STATE OF ARKANSAS

Arkansas Geological and Conservation Commission

Norman F. Williams, Geologist-Director

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GEOLOGY AND GROUND-WATER RESOURCES OF DREW COUNTY, ARKANSAS

By

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GEOLOGY AND GROUND-WATER RESOURCES OF DREW COUNTY, ARKANSAS

By Frank E. Onellion

SUMMARY

More than 95 percent of the water used for all purposes in Drew County comes from wells. Domestic supplies used in the towns and on the individual farms, industrial supplies, and ever-increasing amounts of irrigation water will be derived in the future as in the past from the ground-water supplies.

A study of the ground-water resources of the county was made to assist its citizens in the economic development of this important resource. Specifically, this report is intended to help all well owners, as well as those who may wish to drill wells in the future, to determine for any given location the probable depths to water, character of the materials that will be penetrated by the drill, mineral quality of the water, and quantities of water available.

The geological formations serve as both the storage reservoirs and the conduits through which the ground water is slowly moving from places of natural recharge to places of natural discharge or to wells. For this reason the geologic map, figure 1, is an important key to the availability and character of the ground water.

In the Pleistocene and Recent alluvium (Quaternary deposits), relatively large yields generally may be obtained from wells at depths of 80 to 200 feet. The water is relatively hard and commonly contains considerable iron. Most of the present irrigation wells draw water from these deposits, and they offer possibilities for much additional development. Where Pliocene (?) deposits are sufficiently thick, small supplies of generally satisfactory water can be obtained for domestic purposes.

Throughout the area of the Jackson formation shallow wells are difficult to obtain, and much of the water obtained from such wells is too highly mineralized for most uses.

Relatively soft water, especially well suited for domestic and municipal supplies, can be obtained from the Tertiary formations (Cockfield formation and Sparta sand) throughout the entire county. These water-bearing beds lie below the surface beds shown on the geologic map and at depths ranging from about 300 to 800 feet below the land surface. The depths at which water from the Sparta and Cockfield formations can be obtained are shown on two maps; figure 2 shows the minimum depth of occurrence of water-bearing beds in the Cockfield formation (300 feet in some parts of the county to 600 feet in other parts), and figure 3 shows the maximum depth at which fresh water may be obtained from the Sparta sand (1,100 feet in some parts of the county to 1,600 feet in other parts).

For a better understanding of how the water occurs in the different formations and the relationship of the different formations to one another, readers are referred to the cross sections in figures 4 and 5.

Irrigation wells in the deposits of Quaternary age obtain yields generally ranging from 1,000 to 2,100 gallons per minute (gpm), and municipal wells in the Tertiary formations commonly obtain yields ranging from 300 to 900 gpm. The quantities of water to be obtained from the wells are discussed in detail in the sections on ground water (pages 15 to 22), and the records of wells (table 1) give the characteristics of all the larger irrigation, municipal, and industrial wells in the county, together with many of the smaller domestic and stock wells. At the present time an average of about 15 million gallons of water a day is used in the county, and this represents only a small part of the total ground water available for beneficial use.

Mineral analyses of water from representative wells throughout the county and from different formations are given in table 2. By the use of the index map showing locations of wells and the tables of well records and chemical analyses, one may determine the probable ground-water conditions at the site of his well and the probable mineral quality of the water to be derived from the several water-bearing formations.

INTRODUCTION

This is one of a series of reports on the ground-water resources of Arkansas made under a program of investigation by the United States Geological Survey in cooperation with the Arkansas Geological and Conservation Commission. The investigation has been in progress since 1946 in cooperation with several State agencies, and the areas covered by reports resulting therefrom are shown in figure 6. Because ground water is an important mineral resource in every part of the State, the studies will eventually cover all parts of it. The areas selected for early study are those considered to be in most critical need of the information.

The purpose of this report is to present information about the occurrence, availability, movement, recharge, discharge, and mineral quality of the ground water in Drew County in such a way as to be of maximum use to its citizens in making the most economical development of their ground-water resources and in preventing overdevelopment.

