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BULLETIN 151

GEOLOGY AND GROUND-WATER RESOURCES OF SUMNER COUNTY, KANSAS

By KENNETH L. WALTERS
(U. S. Geological Survey)

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

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† Deceased

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GEOLOGY AND GROUND-WATER RESOURCES OF SUMNER COUNTY, KANSAS

By Kenneth L. Walters

ABSTRACT

This report describes the geography, geology, and ground-water resources of Sumner County in south-central Kansas. The hydrologic and geologic data upon which this report is based were obtained in the field during the summers of 1955 and 1956. Records of 300 wells and 2 springs, chemical analyses of 219 water samples from wells and test holes and of 15 from streams, and logs of 362 wells and test holes are included in tables.

Sumner County has an area of 1,183 square miles and lies in the Wellington Lowland and Arkansas River Lowlands of the Central Lowland physiographic province. It is drained by Arkansas River, Ninnescah River, and Chikaskia River and their tributaries. The land surface in general is a southeastward-sloping, gently rolling plain. The average annual precipitation at Wellington is about 31 inches. Wheat farming is the principal industry of the county, and oil is the chief natural resource.

The Wellington Formation, of Permian age, crops out in the eastern two-thirds of the county except where it is covered by Pleistocene deposits. The Ninnescah Shale (Permian) overlies the Wellington Formation and crops out in parts of the western third of the county. The Permian rocks yield small quantities of hard water to wells. Pleistocene sand and gravel deposits of Nebraskan age are present in the northwestern corner of the county and yield moderate quantities of good water to wells. Discontinuous deposits of Kansan or Illinoisan age, locally mantled by colluvium, form terraces in southern and eastern Sumner County, and may yield moderate quantities of water. Wisconsinan terrace deposits and Recent alluvium along the major streams yield large quantities of water. Colluvium and dune sand are unimportant as sources of water but may facilitate recharge.

Maps of Sumner County included in this report show the outcrop areas of the formations, geologic cross sections, the shape and slope of the water table, the locations of wells and test holes for which records are given, and the distribution of chloride in water samples.

The ground-water reservoir is recharged principally from rain and snow that fall within the county, by percolation from streams and other surface bodies of water, and by underflow from adjacent areas. Water is discharged from the ground-water reservoir by seepage into streams, by transpiration and evaporation, by movement into adjacent areas, and by wells. Water is pumped from wells for domestic, stock, municipal, industrial, and irrigation use. Irrigation from wells is most extensive in the valley of Arkansas River, in which area further development is most probable.

Chemical analyses of samples of water from Sumner County indicate that the quality varies greatly from place to place. Sulfate is common in water from the Wellington Formation and Ninnescah Shale. Water from Pleistocene deposits is generally suitable for most uses except in local areas where it contains excessive chloride.

INTRODUCTION

Purpose and Scope of Investigation

The ground-water investigation upon which this report is based is part of an extended program begun in 1937 by the U. S. Geological Survey and the State Geological Survey of Kansas in cooperation with the Division of Sanitation of the Kansas State Board of Health and the Division of Water Resources of the Kansas State Board of Agriculture. The investigation in Sumner County is similar to studies that have been completed or are in progress in about two-thirds of the counties of Kansas.

The extended drought from 1951 to 1956 resulted in renewed interest in irrigation from wells, and the increased use of water-consuming household appliances has greatly increased the amount of water needed for domestic use. The investigation in Sumner County was made to determine the quantity, quality, movement, and availability of ground water. This basic information is necessary for determining the feasibility of further development of irrigation from wells and, in parts of the county, for the abatement of pollution.

Location and Extent of Area

Sumner County is in the first row of counties north of Oklahoma and is about midway between the east and west borders of Kansas (Fig. 1). It is bordered on the east by Cowley County, on the north by Sedgwick County, on the west by Kingman and Harper

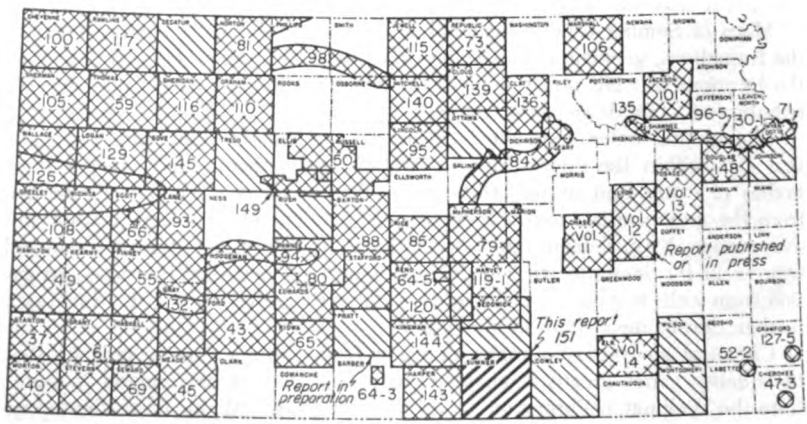

Fig. 1.—Index map of Kansas showing area discussed in this report and other areas for which cooperative ground-water reports have been published or are in preparation.

Counties, and on the south by Grant and Kay Counties, Oklahoma. The county has an area of about 1,183 square miles, extending 36 miles from east to west and about 33 miles from north to south.

Previous Investigations

Among the early geologic workers in south-central Kansas, F. W. Cragin (1885) named and described the Wellington Formation. Bass (1926) described the structure and limits of the Kansas salt beds with special reference to the Wellington Formation. Later (1929) Bass mapped the geology and prepared a report on geologic conditions in Cowley County. The geologic map of Kansas prepared by Moore and Landes (1937) shows the surface geology of Sumner County on a small scale. Landes (1937) also described the mineral resources of Sumner County and included a general description of the geology. Norton (1939) named the Ninnescah Shale in a report on the Permian redbeds of Kansas. The surface and subsurface rocks of Kansas were described by Moore and others (1951). Frye and Leonard (1952) described the Pleistocene geology of Kansas and made several specific references to Sumner County. Swineford (1955) prepared a very detailed report on the petrography of the upper part of the south-central Kansas Permian rocks. A report by Kulstad and others (1956) on gypsum includes this area. Investigations of the geology and ground-water resources of adjacent counties, including Kingman County (Lane, 1960), Harper County (Bayne, 1960), Sedgwick County (Williams and Lohman, 1949; Lane and Miller, in preparation), and Cowley County (Bayne, in preparation) have been completed or are in progress.

Methods of Investigation

Most of the field work upon which this report is based was done during the summers of 1955 and 1956. In 300 wells the depth of the well and the depth to water below the land surface were measured with a steel tape (Table 11). Well owners and well drillers were asked the lithology and thickness of the water-bearing materials penetrated in the wells. Information pertaining to the yield of wells and the quality of the water was obtained where possible. Special effort was made to inventory all irrigation, municipal, and industrial wells, but only representative stock and domestic wells were inventoried.

In areas where information was not available from wells or where special water-supply problems existed, 296 test holes were drilled with a power auger or a portable hydraulic-rotary rig owned by the

State Geological Survey and operated by E. L. Reavis, Dwane Anderson, and William Gellinger. Samples of drill cuttings collected from some of these holes were studied in the field and later were examined in the laboratory under binocular microscope. Logs of 66 test holes drilled by contractors are included in this report. The altitudes of the measuring points of the wells and test holes were determined with a planetable and alidade by E. L. Reavis.

During the investigation, 234 water samples were collected from wells, test holes, and streams; 71 samples from wells were given a comprehensive chemical analysis and 148 samples from wells and 15 samples from streams were analyzed only for content of chloride or chloride and sulfate. Some of the analyses are of samples collected in 1944, but most are of those collected during this investigation.

Twenty-five observation wells were installed in 1954 in the valley of Arkansas River near Mulvane to determine what effect pumping by the cities of Augusta and El Dorado would have on the water level. The wells are measured periodically, and hydrographs are included in this report.

Geology was mapped on aerial photographs from observations in the field and from stereoscopic study of the photographs. The mapping was later transferred from the aerial photographs to a base map made from a county map prepared by the Soil Conservation Service.

Well-Numbering System

The wells and test holes in this report are numbered according to their location as determined by the General Land Office system of land classification. The component parts of a well number indicate respectively the township, the range, the section, and subdivisions of the section. The first small letter denotes the quarter section, the second denotes the quarter-quarter section, and the third denotes the 10-acre tract; these are designated in a counterclockwise direction, beginning in the northeast quadrant. If two or more wells are within the same 10-acre tract, they are numbered serially according to the order in which they were inventoried. All the townships in Sumner County are south of the base line, hence no letter designation of north or south is necessary; however, as the county extends both east and west of the sixth principal meridian, the range number is followed by "E" or "W". An example of the well-numbering system is given in Figure 2.

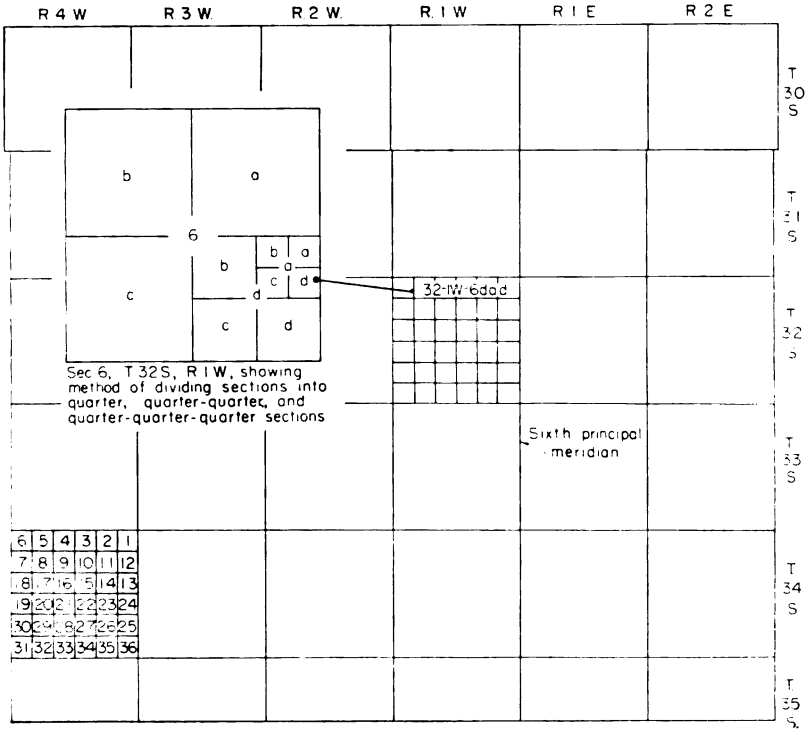

FIG. 2.—Map of Sumner County illustrating well-numbering system used in this report.

ACKNOWLEDGMENTS

Appreciation is expressed to the many persons who co-operated and assisted in the collection of field data. The city officials were helpful in supplying information concerning their municipal wells. Many landowners in the county supplied information pertaining to the yield of their wells and were very co-operative in allowing tests to be made or test drilling to be done. Special thanks are extended to Latta and Fent of Salina (now known as the Hydraulic Drilling Co.) for making available the logs of test holes in the Wellington well field.

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

GEOGRAPHY

Topography and Drainage

Sumner County is in the Wellington Lowland and the Arkansas River Lowlands of the Central Lowland physiographic province (Schoewe, 1949). The upland areas of the county, because of the thick shale beds underlying the surface, are chiefly gently rolling plains. The valleys are wide and flat except locally where sand dunes have formed. The highest points in the county are in the area west of Conway Springs. The lowest points are near Drury and Geuda Springs along Chikaskia and Arkansas Rivers. The total relief in the county is about 400 feet.

Sumner County is drained by southeastward-flowing streams. Arkansas River crosses the northeast corner of the county and is joined by Ninnescah River near Oxford. Cowskin Creek enters the county a short distance west of Mulvane and joins Arkansas River between Mulvane and Oxford. Slate Creek has its headwaters northwest of Conway Springs and joins Arkansas River near Geuda Springs. Salt Creek is a small tributary to Arkansas River flowing through Geuda Springs. Chikaskia River enters the county west of Argonia and leaves it south of Drury. Prairie Creek, whose headwaters are north of Mayfield, joins Chikaskia River west of Corbin. Bluff Creek and Fall Creek drain the southwestern part of the county, joining a short distance east of Caldwell.

Population

According to the 1950 census, the population of Sumner County was 23,646. The average density of population was 20.0 per square mile as compared to 23.2 for the entire state. The population of Sumner County in 1940 was 26,163, hence by 1950 it had decreased 9.6 percent. The incorporated cities of Sumner County and their 1950 populations are as follows: Argonia, 562; Belle Plaine, 971; Caldwell, 2,000; Conway Springs, 816; Geuda Springs, 245; Hunnewell, 103; Mayfield, 134; Milan, 165; Mulvane, 1,387; Oxford, 798; South Haven, 358; and Wellington, 7,747. In 1950 the population of the county was 32.8 percent urban, as compared to 27.7 percent in 1940.

Transportation

Sumner County is served by lines of the Atchison, Topeka, and Santa Fe Railway Co.; the Chicago, Rock Island, and Pacific Railway; the Missouri Pacific Railroad Co., and the Midland Valley

Railroad Co. It is traversed by U. S. Highways 81, 160, 166, and 177 and by State Highways 2, 15, 42, 44, 49, 53, and 55. The Kansas Turnpike crosses the county from north to south a few miles east of Wellington and South Haven. The county is served also by a satisfactory network of graveled or otherwise improved county roads.

Agriculture

In 1952 there were 2,299 farms in Sumner County having a total area of approximately 757,120 acres. The county ranked first in the state in the production of wheat in 1952, yielding a crop of 10,727,000 bushels, an average yield of 25.3 bushels per acre. Sorghum is the second most important crop (Table 1). Tame and prairie pasture in Sumner County totaled 162,000 acres in 1952.

Table 1.—*Acreage and value of crops harvested in Sumner County in 1952*

Crop	Acres harvested	Value
Wheat	424,000	$22,634,000
Corn	12,800	376,200
Oats	18,000	383,100
Sorghum	41,300	1,924,500
Alfalfa	15,310	1,027,050
Others	15,735	407,320

Mineral Resources

The mineral resources of Sumner County include oil and gas, sand and gravel, salt, limestone, and gypsum.

Oil and gas.—Gas was discovered in the county in June 1915 in what is now known as the Vernon North pool. The first oil was discovered in May 1925 in the "Mississippi lime" in sec. 22, T. 34 S., R. 2 E. (Ver Wiebe and others, 1948). Oil and gas are produced from rocks of the Arbuckle Group (Cambrian-Ordovician), the Simpson Group (Ordovician), the upper part of the Mississippian System, and the Pennsylvanian Cherokee, Kansas City, Lansing, and Shawnee Groups. In 1959, Sumner County produced 2,892,057 barrels of oil from 791 wells. The total cumulative production of the county to January 1, 1960, was almost 73 million barrels, about half of which came from the Oxford and Churchill pools. In 1959 Sumner County produced more than 600,000 M cubic feet of natural gas (Goebel and others, 1960).

Secondary recovery projects have been attempted in the Churchill, Fall Creek, Oxford, and Wellington pools. The Wellington and Fall Creek projects are now in operation (Goebel and others, 1960a).

Sand and gravel.—Sand and gravel deposits of Pleistocene age have been worked commercially for many years in the valleys of Arkansas River and Slate Creek near Wellington. Need for sand and gravel in construction of the Kansas Turnpike through Sumner County resulted in the opening of two large gravel pits in older Pleistocene deposits in the area east and north of South Haven.

Limestone.—Limestone is not abundant nor widespread in Sumner County, but a quarry in the NW¼ sec. 36, T. 31 S., R. 2 E., now abandoned, produced stone for several buildings and bridges in the Oxford area. Limestone of poor quality has been quarried in the SE¼ sec. 36, T. 32 S., R. 1 W., and in the SE¼ sec. 15, T. 34 S., R. 2 E.

Salt.—In 1887, salt beds were discovered at Wellington in a prospect hole at a depth of 240 feet. Wellington is near the east edge of the salt beds in the Wellington Formation, of Permian age, and the salt is only 50 feet thick there. A small plant having a maximum daily capacity of 158 barrels was erected at Wellington in 1888 to process salt. This plant and mine operated only a short time before being abandoned because of financial failure.

Gypsum.—A bed of gypsum of good quality but of undetermined thickness crops out in the SW¼ SE¼ sec. 27, T. 33 S., R. 2 E. This gypstone is in the Wellington Formation. A quantity of gypsum is reported to have been quarried from this locality to build the "Marble block" building in Wellington. Exploratory test drilling probably would be necessary to determine the economic importance of the deposit.

Climate

The climate of Sumner County is characterized by wide variations in temperature and precipitation. The winters are usually mild; the summers are hot, but because of the relatively low humidity and brisk air movement, they are not unduly uncomfortable.

The U. S. Weather Bureau maintains precipitation stations at Belle Plaine, Caldwell, Conway Springs, Oxford, and Wellington in Sumner County. The station at Wellington is the most centrally located and has the longest records, hence this discussion of the climate of Sumner County is based principally on the records of that station.

The normal monthly precipitation is given in Table 2. The normal

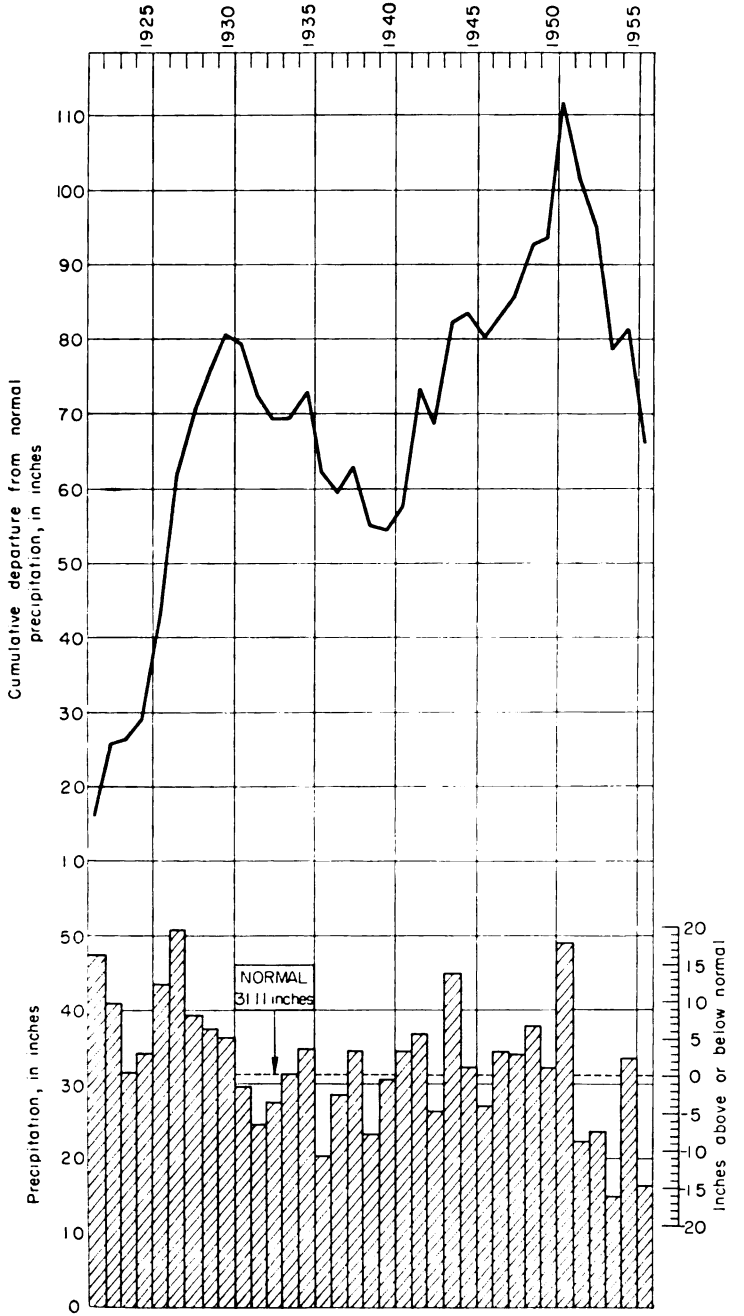

FIG. 3.—**Annual precipitation and cumulative departure from normal precipitation at Wellington.**

TABLE 2.—*Normal monthly precipitation at Wellington*

Month	Precipitation (inches)	Month	Precipitation (inches)
January	1.02	July	3.08
February	1.27	August	2.99
March	1.68	September	3.36
April	3.09	October	2.23
May	4.74	November	1.69
June	4.60	December	1.36

annual precipitation at Wellington is 31.11 inches. A precipitation station was established at Wellington in 1889, and continuous records have been kept since 1922 except for the month of May 1945. The annual precipitation and the cumulative departure from normal precipitation at Wellington are given in Figure 3. In preparing Figure 3, the precipitation for May 1945 was interpolated from the precipitation at Belle Plaine and Oxford for that month.

About 70 percent of the precipitation falls during the six-month period from April 1 to September 30. The highest temperature ever recorded at Wellington was 120° F. and the lowest was –19° F.

GENERAL GEOLOGY

SUMMARY OF STRATIGRAPHY*

The rocks that crop out in Sumner County are sedimentary in origin and range in age from Paleozoic to Recent (Pl. 1). The oldest rocks are a part of the Wellington Formation of the Leonardian Stage, Permian System. The Wellington Formation forms the bedrock surface in approximately the eastern two-thirds of the county and crops out in local areas where it is not covered by Pleistocene deposits. The Ninnescah Shale, also of the Leonardian Stage, forms the bedrock surface in approximately the western third of the county and crops out in local areas where it is not covered by Pleistocene deposits.

Cenozoic deposits of the Pleistocene Series representing four glacial stages and possibly the interglacial stages occur in Sumner County. Deposits of Nebraskan-Aftonian age underlie the surface in the northwestern part of the county near Conway Springs. Deposits of Kansan-Yarmouthian age are most extensive in the eastern and southern parts of the county. Illinoisan-Sangamonian and

* The classification and nomenclature of the rock units described in this report have been adopted by the State Geological Survey of Kansas. They differ somewhat from the usage adopted by the U. S. Geological Survey.

TABLE 3.—*Generalized section of rocks* that crop out in Sumner County and their water-bearing characteristics*

System	Series	Subseries	Stage	Stratigraphic unit	Thickness, feet	Physical character	Water supply, Sumner County
Quaternary	Pleistocene	Upper Pleistocene	Recent	Dune sand	0–30	Sand, medium and fine, some silt.	Generally above the water table, and does not yield water to wells.
				Alluvium	0–75	Chiefly arkosic sand and gravel; contains discontinuous lenses of silt and clay.	Yields large quantities of water to wells.
				Colluvium Recent to Illinoisan	0–25	Silt and clay, minor amounts of sand and gravel, resembling the underlying bedrock material.	Does not yield appreciable quantities of water to wells.
			Wisconsinan	Terrace deposits	0–75	Chiefly arkosic sand and gravel; contain discontinuous lenses of silt and clay. Can be differentiated from alluvium only by topographic position.	Yield large quantities of water to wells.
			Illinoisan	Crete Formation	0–65	Poorly sorted sand and gravel; contains considerable red-brown silt and locally derived limestone and shale fragments.	Yields moderate quantities of water to wells.
		Lower Pleistocene	Kansan	.....	0–90	Poorly sorted sand and gravel; locally contains much silt and clay.	Yields moderate quantities of water to wells.
			Nebraskan	Terrace deposits	0–90	Chiefly medium to coarse sand; contain some silt and clay.	Yield moderate quantities of water of good quality to wells.
Permian	Middle Permian	.....	Leonardian (Sumner Group)	Ninnescah Shale	0–250	Predominantly silty shale, mostly brownish red with gray-green spots; contains beds of dolomite, calcareous siltstone, and fine-grained sandstone.	Yields small quantities of hard water to wells.
				Wellington Formation	40–650	Chiefly shale and silty shale, mostly gray and green, some red; contains lenticular beds of gypsum, silty limestone, dolomite, and the thick Hutchinson Salt member near base.	Yields small quantities of hard water to wells.

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

Wisconsinan terrace deposits border most of the major streams of the county, and Recent deposits form the flood plains and occur also as sand dunes. Deposits of the interglacial stages were not recognized, however, and therefore in this report the deposits referred to a glacial stage include those of the subsequent interglacial stage if present. Deposits of Kansan and Illinoisan age are mapped together on Plate 1.

A generalized section of the rocks that crop out in Sumner County is given in Table 3.

GROUND WATER

Principles of Occurrence

The following discussion of the occurrence of ground water has been adapted from Meinzer (1923) and the reader is referred to his report for a more detailed discussion. A general discussion of the principles of ground-water occurrence with special reference to Kansas has been presented by Moore and others (1940).

Hydrologic Properties of Water-Bearing Materials

The rocks that make up the crust of the earth generally are not solid but have many openings, called voids or interstices, which may contain air, natural gas, oil, or water. The many kinds of rocks differ greatly in the number, size, shape, and arrangement of their interstices; therefore, the occurrence of water in any region is determined by the geology of the region.

The interstices or voids in rocks range in size from microscopic openings to the huge caverns found in some limestones. The porosity of a rock is expressed quantitatively as the percentage of the total volume of the rock that is occupied by interstices or that is not occupied by solid rock material. Uncemented deposits of gravel having a uniform grain size have greater porosity than deposits made up of a mixture of sand, clay, and gravel, in which the smaller particles occupy space between adjacent large particles. Relatively soluble rock such as limestone, though originally dense, may become cavernous as a result of the removal of part of its substance through the solvent action of percolating water. Hard, brittle rock may acquire large interstices through fracturing that results from shrinkage or deformation of the rocks or through other agencies.

The permeability of a rock is its capacity for transmitting water under pressure and is measured by the rate at which the rock will

transmit water through a given cross section under a given difference of head per unit of distance. The permeability of water-bearing material generally is expressed as a coefficient of permeability, which is commonly defined by the U. S. Geological Survey as the number of gallons of water per day at a temperature of 60° F that will be conducted through each mile of the water-bearing bed under investigation, measured at right angles to the direction of flow, for each foot of thickness of the bed and for each foot per mile of hydraulic gradient. The quantity of water that will percolate through a given cross section of water-bearing material under a known hydraulic gradient is directly proportional to the coefficient of permeability. Thus, to compute the quantity of water that will percolate into or out of a given area the permeability must be determined.

Coefficients of permeability have a wide range in value. Clay and silt, which are fine grained, may have moderate porosity but only slight permeability; a coarse-grained sand may have less porosity but much greater permeability, *i. e.*, a greater ability to transmit water. Coefficients of permeability of less than 100 gallons per day per square foot are regarded as low, coefficients of 100 to 1,000 are medium, and those of more than 1,000 are high.

The coefficient of transmissibility is equal to the field coefficient of permeability (same as the coefficient defined above, except that it is for the prevailing temperature of the ground water) multiplied by the saturated thickness of the aquifer (water-bearing material) in feet. The coefficient of transmissibility and the coefficient of permeability are discussed further in the section on aquifer tests.

The specific yield of a rock or soil is the ratio of (1) the volume of water it will yield by gravity after being saturated to (2) its own volume. This ratio is stated as a percentage. The specific retention of a rock is the ratio of (1) the volume of water it will retain against the pull of gravity after being saturated to (2) its own volume.

Classification of Subsurface Water

The permeable rocks that lie below a certain level are generally saturated with water under hydrostatic pressure, and such rocks are said to be in the zone of saturation (Fig. 4). The zone of saturation ordinarily extends down to a depth much greater than is reached by modern drilling methods. The term ground water is used to designate that part of the subsurface water within the zone of saturation. The upper surface of the zone of saturation, where not formed by an impermeable body, is called the water table. In most places there is only one zone of saturation, but in certain localities the

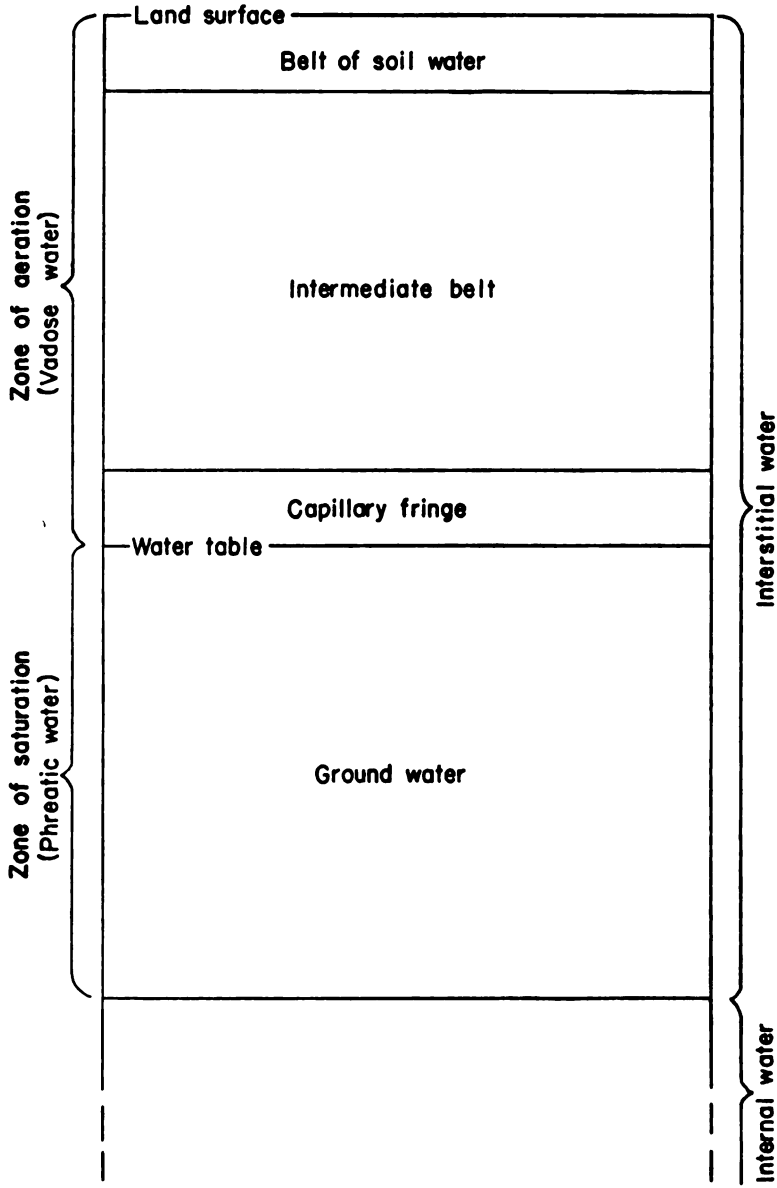

FIG. 4.—Diagram showing divisions of subsurface water (after Meinzer).

water may be hindered in its downward course by an impermeable or nearly impermeable bed to such an extent that it forms an upper zone of saturation, or perched water body, which is not associated with the lower zone of saturation.

Subsurface water above the water table is in the zone of aeration, which ordinarily consists of three parts: the belt of soil water, the intermediate belt, and the capillary fringe.

Soil water, which is water held by molecular attraction, lies just below the land surface and extends down to the maximum depth to which evaporation and plant action are effective. The soil water is not available to wells but is of the utmost importance to agriculture. Before any water can percolate downward to the water table through this belt, the amount of water present must exceed that which will be held by adhesion. The thickness of the belt of soil water is determined by the texture of the rock or soil and by the character of the vegetation.

The intermediate belt, which lies between the belt of soil water and the capillary fringe, is thick where the depth to the water table is great but may be absent where the water table is at or near the land surface. In this belt the interstices in the rocks contain some water held by molecular attraction but also may contain appreciable quantities of water that is moving downward from the belt of soil moisture to the water table.

The capillary fringe lies directly above the water table and contains water held above the zone of saturation by capillary force. The water in the capillary fringe is not available to wells, which must be deepened to the zone of saturation before water will enter them. The capillary fringe may be very thin in coarse-grained sediments, in which capillary action is negligible, or it may be several feet thick in fine-grained sediments.

The Water Table and Movement of Ground Water

Shape and Slope

The water table has been defined as the upper surface of the zone of saturation. The water table is not a static, level surface; generally it is a sloping surface having many irregularities and constantly changing. The irregularities are caused chiefly by local differences in geology and topography, and the fluctuations are due to gain or loss of water within the zone of saturation.

The generalized shape of the water table in Sumner County is shown in Plate 2 by contour lines. All points along a contour line have the same altitude, and the shape and slope of the water table

are shown by the lines as the land surface is shown by topographic contours. Water moves downslope in a direction at right angles to the contour lines. The movement is very slow because of the frictional resistance offered by the small interstices through which the water must pass. The shape of the water table in Sumner County conforms in general to the land surface, but relief is much more subdued. In areas where conditions are suitable for rapid recharge, water may percolate down to the water table faster than it can spread laterally, thus a mound or ridge is formed in the water table. Conversely, if water is withdrawn from the zone of saturation faster than it can flow in laterally, the water is lowered locally, and a cone or trough is formed. The permeability of the water-bearing material has a significant effect upon the slope of the water table. To produce a given rate of flow, the slope of the water table must be much steeper in a fine-grained deposit having slight permeability than in a coarse-grained permeable deposit.

The slope of the water table in Sumner County ranges from considerably less than 10 feet per mile in the extremely permeable alluvium of Arkansas River to at least 40 feet per mile in the relatively impermeable Wellington Formation and Ninnescah Shale. Ground water in general moves toward the major streams. The water-table contours in Plate 2 are much more generalized in the areas where the Wellington Formation or the Ninnescah Shale is the chief aquifer, because fewer wells were inventoried in these areas. In the area west of Conway Springs the water table is in a sense perched, in that the water accumulates in the permeable sand and gravel faster than it can percolate downward through the relatively impermeable Ninnescah Shale. The underlying Ninnescah Shale, however, probably is completely saturated.

Fluctuations in Water Level

In general, the water table rises when the rate of recharge exceeds the rate of discharge and declines when the rate of discharge exceeds the rate of recharge. Changes in the water level in wells indicate fluctuations of the water table, and thus indicate whether the groundwater reservoir is being depleted or replenished.

An observation-well program was started in the Arkansas River valley near Mulvane in 1954; water-level measurements in these wells are shown in Table 4. Hydrographs showing fluctuations in several of the wells are given in Figures 5 and 6. T. Max Reitz has made periodic measurements in his irrigation well 31-2E-20acc since 1935, and fluctuations in water level in this well are shown in Figure 7 and Table 5.

TABLE 4.—*Water-level measurements in observation wells in Sumner County*

	30-1E-11aba	30-2E-5cdc	30-2E-6ddd	30-2E-7aab	30—2E-7aad	30-2E-7abc2	30-2E-7aca	30-2E-7acc	30-2E-7bdd1	30-2E-7bdd2	20-2E-7caa2	30-2E-7caa3	30-2E-7dbc1	30-2E-7dbc2	30-2E-7dbd2	30-2E-7ddb	30-2E-7ddd	30-2E-8cba	30-2E-17bbb	30-2E-17dbb	30-2E-18aba	30-2E-18dcc	30-2E-21bbb	30-2E-21dcc	30-2E-27caa
	Depth to water, feet below land surface																								
1954																									
Aug. 30-Sept. 4	12.99	13.10	20.06	15.21	16.43	15.57	14.20	.....	18.80	9.29	10.71	9.50	.....	8.80	9.99	7.44	13.08	16.61	13.10	11.88	12.49	10.90	.....	.....	.....
Sept. 25	.....	.....	.....	.....	.....	.....	.....	10.45	.....	.....	.....	.....	11.71	.....	.....	.....	.....	.....	.....	.....	.....	.....	10.23	6.09	18.36
Oct. 29	13.05	13.61	19.80	15.12	15.95	15.04	13.66	10.49	15.32	10.48	14.39	16.95	15.17	11.57	13.49	10.33	13.32	17.14	13.09	11.74	12.51	10.93	9.92	6.19	18.53
Nov. 24	12.92	13.88	19.80	15.24	16.19	15.26	13.89	11.11	16.20	11.07	14.87	17.58	13.54	12.91	14.66	7.40	13.10	17.19	13.02	11.61	12.66	10.94	9.61	6.33	18.60
1955																									
Feb. 8	12.64	13.09	19.87	15.59	16.83	15.85	14.43	12.69	17.20	11.96	12.17	13.36	13.56	12.99	14.61	10.78	13.20	17.33	12.79	11.29	12.54	10.72	9.48	6.50	.....
Apr. 25	12.58	13.30	19.92	15.49	17.88	15.66	14.23	12.46	15.87	11.91	14.82	17.70	12.66	11.83	13.86	7.22	12.62	17.12	12.46	11.08	12.02	10.46	9.20	6.52	18.85
June 2-3	12.44	11.77	19.69	15.14	21.50	15.26	13.71	11.80	15.21	11.13	13.47	16.24	10.07	9.75	11.32	8.63	11.81	16.37	11.49	10.55	11.06	10.80	9.11	6.49	18.85
July 20	12.10	12.22	19.30	15.70	16.10	18.17a	15.13	11.57	14.24b	9.60b	13.76	16.40a	11.00a	10.55a	12.20a	7.02	12.60	16.35	12.54	10.46	11.63	10.08	7.40	6.41	18.72
Nov. 8	11.70	11.14	18.90	14.38	15.24	14.52	13.05	11.35	14.89	11.22	13.86a	16.23a	11.30a	10.23	12.77a	7.34	12.90	16.16	12.96	9.94	11.90	10.13	6.25	5.91	18.50
1956																									
Feb. 21	12.13	11.01	19.53	15.33	16.23	15.55	14.02	11.88	14.44	11.54	14.75	17.23a	12.62	10.94a	13.86	7.35	12.80	16.70	12.69	10.89	12.15	10.45	8.02	5.88	18.57
May 1	12.25	11.06	19.60	15.58	12.80	16.08	14.36	12.86	14.56	12.40	15.28	17.90	12.23	11.30	14.65a	7.65	13.06	16.95	12.93	11.15	12.36	10.70	8.30	5.94	18.75
July 17	12.72	13.73	21.02	18.39	c	21.02a	17.63	d	16.60	13.00	15.22	17.90a	d	11.89	12.00a	7.58	13.24	17.76	13.06	11.85	12.58	10.96	8.78	6.00	19.03
Sept. 13	13.25	14.10	21.62	19.20	c	21.81b	18.49	.....	17.77	13.79	16.43	19.18a	.....	15.00a	15.43a	8.45	13.85	18.40	13.63	12.18	13.55	11.57	9.75	6.26	19.25
Dec. 18-19	13.43	14.47	22.61	20.32	19.44	22.92a	19.82	.....	19.08	15.25	18.17a	21.03a	.....	17.32	18.08a	9.33	14.23	19.34	13.62	12.12	14.83	11.57	9.95	6.59	19.43
1957																									
Mar. 19	13.22	14.29	23.14	20.57	d	22.87	19.92	.....	19.00	14.95	17.90	19.79	.....	15.17	16.65	11.60a	14.64	19.62	13.57	11.89	14.40	11.38	10.07	6.70	19.56
Apr. 22	12.80	12.69	23.10	20.15	.....	20.00	19.19	.....	16.00	12.82	12.48	14.95a	.....	9.62	9.95	7.90	12.75	18.79	12.15	10.95	11.91	10.36	9.75	6.10	19.50
June 6e	10.38	8.61	21.83	13.56	.....	11.00	10.31	.....	9.15	4.90	6.17	6.93	.....	d	5.52	2.80	8.65	13.04	8.73	6.65	8.17	8.77	2.80	.....	19.03
Aug. 14	10.30	11.74	16.88	12.22	.....	11.88	12.50	.....	11.22	6.96	9.36	9.84	.....	.....	.....	6.53	12.48	14.87	.....	9.66	11.13	9.10	.....	.....	17.56

a. Nearby well being pumped.
b. Water from pumped well flowing in ditch past observation well.
c. Well partly plugged.
d. Well destroyed; measurement discontinued.
e. Pumping by El Dorado-Augusta Water Association discontinued May 15, 1957.

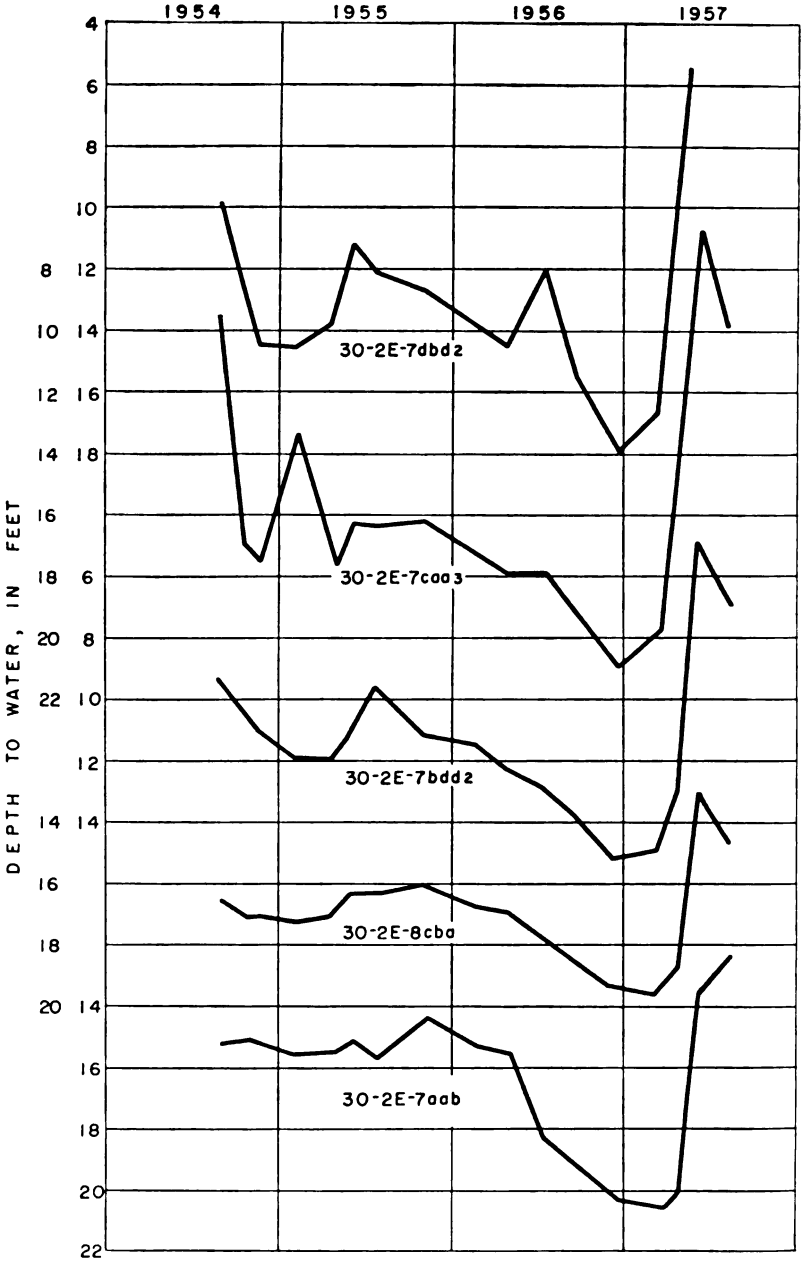

FIG. 5.—Hydrographs showing fluctuations of water level in five wells in Mulvane area.

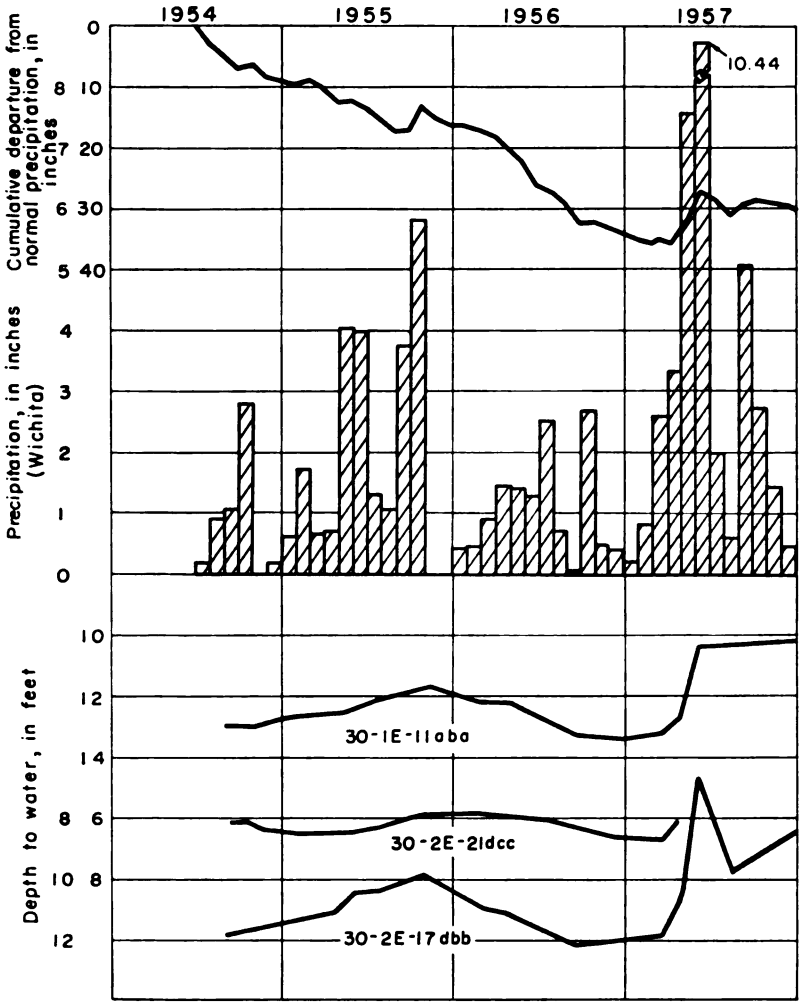

FIG. 6.—Hydrographs showing fluctuations of water level in three wells in Mulvane area, and monthly precipitation and cumulative departure from normal precipitation at Wichita.

TABLE 5.—*Water levels in irrigation well 31-2E-20acc*

Date	Depth to water, feet	Date	Depth to water, feet
Jan. 1, 1935	22.00	Oct. 1, 1940	19.50
June 1	16.00	Nov. 15	20.15
		Dec. 1	20.15
Jan. 1, 1936	20.00		
June 1	19.00	Jan. 1, 1941	19.83
		Feb. 1	19.15
Jan. 1, 1937	20.90	Mar. 1	19.50
Feb. 1	20.75	Apr. 1	19.50
Mar. 1	20.15	May 1	19.33
Apr. 1	20.42	June 1	19.00
May 1	20.50	July 1	17.25
June 1	17.00	Aug. 1	15.66
July 1	19.00	Oct. 1	20.08
Aug. 1	16.00		
Sept. 1	17.00	Mar. 1, 1942	19.33
Oct. 1	18.00	May 1	17.50
Nov. 1	19.33	June 1	15.50
Dec. 1	19.50	July 1	16.00
		Sept. 1	17.00
Jan. 1, 1938	20.00	Nov. 1	15.00
Feb. 1	20.08		
Mar. 1	19.92	Jan. 1, 1943	15.00
Apr. 1	20.08	Feb. 1	18.15
May 1	19.58	Apr. 1	18.33
June 1	14.00	May 1	18.66
July 1	17.25	June 15	16.50
Aug. 1	17.50	Aug. 1	19.00
Sept. 1	18.00	Sept. 1	20.00
Oct. 1	18.25		
Nov. 1	18.50	Mar. 20, 1944	18.00
Dec. 1	18.75	Apr. 10	16.00
		Apr. 22	10.00
Jan. 1, 1939	19.25	June 1	16.00
Feb. 1	19.50		
Mar. 1	19.42	Mar. 1, 1945	18.00
Apr. 1	19.33	Apr. 15	11.50
May 1	19.50	June 1	15.50
June 1	19.83	Sept. 4	18.00
July 1	18.50	Oct. 1	12.50
Aug. 1	18.66	Dec. 1	15.00
Sept. 1	19.00		
Oct. 1	19.50	Jan. 15, 1946	18.00
Nov. 1	20.00	Apr. 1	18.50
Dec. 1	20.83	May 1	18.83
		June 15	20.15
Jan. 1, 1940	20.83	July 15	20.58
Feb. 1	20.66	Oct. 1	20.00
Mar. 1	20.66		
Apr. 1	20.66	Jan. 1, 1947	19.50
May 1	20.00	Apr. 15	13.00
June 1	19.50	May 10	14.50
July 1	19.66	July 1	16.00
July 10	18.00	Sept. 21	18.00
Aug. 1	19.50	Oct. 23	19.50
Sept. 1	19.92		

TABLE 5.—*Water levels in irrigation well 31-2E-20acc—Concluded*

Date	Depth to water, feet
Mar. 1, 1948	10.00
Apr. 25	16.00
May 25	18.33
June 25	13.00
July 14	15.50
July 30	13.00
Aug. 10	15.00
Aug. 20	12.50
Sept. 13	16.50
Jan. 1, 1949	15.00
Mar. 1	13.00
Apr. 1	15.00
May 20	13.00
June 15	13.50
July 1	15.50
May 1, 1950	19.00
July 1	15.50
Aug. 1	12.00
Sept. 1	15.00
Nov. 1	16.00
Mar. 1, 1951	18.00
Apr. 15	17.00
May 17	11.00
July 8	12.00
Aug. 3	13.00
Oct. 1	14.50
Jan. 1, 1952	15.00
Mar. 1	15.00
May 1	16.00
July 1	18.00
Oct. 1	20.00
June 15, 1953	20.50
Aug. 27	20.50
Oct. 6	21.15
Nov. 7	21.15
Jan. 1, 1954	21.15
Apr. 5	20.92
June 4	20.08
July 20	21.00
Aug. 15	21.50
Oct. 1	21.66
Nov. 1	21.08
Dec. 31	21.08
Feb. 1, 1955	21.00
Apr. 1	21.50
May 15	21.50
June 1	20.83
Aug. 1	20.50

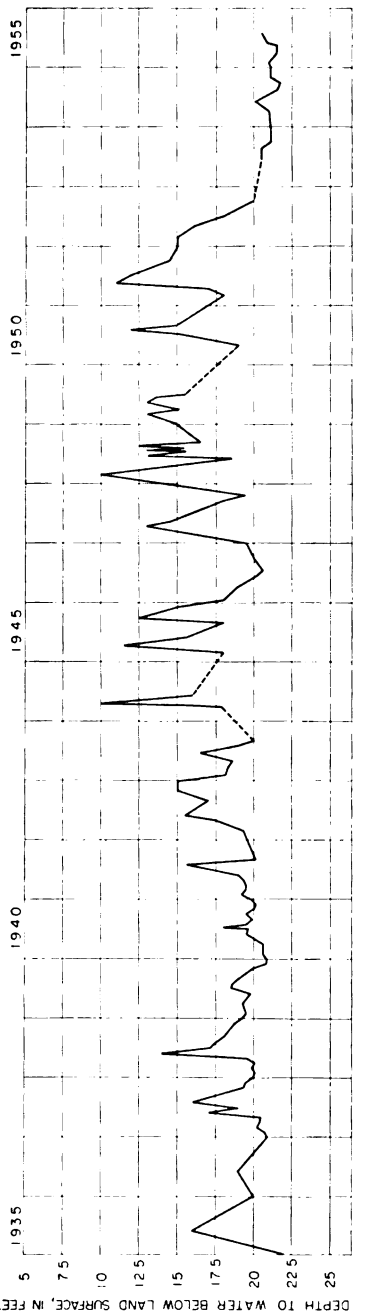

FIG. 7.—Hydrograph showing fluctuations of water level in well 31-2E-20acc.

Interpretation of fluctuations in water levels is complicated by the interrelation of several factors. Declines in water level are caused by prolonged periods of deficient rainfall, by increased transpiration of plants, by increased evaporation, by increased pumping, and by seepage into streams. Rises in the water level may be caused by increased precipitation, by decreased transpiration and evaporation, by decreased pumping, and by seepage from streams. The factors affecting the water level are discussed in further detail in the sections on recharge and discharge.

