STATE OF ARKANSAS

Arkansas Geological and Conservation Commission

Norman F. Williams, Geologist-Director

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WATER RESOURCES CIRCULAR No. 7

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# GROUND-WATER POTENTIAL OF MISSISSIPPI COUNTY, ARKANSAS

By

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U. S. GEOLOGICAL SURVEY

Prepared in cooperation with the United States Geological Survey

Little Rock, Ark.

1960

STATE OF ARKANSAS

Orval E. Faubus, Governor

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# GROUND-WATER POTENTIAL OF MISSISSIPPI COUNTY, ARKANSAS

By Roy W. Ryling

## SUMMARY

The people of Mississippi County depend almost exclusively upon ground water to meet their water needs. The rate of pumping in 1957, averaged over the year, is estimated at 12.1 (mgd) million gallons per day. The rates of use for different purposes were: domestic, 0.5 mgd; municipal and industrial, 5.4 mgd; and irrigation, 6.2 mgd, of which 2.2 mgd was used for the irrigation of rice and 4.0 mgd for the supplemental irrigation of row crops.

Ground water is obtained from wells screened in the water-bearing materials of the different rock strata that underlie the county. The Quaternary deposits currently are the most important aquifer in the county with respect to total yield (about 6.7 mgd) and to the number of people supplied (about 52,500). The second most important aquifer is the Wilcox formation, which yields about 5.4 mgd to meet the needs of about 29,900 people and several industries.

Two cross sections (figs. 6 and 7) show selected graphic logs of water wells and electric logs of oil-test holes in the northern part of the Mississippi embayment with the inferred positions of the different rock units and their thickness and depth below land surface. The rocks underlying Mississippi County, in order from the land surface downward, are the Quaternary deposits, the Claiborne group, the Wilcox formation, the Midway group, the Cretaceous deposits, and the rocks of Paleozoic age. A stratigraphic chart (table 6) tabulates generalized information concerning these different rock units and the quality of water they contain.

The Quaternary deposits yield a calcium bicarbonate water that generally is high in iron content and very hard. The Claiborne group may yield a calcium bicarbonate water relatively low in mineralization but hard and high in iron. The Wilcox formation contains a sodium bicarbonate water, low in mineralization, generally soft, and low in iron. The Midway group does not yield water to wells. The Cretaceous deposits presumably would yield a sodium bicarbonate water of moderate mineralization, soft, and containing very little iron. The rocks of Paleozoic age yield a sodium chloride water that is extremely mineralized and excessively hard.

The temperature, in degrees Fahrenheit, of water from the different rock units is: Quaternary deposits (average of 18 samples) 62, Claiborne group (single sample) 62, Wilcox formation (average of 9 samples) 75, Cretaceous deposits (average of 4 samples) 86, and Paleozoic rocks (single sample) 110.

Aquifer tests on 4 wells screened in the Quaternary aquifer and on 1 well screened in the Wilcox formation indicate that the average permeability of the Quaternary aquifer is about 1,900 gpd (gallons per day) per square foot as compared to about 1,300 gpd for the water-bearing sands of the Wilcox formation. Well yields range from a few gallons per minute to a reported 3,000 gpm in the Quaternary aquifer, and from 30 to 1,800 gpm in the Wilcox formation, depending largely upon the size of the well installations. The average specific capacity of 13 irrigation wells screened in Quaternary deposits is 56 gpm per foot of drawdown, as compared to an average of 30 gpm per foot of drawdown for 3 wells screened in the Wilcox formation.

Water levels in wells in the Quaternary deposits are less than 10 feet below the land surface in more than half the county, and levels range from 10 to 20 feet below land surface in most of the remaining area. Water levels are more than 20 feet below land surface principally in a belt parallel to the Mississippi River which occupies less than 10 percent of the county. The direction of ground-water movement in the Quaternary deposits generally is to the southwest.

The water level in one well screened in sands of the Claiborne group is about 19 feet below land surface. The water-bearing sands of this group apparently never have supported flowing wells, and present water levels seem to be about the same as water levels

measured in the early 1900's. There is no evidence of any large decline in water levels in the report area caused by heavy pumping from the Claiborne group in Memphis, Tenn.

Water levels in the Wilcox formation range from 3.3 feet above land surface to 15.3 feet below. Although this formation originally supported flowing wells, water levels have generally declined 25 to 30 feet in the last 48 years. Only one well is known to flow. The general direction of ground-water movement in this formation is southwestward.

There is no information concerning water levels in the Cretaceous deposits in the study area. Although the available data in the southern part of southeastern Missouri is inadequate for making definite predictions regarding water-level elevations in Mississippi County, they suggest that the deposits may support flowing wells in the northwestern part of the county. The general direction of ground-water movement in the Cretaceous deposits in southeastern Missouri is southeastward.

Information concerning water levels in the Paleozoic rocks is limited to data obtained from one oil-test well in the area. When drilling had reached depths of 2,960 and 3,310 feet, water rose to within 300 and 100 feet of land surface, respectively. At 4,405 feet, water rose in the well to above land surface. Upon completion of the well, at 4,535 feet, water flowed at a rate of 70 gpm.

Withdrawal of ground water from the Quaternary deposits and the Wilcox formation can be increased greatly throughout Mississippi County. The Claiborne group yields water to only one well in the area but is an important potential source of additional ground water. The Cretaceous deposits are an entirely undeveloped source of ground water in the area and presumably will yield an abundant supply of warm water of good quality in the northern half of the county. Industries requiring water of extremely high mineralization may eventually use water from the Paleozoic rocks.

# INTRODUCTION

This report is one of a series dealing with the ground-water resources of Arkansas made under a program of investigations by the United States Geological Survey in cooperation with the Arkansas Geological and Conservation Commission.

Cooperative work of the U. S. Geological Survey began in 1945 with the Bureau of Research of the University of Arkansas and later with the University of Arkansas Institute of Science and Technology. The cooperative investigations led to the publication of four reports:

1. Public water supplies of Arkansas (Hale and others, 1947)[1]
2. Ground-water resources of the El Dorado area, Union County, Arkansas (Baker and others, 1948)
3. Ground-water resources of Ashley County, Arkansas (Hewitt and others, 1949)
4. Ground-water resources of Jefferson County, Arkansas (Klein and others, 1950)

The present cooperation with the Arkansas Geological and Conservation Commission, and its predecessor the Arkansas Resources and Development Commission, was established in 1950 and has resulted in the publication to date of additional reports as listed below:

1. The ground-water resources of Columbia County, Arkansas, a reconnaissance (Tait and others, 1953)
2. Changes in water levels in deposits of Quaternary age in eastern Arkansas from 1938 to 1953 (Counts, 1954)
3. Arkansas' ground-water resources (Baker, 1955)
4. Ground-water resources in a part of southwestern Arkansas (Counts and others, 1955)
5. Ground-water resources in Chicot County, Arkansas (Onellion and Criner, 1955)
6. Geology and ground-water resources of Drew County, Arkansas (Onellion, 1956)
7. Ground-water resources of parts of Lonoke, Prairie, and White Counties, Arkansas (Counts, 1957)
8. Geology and ground-water resources of Desha and Lincoln Counties, Arkansas (Bedinger and Reed, 1960)

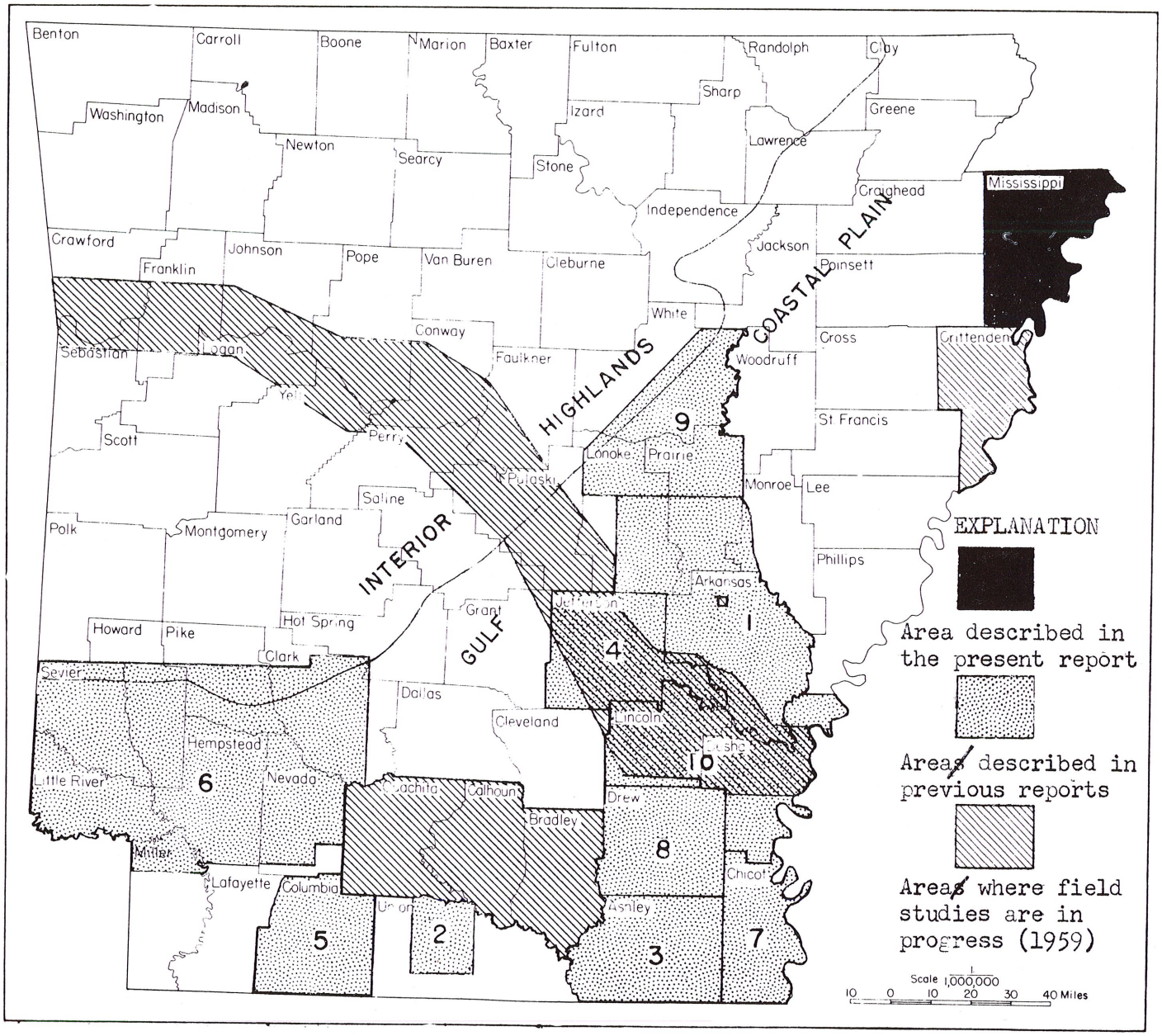
The areas covered by the reports listed above are shown in figure 1.

This report presents the findings of a study concerned with determining what water-bearing formations are present in Mississippi County, their thickness and lateral extent, their depths below land surface, their respective water levels, their ability to yield water to wells, the chemical quality of water they contain, the extent to which they have been utilized, and the areas of substantial recharge to the deposits of Quaternary age.

The study was started in October 1955 and included 6 weeks of field work in 1955, 27 weeks in 1956, and 21 weeks in 1957. The field work consisted of (1) establishing a network of observation wells for water-level measurements, (2) making an inventory of public-supply, irrigation, industrial, and deep domestic wells, (3) making a partial inventory of shallow domestic wells, (4) collecting water samples from representative wells for chemical analysis, (5) obtaining formation samples during drilling of water wells, (6) obtaining well logs from drilling companies, (7) drilling 60 shallow test holes, (8) making pumping tests, (9) measuring well-discharge rates, (10) determining specific capacities of wells, and (11) obtaining pertinent data from Federal and State agencies.

The study was under the direct supervision of P. E. Dennis, District Geologist, and under the general direction of A. N. Sayre, Chief of the Ground Water Branch, U. S. Geological Survey. The chemical analyses, unless otherwise indicated, were made by the Quality of Water Branch of the U. S. Geological Survey at Fayetteville, and the quality-of-water section of the report was reviewed by Merle E. Schroeder, District Chemist, of that office.

[1] For complete reference see selected bibliography.




(1) Engler, 1945, (2) Baker, 1948, (3) Hewitt, 1949, (4) Klein, 1950, (5) Tait, 1953, (6) Counts, 1955, (7) Onellion, 1955, (8) Onellion, 1956, (9) Counts, 1957, (10) Bedinger and Reed, 1960.

(For complete references, see bibliography)

**Figure 1.—Map of Arkansas showing areas of ground-water investigation.**

## Acknowledgments

The investigation was facilitated by the cooperation of many people, including landowners, farm managers, town and city waterworks superintendents, representatives of various industries and of a private water company, and water-well drillers. Many logs were furnished for publication by the Layne-Arkansas Co. and by the Carloss Well Supply Co. The use of privately owned wells for pumping tests was permitted by Mr. C. L. Denton, Mr. Lawrence Woodard, the Lee Wilson Co., and Mrs. R. A. Greenway. Mr. Earl H. Wildy, the Federal Compress Co. of Blytheville, and the Blytheville City Water Co. allowed the installation of water-level recorders on unused wells. To all these people the writer is very grateful.

## Location and Extent of Area

Mississippi County is in the northeastern corner of Arkansas. It is bounded on the north by the State of Missouri, on the east by the Mississippi River and the State of Tennessee, and on the west and south by Craighead and Poinsett Counties and Crittenden County, Ark. Its northern border, running east-west, is 31 miles long, its western border, running north-south, is 38½ miles long; and the southern boundary is 20 miles long. The eastern boundary, about 100 miles long, is highly irregular, trends generally southwestward, and follows almost exclusively the meandering course of the Mississippi River.

Of the 75 counties in Arkansas, Mississippi County ranks seventh in area, comprising 932 square miles, and is second in population, with about 82,400 inhabitants in 1950.

## Topography and Drainage

The topography of Mississippi County is typical of a flood plain of a large river. The general slope of the land is from the banks of the Mississippi River toward the western part of the county, where the surface elvation is about 30 feet lower than the top of the natural levees bordering the river (in the eastern part of the county). The land surface is highest, about 260 feet above mean sea level, in the northeastern part of the county; and lowest, about 215 feet, in the southwestern corner of the county. Although the county is essentially a plain, there are local variations in topography in the form of low sand mounds, shallow depressions, faint ridges, and the deeper depressions of abandoned and active stream channels. Conspicuous manmade topographic features of relatively recent origin are the levees along the courses of the Mississippi River and the Little River and hundreds of miles of drainage ditches. A few pre-Columbian Indian mounds, in various stages of destruction, still survive the agricultural activities in the county.

The Louisiana Purchase of 1803 included land which in 1833, by act of the Territorial Legislature, became Mississippi County. Until the construction of the Mississippi levee was begun in 1891-95, the whole land area within the boundaries of this county, with the exception of a part of the natural levees along the river, was subject to annual overflows of the river.

Little interest was taken in drainage before the building of the levees. However, once the land was protected from inundation from the Mississippi River, the drainage of the low areas became a problem. In 1895 the first drainage ditch was constructed in Mississippi County; by 1914 about 320 miles had been dug or were under construction. At the present time there are about 950 miles of drainage ditches in the county. This figure includes only the major system of ditches, which are financed by bond issues, and does not include the smaller ditches constructed by individual landowners, which probably total several thousand miles. The result of these vast public and private drainage projects is the reclamation of thousands of acres of land for agricultural use and the destruction of vast breeding grounds for the malaria-spreading *Anopheles* mosquito.

Most of the natural drainage of Mississippi County is from northeast to southwest. Stream and ditch gradients are low, and water movement tends to be sluggish toward the St. Francis River, in adjacent Craighead and Poinsett Counties, and toward its tributaries. Little water drains eastward into the Mississippi River.

The northwestern part of Mississippi County is drained principally by Buffalo Creek Ditch and the Right and Left Hand Chutes of Little River. Pemiscot Bayou and Crooked Lake Bayou, together with an extensive system of ditches, drain the northeastern part of the county. The central part of Mississippi County is drained by a number of major ditches connected to smaller lateral ditches which are dry for the greater part of the year. Kochtitski Ditch is one of the important drainage ditches in this area. Southern Mississippi County is drained by Frenchmans Bayou and Cross

**TABLE 1**

**Selected data on temperature at Blytheville, Ark., from 1955 through 1958**

**From records of the U. S. Weather Bureau (in degrees Fahrenheit)**

| Month | Long-term means[1] | Average temperature | | | | Average maximum temperature | | | | Average minimum temperature | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1955 | 1956 | 1957 | 1958 | 1955 | 1956 | 1957 | 1958 | 1955 | 1956 | 1957 | 1958 |
| January | 40.5 | 39.1 | 36.2 | 37.5 | 36.4 | 48.2 | 45.2 | 46.0 | 44.7 | 30.0 | 27.1 | 28.9 | 28.1 |
| February | 43.4 | 41.5 | 45.3 | 47.3 | 32.5 | 51.7 | 54.0 | 55.7 | 41.5 | 31.0 | 36.6 | 38.8 | 23.4 |
| March | 51.2 | 51.5 | 50.9 | 49.7 | 44.1 | 61.8 | 62.4 | 59.9 | 51.6 | 41.1 | 39.4 | 39.5 | 36.5 |
| April | 61.2 | 65.8 | 58.8 | 63.6 | 59.6 | 76.0 | 70.5 | 74.9 | 69.9 | 55.6 | 47.1 | 52.3 | 49.2 |
| May | 70.1 | 72.4 | 72.0 | 70.3 | 70.0 | 82.1 | 82.8 | 80.9 | 80.6 | 62.6 | 61.1 | 59.6 | 59.3 |
| June | 78.9 | 73.3 | 76.4 | 77.5 | 77.9 | 83.0 | 88.5 | 87.6 | 89.0 | 63.6 | 64.3 | 67.4 | 66.7 |
| July | 81.6 | 83.2 | 80.8 | — | 80.6 | 92.4 | 93.4 | — | 89.5 | 74.0 | 68.1 | — | 71.7 |
| August | 80.5 | 80.3 | 79.6 | 77.0 | 79.3 | 91.2 | 93.1 | 87.8 | 89.9 | 69.4 | 66.0 | 66.1 | 68.6 |
| September | 73.7 | 75.3 | 69.9 | 70.3 | 71.8 | 89.2 | 85.7 | 80.2 | 80.7 | 61.4 | 54.1 | 60.4 | 62.9 |
| October | 63.4 | 61.5 | 65.1 | 58.0 | 60.7 | 75.1 | 79.1 | 68.8 | 72.7 | 47.9 | 51.0 | 47.1 | 48.6 |
| November | 50.0 | 48.0 | 50.4 | 49.4 | 53.3 | 59.8 | 62.7 | 58.0 | 64.7 | 36.2 | 38.0 | 40.7 | 41.9 |
| December | 41.8 | 39.5 | 46.8 | 46.8 | 37.6 | 50.4 | 56.1 | 56.2 | 46.8 | 28.5 | 37.4 | 37.3 | 28.4 |

[1] Computed as of 1958.

Bayou, together with the drainage-ditch system.

The natural drainage system, and to a lesser extent the constructed ditches, also serve as ground-water drains, especially during periods of high water table. The contour maps of the water table (fig. 11) show that the ground water drains to the Mississippi River only along a strip a few miles wide next to the river. Throughout the rest of the county the ground-water drainage, like the surface drainage, is to the southwest into the Pemiscot Bayou, Little River, and other streams.

## Climate

The winters in Mississippi County are short and usually mild. Freezing weather lasts for short periods, and snowfall is very light. Severe conditions are very uncommon and are of short duration. The average winter, spring, summer, and fall temperatures are about 42, 61, 80, and 62 degrees Fahrenheit, respectively. Table 1 shows selected temperature data.

Mississippi County receives about 46.6 inches of rain per year. Based on long-term means, about 29.9 percent of the annual precipitation occurs during the winter. Precipitation during the spring is about 27.9 percent of the annual amount. Summer and fall receive about 21.7 and 20.5 percent, respectively.

The first weather station in Mississippi County was established by the U. S. Weather Bureau at Osceola in 1887. Since then four additional stations have been established at Blytheville, Wilson, Big Lake Outlet, and Burdette. Precipitation is measured at all stations; temperature at only Blytheville and Wilson. Table 2 shows selected precipitation data at Blytheville, Ark. and table 3 shows the annual precipitation at the several U. S. Weather Bureau stations.

**TABLE 2**

**Selected precipitation data at Blytheville, Ark., from 1955 through 1958**

**From records of the U. S. Weather Bureau (in inches)**

| Month | Long-term means | Monthly precipitation | | | |
|---|---|---|---|---|---|
| | | 1955 | 1956 | 1957 | 1958 |
| January | 5.47 | 1.78 | 5.73 | 8.97 | 4.00 |
| February | 4.08 | 4.65 | 9.52 | 6.18 | 3.13 |
| March | 5.34 | 6.31 | 2.03 | 1.74 | 6.90 |
| April | 3.89 | 8.32 | 6.26 | 8.04 | 4.21 |
| May | 3.79 | 4.74 | 1.95 | 12.47 | 6.45 |
| June | 3.12 | 2.88 | 3.01 | 5.87 | 2.44 |
| July | 3.73 | 4.57 | 0.52 | 5.74 | 6.06 |
| August | 3.27 | 1.03 | 2.28 | 6.39 | 1.32 |
| September | 3.16 | 3.53 | 0.50 | 3.31 | 7.09 |
| October | 2.85 | 3.41 | 1.50 | 5.11 | 1.01 |
| November | 3.55 | 2.80 | 3.89 | 11.43 | 5.74 |
| December | 4.38 | 1.49 | 2.83 | 6.18 | 0.93 |
| Annual | 46.63 | 45.51 | 40.02 | 81.43 | 49.28 |

The climatological data are summarized below:

| Month | Season | Average precipitation in inches | Average temperature in °F | Average frost-free growing season |
|---|---|---|---|---|
| December<br>January<br>February | Winter | 13.7 | 42 | |
| March<br>April<br>May | Spring | 13.5 | 61 | March 29 ↑ |
| June<br>July<br>August | Summer | 10.0 | 80 | 218 days |
| September<br>October<br>November | Fall | 9.4 | 62 | ↓ October 30 |

The growing season in Mississippi County is about 218 days. March 29 is the average date of the last killing frost in the spring, and October 30 is about the first killing frost in the fall.

**TABLE 3**

**Annual precipitation data from U. S. Weather Bureau Stations—**

(in inches)

| Year | Osceola | Blytheville | Wilson | Big Lake Outlet | Burdette |
|---|---|---|---|---|---|
| 1887 | -------- | | | | |
| 1888 | 44.08 | | | | |
| 1889 | 42.72 | | | | |
| 1890 | 67.76 | | | | |
| 1891 | 51.41 | | | | |
| 1892 | 54.97 | | | | |
| 1893 | 51.59 | | | | |
| 1894 | 45.10 | | | | |
| 1895 | 40.25 | | | | |
| 1896 | 39.87 | | | | |
| 1897 | 44.35 | | | | |
| 1898 | 54.90 | | | | |
| 1899 | 48.78 | | | | |
| 1900 | 50.86 | | | | |
| 1901 | 35.52 | | | | |
| 1902 | -------- | | | | |
| 1903 | 33.55 | | | | |
| 1904 | 48.76 | | | | |
| 1905 | 53.21 | | | | |
| 1906 | 37.63 | | | | |
| No record for the years from 1907 to 1916 | | | | | |
| 1917 | 32.81 | | | | |
| 1918 | 40.72 | | | | |
| 1919 | 68.61 | | | | |
| 1920 | 53.05 | | | | |
| 1921 | 49.85 | | | | |
| 1922 | 41.93 | | | | |
| 1923 | 64.49 | | | | |
| 1924 | 28.38 | | | | |
| 1925 | 41.20 | | | | |
| 1926 | 43.64 | 46.41 | 50.27 | | |
| 1927 | 71.71 | 72.51 | 68.02 | | |
| 1928 | 48.18 | 45.06 | 43.86 | | |
| 1929 | 45.16 | 47.39 | 44.84 | | |
| 1930 | 48.99 | 36.81 | 44.61 | | |
| 1931 | 39.97 | 53.49 | 46.37 | 41.66 | |
| 1932 | 57.58 | 51.47 | 58.09 | 47.09 | |
| 1933 | 47.16 | 55.57 | 46.33 | 49.41 | |
| 1934 | 41.82 | 46.55 | 46.93 | 40.30 | |
| 1935 | 50.42 | 47.23 | 54.72 | 44.00 | |
| 1936 | -------- | 39.93 | 43.02 | 37.03 | |
| 1937 | -------- | 63.88 | 51.29 | 62.04 | |
| 1938 | -------- | 35.55 | 40.09 | 36.92 | |
| 1939 | -------- | 43.98 | -------- | 50.85 | |
| 1940 | 36.68 | 41.96 | -------- | 40.02 | |
| 1941 | 23.32 | 23.18 | 28.88 | 27.50 | |
| 1942 | 46.45 | 43.41 | 37.42 | 41.77 | |
| 1943 | 32.64 | 30.59 | 32.53 | 30.32 | -------- |
| 1944 | 52.02 | 48.82 | 54.72 | 49.46 | 57.48 |
| 1945 | -------- | 58.81 | 59.47 | -------- | 63.47 |
| 1946 | -------- | 48.47 | -------- | 45.59 | 51.89 |
| 1947 | -------- | 34.62 | -------- | 37.00 | 36.32 |
| 1948 | -------- | -------- | -------- | 52.03 | 53.52 |
| 1949 | 57.09 | 59.22 | -------- | 60.57 | -------- |
| 1950 | 58.80 | 66.84 | -------- | 66.74 | 68.88 |
| 1951 | 57.20 | 53.86 | -------- | 53.09 | 58.30 |
| 1952 | 39.39 | 42.15 | 37.98 | 38.77 | 49.48 |
| 1953 | 47.64 | 42.70 | 42.15 | 44.16 | 47.91 |
| 1954 | 34.92 | 36.92 | -------- | 37.68 | 41.01 |
| 1955 | 40.32 | 45.51 | 45.63 | 42.31 | 48.42 |
| 1956 | 42.06 | 40.02 | 45.94 | 47.36 | 53.48 |
| 1957 | 77.10 | 81.43 | 73.82 | 79.06 | 91.83 |
| 1958 | 47.71 | 49.28 | 48.31 | 52.85 | 58.33 |

## Culture

When the first settlers moved into Mississippi County they found dense forests consisting of such trees as oak, cottonwood, willow, gum, maple, elm, cypress, ash, pecan, boxelder, persimmon, sycamore, hickory, and honey locust. The removal of this timber was at first a slow process, but with the arrival of a number of large lumber companies the timber rapidly disappeared. Today forested areas are present only along some of the rivers and creeks and in the Big Lake National Wild Life Refuge.

As the forests were cut, the county was opened to increased settlement. In 1840, 7 years after the county was created by an act of the Territorial Legislature, there were 1,410 inhabitants constituting 1.4 percent of the total population of Arkansas. By 1900 there were 16,384 inhabitants. In 1950 the population of Mississippi County had grown to 82,375, or 4.3 percent of that of the entire State. The cities of Blytheville and Osceola increased in population from 302 and 953 in 1900 to 16,234 and 5,006, respectively, in 1950. Table 4 shows census data for the population of Mississippi County, and table 5 shows the population figures for all cities and large towns from 1890 to 1950.

**TABLE 4**

**Population of Mississippi County, Ark.**

**From records of the U. S. Bureau of Census**

| Census Year | Population | Census Year | Population |
|---|---|---|---|
| 1790 | -------- | 1880 | 7,325 |
| 1800 | -------- | 1890 | 11,635 |
| 1810 | -------- | 1900 | 16,384 |
| 1820 | -------- | 1910 | 30,468 |
| 1830 | -------- | 1920 | 47,320 |
| 1840 | 1,410 | 1930 | 69,289 |
| 1850 | 2,368 | 1940 | 80,217 |
| 1860 | 3,895 | 1950 | 82,375 |
| 1870 | 3,633 | | |

Farming is the principal occupation of Mississippi County. Cotton has been the chief crop for many years. However, in 1957, the latest year for which statistical data is available, soybean acreage exceeded that of cotton by 39,600 acres. The major crop acreages in 1957 were as follows:

| Crop | Acreage |
|---|---|
| Corn | 25,000 |
| Cotton | 174,000 |
| Oats | 10,400 |
| Rice | 1,290 |
| Soybeans | 213,600 |
| Wheat | 26,800 |
| Sum | 451,090 |

**TABLE 5**

**Population of cities and towns**

**From records of the U. S. Bureau of Census**

| Year | Osceola | Blytheville | Luxora | Manila | Dell | Burdette | Leachville | Joiner | Keiser | Wilson |
|---|---|---|---|---|---|---|---|---|---|---|
| 1890 | 458 | -------- | -------- | -------- | -------- | -------- | -------- | -------- | -------- | -------- |
| 1900 | 953 | 302 | 943 | -------- | -------- | -------- | -------- | -------- | -------- | -------- |
| 1910 | 1,769 | 3,849 | 677 | 562 | 162 | -------- | -------- | -------- | -------- | -------- |
| 1920 | 1,755 | 6,447 | 1,179 | 971 | 233 | 100 | -------- | -------- | -------- | -------- |
| 1930 | 2,573 | 10,098 | 1,074 | 1,226 | 267 | 155 | 1,157 | 306 | -------- | -------- |
| 1940 | 3,226 | 10,652 | 1,258 | 1,248 | 323 | 110 | 1,076 | 388 | 452 | -------- |
| 1950 | 5,006 | 16,234 | 1,302 | 1,729 | 384 | 122 | 1,230 | 596 | 522 | 1,301 |

The total acreage of Mississippi County is about 596,000. Of this, approximately 85 percent is crop land. The remaining acreage consists of the Big Lake floodway, Mississippi River front land, and rights-of-way for roads, railroads, and ditches.

Railroads run from Leachville north into Missouri, southwest into neighboring Craighead County, southeast and east to Manila, Dell, Blytheville, and Armorel. West of Dell a branch line runs south through Victoria and Keiser to Wilson. At Blytheville railroads run north and northwest to Missouri and south to Luxora, Osceola, Wilson, Bassett, Joiner, and on into Crittenden County.

The people of Mississippi County depend almost exclusively upon ground water for their water supply. Thus, the economy and development of the county are dependent upon the continued effective use of the ground-water resources. This report is intended to aid in the utilization of these resources. What is known of the geology and hydrology of the county is therefore presented.

## Well-Numbering System

The well-numbering system in this report is based upon the location of the wells with respect to the Federal land-survey used in Arkansas. This system involves numbers and letters. The numbers refer to township, range, and section as read from left to right. The township lines have a north-south arrangement relative to the base line, and the township component of the well number is designated "N" or "S" to indicate this relationship. Range lines are oriented east-west with respect to the fifth principal meridian, and the range component of the well number is designated "E" or "W." The area enclosed by township and range lines is referred to as a township and consists of 36 sections, each normally a mile square. Each section in turn is subdivided into quarter sections, quarter-quarter sections, and quarter-quarter-quarter sections. The lower-case letters are assigned in counterclockwise order beginning with "a" for the northeast quadrant of the first, second, and third order quarter sections. If several wells are within the 10-acre area covered by the quarter-quarter-quarter section, a suffix number is appended which indicates whether the well is the first, second, or third well within the area, and is used only when two or more wells have been scheduled in the 10-acre area.

This system of numbering wells according to their location is illustrated in figure 2.

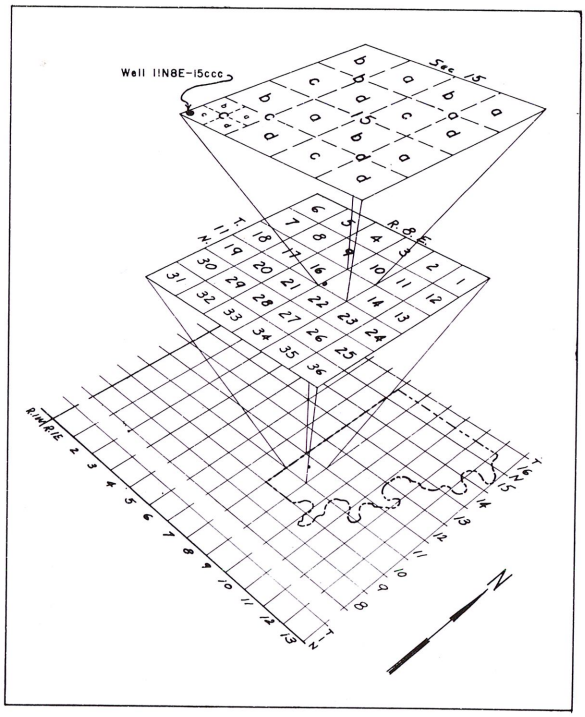



**Figure 2.—Sketch showing well-numbering system.**

## Geology and Water-Bearing Properties of the Rocks

Water at varying depths is evidence of the porous character of the rocks that underlie the land surface, because water can pass through and accumulate only in that space not occupied by solid material.

The open spaces in soil and rock are called voids, pores, or interstices. These voids provide not only the conduits which allow surface water to infiltrate and move through soil and rock but also the space for ground-water storage. Water moves downward from the land surface to the zone of saturation. The water surface at the top of the saturated zone below which the rock interstices are filled with water under hydrostatic pressure is called the water table. The term **water table** is used in this report for convenience to refer to a composite water surface which is made up of an unconfined water surface (in areas where ground water occurs under water-table conditions) and a pressure-head-indicating piezometric surface (in areas where the water is confined and under slight artesian pressure).

The interstices differ considerably in shape, size, arrangement, and continuity. The porosity of a rock, expressed in percent, is the aggregate volume of voids in relation to the volume of the rock in which they occur. However, porosity is independent of the size and degree of interconnection of the voids, and these are the principal factors controlling the amount of water that will pass through a rock. The property of an aquifer to conduct water is known as permeability and may be expressed in gallons per day per square foot.

The character and aggregate volume of the voids are related to the type of rock in which they occur. Thus, a ground-water investigation involves the study of the rock formations at or near the land surface and of those at depth.

Rocks are classified in three groups based on differences in mode of origin. The three groups are: (1) igneous rocks resulting from the solidification of molten rock material on or beneath the land surface, (2) sedimentary rocks resulting from the accumulation of material derived from the chemical decomposition and mechanical disintegration of preexisting rocks, and (3) metamorphic rocks resulting from the moderate to profound alteration of igneous, sedimentary, or other metamorphic rocks.

No igneous rocks are known to be present in Mississippi County. Consolidated rocks of sedimentary origin, which may be weakly metamorphosed, occur at considerable depth below land surface. From the upper surface of these deeply buried rocks to ground level, there is a sequence of rock layers consisting of unconsolidated to slightly consolidated sedimentary material. All the useful water-bearing formations in the county are within this zone of sedimentary rocks.

Table 6 lists the rock units in their natural order as they would be penetrated by a well, with the oldest at the bottom and the youngest at the top. The table also gives a summary statement of the water-bearing properties of each rock unit.

### Paleozoic Rocks

The oldest and most deeply buried rocks known in Mississippi County are of Paleozoic age. They underlie the county at depths ranging from about 2,050 feet below land surface in the northwestern part to about 3,200 feet in the southern part. The total thickness of the Paleozoic rocks is unknown. However, the Benedum-Trees Oil Co. C. W. Mack No. 1 well, which was drilled 7 miles northeast of Blytheville in 1939, reached a total depth of 4,535 feet and cut into 1,729 feet of rocks of Paleozoic age. According to Grohskopf (1955, p. 124-125) the formations of Paleozoic age penetrated in the oil-test hole were the Jefferson City formation, the Roubidoux formation, the Gasconade and Van Buren formations (all of Early Ordovician age), and the Eminence formation of Late Cambrian age. The formations of Ordovician age consist predominantly of dark-gray cherty limestone and have an aggregate thickness of 1,512 feet. The Cambrian Eminence formation consists of 217 feet of dolomite.

In Arkansas, the Jefferson City formation crops out in the northeastern part of the Interior Highlands province, where land-surface elevations range from about 250 feet to more than 750 feet above sea level. All the formations of Paleozoic age which are known to occur at depth in Mississippi County crop out in the southeastern part of Missouri. Figure 3 is a map showing structural contours drawn on the top of undifferentiated Paleozoic rock.

The high mineralization of the water from rocks of Paleozoic age makes it unsuitable for irrigation, public-supply, domestic, and many industrial uses. Water encountered at depths

## TABLE 6

**Stratigraphic chart showing major divisions of geologic time and the rock units present in Mississippi County, Ark.**
(Time span given in approximate number of million years ago)

| ERA | SYSTEM | SERIES | TIME SPAN | SUBDIVISION | THICKNESS | WATER-BEARING CHARACTERISTICS |
|---|---|---|---|---|---|---|
| Cenozoic | Quaternary | Recent<br>Pleistocene | 0-1 | | 101-198 | Clay, silt, sand, and gravel. Calcium bicarbonate water generally high in iron content and hard. Water of excellent quality in some places at shallow depths. Average water temperature 62° F. Most productive aquifer in the county. Relatively high permeability. |
| | Tertiary | Pliocene | 1-10 | Absent | | |
| | | Miocene | 12-25 | | | |
| | | Oligocene | 28-40 | | | |
| | | Eocene | 40-60 | Jackson group | Presence unknown | |
| | | | | Claiborne group | 570-920 | Interbedded sand and clay. Lignitic. Analysis of one water sample indicates calcium bicarbonate water, high iron content, hard. Temperature 62°F. Well yield comparable to those wells screened in sands of the Wilcox formation. Potential source of ground water. |
| | | | | Wilcox formation | 445-730 | Interbedded sand and clay. Predominantly sand in lower part of formation. Sodium bicarbonate water of excellent quality. Average water temperature 75°F. Currently second most productive aquifer in county. Permeability about ⅔ to ½ that of Quaternary deposits. |
| | | Paleocene | | Midway group: Porters Creek formation<br>Clayton formation | 435-640 | Clay; lower part calcareous. Too fine grained to yield water to wells. |
| Mesozoic | Cretaceous | Upper | 60-125 | Undifferentiated | 525-750 | Predominantly sand in northern part of county. Sodium bicarbonate water of presumed good quality in northern part of county. Presumed unsatisfactory quality in central and southern parts. Temperature probably 85° to 95°. Potential source of ground water. |
| | | Lower | | Absent | | |
| | Jurassic | Upper<br>Middle<br>Lower | 125-150 | | | |
| | Triassic | Upper<br>Middle<br>Lower | 150-180 | | | |
| Paleozoic | Permian | | 180-205 | | | |
| | Carboniferous System: Pennsylvanian | Upper<br>Middle<br>Lower | 205-235 | | | |
| | Carboniferous System: Mississippian | Upper<br>Lower | 235-255 | | | |
| | Devonian | Upper<br>Middle<br>Lower | 255-315 | | | |
| | Silurian | Upper<br>Middle<br>Lower | 315-350 | | | |
| | Ordovician | Upper<br>Middle<br>Lower | 350-430 | Undifferentiated | 1,512 | Limestone and dolomite. Sodium chloride water of extremely high mineralization. Recorded temperature of 110°F. Possibly suitable for special industrial uses. |
| | Cambrian | Upper<br>Middle<br>Lower | 430-510 | | 217 | |
| Precambrian | | Upper<br>Middle<br>Lower | 510-3,000+ | Presence unknown | | |

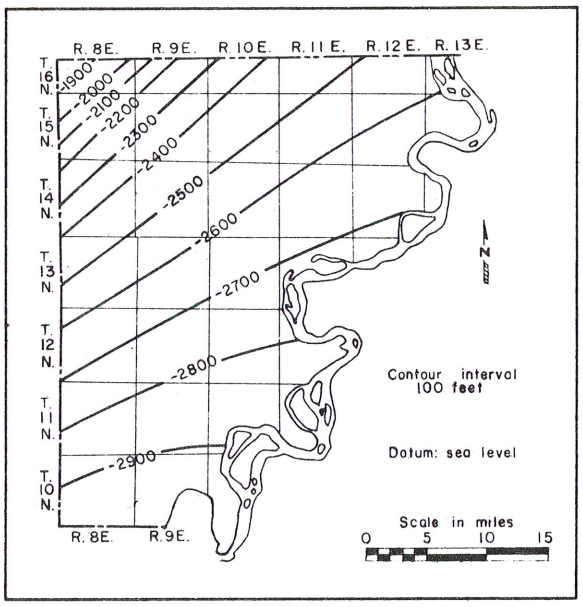



Figure 3.—Map of Mississippi County, Ark., showing the altitude of the top of Paleozoic rocks beneath the Coastal Plain (after Caplan, 1954).

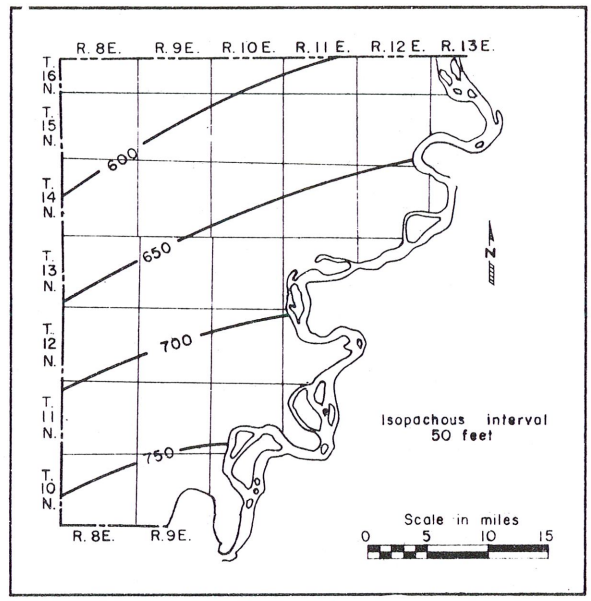



Figure 4.—Map of Mississippi County, Ark., showing the approximate thickness of the Cretaceous deposits (after Caplan, 1954).

greater than those shown on the subsurface contour map (fig. 3) is almost certain to be highly mineralized.

## Mesozoic Rocks

Deposits of Late Cretaceous age overlie the Paleozoic rocks with marked unconformity, and underlie Mississippi County at a depth below land surface ranging from about 1,500 feet, in the northwestern part of the county near Leachville, to about 2,400 feet, near the Crittenden County line. According to Caplan (1954, pl. III) the inferred thickness of the Cretaceous sediments ranges from about 560 feet in the northwestern part to approximately 780 feet in the extreme southern part of the county. The Benedum-Trees Oil Co. C. W. Mack No. 1 well penetrated 639 feet of Cretaceous deposits, of which 598 feet were logged as sand and 41 feet as sandy shale and clay. This is the only well known to have been drilled sufficiently deep to penetrate deposits of Cretaceous age in the county. The isopachous map of undifferentiated deposits of Cretaceous age shown in figure 4 is based on the above well and data from adjacent regions.

Figure 5 is a map of the northern Mississippi embayment showing the location of the two cross-section lines A-A′ and B-B′. The cross sections show the inferred continuity of the Cretaceous, Tertiary, and Quaternary deposits and the structural and stratigraphic relationships of these rock units. Cross section A-A′ (fig. 6) extends from Oran, Mo. southwestward to near Lehi, Ark., and cross section B-B′ (fig. 7) extends from near Blytheville, Ark., eastward to near Cord, Ark.

The log of the Benedum-Trees C. W. Mack No. 1 well shows the Cretaceous deposits to consist mostly of sand, but in southeastern Missouri, where a number of towns have wells screened in this rock unit, the well logs show a larger proportion of clay in the Cretaceous section. The Pattison No. 1 well shows the Cretaceous deposits to consist mostly of clay and sandy clay. This recorded lithology is not typical of these deposits in southeastern Missouri and may reflect the logging techniques rather than the true lithology of the Cretaceous sediments. In Crittenden County, about 50 to 65 miles southwest of the Benedum-Trees Oil Co. C. W. Mack No. 1 well, the electric logs of the Stanley Oil Corp. Danner No. 1 well and of the Ramsey Petroleum Co. Sanderson No. 1 well show a predominance of clay over sand in the Cretaceous deposits. In Craighead County the electric log of Tennark Inc. Ruby Martin No. 1 well shows the Cretaceous deposits as consisting of a large aggregate thickness of sand.

The available data concerning the character of the Cretaceous sediments in Mississippi County and in adjacent areas suggest that these sediments consist mostly of sand in the northern half of the county.

