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BULLETIN 116

GEOLOGY AND GROUND-WATER RESOURCES OF SHERIDAN COUNTY, KANSAS

By CHARLES K. BAYNE
State Geological Survey of Kansas
Lawrence, Kansas

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

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* Intermittent employment only.

CONTENTS

ILLUSTRATIONS

TABLES

GEOLOGY AND GROUND-WATER RESOURCES OF SHERIDAN COUNTY, KANSAS

By Charles K. Bayne
State Geological Survey
Lawrence, Kansas

ABSTRACT

This report describes the geography, geology, and ground-water resources of Sheridan County, Kansas. The county is in the High Plains section of the Great Plains physiographic province and has an area of about 893 square miles. The population of the county in 1950 was 4,607, about 66 percent of which is on farms. The climate of the county is dry, subhumid to semiarid, the normal annual rainfall being 19.35 inches and the mean annual temperature being 53.6° F. Farming and livestock raising are the principal occupations in the county.

The rocks that crop out in Sheridan County are sedimentary and range in age from late Cretaceous to Recent. A map showing the surficial geology and cross sections showing the subsurface relations of the geologic formations are included in the report. Much of the county is underlain by the Ogallala formation of Tertiary age, which in the upland areas is mantled by loess of Pleistocene age. The Smoky Hill chalk member of the Niobrara formation (late Cretaceous) is the oldest rock cropping out in the county and is exposed only in the valleys of the major streams in the eastern part of the county. The Ogallala formation is the most important aquifer in the county although the alluvium and materials beneath the Pleistocene terraces yield water to wells.

The report contains (1) a map that shows the location of wells and the depth to water in wells for which records are given and that indicates that the depth to water ranges from less than 10 to about 160 feet; (2) a map that shows the shape and slope of the water table and that indicates that the water table slopes generally eastward at an average rate of 15 feet to the mile; (3) a map that shows the thickness of Pliocene and Pleistocene water-bearing materials, which range from a featheredge to 140 feet; and (4) a map showing the configuration of the pre-Tertiary bedrock surface. The ground-water reservoir is recharged chiefly by precipitation that falls locally and in areas to the west. Ground water is discharged primarily by transpiration and evaporation in the valleys where the water table is relatively shallow and to a lesser extent by subsurface movement into adjacent areas, by pumping, and by stream runoff. All public and most domestic and stock-water supplies in the county are obtained from wells.

Some irrigation has been practiced for several years in the county, but only one irrigation well was in operation during the summer of 1952; it obtained water from the Ogallala formation and was used to irrigate about 140 acres. Water from the alluvium and terrace materials has been used for irrigation in previous years. Additional large-capacity wells can be developed in the upland areas of the county although the yields will be dependent on the local thickness and permeability of the water-bearing materials.

Analyses of samples of water from 18 wells indicate that the water is suitable for most uses and that water from the Ogallala formation is slightly better in quality than water from the terrace deposits and from alluvium. The field data upon which the report is based are given in tables and include records of 160 wells, chemical analyses of 18 water samples, and logs of 34 test holes and 1 well.

INTRODUCTION

Purpose and Scope of the Investigation

An investigation of the geology and ground-water resources of Sheridan County was begun in 1952 as a part of the program of ground-water studies in Kansas by the United States Geological Survey and the State Geological Survey of Kansas, with the cooperation of the Division of Sanitation of the State Board of Health and the Division of Water Resources of the State Board of Agriculture. Ground water is one of the principal natural resources of Sheridan County. Nearly all water supplies in the county are obtained from wells. Irrigation has not been practiced extensively in the county, but considerable recent interest has been expressed in irrigation and an adequate understanding of the quantity and quality of ground water available and the measures necessary to safeguard its development and use is needed.

Location and Extent of the Area

Sheridan County is in the second tier of counties south of the Nebraska border and the third tier of counties east of the Colorado border. Sheridan County is bounded on the east by Graham County,

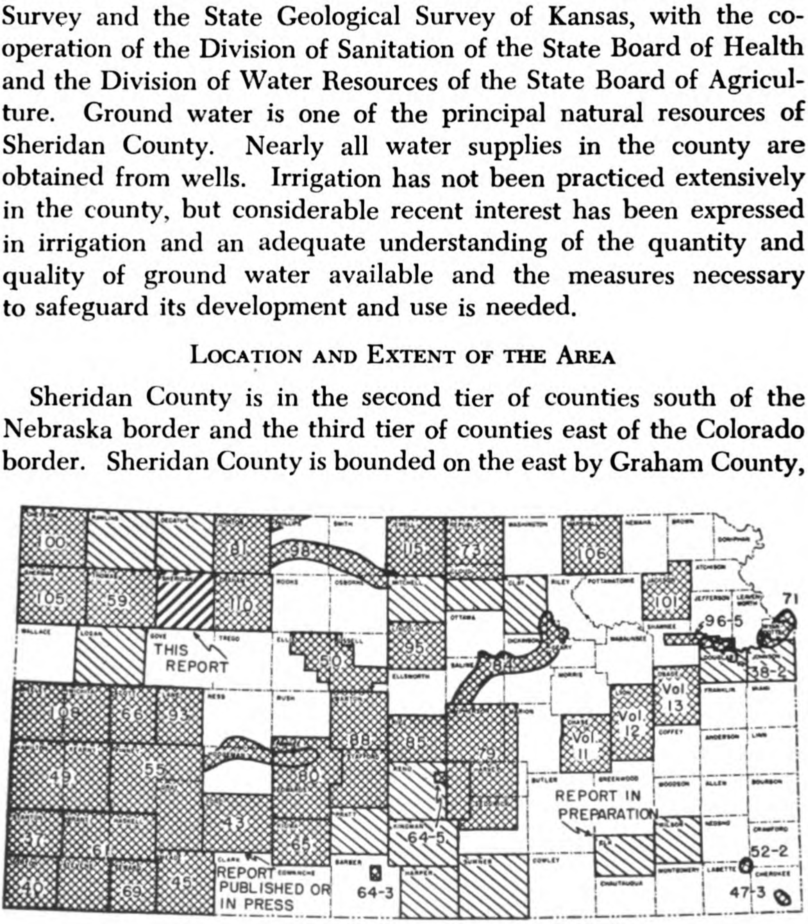

Fig. 1.—Index map of Kansas showing area covered by this report and areas for which cooperative ground-water reports have been published or are in preparation.

on the north by Decatur County, on the west by Thomas County, and on the south by Gove County. It contains 25 townships and has an area of approximately 893 square miles. Sheridan County and other areas in which cooperative ground-water investigations have been made are shown in Figure 1.

PREVIOUS INVESTIGATIONS

No detailed geologic reports on Sheridan County have been published, but several reports refer to the county either directly or in a general way. Haworth studied the regional geology and water resources of western Kansas in 1895 (Haworth, 1897); Johnson (1901, 1902), in his report on the utilization of the southern High Plains, made special reference to the source, availability, and use of ground water in western Kansas; and Darton (1905) made a study of the geology and ground-water resources of the central Great Plains. The work by Elias (1931) on the geology of Wallace County was an important contribution to the geology of western Kansas in that his studies of the Ogallala formation are probably the most comprehensive and his definition of the Sanborn formation was the foundation for later studies of the Pleistocene deposits in western Kansas. A study of the geology and ground-water resources of Thomas County was made by Frye (1945) and a similar study of Norton and northwestern Phillips Counties was made by Frye and Leonard (1949). A report was prepared by Beck and McCormack (1951) on the geologic construction materials in Sheridan County, and is one of a series of similar county reports. A comprehensive study of the Pleistocene geology of Kansas was made by Frye and Leonard (1952). Field studies of the geology and ground-water resources of Decatur, Gove, Graham, and Rawlins Counties in northwestern Kansas have been completed and reports are in preparation.

METHODS OF INVESTIGATION

The geology of the area was studied and was mapped on aerial photographs during the summer of 1952 and the data were then transferred to Plate 1 with a Focalmatic projector. The wells listed in Table 7 were visited during the investigation and the depths to water and the depths of the wells were measured with a steel tape from a fixed measuring point near the land surface, generally the top of the casing. The character of the material below the land surface was determined by the drilling of 34 test holes through the Pleistocene and Tertiary deposits to the Cretaceous bedrock. The test holes were drilled with the hydraulic-rotary drilling machine owned by the State Geological Survey of Kansas and operated by N. W. Biegler and W. T. Conner of the State Geological Survey. The altitudes of the wells and test holes were determined by field parties under the direction of W. W. Wilson and Edwin Rhine of the Federal Geological Survey using a plane table and alidade.

Wells shown on Plate 2 were located within the sections by use of an odometer. The figures adjacent to the well locations on Plate 2 refer to the depth of the water below the land surface and brackets around the figures indicate that a chemical analysis is given in Table 3. Samples of water were collected from 18 wells and were analyzed by Howard Stoltenberg, chemist, in the Water and Sewage Laboratory of the Kansas State Board of Health. Base maps of the county were prepared by Bernita Mansfield from maps from the Soil Conservation Service.

WELL-NUMBERING SYSTEM

The well and test-hole numbers in this report give the location of the wells and test holes in accordance with the Bureau of Land Management system of land subdivision. The first numeral of a well number indicates the township, the second the range, and the third the section. The quarter sections and quarter-quarter sections are designated a, b, c, or d in a counterclockwise direction beginning in the northeast quarter. For example, well 9-26-30da (Fig. 2) is in the NE¼ SE¼ sec. 30, T. 9 S., R. 26 W. If 2 or more wells are within a 40-acre tract, the wells are numbered serially according to the order in which they were inventoried.

GEOGRAPHY

TOPOGRAPHY AND DRAINAGE

Sheridan County is in the High Plains section of the Great Plains physiographic province. The county consists of nearly flat, gently rolling uplands dissected by valleys of the major streams. The upland surface declines eastward at an average rate of about 15 feet to the mile. The highest point in the county (2,900 feet) is in the westernmost part near Thomas County and the lowest point (about 2,250 feet) is in the valley of South Fork Solomon River near Studley.

The principal streams in Sheridan County are Saline, South Solomon, and North Solomon Rivers, and Sand and Prairie Dog Creeks. Saline, North Solomon, and South Solomon Rivers and Prairie Dog

Creek rise southwest of Colby, in Thomas County. The North and South Forks of Solomon River and Prairie Dog Creek flow eastward and northeastward and Saline River flows nearly due east. Sand Creek rises in eastern Thomas County and flows due east to its junction with South Fork Solomon River in eastern Sheridan County. The eastward-flowing rivers are perennial through the eastern two-thirds of the county and are intermittent in the western third of the county. Their valleys are broad and relatively flat in the west part of the county, deepening as they progress. Like most of the east-west stream valleys in the northwestern part of the state, the valleys of these major east-west streams are asymmetric, the northward-flowing tributaries are more numerous but are shorter and have steeper gradients than the southward-flowing tributaries. The eastern third of the county is moderately well dissected for a dis-

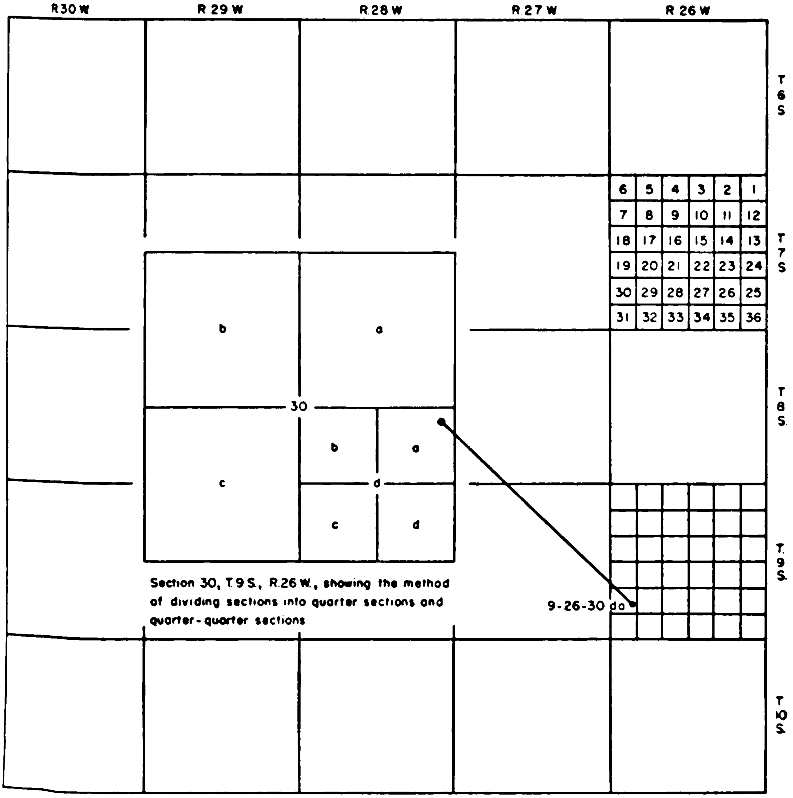

FIG. 2.—Map of Sheridan County illustrating the well-numbering system used in this report.

tance of several miles from the main streams. The slopes are generally steep and the land is used primarily for grazing.

CLIMATE

The climate of Sheridan County is dry subhumid to semiarid and is characterized by slight to moderate precipitation, moderately high wind velocity, and rapid evaporation. During the summer the days are hot, but the nights are generally cool. The hot weather in summer is moderated by good wind movement and relatively low humidity. The winters are generally characterized by moderate weather with severe cold periods of short duration and with relatively little snow.

The average mean temperature at Hoxie is 53.6° F. July generally is the hottest month with an average temperature of 78° F. and January generally is the coldest month with an average temperature of 29° F. The average length of the growing season is 161 days; the average date of the last killing frost is May 1 and of the first killing frost is October 11.

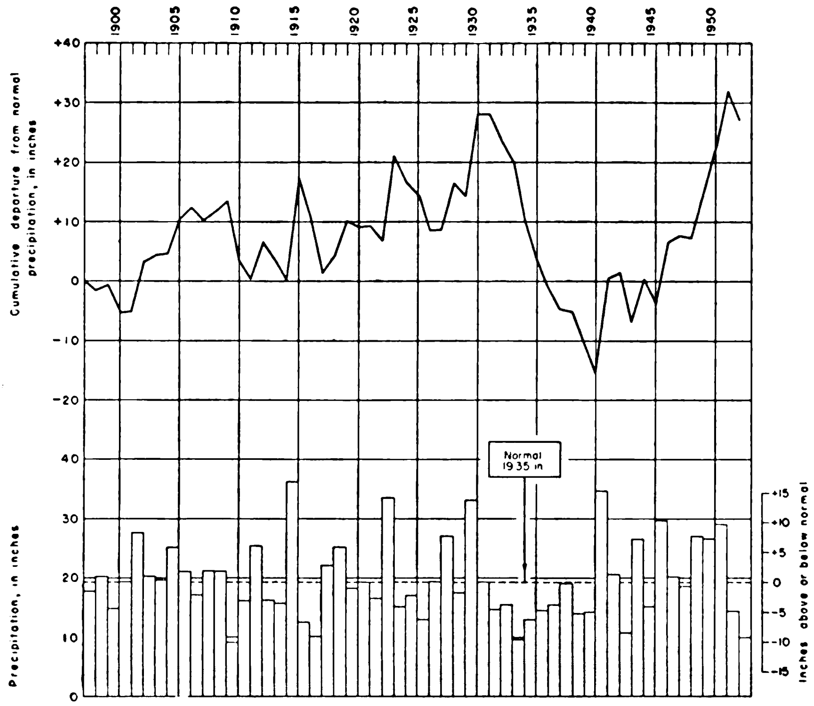

FIG. 3.—Graph showing the annual precipitation and the cumulative departure from normal precipitation at Hoxie.

The normal annual precipitation at Hoxie is 19.35 inches. The greatest annual precipitation was 36.43 inches in 1915 and the least was 9.27 inches in 1910. Most of the precipitation falls during the growing season from April through September. The annual precipitation for the period of record and the cumulative departure from normal precipitation are shown in Figure 3.

POPULATION

According to the 1950 census, the population of Sheridan County was 4,607, which is an average of 5.2 persons per square mile as compared to 23.2 persons per square mile for the State. The population of the county has declined steadily since the 1930 census when the population was 6,038. Hoxie and Selden, with populations of 1,157 and 438 respectively, are the only cities in the county for which population figures are available. Although the county has declined in population, the cities have increased in population. About 20 percent of the people lived in the cities in 1930 whereas 34 percent lived in the cities in 1950.

TRANSPORTATION

Sheridan County is served by the main line of the Chicago, Rock Island, and Pacific Railroad, which traverses the northwest corner of the county and passes through Selden, and by a branch line of the Union Pacific Railroad that crosses the county from east to west and passes through Hoxie. Several hard-surfaced Federal and State highways serve the county. U. S. Highway 24 crosses east-west through the middle of the county and Kansas Highway 23 crosses north-south through the middle of the county. U. S. Highways 83 and 383 parallel the railroad and extend through Selden. The rest of the county is served by county and township roads.

AGRICULTURE

Agriculture is the chief occupation in Sheridan County and, according to the 1945 census, the county contains 739 farms comprising about 540,000 acres, of which about 201,000 acres is pasture or range land and about 339,000 acres is crop land. Because of the practice of summer fallowing a part of the cultivated land each year, the acreage harvested differs from year to year. Crops were harvested from 242,000 acres in 1947, 168,000 acres in 1948, 206,000 acres in 1949, and 177,000 acres in 1950. Wheat is the principal crop in the county, sorgums, hay, barley, and corn following in order of acreage harvested. The acreages of the principal crops grown in 1950 are given in Table 1.

TABLE 1.—*Acreages of principal crops grown in Sheridan County in 1950.*

Crop	Acres
Wheat	145,000
Corn	2,600
Barley	3,560
Sorgums	19,790
Hay	4,920
Total	175,870

MINERAL RESOURCES

The principal mineral resources of Sheridan County are oil, gas, construction materials, and volcanic ash.

Oil and gas.—The first producing oil well in Sheridan County was drilled in 1943 although several dry holes were drilled prior to that time. The first production was in the Studley field from rocks of the Arbuckle group of Cambrian and Ordovician age. The Adell pool in northeastern Sheridan County was discovered in 1944, the Studley Southwest pool in 1945, and two other pools in 1952. Production of oil in Sheridan County in 1952 was 394,353 barrels from 47 wells. At the end of 1952 the cumulative production of oil in the county was 3,094,812 barrels. Wells formerly producing from the Arbuckle group in the county have been abandoned, and at the present time all production is obtained from the Kansas City and Lansing groups at a depth of about 3,800 feet.

Construction materials.—Large quantities of sand and gravel are available for construction materials in Sheridan County, principally from the Ogallala formation. Lesser amounts of sand and gravel are available from terrace deposits and from alluvium along the principal streams. The sand and gravel in all the pits observed by the writer was suitable for use as road material, and that in several pits was suitable for concrete aggregate. Mortar beds of the Ogallala formation have been used for building blocks, but because of the difference in the hardness of the mortar beds, the blocks show differential weathering and are not as desirable for use in building as are other materials available in the vicinity of Sheridan County.

Volcanic ash.—Volcanic ash consists of fine glass-like shards ejected during the explosive phase of a volcanic eruption. Four deposits of ash, two of which have been exploited, were observed in the county. The ash has been used as a mineral filler in road construction. For a more detailed discussion of volcanic ash and construction materials in Sheridan County, the reader is referred to the report by Beck and McCormack (1951).

GEOLOGY

SUMMARY OF STRATIGRAPHY *

The rocks cropping out in Sheridan County are sedimentary and are of Cretaceous (Gulfian), Pliocene, and Pleistocene age. The subdivisions and stratigraphic classification of these strata are given in Table 2 and in the cross sections in Figures 4A and 4B. The areal distribution of the outcrops is shown on the geologic map (Pl. 1).

The Niobrara formation of late Cretaceous age underlies the entire county but crops out only in the valleys of Saline and South Fork Solomon Rivers in the extreme eastern part of the county. The Pierre shale underlies the western one-third of the county but does not crop out. The Ogallala formation of Pliocene age underlies all the county with the exception of narrow bands along the edges of the major valleys, and crops out along some of the major streams and their tributaries, particularly in the eastern part of the county. Deposits classified as the Meade formation of Pleistocene age (Kansan and Yarmouthian stages) occupy a relatively high position along the major valleys, and Crete terrace deposits of sand and gravel containing some silt lie at a lower position than the Meade formation along the lower parts of the major valleys. The upland area of the county is mantled by thick eolian silt, which is classified as a part of the Sanborn formation, and is divided into the Loveland, Peoria, and Bignell silt members. Deposits of eolian silt of late Wisconsinan age that are at least in part equivalent in age to the Bignell silt member underlie the more prominent terraces along the major stream valleys. There are low terrace deposits in the major valleys in about the eastern two-thirds of the county and Recent alluvium underlies the floodplains of the major valleys and their larger tributaries.

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* The geologic classification and nomenclature of this report follow the usage of the State Geological Survey of Kansas and differ somewhat from those used by the U. S. Geological Survey.

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

SYSTEM	Series	Formation		Stage	Thickness, feet	Character	Water supply
Quaternary	Pleistocene	Alluvium		Recent	0–30	Sand, gravel, silt, and clay; stratified or cross-bedded, unconsolidated.	Yields abundant supplies of water to wells along major streams and smaller supplies along tributaries.
		Undifferentiated valley deposits		Recent and Late Wisconsinan	0–40	Includes undifferentiated late Wisconsinan terrace deposits. Recent alluvium, and colluvium. Contains silt and clay in upper part; interbedded silt, clay, sand, and gravel in lower part.	Yields moderate supplies of water to wells where sand and gravel is present.
		Sanborn formation	Terrace deposits	Late Wisconsinan	0–60	Silt and clay; stratified, locally contains buried soil zones in upper part. Lower part contains sand and gravel and lenses of silt.	do
			Bignell silt member		0–6	Silt, massive, yellow-gray, well-sorted; blankets uplands in places.	Above water table; yields no water to wells.
			Peoria silt member	Early Wisconsinan	0–30	Silt, massive, light-tan to light-gray, well-sorted; Brady soil at top. Generally mantles or underlies uplands.	do
			Loveland silt member	Illinoian	0–16	Silt, massive, tan to light-tan; Loveland soil at top.	Yields no water to wells.
			Crete sand and gravel member		0–55	Sand, gravel, and silt. Borders major stream valleys.	Yields small to moderate supplies of water to wells where basal sand and gravel is present.