Recharge

The amount of water in storage in the zone of saturation does not remain constant but fluctuates with the precipitation and rate of withdrawal. Recharge is the addition of water to the ground-water reservoir and may be accomplished in several ways.

All ground water in Sumner County originally fell as rain or snow within the county or in adjacent areas. Water reaches the zone of saturation in Sumner County by direct recharge from local precipitation, by recharge from streams and ponds, and by subsurface movement from outside the area.

Recharge from Local Precipitation

The normal annual precipitation in Sumner County is about 31 inches, but only a small part of this amount enters the zone of saturation as recharge to the ground-water reservoir. A large part of the precipitation is evaporated or is transpired by plants, and a small part leaves the county as surface runoff.

The relation of water levels to precipitation is illustrated by the hydrographs in Figures 5, 6, and 7. The initial abrupt decline of water level in some of the Mulvane wells is caused by the beginning of pumping of the El Dorado-Augusta Water Association wells. In this area generally, water levels declined in 1954, rose sharply in 1955 in those months when the precipitation was near or above normal, and declined in 1956 when precipitation was considerably below normal. Normal or above-normal precipitation in the spring of 1957 resulted in a sharp rise in water level in most observation wells, although pumping by the El Dorado-Augusta Water Association continued at a nearly uniform rate until May 15.

Percolation from Outside Areas

The movement of ground water into Sumner County is, in general, southeastward from Harper, Kingman, and Sedgwick Counties.

There may be some movement westward in the westward-dipping Permian rocks, which are exposed at the surface in the area to the east, but not many wells in Sumner County obtain water from these rocks. The amount of water entering the county by subsurface movement probably is only slightly greater than the amount that leaves the county by this means.

Seepage from Streams and Ponds

Two factors governing the amount of water seeping into the ground-water reservoir from streams and ponds are (1) the level of the water in the stream or pond relative to the level of the ground water and (2) the character of the material between the stream channel or pond and the water table.

The water-table contours show that most streams in Sumner County are effluent (Fig. 8); that is, normally the streams receive

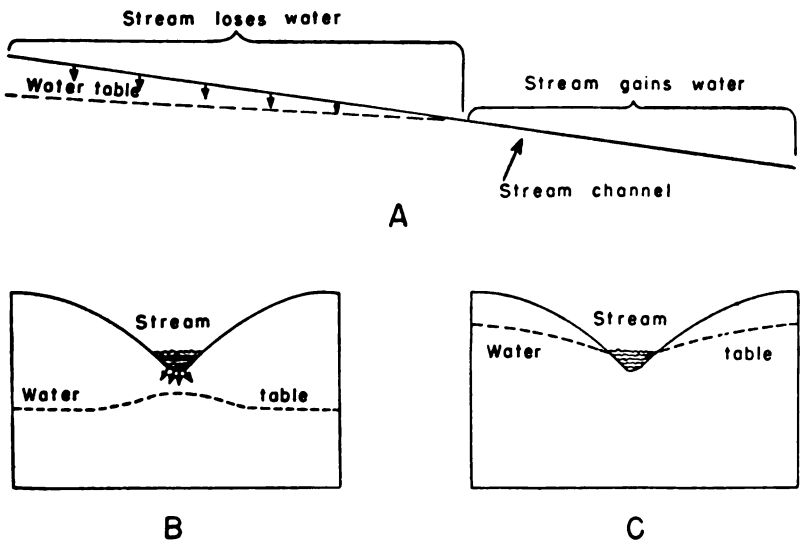

FIG. 8.—Diagrammatic sections showing influent and effluent streams. (After Meinzer.)

water from the ground-water reservoir. During periods of flood, the water level in the streams is higher than the level of the ground water, hence water moves from the streams into the ground-water reservoir. In areas of local heavy pumping near a stream, the water table may be lowered to such an extent that the natural

flow is reversed, and water moves from the stream into the ground-water reservior. This is especially noticeable in the Chikaskia River valley at the Caldwell municipal wells. During periods of drought when Chikaskia River ceases flowing, the yield of the municipal wells is greatly decreased; when the river begins to flow again, the yield of the wells returns to normal although there may have been no local precipitation.

If the material between a stream channel or pond and the water table is relatively impermeable, the rate of downward percolation may be so slow that the amount of recharge by this means is negligible. The alluvium of Bluff, Slate, Salt, and Fall Creeks is relatively impermeable, and recharge from them would be small even though the water level in the streams might be high enough to permit recharge. The alluvium of Cowskin Creek and of Ninnescah, Chikaskia, and Arkansas Rivers is fairly permeable and would permit rapid recharge. A heavy coating of algae and contaminating material on the stream floor of Arkansas River undoubtedly impedes recharge from this stream considerably. Most farm ponds in Sumner County have been constructed purposely in relatively impermeable material so that recharge from them is small.

Discharge

Ground-water discharge is the removal, by any method, of water from the zone of saturation. Ground water in Sumner County is discharged by transpiration and evaporation, by seepage into streams, by wells, and by subsurface movement into adjacent areas.

Discharge by Transpiration and Evaporation

Transpiration is the process by which water is taken into the root system of plants directly from the zone of saturation, or from the capillary fringe just above it, and discharged into the atmosphere. The depth from which plants will lift the ground water differs with plant species and type of soil. Ordinary grasses and field crops will not send their roots more than a few feet in search of water, but alfalfa, some trees, and certain desert plants draw water from much greater depths. The water table along most of the major valleys in Sumner County is within easy reach of such deep-rooting plants, and much water is discharged from the zone of saturation in this way. Ground water can be discharged by evaporation only where the water table is within a few feet of the land surface, and in Sumner County this condition is limited chiefly to areas along streams.

That considerable ground water is discharged in Sumner County

by transpiration and evaporation is illustrated by the significant rise in the water table in valley areas in the fall when vegetation becomes dormant and evaporation decreases. The rise in the water table may be several feet, although there may be no recharge from precipitation. In Sumner County the quantity of ground water discharged by evaporation and transpiration is probably greater than the amount discharged by any other means.

Discharge by Springs and Seeps

Ground water is discharged by springs and seeps at points where the water table intersects the land surface. In Sumner County springs and seeps occur in the banks of streams that are cut below the water table and at the margins of Pleistocene sand and gravel deposits that are underlain by impermeable shale. Springs are especially noticeable at the south margin of the Nebraskan deposits in the area west of Conway Springs. The amount of ground water discharged by springs and seeps in Sumner County probably ranks next in importance to the amount discharged by transpiration and evaporation.

Discharge by Wells

Most of the water used in Sumner County is derived from wells. Although wells are the most obvious means of ground-water discharge and are increasing in number, the quantity of water withdrawn by pumping is not large compared with the amount discharged by other means. The amount of ground water pumped in Sumner County could not be determined accurately, but figures based on reported pumpage for irrigation, municipal, and industrial use and estimated pumpage for rural domestic and stock use indicate that a total of about 3.5 billion gallons, or 10,800 acre-feet, of water was withdrawn in 1955. This would be equal to about 0.17 inch of water spread over the county. Much of this water, had it not been discharged by pumping, would no doubt have been discharged by natural seepage or by transpiration.

Discharge by Percolation

The amount of ground water moving out of Sumner County by percolation is probably a little less than the amount moving into the county by this means. Within the major valleys of the county the amounts of water entering and leaving the county by percolation are probably about equal. The amount of water that could percolate into or out of the county through the relatively impermeable Permian

shale is insignificant and can be disregarded. In the area of Nebraskan deposits west of Conway Springs, however, and in the area between Ninnescah and Arkansas Rivers on the Sumner-Sedgwick County line, ground water in appreciable quantities moves into Sumner County. Most of this water is discharged within Sumner County by springs and seeps, by transpiration, and by wells.

Recovery

When a well is at rest, under static conditions, the level of the water in the well is the same as the level of the water in the surrounding material, and there is little or no movement of the water. When water is withdrawn from the well, the water level in the well is lowered, and water flows into the well from the surrounding material. The amount of lowering of the water level in the well may be so small that it is not noticeable, but some lowering must occur before water can move into the well. When pumping is continued for some time, the water table is lowered around the well to form a depression in the water table that somewhat resembles an inverted cone. This depressed area is known as the cone of depression or cone of influence. As the pumping rate of the well is increased, the drawdown becomes greater. When a well is first pumped, the water level falls very rapidly, but as pumping is continued, the drawdown increases at a diminishing rate. When the pump is stopped, the water level rises rapidly at first, then more slowly, and may continue to rise for a long time.

The yield of a well is the rate at which it will deliver water continuously after the water stored in the well has been removed. The yield depends upon the quantity of water available, the thickness and permeability of the water-bearing bed, and the construction and condition of the well. The yield of a well is usually expressed in gallons per minute (gpm). Reported yields of wells in Sumner County range from 1 gpm for some domestic wells to about 2,500 gpm for some irrigation wells.

The specific capacity of a well is the rate of yield per unit of drawdown and is expressed in gallons per minute per foot. In testing the specific capacity of a well, pumping is continued until the water level remains approximately stationary. Specific capacities as great as 175 gpm per foot were reported for some wells in Sumner County.

Utilization

Domestic and Stock Supplies

Nearly all domestic and stock supplies in the county are obtained from wells. The domestic use of water generally includes drinking, cooking, laundering, and in some places the disposal of sewage for homes not served by municipal water systems. Water supplies for those schools not served by public-supply systems are classed as domestic. Ground-water supplies in several areas of Sumner County are inadequate, and water for domestic and stock use must be hauled. In general, the ground water is suitable for domestic and stock use, but locally it contains too much chloride or sulfate. It is estimated that about 900 acre-feet of water was pumped for rural domestic use in Sumner County in 1955 and about 950 acre-feet for stock supplies.

Public Supplies

Six municipalities in Sumner County obtain their entire water supply from wells in the county, and Wellington obtains part of its supply from wells and part from surface water. Udall, in Cowley County, also obtains its water supply from wells in Sumner County; and Oxford, in Sumner County, obtains its supply from wells in Cowley County. El Dorado and Augusta, in Butler County, obtained water from wells in Sumner County from 1954 to 1957 as a drought-relief measure. It is estimated that about 3,550 acre-feet of ground water was pumped from Sumner County for municipal use in 1955.

Argonia.—The city of Argonia in the Chikaskia River valley obtains its water from four drilled wells at the north edge of town. All the wells extend through the terrace deposits into the underlying Ninnescah Shale and obtain water from both units. Two of these wells are cased with 10-inch steel casing, and two with 12-inch steel casing. All are equipped with turbine pumps driven by electric motors. Three of the wells have a reported depth of 65 feet and a reported static water level of about 21.5 feet below the land surface. One well (32-4W-9ccc4) is 75 feet deep and has a static water level of about 29.6 feet. A chemical analysis of a sample of the water is included in Table 6.

The average water consumption of Argonia is about 100,000 gallons per day. Water is pumped from the wells directly into the

mains, the excess going into a 50,000-gallon elevated steel storage tank.

Augusta.—From September 1954 to May 1957 the city of Augusta obtained its water supply from wells in the Arkansas River valley near Mulvane. The wells, pumping plant, and pipeline are owned by a group of users known as the El Dorado-Augusta Water Association; a more detailed discussion of these facilities is given in the section on industrial supplies. Augusta has an average daily water consumption of about 350,000 gallons.

Belle Plaine.—The city of Belle Plaine obtains its water supply from two drilled wells penetrating sand and gravel of the Wisconsinan terrace deposits east of town. Well 30-1E-36caa has a reported depth of 43 feet and a static water level of 11 feet; it is cased with 12-inch steel casing. The chemical analysis of a sample of water from this well is given in Table 6. Well 30-1E-36dbb is 38.6 feet deep, has a static water level of 15 feet, and is cased with 12-inch steel casing. Both wells are equipped with turbine pumps driven by electric motors. Water is pumped from the wells directly into the mains, the excess going into a 55,000-gallon elevated steel storage tank. The average water consumption of Belle Plaine is about 120,000 gpd. Two drilled wells about 54 feet deep and 55 feet apart in the northeastern part of town supplied the city with water until 1953, but are now abandoned.

Caldwell.—The city of Caldwell obtains its water supply from twelve drilled wells penetrating the alluvium of Chikaskia River about 5 miles northeast of town. Seven wells in sec. 21 are each about 30 feet deep and each well normally yields about 50 gpm. These wells are connected to a common suction pipe and are pumped by a single centrifugal pump driven by an electric motor. Five wells in sec. 22 have an average depth of about 30 feet and a reported static water level of about 22 feet. These wells are cased with 10-inch steel casing and are equipped with turbine pumps driven by electric motors. Each of these wells also normally yields about 50 gpm.

The alluvium along Chikaskia River is very permeable, but only the lower 8 to 10 feet is saturated with water. The wells in the well field are closely spaced and the cone of influence of the well field extends under the channel of the river. When the river is flowing, water infiltrates from the river into the wells, but when the river is dry the yield of the wells is greatly reduced. The Western Light & Power Co., which owns the Caldwell water system, started plans

in 1956 to construct a low dam on Chikaskia River at the well field in order to impound a few feet of water in the river channel and thus increase the saturated thickness of alluvium in that portion of the valley.

The average water consumption of Caldwell is about 300,000 gallons per day. Water is pumped from the wells directly into a 200,000-gallon storage reservoir. The chemical analysis of a composite sample of water from the Caldwell system is given in Table 6 (34-2W-21).

Conway Springs.—The city of Conway Springs obtains its water supply from two drilled wells about a mile southwest of town, and from seven wells in the southwest corner of town. All the wells penetrate sand and gravel deposits of Nebraskan age. The seven wells in town are each about 40 feet deep; five of them are cased with 12-inch concrete casing and two have 16-inch casing. These wells yield about 21 gpm each. A chemical analysis of a composite sample from the seven wells in town (30-3W-33) is given in Table 6. Well 31-3W-5acdl is about 43 feet deep, is cased with 10-inch steel casing, and has a static water level of 21.7 feet. The chemical analysis of a sample of water from this well also is given in Table 6. Well 31-3W-5acd2 is about 37 feet deep, is cased with 10-inch steel casing, and has a static water level of 12.3 feet. The wells are equipped with turbine pumps driven by electric motors.

The average daily water consumption of Conway Springs is about 90,000 gallons. Water is pumped from the wells directly into the mains, the excess going into a 70,000-gallon elevated steel storage tank.

El Dorado.—From September 1954 to May 1957, El Dorado obtained its water supply from wells in the Arkansas River valley near Mulvane owned by the El Dorado-Augusta Water Association. The average daily water use is about 750,000 gallons.

Mulvane.—The city of Mulvane obtains its water supply from four drilled wells penetrating Wisconsinan terrace deposits along Arkansas River. Well 30-2E-6aca is about 27 feet deep and is cased with 8-inch steel casing. This well has a reported static water level of 18 feet and yields about 350 gpm. Well 30-2E-6acd is about 32 feet deep and is cased with 8-inch steel casing. It also has a reported static water level of 18 feet and yields about 400 gpm. Well 30-2E-6cab is 44 feet deep and is cased with 12-inch steel casing. The yield of this well is about 600 gpm. Well 30-2E-6cac is about 33 feet deep and is also cased with 12-inch steel casing. It has a

static water level of about 12 feet and is reported to yield about 1,400 gpm. All four wells are equipped with turbine pumps driven by electric motors. Water is pumped from the wells directly into a 65,000-gallon elevated steel storage tank. The chemical analysis of a composite sample of water from the Mulvane system (30-2E-6) is given in Table 6.

The maximum daily water consumption of Mulvane is about 300,000 gallons.

Oxford.—The city of Oxford obtains its water supply from two wells about 2 miles east of town, in Cowley County. The wells are about 40 feet deep and obtain water from terrace deposits along Arkansas River. The maximum daily water consumption of Oxford is about 115,000 gallons.

Oxford originally obtained its water supply from two wells about 1,000 feet east of the Arkansas River bridge in sec. 12. In 1937 this supply became so contaminated by brine from the Churchill oil field that it was abandoned in favor of the present supply.

South Haven.—The city of South Haven obtains its water supply from a dug well of large diameter near the northeast corner of town and from a drilled well about a mile northeast of town.

Well 34-1W-26aaa is 60 feet deep and is cased with 10-inch steel casing. This well has a static water level of about 28 feet and is equipped with a turbine pump and electric motor. Well 34-1W-35bab3 is about 16 feet deep, 20 feet in diameter, and walled with brick. It has a static water level of about 10.5 feet. Both wells obtain water from sand and gravel deposits of Kansan or Illinoisan age. Water is pumped from the wells directly into a 55,000-gallon elevated steel storage tank.

The average water consumption of South Haven is about 84,000 gpd. A chemical analysis of a composite sample of water from the two wells is given in Table 6.

Udall.—The city of Udall, in Cowley County, obtains its water supply from two drilled wells in the valley of Arkansas River in Sumner County. Well 31-2E-2bba is 29 feet deep and is cased with 10-inch steel casing. This well has a static water level of about 16 feet and yields about 140 gpm. Well 31-2E-2bbb is 31 feet deep and is cased with 10-inch steel casing. This well has a static water level of about 15 feet and yields about 130 gpm. Both wells are equipped with turbine pumps driven by electric motors.

The average daily water consumption of Udall is about 80,000 gallons. A chemical analysis of a composite sample of water from the two wells is given in Table 6.

Wellington.—Wellington obtains part of its water supply from a reservoir formed by an earthen dam on East Branch Prairie Creek. This reservoir has a drainage area of about 18 square miles and an estimated capacity of 3,400 acre-feet. Work was begun in 1956 on a pipeline and pumping facilities to obtain water from Chikaskia River during the winter and store it in the Prairie Creek reservoir for use during the summer.

The city of Wellington also has 35 wells in the area southwest of Mayfield, which are used intermittently. On August 14, 1954, water was being pumped from 21 wells having a combined capacity of 1,568,000 gpd. Six additional wells having a combined capacity of 2,534,000 gpd were ready to be put into service at that time. Wells in the Wellington well field penetrate sand and gravel deposits of Kansan or Illinoisan age. Logs of test holes drilled in 1948 by Latta and Fent for the city of Wellington are included in a later section of this report.

Water from the wells is collected at a pumping station near the northwest corner of sec. 36, T. 32 S., R. 3 W., and is pumped into a 500,000-gallon elevated steel tank at Mayfield and then into Wellington. A chemical analysis of a sample of water from well 32-3W-25ccb is given in Table 6.

Industrial Supplies

Most of the water pumped in Sumner County for industrial use is used in areas outside the county. Industrial supplies obtained from municipal systems are classed as municipal supplies in this report. Several industrial wells having low yields or short periods of use are not discussed separately. These include oil-well supply wells, a well from which the water is bottled and sold for drinking, and a well that was drilled to obtain water to use in construction of the Kansas Turnpike. It is estimated that in 1955 about 3,500 acre-feet of water was pumped in Sumner County for industrial use.

El Dorado-Augusta Water Association.—The El Dorado-Augusta Water Association was organized in 1954 to develop a water system to supply water for the city of Augusta, the city of El Dorado, El Dorado Refining Co. at El Dorado, Skelly Oil Co. at El Dorado, and Socony-Vacuum Oil Co. at Augusta. Four wells were drilled in the Arkansas River valley about a mile south of Mulvane. The wells are 40 to 50 feet deep, are cased with 14-inch steel casing, and are equipped with turbine pumps and electric motors. Water from the wells is discharged into a nearby abandoned gravel pit and then by diesel-powered pumps into the pipeline to the users.

Chemical analyses of samples of water from the wells are given in Table 6. In 1955 infiltration of sewage-laden water from Arkansas River caused a concentration of detergents in well 30-2E-7dca1 and necessitated replacement of this well by well 30-2E-7abc1, which is farther from the river and yields water of better quality. Water from these wells contains much chloride and enough iron to be troublesome for some uses.

During 1955 these wells were pumped nearly continuously at a combined rate of 3,600 gpm. Each of the three refineries uses approximately 1,000,000 gpd. Water not used by the refineries or by the cities of Augusta and El Dorado is impounded in surface reservoirs for emergency use. Additional wells were drilled in 1957 to increase the capacity of the system, and these new wells, which are farther from the river, also yield water of better quality than the original wells.

Before the El Dorado-Augusta Water Association system was put into operation, 25 strategically located observation wells were installed in and around the well field to determine how pumping would affect the water level. After the heavy rains of May 1957, the system was placed on a standby basis.

Other industrial supplies.—Well 35-2E-2bdd1 supplies water for cooling compressors in a pipeline pumping station about 3 miles south of the well. This well is reported to have a yield of about 200 gpm, but it is pumped at a much lower rate. Water from this well is piped at the rate of about 30 gpm to the east side of sec. 2 where it is collected in a large pond and is used in the drilling of oil wells. Well 35-2E-2bdd2 is about 40 feet north of 35-2E-2bdd1 and is to be used in case of failure of the regular well. These wells penetrate sand and gravel deposits of Kansan or Illinoisan age. A partial chemical analysis of a sample of water from well 35-2E-2bdd1 is given in Table 7.

Irrigation Supplies

In areas of Sumner County where sufficient water is available, irrigation from wells is practiced extensively; 48 wells, gravel pits, and springs that were being used for irrigation were inventoried, most of them in the Arkansas River valley. Sprinklers are used generally, though some fields have been leveled and are being irrigated by gated pipe or by ditch and siphon. Alfalfa, corn, and forage are the crops most commonly irrigated in the county. The amount of ground water pumped for irrigation in 1955 is estimated as 1,900 acre-feet.

Chemical analyses of several samples of water from irrigation wells are given in Table 6, and the suitability of water for irrigation is discussed in another section of this report.

Possibilities of Developing Additional Supplies

Most of the land irrigated with ground water in Sumner County in 1956 lies in the Arkansas River valley, which is also the part of the county where more irrigation wells could be used to the greatest advantage. On the assumption that the alluvium and Wisconsinan terrace deposits in the valley have an average width of 3 miles, a length of 15 miles, an average thickness of saturated material of 25 feet, and a specific yield of 10 percent, there would be about 72,000 acre-feet of water in storage, which is more than 35 times the amount of water pumped for irrigation in 1955. If pumping were increased enough to lower the water table below river level, the ground-water reservoir would be recharged from the river instead of discharging into the river as it does now.

In other areas of Sumner County that are irrigated with well water, recharge conditions are not as favorable, nor it there as much water in storage. In these areas, pumping probably could not be increased without some depletion of the ground-water reservoir.

Chemical Character of the Water

The chemical character of ground water in Sumner County is indicated by the analyses of 219 samples given in Table 6, and the analyses of 13 samples shown graphically in Figure 9. The analyses were made by Howard Stoltenberg in the Water and Sewage Laboratory of the Kansas State Board of Health. Samples of water were collected from wells and test holes distributed as uniformly as possible within the county and representing the principal water-bearing formations of the area. Analyses of samples from all municipal supplies and of samples collected during 1943 and 1944 as part of an earlier study also are included. In areas where the ground water has been contaminated by oil-field brines, samples were collected from closely spaced test holes to determine the extent of contamination. Analyses of 15 samples of surface water (Table 7) are included to show the effects of contamination. Because chloride and sulfate are the critical constituents in ground water in much of Sumner County, 71 samples were analyzed only for one or both of these substances.

TABLE 6.—*Analyses of water from typical wells, springs, and test holes in Sumner County*

Analyst, H. A. Stoltenberg. Dissolved constituents given in parts per million [a]

Well number	Depth, feet	Geologic source	Date of collection	Temperature (°F)	Dissolved solids	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Hardness as $CaCO_3$		
																Total	Carbonate	Noncarbonate
[1]30-2E-6.....	27–44	Wisconsinan terrace deposits	1- 3-56	.....	1,067	.....	.07	139	24	196	314	193	288	.4	6.6	446	257	189
30-2E-7caa1....	.....	Alluvium.....	1-14-55	.....	.....	.....	.36	143	21	.....	.....	207	285	.6	2.8	444	254	190
30-2E-7cad.....	.....	do.....	1-14-55	.....	.....	.....	.72	115	11	.....	.....	118	424	.7	1.6	332	308	24
30-2E-7dbd1...	.....	Wisconsinan terrace deposits	1-14-55	.....	.....	.....	.48	136	34	.....	.....	243	373	.7	2.6	479	282	197
30-2E-7dca1....	50.5	Alluvium.....	1-14-55	.....	.....	.....	.22	132	24	.....	.....	210	436	.7	2.5	428	280	148
30-2E-8bbb....	30	Wisconsinan terrace deposits	9-13-56	61	962	28	.02	205	32	69	343	319	110	.2	30	643	281	362
30-2E-12cdc....	43.3	Wellington Formation....	9-11-56	62	644	16	.14	116	43	50	356	151	82	.5	10	466	292	174
30-2E-16ccc1...	17.8	Alluvium.....	5- 2-56	58	946	14	.26	245	26	19	305	416	23	.4	53	718	250	468
30-2E-18cdd....	25	Wisconsinan terrace deposits	8-14-43	62	400	.....	2.1	111	17	9.9	316	87	10	.6	4.3	347	259	88
30-2E-20abb...	25	Alluvium.....	8-14-43	.....	666	.....	.10	148	23	52	334	190	60	.5	25	464	274	190
30-2E-31bbb...	25	Wisconsinan terrace deposits	8-14-43	65	353	.....	.59	87	18	22	334	42	14	.5	2.1	291	274	17
30-1E-1bbb....	51–56	do.....	6- 8-44	.....	595	.....	.....	115	19	65	204	201	91	.6	1.1	365	167	198
30-1E-2aab1....	53	do.....	9-14-56	60	403	14	.01	82	13	47	278	56	49	.6	4.2	258	228	30
30-1E-13ddc1...	28.8	do.....	9-13-56	60	398	21	.03	85	11	41	278	72	28	.4	3.1	257	228	29
30-1E-15cdc....	25	Illinoisan or Kansan terrace deposits	8-16-43	65	276	.....	.10	50	13	39	261	16	16	.3	11	178	178	0
30-1E-16bba...	20	do.....	5- 4-56	.....	326	19	.04	52	12	52	285	24	17	.3	9.3	179	179	0
30-1E-17bab...	50	do.....	5- 4-56	.....	251	19	1.2	40	7.8	42	244	3.7	7.0	.2	11	132	132	0
30-1E-25bcc....	32–37	Wisconsinan terrace deposits	5-18-44	.....	299	.....	.....	52	14	42	254	21	21	.3	22	187	187	0
30-1E-36caa....	43	do.....	9-30-53	.....	312	15	.08	48	11	49	232	22	26	.3	25	165	165	0
30-1W-2ddd....	20	do.....	9-14-56	.....	431	22	.01	102	18	24	332	74	15	.2	12	328	272	56
30-1W-3bab....	37–42	do.....	6- 6-44	.....	459	.....	.....	94	28	33	320	113	26	.3	4.9	350	262	88
30-2W-22ada...	44.7	Wellington Formation....	9-14-56	.....	3,360	6.5	.08	427	149	447	199	1,420	580	.7	230	1,680	160	1,520
[3]30-3W-33.....	40	Nebraskan terrace deposits	6- 7-54	.....	203	24	.24	25	2.8	17	49	19	10	.1	44	74	40	34
30-4W-16ccb...	20	do.....	9-14-56	60	192	24	.02	31	4.5	22	100	18	12	.3	31	96	82	14
[4]31-2E-2.....	29–31	Wisconsinan terrace deposits	3-26-56	.....	405	17	.18	82	15	26	221	104	12	.2	19	266	181	85

31-2E-7ebc	30	do	8-14-43	64	363		.18	87	20	21	323	50	14	.3	8.8	299	265	34
31-2E-8bbb	32	do	5- 2-56	59	431	19	.06	95	16	46	429	30	13	.5	.7	303	303	0
31-2E-10dcc	19.0	do	8-14-43	62	354		3.8	102	17	6.9	339	38	12	.7	3.9	324	278	46
31-2E-11dcd	30	do	8-14-43	64	510		3.0	136	18	22	343	116	41	.2	2.0	414	281	133
31-2E-25bbc	22	do	8-16-43	63	1,516		6.5	374	35	59	344	817	50	.7	2.1	1,080	280	800
31-2E-28aab	20	do	8-16-43	61	651		.12	142	34	36	340	217	43	.5	8.0	494	279	215
31-2E-29cbb	25	Alluvium	8-16-43	63	348		.31	66	15	33	220	13	22	.3	88	226	180	46
31-1E-3abb	35-40	Wisconsinan terrace deposits	5-16-44		158,375			1,606	1,174	57,930	173	7,828	89,800			8,832	142	8,690
31-1E-4bbb	34	do	9-12-56		454	16	.21	95	17	50	364	51	44	.3	1.5	307	298	9
31-1E-4bdc1	46.5	Alluvium	12-18-55		625	17	3.9	109	21	94	373	59	136	.3	1.8	358	306	52
31-1E-4bdc2	39.8	do	12-18-55		845	12	18	110	27	171	368	69	270	.4	1.3	386	302	84
31-1E-5aba	25	do	8-16-43	63	316		.95	91	16	1.2	276	42	6.5	.2	20	293	226	67
31-1E-25bba1	65	Illinoisan or Kansan terrace deposits	9-21-56	63	411	17	.06	62	16	65	312	44	27	.2	26	220	220	0
31-1W-24bcb	35.6	Wellington Formation	9-12-56	59	2,680	15	.05	544	125	90	215	1,740	49	.7	5.8	1,870	176	1,690
31-3W-5acd1	43.2	Nebraskan terrace deposits	8-30-55		149	28	.08	17	4.8	17	60	16	9	.1	27	62	49	13
31-3W-23baa	54.2	Ninnescah Shale	9-15-56	59	311	14	.38	52	27	23	283	13	17	.2	26	240	232	8
31-4W-12bbd1	40	Nebraskan terrace deposits	5- 3-56	58	146	30	.03	16	3.4	18	55	8.2	8.0	.2	35	54	45	9
32-2E-14bbb1	25	Illinoisan or Kansan terrace deposits	5- 2-56		451	20	.05	77	22	49	300	25	48	.1	62	282	246	36
32-2E-36abb	20	Wisconsinan terrace deposits	8-18-43	61	434		3.9	88	20	49	398	57	14	.4	2.3	302	302	0
32-2W-20ddd	20.3	Wellington Formation	5- 3-56	57	1,210	14	.27	122	53	229	376	196	291	.2	120	522	308	214
32-3W-11bbb	32	Ninnescah Shale	9-21-56		2,670	15	.04	570	85	123	193	1,710	68	.7	2.8	1,770	158	1,610
32-3W-25ccb	69.8	Illinoisan or Kansan terrace deposits	5- 3-56		427	20	.05	59	25	59	300	54	41	.1	21	250	246	4
32-4W-5abb	27.7	do	9-15-56	59	221	19	.27	31	12	26	156	21	9.0	.2	26	127	127	0
32-4W-9ccc4	74.5	Ninnescah Shale	9-13-55		295	24	.35	43	18	34	232	25	16	.2	19	182	182	0
32-4W-20add	20	Alluvium	9-15-56		271	14	.02	56	19	12	224	21	12	.4	26	218	184	34
33-2E-6bba	44	Illinoisan or Kansan terrace deposits	8-16-56		2,720	11	.08	425	109	318	332	1,240	445	.6	8.4	1,510	272	1,240
33-2E-25bbb	15.6	do	8-18-43		506		.32	98	35	40	432	26	37	.2	53	388	354	34
33-2E-26bdd	12.5	Wisconsinan terrace deposits	5- 2-56		6,140	9.0	.25	771	146	1,160	273	1,944	1,980	.7	2.2	2,520	224	2,300
33-2W-14ccd	30.0	Illinoisan or Kansan terrace deposits	9-21-56	63	503	21	.14	79	21	74	342	71	57	.2	11	284	280	4
33-3W-11bab	60	Wellington Formation	9-17-56	61	2,720	11	.79	546	69	201	190	1,660	137	.6	2.0	1,650	156	1,490
33-3W-18baa	52.7	Ninnescah Shale	5- 3-56		398	25	.14	54	23	57	317	33	29	.2	21	229	229	0
34-2E-2baa	50	Wellington Formation	5- 9-44		2,730		.32	356	83	456	296	828	700	.5	159	1,230	242	987
34-2E-17ccc	43.8	do	9-18-56	63	865	12	.47	117	59	103	510	254	34	.2	35	534	418	116
34-1E-32bdd	33.3	do	5- 2-56	56	2,270	11	1.2	297	182	158	376	1,330	88	.7	16	1,490	308	1,180
34-1W-25ddb	Spring	Illinoisan or Kansan terrace deposits	5- 2-56		504	27	.08	97	31	40	329	42	94	.1	11	370	270	100
[5]34-1W-26	60	do	2-29-56		561	22	.13	97	33	57	290	56	139	.1	12	342	238	104
34-2W-4bba	28	do	9-20-56	63	670	15	.06	82	33	89	160	151	110	.1	111	340	131	209

TABLE 6.—*Analyses of water from typical wells, springs, and test holes in Sumner County—Concluded*

Well number	Depth, feet	Geologic source	Date of collection	Temperature (°F)	Dissolved solids	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na+K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Hardness as $CaCO_3$		
																Total	Carbonate	Noncarbonate
34-2W-21	30	Alluvium	6-16-55	.....	399	14	.15	78	22	25	281	61	30	.2	2.6	285	230	55
34-3W-31ede	45	Illinoisan or Kansan terrace deposits	9-17-56	61	374	24	.10	54	22	50	284	33	40	.2	11	225	225	0
31-3W-35bac	65	Ninnescah Shale	9-17-56	60	554	21	.00	84	36	63	246	69	152	.2	7.5	358	202	156
34-4W-18aaa	63.3	do	5- 3-56	56	525	19	.20	49	27	108	337	48	90	.4	18	233	233	0
35-1W-15dbb	34.6	Wellington Formation	5- 2-56	57	573	19	.42	74	29	90	366	93	52	.2	36	304	300	4
35-2W-13dcc1	26.4	Wisconsinan terrace deposits	9-19-56	64	446	14	.01	72	22	63	349	35	50	.2	18	270	270	0
35-3W-11dca	50	Alluvium	9-19-56	63	513	19	.67	89	40	40	425	100	13	.1	2.7	386	348	38
35-3W-17aad	71	Ninnescah Shale	9-17-56	61	745	19	.02	85	28	136	370	249	38	.3	7.5	327	304	23
35-4W-8ccd	23.2	do	9-17-56	62	742	20	.67	64	33	162	355	122	156	.4	10	295	291	4

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.

1. Composite sample from wells 30-2E-6aca, 30-2E-6acd, 30-2E-6cab, 30-2E-6cac.

2. Depth of well is total depth; depth of test hole is depth at which sand point was set.

3. Composite sample from 30-3W-33dcc and 31-3W-4abb.

4. Composite sample from 31-2E-2bba and 31-2E-2bbb.

5. Composite sample from 34-1W-26aaa and 34-1W-35bab3.

6. Composite sample from 34-2W-21add and 34-2W-22bcc.

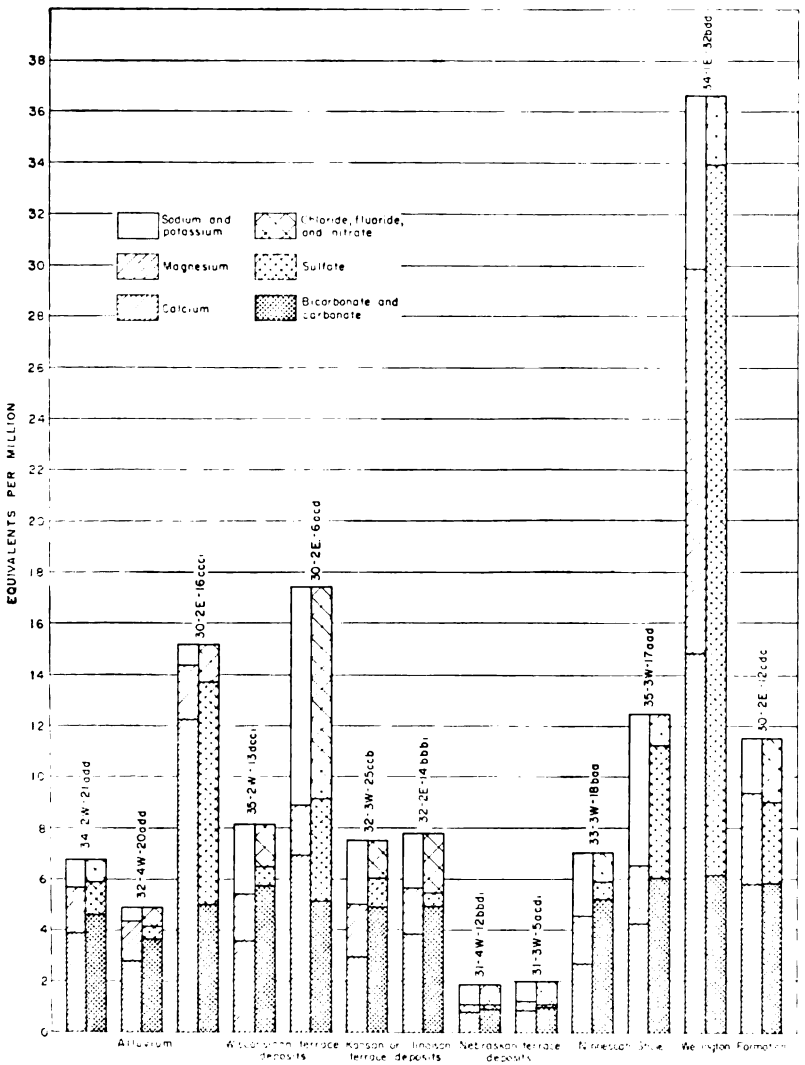

FIG. 9.—Graphic representation of analyses of water from principal water-bearing formations in Sumner County.

TABLE 7.—*Partial analyses of water from wells and test holes in Sumner County*

Well number	Depth, feet	Geologic source	Date of collection	Temperature (°F)	Sulfate (SO_4)	Chloride (Cl)
30-2E-6bcb.....	47-52	Wisconsinan terrace deposits..	5-23-44	.....	.....	114
30-2E-6bdd.....	20-25	do.....	5-23-44	.....	.....	33
30-2E-7abc1.....	.....	do.....	9- 8-55	.....	.....	147
30-2E-17acb1....	38.6	do.....	8- 9-56	.....	1,240	65
30-2E-17bba.....	50-55	do.....	5-20-44	.....	.....	54
30-2E-19aba.....	67-72	do.....	5-20-44	.....	.....	43
30-2E-19bcc.....	46-51	do.....	5-19-44	.....	.....	34
30-2E-19ccb.....	39-41	Alluvium.....	6-14-56	.....	.....	24
30-2E-20ccc.....	20	Wisconsinan terrace deposits..	8-23-43	62	.....	20
30-2E-28aba.....	20	Alluvium.....	8-23-43	64	.....	76
30-2E-29aab.....	58-60	Wisconsinan terrace deposits..	6-18-56	.....	.....	347
30-2E-29aba2....	54-56	do.....	6-14-56	.....	.....	451
30 2E 29add.....	37-39	do.....	6-18-56	.....	.....	328
30-2E-29baa.....	56-58	do.....	6-18-56	.....	.....	435
30-2E-29bbb.....	47-49	do.....	6-14-56	.....	.....	31
30-2E-30ccc.....	11-13	do.....	9- 7-55	.....	.....	14
30-2E-30dba.....	36.3	do.....	8- 9-56	.....	46	16
30-2E-33bbb.....	20	do.....	8-23-43	62	.....	15
30-2E-34bbb.....	17-19	Alluvium.....	6-13-56	.....	.....	39
30-1E-1aac.....	45-50	do.....	6- 8-44	.....	.....	118
30-1E-1abb.....	47-49	Wisconsinan terrace deposits..	7- 3-56	.....	.....	143
30-1E-1acd.....	34-36	Alluvium.....	7- 4-56	.....	.....	82
30-1E-2abb.....	51-56	Wisconsinan terrace deposits..	6- 9-44	.....	.....	81
30-1E-3aaa.....	45-47	do.....	7- 4-56	.....	.....	33
30-1E-3abb.....	33-38	do.....	6- 9-44	.....	.....	28
30-1E-3bbb.....	19-21	do.....	9- 5-56	.....	.....	18
30-1E-4aab.....	9-14	do.....	6- 9-44	.....	.....	20
30-1E-4bab.....	25-30	Illinoisan or Kansan terrace deposits..	6- 9-44	.....	.....	29
30-1E-6bbb.....	61-67	do.....	6- 7-44	.....	.....	22
30-1E-9add.....	26-28	do.....	7- 5-56	.....	.....	17
30-1E-11aaa.....	48-50	Wisconsinan terrace deposits..	7- 3-56	.....	.....	75
30-1E-13bab.....	20	do.....	8-23-43	.....	.....	24
30-1E-13daa.....	33.0	do.....	9- 7-55	.....	.....	23
30-1E-14aaa.....	58-60	do.....	7- 3-56	.....	.....	31
30-1E-14ccd.....	20	do.....	8-23-43	65	.....	40
30-1E-18cbc.....	30.0	do.....	9- 1-55	.....	.....	235
30-1E-23aab.....	19-21	do.....	7- 3-56	.....	.....	27
30-1E-25aba.....	20	do.....	8-23-43	.....	.....	45
30-1E-25baa.....	31-36	do.....	5-18-44	.....	.....	28
30-1E-28ccc.....	30-32	do.....	9- 7-55	.....	.....	40
30-1E-33cdc.....	29-31	do.....	6- 7-56	.....	.....	755
30-1E-33ddd.....	29-31	Alluvium.....	6- 6-56	.....	.....	70,100
30-1E-34add.....	25-27	Wisconsinan terrace deposits..	8-11-56	.....	.....	11,700
30-1E-34bbc.....	31-33	do.....	6- 6-56	.....	.....	178
30-1E-34bcc.....	40-42	do.....	6- 6-56	.....	.....	15,100
30-1E-34ccb.....	36-38	do.....	6- 6-56	.....	.....	64,400
30-1E-34ccd.....	37-39	Alluvium.....	6- 8-56	.....	.....	115,000
30-1E-34dcd.....	37-39	do.....	6- 8-56	.....	.....	12,200
30-1E-35aaa.....	36-38	Illinoisan or Kansan terrace deposits..	9- 7-55	.....	.....	15
30-1E-35bcc.....	20-25	Wisconsinan terrace deposits..	5-17-44	.....	.....	96
30-1E-35cbc.....	31-33	do.....	6-11-56	.....	.....	2,070
30-1W-2abb.....	30-35	do.....	6- 7-44	.....	.....	15
30-1W-5abb.....	29-31	do.....	8-31-55	.....	.....	13
30-1W-13aaa....	40.0	do.....	9- 1-55	.....	.....	71
30-4W-23ddd....	45.8	Ninnescah Shale.....	8-13-56	.....	58	27
31-2E-2ddd.....	17-19	Wisconsinan terrace deposits..	6-18-56	.....	.....	8.0
31-2E-3aba.....	12-14	Alluvium.....	6-29-56	.....	.....	14
31-2E-3baa.....	19-21	do.....	6-18-56	.....	.....	36
31-2E-3bbb.....	48-50	Wisconsinan terrace deposits..	6-12-56	.....	.....	54
31-2E-3cbb.....	20	Alluvium.....	8-23-43	.....	.....	43
31-2E-3ddd.....	24-26	do.....	6-29-56	.....	.....	52
31-2E-5cdd.....	20	Wisconsinan terrace deposits..	8-23-43	62	.....	27

TABLE 7.—*Partial analyses of water from wells and test holes in Sumner County—Continued*

Well number	Depth, feet	Geologic source	Date of collection	Temperature (°F)	Sulfate (SO_4)	Chloride (Cl)
31-2E-5ddd.....	48-50	Wisconsinan terrace deposits..	6-12-56	.....	.....	18
31-2E-7ccc.....	31-33	do.....	9- 8-55	.....	.....	6.0
31-2E-9adb.....	61.8	do.....	8-13-56	.....	166	26
31-2E-11ada.....	20	do.....	8-23-43	63	.....	29
31-2E-12bcc.....	16-18	do.....	6-19-56	.....	.....	19
31-2E-13bba.....	17-19	do.....	6-19-56	.....	.....	31
31-2E-13bca.....	21-23	do.....	6-19-56	.....	.....	48
31-2E-13cca.....	28-30	do.....	6-20-56	.....	.....	36
31-2E-14aab.....	29-31	do.....	6-19-56	.....	.....	48
31-2E-15aaa.....	48-50	do.....	6-12-56	.....	.....	48
31-2E-16aaa.....	20	do.....	8-23-43	.....	.....	18
31-2E-17cdc.....	25	do.....	8-23-43	.....	.....	40
31-2E-20ddc.....	25	Alluvium.....	8-26-43	.....	.....	24
31-2E-24bab.....	20-22	Wisconsinan terrace deposits..	9-10-55	.....	.....	47
31-2E-24cdd.....	42-47	do.....	5-25-44	.....	.....	85,500
31-2E-24dca.....	18-20	do.....	6-20-56	.....	.....	64,700
31-2E-24dcc.....	39-41	do.....	6-20-56	.....	.....	430
31-2E-25aba.....	36-38	do.....	6-20-56	.....	.....	27,500
31-2E-25ada.....	11-13	do.....	6-20-56	.....	.....	915
31-2E-25cac.....	28-30	Alluvium.....	6-21-56	.....	.....	515
31-2E-25cad.....	27-29	do.....	6-21-56	.....	.....	2,080
31-2E-25dcc.....	42-47	do.....	5-26-44	.....	.....	74,200
31-2E-25dda.....	47-49	Wisconsinan terrace deposits..	6-20-56	.....	.....	37,400
31-2E-25ddd.....	41-43	do.....	9-10-55	.....	.....	56,400
31-2E-26bbb.....	27-29	do.....	9- 9-55	.....	.....	18
31-2E-26ddd.....	18-23	do.....	5-13-44	.....	.....	28
31-2E-27aaa.....	25	do.....	8-26-43	62	.....	42
31-2E-34aba.....	28	do.....	8-26-43	62	.....	24
31-2E-36aad.....	34-36	Alluvium.....	6-21-56	.....	.....	23,600
31-2E-36abb.....	11-13	do.....	6-21-56	.....	.....	760
31-2E-36acb.....	10-12	do.....	6-21-56	.....	.....	485
31-2E-36dca.....	9-11	do.....	6-28-56	.....	.....	510
31-2E-36ded.....	9-11	do.....	6-28-56	.....	.....	490
31-1E-2baa.....	17-19	Wisconsinan terrace deposits..	6-12-56	.....	.....	54
31-1E-2bad.....	21-23	do.....	6-12-56	.....	.....	78
31-1E-2bbb.....	30-32	do.....	6-11-56	.....	.....	1,590
31-1E-2bcc.....	30-32	do.....	6-11-56	.....	.....	595
31-1E-3baa.....	37-39	do.....	6- 8-56	.....	.....	160,000
31-1E-4aab.....	34-36	do.....	6- 7-56	.....	.....	20,400
31-1E-4aac.....	24-26	do.....	6- 7-56	.....	.....	6,080
31-1E-4ade.....	34-36	do.....	6- 8-56	.....	.....	7,200
31-1E-4baa.....	28-33	do.....	5-16-44	.....	.....	250
31-1E-4bad.....	32-34	do.....	6- 7-56	.....	.....	280
31-1E-9abb2.....	35-40	do.....	6- 6-44	.....	.....	70
31-1E-10aaa1.....	25	do.....	8-27-43	63	.....	72
31-1E-10aaa2.....	25	do.....	7- 5-56	.....	.....	79
31-1E-11ada.....	25	do.....	8-26-43	62	.....	117
31-1E-11baa.....	41-43	do.....	6-12-56	.....	.....	202
31-1E-11bbb.....	33-35	Alluvium.....	6-11-56	.....	.....	930
31-1E-11bcc.....	34-36	Wisconsinan terrace deposits..	6-11-56	.....	.....	8,050
31-1E-11cbb.....	24	do.....	6-11-56	.....	.....	2,900
31-1E-11cbc.....	14-16	Alluvium.....	7- 5-56	.....	.....	1,750
31-1E-12bbb.....	38-40	Wisconsinan terrace deposits..	6-12-56	.....	.....	64
31-1E-13bbb.....	35-40	do.....	5-15-44	.....	.....	1,180
31-1E-14aaa.....	26-28	Alluvium.....	7- 6-56	.....	.....	262
31-1W-26add.....	33	Wellington Formation.....	7-26-56	.....	2,350	89
32-2E-1abd.....	15-17	Alluvium.....	6-28-56	.....	.....	361
32-2E-1dcd.....	9-11	do.....	6-27-56	.....	.....	550
32-2E-13aaa.....	34-36	Wisconsinan terrace deposits..	6-22-56	.....	.....	2,290
32-2E-13abb.....	35-37	do.....	6-27-56	.....	.....	32,700
32-2E-13add1.....	25.0	do.....	8-21-43	63	.....	356
32-2E-13daa.....	36-39	do.....	6-22-56	.....	.....	9,820
32-2E-13ddc.....	39-41	do.....	6-22-56	.....	.....	374
32-2E-17acc.....	72.9	Wellington Formation.....	7-26-56	.....	1,630	394
32-2E-22aaa.....	40	Illinoisan or Kansan terrace deposits..	7-26-56	.....	15	10
32-2E-24aaa.....	45-47	Wisconsinan terrace deposits..	6-22-56	.....	.....	237

TABLE 7.—*Partial analyses of water from wells and test holes in Sumner County—Concluded*

Well number	Depth, feet	Geologic source	Date of collection	Temperature (°F)	Sulfate (SO_4)	Chloride (Cl)
32-2E-24bcd	.....	Wisconsinan terrace deposits	8-16-56	.....	56	8,540
32-2E-25abb	37-39	Alluvium	6-26-56	.....	.....	18,700
32-2E-25ddd	30-32	do	9-13-55	.....	.....	1,160
32-2E-31cdc	44.0	Illinoisan or Kansan terrace deposits	8-16-56	.....	1,800	770
32-1E-8ddd	49.4	Wellington Formation	6-26-56	.....	2,620	755
32-1E-9ddc	37.4	do	6-26-56	.....	130	183
32-1E-12dcc	.....	do	6-26-56	.....	2,270	333
32-1E-16aaa	.....	do	6-26-56	.....	2,470	810
32-4W-20ddd	37.4	Wisconsinan terrace deposits	8-15-56	.....	348	60
33-2E-1cbb	87.2	Illinoisan or Kansan terrace deposits	7-26-56	.....	42	14
33-2E-23cdd	19-24	Wisconsinan terrace deposits	5-10-44	.....	.....	65
33-2E-27cad	39	Wellington Formation	7-26-56	.....	1,688	281
33-2E-27cdc	66	do	7-26-56	.....	3,470	5,020
33-3W-14cbb	51	do	8-15-56	.....	1,940	505
33-3W-15add	60	do	8-15-56	.....	806	273
33-4W-3aaa	241.0	Ninnescah Shale	8-16-56	.....	2,180	5,640
35-2E-1aaa	85.9	Wellington Formation	8-10-56	.....	1,410	129
35-2E-2bdd1	84.8	Illinoisan or Kansan terrace deposits	8-10-56	.....	43	44
35-1E-4aaa	32.1	Wellington Formation	8-10-56	.....	2,540	535
35-2W-8aaa	31.0	Ninnescah Shale	8-10-56	.....	296	414

The relation of the geology to the quality of water in an aquifer is discussed in a later section.

The results of the analysis of water samples listed in Tables 6, 7, and 8 are given in parts per million. Factors for converting parts per million of mineral constituents to equivalents per million are given in Table 9. The parts per million of a constituent are multiplied by the conversion factor to obtain the equivalents per million of that constituent.

