec. 14....	....	B	50	4	N	do.........	do............	N	N	do...........	0	1,483.1	....	6- 3-55	T. H. by USGS and KGS.
30-5-15dda..	NE SE SE sec. 15...	L. B. Holder..	Dr	49.5	6	GI	do.........	do............	Cy, W	S	Top of casing	0	1,462.7	9.6	9-15-55	
30-5-17bbb..	NW NW NW sec. 17	....	B	7	4	N	....	....	N	N	Land surface	0	1,421.2	Dry	6- 7-55	T. H. by USGS and KGS.
30-5-19aaa...	NE NE NE sec. 19..	....	B	17	4	N	Silt and sand	Holdrege Formation	N	N	do...........	0	1,394.1	9.0	6- 7-55	do.
30-5-21baa..	NE NE NW sec. 21..	C. L. Weathered	Dr	30	6	GI	Shale......	Ninnescah Shale	N	N	Top of 1¼ in. pump column	1.0	1,413.2	7.5	9-15-55	
30-5-23ccc...	SW SW SW sec. 23..	L. B. Holder..	Du	21	36	R	do.........	do............	J, E	D	Top of concrete platform	.4	1,412.8	15.8	9-15-55	
30-5-26aaa...	NE NE NE sec. 26..	....	B	5	4	N	....	....	N	N	Land surface	0	1,425.4	Dry	6- 8-55	T. H. by USGS and KGS.

30-5-29cdc	SW SE SW sec. 29		B	31	4	N	Sand and gravel	Terrace deposits	N	N	do	0	1,355.9	6.8	6- 8-55	do.
30-5-29ddd	SE SE SE sec. 29		B	•26	4	N	Silt and sand	Colluvium	N	N	do	0	1,366.9	18.8	6- 8-55	do.
30-5-30aaa1	NE NE NE sec. 30		B	30	4	N	Sand and gravel	Terrace deposits	N	N	do	0	1,368.3	4.9	6- 8-55	do.
*30-5-30aaa2	NE NE NE sec. 30	J. H. Wartick	Dr	15.7	5	GI	do	do	Cy, W	S	Top of casing	1.5	1,368.3	4.9	9-29-55	
30-5-31aaa	NE NE NE sec. 31		B	50	4	N	do	do	N	N	Land surface	0	1,365.8	17.1	6- 8-55	T. H. by USGS and KGS.
30-5-32bcc	SW SW NW sec. 32		B	7	4	N			N	N	do	0	1,345.8	Dry	6- 8-55	do.
30-5-32cdd	SE SE SW sec. 32		B	46	4	N	Sand and gravel	Terrace deposits	N	N	do	0	1,342.7	10.6	6- 4-55	do
30-5-33cdd	SE SE SW sec. 33		B	15	4	N	Silt and sand	do	N	N	do	0	1,352.0	10.7	6- 4-55	do.
30-5-34ccc	SW SW SW sec. 34		B	25	4	N			N	N	do	0	1,365.8	Dry	6- 4-55	do.
*30-5-35cbb	NW NW SW sec. 35	Vernon Glassburn	Dr		6	GI	Shale	Ninnescah Shale	J, E	D	do	0			10- 9-56	
30-5-36ccc	SW SW SW sec. 36		B	5	4	N			N	N	do	0	1,398.7	Dry	6- 4-55	T. H. by USGS and KGS.
30-5-36ddd	SE SE SE sec. 36		B	20	4	N			N	N	do	0	1,419.0	Dry	6- 4-55	do.
	T. 30 S., R. 6 W.															
30-6-1dda	NE SE SE sec. 1	J. R. Fieser	Dr	50	6	GI	Shale	Ninnescah Shale	T, E	D, S	Top of wood pit cover	0	1,443.3	18.0	9-29-55	
30-6-2abb	NW NW NE sec. 2	Frank Deckert	Dr	30.3	6	GI	Sand and gravel	Holdrege Formation	J, E	D, S	Top of casing	1.0	1,486.4	20.3	9-29-55	
30-6-3bbb	NW NW NW sec. 3	C. A. Risler	Dr	65.3	6	GI	Shale	Ninnescah Shale	J, E	D	do	.2	1,487.9	27.2	9-30-55	
30-6-5bbb	NW NW NW sec. 5		B	16	4	N	Silt	Colluvium	N	N	Land surface	0	1,441.6	7.9	6-20-55	T. H. by USGS and KGS.
30-6-8ada	NE SE NE sec. 8		B	46	4	N	Sand and gravel	Terrace deposits	N	N	do	0	1,409.2	18.5	6- 7-55	do.
30-6-9cbb	NW NW SW sec. 9		B	20	4	N	do	do	N	N	do	0	1,391.3	8.7	6- 7-55	do.
30-6-9dac	SW NE SE sec. 9	Childs	Dr	51	16	S	do	do	T, B	I	do	0	1,412.3	14.0	9-29-55	Gravel-packed well. Depth of well and depth to water reported. Reported yield 300.
30-6-14aba	NE NW NE sec. 14	D. V. Smith, Jr.	Du	23.3	48	C	Shale	Ninnescah Shale	Cy, W	S	Top of wood platform	1.0	1,414.0	15.2	9-30-55	
30-6-17aaa	NE NE NE sec. 17		B	29	4	N	Sand and gravel	Alluvium	N	N	Land surface	0	1,391.3	10.1	6- 7-55	T. H. by USGS and KGS.
*30-6-21cda	NE SE SW sec. 21	Everett Smart	Dr	36.2	12	S	Shale and Siltstone	Harper Siltstone	Cy, W	D, S	Top of wood platform	1.5	1,392.3	9.5	10-20-55	
30-6-31cdc	SW SE SW sec. 31	B. M. Ruppert	Dr	54.5	6	GI	do	Chikaskia Siltstone	Cy, W	D, S	Top of concrete platform	.5	1,578.5	52.6	9-30-55	

TABLE 7.—*Records of wells, test holes, and springs in Kingman County—Continued*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 30 S., R. 6 W.															
30-6-33ccc	SW SW SW sec. 33		B	50	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,552.1	38.0	6-4-55	T. H. by USGS and KGS.
30-6-34ccc	SW SW SW sec. 34		B	25	4	N			N	N	do.	0	1,521.1	Dry	6-4-55	do.
30-6-35ddd	SE SE SE sec. 35	R. Marshall	B	50.7	18	T	Shale	Ninnescah Shale	Cy, W	S	Top of wood platform	.8	1,370.5	41.2	9-30-55	
	T. 30 S., R. 7 W.															
30-7-1ccc	SW SW SW sec. 1		B	45	4	N	Sand and gravel	Terrace deposits	N	N	Land surface	0	1,444.8	20.8	9-9-56	T. H. by USGS and KGS.
30-7-9aaa	NE NE NE sec. 9		B	36	4	N	do.	do.	N	N	do.	0	1,455.2	10.6	6-21-55	do.
30-7-10cbc	SW NW SW sec. 10		B	25	4	N	do.	Alluvium	N	N	do.	0	1,438.9	3.6	6-21-55	do.
30-7-13dda	NE SE SE sec. 13	Glen Nicholas	Dr	70.8	4	S	Shale and siltstone	Chikaskia Siltstone	N	N	Top of casing	0		27.5	10-18-55	
30-7-16daa	NE NE SE sec. 16		B	40	4	N	Silt and sand	Terrace deposits	N	N	Land surface	0	1,451.0	11.0	6-21-55	T. H. by USGS and KGS.
30-7-25dcc	SW SW SE sec. 25		B	40	4	N	Sand and gravel	Holdrege Formation	N	N	do.	0	1,559.8	32.4	8-8-56	do.
30-7-28ddd	SE SE SE sec. 28		B	50	4	N	do.	do.	N	N	do.	0	1,592.6	33.3	6-21-55	T. H. by USGS and KGS.
30-7-30aaa	NE NE NE sec. 30		B	20	4	N	do.	do.	N	N	do.	0	1,550.0	8.8	8-7-56	do.
30-7-31cbb	NW NW SW sec. 31	Anshutz Drilling Co.											1,649			Oil-well test. Depth to bedrock 110 feet.
30-7-34ccc	SW SW SW sec. 34		Dr	80	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,604.1	49.1	7-26-55	T. H. by USGS and KGS.
30-7-35ccd	SE SW SW sec. 35		B	50	4	N	do.	do.	N	N	do.	0	1,569.7		6-3-55	do.
	T. 30 S., R. 8 W.															
30-8-6bcb	NW SW NW sec. 6		Dr	50	4	N	do.	Terrace deposits	N	N	do.	0	1,536.5		7-26-55	do.
30-8-9bcd	SE SW NW sec. 9	Petroleum, Inc.											1,513			Oil-well test. Depth to bedrock 40 feet.

30-8-22daa	NE NE SE sec. 22	Stanolind Oil and Gas Co.										1,534			Oil-well test. Depth to bedrock 80 feet.
30-8-23dcc	SW SW SE sec. 23		B	25	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,583.5	18.4	8-7-56	T. H. by USGS and KGS.
30-8-28ccc	SW SW SW sec. 28		B	45	4	N	do	do	N	N	do	0	1,618.3	29.0	8-7-56	do.
30-8-32abc	SW NW NE sec. 32	Sinclair Oil and Gas Co.											1,664			Oil-well test. Depth to bedrock 117 feet.
30-8-34dcc	SW SW SE sec. 34	Mull Drilling Co., Inc.											1,650			Oil-well test. Depth to bedrock 100 feet.
	T. 30 S. R. 9 W.															
30-9-1bda	NE SE NW sec. 1	Rupp-Ferguson Drilling Co.											1,554			Oil-well test. Depth to bedrock 45 feet.
30-9-1dda	NE NE SE sec. 1		B	50	4	N	Silt and sand	Terrace deposits	N	N	Land surface	0	1,546.3	11.6	7-21-55	T. H. by USGS and KGS.
30-9-1ddd	SE SE SE sec. 1		B	25	4	N			N	N	do	0	1,578.4	Dry	7-21-55	do.
30-9-2ccb	NW SW SW sec. 2		B	20	4	N	Sand and gravel	Holdrege Formation	N	N	do	0	1,617.7	16.3	8-8-56	do
30-9-10dbb	NW NW SE sec. 10	Deep Rock Oil Corp.														Oil-well test. Depth to bedrock 125 feet.
30-9-17aad	SE NE NE sec. 17		B	70	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,712.1	67.5	8-3-56	T. H. by USGS and KGS.
30-9-20ddd	SE SE SE sec. 20		B	20	4	N	do	Holdrege Formation	N	N	do	0	1,647.3	7.1	8-3-56	do.
*30-9-22db	NW SE sec. 22	Sam Swingle	Sp				do	do		DS					10-13-56	Estimated flow 75.
30-9-23bbb	NW NW NW sec. 23		B	40	4	N	do	do	N	N	Land surface	0	1,619.7	23.9	8-6-56	T. H. by USGS and KGS.
30-9-24aaa	NE NE NE sec. 24		B	49	4	N	do	do	N	N	do	0	1,554.7	30.5	7-21-55	do.
30-9-24add	SE SE NE sec. 24		B	50	4	N	do	Terrace deposits	N	N	do	0	1,537.5		7-21-55	do.
30-9-25ddd	SE SE SE sec. 25		B	65	4	N	do	Holdrege Formation	N	N	do	0	1,652.9	51.9	8-7-56	do.
30-9-26ccc	SW SW SW sec. 26		B	60	4	N	do	Grand Island Formation	N	N	do	0	1,656.3	53.8	8-6-56	do.
30-9-28cbb	NW NW SW sec. 28	Welch and Olson Drilling Co.											1,658			Oil-well test. Depth to bedrock 75 feet.
30-9-31cbb	NW NW SW sec. 31		Dr	50	4	N	Sand and gravel	Terrace deposits	N	N	Land surface	0	1,651.4		8-2-55	T. H. by USGS and KGS.
30-9-32cac	SW NE SW sec. 32	Magnolia Petroleum Corp.											1,634			Oil-well test. Depth to bedrock 75 feet.

TABLE 7.—*Records of wells, test holes, and springs in Kingman County*—*Concluded*

Well number (1)	Location	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, inches	Type of casing (4)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (5)	Use of water (6)	Measuring point: Description	Measuring point: Distance above land surface, feet	Measuring point: Height above mean sea level, feet	Depth to water level below land surface datum, feet	Date of measurement	Remarks (Yield given in gallons a minute; drawdown in feet)
	T. 30 S., R. 9 W.															
30-9-34acc	SW SW NE sec. 34	Pickrell Drilling Co.											1,667			Oil-well test. Depth to bedrock 80 feet.
30-9-35bbd	SE NW NW sec. 35	J. A. Vickers Oil Co.											1,694			Oil-well test. Depth to bedrock 107 feet.
30-9-36ddd	SE SE SE sec. 36		Dr	109	4	N	Sand and gravel	Holdrege Formation	N	N	Land surface	0	1,683.3		7-26-55	T. H. by USGS and KGS.
	T. 30 S., R. 10 W.															
30-10-1bbb	NW NW NW sec. 1		Dr	35	4	N	do	Terrace deposits	N	N	do	0	1,638.9		8- 2-55	do.
30-10-1ddd	SE SE SE sec. 1		B	55	4	N	do	Grand Island Formation	N	N	do	0	1,717.7	52.7	8-13-56	do.
30-10-3caa	NE NE SW sec. 3	Welch and Olson Drilling Co.											1,698			Oil-well test. Depth to bedrock 85 feet.
30-10-7ccc	SW SW SW sec. 7		B	70	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,792.4	47.4	8- 2-56	T. H. by USGS and KGS.
30-10-15aaa	NE NE NE sec. 15		B	65	4	N	do	do	N	N	do	0	1,745.8	54.4	8- 3-56	do.
30-10-18add	SE SE NE sec. 18	Sierra Petroleum Co.											1,787			Oil-well test. Depth to bedrock 165 feet.
30-10-24aaa	NE NE NE sec. 24		Dr	135	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,744.6	65.1	10- 1-55	T. H. by USGS and KGS.
30-10-26cbc	SW NW SW sec. 26		B	10	4	N	do	do	N	N	do	0	1,691.5	8.9	8- 3-56	do.
30-10-28ccc	SW SW SW sec. 28	Musgrove Petroleum Co.											1,748			Oil-well test. Depth to bedrock 140 feet.

30-10-29aaa	NE NE NE sec. 29	....	B	30	4	N	Sand and gravel	Grand Island Formation	N	N	Land surface	0	1,743.3	19.5	8- 3-56	T. H. by USGS and KGS.
30-10-30ccc	SW SW SW sec. 30	....	B	15	4	N	do	do	N	N	do	0	1,746.9	10.0	8- 3-56	do.
30-10-31ccc	SW SW SW sec. 31	....	Dr	129	4	N	do	do	N	N	do	0	1,779.4	....	8-23-55	do.
	T. 31 S., R. 5 W.															
31-5-5aab	NW NE NE sec. 5	....	B	7	4	N	....	....	N	N	do	0	1,343.0	Dry	6- 4-55	do.
31-5-5abb	NW NW NE sec. 5	....	B	7	4	N	....	....	N	N	do	0	1,340.0	Dry	6- 4-55	do.
	T. 31 S., R. 6 W.															
31-6-1baa	NE NE NW sec. 1	....	B	4	4	N	....	....	N	N	do	0	1,341.1	Dry	6- 6-55	do.
31-6-2aab	NW NE NE sec. 2	....	B	8	4	N	....	....	N	N	do	0	1,373.5	Dry	6- 6-55	do.
31-6-5bbb	NW NW NW sec. 5	....	B	32	4	N	Sand and gravel	Holdrege Formation	N	N	do	0	1,537.1	14.4	6- 4-55	do.
31-6-6bbb	NW NW NW sec. 6	....	B	50	4	N	do	do	N	N	do	0	1,575.2	42.0	6- 4-55	do.
	T. 31 S., R. 7 W.															
31-7-1bbb	NW NW NW sec. 1	....	B	50	4	N	do	do	N	N	do	0	1,587.4	....	6- 3-55	do.
31-7-3bbb	NW NW NW sec. 3	....	B	50	4	N	do	do	N	N	do	0	1,594.1	40.6	6- 3-55	do.

1. Asterisk beside number indicates that analysis of water is given in Table 4.
2. B, bored test hole or well; D, dug well; Dn, driven well; Dr, drilled well or test hole; Sp, spring.
3. Depths of wells and test holes are given in feet below land surface.
4. C, concrete; GI, galvanized sheet iron; N, none; S, steel; T, tile.
5. Method of lift: Ce, centrifugal; Cy, cylinder; F, natural flow; J, jet; N, none; T, turbine.
   Type of power: B, butane; E, electric; H, hand; Ng, natural gas engine; T, tractor; W, windmill.
6. D, domestic; I, irrigation; Ind, industrial; N, none; O, observation; PS, public supply; S, stock.

LOGS OF WELLS AND TEST HOLES

The logs of 254 wells and test holes are given on the following pages and are summarized as follows: There are logs of 199 auger holes and of 36 hydraulic-rotary test holes all put down by the State Geological Survey. Drillers logs are given for 7 wells and 12 test holes drilled by private contractors. The samples from test holes drilled by the State Geological Survey were examined and logged in the field. On the logs that follow, those designated "sample logs" were prepared after miscroscopic examination of the samples in the laboratory and comparison with the field log.