		Meade formation	Sappa member	Kansan	0–20	Silt and sandy silt. Locally contains volcanic ash deposits.	Lies above water table; yields no water to wells.
			Grand Island member		0–25	Sand, gravel, and silt.	Lies principally above water table; yields no water to wells.
Tertiary	Pliocene	Ogallala formation			0–220	Sand, gravel, silt, and clay interbedded and cross-bedded; in part cemented with calcium carbonate. Locally cemented with silica in lower part.	Yields large to moderate supplies of water over most of area. Lies in part above water table.
Cretaceous	Gulfian	Pierre shale			0–375±	Shale, brown or black to yellow-gray; bentonitic, in part calcareous.	Yields no water to wells.
		Niobrara formation	Smoky Hill chalk and Fort Hays limestone members		630±	Chalk and chalky shale, white to blue-gray.	do

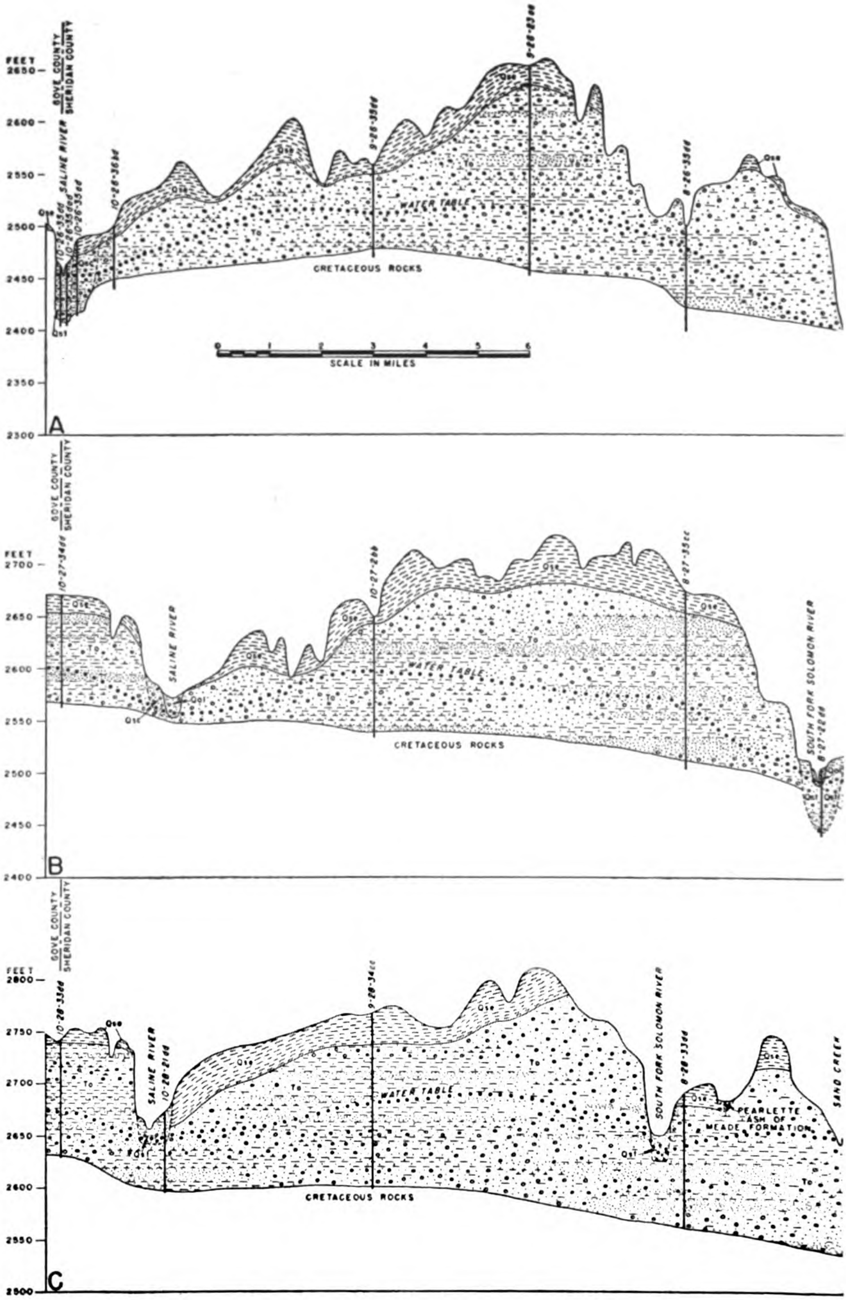
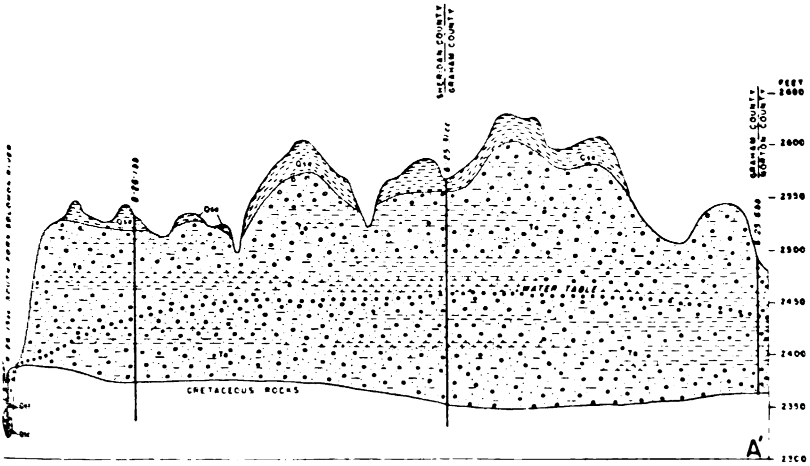


FIG. 4A.—Geologic cross sections through Sheridan County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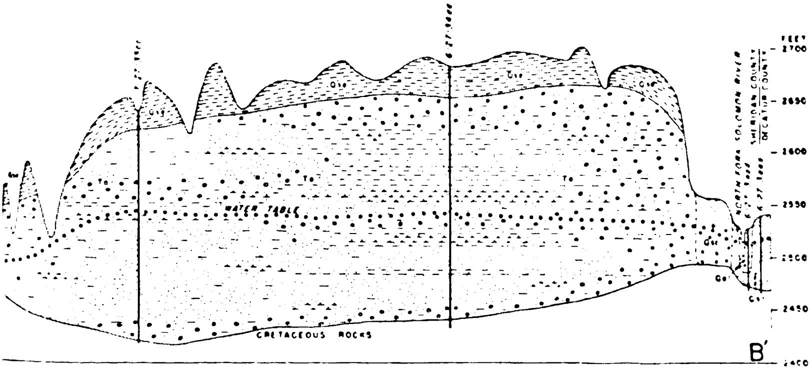
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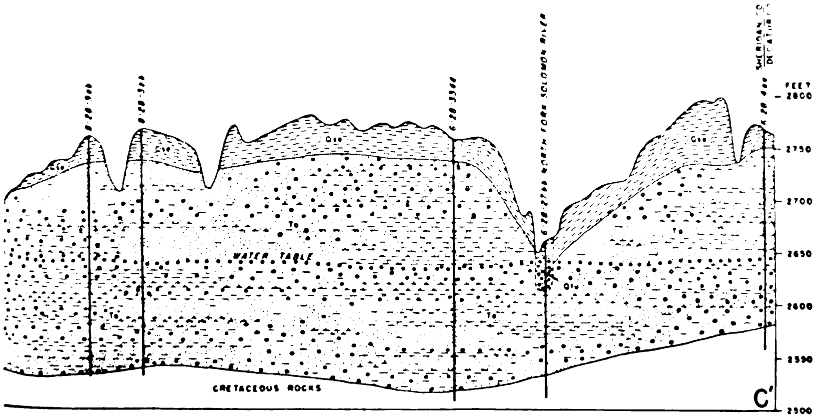
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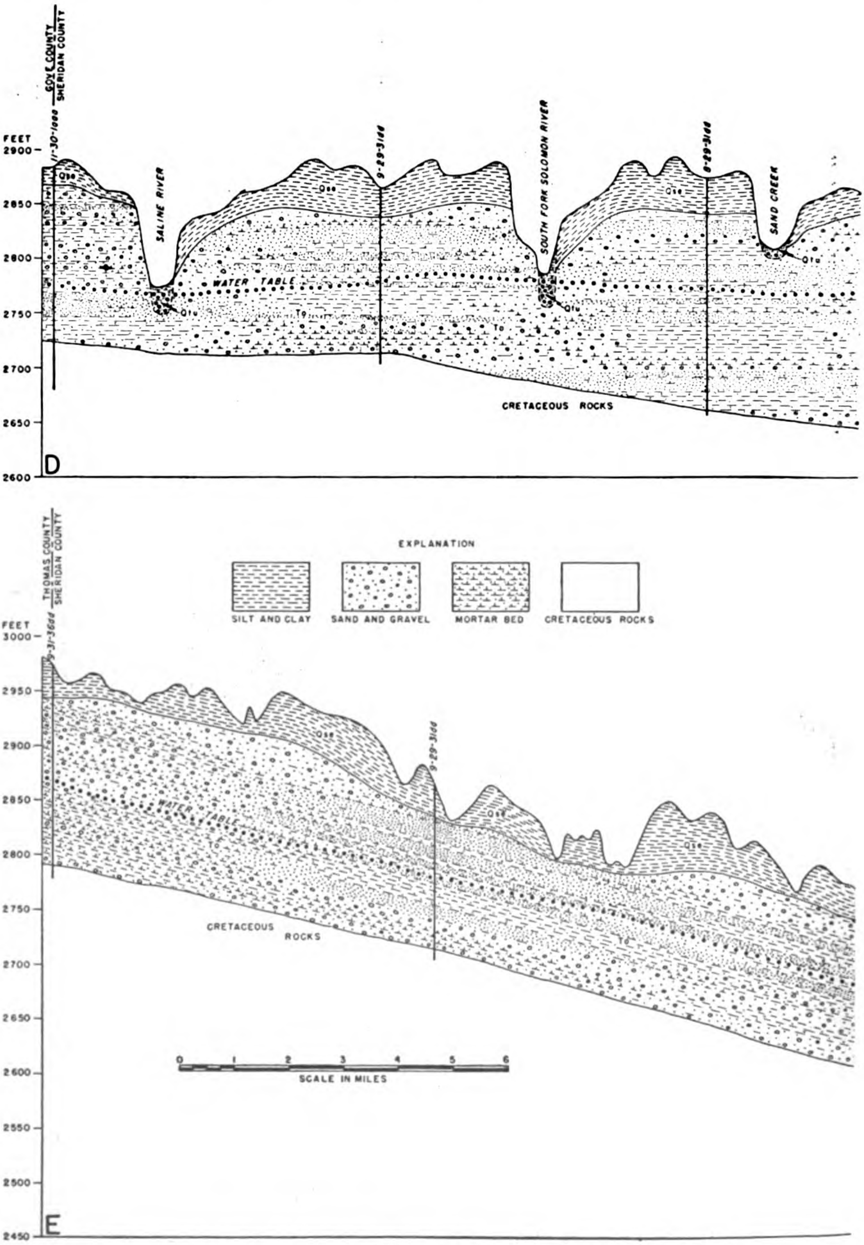
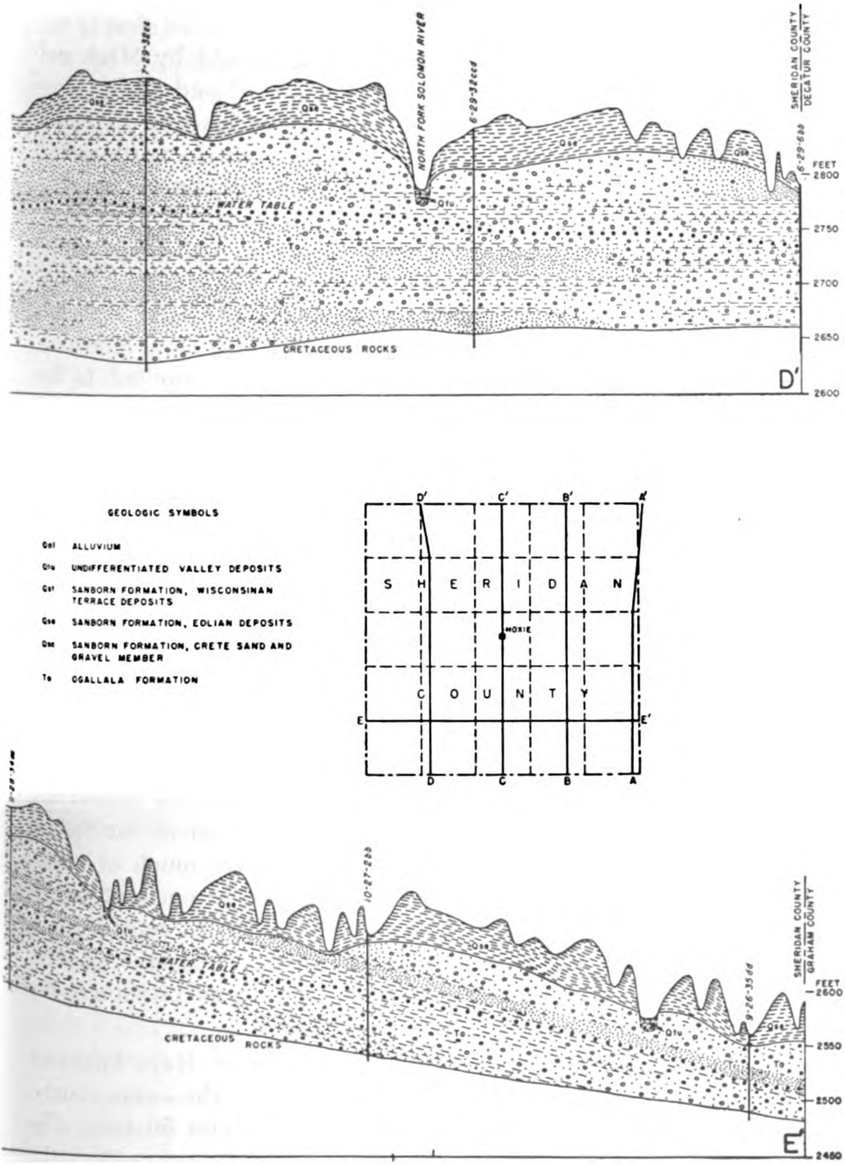


FIG. 4B.—Geologic cross sections through Sheridan County.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Qse SANBORN FORMATION, EOLIAN DEPOSITS
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GEOLOGY IN RELATION TO GROUND WATER

Cretaceous System—Gulfian Series

Niobrara Formation

Character.—The Niobrara formation was named by Meek and Hayden (1862) for exposures of calcareous marl and chalky limestone near the mouth of Niobrara River in northeastern Nebraska. Logan (1897) described the Niobrara formation in north-central Kansas. He used a two-fold subdivision of the Niobrara formation consisting of the Fort Hays limestone and the Smoky Hill chalk members. Cragin had proposed the name Smoky Hill chalk earlier, and Williston proposed the name Fort Hays. The Niobrara formation in Sheridan County consists predominantly of chalky shale but also includes chalky limestone and chalk. The Fort Hays limestone, the lower member of the formation, does not crop out in the county, but drilling records indicate that the member is composed of massive beds of chalk and chalky limestone separated by thin beds of chalky clay shale. The thickness ranges from about 45 feet along the eastern edge of the outcrop east of Sheridan County to about 60 feet near the Colorado line.

The Smoky Hill chalk member of the Niobrara formation conformably overlies the Fort Hays limestone member and consists of soft beds of alternating chalk and chalky shale. Unweathered beds of chalk in the member are light to dark gray; weathered beds are white, tan, yellowish-pink, or brown. The member contains many thin beds of bentonite, and concretions of pyrite and limonite are common throughout. The lower part of the Smoky Hill chalk member is more massive and chalky and resembles the underlying Fort Hays limestone member. The uppermost part of the Smoky Hill chalk member has been silicified locally over much of northwestern Kansas and beds of silicified chalk were encountered in several test holes in Sheridan County. The siliceous cement probably was derived from the overlying Ogallala formation by solution of silica in percolating ground water and reprecipitation in the underlying chalk (Frye and Swineford, 1946).

Distribution and thickness.—Although the Fort Hays limestone does not crop out in Sheridan County, it underlies the entire county. Oil-well logs indicate a uniform thickness of about 50 feet. The Smoky Hill chalk member crops out in Sheridan County only in the extreme eastern part along the valleys of the Saline and South Fork Solomon Rivers. The Smoky Hill chalk member underlies the entire county and reaches a maximum thickness of about 580 feet in the western part of the county. The minimum thickness is about 400 feet in the southeastern part of the county, the upper 150 to 200 feet of beds having been removed by pre-Ogallala and later erosion.

Water supply.—The Niobrara formation is a poor aquifer in Kansas and it yields no water to wells in Sheridan County. The limestones and shales are relatively impervious and could yield water only from joints and seams (Pl. 3A). The uppermost part of the formation might yield water to wells locally from beds of silicified chalk, as these generally are fractured and jointed. The yield of wells tapping these beds would be small because the silicified chalk generally is relatively thin (Pl. 3B).

Pierre Shale

The Pierre shale, which conformably overlies the Niobrara formation in northwestern Kansas, was named by Meek and Hayden in 1862 from exposures at old Fort Pierre in South Dakota. Elias (1931) described and named the several members of the Pierre shale in Kansas and discussed their correlation with later Cretaceous units of North America. The Pierre shale does not crop out in Sheridan County but it underlies the western one-third of the county. The weathered shale generally is greenish gray or brownish gray and is locally bentonitic, whereas the unweathered shale is predominantly dark gray or black. The thickness of the Pierre shale in Sheridan County ranges from a featheredge at its eastern limit to 375 feet in the northwestern part of the county. The formation yields no water to wells in Sheridan County, and in areas outside the county it supplies only meager amounts of highly mineralized water to wells.

Tertiary System—Pliocene Series

Ogallala Formation

The Ogallala formation was named by Darton (1899) for exposures near Ogallala in southwestern Nebraska. Elias (1931) made a detailed study of the Ogallala formation in Wallace County and adjacent areas in western Kansas.

Character.—The Ogallala formation in Sheridan County consists of a diversity of clastic sediments including sand, gravel, clay, silt, bentonitic clay, and locally, sandy and silty limestone and opal-cemented sand and gravel called "quartzite" and "caliche". The beds of sand and gravel and of clay within the formation are lenticu-

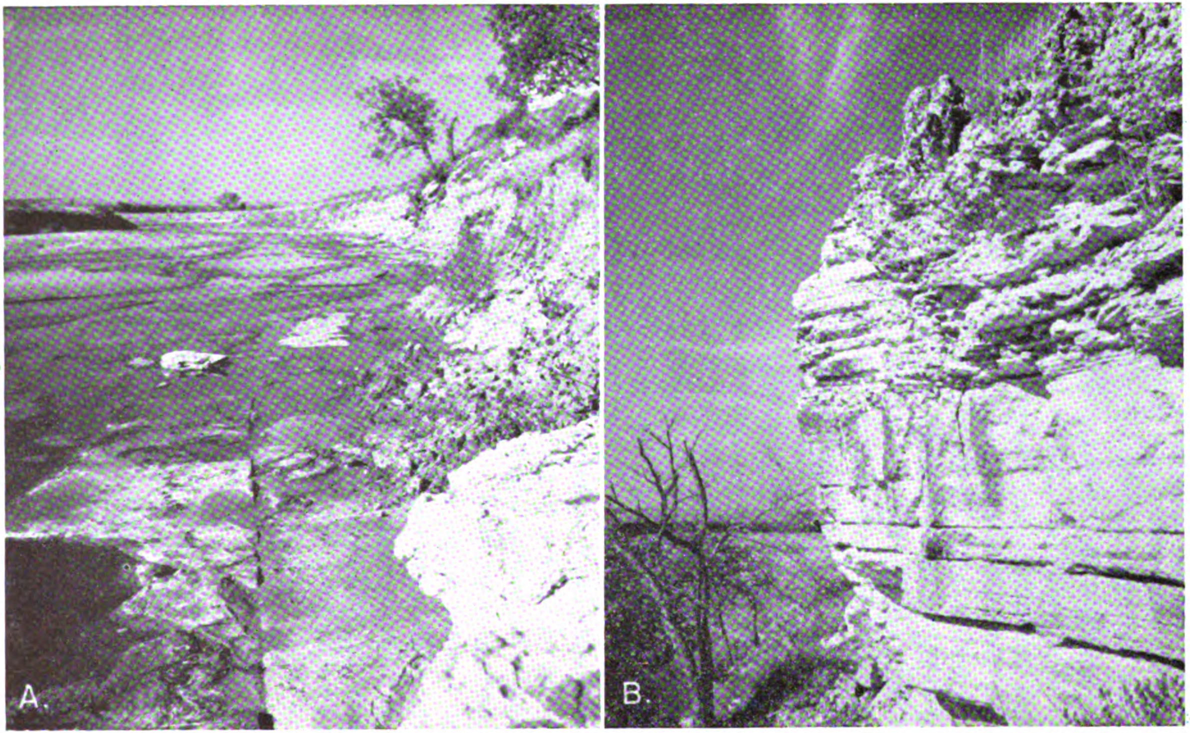

Plate 3.—**A**, Jointing in Niobrara formation in bed of Saline River near center sec. 36, T. 10 S., R. 26 W. **B**, Silicified chalk at the top of the Smoky Hill chalk member of the Niobrara formation. The overlying rocks are "mortar beds" of the Ogallala formation.

lar and grade from one lithologic type to another within short distances both laterally and vertically. Although the materials that make up the Ogallala formation are diverse, the pattern of outcrop is uniform and easily identified. The hard ledges generally are cemented with calcium carbonate and form rough weathered benches or cliffs. If the clastic materials of the Ogallala formation are cemented with calcium carbonate, they resemble mortar and are often called "mortar beds" (Pl. 4A). The thickness of the "mortar beds" ranges from a few inches to several feet, and the degree of cementation differs greatly within short distances. Sand is the principal constituent of the Ogallala formation and occurs at all horizons. The sand ranges in size from fine to coarse and may be found in beds of silt and clay, and in the "mortar beds". The logs of some of the test holes indicate the presence of some well-sorted sand in the Ogallala.

The State Geological Survey of Kansas classifies the Ogallala as a formation and recognizes three members, which, in ascending order, are the Valentine, Ash Hollow, and Kimball. The upper limit of the formation is marked in Kansas by a capping bed called the "algal limestone", which, except for small local deposits, has been removed from most of northwestern Kansas by post-Ogallala erosion. The algal limestone probably was deposited in shallow water-table lakes, whereas much of the calcium carbonate in "caliche" and in "mortar beds" probably was deposited at or near the water table. Changes in the water table within the formation may account for the position of "mortar beds" and "caliche" at various levels in the formation.

Distribution and thickness.—The Ogallala formation was deposited by streams flowing generally eastward from the Rocky Mountain region. The streams carried heavy loads of material, and as the gradients and velocities decreased, the streams deposited their loads, filling their channels and forming broad floodplains. The floodplains were traversed by the aggrading streams and were built up by the deposition of debris until the streams crossed the low divides of the older Cretaceous rocks. The Ogallala formation originally covered most of the western half of Kansas, but subsequent erosion removed the deposits from much of the area. The thickness of the Ogallala formation ranges from a featheredge along its eastern limit and across some of the high ridges of Cretaceous rocks to more than 350 feet in the western part of the State.

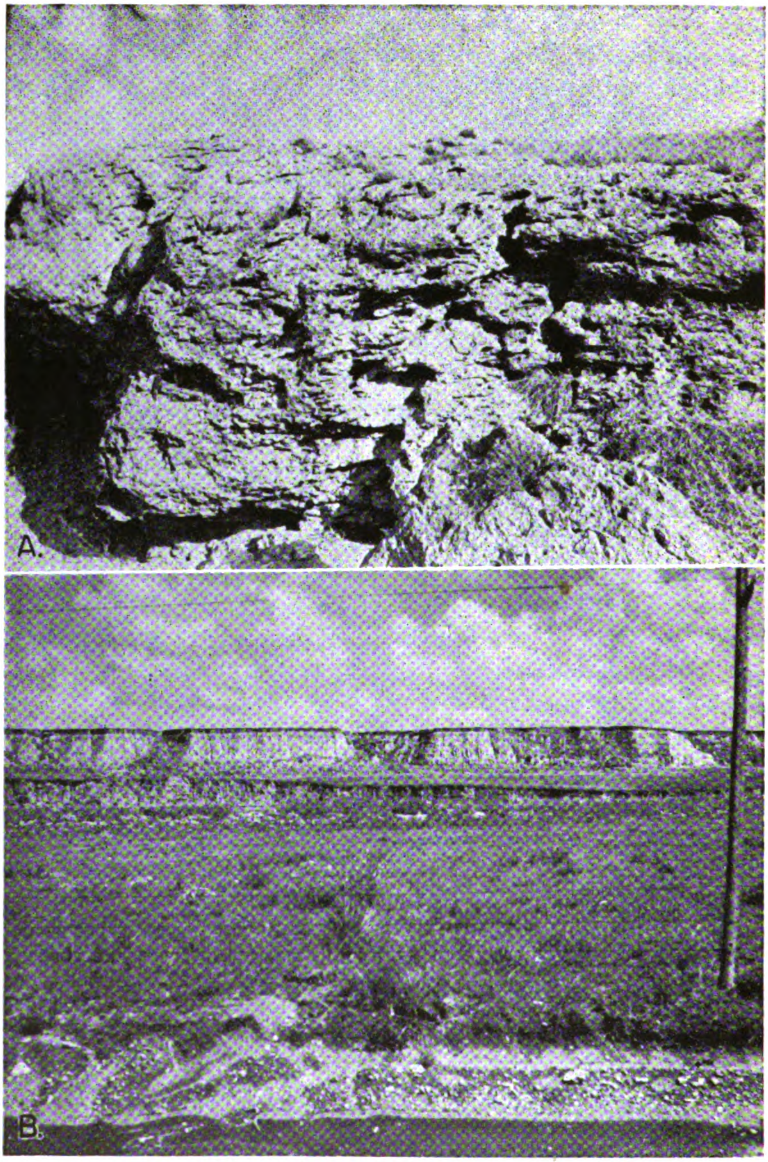

Plate 4.—A, Typical "mortar beds" in the Ogallala formation in sec. 31, T. 8 S., R. 24 W. **B,** Sanborn formation. Crete sand and gravel member below Loveland silt member and silt of late Wisconsinan age. Loveland silt member forms bench about halfway down cliff. Crete sand and gravel member in vertical cut below Loveland silt member.