TABLE 8.—*Analyses of water from streams in Sumner County, Kansas*

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

Sample no.	Source	Date of collection	Sulfate (SO_4)	Chloride (Cl)
30–1E–1aaa	Arkansas River	8–13–56	115	231
30–1E–3bbb	Cowskin Creek	8–13–56	194	95
30–1E–32ddc	Ninnescah River	8–14–56	163	348
30–1E–33ddd	Oxbow Lake	6–23–56	.....	66
30–2W–1aaa	Ninnescah River	8–14–56	70	500
31–2E–35bda	do	8–14–56	85	493
31–1E–11bcc	do	8–14–56	95	650
32–2E–12dcc	Arkansas River	7–11–56	157	555
32–2E–14daa	Stream	7–26–56	.....	8,130
32–1E–32cbc	Slate Creek	7–26–56	102	81
33–2E–15ccc	do	7–26–56	842	4,010
33–2E–23dad	do	7–26–56	1,890	13,700
34–2E–1dda	Salt Creek	7–26–56	3,220	19,800
34–2E–2cbc	do	7–26–56	798	124
34–2E–23bcc	Ditch	7–11–56	.....	71,400

TABLE 9.—*Factors for converting parts per million of mineral constituents to equivalents per million*

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

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.

Dissolved solids.—When water is evaporated, the residue consists mainly of the mineral constituents listed in the tables of analyses, but generally includes a small quantity of organic material and some water of crystallization. Water containing less than 500 ppm of dissolved solids is satisfactory for domestic use except for difficulties resulting from its hardness or excessive iron content. Water containing more than 1,000 ppm is likely to include enough of certain constituents to cause a noticeably poor taste or to make the water unsuitable in some other respect.

The dissolved solids in 67 samples of ground water from Sumner County ranged from 146 to 158,400 ppm. Of these, 34 samples contained less than 500 ppm, 21 samples contained 500 to 1,000 ppm, and 12 samples contained more than 1,000 ppm. Strong concentrations of dissolved solids in water from unconsolidated aquifers in the county are probably due to contamination by brines.

Hardness.—The hardness of water is recognized most commonly by its effects when soap is used with the water. Calcium and magnesium cause almost all the hardness of ordinary water and are the active agents in the formation of most of the scale in steam boilers and other vessels used to heat or evaporate water.

In addition to the total hardness, the carbonate and noncarbonate hardness are listed in the table of analyses. The carbonate hardness is due to the presence of calcium and magnesium bicarbonates and can be removed almost completely by boiling. This type of hardness is sometimes called "temporary" hardness as compared to "permanent" or noncarbonate hardness due to the presence of sulfates or chlorides of calcium and magnesium, which cannot be removed by boiling. With reference to soap consumption, the carbonate and the noncarbonate hardness do not differ. In general, water of noncarbonate hardness forms harder scale in steam boilers.

Water having a hardness of less than 50 ppm is generally rated as soft, and softening treatment is not necessary under ordinary circumstances. Hardness of 50 to 150 ppm does not interfere seriously with the use of water for most purposes, but it does increase the amount of soap used, and its removal is profitable for

laundries and certain other industries. Water having a hardness in the upper part of this range will cause considerable scale in steam boilers. Hardness exceeding 150 ppm is very noticeable, and if the hardness is 200 to 300 ppm, water for household use is commonly softened. Where municipal water supplies are softened, an attempt generally is made to reduce the hardness to about 80 ppm. Additional improvement by further softening of a public supply generally is not deemed worth the increased cost.

The total hardness of 71 samples of ground water from Sumner County ranged from 54 to 8,800 ppm. Of these, 6 samples had less than 150 ppm, 21 samples had 150 to 300 ppm, and 41 samples had more than 300 ppm. Total hardness concentrations in excess of about 2,000 ppm are probably due to contamination of ground water by brine. Thirty-six samples contained less than 50 ppm of noncarbonate hardness and could be softened considerably by boiling.

Chloride.—Chloride salts are found in nature in great abundance. They occur in sea water, in oil-field brines, in beds of nearly pure salt, and, in small quantities, in other types of rock. Concentrations of chloride salts in water can be readily recognized by the salty taste, but chloride content has little effect on the suitability of water for domestic use unless present in excessive quantity. Water containing much chloride may be corrosive if used in steam boilers. The removal of the chloride ion by present methods is too expensive to be practical. Most persons cannot detect a salty taste if chloride concentration is less than 500 ppm and can drink water containing as much as 2,000 ppm of chloride. Some livestock may survive on water containing as much as 10,000 ppm, but it has been recommended that, for their best production, stock should have water of a quality satisfactory for human consumption.

Analyses were made of 219 samples of water from wells and test holes in Sumner County to determine chloride content. The range was from 60 to 160,000 ppm: 170 of the samples had less than 500 ppm, 20 samples contained 500 to 2,000 ppm, 11 contained 2,001 to 10,000 ppm, and 18 contained more than 10,000 ppm. The distribution of chloride in water in Sumner County is shown in Plate 4. Chloride concentration in excess of about 5,000 ppm is probably due to contamination by brine. The concentration of chloride in the area west of Belle Plaine is probably due to natural pollution; that in the Oxford area, to contamination by oil-field brine.

The chloride content of 15 samples of surface water in Sumner County ranged from 66 to 71,400 ppm. Sample 32-2E-14daa was

taken from a small stream near the center of the east side of sec. 14. The chloride concentration of this sample (8,130 ppm) was due chiefly to brine from three poorly plugged oil wells near the intersection of the two railroads in sec. 14. This condition will continue until the flow of salt water is stopped by proper plugging of these wells. Sample 34-2E-23bcc was taken from a small stream near the center of the west side of sec. 23. The concentration of chloride (71,400 ppm) in this sample came from several nearby abandoned oil-field brine ponds. Salt-water seepage can be expected to continue for several years in this area because the surface material surrounding the brine ponds is saturated with salt water. In August 1956 the chloride content of Arkansas River was found to increase downstream from 231 ppm west of Mulvane (sample 30-1E-1aaa) to 555 ppm at Oxford (sample 32-2E-12dcc). This increase in chloride is due to the movement of brine-contaminated ground water into the river from the Churchill oil field northeast of Oxford. A sample taken from Cowskin Creek, which carries much less sewage and industrial waste than Arkansas River, contained only 95 ppm of chloride (sample 30-1E-3bbb) as compared to 231 ppm chloride in a sample from Arkansas River in the same general area (sample 30-1E-1aaa). The chloride content of samples of water from Slate Creek increased greatly downstream from Wellington. Sample 32-1E-32cbc contained only 81 ppm of chloride, sample 33-2E-15ccc contained 4,010 ppm, and sample 33-2E-23dad contained 13,700 ppm. This increase in chloride content occurs where Slate Creek flows over that part of the Wellington Formation from which most of the Hutchinson Salt member has been removed by solution. Sample 34-2E-2cbc, from Salt Creek, contained 124 ppm, and sample 34-2E-1dda, taken from Salt Creek 2 miles farther east, contained 19,800 ppm chloride. This increase also is due to solution of salt from the Wellington Formation.

Iron.—If a water contains more than a few tenths of a part per million of iron, it may have a disagreeable taste and will stain cooking utensils and plumbing. Upon exposure to air, most of the iron will settle out of the water as a reddish precipitate. The usual treatment of water to remove iron is aeration and filtration, but some water requires the addition of lime or some other substance. The quantity of iron in ground water may differ greatly from place to place although the water may be derived from the same formation. Iron carbonate is especially troublesome in water from the alluvial deposits of Ninnescah River.

The iron content of 67 samples of ground water from Sumner County ranged from 0 to 18 ppm. In 27 samples it was less than 0.11 ppm; 33 samples contained 0.11 to 2.0 ppm, and 7 contained more than 2.0 ppm.

Sulfate.—Sulfate (SO_4) in ground water is derived principally from gypsum (hydrous calcium sulfate) and from the oxidation of pyrite (iron disulfide). Magnesium sulfate (Epsom salts) and sodium sulfate (Glauber's salts), if present in sufficient quantity, will impart a bitter taste to the water and may have a laxative effect upon persons who are not accustomed to drinking such water. According to the U. S. Public Health Service (1946), sulfate in water supplies used on interstate carriers preferably should not exceed 250 ppm.

The sulfate content of 95 samples of ground water from Sumner County ranged from 3.7 to 7,800 ppm. In 30 samples it was less than 50 ppm; 36 contained 50 to 250 ppm, 8 contained 251 to 1,000 ppm, and 21 contained more than 1,000 ppm. The sulfate content of 12 samples of water from streams in Sumner County ranged from 70 to 3,220 ppm.

Fluoride.—The fluoride content of drinking water is associated with the dental defect known as mottled enamel. Mottled enamel may appear on the teeth of children who, during the period of formation of the permanent teeth, customarily drink water containing fluoride in excess of 1.5 ppm. Concentrations of fluoride of about 1 ppm are known to prevent or lessen the incidence of tooth decay (Dean, 1938), and fluoride is now being added to many municipal supplies.

The fluoride content of 70 samples of ground water from Sumner County ranged from 0.1 to 0.7 ppm.

Nitrate.—The use of water containing an excessive amount of nitrate in the preparation of a baby's formula can cause cyanosis or oxygen starvation. Some authorities advocate that water containing more than 45 ppm of nitrate should not be used (Metzler and Stoltenberg, 1950). Water containing 90 ppm of nitrate generally is regarded as very dangerous to infants, and water containing 150 ppm may cause severe cyanosis. Cyanosis is not produced in adults and older children by such concentrations of nitrate. The source of nitrate in ground water is not known, and boiling of water containing excessive nitrate does not make it safe for use by infants. Therefore, only water that is known to have a low content of nitrate should be given to infants.

The nitrate content of 70 samples of ground water from Sumner County ranged from 0.7 to 230 ppm. In 62 samples it was less than 45 ppm; 4 contained 45 to 90 ppm, 2 contained 91 to 150 ppm, and 2 contained more than 150 ppm.

Water for Irrigation

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

The development and maintenance of successful irrigation projects involve not only the supplying of irrigation water to the land, but also the control of the salinity and alkali of the soil. Irrigation practices, drainage conditions, and quality of irrigation water are all involved in salinity and alkali control. Soil that was originally nonsaline and nonalkaline may become unproductive if excessive soluble salts or exchangeable sodium are allowed to accumulate because of improper irrigation and soil management or inadequate drainage.

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

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

For purposes of diagnosis and classification, the total concentration of soluble salts in irrigation water can be adequately expressed in terms of electrical conductivity. Electric conductivity is the meas-

ure of the ability of the inorganic salts in solution to conduct an electric current and is usually expressed in terms of micromhos per centimeter. The electrical conductivity can be determined accurately in the laboratory, or an approximation of the electrical conductivity can be obtained by multiplying the total equivalents per million of calcium, sodium, magnesium, and potassium by 100, or by dividing the total dissolved solids in parts per million by 0.64. In general, water having electrical conductivity of less than 750 micromhos per centimeter is satisfactory for irrigation insofar as salt content is concerned, although salt-sensitive crops such as strawberries, green beans, and red clover may be adversely affected by water having an electrical conductivity in the range of 250 to 750 micromhos per centimeter. Water in the range of 750 to 2,250 micromhos per centimeter is widely used, and satisfactory crop growth is obtained under good management and favorable drainage conditions, but saline conditions will develop if leaching and drainage are inadequate. Use of water having a conductivity greater than 2,250 micromhos per centimeter is rare, and very few instances can be cited where such water has been used successfully.

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

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

where the ionic concentrations are expressed in equivalents per million. The sodium-adsorption ratio may be determined also by use of the nomogram shown in Figure 10.

In using the nomogram to determine the sodium-adsorption ratio of a water, the concentration of sodium expressed in equivalents per million is plotted on the left scale (A), and the concentration of calcium plus magnesium expressed in equivalents per million is plotted on the right scale (B). The point at which a line connecting these two points intersects the sodium-adsorption-ratio scale (C) indicates the sodium-adsorption ratio of the water. When the sodium-adsorption ratio and the electrical conductivity of a water are known, the suitability of the water for irrigation can be determined by plotting these values on the diagram shown in Figure 11.

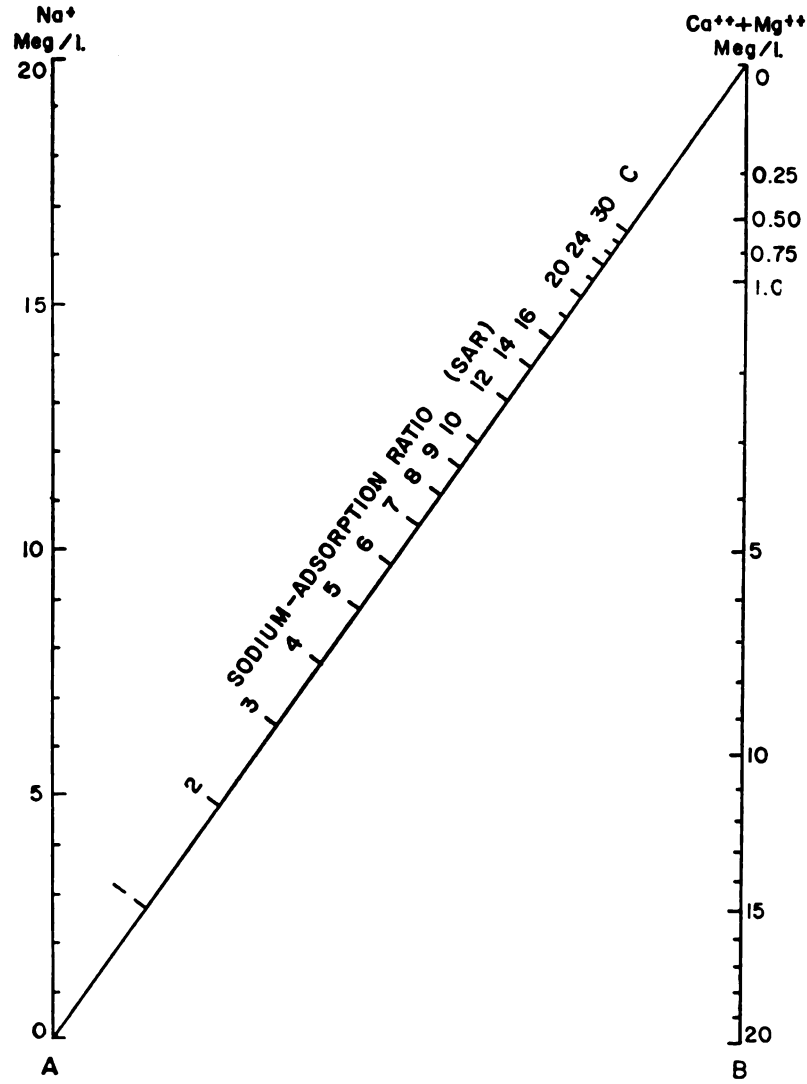

FIG. 10.—Nomogram for determining value of sodium-adsorption ratio of irrigation water.

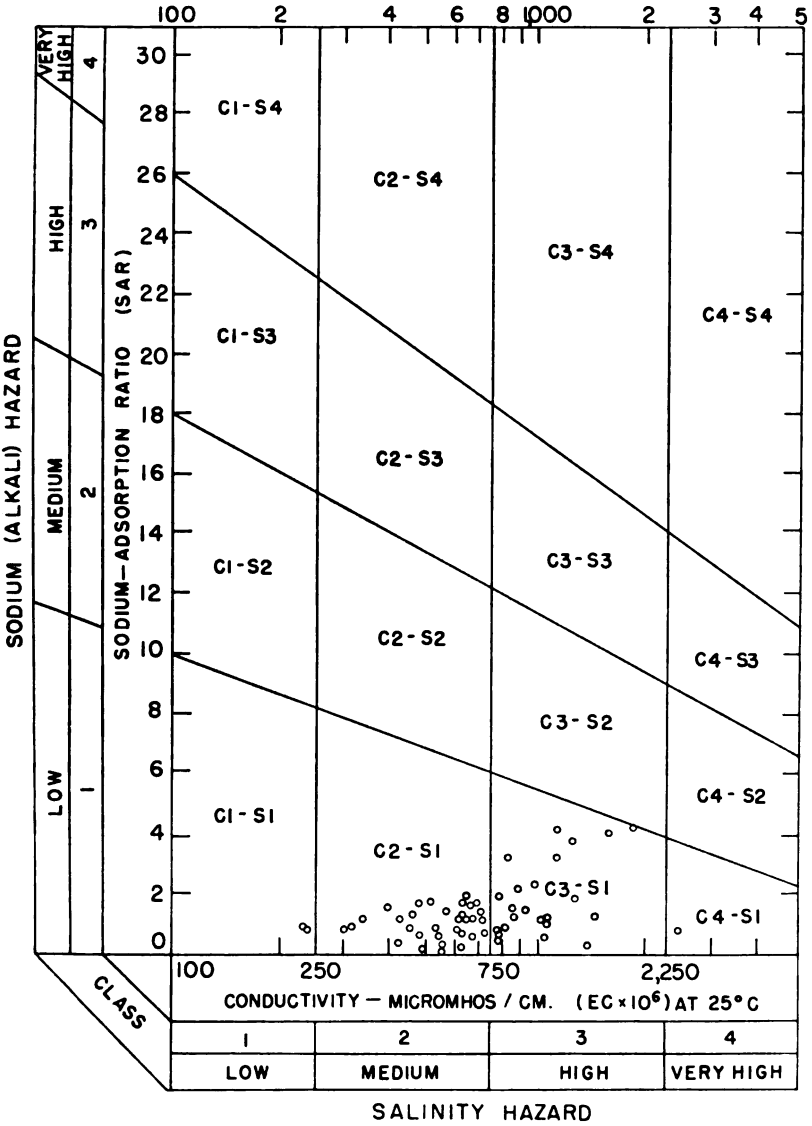

FIG. 11.—Diagram showing classification of typical waters of Sumner County for irrigation use.

Low-sodium water (S1) can be used for irrigation on almost all soils with little danger of developing harmful levels of exchangeable sodium. Medium-sodium water (S2) will present an appreciable sodium hazard in certain fine-textured soils, especially under poor leaching conditions. This water may be safely used on coarse-textured or organic soils having good permeability. High-sodium water (S3) may produce harmful levels of exchangeable sodium in most soils and will require special soil management such as good drainage, thorough leaching, and additions of organic matter. Very high sodium water (S4) is generally unsatisfactory for irrigation unless special action is taken, such as addition of gypsum to the soil.

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

Boron is essential to normal plant growth, although the quantity required is very small. Crops vary greatly in their boron tolerances, but in general it may be said that the ordinary field crops common to Kansas are not adversely affected by boron concentrations of less than 1 ppm.

Prolonged use, under adverse conditions, of water having a strong concentration of bicarbonate could have an undesirable effect upon the soil texture and plant growth.

Of the 67 samples of ground water from Sumner County that were classified as to suitability for irrigation use, 9 (Table 10) were of such poor quality that they could not be plotted on Figure 11. All samples plotted had a low sodium hazard, but one sample had a very high salinity hazard and could be used for irrigation only under special conditions; 23 samples had a high salinity hazard, but could be used for irrigating most field crops on soils having adequate drainage; 32 samples had a medium salinity hazard and could be used for irrigation with no special practices on most soils, and 2 samples had a low salinity hazard and could be used to irrigate any crop on all types of soil.

TABLE 10.—*Classification of water in Sumner County for irrigation use*

Well number	Approximate conductivity, (micromhos/cm.)	Approximate sodium-adsorption ratio	Class
30–2E–6acd	1,670	4.0	C3–S1
30–2E–8bbb	1,500	1.3	C3–S1
30–2E–12cdc	1,010	1.0	C3–S1
30–2E–16ccc1	1,480	.3	C3–S1
30–2E–18cdd	625	.2	C2–S1
30–2E–20abb	1,040	1.1	C3–S1
30–2E–31bbb	550	.6	C2–S1
30–1E–1bbb	930	1.5	C3–S1
30–1E–2aab1	630	1.4	C2–S1
30–1E–13ddc1	620	1.1	C2–S1
30–1E–15cdc	430	1.1	C2–S1
30–1E–16bba	510	1.7	C2–S1
30–1E–17bab	390	1.6	C2–S1
30–1E–25bcc	470	1.3	C2–S1
30–1E–36caa	490	1.7	C2–S1
30–1W–2ddd	670	.6	C2–S1
30–1W–3bab	720	.7	C2–S1
30–2W–22ada	5,250	...	.....
30–3W–33dcc	320	.8	C2–S1
30–4W–16ccb	300	.8	C2–S1
31–2E–2bba	630	.6	C2–S1
31–2E–7cbc	570	.4	C2–S1
31–2E–8bbb	670	1.2	C2–S1
31–2E–10dcc	550	.2	C2–S1
31–2E–11dcd	800	.4	C3–S1
31–2E–25bbc	2,370	.8	C4–S1
31–2E–28aab	1,020	.6	C3–S1
31–2E–29cbb	540	.8	C2–S1
31–1E–3abb	247,500	...	.....
31–1E–4bbb	710	1.3	C2–S1
31–1E–4bdc1	980	2.2	C3–S1
31–1E–4bdc2	1,320	3.8	C3–S1
31–1E–5aba	490	.1	C2–S1
31–1E–25bba1	640	1.9	C2–S1
31–1W–24bcb	4,190	...	.....
31–3W–5acd1	230	.9	C1–S1
31–3W–23baa	490	.6	C2–S1
31–4W–12bbd1	230	.9	C1–S1
32–2E–14bbb1	700	1.4	C2–S1
32–2E–36abb	680	1.2	C2–S1
32–2W–20ddd	1,890	4.4	C3–S1
32–3W–11bbb	4,180	...	.....
32–3W–25ccb	670	1.6	C2–S1
32–4W–5abb	345	1.0	C2–S1
32–4W–9cc4	460	1.0	C2–S1
32–4W–20add	420	.3	C2–S1
33–2E–6bba	4,260	...	.....
33–2E–25bbb	790	.8	C3–S1
33–2E–26bdd	9,600	...	.....
33–2W–14ccd	790	2.0	C3–S1
33–3W–11bab	4,260	...	.....
33–3W–18baa	620	1.7	C2–S1
34–2E–2baa	4,270	...	.....
34–2E–17ccc	1,350	2.0	C3–S1
34–1E–32bdd	3,540	...	.....

TABLE 10.—*Classification of water in Sumner County for irrigation use—Concluded*

Well number	Approximate conductivity, (micromhos/cm.)	Approximate sodium-adsorption ratio	Class
34–1W–25ddb	790	.8	C3–S1
34–1W–26aaa	880	1.3	C3–S1
34–2W–4bba	1,050	2.0	C3–S1
34–2W–21add	620	.8	C2–S1
34–3W–31cdc	580	1.6	C2–S1
34–3W–35bac	865	1.5	C3–S1
34–4W–18aaa	820	3.1	C3–S1
35–1W–15ddb	895	2.2	C3–S1
35–2W–13dcc1	700	1.6	C2–S1
35–3W–11dca	800	.8	C3–S1
35–3W–17aad	1,160	3.2	C3–S1
35–4W–8ccd	1,160	4.2	C3–S1

GEOLOGIC FORMATIONS IN RELATION TO GROUND WATER

PERMIAN SYSTEM—LEONARDIAN STAGE

Wellington Formation

Character, distribution, and thickness.—The Wellington Formation underlies all of Sumner County except possibly small areas in the valley of Arkansas River. In the eastern two-thirds of the county the formation crops out or is covered by Pleistocene deposits; in the western third of the county it is overlain by the Ninnescah Shale.

The Wellington Formation as now defined by the State Geological Survey of Kansas includes all beds between the Nolans Limestone below and the Ninnescah Shale above.

The lower 150 to 200 feet of the Wellington Formation consists principally of gray to greenish-gray silty shale but includes several discontinuous limestone and dolomitic limestone beds. A persistent bed of dolomitic limestone, the Hollenberg, lies about 35 to 40 feet above the base of the formation. A dolomitic limestone that somewhat resembles the Herington Limestone member of the Nolans Limestone is exposed in an abandoned quarry in the NW¼ sec. 36, T. 31 S., R. 2 E. This limestone is regarded by Swineford (1955) and Norton (1939) as a lenticular bed within the Wellington Formation. An unusual bed of massive nonfossiliferous limestone is exposed in the NE¼ sec. 21, T. 33 S., R. 2 E. This bed is stratigraphically at about the level of the Carlton

Limestone member but differs greatly from the beds classified as Carlton in the NW¼ sec. 32, T. 34 S., R. 1 E (Swineford, 1955). A bed of gypsum crops out in the SW¼ SE¼ sec. 27, T. 33 S., R. 2 E. The thickness and lateral extent of the gypsum were not determined. The middle part of the Wellington Formation is composed of salt. The thickness of salt in Sumner County is greatest in the northwest corner but probably does not exceed 150 feet anywhere in the county.

The salt beds are overlain by about 300 feet of shale constituting the upper part of the Wellington Formation. Red and purplish-red shale is much more common in the upper part of the formation than in the lower part. The Milan Dolostone member, which crops out in the bank of Chikaskia River south of Milan, forms the top of the Wellington Formation. The Milan consists of three beds of dolomitic limestone containing flakes of bright-green copper carbonate, interbedded with a few feet of grayish-green shale. In many places in Sumner County the Milan cannot be recognized; hence the contact between the Wellington Formation and the overlying Ninnescah Shale is indefinite.

Water supply.—The Wellington Formation yields only small quantities of water to wells in Sumner County. Most of the material composing the formation is almost impermeable, and the water comes from small fracture zones or from thin limestone lenses. For this reason the Wellington is extremely unpredictable as an aquifer. Many wells yield water that is strongly mineralized by material derived from the salt and gypsum beds in the formation. Strongly mineralized water under artesian pressure in the Wellington Formation west of Belle Plaine has contaminated the water in the overlying alluvium and terrace deposits of Ninnescah River.

Ninnescah Shale

Character, distribution, and thickness.—The Ninnescah Shale crops out in the western third of Sumner County but is mantled locally by Pleistocene deposits. The Ninnescah Shale, like the Wellington Formation, forms an almost featureless topography of low relief and good exposures are rare. The best exposure is along U. S. Highway 81 south of Caldwell. The Ninnescah consists chiefly of reddish-brown silty shale containing many beds of thin calcareous siltstone and blocky reddish-brown shale having scattered greenish-gray spots, and, in the upper part, thin beds of very fine grained sandstone. Locally there are many small veinlets of gypsum or

gypsiferous siltstone. Only a part of the Ninnescah Shale, about 250 feet, is present in Sumner County.

Water supply.—The Ninnescah Shale yields small quantities of water to many wells in western Sumner County. Much of the water, like much of that from the Wellington Formation, is strongly mineralized. In general, the Ninnescah Shale is not as good an aquifer as the Wellington Formation.

Quaternary System—Pleistocene Series

Nebraskan Terrace Deposits

Character, distribution, and thickness.—A high upland area in the northwest corner of Sumner County is mantled with sand and gravel of Nebraskan age. These deposits cover an area of about 30 square miles and seem to fill a broad, shallow channel or bedrock sag, which alines approximately with the present course of Slate Creek. Deposits of Nebraskan age were probably much more extensive at one time, but they have been eroded away by Slate Creek and by tributaries to Chikaskia River.

The lower part of the Nebraskan deposits consists chiefly of fine to medium sand but includes minor amounts of coarse sand and arkosic gravel. The upper part consists of silt and tan or red sandy clay. The greatest known thickness of these deposits in Sumner County is about 90 feet.

Water supply.—Nebraskan deposits yield moderate quantities of water of very good quality. In 1956 only one irrigation well was obtaining water from these deposits in Sumner County. Municipal wells of Conway Springs also obtain water from them.

Kansan or Illinoisan Terrace Deposits

Character, distribution, and thickness.—Kansan and Illinoisan terrace deposits in Sumner County can generally be differentiated only on the basis of relative topographic position. The Kansan deposits, which occupy a higher topographic position than the Illinoisan deposits, have been eroded along their edges, and small quantities of reworked Kansan deposits have accumulated upon the Illinoisan deposits or upon the bedrock that occupies a topographic position between the Kansan and Illinoisan deposits. Illinoisan deposits in Sumner County are probably a part of the Crete Formation. Large areas of the county contain thin or discontinuous Kansan or Illinoisan deposits overlain by colluvium derived from the Ninnescah Shale and Wellington Formation. Because of the difficulty in distinguishing between the Kansan and Illinoisan deposits, they are

treated as a single unit in this report. Sand and gravel, chiefly arkosic, are exposed in numerous road cuts and gravel pits, and many test holes were drilled through these deposits, which become coarser toward the base. In many places these rocks are recognizable as terrace deposits only because they occupy areas that roughly parallel present streams; they may be 50 feet or more above present flood plains. Their maximum known thickness in Sumner County is about 90 feet.

Water supply.—The Kansan or Illinoisan terrace deposits yield moderate quantities of water to wells in Sumner County. The water from these deposits is of good quality except where it is polluted by oil-field brine.

Wisconsinan Terrace Deposits

Character, distribution, and thickness.—Terrace deposits of Wisconinan age occur in all major stream valleys in Sumner County. These deposits represent the valley-filling phase of Wisconsinan glaciation and range in thickness from a featheredge to as much as 75 feet. The materials composing the Wisconsinan terrace deposits differ greatly from place to place, according to the type of material available to the stream that deposited them. Along Arkansas, Ninnescah, and Chikaskia Rivers they are composed chiefly of arkosic sand and gravel but include small amounts of silt and clay. Along Slate Creek, Bluff Creek, Fall Creek, and the other small creeks in Sumner County they include a much larger percentage of silt and clay and contain only minor amounts of sand and gravel.

Water supply.—In Sumner County the Wisconsinan terrace deposits along Arkansas River yield large quantities of water of good quality except in local areas polluted by oil-field brine or sewage. Wisconsinan terrace deposits along Ninnescah River yield moderate to large quantities of water. In most of the valley, the quality of water from these deposits is good except for locally troublesome quantities of iron. In an area about 2 miles west of Belle Plaine, however, the Wisconsinan deposits rest upon that part of the Wellington Formation from which most of the Hutchinson Salt member has been removed by solution, and in this area salt water under artesian pressure enters the Wisconsinan deposits from the Wellington Formation, markedly increasing the chloride concentration in water from the Wisconsinan terrace deposits.

Colluvium

Character, distribution, and thickness.—Much of Sumner County is mantled by an accumulation of colluvium. These deposits, of Illinoisan to Recent age, were formed partly by weathering of Permian shales in place and partly by deposition of silt, clay, and sand by sheet wash or unconcentrated wash. They rarely exceed 20 feet in thickness but in areas of low topographic relief they may completely conceal the underlying material over several square miles. On Plate 1 the colluvial deposits that overlie Permian shale are differentiated from those that overlie discontinuous Kansan or Illinoisan terrace deposits.

Water supply.—Colluvium lies above the water table in most places, but yields small quantities of water to a few wells in Sumner County.

Recent Deposits

Alluvium

Character, distribution, and thickness.—The Recent alluvium in Sumner County resembles lithologically the Wisconsinan terrace deposits from which most of it was derived. In the Arkansas, Ninnescah, and Chikaskia River valleys the basal part of the alluvial deposits consists of coarse sand and gravel, which grades upward into finer sand and silt. The alluvium of Bluff Creek is composed chiefly of fine sand, silt, and clay. In Slate Creek valley no contact between alluvium and Wisconsinan terrace deposits is discernible; therefore Recent alluvium in this valley is presumed to be present only in the bottom of the creek channel. Because alluvium and Wisconsinan terrace deposits cannot be differentiated in the subsurface, the entire thickness of unconsolidated sediments underlying the flood plains of the streams is treated as Recent alluvium in logs and sections.

Water supply.—The alluvium of Arkansas River yields very large quantities of water, which varies in quality considerably from place to place. In general, the ground water in the alluvium near the river is of poorer quality than that farther from the river, because of infiltration of surface water laden with sewage and other wastes. In the Oxford area, water in the alluvium is badly polluted by oilfield brines.

The alluvium of Ninnescah and Chikaskia Rivers and Cowskin Creek yields moderate to large quantities of water. The water is good except in an area along Ninnescah River near Belle Plaine,

where there has been some natural pollution by artesian brine. The alluvium of Bluff Creek yields small to moderate quantities of hard water.

Dune Sand

Character, distribution, and thickness.—Numerous dune tracts border Chikaskia and Arkansas Rivers. Most of these tracts lie on the north side of the rivers or north of certain large loops or bends in the rivers. The dunes are composed mainly of fine- to medium-grained well-rounded quartz sand, which has been blown from the flood plains of the rivers by the prevailing south winds. Many of the dunes are only sparsely vegetated and are subject to blowouts during periods of strong wind and drought.

Water supply.—The sand dunes are above the water table and do not yield water to wells, but because of their high porosity and permeability and incomplete drainage, they serve as important recharge areas.

RECORDS OF TYPICAL WELLS, SPRINGS, AND TEST HOLES

On pages that follow are records of 365 test holes, 300 wells, and 2 springs inventoried in Sumner County. Depths of wells expressed to the nearest foot, and depths to water expressed to the nearest foot or tenth were reported by the owner, tenant, or driller. The test holes and many of the wells were measured with a steel tape and such measured depths of wells are expressed to the nearest tenth of a foot and measured depths to water to the nearest hundredth of a foot.

TABLE 11.—*Records of wells, test holes, and springs in Sumner County*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed		Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
						Character of material	Geologic source						
30-2E-3aba	W. E. Prickett	Dr	61.8	6	GI	Shale	Wellington Formation	N	D	1,298.6	34.20	6- 3-55	Pump not installed.
30-2E-3abb		Dr	10.0	4	N			N	O	1,300.2	Dry		T. H. by U.S.G.S. and K.G.S.
30-2E-4aaa		Dr	20.0	4	N			N	O	1,283.5	Dry		do
30-2E-4bbb		Dr	20.0	4	N	Silt	Colluvium	N	O	1,235.2	4.73	5-22-44	do
30-2E-4ddd		Dr	20.0	4	N			N	O	1,270.8	Dry		do
30-2E-5cdc		B	28.9	1¼	S	Clay	Wisconsinan terrace deposits	N	O	1,225.1	13.10	9- 3-54	Observation well by U.S.G.S. and K.G.S.
30-2E-6aaa		Dr	20.0	4	N	gravel	Illinoisan or Kansan terrace deposits	N	O	1,236.9	7.19	5-24-44	T. H. by U.S.G.S. and K.G.S.
*30-2E-6aca	City of Mulvane	Dr	27	8	S	do	Wisconsinan terrace deposits	T, E	P	1,225.1	18		Yields about 350 gpm.
*30-2E-6acd	do	Dr	32	8	S	do	do	T, E	P	1,223.3	18		Yields about 400 gpm.
*30-2E-6bcb		Dr	60.0	4	N	do	do	N	O	1,224.3	12.90	5-23-44	T. H. by U.S.G.S. and K.G.S.
*30-2E-6bdd		Dr	28.0	4	N	Sand	do	N	O	1,221.2	6.90	5-23-44	do
*30-2E-6cab	City of Mulvane	Dr	44	14	S	Sand and gravel	do	T, E	P	1,221.4			Yields about 600 gpm.
*30-2E-6cac	do	Dr	33.4	12	S	do	do	T, E	P	1,220.7	12.20	8- 9-55	Reported to yield about 1400 gpm at 8 feet drawdown.
30-2E-6ddd		B	42.1	1¼	S	do	do	N	O	1,222.8	20.06	8-31-54	Observation well by U.S.G.S. and K.G.S.
30-2E-7aab		B	30.8	1¼	S	do	do	N	O	1,218.9	15.21	8-31-54	do
30-2E-7aad		B	27.9	1¼	S	do	do	N	O	1,217.9	16.43	8-31-54	do
*30-2E-7abc1	El Dorado-Augusta Water Assn.	Dr		14	S	do	do	T, E	Ind				
30-2E-7abc2		B	42.5	1¼	S	do	do	N	O	1,218.5	15.57	8-30-54	Observation well by U.S.G.S. and K.G.S.
30-2E-7aca		B	43.5	1¼	S	do	do	N	O	1,216.7	14.20	8-31-54	do
30-2E-7acc		B	34.8	1¼	S	do	Alluvium	N	O		10.45	9-25-54	do
30-2E-7bdd1		B	40.7	1¼	S	do	do	N	O	1,214.1	18.80	9-30-54	do
30-2E-7bdd2		B	34.3	1¼	S	do	do	N	O	1,211.8	9.29	8-30-54	do
*30-2E-7caa1	El Dorado-Augusta Water Assn.	Dr		14	S	do	do	T, E	Ind				
30-2E-7caa2		B	43.4	1¼	S	Gravel	do	N	O	1,213.4	10.71	8-30-54	Observation well by U.S.G.S. and K.G.S.
30-2E-7caa3		B	42.7	1¼	S	do	do	N	O	1,214.1	9.50	8-30-54	do

*30-2E-7cad	El Dorado-Augusta Water Assn.	Dr	.....	14	S	do	do	T, E	Ind	.....	.....	.....	
30-2E-7ccc		B	55.0	4	N	Sand	Wisconsinan terrace deposits	N	O	1,211.0	11.50	9- 7-55	T. H. by U.S.G.S. and K.G.S.
30-2E-7dbc1		B	28.6	1¼	S	do	Alluvium	N	O	.....	11.71	9-25-54	Observation well by U.S.G.S. and K.G.S.
30-2E-7dbc2		B	30.3	1¼	S	Sand and gravel	do	N	O	1,211.4	8.80	9-1 -54	do
*30-2E-7dbd1	El Dorado-Augusta Water Assn.	Dr	.....	14	S	Gravel	do	T, E		.....	.....	.....	
30-2E-7dbd2		B	25.1	1¼	S	do	do	N	O	1,212.0	9.99	8-31-54	Observation well by U.S.G.S. and K.G.S.
*30-2E-7dca1	El Dorado-Augusta Water Assn.	Dr	50.5	14	S	Sand and gravel	do	N	Ind	1,208.2	7.37	11- 8-55	Abandoned because of high detergent content of water.
30-2E-7dca2		B	29.9	1¼	S	do	do	N	O	1,208.4	7.44	9- 1-54	Observation well by U.S.G.S. and K.G.S.
30-2E-7ddd		B	29.1	1¼	S	do	Wisconsinan terrace deposits	N	O	1,213.6	13.08	9- 1-54	do
*30-2E-8bbb	Woodward	Dr	30	6	GI	do	do	J, E	D, S	.....	.....	.....	
30-2E-8cba		B	29.9	1¼	S	do	do	N	O	1,217.1	16.61	9- 1-54	Observation well by U.S.G.S. and K.G.S.
30-2E-8dcc	Fred Kersey	Dr	30.2	5	S	do	do	Ce, G	Ind	1,216.1	16.50	9- 8-55	Abandoned oil-well supply.
30-2E-9abb		Dr	48.0	4	N	do	Illinoisan or Kansan terrace deposits	N	N	1,284.2	.....	.....	T. H. by U.S.G.S. and K.G.S.
30-2E-9bcc		Dr	55.0	4	N	do	do	N	O	1,265.3	42.00	5-22-44	do
30-2E-10aab	Maude Quinn	Dr	103.7	6	GI	Shale	Wellington Formation	Cy, W	S	1,311.4	44.30	6- 3-55	
*30-2E-12cdc	L. W. Engle	Du	43.3	48	R	do	do	Cy, W	S	.....	37.20	9-11-56	
30-2E-15bbb		B	36.0	4	N	.....	.....	N	O	1,268.1	Dry	.....	T. H. by U.S.G.S. and K.G.S.
30-2E-16bbb		B	35.0	4	N	.....	.....	N	O	1,273.0	Dry	.....	do
30-2E-16bcc	H. J. Hill	Dr	49	12	S	Sand	Illinoisan or Kansan terrace deposits	J, E	D, S	.....	37	.....	
*30-2E-16ccc1	do	B	17.8	10	GI	Gravel	Alluvium	Ce, B	I	1,201.8	8.20	5- 1-56	
30-2E-16ccc2	do	B	15.7	10	GI	do	do	Ce, B	I	1,203.1	8.75	5- 2-56	
30-2E-16ccc3	do	B	14.4	10	GI	Sand and gravel	do	Ce, B	I	1,202.4	8.05	5- 2-56	Well ends in shale.
30-2E-16ccc4	do	B	13.8	10	GI	do	do	Ce, B	I	1,202.3	8.00	5- 2-56	do
*30-2E-17acb1	do	Dr	38.6	12	GI	do	Wisconsinan terrace deposits	Ce, B	I	.....	13.35	8- 8-56	Yields about 260 gpm.
30-2E-17acb2	do	Dr	27	6	S	do	do	Ce, B	I	.....	.....	.....	Battery of 3 wells. Yields about 260 gpm.
*30-2E-17bba		Dr	60.0	4	N	do	do	N	O	1,213.4	10.66	5-20-44	T. H. by U.S.G.S. and K.G.S.
30-2E-17bbb		B	28.9	1¼	S	do	Alluvium	N	O	1,213.1	13.10	9- 3-54	Observation well used by U.S.G.S. and K.G.S.
30-2E-17dbb		B	28.1	1¼	S	do	Wisconsinan terrace deposits	N	O	1,209.0	11.88	9- 1-54	do
30-2E-18aba		B	28.6	1¼	S	do	do	N	O	1,213.7	12.49	9- 4-54	do
30-2E-18bcb	W. R. Humbolt	Dr	49.2	12	S	do	do	T, B	I	1,214.2	10.05	11- 8-55	
*30-2E-18cdd	H. E. Zotter	Dn	25	1¼	S	do	do	Cy, W	S	.....	.....	.....	
30-2E-18dcc		B	26.0	1¼	S	do	do	N	O	1,209.2	10.90	9- 4-54	Observation well by U.S.G.S. and K.G.S.
*30-2E-19aba		Dr	76.0	4	N	do	do	N	O	1,208.1	4.70	5-20-44	T. H. by U.S.G.S. and K.G.S.
*30-2E-19bcc		Dr	55.0	4	N	do	do	N	O	1,207.2	2.40	5-19-44	do
*30-2E-19ccb		B	47.5	4	N	do	Alluvium	N	O	.....	8.50	6-14-56	do
*30-2E-20abb	Mulvane State Bank	Dn	25	2	S	do	do	Cy, W	S	.....	.....	.....	

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed		Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
						Character of material	Geologic source						
*30-2E-20ccc	D. Ernest	Dn	20	1¼	S	Sand and gravel	Wisconsinan terrace deposits	Cy, W	S				
30-2E-21bbb		B	22.7	1¼	S	do	Alluvium	N	O	1,202.7	10.23	9-25-54	Observation well by U.S.G.S. and K.G.S.
30-2E-21dcc		B	21.9	1¼	S	do	do	N	O	1,193.6	6.09	9-25-54	do
30-2E-23aaa	T. A. Scroggins	Dr	64.3	6	GI	Shale	Wellington Formation	N	D	1,289.1	53.00	6-3-55	Pump not installed.
30-2E-26ccc		B	30.0	4	N			N	N	1,221.0	Dry		T. H. by U.S.G.S. and K.G.S.
30-2E-27caa		B	38.9	1¼	S	Sand	Wisconsinan terrace deposits	N	O	1,206.9	18.36	9-25-54	Observation well by U.S.G.S. and K.G.S.
*30-2E-28aba		Dn	20	1¼	S	Gravel	Alluvium	Cy, H	D, S				
*30-2E-29aab		B	63.5	4	N	do	Wisconsinan terrace deposits	N	O	1,203.1	14.29	6-18-56	T. H. by U.S.G.S. and K.G.S.
30-2E-29aba1	Wayne Fuller	Dr	37.1	8	S	Sand and gravel	do	Ce, B	I	1,202.5	12.70	6-14-56	Battery of two wells. Yields about 800 gpm.
*30-2E-29aba2		B	69.0	4	N	do	do	N	O	1,202.5	12.70	6-14-56	T. H. by U.S.G.S. and K.G.S.
*30-2E-29add		B	42.5	4	N	do	do	N	O	1,202.0	17.20	6-18-56	do
*30-2E-29baa		B	70.0	4	N	do	do	N	O	1,205.9	14.80	6-18-56	do
*30-2E-29bbb		B	49.5	4	N	do	do	N	O	1,206.0	12.00	6-14-56	do
30-2E-29ccc		B	50.0	4	N	do	do	N	O	1,196.4	8.50	9-7-55	do
30-2E-29ddd		B	60.0	4	N	do	do	N	O	1,197.0	12.50	9-7-55	do
*30-2E-30ccc		B	37.0	4	N	do	do	N	O	1,204.0	10.50	9-7-55	do
*30-2E-30dba	Wayne Fuller	Dr	36.3	8	S	do	do	Ce, B	I		12.01	8-9-56	Battery of two wells. Yields about 1,100 gpm.
30-2E-30dcc	do	Dr	32.4	8	S	do	do	Ce, B	I		9.50	8-9-56	Yields about 450 gpm.
30-2E-30ddb	do	Dr	37	8	S	do	do	Ce, B	I		10		Battery of two wells. Yields about 1,100 gpm.
30-2E-31baa	Stephenson sisters	GP	55			do	do	Ce, B	I				
*30-2E-31bbb	do	Dn	25	1¼	S	do	do	Cy, W	S				
30-2E-31dcc	E. N. Bishor	Dr	29.2	12	GI	do	do	Ce, G	I	1,198.0	11.70	8-12-55	
30-2E-32aab	F. J. Metzger	Dr	33	10	S	do	do	Ce, B	I		8.50	7-25-56	Yields about 700 gpm.
30-2E-33aaa		B	53.0	4	N	do	Alluvium	N	O	1,190.2	9.20	9-7-55	T. H. by U.S.G.S. and K.G.S.
*30-2E-33bbb	School district	Dn	20	1¼	S	do	Wisconsinan terrace deposits	Cy, H	D				
30-2E-34aad		B	30.0	4	N	Gravel	Illinoisan or Kansan terrace deposits	N	N	1,214.5			T. H. by U.S.G.S. and K.G.S.
30-2E-34baa		B	57.0	4	N	Sand and gravel	do	N	O	1,205.9	18.30	9-8-55	do

*30-2E-34bbb		B	22.0	4	N		Alluvium	N	O	1,186.4	6.80	6-13-56	T. H. by U.S.G.S. and K.G.S. No log.
30-2E-34ddd		Dr	62.1	12	GI	Gravel	do	N	O	1,181.6	6.50	5- 7-55	Municipal test well. No log.
30-2E-36ccc	T. Preston	Dr	69.5	5	GI	Shale	Wellington Formation	J, E	D	1,201.2	35.30	8- 9-55	
*30-1E-1aac		Dr	50.0	4	N	Sand and gravel	Alluvium	N	O	1,218.1	3.20	6- 8-44	T. H. by U.S.G.S. and K.G.S.
*30-1E-1abb		B	54.0	4	N	do	Wisconsinan terrace deposits	N	O	1,222.8	10.10	7- 3-56	do
*30-1E-1acd		B	59.0	4	N	do	Alluvium	N	O	1,218.6	7.80	7- 4-56	do
*30-1E-1bbb		Dr	60.0	4	N	do	Wisconsinan terrace deposits	N	O	1,225.7	5.77	6- 7-44	do
30-1E-1bbc	Forest Butts	Dr				do	do	Ce, B	I				
*30-1E-2aab1	do	Dr	53	12	GI	do	do	Ce, B	I	1,222.5	9.30	7- 4-56	Yields 700 gpm. Aquifer test made.
30-1E-2aab2		B	50.0	4	N	do	do	N	O	1,222.5	9.30	7- 4-56	Observation well for aquifer test.
*30-1E-2abb		Dr	60.0	4	N	do	do	N	O	1,226.8	5.68	6- 9-44	T. H. by U.S.G.S. and K.G.S.
*30-1E-3aaa		B	50.5	4	N	do	do	N	O	1,226.4	10.40	7- 4-56	do
*30-1E-3abb		Dr	40.0	4	N	do	do	N	O	1,228.7	4.45	6- 9-44	do
30-1E-3abc	Harold Orrell	Dr	38	6	S	do	do	Ce, G	I		10		Well drilled to shale.
*30-1E-3bbb		B	23.0	4	N	do	do	N	O	1,228.5	8.70	7- 5-56	T. H. by U.S.G.S. and K.G.S.
30-1E-4aaa	E. R. Schuessler	Dr	20	4	S	do	do	Ce, B	I				Yields about 150 gpm.
*30-1E-4aab		Dr	14.0	4	N	do	do	N	O	1,231.7	3.35	6- 9-44	T. H. by U.S.G.S. and K.G.S.
*30-1E-4bab		Dr	30.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,251.6			do
30-1E-6aaa		Dr	48.0	4	N	do	do	N	O	1,260.8	25.26	6- 7-44	do
*30-1E-6bbb		Dr	70.0	4	N	do	do	N	O	1,251.9	12.30	6- 7-44	do
30-1E-7aba	George Devorak	Dr	40	10	S	do	do	Ce, G	I		21		Yields about 400 gpm.
30-1E-7bbb		B	69.0	4	N	do	do	N	O	1,247.0	14.00	9- 2-55	T. H. by U.S.G.S. and K.G.S.
30-1E-7ccb	Harry Troutman	Dr	30	6	GI	do	Wisconsinan terrace deposits	Ce, B	I		16		Yields about 150 gpm.
30-1E-7ddd		B	84.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,259.0	26.80	9- 2-55	T. H. by U.S.G.S. and K.G.S.
30-1E-9aad	M. N. Fortner	Dr	21	6	S	do	do	Ce, B	I		13		Battery of 3 wells. Yields about 120 gpm.
30-1E-9abc	do	Dr	33	6	S	do	do	Ce, B	I		16		Yields about 200 gpm.
*30-1E-9add		B	33.0	4	N	do	do	N	O	1,244.0	18.20	7- 5-56	T. H. by U.S.G.S. and K.G.S.
30-1E-10daa	E. Pengrem	Dr	20	6	GI	do	Wisconsinan terrace deposits	Ce, G	I	1,224.5	11.65	6- 4-55	Abandoned.
*30-1E-11aaa		B	53.0	4	N	do	do	N	O	1,222.5	11.90	7- 3-56	T. H. by U.S.G.S. and K.G.S.
30-1E-11aba		B	31.3	1¼	S	do	do	N	O	1,225.3	12.99	9- 4-54	Observation well by U.S.G.S. and K.G.S.
*30-1E-13bab	H. M. Maguire	Dn	20	1¼	S	do	do	Cy, H	D				
*30-1E-13daa	Francis Shoup	Dr	33.0	6	S	do	do	Ce, B	I	1,209.3	8.40	8-12-55	Yields 375 gpm.
30-1E-13dcb	do	Dr	35	6	S	do	do	Ce, B	I	1,209.5	9		Yields 425 gpm.
*30-1E-13ddc1	do	Dr	28.8	6	S	do	do	Ce, B	I	1,209.4	9.90	8-12-55	Aquifer test made. Yields 405 gpm.
30-1E-13ddc2		B	49.5	1¼	S	do	do	N	O	1,210.2	10.80	6-14-56	
*30-1E-14aaa		B	65.0	4	N	do	do	N	O	1,216.3	9.70	7- 3-56	T. H. by U.S.G.S. and K.G.S.
*30-1E-14ccd	T. G. Hobbs	Dn	20	1¼	S	do	do	Cy, H	D				