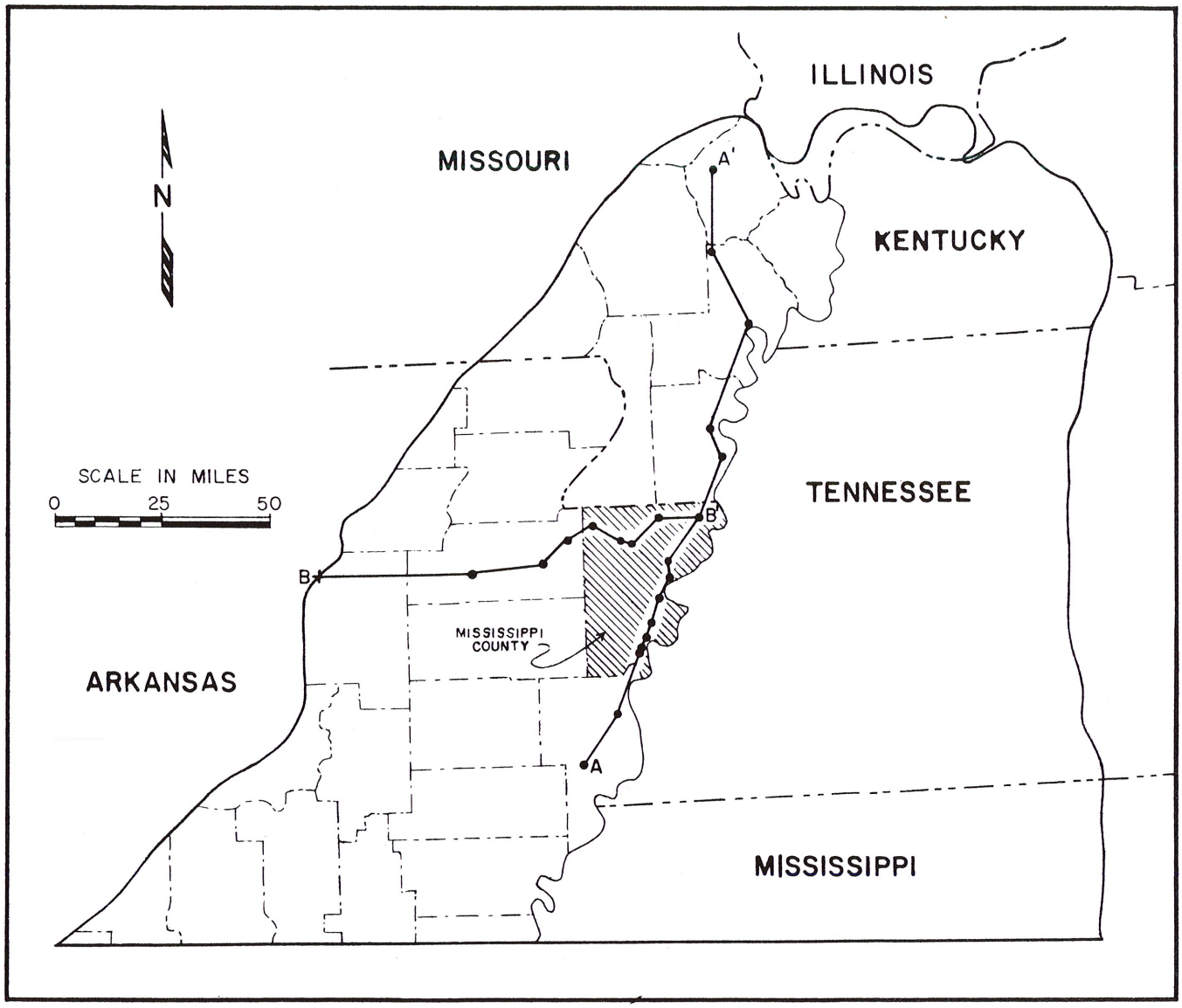
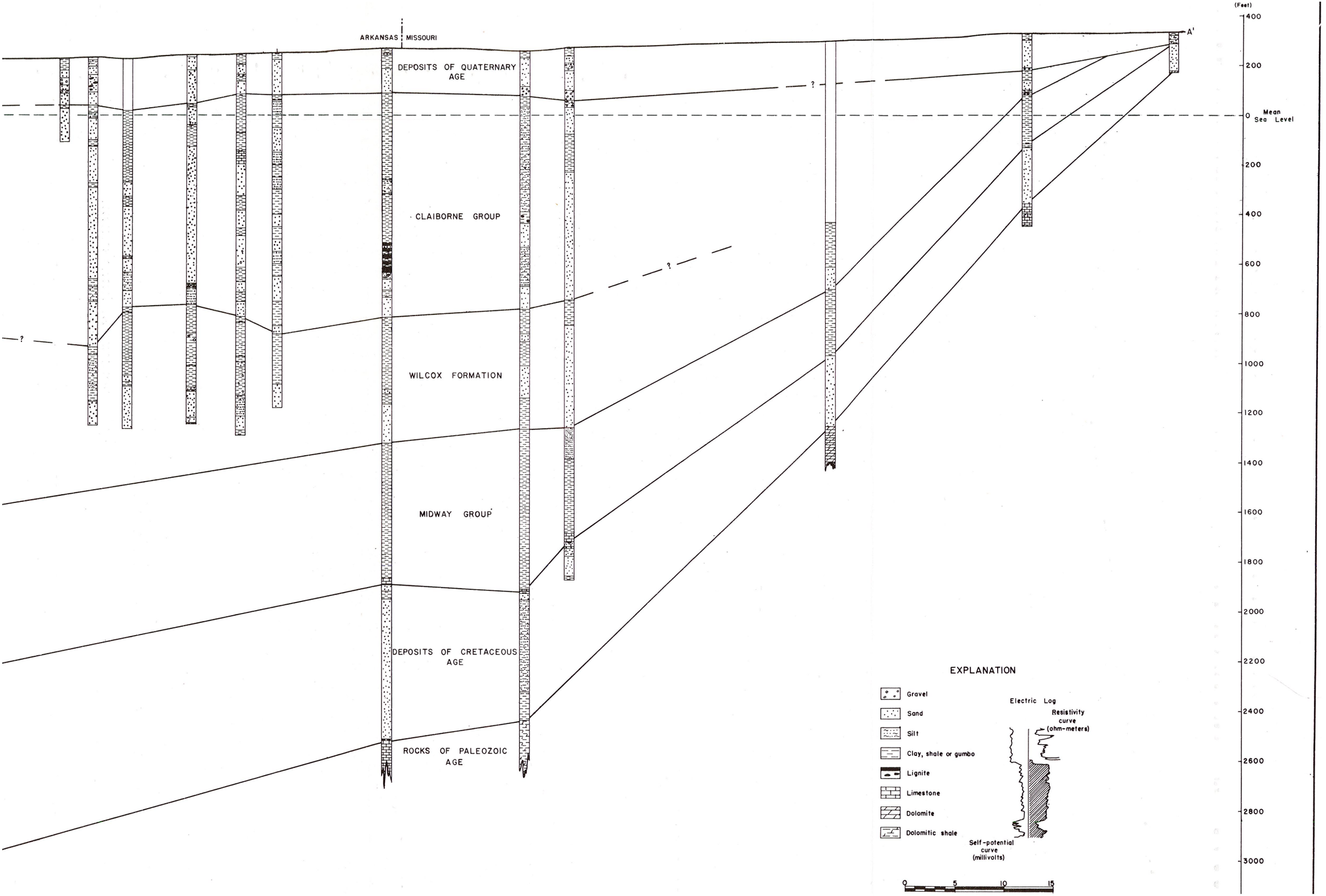
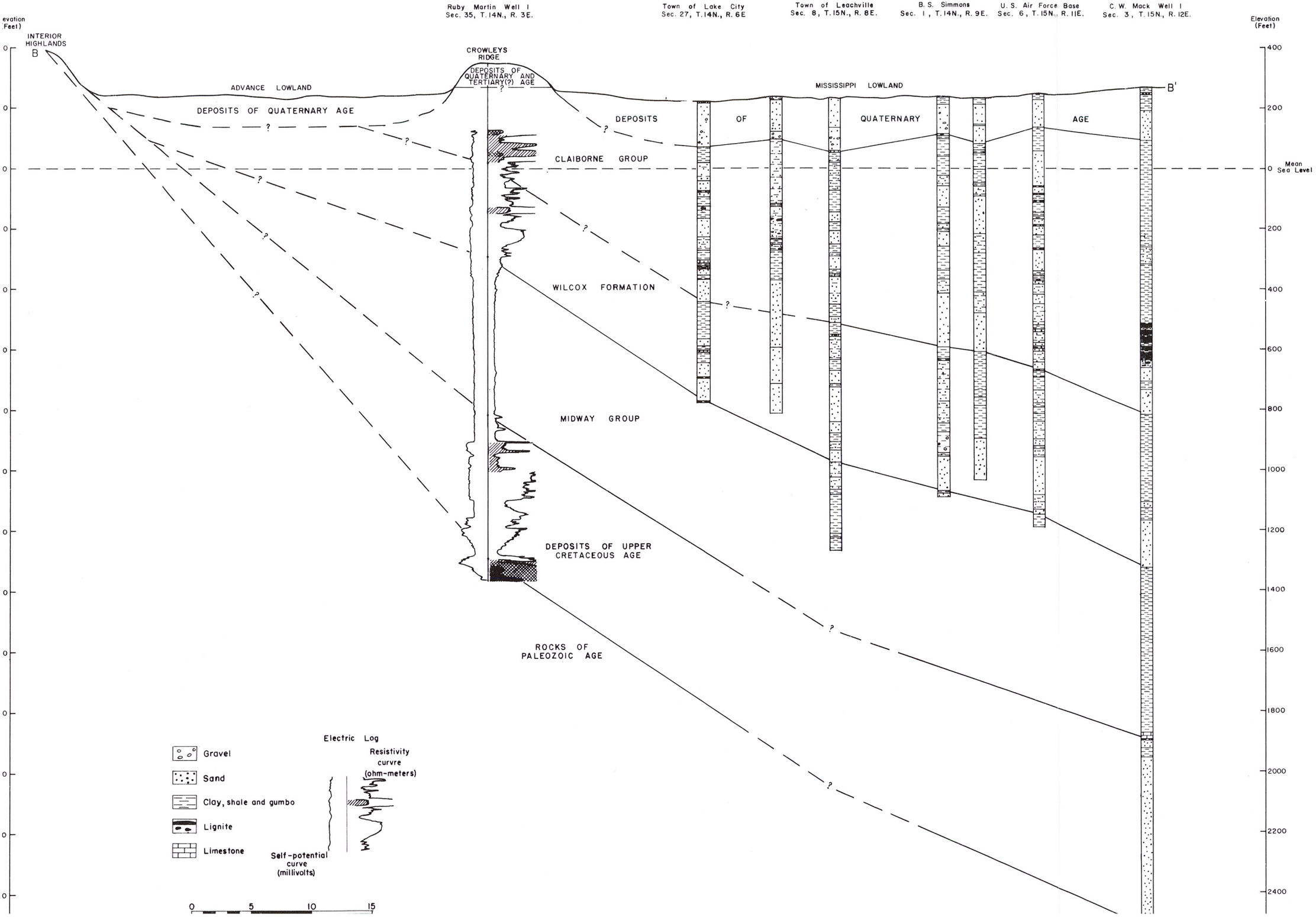



**Figure 5.—Map of the northern Mississippi Embayment showing cross-section lines A - A′ and B - B′.**


ARKANSAS
MISSOURI
A'
DEPOSITS OF QUATERNARY AGE
CLAIBORNE GROUP
WILCOX FORMATION
MIDWAY GROUP
DEPOSITS OF CRETACEOUS AGE
ROCKS OF PALEOZOIC AGE
?
(Feet)
400
200
0
Mean Sea Level
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
EXPLANATION
Gravel
Sand
Silt
Clay, shale or gumbo
Lignite
Limestone
Dolomite
Dolomitic shale
Electric Log
Resistivity curve (ohm-meters)
Self-potential curve (millivolts)
0
5
10
15


Ruby Martin Well 1
Sec. 35, T.14N., R. 3E.
Town of Lake City
Sec. 27, T.14N., R. 6E
Town of Leachville
Sec. 8, T.15N., R. 8E.
B. S. Simmons
Sec. 1, T.14N., R. 9E.
U. S. Air Force Base
Sec. 6, T.15N., R. 11E.
C. W. Mack Well 1
Sec. 3, T.15N., R. 12E.
Elevation (Feet)
INTERIOR HIGHLANDS
B
B'
CROWLEYS RIDGE
DEPOSITS OF QUATERNARY AND TERTIARY(?) AGE
ADVANCE LOWLAND
MISSISSIPPI LOWLAND
DEPOSITS OF QUATERNARY AGE
DEPOSITS OF QUATERNARY AGE
CLAIBORNE GROUP
WILCOX FORMATION
MIDWAY GROUP
DEPOSITS OF UPPER CRETACEOUS AGE
ROCKS OF PALEOZOIC AGE
Mean Sea Level
400
200
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
Gravel
Sand
Clay, shale and gumbo
Lignite
Limestone
Electric Log
Resistivity curvre (ohm-meters)
Self-potential curve (millivolts)
0
5
10
15

The Cretaceous deposits crop out in a discontinuous belt of varying width along the edge of the northern part of the Mississippi embayment. In Arkansas the area of outcrop parallels the Interior Highlands between Batesville and Powhatan. In southeastern Missouri the Cretaceous sediments crop out in the northern end of Crowleys Ridge and in the Benton Hills south of Cape Girardeau. Likewise, in the southernmost part of Illinois, in western Kentucky, and in western Tennessee the Cretaceous deposits crop out adjacent to the edge of the embayment.

The chemical quality of the water in the sand of Cretaceous age in Mississippi County is undetermined, because no water wells have been drilled to the deposits. No electric logs are available for wells in Mississippi County; however, a number of electric logs have been made in the adjacent counties of Craighead, Poinsett, Cross, and Crittenden. The interpretation of these electric-log data indicates that the water in the deposits of Cretaceous age is probably salty in all the wells nearest to Mississippi County in Craighead, Poinsett, Cross, and Crittenden Counties.

In southeastern Missouri, 3 to 13 miles north of Mississippi County, Ark., several municipal wells obtain water of good quality from deposits of Cretaceous age. Because there are no wells in the Cretaceous deposits in the report area, the location of the boundary between fresh and salt water is unknown. The deposits of Cretaceous age are, however, a potential source of fresh water from the Missouri State line south to Arkansas Highway 18, and possibly as far south as Arkansas Highway 40.

## Cenozoic Rocks

### Midway Group

Marine deposits of Paleocene age, known as the Midway group, unconformably overlie the deposits of Late Cretaceous age. In Mississippi County the group was penetrated by the Benedum-Trees C. W. Mack No. 1 well. According to Grohskopf (1955, p. 123) the Porters Creek clay and the underlying Clayton formation, which comprise the Midway group, have an aggregate thickness of 567 feet in this test hole. The Porters Creek clay consists of 550 feet of dark-gray clay, and the Clayton formation is a glauconitic, fossiliferous marl or limestone having a thickness of 17 feet in this test hole.

The sediments which make up the Porters Creek clay are too fine grained to yield water to wells from pores. The structural history of the area is unlikely to have produced fracturing, especially since the clay of which the formation is composed probably is too plastic to fracture. Thus, the presence of water in fractures in the Porters Creek clay is very unlikely.

The Clayton formation, which consists of marl and limestone, may be permeable enough to yield water to wells, but the formation is very thin (17 feet in the Benedum-Trees Oil Co. C. W. Mack No. 1 well) and is at great depth below land surface (2,150 feet in the same well.) The formation is overlain by marine clay. Cretaceous sediments, which probably contain salt water, underlie the Clayton formation in the southern half of Mississippi County. The availability of excellent aquifers at shallower depths makes the Clayton formation an unlikely source of ground water.

### Wilcox Formation

In Mississippi County the predominantly unconsolidated continental sediments of the Wilcox formation overlie the marine deposits of the Midway group. On the geologic cross sections A-A′ and B-B′ (figs. 6 and 7) the formation thickness is shown to range from 550 feet at the Mississippi-Crittenden County line in the south to 500 feet at the Arkansas-Missouri State line in the north. In an east-west direction from the Benedum-Trees C. W. Mack No. 1 well to Leachville, Ark., it ranges in thickness from 510 feet to 464 feet. The water-bearing sand zone is within the lower half or third of the Wilcox formation. The depths below land surface to the top of the sand zone may be determined in the logs of deep-wells shown in the cross sections in figures 6 and 7.

In Mississippi County the contact between the Wilcox formation and the underlying Midway group is known from subsurface data only. Electric logs in the adjacent counties in Arkansas show a zone of general lithologic transition extending from the base of the prominent sand of the Wilcox group, locally called the "1,400-foot" sand, to the top of the Porters Creek clay. The thickness of this transition zone varies from about 200 to 400 feet and averages about 315 feet. Stearns and Armstrong (1955, p. 4-5) indicate that the interval "* * * is a regressive sandy zone grading laterally into Porters Creek clay. For this reason, the interval is included in the Paleocene series and the base of the '1,400-foot' sand is chosen as the base of the Eocene."

In the present report the contact between the Wilcox formation and the Midway group was drawn at the base of the deepest distinct sand bed within the transition zone. However, a number of descriptive logs show no transition zone, and the bottom of the Wilcox formation is considered to coincide with the base of the "1,400-foot" sand.

The Wilcox formation is characterized by interbedded clay and sand, the clay predominating over sand in the upper part of the formation. Prominent water-bearing sands which are correlative with the "1,400-foot" sand in western Tennessee are near, or at, the base of the Wilcox formation. Relatively thin lenticular beds of clay occur within the basal sand zone. In Mississippi County this sand zone ranges in aggregate thickness from 180 feet, northeast of Blytheville to 115 feet, northwest of Dell. A number of the deep wells in Mississippi County probably do not penetrate the entire thickness of the Wilcox formation, thus limiting the data on the full thickness of the "1,400-foot" sand to those few wells that bottom in the Porters Creek clay.

In this report the contact between the Wilcox formation and the overlying Claiborne group is picked as closely as possible to conform with the usage of Stearns and Armstrong (1955, p. 4-6). According to these authors, the base of the Claiborne group was chosen to coincide with the base of the "500-foot" sand, the term locally used to denote the sands of the Claiborne group. The top of the Wilcox formation is thus determined by the position of the base of the Claiborne group. However, the "500-foot" sand of western Tennessee is subject to considerable lateral gradation, and it is somewhat questionable to correlate the sand lenses of the Claiborne group in Mississippi County and southeastern Missouri with the "500-foot" sand of the Memphis area. Therefore, the usage of Stearns and Armstrong is applied in the present report, emphasis being placed on the prominent bed of clay that generally overlies the "1,400-foot" sand and directly underlies the "500-foot" sand in western Tennessee. Thus, in the present report the top of the Wilcox formation was drawn at the upper surface of the first prominent bed of clay overlying the "1,400-foot" sand.

The current usage of the Missouri Geological Survey (Grohskopf, 1955, p. 23) is to define the Wilcox formation to "* * * include only those beds of sand and clay that lie between the top of the Midway and the base of the Pliocene(?) Therefore, the entire thickness of Eocene sediments between the top of the Midway formation and the Pleistocene alluvium in southeastern Missouri is referred to as the Wilcox group, and the Claiborne group is not recognized in Missouri.

The Wilcox formation crops out along the flanks of Crowleys Ridge in northeastern Arkansas. Sediments occupying the same stratigraphic position as those of the Wilcox formation and the Claiborne group in Mississippi County crop out in Crowleys Ridge and in the Benton Hills of Missouri. Eocene sediments, probably at least in part equivalent to the Wilcox formation, occur at or near the surface in western Kentucky and Tennessee.

The basal sands of the Wilcox formation at present are the second most important aquifer in Mississippi County with respect to total pumpage from it and the number of people dependent upon this aquifer as a source of water supply. The deepest wells in the county obtain water from this aquifer. Wells have reported yields up to 1,800 gpm and range in depth from 1,080 feet to 1,578 feet. The aquifer is the source of the water supplies of all cities and towns in the county as well as for several rural communities.

Water from wells in the Wilcox formation is of excellent quality, being relatively low in iron content and soft. The temperature of the water averages about 75°F and is about 12 degrees warmer than that of the Quaternary deposits.

### Claiborne Group

The Claiborne group is subdivided into four formations in southern Arkansas. This fourfold division is difficult to make in northeastern Arkansas where the group consists of interbedded sand and clay with some lignite. The upper part of the group consists chiefly of clay, sandy clay, and silt; whereas, the lower parts consist of about equal amounts of interbedded sand and clay and include a few beds of lignite. The thickness of the Claiborne group varies from about 600 feet at Leachville to about 900 feet northeast of Blytheville and at Wilson.

In the present report the contact between the Claiborne group and the Wilcox formation is based entirely upon the interpretation of subsurface lithology. However, because of considerable lithologic similarity between the Wilcox formation and the Claiborne group in northeastern Arkansas and the lack of decisive

paleontologic evidence, the placement of the contact between these units is somewhat arbitrary. As a result, this report differs in some details from earlier reports that include Mississippi County.

Stevenson and Crider (1916, pl. II) show the Wilcox formation as underlying Crowleys Ridge from north of Harrisburg in Poinsett County, Ark., to the northern border of Clay County, Ark. Cross section B-B′ in the present report shows the Claiborne formation as underlying the deeper part of Crowleys Ridge as far north as Jonesboro, Ark., some 20 miles north of Harrisburg. Fisk (1944, fig. 7) shows the possible Wilcox-Claiborne contact (which is covered by deposits of Quaternary age) several miles east of Leachville. Caplan (1954, pl. VII), in his cross section C-C′, shows deposits of Claiborne age underlying the core of Crowleys Ridge at Jonesboro, Ark. Grohskopf (1955) includes in the Wilcox group all sediments from the top of the Midway group to the base of the Pliocene(?) gravels.

Only one well is known to obtain water from the sands of the Claiborne group in Mississippi County. It is screened in the upper part of the group and yields water which in comparison to that from the "1,400-foot" sand is more mineralized, harder, and higher in iron content. However, the water from this well is generally less mineralized and not as hard as that from wells in the Quaternary deposits, although both contain excessive amounts of iron.

Drillers' logs and electric logs indicate that the sand beds in the Claiborne group are similar to the sand beds in the Wilcox formation in thickness and permeability. Therefore, wells developed in the Claiborne group may be expected to have yields comparable to those developed in the Wilcox formation. The probable reason why wells are not completed in the Claiborne group in Mississippi County is that when quantity is of main importance in a particular water supply the Quaternary deposits are utilized, and when quality is of paramount importance the wells are drilled into sands of the Wilcox formation.

### Jackson Group

The marine encroachments of this part of the Mississippi embayment during Late Cretaceous and Paleocene time were followed by marine withdrawals and the deposition of nonmarine sediments during early and middle Eocene time. However, a final inundation occurred during late Eocene time when marine sediments of the Jackson group were laid down upon the continental deposits of the Claiborne group.

Sediments of the Jackson group were identified by Fisk (1944, p. 14, pl. 10) in northern Crittenden County but were not differentiated from the Claiborne group. Whether sediments of the Jackson group are present in Mississippi County is undetermined.

### Quaternary Deposits

The Quaternary deposits are the youngest rocks in Mississippi County and cover the entire area to depths of 100 to 200 feet below the land surface. These deposits unconformably overlie sediments of Eocene age. The unconformity between the two rock units represents a long interval of time, for the upper unit was deposited during the last million years and the lower unit some 40 million years ago. The hiatus represents an interval of nondeposition, or of deposition and subsequent erosion, between Eocene and Quaternary time.

There is still some difference of opinion as to the age of the erosion surface upon which the Quaternary materials were deposited and as to the age of the deposits themselves. Stephenson and Crider (1916, p. 114) state that "The Mississippi lowland * * * is also underlain * * * by alluvium which belongs to both the Pleistocene and Recent epochs." But according to Fisk (1944, p. 11), "* * * the buried valley was excavated during the latest glacial stage, the late Wisconsin, and was filled with Recent alluvium."

Figure 8 is a subsurface contour map of the erosion surface at the base of the Quaternary deposits in Mississippi County. It shows that this older surface had a maximum relief of about 75 feet, whereas the present surface has a maximum relief of about 45 feet. The irregularity of the surface upon which the Quaternary materials were deposited, together with the present topographic relief, account for the varying thickness of the Quaternary deposits.

The Quaternary deposits in Mississippi County were laid down by the ancestral Ohio and Mississippi Rivers and by the modern Mississippi River and its tributaries. They are lithologically similar to deposits of Quaternary age in other parts of the Coastal Plain of Arkansas and consist of coarse sand and gravel at the base grading upward through finer sand to silt or clay at the top. This general sequence

of deposition is thought to have been modified somewhat by the relatively recent shifting of the Mississippi River. The reworking of the shallower parts of the Quaternary deposits by the river has made them more variable in a belt bordering the river. This belt is shown by crosshatching in figure 9.

Sixty test holes were drilled to determine the character and distribution of the sediments overlying the Quaternary aquifer. They were augered near the corners and near the center of each township to provide even coverage of the entire county. A total of 1,888 feet was drilled. The shallowest hole was 19 feet, the deepest 36 feet, and the average, 31.5 feet.

Information concerning the character of the surficial deposits, based upon this drilling program, are presented in two illustrations. Figure 9 is a map of Mississippi County showing the general areas underlain predominantly by (1) sand, (2) silty clay and clay, and (3) sand, silt, and clay of irregular distribution. These deposits lie in three belts roughly parallel to the Mississippi River. The well logs and logs of U. S. Geological Survey test holes on which these illustrations are based are in the section of this report that lists logs of wells.

The sand area of northwestern Mississippi County is west of Big Lake and Little River. The sand occurs at the surface and extends to the base of the deposits of Quaternary age with only a few thin beds of silt at shallow depths. The area covers about 191 square miles, and conditions here are highly favorable for recharge.

The area underlain predominantly by silty clay and clay extends from the north-central part of the county south and southwestward to the Poinsett County line in a belt about 8 to 14 miles wide. It covers an area of approximately 408 square miles. Much less natural recharge would be expected in this area as compared to the sand area to the west. Nevertheless, the "clay cap" in Mississippi County is not as tight nor as thick and extensive as that covering the Grand Prairie region of Arkansas.

The area of highly variable surficial deposits is adjacent and roughly parallel to the Mississippi River. In this belt sand, silt, silty clay, or clay may occur at the surface or at shallow depth. The sediments vary not only in kind but also in thickness and lateral extent. As a result recharge conditions vary throughout this approximately 333-square-mile area. Clay "plugs" as much as 80 feet thick are reported in some places. Thick, poorly permeable sediments occur in the area northeast of Luxora and extend in a relatively narrow band northward to the eastern extremity of the county.

Figure 10 is a series of 14 east-west cross sections superimposed upon a map of Mississippi County. These sections are based upon the logs of the 60 shallow test holes and selected logs of irrigation wells for which formation samples are available. They show the vertical and estimated lateral extent of various beds within the shallower parts of the deposits of Quaternary age. The stratigraphic relationships between the three areas previously described are shown in a general way in these cross sections. Cross sections 1 through 7 show the predominance of sand underlying the northwestern part of the county. Otherwise, sand is at or near the surface only in the belt parallel to the Mississippi River, as shown in cross sections 2, 3, 4, 7, 8, 10, 11, 12, and 14. Clay and silty clay generally are concentrated in the belt extending from the north-central to the southwestern edge of the county.

These cross sections show diagrammatically, in a very generalized manner, the general geologic relationships of the shallower parts of the Quaternary deposits.

The Quaternary deposits contain the most important aquifer in the county, both in total quantity of water used and in the number of people depending upon it as a source of supply. Water obtained from wells screened in these deposits is generally hard and is generally high in iron content. This is particularly true of water from the deeper wells in these deposits. Some of the shallower wells yield soft water of excellent quality with iron content below 0.3 ppm. The deposits of Quaternary age are used almost exclusively as a source of water in the rural areas.

## GROUND WATER

### Occurrence, Recharge, Movement, and Discharge of Ground Water

All ground water used in Mississippi County comes from wells. Whether the wells are screened in the water-bearing sediments of Quaternary or Tertiary age, water moves into and through them in an immense network of extremely small interconnecting voids which extend in all directions throughout the water-bearing rock unit. The quantity of water pumped from an irrigation well at a rate of

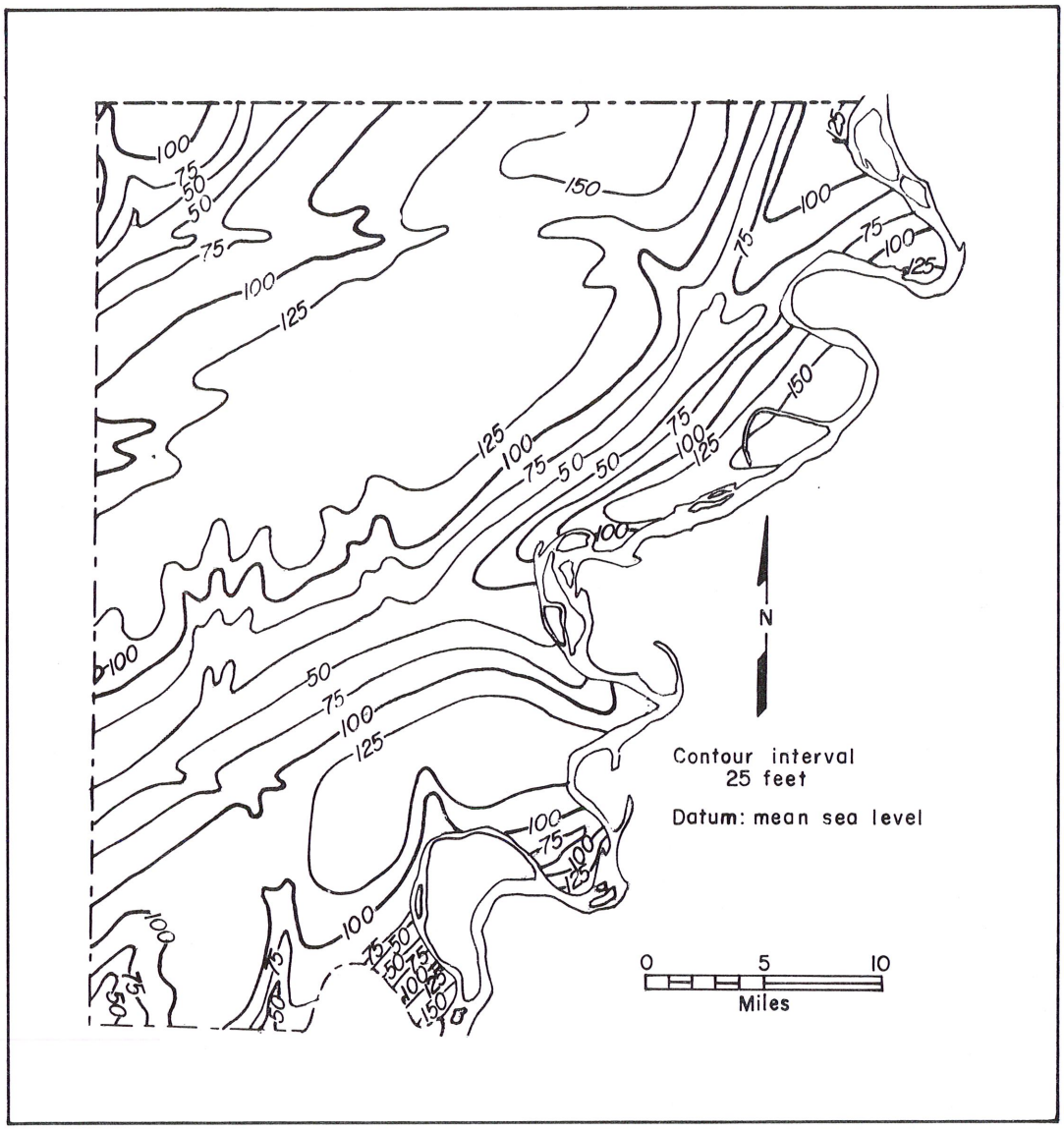



**Figure 8.—Map of Mississippi County, Ark., showing the altitude of the Tertiary-Quaternary erosion surface (after Fisk).**

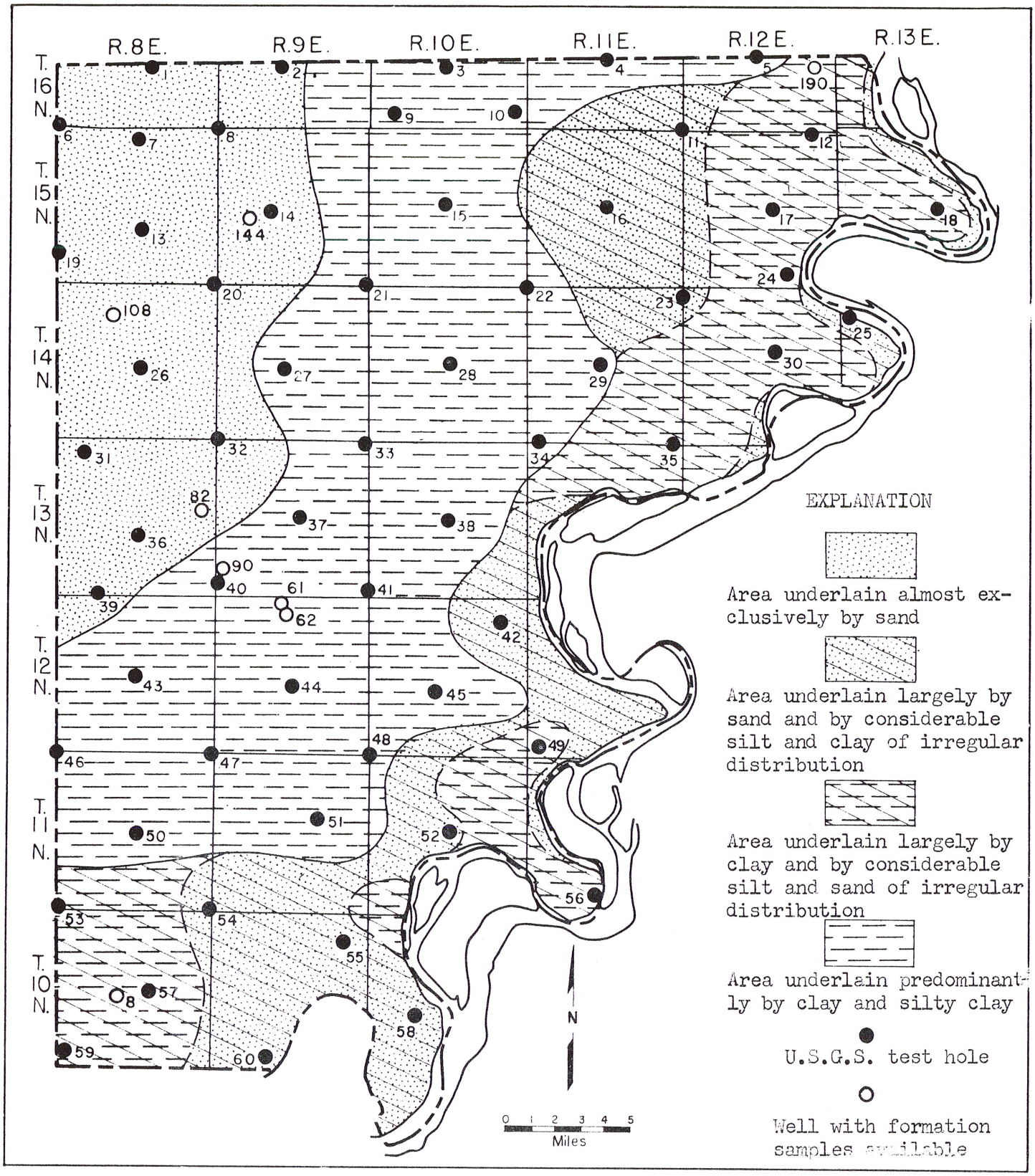



**Figure 9.—Map of Mississippi County, Ark., showing the general areas predominantly underlain by surficial deposits consisting predominantly of (1) sand, (2) silty clay and clay, and (3) sand, silt, and clay of irregular distribution.**

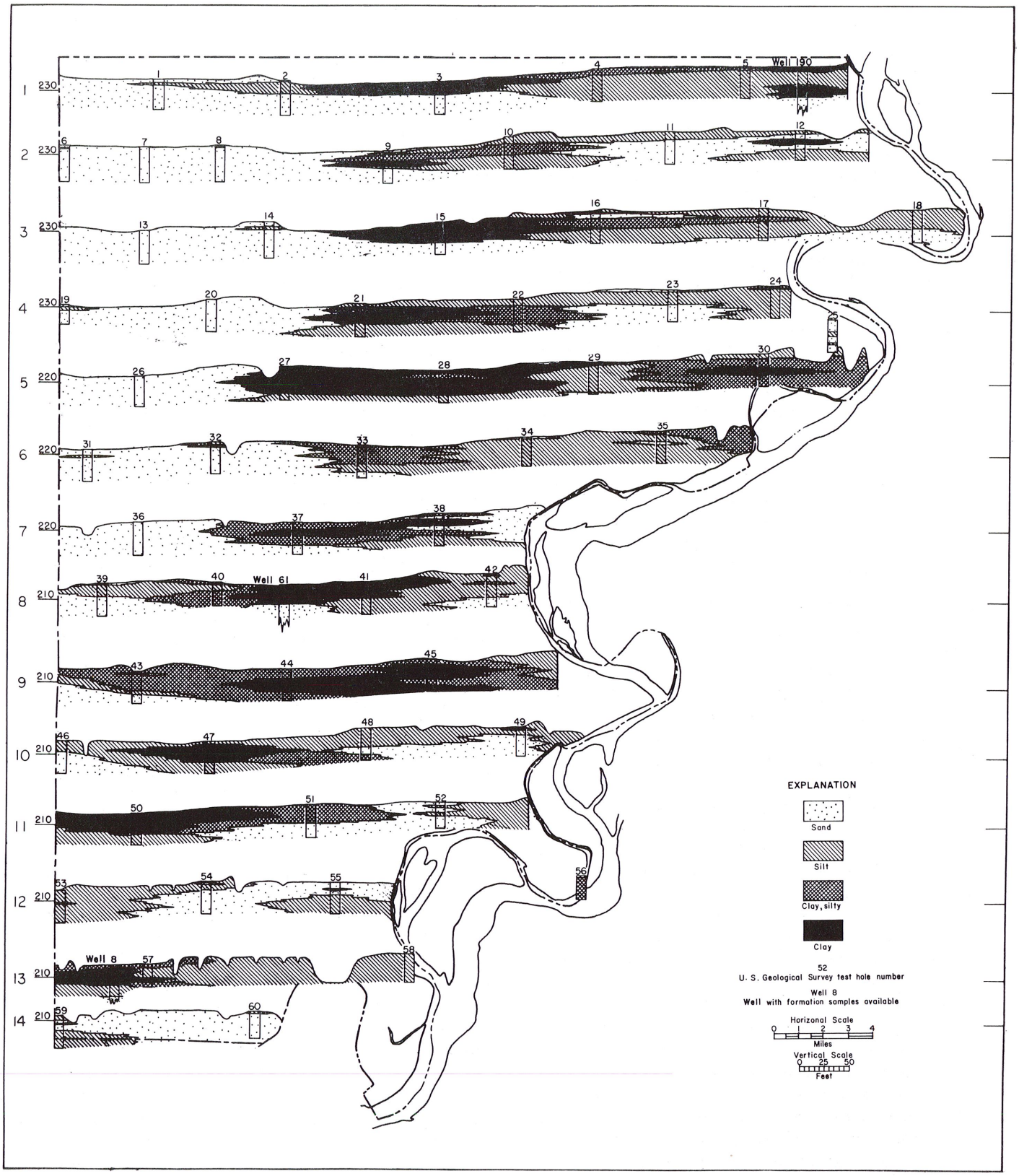



Figure 10.—Map of Mississippi County, Ark., showing 14 cross sections of the upper 19 to 36 feet of the Quaternary deposits.

2,000 gpm for a period of 25 days amounts in approximate figures to 72,000,000 gallons or 9,600,000 cubic feet. Wells producing such quantities are not uncommon. This quantity would correspond to the volume of a column 10 feet square at the base and 96,000 feet high. That such pumpage could result from the flow of water through minute interconnected pore spaces between the sand grains may at first seem incomprehensible, especially when the diameter of such openings commonly is less than a millimeter. It is no wonder then that ideas have been advanced that explain the occurrence of ground water in terms of underground streams, pools, or veins. Although the amount of water contained in each pore is extremely small, the volume of water contained within the total aggregation of interconnected pore spaces is immense. For example, the Quaternary deposits that underlie Mississippi County contain about 3.2 trillion ($3.2 \times 10^{12}$) cubic feet of material (assuming an average thickness of 125 feet). Furthermore, assuming a porosity of 33 percent and a saturated thickness of 100 feet, some 860 billion ($8.6 \times 10^{11}$) cubic feet of water is in underground storage. This corresponds to 6.4 trillion ($6.4 \times 10^{12}$) gallons. Thus, the 72 million gallons pumped from the irrigation well mentioned above is but 0.001 percent of the total estimated quantity of water in underground storage in the Quaternary deposits. It would take 100,000 wells pumping 2,000 gpm each for 25 days to discharge an amount of water equal to that in storage in the Quaternary deposits. However, only a fraction of this water is available for pumping, because pumping lifts increase and the quantities of water pumped decrease as the water is removed from storage. Thus pumping becomes uneconomical long before the ground water is exhausted. Nevertheless, a very substantial fraction of the stored water is available for pumping. Also, the deposits are freely recharged from precipitation, and potentially rechargeable from streamflow, in a large aggregate area.

If wells were to be drilled into the beds of limestone and dolomite of Paleozoic age the water would be found in solution channels and fractures rather than in intergranular spaces. The success in obtaining water would depend upon intersecting these openings. Their size, shape, distribution, and interconnection would control the well yield.

Recharge to the ground-water bodies results from direct penetration of rainfall and from influent seepage from streams, lakes, and ditches. Because ground-water levels generally are higher than stream, lake, and ditch levels except during short periods of rapidly rising stream levels following heavy rains, it is evident that recharge in Mississippi County is derived chiefly from direct penetration of rainfall. Only a small part of the annual precipitation of 46.6 inches reaches the zone of saturation, for a large part runs off at the surface or is returned to the atmosphere by evaporation and transpiration. Furthermore, infiltration to the zone of saturation generally occurs only after the soil moisture has reached "field capacity" — the maximum amount of water the soil can hold against the pull of gravity. Deposits of clay at or near the surface may reduce or prevent recharge by direct penetration of rainfall, and water-bearing rocks beneath such clay caps must receive recharge from more distant areas. However, such clay caps are of limited extent and are present in only part of Mississippi County, and direct penetration of rainfall can occur over most of the county.

In the zone of saturation ground water moves slowly in response to the influence of gravity. This movement is from areas of recharge to areas of discharge. The rate of movement depends upon the porosity and permeability of the aquifer and upon the ground-water gradient. In the more permeable rocks, water moves with comparative freedom, although the movement is very slow compared to the flow of a stream. Water-level contour maps may be used to determine the direction of movement. The direction of ground-water movement at any location is at right angles to the contour lines.

Ground-water discharge from an area may result from pumping a well, evaporation and transpiration, ground-water movement into streams, lakes, or ditches, and underflow. The type of discharge from any particular aquifer depends largely upon the depth of the aquifer. Where the water table is sufficiently close to the land surface, discharge from the shallow aquifer may occur by evaporation and by the transpiration of water from plants whose root systems reach the capillary fringe or the saturated zone. During periods when stream stages are low relative to water levels in the adjacent land, ground-water movement may result in effluent seepage into the stream. Discharge from deeper aquifers may be limited to pumpage from wells, movement out of the area by underflow, and crossbed leakage.

The recharge area of the Paleozoic rocks which underlie Mississippi County is presumed to be chiefly in the Interior Highlands of northeastern Arkansas and southeastern Missouri. The direction of ground-water movement is unknown. Discharge from these aquifers probably is by very slow underflow out of the area and by crossbed leakage.

The Cretaceous deposits are at or near the land surface along the western margin of the Mississippi embayment in Arkansas and in Crowleys Ridge and the Benton Hills of Missouri. Although data are sparse, water-level contours in a relatively small area suggest ground-water movement toward the southeast. Ground-water discharge probably occurs largely by underflow out of the report area.

The Wilcox formation crops out in Crowleys Ridge in Arkansas and possibly in the same ridge in Missouri. The water-bearing sands of this formation appear to be recharged in western Tennessee where the formation is overlapped by the Claiborne group. The direction of ground-water movement is southwestward at a rate of approximately 0.1 foot per day. Water is discharged from this formation by wells in the county and by underflow out of the county.

The Claiborne group underlies and is recharged from the Quaternary deposits in a large part of the northern embayment area in Arkansas, Missouri, Kentucky, and Tennessee. The group crops out in Crowleys Ridge in Arkansas and in western Tennesse. Data are insufficient to determine the direction of ground-water movement in Mississippi County. Discharge occurs by pumping from a single well and by underflow.

The aquifer in the Quaternary deposits crops out in Mississippi County principally west of Big Lake and Little River, as shown in figures 9 and 10. This area is the largest in the county where the geologic conditions are highly favorable for recharge. In the area underlain predominantly by silty clay and clay, much less recharge would be expected as compared to the sand area to the west. In a belt roughly parallel to the Mississippi River the near-surface Quaternary materials are sand, silt, silty clay, and clay of irregular distribution. In this area the amount of recharge that results from direct precipitation of rainfall probably varies greatly.

A series of four maps in figure 11 show the water-table configuration for September and December 1955 and March and June 1956. The configuration is shown by contour lines drawn through points on the water table of equal elevation above mean sea level. The direction of ground-water movement is at right angles to the contour lines. Close spacing of the contour lines may indicate areas of recharge or discharge, or areas in which the water-bearing formation is poorly permeable.

The general direction of ground-water movement, as shown on the maps, is toward the southwest, but along the Mississippi River the direction of ground-water movement changes with the season. The highest water levels occur in the northeastern corner and the lowest water levels in the southwestern corner of the county during all four seasons. The maximum relief of the water table was 44 feet for September and December 1955 and June 1956 and was 48 feet for March 1956.