The Ogallala formation was deposited over all of Sheridan County and now lies at or near the surface throughout the county except in the eastern part in the valleys of Saline and South Fork Solomon Rivers. The thickness of the Ogallala formation in Sheridan County ranges from a featheredge to as much as 220 feet in the west-central part of the county. The cross sections (Fig. 4) show that the Ogallala formation thins in the southern part of the county, owing in part to the higher altitude of the Cretaceous bedrock surface as shown in Figure 5 and in part to the removal of some of the deposits by erosion. The geographic distribution of the Ogallala formation is shown on Plate 1.

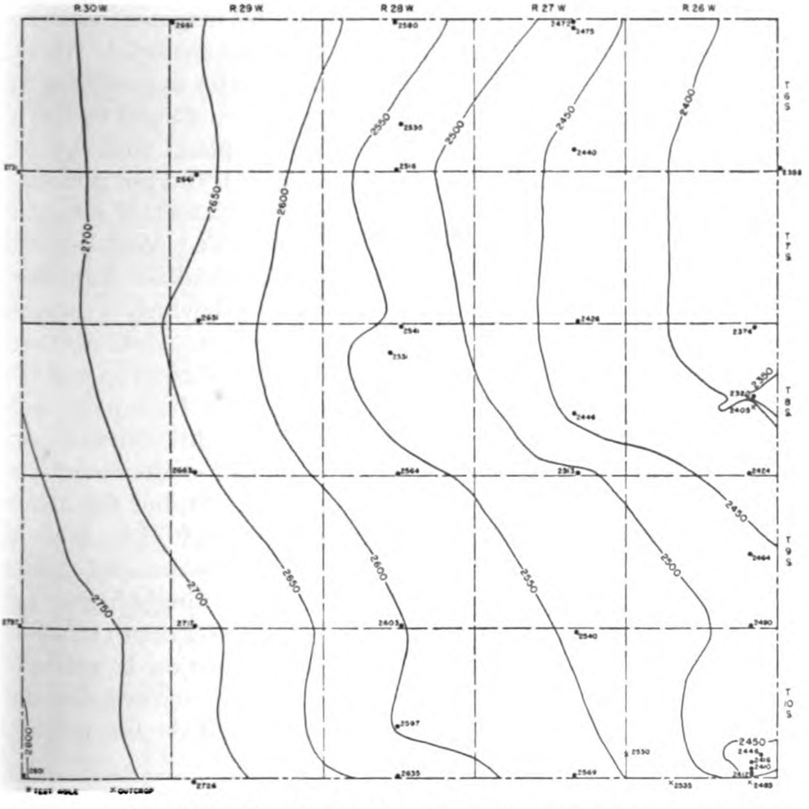

FIG. 5.—Map of Sheridan County showing configuration of the bedrock surface beneath the Ogallala formation, the location of test holes, and the altitude at which bedrock was encountered.

Water supply.—The Ogallala formation is the principal aquifer in Sheridan County. The coarser materials that lie below the water table yield water freely to wells in the upland area of the county. All irrigation wells on the upland obtain their water from the Ogallala formation and those in the valleys obtain at least a part of their water from it. The finer-grained materials in the Ogallala formation may contain water, but because of their low permeability they generally yield only small quantities of water to wells. The thickness of the saturated material in the Ogallala formation differs considerably over the county as shown in Figure 8. All irrigation wells are in areas that have more than 40 feet of saturated material. The irrigation wells in the valleys, but which obtain water in part from the Ogallala formation, lie in areas that have between 40 and 60 feet of saturated material. Well 9-30-34ba is an old upland well that obtains all its water from the Ogallala formation. It did not penetrate the entire thickness of the Ogallala, but from 69 feet of saturated material the well was pumped at a rate of 300 gpm. Well 8-28-9ab is an upland well obtaining water from the Ogallala formation. There is 114 feet of saturated material at this well, which is pumped at a rate of 580 gpm with a drawdown of 63 feet. Data obtained from a study of the Ogallala formation in areas of outcrop and test drilling indicate that the Ogallala formation may be equally permeable in other parts of the county and that additional wells can be developed. The upland area in the north half of the county has the greatest thickness of saturated material (Fig. 8), but this area is also in general the area of greatest depth to water (Pl. 1). Wells of larger capacity probably can be constructed in the areas of greater saturated thickness, but costs would be correspondingly higher and pumping lifts would be greater, owing to the greater depth to water.

The quality of water from the Ogallala formation is generally better than that of water from the alluvium and terrace deposits. The chemical character of water from the Ogallala formation is shown in Table 3.

Quaternary System—Pleistocene Series

Quaternary deposits in Kansas are of continental origin and are assigned to the Pleistocene series. They underlie much of the surface of the State and are composed of silt, clay, sand, gravel, and volcanic ash. The Pleistocene epoch as defined by the State Geological Survey of Kansas is the last of the major divisions of geologic time and has been called the "Ice Age", owing to the presence of continental glaciers in North America and elsewhere. The Pleistocene epoch has been divided into four main glacial stages, the Nebraskan, Kansan, Illinoian, and Wisconsinan; and three inter-

TABLE 3.—*Analyses of water from typical wells in Sheridan County, Kansas*

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

Well number	Depth, feet	Geologic source	Date of collection, 1952	Temperature (°F)	Dissolved solids[b]	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. 6 S., R. 27 W.																		
6-27-10ab	90	Terrace deposits	Nov. 14	56	400	32	0.74	77	20	38	346	38	21	0.6	3.1	274	274	0
T. 6 S., R. 29 W.																		
6-29-28da	142	Ogallala formation	Oct. 24	57	286	33	.09	56	18	17	260	12	10	.7	11	214	213	1
T. 7 S., R. 27 W.																		
7-27-11cd	126	do.	Oct. 24	56	286	40	.89	45	19	24	245	18	10	1.0	8.0	190	190	0
T. 7 S., R. 30 W.																		
7-30-18aa	67	do.	Oct. 24	55	295	28	12	50	18	29	261	19	11	1.4	11	199	199	0
T. 8 S., R. 26 W.																		
8-26-1dd	119	do.	Oct. 24	56	275	36	1.7	50	16	21	240	17	10	.7	6.6	191	191	0
T. 8 S., R. 27 W.																		
8-27-14bd	24	Terrace deposits	Oct. 24	57	1,200	43	.21	255	60	51	312	430	201	.7	6.2	882	256	626
T. 8 S., R. 28 W.																		
8-28-9ab	208	Ogallala formation	Oct. 24	57	298	43	.03	45	18	28	239	27	11	1.4	6.2	186	186	0
T. 8 S., R. 29 W.																		
8-29-14bc	143	do.	Oct. 24	56	307	33	.15	55	22	18	234	33	22	1.0	8.4	228	192	36
T. 9 S., R. 26 W.																		
9-26-23ba	172	do.	Oct. 24	56	255	30	.37	53	16	14	250	8.6	7.0	.6	2.6	198	198	0
T. 9 S., R. 28 W.																		
9-28-5bc	42	Terrace deposits	Oct. 24	56	524	29	.08	101	31	44	436	69	26	1.2	7.5	380	358	22
9-28-36dc	98	Ogallala formation	Oct. 24	57	266	22	.59	53	16	20	249	17	8.0	.9	6.2	198	198	0
T. 9 S., R. 29 W.																		
9-29-35ab	126	do.	Oct. 24	57	282	28	.83	43	18	30	235	24	14	1.3	7.5	182	182	0
T. 9 S., R. 30 W.																		
9-30-3aa	140	do.	Oct. 24	57	267	25	.02	46	19	22	244	15	11	1.6	7.5	193	193	0
9-30-23ad	34	Alluvium	Oct. 24	58	486	28	.14	112	27	26	425	59	24	.5	.6	390	348	42
T. 10 S., R. 26 W.																		
10-26-19aa	96	Ogallala formation	Oct. 24	56	242	18	1.9	49	15	18	227	18	10	.9	1.6	184	184	0
10-26-32ad	32	Terrace deposits	Oct. 24	56	510	31	.05	104	25	52	393	81	41	.6	11	362	322	40
T. 10 S., R. 30 W.																		
10-30-11dd	130	Ogallala formation	Oct. 24	57	277	19	.79	47	18	28	242	23	13	1.3	8.8	191	191	0
10-30-30cb	80	do.	Oct. 24	57	384	21	.28	71	22	36	299	47	28	.9	11	268	215	23

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

glacial stages, the Aftonian, Yarmouthian, and Sangamonian. During the Nebraskan and Kansan stages, the continental glaciers entered northeastern Kansas and covered that area with glacial drift. During the Illinoian and Wisconsinan stages the continental glaciers did not reach the State, but the climatic changes accompanying their approach had a direct effect on deposits over much of Kansas.

Deposits of the Pleistocene epoch in Sheridan County and the rest of western Kansas are both fluviatile and eolian. The fluviatile (stream laid) deposits generally are associated with the present drainage systems or with ancient drainage systems, whereas the eolian deposits generally underlie the uplands but locally may extend into the valleys and may rest on older fluviatile deposits.

Fluviatile deposits of the Nebraskan stage underlie parts of central and southwestern Kansas and extend westward along Smoky Hill River and although they have not been identified in Sheridan County it is believed that they may be present in the county. Identification of these deposits in Sheridan County is difficult because they were principally derived from the Ogallala formation and their lithology is similar to that of the Ogallala.

The Aftonian interglacial stage followed the Nebraskan stage, and like the other interglacial stages it was marked by an unconformity in the geologic section that differs from the usual unconformity in that it represents a period of little erosion; conditions were stable and weathering was the principal agent at work. These conditions were conducive to development of soils on the surface of the older deposits. As no Nebraskan deposits have been observed in Sheridan County, soils developed on the Ogallala formation may be in part of Aftonian age.

The Meade and Sanborn formations were deposited in Sheridan County during the Kansan, Illinoian, and Wisconsinan glacial stages.

The Kansan glaciation was followed by the Yarmouthian interglacial stage during which climatic conditions were again stable and ideal for soil formation. The Yarmouthian stage is the interval of one of the major unconformities in the Pleistocene in Kansas. Although an extensive soil was developed during this stage, it was not recognized in deposits in Sheridan County. This soil, if formed, may have been removed by later erosion, but a part of the soil developed on the Ogallala formation in the county may be equivalent to the Yarmouth soil.

Meade Formation—Kansan and Yarmouthian Stages

The Meade formation was described in 1941 by Frye and Hibbard and was named for some deposits in central Meade County, Kansas. The Meade formation in Kansas is divided into two members, the lower (Grand Island) member, which is fluviatile and generally consists of sand and gravel, and upper (Sappa) member, which is partly fluviatile and partly eolian and generally consists of silt, sand, gravel, and locally of volcanic ash.

The Meade formation in Sheridan County underlies small areas in a high terrace position along the major streams. Only the Sappa member has been identified in the county and its identification was based on the presence of the Pearlette volcanic ash (Carey and others, 1952). The maximum thickness of the ash in the county is 16 feet in the NW¼ sec. 34, T. 8 S., R. 28 W., in the valley of South Fork Solomon River. The Grand Island member of the Meade formation was not identified in Sheridan County, but in the SW¼ sec. 4, T. 8 S., R. 25 W., Graham County, deposits of sand and gravel along the west side of Morland Lake are probably in the Grand Island member. The combined thickness of the Sappa and Grand Island members at this locality is about 25 feet. As this exposure is only about 2 miles east of the eastern border of Sheridan County it is likely that the deposits extend westward into Sheridan County. Identification of the Meade formation is difficult without the presence of distinctive fossils or the volcanic ash, and the terrace is not mappable because it is well dissected and younger deposits mantle the valley walls at the projected level of known deposits. No attempt was made to map the Meade formation in Sheridan County, as nearly everywhere in the county the younger eolian deposits mantle the level at which Meade deposits should occur. Pearlette volcanic ash deposits are shown on the geologic map (Pl. 1).

The Meade formation in Sheridan County is considerably above the water table and furnishes no water to wells.

Sanborn Formation

The Sanborn formation consists of six members. These members in ascending order are Crete sand and gravel, Loveland silt, early Wisconsinan terrace deposits, Peoria silt, Bignell silt, and late Wisconsinan terrace deposits.

The Sanborn formation developed during two glacial stages, the Illinoian and Wisconsinan, and one interglacial stage, the Sangamonian. Because of the difficulty in distinguishing between the silt members of the Sanborn formation, they were mapped as a unit (Sanborn eolian deposits), but the terrace deposits of early Illinoian (Crete) age and of late Wisconsinan age were mapped separately. The areas of the outcrop of the eolian deposits of the Sanborn formation and of the terrace deposits are shown on the geologic map (Pl. 1).

During the Illinoian glacial stage the continental glaciers were a relatively great distance from Kansas, but the accompanying climatic changes had a considerable effect on erosion and deposition in Kansas stream valleys. Subsequent to or contemporary with this fluviatile action, eolian deposits were laid down on the upland areas. Two members of the Sanborn formation were deposited during the Illinoian stage of glaciation, the Crete sand and gravel member, which is composed of interbedded silt, sand, and gravel of fluviatile origin, and the Loveland silt member, which is composed of silt and fine sand of both fluviatile and eolian origin. Both the Crete sand and gravel and the Loveland silt members of the Sanborn formation are recognized in Sheridan County.

The upper part of the Sanborn formation was deposited during the Wisconsinan stage of the Pleistocene in Kansas and consists principally of eolian deposits but includes some fluviatile terrace deposits in most of the valleys. The Wisconsinan stage has been divided into five substages in which the sequence of erosion and deposition is comparable to that of the earlier stages of the Pleistocene, but because of the remoteness of the glaciers, the effect on stream erosion and deposition was less pronounced than in the earlier stages. Glaciation in the Rocky Mountains was an important factor in the deposition of fluviatile materials in Kansas during the Wisconsinan stage. The Brady soil, formed during the Bradyan interglacial stage, lies on the Peoria silt member and is overlain by the Bignell silt member where the Bignell member is present. Where the Bignell silt member is absent the Brady soil merges into and is included with the modern soil.

The character of the Sanborn formation is indicated by the logs of test holes, by Plate 4B, and by the following measured sections.

Measured section of the Sanborn formation along a steep cut on the south side of U. S. Highway 24 in the NW¼ sec. 20, T. 8 S., R. 28 W.

QUATERNARY (Pleistocene)

	Sanborn formation	Feet
15	Soil, dark brownish-gray (modern soil)	0.4
14	Silt, brownish-gray (Bignell silt member)	1.2
13	Clay and silt, dark-gray, blocky (Brady soil)	1.0
12	Silt, light-gray to buff; contains snail shells (Peoria silt member)	14.1
11	Clay, silty, dark-brown; contains some caliche in nodules; soil zone heavy at bottom grading into Peoria above (Farmdale soil)	2.8
10	Gravel and pebbles on old erosional surface	0.1±
9	Silt, limy, light-buff to white; contains some sand and gravel (top of Crete sand and gravel member)	4.0
8	Silt, tan to buff; contains some sand and gravel; less lime cementing than bed 9	5.0
7	Silt, tan to buff; contains nodular caliche and caliche in burrows	7.0
6	Silt, tan to buff; contains much sand and gravel	1.9
5	Silt, tan to buff; contains some very fine sand	4.1
4	Sand, fine, silty, dark-buff	0.7
3	Sand and gravel, persistent stringer	0.1
2	Silt, light-gray to buff, some very fine sand and a few scattered ash shards	4.5
1	Sand and gravel (base of cut)	0.6
	Total	47.5

Measured section of Sanborn formation in steep cutbank of Saline River in the NW¼ sec. 33, T. 10 S., R. 26 W., 100 yards east of road. (Measured by C. K. Bayne, K. L. Walters, and A. R. Leonard)

QUARTERNARY (Pleistocene)

	Sanborn formation	Feet
5	Soil, dark gray-brown; lower 1 foot clayey, blocky, grades into underlying bed (modern and Brady soil)	3.0
4	Silt, gray to tan-buff; contains snail shells (Peoria silt member)	14.0
3	Silt, limy to very limy, upper part light-brown, lower part light-gray to white; possible weak soil zone in upper part, which forms bench (Loveland silt member)	4.7
2	Sand and gravel, crossbedded and lenticular; contains chalk fragments and clay balls, and a few snail and clam shells (Crete sand and gravel member)	10.3
1	Silt, sandy, poorly exposed	12.2
	Total	44.2

Crete sand and gravel member—Illinoian stage.—The distribution of the Crete sand and gravel member of the Sanborn formation is shown on the geologic map (Pl. 1). The Crete in Sheridan County is in a terrace position along the major valleys. The terrace is dissected, discontinuous, and in a position higher than the younger Wisconsinan terraces but lower than the Meade formation. Younger eolian deposits overlie the Crete in some parts of Sheridan County with the result that the Crete is difficult to map except where it is exposed in steep banks or cuts. Plate 4B shows the Crete sand and gravel member overlain by the Loveland silt member and Peoria silt member, in the NW¼ sec. 33, T. 10 S., R. 26 W. Where the Crete is below the water table in Sheridan County it furnishes water to a few wells. In a narrow strip along the valley of Saline River in southeastern Sheridan County where the Ogallala formation is thin, the Crete probably would yield moderate supplies of water to wells. Records of test holes drilled in Sheridan County indicate that the Crete may be as thick as 55 feet.

Loveland silt member—Illinoian and Sangamonian stages.—The Loveland silt member of the Sanborn formation in Sheridan County consists primarily of eolian silt and was observed in many localities. The member is best exposed on slopes in the upland areas of the county where younger deposits have been removed by erosion. The Loveland consists of silt and small amounts of sand and colluvium in the lower part. The silt generally is tan or tan-brown in Sheridan County but eastward it is distinguished by a pronounced reddish color. The thickness of the Loveland in Sheridan County ranges from a featheredge to as much as 16 feet, and as the member generally lies above the water table it yields no water to wells in the county.

The upper limit of the Loveland member is marked by an unconformity resulting from a period of weathering in the Sangamon interglacial stage during which a soil with a well-developed profile was formed. The Sangamon soil is the most prominent fossil soil in western and central Kansas; it is much thicker than the modern soil and is exposed much more widely than the Yarmouth soil. The maximum thickness of the soil observed in Sheridan County was about 4 feet. The upper part of the soil, generally dark brown, grades downward into silt. Generally there is an accumulation of clay a short distance below the top of the soil and an accumulation of limy material at various distances below the clay.

The Loveland silt member was mapped with the eolian members of the late Wisconsinan deposits and they are shown on Plate 1 as Sanborn eolian deposits.

Peoria silt member—Wisconsinan stage.—The Peoria silt member of the Sanborn formation is a uniform, generally fossiliferous, calcareous, massive silt. The deposit generally is buff to light-tan and is easily recognized by its massive appearance and its uniform color. The Peoria silt mantles much of the upland area of Sheridan County, and at the close of deposition of the Peoria the silt probably mantled the entire county with the exception of the lower parts of the valleys where the active streams removed the silt as it was deposited. The Peoria silt extends over the sides of the valleys and mantles the older terrace deposits. Plate 4B shows the Peoria on the Crete sand and gravel member in the valley of Saline River. The Peoria silt member in Sheridan County ranges in thickness from a featheredge to as much as 25 feet. The maximum thickness of the deposit probably never greatly exceeded 25 feet, but along the edges of the valleys the thickness probably was greater than at present as much of the Peoria silt member has been removed by erosion.

The Bradyan interglacial substage, which followed the period of deposition of the Peoria silt member of the Sanborn formation, was a period of relative stability during which deposition of eolian deposits ceased or was reduced to a rate such that a soil was formed. This soil, the Brady soil, although not as thick as the earlier Sangamon and Yarmouth soils, is recognized in many places in the upland areas of Sheridan County. It is commonly thicker than the modern soil and generally is dark-brown, but where it was formed under conditions of poor drainage it may be gray to black and generally has a thicker profile. The thickness of the Brady soil in Sheridan County is commonly about 1 foot but reaches a maximum of 3 feet (Pl. 5).

The Peoria silt member of the Sanborn formation lies above the water table and yields no water to wells.

Bignell silt member—Wisconsinan stage.—Thin discontinuous deposits of the Bignell silt member of the Sanborn formation are distributed widely over northwestern Kansas. The Bignell silt member generally resembles the underlying Peoria silt member in lithology and is separated from the Peoria silt by the moderately developed Brady soil. The Bignell may be identified by its contained molluscan fauna and under ideal stratigraphic conditions by its position.

PLATE 5.—Views of the Brady soil in Sheridan County. **A,** Upland mantled with the Peoria silt member of the Sanborn formation. Dark line across draw and to left of trail is Brady soil. NW¼ sec. 3, T. 11 S., R. 29 W. **B,** Brady soil below Bignell silt member of the Sanborn formation. SW¼ sec. 21, T. 10 S., R. 26 W. Brady soil is dark zone below lighter silt in ditch.

The Bignell silt member in Sheridan County consists of discontinuous deposits of silt over much of the upland area. The silt is gray to light gray-brown. The Bignell silt member is of eolian origin as indicated by its topographic position and its lithology, and is the youngest upland eolian deposit in this area. In Sheridan County the thickness of the Bignell silt member ranges from a few inches to about five feet. Plate 5B shows the Bignell silt member overlying the Brady soil.

The Bignell silt member lies above the water table in Sheridan County and yields no water to wells.

Terrace deposits—Wisconsinan stage.—In Sheridan County, as in much of northwestern Kansas, early Wisconsinan fluviatile deposits have not been identified, but a part of the lower deposits underlying the late Wisconsin terrace deposits in the stream valleys may be early Wisconsinan in age. In southwestern Kansas early Wisconsinan terrace deposits underlie late Wisconsinan terrace deposits in the Cimmaron River valley, and in Wallace County gravels of early Wisconsinan age underlie the Peoria silt member.

After the deposition of the Peoria silt member and in part contemporary with it, there was a period of valley filling during which nearly all major valleys in Kansas received sediments and during which the sediments underlying the wide, flat low terraces in the valleys in western and north-central Kansas were deposited. In Sheridan County these terraces range in width from a few hundred feet to about three-quarters of a mile. The thickness of these terrace deposits reaches a maximum of 60 feet as indicated by the records of wells and test holes drilled in the valleys.

A terrace that is equivalent in age to the low terrace in Sheridan County has been studied and mapped in the Prairie Dog Creek valley by Frye and Leonard (1949). The terrace is in the Republican River basin and was named the Almena terrace. The same terrace in the North Fork Solomon Valley has been named the Kirwin terrace (Leonard, 1952), and a similar terrace in the Smoky Hill Valley, in an equivalent position in relation to the river, has been called the Schoenchen terrace (Leonard and Berry, report in preparation). The Kirwin can be mapped as a continuous unit in the North Fork Solomon Valley from a point in Sheridan County downstream to the confluence with the South Fork Solomon Valley and thence up the South Fork to a point in central Sheridan County. Because this terrace is a continuous mappable unit throughout the valleys of North and South Forks of Solomon River, the name Kirwin terrace is used in this report. A low terrace in the Saline River valley in Sheridan County was mapped during this investigation. Its position relative to the river is comparable to that of the Kirwin and Schoenchen terraces but as it has not been traced downstream and as its relation to the other terraces has not been determined, no name is given to it in this report. The geographic distribution of deposits underlying the Wisconsinan terraces in Sheridan County is shown on the geologic map (Pl. 1).

The Wisconsinan terrace deposits in Sheridan County consist of sand, silt, and small amounts of clay and gravel. Where a sufficient thickness of sand and gravel lies below the water table, abundant supplies of water can be developed. Many stock and domestic wells derive water from Wisconsinan terrace deposits and two irrigation wells derive at least part of their water from these deposits.

Undifferentiated Valley Deposits

Undifferentiated valley deposits were mapped in Sheridan County along tributary streams and upper reaches of the valleys of the major streams. The geographic distribution of these deposits is shown on the geologic map (Pl. 1). The narrow band of Recent alluvium in the major valleys was difficult to show on the map because of the small scale. In the major stream valleys a point was reached upstream at which the margin of the Wisconsinan terrace became difficult to determine and in the tributary stream valleys the margins of alluvium, terrace deposits, and colluvium were difficult to determine. Because of the difficulty in mapping these deposits, which include Recent alluvium, Wisconsinan terrace deposits, and Recent colluvium, these deposits were mapped in one unit. The surface of the undifferentiated valley deposits over much of the area mapped is similar to the surface of the Wisconsinan terrace, but the heel, or side, of the terrace adjacent to the valley wall is difficult to determine because colluvial materials have moved down the valley wall to a broad U-shaped valley with the bottom of the "U" flattened. In general, these deposits are not entrenched into the underlying Cretaceous bedrock, as are the late Wisconsinan terrace deposits, but lie on the Ogallala formation.