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
*30-1E-15cde	R. Barnett	Dn	25	1¼	S	Sand and gravel	Illinoisan or Kansan terrace deposits	Cy, W	S				
*30-1E-16bba	Dr. Seydell	Dn	20	1¼	S	do	do	Cy, E	D	1,237.5			
30-1E-16ddd		B	34.0	4	N	do	do	N	O	1,232.9	16.10	7- 5-56	T. H. by U.S.G.S. and K.G.S.
*30-1E-17bab	Keith Walton	Dn	50	1¼	S	do	do	Cy, E	S	1,266.4	30		
*30-1E-18cbc		B	30.0	4	N	Sand	Wisconsinan terrace deposits	N	O	1,223.7	18.60	9- 1-55	T. H. by U.S.G.S. and K.G.S.
30-1E-19bbb		B	46.0	4	N	Sand and gravel	do	N	O	1,219.9	16.60	9- 1-55	do
30-1E-19bcc1	Melvin Phipps	Dn	32	2	S	do	do		I	1,225.1			30-1E-19bcc1 and 19bcc2 pumped together.
30-1E-19bcc2	do	Dn	26	2	S	do	do		I	1,225.1			
*30-1E-23aab		B	26.0	4	N	do	do	N	O	1,211.1	7.10	7- 3-56	T. H. by U.S.G.S. and K.G.S.
30-1E-24cbd	L. A. Cather	Dr	26	12	GI	do	do	Ce, B	I		13		Yields about 400 gpm.
30-1E-24ccd	do	Dr	26	12	GI	do	do	Ce, B	I		11		do
30-1E-25aaa		B	50.0	4	N	do	do	N	O	1,202.6	7.30	9- 7-55	T. H. by U.S.G.S. and K.G.S.
*30-1E-25aba	L. Bowlby	Dn	20	1¼	S	do	do	Cy, H	D				
*30-1E-25baa		Dr	40.0	4	N	do	do	N	O	1,207.9	3.75	5-18-44	T. H. by U.S.G.S. and K.G.S.
*30-1E-25bcc		Dr	40.0	4	N	do	do	N	O	1,211.4	9.01	5-18-44	do
30-1E-26aaa		B	18.0	4	N	Sand	do	N	O	1,211.0	15	7- 3-56	do
30-1E-27ccc		B	37.0	4	N	Sand and gravel	do	N	O	1,212.0	18.40	9- 7-55	do
30-1E-27ddd		B	30.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,217.0	13.00	9- 7-55	do
*30-1E-28ccc		B	49.0	4	N	Sand	Wisconsinan terrace deposits	N	O	1,211.9	21.50	9- 7-55	do
30-1E-30bcc		B	20.0	4	N			N	O	1,243.0	Dry		do
*30-1E-33cdc		B	41.5	4	N	Sand	Wisconsinan terrace deposits	N	O	1,203.9	14.86	6- 7-56	do
*30-1E-33ddd		B	32.5	4	N	Sand and gravel	Alluvium	N	O	1,195.5	6.85	6- 6-56	do
30-1E-34ada		B	15.5	4	N	do	Wisconsinan terrace deposits	N	O	1,209.8	7.60	6-11-56	do
*30-1E-34add		B	27.5	4	N	do	do	N	O	1,206.1	12.10	8-11-56	do
*30-1E-34bbc		B	33.5	4	N	Sand	do	N	O	1,208.6	13.95	6- 6-56	do
*30-1E-34bcc		B	42.5	4	N	Sand and gravel	do	N	O	1,208.0	14.90	6- 6-56	do
*30-1E-34ccb		B	40.5	4	N	Sand	do	N	O	1,203.8	14.10	6- 6-56	do
*30-1E-34ccd		B	40.5	4	N	do	Alluvium	N	O	1,200.2	14.50	6- 8-56	do
*30-1E-34dcd		B	40.5	4	N	Sand and gravel	do	N	O	1,202.8	14.20	6- 8-56	T. H. by U.S.G.S. and K.G.S.
*30-1E-35aaa		B	43.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,214.5	17.70	9- 7-55	do

30-1E-35add1	City of Belle Plaine	Dr	54	30	C	do	do	N	P	1,220.2	32		Abandoned city well (east).
30-1E-35add2	do	Dr	51	12	S	do	do	N	P	1,220.2	32		Abandoned city well (west).
30-1E-35laa		Dr	25.0	4	N	do	do	N	O	1,216.6			T. H. by U.S.G.S. and K.G.S.
30-1E-35bad	E. M. Paxton					do	do			1,217.3			Abandoned domestic well.
*30-1E-35bcc		Dr	30.0	4	N	do	Wisconsinan terrace deposits	N	O	1,202.8	3.47	5-17-44	T. H. by U.S.G.S. and K.G.S.
*30-1E-35cbc		B	33.5	4	N	do	do	N	O	1,205.8	13.60	6-11-56	do
30-1E-36aab	Laughlin	Dr	36	8	GI	do	do	Ce, B	I		10		Yields about 600 gpm.
*30-1E-36caa	City of Belle Plaine	Dr	43	12	S	do	do	T, E	P	1,204.9	11		Well drilled to shale.
30-1E-36dbb	do	Dr	38.6	12	S	do	do	T, E	P	1,202.9	15.10	8-12-55	
*30-1W-2abb		Dr	36.0	4	N	do	do	N	O	1,244.8	9.84	6- 7-44	T. H. by U.S.G.S. and K.G.S.
*30-1W-2ddd	Harry Stunkel	Dn	20	1¼	S	Sand	do	Cy, W	S				
*30-1W-3bab		Dr	46.0	4	N	Sand and gravel	do	N	O	1,245.1	4.53	6- 6-44	T. H. by U.S.G.S. and K.G.S.
*30-1W-5abb		B	48.0	4	N	Sand	do	N	O	1,250.0	16.00	8-31-55	do
30-1W-7aaa		Dr	10.0	4	N			N	O	1,261.2	Dry		do
*30-1W-13aaa		B	40.0	4	N	Sand and gravel	Wisconsinan terrace deposits	N	O	1,236.1	12.00	9- 1-55	do
30-1W-18bbb		Dr	18.0	4	N			N	O	1,275.0	Dry		do
30-1W-24add		B	28.0	4	N	Sand and gravel	Alluvium	N	O	1,218.0	13.20	9- 1-55	do
30-1W-33cdd	D. Carr	Dr	20.9	6	GI	Shale	Wellington Formation	Cy, W	S	1,262	8.25	4-23-57	
30-2W-1aaa		B	34.0	4	N	Sand and gravel	Alluvium	N	O	1,244.0	8.10	8-31-55	T. H. by U.S.G.S. and K.G.S.
30-2W-8cd	M. Johnson	Dr	44.8	6	GI	Shale	Wellington Formation	Cy, W	S	1,367	23.80	4-23-57	
*30-2W-22ada	A. L. Burchell	Du	44.7	48	R	do	do	Cy, W	S	1,360	32.60	9-14-56	
30-3W-6bcc	W. A. Small	Dr	21.7	6	GI	do	Ninnescah Shale	N	S	1,373.2	17.55	7-22-55	
30-3W-6dcd	F. J. Wolfe	Dr	42.7	6	GI	Sand	Nebraskan terrace deposits	Cy, W	S	1,365	19.40	4-23-57	
30-3W-15bbb		B	15.0	4	N			N	O	1,353.2	Dry		T. H. by U.S.G.S. and K.G.S.
30-3W-18bbb		B	27.0	4	N	Sand	Colluvium	N	O	1,366.3	18		do
*30-3W-33dcc	City of Conway Springs	Dr	40	12	C	Gravel	Nebraskan terrace deposits	Ce, E	P				Five wells of identical construction in water park.
30-4W-4aaa	J. C. Rowan	B		8	CT	do	do	Cy, W	S	1,432	28.60	4-23-57	
30-4W-5ccc	G. G. Skillen	B	15.0	8	CT	do	do	Cy, H	S	1,445.0	11.60	7-28-55	Abandoned.
30-4W-9ccc		B	57.0	4	N	Sand	do	N	O	1,450.6	6.00	8-17-55	T. H. by U.S.G.S. and K.G.S.
30-4W-10aaa		B	9.0	4	N			N	O		Dry		do
30-4W-10ccc		B	7.0	4	N			N	O	1,423.9	Dry		do
*30-4W-16ccb	C. G. Boyer	Dr	20	6	GI	Gravel	Nebraskan terrace deposits	J, E	S	1,470	15		
30-4W-17bbb		B	70.0	4	N	Sand and gravel	do	N	O	1,468.5	12.90	8-16-55	T. H. by U.S.G.S. and K.G.S.
30-4W-18bbb		B	67.0	4	N	Sand	do	N	O	1,468.6	9.10	8-16-55	do
30-4W-19bbb		B	48.0	4	N	Sand and gravel	do	N	O	1,487.4	26.60	8-16-55	do
30-4W-19ccc		B	19.0	4	N	Sand	do	N	O	1,475.3	14.40	8-16-55	do
*30-4W-23ddd	R. E. Burford	Dr	45.8	6	GI	Shale	Ninnescah Shale	Cy, W	S		17.28	8-13-56	
30-4W-24ccc		B	7.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
30-4W-34bbb		B	80.0	4	N	Sand and gravel	Nebraskan terrace deposits	N	O	1,456.9	23.60	8-17-55	T. H. by U.S.G.S. and K.G.S.
30-4W-35bbb	W. G. Fulkerson	B	47.2	8	CT	do	do	J, E	S		38.00	8-13-56	
31-2E-1ada	W. June	Dr	70.1	6	GI	Shale	Wellington Formation	N	S	1,232.3	62.07	6- 3-55	

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
31-2E-2aad		B	44.5	4	N	Sand	Wisconsinan terrace deposits	N	N	1,189.5			T. H. by U.S.G.S. and K.G.S.
*31-2E-2bba	City of Udall	Dr	29	10	S	Sand and gravel	do	T, E	P	1,187.5	16		Yields about 140 gpm.
*31-2E-2bbb	do	Dr	31	10	S	do	do	T, E	P	1,185.5	15		Yields about 130 gpm.
*31-2E-2ddd		B	21.0	4	N	Sand	do	N	O	1,182.0	13.00	6-18-56	T. H. by U.S.G.S. and K.G.S.
*31-2E-3aba		B	24.0	4	N	do	Alluvium	N	O	1,184.3	11.20	6-29-56	do
*31-2E-3baa		B	27.5	4	N	Sand and gravel	do	N	O	1,181.6	8.20	6-18-56	do
*31-2E-3bbb		B	60.5	4	N	do	Wisconsinan terrace deposits	N	O	1,187.6	11.50	6-12-56	do
*31-2E-3cbb	A. A. Hatfield	Dn	20	1¼	S	do	Alluvium	Cy, E	D		14		
*31-2E-3ddd		B	35.0	4	N	do	do	N	O	1,176.0	9.80	6-29-56	T. H. by U.S.G.S. and K.G.S.
31-2E-5bba	R. Smith Estate	Dr	34.0	10	GI	do	Wisconsinan terrace deposits	Ce, B	I	1,193.0	11.25	6-28-55	
31-2E-5bbd	do	Dr	40.1	6	GI	do	do	Ce, B	I	1,189.9	10.50	6-28-55	
*31-2E-5cdd	W. A. Harvey	Dn	20	1¼	S	do	do	Cy, H	S				
*31-2E-5ddd		B	63.0	4	N	do	do	N	O	1,186.4	12.20	6-12-56	T. H. by U.S.G.S. and K.G.S.
31-2E-6bbb		B	35.0	4	N	Sand	do	N	O	1,200.0	10.50	9- 8-55	do
31-2E-7aad	Chas. Wooldridge	Dr	32	5	S	Sand and gravel	do	Ce, B	I	1,187.3	14		Battery of 3 wells. Yields about 240 gpm.
*31-2E-7cbc	A. L. Barner	Dn	30	1¼	S	do	do	Cy, W	S				
*31-2E-7ccc		B	41.0	4	N	do	do	N	O	1,189.8	17.80	9- 8-55	T. H. by U.S.G.S. and K.G.S.
*31-2E-8bbb	Rolley Vancure	Dr	32	5	S	do	do	Ce, B	I	1,187.1	14		Yields about 240 gpm.
31-2E-9aab	Harold Koger	Dr	50.5	20	S	do	do	T, B	I	1,182.2	12.20	8-12-55	
*31-2E-9adb	do	Dr	61.8	20	S	do	do	T, B	I	1,184.4	15.50	8-12-55	Yields about 2,500 gpm.
*31-2E-10dcc	J. H. Tennery	Dn	19.0	1¼	S	do	do	Cy, H	S		9.62	8-14-43	
*31-2E-11ada		Dn	20	1¼	S	do	do	Cy, H	D, S				
*31-2E-11ded	R. Davis	Dn	30	1¼	S	do	do	Cy, H	D, S				
31-2E-12add	G. R. Pittman	Dr	57	6	GI	do	Illinoisan or Kansan terrace deposits	J, E	D, S	1,207.6	32.70	7-27-54	
*31-2E-12bcc		B	20.5	4	N	do	Wisconsinan terrace deposits	N	O	1,177.3	5.80	6-19-56	T. H. by U.S.G.S. and K.G.S.
31-2E-12bdc		B	49.0	4	N	do	Illinoisan or Kansan terrace deposits	N	N	1,199.8			do
31-2E-13aba		B	23.0	4	N			N	O	1,194.4	Dry		do
31-2E-13add		B	33.5	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	N	1,207.0			do
*31-2E-13bba		B	20.5	4	N	do	Wisconsinan terrace deposits	N	O	1,170.9	8.30	6-19-56	do
*31-2E-13bca		B	24.5	4	N	do	do	N	O	1,168.1	6.40	6-19-56	do
*31-2E-13cca		B	33.5	4	N	do	do	N	O	1,170.1	11.00	6-20-56	do

*31-2E-14aab		B	33.5	4	N	do	do	N	O	1,169.5	6.90	6-19-56	do
*31-2E-15aaa		B	60.5	4	N	do	do	N	O	1,174.7	7.60	6-12-56	do
*31-2E-16aaa	School district	Dn	20	1¼	S	do	do	Cy, H	D				
31-2E-17bba	Dr. Howe	Dr	30.2	6	S	do	do	Ce, B	I		12.10	9-12-56	Battery of two wells.
31-2E-17bcd	do					do	do	Ce, B	I				
31-2E-17ccc		B	53.0	4	N	do	do	N	O	1,182.8	17.50	9- 9-55	T. H. by U.S.G.S. and K.G.S.
*31-2E-17cde	A. L. Barner	Dn	25	1¼	S	do	do	Cy, W	S				
31-2E-20acc	T. Max Reitz	Dr	50	14	GI	do	do	Ce, G	I	1,184.8	20.50	8- 1-55	Abandoned.
31-2E-20ccc		B	29.0	4	N	do	do	N	O	1,182.1	17.70	9-12-55	T. H. by U.S.G.S. and K.G.S.
*31-2E-20dde	F. Lanier	Dn	25	1¼	S	do	Alluvium	Cy, W	S				
31-2E-21baa		B	46.0	4	N	do	Wisconsinan terrace deposits	N	O	1,178.1	14.40	9- 9-55	T. H. by U.S.G.S. and K.G.S.
31-2E-22cda	C. G. Boyer	Dr	21.6	1¼	S	do	do	N	O		18.70	7-18-56	Test well.
31-2E-23baa		B	65.0	4	N	do	do	N	O	1,171.2	13		T. H. by U.S.G.S. and K.G.S.
31-2E-24aaa		Dr	39.5	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,204.0	34.90	4-28-44	do
31-2E-24add1		Dr	45.0	4	N	Sand	do	N	O	1,198.6	35		do
31-2E-24add2		B	23.5	4	N			N	O	1,185.5	Dry		do
*31-2E-24bab		B	33.0	4	N	Sand and gravel	Wisconsinan terrace deposits	N	O	1,165.5	7.00	9-10-55	do
*31-2E-24cdd		Dr	47.0	4	N	do	do	N	O	1,162.3	8.64	5-25-44	do
*31-2E-24dca		B	22.0	4	N	do	do	N	O	1,163.2	7.30	6-20-56	do
*31-2E-24dcc		B	45.0	4	N	do	do	N	O	1,160.5	7.00	6-20-56	do
31-2E-25aaa		B	17.5	4	N			N	O	1,174.6	Dry		do
*31-2E-25aba		B	41.0	4	N	Sand and gravel	Wisconsinan terrace deposits	N	O	1,164.1	8.60	6-20-56	do
*31-2E-25ada		B	13.5	4	N	Sand	do	N	O	1,160.3	7.40	6-20-56	do
*31-2E-25bbc	Ira Shore	Dn	22	1¼	S	do	do	Ce, G	D				
*31-2E-25cac		B	35.5	4	N	Sand and gravel	Alluvium	N	O	1,161.3	9.80	6-21-56	T. H. by U.S.G.S. and K.G.S.
*31-2E-25cad		B	45.0	4	N	do	do	N	O	1,159.0	9.20	6-21-56	do
*31-2E-25dcc		B	47.0	4	N	do	do	N	O	1,155.0	3.00	5-26-44	do
*31-2E-25dda		B	50.5	4	N	do	Wisconsinan terrace deposits	N	O	1,160.0	10.82	6-20-56	do
*31-2E-25ddd		B	47.0	4	N	do	do	N	O	1,158.4	11.40	9-10-55	do
*31-2E-26bbb		B	37.0	4	N	do	do	N	O	1,168.8	11.70	9- 9-55	do
*31-2E-26ddd		Dr	28.0	4	N	Sand	do	N	O	1,163.5	12.10	5-13-44	do
*31-2E-27aaa		Dn	25	1¼	S	Sand and gravel	do	Cy, W	S				
*31-2E-28aab	Mrs. M. H. Fisher	Dn	20	1¼	S	do	do	Cy, W	S		10		
*31-2E-29cbb	Fannie Griffeth	Dn	25	1¼	S	do	Alluvium	Cy, W	D, S				
31-2E-29cdd		Dr	75.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,227.9	51.50	5-15-44	T. H. by U.S.G.S. and K.G.S.
31-2E-30bbb		B	70.0	4	N	do	do	N	O	1,204.8			do
*31-2E-34aba	P. Steiner	Dn	28	1¼	S	Gravel	Wisconsinan terrace deposits	Cy, W	S		14		
31-2E-34ddd		B	64.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,215.9	50		T. H. by U.S.G.S. and K.G.S.
31-2E-35bbb		B	41.0	4	N	do	Wisconsinan terrace deposits	N	O	1,166.6	13.00	9- 9-55	do
*31-2E-36aad		B	43.5	4	N	do	Alluvium	N	O	1,153.7	6.80	6-21-56	do
*31-2E-36abb		B	14.5	4	N	Sand	do	N	O	1,155.9	6.50	6-21-56	do
*31-2E-36acb		B	14.5	4	N	Sand and gravel	do	N	O	1,155.2	5.80	6-21-56	do
*31-2E-36dca		B	17.5	4	N	Sand	do	N	O	1,155.0	7.50	6-28-56	do
*31-2E-36dcd		B	16.5	4	N	do	do	N	O	1,150.7	7.40	6-28-56	do

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed		Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
						Character of material	Geologic source						
31-1E-1dda		B	36.0	4	N	Sand and gravel	Wisconsinan terrace deposits	N	N	1,209.6			T. H. by U.S.G.S. and K.G.S.
*31-1E-2baa		B	19.5	4	N	do	do	N	O	1,208.7	10.70	6-12-56	do
31-1E-2bae		B	31.0	4	N	Sand	do	N	O	1,204.1	12.30	6-12-56	do
*31-1E-2bad		B	25.5	4	N	do	do	N	O	1,197.7	8.20	6-12-56	do
*31-1E-2bbb		B	35.5	4	N	do	do	N	O	1,202.8	13.80	6-11-56	do
*31-1E-2bcc		B	33.5	4	N	do	do	N	O	1,201.3	15.40	6-11-56	do
31-1E-2bdd		B	33.5	4	N	Sand and gravel	do	N	O	1,200.0	13.90	6-12-56	do
*31-1E-3abb		Dr	46.0	4	N	do	do	N	O	1,202.7	4.38	5-16-44	do
*31-1E-3baa		B	40.5	4	N	Sand	do	N	O	1,202.8	14.70	6-8-56	do
*31-1E-4aab		B	45.0	4	N	Sand and gravel	do	N	O	1,204.8	15.10	6-7-56	do
*31-1E-4aac		B	41.0	4	N	Sand	do	N	O	1,201.9	13.10	6-7-56	do
*31-1E-4ade		B	37.5	4	N	do	do	N	O	1,199.5	14.67	6-8-56	do
*31-1E-4baa		Dr	50.0	4	N	Sand and gravel	do	N	O	1,203.0	7.50	5-16-44	do
*31-1E-4bad		B	36.5	4	N	Sand	do	N	O	1,206.5	18.10	6-7-56	do
*31-1E-4bbb	Tom Cross	Dr	34	6	GI	Sand and gravel	do	J, E	D, S		26		
*31-1E-4bdc1	Kansas Turnpike Authority	Dr	46.5	7	S	do	Alluvium	T, E	P	1,213.5	28.85	2-22-56	South well.
*31-1E-4bdc2	do	Dr	39.8	7	S	do	do	T, E	P	1,209.4	22.80	2-22-56	North well.
*31-1E-5aba	M. M. Brown	Dn	25	1¼	S	do	do	Cy, H	S				
31-1E-5bbb		Dr	22.0	4	N	Silt	Colluvium	N	O	1,224.0	6.38	5-17-44	T. H. by U.S.G.S. and K.G.S.
31-1E-9abb1	W. S. Nelson	Dr	41.0	6	GI	Sand and gravel	Wisconsinan terrace deposits	Cy, G	S	1,213.0	36.40	6-7-55	
*31-1E-9abb2		Dr	45.0	4	N	do	do	N	O	1,210.1	17.93	6-6-44	T. H. by U.S.G.S. and K.G.S.
*31-1E-10aaa1		Dn	25	1¼	S	do	do	N	S				
*31-1E-10aaa2		Dr	25	6	S	do	do	J, E	D, S	1,197.1			
31-1E-10dad		B	34.0	4	N	Sand	do	N	N	1,195.7			T. H. by U.S.G.S. and K.G.S.
*31-1E-11ada	E. Pergram	Dn	25	1¼	S	do	do	Cy, H	D				
*31-1E-11baa		B	45.0	4	N	do	do	N	O	1,200.0	19.20	6-12-56	T. H. by U.S.G.S. and K.G.S.
*31-1E-11bbb		B	36.0	4	N	Sand and gravel	Alluvium	N	O	1,193.9	12.10	6-11-56	do
*31-1E-11bce		B	36.5	4	N	Sand	Wisconsinan terrace deposits	N	O	1,198.5	18.68	6-11-56	do
*31-1E-11cbb		Dr	24	6	GI	do	do	J, E	D		17		
*31-1E-11cbe		B	30.5	4	N	do	Alluvium	N	O	1,192.0	12.00	7-5-56	T. H. by U.S.G.S. and K.G.S.
*31-1E-12bbb		B	40.5	4	N	Sand and gravel	Wisconsinan terrace deposits	N	O	1,194.7	15.00	6-12-56	do
*31-1E-13bbb		Dr	40.0	4	N	do	do	N	O	1,182.8	8.50	5-15-44	do

*31-1E-14aaa...	.....	B	33.0	4	N	do.....	Alluvium.....	N	O	1,180.3	11.30	7- 6-56	do
31-1E-15bcc...	S. and N. Lawless...	Du	20.6	48	R	do.....	Illinoisan or Kansan terrace deposits	Cy, W	S	1,232.3	13.95	6- 7-55	
31-1E-17aba...	M. Burford.....	Dr	52.0	6	GI	Shale.....	Wellington Formation.....	Cy, H	S	1,275.1	17.55	6- 8-55	Abandoned.
31-1E-17abb...	.....	Dr	21.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,270.9	15.35	6- 6-44	T. H. by U.S.G.S. and K.G.S.
31-1E-24bbb...	.....	Dr	39.0	4	N	do.....	do.....	N	O	1,226.6	30.17	5-15-44	do
31-1E-24bcc...	.....	Dr	31.0	4	N	Silt.....	do.....	N	O	1,200.7	5.02	5-15-44	do
*31-1E-25bba1..	Theodore Neises.....	Dr	65	6	GI	Sand and gravel	do.....	Cy, E	D, S	.....	47	.....	.....
31-1E-25bba2..	.....	B	65.0	4	N	Sand.....	do.....	N	O	1,244.2	50	.....	T. H. by U.S.G.S. and K.G.S.
31-1E-28aaa...	School district.....	Dr	39.6	6	GI	Shale.....	Wellington Formation.....	Cy, H	D	1,273.8	24.08	6- 7-56	
31-1W-2bcb...	.....	Du	28.6	48	R	do.....	do.....	N	S	1,300.0	24.43	6-10-55	Abandoned.
31-1W-12aba..	L. F. Stewart.....	Du	33.8	48	R	do.....	do.....	N	S	1,306.6	32.40	6-10-55	do
*31-1W-24bcb..	F. C. Springer.....	Du	35.6	36	R	do.....	do.....	Cy, W	S	1,295.2	31.25	9-12-56	
31-1W-25abb..	.....	Dr	10.0	4	N	.....	.....	N	O	1,286.7	Dry	.....	T. H. by U.S.G.S. and K.G.S.
*31-1W-26add...	Felt Estate.....	Dr	33	6	GI	Shale.....	Wellington Formation.....	J, E	D, S	.....	20	.....	.....
31-1W-34dad..	M. Swearinger.....	Du	20.5	48	R	do.....	do.....	Cy, W	S	1,251.6	15.91	6- 9-55	
31-1W-35abb..	.....	Dr	7.0	4	N	.....	.....	N	O	1,266.2	Dry	.....	T. H. by U.S.G.S. and K.G.S.
31-2W-8ccc....	.....	B	28.0	4	N	Sand.....	Wisconsinan terrace deposits..	N	O	1,268.4	13.70	8-31-55	do
31-2W-13ddd..	S. T. Botkin.....	Du	40.3	48	R	Shale.....	Wellington Formation.....	Cy, W	S	1,297.0	33.00	6-22-55	
31-2W-20ddd..	Wm. Magill.....	Dr	.....	6	GI	do.....	Ninnescah Shale.....	Cy, W	S	1,290	18.10	4-25-57	
31-2W-31daa..	.....	B	12.0	4	N	.....	.....	N	O	.....	Dry	.....	T. H. by U.S.G.S. and K.G.S.
*31-3W-4abb...	City of Conway Springs	Dr	40	12	C	Gravel.....	Nebraskan terrace deposits...	Ce, E	P	.....	.....	.....	Two wells of identical construction.
*31-3W-5acd1...	do.....	Dr	43.2	10	S	do.....	do.....	T, E	P	1,408.9	21.70	7-28-55	East well.
31-3W-5acd2...	do.....	Dr	37.5	10	S	do.....	do.....	T, E	P	1,400.5	12.30	7-25-55	West well.
31-3W-7bbb...	J. Coulter.....	Dr	90	6	GI	do.....	do.....	Cy, G	S	1,453.3	.....	.....	
*31-3W-23baa..	I. W. Fisher.....	Dr	54.2	6	GI	Shale.....	Ninnescah Shale.....	Cy, W	S	1,330	27.79	9-15-56	
31-3W-31bbb..	.....	B	8.0	4	N	.....	.....	N	O	.....	Dry	.....	T. H. by U.S.G.S. and K.G.S.
31-3W-33cdc...	R. H. Shaffer.....	Dr	.....	6	GI	Clay.....	Colluvium.....	Cy, W	S	1,269	4.75	4-23-57	
31-4W-1add...	Frants.....	Dr	59.1	8	GI	Sand.....	Nebraskan terrace deposits...	Cy, G	Ind	1,444.3	28.90	8-10-55	Water is bottled and sold for drinking.
31-4W-1ccd....	L. Shetlar.....	Dr	50	12	S	do.....	do.....	J, E	D	1,431.7	16	.....	.....
31-4W-2aaa....	.....	B	58.0	4	N	Sand and gravel	do.....	N	O	1,439.5	19.30	8-17-55	T. H. by U.S.G.S. and K.G.S.
31-4W-8ccc....	Amanda Achelpohll..	Dr	25.1	6	GI	Shale.....	Ninnescah Shale.....	Cy, G	S	1,367.1	9.65	7-28-55	
31-4W-10ada..	Ed Smith.....	Sp	.....	.....	.....	Gravel.....	Nebraskan terrace deposits..	.....	I	.....	.....	.....	Water is collected in small pond.
31-4W-11ccc...	Ann Boatright.....	B	46.1	8	CT	do.....	do.....	Cy, W	S	1,371.7	26.00	5- 3-56	
*31-4W-12bbd1	L. Shetlar.....	Dr	40	12	S	Sand and gravel	do.....	Ce, B	I	1,427.7	16	.....	Battery of wells. Yields about 400 gpm.
31-4W-12bbd2	.....	B	42.5	4	N	do.....	do.....	N	N	1,427.7	.....	.....	T. H. by U.S.G.S. and K.G.S.
31-4W-14ddd..	.....	B	20.0	4	N	Clay.....	Colluvium.....	N	O	1,345.7	10.90	8-17-55	do
31-4W-17ccc...	.....	B	14.0	4	N	.....	.....	N	O	1,341.0	Dry	.....	do

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
31-4W-24cce	School district	Dr	43.5	6	GI	Shale	Ninnescah Shale	Cy,H	D	1,329.9	22.40	8-10-55	
31-4W-25dcc	S. and W. Wacker	Du	24.3	48	R	do	do	Cy, H	S	1,308.4	20.40	8-10-55	
31-4W-26ccc		B	35.0	4	N	Sand and gravel	Colluvium	N	O	1,304.5	21.00	8-17-55	T. H. by U.S.G.S. and K.G.S.
31-4W-30bbb		B	43.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,310.6	25.70	8-16-55	do
31-4W-31bbb		B	28.0	4	N	do	do	N	O	1,288.1	17.20	8-16-55	do
31-4W-31ccc		B	15.0	4	N			N	O	1,276.9	Dry		do
31-4W-31ddd		B	36.0	4	N	Sand	Illinoisan or Kansan terrace deposits	N	O	1,291.0	18.30	8-15-55	do
*32-2E-1abd		B	21.5	4	N	do	Alluvium	N	O	1,149.4	8.10	6-28-56	do
*32-2E-1ded		B	12.5	4	N	do	do	N	O	1,143.2	4.50	6-27-56	do
32-2E-5daa	C. Lowry	Du	50.1	40	R	Shale	Wellington Formation	Cy, W	S	1,242.4	32.30	5- 7-55	
32-2E-7abb		Dr	10.0	4	N			N	O	1,246.3	Dry		T. H. by U.S.G.S. and K.G.S.
32-2E-7bbb		Dr	40.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,265.1	28.90	5-11-44	do
32-2E-8abb		Dr	32.0	4	N	Clay	do	N	N	1,227.1			do
32-2E-8bbb		Dr	10.0	4	N			N	O	1,239.2	Dry		do
32-2E-8cdd	Roy Ostrander	Dr	90.0	6	GI	Shale	Wellington Formation	J, E	D, S	1,268.1	60.00	5-1-55	
32-2E-9bbb		Dr	20.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,245.7		5-12-44	T. H. by U.S.G.S. and K.G.S.
32-2E-10aaa		Dr	46.0	4	N	do	do	N	O	1,201.4	33.60	5-13-44	do
32-2E-10bbb		Dr	44.0	4	N	Sand	do	N	O	1,215.7	17.58	5-12-44	do
32-2E-11aaa		Dr	27.0	4	N	Sand and gravel	do	N	O	1,176.5	24		do
32-2E-11cdd		B	26.0	4	N	Sand	do	N	O	1,170.7			do
32-2E-11ddd		B	43.5	4	N	do	do	N	O	1,181.6	38.80	6-26-56	do
32-2E-12bab		Dr	18.0	4	N	do	do	N	N	1,166.3			do
*32-2E-13aaa		B	42.5	4	N	do	Wisconsinan terrace deposits	N	O	1,142.2	6.90	6-22-56	do
32-2E-13aac1		B	30.0	4	N	do	do	N	N	1,113.8			do
32-2E-13aac2	S. E. Storts	J	19.0	6	S	Sand and gravel	do	Ce, G	I	1,144.4	9.90	9-10-55	Water too salty for irrigation.
*32-2E-13abb		B	47.0	4	N	do	do	N	O	1,141.9	7.80	6-27-56	T. H. by U.S.G.S. and K.G.S.
*32-2E-13add1	S. E. Storts	Du	25	1¼	S	do	do	Cy, W	D, S				
32-2E-13add2	do	GP	20			do	do	Ce, G	I				
*32-2E-13daa		B	45.5	4	N	do	do	N	O	1,142.2	9.20	6-22-56	T. H. by U.S.G.S. and K.G.S.

*32-2E-13ddc		B	45.5	4	N	do	do	N	O	1,110.9	7.40	6-22-56	do
*32-2E-14bbb1	W. G. Buffington	Dr	25.0	6	GI	Sand	Illinoisan or Kansan terrace deposits	J, E	S	1,170.2	7.40	5- 2-56	
32-2E-14bbb2		B	52.0	4	N	do	do	N	O	1,173.0	12.50	9- 9-55	T. H. by U.S.G.S. and K.G.S.
32-2E-14dad		B	24.5	4	N	do	do	N	O	1,147.0	4.30	6-25-56	do
32-2E-14ddd		B	29.0	4	N			N	O	1,155.9	Dry		do
*32-2E-17acc	D. F. Barnes	Dr	72.9	8	S	Shale	Wellington Formation	Cy, W	S		67.53	7-25-56	
32-2E-18cbb		B	20.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
*32-2E-22aaa	S. E. Caldwell	Dr	40	8	S	Sand	Illinoisan or Kansan terrace deposits	J, E	D, S		33		
32-2E-23bbb		Dr	40.0	8	S	do	do	N	N	1,204	37.00	4-25-57	
*32-2E-24aaa		B	48.0	1¼	N	Sand and gravel	Wisconsinan terrace deposits	N	O	1,146.0	15.80	6-22-56	City of Winfield observation well.
*32-2E-24bcd	J. W. Sargent	GP				do	do	Cy, H	S				
*32-2E-25abb		B	44.0	4	N	do	Alluvium	N	O	1,133.6	6.90	6-26-56	T. H. by U.S.G.S. and K.G.S.
*32-2E-25ddd		B	39.0	4	N	do	do	N	O	1,128.4	6.80	9-13-55	do
32-2E-27ddd		B	28.0	4	N			N	O	1,171.4	Dry		do
*32-2E-31cdc	E. Paton	Dr	44.0	6	GI	Clay	Illinoisan or Kansan terrace deposits	N	D		34.20	8-16-56	Water too salty to use.
*32-2E-36abb	Cheveront	Dn	20	1¼	S	Sand and gravel	Wisconsinan terrace deposits	Cy, H	S				
32-2E-36baa	A. E. Fink	Dr	36.8	6	S	do	do	Ce, G	I	1,138.5	14.80	5- 4-55	
32-2E-36bbb		B	25.0	4	N			N	O	1,152.3	Dry		T. H. by U.S.G.S. and K.G.S.
32-2E-36dbb	R. W. James	Du	38.8	48	R	Sand and gravel	Illinoisan or Kansan terrace deposits	Cy, W	S	1,158.1	36.00	5- 4-55	
32-1E-2aab	Wagner	Dr	25.8	8	S	do	do	Cy, W	S	1,244.4	12.50	6- 6-55	
32-1E-8ccc	R. G. Slinker	Du	14.4	48	R	Shale	Wellington Formation	N	D, S	1,235.1	9.60	6- 8-55	Abandoned.
*32-1E-8ddd	E. E. Burdue	Dr	49.4	6	GI	do	do	Cy, G	S	1,247.0	33.30	4-25-57	
*32-1E-9ddc	J. E. Martin	Dr	37.4	6	GI	do	do	Cy, H	D, S	1,216.0	13.60	4-25-57	
32-1E-12bbb		Dr	34.0	4	N			N	O	1,196.7	Dry		T. H. by U.S.G.S. and K.G.S.
*32-1E-12dcc	Bertha Hollingsworth	Du		48	R	Shale	Wellington Formation	J, E	S				
*32-1E-16aaa	J. E. Martin	Dr		6	GI	do	do	Cy, H	D				
32-1E-21abb	H. A. Sykes	Du	25.2	40	R	do	do	Cy, W	S	1,203.8	13.29	6- 7-55	
32-1W-3ddd	L. Lieser	Du	29.1	48	R	do	do	Cy, W	S	1,255.6	26.40	6-21-55	
32-1W-15bba		B	23.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
32-1W-25bcc		B	42.0	4	N	Gravel	Illinoisan or Kansan terrace deposits	N	O	1,191.2	30.10	9-15-55	do
32-1W-26ddd		B	32.0	4	N	Sand and clay	Wisconsinan terrace deposits	N	N	1,166.3			do
32-1W-30bbb		B	14.0	4	N			N	O		Dry		do
32-1W-31bcc		B	14.0	4	N			N	O		Dry		do
32-1W-36bbc	M. Mercer	Dr	23.8	6	GI	Gravel	Wisconsinan terrace deposits	Cy, W	S	1,170.4	15.60	6- 9-55	
32-2W-1ddd	G. W. Failey	Du	32.3	36	R	Shale	Ninnescah Shale	Cy, W	S	1,240	25.95	4-24-57	
32-2W-8aaa		B	9.0	4	N			N	O	1,280.3	Dry		T. H. by U.S.G.S. and K.G.S.
32-2W-8bbb		B	9.0	4	N			N	O	1,269.0	Dry		do
*32-2W-20ddd	M. Gatewood	Dr	20.3	6	GI	Shale	Wellington Formation	Cy, W	S	1,253.6	10.10	5- 3-56	

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
32-2W-30baa	City of Wellington	Dr	.....	10	S	Sand and gravel	Illinoisan or Kansan terrace deposits	T, E	P	.....	.....	.....	Wellington well 14.
32-2W-30bab	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well 13.
32-2W-30cde	do	Dr	49.0	4	N	do	do	N	O	1,225.0	32.00	7- 6-48	T. H., City of Wellington.
32-2W-30cdd1	do	Dr	59.0	4	N	do	do	N	O	1,225.2	32.50	7- 3-48	do
32-2W-30cdd2	do	Dr	32.0	4	N	do	do	N	O	1,221.7	29.30	7- 6-48	do
32-2W-30cdd3	do	Dr	52.5	4	N	do	do	N	O	1,225.1	30.70	7- 7-48	do
32-2W-30dcc	do	Dr	29.0	4	N	do	do	N	O	1,208.2	14.50	7- 2-48	do
32-2W-30ddd	do	Dr	18.0	4	N	do	do	N	N	1,201.0	.....	.....	do
32-2W-31aab	do	Dr	14.0	4	N	Silt	do	N	N	1,204.5	.....	.....	do
32-2W-31ace	do	Dr	.....	10	S	Sand and gravel	do	T, E	P	.....	.....	.....	Wellington well A-5.
32-2W-31bde	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well A-4.
32-2W-31dbb	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well A-6.
32-2W-31dbc	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well A-7.
32-2W-31dbd1	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well A-8.
32-2W-31dbd2	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well A-9.
32-2W-31ded1	do	Dr	42.0	4	N	do	do	N	O	1,197.4	14.30	7- 2-48	T. H., City of Wellington.
32-2W-31ded2	do	Dr	.....	10	S	do	do	T, E	P	.....	.....	.....	Wellington well A-10.
*32-3W-11bbb	R. A. Busch	Dr	32	4	S	Shale	Ninnescah Shale	F	S	.....	.....	.....	
32-3W-12abb		B	10.0	4	N	.....	.....	N	O	1,273.7	Dry	.....	T. H. by U.S.G.S. and K.G.S.
32-3W-15ccb		Dr	50.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,219.0	19.20	6-24-48	T. H., City of Wellington.
32-3W-16bbb		Dr	26.0	4	N	do	do	N	O	1,233.4	14.00	6-28-48	do
32-3W-16bcb		Dr	52.5	4	N	do	do	N	O	1,235.1	24.80	6-26-48	do
32-3W-16bcc		Dr	48.0	4	N	do	do	N	O	1,231.3	23.60	6-25-48	do
32-3W-16ccb		Dr	53.0	4	N	do	do	N	O	1,228.4	23.20	6-25-48	do
32-3W-17aad		Dr	32.0	4	N	do	do	N	O	1,233.6	22.00	6-28-48	do
32-3W-17daa		Dr	59.0	4	N	do	do	N	N	1,231.0	.....	.....	do
32-3W-21aaa		Dr	33.0	4	N	do	do	N	O	1,214.5	2.70	6-30-48	do
32-3W-21bbb		Dr	40.5	4	N	do	do	N	N	1,224.4	.....	.....	do
32-3W-21bbc		Dr	20.0	4	N	do	do	N	O	1,218.4	12.70	6-25-48	do
32-3W-21ccb		Dr	9.0	4	N	do	do	N	O	1,206.7	.....	.....	do
32-3W-21dda		Dr	20.0	4	N	do	do	N	O	1,209.5	14.00	6-29-48	do

32-3W-21ddd		Dr	25 0	4	N	do	do	N	O	1,207 7	14 40	6-29-48	do
32-3W-22aad		Dr	38 0	4	N	do	do	N	O	1,205 0	17 10	6-30-48	do
32-3W-22add		Dr	25 5	4	N	do	do	N	O	1,216 0	20 10	6-30-48	do
32-3W-22bbe		Dr	10 0	4	N			N	O	1,219 1	Dry		do
32-3W-22bee		Dr	24 0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,211 5	11 00	6-29-48	do
32-3W-22ebe1		Dr	29 0	4	N	do	do	N	O	1,210 8	12 30	6-29-48	do
32-3W-22ebe2		Dr	34 0	4	N	do	do	N	O	1,211 8	14 20	6-29-48	do
32-3W-23cab	City of Wellington	Dr		10	S	do	do	T, E	P				
32-3W-23dbb	do	Dr		10	S	do	do	T, E	P				
32-3W-23dcb	do	Dr		10	S	do	do	T, E	P				
32-3W-25ecb1	do	Dr		10	S	do	do	T, E	P				Wellington city well.
*32-3W-25ecb2	do	Dr	69 8	10	S	do	do	T, E	P	1,213 3			Wellington well 6.
32-3W-25ece		Dr	66 0	4	N	do	do	N	O	1,220 0	45 00	6-24-48	T. H., City of Wellington.
32-3W-25ecd1	City of Wellington	Dr		10	S	do	do	T, E	P				Wellington well 7.
32-3W-25ecd2	do	Dr		10	S	do	do	T, E	P				Wellington well 8.
32-3W-25edc	do	Dr		10	S	do	do	T, E	P				Wellington city well.
32-3W-25ddc	do	Dr		10	S	do	do	T, E	P				do
32-3W-26aae1	do	Dr	49 5	10	S	do	do	T, E	P	1,210 2	40 00	6-29-55	Wellington well 5.
32-3W-26aae2	do	Dr	63 3	10	S	do	do	T, E	P	1,210 6	38 70	6-29-55	Wellington well 4.
32-3W-26aba	do	Dr		10	S	do	do	T, E	P				Wellington well 3.
32-3W-26abb1	do	Dr	52 6	10	S	do	do	T, E	P	1,215 5	44 20	2-69-55	Wellington well 2.
32-3W-26abb2	do	Dr		10	S	do	do	T, E	P				Wellington well 1.
32-3W-26ecd		Dr	19 0	4	N	do	do	N	O	1,203 0	12 80	7-13-48	T. H., City of Wellington.
32-3W-26daa	City of Wellington	Dr	55 00	8	S	do	do	T, E	P	1,215 0	43 60	6-29-55	Wellington city well.
32-3W-26dac	do	Dr		10	S	do	do	N	N				To be Wellington city well.
32-3W-26dad	do	Dr		10	S	do	do	T, E	P				Wellington city well.
32-3W-27bbb		Dr	24 0	4	N	do	do	N	O	1,205 2	15 00	7-14-48	T. H., City of Wellington.
32-3W-27bbe		Dr	25 0	4	N	do	do	N	O	1,202 2	17 00	7-14-48	do
32-3W-27dde1		Dr	51 0	4	N	do	do	N	O	1,196 0	26 70	7-13-48	do
32-3W-27dde2		Dr	43 0	4	N	do	do	N	O	1,194 4	25 40	7-14-48	do
32-3W-29aaa		Dr	46 0	4	N	do	do	N	O	1,204 0	21 00	6-24-48	do
32-3W-29aad		Dr	32 0	4	N	do	do	N	O	1,193 8	12 00	6-24 48	do
32-3W-29add		Dr	10 5	4	N	do	do	N	O	1,185 1	6 10	6 24-48	do
32-3W-29beb		Dr	38 0	4	N	do	do	N	O	1,183 1	12 20	6 26-48	do
32-3W-29ebe		Dr	48 0	4	N	do	do	N	O	1,192 6	26 80	6-26 48	do
32-3W-29ecb		Dr	25 0	4	N	do	Wisconsinan terrace deposits	N	O	1,171 8	6 00	6-26 48	do
32-3W-34aad		Dr	39 5	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,190 7	20 60	7-11-48	do
32-3W-34ada		Dr	37 0	4	N	do	do	N	O	1,188 2	20	7-14-48	do
32-3W-36bab1	City of Wellington	Dr		10	S	do	do	T, E	P				Wellington city well.
32-3W-36bab2	do	Dr		10	S	do	do	T, E	P				do
32-3W-36bba1	do	Dr		10	S	do	do	T, E	P				Wellington well 9.
32-3W-36bba2	do	Dr		10	S	do	do	T, E	P				Wellington city well.
32-3W-36bbb	do	Dr		10	S	do	do	T, E	P				Wellington well 10.
32-3W-36ecd		Dr	39 0	4	N	do	do	N	O	1,210 6	30 20	7- 7-48	T. H., City of Wellington.
32-3W-36ede		Dr	42 0	4	N	do	do	N	O	1,211 3	30 70	7- 9-48	do
32-3W-36edd		Dr	44 5	4	N	do	do	N	O	1,212 0	31 00	7- 9-48	do

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
32-4W-4abb		B	20.0	4	N			N	O	1,298.6	Dry		T. H. by U.S.G.S. and K.G.S.
32-4W-5aaa		B	62.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,286.9	16.20	8-15-55	do
*32-4W-5abb	J. A. Mystrom	Dr	27.7	6	GI	do	do	Cy, G	S		13.10	9-15-56	
32-4W-5bbb	O. R. McClellan	Dr	23.6	6	GI		do	Cy, H	S	1,291.7	19.50	7-28-55	Abandoned.
32-4W-6add		B	25.0	4	N	Sand	do	N	O	1,282.3	12.90	8-15-55	T. H. by U.S.G.S. and K.G.S.
32-4W-7ddd		B	24.0	4	N	do	do	N	O	1,260.1	13.80	8-13-55	do
32-4W-8bbb		B	40.0	4	N	do	do	N	O	1,267.5	11.60	8-15-55	do
32-4W-8bcc		B	9.0	4	N			N	O	1,262.7	Dry		do
32-4W-9ccc1	City of Argonia	Dr	63.8	10	S	Shale	Ninnescah Shale	T, E	P	1,258.1	20.30	9-15-53	North well in brick building.
32-4W-9ccc2	do	Dr	63.9	10	S	do	do	T, E	P	1,258.1	20.40	9-15-53	South well in brick building.
32-4W-9ccc3	do	Dr	65	12	S	do	do	T, E	P	1,261.0			Well is northeast of building.
*32-4W-9ccc4	do	Dr	74.5	12	S	do	do	T, E	P	1,261.6	29.60	5-15-55	Well is south of building. See log.
32-4W-11bdb	H. Segenbartt	Dr	65.7	6	GI	do	do	Cy, W	S	1,270.2	22.35	5-3-56	
32-4W-17bcc		B	48.0	4	N	Sand	Wisconsinan terrace deposits	N	O	1,244.7	12.20	8-13-55	T. H. by U.S.G.S. and K.G.S.
32-4W-17ccc		B	18.0	4	N			N	O	1,246.6	Dry		do
32-4W-18dda		B	40.0	4	N	Sand	Wisconsinan terrace deposits	N	O	1,243.8	11.80	8-13-55	do
*32-4W-20add	Ralph Taton	Dr	20	6	GI	do	Alluvium	J, E	D, S		12		
*32-4W-20ddd	Wayne Birkholz	Dr	37.4	6	GI	do	Wisconsinan terrace deposits	Cy, W	D, S		8.00	8-15-56	
32-4W-21bbb		B	15.0	4	N	do	Illinoisan or Kansan terrace deposits	N	N	1,242.0			T. H. by U.S.G.S. and K.G.S.
32-4W-28bbb		B	56.0	4	N	do	Wisconsinan terrace deposits	N	O	1,238.4	23.10	8-18-55	do
32-4W-28cbb		B	47.0	4	N	do	do	N	O	1,231.4	15.20	8-18-55	do
*33-2E-1cbb	A. W. Broadhurst	Dr	87.2	6	S	do	Illinoisan or Kansan terrace deposits	Cy, W	D, S	1,184			
33-2E-2bac	David Paton	Dr	58	6	GI	Shale	Wellington Formation	Cy, W	S				
*33-2E-6bba	do	Dr	44	8	GI	Gravel	Illinoisan or Kansan terrace deposits	T, G	I		35		Yields less than 100 gpm.
33-2E-6bbc	do	Dr	48.0	8	GI	do	do	N	I		31.95	8-16-56	Abandoned irrigation well.
33-2E-6cbb		B	45.0	4	N	Sand	do	N	N				T. H. by U.S.G.S. and K.G.S.
33-2E-10aaa		B	25.0	4	N			N	O	1,145.3	Dry		do

33-2E-11ddd	School district	Dr	42.6	6	GI	Sand and gravel	Illinoian or Kansan terrace deposits	Cy, H	D	1,146.0	20.70	5- 4-55	
33-2E-14ccc		B	57.0	4	N	do	do	N	O	1,134.8	23.50	9-13-55	T. H. by U.S.G.S. and K.G.S.
33-2E-22ccc		Dr	20.0	4	N			N	O	1,114.7	Dry		do
*33-2E-23cdd		Dr	30.0	4	N	Sand and gravel	Wisconsinan terrace deposits	N	O	1,108.8	3.75	5-10-44	do
33-2E-23ddd		Dr	14.0	4	N	do	Illinoisan or Kansan terrace deposits	N	O	1,127.3	9.50	5- 9-44	do
33-2E-25abb		Dr	17.0	4	N	do	do	N	O	1,124.5	12.65	5- 9-44	do
*33-2E-25bbb	R. L. Ward	Du	15.6	48	C	Sand	do	Cy, H	D, S		8.86	8-18-43	
33-2E-26aab		B	25.0	4	N			N	O	1,144.7	Dry		T. H. by U.S.G.S. and K.G.S.
33-2E-26bba		B	52.0	4	N	Clay	Wisconsinan terrace deposits	N	O	1,110.4	4.00	9-13-55	do
*33-2E-26bdd	L. and M. Ward	Dr	12.5	6	GI	Sand	do	Cy, W	S	1,112.2	3.85	5- 2-56	
*33-2E-27cad	Fred Barnes	Dr	39	6	GI	Shale	Wellington Formation	Cy, W	S				
*33-2E-27cdc	Faye McCarty	Dr	66	6	GI	do	do	Cy, H	S				Stock will not drink water from this well.
33-1E-10aba	F. M. Borders	Du	21.2	48	R	do	do	Cy, H	S	1,202.5	14.18	6- 7-55	
33-1E-12add		B	16.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-1E-17bbb	W. K. Rusk	Du	24.7	48	R	Shale	Wellington Formation	Cy, W	S		18.20	8-10-56	
33-1W-2dcc		B	14.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-1W-3bcb	A. M. Black	Du	36.7	48	R	Shale	Wellington Formation	Cy, W	S	1,253.8	28.90	6-21-55	
33-1W-3ccc		B	14.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-1W-5dcc		B	20.0	4	N			N	O		Dry		do
33-1W-13bba	J. C. Engle	Du	28.5	36	R	Shale	Wellington Formation	N	S	1,221.7	23.40	6- 9-55	Abandoned.
33-1W-13bcc		B	15.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-1W-15ccc	School district	Dr	34.1	6	GI	Shale	Wellington Formation	Cy, H	D	1,222.6	26.85	6-21-55	
33-1W-19ccc		B	20.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-1W-25bbc	Bertha Vaidois	Du	38.9	48	R	Shale	Wellington Formation	Cy, W	S	1,225.2	29.70	6- 9-55	
33-1W-26aaa		B	13.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-1W-27ddd	Gail Hamilton	Du	32.5	48	R	Shale	Wellington Formation	J, E	D, S	1,210	26.56	8-17-56	
33-1W-33ddd	School district	Dr	49.1	6	GI	do	do	Cy, H	D	1,184.4	28.10	6-21-55	
33-2W-25bb		B	20.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-2W-4ccc	A. P. Williamson	Du	48.0	18	R	Shale	Wellington Formation	Cy, W	S	1,216.8	41.60	6-25-55	
33-2W-5bbb		Dr	38.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,211.3	28.00	7- 2-48	T. H., City of Wellington.
33-2W-6aaa		Dr	58.0	4	N	do	do	N	O	1,212.2	28.20	7- 2-48	do
33-2W-6aab1	City of Wellington	Dr		10	S	do	do	T, E	P				Wellington well A-12.
33-2W-6aab2		Dr	50.5	4	N	do	do	N	O	1,194.7	11.20	7- 2-48	T. H., City of Wellington.
33-2W-6aac	City of Wellington	Dr		10	S	do	do	T, E	P				Wellington well A-13.
33-2W-6aba	do	Dr		10	S	do	do	T, E	P	1,191.9	19.80	6-27-55	Wellington well A-11.
33-2W-6adb	do	Dr		10	S	do	do	T, E	P	1,200.3	24.7	6-27-55	Wellington well A-14.
33-2W-6add	do	Dr	52	10	S	do	do	T, E	P	1,205.3	30.30	6-27-55	Wellington well A-15.
33-2W-6baa		Dr	27.0	4	N			N	O	1,217.1	Dry		T. H., City of Wellington.
33-2W-6bba		Dr	24.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,215.7	21.50	7- 1-48	do
33-2W-6ddd1		Dr	34.0	4	N	do	do	N	O	1,180.9	8.40	7-13-48	do

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Continued*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
33-2W-6ddd2		Dr	57.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,198.1	26.20	7- 9-48	T. H., City of Wellington
33-2W-8aab		Dr	26.0	4	N	do	do	N	O	1,196.7	14.90	7-13-48	do
33-2W-8abb		Dr	41.0	4	N	do	do	N	O	1,209.3	29.00	7-12-48	do
33-2W-8bab		Dr	40.0	4	N	do	do	N	O	1,211.4	21.70	7-12-48	do
33-2W-8bba		Dr	54.0	4	N	do	do	N	O	1,202.7	24.60	7- 9-48	do
33-2W-8bbb1		Dr	67.0	4	N	do	do	N	O	1,205.3	32.80	7-13-48	do
33-2W-8bb2		Dr	64.0	4	N	do	do	N	O	1,202.4	30.70	7- 9-48	do
33-2W-9abb		B	24.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
33-2W-12aaa		B	35.0	4	N			N	O		Dry		do
33-2W-13add		B	34.0	4	N			N	O		Dry		do
*33-2W-14ccd	George Duncan	Dn	30.0	1¼	S	Sand	Illinoisan or Kansan terrace deposits	Cy, H	D		20		
33-2W-24bcb	C. H. Wagner	Du	31.2	48	R	do	do	Cy, W	S	1,201.8	28.97	6-24-55	
33-2W-24cbc	G. L. Whaley	Du	25.8	48	R	do	do	Cy, W	S		21.05	8-13-56	
33-2W-29aaa		B	20.0	4	N			N	O	1,174.2	Dry		T. H. by U.S.G.S. and K.G.S.
33-2W-33aba	J. N. Akers	Du	24.2	48	R	Shale	Wellington Formation	Cy, W	S	1,178.2	17.20	6-25-55	
33-2W-33bbb		B	23.0	4	N			N	O	1,163.6	Dry		T. H. by U.S.G.S. and K.G.S.
33-3W-1aaa		Dr	19.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,213.3	16.70	7- 1-48	T. H., City of Wellington.
33-3W-1aba		Dr	30.5	4	N	do	do	N	N	1,207.8			do
33-3W-1abb		Dr	46.0	4	N	do	do	N	O	1,210.6	31.00	7- 1-48	do
33-3W-2bba		Dr	46.0	4	N	do	do	N	O	1,191.5	20.00	7-14-48	do
33-3W-4cbc	Eva Youngmeyer	Du	35.6	48	R	Shale	Wellington Formation	Cy, W	S		32.62	7-23-56	
33-3W-10aaa1		Dr	28.0	4	N	Sand and gravel	Alluvium	N	O	1,152.1	5.00	7-14-48	T. H., City of Wellington.
33-3W-10aaa2		Dr	46.0	8	GI	do	Wisconsinan terrace deposits	N	S	1,166.8	Dry	7-23-56	This well was salty before going dry.
33-3W-10aba		Dr	28.0	4	N	do	Alluvium	N	O	1,151.7	3.00	7-14-48	T. H., City of Wellington.
33-3W-10cdd	M. Wolff	Dr	47	6	GI	Gravel	Wisconsinan terrace deposits	J, E	D, S	1,159.5			
33-3W-10ded		B	52.0	4	N	Sand and clay	do	N	O	1,162.6	18.80	8-19-55	T. H. by U.S.G.S. and K.G.S.
*33-3W-11bab	Phillip Woodbridge	Dr	60	6	S	Shale	Wellington Formation	Cy, W	S				
33-3W-12add		B	14.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.