The investigation upon which this report is based was begun in the fall of 1953, utilizing information on public wells obtained in 1949 by H. B. Counts and on irrigation wells obtained in 1952 by J. H. Criner. A Complete inventory of existing irrigation, public supply, and deep domestic wells and a partial inventory of shallow domestic wells was completed during 4 weeks of field work in 1953, 11 weeks in 1954, and 3 weeks in 1955. The geology of the area was studied and mapped during 6 weeks of field work in 1953, 10 weeks in 1954, and 3 weeks in 1955. Samples of water from representative wells were collected for chemical analysis in connection with this field work and analyzed by the Quality of Water Branch of the U. S. Geological Survey at Fayetteville, Ark., and James W. Geurin, District Chemist, assisted in writing the section on quality of the ground water. The geologic mapping was done on base maps prepared by the State Highway Commission supplemented by stereoscopic study of aerial photographs of part of the area.

PREVIOUS INVESTIGATION

The only previous report on the ground-water resources of Drew County was made by Veatch in 1906. He pointed out at that early date that the Cockfield formation generally is the source of the best water for domestic use in this county and that supplies generally could be obtained in the Cockfield in the western part of the county at depths of about 300 feet and in the eastern part at about 400 feet. He mentioned the large quantities of water in the Quaternary sand and gravel, although only small domestic wells were supplied from these deposits at that time (Veatch, 1906, pp. 119 and 120). The same report includes (pp. 156-158) records of 1 well at Blissville (Jerome), 1 at Constance, 4 at Monticello, and 3 at Wilmar. So far as could be determined, none of these wells are now extant, new wells having replaced them.

ACKNOWLEDGMENTS

The writer is grateful for the cooperation and help received from many people during this investigation and in the preparation of this report, including well owners, water-well drillers, representatives of various Government agencies, and others. Messrs. W. T. Martin and C. C. Price, of the Soil Conservation Service, furnished information and provided field office space; Mr. Leroy Hunt, of Arkansas A. and M. College, and Mr. Maxwell Hill assisted in making pumping tests; the W. H. Fair Co. and the Star City Water Well Co. permitted the collection of cuttings from wells they were drilling; well logs were made available by the Layne-Arkansas Co., Lilly Bros., H. S. Ragland Co., and Hogan Etheridge.

LOCATION AND GENERAL DESCRIPTION OF THE AREA

Drew County is a rectangular area of about 836 square miles on the Gulf Coastal Plain near the southeastern corner of Arkansas. It has a total range in altitude of about 305 feet; the lowest point (105 feet) is on the Saline River at the southwestern corner of the county, and the highest point (410 feet) is about 13 miles south of Monticello. Locally, the relief ranges from 20 feet in the vicinity of Bayou Bartholomew to 100 feet in the vicinity of the Monticello Ridge.

Topographically, the county is divided into three belts that trend in a general north-south direction. The most prominent of these belts is the Monticello Ridge, which occupies the west-central part of the county. It is about 5 miles wide at the south and about 12 miles wide at the north and consists of a highly dissected upland. Its position is shown on the map (fig. 1) by the outcrop areas of the Pliocene (?) deposits. The relatively resistant gravel beds of Pliocene (?)