The thickness of the undifferentiated valley deposits in Sheridan County ranges from a featheredge to as much as 40 feet in the major valleys. The deposits lie, in part, below the water table; and where there is a sufficient thickness of saturated gravel or sand, moderate supplies of water can be developed. Many domestic and stock wells in the county yield water derived, at least in part, from these deposits.

Alluvium

The Recent alluvium shown on the geologic map (Pl. 1) includes those deposits that are in the active channel of the streams and deposits that lie above the channel but below the level of the late Wisconsinan terrace. The areas underlain by Recent alluvium are subject to flooding, and new deposits of sand and silt are built up by each succeeding flood. The water table in the alluvium is continuous with the water table in the late Wisconsinan terrace deposits, and wells of moderate capacity can be developed in these deposits at shallow depths. Because of its small areal distribution, the alluvium is not one of the principal aquifers in Sheridan County.

GROUND WATER

SOURCE

The following discussion on the source and occurrence of ground water has been adapted from Meinzer (1923) and the reader is referred to his report for a complete discussion of the subject.

Water that occurs in the pores or openings of the rocks and within the zone of saturation is called ground water. The amount of ground water below the surface in any region and the manner and rate of its movement to wells depend on the nature of the rocks in the region.

In Sheridan County, as well as other parts of northwestern Kansas, ground water is derived almost entirely from precipitation. A part of the water that falls as rain or snow becomes surface runoff; part evaporates directly into the air; and part is absorbed by plants and transpired into the air. The rest percolates downward through the soil and underlying strata until it reaches the water table where it becomes ground water. Estimates of the amount of water entering the ground-water reservoir in northwestern Kansas each year range from 0.1 to 0.5 inch. Although this is a relatively small percentage of the total annual precipitation, it should be noted that 0.25 inch of water entering the ground-water reservoir amounts to more than 13 acre-feet per square mile and more than 11,600 acre-feet in the entire county.

Ground water moves slowly through the rocks in directions determined by the shape and slope of the water table, which are controlled by topography, local variations in quantities of recharge and discharge, and the lithology and structure of the rocks. The water moves down gradient and is eventually discharged through wells and springs, through seeps along valley walls or into the streams, or by evaporation or transpiration in areas where the water table is near the ground surface. Most of the water that is obtained from wells in Sheridan County comes from precipitation within the county and in adjacent areas particularly to the west.

OCCURRENCE

Nearly all rocks that underlie the earth's surface at depths shallow enough to be penetrated by drilling contain voids or interstices, which range in size from microscopic openings to large caverns developed in some limestones. The percentage of the volume of the rock mass consisting of such open spaces is known as the porosity of the rock. Although it is desirable to know the porosity of the rock when considering the availability of ground water in a given area, it is not the porosity but the permeability of the material that determines the rate at which water can move through it. The permeability of an aquifer is determined by the size, shape, and arrangement of the openings in that aquifer. Beds of silt may have a high porosity but openings so small that the water cannot move freely through them and therefore the permeability is low. Limestone with large but poorly connected openings may likewise have a high porosity but low permeability. Several common types of openings or interstices in relation to texture and porosity are shown in Figure 6.

PERMEABILITY OF THE WATER-BEARING MATERIALS

The rate of movement of ground water is determined by the size, shape, quantity, and degree of connection of the interstices and by the hydraulic gradient. The capacity of a water-bearing material for transmitting water under hydraulic head is its permeability. The field coefficient of permeability may be expressed in Meinzer's units as the rate of flow of water, in gallons a day, through a cross-sectional area of one square foot under a hydraulic gradient of 100 percent at the prevailing temperature of the ground water. The coefficient of transmissibility is a similar measure and is defined as the number of gallons of water a day transmitted through each 1-foot strip extending the height of the aquifer under a unit hydraulic gradient (Theis, 1935, p. 520). It may also be expressed as the number of gallons of water a day transmitted through each section one mile wide extending the height of the aquifer, under a hydraulic gradient of one foot to the mile. The coefficient of transmissibility is equivalent to the field coefficient of permeability multiplied by the thickness of the aquifer.

The coefficient of permeability of water-bearing materials can be determined in the laboratory (methods summarized by V. C. Fishel in Wenzel, 1942, pp. 56-58) or in the field using any of several methods. The recovery method involving the formula developed by Theis (1935, p. 522) and later described by Wenzel (1942, pp. 94-96) was used in a pumping test on well 8-28-9ab in Sheridan County in the summer of 1952. Results of this test were computed by the Theis recovery formula:

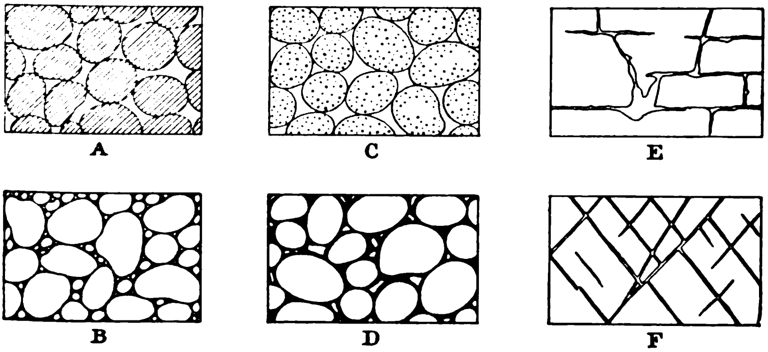

FIG. 6.—Diagrams showing several types of rock interstices and the relation of rock texture to porosity. **A**, well-sorted sedimentary deposit having a high porosity; **B**, poorly sorted sedimentary deposit having low porosity; **C**, well-sorted sedimentary deposit consisting of pebbles that are themselves 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. (From O. E. Meinzer.)

$$T = \frac{264\,Q \log_{10} \frac{t}{t'}}{s'}$$

in which T = coefficient of transmissibility in gallons per day per foot
Q = pumping rate, in gallons a minute
t = time since pumping started, in minutes
t' = time since pumping stopped, in minutes
s' = residual drawdown at the pumping well, in feet, at time t'.

The residual drawdown (s') is computed by subtracting the static (nonpumping) water level from the depth to water level at any time (t') after pumping stops. The proper ratio of $\log_{10}\frac{t}{t'}$ to s' is determined graphically by plotting $\log_{10}\frac{t}{t'}$ against corresponding values of s'. This procedure is simplified by plotting $\frac{t}{t'}$ on the logarithmic scale and s' on the arithmetic scale of semi-logarithmic paper. If $\log\frac{t}{t'}$ is taken over one log cycle it will become unity and the equation becomes simply $T = \frac{264\,Q}{\Delta s'}$ in which $\Delta s'$ is the difference in drawdown (s') over one log cycle.

Well 8-28-9ab, an irrigation well on the farm of A. M. Shatzell, was pumped for approximately 8 hours on October 8, 1952. Measurements of drawdown were made with a tape and an electric gage during the period of pumping, and measurements of recovery were made for a period of nearly 2 hours after the pump was shut down. The well was pumped at an average rate of 403 gallons a minute (determined by a Collins flow gage); at the end of pumping the drawdown was 63 feet and the specific capacity was about 6.4 gallons per minute per foot of drawdown.

The computations for permeability and transmissibility are as follows:

$$T = \frac{264 \times 403}{2.10} = 50{,}700 \text{ gpd/ft}$$

$$P = \frac{50{,}700}{114} = 445 \text{ gpd/sq. ft.}$$

The transmissibility is computed to be about 50,000 gallons per day per foot and the coefficient of permeability, determined by dividing the transmissibility by the thickness of the aquifer (114 feet), is about 450 gallons per day per square foot.

THE WATER TABLE AND MOVEMENT OF GROUND WATER

The water table is defined as the upper surface of the zone of saturation, except where that surface is formed by an impermeable rock. If the upper surface is formed by an impermeable rock, the water will rise in a drill hole to a point where the pressure from the aquifer is equalized. Under such conditions the aquifer is said to be under artesian pressure and the upper surface of the water when it rises in the drill hole is a point on the piezometric surface. The piezometric surface is the surface to which water from a given aquifer will rise under its full head. There may be small local areas in Sheridan County where the water is under slight artesian pressure because the rock at the surface of the zone of saturation is relatively impermeable clay or silt, but these areas are negligible; ground water generally will not rise in a well or drill hole above the level at which it is tapped. The water table is not a level surface but rather a sloping surface having many irregularities caused by differences in permeability or thickness of the aquifer or by unequal additions to or withdrawals from the ground-water reservoir.

The shape and slope of the water table in Sheridan County are shown on the map (Pl. 1) by means of contour lines drawn on the water table. Each point on the water table along a given contour line has the same altitude. The contour lines show the configuration of the surface of the ground-water body just as topographic contour lines show the configuration of the land surface. The direction of movement of ground water is at right angles to the coutour line in the direction of the downward slope. The water-table contour map is generalized and minor variations in the surface of the ground-water body cannot be shown because the wells in Sheridan County are spaced too widely.

The water-table contour map (Pl. 1) shows that the water moves across Sheridan County in a general easterly direction. The minor exceptions probably are caused by variations in recharge, discharge, and topographic conditions. Along the major streams ground water moves toward the valleys and in some places it moves nearly at right angles to the direction of the general movement of ground water. In the upland area where the water-table contours are fairly uniform the water table slopes eastward at the rate of approximately 15 feet per mile. In areas along the edges of the major valleys where the water moves toward the streams, the slope of the water table is as much as 50 feet per mile. The major valleys in the county exert much influence on the shape of the water table. Contours bend upstream along all the streams in the easten half of the county, indicating that the ground-water reservoir is losing water to the streams. In parts of western Sheridan County the water-table contours bend downstream indicating that the ground-water body is gaining water from the streams. At the point where the contour lines change from bending downstream to upstream, the stream changes from intermittent to perennial. Figure 7 shows the relation between streams and the water table. Streams that lose water to the ground-water reservoir are called influent streams and

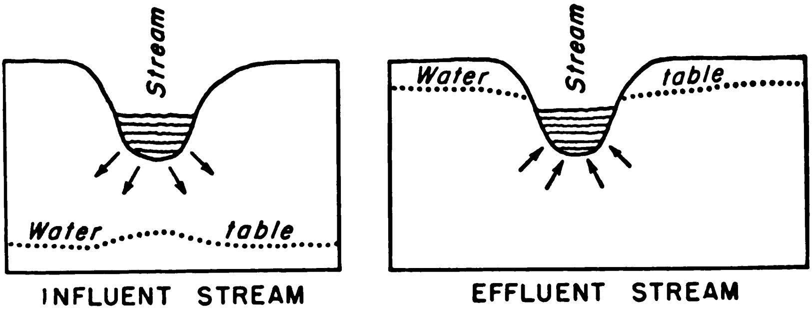

FIG. 7.—Diagrammatic sections showing influent and effluent streams.

streams that gain water from the ground-water reservoir are called effluent streams.

The water table does not remain in a stationary position but fluctuates much the same as the water level in a surface reservoir. Precipitation may cause recharge to the ground-water reservoir with the result that the water table will rise. If the rate of discharge of ground water exceeds the rate of recharge the water table will decline. In Sheridan County, as well as in the greater part of northwestern Kansas, these changes in water table are not great. No long-term records of the depth to water in wells in Sheridan County are available, but records of wells in Thomas County show that over a period of about 10 years the water levels there have fluctuated a maximum of about 6 feet.

RECHARGE AND DISCHARGE

Recharge is the addition of water to the ground-water reservoir and may be accomplished in several ways. All ground water in Sheridan County that lies within a practicable drilling depth, which in this report is considered to include the ground water in the Pleistocene and Pliocene deposits, is derived from precipitation either within the county or in adjacent areas to the west. Once the water becomes a part of the ground-water body, it moves in the direction of the slope of the water table to be discharged by wells, into streams, or by evaporation and transpiration in the valleys where the water table is relatively shallow. Some ground water is discharged as underflow into adjacent areas to the east.

Although the normal annual precipitation at Hoxie in Sheridan County is 19.35 inches, only about 0.25 inch of this amount enters the ground-water body as recharge. The depth to the water table exerts an important influence on the quantity of recharge in any given area. Probably the most important factor controlling recharge in Sheridan County is the type of material overlying the water table. The upland areas mantled by thick deposits of Pleistocene loess are relatively impervious and permit very little water to move downward to the water table; hence, the recharge in these areas is relatively small. Along the flanks of the major valleys where permeable beds of the Ogallala formation crop out, recharge probably is considerably greater. In those valleys where the younger valley deposits consist of sandy silt and sand, the permeability is relatively high and the amount of recharge is also high.

In areas where the beds of streams lie above the water table there is considerable recharge by infiltration through stream channels during periods of stream runoff. In times of flood when the level of a perennial stream rises above the water table in adjacent alluvial and terrace deposits, some water is added to the ground-water reservoir from the stream, but much of the water may return to the stream after the flood has passed. Farm ponds in the upland areas probably contribute water to the ground-water reservoir, but the quantity is small because of the low permeability of the materials in which the ponds generally are built.

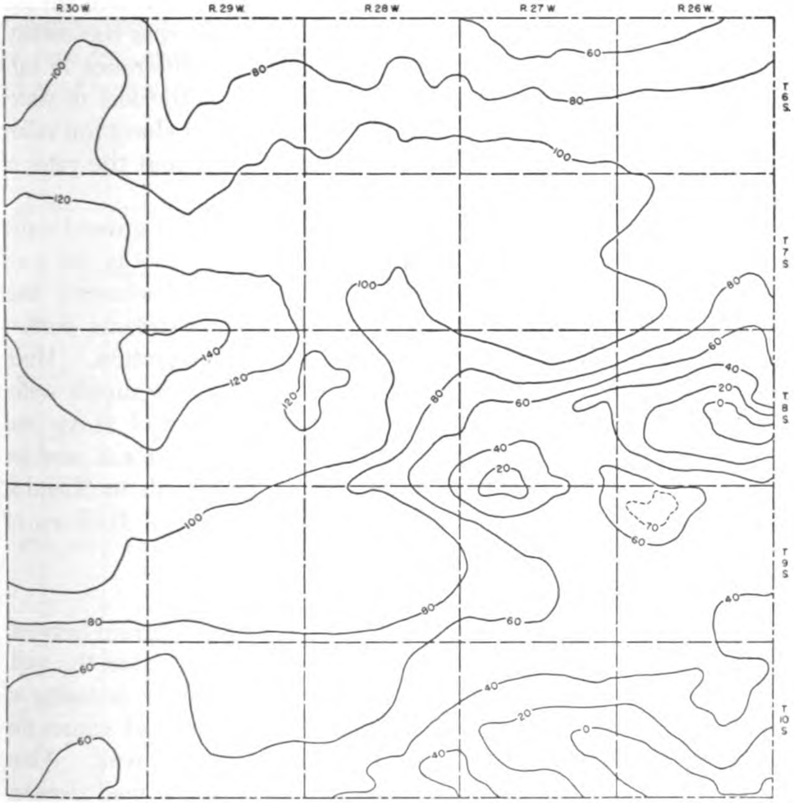

Fig. 8.—Map of Sheridan County showing saturated thickness of Tertiary and Quaternary deposits.

Water moving into the county from the west by means of subsurface inflow is a form of recharge in Sheridan County although the water actually enters the ground-water reservoir outside Sheridan County. The map showing the thickness of saturated Pliocene and Pleistocene sediments (Fig. 8) and the cross sections (Fig. 4) indicate a greater thickness of saturated material on the west side of the county than on the east side. If the permeability of water-bearing materials is everywhere the same, it is apparent that more water enters the county by subsurface flow than leaves the county by this method. This is no doubt true and the difference in quantities of ground water moving into and out of the county are accounted for in part by the discharge of ground water into streams and the resultant gain in flow of streams as they cross the county. The most important factor in accounting for the difference in subsurface inflow and outflow in Sheridan County is the loss of water by evaporation and transpiration in the valleys and along the valley flanks where the water table is relatively shallow and the rates of evaporation and transpiration are high.

Before wells were drilled in Sheridan County the ground-water reservoir was in a state of approximate equilibrium, that is, the average annual recharge balanced the average annual discharge. Discharge was accomplished primarily by seepage into streams, outflow into adjacent areas, and evaporation and transpiration. Much ground water is now being discharged by wells as they supply water for all domestic and most stock needs. The cities of Hoxie and Selden obtain water from wells, and some ground water is used for irrigation. The discharge of ground water from wells in Sheridan County, however, is small in comparison with the total discharge of ground water.

RECOVERY

When water is standing in a well, there is an equilibrium between its head and the head of the water in the aquifer outside the well. When the head of the water in the well is reduced by pumping or some other lifting device, the resultant differential head causes the water outside the well to move toward and into the well. When water is pumped from a well, the water level in the well declines and the water table outside the well is lowered to form a depression resembling an inverted cone—the cone of depression. The distance that the water level is lowered is called the drawdown.

The total capacity of a well is the rate at which it will yield water when the water stored in it has been removed. The capacity depends on the thickness and permeability of the aquifer, the amount of water available, and the construction and condition of the well. The capacity of a well is generally expressed in gallons a minute. The specific capacity of a well is its rate of yield for each unit of drawdown and is determined by dividing the yield of the well in gallons a minute by the drawdown in feet.

When water is withdrawn from a well at a constant rate, the water level declines rapidly at first and then more slowly until the water level becomes nearly stationary. An increase in the pumping rate will again lower the water level until it again becomes nearly stationary. When the pumping of a well is stopped, the water level rises rapidly at first and then more slowly until it eventually reaches or approaches its original position. Curves showing the drawdown and recovery of the water level in well 8-28-9ab during a pumping test are illustrated in Figure 9.

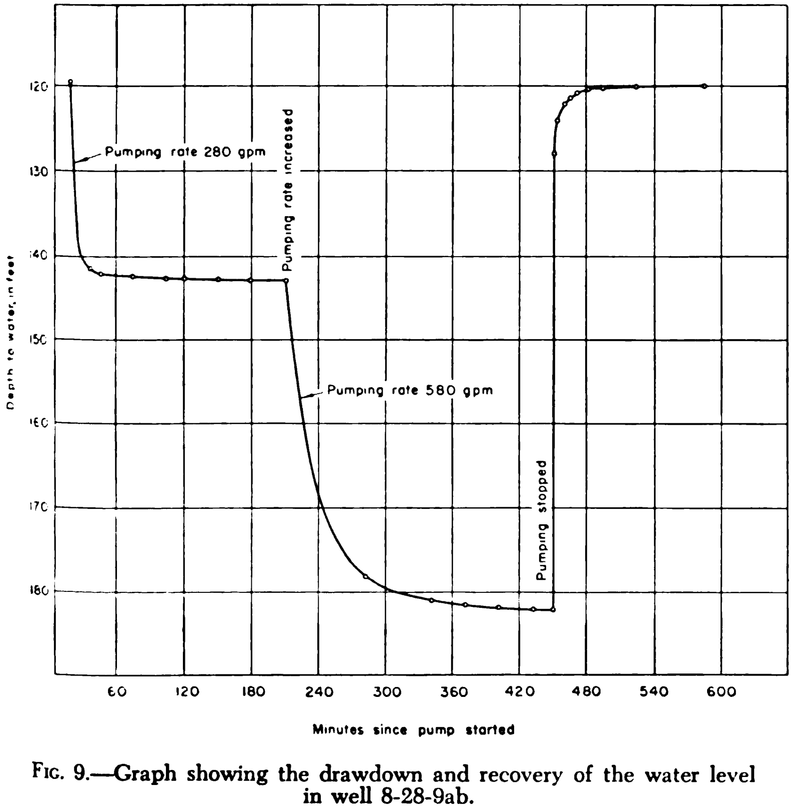

Fig. 9.—Graph showing the drawdown and recovery of the water level in well 8-28-9ab.

Utilization

Data on 160 wells in Sheridan County were obtained during the course of this investigation. All types of wells in all parts of the county were visited and studied. Ground water in Sheridan County is used chiefly for domestic and stock purposes. Two cities obtain their public water supplies from wells but the quantity of ground water they use is only a small fraction of the total amount of ground water used in the county. Five irrigation plants were observed during this investigation but only one well (8-28-9ab) was in operation during the summer of 1952. Records of wells inventoried during the field work for this report are given in Table 7.

Domestic and Stock Supplies

Nearly all domestic and stock-water supplies in the rural areas in Sheridan County are derived from wells, although a few stock-water supplies are obtained from ponds. Smaller towns in the county that do not have public supplies use water from wells. Analyses of water from typical wells in the area indicate that the water is of good quality although water from some wells is relatively hard. The data for the domestic and stock wells are given in Table 7 and the chemical character of the water is shown in Table 5.

Public Supplies

Two cities in Sheridan County have public water supplies. Hoxie, the county seat, is supplied by two wells at the west edge of the city that yield water from the Ogallala formation. The Hoxie supply has a rated capacity of 800,000 gallons per day and the average daily use is about 300,000 gallons. Water is chlorinated at the wells and receives no other treatment.

Selden pumps water from two wells near the center of the city. The wells obtain water from the Ogallala formation and are 200 feet deep. The wells are spaced about 20 feet apart and only one well is pumped, the other being used as an emergency well in case of mechanical difficulty in the main well. Rated capacities are 140 gallons per minute for the main well and 60 gallons per minute for the "stand by" well. The wells are equipped with turbine pumps powered by electric motors. The average daily use of water at Selden is about 30,000 gallons. The water is of good quality and is not treated.

The city of Grinnell in Gove County has a public water supply derived from a well in Sheridan County. The well obtains water from the Ogallala formation and is 150 feet deep. It is equipped with a turbine pump powered by an electric motor. The average daily use is about 30,000 gallons. The water is of good quality and is not treated.

Data concerning the city-supply wells are given in Table 7.

Irrigation Supplies

A relatively small amount of water is used in Sheridan County for irrigation. Five irrigation wells were observed during the course of this investigation (Table 7) but only one (well 8-28-9ab) was in operation during the summer of 1952. The well is 205 feet deep, has a static water level of 119 feet below land surface, and is equipped with a turbine pump powered by a gasoline engine. During a pumping test, the well yielded 580 gallons per minute with a drawdown of 63 feet. The specific capacity of the well was 9.2 gallons per minute per foot of drawdown. The well is used to irrigate about 140 acres.

Two of the irrigation wells observed in the county (6-27-3dd and 10-29-20cc) obtain water from both the Ogallala formation and from Pleistocene deposits; the others obtain water entirely from the Ogallala formation. The chemical analyses of water from typical wells in the county indicate that the water is suitable for irrigation use (Table 3).

Availability of Ground Water for Future Irrigation Development

The availability of ground water for future development of irrigation in Sheridan County is determined by the geology and hydrology of the area. The amount of water available for irrigation depends on the permeability, areal extent, and thickness of the water-bearing materials. The areal extent and thickness of the water-bearing materials in Sheridan County are shown in Figure 8 by means of contours. This map was prepared by superposing the water-table contour map (Pl. 1) on the bedrock contour map (Fig. 5), then subtracting the altitude of the bedrock from the altitude of the water table at points of intersection. Contour lines were then drawn through points of equal thickness.

The contours indicate that the thickness of saturated materials is more than 140 feet in west-central Sheridan County and decreases considerably in the southeastern part of the county in the Saline River valley and in the east-central part of the county along the South Fork Solomon River valley. Well 8-28-9ab yields 580 gallons per minute of water from about 114 feet of saturated material. In other areas with as much saturated material wells should yield comparable quantities of water if the water-bearing materials are as permeable as they are at well 8-28-9ab. In general, the permeability of the Ogallala formation is comparatively low and the lithology of the formation changes in short distances. However, test drilling should locate permeable sand and gravel in much of the county. A well that yields 500 gallons a minute will pump an amount of water in a 24-hour period equal to two-thirds inch on 40 acres.