26-11-36ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 36, T. 26 S., R. 11 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,759.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Soil	1	1
Sand, fine to coarse, interbedded with silt and clay	6	7
Silt and clay, noncalcareous, buff	4	11
Sand, very coarse, and fine gravel	3	14
Silt and clay, sandy, buff	4.5	18.5
Sand, fine to medium	15.5	34
Sand, medium to coarse	7.5	41.5
Clay, silty, calcareous, buff	3.5	45
Sand, coarse, and fine gravel; some calcareous clay	6	51
Sand, medium to coarse	9	60
Sand and fine to medium gravel; some interbedded silt,	3	63
Sand, coarse to very coarse, and fine gravel	7	70
Sand, coarse to very coarse, and fine gravel; some silty buff clay	10	80
Sand, medium to coarse	10	90
Sand, medium to coarse, and fine gravel; contains calcareous buff to brown clay	10	100
Clay, sandy, silty, calcareous, buff	10	110
Sand, medium to coarse; some calcareous clay	16.5	126.5
Sand and clay interbedded, cemented	9.5	136
Sand, coarse, and fine to coarse gravel; some tan calcareous clay	14	150
Sand, coarse to very coarse	4	154
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone and sandstone, red brown	6	160

27-5-1bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 1, T. 27 S., R. 5 W., on east side of road, 5 feet south of center line of east-west road. Drilled by Federal and State Geological Surveys June 16, 1955. Surface altitude, 1,403.8 feet; depth to water, 8.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil, brown	2	2
Colluvium		
Sand, fine to coarse, and fine to medium gravel, silty	11	13
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	15

27-5-6aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 6, T. 27 S., R. 5 W., on south side of road, 40 feet west of center line of north-south road. Drilled by Federal and State Geological Surveys June 16, 1955. Surface altitude, 1,509.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, gray brown; some fine gravel	6	6
Sand, fine to coarse, and fine gravel, silty	4	10
Sand, fine to coarse, and fine to medium gravel; streaks of clayey tan silt	10	20
Sand, fine to coarse, and fine gravel	10	30
Sand, fine to very coarse; silt streaks	5	35
Sand, fine to coarse, very silty; contains fragments of Permian rocks	11	46
Silt, very sandy, pink tan; sand streaks near base	9	55
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	57

27-5-6ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 6, T. 27 S., R. 5 W., on west side of road, 40 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 16, 1955. Surface altitude, 1,525.1 feet; depth to water, 29.9 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
Soil, dark brown	1	5
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan	3	8
Sand, fine to coarse, silty; many thin sandy silt streaks,	17	25
Sand, fine to coarse, and fine gravel; silty	5	30
Sand, fine to coarse, and fine gravel	20	50

27-5-7ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 7, T. 27 S., R. 5 W., on west side of road, 40 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 16, 1955. Surface altitude, 1,507.1 feet; depth to water, 14.0 feet.*

	Thickness, feet	Depth, feet
Soil, brown	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, some fine gravel, pink tan	3	5
Sand, fine to coarse, and fine to medium gravel; some pink-tan silt streaks	10	15
Sand, fine to coarse, silty	10	25
Sand, fine to coarse, and fine gravel, silty	5	30
Sand, fine to coarse, silty	5	35
Sand, fine to coarse, and some fine gravel, silty; some thin silt streaks	14	49
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, pink and green	1	50

27-5-12bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 12, T. 27 S., R. 5 W., on east side of road, 50 feet south of east-west road. Augered by Federal and State Geological Surveys July 23, 1955. Surface altitude, 1,459.8 feet; depth to water, 13.9 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, clayey, calcareous, light gray	4	6
Sand, fine to coarse	6	12
Sand, fine to coarse, and fine gravel; streaks of pink-tan silt	9	21
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	4	25

27-5-14aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 14, T. 27 S., R. 5 W., on west side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys May 10, 1955. Surface altitude, 1,479.8 feet; depth to water, 16.7 feet.*

	Thickness, feet	Depth, feet
Soil, brown	1	1
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to medium gravel, very silty, red brown	3	4
Silt, sandy, tan	1	5
Sand, fine to coarse, and fine gravel; streaks of pink silt,	15	20

	Thickness, feet	Depth, feet
Sand, fine to coarse, some silt	10	30
Sand, fine to coarse, and fine gravel; some silt	12	42
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	3	45

27-5-18ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 18, T. 27 S., R. 5 W., on west side of road, 40 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 16, 1955. Surface altitude, 1,492.0 feet; depth to water, 3.5 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, some sand and fine gravel, tan	2	5
Sand, fine to coarse, and fine gravel; contains much pink-tan silt	5	10
Sand, fine to coarse; some fine gravel	8	18
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, dark red	2	20

27-5-19ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 19, T. 27 S., R. 5 W., on west side of road, 20 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 16, 1955. Surface altitude, 1,465.8 feet; depth to water, 23.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Sand, fine to coarse, very silty, red brown	5	5
Silt, very sandy, brown; contains some gravel	6	11
Silt, sandy, pink tan	24	35
Sand, fine to coarse, and fine gravel, very silty	5	40
Sand, fine to coarse, and fine gravel; streaks of tan silt,	6	46
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	47

27-5-23aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 23, T. 27 S., R. 5 W., on west side of road, 75 feet south of east-west road. Augered by Federal and State Geological Surveys July 23, 1955. Surface altitude, 1,472.2 feet; depth to water, 8.8 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty	5	7
Sand, fine to coarse, very silty; some tan silt and clay streaks	13	20
Sand, fine to coarse, and fine gravel, very silty	17.5	37.5

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2.5	40

27-5-26aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 26, T. 27 S., R. 5 W., on west side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 15, 1955. Surface altitude, 1,503.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty, brown,	5	5
Sand, fine to coarse, and fine gravel; some silt near base	5	10
Sand, fine to coarse, and fine gravel	15	25
Sand, fine to coarse, and fine gravel; streak of silty tan clay near base	5	30
Silt, sandy, yellow tan; contains thin sand streaks	3	33
Sand, fine to coarse, and fine gravel	4	37
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	3	40

27-5-29ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 29, T. 27 S., R. 5 W., in east road ditch, 75 feet north of Highway 54. Drilled by Federal and State Geological Surveys June 15, 1955. Surface altitude, 1,449.8 feet; depth to water, 16.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, dark gray	3	3
Silt, very sandy, light brown	7	10
Silt, very sandy, pink tan	7	17
Sand, fine to coarse, and fine to medium gravel, silty	8	25
Silt, sandy, pink tan	5	30
Sand, fine to coarse, and fine gravel; some thin silt streaks	10	40
Sand, fine to coarse, and fine gravel	10	50
PERMIAN—Leonardian		
Ninnescah Shale		
Siltstone, red	2	52

27-5-31ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 31, T. 27 S., R. 5 W., on west side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 15, 1955. Surface altitude, 1,421.0 feet; depth to water, 5.4 feet.*

	Thickness, feet	Depth, feet
Road fill	5	5
QUATERNARY—Upper Pleistocene		
Alluvium—Wisconsinan Stage to Recent		
Silt, very sandy, dark gray	10	15
Sand, fine to coarse, very silty, gray; thin streaks of dark-gray silt at base	5	20
Sand, fine to coarse, very silty	5	25

27-6-5aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 5, T. 27 S., R. 6 W., on west side of road, 30 feet south of center line of east-west road. Drilled by Federal and State Geological Surveys, June 16, 1955. Surface altitude, 1,510.1 feet; depth to water, 9.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Silt, very sandy, brown	3	3
Silt, very sandy, light tan, some fine gravel	7	10
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, pink tan	12	22
Sand, fine to coarse, and fine to medium gravel	13	35
QUATERNARY—Lower Pleistocene		
Holdrege(?) and Fullerton(?) Formations—Nebraskan(?) and Aftonian(?) Stages		
Silt, sandy, pink tan	11	46
Sand, fine to coarse, and fine gravel; contains many fragments of Permian rocks	8	54
PERMIAN—Leonardian		
Ninnescah Shale		
Siltstone, red	2	56

27-6-9bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 9, T. 27 S., R. 6 W., in corner of field, 15 feet east of north-south road and 15 feet south of east-west road. Augered by Federal and State Geological Surveys June 17, 1955. Surface altitude, 1,503.1 feet; depth to water, 14.2 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, very sandy, dark tan	2	5
Silt, sandy, pink tan; contains caliche nodules	9	14
Sand, fine to medium, silty; contains thin silt streaks	6	20
Sand, fine to coarse, silty	5	25
Sand, fine to coarse, and fine gravel, silty; contains some thin silt streaks	14	39
PERMIAN—Leonardian		
Ninnescah Shale		
Siltstone, red	1	40

27-6-12bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 12, T. 27 S., R. 6 W., in road ditch at southeast corner of intersection. Augered by Federal and State Geological Surveys July 17, 1956. Surface altitude, 1,508.5 feet; depth to water, 11.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy	3	3
Sand, fine to coarse, very silty	2	5
Sand, fine to coarse, clean	9	14

27-6-14ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 14, T. 27 S., R. 6 W., in road ditch at northwest corner of intersection. Augered by Federal and State Geological Surveys July 17, 1956. Surface altitude, 1,465.5 feet; depth to water, 10.8 feet.*

	Thickness, feet	Depth, feet
Soil, black	2	2
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, clayey	2	4
Sand, fine to coarse, and fine gravel; very silty	3	7
Silt, sandy	3	10
Sand, fine to medium	3	13
Silt, sandy	2	15

27-6-16bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 16, T. 27 S., R. 6 W., on south side of road, 25 feet east of center line of north-south road. Augered by Federal and State Geological Surveys June 17, 1955. Surface altitude, 1,478.7 feet; depth to water, 12.1 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Sand, silty, brown	2	5
Sand, fine to coarse, and fine gravel	6	11
Silt, sandy, brown	7	18
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		18

27-6-21bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 21, T. 27 S., R. 6 W., on south side of road, 40 feet east of north-south road. Augered by Federal and State Geological Surveys June 17, 1955. Surface altitude, 1,475.8 feet; depth to water, 8.8 feet.*

	Thickness, feet	Depth, feet
Soil, dark brown	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, red brown	11	13
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	15

27-6-28bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 28, T. 27 S., R. 6 W., on south side of road, 75 feet east of north-south road. Augered by Federal and State Geological Surveys June 17, 1955. Surface altitude, 1,507.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, dark red brown	4	4

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	1	5

27-6-28ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 28, T. 27 S., R. 6 W., on east side of road, 50 feet north of center line of Highway 54. Augered by Federal and State Geological Surveys June 17, 1955. Surface altitude, 1,558.4 feet; depth to water, 16.9 feet.*

	Thickness, feet	Depth, feet
Soil, brown	3	3
TERTIARY—Pliocene		
Ogallala(?) Formation		
Sand, fine to coarse; much material derived from Cretaceous rocks	9	12
Sand, fine to coarse, and fine to medium gravel; a few thin silt streaks and much material derived from Cretaceous rocks	17	29
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, pink	1	30

27-6-30bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 30, T. 27 S., R. 6 W., in road ditch at southeast corner of road intersection. Augered by Federal and State Geological Surveys July 22, 1956. Surface altitude, 1,575.9 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Upper Pleistocene		
Colluvium		
Clay, silty	2	5
Silt, sandy, tan	7	12
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		12

27-7-1bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 1, T. 27 S., R. 7 W., in road ditch at southeast corner of road intersection. Augered by Federal and State Geological Surveys July 12, 1956. Surface altitude, 1,544.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, dark gray	4	4
Sand, very silty	1	5
Silt, clayey	2	7
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		7

27-7-4aab.—*Drillers log of test hole in NW¼ NE¼ NE¼ sec. 4, T. 27 S., R. 7 W., in south road ditch ¼ mile west of north-south road. Augered by Federal and State Geological Surveys July 12, 1956. Surface altitude, 1,574.6 feet; depth to water, 6.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Sand, silty, gray to red brown	6	6
Sand, fine to coarse, silty; some gravel near base	6	12
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		12

27-7-5bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 5, T. 27 S., R. 7 W., on south side of road, 75 feet east of north-south road. Augered by Federal and State Geological Surveys July 22, 1955. Surface altitude, 1,578.3 feet; depth to water, 32.5 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, brown	3	5
Sand, fine to coarse, and fine to coarse gravel, very silty	5	10
Silt, sandy, tan	2	12
Sand, fine to coarse, and fine to medium gravel, very silty	6	18
QUATERNARY—Lower Pleistocene		
Holdrege(?) and Fullerton(?) Formations—Nebraskan(?) and Aftonian(?) Stages		
Silt, very sandy, tan	29	47
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	3	50

27-7-7aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 7, T. 27 S., R. 7 W., on south side of road, 50 feet west of north-south road. Augered by Federal and State Geological Surveys July 22, 1955. Surface altitude, 1,555.8 feet; depth to water, 7.0 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, light brown	3	5
Sand, fine to coarse, silty	5	10
Sand, fine to coarse, and fine gravel	3	13
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	15

27-7-12ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 12, T. 27 S., R. 7 W., on west road shoulder 5 feet north of section-line fence. Augered by Federal and State Geological Surveys July 12, 1956. Surface altitude, 1,499.3 feet; depth to water, 8.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil, sandy, black	3	3
Alluvium—Recent		
Silt, sandy, red	2	5
Sand, fine to coarse; some gravel	2	7
Sand, fine to coarse, and fine to coarse gravel; thin silt streaks	5	12
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		12

27-7-18ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 18, T. 27 S., R. 7 W., on west road shoulder, 20 feet north of section-line fence. Augered by Federal and State Geological Surveys July 22, 1955. Surface altitude, 1,575.4 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
TERTIARY—Pliocene		
Ogallala(?) Formation		
Sand, fine to coarse, very silty, brown	2	5
Sand, fine to coarse, and fine gravel; contains much tan silt	4	9
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	3	12

27-7-22aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 22, T. 27 S., R. 7 W., on south road shoulder, 50 feet west of north-south road. Augered by Federal and State Geological Surveys July 12, 1956. Surface altitude, 1,566.5 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
TERTIARY—Pliocene		
Ogallala(?) Formation		
Silt, clayey	1	4
Sand, silty	1	5
Sand, fine to coarse, and some gravel; very silty	3	8
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		8

7—2171

27-7-29bba.—*Sample log of test hole in NE¼ NW¼ NW¼ sec. 29, T. 27 S., R. 7 W., on west side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys July 22, 1955. Surface altitude, 1,602.4 feet; depth to water, 17.9 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, silty	3	5
Sand, fine to coarse	15	20
Sand, fine to coarse; contains thin streaks of tan silt	17	37
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	3	40

27-7-30bcd.—*Drillers log of test hole in SE¼ SW¼ NW¼ sec. 30, T. 27 S., R. 7 W. Drilled by Dal Wells Drilling Co. for the City of Kingman (Kingman test hole no. 0) October 1, 1957. Surface altitude, 1,596 feet; depth to water, reported 8 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, silty	6	7
Sand, fine	15	22
Clay	5	27
Sand, fine	3	30
Clay	1	31
Sand, fine to coarse	4	35
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	3	38

27-7-30ccd.—*Drillers log of test hole in SE¼ SW¼ SW¼ sec. 30, T. 27 S., R. 7 W. Drilled by Layne-Western Co. for the City of Kingman (Kingman test hole no. LW14) October 1, 1957. Surface altitude, 1,593 feet; depth to water, reported 13 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	2	3
Sand, fine to coarse	7	10
Sand, fine to coarse, and fine gravel	17	27
Clay, white	1	28
Sand, fine to coarse, and gravel	7	35
Clay, white	4	39
Sand, coarse, and gravel	2	41

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	4	45

27-7-30dab.—*Drillers log of test hole in NW¼ NE¼ SE¼ sec. 30, T. 27 S., R. 7 W. Drilled by Layne-Western Co. for City of Kingman (Kingman test hole no. LW5) August 10, 1950. Surface altitude, 1,586 feet; depth to water, reported 4.0 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, brown	1	1
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine; layer of brown clay	3	4
Clay, gray, soft	5	9
Sand, medium, and gray clay	1	10
Sand, fine to medium; thin clay streaks	8	18
Clay, yellow	2	20
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	5	25

27-7-30dbb.—*Drillers log of test hole in NW¼ NW¼ SE¼ sec. 30, T. 27 S., R. 7 W. Drilled by Dal Wells Drilling Co. for City of Kingman (Kingman test hole no. I-3) September 30, 1957. Surface altitude, 1,601 feet; depth to water, reported 12 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine	6	8
Clay	1	9
Sand, coarse	3	12
Sand, fine to coarse	3	15
Sand, medium to coarse	12	27
Sand, medium to coarse; thin cemented streak	3	30
Sand, fine to coarse	3	33
Sand, fine	6	39
Sand, fine, clay streaks	3	42
Sand, fine	3	45
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red		45

27-7-30dcb.—*Drillers log of test hole in NW¼ SW¼ SE¼ sec. 30, T. 27 S., R. 7 W. Drilled by Layne-Western Co. for City of Kingman (Kingman test hole no. LW6) August 10, 1950. Surface altitude, 1,587 feet; depth to water, reported 7.3 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, brown	1	1
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Afton Stages		
Clay, gray and brown	5	6

	Thickness, feet	Depth, feet
Sand, fine to medium; streaks of gray clay	4	10
Sand, fine to medium	10	20
Sand, fine	11	31
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	3	34

27-8-1bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 1, T. 27 S., R. 8 W., on road at southeast corner of intersection. Augered by Federal and State Geological Surveys July 13, 1956. Surface altitude, 1,600.4 feet; depth to water, 9.7 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, black	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, brown; very sandy at base	12	15

27-8-4bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 4, T. 27 S., R. 8 W., in road ditch at southeast corner of road intersection. Augered by Federal and State Geological Surveys July 13, 1956. Surface altitude, 1,635.6 feet; depth to water, 7.2 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, black	2	2
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, silty	5	7
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, clayey, sandy	5	12
Sand, fine, clean	3	15

27-8-9ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 9, T. 27 S., R. 8 W., in east road ditch, 300 feet north of east-west road. Augered by Federal and State Geological Surveys July 13, 1956. Surface altitude, 1,651.5 feet; depth to water, 24.6 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, black	2	2
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse	8	10
Sand, fine to coarse, silty	15	25

27-8-15aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 15, T. 27 S., R. 8 W., in south road ditch, 40 feet west of center line of north-south road. Augered by Federal and State Geological Surveys July 13, 1956. Surface altitude, 1,626.2 feet; depth to water, 7.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy	3	3
Sand, fine to coarse, silty in upper part	12	15

27-8-25aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 25, T. 27 S., R. 8 W. Drilled by Dal Wells Drilling Co. for City of Kingman (Kingman test hole no. 3) October 2, 1957. Surface altitude, 1,603 feet; depth to water, reported 9.5 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine	11	14
Sand, fine to coarse	4	18
Sand, coarse	6	24
Sand, coarse, and fine gravel	3	27
Gravel, fine	3	30
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red		30

27-8-25bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 25, T. 27 S., R. 8 W., on east road shoulder, 35 feet south of center line of east-west road. Augered by Federal and State Geological Surveys July 13, 1956. Surface altitude, 1,628.7 feet; depth to water, 27.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy	5	5
Sand, fine to coarse, silty	2	7
Sand, fine to coarse, clean	23	30

27-8-25daa.—*Drillers log of test hole in NE¼ NE¼ SE¼ sec. 25, T. 27 S., R. 8 W. Drilled by Dal Wells Drilling Co. for Richard A. Funke September 30, 1957. Surface altitude, 1,607 feet.*

	Thickness, feet	Depth, feet
Soil	4	4
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine; clay streaks	3	7
Sand, fine	13	20
Sand, fine to coarse	7	27
Sand, fine	3	30
Clay, yellow	3	33
Clay	3	36
Sand, coarse	7	43
Clay, coarse sand streaks	4	47
No log	3	50
Sand, coarse, and fine gravel	3	53
Gravel, fine	1	54
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	3	57

27-8-25dbb.—*Drillers log of test hole in NW¼ NW¼ SE¼ sec. 25, T. 27 S., R. 8 W. Drilled by Dal Wells Drilling Co. for City of Kingman (Kingman test hole no. 1) October 2, 1957. Surface altitude, 1,606 feet; depth to water, reported 11.5 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	3	6
Sand, fine	8	14
Clay, white	3	17
Sand, fine	4	21
Sand, coarse	4.5	25.5
Clay, sandy	7.5	33
Clay	1	34
Clay, red	3	37
Sand, fine	3	40
Clay	2	42
Sand, fine	1	43
Sand, fine to coarse	8	51
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red		51

27-8-25dcc.—*Drillers log of test hole in SW¼ SW¼ SE¼ sec. 25, T. 27 S., R. 8 W. Drilled by Dal Wells Drilling Co. for City of Kingman (Kingman test hole no. 5) October 2, 1957. Surface altitude, 1,589 feet; depth to water, reported 4.8 feet.*

	Thickness, feet	Depth, feet
Soil	4	4
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, coarse	3	7
Clay	1	8
Sand, fine	1	9
Sand, coarse	3	12
Sand, coarse, and gravel	3	15
Clay, sandy	3	18
Sand, fine; clay streaks	3	21
Sand, coarse	12	33
Sand, fine	2	35
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red		35

27-8-28abb.—*Drillers log of test hole in NW¼ NW¼ NE¼ sec. 28, T. 27 S., R. 8 W., in south road ditch, 20 feet west of steel culvert. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,623.3 feet; depth to water, 21.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to medium, silty	5	5
Sand, fine to coarse, clean	20	25

27-8-30bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 30, T. 27 S., R. 8 W., on south side of road, 300 feet east of road to north. Drilled by Federal and State Geological Surveys October 1, 1955. Surface altitude, 1,645.6 feet; depth to water, 32.5 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty	8	10
Sand, fine to coarse, and fine gravel; silt streak at 12 feet	5	15
Sand, fine to coarse, and fine to medium gravel	10	25
Sand, fine to coarse, and fine gravel; some thin silt streaks	15	40
Sand, fine to coarse, and fine gravel	5	45
Sand, fine to coarse, and fine gravel; some thin silt streaks	15	60
Sand, fine to coarse; some silt streaks	10	70
Sand, fine to coarse	5	75
Sand, fine to coarse, and fine gravel; some thin silt streaks; some material derived from Cretaceous rocks	15	90
Sand, fine to coarse; some thin silt streaks	30	120
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	122

27-8-33ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 33, T. 27 S., R. 8 W., in road ditch at northeast corner of road intersection. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,616.0 feet; depth to water, 33.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, silty	30	30
Sand, fine to coarse, some gravel, clean	13	43
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		43