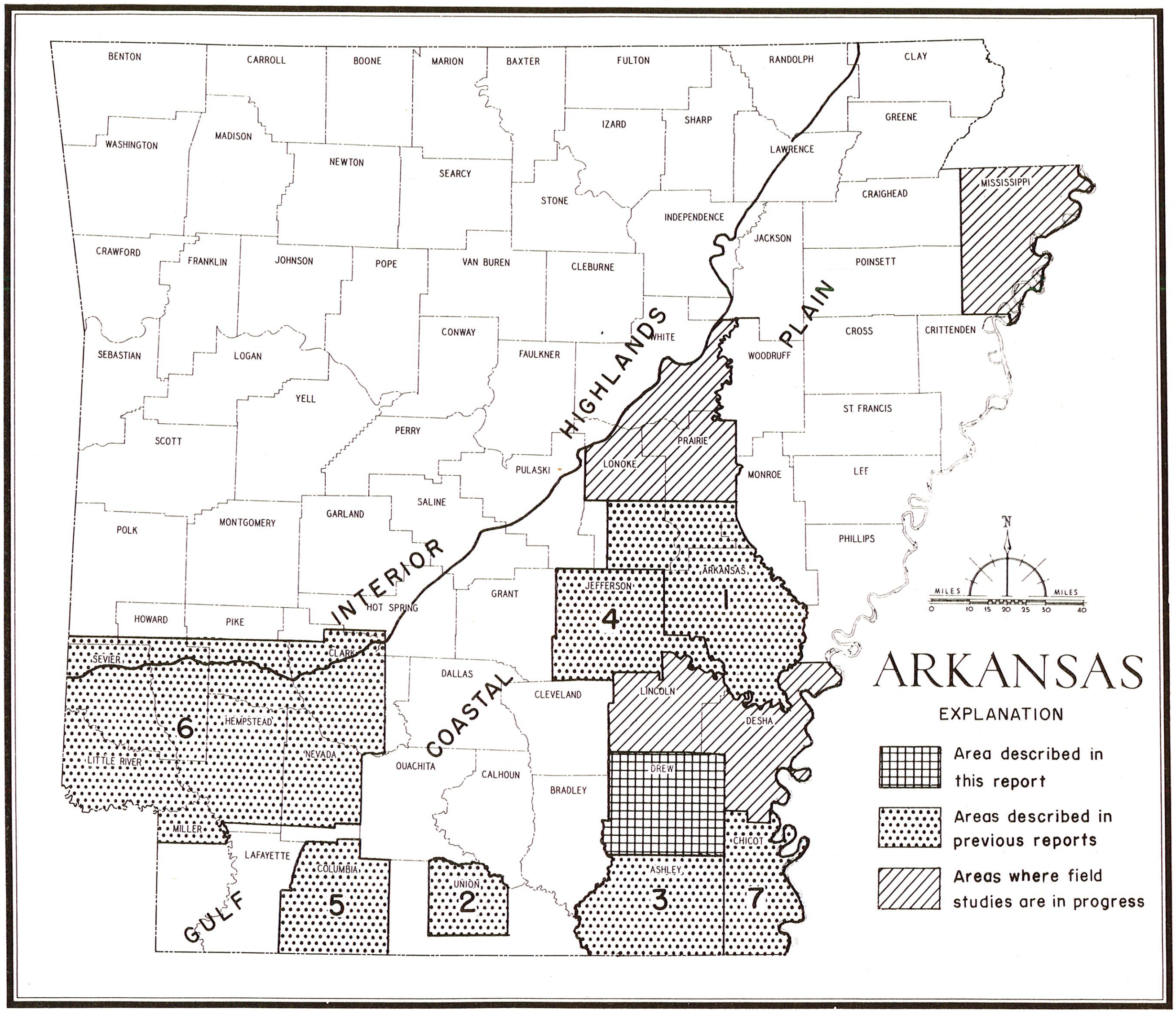


Figure 6. Map of Arkansas Showing Areas in Which Recent Ground-Water Studies Have Been Made.

1. Engler, Thompson, and Kazmann, 1945.
2. Baker, Hewitt, and Billingsley, 1948.
3. Hewitt, Baker, and Billingsley, 1949.
4. Klein, Baker, and Billingsley, 1950.
5. Tait, Baker, and Billingsley, 1953.
6. Counts, Tait, Klein, and Billingsley, 1955.
7. Onellion and Criner, 1955.

(For Complete References, See Bibliography)

age form flat-topped surfaces at similar elevations on the ridge summits. They are similar to gravel beds that cap Crowleys Ridge in northeastern Arkansas, and it seems likely that the eroded Tertiary surface with its gravel cap was once continuous across the intervening area.