In some of the valley areas the map of saturated thickness indi-

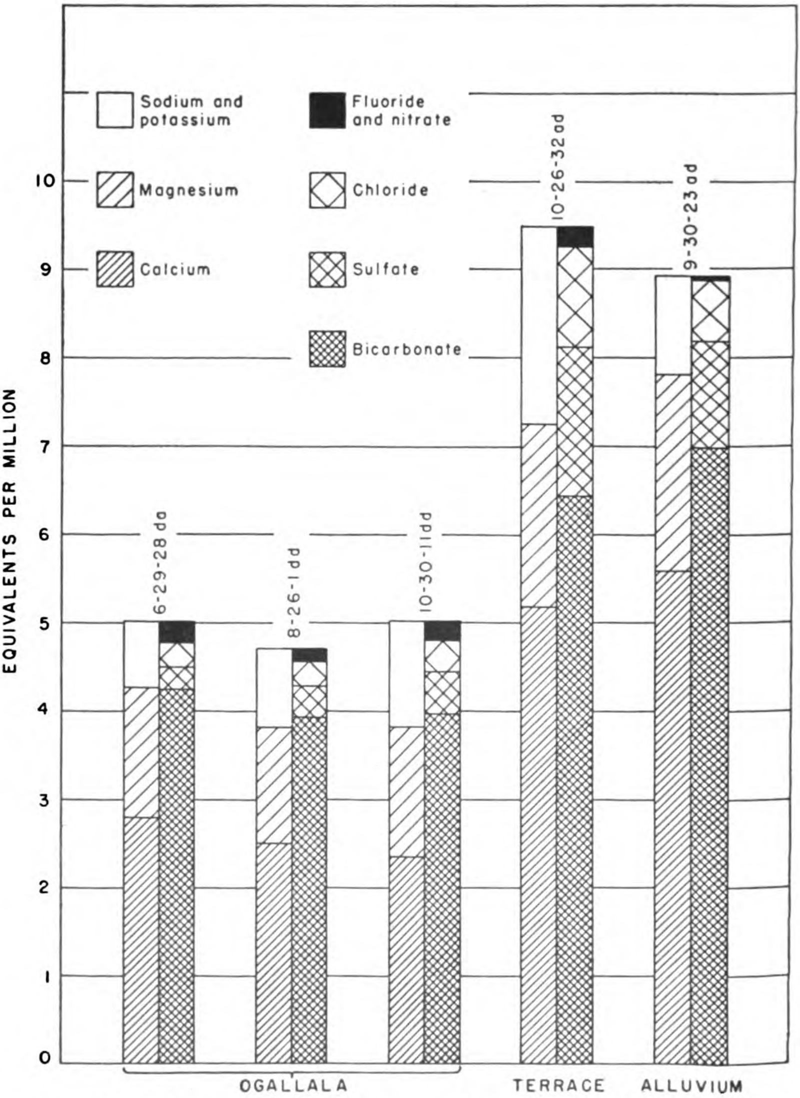

FIG. 10.—Graphical representation of analyses of water from wells in Sheridan County.

cates a thinning of saturated material. This water-bearing material is generally more permeable than water-bearing beds in the Ogallala formation, however, so wells of large capacity can be developed.

CHEMICAL CHARACTER OF GROUND WATER

The chemical character of ground water in Sheridan County is shown by analyses of water from 18 wells representing the principal water-bearing formations (Table 3). Figure 10 shows graphically the chemical character of waters from the Ogallala formation, terrace deposits, and alluvium.

The concentration of mineral constituents is given in equivalents per million in Figure 10, and in parts per million in Table 3. To convert parts per million to equivalents per million the valence of each mineral constituent is divided by its atomic weight; then this factor (listed in Table 4) is multiplied by the parts per million given in Table 3 for each mineral constituent.

TABLE 4.—*Factors for converting parts per million to equivalents per million*

Mineral constituents	Chemical symbol	Factor
Calcium	Ca^{++}	0.0499
Magnesium	Mg^{++}	.0822
Sodium	Na^{+}	.0435
Carbonate	CO_3^{-}	.0333
Bicarbonate	HCO_3^{-}	.0164
Sulfate	SO_4^{--}	.0208
Chloride	Cl^{-}	.0282
Nitrate	NO_3^{-}	.0161
Fluoride	F^{-}	.0526

The samples of water from typical wells in Sheridan County were analyzed by Howard A. Stoltenberg, chemist, in the Water and Sewage Laboratory of the State Board of Health at Lawrence. The analyses show only the dissolved mineral content of the water and do not indicate sanitary conditions. The analyses indicate that the water is suitable for most uses.

Chemical Constituents in Relation to Use

The following discussion of the chemical constituents of ground water has been adapted in part from publications of the U. S. Geological Survey and the State Geological Survey of Kansas. A summary of the dissolved solids, hardness, iron, and fluoride of samples of water from typical wells in Sheridan County is given in Table 5.

Dissolved Solids

Ground water dissolves some of the rock materials with which it comes in contact. After a natural water has been evaporated, the residue consists of mineral matter and some organic matter and water of crystallization. The kind and quantity of these minerals in water determine its suitability for various uses. Water containing less than 500 parts per million of dissolved solids generally is considered satisfactory for domestic use, except for difficulties resulting from hardness or excessive iron content. Water containing more than 1,000 parts per million of dissolved solids may contain enough of certain constituents to cause a noticeable taste or to make the water unsuitable for use in some other respect. The amount of dissolved solids in the 18 samples collected in Sheridan County is given in Table 3. Of the 18 samples collected, 15 contained less than 500 parts per million of dissolved solids, 2 contained between 500 and 1,000 parts per million, and 1 contained more than 1,000 parts per million.

Hardness

Hardness is the property of water that generally receives the most attention, probably because it is recognized easily by its effect when soap is used with water. Hard water requires more soap to form suds. Nearly all hardness in water is caused by calcium and magnesium and these constituents also cause most of the scale formed in steam boilers or other vessels in which water is heated. In addition to total hardness Table 3 gives the carbonate and noncarbonate hardness. The carbonate hardness is due to the presence in the water of calcium and magnesium bicarbonate and may be almost entirely removed by boiling or by a simple softening treatment. Noncarbonate hardness is caused by the presence of sulfates, chlorides, nitrates, and fluorides of calcium and magnesium. Carbonate hardness is called temporary hardness and noncarbonate hardness is called permanent hardness.

Water having a hardness of 50 parts per million or less is considered soft and treatment of such water is not necessary under ordinary circumstances. Water having 50 to 150 parts per million hardness is suitable for most purposes but the use of soap increases and water in the upper part of this range of hardness should be treated for use in boilers or vessels in which water is heated. A hardness of more than 150 parts per million is easily noticeable and the water should be softened for many uses. If the hardness is 200 parts per million or more, the water should be softened for most uses. Where municipal supplies are softened the hardness generally is reduced to less than 100 parts per million.

TABLE 5.—*Summary of dissolved solids, hardness, iron, and fluoride in water from typical wells in Sheridan County*

Range in parts per million	Number of samples		
	Ogallala formation	Terrace deposits	Alluvium
Dissolved solids			
Less than 250	1	0	0
251–500	12	1	1
501–1,000	0	2	0
More than 1,000	0	1	0
Total hardness			
150–300	13	1	0
301–500	0	2	1
More than 500	0	1	0
Iron			
Less than 0.1	3	2	0
0.1 –0.3	2	1	1
0.31–1.0	5	1	0
More than 1.0	3	0	0
Fluoride			
0.5–1.0	8	3	1
1.1–1.5	5	1	0
More than 1.5	0	0	0

None of the samples of water collected in Sheridan County had a hardness less than 150 parts per million, 14 had a hardness between 150 and 300 parts per million, and 4 had a hardness of more than 300 parts per million (Table 5).

Iron

Next to hardness, iron is the mineral constituent in ground water that receives the most attention in everyday use. The quantity of iron in ground water may differ considerably from place to place even within the same formation. If iron is present in water in a concentration greater than 0.3 part per million, the excess may precipitate upon exposure to air. The rusty stain on vessels and plumbing fixtures is commonly caused by excess iron in the water. Generally, where iron is present in sufficient quantity to give a disagreeable taste or to stain utensils, it may be removed by aeration and filtration but in some water further treatment is necessary to remove the iron. The chemical analyses (Table 3) indicate that the concentrations of iron in samples of water from Sheridan County ranged from 0.02 to 12 parts per million. Nine samples contained less than 0.3 part per million, 6 samples contained between 0.3 and 1 part per million, and 3 samples contained more than 1 part per million (Table 5).

Fluoride

Although quantities of fluoride are relatively small as compared with other common constituents of natural water, the amount of fluoride in drinking water that is used by children should be known. Fluoride in water has been associated with the dental defect known as mottled enamel, which may appear on the teeth of children who habitually drink water containing excessive amounts of fluoride during the formation of their permanent teeth. Water containing 1.5 parts per million or more of fluoride is likely to produce mottled enamel (Dean, 1936). Small quantities of fluoride in the drinking water not sufficient to cause mottled enamel are likely to be beneficial by preventing or decreasing the incidence of caries in the permanent teeth of children (Dean and others, 1941). Fluoride has been added to some public water supplies in recent years, generally in concentrations of about 1 part per million.

The concentration of fluoride in samples of water collected in Sheridan County ranged from 0.5 to 1.6 parts per million; only one sample contained more than 1.5 parts per million (Table 3).

Nitrate

Nitrate in natural water has received considerable attention during the last few years because of the discovery that a large amount of nitrate in water may cause cyanosis when the water is used in infant feeding. The Kansas State Board of Health considers water containing less than 50 parts per million of nitrate (as NO_3) safe for use and water containing more than 90 parts per million likely to cause cyanosis.

The concentration of nitrate in the samples of water collected in Sheridan County (Table 3) ranged from 0.6 to 11 parts per million —well within the limit for safe use.

Chemical Quality of Water for Irrigation

The suitability of water for irrigation is dependent principally on the concentration of dissolved solids in the water and the percent of sodium. High concentrations of some mineral constituents are detrimental to plant growth although some plants are more tolerant to certain minerals than others. Plants may be classed in groups as to their tolerance to salinity of the soil. In the first group, which includes those plants that are the least tolerant to salinity, are beans, celery, radishes, red clover, and white clover; in the second group, which includes plants more tolerant to salinity, are rye, oats, wheat, sweet clover, alfalfa, and peas; and in the third group, which includes the most tolerant plants, are barley, milo, sugar beets, cotton, and most grasses.

The approximate critical concentrations or percentages of different constituents in irrigation water (below which it is safe for irrigation use and above which it may be unsafe for irrigation use) are given in Table 6 (Marr, 1944).

TABLE 6.—*Suitability of water for irrigation use*

Classes of water	Dissolved solids, ppm	Percent sodium	Boron, ppm	Chloride, ppm	Sulfate, ppm
1. Good	Less than 525	Less than 40	Less than 2.0	Less than 248	Less than 336
2. Permissible	525—1,400	40—60	2.0—3.0	248—426	336—576
3. Doubtful	1,400—2,100	60—80	3.0—3.75	426—710	576—960
4. Unsuitable	more than 2,100	more than 80	more than 3.75	more than 710	more than 960

The permissible ranges of concentration of solids given in Table 6 will differ somewhat for different soil, climate, and drainage. Water with high concentration of dissolved solids will have less effect on plant growth in well-drained soils than it will have in poorly drained soils. The use of irrigation water having a high mineral content may cause the soil to become less porous or permeable and, in time, the soil may become alkaline.

The concentrations of dissolved solids, chloride, and sulfate and the percent sodium in samples of water collected in Sheridan County were all within the limits of suitability for irrigation (Table 3). Although the content of boron in ground water in Sheridan County was not determined, the content in ground water from the same aquifers in adjacent areas is within the limits of suitability for irrigation (Leonard, 1952, p. 76).

RECORDS OF WELLS

Information pertaining to 160 water wells in Sheridan County is tabulated in the following pages (Table 7). The well-numbering system used in this table is described on page 10.

TABLE 7.—*Records of wells and springs in Sheridan County, Kansas*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement, (1952)	REMARKS (Yield given in gallons a minute; drawdown in feet)
						Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
T. 6 S., R. 26 W.															
6-26-7aa	A. M. Stephenson	Dr	150.0	5	GI	Sand, gravel	Ogallala	N	N	Top of casing	1.2	2,628.3	139.80	9-24	
6-26-10dd	Frank Trypkosh	Dr	124.0	6	GI	do	do	Cy,W	S	do	1.0	2,586.6	121.62	9-24	
6-26-12ad	L. A. Teel	Dr	63.0	5	GI	do	do	Cy,H,W	S	do	.8	2,506.3	57.44	8-11	
6-26-20bb	H. O. Hardesty	Dr	158.8	5	GI	do	do	Cy,W	S	do	.8	2,657.0	154.82	9-24	
6-26-21dc	W. J. Mowery	Dr	176.0	5	GI	do	do	Cy,W	D	do	.6	2,638.4	148.80	9-23	
6-26-35cc	Franklin Life Ins. Co.	Dr	133.5	5	GI	do	do	N	N	do	.4	2,604.7	128.56	9-23	
6-26-36da	F. Wood	Dr	128.0	5	GI	do	do	Cy,H,W	N	do	.2	2,577.3	116.12	7-24	
T. 6 S., R. 27 W.															
6-27-3dd	C. E. Carlton	Dr	60.0	12	OW	do	Terrace	T,T	I	Top of concrete platform	.8	2,561.1	30.80	9-24	
6-27-4cc	W. E. Brales	Dr	36.0	6	GI	do	do	Cy,W	S	Top of casing	.7	2,577.8	24.60	9-24	
6-27-6dd	H. Bates	Dr	120.5	5	GI	do	Ogallala	Cy,W	S	do	.8	2,678.9	105.17	9-24	
(6-27-10ab)	School district	Dr	90.0	6	GI	do	Terrace	Cy,H	D, S	Land surface		2,560.2	29.36	8-22	Shale at 64 feet
6-27-13cc	C. Cramer	Dr	128.0	5	GI	do	Ogallala	Cy,H,W,E	D, S	Base of pump	1.40	2,638.2	121.08	9-24	
6-27-17aa	M. H. Bowman	Dr	50.0	6	GI	do	Terrace	Cy,H	N	Top of casing	1.90	2,601.3	44.08	9-24	
6-27-26cd	N. S. French	Dr	152.5	6	GI	do	Ogallala	Cy,H	N	do	2.50	2,688.3	156.92	9-24	
6-27-33dc	E. W. McCulloch	Dr	156.0	6	GI	do	do	Cy,W	S	do	1.10	2,706.5	148.20	9-24	
T. 6 S., R. 28 W.															
6-28-6aa	A. Trommeter	Dr	148.0	6	GI			Cy,W	S	Base of pump	1.00	2,793.9	124.60	9-29	
6-28-10da	J. W. Harold	Dr	138.0	6	GI	Sand, gravel	Ogallala	Cy,H,W	N	do	.3	2,760.8	127.42	9-25	
6-28-21aa	C. Spresser	Dr	85.0	6	GI	do	do	Cy,H,W	S	do	.5	2,692.1	56.60	9-25	
6-28-25cb	School district	Dr	119.0	5	GI	do	do	Cy,H	N	do	.3	2,708.7	94.92	9-25	
6-28-26aa	S. A. Draelants	Dr	48.0	6	GI	do	Alluvium and Ogallala	Cy,W,H	D, S	do	.8	2,645.4	46.00	9-25	
6-28-28ad	Scott Harold	Dr	66.0	5	GI	do	Ogallala	Cy,H	N	do	.2	2,681.7	41.68	9-25	
6-28-30ab	S. Godfrey	Dr	38.5	6	GI	do	Alluvium	Cy,W	N	Top of casing	.3	2,695.7	31.64	9-25	

T. 6 S., R. 29 W.														
6-29-9cc1	Town of Selden	Dr	200	12	OW	do.	Ogallala	T,E	P	Base of pump	1.3	2,835.5	117.60	10-10	140 gpm
6-29-9cc2	Town of Selden	Dr	200	10	OW	do.	do.	T,E	P					10-10	60 gpm
6-29-11ab	M. Koerperich	Dr	138.0	6	GI	do.	do.	Cy,W	N	Base of pump	0.3	2,830.4	131.00	9-29	
6-29-16aa	Selden Cemetery	Dr	135.0	6	GI	do.	do.	Cy,W	N	Top of casing	.7	2,825.6	114.36	9-25	
6-29-25bc	J. J. Sulsman	Dr	57.0	5	GI	do.	do.	Cy,N	D, S	do.	.5	2,747.0	46.41	9-25	
(6-29-28da)	M. E. Schoen	Dr	142.0	5	GI	do.	do.	Cy,W	S	Base of pump	.9	2,828.1	108.46	9-25	
6-29-4bb	L. Wiggens	Dr	63.0	6	GI	do.	do.	Cy,W	N	do.	1.2	2,756.3	49.50	9-29	
T. 6 S., R. 30 W.														
6-30-2cc	P. Zimmerman	Dr	20.0	6	GI	do.	do.	Cy,W,H	D	do.	1.0	2,797.4	13.55	9-29	
6-30-8dc	A. R. Emmahizer	Dr	32.6	5	GI	do.	Ogallala and Alluvium	Cy,W	S	Top of casing	1.2	2,836.9	29.64	9-29	
6-30-11bc	A. Wachendoffer	Dr	86.5	5	GI	do.	Ogallala	Cy,W	N	Base of pump	.1	2,859.0	74.80	9-29	
6-30-12aa	R. Beckford	Dr	117.0	5	GI	do.	do.	Cy,W	S	Top of casing	.3	2,850.8	107.61	9-4	
6-30-12bd	G. B. Shields	Dr	130.0±	5	GI	do.	do.	Cy,W	S	Top concrete platform	1.1	2,860.6	100.54	6-23	
6-30-27dc	I. W. Reed	Dr	138.0	6	GI	do.	do.	Cy,W	N	Base of pump	.6	2,901.5	106.10	9-29	
6-30-30aa	M. Rogers	Dr	135.0	5	GI	do.	do.	Cy,W	S	Top of casing	.4	2,938.1	118.60	9-29	
T. 7 S., R. 26 W.														
7-26-5bb	S. Bangle	Dr	158.0	6	GI	do.	do.	N	N	Top of concrete platform	.6	2,646.0	138.60	9-23	
7-26-14aa	C. McFadden	Dr	146.0	5	GI	do.	do.	Cy,W	S	Top of casing	.3	2,596.5	132.35	9-23	
7-26-16dd	School district	Dr	185.0	5	GI	do.	do.	Cy,W	D, S	Base of pump	.6	2,635.7	149.61	8-30	
7-26-19ab	E. Trueblood	Dr	152.0	4	GI	do.	do.	N	D	Top of casing	6.0	2,626.5	126.35	8-30	
7-26-21dd	F. A. Smith	Dr	112.6	5	GI	do.	do.	Cy,W	N	do.	1.2	2,584.4	100.33	9-23	
7-26-35cd	C. C. Crofoot	Dr	101.0	5	GI	do.	do.	Cy	N	Base of pump	.4±	2,538.9	87.64	8-30	
T. 7 S., R. 27 W.														
(7-27-11cd)	K. A. Dehert	Dr	126.5	6	GI	do.	do.	Cy,W	D, S	Top of casing	1.0	2,659.4	119.40	9-24	
7-27-18ad	W. French	Dr	164.0	5	GI	do.	do.	Cy,W	N	do.	.9	2,740.2	158.65	9-24	
7-27-28ab	C. H. Davis	Dr	136.5	5	GI	do.	do.	N	N	do.	.6	2,676.3	125.08	9-24	
7-27-32ab	N. Waldern	Dr	126.0	6	GI	do.	do.	Cy,W	N	do.	1.0	2,677.1	92.40	9-24	
7-27-36dd	C. Bell	Dr	161.0	6	GI	do.	do.	Cy,W	S	do.	1.2	2,629.4	95.40	9-23	
T. 7 S., R. 28 W.														
7-28-6cc	Paul Richer	Dr	152.0	5	GI	do.	do.	N	N	do.	0.6	2,828.7	146.40	9-27	
7-28-11cd	J. Oelke	Dr	179.5	6	GI	do.	do.	Cy,H	D	do.	.6	2,774.9	161.29	9-25	
7-28-12ad	W. H. Schruben	Dr	148.0	6	GI	do.	do.	Cy,H	N	do.	1.3	2,733.1	142.60	9-24	
7-28-17dd	A. Selbe	Dr	140.0	5	GI	do.	do.	Cy,W	N	do.	.5	2,780.0	125.74	9-27	
7-28-26bc	F. English	Dr	140.0	5	GI	do.	do.	Cy,W	S	do.	.2	2,749.6	129.64	9-25	
7-28-28dd	V. Schwarts	Dr	128.0	6	GI	do.	do.	Cy,H,W	N	Top of casing	1.0	2,752.8	109.29	8-12	

TABLE 7.—*Records of wells and springs in Sheridan County, Kansas—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement, (1952)	REMARKS (Yield given in gallons a minute; drawdown in feet)
						Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
T. 7 S., R. 29 W.															
7-29-2bc	R. Selbe	Dr	96.0	5	GI	Sand, gravel	Ogallala	Cy,W	S	Top of casing	1.0	2,795.7	74.60	9-27	
7-29-5ba	W. R. Vaughn	Dr	83.5	5	GI	do.	do.	N	S	do.	.6	2,812.2	63.58	9-27	
7-29-13dd	Sheridan County	Dr	112.0	4	N	do.	do.	N	N	Land surface	....	2,802.0	110.50	9-27	Core hole
7-29-16dd	School district	Dr	136.0	5	GI	do.	do.	Cy,W,H	D, S	Base of pump	.1	2,856.3	122.90	9-27	
7-29-26cd	J. Loub	Dr	138.0	5	GI	do.	do.	Cy,H	N	do.	1.4	2,847.7	128.20	9-29	
7-29-28dd	T. Vaughn	Dr	138.0	5	GI	do.	do.	Cy,W	D, S	Top of casing	0	2,861.8	115.60	9-27	
7-29-36da	I. H. Haffedits	Dr	145.0	6	GI	do.	do.	Cy,W	D, S	Base of pump	.6	2,823.0	136.71	9-29	
T. 7 S., R. 30 W.															
7-30-14bb	C. McCormick	Dr	....	6	GI	do.	Ogallala and Alluvium	N	N	Top of casing	.5	2,838.7	25.0±	9-29	
(7-30-18aa)	A. Armstrong	Dr	67.0	6	GI	do.	Ogallala	Cy,W	D, S	Base of pump	.6	2,909.3	61.00	10.13	
7-30-20ad	E. Gilchrist	Dr	140.0	5	GI	do.	do.	Cy,W	N	do.	1.4	2,939.9	108.40	10-13	
7-30-26cd	E. Johnson	Dr	147.0	5	GI	....	....	N	N	Top of casing	.3	2,918.9	118.28	9-29	
T. 8 S., R. 26 W.															
(8-26-1dd)	F. Brits	Dr	199.0	5	GI	Sand, gravel	Ogallala	Cy,H,W	D, S	do.	.5	2,530.5	108.72	9-16	
8-26-5aa	L. N. Sawyer	Dr	148.0	6	GI	do.	do.	Cy,W	D, S	Base of pump	.1	2,595.1	96.50	9-23	
8-26-17cb	T. Conrad	Dr	55.0	5	GI	do.	do.	Cy,H	N	Top of casing	.2	2,500.9	48.67	8-12	
8-26-18bc	F. Kames	Dr	21.0	6	GI	do.	Terrace	Cy,H	D, S	Base of pump	.2	2,469.4	15.81	9-23	
8-26-20da	C. Crofoot	Sp	....	....	....	do.	Ogallala and Sanborn	N	N	....	....	....	flows	9-23	
8-26-26ca	E. W. Coltrin	Dr	42.0	6	GI	do.	Ogallala	Cy,G	D, S	Base of pump	0.7	2,467.6	29.96	9-23	
8-26-28bb	D. G. Hansen	Dr	18.0	5	GI	do.	Alluvium and terrace deposits	Cy,H	D	do.	1.0	2,445.5	10.14	9-23	
T. 8 S., R. 27 W.															
8-27-9cc	E. B. Mickey	Dr	28.6	5	GI	do.	Ogallala	Cy,W	S	Top of casing	.8	2,573.3	25.49	9-20	
(8-27-14bd)	F. Houseworth	Dr	24.0	6	GI	do.	Terrace deposits	Cy,H	D	Base of pump	.1	2,497.5	16.41	9-23	