27-9-2aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 2, T. 27 S., R. 9 W., on south side of road, 150 feet west of north-south road. Drilled by Federal and State Geological Surveys October 1, 1955. Surface altitude, 1,675.6 feet; depth to water, 26.7 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, and fine gravel, silty	3	5
Sand, very fine to coarse, some fine gravel, silty	13	18
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, tan, contains much fine sand	12	30
Silt, very sandy, tan, calcareous	5	35
Silt, very sandy, tan, calcareous; contains streaks of gray-tan calcareous clay	5	40
Sand, fine, streaks of clayey tan silt	5	45
Sand, fine to coarse, some fine gravel; streaks of clayey tan silt	20	65
Sand, fine to coarse, some fine to medium gravel; streaks of clayey tan silt	32	97
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red brown	5	102

27-9-6bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 6, T. 27 S., R. 9 W., on south side of road, 75 feet east of north-south road. Drilled by Federal and State Geological Surveys October 2, 1955. Surface altitude, 1,700.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formation—Kansan and Yarmouthian Stages		
Silt, sandy, light brown	2	2
Silt, sandy, clayey, gray brown	4	6
Sand, fine to coarse, and fine to medium gravel, very silty	4	10
Sand, fine to coarse, and fine to medium gravel	5	15
Gravel, fine to coarse, and some fine to coarse sand	8	23
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, silty, sandy, calcareous, light gray tan	10	33
Silt, very sandy, gray tan, lime cemented	6	39
Clay, silty, sandy, calcareous, tan	1	40
Silt, very sandy, calcareous, tan to gray tan; contains lime-cemented streaks	10	50
Silt, sandy, clayey, calcareous, gray tan; contains caliche nodules	13	63
Sand, fine to coarse, and fine gravel, very silty	5	68
Silt, very sandy, calcareous, tan; contains some caliche nodules	12	80

	Thickness, feet	Depth, feet
Silt, very sandy, calcareous, tan; contains thin sand streaks	5	85
Sand, fine to coarse, and fine gravel, silty	10	95
Sand, fine to coarse, and fine gravel; contains thin streaks of silt and silty clay	90	185
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	2	187

27-9-9bbb2.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 9, T. 27 S., R. 9 W., in south road ditch, 120 feet east of center line of north-south road. Drilled by Federal and State Geological Surveys December 23, 1950. Surface altitude, 1,721 feet.*

	Thickness, feet	Depth, feet
Soil, sandy	3	3
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, some fine gravel	6	9
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy, gray; much caliche	11	20
Clay, sandy, mottled gray brown; much caliche	5	25
Clay, sandy, gray	3	28
Sand, fine to coarse, some fine gravel	30	58
Sand, fine to coarse, and fine gravel; contains a few clay streaks	12	70
Sand, fine to coarse, and fine to medium gravel; contains a few clay streaks	9	79
Gravel, fine to coarse	11	90
Sand and gravel, fine to coarse	20	110
Sand, fine to coarse, and fine to coarse gravel; contains streaks of gray clay	39	149
Gravel, fine to coarse; contains much material derived from Cretaceous rocks	1	150
PERMIAN—Leonardian		
Harper(?) Siltstone		
Siltstone, red	4	154

27-9-12ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 12, T. 27 S., R. 9 W., on side of road at northwest corner of road intersection. Augered by Federal and State Geological Surveys July 16, 1956. Surface altitude, 1,660.0 feet; depth to water, 26.0 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, black	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Clay, sandy	6	9
Sand, fine to coarse, silty	4	13
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	10	23
Sand, fine to coarse	5	28

27-9-14bba.—*Drillers log of test hole in NE¼ NW¼ NW¼ sec. 14, T. 27 S., R. 9 W., on south road shoulder, 860 feet east of north-south road. Augered by Federal and State Geological Surveys July 16, 1956. Surface altitude, 1,689.1 feet; depth to water, 41.8 feet.*

	Thickness, feet	Depth, feet
Road fill and soil	5	5
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, silty	3	8
Sand, fine to coarse, some gravel, silty	7	15
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	10	25
Sand, fine to coarse, silty	2	27
Clay, sandy	8	35
Sand, fine to coarse, silty	5	40
Clay, very sandy	5	45
Sand, fine to coarse	4	49

27-9-16ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 16, T. 27 S., R. 9 W., in east road ditch, 150 feet north of east-west road. Augered by Federal and State Geological Surveys July 16, 1956. Surface altitude, 1,685.1 feet; depth to water, 16.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	2	2
Clay, silty	1	3
Silt, sandy	11	14
Clay	1	15
Clay, sandy	2	17
Sand, fine to coarse	3	20

27-9-18bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 18, T. 27 S., R. 9 W., on road at southeast corner of road intersection. Augered by Federal and State Geological Surveys July 16, 1956. Surface altitude, 1,742.3 feet; depth to water, 18.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	2	2
Sand, silty	3	5
Sand, fine to coarse, some silt	17	22
Clay, sandy	3	25
Sand, fine to coarse, silty	5	30

27-9-19aba.—*Drillers log of test hole in NE¼ NW¼ NE¼ sec. 19, T. 27 S., R. 9 W., in field 800 feet east of house. Drilled by Layne-Western Co. for Clifford Hansen February 4, 1957. Depth to water, reported 80 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene undifferentiated		
Sand, medium	7	10
Sand, medium coarse, and gravel	20	30
Sand, medium to coarse, and gravel	13	43
Clay, brown	15	58
Sand, medium fine	20	78
Sand, fine to coarse, and gravel	3	81
Rock, soft (caliche)	2	83
Sand, fine to coarse	17	100
Sand, medium to coarse, and gravel	15	115
Sand, fine to medium; contains much red silt	15	130
Sand, fine to coarse, and fine gravel; contains much red silt	10	140
Sand, fine to coarse, and gravel; contains much red silt	5	145
Sand, fine to medium; contains much red silt	12	157
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	3	160

27-9-19ada.—*Drillers log of test hole in NE¼ SE¼ NE¼ sec. 19, T. 27 S., R. 9 W., in field 1,800 feet east and 1,350 feet south of house. Drilled by Layne-Western Co. for Clifford Hansen February 5, 1957. Depth to water, reported 75 feet.*

	Thickness, feet	Depth, feet
Soil	4	4
QUATERNARY—Lower Pleistocene undifferentiated		
Sand, fine to medium	6	10
Sand, medium to coarse, and gravel	22	32
Clay	1	33
Sand and gravel	2	35
Clay, brown	14	49
Sand, fine to coarse	11	60
Sand, fine to coarse, and fine to coarse gravel	20	80
Sand, fine to coarse	15	95
Sand, fine to medium; contains much red silt	55	150
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	5	155

27-9-23ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 23, T. 27 S., R. 9 W., on road shoulder at northeast corner of road intersection. Augered by Federal and State Geological Surveys July 16, 1956. Surface altitude, 1,646.9 feet; depth to water, 23.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, silty	7	7
Sand, fine to coarse, silty	5	12
Sand, fine to coarse, and fine to coarse gravel	1	13
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan	7	20
Clay, sandy	10	30
Sand, fine to coarse, very silty	9	39

27-9-29bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 29, T. 27 S., R. 9 W., on east road shoulder, 50 feet south of east-west road. Drilled by Federal and State Geological Surveys October 2, 1955. Surface altitude, 1,720.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, very sandy, brown	2	2
Sand, fine to coarse, and fine gravel	3	5
Sand, fine to coarse, and fine to medium gravel, silty	5	10
Sand, fine to very coarse, silty	6	16
Silt, very sandy, gray tan	4	20
Silt, very sandy, calcareous, gray tan; contains caliche nodules	5	25
Sand, fine to coarse, some silt streaks	5	30
Sand, fine to coarse, and fine gravel	15	45
Sand, fine to coarse, much fine to medium gravel; a few thin silt streaks near top	19	64
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, red brown	4	68
Sand, fine to coarse, mostly fine to medium; contains much red-brown silt	51	119
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, hard, and shale, red	11	130

27-9-32aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 32, T. 27 S., R. 9 W., on south side of road, 20 feet west of north-south road. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,719.8 feet; depth to water, 65 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy	5	5
Sand, fine to coarse, silty	10	15
Sand, fine to coarse, some fine gravel	54	69

27-10-2aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 2, T. 27 S., R. 10 W., on south road shoulder, 150 feet west of north-south road. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,690.1 feet; depth to water, 52.0 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene undifferentiated		
Silt, sandy	8	10
Clay, sandy	2	12
Silt, sandy, white; very heavy concentration of caliche,	4	16
Silt, sandy	4	20
Clay, sandy	5	25
Silt, sandy	7	32
Sand, fine to coarse, silty	5	37
Silt, sandy	3	40
Sand, fine to coarse, silty	3	43
Silt, sandy; few sand streaks	10	53
Sand, fine to coarse, silty	6	59

27-10-5aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 5, T. 27 S., R. 10 W., in road ditch at southwest corner of intersection. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,726.2 feet; depth to water, 11.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) Formation—Illinoisan(?) Stage		
Sand, silty	7	7
Sand, fine to coarse	6	13
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Clay, sandy	7	20
Sand, fine to medium, silty	5	25

27-10-7ccd.—*Drillers log of test hole in SE¼ SW¼ SW¼ sec. 7, T. 27 S., R. 10 W., on north side of road, 40 feet west of steel culvert. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,767.1 feet; depth to water, 54.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	5	5
Sand, fine to coarse, some gravel	5	10
Sand, fine to coarse, silty	43	53
Sand, fine to coarse, and fine to coarse gravel, silty	16	69

27-10-10ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 10, T. 27 S., R. 10 W., on north road shoulder, 450 feet east of north-south road. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,739.0 feet; depth to water, 46.1 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, black	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, silty	3	5
Sand, fine to coarse, some fine gravel	5	10
Sand, fine to coarse, some silt	59	69

27-10-26aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 26, T. 27 S., R. 10 W., in west road ditch, 450 feet south of east-west road. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,703.4 feet; depth to water, 37.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	5	5
Sand, silty	2	7
Sand, fine to coarse	8	15
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	7	22
Sand, fine to coarse, silty	3	25
Silt, sandy	2	27
Sand, fine to medium, silty	3	30
Clay, very sandy	12	42
Sand, fine to coarse, and gravel	2	44

27-10-30bcc.—*Sample log of test hole in SW¼ SW¼ NW¼ sec. 30, T. 27 S. R. 10 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,665.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Sand, medium to coarse	20	20
Sand, coarse	10	30
Sand, medium to coarse; contains a few clay streaks	10	50
Sand, medium to coarse	13.5	63.5
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	6.5	70

27-10-30cbc.—*Sample log of test hole in SW¼ NW¼ SW¼ sec. 30, T. 27 S., R. 10 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,666.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Soil, sandy	1	1
Sand, medium to coarse; contains some calcareous silt,	9	10
Sand, medium to coarse	10	20

	Thickness, feet	Depth, feet
Sand, coarse	20	40
Sand, medium to coarse, and fine to medium gravel	10	50
Sand, medium	15.5	65.5
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red brown	9.5	75

27-10-31cbc.—*Sample log of test hole in SW¼ NW¼ SW¼ sec. 31, T. 27 S., R. 10 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,714.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Sand, coarse to very coarse, and fine gravel	10	10
Sand, coarse, and fine gravel; contains some clay and caliche	10	20
Sand, coarse, and fine gravel	5.5	25.5
Clay, sandy. calcareous, tan to brown	6.5	32
Sand, coarse, and fine gravel	38	70
Sand, coarse; contains some tan clay	10	80
Sand, coarse, and fine gravel; contains material derived from Cretaceous rocks	10	90
Sand, coarse; some fine gravel derived from Cretaceous rocks	17.5	107.5
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red		107.5

27-10-31cca.—*Drillers log of well in NE¼ SW¼ SW¼ sec. 31, T. 27 S., R. 10 W. Drilled by Layne-Western Co. for Cunningham Helium Plant (now abandoned) July 11, 1943. Depth to water, reported 31 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Lower Pleistocene undifferentiated		
Clay and caliche	9	10
Sand, coarse, and gravel	5	15
Clay, gray	3	18
Sand, coarse, and gravel	7	25
Sand, coarse	5	30
Clay	1	31
Sand, fine, and clay; contains cemented streaks	4	35
Sand, medium to coarse; contains cemented streaks	24	59
Clay, contains cemented streaks	4	63
Sand, medium to coarse; contains cemented streaks	25	88
Sand, coarse	7	95
Clay, sandy	3	98
Sand and gravel	3	101
Sand, very fine	2	103
Clay, sandy	2	105
Sand and gravel	2	107

	Thickness, feet	Depth, feet
Clay, sandy	4	111
Sand, coarse, and gravel; clay streaks	7	118
PERMIAN—Leonardian		
Salt Plain Siltstone		
Shale, red		118

27-10-31ccd.—*Drillers log of well in SE¼ SW¼ SW¼ sec. 31, T. 27 S., R. 10 W. Drilled by Layne-Western Co. for Cunningham Helium Plant (now abandoned) July 13, 1943. Depth to water, reported 31 feet.*

QUATERNARY—Lower Pleistocene undifferentiated	Thickness, feet	Depth, feet
Clay, sandy	11	11
Sand and gravel	8	19
Clay	1	20
Sand, coarse	2	22
Sand, coarse, and gravel	6	28
Clay, sandy	2	30
Sand, coarse	4	34
Sand, coarse, cemented streaks	12	46
Clay, sandy	1	47
Sand, coarse, cemented streaks	18	65
Sand, cemented streaks	6	71
Sand, medium to coarse	26	97
Sand, coarse	2	99
Sand, fine	2	101
Clay, sandy	2	103
Sand and gravel	3	106
Clay, sandy	12	118
PERMIAN—Leonardian		
Salt Plain Siltstone		
Shale, red		118

27-11-25aad.—*Sample log of test hole in SE¼ NE¼ NE¼ sec. 25, T. 27 S., R. 11 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,695.7 feet.*

QUATERNARY—Pleistocene undifferentiated	Thickness, feet	Depth, feet
Sand, medium to coarse, silty to clayey	1.5	1.5
Sand, coarse to very coarse	8.5	10
Sand, coarse, and fine gravel	22.5	32.5
Clay, sandy, silty, dark gray	4	36.5
Sand, medium to coarse	33.5	70
Sand, very coarse; streak of tan clay at 73 feet	10	80
Sand, medium to coarse; contains many thin clay streaks	10	90
Sand, coarse to very coarse; contains material derived from Cretaceous rocks	10	100
Sand, medium to coarse; contains material derived from Cretaceous rocks and thin clay streaks	10	110
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	4	114

28-5-2aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 2, T. 28 S., R. 5 W., on west side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys May 21, 1955. Surface altitude, 1,435.7 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, very sandy, pink tan	16	18
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	20

28-5-6dad.—*Sample log of test hole in SE¼ NE¼ SE¼ sec. 6, T. 28 S., R. 5 W., on west side of road, 50 feet north of quarter-section fence. Augered by Federal and State Geological Surveys June 15, 1955. Surface altitude, 1,408.1 feet; depth to water, 11.5 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, red brown	2	5
Sand, fine to coarse, and fine gravel; much red silt	2	7
Sand, fine to coarse, and fine gravel; much calcareous tan silt	3	10
Sand, fine to coarse, and fine gravel, very silty	15	25
Silt, very sandy, gray tan	5	30
Sand and fine gravel, very silty, gray	10	40

28-5-6ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 6, T. 28 S., R. 5 W., on west side of road, 25 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 15, 1955. Surface altitude, 1,405.1 feet; depth to water, 9.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, very sandy, some fine gravel, red brown	5	5
Sand, fine to coarse, very silty, red brown	5	10
Sand, fine to coarse, and fine gravel, very silty, pink tan	15	25
Sand, fine to coarse, very silty; some streaks of gray silt,	14	39
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	40

28-5-14aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 14, T. 28 S., R. 5 W., in southwest quadrant of diamond-shaped intersection, 20 feet west of north-south road, 20 feet south of east-west road. Surface altitude, 1,387.9 feet; depth to water, 6.8 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, gray tan to pink tan	18	20

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	22

28-5-18ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 18, T. 28 S., R. 5 W., on west side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 15, 1955. Surface altitude, 1,413.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, red brown	4	4
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	5

28-5-19ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 19, T. 28 S., R. 5 W., on west side of road, 20 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,431.2 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red	4	6
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	4	10

28-5-26aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 26, T. 28 S., R. 5 W., on west side of road, 40 feet south of center line of east-west road. Augered by Federal and State Geological Surveys May 28, 1955. Surface altitude, 1,384.1 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, very sandy, red brown	3	4
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	1	5

28-5-26dda.—*Sample log of test hole in NE¼ SE¼ SE¼ sec. 26, T. 28 S., R. 5 W., on west side of road, 15 feet south of quarter-section fence line. Augered by Federal and State Geological Surveys May 28, 1955. Surface altitude, 1,362.6 feet; depth to water, 6.9 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Sand, fine to coarse, and fine to medium gravel, very silty	7	9
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	1	10

28-5-30ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 30, T. 28 S., R. 5 W., on west side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,438.4 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red	3	5
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	6

28-5-31ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 31, T. 28 S., R. 5 W., on west side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,407.0 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red	2	4
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	5

28-5-32bad.—*Drillers log of test hole in SE¼ NE¼ NW¼ sec. 32, T. 28 S., R. 5 W., on Calhoun farm, 20 feet north of windmill. Drilled by City of Wichita, November 23, 1955. Depth to water, 22.0 feet.*

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah Shale		
Clay, red	5	5
Shale, red	10	15
Shale, soft, gray	10	25
Shale, red	5	30
Shale, gray	5	35
Shale, red	5	40
Shale, red brown	6	46
Void, lost circulation	2	48
Shale, red	1	49

28-5-35aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 35, T. 28 S., R. 5 W., on west side of road, 25 feet south of center line of east-west road. Augered by Federal and State Geological Surveys May 29, 1955. Surface altitude, 1,361.4 feet.*

	Thickness, feet	Depth, feet
Soil, black	2	2
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, clayey, red brown	8	10
Silt, sandy, red brown	15	25
Silt, sandy, gray; contains many streaks of silty sand	7	32
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		32

28-5-35ada.—*Sample log of test hole in NE¼ SE¼ NE¼ sec. 35, T. 28 S., R. 5 W., on west side of road, 100 feet south of bridge. Augered by Federal and State Geological Surveys May 29, 1955. Surface altitude, 1,362.0 feet; depth to water, 6.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	2	2
Alluvium—Recent		
Sand, fine to medium, very silty	5	7
Silt, sandy, calcareous, pink tan	1	8
Sand, fine to coarse, and fine gravel, silty; many fragments of Permian rock; some silt streaks	17	25
Silt, sandy, gray tan	7	32
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	1	33

28-5-35daa.—*Sample log of test hole in NE¼ NE¼ SE¼ sec. 35, T. 28 S., R. 5 W., on west side of road 10 feet south of half-section fence. Augered by Federal and State Geological Surveys May 29, 1955. Surface altitude, 1,367.9 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, red brown	3	5
Silt, sandy, gray tan to pink tan	5	10
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	5	15

28-5-35ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 35, T. 28 S., R. 5 W., on road shoulder, 50 feet north and 50 feet west of center line of road crossing. Augered by Federal and State Geological Surveys May 29, 1955. Surface altitude, 1,392.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, very sandy, brown	2	2
Sand, fine to coarse, very silty	5	7
Sand, fine to coarse, and fine gravel, silty	5	12
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	3	15

28-6-5bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 5, T. 28 S., R. 6 W., on south side of road, 100 feet east of center line of north-south road. Augered by Federal and State Geological Surveys June 18, 1955. Surface altitude, 1,546.8 feet; depth to water, 8.4 feet.*

	Thickness, feet	Depth, feet
TERTIARY—Pliocene		
Ogallala(?) Formation		
Sand, fine to coarse, and fine to medium gravel; much material derived from Cretaceous rocks; a few streaks of red-brown sandy silt	10	10

	Thickness, feet	Depth, feet
Sand, fine to coarse, and fine to coarse gravel; most gravel derived from Cretaceous rocks	8	18
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red brown	2	20