Flanking the ridge on either side are the broad, gently to moderately undulating Pleistocene terraces. East of the ridge the terraces are 7½ to 12 miles wide and rise 30 to 40 feet (generally in a prominent escarpment) above the river flood plains. West of the ridge the terraces are 3 to 10 miles wide and rise 10 to 20 feet above the flood plain of the Saline River.

The flood plains of the Bayou Bartholomew and the Saline River occupy respectively the easternmost and westernmost parts of Drew County. The flood plains are generally flat to slightly undulating with numerous meander-belt scars consisting of natural levees and oxbow lakes and marshes.

Drew County is drained by two southward-flowing streams, the Bayou Bartholomew on the east and the Saline River on the west. The Monticello Ridge forms the divide and separates eastward-flowing tributaries of the Bayou Bartholomew and westward-flowing tributaries of the Saline River. Both major streams are tributary to the Ouachita River, the Saline River joining it in southern Bradley County and Bayou Bartholomew joining it in northern Louisiana.

CLIMATE

The climate in Drew County is characterized by relatively mild temperatures and by usually abundant rainfall. Winters are usually short and mild, with occasional cold periods of a few days duration. Summers are commonly long and hot, maximum temperatures reaching 100° F during July and August. Rainfall is usually abundant, sometimes excessive, and on the average is well distributed over the year. However, in any given year a varying number of months may receive much more or less than the average amount of precipitation. Large deficiencies or excesses as compared to the average precipitation are especially common during the growing season.

These and other climatic features are shown diagrammatically in figure 7, which is based on U. S. Weather Bureau records for Warren, Bradley County, Ark., situated about 8 miles west of the Drew County line. The records for Warren were used instead of those for Monticello because they cover a much longer period of time and are more nearly complete.

The frost-free growing season averages 224 days, extending from about March 25 to about November 4. However, the last spring frost has occurred as early as February 28 and as late as April 26 and the first autumn frost as early as October 11 and as late as December 19. The mean annual temperature at Warren is 63.6°F and the mean annual precipitation is 52.91 inches.

CULTURE

According to the 1950 Federal census, the population of Drew County was 17,959, which was 1,872 less than the population in 1940 and represented an average density of population of less than 22 persons per square mile. The population of the principal towns in 1950 was as follows: Monticello, 4,501; Wilmar, 746; Tillar, 239; Winchester, 198; and Collins, 183.

As in other counties in southeastern Arkansas, agriculture is the principal occupation in Drew County. About 60 percent of the population is engaged in agriculture. In 1954, 45 percent of the income was obtained from growing cotton—the chief crop. Other important crops are rice, corn, hay, small grains, potoates, fruits, and vegetables. Corn, small grains and other feed crops, and vegetables are grown on nearly all farms but mostly for local consumption. Rice growing in Drew County began about 1947 and in 1954 accounted for 9 percent of the farm income. Livestock enterprises including beef cattle, dairying, hogs, goats, and sheep made up about 16.5 percent of the farm products marketed.

Approximately 75 percent of Drew County is forested, and it is one of the major timber-producing counties in Arkansas. In 1950, 14 lumber and wood-products mills in the county produced 24,211,000 board-feet of lumber.

Transportation lines crossing the county include two U. S. and three State highways, two branch lines of the Missouri Pacific Railroad, and the main line of the Ashley, Drew and Northern Railroad (fig. 1).

Ground water is by far the most important mineral resource of Drew County. Sand and gravel is second in importance, large tonnages from beds of the Pliocene (?) on Monticello Ridge being mined chiefly for road construction. At least one bed of clay in the Jackson formation, exposed in the west-central part of the county, has been used as a bleaching clay. Both