8-27-17da	**B. F. Taylor**	Dr	16.0	6	GI	do.	Alluvium	Cy,H	D	do.	.1	2,556.2	8.90	9-20	
8-27-25bc	**W. Brown**	Dr	116.0	5	GI	do.	Ogallala	Cy,W,H	D, S	do.	.6	2,684.4	108.56	8-26	
8-27-33bb	**School district**	Dr	27.5	5	GI	do.	Terrace deposits	Cy,W,H	D, S	do.	0	2,545.6	8.50	8-26	
T. 8 S., R. 28 W.															
8-28-7ca	C. Buchler	Dr	43.0	6	GI	do.	Ogallala	Cy,W	S	do.	.5	2,716.1	34.81	9-27	
(8-28-9ab)	A. M. Shatzall	Dr	206.0	18	OW	do.	do.	T,G	I	Hole in pump base	.3	2,766.6	119.30	10-8	63 ft. of drawdown at 403 gpm, shale at 233 ft.
8-28-12cc	C. Crum	Dr	89.0	6	GI	do.	do.	Cy,H,W	N	Top of casing	.7	2,677.4	82.88	9-25	
8-28-16dd*1*	City of Hoxie	Dr	....	10	OW	do.	do.	T,E	P	....	....	....	....	....	
8-28-16dd*2*	do.	Dr	....	10	OW	do.	do.	T,E	P	....	....	....	....	....	
8-88-26aa	C. Taylor	Dr	91.2	5	GI	do.	do.	N	N	Top of casing	1.8	2,686.6	78.06	9-17	
8-28-28dd	R. Schambarger	Dr	70	5	GI	do.	do.	Cy,W	S	Base of pump	.4	2,719.7	62.21	9-17	
8-28-33dc	School district	Dr	55.5	8	GI	do.	do.	Cy,H	N, S	Top of casing	.9	2,690.8	49.25	7-7	
T. 8 S., R. 29 W.															
8-29-7ab	H. Feldt	Dr	150.0	5	GI	do.	do.	Cy,W	S	Base of pump	1.3	2,907.5	133.98	10-13	
(8-29-14bc)	E. Buhler	Dr	143.0	5	GI	do.	do.	Cy,W	S	Top of casing	1.0	2,818.0	111.60	10-13	
8-29-36bb	M. A. McIvor	Dr	110.0	5	GI	do.	do.	Cy,W	S	Base of pump	.3	2,798.2	86.94	10-10	
T. 8 S., R. 30 W.															
8-30-6ad	R. L. Hoppas	Dr	110.0	5	GI	do.	do.	Cy,W	D, S	do.	1.0	2,958.4	99.67	10-13	
8-30-10dd	C. M. Dally	Dr	138.0	5	GI	do.	do.	Cy,W	N	do.	.8	2,941.5	116.41	10-13	
8-30-20bb	S. Liegelmeier	Dr	81.0	5	GI	do.	do.	N	N	Top of casing	.8	2,920.4	71.88	10-13	
T. 9 S., R. 26 W.															
9-26-2aa	G. Simon	Dr	35.0	5	GI	do.	do.	Cy,W,H	D, S	do.	.5	2,501.9	19.30	9-30	
9-26-3da	G. McWilliams	Dr	115.0	5	GI	do.	do.	Cy,W	S	Base of pump	1.3	2,614.0	112.19	8-26	
9-26-5ac	W. Transue	Dr	150.0	5	GI	do.	do.	Cy,W,H	D, S	do.	1.2	2,648.3	103.55	8-26	
9-26-10bc	C. Crum	Dr	125.2	5	GI	do.	do.	Cy,W	N	do.	.2	2,629.0	111.68	8-26	
9-26-11ad	M. L. Simon	Dr	81.0	5	GI	do.	do.	N	N	Top of casing	.8	2,658.7	64.68	8-26	
9-26-17dd	G. E. Mills	Dr	152.0	5	GI	do.	do.	Cy,W	S	Base of pump	1.2	2,690.1	143.21	8-25	
(9-26-23ba)	School district	Dr	171.5	5	GI	do.	do.	Cy,W,H	D, S	do.	.5	2,659.2	141.44	8-25	
9-26-30da	L. Breedon	Dr	77.0	5	GI	do.	do.	N	N	Top of casing	.0	2,633.7	60.37	8-25	
T. 9 S., R. 27 W.															
9-27-8cc	C. H. Beers	Dr	136.0	6	GI	do.	do.	N	N	do.	.0	2,745.6	134.60	9-20	
9-27-11cc	Otto Goetz	Dr	132.5	5	GI	do.	do.	Cy,W	S	Base of pump	.5	2,684.3	103.05	8-26	
9-27-19dd	J. Hoffner	Dr	133.0	5	GI	do.	do.	Cy,H,W	D	do.	.2	2,750.4	124.15	9-8	
9-27-23cc	School district	Dr	121.5	5	GI	do.	do.	Cy,W,H	D, S	do.	.1	2,687.7	96.64	8-25	
9-27-33cc	A. Ziegler	Dr	93.0	5	GI	do.	do.	Cy,W	S	Bolt hole in pump	2.8	2,684.6	71.96	9-8	
9-27-35cd	F. Deane	Dr	110.0	5	GI	do.	do.	Cy,W	S	Base of pump	1.0	2,693.7	95.82	8-25	
9-27-36cc	E. Miller	Dr	94.0	5	GI	do.	do.	Cy,W	N	Top of casing	.0	2,677.6	90.24	8-25	

TABLE 7.—*Records of wells and springs in Sheridan County, Kansas—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement, (1952)	REMARKS (Yield given in gallons a minute; drawdown in feet)
						Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
T. 9 S., R. 28 W.															
(9-28-5bc)	M. Clark	Dr	42.0	6	GI	Sand, gravel	Terrace deposits	J,E	D, S	Base of pump	.0	2,688.3	18.41	10-18	
9-28-10bb	M. Dillon	Dr	80	6	GI	do	Ogallala	Cy,W	D, S	do	.2	2,730.7	60.70	9-17	
9-28-15bb	O. Stienshour	Dr	101.5	6	GI	do	do	Cy,W	S	do	.5	2,771.4	99.10	9-17	
9-28-23bb	Sheridan County	Dr	126.0	6	GI	do	do	Cy,W	N	do	.6	2,799.4	112.45	9-8	
9-28-34cb	W. Cressler	Dr	150.0	6	GI	do	do	Cy,W,H	D, S	do	1.2	2,775.4	96.53	9-8	
(9-28-36dc)	T. Humphery	Dr	98.0	6	GI	do	do	Cy,W	S	Bolt hole in pump	1.9	2,690.0	60.48	9-8	
T. 9 S., R. 29 W.															
9-29-5cc	W. Patman	Dr	125.0	5	GI	do	do	Cy,G	S	Base of pump	.3	2,877.8	104.36	10-17	
9-29-10da	T. Pratt	Dr	22.5	5	GI	do	do	Cy,W	S	Top of casing	1.2	2,743.7	14.26	10-18	
9-29-14ac	do	Dr	26.0	6	GI	do	Alluvium	Cy,W,H	D, S	do	.2	2,731.6	10.34	10-18	
(9-29-35ab)	C. Adams	Dr	126.0	5	GI	do	Ogallala	Cy,W	D, S	Top of casing	1.3	2,852.9	104.00	10-18	
T. 9 S., R. 30 W.															
(9-30-3aa)	E. F. Baalman	Dr	140.0	5	GI	do	do	Cy,W	S	Base of pump	0.6	2,933.4	121.40	10-17	
9-30-5cc	H. Johnson	Dr	129.0	5	GI	do	do	N	N	Top of casing	.6	2,575.9	122.29	10-17	
9-30-9ad	D. Johnson	Dr	108.0	5	GI	do	do	Cy,N	N	do	.4	2,925.6	95.98	10-17	
9-30-15cd	F. Johnson	Dr	18.8	6	GI	do	Alluvium	Cy,W	S	do	.7	2,855.3	10.53	8-4	
9-30-20bb	J. Sheetz	Dr	38.5	6	GI	do	do	Cy,W	S	Base of pump	.6	2,892.1	17.28	10-17	
(9-30-23ad)	J. T. Lager	Dr	36.0	6	GI	do	do	Cy,W	D, S	Top of casing	1.0	2,827.0	16.40	10-17	
9-30-34ba	J. Dickman	Dr	198.0	12	GI	do	Ogallala	T,N	I	Base of pump	.8	2,961.1	130.00	10-16	300 gpm ±
9-30-36aa	School district	Dr	130.5	5	GI	do	do	Cy,W	D, S	do	.9	2,911.3	108.30	10-16	
T. 10 S., R. 26 W.															
10-26-1bb	M. Sanders	Dr	67.0	5	GI	do	do	N	N	Top of casing	.3	2,572.8	49.79	8-15	
10-26-1dd	E. Mickey	Dr	23.0	5	GI	do	Alluvium and Ogallala	Cy,N	N	Base of pump	.0	2,527.1	7.82	8-14	
10-26-9cd	L. Mann	Dr	76.0	5	GI	do	Ogallala	Cy,W	S	Top of casing	1.2	2,584.7	48.52	8-25	
10-26-10dc	M. Simon	Dr	72.2	5	GI	do	do	Cy,W	S	Top of concrete curb	.4	2,594.8	64.14	8-14	

(10-26-19aa)	F. Smith	Dr	96.0	5	OW	do.	do.	Cy,W	S	Top of casing	.2	2,603.5	70.47	8-14	
10-26-19cc	School district	Dr	55.0	5	GI	do.	do.	N	N, S	do.	.4	2,574.2	51.00	8-14	
10-26-25cc	H. Von Lintel	Dr	68.0	6	GI	do.	do.	Cy,H	D, S	Base of pump	.3	2,506.7	48.62	8-14	
10-26-25cd	H. Von Lintel	Sp				do.	do.		S			2,458.0		8-11	
10-26-26cc	M. Weissback	Dr	33.8	5	GI	do.	Terrace deposits	Cy,H,W	N	Base of pump	.3	2,476.9	14.49	8-13	
10-26-28ad	J. Miller	Dr	50.0	6	GI	do.	Ogallala	Cy,W	S	Top of casing	.3	2,540.6	41.62	8-15	
(10-26-32ad)	W. Martin	Dr	32.0	6	GI	do.	Terrace deposits	Cy,W,H	D	do.	.3	2,516.8	21.60	8-14	
T. 10 S., R. 27 W.															
10-27-11ca	A. M. Zerr	Dr	79.2	6	GI	do.	Ogallala	J,E	D	Top of well curb	.0	2,642.0	61.41	8-25	
10-27-13db	I. Hines	Dr	48.0	5	GI	do.	do.	N	S	Top of casing	1.8	2,587.5	35.71	8-14	
10-27-14cd	C. A. Zerr	Dr	35.0	5	GI	do.	do.	Cy,H	D	Base of pump	1.2	2,588.6	31.40	8-25	
10-27-16bc	M. Schoenfeld	Dr	86.0	5	GI	do.	do.	Cy,W	S	do.	.6	2,622.4	32.80	9-8	
10-27-22da	H. Ackerman	Dr	32.0	5	GI	do.	Terrace deposits	Cy,W	D, S	Top of casing	.0	2,579.0	22.50	8-25	
10-27-34db	S. Hecker	Dr	91.5	5	GI	do.	Ogallala	Cy,W	D, S	Base of pump	.9	2,683.8	83.95	9-4	Good well
10-27-36dd	C. W. Woodward	Dr	51.0	5	GI	do.	do.	N	N	Top of concrete walk	0	2,598.0	38.00	8-20	
T. 10 S., R. 28 W.															
10-28-6ad	Federal Farm Mtg. Co.	Dr	116.0	6	GI	do.	do.	Cy,W	S	Base of pump	.8	2,775.8	69.52	10-18	
10-28-10cc	J. Shippers	Dr	110.0	5	GI	do.	do.	Cy,W	D, S	do.	.4	2,737.8	76.23	9-17	
10-28-14db	P. Leiker	Dr	107.0	5	GI	do.	do.	Cy,W	S	do.	.6	2,719.5	84.18	9-4	
10-28-24cb	A. Kenderkenecht	Dr	26.5	5	GI	do.	Terrace deposits	Cy,W,H	D, S	do.		2,634.1	13.40	9-4	
10-28-24cc	School district	Dr	66.0	5	GI	do.	Ogallala	Cy,H	D, S	do.		2,671.8	44.82	8-4	
10-28-25ad	J. Mader	Dr	81.5	5	GI	do.	do.	Cy,H	D, S	do.	.3	2,703.5	69.60	9-4	
10-28-27bb	O. F. Neal	Dr	20.1	5	GI	do.	Terrace deposits	Cy,H	N	do.	.3	2,661.6	15.48	9-17	
10-28-33bb	J. Kaiser	Dr	41.2	5	GI	do.	Terrace deposits and Ogallala	Cy,W	S	do.	.3	2,701.5	35.73	9-17	
10-28-34dd	A. Selenke	Dr	75.6	6	GI	do.	Ogallala	Cy,W	S	do.	.6	2,743.9	62.26	9-17	
T. 10 S., R. 29 W.															
10-29-8ad	B. Baalman	Dr	125.0	5	GI	do.	do.	Cy,W	S	do.	.8	2,878.1	114.73	10-18	
10-29-14cd	H. Stewart	Dr	90.0	5	GI	do.	do.	N	N	Top of concrete platform	.3	2,803.9	71.80	10-18	
10-29-20cc	J. Verhoff	Dr	39.0	36	OW	do.	Alluvium	T,G	I	Top of iron beam under pump	.2	2,776.5	8.55	6-26	
10-29-32dc		Dr	128.0	5	GI	do.	Ogallala	Cy,W	S	Base of pump	1.5	2,875.5	112.40	9-16	
10-29-35aa	L. Deges	Dr	36.0	6	GI	do.	Terrace deposits	Cy,W	D, S	do.	0.6	2,731.7	16.48	10-18	

Table 7.—*Records of wells and springs in Sheridan County, Kansas—Concluded*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet (3)	Diameter of well, in.	Type of casing (4)	Principal water-bearing bed		Method of lift (5)	Use of water (6)	Measuring point			Depth to water level below measuring point, feet (7)	Date of measurement, (1952)	REMARKS (Yield given in gallons a minute; drawdown in feet)
						Character of material	Geologic source			Description	Distance above land surface, feet	Height above mean sea level, feet			
T. 10 S., R. 30 W.															
(10-30-11dd)	E. B. Finley	Dr	130.0	6	GI	Sand, gravel	Ogallala	Cy,W	S	Top of casing	1.3	2,893.2	96.40	10-16	
10-30-17ba	F. Reitcheck	Dr	120.0	12	GI	do.	do.	T,G	I	Base of pump	.0	2,927.1	88.90	10-16	250 gpm Shale at 184 feet
10-30-22bb	H. Follbetter	Dr	36.0	5	GI	do.	Ogallala and Alluvium	Cy,H	N	do.	0	2,838.7	19.00	9-16	
10-30-28cd	A. Trapphorn	Dr	120.0	5	GI	do.	Ogallala	N	N	Top of casing	1.2	2,935.7	106.13	10-16	
(10-30-30cb)	I. Ottken	Dr	80.0	5	GI	do.	do.	Cy,W	D, S	Base of pump	.3	2,906.9	61.20	10-17	
10-30-36cc	City of Grinnell	Dr	150.0	10	OW	do.	do.	T,E	D, S	Land surface	0	2,909.2	111.00	10-10	150 feet to shale Drawdown 2 ft., 115 gpm
T. 11 S., R. 27 W.															
11-27-5ab		Dr	82.0	5	GI	do.	do.	Cy,W	S	Base of pump	.6	2,696.2	74.90	9-4	

1. Well number in parentheses indicates that analysis of water is given in Table 3.
2. Dr, drilled well; Sp, spring.
3. Reported depths below land surface are given in feet; measured depths are given in feet and tenths below measuring points.
4. GI, galvanized sheet iron; N, none; OW, oil-well casing.
5. Method of lift: Cy, cylinder; J, jet; N, none; T, turbine. Type of power: E, electric; G, gas engine; H, hand operated; N, none; T, tractor; W, windmill.
6. D, domestic; I, irrigation; N, not being used; P, public supply; S, stock; Sc, school.
7. Measured depths to water level are given in feet, tenths, and hundredths; reported depths to water level are given in feet.

LOGS OF TEST HOLES AND WELLS

The logs of 34 test holes and 1 well in or adjacent to Sheridan County are given on the pages that follow. The test holes were drilled by the State Geological Survey with a hydraulic-rotary drill rig. A system of numbering wells and test holes is described on page 10.

6-25-6ba.—*Sample log of test hole in the NE¼ NW¼ sec. 6, T. 6 S., R. 25 W.; Graham County, 200 feet south of county line and 15 feet east of road; drilled 1952. Surface altitude, 2,492.9 feet.*

	Thickness, feet	Depth, feet
Road fill	0.5	0.5
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, silty; cemented with calcium carbonate	6.5	7
Silt, limy, hard, and fine to medium sand	5	12
Silt to fine sand, limy, white	3	15
Clay, sandy, tan-yellow	3	18
Sand, fine to medium, silty, light-tan	3	21
Sand, fine to coarse, silty, green	6	27
Sand and gravel, fine to coarse; contains cemented stringers	6	33
Sand and gravel, cemented with silty caliche	3	36
Clay, sandy, tan-green to gray-green	3	39
Clay, sandy, tan-gray to yellow-gray	7	46
Sand, fine to medium, silty; some coarse sand and fine gravel	8	54
Clay, tan to yellow-gray	2	56
Clay, light-gray	4	60
Clay, very sandy, light-tan	8	68
Sand, fine to medium, clayey, tan-brown	8	76
Clay, sandy, tan-brown	10	86
Clay, tan-brown; contains stringers of sand	15	101
Sand, fine to medium; contains a lens of clay	10	111
Sand, fine to medium, silty	10	121
Sand, fine to medium	6.5	127.5
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, silicified, very hard, yellow-brown	.5	128.0

6-25-31cc.—*Sample log of test hole in the SW cor. sec. 31, T. 6 S., R. 25 W.; Graham County, 300 feet north and 15 feet east of intersection; drilled 1952. Surface altitude, 2,571.9 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Pleistocene		
Sanborn formation—Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray to gray-green; contains snail shells	10	13
TERTIARY—Pliocene		
Ogallala formation		
Sand and gravel, fine to coarse	9	22
Sand, fine to coarse; contains stringers of tan-gray clay	5	27
Clay, sandy, tan-gray	18	45
Sand, cemented, light-tan	14	59
Sand, fine to coarse	4	63
Sand, cemented, clayey	15	78
Clay, sandy, light-gray	15	93
Sand, fine to coarse; limy cemented stringers	15	108
Sand, fine to coarse, clayey, yellow-gray	19	127
Sand, fine to coarse, silty	7	134
Sand, fine to coarse, interbedded stringers of silty clay	5.5	139.5
Sand, clayey, cemented	24.5	164
Clay, compact, yellow; contains thin stringers of sand,	6	170
Sand, fine to medium, cemented	20	190
Sand, fine to medium; contains some weathered chalk, cemented	19	209
Sand, fine to coarse; contains fragments of silicified chalk	9	218
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, silicified at top, and yellow to orange chalky shale	21	239

6-27-3aaa.—*Sample log of test hole in the NE cor. sec. 3, T. 6 S., R. 27 W.; 20 feet east of north-south fence line and 20 feet south of county-line road; drilled 1952. Surface altitude 2,543.2 feet; depth to water, 22.8 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
QUATERNARY—Pleistocene		
Sanborn formation		
Terrace deposits—(Wisconsinan Stage)		
Clay, compact, brown	18	22
Clay, sandy, tan-brown	10	32
Clay, sandy, dark-brown to gray	6	38

	Thickness, feet	Depth, feet
Sand, medium to coarse	17	55
Clay, yellow-tan, and fine to coarse gravel and fragments of chalk	16	71
Cretaceous—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, clayey, calcareous, blue-black	3	74

6-27-3aad.—*Sample log of test hole in the SE¼ NE¼ NE¼ sec. 3, T. 6 S., R. 27 W.; 110 feet north of bridge and 12 feet west of center of road; drilled 1952. Surface altitude 2,529.3 feet; depth to water, 11.7 feet.*

	Thickness, feet	Depth, feet
Road fill	5	5
Quaternary—Pleistocene		
Recent alluvium		
Sand, fine, silty	3	8
Clay, silty to fine sandy, gray	5	13
Sand, fine to coarse, and fine to coarse gravel	25	38
Sanborn formation		
Terrace deposits—(Wisconsinan Stage)		
Clay and weathered shale, yellow and white	16	54
Cretaceous—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, silicified, varicolored	3	57
Chalk, clayey, calcareous, blue-black	3	60

6-27-34dd.—*Sample log of test hole in the SE cor. sec. 34, T. 6 S., R. 27 W.; 40 feet north and 7 feet west of center of road intersection; drilled 1952. Surface altitude 2,688.2 feet; depth to water, 144.0 feet.*

	Thickness, feet	Depth, feet
Quaternary—Pleistocene		
Sanborn formation		
Bignell silt member—(Wisconsinan Stage)		
Silt, dark-gray to gray	6.5	6.5
Peoria silt member		
Clay, compact, silty, tan-brown (Brady soil)	2.5	9
Silt, tan-gray	3	12
Silt, clayey, tan	6	18
Loveland silt member—(Illinoian Stage)		
Clay, silty and limy, dark-tan	6	24
Clay, compact, tan-yellow	10	34
Tertiary—Pliocene		
Ogallala formation		
Sand, fine to coarse, and fine to coarse gravel; contains some yellow silt	29	63
Clay, sandy, tan-white	12	75
Clay, sandy, gray-white	11	86
Sand, fine to coarse, silty	4	90

	Thickness, feet	Depth, feet
Clay, sandy, tan to tan-gray	15	105
Clay, gray, and interbedded streaks of fine to medium sand	13	118
Sand, cemented, limy, white	18	136
Sand, fine to coarse, silty	19	155
Sand, coarse, and fine to coarse gravel, clayey, tan	3	158
Clay, yellow to tan-yellow; contains some fine sand	5	163
Sand, fine to medium, cemented	9	172
Clay, gray-brown	4	176
Sand, fine to medium, silty, brown	12	188
Sand, fine to coarse; contains interbedded tan-brown silty clay	17	205
Sand, fine to medium, silty	37	242
Sand, fine to coarse, and yellow weathered shale	6	248
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, weathered, yellow	2	250
Shale, clayey, blue-black	5	255

6-28-4aa.—*Sample log of test hole in the NE cor. sec. 4, T. 6 S., R. 28 W.; 35 feet west of road center and 15 feet south of county line; drilled 1952. Surface altitude, 2,768.6 feet; depth to water, 123.0 feet.*

	Thickness, feet	Depth, feet
Soil	1.5	1.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray to tan-green	9.5	11
Silt, tan-green; contains snail shells	9	20
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, limy to cemented	5	25
Sand, fine to coarse, silty to cemented	10	35
Sand, fine to coarse, silty, tan	4	39
Sand, fine to coarse, and fine to coarse gravel, silty	23	62
Sand, fine to medium, cemented	8	70
Clay, sandy, light-gray to tan	7	77
Sand, fine to coarse, cemented, silty	14	91
Sand, fine to coarse, and fine to coarse gravel	7	98
Clay, sandy, tan-brown; contains embedded gravel and shale fragments	14	112
Sand, fine to coarse	4	116
Sand, fine to coarse, cemented to clayey, light-tan	12	128
Gravel, fine to medium, limy	4	132
Clay, limy and sandy, gray-white; contains some embedded gravel	6	138
Sand, fine to medium, silty, light-gray	7	145
Sand, and gravel, silty, gray; interbedded stringers of green clay	6	151

	Thickness, feet	Depth, feet
Sand, fine to coarse, limy	7	158
Sand and gravel, clayey, yellow; contains cemented sand and gravel	20	178
Sand and gravel, fine to coarse	10	188
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, clayey, weathered, calcareous, yellow to yellow-gray	20	208
Shale, clayey, calcareous, light-gray to black	2	210

6-28-27bb.—*Sample log of test hole in the NW¼ NW¼ sec. 27, T. 6 S., R. 28 W.; 0.15 mile south of section corner and 30 feet east of center of highway; drilled 1952. Surface altitude 2,660.2 feet; depth to water, 18.0 feet.*

	Thickness, feet	Depth, feet
Soil and road fill	5	5
QUATERNARY—Pleistocene		
Terrace deposits, undifferentiated		
Clay, dark-brown	6	11
Clay, dark-brown, compact, blocky (Sangamon soil)	2	13
Silt, tan-brown; contains some sand near base	8	21
Sand and gravel, fine to coarse	17	38
Sand, fine to coarse, and some coarse gravel	8	46
TERTIARY—Pliocene		
Ogallala formation		
Sand, limy, cemented	2	48
Sand, silty, cemented	11	59
Sand, fine to medium; contains some embedded light-tan clay	36	95
Sand, and gravel, fine to coarse, silty	20	115
Sand, fine to coarse, and some coarse gravel, silty	12	127
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Clay to weathered shale, yellow-tan	12	139
Shale, clayey, calcareous, gray	11	150

6-28-33dd.—*Sample log of test hole in the SE cor. sec. 33, T. 6 S., R. 28 W.; 40 feet west and 25 feet north of center of road intersection; drilled 1952. Surface altitude 2,761.7 feet; depth to water, 125.0 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray to gray-green; contains fossil snails	22	24
TERTIARY—Pliocene		
Ogallala formation		
Sand and gravel, fine to coarse, cemented, clayey	6	30
Sand, fine to coarse, and fine gravel, silty, tan	9	39