The most conspicuous changes in the water-table configuration are caused by the rise and fall of the Mississippi River. In September 1955 the Mississippi was an effluent stream (receiving water from the ground-water body) as shown by the upstream bending of the contour lines as they cross the river. The closest spacing of the contour lines, indicating maximum slope conditions, occurred in a belt parallel to the river. The rate of ground-water movement toward the river was about 0.7 foot per day in the northern part of T.13N., R.11E. 6 miles northeast of Luxora, where the water table near the river has a slope of about 4.7 feet per mile. Five miles east of Wilson in T.11N., R.10E., the water-table slope was about 5.5 feet per mile, and the rate of ground-water movement toward the river was about 0.8 foot per day. The rate of ground-water movement in northwestern Mississippi County was about 0.2 to 0.3 foot per day with an average water-table slope of 1.6 feet per mile.

In December 1955 the Mississippi River rose about 6 feet, resulting in the stream becoming influent (losing water to the ground-water body) along the northernmost part of its course in Mississippi County but otherwise remaining effluent. A ground-water trough developed parallel to the river southeast of Armorel in T.15N., R.12 and 13 E. This trough was formed because of the relatively rapid rise of the river level adjacent to an area underlain by deposits of relatively low permeability where the water table previously had adjusted itself to the lower stage of the river. The rise of the river resulted in the formation of a

recharge ridge immediately adjacent and parallel to the river. Elsewhere the rise of the river reduced the ground-water gradient toward the river. For example, in the area east of Wilson the slope of the water table toward the Mississippi River was 0.93 foot per mile and the rate of ground-water movement was about 0.1 to 0.2 foot per day. Water-level slopes, and therefore the rates of ground-water movement, in northwestern Mississippi County were about the same in December 1955 as they were in September 1955.

In March 1956 the Mississippi River was influent along its entire course in Mississippi County, as indicated by the downstream crossing of all contour lines. The river stage in March 1956 ranged from 17 to 21 feet above the levels measured in December 1955 and from 23 to 28 feet above those measured in September 1955. Thus during high river stages the Mississippi contributes water to bank storage in a belt immediately adjacent to the river. (See water-table map for March 1956, fig. 11.) Two closed depressions in the water table were formed during this period of major recharge, probably because of the relatively low permeability of the Quaternary sediments in and adjacent to the basins. The larger of the two is northeast of Luxora and underlies an area of about 11 square miles. The basin is the lowest part of a troughlike depression that extends parallel to the course of the Mississippi River for a total distance of about 20 miles.

In June 1956 the stage of the Mississippi River was 14 to 16 feet below that of the previous March, and the river had become effluent along all of its course except in the northeastern corner of the county. In the area adjacent to the river the direction of ground-water movement was again toward the river as it had been in the previous December. Water levels declined over the entire county between March and June 1956, except in two areas where water-table depressions had developed in March. In the area of these depressions the water levels rose 1 to 2 feet from March to June, whereas elsewhere in the county water levels declined from 1 to 8 feet. This rise probably was caused by delayed recharge through the relatively impervious materials underlying these areas.

In summary, the water-table maps shown in figure 11 indicate movement of the ground water generally to the southwest. However, the Quaternary aquifer is hydraulically connected with the Mississippi River, and the troughlike depression in the water table along its course during most of the year shows that it is effluent (a gaining stream). During periods of high river stage, which are usually of relatively short duration, the trough is filled and a narrow ridge is formed in the water table adjacent to the river. During such periods the river is influent (a losing stream), and water moves into bank storage from the river.

The configuration of the water table also indicates ground-water movement from Missouri southwestward into Mississippi County. However, water is being discharged by underflow from the county into the adjacent counties of Craighead, Poinsett, and Crittenden.

To obtain quantitative information concerning ground-water loss and gain by underflow across the boundaries, calculations were made that were based upon the water-table gradients shown in figure 11, an average permeability of 1,900 gpd/ft$^2$, and an average saturated zone of 100 feet. The movement of water by underflow was calculated along the Missouri State line, the Craighead-Poinsett-Crittenden County lines, and the Mississippi River. The findings are tabulated below.

The average net change is a discharge rate

| Month and year | Recharge (+) and discharge (—) by underflow across county boundaries (gpd) | | | Net change |
|---|---|---|---|---|
| | Craighead-Poinsett-Crittenden County | Missouri | Mississippi River | |
| September 1955 | −8,400,000 | +1,600,000 | −150,000,000 | −157,000,000 |
| December 1955 | −8,700,000 | −1,900,000<br>[a] +2,400,000 | + 12,000,000<br>[a] − 49,000,000 | − 45,000,000 |
| March 1956 | −8,300,000 | +4,500,000 | + 52,000,000 | + 49,000,000 |
| June 1956 | −7,300,000 | +3,600,000 | + 1,900,000<br>[a] − 52,000,000 | − 54,000,000 |

[a] On assumption that each situation was effective for half the month.

of about 52 mgd, or about 160 acre-feet per day. Mississippi County comprises 932 square miles, or 596,480 acres. Thus, the net discharge by underflow amounts to about 58,000 acre-feet per year, or the equivalent of about 1.16 inches (0.097 foot) of rainfall.

During a year requiring an average amount of supplemental irrigation, the average rate of pumping from all wells in the Quaternary aquifer is about 6.7 mgd, or 7,505 acre-feet per year, or the equivalent of 0.16 inch (0.013 foot) of rainfall. Although some irrigation water probably percolates through the soil zone and returns to the zone of saturation, the amount is thought to be small.

The net discharge by underflow of 1.16 inches plus the average amount of discharge by pumping of 0.16 inch equals 1.32 inches. This is only 2.8 percent of the average annual precipitation of 46.63 inches per year at Blytheville. To maintain the present water-level conditions the annual recharge must be equivalent to 1.32 inches over the county, plus an amount equivalent to the annual discharge from the ground-water body by evaporation, transpiration, and effluent seepage to streams (other than the Mississippi River), lakes, and ditches. This would seem to be a small amount of recharge to a shallow water table through the relatively permeable materials that generally occur between the surface and the water table in Mississippi County. During the times of heaviest rainfall the water table is very near the land surface (fig. 12). These facts suggest that there may be considerable rejected recharge from rainfall under present conditions; and that, if water levels were lowered sufficiently by pumping, recharge from the Mississippi River and from other streams, bayous, and the ditch system would be increased.

## Water Levels in the Several Water-Bearing Rock Units

### Paleozoic Rocks

Information concerning water levels in the Paleozoic rocks is limited to that obtained by the Missouri Geological Survey and Water Resources from the drilling of the Benedum-Trees Oil Co. C. W. Mack No. 1 well in 1939 (Grohskopf, 1955). Little is known regarding the lateral continuity, dip, and possible changes in lithology of the permeable zones penetrated by the oil-test well. Moreover, ground water in the beds of limestone and dolomite is likely to be in solution channels and fractures of irregular size, shape, and distribution. Therefore, the data obtained from the oil-test well concerning water levels are not necessarily applicable elsewhere in the county. The log of this test hole is shown on page 85.

Water from a 5-foot bed of dolomite at a depth of 2,955 feet in the Jefferson City formation rose to within 300 feet of the land surface, or about 2,655 feet above the top of the bed. Water from a 25-foot bed at a depth of 3,285 feet in the Roubidoux formation rose to within 100 feet of the land surface, or about 3,185 feet above the top of the bed. Water from beds at about 4,405 feet in the Eminence formation rose in the well to above the land surface and flowed at a rate of 70 gpm.

### Cretaceous Deposits

In the absence of information concerning water levels in the Cretaceous deposits in the study area, measurements were made on four wells north of the county at Hornersville, Senath, Kennett, and Hayti in the southeastern part of Missouri. These wells are 3 to 16 miles north of the Mississippi County line and are screened in the water-bearing sands of the Cretaceous deposits. Since all four are flowing wells, a manometer was used to determine the artesian head. The measurements are listed below.

Although the available information on southeastern Missouri is inadequate for making definite predictions regarding water-level elevations in hypothetical wells penetrating the Cretaceous deposits in Mississippi County, the data suggest that these deposits may support flowing wells in the northwestern part of the county. The direction of ground-water movement in the Cretaceous deposits of the south-

| Location | Depth of well (feet) | Date of measurement | Water level above land surface (feet) | Water level elevation (feet above sea level) |
|---|---|---|---|---|
| Hornersville, Mo. | 1,846 | 11-4-58 | 28.9 | 275 |
| Senath, Mo. | 1,717 | 11-4-58 | 31.5 | 291 |
| Kennett, Mo. | 1,600 | 11-4-58 | 20.9 | 286 |
| Hayti, Mo. | 2,140 | 11-4-58 | 9.7 | 280 |

ern part of southeastern Missouri is southeastward.

### Wilcox Formation

The "1,400-foot" sand of the Wilcox formation is an artesian aquifer. The top of the water-bearing sands of this formation is encountered in wells in Mississippi County at depths of about 910 feet to 1,475 feet below the land surface. Water levels in wells screened in this aquifer range from 15.3 feet below to 3.3 feet above the land surface, or about 900 feet to about 1,460 feet above the top of the aquifer. The water in only one well (13N10E-18aab) is known to overflow when the well is not in use.

When first developed, the "1,400-foot" sand contained water under sufficient hydrostatic pressure to support flowing wells. Stephenson and Crider (1916, p. 228) recorded water levels in three wells screened in the aquifer. At Blytheville, the water in a 1,448-foot well had a hydrostatic pressure of 15 feet above the land surface and flowed at a rate of 300 gpm. The present static water level is 12.5 feet below the land surface, indicating that water levels have been lowered about 27.5 feet in nearly 50 years. At Burdette, the artesian head in a 1,495-foot well was 17 feet above land surface. This extant but unused well has a water level about 8 to 10 feet below land surface, a lowering of 25 to 27 feet since about 1912. At Wilson, the water level in a well 1,567 feet deep was reported to be 15 feet above land surface and the rate of natural flow was 208 gpm. The water level is now about 14.5 feet below land surface, a lowering of 29.5 feet since 1912.

Water levels may be measured in only 11 of the 34 wells known to be screened in the "1,400-foot" sand. The measurements obtained are listed in table 7, and were made when water levels had largely recovered from pumping.

The general slope of the piezometric surface in this aquifer, and therefore the direction of movement of the water, are toward the southwest at an average rate of 0.9 foot per mile. The altitude of the surface ranges from 245 feet above sea level in northeastern Mississippi County to 211 feet above sea level in the southwestern part.

### Claiborne Group

The top of the deposits of Claiborne age coincides with the base of the Quaternary deposits, and thus occurs at depths ranging from 98 feet to possibly more than 200 feet below the land surface. The water in the Claiborne is under insufficient artesian pressure to support flowing wells.

Only one well in Mississippi County is known to be screened in an aquifer in the Claiborne group. This well, located at Evadale near Wilson, is reported to be 339 feet deep, and in November 1958 it had a water level of 18.8 feet below land surface. In the early 1900's Stephenson and Crider (1916, p. 228) reported a 520-foot well near Blytheville and two near Osceola that ranged in depth from 440 to 800 feet. None of the wells flowed, and a water

**TABLE 7**

Water levels in the Claiborne group and in the Wilcox formation

| Location | Depth of well (feet) | Date of measurement | Depth to water below land surface (feet) | Water-level altitude above mean sea level (feet) |
|---|---|---|---|---|
| | | Claiborne group | | |
| 11N9E-26aab | 339 | 11-6-58 | 18.8 | 217 |
| | | Wilcox formation | | |
| 10N8E-17daa | 1,510 | 11-6-58 | 9.7 | 211 |
| 11N9E-25bba | 1,578 | 11-7-58 | 14.7 | 221 |
| 12N10E-34cad | 1,535 | 11-7-58 | 7.5 | 225 |
| 13N10E-18aab | 1,417 | 11-4-58 | + 3.3 | 228 |
| 13N10E-36acd | 1,500 | 11-5-58 | 15.3 | 231 |
| 13N11E-9cdd | 1,500 | 11-6-58 | 7.7 | 237 |
| 14N9E-1dad | 1,337 | 9 - 58 | [1] 4 | 234 |
| 15N8E-8dbc | 1,080 | 11-5-58 | 2.9 | 233 |
| 15N9E-31dbb | 1,364 | 11-5-58 | 7.2 | 233 |
| 15N11E-6cba | 1,445 | 11-6-58 | 4.9 | 245 |
| 15N11E-15bdb4 | 1,500 | 11-6-58 | 12.5 | 243 |
| 15N11E-17adb | [1] 1,600 | 12-9-58 | 8.5 | 244 |
| 15N12E-5cba | 1,460 | 8 - 58 | [1] 13.5 | 243 |

[1] Reported

level of 15 feet below the surface is reported for the well near Blytheville. An 864-foot well at Turrell, 4.5 miles south of Mississippi County, had a water level 12 feet below the land surface. Thus, from about 1900 to 1958 there appears to have been a decline in water levels in wells in the Claiborne aquifer of only about 3 or 4 feet.

### Quaternary Deposits

Water levels in the Quaternary deposits were measured periodically from September 1955 to December 1958. Most of the measurements were made in shallow domestic wells of 1¼-inch diameter. The wells selected for this purpose were not used as supply wells or were in use only part of the year. Their locations were chosen sufficiently far from irrigation wells and ditches to reflect principally the regional water table rather than local conditions.

Changes in water levels result from the opposing processes of discharge and recharge. Recharge occurs only with the addition of water to the subsurface reservoir and is dependent upon intermittent precipitation and irregularly occurring influent seepage from fluctuating streams, but natural discharge goes on all the time. Even during periods of recharge, the opposed process of discharge is operative because of the ever-existing ground-water gradients which result in the constant movement of water downslope. Significant changes in water levels reflect the dominance of one process over the other.

The seasonal variations in the depth to water below land surface are shown in a series of four maps in figure 12. Each map shows the water-table conditions at the beginning of the autumn, winter, spring, and summer seasons, respectively, as follows: September and December 1955 and March and June 1956. The map series show areas in Mississippi County where depths to water are 10 feet or less, between 10 and 20 feet, and more than 20 feet below land surface. The seasonal variations of the extent of the three depth-to-water areas reflect the net effect of the opposing processes of recharge and discharge. The period covered by the map series is a normal year with respect to amount and general distribution of rainfall and, thus, represents approximately the average conditions for these months in any year.

The extent of the three depth-to-water areas for September and December 1955 and for March and June 1956 are expressed in percent of total county area and are listed in the table below:

| Month and year | Percent of county area where depth-to-water below land surface is: | | |
|---|---|---|---|
| | Less than 10′ | 10′ - 20′ | More than 20′ |
| September 1955 | 31 | 57 | 12 |
| December 1955 | 37 | 52 | 11 |
| March 1956 | 69 | 31 | 0 |
| June 1956 | 59 | 35 | 6 |

Figure 12 and the above table show that the area in which depths to water below land surface are 10 feet or less was greatest in March 1956. This area covered 69 percent of the county at that time, as compared to 37 percent during the previous December. The increase in extent of the area from December 1955 to March 1956 occurred during a period of concentrated precipitation and high stream stages which caused water levels to rise in the Quaternary aquifer (figs. 13 and 14).

The area in which water levels were 10 feet or less below land surface was smallest in September 1955, when it covered 31 percent of the county. The larger part of the annual precipitation for 1955 occurred during the months of February, March, April, and May. Relatively little precipitation occurred during the growing season extending from June to September. Thus, during this period, discharge by evapotranspiration, underflow, and pumping from the Quaternary aquifer exceeded the recharge to the aquifer. Consequently, water levels declined and the depths to water below land surface increased.

The net effect of the opposed processes of recharge and discharge also determine the size and shape of the area in which water levels range from 10 to 20 feet below land surface. A reduction in the size of the area in which water levels were 10 feet or less would necessarily be concurrent with an increase in the area where water levels ranged from 10 to 20 feet, because the changes in size of both areas result from the same process—namely, a lowering of water levels. This is equally true of the third area in which water levels below land surface are more than 20 feet. This area is largest when water levels are at their lowest. When the water table and the river stages are high, the area in which water levels are more than 20 feet below land surface may disappear, as shown in figure 12 and in the preceding table for the month of March 1956.

**Fluctuations of water levels**

The water levels in Mississippi County are not stationary but rise and fall much like the water level in a lake or reservoir. However, over a long period of time a condition of approximate equilibrium is established between the amount of water that is added annually to ground water in storage and the amount that is discharged annually. In general, the water level rises when the amount of recharge exceeds the amount of discharge, and it declines when the discharge is greater than the recharge. Thus, net changes in the water levels in wells reflect the extent of depletion or replenishment of the ground-water reservoir.

Several factors control the amount of rise of water levels in wells. The principal ones are water from precipitation that passes through the soil and is added to the zone of saturation, and the influent seepage from streams that reaches the underground reservoir. The relation between the amount of precipitation and the levels at which the water stands in wells is complicated by several factors. During a long dry period the soil moisture becomes depleted through evaporation and transpiration. When it does rain, the soil-moisture deficiency must be replenished, thus diverting a large part of the water descending through the soil to the aquifer. Where the water-bearing formation is covered by relatively impermeable clay, as is the aquifer in the deposits of Quaternary age in parts of Mississippi County, the water levels are not affected immediately or greatly by seasonal or yearly changes in rainfall. Instead, there is a time lag and the magnitude of the fluctuations is not as large as that of fluctuations in unconfined aquifers elsewhere.

The principal factors controlling the decline of water levels are the quantity of water pumped from wells, the quantity of water transpired directly from the water table by plants, and the quantity discharged as effluent seepage into the streams. In Mississippi County the quantity pumped from wells is much less than that discharged by the other two methods combined. As a result, ground-water levels do not afford an index of the extent of withdrawal of water for irrigation. If the irrigation development should reach the point when the pumpage exceeds the natural ground-water recharge, the water levels would show net declines from year to year. Thus water-level measurements afford a close check on the relation between the available water supply and its development.

The rise or fall of water levels in wells does not necessarily reflect an actual replenishment or depletion of the ground-water reservoir. Where ground water is under artesian conditions, increased or decreased barometric pressure results in declining or rising water levels. Temporary loading on an artesian aquifer, such as the passing of a train, causes water levels to rise in wells because of compression of the aquifer. Ocean tides, stream tides, earth tides, and earthquakes may cause changes in water levels, although these factors are not important in the area of study.

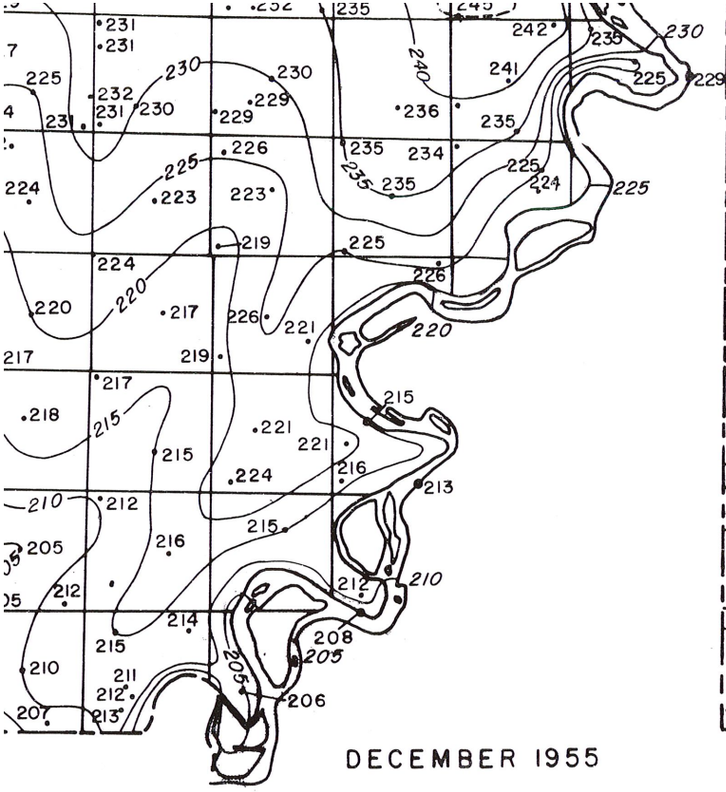
Continuous records of water-level fluctuations were obtained for about 20 months. A recorder was installed on well 14N8E-4cbc, which is 103 feet deep. This irrigation well is a quarter of a mile south of Buffalo Creek in an area where ground water in the deposits of Quaternary age occurs under water-table conditions. Although the well is relatively close to the ditch, the water levels measured in it vary in the same order of magnitude as those measured elsewhere in this general area, and thus principally reflect regional rather than local conditions. The period of record for this well is from September 23, 1955, to May 23, 1957.

A second water-level recorder was installed on an unused industrial well (15N11E16bdb). This well, which is 58 feet deep, is at Blytheville in an area where water in the Quaternary aquifer is under artesian pressure. The period of record for this well is from February 21, 1956, to October 2, 1957.

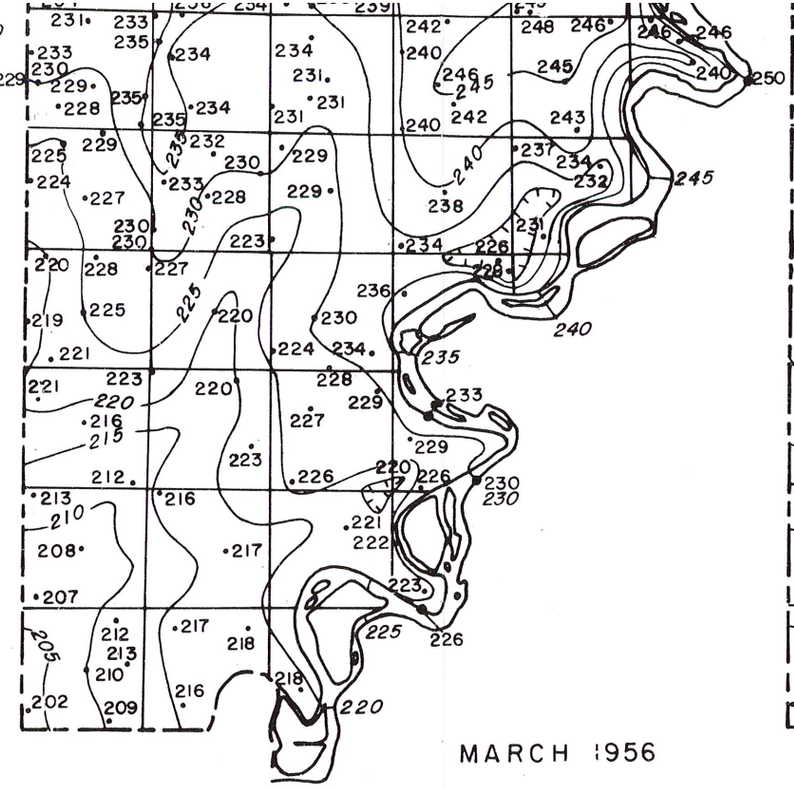
Well 12N9E-6bba is an unused well 33 feet deep, 1¼ inches in diameter, and equipped with a pitcher pump. This well is in the central part of the county where ground water occurs under artesian conditions. Water levels have been measured at intervals in this well since September 14, 1955.

A local observer was obtained to make daily water-level measurements in an unused 1¼-inch well, 97 feet deep. This well (11N11E-18cdd), in the southeast part of Mississippi County about 5 miles east of Wilson, Ark., was selected for daily measurements because of its proximity to the Mississippi River.

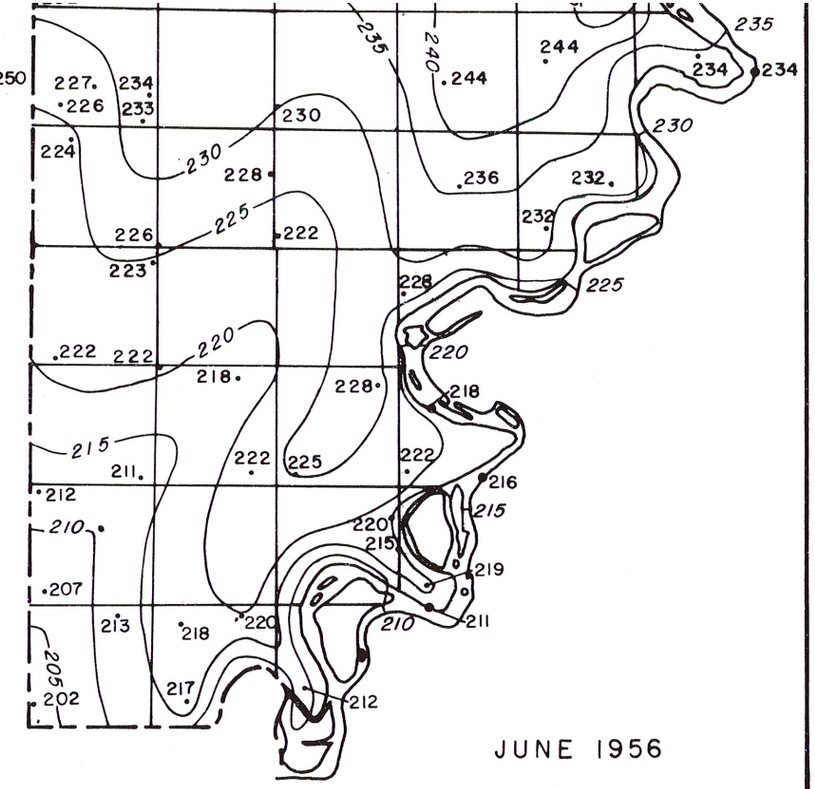
The water-level data pertaining to the four wells mentioned are represented graphically. Figure 13 shows the hydrographs of wells 12N9E-6bba, 14N8E-4cbc, and 15N11E-16bdb, together with precipitation data and the hydrograph of the Little River at Big Lake



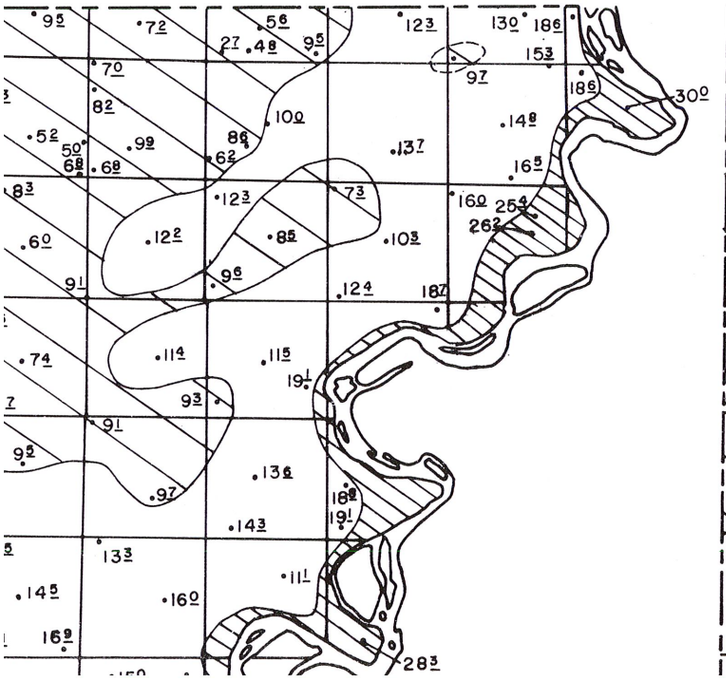
DECEMBER 1955

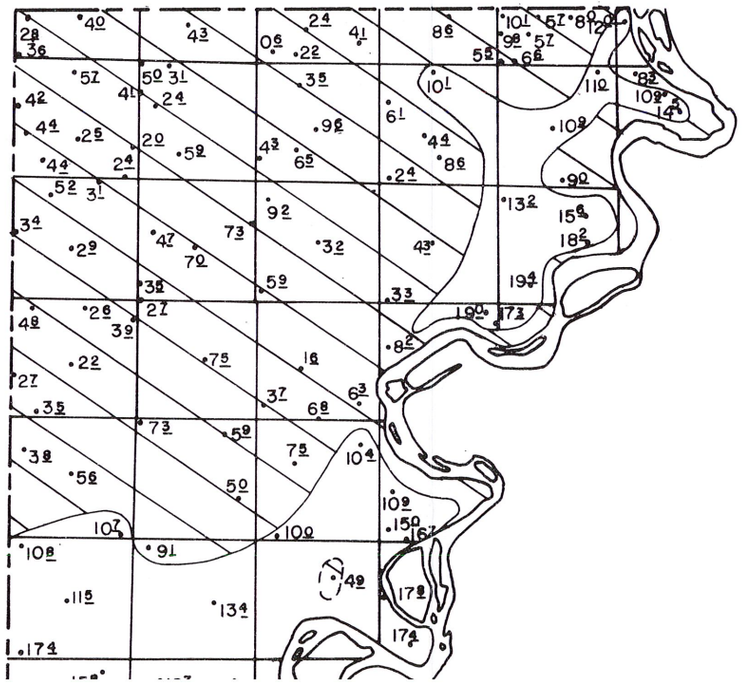


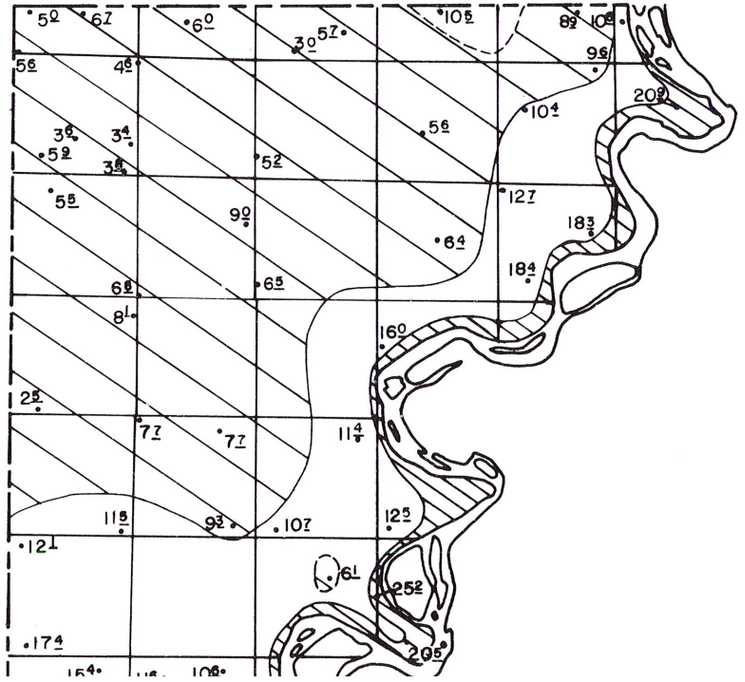
MARCH 1956



JUNE 1956







Outlet for the corresponding period. Figure 14 shows the hydrographs of well 11N11E-18cdd and of the Mississippi River with the precipitation data at Wilson, Ark., or at Osceola, Ark., for those months when precipitation was not recorded at Wilson. The control points on the graphs in this report are expressed in terms of altitude above mean gulf level. These points are connected by straight lines which can convey an erroneous impression that water levels are subject to instantaneous or sudden changes, when in actuality such changes are gradual. Where the lines of the hydrograph have been dashed, no data were recorded for that particular period.

The hydrographs in figure 13 show periods of relatively rapid rise and decline in water levels and periods of relative stability. Rapid rises in water levels occur in response to recharge from precipitation or influent seepage from bodies of surface water. The periods of major recharge increase the water-table gradients between areas favorable for recharge and those less favorable, and raise the water levels closer to the land surface. Following the periods of major recharge are periods of relatively rapid discharge, as reflected by the relatively rapid decline in water levels. The increased gradients built up during the periods of rising water levels accelerate the lateral movement of ground water. Moreover, the decreased depths to water below land surface, resulting from recharge, increase the amount of water available for discharge by evapotranspiration. This discharge occurs mainly during the periods of relatively rapid decline of water levels. The condition of relative stability of water levels reflects a general balance between the opposed processes of recharge and discharge.

A period of relatively stable water levels extended from the beginning of water-level measurements in mid-September 1955 to mid-January 1956. At Big Lake Outlet 36.1 percent (17.08 inches) of the annual precipitation (47.36 inches) occurred between January 18 and February 25, 1956. This 39-day period represented 10.7 percent of a year. The water table rose to its highest level in 1956 during and immediately after this period of concentrated precipitation. In 1956, 64 percent of the annual precipitation occurred from March through December. This amount is about 15 percent less than normal for this 10-month period. The rains were scattered and water levels decreased gradually, with minor reversals, until the latter part of August when the water levels became relatively stable and remained so for the rest of 1956.

The period of relatively little change in water levels extended into the latter part of January 1957. Heavy precipitation started on January 20 and continued intermittantly until February 26. Precipitation during this 38-day period (10.4 percent of a year) amounted to 13.28 inches, or 16.8 percent of the annual precipitation. The hydrographs of water levels in the observation wells shown in figure 13 indicate a rise ranging from 3 to 7 feet during this period.

The amount of precipitation during 1957 exceeded all previous records in the report area, as shown in table 3. The total at Big Lake Outlet was 79.06 as compared to the mean annual of 45.44 inches. At Burdette the annual precipitation was 91.83 inches. The period of concentrated precipitation in January and February 1957 was 1 of 7 similar periods during the year. The maximum effect of precipitation with respect to higher water levels was reached in the latter part of May.

The hydrographs in figure 14 indicate a repetition of the general conditions shown for the corresponding years in figure 13. Observation well 11N11E-18cdd is a quarter of a mile west of the Mississippi River. The inferred positions of the river level were interpolated for a point on the river immediately east of the observation well and about 5 miles upstream from the river-gauging station at Richardsons Landing and 6 miles downstream from the gauging station at Fulton, Tenn.

The Mississippi River may be effluent along part of its course if ground-water levels are higher than adjacent river levels and if the aquifer is traversed by the river channel. Inversely, the river is influent when river levels are higher than adjacent ground-water levels, resulting in water moving from the channel into an adjacent aquifer. The relative positions of the hydrographs of the river stages and the water levels in the observation well are indicative of the periods when the Mississippi River is influent or effluent, or when the Quaternary aquifer receives water from or yields water to the Mississippi River.

Water levels of the Mississippi River were higher than those in observation well 11N11E-18cdd for approximately a 3-month period extending from the early part of February to the early part of May 1956. As shown in figure 11, this condition prevailed over the entire

length of the Mississippi River adjacent to Mississippi County at the time of measurement in March 1956.

Following the period of high river stages relative to water levels in the observation well, there was a 3½-month period, which extended from early May to the latter part of August, that was characterized by an irregular alternation between high ground-water levels relative to river stages and high river stages relative to ground-water levels. During this period, however, the water levels in the observation well more frequently were higher than the river levels.

For a period of nearly 4 months, extending from the latter part of August to the middle of December 1956, the level of the Mississippi River was lower than the water level in the observation well. The maximum difference in water levels for a particular day during this period was about 8 feet.

TABLE 8

December water levels in the Quaternary deposits, 1955-58.
(in feet)

| Well Designation | Depth to water below land surface in December | | | |
|---|---|---|---|---|
| | 1955 | 1956 | 1957 | 1958 |
| 10N8E-22cdd | — | 12.7 | — | 11.6 |
| 10N9E-2dca | 17.0 | 15.5 | 9.8 | 12.5 |
| -20ddd | 19.9 | 19.3 | 14.8 | 16.1 |
| -32abc | 12.1 | 12.0 | 6.6 | 8.6 |
| 10N10E-21ccd | 23.5 | 23.9 | — | 22.0 |
| 11N8E-6dbb | 14.4 | 16.2 | — | — |
| 11N9E-27ccd | 13.5 | — | 8.3 | 9.7 |
| 11N11E-18cdd | — | 31.0 | 20.7 | 28.4 |
| 12N8E-16ddd | — | 13.3 | 6.6 | 11.6 |
| -36dcd | — | 13.0 | — | 12.0 |
| 12N9E-6bba | 12.8 | 12.9 | 4.7 | 10.6 |
| 12N10E-12bbb | — | 19.0 | 6.9 | 15.5 |
| -32cac | 14.3 | 14.2 | 7.8 | 11.4 |
| 12N11E-31dbb | 19.1 | 19.3 | 10.6 | 15.3 |
| 13N8E-33bcc | — | 11.3 | 2.2 | 9.1 |
| 13N9E-6bbb | 9.1 | 10.0 | 0.6 | 7.1 |
| -15cda | 11.4 | 11.3 | 5.4 | 10.0 |
| 13N10E-31bbb | 9.3 | 9.1 | 2.1 | 5.2 |
| -36bbb | 19.1 | — | 5.7 | 16.8 |
| 13N11E-18abb | — | 23.8 | 7.6 | 20.0 |
| 14N8E-18ccc | — | 9.1 | 1.0 | 6.7 |
| 14N10E-18dbb | 13.6 | — | 4.5 | 10.4 |
| 14N12E-6bcc | 16.0 | 16.2 | 9.6 | 13.0 |
| 14N12E-11dbb | 25.4 | 26.7 | 11.3 | 22.6 |
| -32abb | — | 24.5 | 15.6 | 20.9 |
| 15N8E-25aaa | 5.0 | 6.3 | 0.4 | 3.3 |
| 15N9E-28bcc | 9.9 | 10.4 | 2.9 | 8.4 |
| 15N10E-9bcb | — | 7.8 | 2.4 | 4.3 |
| 15N11E-16bdb | — | 16.0 | — | 12.3 |
| -21dbc | — | 10.2 | 1.0 | 6.0 |
| 15N13E-5bbb | 18.6 | 20.0 | 6.5 | 16.1 |
| 16N8E-22abb | 9.5 | 10.2 | 1.2 | 6.7 |
| -31ccc1 | 9.0 | 9.6 | 1.9 | 8.1 |
| 16N9E21cdd | 7.2 | 8.3 | 1.9 | 6.0 |
| 16N10E-26add | — | 9.8 | 2.1 | 5.4 |
| -32add | 4.8 | 6.3 | — | 2.7 |
| 16N11E-22aab | 12.3 | 13.7 | 5.1 | 10.2 |

A period of alternation between high river stage and high water table extended from mid-December 1956 to mid-July 1957. During this period the maximum difference between the altitude of the water table and that of the river stage occurred in early February 1957, when the river was 17.5 feet above the water table. From mid-July to mid-November the Mississippi River was effluent. The river level reached a maximum of 7.5 feet below the water level in observation well 11N11E-18cdd in early September 1957.

In mid-November both the river stage and the water table began to rise, although at different rates. The altitude of the river levels remained higher than the water table as measured in observation well 11N11E-18cdd throughout the rest of the year. The maximum difference between the altitudes of both water levels was 17 feet.

The yearly variation in water levels in the Quaternary deposits from December 1955 to December 1958 are shown in table 8.

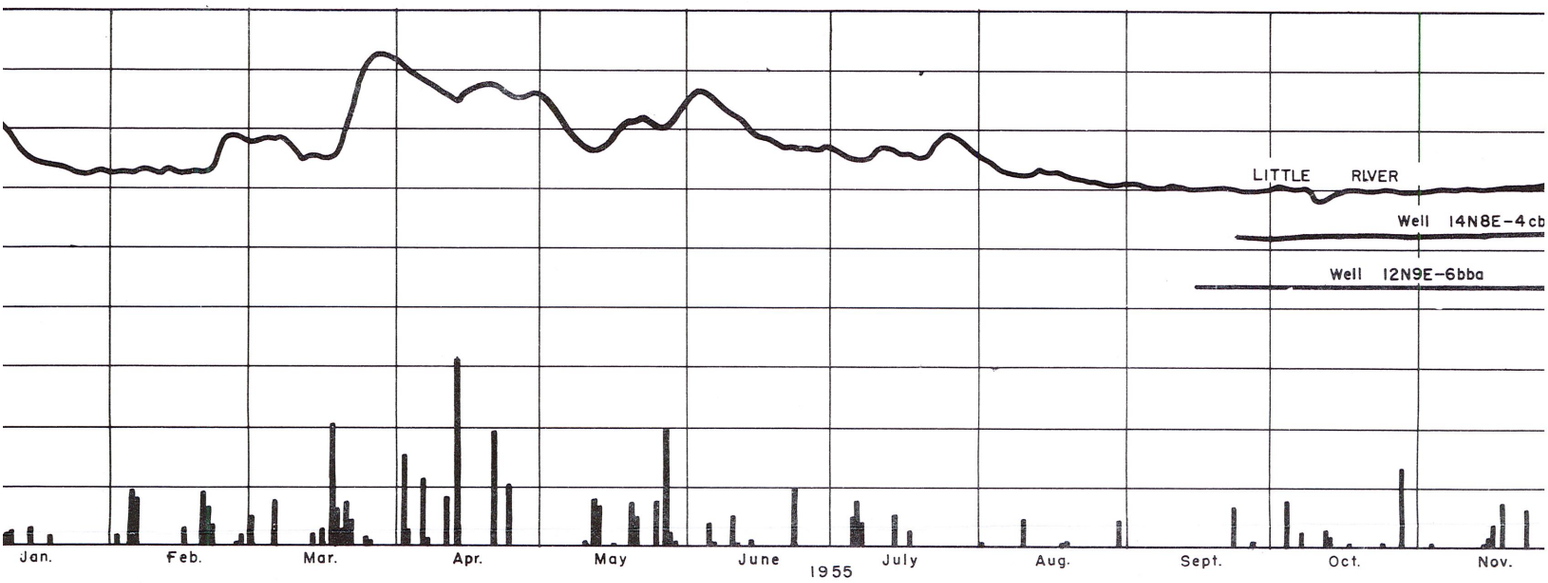
The average depths to water below land surface in December 1955, 1956, 1957, and 1958 were 13.2, 13.6, 5.7, and 10.6 feet, respectively.