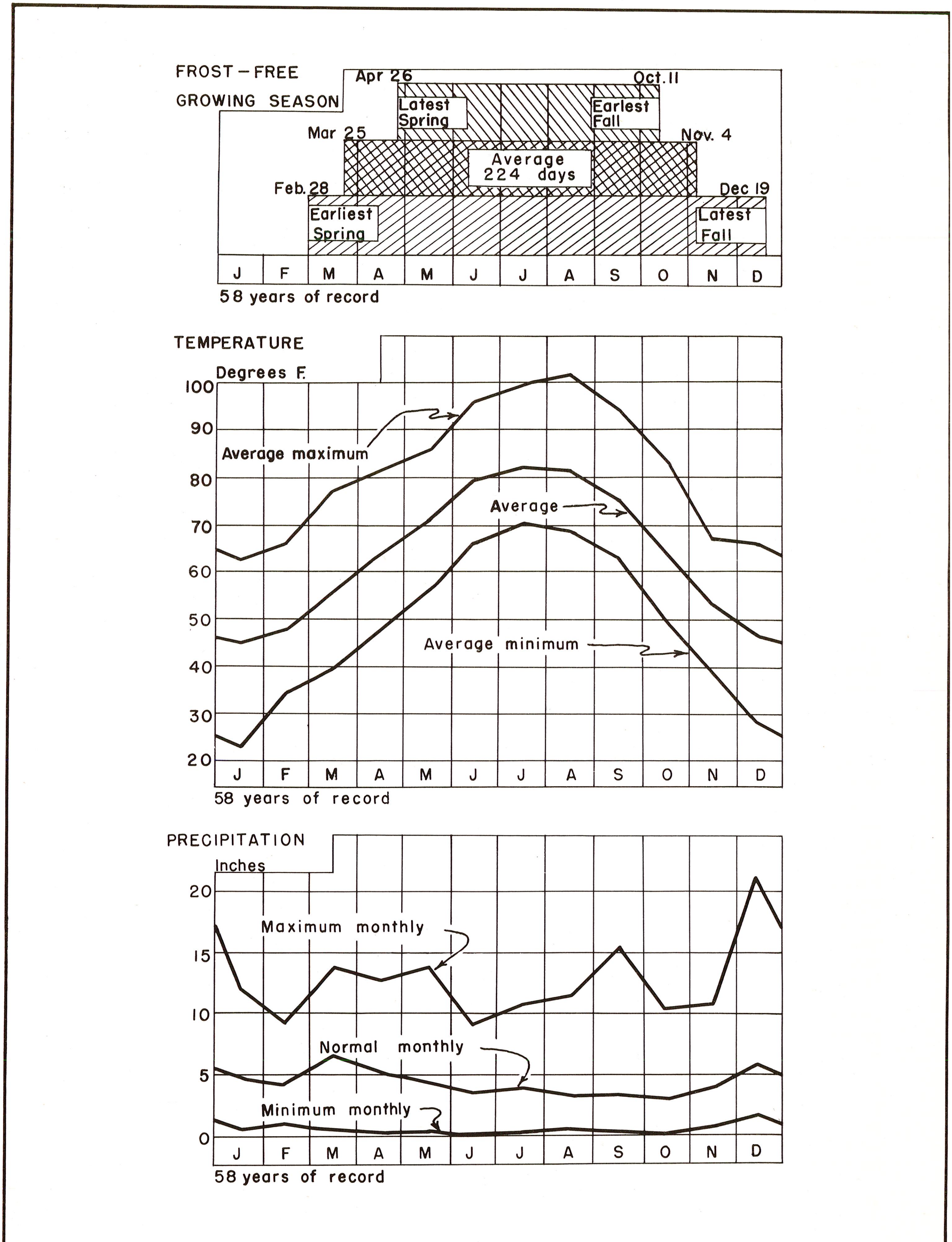


Figure 7. Selected Climatological Data for Warren, Bradley County, Ark.

red and yellow ocher are present in the Pliocene (?) deposits of Monticello Ridge, but the extent of the deposits is not known.

The manufacturing of lumber and wood products is the most important industry in Drew County. However, several small and varied industries also are important to the economy of the area, the largest of which is the Monticello Cotton Mill—engaged in the manufacturing of textiles, rugs, and bath mats. Other industries include a cottonseed-oil mill, a boat factory, a lawn-mower factory, seven cotton gins, and three food-processing plants.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE ROCKS

Ground water occurs in and moves through the generally small openings in the rock materials, and the geological formations therefore serve as both storage reservoirs and the conduits through which the ground water is slowly moving from places of natural recharge to places of natural or artificial discharge. A clear picture of the geologic materials and their relationships therefore is necessary to an understanding of the occurrence and movement of the ground water.