	Thickness, feet	Depth, feet
Clay, sandy, tan-brown; contains limy stringers	9	48
Sand, fine to coarse, and fine gravel, silty	5	53
Clay, tan-gray to gray-green; contains some coarse gravel	4	57
Sand, fine to coarse, clayey, cemented	4	61
Sand and gravel, fine to coarse	15	76
Clay, tan; contains interbedded stringers of sand	48	124
Gravel, fine to coarse, clayey	6	130
Sand, clayey, cemented, tan	18	148
Clay, gray-green; contains sandy stringers	4	152
Sand and gravel, fine to coarse; contains yellow-green silt	6	158
Sand and interbedded stringers of tan-white clay	11	169
Sand, very fine to fine, silty, yellow-green	19	188
Sand, fine to coarse	14	202
Sand, fine to coarse, clayey	21	223
Sand, fine to coarse, silty	22	245
CRETACEOUS—Gulfian		
Niobrara formation— Smoky Hill chalk member		
Clay to weathered shale, yellow to yellow-gray	11	256
Shale, clayey, calcareous, dark-gray to black	9	265

6-29-6bb.—*Sample log of test hole in the NW cor. sec. 6, T. 6 S., R. 29 W.; 200 feet south of county line and 25 feet east of center of road at end of curve; drilled 1952. Surface altitude, 2,789.0 feet; depth to water, 52.8 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, light-tan	4	4
TERTIARY—Pliocene		
Ogallala formation		
Sand and gravel, fine to coarse	1	5
Clay, limy stringers, light-tan	4.5	9.5
Clay, sandy, brown; contains interbedded stringers of medium to coarse sand	7.5	17
Silt to clay, sandy to limy, tan-brown	2.5	19.5
Sand, medium to fine, silty, cemented, brown	7	26.5
Clay, compact, gray-green	2.5	29
Sand and gravel, fine to coarse; contains cemented stringers at 32 to 37 feet	10	39
Clay, tan-brown	4	43
Sand and gravel, fine to coarse, cemented, silty, tan	4	47
Sand and gravel, fine to coarse, silty	7	54
Sand and gravel, fine to coarse, cemented, silty	4.5	58.5
Silt, limy, sandy, light-gray to white	1	59.5
Sand, fine to medium, silty, cemented	1.5	61
Sand and gravel, fine to coarse, limy, silty, cemented	8	69
Clay, sandy, gray	2	71

	Thickness, feet	Depth, feet
Sand, fine to medium, silty; contains cemented stringers of sand	4	75
Sand and gravel, fine to coarse; contains interbedded stringers of tan-gray clay	22	97
Clay, limy, light-gray	1	98
Sand and gravel, fine to coarse	5	103
Clay and interbedded stringers of sand	5	108
Sand and gravel, fine to coarse	14	122
Clay, calcareous, tan; contains stringers of sand in lower part	6	128
CRETACEOUS—Gulfian		
Pierre shale		
Shale, weathered, bentonitic, yellow to yellow-gray	21	149
Niobrara formation—Smoky Hill chalk member		
Shale, clayey, calcareous, dark-gray	1	150

6-29-32ccd.—*Sample log of test hole in the SE¼ SW¼ SW¼ sec. 32, T. 6 S., R. 29 W.; 0.1 mile north of section corner at top of hill, 30 feet east of west right-of-way fence; drilled 1952. Surface altitude, 2,842.3 feet; depth to water, 90.0 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, clayey, tan-gray to gray-green	10	11
Silt, clayey, gray-green	8	19
Loveland silt member—(Illinoian Stage)		
Clay, limy, light-tan	10	29
TERTIARY—Pliocene		
Ogallala formation		
Clay, very limy, gray-white	8	37
Clay, very limy, gray-white; contains some embedded coarse gravel	9	46
Sand and gravel, fine to coarse	9	55
Clay, sandy, tan; contains stringers of fine sand	8	63
Sand and gravel, fine to coarse; contains embedded tan-yellow clay	7	70
Sand, fine to coarse; interbedded stringers of light-tan clay	34	104
Clay, sandy, gray	3	107
Sand, fine to coarse, silty	10	117
Sand, fine to medium; contains embedded tan silty clay	10	127
Sand, fine to coarse, clayey, tan	7	134
Clay, limy to cemented, sandy, light-tan to white	6	140
Sand, fine to medium, limy to cemented	5	145

	Thickness, feet	Depth, feet
Clay, compact, tan-yellow	4.5	149.5
Sand, fine to coarse, and fine to medium gravel	14.5	164
Clay, compact, silty to limy; contains stringers of cemented fine sand	6	170
Sand, fine to coarse; contains embedded tan-brown clay	15	185
CRETACEOUS—Gulfian		
Pierre shale		
Shale, weathered, silty to clayey, calcareous, yellow to gray-yellow	10	195
Shale, compact, calcareous, gray-yellow	5	200

7-27-35cc.—*Sample log of test hole in the SW cor. sec. 35 T. 7 S., R. 27 W.; 5 feet north of section line and 15 feet east of center of road; drilled 1952. Surface altitude, 2,642.5 feet; depth to water, 96.2 feet.*

	Thickness, feet	Depth, feet
Road fill	5	5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, gray-green	11	16
Loveland silt member—(Illinoian Stage)		
Clay, silty to fine sandy, tan	2.5	18.5
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, and fine gravel, silty	5.5	24
Sand, fine, clayey to silty, red-brown	15	39
Sand, fine to coarse, silty, tan	11	50
Sand, fine to coarse, clayey, tan; contains stringers of clay	20	70
Sand, fine to coarse, and fine gravel, silty, tan-gray	18	88
Clay, silty to sandy, tan-white	7	95
Sand, fine to coarse, cemented, light-gray	11	106
Sand, fine to coarse, clayey, contains hard cemented stringers at 106 and 107 feet	6	112
Clay, sandy, light-gray	8	120
Sand, fine to medium; contains interbedded stringers of light-tan clay	18	138
Sand, fine to coarse; contains interbedded stringers of brown clay	19	157
Sand, fine to coarse, silty, tan	48	205
Sand and gravel, fine to coarse; contains some weathered yellow chalk	11	216
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Clay to weathered shale, gray-white	2	218
Shale, clayey, calcareous, dark-gray to black	2	220

7-29-32cc.—*Sample log of test hole in the SW cor. sec. 32, T. 7 S., R. 29 W.; 70 feet south and 12 feet east of center of road intersection; drilled 1952. Surface altitude, 2,892.4 feet; depth to water, 120.5 feet.*

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY.—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, gray-green	20	23
Silt, clayey, gray-green to tan-gray	2.5	25.5
Loveland silt member—(Illinoian Stage)		
Clay, compact, dark-brown (Sangamon Soil)	1	26.5
Clay, limy, light-tan to tan-white	14.5	41
TERTIARY—Pliocene		
Ogallala formation		
Clay, very limy, tan-white	7	48
Caliche to limy clay, tan-white	9	57
Sand and gravel, fine to coarse, limy in lower part	8	65
Sand, fine to coarse, cemented, silty	18	83
Sand and gravel, fine to coarse, clayey	10	93
Sand and gravel, fine to coarse; contains cemented stringers	22	115
Clay, sandy, red to tan	9	124
Sand and gravel, fine to coarse, clayey	3	127
Clay, silty to sandy, tan-gray	15	142
Sand, fine to coarse, silty; contains some fine gravel	22	164
Clay, sandy, gray-green	5	169
Sand, fine to coarse, some fine gravel	10	179
Sand, fine to coarse, silty	20	199
Sand and gravel, fine to coarse; contains embedded tan clay	30	229
Sand, fine to coarse; contains stringers of tan clay at 236 feet	10	239
Sand, fine to coarse, and fine gravel; contains some weathered yellow chalk	22.5	261.5
CRETACEOUS—Gulfian		
Niobrara formation		
Chalk, weathered to chalky shale, yellow to yellow-gray	8.5	270.0

8-26-1bb.—*Sample log of test hole in the NW cor. sec. 1, T. 8 S., R. 26 W.; 20 feet west of east right-of-way fence and 125 feet south of section-line fence; drilled 1952. Surface altitude, 2,537.9 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, gray-green; contains fossil snails	10.5	14.5

	Thickness, feet	Depth, feet
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, and fine to coarse gravel	3.5	18
Sand, fine to coarse, clayey, tan-brown	3	21
Sand, fine to coarse, silty, tan-gray	5	26
Sand and gravel, fine to coarse, cemented	3	29
Clay, limy to cemented, gray-white	4	33
Sand, fine to medium, limy to cemented	6	39
Sand, fine to medium, clayey, brown	5	44
Sand and gravel, fine to coarse, silty, yellow-brown	10	54
Sand, fine to medium, limy to cemented	12	66
Clay, light-tan, and interbedded stringers of sand	4	70
Sand, fine to medium, and interbedded stringers of light-gray clay	18	88
Sand, fine to coarse	2	90
Sand, fine to coarse, silty, cemented	5	95
Sand, fine to coarse, silty to clayey	25	120
Sand, fine to medium	20	140
Sand and gravel, fine to coarse	10	150
Sand and gravel, fine to coarse; contains some weathered yellow-white chalk	10	160
Gravel, fine to coarse; contains some weathered white and yellow chalk	3	163
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, weathered, yellow-orange	35	198
Shale, clayey, calcareous, dark-gray to black	2	200

8-26-13cc.—*Sample log of test hole in the SW cor. sec. 13, T. 8 S., R. 26 W.; 15 feet east of center of road and 40 feet north of railroad; drilled 1952. Surface altitude, 2,387.0 feet; depth to water, 10.1 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Recent alluvium		
Sand, fine to coarse, silty	4	6
Sand, fine to coarse; some fine to coarse gravel	23	29
Sanborn formation		
Terrace deposits—(Wisconsinan Stage)		
Sand and gravel, fine to medium; contains embedded dark-gray to black silt	10	39
Sand and gravel, fine to medium; contains much dark-gray silt	10	49
Sand and gravel, fine to coarse, silty; contains stringers of light-gray clay at 55 and 65 feet	18	67
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, blocky, dark-gray	3	70

8-26-35dd.—*Sample log of test hole in the SE cor. sec. 35, T. 8 S., R. 26 W.; 10 feet north and 30 feet west of center of road intersection; drilled 1952. Surface altitude, 2,501.0 feet.*

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Pleistocene		
Undifferentiated valley deposits		
Sand, fine to medium, silty, red-brown	6	7
Clay, sandy, tan-gray	2	9
Sand, fine to coarse, and fine to coarse gravel, silty, red	10	19
TERTIARY—Pliocene		
Ogallala formation		
Sand and gravel, fine to coarse	9	28
Clay, blocky, yellow-tan	11	39
Sand and gravel, fine to coarse; contains interbedded thin stringers of gray clay	10	49
Sand and gravel, fine to coarse; contains a few pebbles of silicified chalk	7	56
Clay, compact, light-gray	13	69
Sand, fine to medium, silty	5	74
Clay, gray; contains interbedded stringers of fine to medium sand	3	77
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Clay to weathered shale, orange-yellow	10	87
Clay to weathered shale, silty, yellow	11.5	98.5
Shale, silty to clayey, calcareous, dark-gray	4.5	103

8-27-22ad.—*Sample log of test hole in the SE¼ NE¼ sec. 22, T. 8 S., R. 27 W.; 15 feet west of road center and 350 feet north of ridge, 25 feet south of private drive; drilled 1952. Surface altitude, 2,503.9 feet; depth to water, 12.0 feet.*

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand and gravel, fine to coarse; silty at top	10	10
Sand and gravel	5	15
Sanborn formation		
Terrace deposits—(Wisconsinan Stage)		
Sand, fine to coarse, silty to clayey; contains stringers of light-gray clay	20	35
Gravel, coarse; contains stringers of light-gray clay at 39 feet	11	46
Clay, compact, yellow-gray; contains interbedded dark-gray clay and gravel	11	57
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, blocky, calcareous, dark-gray	5	62

8-27-35cc.—*Sample log of test hole in the SW cor. sec. 35, T. 8 S., R. 27 W.; 19 feet east of center of road and 25 feet north of fence line; drilled 1952. Surface altitude, 2,672.0 feet; depth to water, 110.0 feet.*

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, clay, black (Brady soil)	3	6
Silt, tan-gray to gray-green; contains fossil snails	13	19
TERTIARY—Pliocene		
Ogallala formation		
Clay, compact, sandy, tan	9.5	28.5
Sand, fine to medium	1.5	30
Clay, sandy, tan to tan-brown	10	40
Sand, fine to coarse, clayey at top	6	46
Sand, fine to coarse, cemented; contains a few tan-gray clay stringers	9	55
Clay, sandy, tan-brown	6	61
Silt, clayey, tan	3	64
Clay, very sandy, tan-brown	3	67
Sand, fine to coarse, silty; contains some gravel	9	76
Clay, compact, light-gray; contains thin stringers of fine and medium sand	4	80
Clay, sandy, light-tan	9	89
Sand, fine to coarse, silty; contains cemented stringers,	10	99
Sand, fine to coarse, silty; contains stringers of gray clay, interbedded	8	107
Clay, sandy, gray to tan-gray	7	114
Clay, sandy, tan	2	116
Clay, compact, limy, fine-sandy, light-tan to tan-white	2	118
Clay, sandy, tan-brown; contains interbedded stringers of fine sand	7	125
Clay, compact, tan-yellow	11	136
Sand, fine to medium, clayey, light-tan	8	144
Sand, fine to coarse	2	146
Sand, fine to coarse, cemented, light-tan	9.5	155.5
Gravel, fine to medium; contains interbedded stringers of yellow-gray clay	3.5	159
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, yellow-orange to white	10	169

8-28-3bb.—*Sample log of test hole in the NW cor. sec. 3, T. 8 S., R. 28 W.; 18 feet south and 50 feet east of center of intersection in private drive; drilled 1952. Surface altitude, 2,771.4 feet; depth to water, 132.6 feet.*

	Thickness, feet	Depth, feet
Soil and road fill	1.5	1.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Clay, compact, blocky, tan-gray (Brady soil)	2.5	4
Silt, gray-green; contains fossil snails	21	25
Loveland silt member—(Illinoian Stage)		
Clay, silty, blocky, tan-brown (Sangamon soil)	3	28
Clay, silty, tan	2	30
TERTIARY—Pliocene		
Ogallala formation		
Clay, very sandy, tan	3	33
Sand, fine to medium, clayey, tan-brown	17	50
Sand, fine to coarse	5	55
Clay, tan-gray	4	59
Sand, silty, fine to medium	3	62
Sand and gravel, clayey	4	66
Sand, fine to coarse, clayey, tan-brown	14	80
Sand, fine to coarse	12	92
Clay, sandy, tan	5	97
Sand, fine to medium	10	107
Sand, fine to coarse; contains interbedded stringers of tan clay	25	132
Sand, fine to coarse; contains some fine gravel	8	140
Sand, fine to coarse, clayey	8	148
Gravel, fine to coarse; cemented with caliche	9	157
Sand, fine to coarse; contains interbedded sandy gray clay	21	178
Sand, fine to coarse; contains hard cemented stringers,	8	186
Sand, fine to coarse, clayey to cemented	10	196
Sand, fine to coarse, silty	14	210
Sand and gravel, fine to coarse	20	230
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, weathered, gray-white	3	233
Shale, clayey, calcareous, black to blue-black	3	236

8-28-9ab.—*Driller's log of A. M. Shatzell irrigation well in the NW¼ NE¼ sec. 9, T. 8 S., R. 28 W.; drilled 1952. Depth to water, 119.3 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Pleistocene		
Sanborn formation		
Silt and clay, yellow	24	25
TERTIARY—Pliocene		
Ogallala formation		
Sand, (mortar bed at 65 feet)	47	72
Gravel, coarse	5	77
Gravel, fine to medium	15	92
Clay	6	98
Gravel, fine	8	106
Clay	1	107
Mortar bed	1	108
Gravel, medium-coarse	4	112
Clay	2	114
Gravel, medium-coarse	20	134
Clay	2	136
Gravel, medium to coarse	8	144
Clay	6	150
Clay and gravel	5	155
Gravel, medium to coarse, and streaks of mortar bed	20	175
Clay, red, sandy and gravelly	5	180
Gravel, fine	4	184
Clay and gravel	8	192
Gravel, medium to coarse	16	208
Clay, white, compact	4	212
Clay and gravel streaks	11	223
Gravel, medium to coarse	5	228
Clay	5	233
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, black	5	238

8-28-33dd.—*Sample log of test hole in the SE cor. sec. 33, T. 8 S., R. 28 W.; 11 feet north and 300 feet west of center of road intersection at top of hill; drilled 1952. Surface altitude, 2,692.2 feet; depth to water, 56.6 feet.*

	Thickness, feet	Depth, feet
Road fill	1.5	1.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray	11.5	13
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse	5	18
Sand, fine to medium, clayey to cemented	5	23

	Thickness, feet	Depth, feet
Sand, fine to coarse, silty, tan-brown	10	33
Sand, fine to coarse, silty; contains some fine to coarse gravel	3	36
Clay, sandy, gray-brown	4	40
Sand, fine to coarse; contains interbedded stringers of gray clay	5	45
Clay, compact, dark-brown	2	47
Clay, compact, gray-green; contains thin stringers of fine sand	14	61
Clay, dark-gray; contains interbedded stringers of sand	7	68
Sand, fine to coarse	10	78
Sand, fine to coarse, and fine to coarse gravel	10	88
Sand, fine to coarse, cemented to clayey	9	97
Clay, sandy, yellow-green; contains interbedded stringers of sand	6	103
Sand, fine to medium, clayey	11	114
Sand, fine to coarse; contains some fine to coarse gravel and interbedded stringers of light-gray clay,	10	124
Sand and gravel, fine to coarse; contains a few weathered fragments of chalk	4.5	128.5
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, yellow-orange	1.5	130

8-29-31dd.—*Sample log of test hole in the SE cor. sec. 31, T. 8 S., R. 29 W.; 70 feet west and 12 feet north of center of road intersection; drilled 1952. Surface altitude, 2,876.7 feet; depth to water, 104.2 feet.*

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, gray-green to tan-gray	16.5	18.5
Loveland silt member—(Illinoian Stage)		
Clay, limy, compact, light-tan	15.5	34
TERTIARY—Pliocene		
Ogallala formation		
Sand to silty sandy caliche, light-gray to tan-white	14	48
Sand and gravel, coarse to fine; contains interbedded stringers of silty caliche	13	61
Clay, sandy, tan-brown; contains thin stringers of partly cemented gravel	13	74
Clay, sandy, tan-brown	6	80
Sand and gravel, fine to coarse; clayey to silty, limy, tan-white	10	90
Sand and gravel, coarse to fine; contains cemented stringers	5	95

	Thickness, feet	Depth, feet
Clay, sandy, red-brown	2	97
Clay, sandy to compact, light-gray	2.5	99.5
Sand and gravel, fine to coarse, clayey	3	102.5
Clay, compact, tan-yellow	3.5	106
Clay, sandy, tan-gray	3	109
Clay, sandy, red-brown	7	116
Clay, limy, gray-brown; contains some fine to coarse gravel	4	120
Clay, silty, limy, gray	8.5	128.5
Sand and gravel, coarse to fine; contains embedded red-brown clay	4.5	133
Clay, silty, limy, gray to tan-gray; contains stringers of sandy clay	6	139
Clay, red-brown, grading downward to very sandy clay	17	156
Clay, silty, sandy, gray	9	165
Clay, silty, limy, light-gray to white; contains some embedded gravel	11	176
Sand, fine to coarse, clayey, gray	17	193
Clay, sandy, silty, tan-brown	8	201
Sand, fine to medium, cemented, silty, limy	6	207
Caliche, fine-crystalline, hard	6.5	213.5
CRETACEOUS—Gulfian		
Pierre shale		
Shale, bentonitic, yellow-tan to yellow-gray	5.5	220

9-26-23aa.—*Sample log of test hole in the NE cor. sec. 23, T. 9 S., R. 26 W.; 13 feet west and 50 feet south of center of road intersection; drilled 1952. Surface altitude, 2,656.0 feet; depth to water, 140.0 feet.*

	Thickness, feet	Depth, feet
Road fill and soil	4.5	4.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Clay, silty, tan-gray	1.5	6
Silt, tan-gray to gray-green	13	19
TERTIARY—Pliocene		
Ogallala formation		
Silt to limy clay, sandy, white	3	22
Sand, fine to coarse, cemented, tan-white	4	26
Sand and gravel, fine to coarse	4	30
Sand, fine to coarse, cemented, tan-brown	4	34
Sand, fine to medium, clayey, tan-brown	4	38
Sand, fine to coarse, some fine to coarse gravel, and thin interbedded stringers of silty clay	16	54
Sand, fine to coarse, clayey to cemented, tan-brown	5	59
Sand, fine to medium; cemented; contains embedded light-gray, limy clay	9	68

	Thickness, feet	Depth, feet
Sand, fine to medium, clayey, tan-brown	7	75
Silt, sandy, cemented, tan-brown	10	85
Sand, fine to medium, very clayey, tan-brown	9	94
Clay, sandy, gray	7	101
Sand and clay, interbedded, hard, cemented, gray	8	109
Sand, fine to coarse, silty	15	124
Clay, sandy, gray to tan-gray	13	137
Sand, fine to coarse; contains a lens of tan-brown clay,	12	149
Sand, fine to coarse, silty	8	157
Sand, fine to coarse, cemented	6	163
Clay, sandy, light-tan to tan-white	7	170
Sand, fine to coarse, cemented	7	177
Sand, fine to coarse, and some clayey fine gravel, gray	15.5	192.5
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Clay to weathered shale, yellow to light-gray	2.5	195
Shale, clayey, calcareous, black	3	198

9-26-35dd.—*Sample log of test hole in the SE cor. sec. 35, T. 9 S., R. 26 W.; 10 feet north and 70 feet west of center of road intersection; drilled 1952. Surface altitude, 2,560.0 feet; depth to water, 45.4 feet.*

	Thickness, feet	Depth, feet
Road fill	4	4
QUATERNARY—Pleistocene		
Sanborn formation—Peoria silt member—(Wisconsinan Stage)		
Clay, silty, gray-tan	1.5	5.5
Clay, silty to very silty, tan to tan-gray	2.5	8
Clay, tan-brown to brown	2	10
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, and fine to medium gravel, silty	2	12
Clay, sandy, tan-brown	2	14
Sand, fine to coarse, and fine to coarse gravel	4.5	18.5
Clay, sandy to very sandy, tan	4.5	23
Clay, compact to blocky, tan-gray	6	29
Sand, fine to coarse, silty, yellow-brown	5	34
Clay, tan-brown	2	36
Sand, fine to coarse	2	38
Clay, silty to sandy, mottled brown and green	6	44
Sand, fine to coarse, and interbedded stringers of tan-brown clay	3	47
Sand and gravel, fine to coarse; contains a few lenses of gray sandy clay	12	59
Clay, sandy, light-brown	4	63

	Thickness, feet	Depth, feet
Sand, fine to coarse	2	65
Clay, sandy, light-brown	4	69
Silty limestone, sandy; contains some embedded fine gravel	1	70
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, silicified, yellow-brown	2	72
Shale, yellow	8	80

9-28-34cc.—*Sample log of test hole in the SW cor. sec. 34, T. 9 S., R. 28 W.; 30 feet north of center of section-line road and 15 feet west of power line; drilled 1952. Surface altitude, 2,766.3 feet; depth to water, 87.8 feet.*

	Thickness, feet	Depth, feet
Soil, dark-brown	1.5	1.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, clayey, tan-gray	9.5	11
Clay, silty, tan	6	17
Loveland silt member—(Illinoian Stage)		
Clay, compact, dark-brown	2	19
Clay, compact, limy, tan to tan-white	7	26
TERTIARY—Pliocene		
Ogallala formation		
Clay, sandy to very sandy, tan	5	31
Sand, fine to coarse, and fine gravel; silty, tan	13	44
Clay, silty, tan-gray	4	48
Clay, very sandy, tan-brown	2	50
Clay, compact, sandy, light-tan	6	56
Sand and gravel, fine to coarse, cemented to clayey, tan-brown	4	60
Clay, sandy, gray-brown	4	64
Clay, sandy to very sandy, red-brown	13	77
Sand, fine to medium, clayey to cemented	1.5	78.5
Sand, fine to coarse, and fine to coarse gravel	6.5	85
Clay, sandy to very sandy, red-brown	11	96
Sand, fine to medium, cemented	7	103
Clay, sandy, tan-brown	3.5	106.5
Sand, fine to coarse, and fine gravel	6.5	113
Clay, sandy, compact, tan-brown	6	119
Sand and gravel, fine to coarse	19	138
Clay, tan; contains stringers of fine sand	8	146
Sand, fine to coarse, and fine to medium gravel	17	163
CRETACEOUS—Gulfian		
Pierre shale		
Shale, noncalcareous, bentonitic, yellow-gray and gray-white	7	170