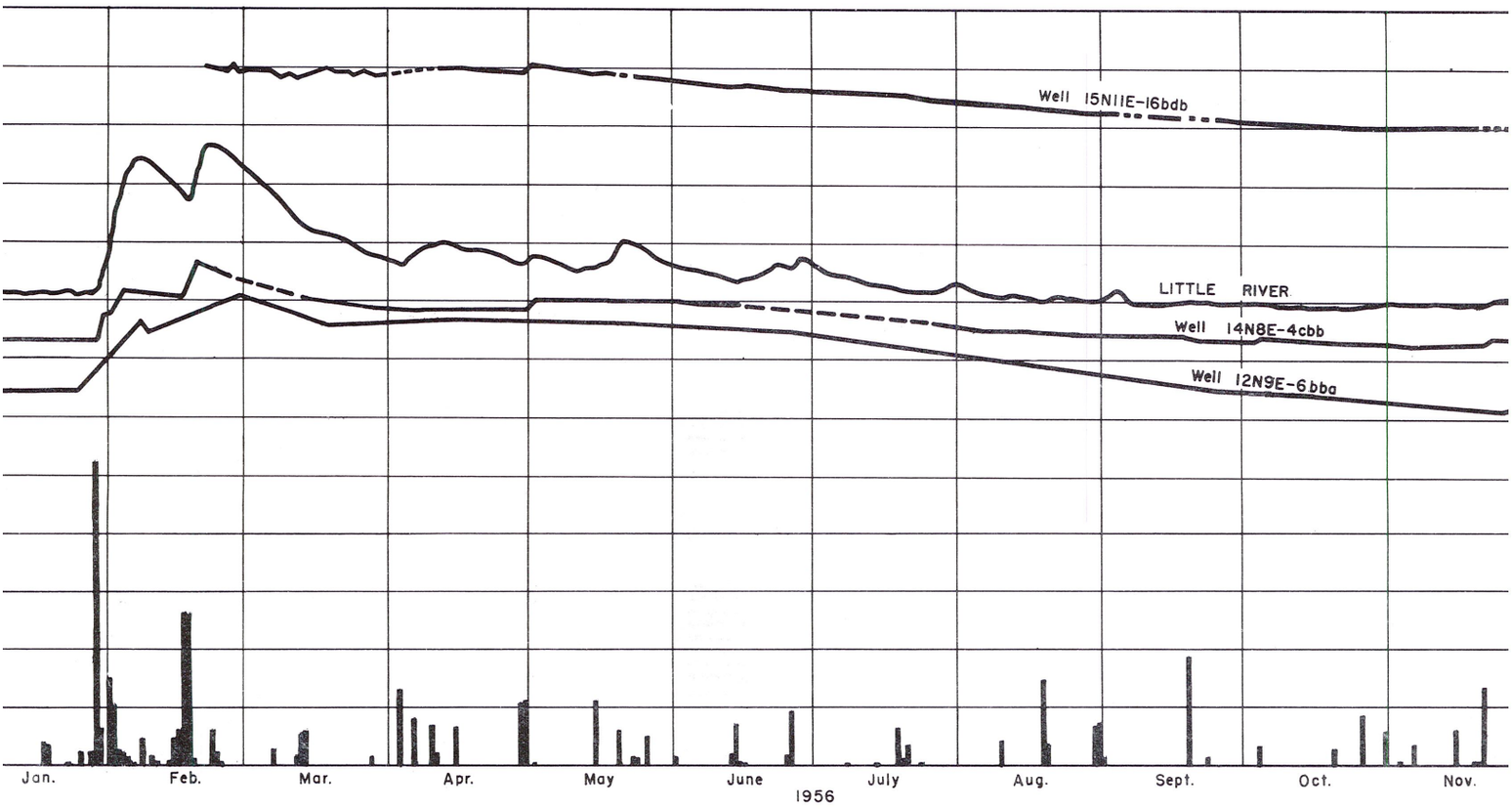
## Recovery of Ground Water by Wells

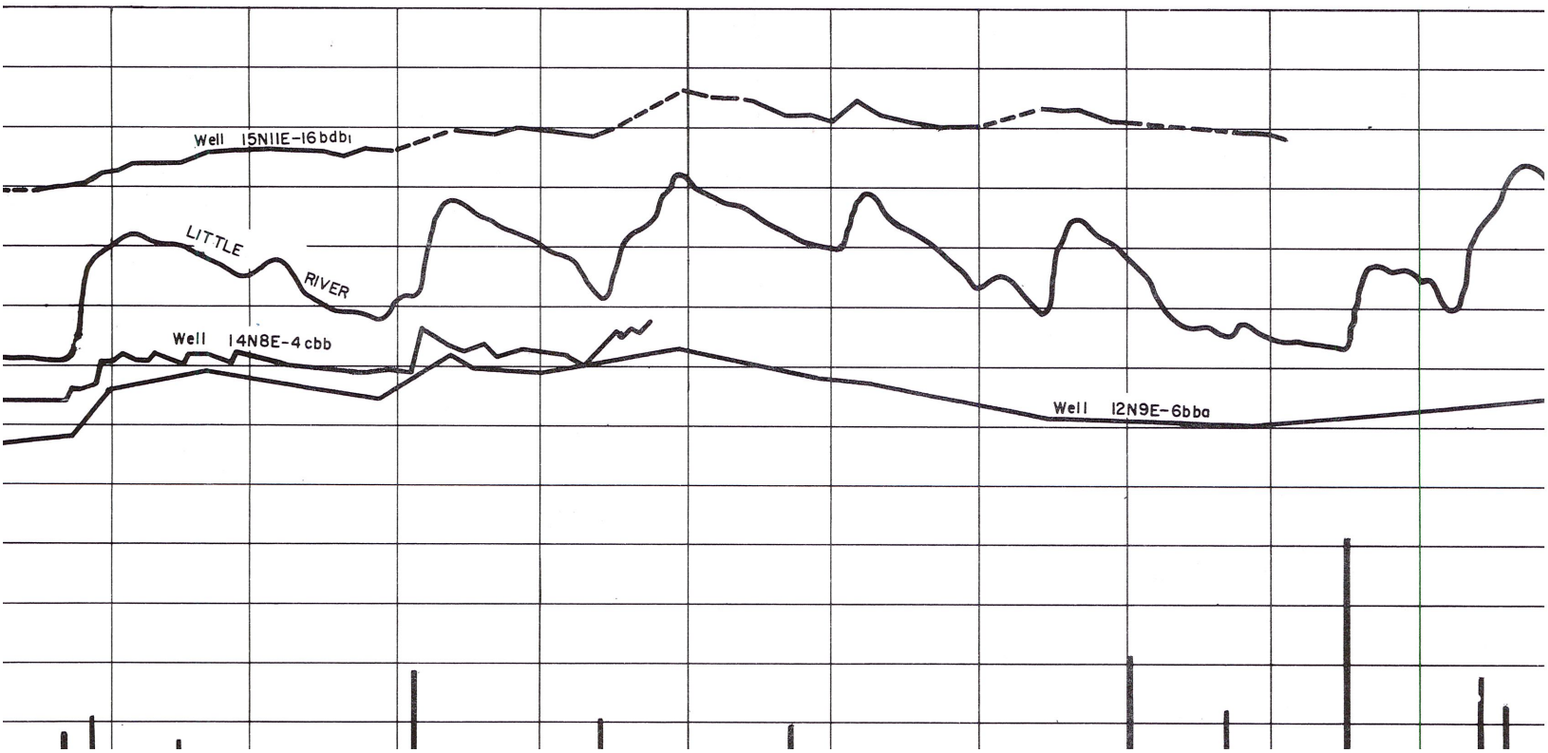
### Principles of Recovery

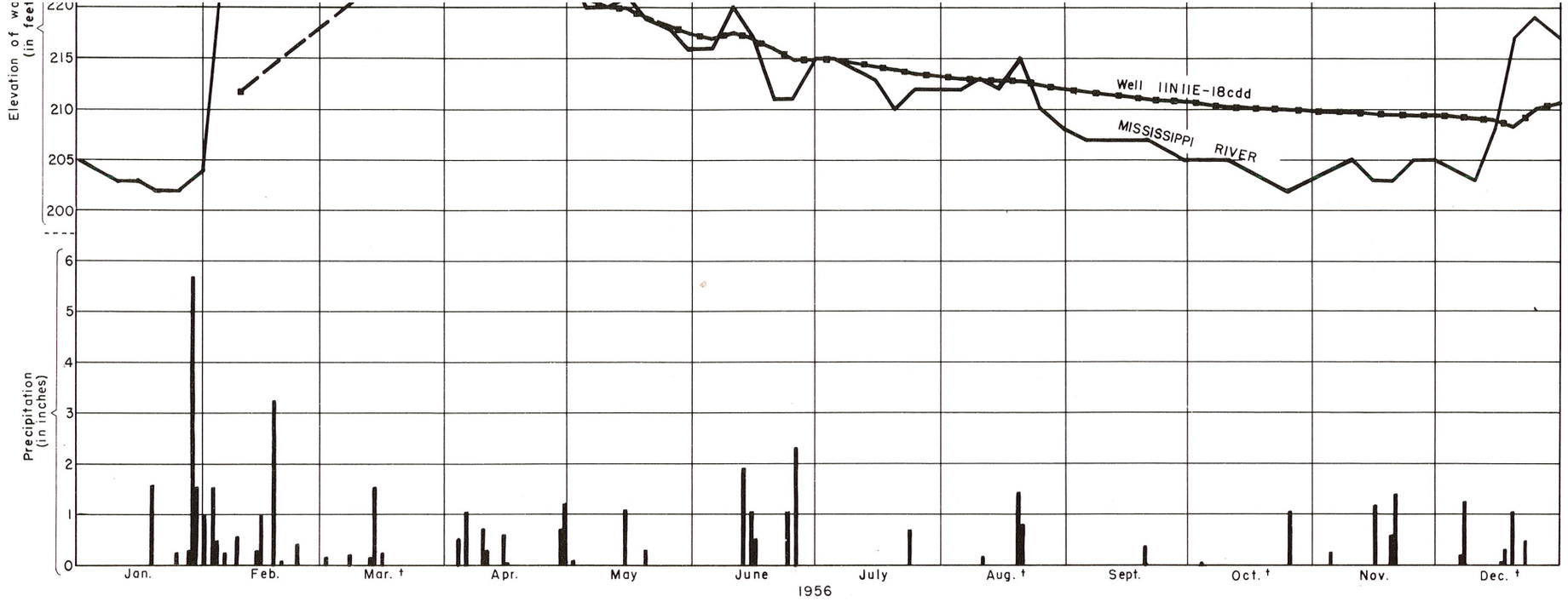
When water is withdrawn from a well the water level in the vicinity of the well declines and assumes a form similar to that of an inverted cone. This is called a "cone of depression." The greater the rate of pumping of the well, the greater the drawdown (difference between static and pumping levels) and the deeper the cone of depression. As pumping continues, the decline in water level extends outward to greater and greater distances so that water levels in wells several hundred feet to a mile or more from the pumped well may be lowered.

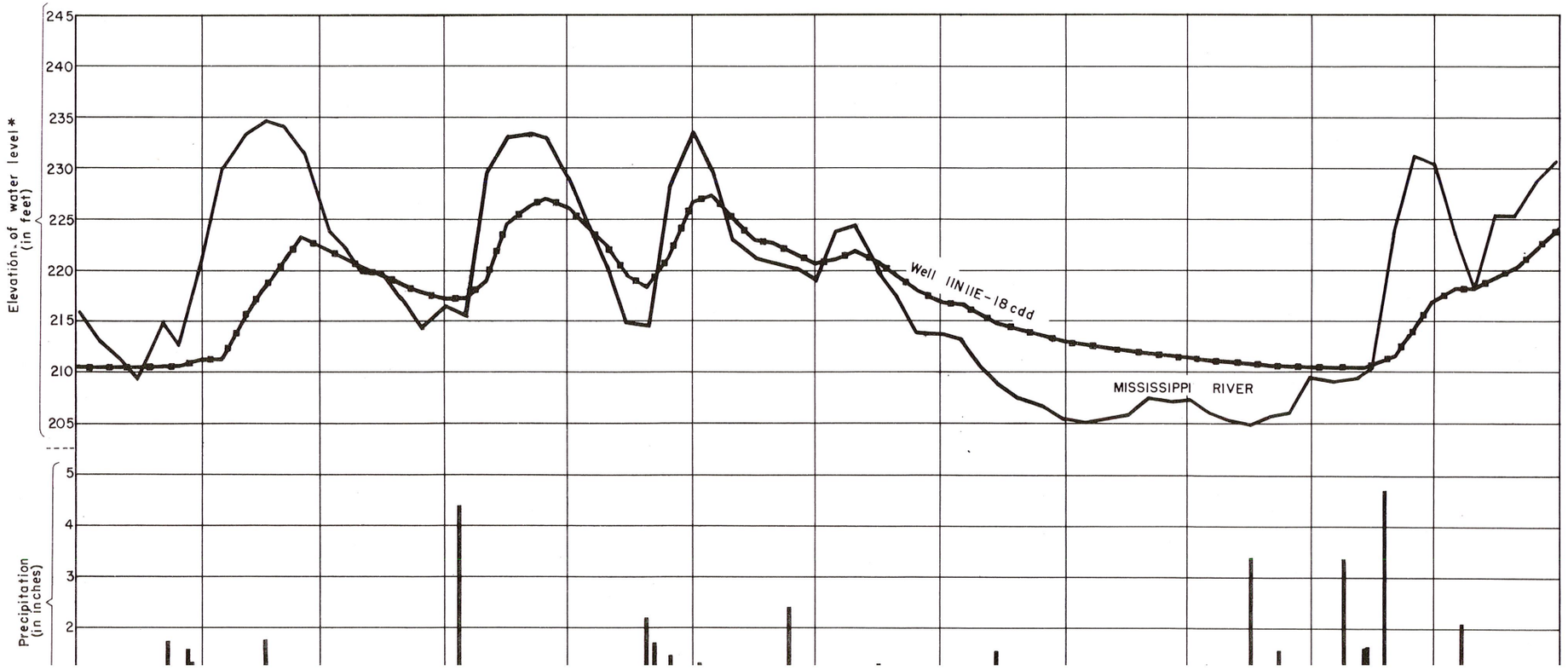
The specific capacity of a well is its rate of yield per unit of drawdown and generally is expressed in gallons per minute per foot of drawdown. For example, well 10N8E-22abb with a measured yield of 1,050 gpm and a drawdown of 13 feet has a specific capacity of 81 gpm per foot of drawdown. When a well is pumped, the water level drops rapidly at first and then progressively slow until a condition of approximate equilibrium between discharge and inflow is reached. In testing the specific capacity of a well, therefore, it is important to pump the well until the drawdown


LITTLE RIVER
Well 14N8E-4cb
Well 12N9E-6bba
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
1955


Well 15N11E-16bdb
LITTLE RIVER
Well 14N8E-4cbb
Well 12N9E-6bba
Jan.
Feb.
Mar.
Apr.
May
June
July
Aug.
Sept.
Oct.
Nov.
1956


Well 15N11E-16bdb
LITTLE RIVER
Well 14N8E-4cbb
Well 12N9E-6bba


Elevation of wa
(in feet)
220
215
210
205
200
Well 11N11E-18cdd
MISSISSIPPI RIVER
Precipitation
(in inches)
6
5
4
3
2
1
0
Jan.
Feb.
Mar. †
Apr.
May
June
July
Aug. †
Sept.
Oct. †
Nov.
Dec. †
1956


Elevation of water level*
(in feet)
245
240
235
230
225
220
215
210
205
Well 11N11E-18cdd
MISSISSIPPI RIVER
Precipitation
(in inches)
5
4
3
2

per unit of time is small. When the pump is stopped, the water level in the well rises rapidly at first and then more slowly until it reaches approximately its original position.

The character and thickness of the water-bearing materials have a definite effect on the yield and drawdown of a well and, therefore, on the specific capacity of a well. If the water-bearing material is coarse and uniform in size, it will readily yield large quantities of water to a well with relatively little drawdown; if the water-bearing material is fine and poorly sorted, it will offer more resistance to the flow of water into the well, thereby decreasing the yield and increasing the drawdown. Other things being equal, the drawdown in a well is inversely proportional to the permeability of the water-bearing materials.

### Well Construction

A water well is a manmade opening which extends from the land surface into water-bearing rock materials and is constructed in such a way as to allow the withdrawal of ground water from the earth to the land surface.

Wells may be constructed according to different methods. In Mississippi County by far the most common well type is the small-diameter driven well. Such a well is constructed by driving a combination drive point and screen, together with casing, into the ground, normally without the use of drilling, augering, or jetting. These wells are almost exclusively 1¼ inches in diameter, and are most commonly equipped with pitcher pumps. Small jet or suction pumps also are used. Irrigation wells are drilled with normal or reverse hydraulic rotary rigs, or with auger and sand-bucket rigs. Most of these wells are constructed with a gravel pack, or envelope, around the well screen or intake area. Deep domestic wells and deep municipal wells are drilled with hydraulic rotary rigs.

Wells in the unconsolidated materials of the Tertiary and Quaternary deposits are cased throughout their entire depth. In most wells a screen or strainer is used to provide intake area and to inhibit movement of sand and gravel from the aquifer into the well. Some wells in deposits of Quaternary age are not provided with specially constructed screens. The intake area of these wells is provided by perforated or slotted casing which is set opposite the water-bearing material. No dug wells or tile-cased wells are known to exist in Mississippi County.

## Hydraulic Properties of the Water-Bearing Formations

The ability of an aquifer to yield water to wells is dependent upon two important hydraulic properties. These particular characteristics pertain to the ability of the water-bearing formation to store and transmit water. Special field methods (referred to as "pumping tests" or "aquifer tests") are used to determine these properties.

Fundamentally, an aquifer test involves the use of a pumped well and one or more observation wells. The test consists of two phases, a pumping phase and a recovery phase. During the pumping phase, water is withdrawn from the aquifer at a controlled rate for a certain length of time. During the period of pumping the resulting changes in the water levels in the pumped well and the neighboring observation wells are measured at periodic intervals. The recovery phase of the test starts when the pumped well is shut down. Water levels are measured again at periodic intervals to determine the rate of recovery.

The field data obtained from aquifer tests are then analyzed mathematically to obtain a numerical expression for the two hydraulic properties sought for the particular aquifer tested.

The coefficient of storage is a nondimensional figure difficult to give physical interpretation. However, the coefficient of storage of an aquifer is defined as the volume of water it releases from or takes into storage per unit surface area of the aquifer, per unit change in the component of head normal to that surface. Thus, the coefficient of storage represents conditions within the cone of depression centering about the pumped well and extending outward from it to where there are no changes in water levels due to the pumping of the test well. For water-table conditions, pumping results in the partial dewatering of the aquifer, and the coefficient of storage closely approaches in magnitude the specific yield or the volume of water that will drain by gravity from a unit volume of the aquifer. For artesian conditions, however, there is no dewatering of the aquifer, and the water obtained by pumping is derived from the compaction of the aquifer and the expansion of water in the aquifer due to the release of hydrostatic pressure at the well site. The coefficient of storage as determined for water-bearing formations under water-table conditions generally is between 0.01 or 0.02 and 0.2

to 0.3; under artesian conditions, it generally ranges from 0.00001 to 0.001. Thus, there is a fundamental difference between the coefficients of storage for water-table and artesian aquifers.

The coefficient of transmissibility is expressed as the number of gallons of water, at the prevailing water temperature, that will flow under unit hydraulic gradient each day through a strip of an aquifer 1 foot wide and having a height equal to the thickness of the aquifer. The coefficient of transmissibility determined from an aquifer test is considered to be representative for a cylindrically shaped area centering about the pumped well and extending outward through the entire thickness of the aquifer from the well to the distance beyond which there is no measurable change in water levels due to pumping.

## Aquifer Tests

Five aquifer tests were made in Mississippi County. Of these, four were in deposits of Quaternary age and one was in the "1,400-foot" sand of the Wilcox formation. Table 9 shows the pertinent data relative to the five aquifer tests.

The four tests made in deposits of Quaternary age were in areas capped by relatively impervious material to avoid the complicating effects of well-discharge water seeping back into the aquifer during the test period. For this reason, no pumping tests were made in northwestern Mississippi County, where the land surface is underlain by sand and silt and the water table is at shallow depth.

In general, the coefficient of permeability of the Quaternary aquifer increases from southern Mississippi County to the north-central part of the county.

## Specific Capacity of Wells

The specific capacity of a well is the ratio between well yield and drawdown. The well yield is the rate of discharge expressed in gallons per minute, and drawdown is the difference between the pumping level and the static water level, measured in feet. Specific capacity is thus expressed in gallons per minute per foot of drawdown.

The specific capacity of a well depends on a number of controlling factors. For a given rate of discharge the drawdown is inversely proportional to the transmissibility, and thus reflects a hydrologic property of the aquifer. However, well construction may reduce the specific capacity. Screen diameter, size, shape, and arrangement of screen openings and screen length also control the amount of ground-water flow into the well. Well develop-

**TABLE 10**

Yield and Specific Capacity of Wells in the Quaternary Deposits and in the Wilcox Formation

| Well location | Date | Yield (gpm) | Specific Capacity (gpm/ft drawdown) |
|---|---|---|---|
| Quaternary deposits: | | | |
| 10N8E-22abb | 3- 6-56 | 1,050 | 81 |
| Do | 8-14-57 | 1,100 | 76 |
| 10N8E-31dba | 8-14-57 | 460 | 79 |
| 11N9E-8dba | 6-10-57 | 2,250 | 60 |
| 11N10E-9dcc | 8-12-57 | 1,050 | 82 |
| 11N10E-16dad | 8-12-57 | 1,000 | 61 |
| 12N9E-14acb | 7- 8-57 | 2,200 | 43 |
| 12N9E-14dbb | 7- 8-57 | 2,125 | 45 |
| 12N9E-34cdc | 8-14-57 | 1,925 | 43 |
| 13N8E-24baa | 8-12-57 | 740 | 39 |
| 13N9E-18cbd | 8-13-57 | 780 | 29 |
| 13N9E-30ccc | 6-11-57 | 875 | 63 |
| 14N10E-18dbb | 6-18-57 | 2,375 | 67 |
| 15N10E-29dca | 8-21-57 | 1,875 | 41 |
| Wilcox formation: | | | |
| 12N10E-1dca | 1953? | [1] 1,500 | [1] 30 |
| 12N10E-1dcd | 1953? | [1] 1,500 | [1] 33 |
| 15N11E-6cba1 | 2- 7-50 | 375 | 28 |

[1] Reported

**TABLE 9**

Aquifer Test Data Obtained from 4 Tests of the Quaternary Deposits and 1 Test in the Wilcox Formation
Water-bearing unit: Q, Quaternary deposits; Tew, Wilcox formation

| Aquifer Test No. | Owner | Location of pumped well | Water-bearing unit tested | Date of pumping test | Depth of pumped well (feet) | Depth of observation well 1 (feet) | Depth of observation well 2 (feet) | Distance from obs. well 1 to pumped well (feet) | Distance from obs. well 2 to pumped well (feet) | Duration of pumping phase (hours) | Duration of recovery phase (hours) | Pumping rate (gpm) | Coefficient of storage | Coefficient of transmissibility (gpd/ft.) | Specific capacity (gpm/ft. drawdown) | Field coefficient of permeability (gpd/ft.²) | Drawdown (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | C. L. Denton | 10N8E-22abb | Q | 3- 6-56 | 120 | 32 | 41 | 80 | 484 | 4.00 | 4.00 | 1,050 | 0.0005 | 290,000 | 81 | 3,100 | 13 |
| 2 | Lee Wilson & Co. | 11N9E-8dba | Q | 6-12-57 | 121 | 44 | 45 | 171 | 848 | 3.13 | 1.67 | 1,950 | .0007 | 210,000 | ---- | 1,900 | ---- |
| 3 | L. Woodard | 13N9E-30ccc | Q | 6-11-57 | 102 | 35 | 34 | 116 | 409 | 4.08 | 2.67 | 875 | .0007 | 120,000 | 63 | 1,200 | 14 |
| 4 | R. A. Greenway | 14N10E-18dbb | Q | 6-18-57 | 101 | 29 | 34 | 262 | 462 | 3.25 | 2.58 | 2,370 | .0009 | 150,000 | 68 | 1,600 | 35 |
| 5 | Blytheville AFB | 15N11E-6cba1 | Tew | 2- 7-50 | 1,445 | 1,313 | ---- | 448 | ---- | 6.00 | 3.50 | 375 | .0002 | 160,000 | 27 | 1,300 | 14 |

ment and well spacing with regard to other wells also may affect the specific capacity. A reduction of well efficiency may result from the accumulation of sand or of chemical precipitates in the well screen.

The specific capacity is generally higher at the beginning of a period of pumping, owing to the shallow cone of depression, but as pumping continues and the cone of depression deepens and expands the specific capacity gradually becomes less.

Table 10 lists the yields and specific capacities of 13 irrigation wells screened in the Quaternary deposits and of 3 wells screened in the Wilcox formation.

## Utilization of Ground Water

The amount of water withdrawn from all wells in Mississippi County is estimated to average 12.1 mgd as of 1957. The rates of use for different purposes are: domestic, 0.5 mgd; public supplies and industrial, 5.4 mgd; irrigation, 6.2 mgd, of which 2.2 mgd is for the irrigation of rice and 4.0 mgd for supplemental irrigation.

The estimate for domestic use pertains to the rural population of the county, which is about 64 percent of the total population and thus involves approximately 52,500 persons. Although there are considerable differences in daily consumption, the assumed average for the rural population is 10 gallons per person. The amount of water used for public supply is estimated primarily by the reports of water superintendents, since metered pumpage is uncommon. Industrial water supplies commonly are obtained from municipal wells and have been included with the public-supply figures. The amount of ground water used for irrigation purposes is computed from the rice acreage for 1958, assuming a water requirement of 2 acre-feet per acre, and the number of wells known to be used for supplemental irrigation. The changing of rice-acreage allotments and the variable need for supplemental irrigation from year to year will result in considerable yearly differences in ground-water pumpage for irrigation.

Table 11 lists information pertaining to selected wells in Mississippi County, Ark., and in adjacent areas in northeastern Arkansas and southeastern Missouri. Figure 15 is a map of Mississippi County showing the location of selected wells in the Quaternary and Tertiary deposits and in rocks of Paleozoic age.

### Public Supplies

There are 14 communities, towns, and cities that use ground water as a source of public supply. Each water supply is briefly described in the following paragraphs.

#### Armorel

The community of Armorel obtains water from two wells owned by the Armorel Planting Co. The main well (15N12E-15cba2) is 1,460 feet deep and is screened in the water-bearing sands of the Wilcox formation. Equipped with an electric turbine pump, this well yields a reported 40,000 gpd and is used almost exclusively to meet the needs of the community. The second well (15N12E-15cba3) is 100 feet deep and is screened in deposits of Quaternary age. This well is equipped with an electric jet pump. Being a standby well, it is used only in emergencies and yields about 210 gpm. Water is pumped from either well to the treatment plant where it is aerated. The water then accumulates in a reservoir and is pumped through two filter tanks into two 500-gallon storage tanks.

#### Blytheville

The city of Blytheville obtains water from three wells (15N11E-15bdb2, 15N11E-15bdb3 and 15N11E-15bdb4) owned by the Blytheville Water Co. These wells are screened in the Wilcox formation and range in depth from 1,373 feet to about 1,500 feet. The wells are equipped with electrically powered turbine pumps and furnish about 2,000,000 gallons of water per day. Two wells yield a reported 1,800 gpm each, and the third well yields 1,200 gpm. The water is pumped from the wells to a treatment plant where the water is aerated. Under gravity flow the aerated water accumulates in the sedimentation basin and passes through a sand filter, after which the water is chlorinated and flows into a subsurface reservoir with a capacity of 275,000 gallons. From the reservoir the water is then pumped to two overhead storage tanks, one at the well field with a capacity of 100,000 gallons, and another in the western part of the city with a capacity of 500,000 gallons. The chemical analysis of raw water from well 15N11E-15bdb2 is listed in table 15.

#### Burdette

A part of Burdette is supplied with water from a well (14N11E-20cda2), 1,429 feet deep, owned by the Burdette gin and Burdette Planting Co. The well is screened in the Wilcox formation and is equipped with an electrically powered jet pump. The yield of the well is

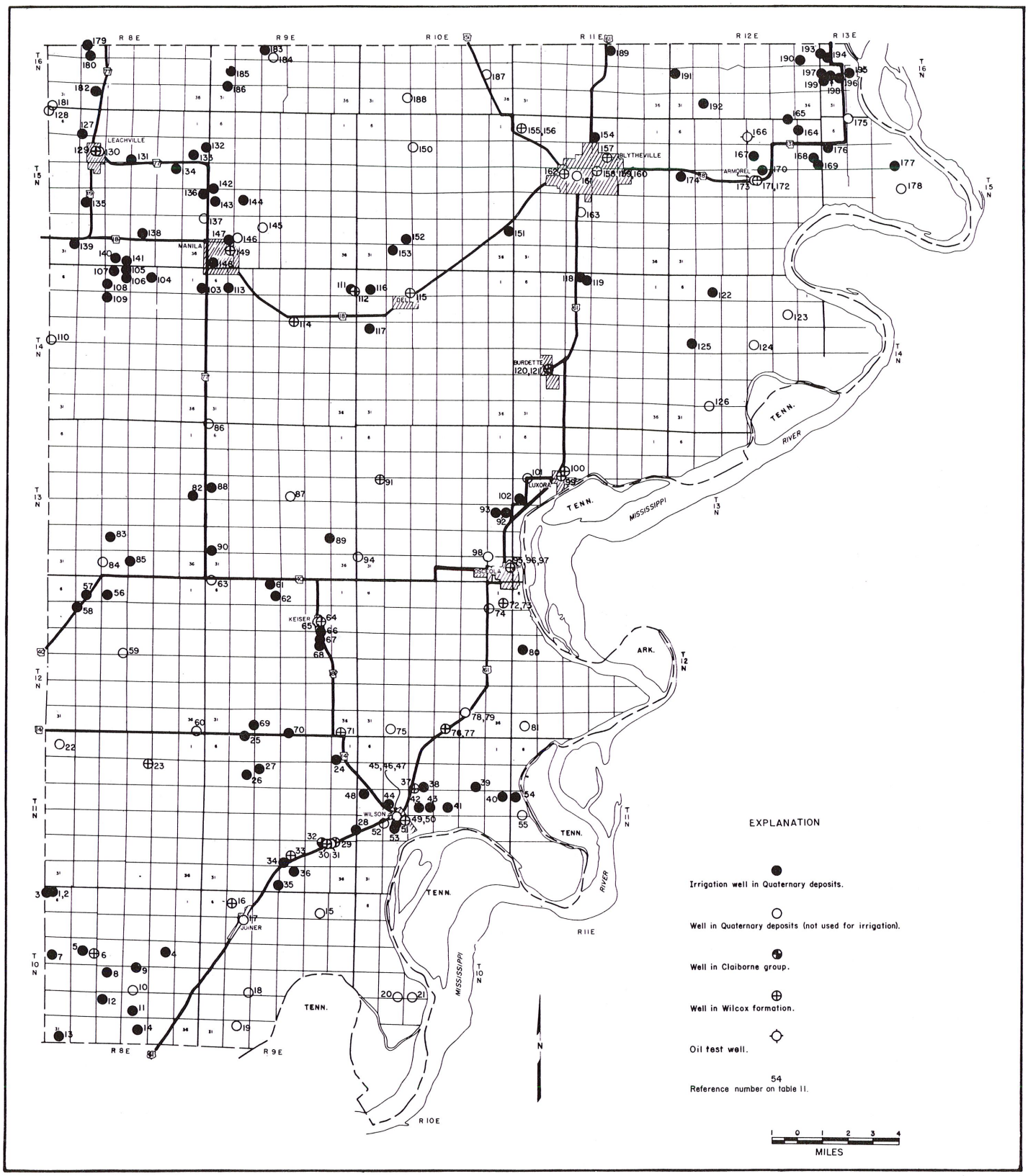



Figure 15.—Map showing the location of selected wells in the Quaternary and Tertiary deposits and in rocks of Paleozoic age.

## TABLE 11

Record of Wells in Mississippi County, Ark.

Well number: Well numbers in parentheses indicate wells used in study of variations of iron content, and hardness of water from shallow wells in the Quaternary deposits. The locations of these wells are shown in figure 19.

Type of well: Ad, augered; Dd, drilled; Dn, driven; S. B., sand bucket.

Stratigraphic unit: C, Cambrian undifferentiated; Q, Quaternary deposits; Tec, Claiborne group; Tew, Wilcox formation.

Depth to water below land surface: Measured depth is given to nearest tenth of a foot. Reported depth is given to nearest foot.

Type of pump: C, centrifugal; F, force; J, jet; N, none; P, pitcher; T, turbine.

Use: Dom., domestic; Ind., industrial; Irr., irrigation; Mil., military; N, not in use; P.S., public supply.

Remarks: C. A., comprehensive water analysis; Par. A., partial water analysis; Pre. A., preliminary analysis; S. A., special water analysis; Log, log included in report; P. T., pumping test.

| Well No. | Location designation | Owner | Driller | Altitude above sea level (feet) | Date of well completion | Type of well | Depth of well (feet) | Diameter of well (inches) | Stratigraphic unit | Depth to water below land surface (feet) | Date of water-level measurement | Type of pump | Well yield (gpm) | Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | 10N 8E- 1aab | Cromer Bros. | ---- | 230 | ---- | Dn | 33 | 1¼ | Q | 17.3 | 2-10-56 | P | ---- | Dom. | S.A. |
| 1 | - 6bac | Jack Glover | Lewis Diesel Engine Co. | 218 | 1956 | Dd | 160 | 12 | Q | ---- | ---- | T | 1,500 | Irr. | |
| 2 | - 6bbd | do | do | 220 | 1954 | Dd | 117 | 12 | Q | 16.8 | 4- 7-59 | N | 1,500 | Irr. | |
| 3 | - 6bcb | do | do | 221 | 1956 | Dd | 150 | 12 | Q | 18.3 | 4- 7-59 | T | 1,500 | Irr. | |
| 4 | -14acc | W. J. Denton | do | 225 | 1955 | Dd | 121 | 14 | Q | 15.5 | 4- 8-55 | T | 2,000 | Irr. | Log |
| 5 | -17caa | C. L. Denton, Sr. | do | 225 | 1955 | Dd | 123 | 14 | Q | 18.1 | 12-16-55 | T | 750 | Irr. | Par. A.; Log |
| 6 | -17daa | do | Lee Wilson and Co. | 221 | 1941 | Dd | 1,510 | 8 | Tew | 9.7 | 11- 6-58 | J | ---- | Dom. | |
| 7 | -18cca | A. A. Banks | Lewis Diesel Engine Co. | 225 | 1955 | Dd | 134 | 12 | Q | 18.6 | 3-17-59 | T | 2,500 | Irr. | |
| 8 | -21bad | R. E. Pugh | | 222 | 1956 | Dd | 100 | 12 | Q | 13.2 | 4- 7-59 | T | ---- | Irr. | |
| (2) | -22aba | W. J. Denton | ---- | 224 | ---- | Dn | 41 | 1¼ | Q | 13.7 | 2-10-56 | P | ---- | Dom. | S.A. |
| 9 | -22abb | do | Lewis Diesel Engine Co. | 224 | 1956 | Dd | 120 | 12 | Q | 15.5 | 11-30-55 | T | 1,050 | Irr. | C.A.; P.T. |
| 10 | -22cdd | A. Higgens | ---- | 225 | ---- | Dn | 40 | 1¼ | Q | 11.6 | 12-30-58 | P | ---- | N | |
| 11 | -27cad | J. W. Speck | Cart Well Company | 225 | 1953 | Dd | 100 | 16 | Q | 13.9 | 4-28-55 | T | 2,500 | Irr. | |
| 12 | -28bdc | C. L. Denton, Jr. | Lewis Diesel Engine Co. | 225 | 1955 | Dd | 110 | 14 | Q | 17.4 | 12-16-55 | T | 2,000 | Irr. | Log |
| (3) | -31bca | J. L. Drace | ---- | 221 | ---- | Dn | 32 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 13 | -31dba | do | Lewis Diesel Engine Co. | 213 | 1957 | Dd | 140 | 12 | Q | 20.8 | 8-14-57 | T | ---- | Irr. | |
| 14 | -34acd | J. W. Speck | Cart Well Company | 227 | 1954 | Dd | 106 | 16 | Q | 17.8 | 8-14-57 | T | 2,500 | Irr. | |
| (4) | -35dbd | R. T. Kuhn | ---- | 227 | ---- | Dn | 57 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 15 | 10N 9E- 2dca | E. G. Chiles | ---- | 233 | ---- | Dn | 30 | 1¼ | Q | 12.5 | 12-30-58 | N | ---- | N | |
| 16 | - 5cba | Mrs. E. H. Bowden | Lee Wilson and Co. | 233 | 1938? | Dd | 1,500 | 8 | Tew | ---- | ---- | J | ---- | Dom. | |
| (5) | - 5ddd | L. L. Lee | ---- | 230 | ---- | Dn | 27 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 17 | - 8aba | Town of Joiner | Carloss Well Supply Co. | 230 | 1948 | Dd | 95 | 6 | Q | ---- | ---- | T | 250 | P.S. | |
| (6) | -11aaa | E. G. Chiles | ---- | 233 | ---- | Dn | 41 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 18 | -20ddd | M. Shippen | ---- | 231 | ---- | Dn | 25 | 1¼ | Q | 16.1 | 12-30-58 | N | ---- | N | |
| 19 | -32abc | G. L. Solmon Est. | ---- | 225 | ---- | Dn | 54 | 1¼ | Q | 8.6 | 12-30-58 | N | ---- | N | |
| (7) | -33cbb | do | ---- | 227 | ---- | Dn | 29 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | P.A. |
| (8) | 10N10E-20dda | do | ---- | 230 | ---- | Dn | 72 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 20 | -20ddc | do | ---- | 230 | ---- | Dn | 65 | 1¼ | Q | 22.0 | 12-30-58 | N | ---- | Dom. | |
| 21 | -21cdc | do | ---- | 230 | ---- | Dn | 36 | 1¼ | Q | 22.0 | 12-29-58 | P | ---- | P.S. | |
| (9) | 11N 8E- 1aba | Lonnie Prentice | ---- | 224 | ---- | Dn | 42 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 22 | - 6dbb | D. Portis | ---- | 224 | ---- | Dn | 22 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | |
| 23 | -10adb | Crain Company | Works Project Adm. | 221 | 1934 | Dd | 2,200 | 6 | Tew | 6-8 | Aug. 58 | T | 200 | P.S. | |
| (10) | -15ccc | O. J. Stephens | ---- | 222 | ---- | Dn | 44 | 1¼ | Q | ---- | ---- | T | ---- | Dom. | S.A. |
| (11) | -32ccb | Cletus Tacker | ---- | 226 | ---- | Dn | 23 | 1¼ | Q | ---- | ---- | T | ---- | Dom. | S.A. |
| 24 | 11N 9E- 1ccd | Lee Wilson and Co. | Lewis Diesel Engine Co. | 233 | ---- | Dd | 120 | ---- | Q | 9.8 | 4- 8-59 | T | 800-900 | Irr. | |
| 25 | - 5abb | do | Cart Well Co. | 226 | 1952 | Dd | 115 | 12 | Q | 9.5 | 4-28-55 | T | 1,500 | Irr. | Par. A |
| 26 | - 8dba | do | do | 227 | 1957 | Dd | 120 | 16 | Q | 7.9 | 4- 8-59 | T | 2,500 | Irr. | |

TABLE 11—Continued

Record of Wells in Mississippi County, Ark.

| Well No. | Location designation | Owner | Driller | Altitude above sea level (feet) | Date of well completion | Type of well | Depth of well (feet) | Diameter of well (inches) | Stratigraphic unit | Depth to water below land surface (feet) | Date of water-level measurement | Type of pump | Well yield (gpm) | Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 11N 9E- 9bca | Lee Wilson and Co. | Cart Well Co. | 228 | 1952 | Dd | 121 | 12 | Q | 9.7 | 4-28-55 | T | 1,950 | Irr. | C.A.; P.T. |
| 28 | -24daa | do | Lee Wilson and Co. | 236 | 1956 | Dd | 97 | 16 | Q | 13.2 | 4- 8-59 | T | 1,800 | Irr. | Log |
| 29 | -25bba | Delta Products Co. | do | 236 | 1947 | Dd | 1,578 | 12 | Tew | 14.7 | 11- 7-58 | T | ---- | Ind. | |
| 30 | -26aad1 | do | Carloss Well Supply Co. | 236 | 1944 | Dd | 1,558 | 8 | Tew | 15.3 | 11- 7-58 | N | ---- | Ind. | Log |
| 31 | -26aad2 | do | do | 236 | 1947 | Dd | 114 | 10 | Q | 18.0 | Oct. 47 | T | 750 | Ind. | Log |
| 32 | -26aba | Memphis Comp. Co. | C. M. Journey | 236 | 1935 | Dd | 339 | 6 | Tec | 18.8 | 11- 6-58 | T | 200 | Ind. | C.A.; Log |
| 33 | -27cad | Crain Company | -------- | 238 | 1930 | Dd | 1,500 | 10 | Tew | ---- | ---- | T | ---- | Dom. | |
| 34 | -27ccd | do | Lewis Diesel Engine Co. | 231 | 1955 | Dd | 94 | 12 | Q | 9.7 | 3-17-59 | T | ---- | Irr. | |
| 35 | -33dda | do | do | 232 | 1954 | Dd | 115 | 12 | Q | 8.4 | 3-17-59 | T | ---- | Irr. | |
| 36 | -34abc | do | do | 236 | 1955 | Dd | 115 | 12 | Q | 13.1 | 3-17-59 | T | ---- | Irr. | |
| (12) | 11N10E- 6bbb | C. S. Standeler | -------- | 233 | ---- | Dn | 37 | 1¼ | Q | ---- | ---- | P | ---- | Stock | S.A. |
| 37 | - 9ccd | Crain Company | Layne-Arkansas Co. | 234 | 1950 | Dd | 1,520 | 6 | Tew | ---- | ---- | T | 200 | Ind. | |
| 38 | - 9dcc | J. H. Crain | -------- | 234 | 1955 | Dd | 120 | 12 | Q | 13.1 | 4-28-55 | T | 1,040 | Irr. | |
| 39 | -11dca | J. E. Crain | Lewis Diesel Engine Co. | 233 | 1954 | Dd | 116 | 16 | Q | 7.2 | 4-28-55 | T | 2,400 | Irr. | Par. A. |
| 40 | -13abd | Univ. of Arkansas | Abel and Son | 235 | 1957 | Dd | 110 | 6 | Q | ---- | ---- | T | 1,200 | Irr. | |
| (13) | -15aab | J. E. Crain | -------- | 232 | ---- | Dn | 46 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 41 | -15ddb | do | -------- | 225 | 1955 | Dd | 116 | 14 | Q | 7.1 | 4-28-55 | T | 2,800 | Irr. | |
| 42 | -16cad | W. J. Denton | Lewis Diesel Engine Co. | 233 | 1594 | Dd | 120 | 12 | Q | 11.4 | 4-28-55 | T | ---- | Irr. | |
| 43 | -16dad | do | do | 233 | 1954 | Dd | 120 | 12 | Q | 10.0 | 4-28-55 | T | 1,000 | Irr. | |
| 44 | -17cba | Lee Wilson and Co. | Cart Well Co. | 236 | 1958 | Dd | 127 | ---- | Q | 13.2 | 4- 8-59 | T | ---- | Irr. | |
| 45 | -17dcd1 | Wilson Soya Co. | do | 235 | 1949 | Dd | 101 | ---- | Q | ---- | ---- | T | ---- | Ind. | |
| 46 | -17dcd2 | do | do | 235 | 1958 | Dd | 120 | 10 | Q | ---- | ---- | T | 300-400 | Ind. | |
| 47 | -17dcd3 | Delta Ice Co. | Layne-Arkansas Co. | 235 | 1952 | Dd | 109 | 4 | Q | ---- | ---- | J | 250 | Ind. | |
| 48 | -18baa | Lee Wilson and Co. | Cart Well Co. | 235 | 1958 | Dd | 118 | ---- | Q | 12.8 | 4- 8-59 | T | 3,000 | Irr. | |
| 49 | -20aad1 | do | Carloss Well Supply Co. | 235 | 1944 | Dd | 1,485 | 8 | Tew | 2.0 | Apr. 44 | T | 326 | P.S. | Log |
| 50 | -20aad2 | do | Johnson and Fleming | 235 | 1936 | Dd | 1,567 | 8 | Tew | ---- | ---- | T | 360 | P.S. | C.A |
| 51 | -20abd | do | Lee Wilson and Co. | 234 | 1956 | Dd | 94 | 10 | Q | ---- | ---- | T | 1,800 | Irr. | |
| 52 | -20bcb | Buring Packing Co. | Carloss Well Supply Co. | 235 | 1953 | Dd | 116 | 8 | Q | ---- | ---- | T | 290 | Ind. | Log |
| 53 | -20caa | -------- | ——— | 233 | ---- | Dd | ---- | ---- | Q | ---- | ---- | T | ---- | Irr. | |
| 54 | 11N11E-18bbd | Lowrence Bros. | Layne-Arkansas Co. | 240 | 1957 | Dd | 129 | 16 | Q | 14.2 | 4-16-59 | T | 2,500 | Irr. | |
| 55 | -18cdd | Mrs. J. K. Hampson | -------- | 240 | ---- | Dn | 97 | 1¼ | Q | 28.4 | 12-30-58 | N | ---- | N | |
| (14) | -33aba | W. O. Yates Est. | -------- | 232 | ---- | Dn | 32 | 1¼ | Q | ---- | ---- | F | ---- | Dom. | Pre. A. |
| 56 | 12N 8E- 4cca | J. C. Portis | Cypress Supply Co. | 224 | 1955 | Dd | 100 | 12 | Q | 2.8 | 4-28-55 | T | ---- | Irr. | |
| 57 | - 5cda | do | do | 224 | 1955 | Dd | 100 | 14 | Q | 3.0 | 4-28-55 | T | 1,100 | Irr. | |
| 58 | - 8bcb | H. B. Richardson | Crumrod Stores | 225 | 1955 | Dd | 105 | 12 | Q | 3.7 | 4-28-55 | T | 1,550 | Irr. | Par. A. |
| 59 | -16ddd | School land | -------- | 226 | ---- | Dn | 15 | 1¼ | Q | 11.6 | 12-30-58 | N | ---- | Dom. | |
| (15) | -31ccc | J. P. Holiman | -------- | 222 | ---- | Dn | 24 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 60 | -36dcd | Burton Motor Co. | -------- | 223 | ---- | Dn | 54 | 1¼ | Q | 12.0 | 12-30-58 | N | ---- | Dom. | |
| 61 | 12N 9E- 4abc | Jane Bolton | Valley Drilling Co. | 226 | 1955 | Dd | 100 | 14 | Q | 9.6 | 12-14-55 | T | 2,500 | Irr. | Par. A.; Log |
| 62 | - 4dac | do | do | 227 | 1955 | Dd | 100 | 14 | Q | 9.9 | 12-14-55 | T | ---- | Irr. | Log |
| 63 | - 6bba | F. A. White | -------- | 230 | ---- | Dn | 33 | 1¼ | Q | 10.6 | 12-30-58 | N | ---- | Dom. | Destroyed |
| (16) | - 6bbb | do | -------- | 229 | ---- | Dn | 30 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 64 | -11dbb1 | Town of Keiser | Lee Wilson and Co. | 230 | 1953 | Dd | 1,420 | 6 | Tew | 3.0 | Sept. 53 | T | 750 | P.S. | C.A. |
| 65 | -11dbb2 | do | Carloss Well Supply Co. | 230 | 1945 | Dd | 72 | 8 | Q | 10.6 | 10- 4-56 | J | 62 | P.S. | Log |