The following generalized section (table 3) gives the name, age, range in thickness, and character and water-bearing properties of the geologic formations in Drew County in order from oldest at the bottom to youngest at the top. The two cross sections (figs. 4 and 5) show the relationships of the water-bearing beds to one another and to confining beds. The map (fig. 1) shows the distribution of the formations exposed at the surface.

Recent and Pleistocene alluvial deposits mantle the river flood plains and terraces on both sides of the Monticello Ridge to a maximum depth of about 175 feet. The ridge is capped by Pliocene (?) deposits, and along its flanks the Jackson formation of late Eocene age crops out or is covered by a thin veneer of older terrace and colluvial material. Older deposits of Paleozoic, Mesozoic, and Tertiary age underlie these materials but are not exposed within the county.

The character and water-bearing properties of these rocks, beginning with the oldest, are described in the following pages.

ROCKS OF PALEOZOIC AND MESOZOIC AGE

Very little is known of the rocks of Paleozoic age in Drew County. However, their general character may be inferred from studies of the outcrop area in the Interior Highlands of northwestern Arkansas, where they consist of well indurated and deformed shale, sandstone, and limestone beds that range in age from Cambrian to Pennsylvanian. No rocks of Permian age are known to crop out in Arkansas, but they are believed to be present beneath part of the Gulf Coastal Plain (Spooner, 1935, p. 20). The rocks of Paleozoic age are considered the basement complex of the Gulf Coastal Plain; and their eroded surface, upon which younger sediments were deposited, slopes steeply southeastward from their area of outcrop towards the axis of the Mississippi Valley embayment.

The depth of the basement complex in Drew County is not definitely known, for as yet it has not been determined whether the red beds and igneous rocks encountered by deep oil-test wells in the area are of Paleozoic or Mesozoic age. These rocks have been encountered at depths of about 4,000 feet below the surface in the northwestern part of the county, about 4,600 feet in the northeastern part, and about 3,560 feet in the southeastern part. Rocks more certainly of Paleozoic age were encountered in the deepest well drilled in Drew County at about 6,010 feet below the surface. Fisk (1941, p. 60, fig. 61) postulated the depth of the basement complex at about 5,500 feet in the northern part of the county and about 8,300 feet in the southern part. He based his figures largely upon the projection of the known slope of the Paleozoic surface further north.

According to Imlay (1949, pp. 2 and 3), rocks of Jurassic age do not crop out in the Gulf Coastal Plain but underlie younger deposits of Cretaceous age in southern Arkansas, Northern Louisiana, eastern Texas, and west-central Mississippi. In Arkansas they consist of conglomerate, sandstone, red beds, reef limestone, anhydrite, and salt.

Spooner (1935, pp. 327 and 328) stated that the Travis Peak formation of the Trinity group of Early Cretaceous age is present in the southwestern part of Drew County, and he estimated its maximum thickness as not less than 800 feet. It is doubtful that other formations of Early Cretaceous age are present in this area.

Rocks of Upper Cretaceous Gulf series crop out over a wide area in southwestern Arkansas, and they have been traced into the subsurface of the Gulf Coastal Plain where they are penetrated by many oil-test wells. Based on data obtained from electric logs and drillers' logs of oil-test wells drilled in Drew County, deposits

Table 3

Generalized Section of the Geologic Formations in Drew County, Ark.