9-29-31dd.—***Sample log of test hole in the SE cor. sec. 31, T. 9 S., R. 29 W.; 100 feet west and 12 feet north of road intersection; drilled 1952. Surface altitude, 2,866.6 feet; depth to water, 86.2 feet.***

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, gray-green to gray-tan	15.5	16.5
Loveland silt member—(Illinoian Stage)		
Clay, compact to silty, brown	3	19.5
Clay, limy, compact, tan to light-tan	7.5	27
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, and fine gravel	1.5	28.5
Sand and gravel, fine to coarse, silty, limy, cemented,	3.5	32
Sand and gravel, fine to coarse, clayey	10	42
Sand and gravel, fine to coarse; contains a few streaks of cemented fine to medium sand	9	51
Clay, sandy, tan-red	4	55
Clay, tan-red; contains interbedded streaks of tan-red sandy clay	3	58
Clay, sandy, tan-gray; contains limy streaks	4	62
Sand and gravel, fine to coarse; contains interbedded stringers of tan-gray clay	6	68
Clay, compact, gray	3	71
Clay, sandy, tan-red	3	74
Sand, fine to coarse, and fine gravel	4	78
Clay, limy to sandy, light-tan	8	86
Sand, fine to coarse, and fine gravel	3	89
Clay, sandy to limy; contains a few thin stringers of fine sand	10	99
Clay, compact, yellow-tan	1.5	100.5
Clay, very sandy, tan-brown	3.5	104
Clay, tan, very sandy; contains interbedded stringers of light-green clay	8.5	112.5
Sand, fine to coarse	4.5	117
Clay, sandy, red-brown	11	128
Sand, fine to medium, cemented to silty	21	149
CRETACEOUS—Gulfian		
Pierre shale		
Shale, weathered, bentonitic, yellow-gray	10	159
Shale, clayey, calcareous, dark-gray to black	4	163

10-26-35ad.—*Sample log of test hole in the SE¼ NE¼ sec. 35, T. 10 S., R. 26 W.; 12 feet west of center of road near entrance to field on west side of road; drilled 1952. Surface altitude, 2,487.6 feet; depth to water, 37.6 feet.*

	Thickness, feet	Depth, feet
Road fill	3.5	3.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Clay, tan-gray to tan	3	6.5
Silt, gray-green; contains fossil snails	3.5	10
Clay, compact, silty, tan	3	13
Loveland silt member—(Illinoian Stage)		
Silt, brown	3.5	16.5
Crete sand and gravel member		
Sand, fine to medium, silty, tan-brown	4.5	21
Sand and gravel, fine to coarse	10	31
Sand and gravel, fine to coarse; contains a few fragments of weathered chalk	15	46
Sand and gravel; contains stringers of silt at 55 and 58 feet	14	60
Clay, sandy, gray; contains some embedded gravel,	7	67
Sand, fine to medium	4	71
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, dark-gray	4	75

10-26-35dad.—*Sample log of test hole in the SE¼ NE¼ SE¼ sec. 35, T. 10 S., R. 26 W.; 12 feet west of center of road and 20 feet north of fence corner on east side of road; drilled 1952. Surface altitude, 2,466.6 feet; depth to water, 18.8 feet.*

	Thickness, feet	Depth, feet
Road fill	8	8
QUATERNARY—Pleistocene		
Sanborn formation		
Terrace deposits—(Wisconsinan Stage)		
Clay, silty, tan-brown	7	15
Sand, fine to coarse, silty	4	19
Clay, fine, sandy, dark-gray	10	29
Sand, fine to medium, silty	9	38
Clay, compact, blue-black; contains some embedded medium sand	17	55
Sand and gravel, silty	1	56
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, blocky, dark-gray	4	60

10-26-35dd.—*Sample log of test hole in the SE cor. sec. 35, T. 10 S., R. 26 W.; 40 feet west of center of road and 40 feet south of private road to east on terrace flat; drilled 1952. Surface altitude, 2,467.4 feet; depth to water, 19.8 feet.*

	Thickness, feet	Depth, feet
Soil	5	5
QUATERNARY—Pleistocene		
Sanborn formation		
Terrace deposits—(Wisconsinan Stage)		
Clay, silty, tan-brown	6	11
Clay, compact, brown to gray-brown	6	17
Clay, compact, tan-brown	4	21
Clay, silty to sandy, gray-brown; contains some embedded fine to coarse gravel	14	35
Clay, silty, blocky, light-brown	7	42
Clay, sandy, blue-black	3	45
Sand, fine to coarse, clayey, black; contains fossil clam shells	7	52
Sand and gravel, fine to coarse	3.5	55.5
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Shale, dark-gray	3.5	59

10-26-36bab.—*Sample log of test hole in the NW¼ NE¼ NW¼ sec. 36, T. 10 S., R. 26 W.; 15 feet south of center of road and 0.3 mile east of section corner; drilled 1952. Surface altitude, 2,500.4 feet; depth to water, 41.3 feet.*

	Thickness, feet	Depth, feet
Soil	1.5	1.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray	9.5	11
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, and some fine to coarse gravel; silty, loosely cemented	6	17
Sand and gravel, fine to coarse, and a few pebbles; contains a cemented stringer at 23 feet	14	31
Sand and gravel, fine to coarse, limy to cemented	7	38
Sand and gravel, fine to coarse	7	45
Sand and gravel, fine to coarse, partly cemented	8	53
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, yellow	1	54
Shale, dark-gray	6	60

10-27-2bb.—***Sample log of test hole in the NW cor. sec. 2, T. 10 S., R. 27 W.; 50 feet south and 28 feet east of center of intersection; drilled 1952. Surface altitude, 2,650.4 feet; depth to water, 48.2 feet.***

	Thickness, feet	Depth, feet
Soil	5	5
TERTIARY—Pliocene		
Ogallala formation		
Sand and gravel, fine to coarse, silty, red-brown	10	15
Clay, silty, light-tan	2	17
Clay, very sandy, partly cemented, gray	5	22
Sand, fine to coarse, cemented to clayey	9	31
Sand, fine to coarse, clayey, red-brown	6	37
Clay, sandy, red-brown	12	49
Clay; contains interbedded stringers of tan-brown and gray-green clay	19	68
Sand, fine to coarse, silty	18	86
Clay, sandy to very sandy, tan-brown	3	89
Sand, fine to medium, limy, clayey to cemented, light-tan	18	107
Sand, fine to coarse	3	110
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, clayey, yellow-orange	4.5	114.5
Chalk, silicified, very hard	0.1	114.6

10-27-34dd.—***Sample log of test hole in the SE cor. sec. 34, T. 10 S., R. 27 W.; 6 feet west and 80 feet north of center of road intersection; drilled 1952. Surface altitude, 2,672.8 feet; depth to water, 71.8 feet.***

	Thickness, feet	Depth, feet
Soil	1.5	1.5
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray	8.5	10
Silt, tan to brown	2	12
Loveland silt member—(Illinoian Stage)		
Clay, dark-brown (Sangamon soil)	3	15
Clay, limy, light-tan	3	18
TERTIARY—Pliocene		
Ogallala formation		
Sand, fine to coarse, clayey, tan-brown	8	26
Sand, fine to coarse, silty	2	28
Clay, very sandy, tan-brown; contains some embedded fine to medium gravel	9	37
Sand, fine to coarse	2	39
Clay, sandy, tan-brown	5	44
Sand and gravel, fine to coarse; contains cemented stringers	15	59
Clay, sandy to very sandy, light-tan	15	74

	Thickness, feet	Depth, feet
Sand and gravel, fine to medium, silty	2	76
Clay, sandy, limy, light-tan	3	79
Sand, fine to medium, silty to cemented	2	81
Clay, very sandy, brown	10	91
Clay, tan-brown; contains interbedded stringers of sandy clay	8	99
Clay, tan-brown; contains interbedded stringers of sand, gravel, and chalk fragments	4	103
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, weathered, white	3	106
Chalk, silicified, brown, white and yellow	2	108

10-28-21dd.—*Sample log of test hole in the SE cor. sec. 21, T. 10 S., R. 28 W.; on north-south fence line 50 feet west of center of highway and 80 feet north of fence corner; drilled 1952. Surface altitude, 2,676.2 feet; depth to water, 21.9 feet.*

	Thickness, feet	Depth, feet
Soil	2	2
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Clay, compact, blocky, gray-brown	1.5	3.5
Silt, tan-gray; contains snail shells	14.5	18
Loveland silt and Crete sand and gravel members—(Illinoian Stage)		
Clay, silty, tan-gray	2	20
Clay, silty to sandy, brown	2	22
Sand, fine to coarse, clayey to silty, tan-gray to yellow-brown	4	26
Clay, compact, and some embedded tan-gray gravel,	6	32
Sand, fine to coarse, clayey	3	35
Clay, silty to fine sandy, tan	2	37
TERTIARY—Pliocene		
Ogallala formation		
Clay, limy, partly cemented, light-tan	4	41
Sand and gravel, coarse to fine, silty	3	44
Clay, silty to limy, light-gray to tan-white	10	54
Clay, limy, tan-white; contains interbedded stringers of sand	4	58
Sand, fine to medium	4	62
Sand, fine to medium, silty, cemented, light-tan	7	69
Clay, compact, tan-yellow	5	74
Clay, compact, gray-white to white	5.5	79.5
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, yellow to yellow-orange	2.5	82

10-28-33dd.—*Sample log of test hole in the SE cor. sec. 33, T. 10 S., R. 28 W.; at county line on north road shoulder, 170 feet west of center of highway; drilled 1952. Surface altitude, 2,741.2 feet; depth to water, 61.6 feet.*

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, clayey, tan-gray	5	6
TERTIARY—Pliocene		
Ogallala formation		
Sand, clayey, red-brown	3.5	9.5
Clay, limy, tan to white	1.5	11
Sand and gravel, coarse to fine, silty	11	22
Sand, coarse to fine; contains some coarse to fine gravel, cemented, silty, tan-brown	5	27
Sand, fine to coarse	5	32
Sand, fine to coarse, and fine to coarse gravel; contains interbedded stringers of sandy clay	6	38
Clay, mottled gray-brown; contains some embedded gravel	9	47
Clay, sandy to very sandy, red-brown	3	50
Sand, fine to coarse	5	55
Clay, sandy, brown; contains some embedded gravel,	9.5	64.5
Sand, fine to coarse; contains some fine to coarse gravel	7.5	72
Clay, gray; contains interbedded coarse to fine sand and gravel	6	78
Sand, fine to coarse	5	83
Clay, gray, and interbedded fine to coarse sand	7	90
Sand and gravel, fine to coarse	8	98
Sand and gravel, fine to coarse, clayey	2	100
Clay, tan-gray, and interbedded fine to coarse sand and gravel	6.5	106.5
CRETACEOUS—Gulfian		
Niobrara formation—Smoky Hill chalk member		
Chalk, yellow-orange; silicified at top	6.5	113

10-30-31cc.—*Sample log of test hole in the SW cor. sec. 31, T. 10 S., R. 30 W.; 60 feet north of county line and 5 feet east of right-of-way fence on east side of road; drilled 1952. Surface altitude, 2,924.6 feet; depth to water, 52.4 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, tan-gray	9	10

	Thickness, feet	Depth, feet
TERTIARY—Pliocene		
Ogallala formation		
Sand and gravel, coarse to fine, cemented, silty, red-brown	8.5	18.5
Sand and gravel, fine to coarse	10.5	29
Clay, sandy to very sandy, light-tan	7	36
Silt, very limy, sandy, white	1	37
Clay, sandy, tan to tan-brown; contains some embedded gravel	18	55
Sand, fine to coarse; contains some fine to coarse gravel	31.5	86.5
Clay, compact, brown	4.5	91
Sand, silty to clayey	20	111
Sand and gravel, fine to coarse	12	123
CRETACEOUS—Gulfian		
Pierre shale		
Shale, bentonitic, gray-white	9	132
Shale, yellow to orange	6	138

11-30-1aa.—*Sample log of test hole in the NE cor. sec. 1, T. 11 S., R. 30 W.; Gove County, 200 feet south and 15 feet west of center of road intersection; drilled 1952. Surface altitude, 2,889.5 feet; depth to water, 112.5 feet.*

	Thickness, feet	Depth, feet
Soil	1	1
QUATERNARY—Pleistocene		
Sanborn formation		
Peoria silt member—(Wisconsinan Stage)		
Silt, clayey, gray-green	10	11
Loveland silt member—(Illinoian Stage)		
Clay, compact to fine sandy, tan	6	17
Clay, limy, compact, light-tan	2.5	19.5
TERTIARY—Pliocene		
Ogallala formation		
Clay, silty to fine sandy, tan-white; contains some embedded gravel	4.5	24
Clay, silty, tan-brown	2	26
Clay, silty, limy, tan-white	2	28
Gravel, coarse to fine, and coarse sand; cemented	2	30
Sand, medium to coarse, and fine to coarse gravel; contains interbedded tan-brown sandy clay	2	32
Sand and gravel, fine to coarse	16	48
Sand and gravel, fine to coarse; contains some embedded gray clay	3	51
Clay, very sandy, red-brown; contains stringers of gravel at 55 and 58 feet	11	62
Clay, fine, sandy, red-brown	3	65
Clay, red-brown, and interbedded fine to coarse sand	10	75
Sand, medium to coarse, and fine to coarse gravel	23	98
Clay, compact, gray-brown	1.5	99.5

	Thickness, feet	Depth, feet
Clay, sandy, red-brown	3.5	103
Clay, silty to sandy, limy, tan-brown	5	108
Sand, medium to coarse, and fine to medium gravel	5	113
Clay, sandy, gray-brown	8	121
Sand, fine to coarse	17	138
Clay, gray-brown, limy	8	146
Clay, gray-brown; contains interbedded stringers of sand	10	156
Silt, very limy, tan-white	7	163
CRETACEOUS—Gulfian		
Pierre shale		
Shale, weathered, mottled yellow-brown	3	166
Shale, bentonitic, yellow-gray	11	177
Shale, clayey, dark-gray	10	187
Niobrara formation—Smoky Hill chalk member		
Shale, calcareous, dark-gray	23	210

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INDEX

AREAL GEOLOGY OF SHERIDAN COUNTY, KANSAS

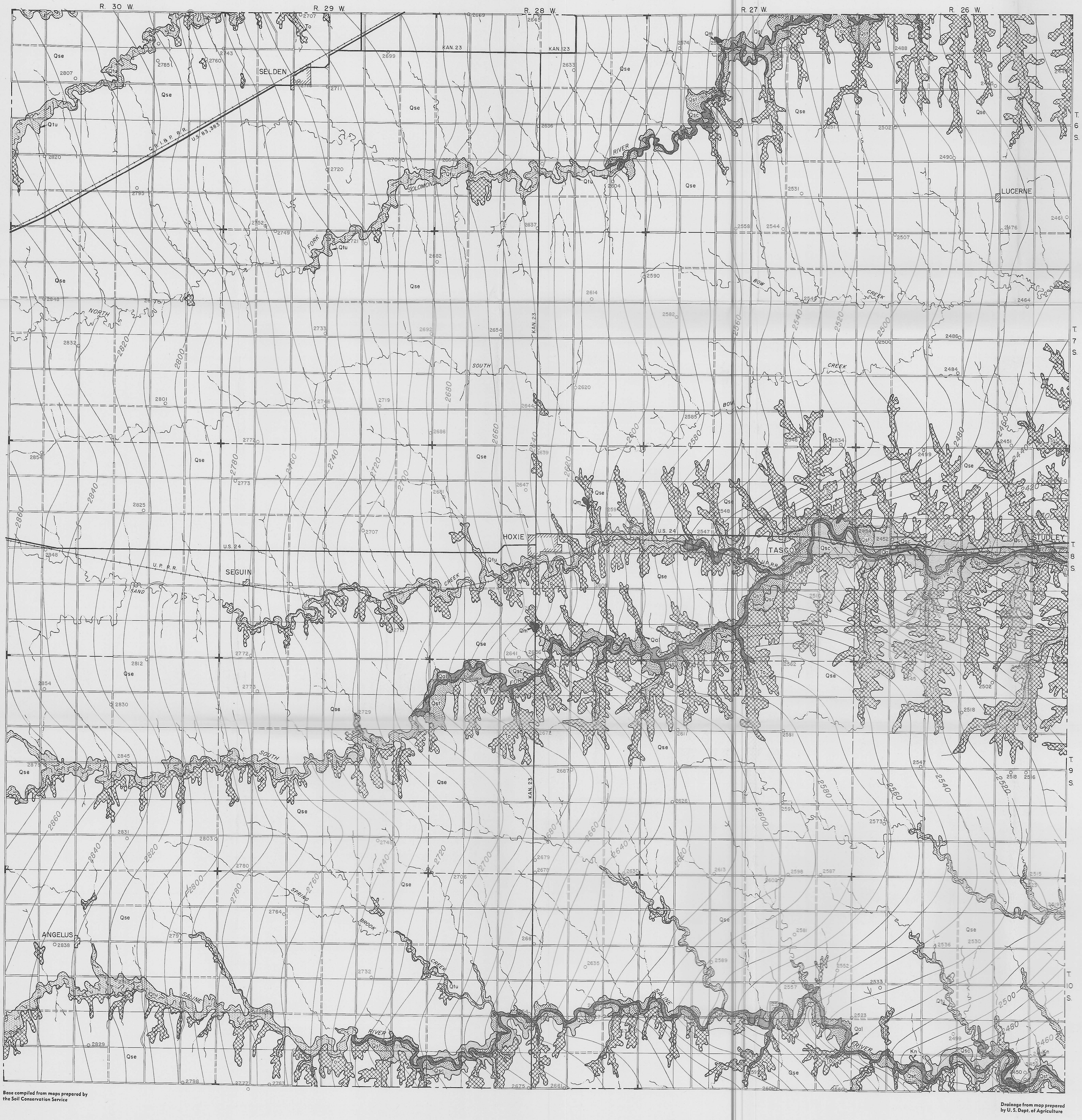
With Water-Table Contours

By Charles K. Bayne

1952

State Geological Survey
of Kansas

Bulletin 116
Plate 1



Base compiled from maps prepared by the Soil Conservation Service

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

EXPLANATION

Qal

Alluvium

Unconsolidated sand, gravel, and silt along the major stream valleys. Yields moderate supplies of water to wells.

Qtu

Undifferentiated valley deposits

Silt, clay, sand, and gravel. Includes alluvium, terrace and slope wash materials along the major streams and tributaries where the deposits are not mappable as separate units. Yields moderate to small amounts of water to wells.

Qst

Sanborn formation
Wisconsinan terrace deposits

Sand, gravel, silt, and clay. Forms low terrace along major stream valleys. Yields moderate to large supplies of water to wells.

Qse

Sanborn formation
Eolian deposits

Tan to reddish-brown silt. Lies above water table and yields no water to wells. Includes Bignall, Peorian and Loveland members.

Qsc

Sanborn formation
Crete sand and gravel member

Sand and gravel with minor amounts of silt and clay in an intermediate terrace position along the major stream valleys. Yields moderate supplies of water to wells where below water table.

Qm

Meade formation

Silt, sand, and gravel and the Pearlette volcanic ash member. Only small deposits exposed. Probably more extensive deposits are covered by silts of the Sanborn formation. Known deposits lie above the water table and yield no water to wells.

PLEISTOCENE — QUATERNARY

To

Ogallala formation

Sand, gravel, clay, and silt; may be consolidated or unconsolidated. Cemented principally with calcium carbonate, but locally cemented with silicates. Yields large supplies of water to wells.

PLIOCENE — TERTIARY

Kn

Niobrara formation

Chalky shale and chalk. Yields no water to wells in Sheridan County.

GULFIAN — CRETACEOUS

○ 4552

Well location. Number refers to altitude of water level

2520

Water table contours based on instrumental levels

Contour interval 10 feet

Federal or State Highway

Graded road

Ungraded road

Railroad

County line (no road)

Township line (no road)

Section line (no road)

Intermittent stream

0 1 2 3 4
SCALE IN MILES

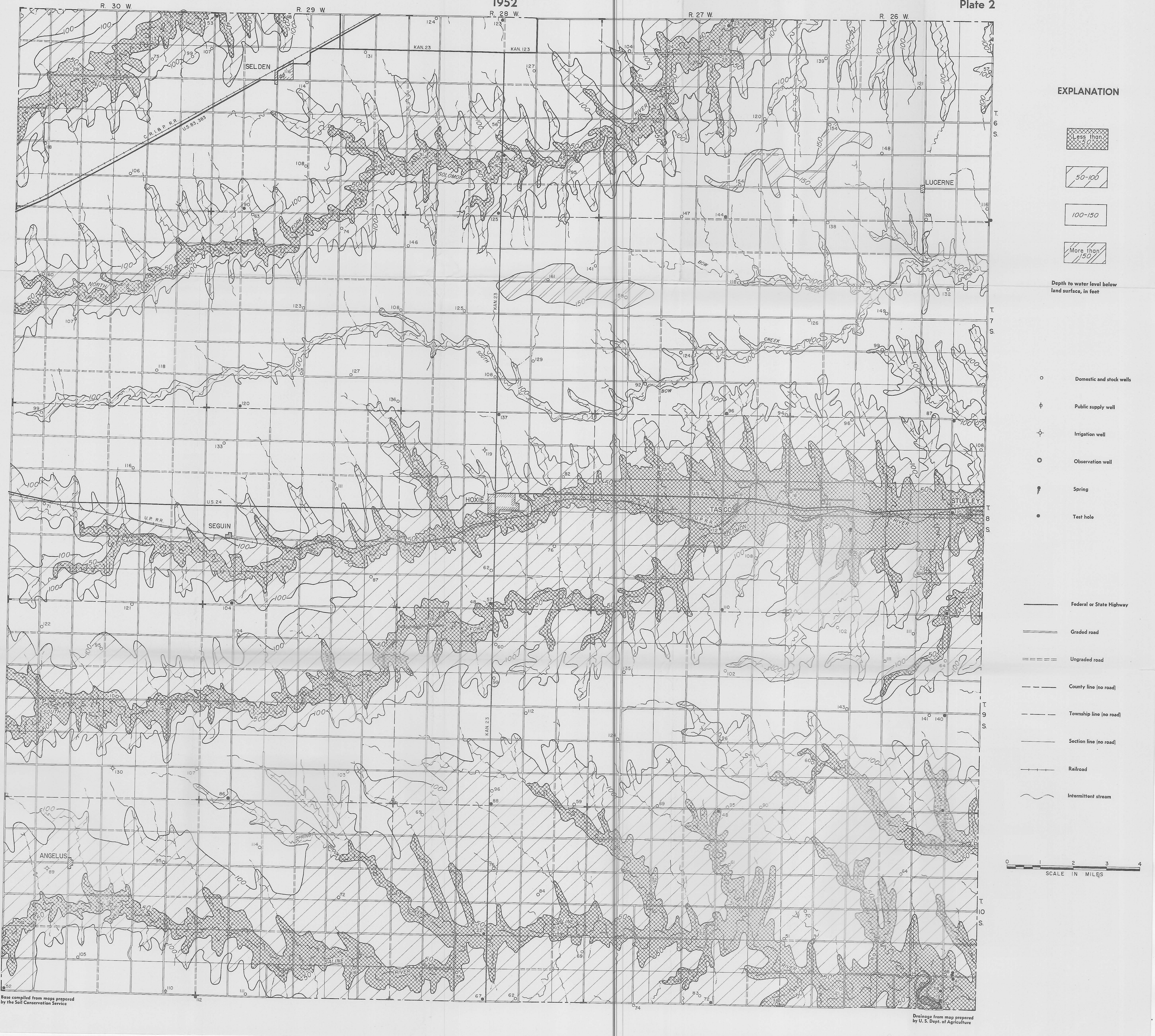
State Geological Survey
of Kansas

MAP OF SHERIDAN COUNTY, KANSAS

Showing the Depths to Water Level and the Location of Wells and Test Holes for Which Records are Given

By Charles K. Bayne
1952

Bulletin 116
Plate 2



Base compiled from maps prepared by the Soil Conservation Service

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