**TABLE 11—Continued**
Record of Wells in Mississippi County, Ark.

| Well No. | Location designation | Owner | Driller | Altitude above sea level (feet) | Date of well completion | Type of well | Depth of well (feet) | Diameter of well (inches) | Stratigraphic unit | Depth to water below land surface (feet) | Date of water-level measurement | Type of pump | Well yield (gpm) | Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 66 | 12N- 9E-14abb | Lee Wilson and Co. | Cart Well Co. | 229 | 1954 | Dd | 109 | 10 | Q | ---- | ---- | T | 1,500 | Irr. | |
| 67 | -14acb | do | do | 229 | 1954 | Dd | 108 | 16 | Q | 5.8 | 4-28-55 | T | 2,200 | Irr. | Par. A. |
| 68 | -14dbb | Lee Wilson and Co. | do | 228 | 1954 | Dd | 101 | 16 | Q | 4.9 | 4-28-55 | T | 2,100 | Irr. | |
| 69 | -32daa | do | do | 225 | 1958 | Dd | 111 | 16 | Q | 10.3 | 4- 8-59 | T | ---- | Irr. | |
| 70 | -34cdc | do | do | 230 | 1954 | Dd | 135 | 16 | Q | 8.9 | 4-28-55 | T | 1,950 | Irr. | |
| 71 | -36cdc | do | -------- | 234 | ---- | Dd | 1,300 | ---- | Tew | ---- | ---- | T | ---- | P.S. | |
| (17) | -36dcd | Mrs. A. C. Cromer | -------- | 230 | ---- | Dn | 60 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 72 | 12N10E- 1dca | Osceola Finishing Co. | Layne-Arkansas Co. | 246 | 1953 | Dd | 1,500 | 18 | Tew | ---- | ---- | T | 1,500 | Ind. | |
| 73 | - 1dcd | do | do | 246 | 1953 | Dd | 1,495 | 18 | Tew | ---- | ---- | T | 1,500 | Ind. | Log |
| (18) | - 2ddd | C. M. Harwell | -------- | 238 | ---- | Dn | 23 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 74 | -12bbb | -------- | -------- | 239 | ---- | Dn | 25 | 1¼ | Q | 15.5 | 12-30-58 | N | ---- | Dom. | |
| 75 | -32cac | A. L. Lynch | -------- | 236 | ---- | Dn | 53 | 1¼ | Q | 11.4 | 12-30-58 | P | ---- | Dom. | |
| (19) | -21dbb | Mrs. E. J. Flannigan | -------- | 235 | ---- | Dn | 44 | 1¼ | Q | ---- | ---- | N | ---- | Dom. | S.A. |
| 76 | -34cad1 | Lowrence Bros. | Layne-Arkansas Co. | 233 | 1927 | Dd | 1,500 | 6 | Tew | ---- | ---- | T | ---- | P.S. | Log |
| 77 | -34cad2 | do | do | 233 | 1955 | Dd | 1,535 | 8 | Tew | 7.5 | 11- 6-58 | T | 100 | P.S. | |
| 78 | -35baa1 | H. F. Ohlendorf | Watson Co. | 234 | 1949 | Dd | 100 | 2 | Q | ---- | ---- | J | ---- | Dom. | Par. A. |
| 79 | -35bab2 | do | do | 234 | 1949 | Dd | 100 | 2 | Q | ---- | ---- | J | ---- | Dom. | |
| 80 | 12N11E-18caa | Clyde L. Whistle | Carloss Well Supply Co. | 240 | 1944 | Dd | 200 | 10 | Q | 11.7 | 4-28-55 | T | ---- | Irr. | |
| (20) | -31caa | Grace Garrott | -------- | 235 | ---- | Dn | 30 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 81 | -31dbb | do | -------- | 235 | ---- | Dn | 33 | 1¼ | Q | 15.3 | 12-30-58 | P | ---- | Dom. | |
| (21) | 13N 8E- 6daa | John Smith | -------- | 225 | ---- | Dn | 20 | 1¼ | Q | 8.4 | 9-13-55 | P | ---- | Dom. | Pre. A. |
| (22) | -22bcc | Mamie Gridley | -------- | 228 | ---- | Dn | 17 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 82 | -24baa | W. S. Cockerham | R. J. McKinnon | 230 | 1955 | Dd | 114 | ---- | Q | 11.8 | 12-14-55 | T | ---- | Irr. | Par. A.; Log |
| 83 | -28bdd | E. S. Wildy | do | 231 | 1954 | Dd | 140 | 14 | Q | ---- | ---- | T | 3,000 | Irr. | |
| (23) | -32dcc | J. M. Brackett | -------- | 226 | ---- | Dn | 23 | 1¼ | Q | 3.7 | 3-27-57 | P | ---- | Dom. | S.A. |
| 84 | -33cbb | Clara Chrismond | -------- | 225 | ---- | Dn | 17 | 1¼ | Q | 9.1 | 12-30-58 | N | ---- | N | |
| 85 | -34cbb | G. L. Gooch | Jones Bros. | 228 | 1955 | Dd | 110 | 12 | Q | 7. | 1955 | T | 1,900 | Irr. | |
| 86 | 13N 9E- 6bbb | Mrs. L. E. Jones | -------- | 233 | ---- | Dn | 17 | 1¼ | Q | 7.1 | 12-30-58 | P | ---- | N | |
| 87 | -15cda | C. R. Coleman | -------- | 228 | ---- | Dn | 38 | 1¼ | Q | 10.0 | 17-30-58 | N | ---- | N | |
| 88 | -18cbd | W. S. Cockerham | R. J. McKinnon | 231 | 1955 | Dd | 114 | 14 | Q | ---- | ---- | T | 780 | Irr. | |
| (24) | -22bcb | C. T. Coleman | -------- | 230 | ---- | Dn | 30 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 89 | -26add | W. C. Mason | Layne-Arkansas Co. | 228 | 1950 | Dd | 100 | 10 | Q | 4.3 | 4-28-55 | T | ---- | Irr. | |
| 90 | -30ccc | Lawrence Woodard | Crumrod Stores | 230 | 1955 | S.B. | 102 | ---- | Q | 12.2 | 12-14-55 | T | ---- | Irr. | C.A.; P.T.; Log |
| (25) | -36add | Russell Gill | -------- | 228 | ---- | Dn | 32 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 91 | 13N10E-18aab | F. L. Wesson | Carloss Well Supply Co. | 225 | 1937 | Dd | 1,417 | 4 | Tew | +3.3 | 11- 4-58 | T | 80 | P.S. | Log.; Flows 3.8 gpm |
| 92 | -24adc | J. B. White | do | 245 | ---- | Dd | ---- | 6 | Q | 8.4 | 4-28-55 | T | ---- | Irr. | |
| 93 | -24bcd | J. B. and M. B. White | do | 241 | ---- | Dd | ---- | ---- | Q | 20.7 | 2-15-55 | T | ---- | Irr. | |
| 94 | -31bbb | T. E. Dill | -------- | 228 | ---- | Dn | 32 | 1¼ | Q | 5.2 | 12-31-58 | N | ---- | N | |
| (26) | -33ddd | Mrs. E. S. Driver | -------- | 235 | ---- | Dn | 47 | 1¼ | Q | 10.7 | 7-31-56 | P | ---- | Dom. | S.A. |
| 95 | -36acd1 | City of Osceola | Layne-Arkansas Co. | 246 | 1916 | Dd | 1,400 | 8 | Tew | ---- | ---- | T | 440 | P.S. | C.A. |
| 96 | -36acd2 | do | do | 246 | 1926 | Dd | 1,480 | 8 | Tew | ---- | ---- | T | 440 | P.S. | Par. A. |
| 97 | -36acd3 | do | do | 246 | 1945 | Dd | 1,500 | 10 | Tew | 15.3 | 11- 5-58 | T | 640 | P.S. | |
| 98 | -36bbb | L. A. Richards | -------- | 240 | ---- | Dn | 44 | 1¼ | Q | 16.8 | 12-30-58 | N | ---- | N | |
| 99 | 13N11E- 8dda | Town of Luxora | Works Project Adm. | 244 | 1937 | Dd | 1,500+ | 8 | Tew | 7.7 | 11- 6-58 | T | 250 | P.S. | C.A. |
| 100 | - 9cbc | do | -------- | 245 | 1916 | Dd | 1,500 | 4 | Tew | 4. | 1951 | T | 250 | P.S. | |
| 101 | -18abb | E. B. Hale | -------- | 244 | ---- | Dn | 43 | 1¼ | Q | 20.0 | 12-29-58 | N | ---- | N | |

**TABLE 11—Continued**
Record of Wells in Mississippi County, Ark.

| Well No. | Location designation | Owner | Driller | Altitude above sea level (feet) | Date of well completion | Type of well | Depth of well (feet) | Diameter of well (inches) | Stratigraphic unit | Depth to water below land surface (feet) | Date of water-level measurement | Type of pump | Well yield (gpm) | Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (27) | 13N11E-18abc | E. B. Hale | ------- | 244 | ---- | Dn | 42 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 102 | -18cca | M. B. White | Carloss Well Supply Co. | 245 | ---- | Dd | ---- | 6 | Q | 10.1 | 4-28-55 | T | ---- | Irr. | |
| 103 | 14N 8E- 1ddd | W. R. Brown | R. J. McKinnon | 237 | 1956 | Dd | 104 | 12 | Q | ---- | ---- | T | ---- | Irr. | |
| 104 | - 3adc | J. A. Pulliam | Lewis Diesel Engine Co. | 231 | 1954 | Dd | 100 | 6 | Q | ---- | ---- | N | 500 | Irr. | |
| 105 | - 4aac | do | do | 229 | 1955 | Dd | 100 | 6 | Q | ---- | ---- | C | 500 | Irr. | |
| 106 | - 4adb | do | do | 229 | 1955 | Dd | 100 | 6 | Q | ---- | ---- | C | 500 | Irr. | |
| 107 | - 4bac | do | do | 228 | 1955 | Dd | 100 | 6 | Q | ---- | ---- | C | 500 | Irr. | |
| 108 | - 4cbc | Earl H. Wildy | R. J. McKinnon | 230 | 1955 | Dd | 103 | 12 | Q | 8.7 | 9-23-55 | T | ---- | Irr. | |
| 109 | - 9bbc | do | do | 230 | 1955 | Dd | 118 | 16 | Q | 8.8 | 12-12-55 | T | ---- | Irr. | Par. A.; Log |
| 110 | -18ccc | Gatz and Bryant | ------- | 229 | ---- | Dn | 18 | 1¼ | Q | 6.7 | 12-30-58 | P | ---- | Dom. | |
| (28) | -19bac | ------- | ------- | 227 | ---- | Dn | 13 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| (29) | -22bcb | Charles Rose | ------- | 228 | ---- | Dn | 20 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 111 | 14N 9E- 1dad | B. S. Simmons | B. S. Simmons | 239 | 1955 | Dd | 100 | ---- | Q | 14.3 | 12-13-55 | T | ---- | ? | |
| 112 | - 1dda | do | Layne-Arkansas Co. | 238 | 1936 | Dd | 1,337 | ---- | Tew | 4. | Sept. 58 | T | ---- | Dom. | Log |
| 113 | - 6dda | N. Hamilton | R. J. McKinnon | 238 | 1956 | Dd | 107 | 12 | Q | 2.6 | 3-20-59 | T | ---- | Irr. | |
| 114 | -10dcc | W. A. Whistle | Layne-Arkansas Co. | 236 | 1936 | Dd | 1,286 | 4 | Tew | ---- | ---- | J | ---- | Dom. | Log |
| (30) | -17bcc | G. C. Yarbro | ------- | 237 | ---- | Dn | 26 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| (31) | -31ccc | H. E. Boling | ------- | 233 | ---- | Dn | 18 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 115 | 14N10E- 5ddd | Dell Compress Co. | Layne-Arkansas Co. | 238 | 1939 | Dd | 1,275 | 10 | Tew | +10. | 6-20-39 | T | ---- | P.S., Ind. | C.A.; Log |
| 116 | - 6dbc | B. S. Simmons | B. S. Simmons | 239 | 1954 | Dd | 110 | ---- | Q | 10.2 | 5-10-55 | T | ---- | Irr. | |
| (32) | -16ddd | School land | ------- | 233 | ---- | Dn | 33 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 117 | -18dbb | Mrs. R. A. Greenway | Newman and Williams | 238 | 1954 | Dd | 101 | 16 | Q | 10.0 | 5-10-55 | T | 1,950 | Irr. | C.A.; P.T.; Log |
| (33) | -30cbc | Lewis Gin Co. | ------- | 230 | ---- | Dn | 24 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 118 | 14N11E- 4abd | Fant Windham | Layne-Arkansas Co. | 247 | 1937 | Dd | 128 | 10 | Q | ---- | ---- | T | 800 | Irr. | |
| 119 | - 4add | Norman Speck | Frank Seay | 247 | 1954 | Dd | 100 | 6 | Q | ---- | ---- | T | 500 | Irr. | |
| (34) | - 6bbb | L. H. Rutrey | ------- | 242 | ---- | Dn | 34 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 120 | -20cda1 | Burdette Gin and Burdette Planting Co. | Johnson and Fleming | 240 | 1910 | Dd | 1,496 | 6 | Tew | +17. | 1910? | N | ---- | ---- | |
| 121 | -20cda2 | do | Carloss Well Supply Co. | 240 | 1946 | Dd | 1,408 | 6 | Tew | 8-10 | 1958 | J | 75 | P.S. | Log |
| (35) | -21aaa | F. D. Aycock | ------- | 246 | ---- | Dn | 33 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| (36) | -35dda | Edith Permenter | ------- | 244 | ---- | Dn | 21 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 122 | 14N12E- 5dbc | Robert Gray | Lewis Diesel Engine Co. | 252 | 1955 | Dd | 96 | 8 | Q | 15.7 | 12-15-55 | T | ---- | Irr. | |
| (37) | - 6bcc | Mrs. T. E. Evans | ------- | 250 | ---- | Dn | 24 | 1¼ | Q | 13.0 | 12-29-58 | P | ---- | Dom. | S.A. |
| 123 | -11dbb | C. A. Vandivart | ------- | 250 | ---- | Dn | 55 | 1¼ | Q | 22.6 | 12-29-58 | P | ---- | N | |
| 124 | -15cac | E. L. Hale | Boone Irrigation Co.? | 252 | 1957 | Dd | ---- | 10? | Q | 7.8 | 3-12-59 | T | ---- | Irr. | |
| 125 | -18dac | Dillard and Coffin | Lawrence Irrigation Co. | 248 | 1957 | Dd | 85 | 12 | Q | 9.5 | 4-17-59 | T | ---- | Irr. | |
| (38) | -23aab | Alvin Wenderlick | ------- | 252 | ---- | Dn | 24 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 126 | -32abb | W. C. Howard | ------- | 250 | ---- | Dn | 44 | 1¼ | Q | 20.9 | 12-29-58 | N | ---- | N | |
| (39) | 15N 8E- 3cbb | T. Honnell | ------- | 237 | ---- | Dn | 19 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 128 | - 6bbc | B. C. Land Co. | ------- | 238 | ---- | Dn | 21 | 1¼ | Q | 8.1 | 12-30-58 | N | ---- | Dom. | |
| 127 | - 5ccc | Jimmy Kennett | Dudley Bros. | 237 | 1956 | S.B. | 94 | 6 | Q | ---- | ---- | C | 550 | Irr. | |
| 129 | - 8dbc1 | Town of Leachville | Layne-Arkansas Co. | 236 | 1935 | Dd | 1,083 | 10 | Tew | 2.9 | 11- 5-58 | T | 135 | P.S. | C.A.; Log |
| 130 | - 8dbc2 | do | Carloss Well Supply Co. | 236 | 1956 | Dd | 120 | 6 | Q | 7. | May 56 | T | 525 | P.S. | Par. A.; Log |
| 131 | - 9ddd | E. C. and F. S. Taylor | Howell Bros. | 238 | 1955 | Dd | 85 | 6 | Q | ---- | ---- | C | 700 | Irr. | |
| 132 | -12adc | ------- | Layne-Arkansas Co. | 236 | ---- | Dd | ---- | ---- | Q | 5.4 | 8-21-57 | T | ---- | Irr. | |
| 133 | -12cda | B. C. Land Co. | do | 237 | 1957 | Dd | 109 | 12 | Q | ---- | ---- | T | ---- | Irr. | |

TABLE 11—Continued
Record of Wells in Mississippi County, Ark.

| Well No. | Location designation | Owner | Driller | Altitude above sea level (feet) | Date of well completion | Type of well | Depth of well (feet) | Diameter of well (inches) | Stratigraphic unit | Depth to water below land surface (feet) | Date of water-level measurement | Type of pump | Well yield (gpm) | Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 134 | 15N 8E -14abb | Fred Patterson | Howell Bros. | 234 | 1956 | Dd | 100 | 6 | Q | | ---- | C | ---- | Irr. | |
| 135 | -20cdb | Bruce Byrd | Newman and Williams | 233 | 1955 | Dd | 112? | 12 | Q | 7.2 | 5- 3-55 | T | 2,200 | Irr. | |
| (40) | -22cdc | E. W. Robertson | -------- | 231 | ---- | Dn | 17 | 1¼ | Q | ---- | ---- | N | ---- | Dom. | S.A. |
| 136 | -24aac | Wright and Horner | R. J. McKinnon | 237 | 1957 | Dd | 99 | 12 | Q | ---- | ---- | N | ---- | Irr. | |
| 137 | -25aaa | B. C. Land Co. | -------- | 237 | ---- | Dn | 18 | 1¼ | Q | 3.3 | 12-30-58 | N | ---- | N | |
| 138 | -27cdc | Lois Love | -------- | 232 | 1954 | Dn | 27-40 | 2-2½ | Q | ---- | ---- | C | 200-250 | Irr. | Battery of 5 Wells |
| (41) | -30ccc | H. D. Gibson | -------- | 234 | ---- | Dn | 14 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | P.A. |
| 139 | -31aaa | W. G. Brown | Newman and Williams | 232 | 1955 | Dd | 110? | 12 | Q | 4.5 | 5- 3-55 | T | 1,200 | Irr. | |
| 140 | -33cda | J. A. Pulliam | Lewis Diesel Engine Co. | 229 | 1955 | Dd | 100 | 6 | Q | ---- | ---- | C | 500 | Irr. | |
| 141 | -33dda | Veon Keich | Lawrence Irrigation Co. | 230 | 1957 | Dd | 100 | ---- | Q | ---- | ---- | T | ---- | Irr. | |
| (42) | -36cdd | Aldwin Dryer | -------- | 235 | ---- | Dn | 17 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| (43) | 15N 9E- 6bbb | B. C. Land Co. | -------- | 238 | ---- | Dn | 15 | 1¼ | Q | 7.9 | 12-12-56 | P | ---- | Dom. | S.A. |
| 142 | -19bbb | Jess Horner | R. J. McKinnon | 237 | 1957 | Dd | 107 | 12 | Q | ---- | ---- | C | 2,000 | Irr. | |
| 143 | -19cac | B. C. Land Co. | do | 236 | 1957 | Dd | 102 | 12 | Q | ---- | ---- | T | 2,100 | Irr. | |
| 144 | -20cba | Riley Duncan | do | 235 | 1955 | Ad | 130 | ---- | Q | ---- | ---- | C | ---- | ---- | Log |
| (44) | -21bcc | do | -------- | 239 | ---- | Dn | 18 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 145 | -28bcc | Max Borowski | -------- | 240 | ---- | Dn | 14 | 1¼ | Q | 8.4 | 12-30-58 | N | ---- | N | |
| 146 | -29ccc | Town of Manila | Layne-Arkansas Co. | 236 | 1952 | Dd | 150 | 10 | Q | ---- | ---- | T | 375 | P.S. | Par. A. |
| 147 | -30ddc | D. C. Wright | R. J. McKinnon | 238 | 1954 | Dd | 100 | 12 | Q | ---- | ---- | N | ---- | Irr. | |
| 148 | -31ccc | C. W. Tipton | do | 241 | ---- | Dd | 100 | 4 | Q | ---- | ---- | C | ---- | Irr. | |
| 149 | -31dbb | Town of Manila | Layne-Arkansas Co. | 240 | 1936 | Dd | 1,364 | 6 | Tew | 7.2 | 11- 5-58 | T | 200 | P.S. | Par. A. |
| 150 | 15N10E- 9bcb | S. T. Freeman | -------- | 238 | ---- | Dn | 27 | 1¼ | Q | 4.3 | 12-30-58 | N | ---- | N | |
| (45) | -15ccc | L. D. Rowland | -------- | 240 | ---- | Dn | 29 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 151 | -25add | Leslie Moore | R. J. McKinnon | 246 | 1957 | Dd | 90 | 16 | Q | 7.4 | 4-17-59 | T | 3,000 | Irr. | |
| 152 | -29dca | J. C. Ellis | Newman and Williams | 237 | 1954 | Dd | 118 | ---- | Q | 10.0 | 5-10-55 | T | 1,900 | Irr. | Par. A. |
| 153 | -32bca | M. R. Griffin | do | 236 | 1958 | Dd | 112 | 14 | Q | 7.4 | 4-17-59 | T | ---- | Irr. | |
| 154 | 15N11E- 3ccc | E. B. Gee | Lewis Diesel Engine Co. | 254 | 1954 | Dd | 120 | 12 | Q | 6.4 | 4-17-59 | T | 1,500 | Irr. | |
| 155 | - 6cba1 | U. S. Air Force | Layne-Arkansas Co. | 250 | 1942 | Dd | 1,445 | 10 | Tew | 4.9 | 11- 6-58 | T | 540 | Mil. | P.T. |
| 156 | - 6cba2 | do | do | 250 | 1942 | Dd | 1,313 | 10 | Tew | ---- | ---- | T | 540 | Mil. | |
| 157 | -10ddb | City of Blytheville | do | 255 | 1936 | Dd | 1,430 | ---- | Tew | ---- | ---- | T | 380 | P.S. | |
| 158 | -15bdb2 | Blytheville Water Co. | do | 256 | 1934 | Dd | ---- | 12 | Tew | ---- | ---- | T | 1,800 | P.S. | C.A. |
| 159 | -15bdb3 | do | do | 256 | 1949 | Dd | 1,500 | 12 | Tew | ---- | ---- | T | 1,800 | P.S. | |
| 160 | -15bdb4 | do | do | 255 | 1926 | Dd | 1,468 | 10 | Tew | 12.5 | 11- 6-58 | T | 1,200 | P.S. | Log |
| 161 | -16bdb | Fed. Comp. of Bly. | -------- | 256 | 1938 | Dd | 58 | 4 | Q | 12.3 | 12-29-58 | N | ---- | N | |
| 162 | -17adb | Sani-Soft Co. | -------- | 252 | 1929 | Dd | 1,600 | 6 | Tew | 8.5 | 12- 9-58 | J | ---- | Ind. | |
| 163 | -21dbc | M. B. Nations | -------- | 250 | ---- | Dn | 27 | 1¼ | Q | 16.1 | 12-29-58 | N | ---- | N | |
| (46) | 15N12E- 1bbc | Armorel Planting Co. | -------- | 255 | ---- | Dn | 30 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 164 | - 1bcc | do | Lewis Diesel Engine Co. | 255 | 1955 | Dd | 109 | 14 | Q | 13.1 | 9-14-55 | T | 2,650 | Irr. | |
| 165 | - 2aba | E. M. Regenold | do | 257 | 1957 | Dd | - | ---- | Q | 7.6 | 8-21-57 | T | ---- | Irr. | |
| 166 | - 3ccb | -------- | Benedum-Trees Oil Co. | 267 | 1939 | Dd | 4,535 | ---- | C | ---- | ---- | N | 70 | Ind. | Oil test hole; Log Destroyed. |
| 167 | -10bdc | Amorel Planting Co. | Lewis Diesel Engine Co | 246 | 1954 | Dd | 100 | 14 | Q | ---- | ---- | N | 3,000 | Irr. | |
| 168 | -12dbb | Bert Hardesty | Lawrence Irrigation Co. | 251 | 1957 | Dd | 101 | 8 | Q | ---- | ---- | C | 500 | Irr. | |
| 169 | -12dca | P. F. McCutcheon | do | 251 | 1957 | Dd | 105-110 | 10 | Q | ---- | ---- | C | ---- | Irr. | |
| 170 | -15aba | Armorel Planting Co. | Layne-Arkansas Co. | 250 | ---- | Dd | ---- | 16 | Q | ---- | ---- | ---- | ---- | ---- | |
| 171 | -15cba1 | do | Lee Wilson and Co. | 255 | 1941 | Dd | 1,393 | ---- | Tew | ---- | ---- | ---- | ---- | P.S. | Destroyed. Log |

**TABLE 11—Continued**
Record of Wells in Mississippi County, Ark.

| Well No. | Location designation | Owner | Driller | Altitude above sea level (feet) | Date of well completion | Type of well | Depth of well (feet) | Diameter of well (inches) | Stratigraphic unit | Depth to water below land surface (feet) | Date of water-level measurement | Type of pump | Well yield (gpm) | Use | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172 | 15N12E-15cba2 | Amorel Planting Co. | Carloss Well Supply Co. | 255 | 1958 | Dd | 1,460 | 6 | Tew | 13.5 | Aug. 58 | T | ---- | P.S. | |
| 173 | -15cba3 | do | do | 255 | 1958 | Dd | 100 | 4 | Q | ---- | ---- | J | ---- | P.S. | |
| 174 | -18acb | do | Lewis Diesel Engine Co. | 257 | 1955 | Dd | 130? | 12 | Q | ---- | ---- | T | 1,800 | Irr. | |
| (47) | -22baa | M. A. Crigger | -------- | 256 | ---- | Dn | 35 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| (48) | -34caa | Golda Regenold | -------- | 252 | ---- | Dn | 24 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 175 | 15N13E- 5bbb | George Cassidy | -------- | 254 | ---- | Dn | 40 | ---- | Q | 16.1 | 12-29-58 | P | ---- | N | |
| 176 | - 7bbd | Weldon McCann | Lawrence Irrigation Co. | 254 | 1957 | Dd | 100 | ---- | Q | ---- | ---- | N | ---- | Irr. | |
| 177 | - 9ddd | Grier Moore | do | 257 | 1956 | Dd | 100 | 8 | Q | ---- | ---- | N | ---- | Irr. | |
| 178 | -15cdc | -------- | -------- | 255 | ---- | Dn | 32 | 1¼ | Q | 30.1 | 12- 6-55 | N | ---- | N | |
| (49) | -15ddd | W. T. Barnett | -------- | 255 | ---- | Dn | 32 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 179 | 16N 8E-20bba | Veon Keich | Lawrence Irrigation Co. | 240 | 1957 | Dd | 100 | 10 | Q | ---- | ---- | N | 1,000 | Irr. | |
| 180 | -20cdc | do | Dudley Bros. | 240 | 1957 | Dd | 105 | 12 | Q | 5.3 | 7-23-57 | T | 1,850 | Irr. | |
| (50) | -22abb | C. E. Cagle | -------- | 240 | ---- | Dn | 21 | 1¼ | Q | 6.7 | 12-30-58 | P | ---- | Dom. | S.A. |
| 181 | -31ccc1 | Don Markin | -------- | 239 | ---- | Dn | 20 | 1¼ | Q | 8.1 | 12-30-58 | N | ---- | Dom. | Destroyed |
| (51) | -31ccc2 | do | -------- | 239 | ---- | Dn | 21 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 182 | -32acb | Paul Carter | Newman and Williams | 241 | 1955 | Dd | 116 | 12 | Q | 8.9 | 9-12-55 | T | ---- | Irr. | |
| 183 | 16N 9E-21bbc | T. J. Rauls | Gordon Drilling Co. | 244 | 1955 | Dd | 60-70 | 6 | Q | ---- | ---- | C | 700 | Irr. | |
| 184 | -21cdd | Solon Davis | -------- | 241 | ---- | Dn | 16 | 1¼ | Q | 6.0 | 12-30-58 | N | ---- | Dom. | |
| (52) | -21bac | W. M. Langdon | -------- | 241 | ---- | Dn | 15 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 185 | -30adc | T. Marshall | R. J. McKinnon | 240 | 1957 | Ad | 85 | 4 | Q | ---- | ---- | C | ---- | Irr. | |
| 186 | -31aba | C. B. Neel | Baker Irrigation Co. | 240 | 1957 | ---- | 120 | 10 | Q | ---- | ---- | C | ---- | Irr. | |
| 187 | 16N10E-26add | B. Pruitt | -------- | 243 | ---- | Dn | 29 | 1¼ | Q | 5.4 | 12-30-58 | N | ---- | N | |
| (53) | -31add | Y. S. Simmons | ——— | 235 | ---- | Dn | 26 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 188 | -32add | Earl Rodgers | -------- | 237 | ---- | Dn | 21 | 1¼ | Q | 2.7 | 12-30-58 | N | ---- | N | |
| (54) | -36acc | C. F. Cooper | -------- | 245 | ---- | Dn | 31 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| (55) | 16N11E-22abb | G. W. Dillahunty | -------- | 253 | ---- | Dn | 32 | 1¼ | Q | 10.2 | 12-29-58 | P | ---- | Dom. | S.A. |
| 189 | -22aca | do | Lawrence Irrigation Co. | 253 | 1955 | Dd | 110 | 12 | Q | ---- | ---- | T | 2,000 | Irr. | |
| (56) | -36ddd | M. L. Warren | -------- | 256 | ---- | Dn | 39 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| (57) | 16N12E-20add | G. E. Keck | -------- | 252 | ---- | Dn | 31 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | Pre. A. |
| 190 | -24cca | Tom Rayder | Valley Drilling Co. | 255 | 1955 | Dd | 100 | ---- | Q | 12.4 | 12-13-55 | T | 1,900 | Irr. | Par. A.; Log |
| 191 | -30bbd | L. M. Gaines | Lawrence Irrigation Co. | 255 | 1956 | Dd | 100 | 8 | Q | ---- | ---- | N | 650 | Irr. | |
| 192 | -32bdd | Armorel Planting Co. | Lewis Diesel Engine Co. | 258 | 1955 | Dd | 140 | 10 | Q | ---- | ---- | T | 2,700 | Irr. | |
| 193 | 16N13E-19bcd | J. W. Rayder | Valley Drilling Co. | 257 | ---- | Dd | ---- | ---- | Q | 10.2 | 5-10-55 | T | ---- | Irr. | |
| 194 | -19caa | Mrs. R. H. Green | Lawrence Irrigation Co. | 256 | 1956 | Dd | 90-95 | 6 | Q | ---- | ---- | C | 450 | Irr. | |
| (58) | -19cdd | R. H. Green, Jr. | -------- | 256 | ---- | Dn | 23 | 1¼ | Q | ---- | ---- | P | ---- | Dom. | S.A. |
| 195 | -29bca | R. H. Green | Lawrence Irrigation Co. | 257 | 1956 | Dd | 100 | 8 | Q | ---- | ---- | C | 450 | Irr. | |
| 196 | -30acd | do | do | 256 | 1956 | Dd | 100 | 10 | Q | ---- | ---- | C | 450 | Irr. | |
| 197 | -30bcb | Paul Green | do | 255 | 1956 | Dd | 100 | 12 | Q | ---- | ---- | N | 1,600 | Irr. | |
| 198 | -30bdd | Grier Moore | do | 254 | 1956 | Dd | 100 | 8 | Q | ---- | ---- | N | 650 | Irr. | |
| 199 | -30cab | do | do | 254 | 1956 | Dd | 100 | 8 | Q | ---- | ---- | C | 650 | Irr. | |

reported to be 75 gpm. To meet the water needs of about 14 homes, a school, a gin, and a store, about 12,000 gpd is reported to be pumped from this well. The water is pumped from the well into the treatment plant where the water is aerated. The water accumulates in an overflow tank and is then pumped into two filter tanks and from these into an outside pressure tank with a capacity of about 3,750 gallons.

**Dell**

The water supply of Dell is obtained from a 1,275-foot well (14N10E-5ddd) owned by the Dell Compress Co. The well is screened in the Wilcox formation and is equipped with an electrically powered turbine pump. The town of Dell reportedly uses about 20,000 gpd. The water is pumped from the well either into a 150,000-gallon reservoir for boiler use of the Dell Compress Co., or into a 100,000-gallon overhead storage tank. Of the total capacity of this tank, 90,000 gallons is kept in reserve for fire protection at the compress and 10,000 gallons is available for use in the town of Dell. The water is treated with sodium hexametaphosphate and calcium hypochlorite. A comprehensive analysis of raw water from well 14N10E-5ddd is shown in table 15.

**Driver**

The community of Driver obtains water from two wells owned by Lowrance Brothers and Co. Well 12N10E-34cad2 is 1,535 feet deep and is screened in the Wilcox formation. The well is equipped with an electrically powered turbine pump and has a reported yield of 100 gpm. A rough estimate of daily pumpage from this well is 15,000 gallons. The water is untreated and is pumped directly into a 1,000-gallon pressure tank. An older well (12N10E-34cad1), which is 1,500 feet deep, also is screened in the Wilcox formation but is used exclusively as a standby well.

**Dyess**

Dyess obtains its water supply from a well reportedly 2,200 feet deep. The well (11N8E-10adb) is equipped with an electrically driven turbine pump and yields about 200 gpm. The estimated daily superfluous pumpage is 25,000 gallons. The water receives no treatment and is pumped directly into a ground storage tank which has a capacity of 800 gallons.

**Joiner**

The town of Joiner has a publicly owned well (10N9E-8aba) which is 95 feet deep. The well is equipped with an electrically powered turbine pump and yields about 250 gpm. Water is withdrawn at an average daily rate of about 96,000 gallons from the Quaternary aquifer. When the water is pumped from the well it is aerated by the entrance of air into the system from an air compressor. The water is then treated with lime and calcium hypochlorite, whereupon it enters two filter tanks. The water is pumped from the filter tanks into the water main and into an 8,000-gallon ground storage tank which is used for backflushing or for emergencies.

**Keiser**

The town of Keiser obtains its water supply from two publicly owned wells. One well (12N9E-11dbb1) is 1,420 feet deep and is screened in the Wilcox formation. The well is equipped with an electrically driven turbine pump and has a reported yield of 750 gpm. A second well (12N9E-11dbb2) is 72 feet deep, is screened in the Quaternary aquifer, and has an electrically driven jet pump. The well yields a measured 63 gpm, and is used only in emergencies. The water is not treated and is pumped directly from the deep well into an elevated storage tank of about 50,000-gallon capacity, or directly into the main. A comprehensive analysis of raw water from well 12N9E-11dbb1 is shown in table 15.

**Leachville**

The town of Leachville obtains water from two wells owned by the town. The supply well (15N8E-8dbc1) is 1,083 feet deep; the standby well (15N8E-8dbc2) is 120 feet deep. The deep well is screened in the Wilcox formation and is used to meet the normal water requirements of the town, and the relatively shallow well is screened in the Quaternary aquifer and is used only in an emergency. Both wells have electrically driven turbine pumps. The supply well yields 135 gpm, and the standby well yields 350 gpm. When the water is pumped from either well, it is first treated with lime and then passed into the filter from which it is pumped either into the water main or into an elevated storage tank of 100,000-gallon capacity. The average daily pumpage is estimated to be about 52,000 gallons. A comprehensive analysis of raw water from well 15N8E-8dbc1 is shown in table 15, and a partial analysis of raw water from well 15N8E-8dbc2.

**Luxora**

The water supply of the town of Luxora is obtained from two wells owned by the town.

Both wells are about 1,500 feet deep and are screened in the Wilcox formation. Equipped with electrically driven turbine pumps, the wells yield a reported 250 gpm each. Well 13N11E-8dda is used almost exclusively to supply the town with water, whereas well 13N11E-9cbc is used in emergencies. A reported 60,000 gallons is pumped daily. The water is withdrawn from the supply well and aerated. Under gravity flow the water collects in a 30,000-gallon concrete reservoir where it is chlorinated and then pumped through the filtering system into an elevated tank of 100,000-gallon capacity. Water from the standby well is pumped directly into a 50,000-gallon ground storage tank and is treated with hypochlorite. The comprehensive analysis of raw water from well 13N11E-8dda is shown in table 15.

**Manila**

The town of Manila obtains water from two publicly owned wells. One well (15N9E-31dbb) is 1,364 feet deep and furnishes water for the principal needs of the town. This well, which is screened in the Wilcox formation, has an electrically powered turbine pump and yields a reported 200 gpm. The second well (15N9E-29ccc), which is 150 feet deep, is screened in the Quaternary aquifer and is equipped with an electrically powered turbine pump. Although the principal purpose of this well is to furnish water for the municipal swimming pool, the water from the well can be pumped into the city mains in case of fire. The yield of this second well is 375 gpm. About 125,000 gpd is pumped from the deep well during the winter months and from 200,000 to 250,000 gpd during the summer. The water is pumped from well 15N9E-31dbb to the treatment plant where it is aerated, filtered, and collected in a subsurface reservoir of 55,000-gallon capacity. The water is then chlorinated as it is pumped into the water mains or into the 50,000-gallon elevated storage tank. A partial analysis of raw water from each well is shown in table 15.

**Osceola**

The city of Osceola has three publicly owned wells which range in depth from about 1,400 to 1,500 feet. All three wells are screened in the Wilcox formation and are equipped with electrically driven turbine pumps. Two wells (13N10E-36acd1 and 13N10E-36acd2 each yield 440 gpm, and the third well (13N10E-36acd3) yields 640 gpm. The water from these wells is aerated by means of a spill system and is then pumped into a settling tank, where it is chlorinated, and alum and clay are added. From the settling tank the water passes into the filtering system. After filtration the water is treated with lime and is then pumped into a 300,000-gallon ground storage tank. Water is then pumped from this tank into an elevated service tank of about 75,000-gallon capacity. The wells yield from about 550,000 gpd in the fall and winter to about 1,000,000 gpd in the summer. A comprehensive analysis of raw water from well 13N10E-36acd1 and a partial analysis of raw water from well 13N10E-36acd2 are shown in table 15.

**Victoria**

The community of Victoria, which is 7.5 miles directly west of Luxora, obtains water from a well (13N10E-18aab) owned by F. L. Wesson. The well is 1,417 feet deep and is screened in the Wilcox formation. Equipped with an electrically powered turbine pump, this well yields 75 gpm. However, the well has a natural flow of 3.8 gpm and is the only well in the Wilcox formation in Mississippi County that is known to flow. Total daily discharge from well 13N10E-18aab is about 30,000 gallons. The water is pumped over a spill system for aeration, and under gravity flow accumulates in a settling compartment of a concrete ground reservoir. From the settling compartment the water passes into the filter compartment which is filled with gravel. From the reservoir the water is pumped into a ground pressure tank of about 1,000-gallon capacity. The well is fitted with an overflow pipe to allow this flowing well to discharge when the pump is not in operation.

**Wilson**

The town of Wilson obtains water from two wells owned by the Lee Wilson Co. Well 11N10E-20aaa1 is 1,485 feet deep and yields about 325 gpm. Well 11N10E-20aaa2 is 1,567 feet deep and yields about 360 gpm. Both wells are equipped with electrically driven turbine pumps and are screened in the Wilcox formation. The combined pumpage from both wells is about 75,000 to 100,000 gpd. When the water is pumped from the wells, it either goes directly into the mains or into the elevated tank which has a capacity of 100,000 gallons. The water is untreated. A comprehensive analysis of water from well 11N10E-20aaa2 is shown in table 15.

## Domestic Supplies

Many wells in the area furnish water for domestic use to about 52,500 people. The estimated average rate of pumping for all domes-

tic use from these privately owned wells is about 0.5 mgd. Most of the wells, 1¼ inches in diameter, are driven into the upper part of the Quaternary deposits and cased with galvanized iron pipe. They are equipped predominantly with hand pumps. There are a few domestic wells screened in the Wilcox formation. No dug wells have been found in the county.

### Irrigation Supplies

There are about 110 irrigation wells in Mississippi County. In 1957 they were pumped at a rate of about 6.2 mgd, averaged over the year, for the irrigation of rice and the supplemental irrigation of row crops. The well yields range from a reported 300 gpm to a reported 3,000 gpm. Measured and reported well yields are shown in table 11.

## Possibilities of Further Development Of Ground Water

The utilization of ground water from the several fresh-water aquifers can be increased throughout Mississippi County.

The deepest potential source of ground water in the report area is an unproved aquifer composed of sediments of Cretaceous age which probably would yield fresh water in the northern part of the county. The evidence supporting this conclusion is presented under the section titled "Mesozoic Rocks."

The estimated pumpage from about 30 wells screened in the Wilcox formation averages 5.4 mgd. No enclosed depressions are developed on the piezometric surface other than those which naturally are formed adjacent to pumping wells. Nonpumping water levels range from 3.3 feet above land surface to 15.3 feet below land surface. Well yields range from a flowing rate of 3.8 gpm to a pumping rate of 1,800 gpm. The Wilcox formation is not being overdeveloped in the report area at the present time (1957).

The water-bearing deposits of Claiborne age are presently being utilized to a slight degree, as only one well is known to be screened in this stratigraphic unit. With a quality of water intermediate between that commonly obtainable from the Quaternary deposits and that of the Wilcox formation, and with well yields comparable to those in the Wilcox formation, the Claiborne group is an important potential source of additional ground water in Mississippi County.

The estimated pumpage from about 110 irrigation wells screened in the Quaternary deposits averages 6.2 million gpd. No permanently enclosed depressions are developed on the water table, although temporary cone-shaped depressions form adjacent to pumping wells. Water levels range from about 1.5 feet to about 28 feet below land surface. Well yields range from about 300 gpm to a reported 3,000 gpm. The Quaternary deposits are not being overdeveloped in the report area at the present time (1957).

## Chemical Quality of Ground Water

Pure water is odorless, tasteless, and colorless; but because of its high solvent powers, pure water does not exist in nature. Even freshly fallen rain, collected under conditions that exclude contamination, is not pure since it contains dissolved gases and dust from the atmosphere. One such gas, carbon dioxide, increases the solvent power of water. When rainwater falls on soil and rock, contact and infiltration result in immediate solvent action. The amount and character of the material dissolved depend upon a number of factors, a major one being the solubility of the minerals of the soil and rock through which the water is percolating.

The chemical composition of water is an important factor in determining its suitability for particular uses. Our ideas as to what constitutes pure water may differ according to the uses we have in mind for the water. The chemist generally thinks of water as being 100 percent $H_2O$. The health department thinks primarily in terms of water lacking bacterial contamination and having a mineral composition not exceeding various empirical maxima for a number of different chemical constituents. Industrialists think of pure water as water containing none of the dissolved or suspended substances which would be harmful in the manufacturing process involved. Hard water or water high in iron content cannot be used satisfactorily in laundries. Where steam is generated there should be no constituents in the water that would form boiler scale or corrosion. The suitability of water thus depends upon the particular use to which it is to be put.

### Chemical Quality in Relation to Use

The following discussion of the chemical constituents in relation to use was adapted from publication of the U. S. Geological Survey and is restricted to those constituents given in tables 15 and 17.

**Silica ($SiO_2$)**

Silica is by far the most abundant rock material composing the water-bearing formations of Mississippi County. However, because it is relatively insoluble, only small quantities of silica are found in the natural waters that occur in the formations. For most domestic and irrigation purposes, silica is not a critical constituent. However, for use in high-pressure boilers a low silica content is necessary in order to avoid the formation of hard boiler scale.

**Iron (Fe)**

Iron is dissolved from many rocks and soils and from pipes through which the water is pumped and distributed. It occurs as a minor cation in most ground water; but, because of the low tolerances of iron for most uses of water, even these relatively small quantities often exceed the limits desired—0.3 ppm of iron and manganese together for drinking water and even lower for some industrial uses.

Excessive amounts of iron in water may cause discoloration of a variety of materials. Common examples of this process of staining are the reddish deposits which accumulate on water buckets, porcelain and enamel ware, and clothing. Iron precipitating out of water from irrigation wells frequently discolors the banks of the distribution canals; coffee, tea, and various foods become discolored when prepared with such water. Water of high iron content may reduce the effective operation of silicate water softeners. Many industrial processes require water of very low iron content.

Aeration and filtration readily remove iron from most waters. It is common practice in rural areas to treat well water with lime.

Objectionable quantities of iron are most likely to occur in water from wells in the Quaternary deposits. The amount of iron carried in solution varies greatly—from well to well and from time to time in the same well. For these reasons, a special effort was made in Mississippi County to determine how the iron content of water in shallow wells varies with geographic location, depth, time, and other factors. The results of this study are discussed in a following section of this report.

**Calcium (Ca) and magnesium (Mg)**

Calcium is found in all natural waters and may occur in large quantities in water that is in contact with limestone, dolomite, and gypsum. Magnesium is dissolved from many rocks, particularly dolomitic rocks. Together they cause most of the hardness in water. These two ions react with soap to form an objectionable scum, and they are largely responsible for the formation of boiler scale.

**Sodium (Na) and potassium (K)**

Sodium and potassium, like calcium and magnesium, are common and widely distributed elements in rocks and soils. Consequently, all natural waters contain some sodium and potassium, but in ground waters the principal cation is generally calcium unless the calcium has been exchanged for sodium in clays and other minerals with which the water comes in contact.

The fitness of water for most industrial or domestic uses is not affected by moderate amounts of sodium and potassium, though quantities larger than 50 ppm may cause foaming in steam-boiler operation. For high-pressure-boiler feed water, a concentration of not more than 2 to 3 ppm has been recommended. Good irrigation water should not contain sodium in a concentration greater than 50 to 60 percent of the cations on an equivalent basis.

**Bicarbonate ($HCO_3$) and carbonate ($CO_3$)**

Some carbon dioxide dissolves in meteoric water during condensation and precipitation. The presence of this carbon dioxide causes the water to become weakly acidic and enables it to dissolve carbonate rocks forming calcium and magnesium bicarbonate. Thus, bicarbonate is present in most natural waters. Moderate concentrations of bicarbonate do not affect the water for most uses, but sodium bicarbonate in large quantities causes foaming and priming in boilers. Carbonate is absent from, or present in only very small quantities, in most natural waters.

**Sulfate ($SO_4$)**

Sulfate is dissolved by ground water from gypsum and other sulfate minerals and from the oxidation products of sulfide minerals. The presence of large amounts of sulfate in water makes it unpalatable, and it combines with calcium to form hard boiler scale.

**Chloride (Cl)**

Chloride may occur in ground water in large quantities because the chloride salts of calcium, magnesium, potassium, and sodium are extremely soluble. Drinking water with chloride present in amounts exceeding 250 to 300 ppm has a salty taste. Large quantities

of chloride may affect the industrial use by increasing the corrosiveness of waters that contain large amounts of calcium and magnesium or sodium or potassium. High concentrations of chloride may be harmful to irrigated crops, especially on poorly drained soil.

**Fluoride (F)**

The occurrence of fluoride in ground water is of considerable importance in domestic and public water supplies. When fluoride is present in drinking water in quantities of about 1.0 ppm, the incidence of dental cavities is effectively reduced in children. However, when the concentration of fluoride exceeds 1.5 to 2.0 ppm, teeth may develop a permanent defect known as mottled enamel when the water is consumed by children during the formation of their permanent teeth (Dean, 1938).

**Nitrate ($NO_3$)**

Nitrate usually occurs in minor quantities in ground water. When it is present in excessive amounts, contamination by sewage or other organic matter may be suspected, as nitrate represents the final stage of oxidation in the nitrogen cycle. Infant cyanosis may be caused by water containing more than 45 ppm of nitrate, and such water should be considered unsafe for infant feeding (Metzler and Steltenberg, 1950). Nitrate is a minor constituent in almost all the ground waters of Mississippi County. However, one shallow well in deposits of Quaternary age had a nitrate content of 80 ppm. This would indicate pollution by sewage or fertilizer, which is more common in shallow wells than in deep wells.