28-6-7daa.—*Sample log of test hole in NE¼ NE¼ SE¼ sec. 7, T. 28 S., R. 6 W., on west side of road, 300 feet north of bridge. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,457.3 feet; depth to water, 1.5 feet.*

	Thickness, feet	Depth, feet
Soil, sandy, brown	3	3
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to medium, very silty	2	5
Sand, fine to coarse, and fine to medium gravel; some silt and fragments of Permian rocks	25	30
Sand, fine to coarse, and fine to medium gravel; few thin silt streaks	12	42
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		42

28-6-8bbc.—*Sample log of test hole in SW¼ NW¼ NW¼ sec. 8, T. 28 S., R. 6 W., on east side of road, 35 feet north of quarter-section fence. Augered by Federal and State Geological Surveys June 18, 1955. Surface altitude, 1,475.2 feet; depth to water, 12.4 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, red brown	22	24
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	1	25

28-6-8ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 8, T. 28 S., R. 6 W., on east side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,472.7 feet; depth to water, 16.6 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Sand, fine to coarse, very silty	3	7
Silt, sandy, dark tan	3	10
Sand, fine to coarse, and fine to medium gravel, very silty	21	31
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		31

28-6-20bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 20, T. 28 S., R. 6 W., on east side of road, 50 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 18, 1955. Surface altitude, 1,560.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to medium gravel, very silty	5	5
Sand, fine to coarse, and fine to medium gravel; silt streak at 7 feet	5	10
Sand, fine to coarse, and fine to coarse gravel, few silt streaks; contains some material derived from Cretaceous rocks	18	28
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	30

28-6-20ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 20, T. 28 S., R. 6 W., on east side of road, 60 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 18, 1955. Surface altitude, 1,566.0 feet; depth to water, 21.5 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to coarse gravel, very silty	7	10
Sand, fine to coarse, and fine gravel, silty	3	13
Sand, very fine, silty, gray tan	7	20
Sand, fine to coarse, thin streaks of clayey brown silt,	5	25
Sand, fine to coarse, and fine gravel	12	37
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	3	40

28-6-32bcb.—*Sample log of test hole in NW¼ SW¼ NW¼ sec. 32, T. 28 S., R. 6 W., on east side of road, 0.3 mile south of section-line fence. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,538.4 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to medium gravel, silty	6	8
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	2	10

28-7-5bdb.—*Drillers log of City of Kingman well 5 in NW¼ SE¼ NW¼ sec. 5, T. 28 S., R. 7 W.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Clay, sandy	5	6
Clay	2	8
Sand and gravel, clay streaks	19	27
Sand, medium, silty	3	30
Clay, blue	3	33
Sand, medium to coarse, clay streaks	7	40
Sand, medium to coarse, and gravel; some clay streaks,	9	49
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	3	52

28-7-6aca.—*Drillers log of City of Kingman well 4 in NE¼ SW¼ NE¼ sec. 6, T. 28 S., R. 7 W. Drilled May 12, 1954. Depth to water, reported 11.3 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Clay, sandy, red	2	3
Sand, medium to coarse	4	7
Sand and gravel	6	13
Clay, gray	7	20
Clay, brown	14	34
Sand and gravel	8	42
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone	3	45

28-7-6dab.—*Drillers log of City of Kingman well 3 in NW¼ NE¼ SE¼ sec. 6, T. 28 S., R. 7 W. Drilled April 24, 1953. Depth to water, reported 6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine	2	2
Clay, brown and blue	8	10
Sand, medium to coarse	18	28
Clay, sandy, blue	2	30
Sand, medium	5	35
Sand, medium to coarse	9	44
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		44

28-7-11bab.—*Drillers log of test hole in NW¼ NE¼ NW¼ sec. 11, T. 28 S., R. 7 W., on north side of road, 50 feet east of bridge. Augered by Federal and State Geological Surveys July 19, 1956. Surface altitude, 1,479.4 feet; depth to water, 7.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, silty	5	5
Silt, sandy	2	7
Clay, sandy	3	10
Sand, fine to coarse, silty	38	48
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		48

28-7-17bba.—*Sample log of test hole in NE¼ NW¼ NW¼ sec. 17, T. 28 S., R. 7 W., on south side of road, 75 feet west of Kansas Highway 14. Augered by Federal and State Geological Surveys June 23, 1955. Surface altitude, 1,587.6 feet; depth to water, 16.9 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, some gravel, silty	3	5
Sand, fine to coarse, silty	5	10
Sand, fine to coarse, and fine gravel; a few thin silt streaks	39.5	49.5
PERMIAN—Leonardian		
Harper Siltsone		
Siltstone, red	0.5	50

28-7-17cdc.—*Sample log of test hole in SW¼ SE¼ SW¼ sec. 17, T. 28 S., R. 7 W., on north side of road, 50 feet east of Kansas Highway 14. Augered by Federal and State Geological Surveys June 23, 1955. Surface altitude, 1,628.6 feet.*

	Thickness. feet	Depth. feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, and fine to medium gravel; a few tan silt streaks	3	5
Sand, fine to coarse, and fine to medium gravel	25	30
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, silty	5	35
Sand, fine to coarse, and fine gravel; many thin silt streaks	5	40

28-7-22aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 22, T. 28 S., R. 7 W., in west road ditch, 300 feet south of east-west road. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,588.3 feet; depth to water, 27.5 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to medium, silty	4	7
Sand, fine to coarse	25	32
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		32

28-7-29bab.—*Sample log of test hole in NW¼ NE¼ NW¼ sec. 29, T. 28 S., R. 7 W., on south side of road, 40 feet east of Kansas Highway 14. Augered by Federal and State Geological Surveys June 23, 1955. Surface altitude, 1,593.2 feet; depth to water, 21.8 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to medium gravel, silty	5	8
Silt, sandy, tan	5	13
Sand, fine to coarse, and fine to medium gravel, silty	5	18
Sand, fine to coarse; much tan silt	22	40

28-7-32ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 32, T. 28 S., R. 7 W., on west side of road, 75 feet north of east-west road. Augered by Federal and State Geological Surveys June 23, 1955. Surface altitude, 1,635.1 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, gray tan	2	5
Silt, sandy, calcareous, light gray	13	18
Sand, fine to coarse, and fine to medium gravel; a few thin silt streaks	19	37
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, gray	3	40

28-7-33bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 33, T. 28 S., R 7 W., on east side of road, 25 feet south of Kansas Highway 14. Augered by Federal and State Geological Surveys June 23, 1955. Surface altitude, 1,588.3 feet; depth to water, 17.7 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, dark gray brown	5	7
Sand, fine to coarse, and fine to medium gravel, silty	8	15
Sand, fine to coarse, very silty	25	40

28-7-35bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 35, T. 28 S., R. 7 W., on south side of road, 500 feet east of north-south road. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,596.4 feet; depth to water, 33.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, silty	5	5
Sand, fine to coarse; some fine gravel near base	65	70

28-8-2bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 2, T. 28 S., R. 8 W., in south road ditch, 50 feet east of north-south road. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude 1,584.3 feet; depth to water, 13.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to medium, silty	7	7
Sand, fine to coarse	8	15

28-8-6cbb.—*Sample log of test hole in NW¼ NW¼ SW¼ sec. 6, T. 28 S., R. 8 W., in edge of field on east side of road, 300 feet north of bridge. Drilled by Federal and State Geological Surveys July 28, 1955. Surface altitude, 1,558.2 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, and fine to medium gravel	13	15
Sand, fine to coarse, and fine to medium gravel; many thin streaks of gray silt	23	38
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	40

28-8-6ccc.—*Drillers log of Well No. 1 in SW¼ SW¼ SW¼ sec. 6, T. 28 S., R. 8 W., 200 feet north and 30 feet east of water tower. Drilled by Layne-Western Co. for Kansas Power and Light Co. June 30, 1950. Depth to water, reported 35 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy, yellow brown	8	10
Sand, coarse, red brown	25	35
Clay, sandy, light brown	30	65
Sand, fine, light brown	10	75
Sand, coarse, brown	7	82
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	2	84

28-8-13bab.—*Drillers log of test hole in NW¼ NE¼ NW¼ sec. 13, T. 28 S., R. 8 W., in south road ditch, 100 feet east of bridge. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,545.6 feet; depth to water, 9.0 feet.*

	Thickness, feet	Depth, feet
Soil, black	4	4
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, silty	3	7
Clay, sandy	1	8
Sand, fine to coarse	2	10

28-8-16ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 16, T. 28 S., R. 8 W., in north road ditch by end of section-line fence. Augered by Federal and State Geological Surveys July 18, 1956. Surface altitude, 1,582.9 feet; depth to water, 16.8 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse	17	20

28-8-19bba.—*Drillers log of test hole in NE¼ NW¼ NW¼ sec. 19, T. 28 S., R. 8 W., in south road ditch, 100 feet east of bridge. Augered by Federal and State Geological Surveys July 19, 1956. Surface altitude, 1,583.6 feet; depth to water, 4.8 feet.*

	Thickness, feet	Depth, feet
Soil, black	4	4
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse	5	9

28-8-25bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 25, T. 28 S., R. 8 W., on south side of road, 500 feet east of north-south road. Augered by Federal and State Geological Surveys July 19, 1956. Surface altitude, 1,643.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	6	6
Sand, fine to coarse	14	20
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, clayey	25	45
Silt, sandy	7	52
Clay, sandy	3	55
Silt, sandy	3	58
Silt, sandy, clayey	11	69

28-8-27ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 27, T. 28 S., R. 8 W., on driveway into field at northeast corner of road intersection. Augered by Federal and State Geological Surveys July 19, 1956. Surface altitude, 1,654.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, very sandy	5	5
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine, silty; some caliche	5	10
Sand, fine to coarse	30	40
Sand, fine to coarse, and fine gravel	29	69

28-8-32ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 32, T. 28 S., R. 8 W., on north side of road, 0.1 mile east of road intersection. Augered by Federal and State Geological Surveys July 19, 1956. Surface altitude, 1,632.2 feet; depth to water, 13.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy	7.5	7.5
Clay, sandy	11.5	19

28-8-36aad.—*Drillers log of test hole in SE¼ NE¼ NE¼ sec. 36, T. 28 S., R. 8 W., on west side of road, 75 feet south of bridge. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,589.5 feet; depth to water, 14.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	5	5
Sand, fine to coarse	5	10

	Thickness, feet	Depth, feet
Silt, sandy, brown	8	18
Sand, fine to coarse	7	25

28-9-1aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 1, T. 28 S., R. 9 W., in borrow ditch 35 feet south of Highway 54, 200 feet west of north-south road. Drilled by Federal and State Geological Surveys July 27, 1955. Surface altitude, 1,562.8 feet; depth to water, 2.5 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, calcareous, gray	3	5
Silt, sandy, dark gray	3	8
Sand, fine to coarse, and fine to medium gravel; a few thin silt streaks	15	23
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	25

28-9-5bcc.—*Sample log of test hole in SW¼ SW¼ NW¼ sec. 5, T. 28 S., R. 9 W., on east road shoulder, 100 feet north of bridge. Drilled by Federal and State Geological Surveys August 1, 1955. Surface altitude, 1,599.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, dark gray	3	3
Sand, fine to coarse, and fine gravel; few streaks of gray silt	17	20
Sand, fine to coarse, very silty	5	25
Silt, sandy, gray; some fine gravel	13	38
Sand, fine to coarse, and fine gravel, silty	6	44
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	4	48

28-9-14bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 14, T. 28 S., R. 9 W., on south side of road, 300 feet east of north-south road. Augered by Federal and State Geological Surveys July 23, 1956. Surface altitude, 1,637.3 feet; depth to water, 22.6 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse	4	7
Sand, silty	3	10
Silt, sandy	7	17
Sand, fine to coarse	8	25
Sand, fine to coarse, silty	4	29

28-9-21bba.—*Drillers log of test hole in NE¼ NW¼ NW¼ sec. 21, T. 28 S., R. 9 W., on driveway on south side of road, 0.25 mile east of north-south road. Augered by Federal and State Geological Surveys July 23, 1956. Surface altitude, 1,650.6 feet; depth to water, 12.2 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Clay, silty	4	7
Sand, fine to coarse, silty	7	14

28-9-26ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 26, T. 28 S., R. 9 W., on north side of road, 450 feet east of north-south road. Augered by Federal and State Geological Surveys July 23, 1956. Surface altitude, 1,687.8 feet; depth to water, 39.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, silty	5	5
Silt, sandy	5	10
Clay	15	25
Sand, fine to coarse	15	40
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	7	47
Sand, fine to coarse, silty	2	49

28-9-32aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 32, T. 28 S., R. 9 W., on road at southwest corner of road intersection. Augered by Federal and State Geological Surveys July 23, 1956. Surface altitude, 1,680.3 feet; depth to water, 11.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, silty	5	5
Sand, fine to coarse	15	20

28-9-36aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 36, T. 28 S., R. 9 W., on south side of road, 75 feet west of section-line fence. Drilled by Federal and State Geological Surveys July 27, 1955. Surface altitude, 1,694.0 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, calcareous, gray tan; contains caliche nodules	3	5
Silt, very sandy, calcareous, tan	4	9
Sand, fine to coarse, and fine to medium gravel	26	35

	Thickness, feet	Depth, feet
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, calcareous, tan	5	40
Silt, sandy, calcareous, tan; contains caliche nodules,	5	45
Silt, sandy, calcareous, pink tan	5	50
Silt, sandy, calcareous, pink tan; some caliche nodules,	5	55
Silt, sandy, calcareous, pink tan; a few thin lime-cemented streaks	10	65
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	1	66

28-10-3ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 3, T. 28 S., R. 10 W., on road at northeast corner of road intersection. Augered by Federal and State Geological Surveys July 23, 1956. Surface altitude, 1,709.3 feet; depth to water, 27.0 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy	4	7
Silt, sandy; contains much caliche	3	10
Clay, silty	2	12
Silt, clayey	23	35
Clay, silty	5	40
Sand, fine to medium, silty	4	44

28-10-6ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 6, T. 28 S., R. 10 W., on north side of road, 200 feet west of north-south road. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,730.1 feet; depth to water, 24.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, silty	7	7
Sand, fine to coarse	18	25
Sand, fine to coarse, silty	15	40

28-10-13aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 13, T. 28 S., R. 10 W., in south road ditch, 20 feet west of north-south road. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,653.2 feet; depth to water, 14.4 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, silty; some sand and gravel	9	12
Sand, fine to coarse, and fine to coarse gravel, silty	3	15

28-10-15ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 15, T. 28 S., R. 10 W., on road at northeast corner of road intersection. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,723.3 feet; depth to water, 29.0 feet.*

QUATERNARY—Lower Pleistocene

Grand Island and Sappa Formations—Kansan and Yarmouthian Stages	Thickness, feet	Depth, feet
Clay, silty	10	10
Sand, fine to coarse, and some fine gravel	13	23
Sand, fine to coarse, and fine to medium gravel, silty	11	34

28-10-19aad.—*Drillers log of test hole in SE¼ NE¼ NE¼ sec. 19, T. 28 S., R. 10 W., on west side of road, 0.2 mile south of east-west road. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,724.5 feet; depth to water, 4.1 feet.*

QUATERNARY—Upper Pleistocene

Terrace deposits—Wisconsinan Stage	Thickness, feet	Depth, feet
Sand, silty	3	3
Sand, fine to coarse; thin silt streaks at 7 feet	6	9

28-10-19ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 19, T. 28 S., R. 10 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,798.6 feet.*

QUATERNARY—Lower Pleistocene undifferentiated	Thickness, feet	Depth, feet
Silt, brown, some fine to medium sand	5	5
Sand, fine, silty	2	7
Sand, coarse, and fine to medium gravel	14	21
Clay, calcareous, light gray to white; contains sand streaks at 22 feet	12	33
Sand, medium to coarse; contains some yellow-tan clay	4	37
Sand, coarse, silty	5	42
Sand, coarse, and fine to coarse gravel	9	51
Clay, calcareous, light gray; contains some medium to coarse sand	4.5	55.5
Clay, sandy, calcareous, light gray	8.5	64
Sand, medium to coarse; contains some tan calcareous clay	16	80
Sand, coarse, and fine gravel	10	90
Sand, coarse, and fine to medium gravel	29	119
Sand, medium to coarse; streak of gray clay at 122 feet,	21	140
Sand, coarse; contains some clay	19	159
Clay, calcareous, tan; contains some fine to coarse sand,	11	170
Sand, silty and clayey	11	181
Sand, coarse; some material derived from Cretaceous rocks	11.5	192.5
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red brown	4	196.5

28-10-25aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 25, T. 28 S., R. 10 W., on west side of road, 75 feet south of east-west road. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,692.7 feet; depth to water, 16.3 feet.*

	Thickness, feet	Depth, feet
Soil, black	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, clayey, sandy	5	8
Sand, fine to coarse, silty	16	24

28-10-27ccd.—*Drillers log of test hole in SE¼ SW¼ SW¼ sec. 27, T. 28 S., R. 10 W., on north side of road, 0.2 mile east of north-south road. Augered by Federal and State Geological Surveys July 24, 1956. Surface altitude, 1,729.4 feet; depth to water, 17.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Clay, silty	5	5
Silt, sandy	3	8
Clay, silty	7	15
Clay, sandy	3	18
Sand, fine to coarse, silty	1	19

28-11-24aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 24, T. 28 S., R. 11 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1745.3 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene undifferentiated		
Sand, coarse, and fine gravel; contains streaks of yellow-tan clay	25	28
Clay, sandy, calcareous, tan	14	42
Clay, calcareous, tan; some sand and gravel near base,	7.5	49.5
Clay, sandy, calcareous, light tan	2.5	52
Sand, coarse	9	61
Clay, sandy, calcareous, tan	7	68
Sand, coarse; contains some clay streaks	12	80
Clay, sandy, calcareous, buff	10	90
Clay, sandy, calcareous, light gray	5	95
Sand, coarse	17	112
Sand, coarse; some streaks of tan clay	11	123
Clay, silty, sandy, calcareous, pink	10	133
Sand, coarse; some pink calcareous clay	5	138
Clay, silty, sandy, calcareous, light gray green	4	142
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	3	145

28-11-24ada.—*Sample log of test hole in NE¼ SE¼ NE¼ sec. 24, T. 28 S., R. 11 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,738.2 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Sand, coarse, and fine gravel, silty	10	10
Sand, coarse, clay from 14 to 18 feet	37	47
Sand, coarse; contains some tan clay	2.5	49.5
Clay, sandy, calcareous, light gray; contains thin sand streaks	8.5	58
Sand, coarse; clay streak at 63 feet	10	68
Sand, coarse	13	81
Sand, medium to coarse, silty	5.5	86.5
Sand, coarse	20.5	107
Sand, coarse; contains some silty clay	9	116
Sand, coarse; contains some gray-pink clay	12	128
Sand, coarse; contains some gravel derived from Cretaceous rocks	7	135
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone and shale, red	4	139

28-11-24daa.—*Sample log of test hole in NE¼ NE¼ SE¼ sec. 24, T. 28 S., R. 11 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,736.2 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene undifferentiated		
Sand, coarse; contains some brown silty clay	5	8
Sand, coarse	14	22
Sand, coarse; contains some calcareous buff clay	10	32
Sand, coarse; some interbedded silt	17	49
Sand, coarse; some calcareous tan clay	5	54
Sand, coarse; some calcareous gray clay	7	61
Sand, medium to coarse; contains some silt and clay streaks	38.5	99.5
Clay, sandy, tan to light gray	11	110.5
Sand, coarse, and fine gravel	9.5	120
Clay, sandy, silty, pink; contains a few sand streaks	7.5	127.5
Sand, coarse, some thin clay streaks	5.5	133
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	2.5	135.5

29-4-7bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 7, T. 29 S., R. 4 W., in south road ditch, 50 feet east of center line of north-south road. Augered by Federal and State Geological Surveys August 1, 1957. Surface altitude, 1,390.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, red brown	5	5
Silt, sandy, red	2	7