*33-3W-14cbb	Harold Roberts	Dr	51	6	S	Shale	Wellington Formation	J, E	D	1,157.2	20		
*33-3W-15add	Fred Roberts	Dr	60	6	S	do	do	N	D, S		20		Pump not installed.
33-3W-15bbb		B	44.0	4	N	Silt	Wisconsinan terrace deposits	N	N	1,164.8			T. H. by U.S.G.S. and K.G.S.
*33-3W-18baa	Agnes Newcomer	Du	52.7	36	R	Shale	Ninnescah Shale	Cy, W	S	1,238.1	42.50	5- 3-56	
33-3W-24aaa		B	14.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
*33-4W-3aaa		Dr	241.0	4	N	Shale	Ninnescah Shale	N	O	1,213	12.00	8-15-56	Seismograph shot hole. No log given.
33-4W-17aaa		B	14.0	4	N			N	O		Dry	8-18-55	T. H. by U.S.G.S. and K.G.S.
33-4W-17bcc	F. W. Krumery	Du	22.8	48	R	Shale	Ninnescah Shale	Cy, W	S		17.50	7-23-56	
34-2E-2aaa		Dr	40.0	4	N	Sand	Illinoisan or Kansan terrace deposits	N	O	1,157.0	14.88	5- 9-44	T. H. by U.S.G.S. and K.G.S.
*34-2E-2baa	E. B. Shawver	Dr	50	6	GI	Shale	Wellington Formation	Cy, W	S				
34-2E-13add		Dr	19.0	4	N			N	O	1,105.6	Dry		T. H. by U.S.G.S. and K.G.S.
*34-2E-17ccc	C. I. Jones	Dr	43.8	6	GI	Shale	Wellington Formation	Cy, W	S	1,225	20.58	9-18-56	
34-2E-28ccc	G. Work	Du	44.0	48	R	do	do	Cy, H	S	1,196.1	34.45	5- 6-55	
34-1E-23bab	W. W. Wolf	Du	26.9	48	R	do	do	Ce, G	S	1,187	21.90	8-16-56	
*34-1E-32bdd	H. W. Strickland	Dr	33.3	6	GI	do	do	Cy, W	S	1,124.9	14.90	5- 2-56	
34-1W-13bbb		B	15.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
*34-1W-25ddb	E. F. Kufus	Sp				Sand	Illinoisan or Kansan terrace deposits						
34-1W-25ddc	do	Dr	59.4	8	GI	Sand and gravel	do	T, G	Ind	1,103.0	10.14	6- 9-55	Water was used in construction of turnpike.
*34-1W-26aaa	City of South Haven	Dr	60	10	S	do	do	T, E	P	1,122.7	28		
34-1W-28cdc		B	18.0	4	N	Clay	Wisconsinan terrace deposits	N	O	1,098.3	6.80	8-26-55	T. H. by U.S.G.S. and K.G.S.
34-1W-29ccc		B	8.0	4	N			N	O		Dry		do
34-1W-33aaa		B	21.0	4	N			N	O	1,116.0	Dry		do
34-1W-33aba		B	23.0	4	N			N	O	1,094.2	Dry		do
34-1W-33ccc		B	9.0	4	N			N	O	1,137.4	Dry		do
34-1W-35bab1	City of South Haven	Dr	81.6	6	GI	Gravel	Illinoisan or Kansan terrace deposits	N	O	1,116.7	15.90	8-11-55	Test well 10 feet south of road, near old city well, no log given.
34-1W-35bab2	do	Dr	81.2	6	GI	do	do	N	O	1,112.5	12.03	8-11-55	Test well 200 feet south of road, near old city well, no log given.
*34-1W-35bab3	do	Du	15.8	240	B	do	do	T, E	P	1,111.2	10.50	8-11-55	Old city well.
34-2W-1bba	L. C. Lentz	Dr	47.3	6	GI	Shale	Wellington Formation	Cy, G	S	1,181	26.77	7-24-56	
*34-2W-4bba	Town of Corbin	Dn	28	1¼	S	Sand and gravel	Illinoisan or Kansan terrace deposits	Cy, H	D		23		
34-2W-4bcc		B	28.0	4	N	do	do	N	O	1,148.5	23		T. H. by U.S.G.S. and K.G.S.
34-2W-8ddd		B	26.0	4	N			N	O	1,129.1	Dry		do
34-2W-15ccb		B	27.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,115.2	14.30	8-26-55	do
34-2W-16aaa		B	23.0	4	N			N	O	1,130.7	Dry		do
34-2W-19aaa	M. A. King	Dr	33.7	6	GI	Gravel	Wisconsinan terrace deposits	Cy, W	S	1,124.2	22.05	6-27-55	

TABLE 11.—*Records of wells, test holes, and springs in Sumner County—Concluded*

Well number (1)	Owner or tenant	Type of well (2)	Depth of well, feet	Diameter of well, inches	Type of casing (3)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic source	Method of lift (4)	Use of water (5)	Height of land surface above mean sea level, feet	Depth to water level below land surface, feet	Date of measurement	REMARKS
*34-2W-21add	City of Caldwell	Dr	30			Sand and gravel	Alluvium	Ce, E	P	1,104.0			Battery of 7 wells of identical construction. Each yields about 50 gpm.
*34-2W-22bcc	do	Dr	30	10	S	do	do	T, E	P	1,102.8	22		5 wells of identical construction. Yield about 50 gpm each.
34-2W-25ded		B	18.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
34-2W-27bbb		B	29.0	4	N			N	O	1,090.2	Dry		do
34-2W-27cbb		B	42.0	4	N	Clay	Wisconsinan terrace deposits	N	O	1,106.0	17.20	8-26-55	do
34-2W-31ccc		B	16.0	4	N			N	O	1,151.3	Dry		do
34-2W-32cbb	A. G. Williams	Dr	28.6	6	GI	Sand	Illinoisan or Kansan terrace deposits	Cy, W	S	1,145.4	26.15	6-27-55	
34-2W-32ddd		B	51.0	4	N	Sand and gravel	do	N	O	1,127.8	16.90	8-23-55	T. H. by U.S.G.S. and K.G.S.
34-2W-33aaa		B	35.0	4	N			N	O	1,120.0	Dry		do
34-2W-34ccc		B	28.0	4	N	Gravel	Illinoisan or Kansan terrace deposits	N	O	1,118.2	20.30	8-23-55	do
34-2W-35ccc		B	27.0	4	N			N	O	1,116.7	Dry		do
34-3W-5cdc		Dr	51.6	6	GI	Shale	Ninnescah Shale	Cy, W	S	1,215	26.08	4-24-57	
34-3W-27bbb		B	30.0	4	N			N	O		Dry		T. H. by U.S.G.S. and K.G.S.
34-3W-28cbb	School district	Dr	45.6	6	GI	Shale	Ninnescah Shale	Cy, H	D	1,166	37.70	8-17-56	
*34-3W-31cdc	Alvin Jenista	Dr	45	6	S	Sand	Illinoisan or Kansan terrace deposits	J, E	D, S				
34-3W-31ddd		B	37.0	4	N			N	O	1,168.2	Dry		T. H. by U.S.G.S. and K.G.S.
*34-3W-35bac	Caldwell Cemetery	Dr	65	6	GI	Shale	Ninnescah Shale	J, E	D	1,173	30		Yields about 15 gpm.
34-4W-8bba	J. G. Nulik	Du	40.6	36	R	do	do	Cy, W	S	1,250	39.10	7-23-56	
*34-4W-18aaa	Fowler	Dr	63.3	6	GI	do	do	Cy, W	S	1,226.3	31.54	5- 3-56	
34-4W-23dcc	John Wencel	Du	64.8	36	R	do	do	Cy, W	S	1,236	41.80	4-24-57	
34-4W-33ccc		B	57.0	4	N	Sand	Wisconsinan terrace deposits	N	N	1,170.5			T. H. by U.S.G.S. and K.G.S.
34-4W-36dcc		B	52.0	4	N	Clay	Illinoisan or Kansan terrace deposits	N	O	1,191.2	30.10	8-22-55	do
*35-2E-1aaa	Wm. Buffington	Dr		8	S	Shale	Wellington Formation	Cy, W	S		81.75	8-10-56	
35-2E-2aaa		B	64.0	4	N	Sand	Illinoisan or Kansan terrace deposits	N	O	1,215.3	41.60	9-13-55	T. H. by U.S.G.S. and K.G.S

*35-2E-2bdd1	A. C. Lawson	Dr	84.8	12	S	Gravel	do	T, G	Ind		65.20	8-10-56	Well being pumped. Water is used at pipeline pumping station.
35-2E-2bdd2	do	Dr	50.2	12	S	do	do	N	Ind		45.20	8-10-56	Well is on standby basis.
35-2E-5dde		Du		48	R	Shale	Wellington Formation	Cy, G	S	1,140	19.60	4-25-57	
*35-1E-4aaa	Effie Logan	Dr	32.1	6	GI	do	do	Cy, W	S	1,135	14.00	8-16-56	
35-1E-6bcc		Du	18.4	36	R	do	do	Cy, H	S	1,101	12.00	4-25-57	
35-1W-2aaa		B	33.0	4	N			N	O	1,122.0	Dry		T. H. by U.S.G.S. and K.G.S.
35-1W-8ddd		B	23.0	4	N	Sand	Illinoisan or Kansan terrace deposits	N	O	1,099.1	21.60	8-25-55	do
*35-1W-15dbb	Town of Hunnewell	Du	34.6	36	R	Shale	Wellington Formation	Cy, H	D	1,103.3	28.75	5- 2-56	
35-1W-16ddd		B	31.0	4	N	Sand	Illinoisan or Kansan terrace deposits	N	O	1,095.8	23.40	8-25-55	T. H. by U.S.G.S. and K.G.S.
35-1W-17ccc		B	25.0	4	N	Sand and gravel	do	N	O	1,071.4	20		do
35-1W-18ccd		B	31.0	4	N	do	Alluvium	N	O	1,057.3	29.60	8-25-55	do
35-1W-18cdc		B	18.0	4	N	do	do	N	O	1,049.1	11.40	8-25-55	do
35-2W-2aab		B	28.0	4	N	Sand	Wisconsinan terrace deposits	N	N	1,089.7			do
*35-2W-8aaa	W. F. McDowell	Du	31.0	36	R	Shale	Ninnescah Shale	Cy, W	S	1,142	29.50	8-17-56	
35-2W-10bbb		B	29.0	4	N	Sand and gravel	Illinoisan or Kansan terrace deposits	N	O	1,119.2	24		T. H. by U.S.G.S. and K.G.S.
*35-2W-13dcc1	E. Brown	Du	26.4	48	R	Sand	Wisconsinan terrace deposits	Cy, W	S		25.80	9-19-56	
35-2W-13dcc2		B	44.0	4	N	Sand and gravel	do	N	O	1,087.7	27		T. H. by U.S.G.S. and K.G.S.
35-2W-13ddd		B	24.0	4	N			N	O	1,073.3	Dry		do
35-2W-15bbb		B	28.0	4	N			N	O	1,119.3	Dry		do
35-2W-15ccc		B	26.0	4	N			N	O	1,085.4	Dry		do
35-2W-15ddd		B	27.0	4	N			N	O	1,096.8	Dry		do
35-3W-2cbc		B	43.0	4	N	Silt and clay	Wisconsinan terrace deposits	N	O		16.50	8-22-55	do
35-3W-11bbb		B	22.0	4	N			N	O		Dry		do
*35-3W-11dca	Chas. Campbell	Dr	50	6	GI	Sand	Alluvium	Cy, W	D	1,105	27		
*35-3W-17aad	Albert Endrud	Dr	71	6	GI	Shale	Ninnescah Shale	J, E	D				
35-4W-2bbb		B	20.0	4	N			N	O	1,211.0	Dry		T. H. by U.S.G.S. and K.G.S.
*35-4W-9ccd	T. R. Hudson	Du	23.2	48	R	Shale	Ninnescah Shale	Cy, W	S	1,200	10.40	9-17-56	
35-4W-11bcc		B	43.0	4	N	Gravel	Wisconsinan terrace deposits	N	O	1,142.9	20		T. H. by U.S.G.S. and K.G.S.
35-4W-16ccc		B	20.0	4	N			N	O	1,201.6	Dry		do
35-4W-17bcc	C. A. Smock	Dr	59.2	6	GI	Shale	Ninnescah Shale	N	D, S	1,233.0	25.60	5- 3-55	Abandoned.

1. Well number: Well number gives the location of the well, as illustrated in Figure 2. Asterisk indicates that a chemical analysis of the water is given in Table 6.
2. B, bored; Dn, driven; Dr, drilled; Du, dug; GP, gravel pit; J, jetted; Sp, spring.
3. B, brick; C, concrete; CT, clay tile; GI, galvanized sheet iron; N, none; R, rock; S, steel.
4. Method of lift: C, centrifugal; Cy, cylinder; F, flowing; J, jet; N, none; T, turbine.
   Type of power: B, butane; E, electric; G, gasoline; H, hand; N, none; W, wind.
5. D, domestic; I, irrigation; Ind, industrial; N, none; O, observation; P, public supply; S, stock.

LOGS OF TEST HOLES AND WELLS

The logs of test holes and wells drilled in Sumner County are given on the pages that follow. Included are logs of 296 test holes of the State and Federal Geological Surveys, which were drilled with a hydraulic-rotary drill rig or bored with a power auger, and logs of 66 test holes and wells drilled by contractors. Logs of 4 test holes listed in Table 11 are not given. Unless otherwise stated in the log heading, the well or test hole was drilled by the State and Federal Geological Surveys. The sample logs are of wells from which cuttings were collected and studied in the laboratory. The drillers logs are of wells from which cuttings were examined only in the field, and the lithology determined at least in part by drilling characteristics.

30-2E-3abb.—Sample log of test hole in NW NW NE sec. 3, T. 30 S., R. 2 E., 0.5 mile west of NE corner; drilled May 24, 1944. Surface altitude, 1,300.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, silty, light yellow gray	3	3
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and dull gray green	2	5
Shale, blocky, yellow and gray green	5	10

30-2E-4aaa.—Sample log of test hole in NE NE NE sec. 4, T. 30 S., R. 2 E., about 70 feet south of road intersection; drilled May 24, 1944. Surface altitude 1,283.5 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, tan	2	2
Clay, silty, compact, yellowish and light gray green; contains some coarse to fine sand	7	9
Silt, yellow gray; contains much coarse to fine sand	2	11
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green, mottled yellow brown	9	20

30-2E-4bbb.—Sample log of test hole in NW NW NW sec. 4, T. 30 S., R. 2 E., about 100 feet south of NW corner; drilled May 22, 1944. Surface altitude, 1,235.2 feet; depth to water, 4.73 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, gray black	2	2
Silt, clayey, light gray to gray	7	9
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellowish and gray green	11	20

30-2E-4ddd.—Sample log of test hole in SE SE SE sec. 4, T. 30 S., R. 2 E., about 0.1 mile north of SE corner; drilled May 25, 1944. Surface altitude, 1,270.8 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, light brown; contains some coarse to fine sand	8	10
Illinoisan or Kansan terrace deposits		
Silt, clayey, light gray green and yellow; contains much fine gravel and sand	7	17
PERMIAN—Leonardian		
Wellington Formation		
Shale, blocky, yellow and gray green	3	20

30-2E-6aaa.—Sample log of test hole in NE NE NE sec. 6, T. 30 S., R. 2 E., half a block east of junction of Main Street and Kansas Highway 15 in Mulvane; drilled May 24, 1944. Surface altitude, 1,326.9 feet; depth to water, 7.19 feet.

	Thickness, feet	Depth, feet
Fill	8.5	8.5
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some medium to fine gravel	1.5	10
Gravel, course to fine, and sand	8	18
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray green	2	20

30-2E-6bcb.—Sample log of test hole in NW SW NW sec. 6, T. 30 S., R. 2 E., along old highway east of old river bridge; drilled May 23, 1944. Surface altitude, 1,224.3 feet; depth to water, 12.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, and silt, buff and gray	5	5
Silt, clayey, buff, gray and gray black; contains much fine sand	9.5	14.5
Gravel, coarse to fine, and sand	5.5	20
Gravel, medium to coarse; contains some silt and clay,	10	30
Gravel, coarse to fine	8	38
Silt, clayey, yellow brown to dark gray and gray blue; contains some coarse to fine sand	2	40
Silt, clayey, gray blue to dark gray; contains some coarse to fine sand	6	46
Gravel, fine, and sand	4.5	50.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, fairly soft, partly laminated, light blue gray and gray	9.5	60

30-2E-6bdd.—Sample log of test hole in SE SE NW sec. 6, T. 30 S., R. 2 E., along old highway about 0.25 mile west of railroad crossing; drilled May 23, 1944. Surface altitude, 1,221.2 feet; depth to water, 6.90 feet.

	Thickness, feet	Depth, feet
Road fill and soil, gray black	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, medium to fine, and silt, buff	6	8
Sand, coarse to fine, and fine to medium gravel	14.5	22.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, fairly hard, gray and gray green	5.5	28

30-2E-7ccc.—Drillers log of test hole in SW SW SW sec. 7, T. 30 S., R. 2 E., on north side of road 15 feet east of corner; bored September 7, 1955. Surface altitude, 1,211.0 feet; depth to water, 11.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, very fine	10	10
Sand, fine	5	15
Sand, fine to coarse	10	25
Sand, fine to coarse, and fine to medium gravel	27	52
PERMIAN—Leonardian		
Wellington Formation		
Shale	3	55

30-2E-9abb.—Sample log of test hole in NW NW NE sec. 9, T. 30 S., R. 2 E., about 0.5 mile east of NW corner; drilled May 25, 1944. Surface altitude, 1,284.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Soil, clayey, gray black	1.5	1.5
Silt, clayey, dark gray and gray brown; contains some sand	3.5	5
Clay, blocky, buff and light gray; contains some coarse to fine sand	12	17
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine, brown	3	20
Sand, coarse to fine; interbedded with some buff silt	10	30
Sand, coarse to fine; contains some medium to fine gravel	10	40
Gravel, fine to medium, and sand	2	42
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellow and gray green	5	47
Shale, dark blue gray	1	48

30-2E-9bcc.—Sample log of test hole in SW SW NW sec. 9, T. 30 S., R. 2 E., about 0.55 mile north of SW corner; drilled May 22, 1944. Surface altitude, 1,265.3 feet; depth to water, 42.00 feet.

	Thickness, feet	Depth, feet
Road fill	1.5	1.5
QUATERNARY—Pleistocene		
Colluvium		
Clay, silty, compact, gray to buff	9.5	11
Clay, silty, compact, light gray and light tan; contains some sand	17	28
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some fine gravel	7	35
Clay, silty, light buff and light gray	2	37
Gravel, fine to medium; contains some sand	3	40
Gravel, fine to coarse	10	50
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green; contains some limestone	5	55

30-2E-15bbb.—Drillers log of test hole in NW NW NW sec. 15, T. 30 S., R. 2 E., on south side of road 15 feet east of corner; bored September 8, 1955. Surface altitude, 1,268.1 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt and clay, red tan	5	10
Illinoisan or Kansan terrace deposits		
Clay, sandy to gravelly, buff	3	13
Clay, green; contains limestone gravel	10	23
Clay, sandy to gravelly, tan to buff	12	35
Clay, gravelly, yellow	1	36

30-2E-16bbb.—Drillers log of test hole in NW NW NW sec. 16, T. 30 S., R. 2 E., on south side of road 10 feet east of corner; bored September 8, 1955. Surface altitude, 1,273.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt, brown	5	10
Illinoisan or Kansan terrace deposits		
Clay, sandy, tan	20	30
Sand, fine to medium	3	33
Clay	2	35

30-2E-17bba.—Sample log of test hole in NE NW NW sec. 17, T. 30 S., R. 2 E., about 0.2 mile east of east end of river bridge; drilled May 20, 1944. Surface altitude, 1,213.4 feet; depth to water, 10.66 feet.

	Thickness, feet	Depth, feet
Road fill and soil, clayey, gray black	4	4
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, compact, gray	10	14
Wisconsinan terrace deposits		
Gravel, medium to coarse, and sand	6	20
Gravel, coarse to fine, and sand	20	40
Gravel, fine to medium, and sand	13	53
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and red brown	7	60

30-2E-19aba.—Sample log of test hole in NE NW NE sec. 19, T. 30 S., R. 2 E., about 0.7 mile east of NW corner; drilled May 20, 1944. Surface altitude, 1,208.1 feet; depth to water, 4.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, buff; contains much medium to fine sand	4	4
Gravel, medium to fine, and sand	9	13
Clay, silty, soft, gray; contains some coarse to fine sand,	5	18
Gravel, coarse to fine, and sand	12	30
Gravel, fine to coarse; contains some sand and clay	10	40
Gravel, fine to medium, and sand	10	50
Gravel, medium to fine, and sand; contains some coarse gravel	10	60
Shale, gray green	1	61
Gravel, medium to fine, and sand	8	69
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and blue gray	7	76

30-2E-19bcc.—Sample log of test hole in SW SW NW sec. 19, T. 30 S., R. 2 E., about 0.5 mile south of NW corner; drilled May 19, 1944. Surface altitude, 1,207.2 feet; depth to water, 2.40 feet.

	Thickness, feet	Depth, feet
Road fill and soil, dark gray	3	3
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, coarse to fine, and fine to coarse gravel	7	10
Sand, coarse to fine, and fine gravel	10	20
Gravel, medium to fine, and sand	10	30
Sand, coarse to fine, and fine gravel	10	40
Gravel, medium to fine, and sand	8	48
PERMIAN—Leonardian		
Wellington Formation		
Shale, soft, blue gray	7	55

30-2E-19ccb.—Drillers log of test hole in NW SW SW sec. 19, T. 30 S., R. 2 E., on east side of road about 0.2 mile north of corner, by 3 big cottonwood trees; bored June 14, 1956. Depth to water, 8.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine	5	5
Sand, fine to medium	20	25
Sand, medium to coarse	5	30
Sand and gravel	17	47
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	47.5

30-2E-26ccc.—Drillers log of test hole in SW SW SW sec. 26, T. 30 S., R. 2 E., on north side of road by cottonwood 300 feet east of corner; bored September 8, 1955. Surface altitude, 1,221.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, tan	7	12
Illinoisan or Kansan terrace deposits		
Sand, fine, tan to brown	3	15
Clay, sandy, tan	2	17
Sand, fine	3	20
Sand, fine to medium	10	30

30-2E-29aab.—Drillers log of test hole in NW NE NE sec. 29, T. 30 S., R. 2 E., 150 feet east and 50 feet south of hay barn on river bank south of ditch; bored June 18, 1956. Surface altitude, 1,203.1 feet; depth to water, 14.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	3	3
Sand, fine, tan	2	5
Sand, fine to medium	15	20
Sand, fine to coarse	20	40
Sand and gravel	23	63
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	63.5

30-2E-29aba2.—Drillers log of test hole in NE NW NE sec. 29, T. 30 S., R. 2 E., in alfalfa field 20 feet north, 10 feet east of irrigation well; bored June 14, 1956. Surface altitude, 1,202.5 feet; depth to water, 12.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt and sand, fine	5	5
Sand, fine	5	10
Sand, fine to coarse	20	30

	Thickness, feet	Depth, feet
Sand, fine to medium	15	45
Sand and gravel, fine to medium	23	68
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	69

30-2E-29add.—Drillers log of test hole in SE SE NE sec. 29, T. 30 S., R. 2 E., on west side of road 20 feet north of half-mile hedge; bored June 18, 1956. Surface altitude, 1,202.0 feet; depth to water, 17.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	10	10
Clay, brown	5	15
Sand, fine	10	25
Sand, fine to coarse	5	30
Sand and gravel	12	42
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	42.5

30-2E-29baa.—Drillers log of test hole in NE NE NW sec. 29, T. 30 S., R. 2 E., on south side of road under big elm tree, 0.1 mile south and 0.1 mile west of tank in field on north side of road; bored June 18, 1956. Surface altitude, 1,205.9 feet; depth to water, 14.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	2	2
Sand, very fine, gray	3	5
Silt, brown	5	10
Sand, fine, tan	5	15
Sand, fine to medium	5	20
Sand and gravel	50	70

30-2E-29bbb.—Drillers log of test hole in NW NW NW sec. 29, T. 30 S., R. 2 E., east side of road 100 feet south of corner; bored June 14, 1956. Surface altitude, 1,206.0 feet; depth to water, 12.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, black	2	2
Sand, fine	3	5
Sand, fine to medium	35	40
Sand and gravel	9	49
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	49.5

30-2E-29ccc.—Drillers log of test hole in SW SW SW sec. 29, T. 30 S., R. 2 E., on east side of road 40 feet north of corner; bored September 7, 1955. Surface altitude, 1,196.4 feet; depth to water, 8.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand and silt, tan	5	5
Sand, fine, clayey	10	15
Sand, fine to coarse, and fine gravel	33	48
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	50

30-2E-29ddd.—Drillers log of test hole in SE SE SE sec. 29, T. 30 S., R. 2 E., on north side of road 100 feet west of corner; bored September 7, 1955. Surface altitude, 1,197.0 feet; depth to water, 12.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, tan	7	7
Sand and silt, gray to black	3	10
Sand, fine, buff	3	13
Sand, fine to coarse, and fine gravel	22	35
Sand, medium to coarse, and fine to medium gravel	24	59
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	60

30-2E-30ccc.—Drillers log of test hole in SW SW SW sec. 30, T. 30 S., R. 2 E., on north side of road 20 feet east of corner; bored September 7, 1955. Surface altitude, 1,204.0 feet; depth to water, 10.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, brown	5	5
Sand, very fine, silty	5	10
Sand, fine to medium	6	16
Sand, fine to coarse	9	25
Sand, medium to coarse, and fine gravel	11	36
PERMIAN—Leonardian		
Wellington Formation		
Shale, red brown	1	37

30-2E-33aaa.—Drillers log of test hole in NE NE NE sec. 33, T. 30 S., R. 2 E., on south side of road near corner; bored September 7, 1955. Surface altitude, 1,190.2 feet; depth to water, 9.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, black	3	3
Sand, very fine	2	5
Sand, fine	5	10

	Thickness, feet	Depth, feet
Sand, fine to coarse	10	20
Sand, fine to coarse, and fine gravel	10	30
Clay, green	5	35
Sand, fine to coarse, and fine gravel	15	50
PERMIAN—Leonardian		
Wellington Formation		
Shale	3	53

30-2E-34aad.—Drillers log of test hole in SE NE NE sec. 34, T. 30 S., R. 2 E., in SE corner of alfalfa field; bored September 14, 1955. Surface altitude, 1,214.5 feet.

QUATERNARY—Pleistocene Illinoisan or Kansan terrace deposits	Thickness, feet	Depth, feet
Silt, black	4	4
Sand, fine to coarse, and gravel	24	28
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	30

30-2E-34baa.—Drillers log of test hole in NE NE NW sec. 34, T. 30 S., R. 2 E., south side of road 75 feet west of drive to west house; bored September 8, 1955. Surface altitude, 1,205.9 feet; depth to water, 18.30 feet.

QUATERNARY—Pleistocene Colluvium	Thickness, feet	Depth, feet
Silt, tan	5	5
Clay, sandy, tan	5	10
Clay, sandy, red tan	5	15
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse	10	25
Sand, fine to coarse, and fine gravel	15	40
Clay, greenish gray	5	45
PERMIAN—Leonardian		
Wellington Formation		
Shale, weathered, greenish gray	10	55
Shale, gray	2	57

30-1E-1aac.—Sample log of test hole in SW NE NE sec. 1, T. 30 S., R. 1 E.; drilled June 8, 1944. Surface altitude, 1,218.1 feet; depth to water, 3.20 feet.

QUATERNARY—Pleistocene	Thickness, feet	Depth, feet
Silt, buff; contains much medium to fine sand	5	5
Sand, coarse to fine; contains much medium to fine gravel	5	10
Gravel, medium to fine, and sand	24	34
Silt, clayey, brown black to gray	6	40
Gravel, medium to fine, and sand	8	48
PERMIAN—Leonardian		
Wellington Formation		
Shale, light and dark gray	2	50

30-1E-1abb.—Drillers log of test hole in NW NW NE sec. 1, T. 30 S., R. 1 E., in south borrow pit in line with hedge row to south, 20 feet east of culvert into field; bored July 3, 1956. Surface altitude, 1,222.8 feet; depth to water, 10.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	5	5
Sand, medium to coarse	5	10
Sand and gravel	40	50
Sand, very coarse	3	53
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	54

30-1E-1acd.—Drillers log of test hole in SE SW NE sec. 1, T. 30 S., R. 1 E., at curve in old highway 30 feet south of blacktop by pole east of lane to gravel pit; bored July 4, 1956. Surface altitude, 1,218.6 feet; depth to water, 7.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, black	5	5
Sand, fine	5	10
Sand, fine to coarse	10	20
Sand and gravel	38	58
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	1	59

30-1E-1bbb.—Sample log of test hole in NW NW NW sec. 1, T. 30 S., R. 1 E.; drilled June 7, 1944. Surface altitude, 1,225.7 feet; depth to water, 5.77 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, dark gray; contains much fine sand	3	3
Sand, medium to fine, and gravel	7	10
Gravel, coarse to fine, and sand	46	56
PERMIAN—Leonardian		
Wellington Formation		
Shale, partly laminated, light and dark gray	4	60

30-1E-2aab2.—Drillers log of test hole in NW NE NE sec. 2, T. 30 S., R. 1 E.; observation well 55 feet south of irrigation well; bored July 4, 1956. Surface altitude, 1,222.5 feet; depth to water, 9.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Clay, brown, sandy	5	10
Sand, fine	5	15
Sand, fine to coarse	5	20
Sand and gravel	30	50

30-1E-2abb.—Sample log of test hole in NW NW NE sec. 2, T. 30 S., R. 1 E., about 0.5 mile west of NE corner; drilled June 9, 1944. Surface altitude, 1,226.8 feet; depth to water, 5.68 feet.

	Thickness, feet	Depth, feet
Road fill and gravel	1	1
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, yellow gray; contains much coarse to fine sand	6	7
Gravel, fine to coarse; contains some silty blue-gray and buff clay	13	20
Gravel, fine, and sand	34	54
PERMIAN—Leonardian		
Wellington Formation		
Shale, soft, interbedded green gray, blue gray, and dull pink; contains much gypsum, coarsely crystalline, at 57 to 58 feet	6	60

30-1E-3aaa.—Drillers log of test hole in NE NE NE sec. 3, T. 30 S., R. 1 E., in south borrow pit 20 feet west of corner; bored July 4, 1956. Surface altitude, 1,226.4 feet; depth to water, 10.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	5	5
Sand, fine to medium	5	10
Sand, medium to coarse	10	20
Sand, medium	5	25
Sand, fine to medium	5	30
Sand and gravel	20	50
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	50.5

30-1E-3abb.—Sample log of test hole in NW NW NE sec. 3, T. 30 S., R. 1 E., about 0.5 mile west of NE corner; drilled June 9, 1944. Surface altitude, 1,228.7 feet; depth to water, 4.45 feet.

	Thickness, feet	Depth, feet
Road fill and gravel	1	1
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, soft, gray and yellow gray; contains some coarse to fine sand	5	6
Sand, coarse to fine; contains much medium to fine gravel	4	10
Gravel, fine to medium, sand, and silt	10	20
Gravel, fine to coarse, and sand	10	30
Gravel, fine, and sand	7	37
PERMIAN—Leonardian		
Wellington Formation		
Shale, light blue gray and gray green	3	40

30-1E-3bbb.—Drillers log of test hole in NW NW NW sec. 3, T. 30 S., R. 1 E., east side of road 100 feet south of highway; bored July 5, 1956. Surface altitude, 1,228.5 feet; depth to water, 8.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Sand, fine to medium	5	10
Sand, medium to coarse	10	20
Sand and gravel	2	22
PERMIAN—Leonardian		
Wellington Formation		
Shale, weathered, gray	1	23

30-1E-4aab.—Sample log of test hole in NW NE NE sec. 4, T. 30 S., R. 1 E., about 0.25 mile west of NE corner; drilled June 9, 1944. Surface altitude, 1,231.7 feet; depth to water, 3.35 feet.

	Thickness, feet	Depth, feet
Road fill and gravel	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, dark gray	3	5
Silt, yellow gray and gray; contains much fine sand	2	7
Sand, medium to fine; contains some fine gravel	5	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, brown to gray green	2	14

30-1E-4bab.—Sample log of test hole in NW NE NW sec. 4, T. 30 S., R. 1 E., about 0.3 mile east of NW corner; drilled June 9, 1944. Surface altitude, 1,251.6 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, light brown; contains some medium to fine sand,	6	6
Clay, silty, light gray	1	7
Sand, coarse to fine; contains some medium to fine gravel	3	10
Sand, coarse to fine; contains medium to fine gravel and light-gray clay	10	20
Gravel, coarse to fine, and sand	8	28
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray green	2	30

30-1E-6aaa.—Sample log of test hole in NE NE NE sec. 6, T. 30 S., R. 1 E., about 70 feet west of corner; drilled June 7, 1944. Surface altitude, 1,260.8 feet; depth to water, 25.26 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Soil and silt, gray	4	4
Silt, tan; contains some sand	6	10

	Thickness, feet	Depth, feet
Sand, coarse to fine; contains much tan and yellow-gray silt and clay and some medium to fine gravel,	20	30
Gravel, fine to coarse, and sand	10	40
Gravel, coarse to fine, and sand; contains some yellow clay	7.5	47.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, blue gray	0.5	48

30-1E-6bbb.—Sample log of test hole in NW NW NW sec. 6, T. 30 S., R. 1 E., about 100 feet east of NW corner; drilled June 7, 1944. Surface altitude, 1,251.9 feet; depth to water, 12.30 feet.

QUATERNARY—Pleistocene Illinoisan or Kansan terrace deposits	Thickness, feet	Depth, feet
Sand, medium to fine, and yellow-gray silt	2	2
Sand, medium to fine	3	5
Silt, clayey, yellow buff to light gray; contains some medium to fine gravel	2	7
Sand, medium to fine	2	9
Clay, silty, light gray	1	10
Sand, medium to coarse; contains some fine gravel and buff and light-gray clay	10	20
Gravel, fine to medium	10	30
Sand, coarse to fine; contains some medium to fine gravel	10	40
Gravel and medium to coarse sand	26	66
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellow gray to gray green and blue gray	4	70

30-1E-7bbb.—Drillers log of test hole in NW NW NW sec. 7, T. 30 S., R. 1 E., on south side of road 30 feet east of corner; bored September 2, 1955. Surface altitude, 1,247.0 feet; depth to water, 14.00 feet.

QUATERNARY—Pleistocene Illinoisan or Kansan terrace deposits	Thickness, feet	Depth, feet
Clay, very sandy, red	5	5
Sand, fine	2	7
Clay, sandy, tan	5	12
Sand, fine	8	20
Sand, fine to coarse	20	40
Sand, fine to coarse, and fine gravel	20	60
Sand, medium to coarse, and fine to medium gravel	8	68
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	69

30-1E-7ddd.—Drillers log of test hole in SE SE SE sec. 7, T. 30 S., R. 1 E., in west road ditch 15 feet north of corner; bored September 2, 1955. Surface altitude, 1,259.0 feet; depth to water, 26.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Clay, red brown	5	5
Clay, sandy, red brown	5	10
Clay, sandy, tan	10	20
Sand, fine	25	45
Sand, fine to coarse, and fine gravel	20	65
Gravel, medium to coarse	5	70
Gravel, medium to coarse, arkosic	8	78
PERMIAN—Leonardian		
Wellington Formation		
Shale, green gray	6	84

30-1E-9add.—Drillers log of test hole in SE SE NE sec. 9, T. 30 S., R. 1 E., in driveway to schoolhouse; bored July 5, 1956. Surface altitude, 1,244.0 feet; depth to water, 18.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, black	5	5
Silt, sandy, red brown	2	7
Sand, fine	8	15
Sand, fine to coarse	5	20
Sand and gravel, arkosic	12	32
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	1	33

30-1E-11aaa.—Drillers log of test hole in NE NE NE sec. 11, T. 30 S., R. 1 E., on south side of road 20 feet west of corner; bored July 3, 1956. Surface altitude, 1,222.5 feet; depth to water, 11.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	7	7
Sand, fine	8	15
Sand, medium to coarse	37	52
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	53

30-1E-13ddc2.—Drillers log of test hole in SW SE SE sec. 13, T. 30 S., R. 1 E.; bored June 14, 1956. West observation well for aquifer test using Francis Shoup irrigation well, near shelter belt. Surface altitude, 1,210.2 feet; depth to water, 10.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, silty	5	5
Sand, fine	5	10
Sand and fine gravel	15	25
Sand and gravel, fine to coarse	24	49
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	49.5

30-1E-14aaa.—Drillers log of test hole in NE NE NE sec. 14, T. 30 S., R. 1 E., on south side of road at curve where road goes northwest; bored July 3, 1956. Surface altitude, 1,216.3 feet; depth to water, 9.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	15	15
Sand, fine to coarse	10	25
Sand and gravel	39	64
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	65

30-1E-16ddd.—Drillers log of test hole in SE SE SE sec. 16, T. 30 S., R. 1 E., north side of road 100 feet west of corner; bored July 5, 1956. Surface altitude, 1,232.9 feet; depth to water, 16.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, black	4	4
Silt, sandy, red brown	6	10
Sand, fine	10	20
Sand and gravel, arkosic	11	31
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	3	34

30-1E-18cbc.—Drillers log of test hole in SW NW SW sec. 18, T. 30 S., R. 1 E., in center of road 0.1 mile south of south house, 20 feet south of north end of hedge row on west side; bored September 1, 1955. Surface altitude, 1,223.7 feet; depth to water, 18.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Clay, sandy, brown	5	5
Clay, sandy, red	5	10
Sand, fine, clayey	5	15
Clay, red	5	20

	Thickness, feet	Depth, feet
Clay, black	3	23
Clay, blue gray	2	25
Sand, fine to medium	4	29
PERMIAN—Leonardian		
Wellington Formation		
Shale, black	1	30

30-1E-19bbb.—Drillers log of test hole in NW NW NW sec. 19, T. 30 S., R. 1 E., in pasture 200 feet NE of barn back of house; bored September 1, 1955. Surface altitude, 1,219.9 feet; depth to water, 16.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, very fine	5	5
Sand, fine	5	10
Sand, fine to medium	5	15
Sand, fine to coarse, and fine gravel	30	45
PERMIAN—Leonardian		
Wellington Formation		
Shale, black	1	46

30-1E-23aab.—Drillers log of test hole in NW NE NE sec. 23, T. 30 S., R. 1 E., south of road in front of mailbox at house on south side; bored July 3, 1956. Surface altitude, 1,211.1 feet; depth to water, 7.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt and clay, black	5	5
Sand, fine to medium	10	15
Sand, medium to coarse	10	25
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	26

30-1E-25aaa.—Drillers log of test hole in NE NE NE sec. 25, T. 30 S., R. 1 E., on west side of road 40 feet south of corner; bored September 7, 1955. Surface altitude, 1,202.6 feet; depth to water, 7.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	5	5
Sand, very fine	20	25
Sand, fine to medium	10	35
Sand, fine to coarse, and fine to medium gravel	14	49
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	50

30-1E-25baa.—Sample log of test hole in NE NE NW sec. 25, T. 30 S., R. 1 E., 0.5 mile east of NW corner; drilled May 18, 1944. Surface altitude, 1,207.9 feet; depth to water, 3.75 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, dark gray; contains much medium to fine sand	3	3
Sand, medium to fine interbedded with silt	5	8
Sand, medium to fine; contains much blue-gray clay	2	10
Gravel, medium to fine, and sand	25	35
PERMIAN—Leonardian		
Wellington Formation		
Shale, soft, gray and dull greenish gray	5	40

30-1E-25bcc.—Sample log of test hole in SW SW NW sec. 25, T. 30 S., R. 1 E., 0.5 mile north of SW corner; drilled May 18, 1944. Surface altitude, 1,211.4 feet; depth to water, 9.01 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Clay, silty, gray	3	5
Silt, yellow brown and light gray; contains some coarse to fine sand	5	10
Gravel, fine to coarse, and sand	10	20
Sand, coarse to fine, and coarse to fine gravel	10	30
Gravel, coarse to fine	5	35
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray blue	5	40

30-1E-26aaa.—Drillers log of test hole in NE NE NE sec. 26, T. 30 S., R. 1 E., south side of road 100 feet west of corner, under mulberry tree; bored July 3, 1956. Surface altitude, 1,211.0 feet; depth to water, about 15 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Sand, very fine, and silt, brown	5	10
Clay, sandy, brown	5	15
Clay, sandy, gray	2	17
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	1	18

30-1E-27ccc.—Drillers log of test hole in SW SW SW sec. 27, T. 30 S., R. 1 E., on north side of road 15 feet east of corner; bored September 7, 1955. Surface altitude, 1,212.0 feet; depth to water, 18.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	4	4
Sand, fine to medium	6	10

	Thickness, feet	Depth, feet
Sand, fine to coarse	10	20
Sand, fine to coarse, and fine gravel	16	36
Clay, brown	1	37

30-1E-27ddd.—Drillers log of test hole in SE SE SE sec. 27, T. 30 S., R. 1 E., on north side of road 40 feet west of corner; bored September 7, 1955. Surface altitude, 1,217.0 feet; depth to water, 13.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Clay, buff	5	5
Gravel, fine to medium; contains some clay	10	15
Sand, fine to coarse, and fine gravel	10	25
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green	5	30

30-1E-28ccc.—Drillers log of test hole in SW SW SW sec. 28, T. 30 S., R. 1 E., on north side of road 175 feet east of corner; bored September 7, 1955. Surface altitude, 1,211.9 feet; depth to water, 21.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand and silt, gray to black	4	4
Clay, sandy, red brown	2	6
Sand, fine, tan	14	20
Sand, fine to medium	10	30
Sand, medium to coarse	17	47
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	49

30-1E-30bcc.—Drillers log of test hole in SW SW NW sec. 30, T. 30 S., R. 1 E., on east side of road 100 feet north of half-mile hedge; bored September 1, 1955. Surface altitude, 1,243.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, sandy, red	20	20

30-1E-33cdc.—Drillers log of test hole in SW SE SW sec. 33, T. 30 S., R. 1 E., in field 50 feet north of center of highway, 100 feet east of turnpike; bored June 7, 1956. Surface altitude, 1,203.9 feet; depth to water, 14.86 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, red tan	5	5
Sand, fine, tan	10	15
Sand, fine to coarse	26	41
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan to gray	0.5	41.5

30-1E-33ddd.—Drillers log of test hole in SE SE SE sec. 33, T. 30 S., R. 1 E., on west side of road 100 feet north of highway east of oxbow lake; bored June 6, 1956. Surface altitude, 1,195.5 feet; depth to water, 6.85 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, black	2	2
Clay, sandy, red brown	3	5
Clay, sandy, brown	2	7
Sand, fine to medium	3	10
Sand and gravel, fine to medium	22	32
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue green	0.5	32.5

30-1E-34ada.—Drillers log of test hole in NE SE NE sec. 34, T. 30 S., R. 1 E., in wheat field west of road, midway between house on west and house on east; bored August 11, 1956. Surface altitude, 1,209.8 feet; depth to water, 7.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Sand, medium, clayey, red	5	10
Sand and gravel, clayey	5	15
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	15.5

30-1E-34add.—Drillers log of test hole in SE SE NE sec. 34, T. 30 S., R. 1 E., in wheat field 35 feet west of white wire gate 10 feet north of alfalfa field; bored August 11, 1956. Surface altitude, 1,206.1 feet; depth to water, 12.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	5	5
Silt and fine sand	5	10
Clay, sandy, brown	2	12
Sand, fine	8	20
Sand and gravel, medium to coarse	7	27
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	27.5

30-1E-34bbc.—Drillers log of test hole in SW NW NW sec. 34, T. 30 S., R. 1 E., on east side of road at wood bridge into alfalfa field, 50 feet north of SW corner of field; bored June 6, 1956. Surface altitude, 1,208.6 feet; depth to water, 13.95 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, brown	5	5
Silt, very fine, sandy, red tan	5	10

	Thickness, feet	Depth, feet
Sand, very fine to fine, red tan	5	15
Sand, fine to coarse	18	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	33.5

30-1E-34bcc.—Drillers log of test hole in SW SW NW sec. 34, T. 30 S., R. 1 E., in east road ditch between two walnut trees, 60 feet north of half-mile line; bored June 6, 1956. Surface altitude, 1,208.0 feet; depth to water, 14.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Clay, brown	5	5
Clay, sandy, red brown	5	10
Silt and clay, brown	5	15
Silt, fine, sandy, brown	20	35
Gravel, fine to medium	7	42
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	0.5	42.5

30-1E-34ccb.—Drillers log of test hole in NW SW SW sec. 34, T. 30 S., R. 1 E., on east side of road across from wooden gate 60 feet south of end of hedge row on east side of road; bored June 6, 1956. Surface altitude, 1,203.8 feet; depth to water, 14.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, black	5	5
Silt, fine, sandy, tan brown	5	10
Sand, fine	5	15
Sand, fine to medium	25	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	0.5	40.5

30-1E-34ccd.—Drillers log of test hole in SE SW SW sec. 34, T. 30 S., R. 1 E., north of highway in SE corner of oat field, 10 feet south of power pole; bored June 8, 1956. Surface altitude, 1,200.2 feet; depth to water, 14.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, brown	5	5
Silt, black	2	7
Clay, tan	3	10
Sand, fine, tan	5	15
Sand, fine to medium	25	40
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	40.5

30-1E-34dcd.—Drillers log of test hole in SE SW SE sec. 34, T. 30 S., R. 1 E., on north side of road 20 feet west of windmill; bored June 8, 1956. Surface altitude, 1,202.8 feet; depth to water, 14.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, black	5	5
Clay, black to brown	5	10
Clay, sandy, brown	5	15
Sand, fine	10	25
Sand, fine to medium, and gravel	15	40
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	40.5

30-1E-35aaa.—Drillers log of test hole in NE NE NE sec. 35, T. 30 S., R. 1 E., on south side of road 100 feet west of corner; bored September 7, 1955. Surface altitude, 1,214.5 feet; depth to water, 17.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Clay, sandy, tan	5	5
Sand, fine to medium, clayey	5	10
Sand, fine	10	20
Sand, medium to coarse, and fine gravel	22	42
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	43

30-1E-35baa.—Sample log of test hole in NE NE NW sec. 35, T. 30 S., R. 1 E., about 80 feet south of center of north side; drilled May 17, 1944. Surface altitude, 1,216.6 feet.