**Dissolved solids**

In analyzing water for its chemical constituents, such as those listed above, the total amount of mineral matter that becomes dissolved in the water in its passage through the rocks also is determined and is indicated as dissolved solids.

Dissolved solids represent not only mineral matter in solution, but also whatever quantities (usually small) of organic matter and water of crystallization that may be present.

Water containing less than 500 ppm of dissolved solids is generally satisfactory for most domestic and many industrial uses, providing the hardness is low and the dissolved iron and manganese do not occur in excessive amounts. Water containing 1,000 ppm of dissolved solids usually contains excessive amounts of some chemical constituents which would impart taste or make it unsuitable for domestic uses. Water containing more than 2,000 ppm may be unsuitable for irrigation, depending upon soil composition, the type of crops grown, the quantity and proportions of the various constituents present in the water, and the drainage conditions.

**Hardness**

Hardness of natural waters is caused principally by compounds of calcium and magnesium, although free hydrogen and metals such as compounds of iron, manganese, and aluminum also contribute to hardness. If there is enough bicarbonate and carbonate in the water to balance all the hardness-producing cations, the hardness is called carbonate hardness. However, if there are some hardness-producing ions left over they produce what is called noncarbonate hardness. Carbonate hardness is also called temporary hardness, as it can be largely removed by boiling the water. Noncarbonate hardness cannot be removed by boiling and thus is referred to as permanent hardness. The hardness is an important factor in determining the suitability of water for domestic and industrial uses.

The most conspicuous property of hard water is its twofold effect on soap. First, more soap is required to make a lather, and second, an insoluble scum is formed as a result of the calcium and magnesium ions reacting with the negative ions of the soap to form insoluble precipitates. Therefore the soap cannot form a lather until all the calcium or magnesium ions present have reacted with the soap.

Upon being heated, hard water deposits a scale in various water containers, such as boilers and pipes, causing decreased heat transference and decreased water flow by constricting pipe openings.

There is some variation in the literature in classifying the hardness of water in terms of calcium carbonate content. The U. S. Geological Survey generally uses the following classification:

| Total hardness as $CaCO_3$ (in ppm) | Designation |
|---|---|
| 0 — 60 | Soft |
| 60 — 120 | Moderately hard |
| 120 — 200 | Hard |
| More than 200 | Very hard |

**Specific conductance**

The chemical constituents dissolved in water enable the solution to conduct electricity, the

water. The water contained 51 ppm of calcium, 240 ppm of bicarbonate, and 219 ppm of dissolved solids. The iron content of the ground water obtained from this well, which is screened in the upper part of the deposits of Claiborne age, is high—5.2 ppm. The water had a hardness of 184 ppm. The field-determined pH was 6.0; the laboratory-determined pH was 6.8. The temperature was 62°F.

The only other data available regarding the quality of water in the Claiborne group in Mississippi County are in the report by Stephenson and Crider (1916, pl. XI), which shows the field assay of a water sample collected in May 1905 from a 440-foot well at Osceola. This assay, admittedly less accurate than a laboratory analysis, shows the iron content to be 6 ppm; carbonate, 0 ppm; bicarbonate, 143 ppm; sulfate, 0 ppm; chloride, 20 ppm; and total dissolved solids, 180 ppm.

Although specific data are meager on the quality of water of the Claiborne group in Mississippi County, additional information is available on adjacent areas which may be suggestive of this quality in the northern, western, and southern parts of the county. At Steele, Mo., 6 miles north of Mississippi County, a well 321 feet deep is screened in the upper part of the Claiborne group and yields a moderately hard iron sodium bicarbonate water. The iron content (26 ppm) causes most of the hardness in this water. At Jonesboro, Ark., 24 miles west of Mississippi County, 2 wells, 235 and 240 feet deep, yield soft to moderately hard calcium bicarbonate water of very low iron content. To the south, at West Memphis, Ark., about 21 miles south of Mississippi County, a well 356 feet deep, and also screened in deposits of Claiborne age, yields moderately hard calcium bicarbonate water which is relatively low in iron content. Chemical analyses of these waters are given in table 14.

Figure 17 is a bar diagram illustrating the chemical characteristics of ground water from the Cretaceous deposits, the Wilcox formation (Tew), the Claiborne group (Tec), and the Quaternary deposits. The sample from the Claiborne group in Mississippi County is similar in quality to the water from the Quaternary deposits.

The available information concerning the quality of water from the Claiborne group is thus restricted to a few samples collected from the upper part of this group. The water sampled from the only well in Mississippi County known to be screened in the group is generally of better quality than that of the Quaternary aquifer. However, too few data are available for drawing general conclusions as to the quality of water obtainable from the entire thickness of sand beds in the Claiborne group or even from the shallower part of the group in Mississippi County.

### Quaternary deposits

**General characteristics.** — The Quaternary deposits of Arkansas characteristically contain a hard calcium bicarbonate water. Without exception, the water samples collected from 58 shallow domestic wells and 18 deep irrigation and municipal wells in this aquifer throughout Mississippi County are of the same type. In general, water from the Quaternary deposits is high in iron and very hard, but there are in some places shallow wells which constantly yield moderately hard water of low iron content.

The 18 irrigation and municipal wells range in depth from 100 to 150 feet. The calcium content of samples from these 18 wells ranged from 33 to 132 ppm; the bicarbonate, from 135 to 567 ppm; and dissolved solids, from 166 to 630 ppm. The iron content is high, with a minimum of 1.1 ppm and a maximum of 26 ppm. The laboratory-determined values of pH of the samples ranged from 6.8 to 8.2. The temperature averaged 62°F with a maximum of 63° and a minimum of 61°F.

The sampling of water from the 58 shallow domestic wells is discussed below.

**Variation of iron and hardness.**—The chemical quality of water from the Quaternary deposits is satisfactory except with respect to iron content and hardness. To obtain additional information concerning the variation and distribution of iron and hardness, a large part of the water sampled from this important aquifer was for special analysis in which total iron, total hardness, specific conductance, and pH were determined.

The study of the variation of iron and hardness had two objectives. The first was to determine the geographic distribution of the various concentrations of these critical constituents in samples collected on a countywide basis, regardless of well depth, during a period of relatively low water levels. The second objective was to determine the possible effects on the concentration of iron and hardness by the addition of water to the aquifer during a

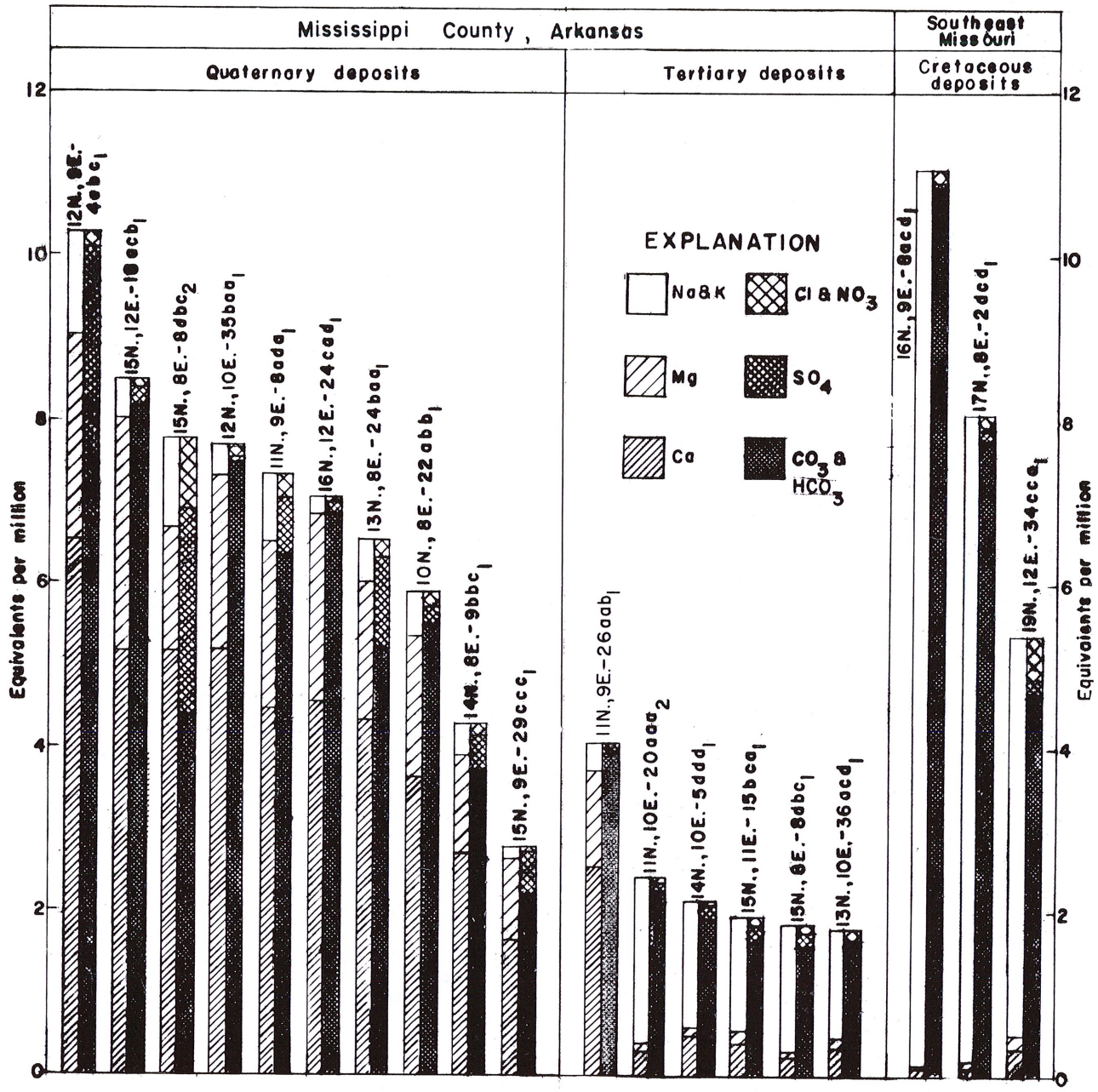



Figure 17.—Bar diagram illustrating chemical characteristics of ground water from the several aquifers.

period of recharge. This determination involved collecting samples during a period of relatively static conditions and during or immediately after a period of major recharge.

The 130 water samples collected for this study were taken from 58 domestic wells of 1¼-inch diameter, ranging in depth from 13 to 72 feet below land surface. The distribution of wells in relation to their depth is as follows:

| Well depths (feet) | Number of wells |
|---|---|
| 13 - 15 | 4 |
| 16 - 20 | 8 |
| 21 - 25 | 11 |
| 26 - 30 | 10 |
| 31 - 35 | 12 |
| 36 - 40 | 2 |
| 41 - 45 | 6 |
| 46 - 50 | 2 |
| 51 - 55 | 0 |
| 56 - 60 | 2 |
| 61 - 65 | 0 |
| 66 - 70 | 0 |
| 71 - 72 | 1 |

Field methods were used to determine the pH of the samples. A slide comparator with permanent colored standards was found to be satisfactory for use under field conditions and field determinations of pH were made on 49 of the 130 water samples collected. Water-temperature measurements were made at the time of sampling. In table 15 are tabulated the results of determinations of iron, hardness, and temperature of water sampled in the summer and fall of 1956 and in the spring of 1957 from the 58 wells.

Figure 18 consists of two maps showing the geographical distribution of iron and hardness in Mississippi County. Admittedly, both maps are generalized. The specific or even the approximate iron content or hardness of water obtainable from the shallower part of the Quaternary aquifer should not be inferred from these maps, since it is to be expected that considerable variation occurs from one location to another and in the same location. However, the maps do show the areal distribution of iron as based upon the particular 58 wells sampled. The geographic distribution of iron is based on analyses of samples collected in the summer and fall of 1956 during a period of relatively static water-table conditions. The range inter-

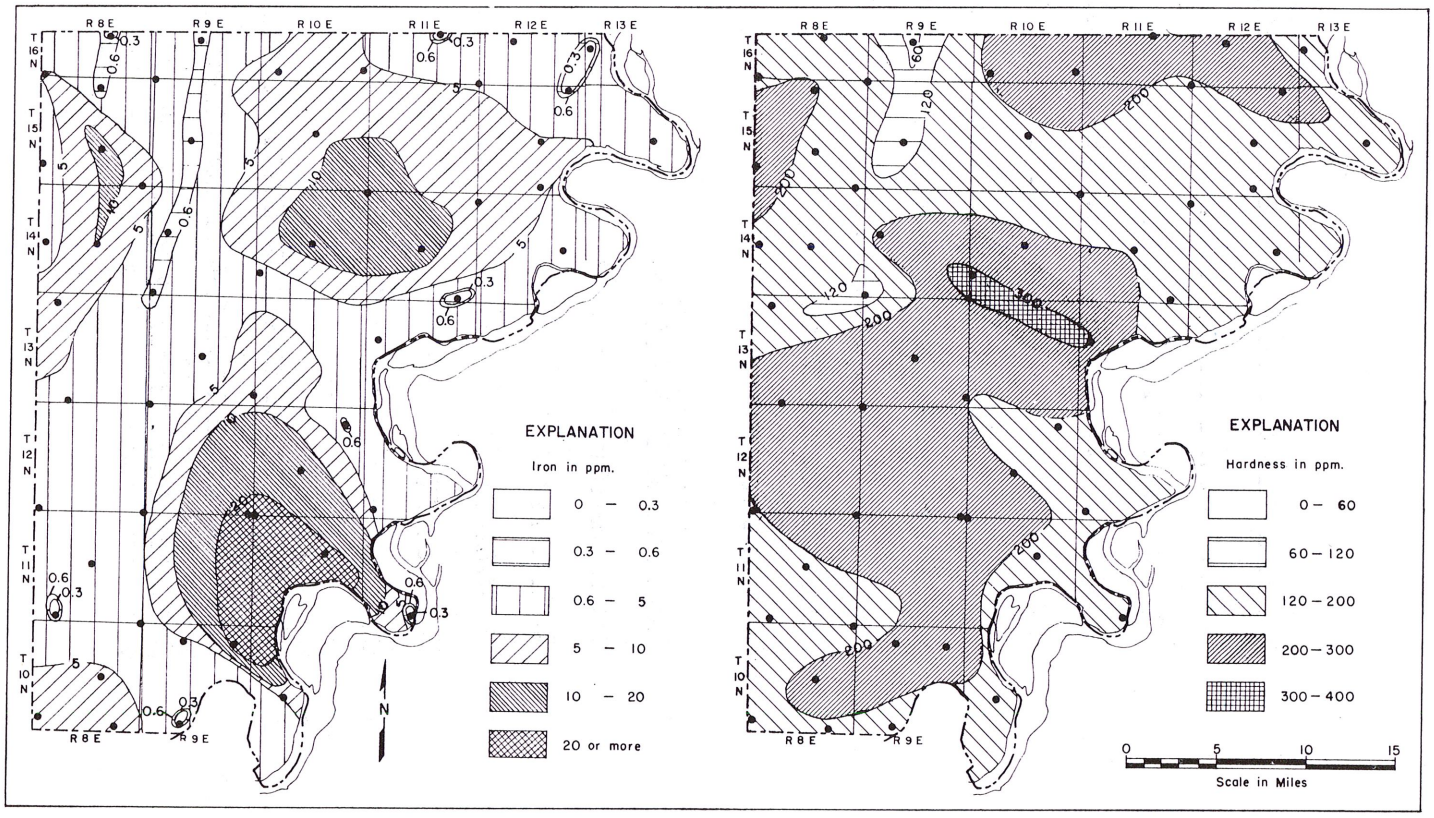



**Figure 18.—Maps showing the generalized geographical distribution of iron content and harness of water samples collected in the summer and fall of 1956 from wells in the Quaternary deposits.**

Chemical analyses of water from wells in Mississippi County, Arkansas, and in adjacent parts of Arkansas and Missouri

(In parts per million except percent sodium, specific conductance and pH)

| Location designation | Owner | Depth (feet) | Date of collection | Temperature (°F) | Silica ($SiO_2$) | Iron (Fe) (total) | Calcium (Ca) | Magnesium (Mg) | Sodium (Na) | Potassium (K) | Bicarbonate ($HCO_3$) | Carbonate ($CO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Dissolved Solids | Hardness as $CaCO_3$ Total | Hardness as $CaCO_3$ Non-Carbonate | Percent sodium (%Na) | Specific Conductance (micromhos at 25°C) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Quaternary deposits** | | | | | | | | | | | | | | | | | | | | | | |
| 3E -17caa | C. L. Denton, Sr. | 123 | 8-17-55 | 63 | — | 10 | 81 | 20 | 14 | — | 0 | 349 | 13 | 6.5 | — | 0.1 | 332 | 284 | 0 | 10 | 550 | 7.6 |
| 22abb | W. J. Denton | 120 | 6- 7-56 | 62 | 18 | 1.1 | 73 | 21 | 9.8 | 2.2 | 0 | 344 | 4.8 | 4.0 | 0.1 | 1.7 | 331 | 268 | 0 | 7 | 498 | 8.2 |
| )E - 5abb | Lee Wilson and Co. | 115 | 8-17-55 | 63 | — | 8.7 | 83 | 28 | 27 | — | 0 | 324 | 96 | 14 | — | .0 | 435 | 322 | 56 | 15 | 685 | 7.9 |
| 8dba | do | 120 | 6-12-57 | 63 | 9.2 | 8.5 | 89 | 24 | 20 | 2.8 | 0 | 388 | 34 | 7.0 | .0 | 2.0 | 399 | 320 | 2 | 12 | 617 | 8.1 |
| 10E-11dca | J. E. Crain | 116 | 8-17-55 | 63 | — | 26 | 132 | 33 | 13 | — | 0 | 567 | 6.6 | 4.0 | — | 9.1 | 503 | 465 | 0 | 6 | 841 | 6.9 |
| 3E - 8bcb | H. B. Richardson | 105 | 8-17-55 | 62 | — | 14 | 94 | 24 | 8.5 | — | 0 | 356 | 42 | 7.0 | — | .2 | 389 | 333 | 42 | 5 | 609 | 6.8 |
| 9E - 4abc | Jane Bolton | 100 | 8-17-55 | 62 | — | 6.2 | 131 | 30 | 30 | — | 0 | 414 | 155 | 7.5 | — | .4 | 630 | 450 | 112 | 13 | 887 | 6.9 |
| 14acb | Lee Wilson and Co. | 108 | 8-17-55 | 63 | — | 4.1 | 101 | 24 | 18 | — | 0 | 358 | 71 | 9.0 | — | 2.0 | 443 | 350 | 57 | 10 | 687 | 7.2 |
| 10E-35baa1 | H. F. Ohlendorf | 100 | 10- 5-56 | 61 | — | 23 | 104 | 26 | 9.0 | — | 0 | 455 | 6.0 | 2.5 | — | 8.2 | 452 | 366 | 0 | 5 | 681 | 7.8 |
| 3E -24baa | W. S. Cockerham | 114 | 6-14-56 | 62 | — | 1.2 | 87 | 21 | 11 | — | 0 | 313 | 48 | 5.2 | — | .8 | 364 | 304 | 47 | 7 | 560 | 7.3 |
| 9E -30ccc | L. Woodard | 102 | 6-11-57 | 62 | 9.7 | 7.8 | 98 | 31 | 7.3 | 1.6 | 0 | 428 | 32 | 3.8 | .0 | .9 | 402 | 372 | 21 | 4 | 671 | 7.2 |
| 3E - 9bbc | Earl H. Wildy | 118 | 8-16-57 | — | — | 7.3 | 53 | 15 | 9.3 | — | 0 | 226 | 22 | 3.0 | — | .1 | 250 | 194 | 9 | 9 | 387 | 8.0 |
| 10E-18dbb | R. A. Greenway | 101 | 6-18-57 | 63 | 11 | 5.0 | 75 | 18 | 10 | 2.8 | 0 | 298 | 31 | 3.8 | .0 | 1.2 | 309 | 261 | 17 | 8 | 510 | 7.3 |
| 3E - 8dbc2 | Town of Leachville | 120 | 6- 6-56 | 63 | — | 4.5 | 104 | 18 | 26 | — | 0 | 269 | 123 | 34 | — | .3 | 512 | 334 | 113 | 14 | 713 | 7.3 |
| 9E -29ccc | Town of Manila | 150 | 6-14-56 | 63 | — | 2.1 | 33 | 12 | 4.1 | — | 0 | 135 | 25 | 1.2 | — | .2 | 166 | 132 | 21 | 6 | 254 | 8.2 |
| 10E-29dca | J. C. Ellis | 118 | 6- 7-56 | 62 | — | 5.6 | 91 | 26 | 11 | — | 0 | 406 | 25 | 4.0 | — | .2 | 400 | 334 | 2 | 7 | 627 | 7.8 |
| 12E-18acb | Armorel Planting Co. | 130(?) | 8-16-55 | 62 | — | 19 | 104 | 34 | 12 | — | 0 | 491 | 7.0 | 4.0 | — | .1 | 437 | 400 | 0 | 6 | 720 | 7.0 |
| 12E-24cca | Tom Rayder | 100 | 8-16-55 | 61 | — | 2.6 | 90 | 28 | 6.2 | — | 0 | 408 | 6.0 | 2.5 | — | 1.3 | 358 | 340 | 5 | 4 | 603 | 7.2 |
| **Claiborne group** | | | | | | | | | | | | | | | | | | | | | | |
| )E -23aaal | U. S. Corps of Engr. | 356 | 11- 5-57 | — | — | .74 | 25 | 6.9 | 8.4 | 1.6 | 0 | 87 | 4.0 | 26 | — | .4 | 136 | 91 | 20 | 17 | 317 | 6.5 |
| 9E-26aba | Memphis Compress Co. | 339 | 10-23-58 | 62 | 10 | 5.2 | 51 | 14 | 5.5 | 4.6 | 0 | 240 | 3.2 | 3.0 | .1 | .3 | 219 | 184 | 0 | 6 | 341 | 6.8 |
| 3E-24add | City of Jonesboro | 235 | 6-20-56 | 62 | 13 | .00 | 21 | 9.3 | 14 | 1.1 | 0 | 98 | 20 | 16 | .1 | .9 | 130 | 91 | 10 | 25 | 238 | 8.0 |
| 3E-24daa | do | 240 | 5- 3-50 | 61 | 32 | .10 | 12 | 4.0 | 11 | 1.4 | 0 | 64 | 3.6 | 9.5 | .0 | 8.6 | 122 | 46 | 0 | 33 | 165 | 6.7 |
| 11E-26a | Town of Steele, Mo. | 321 | 9-24-58 | 65 | 3.7 | 26 | 7.5 | 2.7 | 26 | 5.2 | 0 | 106 | 3.6 | 2.5 | .1 | .2 | 104 | 30 | 0 | 61 | 169 | 7.0 |
| **Wilcox formation** | | | | | | | | | | | | | | | | | | | | | | |
| 10E-20aad2 | Lee Wilson & Co. | 1,567 | 6-21-56 | 78 | 8.0 | .40 | 6.3 | 1.0 | 45 | 2.7 | 0 | 139 | 5.8 | 1.8 | .1 | 1.2 | 148 | 20 | 0 | 81 | 225 | 7.6 |
| 9E -11dbb1 | Town of Keiser | 1,445 | 6- 5-56 | 75 | 7.7 | 1.2 | 3.8 | .4 | 36 | 2.6 | 0 | 104 | 3.4 | 2.0 | .2 | .0 | 120 | 11 | 0 | 84 | 175 | 7.4 |
| 10E-36acd1 | City of Osceola | 1,400 | 6- 6-56 | 70 | 7.9 | 1.6 | 6.8 | 1.4 | 28 | 4.0 | 0 | 105 | 1.6 | 2.0 | .2 | .8 | 112 | 23 | 0 | 69 | 169 | 7.2 |
| 36acd2 | do | 1,480 | 6- 6-56 | 77 | — | 1.5 | 4.4 | 1.2 | 39 | 3.6 | 6 | 107 | 6.2 | 2.0 | — | 1.6 | 140 | 16 | 0 | 80 | 200 | 8.4 |
| 11E- 8dda | Town of Luxora | 1,500+ | 6-21-56 | 76 | 8.0 | 1.6 | 5.6 | 1.5 | 44 | 3.4 | 0 | 129 | 4.8 | 7.5 | .1 | .9 | 150 | 20 | 0 | 80 | 229 | 7.3 |
| 10E- 5ddd | Dell Compress Co. | 1,275 | 6- 6-56 | 70 | — | 2.6 | 9.4 | 1.2 | 34 | 4.4 | 4 | 110 | 7.0 | 2.0 | — | .9 | 133 | 28 | 0 | 68 | 205 | 8.3 |
| 3E - 8dbc1 | Town of Leachville | 1,083 | 6-21-56 | 73 | 5.7 | 1.6 | 4.6 | .8 | 34 | 3.0 | 0 | 96 | 7.6 | 3.0 | .1 | .8 | 108 | 15 | 0 | 80 | 173 | 7.3 |
| 9E 31dbb | Town of Manila | 1,364 | 6-21-56 | — | — | 1.4 | 4.8 | .8 | 34 | — | 0 | 96 | 9.0 | 2.2 | — | .5 | 147 | 15 | 0 | 83 | 177 | 8.2 |
| 11E-15bca | Blytheville Water Co. | — | 6-21-56 | 78 | 4.6 | .18 | 7.5 | 2.2 | 30 | 3.8 | 0 | 99 | 13 | 2.5 | .1 | .0 | 112 | 28 | 0 | 67 | 187 | 7.8 |
| **Cretaceous deposits** | | | | | | | | | | | | | | | | | | | | | | |
| 9E - 8acd | Town of Hornersville, Mo. | 1,846 | 9-26-57 | 88 | 4.8 | .07 | 2.4 | .1 | 248 | 6.4 | 0 | 668 | 4.0 | 9.5 | .5 | 4.0 | 637 | 6 | 0 | 97 | 976 | 8.1 |
| 8E - 2dcd | Town of Senath, Mo. | 1,717 | 9-26-57 | 85 | 6.1 | .01 | 2.0 | 1.2 | 178 | 5.1 | 0 | 420 | 9.2 | 39 | .1 | 2.0 | 487 | 10 | 0 | 96 | 757 | 8.2 |
| )E - 2aad | City of Kennett, Mo. | 1,600 | 9-27-57 | 81 | 6.1 | .04 | 2.1 | .9 | 215 | 5.2 | 0 | 560 | 2.0 | 10 | .1 | 2.4 | 528 | 8 | 0 | 97 | 800 | 8.1 |
| 12E-34cca | City of Hayti, Mo. | 2,140 | 9-27-57 | 95 | 5.7 | .04 | 7.4 | 1.7 | 109 | 5.6 | 0 | 288 | 8.8 | 22 | .1 | .3 | 323 | 26 | 0 | 88 | 513 | 8.0 |
| **Rocks of Paleozoic age** | | | | | | | | | | | | | | | | | | | | | | |
| 12E- 3ccb | [1] Bendum-Trees Oil Co. | 2,960 | 1939 | — | 6.0 | [2].18 | 820 | 1.2 | 4,020 | | 41 | 39 | 934 | 6,840 | — | 0 | 13,300 | 2,060 | 101 | — | — | — |
| | C. W. Mack No. 1 | 3,805 | 1939 | — | 2.4 | .10 | 1,350 | 316 | 5,950 | | 0 | 69 | 2,900 | 10,000 | — | 0 | 22,000 | 4,670 | 57 | — | — | — |
| | Oil test well | 4,533 | 1939 | 110 | 20 | .42 | 1,400 | 402 | 5,950 | | 0 | 144 | 1,710 | 11,000 | — | 0 | 22,000 | 5,150 | 118 | — | — | — |

Mo. Geol. Sur. and Water Resources

precipitated iron not determined

## TABLE 15

**Chemical analyses of water collected from shallow wells in the Quaternary deposits for the study of variations in iron content, and hardness**

(In parts per million except specific conductance, pH, and as indicated)

| Location No. | Well No. | Depth of Well (feet) | Date of Collection | Temperature (°F) | Iron Total (Fe.) | Bicarbonate ($HCO_3$) | Carbonate ($CO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Nitrate ($NO_3$) | Hardness as $CaCO_3$ Total | Hardness as $CaCO_3$ Non-Carbonate | Specific Conductance[2] | pH (field determination) | pH (laboratory determination) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10N 8E—1aab | 1 | 33 | 8- 1-56 | 64 | 4.7 | | | | | | 170 | | 348 | | 8.6 |
| —22aba | 2 | 41 | 8- 1-56 | 63 | 5.5 | | | | | | 233 | | 383 | | 8.5 |
| —31bca | 3 | 32[1] | 8- 1-56 | 63 | 9.4 | | | | | | 149 | | 326 | | 8.6 |
| —35dbd | 4 | 57 | 7-25-56 | 63 | 7.9 | | | | | | 186 | | 363 | | 8.6 |
| do | | | 3-20-57 | 61 | 17 | | | | | | 440 | | 779 | | 7.0 |
| do | | | 5- 7-57 | 62 | 4.2 | 312 | 3 | 22 | 16 | 5.5 | 321 | 60 | 593 | 7.0 | 8.3 |
| 10N 9E—5ddd | 5 | 27 | 7-25-56 | 63 | .59 | | | | | | 204 | | 342 | | 8.5 |
| do | | | 5- 7-57 | 61 | .47 | 239 | 7 | 85 | 8.0 | .2 | 222 | 15 | 410 | 7.4 | 8.4 |
| —11aaa | 6 | 41 | 7-25-56 | 63 | 39 | | | | | | 222 | | 482 | | 8.5 |
| —33cbb | 7 | 29 | 7-25-56 | 62 | .26 | | | | | | 186 | | 369 | | 8.4 |
| do | | | 5- 7-57 | 62 | .10 | 248 | 4 | 90 | 44 | 8.7 | 327 | 117 | 615 | 6.7 | 8.3 |
| 10N10E—20dda | 8 | 72 | 7-25-56 | 63 | 5.1 | | | | | | 185 | | 451 | | 8.4 |
| do | | | 3-14-57 | 61 | 16 | | | | | | 298 | | 548 | | 8.2 |
| do | | | 3-20-57 | 60 | 15 | | | | | | 290 | | 549 | | 8.1 |
| 11N 8E—1aba | 9 | 42 | 8- 1-56 | 63 | 4.5 | | | | | | 260 | | 490 | | 8.4 |
| —15ccc | 10 | 44 | 8- 1-56 | 63 | 4.1 | | | | | | 186 | | 439 | | 8.5 |
| —32ccb | 11 | 23 | 8- 1-56 | 64 | .22 | | | | | | 101 | | 255 | | 8.1 |
| do | | | 3-14-57 | 61 | .33 | | | | | | 112 | | 267 | | 8.1 |
| do | | | 3-20-57 | 61 | .56 | | | | | | 118 | | 275 | | 7.0 |
| 11N10E—6bbb | 12 | 37 | 10- 4-56 | 62 | 23 | | | | | | 253 | | 509 | | 8.3 |
| —15aab | 13 | 46 | 7-25-56 | 63 | 33 | | | | | | 179 | | 379 | | 8.6 |
| do | | | 3-14-57 | 61 | 29 | | | | | | 396 | | 676 | | 8.2 |
| do | | | 3-20-57 | 60 | 31 | | | | | | 431 | | 753 | | 8.0 |
| do | | | 5- 7-57 | 62 | 13 | 241 | 12 | 1 | 3.2 | 7.6 | 217 | 0 | 395 | 6.9 | 8.5 |
| 11N11E—33aba | 14 | 32 | 7-25-56 | 64 | .19 | | | | | | 186 | | 301 | | 8.3 |
| do | | | 5- 7-57 | 60 | .18 | 158 | 10 | 90 | 3.2 | .0 | 186 | 40 | 328 | 6.9 | 8.6 |
| 12N 8E—31ccc | 15 | 24 | 8- 1-56 | 62 | .92 | | | | | | 196 | | 382 | | 8.5 |
| do | | | 3-20-57 | 60 | 2.7 | | | | | | 352 | | 626 | | 8.1 |
| do | | | 5- 7-57 | 60 | .70 | 218 | 7 | 60 | 6.2 | 1.3 | 225 | 35 | 422 | 6.9 | 8.5 |
| 12N 9E—6bbb | 16 | 30 | 5- 8-57 | 61 | 2.8 | 204 | 0 | 24 | 31 | .7 | 236 | 69 | 512 | 7.0 | 8.5 |
| —36dcd | 17 | 60 | 8- 1-56 | 63 | 24 | | | | | | 256 | | 494 | | 8.6 |
| do | | | 3-14-57 | 60 | 22 | | | | | | 493 | | 917 | | 7.8 |
| do | | | 3-20-57 | 61 | 21 | | | | | | 504 | | 926 | | 7.3 |
| do | | | 5- 7-57 | 61 | 20 | 258 | 24 | 2 | 9 | 18 | 256 | 5 | 489 | 6.9 | 8.6 |
| 12N10E—2ddd | 18 | 23 | 7-24-56 | 64 | .55 | | | | | | 182 | | 501 | | 8.4 |
| 12N10E—21dbb | 19 | 44 | 10- 4-56 | 62 | 14 | | | | | | 207 | | 436 | | 8.3 |
| 12N11E—31caa | 20 | 30 | 7-25-56 | 63 | 4.5 | | | | | | 181 | | 320 | | 8.6 |
| 13N 8E—6daa | 21 | 20 | 7-31-56 | 60 | 8.6 | | | | | | 134 | | 306 | | 8.5 |
| do | | | 4-17-57 | 57 | 9.8 | | | | | | 182 | | 353 | 7.1 | 8.5 |
| do | | | 5- 8-57 | 57 | 10 | 144 | 8 | 100 | 16 | 0.0 | 181 | 50 | 366 | 7.2 | 8.4 |
| —22bcc | 22 | 17 | 4-17-57 | 60 | .18 | | | | | | 267 | | 511 | 6.5 | 8.5 |
| do | | | 5- 8-57 | 60 | .21 | 196 | 8 | 1 | 25 | 1.3 | 282 | 108 | 551 | 6.6 | 8.4 |
| —32dcc | 23 | 23 | 11- 1-56 | 61 | 3.5 | | | | | | 283 | | 512 | | 8.5 |
| 13N 9E—22bcb | 24 | 30 | 5- 8-57 | 62 | .82 | 192 | 10 | 97 | 7.5 | .7 | 224 | 50 | 526 | 7.0 | 8.5 |
| —36add | 25 | 32 | 10- 4-56 | 64 | 9.2 | | | | | | 206 | | 432 | | 8.3 |
| 13N10E—33ddd | 26 | 47 | 4-17-57 | 61 | 32 | | | | | | 187 | | 380 | 7.0 | 8.7 |
| do | | | 5- 8-57 | 61 | 8.9 | 336 | 8 | 1 | 4.8 | 8.6 | 294 | 5 | 538 | 7.0 | 8.3 |
| 13N11E—18abc | 27 | 42 | 7-24-56 | 64 | 1.0 | | | | | | 310 | | 555 | | 7.8 |
| 14N 8E—19bac | 28 | 13[1] | 7-24-56 | 61 | 3.4 | | | | | | 154 | | 387 | | 8.4 |
| do | | | 4-17-57 | 59 | 1.2 | 118 | 6 | 65 | 17 | 1.1 | 180 | 73 | 359 | 7.1 | 8.4 |
| —22bcb | 29 | 20 | 7-24-56 | 61 | 10 | | | | | | 178 | | 342 | | 8.5 |
| do | | | 3-14-57 | 59 | 9.2 | | | | | | 288 | | 519 | | 8.5 |
| do | | | 3-20-57 | 59 | 8.6 | | | | | | 285 | | 509 | | 8.3 |
| do | | | 4-17-57 | 59 | 1.5 | | | | | | 216 | | 398 | 7.0 | 8.5 |
| do | | | 5- 8-57 | 59 | 1.2 | 191 | 10 | 115 | 8.5 | 1.0 | 239 | 66 | 423 | 7.0 | 8.5 |
| 14N 9E—17bcc | 30 | 26 | 7-24-56 | 62 | .40 | | | | | | 210 | | 385 | | 8.6 |
| do | | | 3-14-57 | 59 | 1.2 | | | | | | 215 | | 432 | | 8.0 |
| do | | | 3-20-57 | 60 | .7 | | | | | | 226 | | 455 | | 8.1 |
| do | | | 4-17-57 | 60 | .65 | | | | | | 215 | | 401 | 6.5 | 8.5 |
| do | | | 5- 8-57 | 61 | 1.53 | 147 | 12 | 100 | 16 | .2 | 206 | 66 | 400 | 6.5 | 8.6 |
| —31ccc | 31 | 18 | 8-31-56 | 64 | .59 | | | | | | 86 | | 225 | | 7.3 |
| do | | | 3-20-57 | 59 | 1.2 | | | | | | 88 | | 234 | | 6.6 |
| do | | | 5- 8-57 | 59 | 0.25 | 76 | 0 | 25 | 5.2 | .2 | 94 | 32 | 219 | 6.2 | 8.0 |
| 14N10E—16ddd | 32 | 33 | 10-31-56 | 63 | 13 | | | | | | 214 | | 454 | | 8.2 |
| —30cbc | 33 | 24 | 10- 4-56 | 63 | 3.2 | | | | | | 322 | | 664 | | 8.4 |
| do | | | 3-19-57 | 61 | 3.7 | | | | | | 321 | | 657 | | 8.3 |

## TABLE 15—Continued

**Chemical analyses of water collected from shallow wells in the Quaternary deposits for the study of variations in iron content, and hardness**

(In parts per million except specific conductance, pH, and as indicated)

| Location No. | Well No. | Depth of Well (feet) | Date of Collection | Temperature (°F) | Iron Total (Fe.) | Bicarbonate ($HCO_3$) | Carbonate ($CO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Nitrate ($NO_3$) | Hardness as $CaCO_3$ Total | Hardness as $CaCO_3$ Non-Carbonate | Specific Conductance[2] | pH (field determination) | pH (laboratory determination) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14N10E-30cbc | | | 5- 9-57 | 62 | 2.9 | | | | | | 188 | | 478 | 7.1 | 8.1 |
| 14N11E—6bbb | 34 | 34 | 10-31-56 | 62 | 14 | | | | | | 158 | | 311 | | 8.6 |
| do | | | 3-19-57 | 59 | 13 | | | | | | 241 | | 454 | | 8.3 |
| do | | | 5- 9-57 | 61 | 2.4 | | | | | | 122 | | 263 | 7.1 | 8.3 |
| —21aaa | 35 | 33 | 10- 3-56 | 62 | 15 | | | | | | 195 | | 412 | | 8.2 |
| do | | | 4-17-57 | 61 | 16 | | | | | | 215 | | 436 | 7.1 | 8.6 |
| do | | | 5- 7-57 | 61 | 12 | 206 | 32 | 25 | 2 | 3.5 | 216 | 0 | 461 | 7.1 | 8.4 |
| —35dda | 36 | 23[1] | 7-24-56 | 63 | .22 | | | | | | 121 | | 281 | | 8.3 |
| do | | | 4-18-57 | 61 | .11 | | | | | | 111 | | 266 | 6.3 | 8.5 |
| do | | | 5- 9-57 | 61 | .14 | 97 | 0 | 100 | 7.0 | 6.8 | 111 | 31 | 254 | 6.3 | 8.2 |
| 14N12E—6bcc | 37 | 24 | 8-16-56 | 61 | 5.0 | | | | | | 146 | | 340 | | 8.1 |
| —23aab | 38 | 30 | 7-24-56 | 61 | .99 | | | | | | 158 | | 309 | | 8.5 |
| do | | | 4-18-57 | 60 | 1.5 | | | | | | 169 | | 314 | 6.8 | 8.7 |
| do | | | 5- 9-57 | 60 | 1.24 | 236 | 12 | 22 | 5.2 | .4 | 247 | 34 | 432 | 6.8 | 8.6 |
| 15N 8E—3cbb | 39 | 19 | 7-13-56 | 62 | .35 | | | | | | 208 | | 490 | | 8.3 |
| —22cdc | 40 | 17 | 7-13-56 | 67 | 12 | | | | | | 164 | | 307 | | 8.6 |
| —30ccc | 41 | 14 | 8- 3-56 | 63 | 1.7 | | | | | | 282 | | 650 | | 8.6 |
| do | | | 4-16-57 | 55 | .67 | | | | | | 316 | | 751 | 7.0 | 8.6 |
| do | | | 5- 8-57 | 56 | .48 | 180 | 14 | 125 | 66 | 26 | 307 | 136 | 766 | 7.1 | 8.5 |
| —36cdd | 42 | 17 | 7-12-56 | 66 | 7.5 | | | | | | 142 | | 294 | | 8.3 |
| 15N 9E—6bbb | 43 | 15 | 7-12-56 | 63 | 4.5 | | | | | | 169 | | 304 | | 8.4 |
| —21bcc | 44 | 18 | 8- 2-56 | 63 | 0.31 | | | | | | 92 | | 238 | | 8.1 |
| do | | | 3-13-57 | 58 | .33 | | | | | | 132 | | 331 | | 8.1 |
| do | | | 3-19-57 | 57 | .22 | | | | | | 136 | | 327 | | 7.7 |
| do | | | 4-16-57 | 57 | .18 | | | | | | 144 | | 334 | 6.2 | 8.4 |
| do | | | 5- 7-57 | 58 | .14 | 116 | 0 | 22 | 26 | 13 | 162 | 67 | 361 | 6.2 | 8.2 |
| 15N10E—15ccc | 45 | 29 | 10-31-56 | 62 | 8.7 | | | | | | 192 | | 435 | | 8.4 |
| do | | | 3-19-57 | 61 | 9.7 | | | | | | 313 | | 625 | | 8.3 |
| do | | | 4-25-57 | 62 | 18 | | | | | | 200 | | 427 | 6.9 | 8.5 |
| do | | | 5- 9-57 | 62 | 18 | 196 | 8 | 23 | 13 | 1.3 | 208 | 34 | 438 | 6.9 | 8.4 |
| 15N12E—1bbc | 46 | 30 | 7-24-56 | 62 | .29 | | | | | | 240 | | 533 | | 8.3 |
| do | | | 3-14-57 | 59 | .22 | | | | | | 393 | | 790 | | 8.3 |
| do | | | 3-20-57 | 60 | .15 | | | | | | 400 | | 818 | | 8.3 |
| do | | | 4-18-57 | 60 | .08 | | | | | | 320 | | 696 | 6.9 | 8.2 |
| do | | | 5- 9-57 | 61 | .07 | | | | | | 309 | | 686 | 7.0 | 8.4 |
| —22baa | 47 | 35 | 7-24-56 | 63 | 5.5 | | | | | | 147 | | 305 | | 8.4 |
| do | | | 3-19-57 | 59 | 2.3 | | | | | | 292 | | 563 | | 8.2 |
| do | | | 4-18-57 | 61 | 2.5 | | | | | | 161 | | 332 | 6.9 | 8.5 |
| do | | | 5- 9-57 | 62 | 2.8 | 228 | 8 | 1 | 13 | 4.1 | 237 | 37 | 452 | 6.9 | 8.4 |
| 15N12E—34caa | 48 | 24 | 7-24-56 | 63 | 5.6 | | | | | | 144 | | 337 | | 8.5 |
| 15N13E—15ddd | 49 | 32 | 7-24-56 | 63 | 4.5 | | | | | | 170 | | 308 | | 8.3 |
| do | | | 4-18-57 | 61 | .18 | | | | | | 169 | | 337 | 6.7 | 8.5 |
| do | | | 5- 9-57 | 61 | .34 | 330 | 0 | 14 | 10 | 0.2 | 306 | 35 | 556 | 6.8 | 8.0 |
| 16N 8E—22abb | 50 | 21 | 7-12-56 | 61 | .29 | | | | | | 151 | | 434 | | 8.5 |
| —31ccc2 | 51 | 21 | 7-24-56 | 62 | 5.1 | | | | | | 186 | | 523 | | 8.5 |
| do | | | 3-13-57 | 59 | 7.9 | | | | | | 248 | | 639 | | 8.3 |
| do | | | 3-19-57 | 59 | 8.5 | | | | | | 250 | | 639 | | 8.3 |
| do | | | 4-16-57 | 58 | 1.60 | | | | | | 192 | | 578 | 7.2 | 8.5 |
| do | | | 5- 8-57 | 59 | 1.6 | 150 | 6 | 125 | 52 | .2 | 217 | 84 | 602 | 7.1 | 8.4 |
| 16N 9E—21bac | 52 | 15 | 8- 1-56 | 62 | .32 | | | | | | 54 | | 437 | | 7.2 |
| do | | | 4-16-57 | 55 | .32 | | | | | | 108 | | 663 | 6.0 | 7.8 |
| do | | | 5- 8-57 | 57 | .22 | 28 | 0 | 65 | 51 | 80 | 96 | 73 | 551 | 6.0 | 7.4 |
| 16N10E—31add | 53 | 26 | 7-25-56 | 63 | 7.6 | | | | | | 213 | | 511 | | 8.4 |
| —36acc | 54 | 31 | 7-25-56 | 63 | 5.1 | | | | | | 235 | | 371 | | 7.7 |
| do | | | 4-16-57 | 61 | 15 | | | | | | 142 | | 361 | 6.4 | 8.6 |
| do | | | 5- 9-57 | 62 | 16 | 228 | 8 | 25 | 6.5 | .6 | 215 | 15 | 463 | 6.5 | 8.4 |
| 16N11E—22abb | 55 | 32 | 7-25-56 | 63 | .22 | | | | | | 268 | | 400 | | 8.5 |
| —36ddd | 56 | 39 | 7-25-56 | 62 | 4.8 | | | | | | 188 | | 447 | | 8.5 |
| 16N12E—20add | 57 | 31 | 7-25-56 | 62 | 3.2 | | | | | | 275 | | 942 | | 8.5 |
| do | | | 3-14-57 | 62 | 2.6 | | | | | | 505 | | 953 | | 7.5 |
| do | | | 3-20-57 | 61 | 4.9 | | | | | | 502 | | 912 | | 7.2 |
| do | | | 4-18-57 | 62 | 4.5 | | | | | | 333 | | 667 | 6.9 | 8.3 |
| do | | | 5- 9-57 | 62 | 4.2 | 154 | 8 | 142 | 35 | 1.0 | 298 | 159 | 612 | 6.9 | 8.4 |
| 16N13E—19cdd | 58 | 23[1] | 7-24-56 | 62 | .14 | | | | | | 162 | | 419 | | 8.3 |

[1] Reported depth
[2] Specific conductance measured in micromhos at 25°C

vals are arbitrary. Geographic features referred to in the following discussion are shown in figure 19.