	Thickness, feet	Depth, feet
Silt, gray	1	8
Silt, red	2	10
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	12

29-4-18bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 18, T. 29 S., R. 4 W., on east side of road, 40 feet south of center line of east-west road. Augered by Federal and State Geological Surveys July 31, 1957. Surface altitude, 1,406.5 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, dark brown	4	7
Silt, red	3	10
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	11

29-4-18bbc.—*Drillers log of test hole in SW¼ NW¼ NW¼ sec. 18, T. 29 S., R. 4 W., on east side of road, 0.25 mile south of east-west road. Augered by Federal and State Geological Surveys August 1, 1957. Surface altitude, 1,406.8 feet; depth to water, 24.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, black	5	5
Silt, brown	2	7
Silt, red	10	17
Silt, sandy, red	13	30
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	31

29-4-18bcc.—*Drillers log of test hole in SW¼ SW¼ NW¼ sec. 18, T. 29 S., R. 4 W., on east side of road, 0.5 mile south of east-west road. Augered by Federal and State Geological Surveys July 31, 1957. Surface altitude, 1,405.5 feet; depth to water, 20.4 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, gray brown	4	7
Silt, sandy, red	3	10
Silt, sandy, red; contains some fine gravel	5	15
Silt, sandy, red	5	20
Sand, fine; contains red silt	10	30
Sand, fine to medium; contains red silt	27	57

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	58

29-4-19bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 19, T. 29 S., R. 4 W., on south side of road, 40 feet east of north-south road. Augered by Federal and State Geological Surveys July 31, 1957. Surface altitude, 1,405.4 feet; depth to water, 18.5 feet.*

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, dark tan	5	6
Silt, sandy, red brown	5	11
Sand, fine to coarse, and fine gravel, silty	4	15
Silt, sandy, tan	22	37
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	38

29-4-19ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 19, T. 29 S., R. 4 W., in east road ditch, 300 feet north of section-line fence. Augered by Federal and State Geological Surveys August 1, 1957. Surface altitude, 1,397.0 feet; depth to water, 3.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Sand, fine to coarse	5	5
Sand, fine to coarse; some fine to medium gravel	5	10
Sand, fine to coarse; contains shale fragments	10	20
Sand, fine to medium, silty; contains shale fragments,	5	25
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, green	1	26

29-4-30cbb.—*Drillers log of test hole in NW¼ NW¼ SW¼ sec. 30, T. 29 S., R. 4 W., on east side of road, across road from farm drive. Augered by Federal and State Geological Surveys August 1, 1957. Surface altitude, 1,414.4 feet; depth to water, 13.1 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, red	3	5
Silt, sandy, some fine gravel, red	2	7
Silt, sandy, red	6	13
Sand, fine to coarse	2	15
Sand, fine to coarse, and fine gravel	5	20
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	21

29-4-30ccb.—*Drillers log of test hole in NW¼ SW¼ SW¼ sec. 30, T. 29 S., R. 4 W., on east side of road, 0.25 mile north of east-west road. Augered by Federal and State Geological Surveys August 1, 1957. Surface altitude, 1,416.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red	5	5
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	6

29-5-6daa.—*Sample log of test hole in NE¼ NE¼ SE¼ sec. 6, T. 29 S., R. 5 W., on west side of road, 100 feet south of bridge. Augered by Federal and State Geological Surveys Spetember 7, 1955. Surface altitude, 1,395.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, very silty	10	10
Sand, fine to coarse, and fine gravel, silty; contains a few thin silt streaks and fragments of Permian shale,	27	37
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green		37

29-5-8bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 8, T. 29 S., R. 5 W., on south side of road, 50 feet east of center line of north-south road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,402.1 feet; depth to water, 6.9 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, very silty	6	8
Silt, very sandy, gray to brown	7	15
Sand, fine to coarse, and fine gravel; contains much brown silt and many fragments of Permian shale	23	38
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green		38

29-5-8ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 8, T. 29 S., R. 5 W., on west side of road, 100 feet north of section-line fence. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,460.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, red brown	3	3
Silt, sandy, dark tan	2	5
Sand, fine to coarse, and fine gravel	2	7

	Thickness, feet	Depth, feet
Silt, sandy, gray tan; thin streaks of sand and fine gravel	3	10
Sand, fine to coarse, a few thin silt streaks	15	25
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green		25

29-5-12bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 12, T. 29 S., R. 5 W., on east side of road, 100 feet south of east-west road. Augered by Federal and State Geological Surveys July 23, 1955. Surface altitude, 1,391.4 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, clayey, sandy, light brown	2	5
Silt, clayey, sandy, red brown	3	8
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	2	10

29-5-14aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 14, T. 29 S., R. 5 W., on west side of road, 45 feet south of center line of east-west road. Augered by Federal and State Geological Surveys May 12, 1955. Surface altitude, 1,403.7 feet; depth to water, 15.1 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, pink tan	6	9
Sand, fine to coarse, silty	16	25
Silt, sandy, calcareous, gray	10	35
Silt, sandy, light brown	14	49
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	50

29-5-16ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 16, T. 29 S., R. 5 W., on west side of road, 150 feet north of section-line fence. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,479.1 feet; depth to water, 22.6 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Upper Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, light gray tan	4	7
Sand, fine to medium, very silty	3	10
Sand, fine to coarse; a few thin streaks of sandy tan silt	36	46
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	4	50

29-5-20ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 20, T. 29 S., R. 5 W., on east side of abandoned road, 15 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,499.3 feet; depth to water, 24.1 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty	2	5
Sand, fine to coarse, and fine gravel, silty	4	9
Sand, fine to medium; many thin streaks of gray-tan sandy silt	16	25
Sand, fine, very silty	20	45
Sand, fine to coarse, and fine gravel, silty	4	49
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green	1	50

29-5-24bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 24, T. 29 S., R. 5 W., on east side of road, 100 feet south of east-west road. Augered by Federal and State Geological Surveys July 23, 1955. Surface altitude, 1,425.2 feet; depth to water, 12.7 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, tan to gray tan	4	7
Silt, sandy, pink tan	3	10
Sand, fine to coarse, and fine to medium gravel; a few thin silt streaks and fragments of Permian shale	10	20
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	5	25

29-5-26aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 26, T. 29 S., R. 5 W., on west side of road, 75 feet south of center line of east-west road. Augered by Federal and State Geological Surveys May 12, 1955. Surface altitude, 1,425.2 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, very sandy, red brown	9	12
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	13

29-5-30ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 30, T. 29 S., R. 5 W., on west side of road, 40 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,507.6 feet; depth to water, 21.9 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, silty	6	9
Silt, sandy, gray tan	1	10
Sand, fine to coarse, and fine gravel, silty; contains a few streaks of tan silt	15	25
Silt, gray to tan; contains thin streaks of fine to coarse sand	5	30
Sand, fine to coarse, and fine gravel	18	48
Silt, sandy, pink to gray green	2	50

29-5-31ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 31, T. 29 S., R. 5 W., on west side of road, 30 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,508.1 feet; depth to water, 23.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty	10	10
Sand, fine to coarse	10	20
Sand, fine to coarse, and fine gravel; tan silt streaks at 23 to 24 feet	5	25
Sand, fine to coarse, and fine to medium gravel; a few thin silt streaks	18	43
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	45

29-5-35ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 35, T. 29 S., R. 5 W., on west side of road, 40 feet north of center line of east-west road. Augered by Federal and State Geological Surveys May 12, 1955. Surface altitude, 1,462.5 feet; depth to water, 9.2 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, calcareous, tan to gray tan	3	5
Sand, fine to medium, very silty	2	7
Sand, fine to coarse, mostly fine to medium	29	36
PERMIAN—Leonardian		
Ninnescah Shale		
Siltstone, red brown	1	37

29-6-5bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 5, T. 29 S., R. 6 W., on east side of road, 100 feet south of east-west road. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,546.3 feet; depth to water, 5.4 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand and fine gravel, very silty	2	5
Sand, fine to coarse, and some fine gravel; a few thin silt streaks	8	13
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	2	15

29-6-7ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 7, T. 29 S., R. 6 W., on west side of road, 150 feet north of east-west road. Drilled by Federal and State Geological Surveys August 3, 1955. Surface altitude, 1,575.9 feet; depth to water, 36.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, silty	5	5
Sand, fine to coarse, and fine gravel	5	10
Sand, fine to coarse, and fine to medium gravel; a few thin silt streaks	10	20
Sand, fine to coarse, and fine gravel	10	30
Sand, fine to coarse, and fine to coarse gravel	18	48
PERMIAN—Leonardian		
Harper Siltstone		
Shale, red	2	50

29-6-8bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 8, T. 29 S., R. 6 W., on east side of road, 250 feet south of east-west road. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,557.8 feet; depth to water, 16.0 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, clayey, sandy, tan	2	4
Sand, fine to coarse, and fine to medium gravel, silty,	5	9
Sand, fine to coarse, and fine to coarse gravel, very silty	3	12
Sand, fine to coarse, and fine to medium gravel	20	32
Silt, very sandy, light tan	3	35
Sand, fine to coarse; a few thin silt streaks	15	50

29-6-20bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 20, T. 29 S., R. 6 W., on east side of road, 50 feet south of east-west road. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,561.0 feet; depth to water, 31.0 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, dark tan	2	5
Sand, fine to coarse, and fine to medium gravel, silty,	5	10
Sand, fine to coarse; thin streaks of gray-tan sandy silt,	5	15
Sand, fine to coarse	15	30
Sand, fine to coarse, and fine gravel	20	50

29-6-29bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 29, T. 29 S., R. 6 W., on east side of road, 70 feet south of east-west road. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,535.2 feet; depth to water, 20.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, very silty	3	3
Sand, fine to coarse, and fine gravel, silty	2	5
Sand, fine to coarse, some fine gravel; a few thin silt streaks	41	46
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	48

29-6-32bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 32, T. 29 S., R. 6 W., on east side of road, 10 feet south of abandoned road to west. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,507.9 feet; depth to water, 12.5 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty	2	5
Sand, fine to coarse, and fine gravel; a few thin silt streaks	13	18
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	19

29-7-5ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 5, T. 29 S., R. 7 W., on west side of road, 100 feet north of east-west road. Drilled by Federal and State Geological Surveys July 25, 1955. Surface altitude, 1,617.3 feet; depth to water, 50.2 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, and fine gravel, very silty	3	5
Sand, fine to coarse	10	15
Sand, fine to coarse, and fine gravel; contains a few thin clay streaks	9	24
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, calcareous, tan; caliche nodules near base,	11	35
Sand, fine to coarse	10	45
Sand, fine to coarse, some fine gravel	9	54
Silt, sandy, calcareous, gray tan	5	59
Sand, fine to coarse, and fine gravel; a few thin silt streaks	5	64
Sand, fine to coarse, and fine gravel	31	95
Sand, fine to coarse, and fine gravel; many thin streaks of tan silt	31	126
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	4	130

29-7-11bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 11, T. 29 S., R. 7 W., in east road ditch, 75 feet south of east-west road. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,588.9 feet; depth to water, 28.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, silty	5	5
Sand, fine to coarse	20	25
Silt, brown	10	35
Sand, fine to coarse	35	70

29-7-13ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 13, T. 29 S., R. 7 W. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,560.9 feet; depth to water, 24.6 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, tan	6	10
Silt, tan; a few sand streaks	5	15
Silt, tan to gray	25	40
Sand, fine to coarse	30	70

29-7-17aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 17, T. 29 S., R. 7 W., on west side of road, 75 feet south of east-west road. Augered by Federal and State Geological Surveys June 22, 1955. Surface altitude, 1,617.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, and fine gravel, silty	15	15
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan	10	25
Silt, sandy, calcareous, tan	15	40

29-7-17ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 17, T. 29 S., R. 7 W., on west side of road, 75 feet south of east-west road. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,599.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, red brown	6	6
Silt, sandy, clayey, tan to gray tan	7	13
Sand, fine to coarse, and fine gravel, very silty	3	16
Silt, sandy, calcareous, tan to gray tan	9	25
Sand, fine to coarse, and fine gravel, very silty	15	40
Silt, sandy, calcareous, gray tan; contains thin sand streaks	10	50

29-7-21aab.—*Drillers log of test hole in NW¼ NE¼ NE¼ sec. 21, T. 29 S., R. 7 W., on south side of road, 50 feet west of bridge. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,554.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, silty	5	5
Sand, fine to coarse	9	14
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	1	15

29-7-29ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 29, T. 29 S., R. 7 W., on west side of road, 120 feet north of section-line fence. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,516.3 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, some gravel, red brown	5	7
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, hard, red		7

29-7-32ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 32, T. 29 S., R. 7 W., on west side of road, 40 feet north of east-west road. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,502.2 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, some gravel, red brown	5	7
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		7

29-8-11bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 11, T. 29 S., R. 8 W., in south road ditch, 60 feet east of north-south road. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,660.8 feet; depth to water, 62.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, gray brown	5	5
Silt, gray tan, much caliche	5	10
Silt, sandy, gray	45	55
Sand, silty in upper part	13	68
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	2	70

29-8-13baa.—*Sample log of test hole in NE¼ NE¼ NW¼ sec. 13, T. 29 S., R. 8 W., on south side of road, 200 feet east of bridge. Augered by Federal and State Geological Surveys July 22, 1955. Surface altitude, 1,579.4 feet; depth to water, 20.9 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, silty	2	5
Sand, fine to coarse, much gray-tan silt	2	7
Silt, sandy, calcareous, pink to gray; contains caliche	6	13
Silt, sandy, calcareous, pink tan	19	32
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	3	35

29-8-15ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 15, T. 29 S., R. 8 W., in west road ditch, 20 feet north of east-west road. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,652.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, tan, some caliche nodules	10	10

	Thickness, feet	Depth, feet
Silt, sandy, tan to gray, some caliche nodules; very sandy near base	15	25
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	5	30

29-8-17aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 17, T. 29 S., R. 8 W., in south road ditch, 150 feet west of north-south road. Augered by Federal and State Geological Surveys August 8, 1956. Surface altitude, 1,645.6 feet; depth to water, 15.4 feet.*

QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage	Thickness, feet	Depth, feet
Sand, fine to coarse, silty	10	10
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan to gray, some caliche nodules	5	15
Silt, sandy, gray, some caliche nodules	10	25
Sand, fine to coarse, silty	10	35

29-8-29aad.—*Drillers log of test hole in SE¼ NE¼ NE¼ sec. 29, T. 29 S., R. 8 W., on west side of road, 0.2 mile south of east-west road. Augered by Federal and State Geological Surveys August 8, 1956. Surface altitude, 1,632.8 feet; depth to water, 38.3 feet.*

QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages	Thickness, feet	Depth, feet
Silt, sandy	5	5
Silt, sandy, tan; contains caliche nodules	5	10
Sand, silty	8	18
Silt, tan, some caliche	17	35
Sand, fine to coarse, and fine gravel	10	45

29-9-4ccb.—*Drillers log of test hole in NW¼ SW¼ SW¼ sec. 4, T. 29 S., R. 9 W., in east road ditch, 0.15 mile north of east-west road. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,701.3 feet; depth to water, 39.0 feet.*

QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages	Thickness, feet	Depth, feet
Silt, some caliche	5	5
Sand and fine gravel	15	20
Silt, sandy, pink; some sand streaks	10	30
Silt, partly lime cemented, hard	5	35
Sand, fine to coarse, and fine to coarse gravel	5	40
Sand, fine to coarse, and fine gravel	5	45
Sand, fine to coarse, silty	5	50

29-9-6bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 6, T. 29 S., R. 9 W., on east side of road, 130 feet south of east-west road. Drilled by Federal and State Geological Surveys August 1, 1955. Surface altitude, 1,746.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Crete(?) Formation—Illinoisan(?) Stage		
Sand, fine to coarse, and fine gravel, very silty	4	4
Sand, fine to coarse, and fine to medium gravel	8	12
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, very sandy, calcareous, gray white; contains caliche nodules	3	15
Silt, very sandy, calcareous, gray tan	5	20
Silt, very sandy, some fine gravel, calcareous, gray tan,	5	25
Silt, very sandy, calcareous, gray tan	3	28
Sand, fine to coarse, and fine gravel containing lime-cemented streaks	2	30
Sand, fine to coarse, and fine to medium gravel; a few clayey tan silt streaks	30	60
Sand, fine to coarse, and fine to medium gravel; many thin silt streaks	30	90
Sand, fine to coarse, and fine to coarse gravel	11	101
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel; contains much calcareous pink-tan silt	27	128
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	2	130

29-9-10ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 10, T. 29 S., R. 9 W., in north half of triangle formed by road junction, 40 feet west of north-south road. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,701.2 feet; depth to water, 47.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, fine to coarse, and fine gravel	30	30
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, some fine gravel	15	45
Sand, fine to coarse, and fine gravel	15	60

29-9-24aab.—*Drillers log of test hole in NW¼ NE¼ NE¼ sec. 24, T. 29 S., R. 9 W., on south side of road, 0.2 mile west of section-line fence where small creek flows over road. Augered by Federal and State Geological Surveys August 8, 1956. Surface altitude, 1,616.6 feet; depth to water, 10.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium—Recent		
Sand, fine to coarse, silty; thin streaks of gray silt	10	10
Sand, silty	5	15

29-9-24ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 24, T. 29 S., R. 9 W., on north side of road, 40 feet west of center line of north-south road. Drilled by Federal and State Geological Surveys July 27, 1955. Surface altitude, 1,649.5 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Silt, very sandy, tan	2	4
Sand, fine to coarse, and fine to coarse gravel	12	16
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, calcareous, gray tan; contains much caliche	4	20
Silt, sandy, calcareous, gray tan; contains a few thin sand streaks	26	46
Sand, silty, cemented with calcium carbonate	3	49
PERMIAN—Leonardian		
Harper(?) Siltstone		
Siltstone, red	1	50

29-9-30aab.—*Drillers log of test hole in NW¼ NE¼ NE¼ sec. 30, T. 29 S., R. 9 W., on south side of road, 0.2 mile west of north-south road. Augered by Federal and State Geological Surveys August 2, 1956. Surface altitude, 1,654.7 feet; depth to water, 5.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium—Recent		
Sand, fine to coarse	5	5
Sand, fine to coarse, and fine gravel, silty	5	10

29-10-2aad.—*Drillers log of test hole in SE¼ NE¼ NE¼ sec. 2, T. 29 S., R. 10 W., on west side of road, 0.15 mile south of east-west road. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,760.8 feet; depth to water, 57.6 feet.*

	Thickness, feet	Depth, feet
Soil	4	4
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Clay, silty, tan	5	9
Sand, fine to coarse, and fine gravel	6	15
Sand, fine to coarse, and fine to medium gravel	5	20
Sand, fine to coarse, and fine gravel	10	30
Sand, fine to coarse, and fine to coarse gravel	5	35
Sand, fine to coarse, and fine gravel	5	40
Sand, fine to coarse; some thin streaks of pink silt	5	45
Sand, fine to coarse, and fine gravel; some thin silt streaks	25	70

29-10-6bcb.—*Drillers log of test hole in NW¼ SW¼ NW¼ sec. 6, T. 29 S., R. 10 W., on east side of road, 40 feet south of ¼-section fence. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,782.6 feet; depth to water, 37.0 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, tan	5	7
Silt, gray	3	10
Silt, gray tan	5	15
Silt, sandy, gray tan	7	22
Sand, fine to coarse, and fine to coarse gravel; a few thin silt streaks	3	25
Sand, fine to coarse, and fine gravel	10	35
Sand, fine to coarse, and fine gravel; contains a few streaks of calcareous gray silt	15	50

29-10-9bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 9, T. 29 S., R. 10 W., in east road ditch, 150 feet south of east-west road. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,749.1 feet; depth to water, 17.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Silt, very sandy, gray to black	10	10
Sand, fine to coarse, and fine to coarse gravel	5	15
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, gray	5	20
Sand, fine to coarse	10	30

27-10-11bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 11, T. 29 S., R. 10 W., on east side of road, 40 feet south of center line of east-west road. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,721.7 feet; depth to water, 11.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse	10	10
Sand, fine to coarse, silty	10	20