	Thickness, feet	Depth, feet
Road fill and soil, dark gray	2	2
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, clayey, yellow gray; contains much coarse to fine gravel and sand	5	7
Gravel, medium to fine, and sand	3	10
Gravel, coarse to fine, and sand	8	18
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellowish to blue gray	7	25

30-1E-35bcc.—Sample log of test hole in SW SW NW sec. 35, T. 30 S., R. 1 E., 0.5 mile north of SW corner; drilled May 17, 1944. Surface altitude, 1,202.8 feet; depth to water, 3.47 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	2	4

	Thickness, feet	Depth, feet
Sand, medium to fine	16	20
Gravel, fine, and sand	3	23
PERMIAN—Leonardian		
Wellington Formation		
Shale, light and dark gray green	7	30

30-1E-35cbc.—Drillers log of test hole in SW NW SW sec. 35, T. 30 S., R. 1 E., on east side of road at south end of hedge row; bored June 11, 1956. Surface altitude, 1,205.8 feet; depth to water, 13.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	5	5
Silt, fine, buff	5	10
Sand, dark buff	3	13
Sand; contains clay streaks	2	15
Sand, fine to medium	5	20
Sand and gravel	5	25
Gravel	8	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	33.5

30-1W-2abb.—Sample log of test hole in NW NW NE sec. 2, T. 30 S., R. 1 W., 0.5 mile east of NW corner; drilled June 7, 1944. Surface altitude, 1,244.8 feet; depth to water, 9.84 feet.

	Thickness, feet	Depth, feet
Road fill and gravel	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, gray to light brown	10	12
Silt, clayey, gray and tan	10	22
Sand, coarse to fine, and medium to fine gravel	8	30
Gravel, medium to fine, and sand	4	34
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	2	36

30-1W-3bab.—Sample log of test hole in NW NE NW sec. 3, T. 30 S., R. 1 W., about 0.35 mile east of NW corner; drilled June 6, 1944. Surface altitude, 1,245.1 feet; depth to water, 4.53 feet.

	Thickness, feet	Depth, feet
Road fill and gravel	3	3
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, gray to buff; contains some coarse to fine sand	3	6
Silt, tan; contains much medium to fine gravel	4	10
Silt, tan; contains much medium to fine sand	14	24

	Thickness, feet	Depth, feet
Gravel, coarse to fine, and sand	4	28
Silt, buff	1	29
Sand, coarse to medium, and medium to fine gravel	11	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, dark blue gray	6	46

30-1W-5abb.—Drillers log of test hole in NW NW NE sec. 5, T. 30 S., R. 1 W., on south side of road at gap into field about 400 feet east of half-mile line; bored August 31, 1955. Surface altitude, 1,250.0 feet; depth to water, 16.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, silty, black	5	5
Clay, silty and sandy, red	12	17
Sand, fine to medium	30	47
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	48

30-1W-7aaa.—Sample log of test hole in NE NE NE sec. 7, T. 30 S., R. 1 W., 40 feet west of NE corner; drilled June 6, 1944. Surface altitude, 1,261.2 feet.

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, light brown to light gray	5	6
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, yellow gray and light green gray	4	10

30-1W-13aaa.—Drillers log of test hole in NE NE NE sec. 13, T. 30 S., R. 1 W., on west side of road 50 feet south of corner; bored September 1, 1955. Surface altitude, 1,236.1 feet; depth to water, 12.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Clay, sandy, red	5	10
Sand, fine, clayey	2	12
Clay, sandy, tan	2	14
Clay, sandy, green	5	19
Sand, fine to medium	5	24
Sand, fine to coarse, and fine gravel	11	35
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	5	40

30-1W-18bbb.—Sample log of test hole in NW NW NW sec. 18, T. 30 S., R. 1 W., about 425 feet east of corner; drilled June 6, 1944. Surface altitude, 1,275.0 feet.

	Thickness, feet	Depth, feet
Road fill	5	5
QUATERNARY—Pleistocene		
Colluvium		
Clay, silty, light gray; contains trace of medium to fine sand	11	16
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, hard, dark gray	2	18

30-1W-24add.—Drillers log of test hole in SE SE NE sec. 24, T. 30 S., R. 1 W., on west side of road at cottonwood tree just north of half-mile line; bored September 1, 1955. Surface altitude, 1,218.0 feet; depth to water, 13.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine	10	10
Sand, fine to medium	10	20
Clay, black	2	22
Sand, fine	2	24
Sand, fine to coarse, and fine gravel	3	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	28

30-2W-1aaa.—Drillers log of test hole in NE NE NE sec. 1, T. 30 S., R. 2 W., on west side of road 20 feet south of corner; bored August 31, 1955. Surface altitude, 1,244.0 feet; depth to water, 8.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, black	4	4
Sand, fine to medium	6	10
Sand, fine to coarse	20	30
Sand, fine to coarse, and fine to medium gravel	3	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	34

30-3W-15bbb.—Drillers log of test hole in NW NW NW sec. 15, T. 30 S., R. 3 W., on south side of road 40 feet east of intersection; bored August 31, 1955. Surface altitude, 1,353.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, sandy, red	5	10
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	5	15

30-3W-18bbb.—Drillers log of test hole in NW NW NW sec. 18, T. 30 S., R. 3 W., on east side of road 10 feet south of corner; bored August 17, 1955. Surface altitude, 1,366.3 feet; depth to water, about 18 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, gray to black	5	5
Clay, compact, greenish gray	5	10
Clay, green; contains much quartz gravel	2	12
Clay, sandy, red	5	17
Sand, fine to medium	9	26
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	27

30-4W-9ccc.—Drillers log of test hole in SW SW SW sec. 9, T. 30 S., R. 4 W., on north side of road 40 feet east of intersection; bored August 17, 1955. Surface altitude, 1,450.6 feet; depth to water, 6.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, black	3	3
Sand, fine to medium, tan	2	5
Sand, fine, light gray	5	10
Sand, fine to medium, greenish gray	46	56
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	1	57

30-4W-10aaa.—Drillers log of test hole in NE NE NE sec. 10, T. 30 S., R. 4 W., on west side of road 60 feet south of Highway 42; bored August 17, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, sticky, black	3	3
Clay, tan to red tan	4	7
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red and green	2	9

30-4W-10ccc.—Drillers log of test hole in SW SW SW sec. 10, T. 30 S., R. 4 W., on east side of road 10 feet north of corner; bored August 17, 1955. Surface altitude, 1,423.9 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, sandy, tan	3	3
Clay, tan	2	5
Clay, red	1	6
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	7

30-4W-17bbb.—Drillers log of test hole in NW NW NW sec. 17, T. 30 S., R. 4 W., on south side of road 100 feet east of intersection; bored August 16, 1955. Surface altitude, 1,468.5 feet; depth to water, 12.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, black	2	2
Clay, sandy, buff	3	5
Clay, sandy, light buff	2	7
Clay, sand, and gravel, tan	2	9
Clay, sandy, greenish buff	2	11
Sand, fine to medium, clayey	4	15
Sand, fine to coarse	54	69
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	70

30-4W-18bbb.—Drillers log of test hole in NW NW NW sec. 18, T. 30 S., R. 4 W., in triangle north of highway, west of county-line road; bored August 16, 1955. Surface altitude, 1,468.6 feet; depth to water, 9.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, sandy, dark brown	3	3
Sand, fine, tan	2	5
Sand, fine to medium	61	66
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	67

30-4W-19bbb.—Drillers log of test hole in NW NW NW sec. 19, T. 30 S., R. 4 W., on east side of road 30 feet south of intersection; bored August 16, 1955. Surface altitude, 1,487.4 feet; depth to water, 26.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, sandy, tan	2	2
Clay, gravelly, tan	2	4
Clay and sand, tan	3	7
Sand, fine to medium	3	10
Sand, fine to medium, and gravel	13	23
Sand, fine, light tan	7	30
Sand, fine to coarse	17	47
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	1	48

30-4W-19ccc.—Drillers log of test hole in SW SW SW sec. 19, T. 30 S., R. 4 W., on east side of road 50 feet north of intersection; bored August 16, 1955. Surface altitude, 1,475.3 feet; depth to water, 14.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, sandy, dark brown	5	5
Silt, black	2	7
Sand, fine to medium	3	10
Sand, fine to medium, and red clay	8	18
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, green	1	19

30-4W-24ccc.—Drillers log of test hole in SW SW SW sec. 24, T. 30 S., R. 4 W., on east side of road 20 feet north of intersection; bored August 17, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	2	2
Clay, red; contains much gravel	3	5
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	7

30-4W-34bbb.—Drillers log of test hole in NW NW NW sec. 34, T. 30 S., R. 4 W., on east side of road 12 feet south of corner; bored August 17, 1955. Surface altitude, 1,456.9 feet; depth to water, 23.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, black	5	5
Silt, brown	2	7
Sand, fine to medium	8	15
Clay, sandy, tan, and arkosic gravel	5	20
Sand, fine to medium	58	78
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	80

31-2E-2aad.—Drillers log of test hole in SE NE NE sec. 2, T. 31 S., R. 2 E., on west side of road at east end of quarter-mile hedge row; bored June 18, 1956. Surface altitude, 1,189.5 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	3	3
Silt and clay, brown	7	10
Clay, very sandy, tan	5	15
Sand, fine, clayey	29	44
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	44.5

31-2E-2ddd.—Drillers log of test hole in SE SE SE sec. 2, T. 31 S., R. 2 E., on west side of road at corner 15 feet north of hedge row; bored June 18, 1956. Surface altitude, 1,182.0 feet; depth to water, 13.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	8	8
Sand, fine, clayey, tan	7	15
Sand, fine to coarse	5	20
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	21

31-2E-3aba.—Drillers log of test hole in NE NW NE sec. 3, T. 31 S., R. 2 E., 100 yards east of river bridge in south ditch along highway; bored June 29, 1956. Surface altitude, 1,184.3 feet; depth to water, 11.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, black	5	5
Silt, sandy, brown	2	7
Silt, sandy, tan	3	10
Sand, fine to medium	5	15
Sand, coarse	5	20
Sand, coarse, and weathered shale	3	23
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	24

31-2E-3baa.—Drillers log of test hole in NE NE NW sec. 3, T. 31 S., R. 2 E., on dirt road 25 feet west of west end of river bridge and 40 feet south; bored June 18, 1956. Surface altitude, 1,181.6 feet; depth to water, 8.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, brown to black	5	5
Sand, fine to medium	5	10
Sand, medium to coarse	5	15
Sand and gravel	12	27
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	27.5

31-2E-3bbb.—Drillers log of test hole in NW NW NW sec. 3, T. 31 S., R. 2 E., on east side of road 0.1 mile south of corner at center of row of big cottonwood trees; bored June 12, 1956. Surface altitude, 1,187.6 feet; depth to water, 11.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	5	5
Silt, black	1	6

	Thickness, feet	Depth, feet
Sand, fine, silty	4	10
Sand, fine to medium	5	15
Sand and gravel, fine to coarse, arkosic	45	60
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	60.5

31-2E-3ddd.—Drillers log of test hole in SE SE SE sec. 3, T. 31 S., R. 2 E., west of Continental Pipeline marker on south side of road; bored June 29, 1956. Surface altitude, 1,176.0 feet; depth to water, 9.80 feet.

QUATERNARY—Pleistocene Alluvium	Thickness, feet	Depth, feet
Silt, sandy, brown	2	2
Sand, very fine, tan	4	6
Sand, fine	1	7
Sand, medium, silty	3	10
Sand, medium to coarse	5	15
Sand, coarse	10	25
Sand and coarse gravel	2	27
Gravel	7	34
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	35

31-2E-5ddd.—Drillers log of test hole in SE SE SE sec. 5, T. 31 S., R. 2 E., in drive to field at SE corner; bored June 12, 1956. Surface altitude, 1,186.4 feet; depth to water, 12.20 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Silt, tan, and very fine sand	7	7
Sand, fine	8	15
Sand and gravel	47	62
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	63

31-2E-6bbb.—Drillers log of test hole in NW NW NW sec. 6, T. 31 S., R. 2 E., on east side of road 100 feet south of corner; bored September 8, 1955. Surface altitude, 1,200.0 feet; depth to water, 10.50 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Silt, black	3	3
Clay, sandy, tan	3	6
Clay, sandy, green gray	6	12
Sand, fine	11	23
Clay, black to dark gray green	4	27

	Thickness, feet	Depth, feet
Sand, fine	3	30
PERMIAN—Leonardian		
Wellington Formation		
Shale	5	35

31-2E-7ccc.—Drillers log of test hole in SW SW SW sec. 7, T. 31 S., R. 2 E., on north side of road 400 feet east of corner; bored September 8, 1955. Surface altitude, 1,189.8 feet; depth to water, 17.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	3	3
Sand, fine, tan	12	15
Sand, fine to medium	10	25
Gravel, fine to medium	15	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, green gray	1	41

31-2E-12bcc.—Drillers log of test hole in SW SW NW sec. 12, T. 31 S., R. 2 E., on east side of road 100 feet north of half-mile road; bored June 19, 1956. Surface altitude, 1,177.3 feet; depth to water, 5.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, tan	3	3
Silt, sandy, brown	2	5
Silt, brown	2	7
Sand, fine	3	10
Gravel and sand	10	20
PERMIAN—Leonardian		
Wellington Formation		
Shale or limestone, very hard	0.5	20.5

31-2E-12bdc.—Drillers log of test hole in SW SE NW sec. 12, T. 31 S., R. 2 E., at corner of road at quarter-mile corner; bored June 19, 1956. Surface altitude, 1,199.8 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, black	5	5
Sand, fine to medium, clayey	5	10
Clay, sandy, red	5	15
Sand, fine to coarse	15	30
Sand and gravel, arkosic	18	48
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	49

31-2E-13aba.—Drillers log of test hole in NE NW NE sec. 13, T. 31 S., R. 2 E., on south side of road just north of lone hedge tree at west corner of farmyard; bored June 29, 1956. Surface altitude, 1,194.4 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, silty	5	10
Illinoisan or Kansan terrace deposits		
Sand, silty	2	12
Sand, coarse	3	15
Sand, coarse, and gravel	5	20
Sand, clayey	1	21
PERMIAN—Leonardian		
Wellington Formation		
Gravel	2	23

31-2E-13add.—Drillers log of test hole in SE SE NE sec. 13, T. 31 S., R. 2 E., on west side of road at cottonwood tree 0.1 mile north of half-mile hedge; bored June 19, 1956. Surface altitude, 1,207.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, brown	5	5
Silt, clayey, brown	7	12
Illinoisan or Kansan terrace deposits		
Sand, fine	3	15
Sand, fine to medium	10	25
Gravel, fine to coarse, arkosic	8	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	33.5

31-2E-13bba.—Drillers log of test hole in NE NW NW sec. 13, T. 31 S., R. 2 E., in south borrow pit 40 feet west of road; bored June 19, 1956. Surface altitude, 1,170.9 feet; depth to water, 8.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Sand, medium to coarse	10	15
Sand and gravel	5	20
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	0.5	20.5

31-2E-13bca.—Drillers log of test hole in NE SW NW sec. 13, T. 31 S., R. 2 E., in field 0.3 mile south of road "T" 100 feet due south of small elm on terrace break; bored June 19 1956. Surface altitude, 1,168.1 feet; depth to water, 6.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	10	10
Sand, medium to coarse	5	15
Sand and gravel, fine to medium	9	24
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green	0.5	24.5

31-2E-13cca.—Drillers log of test hole in NE SW SW sec. 13, T. 31 S., R. 2 E., in pasture northwest of green house at end of road, along trail through pasture 600 feet east of point where trail enters heavy timber; bored June 20, 1956. Surface altitude, 1,170.1 feet; depth to water, 11.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	10	10
Sand, fine to medium	10	20
Sand and gravel	10	30
Gravel, arkosic	3	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	33.5

31-2E-14aab.—Drillers log of test hole in NW NE NE sec. 14, T. 31 S., R. 2 E., in south borrow pit 0.4 mile west of corner and 50 feet west, 10 feet south of power pole with "Keep Out" sign; bored June 19, 1956. Surface altitude, 1,169.5 feet; depth to water, 6.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, silty	10	10
Sand, fine to coarse	10	20
Sand and gravel	13	33
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	0.5	33.5

31-2E-15aaa.—Drillers log of test hole in NE NE NE sec. 15, T. 31 S., R. 2 E., on west side of road 50 feet south of corner; bored June 12, 1956. Surface altitude, 1,174.7 feet; depth to water, 7.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine; contains some clay	5	5
Sand, fine and medium	5	10
Sand and gravel, fine to coarse, arkosic	50	60

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	60.5

31-2E-17ccc.—Drillers log of test hole in SW SW SW sec. 17, T. 31 S., R. 2 E., north of road in triangle, 15 feet east of corner; bored September 9, 1955. Surface altitude, 1,182.8 feet; depth to water, 17.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	3	3
Clay, sandy, red brown	3	6
Sand, fine, red	7	13
Clay, sandy, red brown	4	17
Sand, fine to medium	23	40
Gravel, fine to medium	12	52
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	53

31-2E-20ccc.—Drillers log of test hole in SW SW SW sec. 20, T. 31 S., R. 2 E., on north side of road 15 feet east of corner; bored September 12, 1955. Surface altitude, 1,182.1 feet; depth to water, 17.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, tan	5	5
Silt, black	2	7
Sand, fine to medium	3	10
Sand, fine	10	20
Sand, fine to coarse, and fine gravel	7	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	29

31-2E-21baa.—Drillers log of test hole in NE NE NW sec. 21, T. 31 S., R. 2 E., on south side of road by grove of trees 100 feet west of railroad; bored September 9, 1955. Surface altitude, 1,178.1 feet; depth to water, 14.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Sand, fine, tan	4	9
Clay, sandy, dark gray	4	13
Sand, fine to medium	12	25
Sand, coarse, and fine to medium gravel	20	45
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	46

31-2E-23baa.—Drillers log of test hole in NE NE NW sec. 23, T. 31 S., R. 2 E., on south side of road 10 feet west of half-mile line; bored September 9, 1955. Surface altitude, 1,171.2 feet; depth to water, about 13 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	4	4
Sand, fine	6	10
Clay, sandy, tan	5	15
Sand, fine to coarse	10	25
Gravel, fine to medium	39	64
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	65

31-2E-24aaa.—Sample log of test hole in NE NE NE sec. 24, T. 31 S., R. 2 E., about 70 feet south of NE corner; drilled April 28, 1944. Surface altitude, 1,204.0 feet; depth to water, 34.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, dark brown	2	2
Silt, sandy, brown	4.5	6.5
Sand, coarse to fine, silty; contains some medium to fine gravel	15.5	22
Gravel, coarse to fine; contains much sand and gray to buff silt	8	30
Gravel, coarse to fine, and sand; contains some silt	6.5	36.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray to blue gray	3	39.5

31-2E-24add1.—Sample log of test hole in SE SE NE sec. 24, T. 31 S., R. 2 E., about 0.45 mile south of NE corner; drilled May 8, 1944. Surface altitude, 1,198.6 feet; depth to water, about 35 feet.

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, clayey, brown; contains some medium to fine sand	7	8
Sand, coarse to fine, and brown silt	14	22
Silt, tan; contains much medium to fine sand and some fine gravel	7	29
Silt, clayey, yellow gray; contains some sand	3	32
Sand	6	38
PERMIAN—Leonardian		
Wellington Formation		
Shale	7	45

31-2E-24add2.—Drillers log of test hole in SE SE NE sec. 24, T. 31 S., R. 2 E., 100 feet south of bridge on east side of road; bored June 29, 1956. Surface altitude, 1,185.5 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Sand, silty, brown	5	10
Illinoisan or Kansan terrace deposits		
Sand, silty, tan	2	12
Sand, fine	5	17
Sand, coarse, and gravel, very silty	6	23
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	23.5

31-2E-24bab.—Drillers log of test hole in NW NE NW sec. 24, T. 31 S., R. 2 E., on south side of road at end of road, 250 feet west of house on south side; bored September 10, 1955. Surface altitude, 1,165.5 feet; depth to water, 7.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	4	4
Sand, very fine	3	7
Sand, fine to medium	3	10
Sand, fine to coarse, and fine gravel	15	25
Gravel, fine to medium	7	32
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	33

31-2E-24cdd.—Sample log of test hole in SE SE SW sec. 24, T. 31 S., R. 2 E., about 0.5 mile east of SW corner; drilled May 25, 1944. Surface altitude, 1,162.3 feet; depth to water, 8.64 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, dark gray and buff; contains much medium to fine sand	3	3
Sand, coarse to fine; contains some medium to fine gravel	17	20
Gravel, coarse to fine, and sand	26	46
PERMIAN—Leonardian		
Wellington Formation		
Limestone and chert, gray white	1	47

31-2E-24dca.—Drillers log of test hole in NE SW SE sec. 24, T. 31 S., R. 2 E., 0.2 mile north of 31-2-25aba at west edge of bare spot caused by brine pond; bored June 20, 1956. Surface altitude, 1,163.2 feet; depth to water, 7.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	5	5
Sand and clay	5	10
Sand, very fine	7	17
Sand and gravel	4	21
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	1	22

31-2E-24dcc.—Drillers log of test hole in SW SW SE sec. 24, T. 31 S., R. 2 E., at drive into pasture, across road from tile house; bored June 20, 1956. Surface altitude, 1,160.5 feet; depth to water, 7.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	5	5
Sand, fine to medium	10	15
Sand, fine to coarse	10	25
Sand and gravel, arkosic	20	45

31-2E-25aaa.—Drillers log of test hole in NE NE NE sec. 25, T. 31 S., R. 2 E., on west side of road 10 feet south of corner; bored June 20, 1956. Surface altitude, 1,174.6 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Sand, clayey, fine	5	5
Illinoisan or Kansan terrace deposits		
Sand, fine	12	17
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	17.5

31-2E-25aba.—Drillers log of test hole in NE NW NE sec. 25, T. 31 S., R. 2 E., at end of section-line trail; oil field road goes south from road; bored June 20, 1956. Surface altitude, 1,164.1 feet; depth to water, 8.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	4	4
Sand, fine	8	12
Sand, fine to medium	8	20
Sand, fine to coarse, and fine gravel	20	40
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	41

31-2E-25ada.—Drillers log of test hole in NE SE NE sec. 25, T. 31 S., R. 2 E., on west side of road in small ravine, 10 feet east of trash dump; bored June 20, 1956. Surface altitude, 1,160.3 feet; depth to water, 7.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Clay, sandy, brown	3	8
Sand, fine to medium	5	13
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	13.5

31-2E-25cac.—Drillers log of test hole in SW NE SW sec. 25, T. 31 S., R. 2 E., near river at end of trail, 40 feet west of W. C. Churchill #13 oil well; bored June 21, 1956. Surface altitude, 1,161.3 feet; depth to water, 9.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, brown	5	5
Sand, fine, tan	5	10
Sand, medium to coarse	10	20
Sand and gravel, arkosic	15	35
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	35.5

31-2E-25cad.—Drillers log of test hole in SE NE SW sec. 25, T. 31 S., R. 2 E., on south side of road 100 feet south and 100 feet west of tile silo; bored June 21, 1956. Surface altitude, 1,159.0 feet; depth to water, 9.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine	10	10
Sand, fine to medium	15	25
Sand, medium to coarse	5	30
Sand and gravel, arkosic	15	45

31-2E-25dcc.—Sample log of test hole in SW SW SE sec. 25, T. 31 S., R. 2 E., near center of south side of section; drilled May 26, 1944. Surface altitude, 1,155.0 feet; depth to water, 3.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine, and silt, gray buff	3	3
Sand, coarse to fine; contains some medium to fine gravel	7	10
Gravel, medium to fine; contains some sand and clay,	10	20
Gravel, coarse to fine, and sand	25	45
PERMIAN—Leonardian		
Wellington Formation		
Limestone, brittle, light gray	2	47

31-2E-25dda.—Drillers log of test hole in NE SE SE sec. 25, T. 31 S., R. 2 E., on west side of road under big cottonwood tree where private road turns off at Shell Company camp; bored June 20, 1956. Surface altitude, 1,160.0 feet; depth to water, 10.82 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, very fine, and black silt	5	5
Sand, fine	5	10
Sand, fine to medium	15	25
Sand, medium to coarse	10	35
Sand and gravel, arkosic	15	50
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	0.5	50.5

31-2E-25ddd.—Drillers log of test hole in SE SE SE sec. 25, T. 31 S., R. 2 E., on west side of road on county line, 20 feet north of corner; bored September 10, 1955. Surface altitude, 1,158.4 feet; depth to water, 11.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine	10	10
Sand, fine to coarse	10	20
Sand, fine to coarse, and fine to medium gravel	26	46
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	47

31-2E-26bbb.—Drillers log of test hole in NW NW NW sec. 26, T. 31 S., R. 2 E., east of road 15 feet south of railroad track; bored September 9, 1955. Surface altitude, 1,168.8 feet; depth to water, 11.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	4	4
Clay, black	3	7
Clay, sandy, red brown	3	10
Sand, fine, red stained	10	20
Sand, fine to medium	5	25
Sand, fine to coarse, and fine gravel	11	36
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue black	1	37

31-2E-26ddd.—Sample log of test hole in SE SE SE sec. 26, T. 31 S., R. 2 E., near SE corner; drilled May 13, 1944. Surface altitude, 1,158.5 feet; depth to water, 12.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, gray; contains much medium to fine sand	5	5
Sand, medium to fine; contains some buff silt	5	10

	Thickness, feet	Depth, feet
Sand, medium to fine	11	21
PERMIAN—Leonardian		
Wellington Formation		
Shale, very hard, light gray	7	28

31-2E-29cdd.—Sample log of test hole in SE SE SW sec. 29, T. 31 S., R. 2 E., about 0.5 mile west of SE corner; drilled May 15, 1944. Surface altitude, 1,227.9 feet; depth to water, 51.50 feet.

	Thickness, feet	Depth, feet
Road fill and silt, gray brown	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, gray to light gray; contains scattered sand	4	7
Silt, brown; contains some coarse to fine gravel and sand	10	17
Clay, yellow gray	5	22
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some coarse to fine gravel	8	30
Silt, tan and yellow buff	4	34
Gravel, fine to coarse, and blue-gray clay	18	52
Silt, clayey, light gray green and buff; contains some medium to fine sand	7	59
Clay, light gray green; interbedded with some coarse to fine gravel	4	63
Gravel, fine to coarse; contains some sand and clay	8	71
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray and blue gray	4	75

31-2E-30bbb.—Drillers log of test hole in NW NW NW sec. 30, T. 31 S., R. 2 E., on east side of road 5 feet south of corner; bored September 12, 1955. Surface altitude, 1,204.8 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan brown	7	7
Clay, sandy, red brown	8	15
Illinoisan or Kansan terrace deposits		
Sand, fine	7	22
Sand, fine to medium, and fine gravel	3	25
Clay, sandy, greenish tan	15	40
Clay, sandy, tan to brown	15	55
Sand, fine to coarse, and fine gravel	15	70

31-2E-34ddd.—Drillers log of test hole in SE SE SE sec. 34, T. 31 S., R. 2 E., on west side of road 20 feet north of corner; bored September 9, 1955. Surface altitude, 1,215.9 feet; depth to water, about 50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, brown	3	3
Clay, sandy, red brown	12	15
Clay, gravelly, brown	5	20
Clay, sandy, brown and green	10	30
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and fine gravel, clayey	15	45
Clay, sandy, greenish tan	10	55
Sand, fine to coarse	8	63
PERMIAN—Leonardian		
Wellington Formation		
Shale, greenish gray	1	64

31-2E-35bbb.—Drillers log of test hole in NW NW NW sec. 35, T. 31 S., R. 2 E., on east side of road 20 feet south of corner; bored September 9, 1955. Surface altitude, 1,166.6 feet; depth to water, 13.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Clay, sandy, tan to gray	5	10
Clay, sandy, red	5	15
Sand, fine to medium	10	25
Sand, fine to coarse, and fine to medium gravel	15	40
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	41

31-2E-36aad.—Drillers log of test hole in SE NE NE sec. 36, T. 31 S., R. 2 E., 0.2 mile south of corner and just north of timbered ditch; bored June 21, 1956. Surface altitude, 1,153.7 feet; depth to water, 6.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, black	5	5
Sand, fine	10	15
Sand, fine to medium	10	25
Sand, medium to coarse	10	35
Sand and gravel	8	43
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	43.5

31-2E-36abb.—Drillers log of test hole in NW NW NE sec. 36, T. 31 S., R. 2 E., 50 feet southeast of east end of dam across river, 100 feet south of "Not responsible for accidents" sign; bored June 21, 1956. Surface altitude, 1,155.9 feet; depth to water, 6.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine	5	5
Sand, fine to medium	5	10
Sand, medium to coarse	4	14
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	0.5	14.5

31-2E-36acb.—Drillers log of test hole in NW SW NE sec. 36, T. 31 S., R. 2 E., along trail about 100 feet south of southwest end of river dam; bored June 21, 1956. Surface altitude, 1,155.2 feet; depth to water, 5.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine	5	5
Sand, medium to coarse	5	10
Sand and gravel	4	14
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	14.5

31-2E-36dca.—Drillers log of test hole in NE SW SE sec. 36, T. 31 S., R. 2 E., east side of dam 100 feet north on east side of road; bored June 28, 1956. Surface altitude, 1,155.0 feet; depth to water, 7.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, silty, brown	2	2
Sand, fine	1	3
Sand, fine to medium	2	5
Sand, medium coarse	5	10
Sand, medium to coarse	7	17
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	17.5

31-2E-36dcd.—Drillers log of test hole in SE SW SE sec. 36, T. 31 S., R. 2 E., west side of dam, south 100 feet along road and 50 feet east of road in clearing; bored June 28, 1956. Surface altitude, 1,150.7 feet; depth to water, 7.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, black	2	2
Sand, fine, tan	1	3
Silt, sandy, black	2	5
Silt, sandy, clayey	1	6

	Thickness, feet	Depth, feet
Sand, fine	1	7
Sand, fine to medium	3	10
Sand, medium to coarse	6	16
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	16.5

31-1E-1dda.—Drillers log of test hole in NE SE SE sec. 1, T. 31 S., R. 1 E., on west side of road at corner of hedge just south of south railroad; bored September 8, 1955. Surface altitude, 1,209.6 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Silt, sandy, red tan	3	3
Sand, very fine	7	10
Clay, sandy, red brown	5	15
Sand, fine to medium	15	30
Gravel, fine to medium; contains much tan clay	5	35
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	1	36

31-1E-2baa.—Drillers log of test hole in NE NE NW sec. 2, T. 31 S., R. 1 E., on west side of street; bored June 12, 1956. Surface altitude, 1,208.7 feet; depth to water, 10.70 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Sand, fine, silty, tan	5	5
Sand, fine to medium, tan	5	10
Sand, coarse, and medium gravel	9	19
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	19.5

31-1E-2bac.—Drillers log of test hole in SW NE NW sec. 2, T. 31 S., R. 1 E., 50 feet east and 15 feet north of tool house; bored June 12, 1956. Surface altitude, 1,204.1 feet; depth to water, 12.30 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Silt, brown	5	5
Silt, sandy, brown	5	10
Sand, very fine	5	15
Sand, fine to medium	7	22
Clay	1	23
Sand, medium to coarse	7	30
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	31

31-1E-2bad.—Drillers log of test hole in SE NE NW sec. 2, T. 31 S., R. 1 E., on west side of road at SE corner of park; bored June 12, 1956. Surface altitude, 1,197.7 feet; depth to water, 8.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	2	2
Silt, brown	3	5
Silt, sandy, brown	2	7
Sand, silty, fine	3	10
Sand, fine to coarse	15	25
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	25.5

31-1E-2bbb.—Drillers log of test hole in NW NW NW sec. 2, T. 31 S., R. 1 E., on east side of road at hedge tree 100 feet south of highway; bored June 11, 1956. Surface altitude, 1,202.8 feet; depth to water, 13.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, brown	7	7
Silt, black	13	20
Sand, muddy	15	35
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	35.5

31-1E-2bcc.—Drillers log of test hole in SW SW NW sec. 2, T. 31 S., R. 1 E., on east side of road at cottonwood tree 50 feet north of north railroad; bored June 11, 1956. Surface altitude, 1,201.3 feet; depth to water, 15.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, red brown	5	5
Silt, sandy, red brown	5	10
Clay, brown	5	15
Clay, sandy, green gray	5	20
Sand	5	25
Sand, fine to coarse	8	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	33.5

31-1E-2bdd.—Drillers log of test hole in SE SE NW sec. 2, T. 31 S., R. 1 E., on west side of road across from SW corner of Belle Plaine cemetery; bored June 12, 1956. Surface altitude, 1,200.0 feet; depth to water, 13.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Clay, silty, black	5	5
Silt, sandy, red brown	7	12

	Thickness, feet	Depth, feet
Sand, fine, clayey	3	15
Sand, fine	5	20
Gravel, fine to medium	13	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	33.5

31-1E-3abb.—Sample log of test hole in NW NW NE sec. 3, T. 31 S., R. 1 E., about 0.5 mile west of NE corner; drilled May 16, 1944. Surface altitude, 1,202.7 feet; depth to water, 4.38 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, gray brown to tan	7	7
Silt, soft, light gray	3	10
Silt, clayey, light brown and gray	6	16
Sand, coarse to fine; contains some medium to fine gravel	4	20
Gravel, fine to coarse, and sand	10	30
Gravel, fine, and sand	8	38
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, blue gray	8	46

31-1E-3baa.—Drillers log of test hole in NE NE NW sec. 3, T. 31 S., R. 1 E., bored June 8, 1956. Surface altitude, 1,202.8 feet; depth to water, 14.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Clay, brown	5	5
Clay, black	2	7
Clay, red brown	3	10
Clay, sandy, brown	5	15
Clay, black	5	20
Sand, fine to medium, muddy	10	30
Sand, fine to coarse	10	40
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	40.5

31-1E-4aab.—Drillers log of test hole in NW NE NE sec. 4, T. 31 S., R. 1 E., south of highway in driveway to alfalfa field; bored June 7, 1956. Surface altitude, 1,204.8 feet; depth to water, 15.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	3	3
Sand, fine, red brown	3	6
Sand, fine, tan to brown	9	15
Sand, fine to medium	15	30

	Thickness, feet	Depth, feet
Sand and gravel	13	43
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	2	45

31-1E-4aac.—Drillers log of test hole in SW NE NE sec. 4, T. 31 S., R. 1 E., 0.25 mile south of highway, through alfalfa to NW corner of wheat field; bored June 7, 1956. Surface altitude, 1,201.9 feet; depth to water, 13.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, brown	5	5
Sand, fine, red tan	5	10
Sand, fine to medium	30	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	41

31-1E-4adc.—Drillers log of test hole in SW SE NE sec. 4, T. 31 S., R. 1 E., just north of river 500 feet east of cabin; bored June 8, 1956. Surface altitude, 1,199.5 feet; depth to water, 14.67 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Silt, sandy, brown	5	10
Sand, fine to medium, red	5	15
Sand, medium to coarse, tan	22	37
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	37.5

31-1E-4baa.—Sample log of test hole in NE NE NW sec. 4, T. 31 S., R. 1 E., about 0.4 mile east of NW corner; drilled May 16, 1944. Surface altitude, 1,203.0 feet; depth to water, 7.50 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, soft, dark gray to buff; contains much fine sand	6	8
Sand, medium to fine; contains some medium to fine gravel	4	12
Silt, dark blue gray; contains some medium to fine sand	2	14
Gravel, medium to fine, and sand	17	31
Silt, soft, light gray green and brown; interbedded with fine gravel and sand	8	39
PERMIAN—Leonardian		
Wellington Formation		
Shale, light and dark gray green and red	11	50

31-1E-4bad.—Drillers log of test hole in SE NE NW sec. 4, T. 31 S., R. 1 E., on west side of road 0.5 mile south of highway, where fence runs west between fields; bored June 7, 1956. Surface altitude, 1,206.5 feet; depth to water, 18.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, tan brown	5	5
Sand, very fine, tan to brown	5	10
Sand, very fine, tan	10	20
Sand, fine to medium	16	36
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	36.5

31-1E-5bbb.—Sample log of test hole in NW NW NW sec. 5, T. 31 S., R. 1 E., about 75 feet south of NW corner; drilled May 17, 1944. Surface altitude, 1,224.0 feet; depth to water, 6.38 feet.

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, dark gray	3	6
Silt, clayey, light greenish gray; contains some medium to fine gravel	6	12
Silt, soft, clayey, greenish and yellow gray; contains some coarse to fine gravel	6	18
PERMIAN—Leonardian		
Wellington Formation		
Shale, partly thin bedded, dark blue gray	4	22

31-1E-9abb2.—Sample log of test hole in NW NW NE sec. 9, T. 31 S., R. 1 E., about 0.6 mile east of NW corner; drilled June 6, 1944. Surface altitude, 1,210.1 feet; depth to water, 17.93 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, light brown and gray	6	6
Clay, silty, gray; contains scattered gravel and sand	4	10
Clay, silty, light gray and brown; contains some medium to fine sand	7	17
Gravel, coarse to fine, and sand; contains much dark-gray clay	21	38
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green to dark blue gray	7	45

31-1E-10dad.—Drillers log of test hole in SE NE SE sec. 10, T. 31 S., R. 1 E., on west side of road under big hackberry tree; bored July 5, 1956. Surface altitude, 1,195.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, brown	4	4
Clay, brown	6	10
Clay, sandy, brown	5	15
Sand, fine to medium	10	25
Sand, fine	8	33
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	34

31-1E-11baa.—Drillers log of test hole in NE NE NW sec. 11, T. 31 S., R. 1 E., in NE corner of alfalfa field 50 feet south of center line of east-west road; bored June 12, 1956. Surface altitude, 1,200.0 feet; depth to water, 19.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	3	3
Silt, red tan, and very fine sand	12	15
Sand, fine to medium, silty	5	20
Clay, brown	1	21
Sand, medium to coarse	24	45

31-1E-11bbb.—Drillers log of test hole in NW NW NW sec. 11, T. 31 S., R. 1 E., in east ditch 200 feet south of corner; bored June 11, 1956. Surface altitude, 1,193.9 feet; depth to water, 12.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, brown	5	5
Silt, sandy, buff	7	12
Sand, light brown	8	20
Sand, fine to coarse	5	25
Sand, coarse, and medium gravel	10.5	35.5
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	36

31-1E-11bcc.—Drillers log of test hole in SW SW NW sec. 11, T. 31 S., R. 1 E., in field east of road 15 feet west of old shed north of large square house; bored June 11, 1956. Surface altitude, 1,198.5 feet; depth to water, 18.68 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, brown	10	10
Sand, fine, red	5	15
Sand, fine to medium	21	36

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	36.5

31-1E-11cbc.—Drillers log of test hole in SW NW SW sec. 11, T. 31 S., R. 1 E., in field north of fence by lone hedge tree, about 150 feet east of 31-1E-10dad; bored July 5, 1956. Surface altitude, 1,192.0 feet; depth to water, 12.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine, red brown	5	5
Clay, sandy, brown	5	10
Sand, medium to coarse	5	15
Sand, medium	5	20
Sand, fine to medium	10	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan	0.5	30.5

31-1E-12bbb.—Drillers log of test hole in NW NW NW sec. 12, T. 31 S., R. 1 E., 15 feet south of center of dirt road 50 feet east of center of blacktop; bored June 12, 1956. Surface altitude, 1,194.7 feet; depth to water, 15.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	7	7
Silt, tan, and very fine sand	3	10
Silt, clayey, dark brown	5	15
Sand, fine to medium	5	20
Sand, medium to coarse	10	30
Gravel, medium to coarse	10	40
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	40.5

31-1E-13bbb.—Sample log of test hole in NW NW NW sec. 13, T. 31 S., R. 1 E., on east side of road about 750 feet south of south end of river bridge; drilled May 15, 1944. Surface altitude, 1,182.8 feet; depth to water, 8.50 feet.

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, coarse to fine; contains some medium to fine gravel	7	10
Gravel, fine, and sand; contains some medium gravel,	10	20
Gravel, medium to fine, and sand	18	38
PERMIAN—Leonardian		
Wellington Formation		
Shale, dull brown and gray green	2	40

31-1E-14aaa.—Drillers log of test hole in NE NE NE sec. 14, T. 31 S., R. 1 E., west of blacktop road in driveway between alfalfa and corn fields 15 feet west of gate; bored July 6, 1956. Surface altitude, 1,180.3 feet, depth to water, 11.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine	10	10
Sand, medium to coarse	5	15
Sand and gravel	17	32
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	33

31-1E-17abb.—Sample log of test hole in NW NW NE sec. 17, T. 31 S., R. 1 E., about 0.5 mile east of NW corner; drilled June 6, 1944. Surface altitude 1,270.9 feet; depth to water, 15.35 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, dull tan	2	2
Silt, tan; contains much coarse to fine gravel and sand,	3	5
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some coarse to fine gravel,	15	20
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, gray green	1	21

31-1E-24bbb.—Sample log of test hole in NW NW NW sec. 24, T. 31 S., R. 1 E., about 45 feet east of NW corner; drilled May 15, 1944. Surface altitude, 1,226.6 feet; depth to water, 30.17 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan	10	10
Silt, light tan; contains some coarse to fine sand	7	17
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine, interbedded with tan silt	3	20
Sand, coarse to fine; contains some coarse to fine gravel and yellow-gray clay	10	30
Gravel, medium to fine, and sand	5	35
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellowish and green gray	4	39

31-1E-24bcc.—Sample log of test hole in SW SW NW sec. 24, T. 31 S., R. 1 E., 0.5 mile north of SW corner; drilled May 15, 1944. Surface altitude, 1,200.7 feet; depth to water, 5.02 feet.

	Thickness, feet	Depth, feet
Road fill	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt, gray black	3	6

	Thickness, feet	Depth, feet
Silt, clayey, buff to gray	4	10
Silt, clayey, gray	7	17
Silt, clayey, gray black	8	25
Illinoisan or Kansan terrace deposits		
Silt, clayey, gray green; contains some coarse to fine sand	3	28
Sand, coarse to fine, and some coarse to fine gravel	2	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and blue gray	1	31

31-1E-25bba2.—Drillers log of test hole in NE NW NW sec. 25, T. 31 S., R. 1 E., in corner of field east of house; bored September 12, 1955. Surface altitude, 1,244.2 feet; depth to water, about 50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan	5	5
Clay, sandy, red	25	30
Illinoisan or Kansan terrace deposits		
Sand, fine to medium, clayey	30	60
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	5	65

31-1W-25abb.—Sample log of test hole in NW NW NE sec. 25, T. 31 S., R. 1 W., at N quarter corner; drilled June 6, 1944. Surface altitude, 1,286.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, silty, light brown grading downward to light gray; contains scattered coarse to fine sand	7	7
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, greenish gray	3	10

31-1W-35abb.—Sample log of test hole in NW NW NE sec. 35, T. 31 S., R. 1 W., about 35 feet east of center of north side; drilled June 6, 1944. Surface altitude, 1,266.2 feet.

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, brown gray	3	4
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, green gray	3	7

31-2W-8ccc.—Drillers log of test hole in SW SW SW sec. 8, T. 31 S., R. 2 W., on south side of road 15 feet east of corner; bored August 31, 1955. Surface altitude, 1,268.4 feet; depth to water, 13.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	5	5
Silt, black	2	7
Clay, tan	8	15
Clay, sandy, tan	5	20
Sand, fine; contains much blue-gray clay	7	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	28

31-2W-31daa.—Drillers log of test hole in NE NE SE sec. 31, T. 31 S., R. 2 W., on west side of road 50 feet south of half-mile line, in small valley; bored August 31, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, black	6	6
Clay, gravelly, red brown	4	10
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	12

31-3W-31bbb.—Drillers log of test hole in NW NW NW sec. 31, T. 31 S., R. 3 W., on east side of road 30 feet south of corner; bored August 18, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Clay, tan, sandy, and gravel	4	7
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	8

31-4W-2aaa.—Drillers log of test hole in NE NE NE sec. 2, T. 31 S., R. 4 W., on south side of road at cement bridge west of corner; bored August 17, 1955. Surface altitude, 1,439.5 feet; depth to water, 19.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Silt, sandy, black	3	3
Silt, sandy, brown	2	5
Sand, fine to medium	2	7
Clay, sandy, tan	3	10
Clay, tan; contains much quartz gravel	5	15
Sand, fine	5	20
Sand, fine to medium	20	40

	Thickness, feet	Depth, feet
Sand, fine to coarse, and fine gravel	17	57
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	58

31-4W-12bbd2.—Drillers log of test hole in SE NW NW sec. 12, T. 31 S., R. 4 W., observation well 95 feet north of Luther Shetlar irrigation well; bored July 6, 1956. Surface altitude, 1,427.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Nebraskan terrace deposits		
Sand, fine to medium, clayey	5	5
Sand, fine to coarse	5	10
Clay, compact, sandy, tan	5	15
Clay, sandy, tan	5	20
Sand, fine to coarse	5	25
Sand and gravel	17	42
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	0.5	42.5

31-4W-14ddd.—Drillers log of test hole in SE SE SE sec. 14, T. 31 S., R. 4 W., on west side of road 25 feet north of corner; bored August 17, 1955. Surface altitude, 1,345.7 feet; depth to water, 10.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Sand, fine to medium, silty	6	6
Silt, black	2	8
Clay, gravelly, red	2	10
Clay, sandy, red	9	19
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red and green	1	20

31-4W-17ccc.—Drillers log of test hole in SW SW SW sec. 17, T. 31 S., R. 4 W., on east edge of road 30 feet north of intersection; bored August 16, 1955. Surface altitude, 1,341.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	2	2
Silt and clay, very sandy, black	3	5
Clay, dark gray; contains some gravel	2	7
Clay, very gravelly, buff	2	9
Gravel, medium; contains some fine to coarse sand and red clay	4	13
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red and green	1	14

31-4W-26ccc.—Drillers log of test hole in SW SW SW sec. 26, T. 31 S., R. 4 W., on north side of road 20 feet east of corner; bored August 17, 1955. Surface altitude, 1,304.5 feet; depth to water, 21.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, gravelly, tan	5	5
Gravel, fine to coarse, arkosic, and red clay	7	12
Sand, fine to medium; contains much red clay	5	17
Clay, red	16	33
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, greenish gray	2	35

31-4W-30bbb.—Drillers log of test hole in NW NW NW sec. 30, T. 31 S., R. 4 W., on south side of road 10 feet east of intersection; bored August 16, 1955. Surface altitude, 1,310.6 feet; depth to water, 25.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, sandy, red, and fine to medium gravel	8	8
Clay, sandy, tan to red tan	5	13
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and fine to medium gravel	29	42
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	43

31-4W-31bbb.—Drillers log of test hole in NW NW NW sec. 31, T. 31 S., R. 4 W., on east side of road 30 feet south of intersection; bored August 16, 1955. Surface altitude, 1,288.1 feet; depth to water, 17.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, tan	3	3
Clay, sandy, red tan	2	5
Illinoisan or Kansan terrace deposits		
Sand, medium to coarse	10	15
Sand, medium to coarse, and fine to medium gravel	12	27
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	28

31-4W-31ccc.—Drillers log of test hole in SW SW SW sec. 31, T. 31 S., R. 4 W., in center of intersection; bored August 16, 1955. Surface altitude, 1,276.9 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	2	2
Clay, sandy, red	5	7

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and fine to medium gravel	5	12
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	3	15

31-4W-31ddd.—Drillers log of test hole in SE SE SE sec. 31, T. 31 S., R. 4 W., on west side of road at tree 100 feet north of corner; bored August 15, 1955. Surface altitude, 1,291.0 feet; depth to water, 18.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	2	2
Clay, sandy, dark gray	2	4
Clay, sandy, buff to red	6	10
Clay, sandy, red	5	15
Illinoisan or Kansan terrace deposits		
Sand, fine to medium; contains some red clay	20	35
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, hard, red	1	36

32-2E-1abd.—Drillers log of test hole in SE NW NE sec. 1, T. 32 S., R. 2 E., four poles south of pole number 52820 along railroad track, in west ditch; bored June 28, 1956. Surface altitude, 1,149.4 feet; depth to water, 8.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, black	5	5
Clay, sandy	2	7
Sand, fine	8	15
Sand, medium coarse	6	21
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	21.5

32-2E-1dcd.—Drillers log of test hole in SE SW SE sec. 1, T. 32 S., R. 2 E., in east ditch at curve in road on east side of railroad track; bored June 27, 1956. Surface altitude, 1,143.2 feet; depth to water, 4.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, silty, brown	3	3
Clay, sandy	2	5
Clay, very sandy	5	10
Sand, fine	2	12
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	12.5

32-2E-7abb.—Sample log of test hole in NW NW NE sec. 7, T. 32 S., R. 2 E., about 0.5 mile east of NW corner; drilled May 11, 1944. Surface altitude 1,246.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, dark gray	1	1
Silt, clayey, tan	4	5
Silt, yellow tan; contains some coarse to fine sand	2	7
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellowish to light gray green	3	10

32-2E-7bbb.—Sample log of test hole in NW NW NW sec. 7, T. 32 S., R. 2 E., about 50 feet east of NW corner; drilled May 11, 1944. Surface altitude, 1,265.1 feet; depth to water, 28.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, dark gray brown; contains some coarse to fine sand	6	6
Silt, clayey, light gray green and light tan; contains some coarse to fine sand	4	10
Illinoisan or Kansan terrace deposits		
Silt, soft, yellow buff; contains much medium to fine sand and some fine gravel	12	22
Silt, buff	6	28
Silt, clayey, light gray, mottled yellow	7	35
Sand, coarse to fine; contains some fine gravel	2	37
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	3	40

32-2E-8abb.—Sample log of test hole in NW NW NE sec. 8, T. 32 S., R. 2 E., about 0.5 mile east of corner; drilled May 12, 1944. Surface altitude, 1,227.1 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, blocky, gray brown; contains some medium to fine gravel and sand	5	5
Illinoisan or Kansan terrace deposits		
Silt, clayey, gray; contains trace of medium to fine gravel and sand	3	8
Clay, light blue gray	11	19
Clay, light brown gray; contains trace of medium to fine gravel and sand	9	28
PERMIAN—Leonardian		
Wellington Formation		
Shale, green gray, yellow, and red	4	32

32-2E-8bbb.—Sample log of test hole in NW NW NW sec. 8, T. 32 S., R. 2 E., about 45 feet east of corner; drilled May 11, 1944. Surface altitude, 1,239.2 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt, brown; contains some gravel and fine sand	3	5
Silt, clayey, tan and gray; contains some coarse to fine gravel and sand	3	8
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green	2	10

32-2E-9bbb.—Sample log of test hole in NW NW NW sec. 9, T. 32 S., R. 2 E., about 60 feet east of NW corner; drilled May 12, 1944. Surface altitude, 1,245.7 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt, dark gray and brown; contains trace of medium to fine gravel and sand	3	5
Silt, yellow tan and light gray; contains some sand and medium to fine gravel	6	11
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some coarse to fine gravel	5.5	16.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and brown	3.5	20

32-2E-10aaa.—Sample log of test hole in NE NE NE sec. 10, T. 32 S., R. 2 E.; drilled May 13, 1944. Surface altitude, 1,201.4 feet; depth to water, 33.60 feet.