According to the iron-distribution map, the lowest concentrations of iron (0.3 ppm or less) have a scattered arrangement but occur predominantly near the Mississippi River and the Little River, the two major streams in the county.

Waters having concentrations of iron ranging from 0.3 to 0.6 ppm are generally scattered. However, in the northwestern part of Mississippi County there is a conspicious alignment, parallel and adjacent to Big Lake and Little River, of four wells that yield water having an iron content falling within this particular range.

The largest part of the county is presumably underlain by water containing iron in the range of 0.6 to 5 ppm. In the western and northwestern parts of the county this area coincides roughly with the course of the Little River. In the east-central and northeastern parts of the county the area roughly parallels and is adjacent to the Mississippi River.

There are four areas in Mississippi County where the iron content generally exceeds 5 ppm, as shown in figure 18. The high-iron area south of Leachville and west of Manila includes a well having the maximum iron content of 12 ppm. The maximum iron content of water sampled in the high-iron area of the north-central part of the county is 14 ppm. In the southeastern part of the county, four wells yielded water containing 23 to 39 ppm of iron. This area is adjacent to the Mississippi River and extends northwestward toward the central part of the county. In the fourth area of high iron content, in the southwest corner of the county, the maximum iron contained in the water samples was 9.4 ppm.

The geographic distribution of hardness is based on analyses of samples collected in the summer and fall of 1956 during a period of relatively static water levels. The range intervals shown on the distribution map were chosen to agree with the standard hardness classification given in the section on "Chemical constituents in relation to use," except for the interval of 300 ppm or more.

The areas of soft water (0-60 ppm) and moderately hard water (60-120 ppm) are in the vicinity of Big Lake and Little River, in that part of the county which is underlain almost exclusively by sand. Hard water (120-200 ppm) underlies a large part of northwestern Mississippi County roughly paralleling Little River. This range in hardness extends eastward to the Mississippi River in areas largely covered by clay and silty clay. South and west of Osceola along the course of the Mississippi River there is also a belt of hard water. This belt extends westward in the southern part of the county and underlies much of the southwestern corner of the county.

Very hard water (200 ppm of hardness or more) occurs over more than half the county. There are presumably three major areas where very hard water is common. These three areas are in northwestern, northern, and central and southern Mississippi County, where the upper part of the Quaternary deposits may consist either of sand or of clay or silty clay. There are two well samples with hardness exceeding 300 ppm. Their location suggests a narrow belt of very hard water extending northwestward from near Luxora.

The second objective of the special study was to determine the possible effects on the concentration of iron and hardness by the addition of water to the aquifer during a period of considerable recharge. The countywide sampling during the summer and fall of 1956 would also provide a basis for comparison, since the water levels were relatively low at the time of sampling.

In 1956 the period of maximum recharge occurred between January 18 and February 25. Although this period comprises only 11 percent of a year, 38 percent of the annual precipitation took place during this period. Water samples were collected in July, August, and October, 1956, from 5 to 8 months after this period of maximum recharge. The water sampling of the summer and fall of 1956 preceded the first period of considerable recharge in the winter of 1957 by 3 to 6 months.

The iron content of water sampled from 26 wells in the summer and fall of 1956 and again in the spring of 1957 generally increased in more than half of the wells from the first sampling to the time of resampling. The total iron content increased in 14 wells (or 54 percent of the wells sampled), remained the same in 1 well (4 percent), and decreased in 11 wells (42 percent). Those samples which initially had an iron content exceeding the maximum (0.3 ppm) recommended by the U. S. Public Health Service, and, with one exception, those which decreased in iron content still contained sufficient iron well above the recom-

mended maximum. Water from well 49 (table 15) was the single exception, with a change from 4.5 to 0.18 ppm of iron.

Of the 5 samples from wells 11, 14, 36, 44, and 52 which initially had an iron content of about 0.3 ppm or less (as shown in table 15) 4 samples decreased even further in iron content. The samples from well 11 showed an increase in iron content, bringing it above the recommended limit.

The hardness of the water samples collected from the 26 wells mentioned above increased in 22 wells (or in 85 percent of the wells sampled) and decreased in 4 wells (15 percent) from the first sampling in 1956 to the time of resampling in 1957. When the samples were collected in 1956, 1 sample was soft, 3 samples were moderately hard, 14 samples were hard, and the remaining 6 were very hard. By the spring of 1957, resampling of the same wells showed that 4 samples were moderately hard, 5 were hard, and 16 were very hard. Figure 19 shows the location, number designation, and depth of the 58 wells and the respective analyses are shown in table 15.

**Variation of chemical constituents with depth.**—Figure 20 is a diagram showing the variation of the iron content of water sampled from wells ranging in depth from 13 feet to 150 feet below land surface. According to this diagram the iron content of water from shallow wells has a considerably wider range than that of water from wells screened in the deeper part of the aquifer.

Although 29 percent of the samples collected from wells between 13 and 72 feet deep contained less than 1 ppm, all the samples from wells 100 to 150 feet deep contained 1 ppm or more of iron. Water from about 47 percent of the shallow wells and 78 percent of the deep wells has an iron content between 1 and 10 ppm. Iron in quantities exceeding 10 ppm occurred in water in 24 percent of the shallow wells and in 22 percent of the deep wells. The water lowest in iron is found at depths of about 35 feet or less. Even so, water from most wells of this depth may be expected to contain iron in amounts exceeding the recommended maximum.

The variation with depth of bicarbonate, carbonate, chloride, hardness, and specific conductance is shown in figure 21. Carbonate and chloride show a trend of decreasing concentration with depth, whereas bicarbonate, hardness, and specific conductance tend to increase with depth. Nitrate and sulfate did not show any definite trend.

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## LOGS OF TEST HOLES AND WELLS

On the following pages are the logs of 91 test holes and wells in Mississippi County. The test holes 1 through 60 were augered by the U. S. Geological Survey, and the corresponding logs were based on the field and laboratory description of the material samples. Well cuttings were collected during the drilling of 8 irrigation wells in the county, and the logs of 7 of these wells are also listed. The drillers' logs of 9 wells screened in the Quaternary deposits and of 13 wells finished in the Tertiary deposits are included, together with the log of the Benedum-Trees Oil Co. C. W. Mack No. 1 well. The descriptions of the materials given in the drillers' logs are as reported by the drillers.

The log of the C. W. Mack No. 1 well was published by Grohskopf (1955, p. 123) and is included in this report with some modification. The description of the rock materials have not been changed for that part of the log ranging from land surface to the base of the Tertiary formations or to a depth of 2,806 feet below land surface. However, the detailed log of the Paleozoic formations has been simplified and condensed to conform with the general purpose of this report. The interpretive part of the log, which involves the separation of the descriptive log into the different rock units, has been maintained as presented by Grohskopf but with two exceptions. To conform with the stratigraphic terminology of Arkansas, that section of the log referred to by Grohskopf as the Wilcox group is divided in the present report into the Claiborne group and the Wilcox formation. The Quaternary deposits of the modified log correspond to the Recent alluvium in the report by Grohskopf.

The well logs listed in the following section are separated into three groups. The first group comprises the U. S. Geological Survey test-hole logs and are shown on page 71 to page 78. These logs are numbered in sequence from 1 to 60 to facilitate cross reference with figures 9 and 10. The second group comprises logs of irrigation wells and are listed on pages 79 to 81. The well logs included in the third group are of wells in the Claiborne group, the Wilcox formation, or the Paleozoic rocks. Within the second and third groups the well

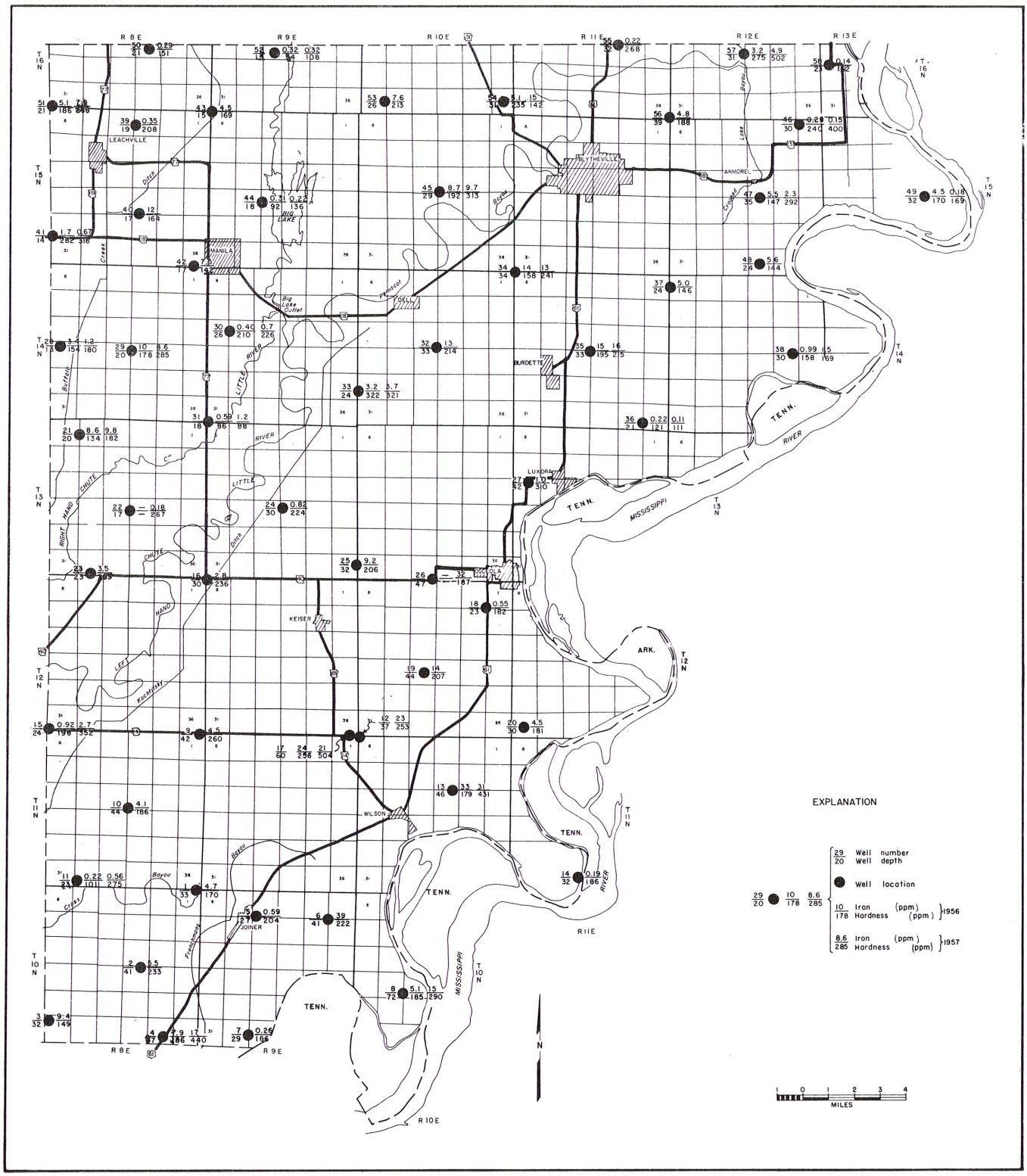



**Figure 19.—Map of Mississippi County, Ark., showing location of wells used in sampling water from the Quaternary deposits for the study of iron and hardness.**

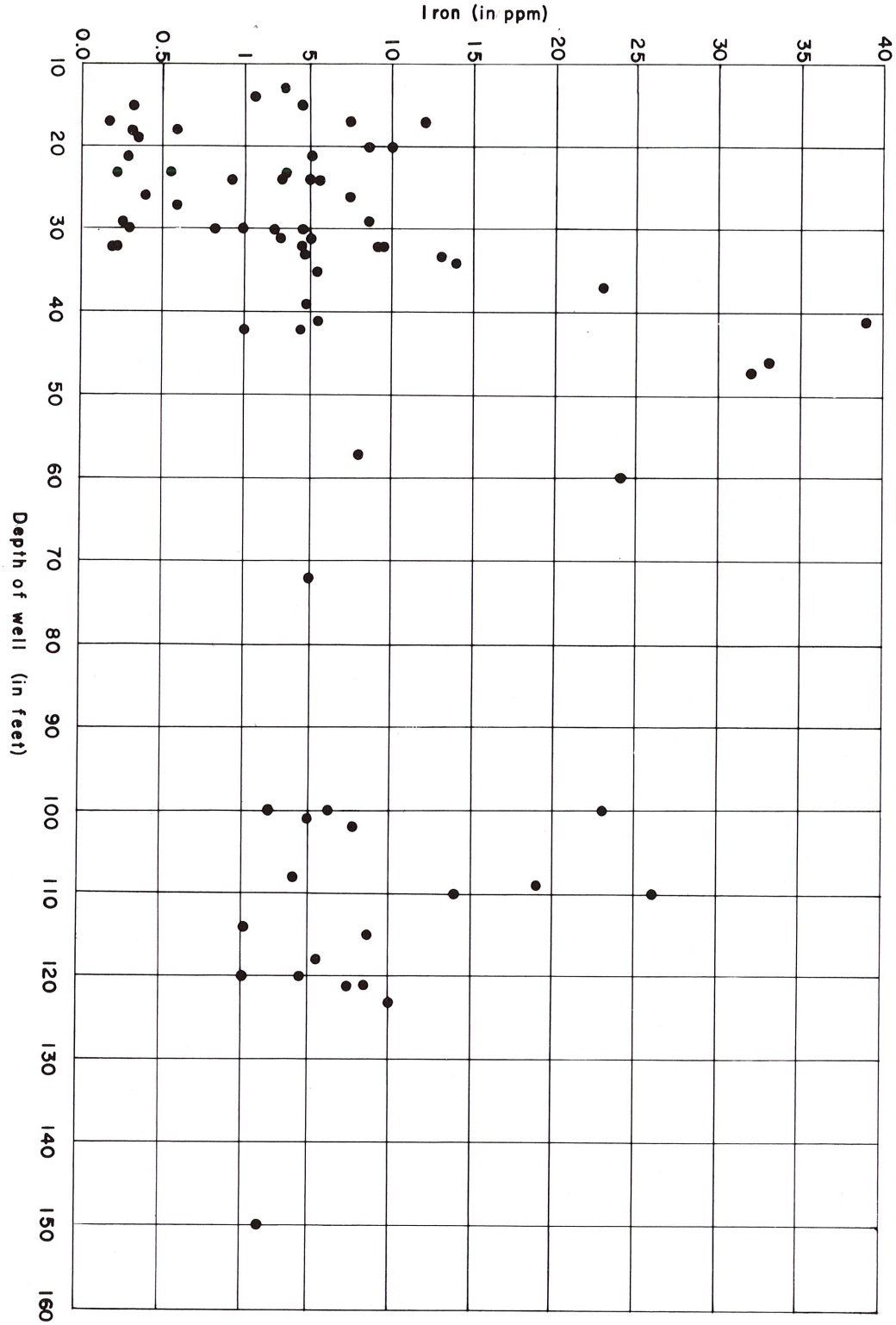
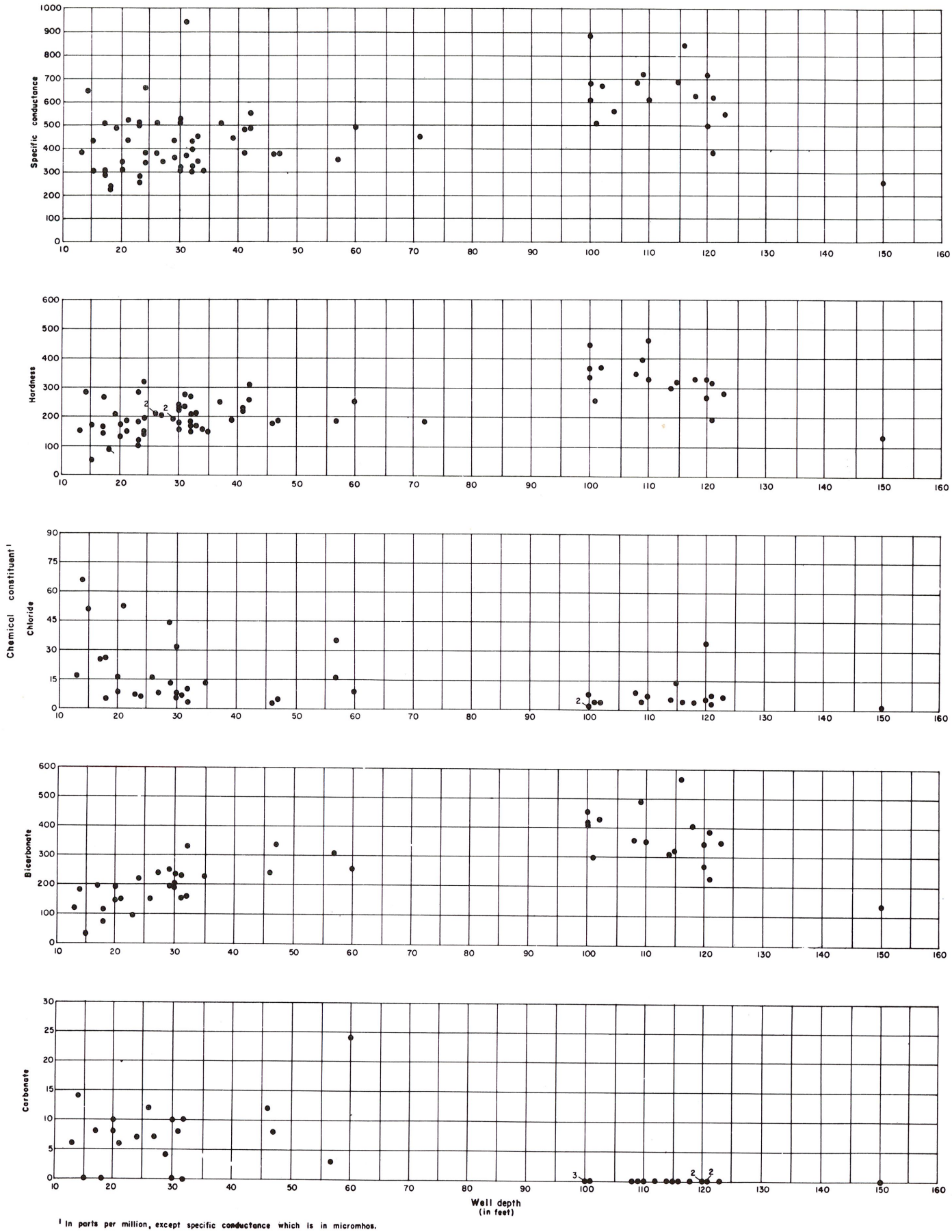



**Figure 20.—Graph showing variations in total iron content of ground water with depth of sampling in the Quaternary deposits.**




[1] In parts per million, except specific conductance which is in micromhos.

Figure 21.—Graph showing variations in bicarbonate, carbonate, chloride, hardness, and specific conductance of ground water with depth of sampling in the Quaternary deposits.

logs are shown in sequence from low to higher township, range, and section numbers and are numbered according to the well-numbering system referred to on page 8. However, the log of the Benedum-Trees Oil Co. C. W. Mack No. 1 well is designated by this name, and is not referred to by number. The well logs of the third group listed on pages 81 to 86.

### TEST HOLE 1

Location designation: 16N8E-22abb
Altitude: 241 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, dark-brown | 1.5 | 1.5 |
| Sand, fine, light-brown | 1.5 | 3 |
| Silt, light-brown | 3 | 6 |
| Sand, fine, yellow-brown | 2 | 8 |
| Sand, fine, brown | 2 | 10 |
| Sand, medium, brown | 6 | 16 |
| Sand, fine, brown | 2 | 18 |
| Sand, medium, brown | 12 | 30 |

### TEST HOLE 2

Location designation: 16N9E-21abb
Altitude: 240 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, dark-brown | 1.5 | 1.5 |
| Silt, brown | 1.5 | 3 |
| Silt, clayey, yellow | 3 | 6 |
| Silt, clayey, light-yellow | 1.5 | 7.5 |
| Silt, light-yellow | .5 | 8 |
| No recovery | 5 | 13 |
| Sand, medium, brown; thin streak of white silt at 14.5 feet | 5 | 18 |
| Sand, medium, brown | 5 | 23 |
| Sand, medium, brown, lignitic | 10 | 33 |
| Sand, coarse, brown, lignitic | 3 | 36 |

### TEST HOLE 3

Location designation: 16N10E-21daa
Altitude: 239 feet

| | | |
|---|---|---|
| Quaternary deposits: | | |
| Clay, light-brown | 13 | 13 |
| Sand, coarse, silty, gravelly, gray | 1 | 14 |
| Sand, silty, gray | 10 | 24 |
| Sand, very coarse, gravelly, gray, lignitic | 8 | 32 |

### TEST HOLE 4

Location designation: 16N11E-22bbb
Altitude: 251 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, brown | 6 | 6 |
| Silt, clayey, yellow-brown | 2 | 8 |
| Silt, yellow-brown | 4 | 12 |
| Silt, very calcareous, yellow-brown | 14 | 26 |
| Silt, very calcareous, light-gray-brown | 6 | 32 |

### TEST HOLE 5

Location designation: 16N12E-20aaa
Altitude: 255 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, brown | 1.5 | 1.5 |
| Clay, silty, brown | 2 | 3.5 |
| Silt, clayey, brown | 3.5 | 7 |
| Slit, yellow-brown | 5 | 12 |
| Silt, clayey, calcareous, gray, with streaks of clay | 10 | 22 |
| Silt, clayey, calcareous, gray | 8 | 30 |

### TEST HOLE 6

Location designation: 16N8E-31ccc
Altitude: 238 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, dark-brown | 2 | 2 |
| Silt, sandy, yellow-brown | 1 | 3 |
| Sand, fine, brown-yellow | 8 | 11 |
| Sand, fine, slightly calcareous, dark-brown-yellow | 2 | 13 |
| Sand, medium, slightly calcareous, dark-brown-yellow | 5 | 18 |
| Sand, medium, slightly calcareous, dark-yellow-brown, lignitic | 4 | 22 |
| Sand, coarse, calcareous, brown-gray, lignitic | 4 | 26 |
| Sand, medium, calcareous, brown-gray | 10 | 36 |

### TEST HOLE 7

Location designation: 15N8E-3cbb
Altitude: 237 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, dark-brown | 1 | 1 |
| Sand, medium, brown | 2 | 3 |
| Sand, fine, silty, dark-brown-yellow | 1.5 | 4.5 |
| Sand, fine, silty, brown-yellow | 3.5 | 8 |
| Sand, medium, yellow-brown | 5 | 13 |
| Sand, medium, slightly calcareous, yellow-brown, lignitic | 4 | 17 |
| Sand, medium, calcareous, dark-yellow-brown, lignitic | 6 | 23 |
| Sand, coarse, calcareous, brown-gray, lignitic | 3 | 26 |
| Sand, medium, calcareous, brown-gray, lignitic | 6 | 32 |
| Sand, coarse, calcareous, brown-gray, lignitic | 4 | 36 |

### TEST HOLE 8

Location designation: 15N9E-6bbb
Altitude: 238 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, silty, dark-brown | 1.5 | 1.5 |
| Silt, sandy, dark-gray-brown | .5 | 2 |
| Sand, fine, silty, dark-gray-brown | 1 | 3 |
| Sand, fine, silty, very dark-gray | 3 | 6 |
| Sand, medium, slightly calcareous, light-gray | 2 | 8 |

**TEST HOLE 8 (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand, medium, slightly calcareous, brown-gray | 3 | 11 |
| Sand, medium, slightly calcareous, gray, lignitic | 2 | 13 |
| Sand, coarse, calcareous, brown-gray, lignitic | 13 | 26 |
| Sand, coarse, calcareous, dark-brown-gray, lignitic | 3 | 29 |
| Sand, very coarse, gravelly, calcareous, brown-gray, lignitic | 3 | 32 |
| Sand, medium, calcareous, brown-gray, lignitic | 4 | 36 |

**TEST HOLE 9**

Location designation: 16N10E-31add
Altitude: 236 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, dark-gray-brown | 1.5 | 1.5 |
| Silt, sandy, yellow-gray-brown | 1.5 | 3 |
| Clay, silty, yellow-brown and gray, mottled | 8 | 11 |
| Clay, yellow-gray-brown | 4 | 15 |
| Silt, light-yellow-gray | 2 | 17 |
| Sand, medium, silty, light-yellow-gray | 5 | 22 |
| Sand, medium, gravelly, dark-brown-gray, lignitic | 1.5 | 23.5 |
| Sand, coarse, gravelly, brown-gray, lignitic | 3.5 | 27 |
| Sand, very coarse, gravelly, brown-gray, lignitic | 5 | 32 |

**TEST HOLE 10**

Location designation: 16N10E-36acc
Altitude: 245 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, light-brown | 2 | 2 |
| Silt, clayey, light-brown-yellow | 5 | 7 |
| Clay, silty, slightly calcareous from 12 to 18 feet, light-brown | 11 | 18 |
| Silt, clayey, slightly calcareous, light-brown | 5 | 23 |
| Silt, clayey, calcareous, light-gray | 9 | 32 |

**TEST HOLE 11**

Location designation: 16N11E-36ddd
Altitude: 255 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, sandy, light-brown | 3 | 3 |
| Silt, clayey, sandy, yellow-brown | 2 | 5 |
| Silt, clayey, yellow-brown | 1 | 6 |
| Silt, clayey, sandy, yellow-brown | 2 | 8 |
| Sand, very fine, silty, brown | 4 | 12 |
| Sand, very fine, silty, brown | 7 | 19 |
| Sand, very fine, silty, very calcareous, gray | 13 | 32 |

**TEST HOLE 12**

Location designation: 15N12E-1bbc
Altitude: 254 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, sandy, very calcareous, dark-brown | 1.5 | 1.5 |
| Silt, clayey, sandy, brown | 1.5 | 3 |
| Sand, very fine, silty, slightly calcerous, light-yellow-brown | 1 | 4 |
| Sand, very fine, silty, light-yellow-brown streak and brown clay | 4 | 8 |
| Clay, light-brown | 5 | 13 |
| Sand, very fine, silty, brown | 5 | 18 |
| Silt, sandy, brown | 11 | 29 |

**TEST HOLE 13**

Location designation: 15N8E-22cdc
Altitude: 230 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, silty, dark-brown | 3 | 3 |
| Sand, fine, silty, yellow-brown | 3 | 6 |
| Sand, medium, yellow-brown | 9 | 15 |
| Sand, medium, calcareous, gray | 3 | 18 |
| Sand, coarse, calcareous, gray, lignitic | 8 | 26 |
| Sand, coarse, calcareous, gray, lignitic, gravelly | 3 | 29 |
| Sand, coarse, calcareous, brown, lignitic | 4 | 33 |

**TEST HOLE 14**

Location designation: 15N9E-21bcc
Altitude: 239 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, dark-brown | 2 | 2 |
| Sand, medium, slightly calcareous from 2 to 3 feet, very dark-brown | 2 | 4 |
| Silt, sandy, brown | 1 | 5 |
| Silt, sandy, dark-yellow-brown | 2.5 | 7.5 |
| Sand, very fine, silty, yellow-brown | .5 | 8 |
| Sand, fine, silty, yellow-brown | 5 | 13 |
| Sand, fine, brown | 5 | 18 |
| Sand, medium, brown | 8 | 26 |
| Sand, medium, brown, lignitic | 3 | 29 |
| Sand, coarse, brown | 7 | 36 |

**TEST HOLE 15**

Location designation: 15N10E-16ddd
Altitude: 241 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, brown | 2 | 2 |
| Clay, light-brown | 4 | 6 |
| Clay, light-brown and gray mottled | 4 | 10 |
| Clay, light-brown | 3 | 13 |
| Clay, light-brown and gray mottled | 6 | 19 |
| Clay, light-brown | 1 | 20 |
| Sand, fine to medium, silty, slightly calcareous, brown | 9 | 29 |
| Sand, fine to medium, silty, brown | 3 | 32 |

## TEST HOLE 16

Location designation: 15N11E-15ccc
Altitude: 253 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, slightly calcareous, light-brown | 1 | 1 |
| Clay, slightly calcareous, brown | 1 | 2 |
| Clay, light-brown | 0.5 | 2.5 |
| Sand, fine, yellow-brown | 0.5 | 3 |
| Sand, fine, calcareous, yellow-brown | 1 | 4 |
| Sand, clay balls, light-brown | 3 | 7 |
| Clay, silty, light-brown | 7 | 14 |
| Clay, silty, calcareous, light-brown | 2 | 16 |
| Clay, slightly calcareous, brown and gray mottled | 1 | 17 |
| Clay, slightly calcareous, brown | 2 | 19 |
| Clay, calcareous, brown | 4 | 23 |
| Silt, very fine sand, very calcareous, gray | 6 | 29 |
| Silt, very calcareous, gray | 3 | 32 |

## TEST HOLE 17

Location designation: 15N12E-22baa
Altitude: 255 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, calcareous, dark-brown | 2.5 | 2.5 |
| Silt, yellow-brown | 4.5 | 7 |
| Silt, slightly calcareous, yellow-brown | 1 | 8 |
| Clay, silty, yellow-brown | 5 | 13 |
| Silt, clayey, yellow-brown | 5 | 18 |
| Silt, clayey, slightly calcareous, yellow-brown | 5 | 23 |
| Silt, clayey, yellow-brown | 2 | 25 |
| Silt, calcareous, gray | 3 | 28 |
| Silt, sandy, calcareous, gray | 1 | 29 |
| Sand, very fine, silty, calcareous, gray | 3 | 32 |

## TEST HOLE 18

Location designation: 15N13E-15ddd
Altitude: 255 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, calcareous, yellow-brown | 3 | 3 |
| Silt, clayey, very calcareous, yellow-brown | 12 | 15 |
| Silt, very calcareous, gray-brown | 2 | 17 |
| Silt, sandy, very calcareous, brown | 1 | 18 |
| Sand, fine, slightly calcareous, brown | 6 | 24 |
| Sand, fine, silty, very calcareous, brown | 5 | 29 |
| Sand, medium, brown | 3 | 32 |

## TEST HOLE 19

Location designation: 15N8E-30ccc
Atlitude: 243 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, silty, dark-gray-brown | 1 | 1 |
| Sand, medium, dark-brown | 1 | 2 |

## TEST HOLE 19 (Continued)

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Silt, clayey, light-gray | 0.7 | 2.7 |
| Silt, clayey, sandy, slightly calcareous, light-gray | 0.3 | 3 |
| Silt, clayey, light-gray | 3 | 6 |
| Sand, medium, silty, dark-gray with thin streak of silty, light-brown clay at 8 feet | 2 | 8 |
| Sand, medium, silty, light-brown | 1 | 9 |
| Sand, medium, gray | 5 | 14 |
| Sand, medium, gray, lignitic | 5 | 19 |

## TEST HOLE 20

Location designation: 14N8E-1aaa2
Altitude: 237 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, dark-yellow-brown | 2 | 2 |
| Sand, medium, yellow-brown | 1 | 3 |
| Sand, medium, silty, dark-brown-yellow | 1.5 | 4.5 |
| Sand, very fine, silty, clayey, brown-yellow | 0.5 | 5 |
| Sand, fine, silty, dark-brown-yellow | 0.5 | 5.5 |
| Sand, fine, brown-yellow | 2.5 | 8 |
| Sand, medium, silty, brown-yellow | 1 | 9 |
| Sand, medium, yellow-brown | 5 | 14 |
| Sand, medium, brown-yellow | 5 | 19 |
| Sand, coarse, dark-brown-yellow | 5 | 24 |
| Sand, coarse, slightly calcareous, dark-brown-yellow, lignitic | 5 | 29 |
| Sand, coarse, dark-brown-yellow, lignitic | 3 | 32 |

## TEST HOLE 21

Location designation: 14N9E-1aaa
Altitude: 235 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, sandy, light-brown | 3 | 3 |
| Clay, medium, brown | 2 | 5 |
| Clay, silty, sandy, brown | 3 | 8 |
| Clay, mottled brown and yellow-brown | 1 | 9 |
| Clay, slightly calcareous, mottled brown and yellow-brown and gray | 10 | 19 |
| No recovery | 3 | 22 |
| Silt, clayey, sandy, yellow | 2 | 24 |
| Silt, sandy, clayey, yellow | 5 | 29 |
| Silt, sandy, yellow | 3 | 32 |

## TEST HOLE 22

Location designation: 14N11E-6bbb
Altitude: 242 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, sandy, gray-brown | 1 | 1 |
| Silt, clayey, sandy, yellow-brown | 1 | 2 |
| Silt, clayey, brown | 4 | 6 |
| Clay, silty, sandy, brown, lignitic | 1 | 7 |
| Clay, silty, brown and brown-gray mottled | 8 | 15 |
| Clay, silty, gray-brown and blue | 2 | 17 |
| Clay, silty, gray | 7 | 24 |
| Silt, clayey, sandy, slightly calcareous, gray | 5 | 29 |
| Silt, clayey, sandy, gray | 3 | 32 |

### TEST HOLE 23

Location designation: 14N12E-6bcc
Altitude: 250 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, very fine, silty, very dark-brown | 0.5 | 0.5 |
| Sand, fine, silty, brown | 1.5 | 2 |
| Silt, dark-brown-black | 1 | 3 |
| Silt, brown | 0.5 | 3.5 |
| Silt, slightly calcareous, brown | 2.5 | 6 |
| Silt, clayey, yellow-brown | 7 | 13 |
| Silt, some coarse sand, yellow-brown | 1 | 14 |
| Sand, very fine, silty, brown | 15 | 29 |
| Sand, medium, silty, brown | 3 | 32 |

### TEST HOLE 24

Location designation: 15N12E-35cbc
Altitude: 254 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, sandy, brown | 1 | 1 |
| Sand, fine, silty, yellow-brown | 1 | 2 |
| Sand, very fine, silty, gray-brown | 0.5 | 2.5 |
| Silt, yellow-brown | 0.5 | 3 |
| Silt, clayey, yellow-brown | 4.5 | 7.5 |
| Silt, yellow-brown | 0.5 | 8 |
| Silt, clayey, yellow-brown | 2.5 | 10.5 |
| Silt, yellow-brown | 2.5 | 13 |
| Silt, very calcareous, light-gray-brown | 10 | 23 |
| Silt, very calcareous, gray | 9 | 32 |

### TEST HOLE 25

Location designation: 14N13E-6baa
Altitude: 259 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, silty, slightly calcareous, brown | 6 | 6 |
| Sand, fine, silty, very calcareous, brown | 6 | 12 |
| Silt, sandy, very calcareous, brown | 4.5 | 16.5 |
| Sand, fine, silty, calcareous, brown | 0.5 | 17 |
| Sand, coarse, granules, brown | 1 | 18 |
| Sand, coarse, granules and pebbles, brown | 4 | 22 |
| Sand, coarse, granules, dark-brown | 1 | 23 |
| Silt, sandy, granules and pebbles, calcareous, brown | 2 | 25 |
| Sand, coarse, granules, silty, brown | 1 | 26 |
| Sand, coarse, granules, silty, calcareous, brown | 3 | 29 |
| Sand, coarse, granules and pebbles, silty, calcareous, brown | 1 | 30 |
| Sand, coarse, gray | 2 | 32 |

### TEST HOLE 26

Location designation: 14N8E-22bcb
Altitude: 230 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, dark-brown; streak of fine black sand at 1 foot | 1 | 1 |

### TEST HOLE 26 (Continued)

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand, very fine, silty, yellow-brown; streak of light-brown clayey, slightly calcareous silt at 6 feet | 7 | 8 |
| Sand, medium, yellow-brown | 0.5 | 8.5 |
| Sand, medium, very calcareous, gray | 0.5 | 9 |
| Sand, medium, very calcareous, gray, lignitic | 20 | 29 |

### TEST HOLE 27

Location designation: 14N9E-21ada
Altitude: 235 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, brown | 4 | 4 |
| Clay, calcareous, brown | 5 | 9 |
| Clay, brown | 7 | 16 |
| Clay, gray | 3 | 19 |
| Clay, gray-green | 5 | 24 |
| Clay, gray | 2.5 | 26.5 |
| Silt, clayey, sandy, slightly calcareous, gray | 3.5 | 30 |
| Silt, clayey, sandy, calcareous, gray | 1 | 31 |
| Silt, clayey, sandy, gray-green | 1 | 32 |

### TEST HOLE 28

Location designation: 14N10E-22bbb
Altitude: 232 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, sandy, dark-brown | 0.5 | 0.5 |
| Clay, dark-brown | 1.5 | 2 |
| Clay, silty, yellow | 1 | 3 |
| Clay, silty, yellow-brown | 5 | 8 |
| Clay, yellow-brown with gray mottling | 10 | 18 |
| Clay, slightly calcareous, yellow-brown with gray mottling | 3 | 21 |
| Clay, calcareous, gray | 2 | 23 |
| Clay, slightly calcareous, gray | 1 | 24 |
| Silt, clayey, calcareous, gray | 8 | 32 |

### TEST HOLE 29

Location designation: 14N11E-21aaa
Altitude: 242 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, brown | 2 | 2 |
| Clay, yellow-brown | 1 | 3 |
| Silt, clayey, very calcareous, yellow-brown | 3 | 6 |
| Silt, silghtly calcareous, yellow-brown | 2 | 8 |
| Silt, very calcareous, yellow-brown | 3 | 11 |
| Silt, very calcareous, gray | 15 | 26 |
| Silt, very fine sand, very calcareous, gray | 3 | 29 |
| Sand, very fine, silty, very calcareous, gray | 3 | 32 |

### TEST HOLE 30

Location designation: 14N12E-15cdd
Altitude: 251 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, slightly calcareous, brown | 4 | 4 |
| Sand, very fine, silty, clayey, slightly calcareous, brown | 0.5 | 4.5 |
| Clay, silty, calcareous, brown | 2.5 | 7 |
| Clay, silty, very calcareous, brown | 0.5 | 7.5 |
| Clay, silty, very calcareous, light-brown | 5.5 | 13 |
| Clay, calcareous, gray | 6 | 19 |
| Clay, silty, very calcareous, gray | 13 | 32 |

### TEST HOLE 31

Location designation: 13N8E-6daa
Altitude: 225 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, silty, dark-brown | 1.5 | 1.5 |
| Sand, medium, very calcareous, yellow-brown | 1.5 | 3 |
| Sand, medium, silty, calcareous, yellow-brown | 3 | 6 |
| Silt, sandy, clayey, calcareous, light-brown | 2 | 8 |
| Sand, fine, silty, calcareous, yellow-brown | 5 | 13 |
| Sand, fine, silty, yellow-brown | 5 | 18 |
| Sand, medium, silty, slighty calcareous, yellow-brown | 5 | 23 |
| Sand, medium, calcareous, yellow-brown | 3 | 26 |
| Sand, coarse, very calcareous, yellow-brown | 3 | 29 |
| Sand, coarse, very calcareous, granules, yellow-brown | 3 | 32 |

### TEST HOLE 32

Location designation: 14N9E-31ccc
Altitude: 233 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, sandy, dark-brown | 1 | 1 |
| Silt, clayey, dark-brown | 1 | 2 |
| Clay, silty, light-brown | 1 | 3 |
| Silt, clayey, light-brown | 1.5 | 4.5 |
| Sand, very fine, silty, brown | 1.5 | 6 |
| Sand, fine, silty, yellow-brown | 2 | 8 |
| Sand, medium, silty, dark-brown | 1 | 9 |
| Sand, medium, silty, brown | 15 | 24 |
| Sand, medium, silty, granules, brown | 5 | 29 |
| Sand, medium, brown | 3 | 32 |

### TEST HOLE 33

Location designation: 13N9E-laaa
Altitude: 230 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, gray-brown | 8 | 8 |
| Clay, silty, gray-brown and rust-brown mottling | 5 | 13 |

### TEST HOLE 33 (Continued)

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Clay, silty, gray-brown | 5 | 18 |
| Silt, clayey, gray | 8 | 26 |
| Sand, fine, silty, light-gray-brown | 3 | 29 |
| Sand, medium, silty, light-gray-brown | 3 | 32 |

### TEST HOLE 34

Location designation: 14N11E-31cdc
Altitude: 237 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, yellow-brown | 1.5 | 1.5 |
| Silt, clay, sandy, light-brown | 1.5 | 3 |
| Silt, sandy, light-brown | 2 | 5 |
| Silt, clayey, slightly calcareous, yellow-brown | 2 | 7 |
| Silt, calcareous, yellow-brown | 6 | 13 |
| Silt, clayey, slightly calcareous, yellow-brown | 2 | 15 |
| Silt, clayey, slightly calcareous, gray and brown mottled | 3 | 18 |
| Silt, clayey, slightly calcareous, brown | 2 | 20 |
| Silt, clayey, gray | 3 | 23 |
| No recovery | 3.5 | 26.5 |
| Silt, clayey, gray | 5.5 | 32 |

### TEST HOLE 35

Location designation: 13N11E-1abb
Altitude: 245 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, calcareous, dark-brown | 1.5 | 1.5 |
| Clay, silty, yellow-brown | 1.5 | 3 |
| Silt, clayey, calcareous, light-brown | 7 | 10 |
| Sand, very fine, silty, light-brown | 3 | 13 |
| Silt, sandy, very calcareous, light-brown | 5 | 18 |
| Silt, clayey, very calcareous, gray | 5 | 23 |
| Silt, very calcareous, gray | 9 | 32 |

### TEST HOLE 36

Location designation: 13N8E-22bcc
Altitude: 230 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, very fine, silty, clayey, dark-brown | 1 | 1 |
| Sand, very fine, brown | 1 | 2 |
| Sand, very fine, brown, clay balls | 6 | 8 |
| Sand, very fine, silty, brown, gray-brown clay balls | 2 | 10 |
| Sand, very fine, silty, clayey, brown | 3 | 13 |
| Sand, very fine, silty, clayey, light-brown | 11 | 24 |
| Sand, very fine, light-brown | 5 | 29 |
| Sand, very fine, slightly calcareous, light-brown | 3 | 32 |

### TEST HOLE 37

Location designation: 13N9E-15cda
Altitude: 228 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, gray-brown | 3 | 3 |
| Clay, silty, light-gray-brown | 4 | 7 |
| Clay, brown | 6 | 13 |
| Clay, silty, slightly calcareous, brown | 5 | 18 |
| Clay, silty, brown | 5 | 23 |
| Sand, fine, silty, brown | 9 | 32 |

### TEST HOLE 38

Location designation: 13N10E-21aaa
Altitude: 238 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, brown | 2 | 2 |
| Sand, very fine, brown, clay balls | 1 | 3 |
| Sand, very fine, silty, brown, gray clay balls | 3 | 6 |
| Clay, silty, gray-brown | 2 | 8 |
| Clay, gray-brown | 3 | 11 |
| Clay, calcareous, gray-brown | 1 | 12 |
| Sand, very fine, very calcareous, gray-brown | 5 | 17 |
| Clay, silty, calcareous, gray-brown | 1 | 18 |
| Clay, silty, calcareous, light-brown | 4 | 22 |
| Silt, clayey, very calcareous, light-brown | 10 | 32 |

### TEST HOLE 39

Location designation: 13N8E-32dcc
Altitude: 225 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine, silty, dark-gray-brown | 1 | 1 |
| Sand, very fine, silty, very dark-gray, lignitic | 0.5 | 1.5 |
| Silt, clayey, brown | 5.5 | 7 |
| Silt, clayey, sandy, brown | 4 | 11 |
| Silt, clayey, sandy, gray-brown | 2 | 13 |
| Sand, fine, silty, gray | 9.5 | 22.5 |
| Sand, fine, silty, slightly calcareous, gray | 9.5 | 32 |

### TEST HOLE 40

Location designation: 13N9E-31cbc
Altitude: 229 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, dark-brown | 2 | 2 |
| Clay, silty, light-brown | 0.5 | 2.5 |
| Silt, clayey, yellow-brown | 5.5 | 8 |
| Clay, silty, light-gray | 5 | 13 |
| No recovery | 3 | 16 |
| Clay, silty, light-gray | 7 | 23 |

### TEST HOLE 41

Location designation: 13N10E-31ccb
Altitude: 229 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, dark-brown | 3 | 3 |
| Clay, light-brown | 4 | 7 |
| Clay, yellow-brown and light-brown mottled | 6 | 13 |
| Clay, gray | 3 | 16 |
| Silt, calcareous, gray | 16 | 32 |