29-10-13aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 13, T. 29 S., R. 10 W., in south road ditch, 75 feet west of center line of north-south road. Augered by Federal and State Geological Surveys August 2, 1956. Surface altitude, 1,733.4 feet; depth to water, 43.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, gray and tan; much caliche in upper part	10	10
Clay, silty, sandy, tan	4	14
Sand, fine to coarse, and fine gravel	9	23
Silt, very sandy, tan	2	25
Silt, sandy, gray and tan; some caliche throughout	15	40
Silt, sandy, gray tan; some silty sand and gravel near base	5	45
Sand, fine to coarse, and fine gravel, very silty	10	55
Sand, fine to coarse, very silty	14	69
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Shale, red		69

29-10-23add.—*Drillers log of test hole in SE¼ SE¼ NE¼ sec. 23, T. 29 S., R. 10 W., on west side of road, 0.4 mile south of east-west road. Augered by Federal and State Geological Surveys August 2, 1956. Surface altitude, 1,719.7 feet; depth to water, 60.0 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, silty	7	10
Sand, fine to coarse, and fine gravel	20	30
Sand, fine to coarse, and fine gravel; some silt	40	70

29-10-26ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 26, T. 29 S., R. 10 W., on west side of road, 150 feet north of east-west road. Drilled by Federal and State Geological Surveys October 1, 1955. Surface altitude, 1,690.5 feet; depth to water, 45.4 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, calcareous, gray tan; contains caliche nodules	3	5
Silt, sandy, calcareous, pink tan	15	20
Silt, sandy, calcareous, tan to gray tan; contains much clay	5	25
Clay, very silty, sandy, calcareous, light gray tan	4	29
Sand, fine to coarse, and fine gravel; contains a thin lime-cemented streak	6	35

	Thickness, feet	Depth, feet
Sand, fine to coarse, and fine gravel; a few thin streaks of tan silt	10	45
Sand, fine to coarse, and fine to medium gravel; a few thin gray silt streaks	5	50
Sand, fine to coarse, and fine gravel	16	66
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, calcareous, tan; contains caliche nodules	9	75
Sand, fine to very coarse	8	83
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	4	87

29-10-28aba.—*Drillers log of test hole in NE¼ NW¼ NE¼ sec. 28, T. 29 S., R. 10 W., on south side of road, 100 feet west of small bridge. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,718.1 feet; depth to water, 12.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island Formation—Kansan Stage		
Sand, silty	5	5
Sand, fine to coarse, and fine to coarse gravel	5	10
Sand, fine to coarse	10	20

29-10-31ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 31, T. 29 S., R. 10 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,767.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Sand, medium, silty	5	5
Sand, coarse; some tan silt	10	15
Sand, medium to coarse; contains some silt streaks	5	20
Sand, medium to coarse; clay streaks at 38 feet	20	40
Clay, silty, calcareous, buff	9	49
Sand, medium to coarse; contains streaks of calcareous buff clay	13.5	62.5
Sand, medium; some clay streaks	23.5	86
Sand, medium to coarse	23.5	109.5
Sand, medium to coarse; contains clay streaks at 109.5 and 115 feet	10.5	120
Sand, medium to coarse	7	127
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	5	132

29-11-12ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 12, T. 29 S., R. 11 W. Drilled by Federal and State Geological Surveys. Surface altitude, 1,789.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene undifferentiated		
Sand, medium, silty	6.5	6.5
Sand, silty; some caliche	1	7.5

	Thickness, feet	Depth, feet
Silt, clayey to sandy, calcareous	6	13.5
Sand, coarse, and fine gravel; contains clay streaks at 30 to 36 feet	22.5	36
Sand, medium, silty	12	48
Silt, sandy, calcareous, buff	4	52
Sand, medium; some calcareous buff silt	3	55
Sand, coarse	10	65
Sand, coarse, and fine gravel; contains some clay streaks	10	75
Sand, coarse	6	81
Sand, coarse, and fine gravel; contains clay streaks at 81 to 88 feet	9.5	90.5
Sand, coarse, silty	12.5	103
Sand, coarse; contains some red silt	14.5	117.5
Silt, sandy, red	3.5	121
Silt, sandy; contains caliche	7.5	128.5
Sand, coarse; contains streaks of brown silt	11.5	140
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	6.5	146.5

29-11-24ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 24, T. 29 S., R. 11 W., in north road ditch, 50 feet west of center line of north-south road. Augered by Federal and State Geological Surveys August 1, 1956. Surface altitude, 1,767.2 feet; depth to water, 22.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Sand, fine to coarse, and fine gravel	9	9
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, tan	6	15
Silt, sandy, gray tan	5	20
Sand, fine to coarse, silty	5	25

30-4-18bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 18, T. 30 S., R. 4 W., in triangle north of highway, west of county-line road. Augered by Federal and State Geological Surveys August 16, 1955. Surface altitude, 1,468.6 feet; depth to water, 9.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, dark brown	3	3
Sand, fine, tan	2	5
Sand, fine to medium	61	66
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	67

30-4-19bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 19, T. 30 S., R. 4 W., on east side of road, 30 feet south of east-west road. Augered by Federal and State Geological Surveys August 16, 1955. Surface altitude, 1,487.4 feet; depth to water, 20.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan	2	2
Clay, tan, some gravel	2	4
Clay and sand, tan	3	7
Sand, fine to medium	3	10
Sand, fine to medium, and gravel	13	23
Sand, fine, light tan	7	30
Sand, fine to coarse	17	47
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	48

30-4-19ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 19, T. 30 S., R. 4 W., on east side of road, 50 feet north of east-west road. Augered by Federal and State Geological Surveys August 16, 1955. Surface altitude, 1,475.3 feet; depth to water, 14.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, brown	5	5
Silt, black	2	7
Sand, fine to medium	3	10
Sand, fine to medium, and clay, red	8	18
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, green	1	19

30-5-3cdd1.—*Drillers log of well in SE¼ SE¼ SW¼ sec. 3, T. 30 S., R. 5 W. Drilled by Layne-Western Co. for town of Norwich in 1936. Surface altitude, 1,490.8 feet; depth to water, 24.0 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Clay, sandy	4	5
Sand, fine	19	24
Sand, medium, and clay	4	28
Sand, medium	14	42
Clay, yellow	1	43
Clay, very sandy	3	46
Sand, fine	5	51
Clay, yellow	5	56

	Thickness, feet	Depth, feet
Clay, sandy	2	58
Sand, fine	15	73
Sand, medium; contains shale fragments	19	92
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		92

30-5-5ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 5, T. 30 S., R. 5 W., on east side of road, 50 feet north of center line of Kansas Highway 42. Augered by Federal and State Geological Surveys June 14, 1955. Surface altitude, 1,473.5 feet; depth to water, 8.1 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel; contains much tan to gray silt	7.5	9.5
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	0.5	10

30-5-14aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 14, T. 30 S., R. 5 W., on west side of road, 75 feet south of east-west road. Drilled by Federal and State Geological Surveys August 4, 1955. Surface altitude, 1,490.2 feet; depth to water, 26.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, contains much tan silt	4	4
Sand, fine to coarse, and fine gravel, silty	6	10
Sand, fine to coarse, and fine gravel; contains thin streaks of tan silt	5	15
Sand, fine to coarse, and fine gravel	30	45
Sand, fine to coarse, and fine to medium gravel; contains a few thin silt streaks	15	60
Sand, fine to coarse, and fine gravel	13	73
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	75

30-5-14ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 14, T. 30 S., R. 5 W., on west side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 3, 1955. Surface altitude, 1,483.1 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, brown	3	5

	Thickness, feet	Depth, feet
Silt, tan	3	8
Silt, gray	4	12
Sand, fine to coarse	3	15
Sand, fine to coarse, and fine gravel	10	25
Sand, fine to coarse, and fine gravel; contains thin silt streaks	5	30
Sand, fine to coarse, and fine gravel	20	50

30-5-17bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 17, T. 30 S., R. 5 W., on east side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 7, 1955. Surface altitude, 1,421.2 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red brown; contains sand and gravel	3	7
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		7

30-5-19aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 19, T. 30 S., R. 5 W., on west side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 7, 1955. Surface altitude, 1,394.1 feet; depth to water, 9.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Sand, fine to coarse, very silty	5	5
Silt, very sandy, red brown	3	8
Sand, fine to coarse; contains much red silt	5	13
Sand, fine to coarse, and fine to medium gravel; contains much red silt	4	17
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		17

30-5-26aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 26, T. 30 S., R. 5 W., on west side of road, 30 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 8, 1955. Surface altitude, 1,425.4 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red	2	4
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	5

30-5-29cdc.—*Sample log of test hole in SW¼ SE¼ SW¼ sec. 29, T. 30 S., R. 5 W., on north side of road, 0.35 mile east of north-south road. Augered by Federal and State Geological Surveys June 8, 1955. Surface altitude, 1,355.9 feet; depth to water, 6.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil, very sandy	2	2
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse; contains some gray and tan silt	18	20
Sand, fine to coarse, and fine gravel	11	31
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, gray green		31

30-5-29ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 29, T. 30 S., R. 5 W., on north side of road, 75 feet west of center line of north-south road. Augered by Federal and State Geological Surveys June 8, 1955. Surface altitude, 1,366.9 feet; depth to water, 18.8 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, red; contains sand and gravel	7	10
Sand, fine to coarse, and fine gravel; contains much red-brown silt	8	18
Sand, fine to coarse, and fine to medium gravel, silty	8	26
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		26

30-5-30aaa1.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 30, T. 30 S., R. 5 W., on west side of road, 20 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 8, 1955. Surface altitude, 1,368.3 feet; depth to water, 4.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, some silt	10	10
Sand, fine to coarse, and fine gravel, silty	19	29
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	30

30-5-31aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 31, T. 30 S., R. 5 W., on west side of road, 20 feet south of center line of east-west road. Augered by Federal and State Geological Surveys June 8, 1955. Surface altitude, 1,365.8 feet; depth to water, 17.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, very sandy, red brown	8	8
Sand, fine to coarse; much red-brown silt	2	10
Sand, fine to coarse, and fine to medium gravel, silty,	5	15

	Thickness, feet	Depth, feet
Clay, silty, red brown; contains sand and gravel	2	17
Sand, fine to coarse, and fine to medium gravel, silty; contains fragments of Permian rocks	32	49
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	50

30-5-32bcc.—*Sample log of test hole in SW¼ SW¼ NW¼ sec. 32, T. 30 S., R. 5 W., on east side of road, 100 feet north of end of road. Augered by Federal and State Geological Surveys June 8, 1955. Surface altitude, 1,345.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, brown	5	5
Silt, very sandy, tan	2	7
PERMIAN—Leonardian		
Ninnescah Shale		
Siltstone, red		7

30-5-32cdd.—*Sample log of test hole in SE¼ SE¼ SW¼ sec. 32, T. 30 S., R. 5 W., in center of abandoned road, 10 feet west of half-section fence. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,342.7 feet; depth to water, 10.6 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, pink tan	3	5
Sand, fine to coarse, and fine gravel, very silty	8	13
Sand, fine to coarse, and fine to medium gravel	32	45
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, green	1	46

30-5-33cdd.—*Sample log of test hole in SE¼ SE¼ SW¼ sec. 33, T. 30 S., R. 5 W., on north side of road, even with east side of abandoned road to south. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,352.0 feet; depth to water, 10.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	2	2
Colluvium		
Sand, fine to coarse, and fine gravel, some silt	3	5
Sand, fine to coarse, and fine gravel, silty; contains fragments of Permian rock	5	10
Silt, very sandy, red brown	2	12
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	3	15

30-5-34ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 34, T. 30 S., R. 5 W., on north side of road, opposite corner fence post across road. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,365.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	2	2
Colluvium		
Sand, fine to coarse, and fine gravel, very silty	3	5
Sand, fine to coarse, and fine to medium gravel, very silty	4	9
Silt, sandy, tan	8	17
Sand, fine to coarse, very silty	3	20
Sand, fine to coarse, and fine to medium gravel, very silty	3	23
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	25

30-5-36ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 36, T. 30 S., R. 5 W., on east side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,398.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	2	2
Colluvium		
Silt, clayey, red	3	5
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		5

30-5-36ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 36, T. 30 S., R. 5 W., on north side of road, 20 feet west of center line of north-south road. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,419.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	3	3
Colluvium		
Sand, fine to coarse, very silty	6	9
Silt, very sandy, red brown	6	15
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	5	20

30-6-5bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 5, T. 30 S., R. 6 W., on east side of road, 20 feet south of east-west road. Augered by Federal and State Geological Surveys June 20, 1955. Surface altitude, 1,444.6 feet; depth to water, 7.9 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Colluvium		
Silt, sandy, brown	3	5

	Thickness, feet	Depth, feet
Sand, fine to coarse, very silty	5	10
Silt, very sandy, pink tan	3	13
Sand, fine to coarse, and fine gravel, very silty	3	16
PERMIAN—Leonardian		
Ninnescah Shale		
Siltstone, red	1	17

30-6-8ada.—*Sample log of test hole in NE¼ SE¼ NE¼ sec. 8, T. 30 S., R. 6 W., on west side of road, 0.25 mile south of Kansas Highway 42. Augered by Federal and State Geological Surveys June 7, 1955. Surface altitude, 1,409.2 feet; depth to water, 18.5 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, very sandy, tan	2	5
Silt, red tan; contains sand and gravel	5	10
Silt, sandy, tan	5	15
Silt, sandy, gray tan	10	25
Sand, fine to coarse, very silty	10	35
Sand, fine to coarse, and fine gravel, silty	11	46
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		46

30-6-9ccb.—*Sample log of test hole in NW¼ SW¼ SW¼ sec. 9, T. 30 S., R. 6 W., on east side of road, 10 feet south of half-section fence. Augered by Federal and State Geological Surveys June 7, 1955. Surface altitude, 1,391.3 feet; depth to water, 8.7 feet.*

	Thickness, feet	Depth, feet
Road fill	8	8
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse	2	10
Sand, fine to coarse, and fine gravel	3	13
Sand, fine to coarse, silty	5	18
Sand, fine to coarse, and fine gravel, silty	2	20
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		20

30-6-17aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 17, T. 30 S., R. 6 W., on west side of road, 100 feet north of center bridge of three bridges. Augered by Federal and State Geological Surveys June 7, 1955. Surface altitude, 1,391.3 feet; depth to water, 10.1 feet.*

	Thickness, feet	Depth, feet
Road fill	10	10
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Silt, very sandy, gray brown	5	15
Sand, fine to coarse, and fine gravel, silty	14	29
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	30

30-6-33ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 33, T. 30 S., R. 6 W., on north side of road, opposite center of road to south. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,552.1 feet; depth to water, 38.0 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, silty	8	10
Sand, fine to coarse, very silty	10	20
Sand, fine to coarse, and fine gravel, silty; contains thin streaks of tan silt	5	25
Silt, sandy, calcareous, light tan; contains many thin sand streaks	10	35
Silt, very sandy, calcareous, light tan	10	45
Sand, fine to medium, very silty	5	50

30-6-34ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 34, T. 30 S., R. 6 W., on north side of road, 500 feet east of road to north. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,521.1 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan	2	4
Silt, clayey, sandy, gray tan	1	5
Sand, fine to coarse, and fine gravel	19	24
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red brown	1	25

30-7-1ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 1, T. 30 S., R. 7 W., on east side of road, 75 feet north of Kansas Highway 42. Augered by Federal and State Geological Surveys August 9, 1956. Surface altitude, 1,444.8 feet; depth to water, 20.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, silty	5	5
Sand, fine to coarse	10	15
Silt, sandy, dark brown	5	20
Sand, fine to coarse; contains much dark-brown to gray silt	24	44
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	1	45

30-7-9aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 9, T. 30 S., R. 7 W., near center of triangular road junction, 50 feet south of center line of Kansas Highway 42. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,455.2 feet; depth to water, 10.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse; contains much red-brown silt	10	10
Sand, fine to coarse, and fine to medium gravel; contains a few silt streaks	25	35
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red brown	1	36

30-7-10cbc.—*Sample log of test hole in SW¼ NW¼ SW¼ sec. 10, T. 30 S., R. 7 W., halfway between two highway bridges, 80 feet east of Kansas Highway 14. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,438.9 feet; depth to water, 3.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Alluvium—Recent		
Sand, fine to medium, silty	5	5
Sand, fine to very coarse	5	10
Sand, fine to coarse, and fine to medium gravel	14	24
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red brown	1	25

30-7-16daa.—*Sample log of test hole in NE¼ NE¼ SE¼ sec. 16, T. 30 S., R. 7 W., in borrow pit between Kansas Highway 14 and railroad track, 15 feet south of farm drive. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,451.0 feet; depth to water, 11.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, brown	2	2
Sand, fine to coarse, and fine to medium gravel	3	5
Silt, sandy, light brown to red	5	10
Sand, fine to very coarse; contains much pink-tan silt	29	39
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	1	40

30-7-25dcc.—*Drillers log of test hole in SW¼ SW¼ SE¼ sec. 25, T. 30 S., R. 7 W., on east side of road, 75 feet north of east-west road. Augered by Federal and State Geological Surveys August 8, 1956. Surface altitude, 1,559.8 feet; depth to water, 32.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, silty	5	5
Sand, fine to coarse, and fine gravel	20	25
Sand, fine to coarse, and fine gravel; contains a few silt streaks	15	40

30-7-28ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 28, T. 30 S., R. 7 W., on west side of road, 60 feet north of east-west road. Augered by Federal and State Geological Surveys June 21, 1955. Surface altitude, 1,592.6 feet; depth to water, 33.3 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine gravel, very silty	8	10
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	5	15
Sand, fine to coarse	5	20
Sand, fine to coarse, and fine to medium gravel, thin silt streaks at 23 feet	5	25
Sand, fine to coarse, and fine gravel	8	33
Silt, tan; some sand and gravel	2	35
Sand, fine to coarse, and fine gravel; contains thin streaks of clayey tan silt	15	50

30-7-30aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 30, T. 30 S., R. 7 W., on west side of road, 150 feet south of section-line fence. Augered by Federal and State Geological Surveys August 7, 1956. Surface altitude, 1,550.0 feet; depth to water, 8.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse	20	20

30-7-34ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 34, T. 30 S., R. 7 W., in triangle at road junction, 35 feet north of center line of east-west road and 60 feet east of center line of north-south road. Drilled by Federal and State Geological Surveys July 26, 1955. Surface altitude, 1,604.1 feet; depth to water, 49.1 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, tan	2	4
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	6	10
Sand, fine to coarse; contains a few thin silt streaks	5	15
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, clayey, tan	5	20
Silt, clayey, gray to pink gray	9	29
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	21	50
Sand, fine to coarse	5	55
Sand, fine to coarse, and fine gravel; contains thin silt streaks	9	64

	Thickness, feet	Depth, feet
Silt, sandy, tan	2	66
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	10	76
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	4	80

30-7-35ccd.—*Sample log of test hole in SE¼ SW¼ SW¼ sec. 35, T. 30 S., R. 7 W., on north side of road, near center line of road to south. Augered by Federal and State Geological Surveys June 3, 1955. Surface altitude, 1,569.7 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, red to brown; contains some sand and fine gravel,	2	5
Sand, fine to coarse, and fine to coarse gravel, very silty	4	9
Silt, very sandy, tan	1	10
Sand, fine to coarse, and fine to medium gravel, silty,	3	13
Sand, fine to coarse, and fine gravel; contains much gray-tan silt	4	17
Sand, fine to coarse, and fine to medium gravel; contains a few thin streaks of tan silt	20	37
Silt, sandy, calcareous, tan to gray tan	8	45
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red	5	50