	Thickness, feet	Depth, feet
Road fill	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan; contains some coarse to fine sand	9	10
Silt, clayey, very light brown to light gray green	7	17
Illinoisan or Kansan terrace deposits		
Silt, soft, light yellow green; contains much fine sand,	4	21
Sand, medium to fine; contains some light-brown and light-green-gray clay, medium to fine gravel, and coarse sand	9	30
Sand, coarse to fine; contains some coarse to fine gravel and light-green-gray clay	8	38
PERMIAN—Leonardian		
Wellington Formation		
Shale, clayey, dull yellow and green gray	5	43
Shale, thin bedded, blue gray	3	46

32-2E-10bbb.—Sample log of test hole in NW NW NW sec. 10, T. 32 S., R. 2 E., about 100 feet east of corner; drilled May 12, 1944. Surface altitude, 1,215.7 feet; depth to water, 17.58 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan; contains scattered sand and gravel	9	9
Clay, light gray; contains much fine sand and gravel,	4	13
Illinoisan or Kansan terrace deposits		
Silt, light brown and light gray green; contains much coarse to fine sand	13	26
Sand, coarse to fine	8	34
Clay, light greenish gray; contains some coarse to fine sand	6	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and yellow gray; contains some cone-in-cone calcite	4	44

32-2E-11aaa.—Sample log of test hole in NE NE NE sec. 11, T. 32 S., R. 2 E., about 125 feet west of corner; drilled May 13, 1944. Surface altitude, 1,176.5 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt, light tan	13	15
Silt, clayey, buff	3	18
Illinoisan or Kansan terrace deposits		
Sand, coarse to medium; contains some fine gravel	2	20
Sand, coarse to fine; contains some coarse to fine gravel	6.5	26.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray green	0.5	27

32-2E-11cdd.—Drillers log of test hole in SE SE SW sec. 11, T. 32 S., R. 2 E., on south side of road in ditch 20 yards east of highway sign giving distance to towns west of Oxford; bored June 25, 1956. Surface altitude, 1,170.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, silty, sandy	5	5
Clay, sandy	10	15
Sand, clayey	5	20
Clay and weathered shale	5	25
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	26

32-2E-11ddd.—Drillers log of test hole in SE SE SE sec. 11, T. 32 S., R. 2 E., 30 feet north of Bisset Garage; bored June 26, 1956. Surface altitude, 1,181.6 feet; depth to water, 38.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Silt, brown	7	10
Silt, clayey	5	15
Clay, tan	10	25
Illinoisan or Kansan terrace deposits		
Clay, sandy	5	30
Sand, fine to medium	5	35
Sand, fine	5	40
Sand, fine, silty	3	43
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	43.5

32-2E-12bab.—Sample log of test hole in NW NE NW sec. 12, T. 32 S., R. 2 E., near center of north side of section; drilled May 13, 1944. Surface altitude, 1,166.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, light buff; contains much medium to fine sand	6	6
Sand, coarse to fine; contains some fine gravel	4	10
Gravel, medium to fine, and sand	3	13
PERMIAN—Leonardian		
Wellington Formation		
Shale, clayey, light green gray	3	16
Shale, blue gray	2	18

32-2E-13aaa.—Drillers log of test hole in NE NE NE sec. 13, T. 32 S., R. 2 E., on west side of road 10 feet south of corner; bored June 22, 1956. Surface altitude, 1,142.2 feet; depth to water, 6.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	2	2
Sand, fine	3	5
Sand, fine to medium	5	10
Sand, medium to coarse	10	20
Sand, coarse, and fine gravel	10	30
Sand and gravel, arkosic	12	42
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	42.5

32-2E-13aac1.—Drillers log of test hole in SW NE NE sec. 13, T. 32 S., R. 2 E., on south side of highway in borrow pit at gate to field, by irrigation well; bored September 10, 1955. Surface altitude, 1,143.8 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, tan	10	10
Gravel, fine to medium	20	30

32-2E-13abb.—Drillers log of test hole in NW NW NE sec. 13, T. 32 S., R. 2 E., 100 yards south of highway at end of row of cottonwood trees on east side of lane; bored June 27, 1956. Surface altitude, 1,141.9 feet; depth to water, 7.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, black	3	3
Silt, sandy, brown	2	5
Sand, fine	5	10
Sand, fine to medium	5	15
Sand, medium to coarse	15	30
Sand, coarse, and gravel	16	46
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	47

32-2E-13daa.—Drillers log of test hole in NE NE SE sec. 13, T. 32 S., R. 2 E., on west side of road 40 feet north of half-mile line and 70 feet south of south railroad track; bored June 22, 1956. Surface altitude, 1,142.2 feet; depth to water, 9.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	2	2
Sand, fine	8	10
Sand, fine to medium	10	20
Sand and gravel, arkosic	25	45
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	0.5	45.5

32-2E-13ddc.—Drillers log of test hole in SW SE SE sec. 13, T. 32 S., R. 2 E., on east side of dike 0.2 mile west of Lowell Green farmhouse and 100 feet north of pond; bored June 22, 1956. Surface altitude, 1,140.9 feet; depth to water, 7.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, tan	5	5
Sand, fine, silty	5	10
Sand, fine, clayey	5	15
Sand, medium to coarse	20	35

	Thickness, feet	Depth, feet
Sand and gravel, arkosic	10	45
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	45.5

32-2E-14bbb2.—Drillers log of test hole in NW NW NW sec. 14, T. 32 S., R. 2 E., on east side of road 30 feet south of highway; bored September 9, 1955. Surface altitude, 1,173.0 feet; depth to water, 12.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, brown	5	5
Clay, sandy, tan	5	10
Illinoisan or Kansan terrace deposits		
Sand, fine, clayey	5	15
Sand, fine to medium	10	25
Sand, fine to medium, clayey	10	35
Clay, sandy, gray	15	50
PERMIAN—Leonardian		
Wellington Formation		
Shale	2	52

32-2E-14dad.—Drillers log of test hole in SE NE SE sec. 14, T. 32 S., R. 2 E., 0.4 mile south of railroad tracks, just inside driveway on south side of small concrete bridge, west side of road; bored June 25, 1956. Surface altitude, 1,147.0 feet; depth to water, 4.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	5	5
Silt, sandy to clayey, black	5	10
Illinoisan or Kansan terrace deposits		
Clay, sandy	5	15
Sand, very fine, silty	9	24
PERMIAN—Leonardian		
Wellington Formation		
Shale	0.5	24.5

32-2E-14ddd.—Drillers log of test hole in SE SE SE sec. 14, T. 32 S., R. 2 E., in ditch at corner; bored June 26, 1956. Surface altitude, 1,155.9 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, red	5	5
Silt, sandy, red	10	15
Clay, sandy, brown	5	20
Clay, gray	5	25
Clay, gray, to weathered blue shale	3	28
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	29

32-2E-18cbb.—Drillers log of test hole in NW NW SW sec. 18, T. 32 S., R. 2 E., on east side of road 20 feet south of railroad; bored September 12, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, green	5	10
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan green	10	20

32-2E-25abb.—Drillers log of test hole in NW NW NE sec. 25, T. 32 S., R. 2 E., on west side of north-south road at corner just east of cottonwood tree; bored June 26, 1956. Surface altitude, 1,133.6 feet; depth to water, 6.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, black	3	3
Sand, fine, tan	2	5
Sand, fine to medium, tan	5	10
Sand, coarse, and gravel	10	20
Gravel, fine to medium	20	40
Gravel, coarse	3	43
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	44

32-2E-25ddd.—Drillers log of test hole in SE SE SE sec. 25, T. 32 S., R. 2 E., on north side of road 20 feet west of gate where trail goes south; bored September 13, 1955. Surface altitude, 1,128.4 feet; depth to water, 6.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, sandy, brown	5	5
Sand, fine to medium	10	15
Sand, fine to coarse	10	25
Sand, fine to coarse, and fine to medium gravel	13	38
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	1	39

32-2E-27ddd.—Drillers log of test hole in SE SE SE sec. 27, T. 32 S., R. 2 E., on north side of road 35 feet west of corner; bored September 13, 1955. Surface altitude, 1,171.4 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, red	5	5
Clay, sandy, light tan	5	10
Clay, sandy, green gray	5	15

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse	12	27
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	28

32-2E-36bbb.—Drillers log of test hole in NW NW NW sec. 36, T. 32 S., R. 2 E., on south side of road 30 feet east of corner; bored September 13, 1955. Surface altitude, 1,152.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, brown	5	5
Clay, red brown	5	10
Clay, greenish tan	5	15
Clay, green	8	23
Clay, sandy, gray green; probably contains weathered shale	2	25

32-1E-12bbb.—Sample log of test hole in NW NW NW sec. 12, T. 32 S., R. 1 E., about 70 feet east of NW corner; drilled May 11, 1944. Surface altitude, 1,296.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, gray brown to tan; contains coarse to fine sand	7	7
Silt, clayey, light gray; contains some coarse to fine sand	10	17
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some medium to fine gravel and silt	10.5	27.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and yellowish	2.5	30
Shale, hard and laminated, blue gray	4	34

32-1W-15bba.—Drillers log of test hole in NE NW NW sec. 15, T. 32 S., R. 1 W., on south side of road where fence line runs south on quarter-mile line; bored September 15, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, sandy, red	5	10
Illinoisan or Kansan terrace deposits		
Sand and gravel, red stained	5	15
Gravel, fine, and clay	5	20
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	3	23

32-1W-25bcc.—Drillers log of test hole in SW SW NW sec. 25, T. 32 S., R. 1 W., on east side of road about midway between house and half-mile corner at first power pole south of transformer; bored September 15, 1955. Surface altitude, 1,191.2 feet; depth to water, 30.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown	5	5
Silt, light brown	5	10
Illinoisan or Kansan terrace deposits		
Clay, brown, and fine gravel	10	20
Gravel, fine to coarse	20	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan	2	42

32-1W-26ddd.—Drillers log of test hole in SE SE SE sec. 26, T. 32 S., R. 1 W., on west side of road 400 feet south of Slate Creek at gap in hedge into field on west; bored September 15, 1955. Surface altitude, 1,166.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Clay, red	5	10
Clay, red brown	5	15
Clay, sandy, black	5	20
Sand, fine to medium	5	25
Clay	5	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	2	32

32-1W-30bbb.—Drillers log of test hole in NW NW NW sec. 30, T. 32 S., R. 1 W., on east side of road 30 feet south of corner; bored August 31, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, black	5	5
Clay, sandy and gravelly, red brown	7	12
Sand, fine to coarse, and red clay	2	14

32-1W-31bcc.—Drillers log of test hole in SW SW NW sec. 31, T. 32 S., R. 1 W., on east side of road 15 feet north of half-mile hedge; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, black	5	5
Clay, sandy, brown	5	10
Clay and fine to medium arkosic gravel	2	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	14

32-2W-8aaa.—Drillers log of test hole in NE NE NE sec. 8, T. 32 S., R. 2 W., on south side of road 20 feet west of corner; bored August 31, 1955. Surface altitude, 1,280.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, black	7	7
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	9

32-2W-8bbb.—Drillers log of test hole in NW NW NW sec. 8, T. 32 S., R. 2 W.; bored August 31, 1955. Surface altitude, 1,269.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, black	5	5
Clay, tan to black	2	7
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	9

32-2W-30cdc.—Drillers log of test hole in SW SE SW sec. 30, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 6, 1948, on north edge of road about 0.35 mile east of corner. Surface altitude, 1,225.0 feet; depth to water, 32.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, fine, sandy, brown to red brown; contains some gravel	16.5	19.5
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse; contains silt	14.5	34
Silt, sandy, brown	6.5	40.5
Sand and gravel, fine to coarse	7.5	48
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	49

32-2W-30cdd1.—Drillers log of test hole in SE SE SW sec. 30, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 3, 1948, about 0.4 mile east of corner. Surface altitude, 1,225.2 feet; depth to water, 32.50 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown; contains some gravel	4	6
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	4.5	10.5

	Thickness, feet	Depth, feet
Silt, sandy, brown	6.5	17
Sand and gravel, fine to coarse	1	18
Silt, sandy, brown; contains lenses of sand and gravel,	4	22
Sand and gravel, fine to coarse; contains thin beds of brown silt	18	40
Silt, fine sandy, brown	9	49
Sand and gravel, fine to coarse, clean	9	58
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	59

32-2W-30cdd2.—Drillers log of test hole in SE SE SW sec. 30, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 6, 1948, about 125 feet west of south quarter corner. Surface altitude, 1,221.7 feet; depth to water, 29.30 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown to red brown	14	16
Illinoisan or Kansan terrace deposits		
Sand, fine to medium; contains very little coarse sand and fine gravel	9	25
Sand and gravel, fine to coarse	6	31
PERMIAN—Leonardian		
Wellington Formation		
Shale, green, and thin bed of white limestone	1	32

32-2W-30cdd3—Drillers log of test hole in SE SE SW sec. 30, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 7, 1948, about 0.1 mile west of south quarter corner. Surface altitude, 1,225.1 feet; depth to water, 30.70 feet.

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown and gray; contains some gravel	15	18
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse, silty	17	35
Silt, sandy, brown	8	43
Silt, brown, and fine to coarse sand; contains some gravel	5	48
Sand and gravel, fine to coarse	4	52
PERMIAN—Leonardian		
Wellington Formation		
Shale, green and gray	0.5	52.5

32-2W-30dcc.—Drillers log of test hole in SW SW SE sec. 30, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 2, 1948, about 0.45 mile west of corner. Surface altitude, 1,208.2 feet; depth to water, 14.50 feet.

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to brown	3	6
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse; contains thin silt bed at 8.5 feet	9	15
Silt, sandy, brown	1	16
Sand and gravel, fine to coarse	4	20
Sand and gravel, fine to very coarse	8	28
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray, greenish gray, and pink tan	1	29

32-2W-30ddd.—Drillers log of test hole in SE SE SE sec. 30, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 3, 1948, on north edge of road at corner. Surface altitude, 1,204.0 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to gray brown	3.5	5.5
Silt and clay alternating with beds of sand and gravel,	5.5	11
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse; contains some fine to coarse gravel,	6	17
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	18

32-2W-31aab.—Drillers log of test hole in NW NE NE sec. 31, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 3, 1948, about 0.2 mile west of corner. Surface altitude, 1,204.5 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, dark gray and gray brown	9.5	11.5
Shale rubble	1.5	13
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan, gray, and green	1	14

32-2W-31dcd1.—Drillers log of test hole in SE SW SE sec. 31, T. 32 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 2, 1948, about 0.3 mile west of corner. Surface altitude, 1,197.4 feet; depth to water, 14.30 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown	3	5
Illinoisan or Kansan terrace deposits		
Silt, sandy, brown; contains lenses of sand and gravel,	5	10
Silt, sandy, brown	4	14
Silt, sandy, and gravel	4	18
Silt, sandy, brown	12.5	30.5
Silt, sandy, brown; contains thin lenses of fine to coarse sand	4.5	35
Sand and gravel, fine to coarse	6.5	41.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan to gray	0.5	42

32-3W-12abb.—Drillers log of test hole in NW NW NE sec. 12, T. 32 S., R. 3 W., on south side of road 125 feet east of half-mile hedge; bored August 31, 1955. Surface altitude, 1,273.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	7	7
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	8
Shale, green	2	10

32-3W-15ccb.—Drillers log of test hole in NW SW SW sec. 15, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, about 0.1 mile north of U. S. Highway 160 and 15 feet east of U. S. Highway 49. Surface altitude, 1,219.0 feet; depth to water, 19.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse; contains some fine to medium gravel	26	26
Sand and gravel, fine to coarse	5	31
Sand and gravel, fine to medium; contains some coarse gravel	10	41
Sand and gravel, fine to coarse	8	49
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	50

32-3W-16bbb.—Drillers log of test hole in NW NW NW sec. 16, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 28, 1948, about 110 feet south of corner. Surface altitude, 1,233.4 feet; depth to water, 14.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown to tan	7	7
Illinoisan or Kansan terrace deposits		
Sand, fine to medium; contains some coarse sand and fine to medium gravel	7	14
Silt and clay, sandy, red brown	6	20
Sand and gravel; composed chiefly of Permian shale grains	3	23
Silt and clay, red brown	1	24
Shale rubble	1.5	25.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray and green	0.5	26

32-3W-16bcb.—Drillers log of test hole in NW SW NW sec. 16, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 26, 1948, about 0.1 mile north of west quarter corner. Surface altitude, 1,235.1 feet; depth to water, 24.80 feet.

	Thickness, feet	Depth, feet
Road fill	1.5	1.5
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, brown and red brown; contains some fine to coarse gravel	5.5	7
Illinoisan or Kansan terrace deposits		
Silt and clay, sandy, red brown	3	10
Silt, sand, and gravel, poorly sorted	6	16
Sand and gravel, fine to coarse	24	40
Silt, red brown	5	45
Sand and gravel, fine to coarse	6.5	51.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	52.5

32-3W-16bcc.—Drillers log of test hole in SW SW NW sec. 16, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 25, 1948, at east edge of road at west quarter corner. Surface altitude, 1,231.3 feet; depth to water, 23.60 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown	3	4
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse	2	6

	Thickness, feet	Depth, feet
Silt and clay, sandy, red brown	3	9
Sand and gravel, fine to coarse	38	47
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	48

32-3W-16ccb.—Drillers log of test hole in NW SW SW sec. 16, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 25, 1948, on east edge of road 90 feet south of railroad track. Surface altitude, 1,228.4 feet; depth to water, 23.20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown	5	7
Silt, sand, and some gravel, fine to coarse, poorly sorted	3	10
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse; contains 4-inch bed of red-tan silt at 16 feet	10	20
Sand, fine to coarse; contains some fine to coarse gravel	5	25
Silt, sandy, gray tan	2	27
Sand, fine to medium; contains some coarse sand	3	30
Sand and gravel, fine to coarse	20	50
Silt, red brown	1	51
Sand and gravel, fine to coarse, mostly shale pebbles,	1	52
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	53

32-3W-17aad.—Drillers log of test hole in SE NE NE sec. 17, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 28, 1948, about 0.2 mile south of corner. Surface altitude, 1,233.6 feet; depth to water, 22.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown; contains some gravel,	7	7
Silt and clay, sandy, brown	3	10
Illinoisan or Kansan terrace deposits		
Silt, sand, and gravel, poorly sorted	3	13
Sand and gravel, fine to coarse	13	26
Silt and clay, sandy, red brown	4	30
Silt and shale rubble	1.5	31.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	0.5	32

32-3W-17daa.—Drillers log of test hole in NE NE SE sec. 17, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 25, 1948, at west edge of road about 0.4 mile north of corner. Surface altitude, 1,231.0 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown and red brown	10	11
Silt and clay, red brown	5.5	16.5
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse, and alternating beds of red-brown silt	13	29.5
Silt and clay, red brown	5.5	35
Sand, fine to coarse; contains some gravel. Thin bed of red-brown silt at 37 feet	5	40
Sand and gravel, fine to coarse; contains some silt	10	50
Sand and gravel, fine to coarse; contains thin beds of red-brown silt	8	58
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	59

32-3W-21aaa.—Drillers log of test hole in NE NE NE sec. 21, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 30, 1948, about 170 feet south of corner. Surface altitude, 1,214.5 feet; depth to water, 2.70 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse; contains silty layers at 5 to 8 feet	11	13
Sand and gravel, fine to medium, alternating with beds of brown sandy silt	9	22
Sand and gravel, fine to coarse	10	32
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green	1	33

32-3W-21bbb.—Drillers log of test hole in NW NW NW sec. 21, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 24, 1948, about 80 feet south of corner. Surface altitude, 1,224.4 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, fine, sandy, brown and red brown	4	5
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	20	25

	Thickness, feet	Depth feet
Silt, red tan	6	31
Sand and gravel, fine to coarse	9	40
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	0.5	40.5

32-3W-21bbc.—Drillers log of test hole in SW NW NW sec. 21, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 25, 1948, about 0.25 mile south of corner. Surface altitude, 1,218.4 feet; depth to water, 12.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown; contains some gravel,	5	5
Illinoisan or Kansan terrace deposits		
Silt, sand, and gravel, poorly sorted	5	10
Sand and gravel, fine to coarse	8	18
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	2	20

32-3W-21ccb.—Drillers log of test hole in NW SW SW sec. 21, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 24, 1948, about 0.25 mile north of corner. Surface altitude, 1,206.7 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1.5	1.5
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown and red brown; contains some gravel	6	7.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	1.5	9

32-3W-21dda.—Drillers log of test hole in NE SE SE sec. 21, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, 0.1 mile north of corner. Surface altitude, 1,209.5 feet; depth to water, 14.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown and gray brown	5	7
Illinoisan or Kansan terrace deposits		
Silt, sand, and gravel, poorly sorted	8	15
Sand and gravel, fine to coarse	4.5	19.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	0.5	20

32-3W-21ddd.—Drillers log of test hole in SE SE SE sec. 21, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, 60 feet north of road intersection on west edge of road. Surface altitude, 1,207.7 feet; depth to water, 14.40 feet.

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, gray brown to red brown; contains some sand and gravel	12	15
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	4.5	19.5
Silt, sandy, light to medium gray; contains some fine to coarse gravel	4.5	24
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	25

32-3W-22aad.—Drillers log of test hole in SE NE NE sec. 22, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 30, 1948, about 0.25 mile south of Highway 160 at west edge of road. Surface altitude, 1,205.0 feet; depth to water, 17.10 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt, gray to brown; contains sand and gravel	13	15
Silt, sandy, light gray	3	18
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	19	37
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray and gray green	1	38

32-3W-22add.—Drillers log of test hole in SE SE NE sec. 22, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 30, 1948, on west edge of road about 0.4 mile south of corner. Surface altitude, 1,216.0 feet; depth to water, 20.10 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown; contains some gravel	6	8
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	16.5	24.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light to medium gray	1	25.5

32-3W-22bbc.—Drillers log of test hole in SW NW NW sec. 22, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, 0.25 mile south of corner. Surface altitude, 1,219.1 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray brown and red brown	7	9
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	10

32-3W-22bcc.—Drillers log of test hole in SW SW NW sec. 22, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, about 75 feet north of half-mile line. Surface altitude, 1,211.5 feet; depth to water, 11.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown	4	4
Illinoisan or Kansan terrace deposits		
Silt, sand, and gravel, poorly sorted	3	7
Silt and clay, tan; contains some sand and gravel	4.5	11.5
Silt and clay, gray	2.5	14
Sand and gravel, fine to coarse	8.5	22.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1.5	24

32-3W-22cbc1.—Drillers log of test hole in SW NW SW sec. 22, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, about 0.1 mile south of west quarter corner. Surface altitude, 1,210.8 feet; depth to water, 12.30 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, red brown; contains some gravel,	7	8
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	16	24
Silt and clay	1	25
Sand and gravel, fine to coarse	3	28
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray to green gray	1	29

32-3W-22cbc2.—Drillers log of test hole in SW NW SW sec. 22, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 29, 1948, 0.25 mile north of corner. Surface altitude, 1,211.8 feet; depth to water, 14.20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, red brown and gray; contains some sand and gravel	6	9
Silt and clay, sandy, red brown, brown, and gray brown	11	20
Illinoisan or Kansan terrace deposits		
Silt, sandy, light gray	2	22
Sand and gravel, fine to coarse	11	33
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	34

32-3W-25ccc.—Drillers log of test hole in SW SW SW sec. 25, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 24, 1948, 425 feet east of corner. Surface altitude, 1,220.0 feet; depth to water, 45.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1.5	1.5
QUATERNARY—Pleistocene		
Colluvium		
Silt and sand, fine to coarse, reddish brown; contains some gravel	15	16.5
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, reddish brown	1.5	18
Silt and sand, reddish brown; contains some very coarse gravel	6	24
Sand and gravel, fine to coarse; contains much fine sand	31	55
Silt, sand, and gravel	5	60
Sand and gravel, fine to coarse; contains much fine sand	4.5	64.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and gray green	1.5	66

32-3W-26ccd.—Drillers log of test hole in SE SW SW sec. 26, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 13, 1948, about 0.2 mile east of corner. Surface altitude, 1,203.0 feet; depth to water, 12.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, light to dark brown; contains much sand and gravel in lower part	13	13

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Silt, sandy, white	2	15
Silt, sandy, brown	1	16
Sand and gravel, fine to coarse	2	18
PERMIAN—Leonardian		
Wellington Formation		
Shale, brown	1	19

32-3W-27bbb.—Drillers log of test hole in NW NW NW sec. 27, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, about 0.1 mile south of corner. Surface altitude, 1,205.2 feet; depth to water, 15.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1.5	1.5
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, tan to brown; contains much sand and gravel	5.5	7
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	6	13
Silt, fine, sandy, tan to brown and light gray	10.5	23.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	0.5	24

32-3W-27bbc.—Drillers log of test hole in SW NW NW sec. 27, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, about 0.25 mile south of corner. Surface altitude, 1,202.2 feet; depth to water, 17.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, light to dark brown gray	21	22
Illinoisan or Kansan terrace deposits		
Gravel, fine to coarse, and sand	2	24
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	1	25

32-3W-27ddc1.—Drillers log of test hole in SW SE SE sec. 27, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 13, 1948, on north edge of road about 0.15 mile west of corner. Surface altitude, 1,196.0 feet; depth to water, 26.70 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, medium to dark gray	3	5
Silt and clay, sandy, brown; contains some gravel	23.5	28.5

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	18.5	47
Gravel and shale rubble, very coarse, and sand; contains silt	3	50
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	51

32-3W-27ddc2.—Drillers log of test hole in SW SE SE sec. 27, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, about 0.25 mile west of corner. Surface altitude, 1,194.4 feet; depth to water, 25.40 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, light to dark brown	5	7
Silt and clay, brown; contains some sand and gravel and lime-cemented nodules of silt in upper 5 feet	20	27
Illinoisan or Kansan terrace deposits		
Silt, sandy, brown	2	29
Sand and gravel, fine to coarse	13	42
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray to green	1	43

32-3W-29aaa.—Drillers log of test hole in NE NE NE sec. 29, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 24, 1948, 65 feet south of corner. Surface altitude, 1,204.0 feet; depth to water, 21.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1.5	1.5
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, fine, sandy, brown and red brown	7.5	9
Illinoisan or Kansan terrace deposits		
Sand, fine to medium; contains some coarse sand, fine to coarse gravel, and red-brown silt	17	26
Silt, fine, sandy, red brown	1.5	27.5
Sand, fine to coarse; contains some fine to coarse gravel	12.5	40
Sand and gravel, fine to coarse; contains large percentage of fine to medium sand	5.5	45.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	0.5	46

32-3W-29aad.—Drillers log of test hole in SE NE NE sec. 29, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 24, 1948, about 0.25 mile south of corner. Surface altitude, 1,193.8 feet; depth to water, 12.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, fine, sandy, red brown	2	3
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and fine to coarse gravel	13	16
Silt and clay, red brown	2	18
Sand, fine to coarse, and fine to medium gravel	13	31
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue and green	1	32

32-3W-29add.—Drillers log of test hole in SE SE NE sec. 29, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 24, 1948, at east quarter corner. Surface altitude, 1,185.1 feet; depth to water, 6.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt and sand, fine to coarse, red brown	4	4
Sand and gravel, fine to coarse	6	10
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue and red	0.5	10.5

32-3W-29bcb.—Drillers log of test hole in NW SW NW sec. 29, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 26, 1948, about 0.5 mile north of north end of river bridge. Surface altitude, 1,183.1 feet; depth to water, 12.20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown and red brown	21	23
Illinoisan or Kansan terrace deposits		
Silt, fine, sandy, gray	10	33
Sand and gravel, fine to coarse; contains thin layer of gray silt at 35 feet	4	37
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue	1	38

32-3W-29cbc.—Drillers log of test hole in SW NW SW sec. 29, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 26, 1948, about 0.13 mile north of north end of bridge. Surface altitude, 1,192.6 feet; depth to water, 26.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand, fine to medium, loose	10	10
Illinoisan or Kansan terrace deposits		
Silt and clay; brown	15	25
Silt and clay, sandy, brown	3	28
Silt and clay, sandy, brown; contains some coarse gravel	2.5	30.5
Sand and gravel, fine to coarse; contains few thin beds of blue-gray soft silt	9.5	40
Sand and gravel, fine to coarse	7	47
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	48

32-3W-29ccb.—Drillers log of test hole in NW SW SW sec. 29, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, June 26, 1948, on east edge of road 180 feet north of north end of bridge. Surface altitude, 1,171.8 feet; depth to water, 6.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, brown; contains sand and gravel	7	7
Sand and gravel, fine to coarse	3	10
Sand, fine to coarse; contains some fine to coarse gravel	10	20
Sand, fine to medium	4	24
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	1	25

32-3W-34aad.—Drillers log of test hole in SE NE NE sec. 34, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, about 0.15 mile south of corner. Surface altitude, 1,190.7 feet; depth to water, 20.60 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt and clay, sandy, brown; contains some sand and gravel	11	13
Sand, fine to coarse; contains some gravel	1	14
Silt, sandy, brown	2	16

	Thickness, feet	Depth, feet
Sand and gravel, fine to coarse	22.5	38.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light greenish gray	1	39.5

32-3W-34ada.—Drillers log of test hole in NE SE NE sec. 34, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 13, 1948, about 0.35 mile south of corner. Surface altitude, 1,188.2 feet; depth to water, about 20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to brown	8	10
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	26	36
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray to green	1	37

32-3W-36ccd.—Drillers log of test hole in SE SW SW sec. 36, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 7, 1948, 0.25 mile east of corner. Surface altitude, 1,210.6 feet; depth to water, 30.20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	3	3
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to brown and red brown	16	19
Illinoisan or Kansan terrace deposits		
Silt and sand, fine to medium; contains some gravel	5	24
Sand and gravel, fine to coarse	14	38
PERMIAN—Leonardian		
Wellington Formation		
Shale, green; contains thin bed of hard tan limestone at top	1	39

32-3W-36cdc.—Drillers log of test hole in SW SE SW sec. 36, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 9, 1948, about 0.4 mile east of corner. Surface altitude, 1,211.3 feet; depth to water, 30.70 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown to red brown; contains much sand and gravel	16	18
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	3.5	21.5

	Thickness, feet	Depth, feet
Silt, brown	1	22.5
Sand and gravel, fine to coarse	1.5	24
Silt, brown	1	25
Sand and gravel, fine to coarse	2.5	27.5
Silt, brown	0.5	28
Sand and gravel, fine to coarse	13	41
PERMIAN—Leonardian		
Wellington Formation		
Shale, light green gray	1	42

32-3W-36cdd.—Drillers log of test hole in SE SE SW sec. 36, T. 32 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 9, 1948, about 200 feet west of south quarter corner. Surface altitude, 1,212.0 feet; depth to water, 31.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to gray brown and brown; contains some fine to coarse gravel	13	15
Silt and clay, brown	12	27
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	16.5	43.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, brown, gray, and green	1	44.5

32-4W-4abb.—Drillers log of test hole in NW NW NE sec. 4, T. 32 S., R. 4 W., on south side of road 100 feet west of east end of hedge row; bored August 16, 1955. Surface altitude, 1,298.6 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	2	2
Silt and clay, sandy, tan	3	5
Clay, sandy, red	5	10
Illinoisan or Kansan terrace deposits		
Gravel, fine to medium; contains some red clay	5	15
Clay, sandy, red	5	20

32-4W-5aaa.—Drillers log of test hole in NE NE NE sec. 5, T. 32 S., R. 4 W., on south side of road at tree 170 feet west of corner; bored August 15, 1955. Surface altitude, 1,286.9 feet; depth to water, 16.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	1	1
Silt and clay, tan	4	5
Clay, silty, red tan	8	13

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Gravel, fine to coarse; contains some clay	2	15
Clay, sandy, red	15	30
Sand, fine; contains much red clay	15	45
Sand, fine to medium, clayey	5	50
Gravel, fine to coarse	10	60
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	2	62

32-4W-6add.—Drillers log of test hole in SE SE NE sec. 6, T. 32 S., R. 4 W., on west side of road 15 feet north of half-mile line; bored August 15, 1955. Surface altitude, 1,282.3 feet; depth to water, 12.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, tan	2	2
Clay, sandy, red tan	3	5
Clay, red	5	10
Clay, sandy, red	3	13
Illinoisan or Kansan terrace deposits		
Sand, fine to medium; contains some red clay	11	24
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	25

32-4W-7ddd.—Drillers log of test hole in SE SE SE sec. 7, T. 32 S., R. 4 W., on west side of road 40 feet north of blacktop; bored August 13, 1955. Surface altitude, 1,260.1 feet; depth to water, 13.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Sand, fine to medium, silty	8	8
Clay, sandy, red	2	10
Sand, fine; contains much red clay	5	15
Clay, sandy, red	7	22
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, hard, red	2	24

32-4W-8bbb.—Drillers log of test hole in NW NW NW sec. 8, T. 32 S., R. 4 W., on east edge of road 70 feet south of mail box on corner; bored August 15, 1955. Surface altitude, 1,267.5 feet; depth to water, 11.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, tan to brown	2	2
Clay, sandy, red tan	5	7
Illinoisan or Kansan terrace deposits		
Clay, very sandy, red tan	23	30
Sand, fine to medium; contains much red clay	8	38

	Thickness, feet	Depth, feet
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, sandy, very hard, red	2	40

32-4W-8bcc.—Drillers log of test hole in SW SW NW sec. 8, T. 32 S., R. 4 W., on east edge of road 50 feet north of half-mile line, across road from pump; bored August 15, 1955. Surface altitude, 1,262.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, black	2	2
Silt, very sandy, reddish	1	3
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to medium; contains some red clay	2	5
Sand, fine to medium	3	8
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	9

32-4W-9ccc4.—Drillers log of well in SW SW SW sec. 9, T. 32 S., R. 4 W. Drilled by Wichita Pump and Supply Co. for city of Argonia in 1955. Surface altitude, 1,261.6 feet; depth to water, 29.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Soil and red clay	22	22
Sand and red clay	13	35
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	39.5	74.5

32-4W-17bcc.—Drillers log of test hole in SW SW NW sec. 17, T. 32 S., R. 4 W., on the east side of road 70 feet north of railroad track; bored August 13, 1955. Surface altitude, 1,244.7 feet; depth to water, 12.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, very sandy, dark gray	2	2
Silt, black	1	3
Sand, fine to medium, gray to tan	2	5
Sand, fine to medium, tan	5	10
Sand, fine to medium, gray to tan	3	13
Clay, sandy to silty, tan	2	15
Sand, fine, clayey, tan	30	45
Clay, black gray	2	47
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, hard, red	1	48

32-4W-17ccc.—Drillers log of test hole in SW SW SW sec. 17, T. 32 S., R. 4 W., on north edge of road at corner and 15 feet east of power pole 815; bored August 13, 1955. Surface altitude, 1,246.6 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Dune sand		
Sand; contains some red clay	1	1
Sand, fine to medium, light tan	9	10
Wisconsinan terrace deposits		
Sand, medium, tan to gray	3	13
Sand and gravel; contains some red clay	3	16
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, very hard, red and greenish tan	2	18

32-4W-18dda.—Drillers log of test hole in NE SE SE sec. 18, T. 32 S., R. 4 W., on west side of road at northeast corner of farmyard; bored August 13, 1955. Surface altitude, 1,243.8 feet; depth to water, 11.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, sandy, black	1	1
Sand, fine, clayey, tan	4	5
Sand, fine, light tan	1	6
Silt, dark brown	2	8
Sand, silty, tan	2	10
Clay, fine to medium, sandy, red	10	20
Sand, fine to medium; contains much red clay	5	25
Sand, fine, silty	12	37
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, hard, red	3	40

32-4W-21bbb.—Drillers log of test hole in NW NW NW sec. 21, T. 32 S., R. 4 W., in triangle formed by roads, straight east of south house; bored August 18, 1955. Surface altitude, 1,242.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Silt, black	3	3
Sand, fine to coarse; contains some red clay	11	14
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	15

32-4W-28bbb.—Drillers log of test hole in NW NW NW sec. 28, T. 32 S., R. 4 W., at east side of road 10 feet west of big cottonwood tree; bored August 18, 1955. Surface altitude, 1,238.4 feet; depth to water, 23.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Sand, fine, tan	5	5
Silt, sandy, black	2	7
Silt, tan	8	15

	Thickness, feet	Depth, feet
Sand, fine to medium	10	25
Clay, sandy, dark gray to brown	5	30
Sand, fine to medium, clayey	25	55
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	1	56

32-4W-28cbb.—Drillers log of test hole in NW NW SW sec. 28, T. 32 S., R. 4 W., on east side of road across from catalpa grove; bored August 18, 1955. Surface altitude, 1,231.4 feet; depth to water, 15.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, tan	3	3
Silt, sandy, black	2	5
Clay, dark gray	5	10
Sand, fine to medium	5	15
Clay, sandy, tan	5	20
Clay, dark gray	10	30
Sand, fine, clayey	16	46
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, green	1	47

33-2E-6cbb.—Drillers log of test hole in NW NW SW sec. 6, T. 33 S., R. 2 E., on east side of road at half-mile hedge line; bored September 12, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt, light gray	2	7
Clay, sandy, buff	3	10
Clay, brown	5	15
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse	5	20
Sand, clayey	5	25
Clay, green; probably weathered shale	5	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, soft, green	15	45

33-2E-10aaa.—Drillers log of test hole in NE NE NE sec. 10, T. 33 S., R. 2 E., on south side of road 15 feet west of corner; bored September 13, 1955. Surface altitude, 1,145.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and fine to medium gravel	9	14

	Thickness, feet	Depth, feet
Clay, sandy, green tan	6	20
PERMIAN—Leonardian		
Wellington Formation		
Shale, blue gray	5	25

33-2E-14ccc.—Drillers log of test hole in SW SW SW sec. 14, T. 33 S., R. 2 E., on east side of road 30 feet north of corner; bored September 13, 1955. Surface altitude, 1,134.8 feet; depth to water, 23.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, brown	5	5
Silt and clay, red brown	5	10
Clay, sandy, red	10	20
Illinoisan or Kansan terrace deposits		
Sand, fine to medium	20	40
Sand, fine to medium, and fine to medium gravel	13	53
PERMIAN—Leonardian		
Wellington Formation		
Shale	4	57

33-2E-22ccc.—Sample log of test hole in SW SW SW sec. 22, T. 33 S., R. 2 E., about 20 feet east of corner; drilled May 10, 1944. Surface altitude, 1,114.7 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, gray and buff; contains sand and fine gravel	8	10
Clay, gray	6.5	16.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and gray	3.5	20

33-2E-23cdd.—Sample log of test hole in SE SE SW sec. 23, T. 33 S., R. 2 E., about 0.5 mile west of corner; drilled May 10, 1944. Surface altitude, 1,108.8 feet; depth to water, 3.75 feet.

	Thickness, feet	Depth, feet
Road fill	2	2
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, clayey, gray black	5	7
Silt, clayey, light buff gray; contains much medium to fine sand	6.5	13.5
Sand, coarse to fine; contains some fine gravel	2.5	16
Gravel, medium to fine, and sand; contains some clay,	4.5	20.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, laminated, gray and dull greenish gray	9.5	30

33-2E-23ddd.—Sample log of test hole in SE SE SE sec. 23, T. 33 S., R. 2 E., about 45 feet west of corner; drilled May 9, 1944. Surface altitude, 1,127.3 feet; depth to water, 9.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan; contains some sand and medium to fine gravel	7	7
Silt, light tan; contains some coarse to fine gravel and sand	2.5	9.5
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some medium to fine gravel	2.5	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, purple and gray green	2	14

33-2E-25abb.—Sample log of test hole in NW NW NE sec. 25, T. 33 S., R. 2 E., about 0.5 mile west of corner; drilled May 9, 1944. Surface altitude, 1,124.5 feet; depth to water, 12.65 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, tan	10	10
Silt, clayey, yellow buff	2.5	12.5
Illinoisan or Kansan terrace deposits		
Sand, coarse to fine; contains some medium to fine gravel	2.5	15
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green	2	17

33-2E-26aab.—Drillers log of test hole in NW NE NE sec. 26, T. 33 S., R. 2 E., bored September 13, 1955. Surface altitude, 1,144.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Illinoisan or Kansan terrace deposits		
Sand, fine to medium	5	5
Sand, fine to coarse	8	13
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	12	25

33-2E-26bba.—Drillers log of test hole in NE NW NW sec. 26, T. 33 S., R. 2 E., on south side of road 250 feet west of large dead elm tree on north side of road; bored September 13, 1955. Surface altitude, 1,110.4 feet; depth to water, 4.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt and clay, black	51	51
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	52

33-1E-12add.—Drillers log of test hole in SE SE NE sec. 12, T. 33 S., R. 1 E., on west side of road 25 feet north of Slate Creek bridge; bored September 12, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	10	10
Clay, red	4	14
Sand, fine to medium	1	15
PERMIAN—Leonardian		
Wellington Formation		
Rock, very hard	1	16

33-1W-2dcc.—Drillers log of test hole in SW SW SE sec. 2, T. 33 S., R. 1 W., on north side of road 30 feet east of railroad track; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	4	4
Clay, tan black	2	6
Clay, red tan	6	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	14

33-1W-3ccc.—Drillers log of test hole in SW SW SW sec. 3, T. 33 S., R. 1 W., on north side of road 40 feet east of intersection; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, tan	2	7
Clay, sandy, tan; contains some gravel	5	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, green to gray	2	14

33-1W-5dcc.—Drillers log of test hole in SW SW SE sec. 5, T. 33 S., R. 1 W., on north side of road 5 feet east of half-mile line; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, red tan	5	10
Clay, sandy	5	15
Clay, greenish gray	2	17
PERMIAN—Leonardian		
Wellington Formation		
Shale, green to gray	3	20

33-1W-13bcc.—Drillers log of test hole in SW SW NW sec. 13, T. 33 S., R. 1 W., on east side of road 30 feet north of half-mile line; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Clay, greenish gray	2	5
Clay, sandy, red tan	7	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	3	15

33-1W-19ccc.—Drillers log of test hole in SW SW SW sec. 19, T. 33 S., R. 1 W., on north side of road 30 feet east of corner; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black to dark gray	5	5
Clay, red	7	12
Illinoisan or Kansan terrace deposits		
Clay, sandy, gray tan	3	15
Clay, very sandy, tan to green gray	4	19
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	20

33-1W-26aaa.—Drillers log of test hole in NE NE NE sec. 26, T. 33 S., R. 1 W., in south grader ditch 20 feet west of corner; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, sandy and gravelly, red	5	5
Illinoisan or Kansan terrace deposits		
Gravel, fine to medium, arkosic	7	12
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	13

33-2W-2bbb.—Drillers log of test hole in NW NW NW sec. 2, T. 33 S., R. 2 W., on north side of road 15 feet east of corner; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	4	4
Silt, gray tan	4	8
Clay, sandy, red tan	4	12
Clay, sandy, red	8	20

33-2W-5bbb.—Drillers log of test hole in NW NW NW sec. 5, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 2, 1948, about 0.1 mile east of corner. Surface altitude, 1,211.3 feet; depth to water, 28.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	4	4
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, light gray to brown	11	15
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	22.5	37.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light gray and red	0.5	38

33-2W-6aaa.—Drillers log of test hole in NE NE NE sec. 6, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 2, 1948, about 60 feet west of corner. Surface altitude, 1,212.2 feet; depth to water, 28.20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to brown and tan	16.5	18.5
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	15.5	34
Sand, fine to coarse, silty; contains some gravel	11	45
Silt, fine, sandy, brown	12.5	57.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, light greenish gray	0.5	58

33-2W-6aab2.—Drillers log of test hole in NW NE NE sec. 6, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 2, 1948, about 0.2 mile west of corner. Surface altitude, 1,194.7 feet; depth to water, 11.20 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, dark gray to black	5.5	7.5
Silt, sand, and gravel, poorly sorted	1.5	9
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine	2	11
Silt, sandy, gray tan	2	13
Sand and gravel, fine to coarse	6	19
Silt, sandy, brown	11	30
Sand and gravel, fine to coarse	20	50
PERMIAN—Leonardian		
Wellington Formation		
Shale, light greenish gray	0.5	50.5

33-2W-6baa.—Drillers log of test hole in NE NE NW sec. 6, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 1, 1948, about 250 feet west of north quarter corner. Surface altitude, 1,217.1 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown	14	16
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, silty; contains some fine to coarse gravel	10	26
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray and red	1	27

33-2W-6bba.—Drillers log of test hole in NE NW NW sec. 6, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 1, 1948, about 0.25 mile east of corner. Surface altitude, 1,215.7 feet; depth to water, 21.50 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to gray brown and brown	9	11
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse; contains small percentage of fine to coarse gravel	12	23
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray green and red	1	24

33-2W-6ddd1.—Drillers log of test hole in SE SE SE sec. 6, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 13, 1948, about 0.1 mile west of corner. Surface altitude, 1,180.9 feet; depth to water, 8.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown	9	9
Silt and clay; contains sand and gravel	3	12
Silt and clay, sandy, dark gray	7	19
Silt, blue gray; contains much sand and gravel	9	28
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	5.5	33.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	0.5	34

33-2W-6ddd2.—Drillers log of test hole in SE SE SE sec. 6, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 9, 1948, 60 feet north of corner. Surface altitude, 1,198.1 feet; depth to water, 26.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown; contains fine sand to fine gravel	3.5	3.5
Silt and clay, dark gray	3.5	7
Silt and clay, fine, sandy, brown	10.5	17.5
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to medium; contains some coarse gravel	1.5	19
Clay, light to dark gray and gray brown	4.5	23.5
Sand and gravel, fine to medium; contains some coarse gravel	6.5	30
Sand and gravel, fine to coarse	20	50
Sand and gravel, fine to coarse; contains thin lenses of brown silt	6.5	56.5
PERMIAN—Leonardian		
Wellington Formation		
Limestone, hard, light gray, and green shale	0.5	57

33-2W-8aab.—Drillers log of test hole in NW NE NE sec. 8, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 13, 1948, on south edge of road, 0.25 mile west of corner. Surface altitude, 1,196.7 feet; depth to water, 14.90 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown	3	5
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to medium	2	7
Silt and clay, sandy, tan brown and gray	11	18
Sand and gravel, fine to medium; contains silt	2	20
Sand and gravel, fine to coarse	5.5	25.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, red, green, and gray brown	0.5	26

33-2W-8abb.—Drillers log of test hole in NW NW NE sec. 8, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 12, 1948, about 230 feet east of north quarter corner. Surface altitude, 1,209.3 feet; depth to water, 29.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to reddish brown, tan, and gray tan	23.5	25.5
Illinoisan or Kansan terrace deposits		
Sand and gravel, silty	3.5	29

	Thickness, feet	Depth, feet
Sand and gravel, fine to coarse	11.5	40.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, green and red	0.5	41

33-2W-8bab.—Drillers log of test hole in NW NE NW sec. 8, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 12, 1948, about 0.25 mile east of corner. Surface altitude, 1,211.4 feet; depth to water, 21.70 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray brown to brown and tan	13	15
Silt, soft, sandy, tan to brown	15	30
Illinoisan or Kansan terrace deposits		
Clay, light gray	2	32
Sand and gravel, fine to coarse	7	39
PERMIAN—Leonardian		
Wellington Formation		
Shale, light greenish gray	1	40

33-2W-8bba.—Drillers log of test hole in NE NW NW sec. 8, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 9, 1948, 0.25 mile east of corner. Surface altitude, 1,202.7 feet; depth to water, 24.60 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, light to dark brown; contains lenses of fine to medium sand in lower 5 feet	13	14
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	9.5	23.5
Silt, sandy, brown	4	27.5
Sand and gravel	0.5	28
Silt, sandy, brown	23.5	51.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, soft, red, brown, and green	2.5	54

33-2W-8bbb1.—Drillers log of test hole in NW NW NW sec. 8, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 13, 1948, about 270 feet east of corner. Surface altitude, 1,205.3 feet; depth to water, 32.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to brown	18	18
Silt, sand, and gravel, poorly sorted	2	20
Silt and clay, brown; contains lenses of sand	6.5	26.5

	Thickness, feet	Depth, feet
Silt and clay, sandy, dark gray	2.5	29
Silt and clay, sandy, light gray	1	30
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	3.5	33.5
Silt, brown	1.5	35
Sand, fine to medium, silty	8	43
Silt, brown	0.5	43.5
Sand and gravel, fine to coarse	6.5	50
Sand and gravel, fine to coarse; contains thin beds of brown silt	10	60
Gravel, fine to coarse, and sand	6	66
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and gray	1	67

33-2W-8bbb2.—Drillers log of test hole in NW NW NW sec. 8, T. 33 S., R. 2 W. Drilled by Latta and Fent for city of Wellington, July 9, 1948, about 0.1 mile east of corner. Surface altitude, 1,202.4 feet; depth to water, 30.70 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown to red brown; contains small caliche nodules	18	18
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse; contains some fine to medium gravel	4	22
Silt and clay, light gray to brown	6	28
Silt, brown, and fine to medium sand	12	40
Silt and sand, fine to coarse	10	50
Sand and gravel, fine to coarse; contains thin beds of brown silt	11	61
Silt, brown	2	63
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and light gray	1	64

33-2W-9abb.—Drillers log of test hole in NW NW NE sec. 9, T. 33 S., R. 2 W., on south side of road 10 feet east of half-mile line; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt and clay, sandy, red tan	2	7
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to medium, and clay	5	12
Clay, sandy, red; contains some coarse limestone gravel,	12	24

33-2W-12aaa.—Drillers log of test hole in NE NE NE sec. 12, T. 33 S., R. 2 W., on south side of road 50 feet west of corner; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan to black	5	5
Clay, green gray	5	10
Clay, sandy, tan	5	15
Clay, dark gray	1	16
Illinoisan or Kansan terrace deposits		
Clay, sandy; contains some gravel	4	20
Clay, sandy, red	5	25
Clay, very sandy, light gray	5	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray	5	35

33-2W-13add.—Drillers log of test hole in SE SE NE sec. 13, T. 33 S., R. 2 W., on west side of road 20 feet north of half-mile hedge; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Clay, black	5	5
Clay, tan brown	2	7
Clay, sandy, brown	5	12
Clay, sandy, tan brown	8	20
Illinoisan or Kansan terrace deposits		
Clay, sandy, tan to red; contains some gravel at bottom	7	27
Clay, sandy, greenish tan	5	32
PERMIAN—Leonardian		
Wellington Formation		
Shale, green and red	2	34

33-2W-29aaa.—Drillers log of test hole in NE NE NE sec. 29, T. 33 S., R. 2 W., on south side of road 25 feet west of corner; bored August 29, 1955. Surface altitude, 1,174.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Silt and clay, black	2	5
Clay, gravelly, greenish gray	7	12
Illinoisan or Kansan terrace deposits		
Clay, sandy, red	5	17
Sand, very fine; contains some red clay	2	19
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	20

33-2W-33bbb.—Drillers log of test hole in NW NW NW sec. 33, T. 33 S., R. 2 W., on south side of road 15 feet east of corner; bored August 29, 1955. Surface altitude, 1,163.6 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, black	3	3
Clay, tan gray	4	7
Illinoisan or Kansan terrace deposits		
Sand, fine to medium	15	22
PERMIAN—Leonardian		
Wellington Formation		
Shale, green and red	1	23

33-3W-1aaa.—Drillers log of test hole in NE NE NE sec. 1, T. 33 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 1, 1948, about 120 feet west of corner. Surface altitude, 1,213.3 feet; depth to water, 16.70 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, gray to brown	2	4
Silt, sandy, brown; contains thin beds of sand and gravel	5	9
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	9	18
PERMIAN—Leonardian		
Wellington Formation		
Shale, gray and pink brown	1	19

33-3W-1aba.—Drillers log of test hole in NE NW NE sec. 1, T. 33 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 1, 1948, about 0.1 mile east of north quarter corner. Surface altitude, 1,207.8 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, gray to brown	9.5	11.5
Silt, sandy, tan to brown; contains thin beds of fine to coarse brown sand	3.5	15
Illinoisan or Kansan terrace deposits		
Silt and clay, sandy, brown	10	25
Sand and gravel, fine to coarse	5	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, yellow green	0.5	30.5

33-3W-1abb.—Drillers log of test hole in NW NW NE sec. 1, T. 33 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 1, 1948, about 110 feet east of north quarter corner. Surface altitude, 1,210.6 feet; depth to water, 31.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, gray to red brown; contains gravel in lower part	13	15
Silt and clay, brown	12	27
Illinoisan or Kansan terrace deposits		
Sand and gravel, fine to coarse	18	45
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	46

33-3W-2bba.—Drillers log of test hole in NE NW NW sec. 2, T. 33 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, about 0.25 mile east of corner. Surface altitude, 1,191.5 feet; depth to water, 20.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	1	1
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, sandy, brown, red brown, and light gray,	11	12
Illinoisan or Kansan terrace deposits		
Sand, fine to medium	2	14
Silt, sandy, brown	4	18
Sand, fine to coarse; contains some gravel	12	30
Sand and gravel, fine to coarse	11	41
Silt, sand, and gravel, fine to coarse	4.5	45.5
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	0.5	46

33-3W-10aaa1.—Drillers log of test hole in NE NE NE sec. 10, T. 33 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, on south edge of road 90 feet west of west end of bridge. Surface altitude, 1,152.1 feet; depth to water, 5.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt and sand, fine to coarse	6	6
Sand and gravel, fine to coarse	5.5	11.5
Silt and clay, gray to brown; contains some sand	12.5	24
Sand, fine to coarse; contains some gravel and much silt	3	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	28

33-3W-10aba.—Drillers log of test hole in NE NW NE sec. 10, T. 33 S., R. 3 W. Drilled by Latta and Fent for city of Wellington, July 14, 1948, about 400 feet west of west end of bridge. Surface altitude, 1,151.7 feet; depth to water, 3.00 feet.