### TEST HOLE 42

Location designation: 12N10E-2ddd
Altitude: 239 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, sandy, dark-brown | 0.5 | 0.5 |
| Silt, sandy, slightly calcareous, dark-brown | 0.5 | 1 |
| Sand, medium, silty, brown | 0.5 | 1.5 |
| Silt, sandy, dark-brown | 0.5 | 2 |
| Silt, clayey, sandy, brown | 1 | 3 |
| Silt, very calcareous, light-brown | 5 | 8 |
| Clay, silty, slightly calcareous, light-brown | 3 | 11 |
| Silt, sandy, brown | 2 | 13 |
| Silt, sandy, slightly calcareous, brown | 10 | 23 |
| Sand, fine, silty, brown, streak of light-brown sandy silt at 28 feet | 6 | 29 |
| Sand, silty, brown | 3 | 32 |

### TEST HOLE 43

Location designation: 12N8E-22bbb
Altitude: 224 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, slightly calcareous, light-gray-brown | 2 | 2 |
| Sand, medium, brown; gray clay balls | 1 | 3 |
| Clay, silty, brown-gray; streaks of fine brown sand | 4 | 7 |
| Clay, silty, light-brown | 4 | 11 |
| Clay, silty, slightly calcareous, gray | 1 | 12 |
| Clay, silty, brown | 4 | 16 |
| Clay, silty, gray | 2 | 18 |
| Clay, silty, gray-brown | 1 | 19 |
| Silt, clayey, sandy, brown | 4 | 23 |
| Sand, fine, clayey, silty, brown | 6 | 29 |
| Sand, fine, silty, brown | 3 | 32 |

### TEST HOLE 44

Location designation: 12N9E-22bcc
Altitude: 226 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, dark-brown | 9 | 9 |
| Clay, light-brown | 5 | 14 |
| Clay, slightly calcareous, light-brown | 9 | 23 |
| Clay, silty, calcareous, light-brown | 2 | 25 |
| Clay, silty, slightly calcareous, light-brown | 1 | 26 |
| Clay, silty, calcareous, light-brown | 6 | 32 |

### TEST HOLE 45

Location designation: 12N10E-21dbb
Altitude: 235 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, slightly calcareous, dark-brown | 4.5 | 4.5 |
| Clay, dark-brown | 3.5 | 8 |
| Clay, brown | 5 | 13 |
| Clay, very calcareous, brown | 3 | 16 |
| Clay, calcareous, gray-brown | 4 | 20 |
| Clay, silty, calcareous, brown | 6 | 26 |
| Clay, very calcareous, brown-gray | 6 | 32 |

### TEST HOLE 46

Location designation: 11N8E-6bbb
Altitude: 223 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, brown | 1.5 | 1.5 |
| Silt, brown | 4 | 5.5 |
| Silt, yellow-brown | 5.5 | 11 |
| Sand, medium, yellow-brown | 2 | 13 |
| Sand, coarse, yellow-brown | 3 | 16 |
| Sand, coarse, brown, and granules | 5 | 21 |
| Sand, medium, brown | 8 | 29 |
| Sand, coarse, brown | 3 | 32 |

### TEST HOLE 47

Location designation: 11N8E-1aaa
Altitude: 224 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Not recorded | 1 | 1 |
| Silt, sandy, dark-brown | 1 | 2 |
| Clay, dark-gray-brown | 4 | 6 |
| Clay, light-brown | 7 | 13 |
| Clay, slightly calcareous, brown | 5 | 18 |
| Clay, slightly calcareous, brown with white specks | 3 | 21 |
| Silt, sandy, calcareous, gray-brown | 11 | 32 |

### TEST HOLE 48

Location designation: 11N10E-6bba
Altitude: 230 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, brown | 1 | 1 |
| Silt, clayey, yellow-brown | 2.5 | 3.5 |
| Silt, very calcareous, yellow-brown | 0.5 | 4 |
| Silt, clayey, very calcareous, yellow-brown | 4 | 8 |
| Silt, very calcareous, yellow-brown | 5 | 13 |
| Silt, calcareous, yellow-brown | 3 | 16 |
| Silt, very calcareous, gray-brown | 2 | 18 |
| Sand, very fine, silty, very calcareous, gray | 8 | 26 |
| Silt, sandy, very calcareous, gray | 6 | 32 |

### TEST HOLE 49

Location designation: 12N11E-31caa
Altitude: 235 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, sandy, dark-brown | 1 | 1 |
| Silt, sandy, very dark-brown | 0.5 | 1.5 |
| Clay, silty, sandy, dark-brown | 1.5 | 3 |
| Silt, yellow-brown | 1 | 4 |
| Silt, sandy, yellow-brown | 4 | 8 |
| Sand, very fine, silty, very calcareous, yellow-brown | 5 | 13 |
| Sand, very fine, silty, very calcareous, brown-gray | 4 | 17 |
| Sand, very fine, silty, very calcareous, gray | 7 | 24 |
| Sand, very fine, silty, very calcareous, brown-gray | 5 | 29 |
| No recovery | 3 | 32 |

### TEST HOLE 50

Location designation: 11N8E-22bbb
Altitude: 222 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, brown | 3 | 3 |
| Clay, slightly calcareous, brown | 16 | 19 |
| Clay, silty, sandy, slightly calcareous, light-gray | 2 | 21 |
| Silt, sandy, calcareous, dark-gray | 1 | 22 |
| Silt, sandy, slightly calcareous, dark-gray | 10 | 32 |

### TEST HOLE 51

Location designation: 11N9E-15daa
Altitude: 232 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, calcareous, light-brown-gray | 3 | 3 |
| Clay, silty, light-brown-gray | 5 | 8 |
| Clay, silty, gray | 5 | 13 |
| Clay, silty, light-brown-gray | 5 | 18 |
| Sand, very fine, silty, clayey, slightly calcareous, light-brown | 5 | 23 |
| Sand, very fine, silty, clayey, calcareous, light-brown | 6 | 29 |
| Sand, very fine ,silty, clayey, very calcareous, light-brown | 3 | 32 |

### TEST HOLE 52

Location designation: 11N10E-15ccc
Altitude: 236 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, medium, silty, yellow-brown | 3 | 3 |
| Silt, sandy, yellow-brown | 2 | 5 |
| Sand, very fine, silty, calcareous and noncalcareous, yellow-brown | 3 | 8 |
| Sand, very fine, silty, very calcareous, yellow-brown | 2 | 10 |
| Silt, clayey, very calcareous, gray-brown | 3 | 13 |

**TEST HOLE 52 (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand, very fine, silty, very calcareous, gray with blue streaks | 5 | 18 |
| Sand, fine, silty, very calcareous, gray | 5 | 23 |
| Sand, medium, slightly calcareous, gray | 3 | 26 |

**TEST HOLE 53**

Location designation: 11N8E-31ccc
Altitude: 220 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, sandy, brown | 8 | 8 |
| Silt, clayey, brown | 6 | 14 |
| Clay, silty, brown | 2 | 16 |
| Silt, clayey, brown | 1 | 17 |
| Silt, clayey, sandy, brown | 5 | 22 |
| Silt, clayey, brown | 8.5 | 30.5 |
| Silt, clayey, sandy, brown | 1.5 | 32 |

**TEST HOLE 54**

Location designation: 11N8E-36ddc
Altitude: 230 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, sandy, brown | 0.5 | 0.5 |
| Sand, very fine, silty, light-brown | 2.5 | 3 |
| Silt, clayey, brown | 8 | 11 |
| Sand, fine, silty, brown | 11 | 22 |
| Sand, fine, silty, slightly calcareous, brown | 10 | 32 |

**TEST HOLE 55**

Location designation: 10N9E-11aaa
Altitude: 233 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, very fine, silty, light-brown | 0.5 | 0.5 |
| Sand, very fine, silty, yellow-brown | 2.5 | 3 |
| Sand, very fine, silty, slightly calcareous, yellow-brown | 1 | 4 |
| Sand, very fine, silty, calcareous, brown | 2.5 | 6.5 |
| Silt, calcareous, gray-brown | 0.5 | 7 |
| Sand, very fine, silty, calcareous, yellow-brown | 5 | 12 |
| Silt, very calcareous, gray-brown | 1 | 13 |
| Silt, very calcareous, gray | 13 | 26 |
| Silt, sandy, very calcareous, gray | 6 | 32 |

**TEST HOLE 56**

Location designation: 11N11E-33aba
Altitude: 236 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, sandy, calcareous, brown | 2 | 2 |
| Clay, silty, calcareous, dark-brown | 5 | 7 |
| Clay, silty, slightly calcareous and noncalcareous, yellow-brown | 1 | 8 |
| Clay, silty, yellow-brown | 2 | 10 |
| Clay, silty, sandy, yellow-brown | 8 | 18 |
| Clay, silty, sandy, calcareous, brown | 5 | 23 |
| No recovery; drilled like clay | 8.5 | 31.5 |

**TEST HOLE 57**

Location designation: 10N8E-22abb
Altitude: 224 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, silty, sandy, dark-brown | 0.5 | 0.5 |
| Clay, silty, sandy, light-yellow-brown | 2 | 2.5 |
| Clay, silty, sandy, dark-brown | 1 | 3.5 |
| Silt, clayey sandy, slightly calcareous, yellow-brown | 4.5 | 8 |
| Silt, mottled brown and yellow-brown | 5 | 13 |
| Clay, gray | 4 | 17 |
| Silt, clayey, sandy, brown | 1 | 18 |
| Clay, silty, sandy, gray | 5 | 23 |
| No recovery; drilled like clay | 3 | 26 |

**TEST HOLE 58**

Location designation: 10N10E-20ddc
Altitude: 231 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, calcareous, light-brown | 2 | 2 |
| Silt, light-brown | 1 | 3 |
| Silt, sandy, light-brown | 2 | 5 |
| Silt, slightly calcareous and calcareous, light-brown | 2 | 7 |
| Silt, very calcareous, light-brown-yellow with streak of blue-gray, silty, very calcareous clay at 15 feet | 8 | 15 |
| Silt, very calcareous, light-brown-yellow | 5 | 20 |
| Silt, very calcareous, light-gray | 9 | 29 |

**TEST HOLE 59**

Location designation: 10N8E-31bca
Altitude: 221 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, clayey, yellow-brown | 4 | 4 |
| Sand, fine, silty, yellow-brown | 3.5 | 7.5 |
| Silt, clayey, yellow-brown | 0.5 | 8 |
| Sand, medium, fine to coarse, yellow-brown | 3 | 11 |
| Sand, coarse, yellow-brown | 3 | 14 |
| Silt, sandy, yellow-brown; streak of calcareous yellow-brown silt at 16 feet | 2 | 16 |
| Silt, clayey, very calcareous, light-gray-brown | 1 | 17 |
| Silt, clayey, very calcareous, gray | 5 | 22 |
| Silt, clayey, sandy, very calcareous, gray | 10 | 32 |

**TEST HOLE 60**

Location designation: 10N9E-33cbb
Altitude: 227 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Silt, slightly calcareous, yellow-brown | 2.5 | 2.5 |
| Sand, very fine, silty, slightly calcareous, yellow-brown | 0.5 | 3 |
| Sand, very fine, calcareous, yellow-brown | 4.5 | 7.5 |
| Sand, fine, calcareous, yellow-brown | 1.5 | 9 |

**TEST HOLE 60 (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand, fine, slightly calcareous, yellow-brown | 2 | 11 |
| Sand, fine, very calcareous, yellow-brown | 2 | 13 |
| Sand, fine, slightly calcareous, yellow-brown | 4 | 17 |
| Sand, very calcareous, brown; streak of brown clay | 1 | 18 |
| Sand, fine, slightly calcareous, brown | 5 | 23 |
| Sand, medium, slightly calcareous, brown | 3 | 26 |

**WELL 10N8E-14acc**

Owner: W. J. Denton
Altitude: 225 feet
Driller: Lewis Diesel

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo | 20 | 20 |
| Quicksand | 20 | 40 |
| Sand and gravel | 81 | 121 |

**WELL 10N8E-17caa**

Owner: C. L. Denton, Sr.
Altitude: 225 feet
Driller: Lewis Diesel

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo, yellow-brown | 7 | 7 |
| Quicksand, gray | 73 | 80 |
| Sand and gravel | 43 | 123 |
| Solid cement rock | | at 123 |

**WELL 10N8E-28bdc**

Owner: C. L. Denton, Jr.
Altitude: 225 feet
Driller: Lewis Diesel

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo, blue-gray | 60 | 60 |
| Sand and gravel | 50 | 110 |
| Gumbo, white | | at 110 |

**WELL 11N9E-24daa**

Owner: Lee Wilson and Company
Altitude: 236 feet
Driller: Lee Wilson and Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand | 40 | 40 |
| Clay streak | .5 | 40.5 |
| Sand with coarse gravel toward bottom | 56.5 | 97 |

**WELL 11N9E-25bba**

Owner: Delta Products Company
Altitude: 236 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Top soil | 1 | 1 |
| Brown clay | 16 | 17 |
| Hard blue clay | 59 | 76 |
| Medium gray water-bearing sand | 6 | 82 |
| Blue clay | 3 | 85 |
| Very good coarse gray water-bearing sand and gravel | 29 | 114 |

**WELL 11N10E-20bcb**

Owner: Buring Packing Company
Altitude: 235 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Top soil and blue gumbo | 20 | 20 |
| Yellow clay | 20 | 40 |
| Mucky sand | 10 | 50 |
| Fine sand | 10 | 60 |
| Coarse water-bearing sand | 10 | 70 |
| Hard coarse sand | 10 | 80 |
| Coarse water-bearing sand and gravel | 36 | 116 |

**WELL 12N9E-4abc**

Owner: Jane Bolton
Altitude: 226 feet
Driller: Valley Drilling Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, gray to blue-gray | 26 | 26 |
| Clay, gray | 2 | 28 |
| Sand, medium to very coarse | 2 | 30 |
| Sand, medium | 4 | 34 |
| Sand, medium to very coarse | 5 | 39 |
| Sand, very coarse and fine gravel | 1 | 40 |
| Sand, very coarse | 10 | 50 |
| Sand, medium | 4 | 54 |
| Sand, very coarse and gravel | 11 | 65 |
| Sand, medium to coarse | 19 | 84 |
| Sand, coarse to very coarse | 6 | 90 |
| Sand, coarse and granules, very lignitic | 5 | 95 |
| Sand, coarse and pebbles | 5 | 100 |

**WELL 12N9E-4dac**

Owner: Jane Bolton
Altitude: 227 feet
Driller: Valley Drilling Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, dark-gray | .5 | .5 |
| Sand, brown | 1 | 1.5 |
| Clay, gray and streaks of blue-gray | 13.5 | 15 |
| Clay, gray | 3 | 18 |
| Sand, fine to medium, lignitic | 2 | 20 |
| Sand, fine to medium, gray; brown sand at about 24 feet | 15 | 35 |
| Sand, medium to very coarse, and granules; streaks of dark-gray clay | 5 | 40 |

**WELL 12N9E-4dac (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand, fine to very coarse, granules and pebbles; dark-gray clay at 46 feet | 10 | 50 |
| Sand, medium to very coarse, and gravel | 5 | 55 |
| Sand, coarse to very coarse, and gravel | 12 | 67 |
| Sand, coarse to very coarse, and granules, very lignitic | 2 | 69 |
| Sand, coarse to very coarse, and gravel | 10 | 79 |
| Lignite with coarse to very coarse sand, some gravel | 1 | 80 |
| Sand, coarse to very coarse, and gravel | 16 | 96 |
| Sand, coarse to very coarse, and gravel, very lignitic | 2 | 98 |
| Sand, coarse to very coarse, and gravel | 2 | 100 |

**WELL 12N9E-11dbb2**

Owner: Town of Keiser
Altitude: 230 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sandy loam | 15 | 15 |
| Gumbo | 15 | 30 |
| Hard gumbo | 10 | 40 |
| Fine sand | 10 | 50 |
| Coarse water-bearing sand | 22 | 72 |

**WELL 13N8E-24baa**

Owner: W. S. Cockerham
Altitude: 230 feet
Driller: R. J. McKinnon

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| No record | 41 | 41 |
| Sand, brown, lignite, gravel, medium to coarse | 4 | 45 |
| Sand, brown, gravel and lignite | 7 | 52 |
| Clay, brown | 1 | 53 |
| Sand, gray, pea gravel | 12 | 65 |
| Sand, gray, coarse, more gravel | 10 | 75 |
| Sand, gray, coarse, and gravel | 10 | 85 |
| Sand and gravel, 91-93 fine sand | 15 | 100 |
| Sand, coarse and gravel | 5 | 105 |
| Sand, coarse | 9 | 114 |
| Wood, slow drilling | | 114 |

**WELL 13N9E-30ccc**

Owner: Lawrence Woodard
Altitude: 230 feet
Driller: Crumrod Stores

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay | 34 | 34 |
| Sand | 60 | 94 |
| Sand and clay balls | 6 | 100 |
| Sand and very coarse gravel | 2 | 102 |

**WELL 14N8E-9bbc**

Owner: Earl H. Wildy
Altitude: 230 feet
Driller: R. J. McKinnon

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, fine to medium, silty, gray | .8 | .8 |
| Sand, medium to very coarse, light-brown | .6 | 1.4 |
| Clay, silty, light-brown | 4.6 | 6 |
| Sand, fine to medium, light-brown, lignitic | 2 | 8 |
| Sand, fine to very coarse, light-brown, lignitic | 2 | 10 |
| Sand, fine to very coarse, light-brown, lignitic; contains silty, dark-brown clay | 1 | 11 |
| Silt, yellow-brown | 2 | 13 |
| Sand, fine to medium, light-brown, lignitic | 3 | 16 |
| Sand, coarse to very coarse, light-brown, lignitic; contains granules | 5 | 21 |
| Sand, coarse to very coarse, light-brown, lignitic; contains granules and pebbles | 5 | 26 |
| Sand, coarse to very coarse, light-brown, lignitic; contains granules | 2 | 28 |
| Sand, coarse to very coarse, light-brown, lignitic; contains granules and pebbles | 5 | 33 |
| Lignite, very coarse, water-worn, black; contains granules and pebbles, and very coarse sand | 1 | 34 |
| Sand, medium to very coarse, light-brown, lignitic; contains granules and pebbles | 17 | 51 |
| Sand, medium to very coarse, light-brown, lignitic; contains a few granules and pebbles | 9 | 60 |
| Sand, coarse to very coarse, light-brown, lignitic, and granules and pebbles | 1 | 61 |
| Gravel, pebbles and granules, and medium to coarse light-brown lignitic sand | 4 | 65 |
| Sand, very fine to fine, gray, very lignitic, micaceous | 1 | 66 |
| Gravel, pebbles and granules, and medium to coarse, lignitic sand | 9 | 75 |
| Sand, coarse to very coarse, light-brown, lignitic, and pebbles and granules | 6 | 81 |
| Gravel, pebbles and granules, and medium to very coarse light-brown sand | 10 | 91 |
| Gravel, pebbles and granules, and medium to very coarse light-brown lignitic sand | 4 | 95 |
| Sand, medium to very coarse, light-brown, lignitic, and granules and pebbles | 2 | 97 |
| Sand, medium, light-brown, lignitic | 2 | 99 |
| Gravel, pebbles and granules, and medium to very coarse light-brown sand | 16 | 115 |
| Clay, silty, gray, and granules and pebbles | 1 | 116 |
| Gravel, granules and pebbles, and fine to very coarse light-brown sand | 5 | 121 |

### WELL 14N10E-18dbb

Owner: Mrs. R. A. Greenway
Altitude: 238 feet
Driller: George Newman

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo | 18 | 18 |
| Fine sand and quicksand | 30 | 48 |
| Sand and gravel | 53 | 101 |

### WELL 15N8E-8dbc2

Owner: Town of Leachville
Altitude: 236 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Yellow surface clay | 18 | 18 |
| Fine sand | 42 | 60 |
| Coarse sand and very coarse gravel | 60 | 120 |

### WELL 15N9E-20cba

Owner: Riley Duncan
Altitude: 234 feet
Driller: R. J. McKinnon

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand, clayey, black | 2 | 2 |
| Sand, dark-brown | 1 | 3 |
| Sand, light-brown | 2 | 5 |
| Sand, gray | 10 | 15 |
| Sand, fine to medium, dark-blue-gray | 10 | 25 |
| Sand, fine to medium, blue-gray; streaks of lignite | 5 | 30 |
| Sand, coarse, some gravel | 55 | 85 |
| Sand, medium to very coarse, gray, and granules | 5 | 90 |
| Sand, medium to very coarse, gray, and pebbles, lignitic | 40 | 130 |

### WELL 16N12E-24cca

Owner: Tom Rayder
Altitude: 255 feet
Driller: Valley Drilling Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay, dark-gray to black | 4 | 4 |
| Silt, clayey, brown and sand, fine to medium | 13 | 17 |
| Sand, dark-gray, intermixed with brown | 2 | 19 |
| Clay, dark-gray | 8 | 27 |
| Wood | | at 27 |
| Clay, dark-gray, and gray sand and gravel | 3 | 30 |
| Sand, gray | 5 | 35 |
| Sand, very coarse, and fine gravel | 5 | 40 |
| Sand and gravel | 10 | 50 |
| Wood, lignite | | at 50 |
| Sand, gray, and gravel | 5 | 55 |
| Sand, gray, and gravel, some wood | 5 | 60 |
| Sand, gray, and gravel | 10 | 70 |
| Sand, coarse and very coarse, gravel | 10 | 80 |
| Sand, gray, and gravel | 15 | 95 |
| Sand, gray, and gravel, lignitic | 3 | 98 |
| Sand | 2 | 100- |

### WELL 11N9E-26aad1

Owner: Delta Products Company
Altitude: 236 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Top soil | 10 | 10 |
| Blue clay | 5 | 15 |
| Sand and streaks of clay | 60 | 75 |
| Quaternary deposits and Claiborne group undifferentiated: | | |
| Water-bearing sand with streaks of gravel | 269 | 344 |
| Caliborne group: | | |
| Very hard clay | 15 | 359 |
| Hard blue clay | 61 | 420 |
| Hard packed sands; streaks of clay | 66 | 486 |
| Hard blue clay | 17 | 503 |
| Hard packed sand with streaks of clay | 229 | 732 |
| Very hard packed sand with streaks of clay | 243 | 975 |
| Hard blue clay | 18 | 993 |
| Hard packed sand with streaks of blue clay | 170 | 1,163 |
| Wilcox formation: | | |
| Hard clay | 67 | 1,230 |
| Hard blue clay | 55 | 1,285 |
| Sand with soft streaks of clay | 21 | 1,306 |
| Fine gray sand | 78 | 1,384 |
| Hard blue clay | 33 | 1,417 |
| Fine gray water-bearing sand | 21 | 1,438 |
| Very tough hard white clay | 32 | 1,470 |
| All white water-bearing sand | 88 | 1,558 |

### WELL 11N9E-26aba

Owner: Memphis Compress and Storage Company
Altitude: 236 feet
Driller: C. M. Journey

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Clay | 21 | 21 |
| Gumbo | 20 | 41 |
| Shale | 8 | 49 |
| Sand | 31 | 80 |
| Gravel | 31 | 111 |
| Sand | 21 | 132 |
| Gravel | 10 | 142 |
| Sand | 54 | 196 |
| Claiborne group: | | |
| Gumbo | 8 | 204 |
| Sand | 134 | 338 |
| Gumbo | 1 | 339 |

### WELL 11N10E-20aad1

Owner: Lee Wilson and Company
Altitude: 235 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Top soil | 10 | 10 |
| Sandy clay | 25 | 35 |
| Coarse water-bearing sand | 35 | 70 |
| Sand and lignite | 70 | 140 |
| Hard packed sand | 55 | 195 |
| Claiborne group: | | |
| Clay | 26 | 221 |
| Rock | 1 | 222 |

**WELL 11N10E-20aad1 (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sandy clay | 23 | 245 |
| Fine water-bearing sand | 90 | 335 |
| Clay | 24 | 359 |
| Fine white sand | 151 | 510 |
| Hard clay | 15 | 525 |
| Coarse sand | 185 | 710 |
| Hard packed sand | 187 | 897 |
| Clay | 21 | 918 |
| Soft rock | 1 | 919 |
| Clay | 11 | 930 |
| Sandy clay | 60 | 990 |
| Water-bearing sand | 185 | 1,175 |
| Wilcox formation: | | |
| Clay | 27 | 1,202 |
| Hard rock | 1 | 1,203 |
| Gumbo with streaks of sandy shale | 192 | 1,395 |
| Good water-bearing sand, medium grained, white; full thickness not penetrated | 96 | 1,491 |

**WELL 12N9E-11dbb3**

Owner: Town of Keiser
Altitude: 230 feet
Driller: Lee Wilson and Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Loam and sand | 21 | 21 |
| Gumbo | 7 | 28 |
| Log | 2 | 30 |
| Gumbo | 8 | 38 |
| Sand | 2 | 40 |
| Sand and gravel (fine) | 19 | 59 |
| Coarse sand and gravel | 3 | 62 |
| Gumbo | 25 | 87 |
| Coarse sand | 27 | 114 |
| Gumbo | 7 | 121 |
| Sand | 75 | 196 |
| Claiborne group: | | |
| Rock | 1 | 197 |
| Gumbo | 64 | 261 |
| Sand | 97 | 358 |
| Fine gravel | 6 | 364 |
| Sand and gravel | 24 | 388 |
| Hard coarse sand | 20 | 408 |
| Hard sand and rock | 2 | 410 |
| Hard gumbo | 36 | 446 |
| Sand | 5 | 451 |
| Hard sand | 162 | 613 |
| Hard gumbo | 4 | 617 |
| Hard sand | 130 | 747 |
| Hard gumbo | 38 | 785 |
| Sand | 28 | 813 |
| Hard gumbo | 3 | 816 |
| Sand | 19 | 835 |
| Hard rock | 4 | 839 |
| Gumbo | 89 | 928 |
| Thin ledger rock | 19 | 947 |
| Hard sand | 3 | 950 |
| Thin ledger rock | 53 | 1,003 |
| Sandy shale | 43 | 1,046 |
| Sand | 12 | 1,058 |
| Wilcox formation: | | |
| Gumbo | 42 | 1,100 |
| Gumbo and sand | 43 | 1,143 |
| Hard rock | 1 | 1,144 |
| Sandy shale | 2 | 1,146 |
| Hard gumbo | 32 | 1,178 |
| Sandy chitery shale | 111 | 1,289 |
| Sand | 11 | 1,300 |
| Sandy shale | 71 | 1,371 |
| Ripley sand | 74 | 1,445 |

**WELL 12N10E-1dcd**

Owner: Osceola Finishing Company
Altitude: 246 feet
Driller: Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sandy clay | 10 | 10 |
| Fine sand | 20 | 30 |
| Medium sand | 30 | 60 |
| Coarse sand and gravel | 136 | 196 |
| Claiborne group: | | |
| Clay | 16 | 212 |
| Fine sand | 71 | 283 |
| Clay | 89 | 372 |
| Medium sand | 554 | 926 |
| Shale and lignite | 5 | 931 |
| Fine sand | 6 | 937 |
| Shale | 4 | 941 |
| Sandy shale | 74 | 1,015 |
| Wilcox formation: | | |
| Coarse shale? | 115 | 1,130 |
| Shale and boulders | 39 | 1,169 |
| Rock | 1 | 1,170 |
| Shale | 90 | 1,260 |
| Rock | 1 | 1,261 |
| Shale | 91 | 1,352 |
| Sand | 9 | 1,361 |
| Shale | 4 | 1,365 |
| Medium sand | 105 | 1,470 |
| Break | 2 | 1,472 |
| Broken sand | 18 | 1,490 |
| Gumbo | 5 | 1,495 |

**WELL 12N10E-34cad1**

Owner: Lowrance Brothers and Company
Altitude: 233 feet
Driller: Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Sand and gumbo | 210 | 210 |
| Claiborne group: | | |
| Gumbo | 290 | 500 |
| Sand | 55 | 555 |
| Gumbo | 45 | 600 |
| Sand | 200 | 800 |
| Gumbo | 10 | 810 |
| Sand | 60 | 870 |
| Sand and gumbo | 72 | 942 |
| Sand | 68 | 1,010 |
| Wilcox formation: | | |
| Gumbo | 20 | 1,030 |
| Shale and mudstone | 200 | 1,230 |
| Gumbo | 55 | 1,285 |
| Sand | 25 | 1,310 |
| Gumbo | 20 | 1,330 |
| Sand | 170 | 1,500 |

**WELL 13N10E-18aab**

Owner: F. L. Wesson
Altitude: 225 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo | 15 | 15 |
| Shale | 36 | 51 |
| Sand | 59 | 110 |
| Hard sand | 21 | 131 |

**WELL 13N10E-18aab (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Claiborne group: | | |
| Hard shale | 21 | 152 |
| Gumbo | 3 | 155 |
| Rock | 1 | 156 |
| Gumbo | 39 | 195 |
| Sand | 47 | 242 |
| Shale | 11 | 253 |
| Rock | 1 | 254 |
| Gumbo | 32 | 286 |
| Soapstone | 5 | 291 |
| Rock | 1 | 292 |
| Sand | 57 | 349 |
| Soapstone | 17 | 366 |
| Sand | 74 | 440 |
| Hard shale | 97 | 537 |
| Sand | 43 | 580 |
| Sandy shale | 123 | 703 |
| Gumbo | 71 | 774 |
| Hard shale | 22 | 796 |
| Tough gumbo | 33 | 829 |
| Sand | 11 | 840 |
| Hard sand | 32 | 872 |
| Rock | 2 | 874 |
| Sand | 12 | 886 |
| Tough gumbo | 23 | 909 |
| Gumbo | 22 | 931 |
| Hard sandy shale | 45 | 976 |
| Wilcox formation: | | |
| Hard shale | 44 | 1,020 |
| Hard gumbo | 60 | 1,080 |
| Hard sand | 11 | 1,091 |
| Gumbo | 15 | 1,106 |
| Rock | 1 | 1,107 |
| Gumbo | 45 | 1,152 |
| Shale | 8 | 1,160 |
| Rock | .3 | 1,160.3 |
| Shale | 2.7 | 1,163 |
| Rock | 1 | 1,164 |
| Shale | 7 | 1,171 |
| Soapstone | 51 | 1,222 |
| Gumbo | 115 | 1,337 |
| Sand | 80 | 1,417 |

**WELL 14N9E-1dda**

Owner: B. S. Simmons
Altitude: 239 feet
Driller: Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Soil | 5 | 5 |
| Gumbo | 25 | 30 |
| Sand and gravel | 98 | 128 |
| Claiborne group: | | |
| Gumbo | 10 | 138 |
| Gummy shale | 10 | 148 |
| Gumbo | 52 | 200 |
| Gummy shale | 65 | 265 |
| Sandy shale | 35 | 300 |
| Fine sand | 70 | 370 |
| Gumbo | 55 | 425 |
| Sand | 15 | 440 |
| Shale | 10 | 450 |
| Hard sand | 50 | 500 |
| Hard shale | 80 | 580 |
| Brown clay | 30 | 610 |
| Sandy shale | 45 | 655 |
| Hard sand | 145 | 835 |
| Wilcox formation: | | |
| Gumbo | 40 | 875 |
| Shale | 2 | 877 |
| Rock | 3 | 880 |

**WELL 14N9E-1dda (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Streaks of sand and clay | 135 | 1,015 |
| Shale | 5 | 1,020 |
| Sand and shale; rock at 1,090 feet. One hour drilling through it. | 70 | 1,090 |
| Gumbo | 30 | 1,120 |
| Shale and boulders | 70 | 1,190 |
| Gumbo | 10 | 1,200 |
| Artesian sand | 115 | 1,315 |
| Gumbo | 10 | 1,325 |
| Shale and sand | 12 | 1,337 |

**WELL 14N9E-10dcc**

Owner: Mrs. W. A. Whistle
Altitude: 236 feet
Driller: Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Soil | 5 | 5 |
| Sandy clay | 10 | 15 |
| Muddy sand | 33 | 48 |
| Fine sand and mud | 30 | 78 |
| Sand and gravel | 32 | 110 |
| Sand and heavy gravel | 60 | 170 |
| Claiborne group: | | |
| Gumbo and boulder | 28 | 198 |
| Gumbo | 22 | 220 |
| Gummy shale | 43 | 263 |
| Gumbo | 21 | 284 |
| Hard shale | 10 | 294 |
| Sand, hard packed, no good | 6 | 300 |
| Hard sand, good | 10 | 310 |
| Shale and sand | 5 | 315 |
| Hard shale | 10 | 325 |
| Gumbo | 25 | 350 |
| Hard packed sand, not so good | 25 | 375 |
| Hard packed sand, better | 38 | 413 |
| Gumbo | 10 | 423 |
| Shale | 12 | 435 |
| Sand, fair | 67 | 502 |
| Shale | 36 | 538 |
| Gumbo | 8 | 546 |
| Hard shale | 64 | 610 |
| Sandy shale | 59 | 669 |
| Gumbo | 15 | 684 |
| Sand | 25 | 709 |
| Hard shale | 25 | 734 |
| Sand | 20 | 754 |
| Wilcox formation: | | |
| Gumbo | 33 | 787 |
| Hard shale | 23 | 810 |
| Soft shale | 29 | 839 |
| Rock | 1 | 840 |
| Shale | 4 | 844 |
| Rock | 1 | 845 |
| Shale | 4 | 849 |
| Rock | 1 | 850 |
| Shale and rock streak | 9 | 859 |
| Shale | 4 | 863 |
| Boulders, shale | 1 | 864 |
| Soft shale and rock streak | 3 | 867 |
| Shale and rock streak | 3 | 870 |
| Shale | 15 | 885 |
| Boulder and shale | 1 | 886 |
| Sand and shale | 12 | 898 |
| Gumbo | 32 | 930 |
| Shale and gumbo | 43 | 973 |
| Sand | 5 | 978 |
| Hard shale and boulder | 3 | 981 |
| Shale | 30 | 1,011 |
| Gumbo | 10 | 1,021 |

**WELL 14N9E-10dcc (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand | 29 | 1,050 |
| Shale | 5 | 1,055 |
| Gumbo, tough | 5 | 1,060 |
| Shale, soft | 5 | 1,065 |
| Sand | 55 | 1,120 |
| Shale | 10 | 1,130 |
| Sand | 156 | 1,286 |

**WELL 14N10E-5ddd**

Owner: Dell Compress Company
Altitude: 238 feet
Driller: Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo | 25 | 25 |
| Sand | 68 | 93 |
| Rock | 4 | 97 |
| Sand, streaked with lignite | 58 | 155 |
| Claiborne group: | | |
| Clay | 22 | 177 |
| Sticky shale | 11 | 188 |
| Chalky clay | 54 | 242 |
| Gumbo | 44 | 286 |
| Shale | 12 | 298 |
| Muddy sand | 32 | 330 |
| Sand | 125 | 455 |
| Hard sandy shale | 65 | 520 |
| Shale | 130 | 650 |
| Sandy shale | 70 | 720 |
| Sand | 130 | 850 |
| Wilcox formation: | | |
| Hard shale | 127 | 977 |
| Boulders | 1 | 978 |
| Hard shale | 22 | 1,000 |
| Gumbo | 27 | 1,027 |
| Hard shale | 113 | 1,140 |
| Good sand | 135 | 1,275 |

**WELL 14N11E-20cda2**

Owner: Burdette Gin and Burdette Planting Company
Altitude: 240 feet
Driller: Carloss Well Supply Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Red soil and gumbo | 25 | 25 |
| Sand | 50 | 75 |
| Gray sand | 93 | 168 |
| Claiborne group: | | |
| Gumbo | 21 | 189 |
| Sandy shale | 61 | 250 |
| Gumbo | 50 | 300 |
| Gray sand | 100 | 400 |
| Sandy shale | 50 | 450 |
| Shale | 50 | 500 |
| Sandy shale | 50 | 550 |
| Shale, hard | 50 | 600 |
| Gumbo | 50 | 650 |
| Sand, red | 50 | 700 |
| Gumbo | 50 | 750 |
| Sand and boulders | 35 | 785 |
| Rock | 3 | 788 |
| Sandy shale | 62 | 850 |
| Gumbo | 50 | 900 |
| Gray sand | 50 | 950 |
| Rock | 2.5 | 952.5 |
| Sand | 47.5 | 1,000 |
| Gumbo | 100 | 1,100 |
| Sand | 34 | 1,134 |
| Wilcox formation: | | |
| Gumbo | 202 | 1,336 |
| Water-bearing sand | 93 | 1,429 |

**WELL 15N8E-8dbc1**

Owner: Town of Leachville
Altitude: 237 feet
Driller: Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Top soil | 5 | 5 |
| Fine soil | 10 | 15 |
| Coarse sand | 85 | 100 |
| Coarse sand and gravel | 75 | 175 |
| Fine sand | 5 | 180 |
| Claiborne group: | | |
| Gumbo | 36 | 216 |
| Sandy shale | 96 | 312 |
| Chalk clay | 69 | 381 |
| Fine hard sand | 29 | 410 |
| Hard clay | 33 | 443 |
| Hard sand | 47 | 490 |
| Gumbo | 29 | 519 |
| Shale | 10 | 529 |
| Hard sand | 45 | 574 |
| Gumbo | 15 | 589 |
| Sandy shale | 10 | 599 |
| Hard sand and shale | 31 | 630 |
| Hard clean sand | 63 | 693 |
| Hard clay | 37 | 730 |
| Sand and soft clay | 22 | 752 |
| Wilcox formation: | | |
| Hard gumbo | 41 | 793 |
| Sandy shale | 5 | 798 |
| Chalk and sandy clay | 76 | 874 |
| Chalk clay | 37 | 911 |
| Hard sand | 44 | 955 |
| Gumbo | 10 | 965 |
| Sand (hard white) | 115 | 1,080 |
| Shale or clay | 3 | 1,083 |
| Sand | 36 | 1,119 |
| Hard clay | 28 | 1,147 |
| Sandy shale | 30 | 1,177 |
| Very fine sand | 29 | 1,206 |
| Midway group: | | |
| Sandy soapstone | 49 | 1,255 |
| Sandy shale | 40 | 1,295 |
| Gummy shale | 16 | 1,311 |
| Gumbo | 126 | 1,437 |
| Rock | 1 | 1,438 |
| Gummy shale and boulders | 4 | 1,442 |
| Tough gumbo | 14 | 1,456 |
| No record | 44 | 1,500 |

**WELL 15N11E-15bdb1**

Owner: Blytheville Water Company
Altitude: 255 feet
Driller: Edward Mooney. Completed by Layne-Arkansas Company

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Top soil | 10 | 10 |
| Fine sand | 50 | 60 |
| Sand and gravel | 70 | 130 |
| Claiborne group: | | |
| Clay | 40 | 170 |
| Very fine sand | 40 | 210 |
| Gravel | 20 | 230 |
| Sand | 195 | 425 |
| Clay | 50 | 475 |
| Sand | 42 | 517 |
| Clay | 21 | 538 |
| Sand | 43 | 581 |
| Clay | 10 | 591 |
| Sand | 280 | 871 |
| Clay | 20 | 891 |
| Sand | 180 | 1,071 |

**WELL 15N11E-15bdb1 (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Wilcox formation: | | |
| Gumbo | 113 | 1,184 |
| Clay and boulders | 5 | 1,189 |
| Hard shale | 15 | 1,204 |
| Clay and boulders | 10 | 1,214 |
| Hard sand | 10 | 1,224 |
| Clay | 74 | 1,298 |
| Hard sand | 170 | 1,468 |

**BENEDUM-TREES OIL COMPANY, C. W. MACK NO. 1 WELL**

Location designation: 15N12E-3ccb

Altitude: 267 feet

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Shale, black, gummy | 21 | 21 |
| Sand | 5 | 26 |
| Shale, sand streaks | 54 | 80 |
| Sand, gray | 100 | 180 |
| Claiborne group: | | |
| Shale, gummy | 50 | 230 |
| Shale, gummy, lignite | 30 | 260 |
| Shale, gummy | 10 | 270 |
| Shale, streaks of sand | 20 | 290 |
| Shale, blue and green, sticky | 71 | 361 |
| Shale, blue and gray | 19 | 380 |
| Shale, sandy and streaks of sand | 150 | 530 |
| Sand, gray, streaks of shale | 55 | 585 |
| Shale, green and blue, streaks of sand | 205 | 790 |
| Lignite, streaks of sand and shale | 94 | 884 |
| Lignite | 23 | 907 |
| Lignite and sand | 26 | 933 |
| Sand | 47 | 980 |
| Shale, gummy | 30 | 1,010 |
| Sample log begins at 1,010 feet | | |
| Sand, brown, clay, gray | 30 | 1,040 |
| Sand, brown, frosted grains | 20 | 1,060 |
| Sand, as above, clay, gray, silty, kyanite | 30 | 1,090 |
| Wilcox formation: | | |
| Clay, brown, silty | 50 | 1,140 |
| Clay, as above, sand | 20 | 1,160 |
| Clay, brown and gray | 110 | 1,270 |
| Clay, as above, siderite | 10 | 1,280 |
| Clay, brown, plant remains | 55 | 1,335 |
| Clay, as above, micaceous sand | 45 | 1,380 |
| Sand, fractured quartz grains, kyanite | 20 | 1,400 |
| Clay, sandy | 40 | 1,440 |
| Sand, fractured quartz grains | 160 | 1,600 |
| Midway group: | | |
| Clay, dark gray | 200 | 1,800 |
| Clay, as above, micaceous | 20 | 1,820 |
| Clay, dark gray, foraminifera | 330 | 2,150 |
| Marl or limestone, glauconitic, fossiliferous | 17 | 2,167 |
| Cretaceous deposits: | | |
| Shale or clay, micaceous | 5 | 2,172 |
| Sand, bright, angular quartz grains | 28 | 2,200 |
| Shale, sandy | 30 | 2,230 |
| Sand, fine grained, glauconitic | 10 | 2,240 |
| Sand, fine grained | 50 | 2,290 |
| Sand, fine grained, calcareous cement | 60 | 2,350 |
| Sand, glauconitic, angular, micaceous | 30 | 2,380 |
| Sand, angular | 50 | 2,430 |
| Sand, angular, calcareous fossils, glauconite | 50 | 2,480 |
| Sand, angular, slightly calcareous | 80 | 2,560 |
| Sand, angular, glauconitic, calcareous fossils | 80 | 2,640 |

**BENEDUM-TREES OIL COMPANY, C. W. MACK NO. 1 WELL (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand, angular, slightly calcareous | 150 | 2,790 |
| Sand, as above, glauconitic | 10 | 2,800 |
| Clay, dark gray, micaceous, glauconitic | 6 | 2,806 |
| Jefferson City formation: | | |
| Limestone, dark gray to black, oolitic | 90 | 2,896 |
| As above, some dolomitic limestone | 59 | 2,955 |
| Dolomite, gray, finely crystalline and sandy. Water encountered, level 300 feet below surface | 5 | 2,960 |
| Limestone, dark gray, dolomitic and sandy, tan oolite chert | 10 | 2,970 |
| Limestone, dark gray | 77 | 3,047 |
| Limestone, slightly dolomitic, dark gray | 38 | 3,085 |
| Limestone, as above, sandy | 15 | 3,100 |
| Limestone, dark gray | 50 | 3,150 |
| Roubidoux formation: | | |
| Limestone, oolitic | 10 | 3,160 |
| Limestone, dark gray | 40 | 3,200 |
| Limstone, dolomitic, dark gray | 35 | 3,235 |
| Limestone, dark gray | 50 | 3,285 |
| Limestone, dark gray, oolitic. Water level rose to within 100 feet of surface | 25 | 3,310 |
| Limestone, dark gray, some oolitic | 50 | 3,360 |
| Limestone, dark gray | 7 | 3,367 |
| Limestone, dark gray, oolitic | 13 | 3,380 |
| Limestone, dark gray | 225 | 3,605 |
| Gasconade and Van Buren formations: | | |
| Limestone, dark gray, some oolitic to 4025 feet | 470 | 4,075 |
| Limestone, dark gray, thin beds of dolomite limestone | 195 | 4,270 |
| Limestone, light gray to white | 48 | 4,318 |
| Eminence formation: | | |
| Dolomite, light to dark, fine grained to crystalline. Water level rose above the ground surface at 4,405 feet. Upon completion of the well the flow was 70 gpm of water which had a temperature of 110° F. | 217 | 4,535 |

**WELL 15N12E-15cba1**

Owner: Armorel Planting Company

Altitude: 255 feet

Driller: Lee-Wilson and Company(?)

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Quaternary deposits: | | |
| Gumbo | 36 | 36 |
| Sand | 124 | 160 |
| Hard sand | 33 | 193 |
| Caliborne group: | | |
| Gumbo | 34 | 227 |
| Sand | 31 | 258 |
| Gumbo | 76 | 334 |
| Rock | 2 | 336 |
| Gumbo | 85 | 421 |
| Sand | 44 | 465 |
| Shale | 25 | 490 |
| Sand | 390 | 880 |
| Gumbo | 5 | 885 |
| Hard gumbo | 48 | 933 |
| Shale | 10 | 943 |
| Sandy shale | 21 | 964 |
| Sand | 23 | 987 |
| Shale | 19 | 1,006 |
| Sand | 54 | 1,060 |
| Hard sand | 49 | 1,109 |

**WELL 15N12E-15cba1 (Continued)**

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Wilcox formation: | | |
| Gumbo | 37 | 1,146 |
| Soapstone | 10 | 1,156 |
| Gumbo | 14 | 1,170 |
| Rock | 1 | 1,171 |
| Gumbo | 20 | 1,191 |
| Rock | 0.5 | 1,191.5 |
| Shale | 6.5 | 1,198 |
| Rock | 1 | 1,199 |
| Shale | 54 | 1,253 |
| Sandy shale | 20 | 1,273 |
| Sand | 120 | 1,393 |

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