30-8-6bcb.—*Sample log of test hole in NW¼ SW¼ NW¼ sec. 6, T. 30 S., R. 8 W., on edge of field on east side of road, 150 feet north of bridge. Drilled by Federal and State Geological Surveys July 26, 1955. Surface altitude, 1,536.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, brown	2	2
Sand, fine to coarse, and fine gravel	16	18
Silt, sandy, gray; contains thin sand streaks	7	25
Silt, very sandy, gray	5	30
Sand, fine to coarse, and fine gravel; contains a few streaks of sandy gray silt	5	35
Silt, sandy, gray; contains thin streaks of sand and gravel	5	40
Sand, fine to coarse, and fine gravel; contains thin streaks of tan silt	9	49
PERMIAN—Leonardian		
Harper(?) Siltstone		
Siltstone, red	1	50

30-8-23dcc.—*Drillers log of test hole in SW¼ SW¼ SE¼ sec. 23, T. 30 S., R 8 W., on east side of road, 150 feet north of transmission line at section corner. Augered by Federal and State Geological Surveys August 7, 1956. Surface altitude, 1,583.5 feet; depth to water, 18.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, silty	10	10
Sand, fine to coarse, and fine gravel	15	25

30-8-28ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 28, T. 30 S., R. 8 W., in east road ditch, 40 feet north of center line of east-west road. Augered by Federal and State Geological Surveys August 7, 1956. Surface altitude, 1,618.3 feet; depth to water, 29.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan; contains caliche nodules	5	5
Silt, sandy, tan	7	12
Sand, fine to coarse, and fine gravel	13	25
Silt, tan	5	30
Sand, fine to coarse	15	45

30-9-1dda.—*Sample log of test hole in NE¼ SE¼ SE¼ sec. 1, T. 30 S., R. 9 W., on west side of road, 0.2 mile north of east-west road. Augered by Federal and State Geological Surveys July 21, 1955. Surface altitude, 1,546.3 feet; depth to water, 11.6 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	3	3
Terrace deposits—Wisconsinan Stage		
Silt, sandy, dark gray	2	5
Silt, sandy, tan	10	15
Silt, sandy, calcareous, tan	5	20
Silt, sandy, calcareous, gray tan	5	25
Silt, sandy, gray tan	5	30
Silt, sandy, tan	5	35
Silt, sandy, gray	15	50

30-9-1ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 1, T. 30 S., R. 9 W., on west side of road, 60 feet north of center line of east-west road. Augered by Federal and State Geological Surveys July 21, 1955. Surface altitude, 1,578.4 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, calcareous, tan	4	7
Silt, very sandy, calcareous, gray tan	3	10
Silt, sandy, calcareous, pink tan	13	23
PERMIAN—Leonardian		
Harper(?) Siltstone		
Siltstone, red	2	25

30-9-2ccb.—*Drillers log of test hole in NW¼ SW¼ SW¼ sec. 2, T. 30 S., R. 9 W., in east road ditch, 50 feet north of surfaced road to east. Augered by Federal and State Geological Surveys August 8, 1956. Surface altitude, 1,617.7 feet; depth to water, 16.3 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse	10	10
Sand, fine to coarse, silty	5	15
Sand, fine to coarse	5	20

30-9-17aad.—*Drillers log of test hole in SE¼ NE¼ NE¼ sec. 17, T. 30 S., R. 9 W., on west side of road, 0.15 mile south of Kansas Highway 42. Augered by Federal and State Geological Surveys August 3, 1956. Surface altitude, 1,712.1 feet; depth to water, 67.5 feet.*

	Thickness, feet	Depth, feet
Road fill	5	5
QUATERNARY—Upper Pleistocene		
Crete(?) Formation—Illinoisan(?) Stage		
Sand, fine to coarse, and fine gravel	8	13
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, tan	2	15
Silt, sandy, gray to tan	5	20
Sand, fine to coarse	10	30
Sand, fine to coarse, and fine to coarse gravel	15	45
Sand, fine to coarse, and fine gravel	25	70

30-9-20ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 20, T. 30 S., R. 9 W., on west side of road, 300 feet north of east-west road. Augered by Federal and State Geological Surveys August 3, 1956. Surface altitude, 1,647.3 feet; depth to water, 7.1 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, tan	5	5
Silt, very sandy, red brown	10	15
Sand, fine to coarse, silty	5	20

30-9-23bbb.—*Drillers log of test hole in NW¼ NW¼ NW¼ sec. 23, T. 30 S., R. 9 W., in east road ditch, 50 feet south of center line of east-west road. Augered by Federal and State Geological Surveys August 6, 1956. Surface altitude, 1,619.7 feet; depth to water, 23.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, red brown	15	15
Sand, fine to coarse	10	25
Silt, sandy, tan	5	30
Sand, fine to coarse	10	40

30-9-24aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 24, T. 30 S., R. 9 W., on west side of road, 30 feet south of section-line fence. Augered by Federal and State Geological Surveys July 21, 1955. Surface altitude, 1,584.7 feet; depth to water, 30.5 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, very sandy, tan	11	13
Silt, sandy, gray tan; contains caliche nodules	2	15
Sand, fine to coarse, very silty	5	20
Sand, fine to coarse, and fine gravel	5	25
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	5	30
Sand, fine to coarse, very silty	5	35
Sand, fine to coarse, and much fine tc medium gravel, silty	13	48
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	2	50

30-9-24add.—*Sample log of test hole in SE¼ SE¼ NE¼ sec. 24, T. 30 S., R. 9 W., on west side of road, 75 feet south of bridge. Augered by Federal and State Geological Surveys July 21, 1955. Surface altitude, 1,537.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	2	2
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, and fine gravel	3	5
Sand, fine to coarse, and fine to medium gravel	10	15
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	25	40
Sand, fine to coarse, and fine gravel; contains much dark-gray silt	7.5	47.5
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	2.5	50

30-9-25ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 25, T. 30 S., R. 9 W., on west side of road, 25 feet north of section-line fence. Augered by Federal and State Geological Surveys August 7, 1956. Surface altitude, 1,652.9 feet; depth to water, 51.9 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse	17	20
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	32	52
Fullerton Formation—Nebraskan and Aftonian Stages		
Silt, sandy, gray tan; contains caliche nodules	13	65

30-9-26ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 26, T. 30 S., R. 9 W., in east road ditch, 40 feet north of section-line fence. Augered by Federal and State Geological Surveys August 6, 1956. Surface altitude, 1,656.3 feet; depth to water, 53.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, silty	5	5
Sand, fine to medium	15	20
Sand, fine to coarse, and fine to medium gravel	40	60

30-9-31cbb.—*Sample log of test hole in NW¼ NW¼ SW¼ sec. 31, T. 30 S., R. 9 W., on east side of road, 100 feet south of north bridge. Drilled by Federal and State Geological Surveys August 2, 1955. Surface altitude, 1,651.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Sand, fine to coarse, and fine gravel	10	10
Sand, fine to coarse, and fine to medium gravel; contains a few streaks of dark-gray silt	10	20
Sand, fine to coarse, and fine to medium gravel	5	25
Sand, fine to coarse, and fine gravel; contains streaks of dark-gray silt	15	40
Sand, fine to coarse, and fine gravel	7	47
PERMIAN—Leonardian		
Salt Plain Siltstone		
Sandstone, fine, red	3	50

30-9-36ddd.—*Sample log of test hole in SE¼ SE¼ SE¼ sec. 36, T. 30 S., R. 9 W., on west side of road, 100 feet north of center line of east-west road. Drilled by Federal and State Geological Surveys July 26, 1955. Surface altitude, 1,683.3 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Upper Pleistocene		
Crete(?) and Loveland(?) Formations—Illinoisan(?) and Sangamonian(?) Stages		
Silt, sandy, calcareous, tan	6	8
Sand, fine to coarse, and fine gravel, silty	9	17
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Clay, silty, calcareous, gray white; contains much caliche	3	20
Silt, sandy, calcareous, light gray; contains caliche nodules	5	25
Silt, sandy, calcareous, gray tan; contains caliche nodules	11	36
Sand, fine to coarse, and fine to medium gravel, very silty	4	40
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	45	85

	Thickness, feet	Depth, feet
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, calcareous, gray tan; contains caliche nodules	10	95
Silt, sandy, tan to pink tan; contains thin streaks of sand and fine gravel	5	100
Sand, fine to coarse, and fine gravel; contains streaks of pink-tan calcareous silt	6	106
PERMIAN—Leonardian		
Salt Plain(?) Siltstone		
Siltstone, red	3	109

30-10-1bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 1, T. 30 S., R. 10 W., on east side of road, 75 feet north of bridge. Drilled by Federal and State Geological Surveys August 2, 1955. Surface altitude, 1,638.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Terrace deposits—Wisconsinan Stage		
Silt, sandy, dark gray	5	5
Sand, fine to coarse, and fine gravel	13	18
Silt, very sandy, light gray	2	20
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	10	30
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	5	35

30-10-1ddd.—*Drillers log of test hole in SE¼ SE¼ SE¼ sec. 1, T. 30 S., R. 10 W., on north side of road, 50 feet west of road to south. Augered by Federal and State Geological Surveys August 13, 1956. Surface altitude, 1,717.7 feet; depth to water, 52.7 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, silty	5	5
Sand, fine to medium	25	30
Sand, fine to coarse, and fine gravel, silty	25	55

30-10-7ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 7, T. 30 S., R. 10 W., on east side of abandoned road, 20 feet north of center line of east-west road. Augered by Federal and State Geological Surveys August 2, 1956. Surface altitude, 1,792.4 feet; depth to water, 47.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Dune sand—Recent		
Sand, fine to medium, silty	15	15
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, brown	10	25
Silt, sandy, gray	15	40
Silt, sandy, gray tan	5	45
Sand, fine to coarse, very silty	10	55
Silt, sandy, gray	5	60
Sand, fine to coarse	10	70

30-10-15aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 15, T. 30 S., R. 10 W., on west side of road, 50 feet north of railroad track. Augered by Federal and State Geological Surveys August 3, 1956. Surface altitude, 1,745.8 feet; depth to water, 54.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, gray; contains much caliche	10	10
Sand, fine to coarse	15	25
Silt, gray tan	5	30
Sand, fine to coarse, and fine gravel	35	65

30-10-24aaa.—*Sample log of test hole in NE¼ NE¼ NE¼ sec. 24, T. 30 S., R. 10 W., on west side of road, 100 feet south of east-west road. Drilled by Federal and State Geological Surveys October 1, 1955. Surface altitude, 1,744.6 feet; depth to water, 65.1 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, very sandy, tan	3	5
Silt, very sandy, light gray tan; contains caliche	13	18
Sand, fine	2	20
Silt, very sandy, gray tan to light gray; contains caliche	17	37
Sand, fine to medium, silty	3	40
Sand, fine to coarse, and fine gravel; contains a few thin silt streaks	45	85
Sand, fine to coarse, and fine to medium gravel; lime-cemented streak at 87 feet	5	90
Sand, fine to coarse, and fine to medium gravel; contains thin streaks of tan silt	10	100
Sand, fine to coarse; contains some silt	14	114
Sand, fine to coarse, and fine gravel; contains thin streak of gray silt	6	120
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, clayey, sandy, tan; contains thin hard streaks of caliche	5	125
Sand, fine to coarse, and fine to coarse gravel; contains thin streaks of tan silt	5	130
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	5	135

30-10-26cbc.—*Drillers log of test hole in SW¼ NW¼ SW¼ sec. 26, T. 30 S., R. 10 W., on east side of road, 0.15 mile south of half-section road. Augered by Federal and State Geological Surveys August 3, 1956. Surface altitude, 1,691.5 feet; depth to water, 8.9 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse; brown silt at base	10	10

30-10-29aaa.—*Drillers log of test hole in NE¼ NE¼ NE¼ sec. 29, T. 30 S., R. 10 W., on south side of road, 300 feet west of north-south road. Augered by Federal and State Geological Surveys August 3, 1956. Surface altitude, 1,743.3 feet; depth to water, 19.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, sandy, gray	5	5
Sand, fine to coarse, and fine gravel, very silty	5	10
Sand, fine to coarse, and fine gravel	20	30

30-10-30ccc.—*Drillers log of test hole in SW¼ SW¼ SW¼ sec. 30, T. 30 S., R. 10 W., on east side of road, 50 feet north of center line of east-west road. Augered by Federal and State Geological Surveys August 3, 1956. Surface altitude, 1,746.9 feet; depth to water, 10.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Silt, gray tan	10	10
Sand, fine to coarse; contains much gray silt	5	15

30-10-31ccc.—*Sample log of test hole in SW¼ SW¼ SW¼ sec. 31, T. 30 S., R. 10 W., on east side of road, 100 feet north of turn in road. Drilled by Federal and State Geological Surveys August 23, 1955. Surface altitude, 1,779.4 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, and fine gravel, silty	5	5
Sand, fine to coarse, and fine to coarse gravel	13	18
Silt, clayey, sandy	2	20
Sand, fine to coarse, and fine gravel; contains thin silt streaks	10	30
Sand, fine to very coarse	10	40
Silt, very sandy, tan to gray tan	14	54
Sand, fine to coarse, and fine gravel	16	70
Sand, fine to coarse, and fine to coarse gravel; contains many thin silt streaks	39	109
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, calcareous, light tan	11	120
Sand, fine to coarse, mostly fine to medium, silty	5	125

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Salt Plain Siltstone		
Siltstone, red	4	129

31-5-5aab.—*Drillers log of test hole in NW¼ NE¼ NE¼ sec. 5, T. 31 S., R. 5 W., on south side of road 0.25 mile west of north-south road. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,343.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	2	2
Colluvium		
Silt, tan; contains some sand and gravel	5	7
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		7

31-5-5abb.—*Drillers log of test hole in NW¼ NW¼ NE¼ sec. 5, T. 31 S., R. 5 W., on south side of road, 5 feet east of half-section fence. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,340.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil	3	3
Colluvium		
Silt, sandy, tan	4	7
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		7

31-6-1baa.—*Drillers log of test hole in NE¼ NE¼ NW¼ sec. 1, T. 31 S., R. 6 W., on south side of road on center line of road to north. Augered by Federal and State Geological Surveys June 6, 1955. Surface altitude, 1,341.1 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	4

31-6-2aab.—*Drillers log of test hole in NW¼ NE¼ NE¼ sec. 2, T. 31 S., R. 6 W., on south side of road, 0.25 mile west of north-south road. Augered by Federal and State Geological Surveys June 6, 1955. Surface altitude, 1,373.5 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Upper Pleistocene		
Soil, black	3	3
Colluvium		
Clay, sandy, brown to red	5	8
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red		8

31-6-5bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 5, T. 31 S., R. 6 W., on south side of road, 150 feet east of small bridge. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,537.1 feet; depth to water, 14.4 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to medium gravel, silty; contains a few thin silt streaks	7	9
Clay, sandy, gray green to tan; contains thin sand streaks	6	15
Sand, fine to coarse, silty	17	32
PERMIAN—Leonardian		
Harper Siltstone		
Siltstone, red		32

31-6-6bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 6, T. 31 S., R. 6 W., on south side of road, 280 feet east of section-line fence. Augered by Federal and State Geological Surveys June 4, 1955. Surface altitude, 1,575.2 feet; depth to water, 42.0 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Sand, fine to coarse, and fine to medium gravel, very silty	3	5
Sand, fine to coarse, and fine to coarse gravel; contains much tan silt	4	9
Sand, fine to coarse, and fine gravel, silty	15	24
Silt, sandy, tan	1	25
Sand, fine to coarse, and fine gravel, silty	10	35
Sand, fine to coarse, and fine to coarse gravel, silty	5	40
Sand, fine to coarse, and fine gravel, silty	10	50

31-7-1bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 1, T. 31 S., R. 7 W., in south road ditch, 0.5 mile west of road to south. Augered by Federal and State Geological Surveys June 3, 1955. Surface altitude, 1,587.4 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Lower Pleistocene		
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, red brown; some sand and gravel	3	5
Sand, fine to coarse, and fine to coarse gravel; contains a few thin silt streaks	45	50

31-7-3bbb.—*Sample log of test hole in NW¼ NW¼ NW¼ sec. 3, T. 31 S., R. 7 W., in small triangle at road intersection, 30 feet south of east-west road. Augered by Federal and State Geological Surveys June 3, 1955. Surface altitude, 1,594.1 feet; depth to water, 40.6 feet.*

	Thickness, feet	Depth, feet
Soil	3	3
QUATERNARY—Lower Pleistocene		
Grand Island and Sappa Formations—Kansan and Yarmouthian Stages		
Sand, fine to coarse, and fine to medium gravel, very silty	4	7
Holdrege and Fullerton Formations—Nebraskan and Aftonian Stages		
Silt, sandy, clayey, tan	3	10
Silt, clayey, gray tan	5	15
Silt, sandy, gray tan	3	18
Sand, fine to coarse, silty	2	20
Silt, sandy, gray tan	5	25
Sand, fine to coarse, and fine gravel	10	35
Sand, fine to coarse, and fine to medium gravel; contains a few thin tan silt streaks	15	50

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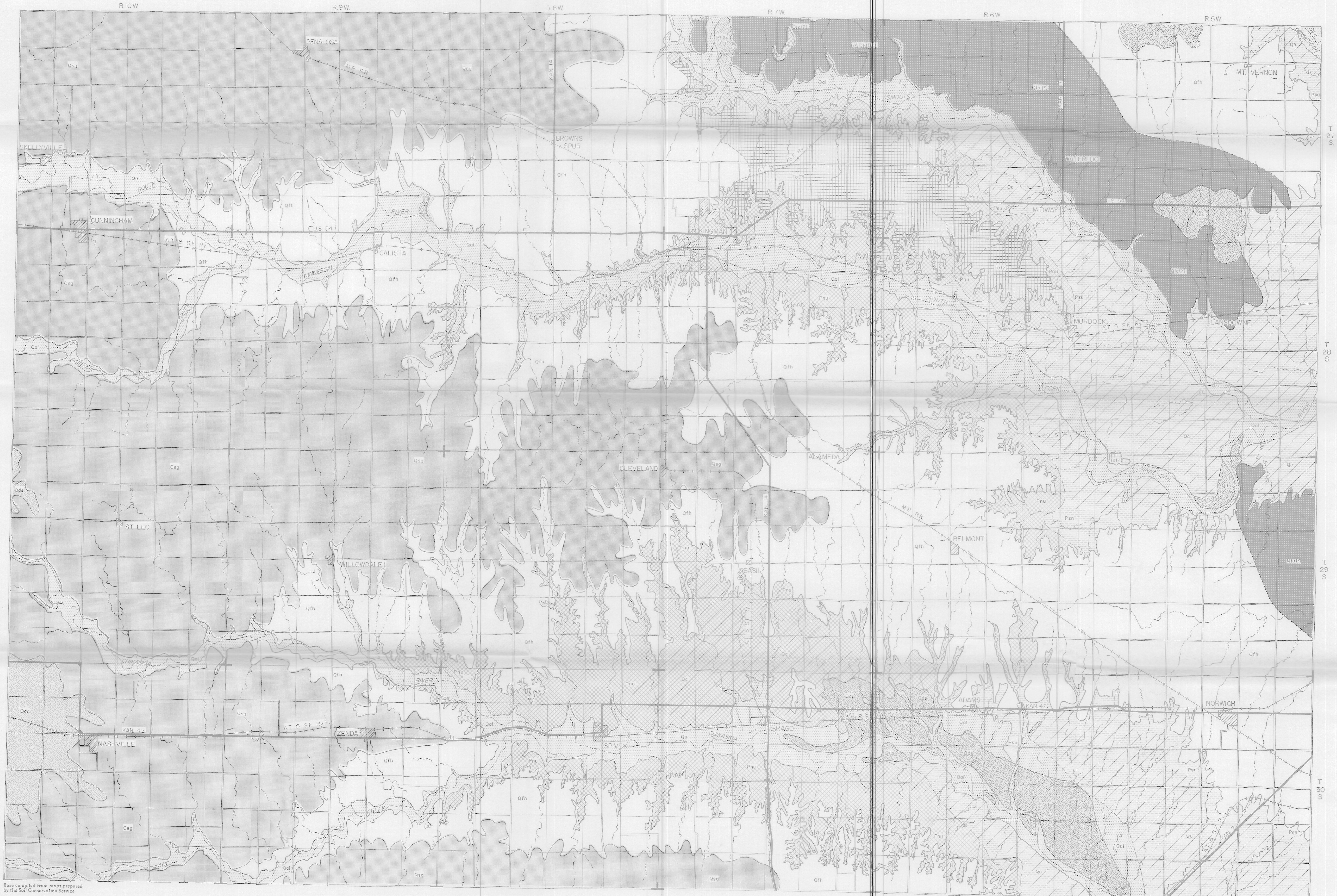
MAP OF KINGMAN COUNTY, KANSAS, SHOWING AREAL GEOLOGY

Bulletin 144
Plate 1

By Charles W. Lane
1956

State Geological Survey
of Kansas



Base compiled from maps prepared by the Soil Conservation Service

EXPLANATION

QUATERNARY — Pleistocene

Upper Pleistocene — Wisconsinan to Recent

Qds — Dune sand
Fine to medium sand and some silt. Lies above the water table and yields no water to wells.