	Thickness, feet	Depth, feet
Road fill and soil	2	2
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine to coarse; contains some fine to coarse gravel,	7	9
Silt, sandy, tan	13	22
Sand, fine to coarse; contains some fine to coarse gravel,	5	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	28

33-3W-10dcd.—Drillers log of test hole in SE SW SE sec. 10, T. 33 S., R. 3 W., on north side of road at west end of hedge row; bored August 19, 1955. Surface altitude, 1,162.6 feet; depth to water, 18.80 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt and fine sand, tan	5	5
Silt, dark brown	5	10
Clay, sandy, red brown	15	25
Clay, dark gray to brown	20	45
Sand, fine to coarse	5	50
PERMIAN—Leonardian		
Wellington Formation		
Shale	2	52

33-3W-12add.—Drillers log of test hole in SE SE NE sec. 12, T. 33 S., R. 3 W., in driveway to schoolhouse on west side of Highway 49; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	4	4
Silt, tan	2	6
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and gravel	4	10
Sand and gravel, clayey	3	13
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and gray	1	14

33-3W-15bbb.—Drillers log of test hole in NW NW NW sec. 15, T. 33 S., R. 3 W., on south side of road 30 feet east of corner; bored August 18, 1955. Surface altitude, 1,164.8 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, reddish brown	15	15
Clay, reddish brown	28	43
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	44

33-3W-24aaa.—Drillers log of test hole in NE NE NE sec. 24, T. 33 S., R. 3 W., on west side of Highway 49 10 feet south of corner; bored August 30, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Silt, tan	2	5
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse, and fine to medium gravel	8	13
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and gray	1	14

33-4W-17aaa.—Drillers log of test hole in NE NE NE sec. 17, T. 33 S., R. 4 W., in road intersection; bored August 18, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Silt, brown	2	5
Clay, sandy, red brown	2	7
Clay, sandy, red	3	10
Clay, sandy, green	2	12
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red and green	2	14

34-2E-2aaa.—Sample log of test hole in NE NE NE sec. 2, T. 34 S., R. 2 E., about 75 feet south of corner; drilled May 9, 1944. Surface altitude, 1,157.0 feet; depth to water, 14.28 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, clayey, tan	8	8
Illinoisan or Kansan terrace deposits		
Clay, silty, light green gray; contains some coarse to fine sand and fine gravel	8.5	16.5
Sand, coarse to fine, and silt, buff	3	19.5

PERMIAN—Leonardian Wellington Formation	Thickness, feet	Depth, feet
Shale, blocky, gray green	8.5	28
Shale, gray green and brownish purple	2	30
Shale, very light greenish gray and gray green	7	37
Shale, calcareous, light greenish yellow	3	40

34-2E-13add.—Sample log of test hole in SE SE NE sec. 13, T. 34 S., R. 2 E., about 0.4 mile south of corner; drilled March 24, 1944. Surface altitude, 1,105.6 feet.

QUATERNARY—Pleistocene Colluvium	Thickness, feet	Depth, feet
Soil and silt, dark gray	3	3
Silt, brown, contains some medium to fine sand	3	6
Silt, clayey, buff	10	16
PERMIAN—Leonardian Wellington Formation		
Shale, soft, gray	3	19

34-1W-13bbb.—Drillers log of test hole in NW NW NW sec. 13, T. 34 S., R. 1 W., on east side of road 20 feet south of corner; bored September 13, 1955.

QUATERNARY—Pleistocene Illinoisan or Kansan terrace deposits	Thickness, feet	Depth, feet
Silt, black	3	3
Gravel, fine to medium	4	7
Clay, brown	2	9
PERMIAN—Leonardian Wellington Formation		
Shale, gray green	6	15

34-1W-28cdc.—Drillers log of test hole in SW SE SW sec. 28, T. 34 S., R. 1 W., on north side of road 0.25 mile west of bridge; bored August 26, 1955. Surface altitude, 1,098.3 feet; depth to water, 6.80 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Silt, black	5	5
Clay, black	5	10
Clay, sandy, tan	7	17
PERMIAN—Leonardian Wellington Formation		
Shale, green	1	18

34-1W-29ccc.—Drillers log of test hole in SW SW SW sec. 29, T. 34 S., R. 1 W., on north side of road at corner; bored August 26, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Clay, tan	2	5
Illinoisan or Kansan terrace deposits		
Gravel, fine to medium, arkosic	2	7
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	8

34-1W-33aaa.—Drillers log of test hole in NE NE NE sec. 33, T. 34 S., R. 1 W., on west side of road 25 feet south of corner; bored August 26, 1955. Surface altitude, 1,116.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown	3	3
Clay, sandy, brown	2	5
Clay, sandy, red brown	10	15
Illinoisan or Kansan terrace deposits		
Clay, sandy, red; contains some green shale gravel	5	20
PERMIAN—Leonardian		
Wellington Formation		
Shale, black	1	21

34-1W-33aba.—Drillers log of test hole in NE NW NE sec. 33, T. 34 S., R. 1 W., on south side of road 0.3 mile west of corner at small gap in hedge on north side; bored August 26, 1955. Surface altitude, 1,094.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, black	4	4
Silt and clay, tan	4	8
Clay, dark gray	2	10
Clay, slightly sandy, red tan	12	22
PERMIAN—Leonardian		
Wellington Formation		
Shale, greenish gray	1	23

34-1W-33ccc.—Drillers log of test hole in SW SW SW sec. 33, T. 34 S., R. 1 W., on east side of road 100 feet north of Highway 81; bored August 26, 1955. Surface altitude, 1,137.4 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Clay, black	2	5
Clay, tan	2	7

PERMIAN—Leonardian Wellington Formation	Thickness, feet	Depth, feet
Shale, green	1	8
Shale, pink	1	9

34-2W-4bcc.—Drillers log of test hole in SW SW NW sec. 4, T. 34 S., R. 2 W., on east side of road 10 feet north of intersection in front of Corbin school; bored August 29, 1955. Surface altitude, 1,148.5 feet; depth to water, about 23 feet.

QUATERNARY—Pleistocene Colluvium	Thickness, feet	Depth, feet
Silt, black	2	2
Silt and clay, gray tan	2	4
Clay, tan	2	6
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse; contains some red clay	4	10
Sand, fine to coarse, and fine to medium gravel	17	27
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	28

34-2W-8ddd.—Drillers log of test hole in SE SE SE sec. 8, T. 34 S., R. 2 W., on west side of road 20 feet north of corner; bored August 26, 1955. Surface altitude, 1,129.1 feet.

QUATERNARY—Pleistocene Colluvium	Thickness, feet	Depth, feet
Clay, tan brown	5	5
Illinoisan or Kansan terrace deposits		
Sand, fine to medium	5	10
Clay, red	5	15
Gravel, fine to medium	8	23
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	3	26

34-2W-15ccb.—Drillers log of test hole in NW SW SW sec. 15, T. 34 S., R. 2 W., on east side of road in front of schoolhouse; bored August 26, 1955. Surface altitude, 1,115.2 feet; depth to water, 14.30 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Clay and silt, gravelly, red	8	8
Clay, sandy, red	7	15
Sand, fine, clayey	5	20
Gravel, fine to medium	6	26
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	27

34-2W-16aaa.—Drillers log of test hole in NE NE NE sec. 16, T. 34 S., R. 2 W., on south side of road 40 feet west of corner; bored August 26, 1955. Surface altitude, 1,130.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, gravelly, red	2	7
Illinoisan or Kansan terrace deposits		
Gravel, fine to coarse	15	22
PERMIAN—Leonardian		
Wellington Formation		
Shale, red	1	23

34-2W-25dcd.—Drillers log of test hole in SE SW SE sec. 25, T. 34 S., R. 2 W., on north side of road 0.35 mile west of corner; bored August 26, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, sandy, red	11	16
PERMIAN—Leonardian		
Wellington Formation		
Shale	2	18

34-2W-27bbb.—Drillers log of test hole in NW NW NW sec. 27, T. 34 S., R. 2 W., on east side of road 50 feet south of corner; bored August 26, 1955. Surface altitude, 1,090.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine, silty	5	5
Sand, fine to medium	22	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	29

34-2W-27cbb.—Drillers log of test hole in NW NW SW sec. 27, T. 34 S., R. 2 W., on east side of road 50 feet south of drainage ditch on half-mile line; bored August 26, 1955. Surface altitude, 1,106.0 feet; depth to water, 17.20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Silt and very fine sand, tan	5	10
Clay, sandy, red brown	15	25
Clay, dark gray to black	5	30
Clay, sandy, tan	11	41
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	42

34-2W-31ccc.—Drillers log of test hole in SW SW SW sec. 31, T. 34 S., R. 2 W., on east side of road 35 feet north of intersection; bored August 23, 1955. Surface altitude, 1,151.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan	3	3
Silt, red brown	4	7
Silt, black	1	8
Clay; contains much very fine sand, red	7	15
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red	1	16

34-2W-32ddd.—Drillers log of test hole in SE SE SE sec. 32, T. 34 S., R. 2 W., on north side of road 30 feet west of corner; bored August 23, 1955. Surface altitude, 1,127.8 feet; depth to water, 16.90 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, dark gray	3	3
Clay, gravelly, buff	2	5
Clay, sandy, red	2	7
Illinoisan or Kansan terrace deposits		
Sand, fine	5	12
Gravel, fine to medium	4	16
Sand, fine to coarse	19	35
Sand, fine; contains some clay	15	50
PERMIAN—Leonardian		
Wellington Formation		
Shale, greenish gray	1	51

34-2W-33aaa.—Drillers log of test hole in NE NE NE sec. 33, T. 34 S., R. 2 W., in old schoolyard west of tree; bored August 26, 1955. Surface altitude, 1,120.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, tan	5	5
Silt and clay, sandy, red	5	10
Illinoisan or Kansan terrace deposits		
Clay, sandy, red	10	20
Sand, fine to medium, and red clay	14	34
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	35

34-2W-34ccc.—Drillers log of test hole in SW SW SW sec. 34, T. 34 S., R. 2 W., in drive to field 15 feet east of corner; bored August 23, 1955. Surface altitude, 1,118.2 feet; depth to water, 20.30 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, sandy, greenish tan	2	7
Illinoisan or Kansan terrace deposits		
Clay, sandy, brown	3	10
Clay, sandy, red	10	20
Gravel, fine to medium	7	27
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	28

34-2W-35ccc.—Drillers log of test hole in SW SW SW sec. 35, T. 34 S., R. 2 W., on north side of road 10 feet east of corner; bored August 23, 1955. Surface altitude, 1,116.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, brown	5	5
Clay, sandy, red	7	12
Illinoisan or Kansan terrace deposits		
Sand, fine to medium	5	17
Gravel, fine to coarse	9	26
PERMIAN—Leonardian		
Wellington Formation		
Shale, green and red	1	27

34-3W-27bbb.—Drillers log of test hole in NW NW NW sec. 27, T. 34 S., R. 3 W., on east side of road 5 feet south of intersection; bored August 19, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, brown	5	5
Silt, red tan	10	15
Clay, gravelly, red	15	30

34-3W-31ddd.—Drillers log of test hole in SE SE SE sec. 31, T. 34 S., R. 3 W., on north side of road 20 feet west of corner; bored August 22, 1955. Surface altitude, 1,168.2 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt, sandy, red tan	15	20
Sand, fine	15	35
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	2	37

34-4W-33ccc.—Drillers log of test hole in SW SW SW sec. 33, T. 34 S., R. 4 W., on south side of road where road angles north; bored August 23, 1955. Surface altitude, 1,170.5 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, tan	5	5
Silt, black	2	7
Silt, sandy, tan	13	20
Sand, fine	5	25
Clay, sandy, red	10	35
Sand, fine, clayey	21	56
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	1	57

34-4W-36dcc.—Drillers log of test hole in SW SW SE sec. 36, T. 34 S., R. 4 W., on north side of road 20 feet east of half-mile line; bored August 22, 1955. Surface altitude, 1,191.2 feet; depth to water, 36.10 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	7	7
Silt and clay, sandy, red tan	8	15
Illinoisan or Kansan terrace deposits		
Clay, sandy and gravelly, red	35	50
Clay, very sandy, red	2	52

35-2E-2aaa.—Drillers log of test hole in NE NE NE sec. 2, T. 35 S., R. 2 E., on south side of road 20 feet west of corner; bored September 13, 1955. Surface altitude, 1,215.3 feet; depth to water, 41.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Clay, brown	10	15
Illinoisan or Kansan terrace deposits		
Gravel, fine to medium, and clay	5	20
Clay, sandy, red	30	50
Sand, fine to medium	13	63
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	64

35-1W-2aaa.—Drillers log of test hole in NE NE NE sec. 2, T. 35 S., R. 1 W., on south side of road 20 feet west of corner; bored September 13, 1955. Surface altitude, 1,122.0 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, sandy, red	15	15
Clay, sandy, tan gray	10	25

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Gravel, fine to medium, clayey	7	32
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	33

35-1W-8ddd.—Drillers log of test hole in SE SE SE sec. 8, T. 35 S., R. 1 W., on west side of road 100 feet north of corner; bored August 25, 1955. Surface altitude, 1,099.1 feet; depth to water, 21.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt and clay, gravelly, black and gray	2	7
Illinoisan or Kansan terrace deposits		
Sand, fine to medium, yellow	3	10
Sand, fine to coarse, white	12	22
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	23

35-1W-16ddd.—Drillers log of test hole in SE SE SE sec. 16, T. 35 S., R. 1 W., on north side of road 20 feet west of corner; bored August 25, 1955. Surface altitude, 1,095.8 feet; depth to water, 23.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Sand, very fine, buff	5	8
Sand, fine to medium	2	10
Clay, sandy, red	5	15
Illinoisan or Kansan terrace deposits		
Sand, fine to coarse	15	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, tan to green	1	31

35-1W-17ccc.—Drillers log of test hole in SW SW SW sec. 17, T. 35 S., R. 1 W,. on north side of road at tree on south side, house on south side 400 feet east; bored August 25, 1955. Surface altitude, 1,071.4 feet; depth to water, about 20 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	5	5
Silt and clay, sandy, tan	5	10
Clay, sandy, red tan	5	15
Illinoisan or Kansan terrace deposits		
Sand and gravel	9	24
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	25

35-1W-18ccd.—Drillers log of test hole in SE SW SW sec. 18, T. 35 S., R. 1 W., on north side of road 30 feet west of grove of trees surrounding abandoned farmstead; bored August 25, 1955. Surface altitude, 1,057.3 feet; depth to water, 29.60 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Silt, black	4	4
Sand, fine, tan	11	15
Sand, fine to medium	5	20
Sand, some gravel	10	30
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	31

35-1W-18cdc.—Drillers log of test hole in SW SE SW sec. 18, T. 35 S., R. 1 W., on north side of road across from big elm tree 300 feet west of river; bored August 25, 1955. Surface altitude, 1,049.1 feet; depth to water, 11.40 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Alluvium		
Sand, fine to medium	10	10
Sand, fine to coarse, and fine to coarse arkosic gravel,	7	17
PERMIAN—Leonardian		
Wellington Formation		
Shale, red and green	1	18

35-2W-2aab.—Drillers log of test hole in NW NE NE sec. 2, T. 35 S., R. 2 W., on east side of road where road angles; bored August 23, 1955. Surface altitude, 1,089.7 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	5	5
Sand, very fine	10	15
Clay and very fine sand, tan	5	20
Clay, sandy, greenish gray	5	25
Sand, fine to medium	2	27
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	1	28

35-2W-10bbb.—Drillers log of test hole in NW NW NW sec. 10, T. 35 S., R. 2 W., on east side of road 30 feet south of corner; bored August 25, 1955. Surface altitude, 1,119.2 feet; depth to water, about 24.00 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt, black	3	3
Clay, gray black	2	5
Clay, sandy, red tan	5	10

	Thickness, feet	Depth, feet
Illinoisan or Kansan terrace deposits		
Sand, fine to medium, and fine gravel	15	25
Clay, red	2	27
PERMIAN—Leonardian		
Wellington Formation		
Shale	2	29

35-2W-13dcc2.—Drillers log of test hole in SW SW SE sec. 13, T. 35 S., R. 2 W., on north side of road in front of abandoned house; bored August 25, 1955. Surface altitude, 1,087.7 feet; depth to water, about 27 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, tan	5	5
Clay, buff	5	10
Clay, tan	7	17
Clay, sandy, red	3	20
Sand, fine to coarse; contains some red clay	10	30
Gravel, fine to coarse, and coarse quartz sand	13	43
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	44

35-2W-13ddd.—Drillers log of test hole in SE SE SE sec. 13, T. 35 S., R. 2 W., on north side of road 100 feet west of house on north side of road; bored August 25, 1955. Surface altitude, 1,073.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Silt and very fine sand, tan	5	10
Clay, sandy, tan	7	17
Gravel, fine to medium	6	23
PERMIAN—Leonardian		
Wellington Formation		
Shale	1	24

35-2W-15bbb.—Drillers log of test hole in NW NW NW sec. 15, T. 35 S., R. 2 W., on east side of road 15 feet south of corner; bored August 25, 1955. Surface altitude, 1,119.3 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Colluvium		
Silt and clay, black	5	5
Clay, tan	2	7
Clay, sandy, tan to red	8	15
Illinoisan or Kansan terrace deposits		
Sand, fine to medium, clayey, red	12	27
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	1	28

35-2W-15ccc.—Drillers log of test hole in SW SW SW sec. 15, T. 35 S., R. 2 W., on north side of road 150 feet east of corner; bored August 25, 1955. Surface altitude, 1,085.4 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Silt and clay, black	5	10
Clay, sandy, red	2	12
Clay, red	5	17
Clay, sandy, tan	3	20
Gravel, clay, and sand	5	25
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red and green	1	26

35-2W-15ddd.—Drillers log of test hole in SE SE SE sec. 15, T. 35 S., R. 2 W., on north side of road 20 feet west of corner; bored August 25, 1955. Surface altitude, 1,096.8 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	5	5
Clay, red	5	10
Sand, very fine	10	20
Sand, fine, and tan clay	5	25
PERMIAN—Leonardian		
Wellington Formation		
Shale, green	2	27

35-3W-2cbc.—Drillers log of test hole in SW NW SW sec. 2, T. 35 S., R. 3 W., on east side of road, half way between hedge and curve; bored August 22, 1955. Depth to water, 16.50 feet.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, black	3	3
Silt, brown	2	5
Silt and clay, black	3	8
Silt and clay, slightly sandy, tan and dark gray	34	42
PERMIAN—Leonardian		
Ninnescah Shale		
Shale	1	43

35-3W-11bbb.—Drillers log of test hole in NW NW NW sec. 11, T. 35 S., R. 3 W., under power line at corner; bored August 22, 1955.

	Thickness, feet	Depth, feet
QUATERNARY—Pleistocene		
Wisconsinan terrace deposits		
Silt, brown	3	3
Silt, tan	4	7
Silt, red brown	4	11

	Thickness, feet	Depth, feet
Clay, silty, red	10	21
PERMIAN—Leonardian		
Ninnescah Shale		
Shale, red and gray	1	22

35-4W-2bbb.—Drillers log of test hole in NW NW NW sec. 2, T. 35 S., R. 4 W., on east side of road at corner; bored August 23, 1955. Surface altitude, 1,211.0 feet.

QUATERNARY—Pleistocene Colluvium	Thickness, feet	Depth, feet
Silt, sandy, tan	5	5
Silt and clay, sandy, red	15	20

35-4W-11bcc.—Drillers log of test hole in SW SW NW sec. 11, T. 35 S., R. 4 W., on east side of road 125 feet south of hedge on east; bored August 23, 1955. Surface altitude, 1,142.9 feet; depth to water, about 20 feet.

QUATERNARY—Pleistocene Wisconsinan terrace deposits	Thickness, feet	Depth, feet
Sand, fine to medium	5	5
Silt, tan	2	7
Gravel, fine to coarse	36	43

35-4W-16ccc.—Drillers log of test hole in SW SW SW sec. 16, T. 35 S., R. 4 W., on north side of road just east of grove of trees; bored August 23, 1955. Surface altitude, 1,204.6 feet.

QUATERNARY—Pleistocene Colluvium	Thickness, feet	Depth, feet
Silt, tan	3	3
Silt and clay, black	2	5
Clay, tan	5	10
Clay, sandy, red tan	5	15
Clay, red, sandy; contains some coarse gravel	5	20

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AREAL GEOLOGY OF SUMNER COUNTY, KANSAS

State Geological Survey
of Kansas

by Kenneth L. Walters
1957

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Plate 1

R 4 W | R 3 W | R 2 W | R 1 W | R 1 E | R 2 E

T 30 S. | T 31 S. | T 32 S. | T 33 S. | T 34 S. | T 35 S.

EXPLANATION

QUATERNARY

PLEISTOCENE

Recent

Qds — Dune sand

Sand, medium and fine; contains some silt. Generally above the water table; does not yield water to wells.

Qal — Alluvium

Chiefly arkosic sand and gravel; contains lenses of silt and clay. Yields large quantities of water to wells.

Wisconsinan

Qw — Terrace deposits

Chiefly arkosic sand and gravel; contains lenses of silt and clay. Yields large quantities of water to wells.

Kansan and Illinoisan

Qki — Terrace deposits

Poorly sorted sand and gravel; contains red-brown silt and locally derived gravel. Yields moderate quantities of water to wells.

Nebraskan

Qn — Terrace deposits

Chiefly medium to coarse arkosic sand. Yields moderate quantities of water to wells.

PERMIAN

Pn — Ninnescah Shale

Predominately silty shale, mostly brownish red with gray-green spots; contains beds of dolomite, calcareous siltstone, and fine-grained sandstone. Yields small quantities of hard water to wells.

Pw — Wellington Formation

Chiefly shale and silty shale, mostly gray and green, some red; contains lenticular beds of gypsum, silty limestone, and dolomite. Yields small quantities of hard water to wells.

PLEISTOCENE

Illinoisan to Recent

Qc — Colluvium or pediment deposits

Silt and clay; contains minor amounts of sand and gravel. Does not yield appreciable quantities of water to wells.

Konsan to Recent

QcKI — Colluvium or pediment deposits underlain by Kansan or Illinoisan terrace deposits

Silt and clay; contains minor amounts of sand and gravel underlain by discontinuous Kansan or Illinoisan terrace deposits. Yields moderate supplies of water to wells locally

- Federal or state highway
- Graded road
- Railroad
- Ungraded road
- County line (no road)
- State line (no road)
- Section line (no road)
- Intermittent stream

0 1/2 1 2 3 4 5
Scale, in miles

Base and drainage compiled from maps prepared by the Soil Conservation Service.

MAP OF SUMNER COUNTY, KANSAS

showing generalized water-table contours and location of wells and test holes for which records are given

by Kenneth L. Walters
1957

State Geological Survey of Kansas

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Plate 2

R.4 W. R.3 W. R.2 W. R.1 W. R.1 E. R.2 E.

T. 30 S. T. 31 S. T. 32 S. T. 33 S. T. 34 S. T. 35 S.

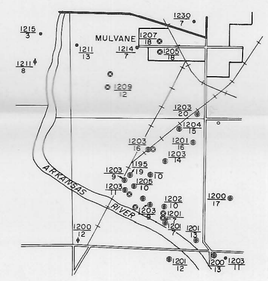
MILTON · MILLERTON · CONWAY SPRINGS · ANSON · RIVERDALE · ARGONIA · MILAN · MAYFIELD · WELLINGTON · PERTH · SCORBIN · BLACKSTONE · CALDWELL · DRURY · SOUTH HAVEN · HUNNEWELL · ZYBA · PECK · MULVANE · BELLE PLAINE · CICERO · WHITMAN · OXFORD · DALTON · ROME · ADAMSVILLE · GEUDA SPRINGS · PORTLAND · ASHTON

Chikaskia River · Slate Creek · Dixon Creek · Caldwell Bluff Creek · Kansas Turnpike · U.S. 81 · U.S. 160 · U.S. 166 · U.S. 177 · Kon. 42 · Kon. 44 · Kon. 49 · Kon. 19 · Kon. 15 · MO. PAC. R.R. · A.T. & S.F. RY. · C.R.I. & P. RY. · MIDLAND VALLEY R.R.

EXPLANATION

- Drilled test hole
- Augered test hole
- Domestic or stock well
- Public supply well
- Irrigation well
- Industrial well
- Observation well
- 1180 — Water-table contour
- 1189 / 26 — Upper number refers to altitude of water level, in feet; Lower number refers to depth to water below land surface, in feet
- Federal or state highway
- Graded road
- Railroad
- Ungraded road
- County line (no road)
- State line (no road)
- Section line (no road)
- Outline of area shown in inset map
- Intermittent stream

Scale, in miles: 0 1/2 1 2 3 4 5



Enlargement of area near Mulvane

Base and drainage compiled from maps prepared by the Soil Conservation Service.

GEOLOGIC SECTIONS, SUMNER COUNTY, KANSAS

State Geological Survey
of Kansas

by Kenneth L. Walters
1957

Bulletin 151

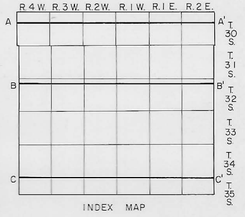
Plate 3

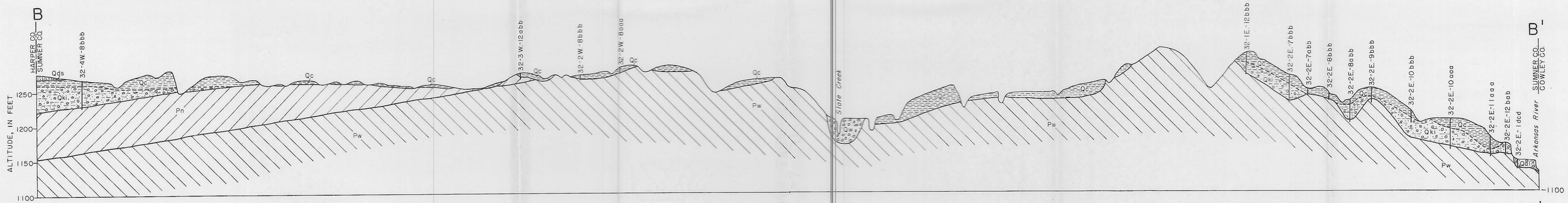
EXPLANATION

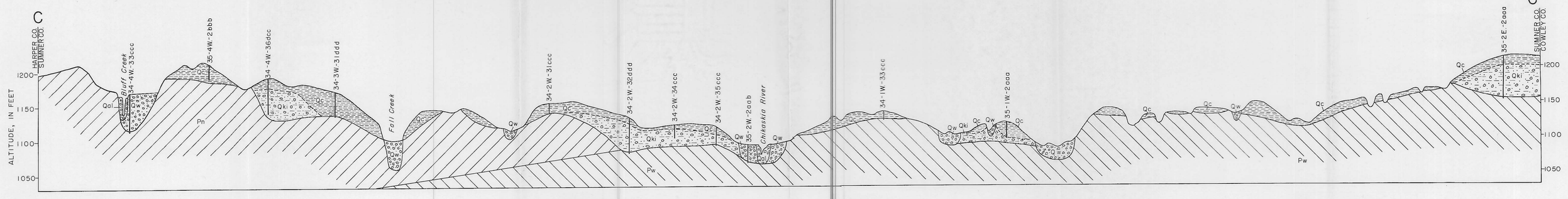
Pleistocene
- Illinoisan to Recent
  - Colluvium or pediment deposits (Qc)
- Pleistocene
  - Recent
    - Dune sand (Qds)
    - Alluvium (Qal)
  - Wisconsinan
    - Terrace deposits (Qw)
  - Kansan and Illinoisan
    - Terrace deposits (Qki)
  - Nebraskan
    - Terrace deposits (Qn)

Quaternary

Permian
- Ninnescah Shale (Pn)
- Wellington Formation (Pw)







MAP OF SUMNER COUNTY

showing the location of wells and concentration of chloride in samples of ground water

by Kenneth L. Walters

1957

Bulletin 151
Plate 4

State Geological Survey
of Kansas

R.4W. R.3W. R.2W. R.1W. R.1E. R.2E.

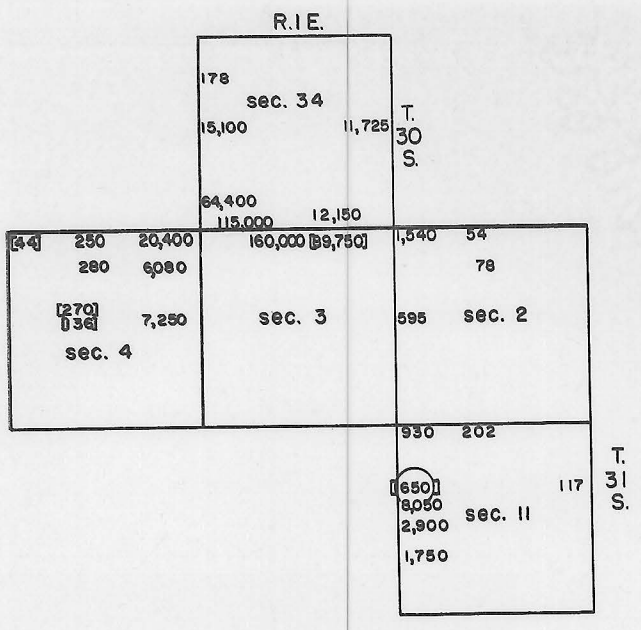
T. 30 S.
T. 31 S.
T. 32 S.
T. 33 S.
T. 34 S.
T. 35 S.

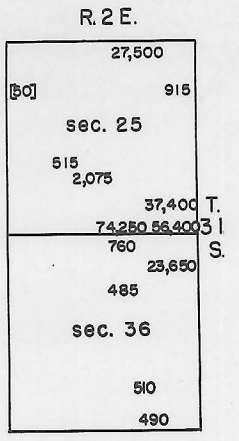
ARGONIA
WELLINGTON
OXFORD
BELLE PLAINE
CALDWELL
SOUTH HAVEN

NINNESCAH RIVER
ARKANSAS RIVER
CHIKASKIA RIVER
SLATE CREEK
WALNUT CREEK
BLUFF CREEK
SALT CREEK

EXPLANATION

Number is at location of well or test hole and gives chloride content in ppm
Brackets around number indicate sample was analyzed for other constituents also
Circle around number indicates surface-water sample
Diagonal pattern indicates inset





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State Geological Survey
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EXPLANATION

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    - Qn — Terrace deposits
- Quaternary
- Permian
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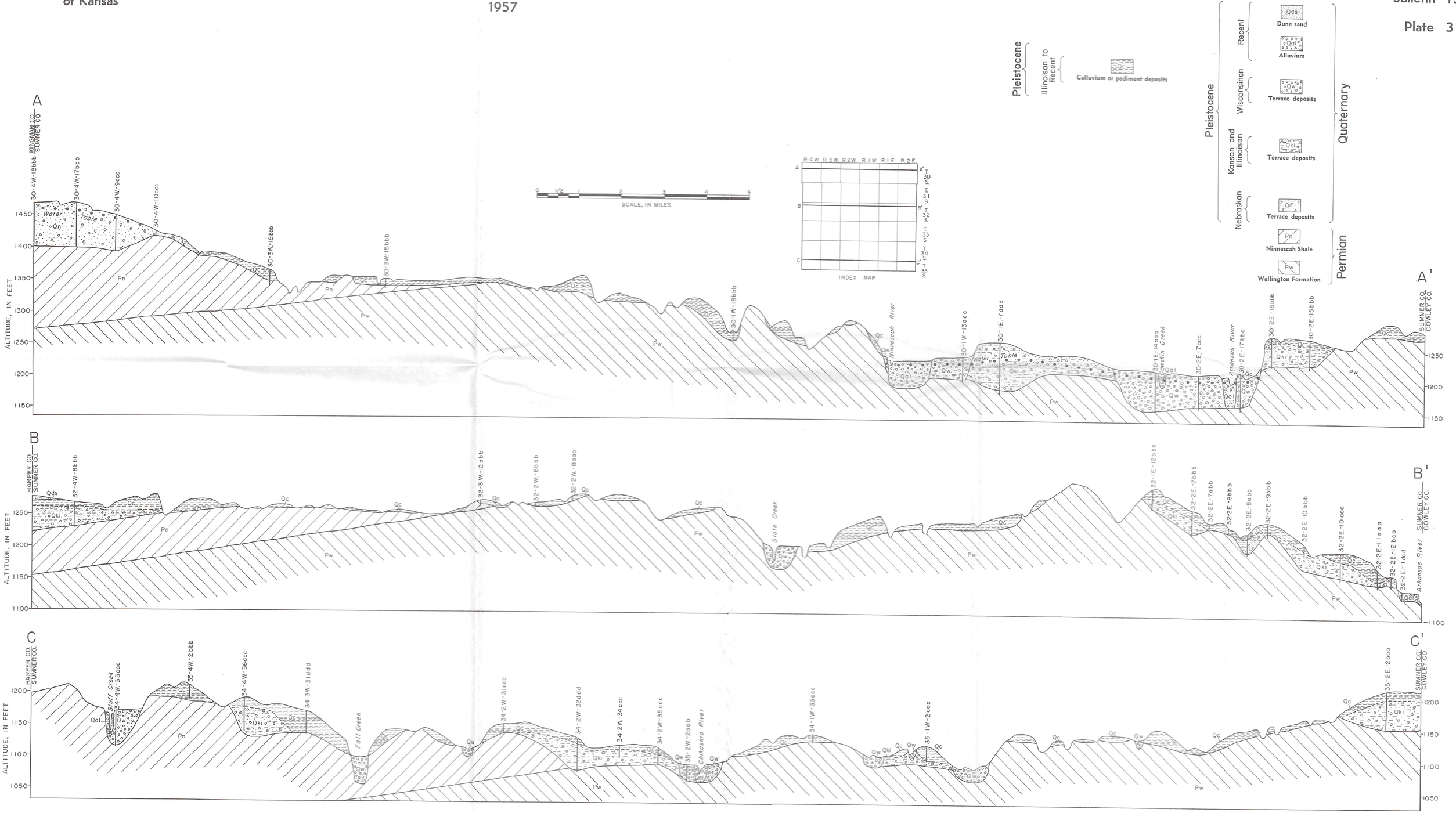

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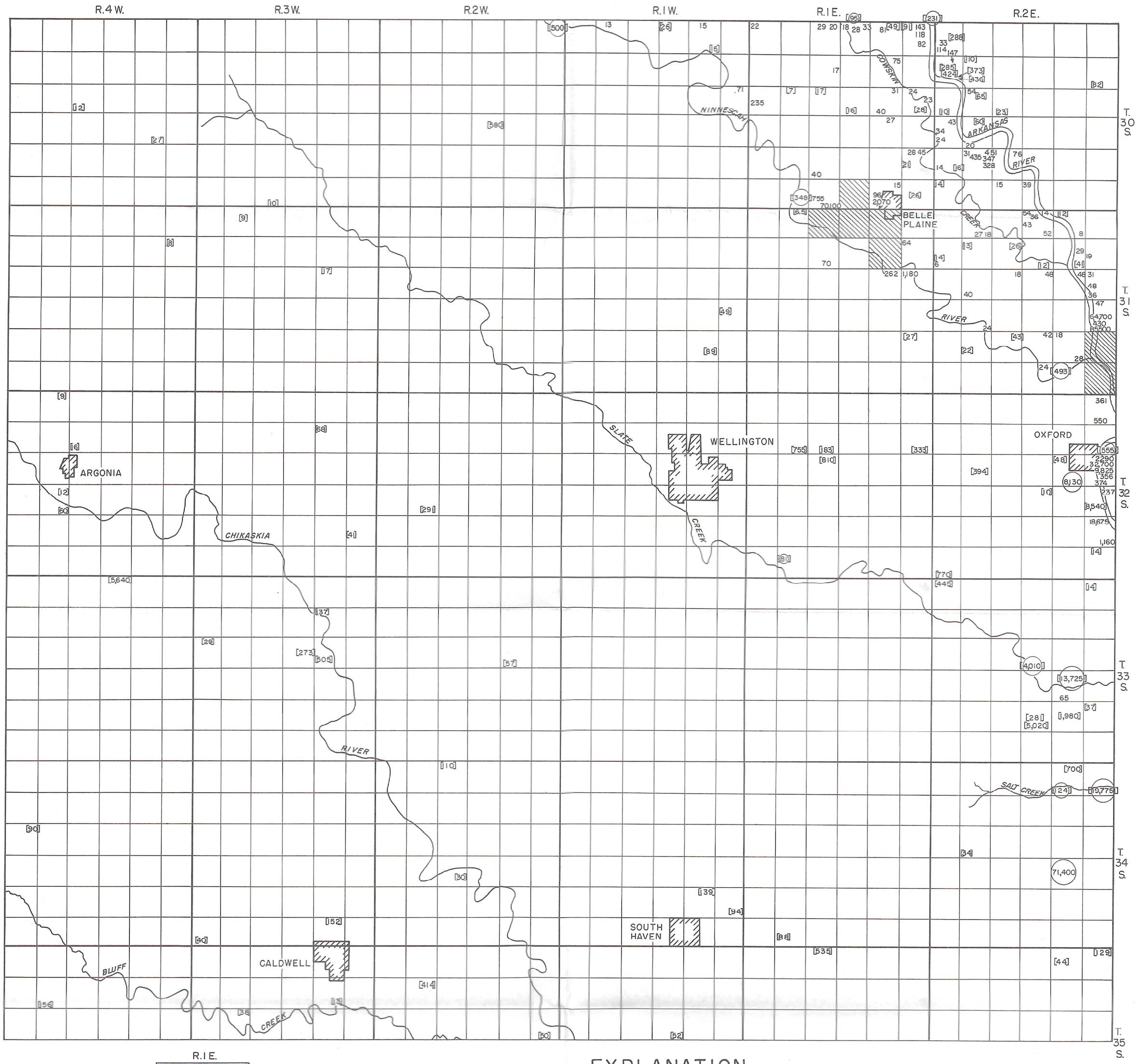

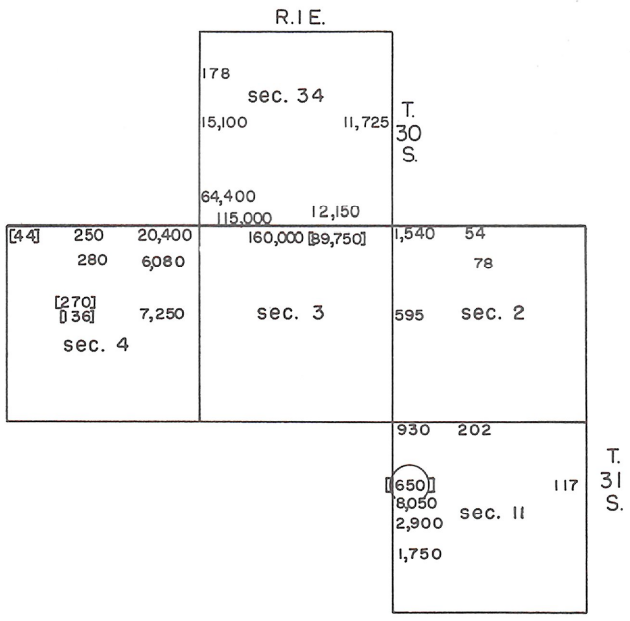

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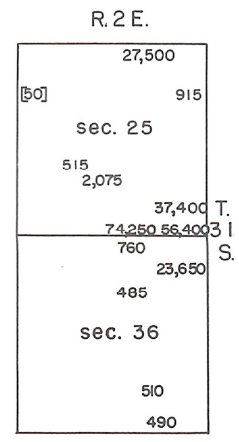
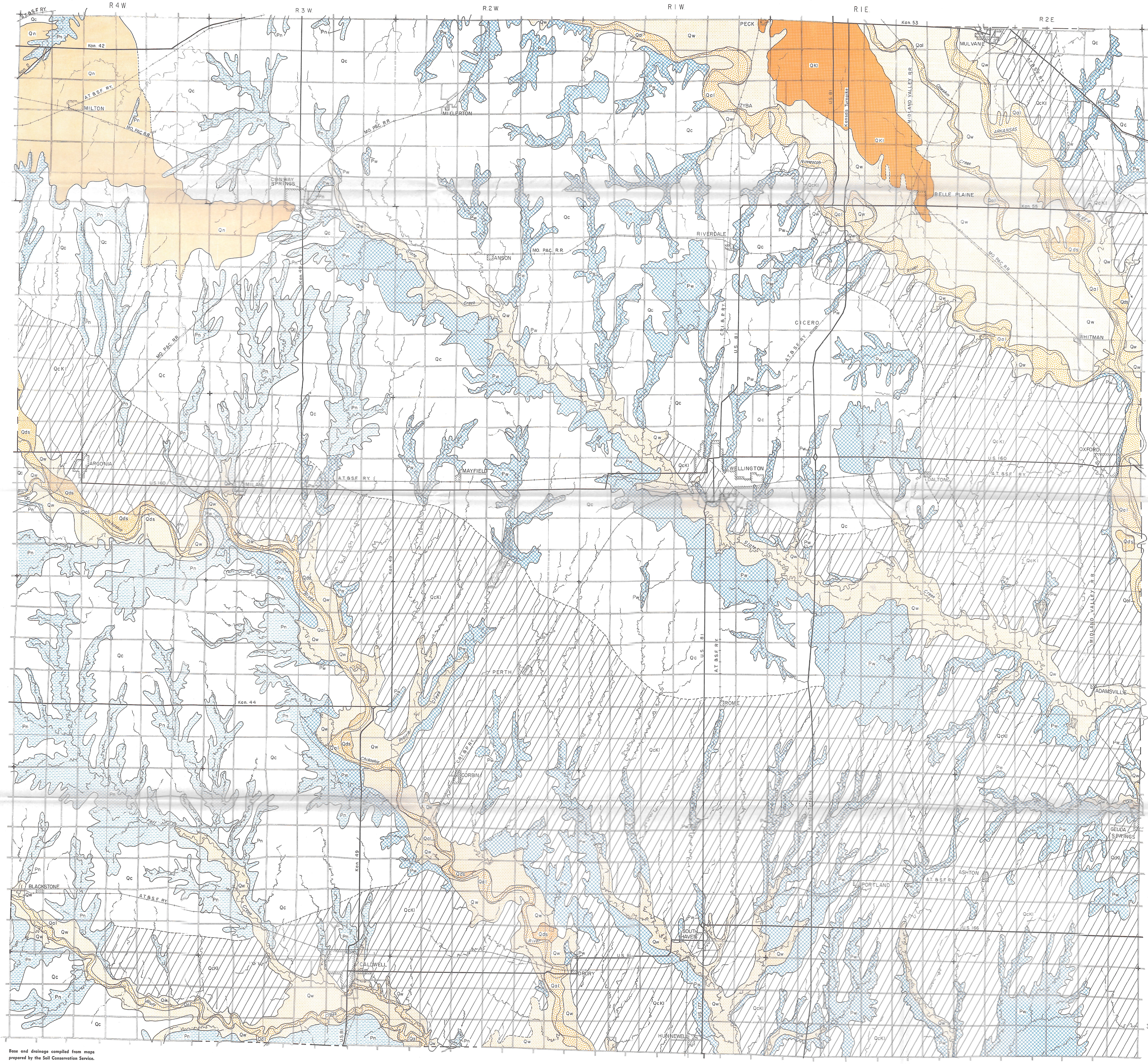


AREAL GEOLOGY OF SUMNER COUNTY, KANSAS

State Geological Survey
of Kansas

by Kenneth L. Walters
1957

Bulletin 151
Plate 1



EXPLANATION

QUATERNARY — PLEISTOCENE

Recent

Qds — Dune sand

Sand, medium and fine; contains some silt. Generally above the water table; does not yield water to wells.

Qal — Alluvium

Chiefly arkosic sand and gravel; contains lenses of silt and clay. Yields large quantities of water to wells.

Wisconsinan

Qw — Terrace deposits

Chiefly arkosic sand and gravel; contains lenses of silt and clay. Yields large quantities of water to wells.

Kansan and Illinoisan

Qki — Terrace deposits

Poorly sorted sand and gravel; contains red-brown silt and locally derived gravel. Yields moderate quantities of water to wells.

Nebraskan

Qn — Terrace deposits

Chiefly medium to coarse arkosic sand. Yields moderate quantities of water to wells.

PERMIAN

Pn — Ninnescah Shale

Predominately silty shale, mostly brownish red with gray-green spots; contains beds of dolomite, calcareous siltstone, and fine-grained sandstone. Yields small quantities of hard water to wells.

Pw — Wellington Formation

Chiefly shale and silty shale, mostly gray and green, some red; contains lenticular beds of gypsum, silty limestone, and dolomite. Yields small quantities of hard water to wells.

PLEISTOCENE

Illinoisan to Recent

Qc — Colluvium or pediment deposits

Silt and clay; contains minor amounts of sand and gravel. Does not yield appreciable quantities of water to wells.

Kansan to Recent

QcKI — Colluvium or pediment deposits underlain by Kansan or Illinoisan terrace deposits

Silt and clay; contains minor amounts of sand and gravel underlain by discontinuous Kansan or Illinoisan terrace deposits. Yields moderate supplies of water to wells locally

Federal or state highway
Graded road
Railroad
Ungraded road
County line (no road)
State line (no road)
Section line (no road)
Intermittent stream

0 1/2 1 2 3 4 5
Scale, in miles

State Geological Survey
of Kansas

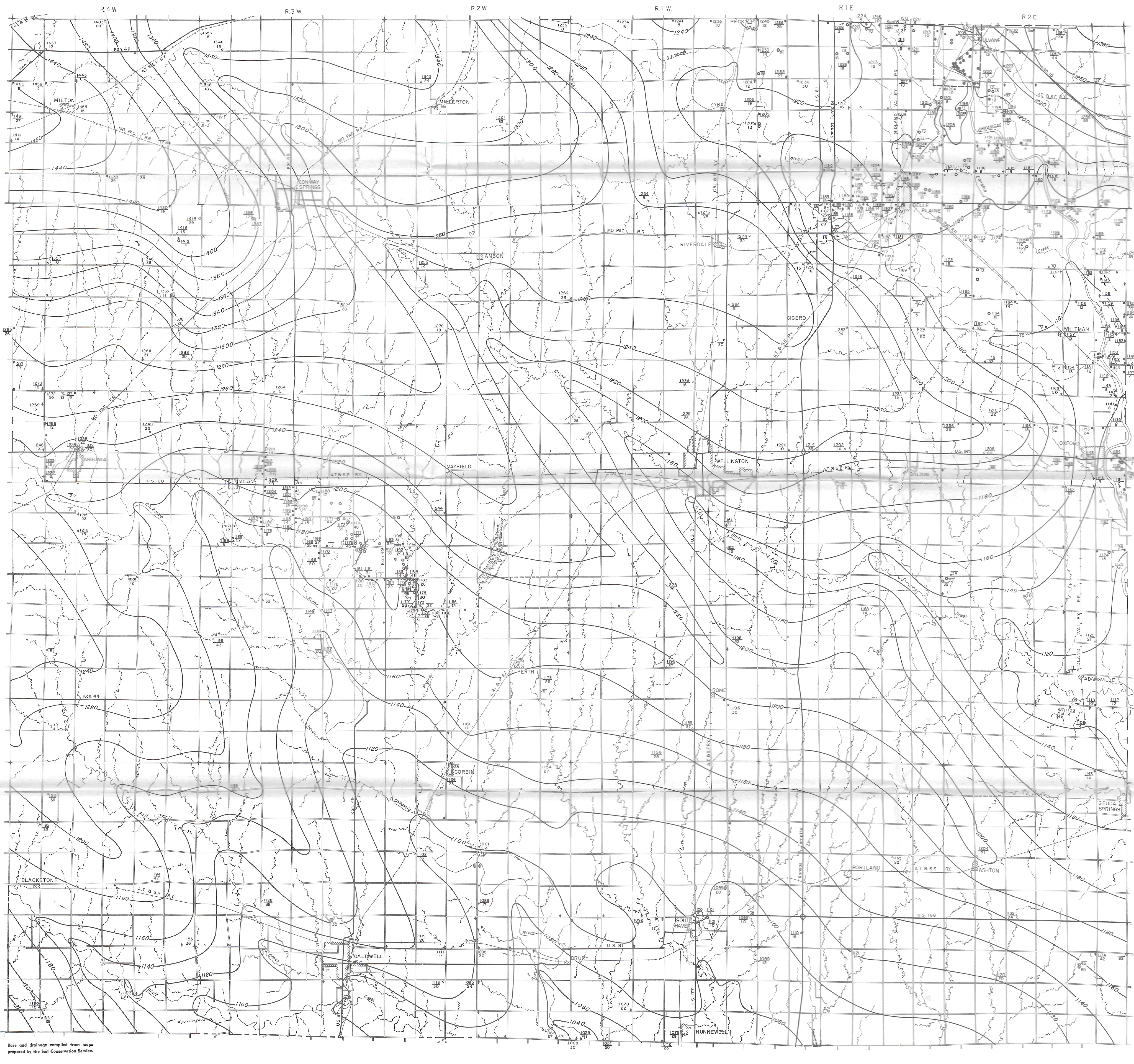
MAP OF SUMNER COUNTY, KANSAS

showing generalized water-table contours and location of
wells and test holes for which records are given

by Kenneth L. Walters

1957

Bulletin 151
Plate 2



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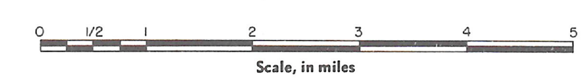

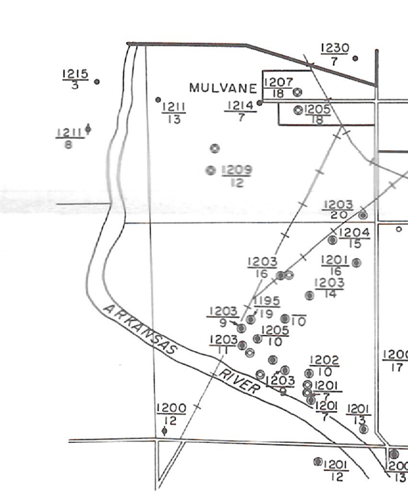

Enlargement of area near Mulvane