Qal — Alluvium and terrace deposits
Silt, sand, and gravel in channels of major streams and beneath terraces adjacent to streams. Yield moderate to large water supplies to wells.

Upper Pleistocene — Illinoisan and Sangamonian

Qlc — Loveland (?) and Crete (?) Formations
Silt, sand, and gravel, containing some caliche. Form terrace in eastern part of the county. Small, isolated deposits of the Crete (?) Formation are on upland divides in extreme western part of the county and are not shown. Yield moderate water supplies for stock, domestic, and limited irrigation use in the eastern part of the county.

Illinoisan to Recent

Qc — Colluvium
Silt, sand, and some gravel deposited on Permian rocks by sheet wash and soil creep. Yields small water supplies for stock and domestic use in small areas in the eastern part of the county.

Lower Pleistocene — Kansan and Yarmouthian

Qsg — Sappa and Grand Island Formations
Silt, clay, sand, gravel, and some caliche; contains volcanic ash locally. The Sappa Formation is absent in a part of the mapped area. Yield moderate to large water supplies where saturated thickness is sufficient.

Lower Pleistocene — Nebraskan and Aftonian

Qfh — Fullerton and Holdrege Formations
Silt, clay, sand, gravel, and some caliche. The Fullerton Formation is absent in a part of the mapped area. Yield moderate to large water supplies where saturated thickness is sufficient.

TERTIARY — Pliocene

To — Ogallala (?) Formation
Silt, sand, and gravel, locally derived. Yields small water supplies for stock and domestic use in a small area of the county.

PERMIAN — Leonardian

Pnu / Psu — Nippewalla Group undifferentiated and Sumner Group undifferentiated
Reddish-brown to red shale, siltstone, sandstone, and thin limestone. Yield small water supplies for stock and domestic use in most of area of outcrop from deeply weathered zone.

Federal or State Highway
Gravel road
Railroad
County line (no road)
Township line (no road)
Section line (no road)
Intermittent stream

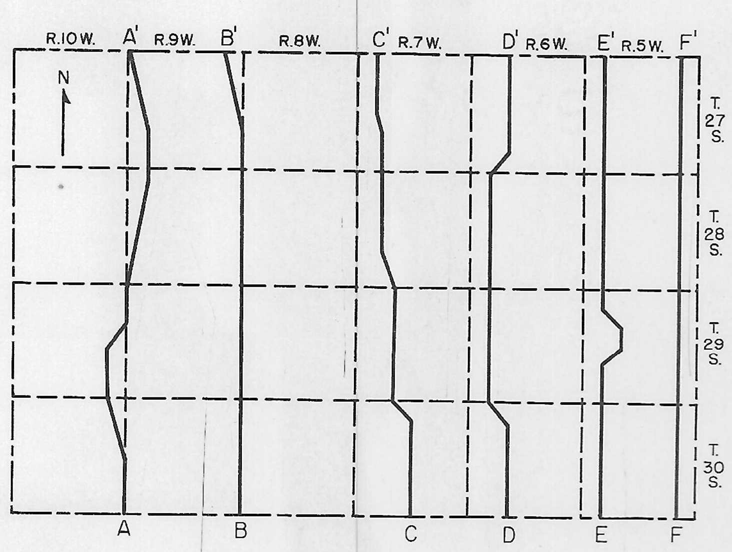
0 1 2 3
Scale, in miles

GEOLOGIC CROSS SECTIONS
OF KINGMAN COUNTY, KANSAS
By Charles W. Lane
1956

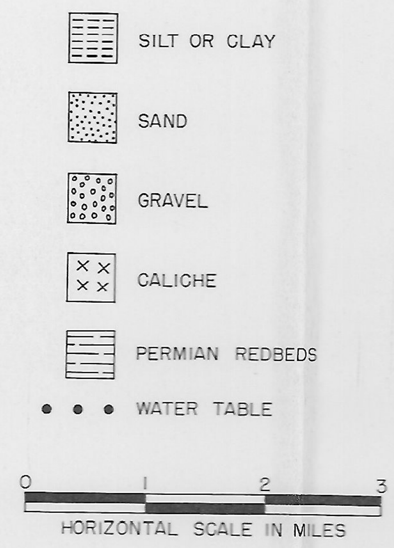
STATE GEOLOGICAL SURVEY OF KANSAS

BULLETIN 144

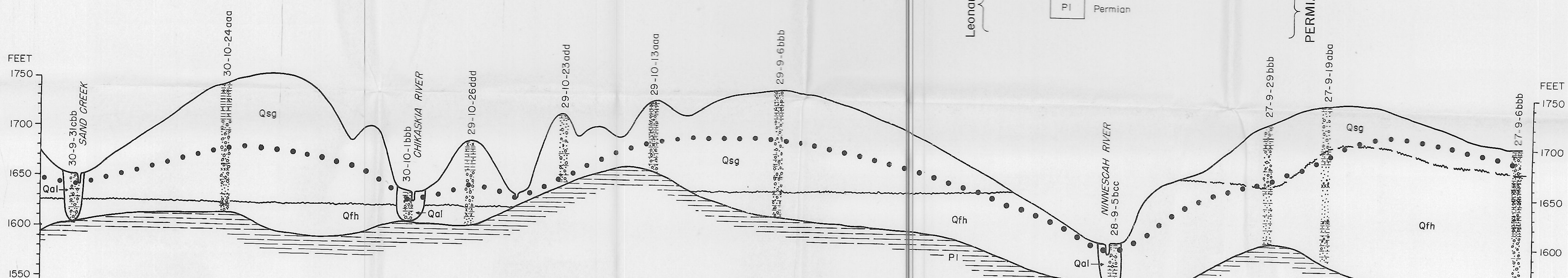
PLATE 2



Index map



Pleistocene	Upper Pleistocene	Qds	Dune sand		QUATERNARY
		Qal	Undifferentiated Recent alluvium and Wisconsinan terrace deposits		
		Qlc	Loveland (?) and Crete (?) Formations		
		Qc	Colluvium		
	Lower Pleistocene	Qsg	Sappa and Grand Island Formations		
		Qfh	Fullerton and Holdrege Formations		
Pliocene		To	Ogallala (?) Formation		TERTIARY
Leonardian		Pl	Permian		PERMIAN



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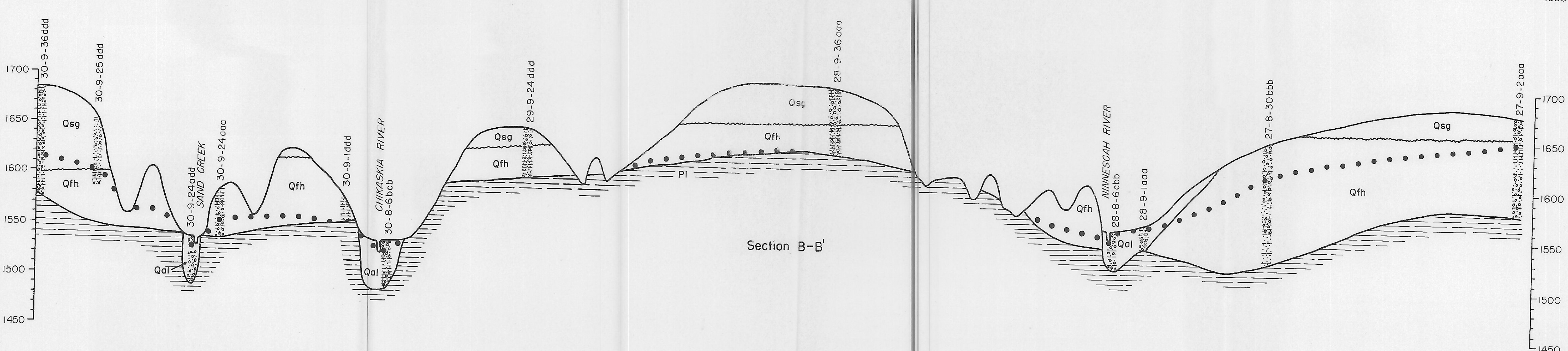

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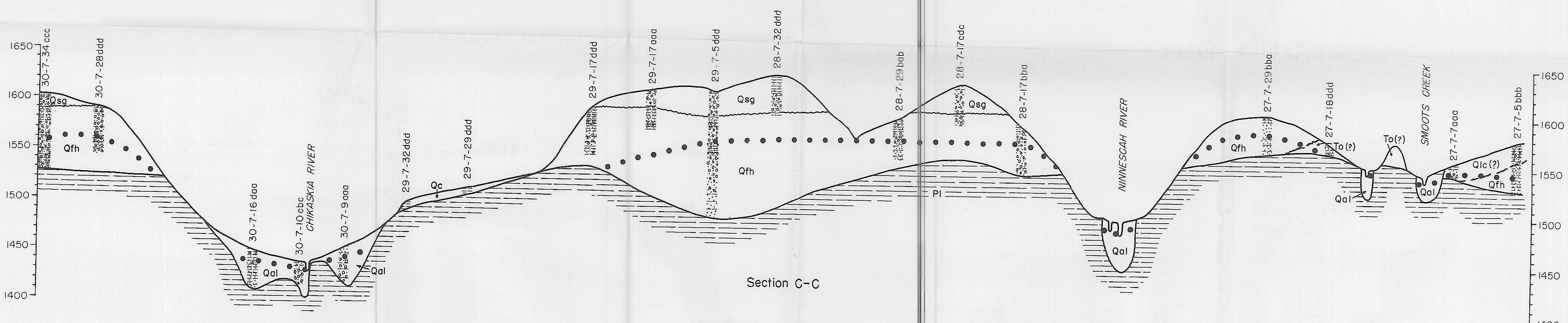

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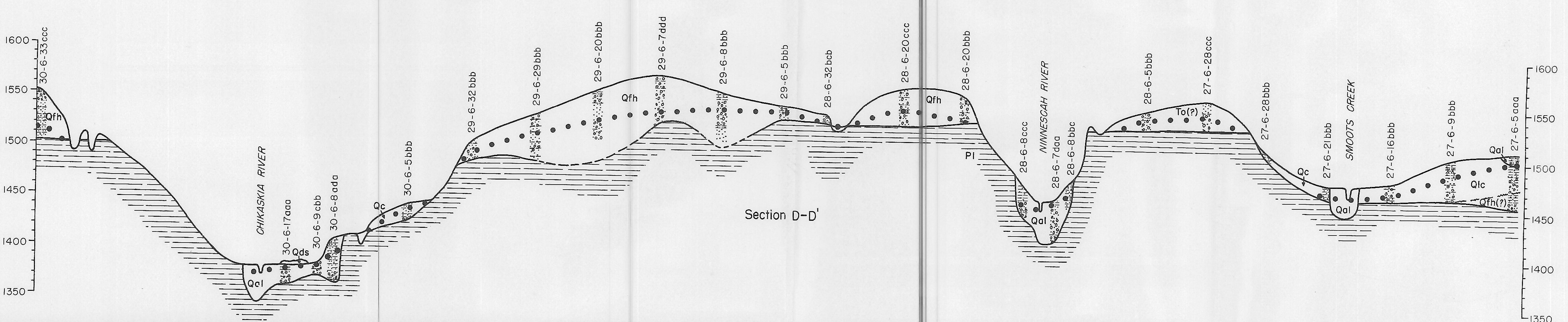

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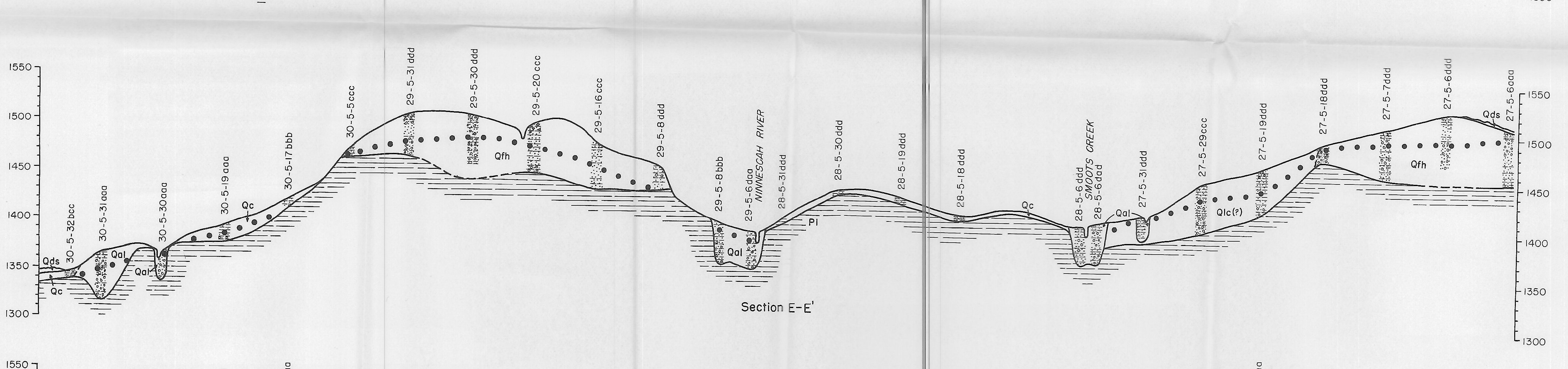

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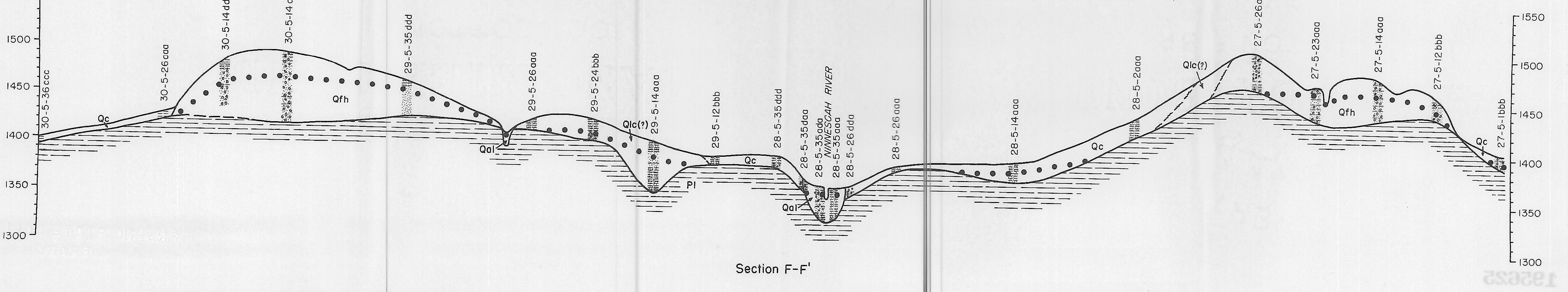


Section F-F'

Bulletin 144

Plate 3

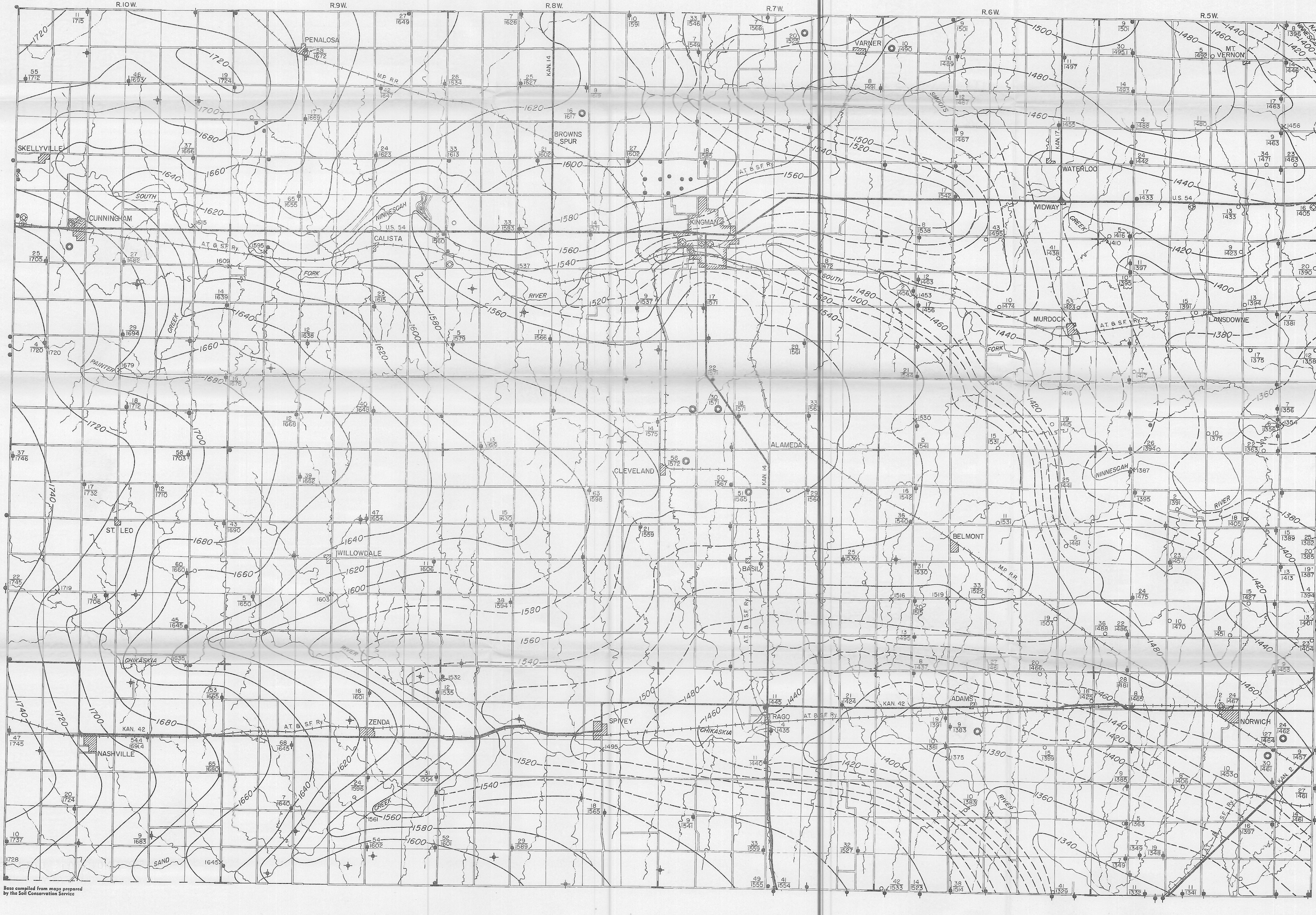
MAP OF KINGMAN COUNTY, KANSAS

showing water-table contours, depth to water, water-table altitude, and location of wells, test holes, and springs for which records are given

By Charles W. Lane

1956

State Geological Survey of Kansas



EXPLANATION

- Domestic or stock well
- Drilled test hole
- Augered test hole
- Irrigation well
- Public supply well
- Industrial well
- Observation well
- Oil-well test hole
- Spring
- Stream altitude

Contour interval 20 feet

10 / 1500 — Upper number is depth to water in feet below land surface; lower number is altitude of water table in feet above mean sea level

—1500— Contours on the water table

---1500--- Inferred altitude of the water table; water table discontinuous

0 1 2 3 SCALE IN MILES