Era	System	Series	Group	Subdivision	Thickness (feet)	Character and Water-bearing Characteristics
Cenozoic	Quaternary	Recent		Alluvium of Recent age	0-120 ?	Clay, silt, sand, and some gravel (basal part may be Pleistocene). Water may contain excessive amount of iron, generally hard — available in large quantities.
		Pleistocene		Alluvium of Pleistocene age	0-175	Clay, silt, and sand; ⅓ to ½ of basal part generally is gray sand and gravel. Water generally hard and sometimes contains excessive iron. Yields large quantities of water — most important aquifer in county.
	Tertiary	Pliocene(?)		Deposits of Pliocene(?) age	0-60	Gravel, sandy, silty, and clayey; reddish-brown; contains lenses of sand, silt, and shale. Parts below water table contain small amounts of water of satisfactory quality.
		Eocene		Jackson formation	30-250	Shale and clay, greenish-gray to brownish on weathering; contains some lenses of silt and fine sand. Yields very little water; water generally highly mineralized.
			Claiborne	Cockfield formation	180-370	Sand, fine- to medium-grained, gray, in part lignitic; and gray to dark gray lignitic clay. Sand beds absent in some areas, as near Monticello. Water generally soft, and available in moderate quantities. Important aquifer.
				Cook Mountain formation	90-167	Clay, sandy clay, and some sand; in part calcareous. Too fine-grained to be an aquifer.
				Sparta sand	636-795	Sand, fine to medium, gray to white; and gray to brown sandy clay containing thin lignite beds. Water soft; moderate to large quantities generally available. Important aquifer.
				Cane River formation	365-465	Clay, sandy clay, and marl; green and brown; and sand, in part calcareous and glauconitic. Yields little or no water. Water salty.
				Wilcox formation	710-1140	Sand interbedded with clay and carbonaceous clay, some lignite and occasional thin bed of calcereous sand and clay. Water salty.
		Paleocene		Midway formation	475-665	Shale and clay, gray to blue-gray; lower part calcareous. Too fine-grained to yield water to wells.
Mesozoic	Cretaceous					

of Saratoga, Nacatoch, and Arkadelphia age are present and consist of sand, calcareous sandstone, chalk, shale, and marl. They lie from about 3,025 feet below the land surface in the southeastern part of the county to about 3,650 feet in the northeastern part and, according to Spooner (1935, p. 328), they range in thickness from 300 feet in the southeastern corner to 800 feet in the northern part of the county.

The rocks of Paleozoic and Mesozoic age penetrated by oil-test wells in Drew County have been well indurated and generally are fine grained; and it is doubtful, therefore, if much water could be obtained from them. Furthermore, the water in these deposits may be too mineralized for most uses.

ROCKS OF CENOZOIC AGE

The surface of the Gulf Coastal Plain of Arkansas is mantled entirely by rocks of Cenozoic age, except for rocks of Cretaceous age which are exposed in a relatively small area in southwestern Arkansas and in tiny patches in Independence and Lawrence Counties. The rocks of Cenozoic age consist of Paleocene, Eocene, Miocene, and Pliocene (?) deposits of Tertiary age and Pleistocene and Recent deposits of Quaternary age. Information from well records of oil tests indicates that formations of Paleocene and Eocene age are present in the subsurface of Drew County. Exposed at the surface are the Jackson formation of Eocene age, Pliocene (?) deposits, and Pleistocene and Recent alluvial deposits.

The Tertiary rocks consist of poorly consolidated sand, sandy clay, clay, and marl, in part glauconitic and containing thin beds and lenses of marine limestone and chalk; and nonmarine beds of sand, sandy clay, and clay, in part lignitic and carbonaceous. The Pliocene (?) deposits consist of fluvial sand, sand and gravel, friable sandstone, siltstone, and shale. The deposits of Pleistocene and Recent age consist of fluvial clay, sand, and gravel. Data based on well records of oil tests in Drew County indicate that the rocks of Cenozoic age are about 2,860 to 3,700 feet thick.

All the ground water thus far developed in Drew County and all or most of the potential fresh ground water occurs in the upper third of the Cenozoic deposits. For this reason the rocks of Cenozoic age are described in greater detail.

Structure of the Rocks of Cenozoic Age

Drew County lies on the southwestern flank of the Desha basin and on the northeastern flank of the Monroe uplift, structural features resulting from Cretaceous and Tertiary diastrophism. Consequently, the Tertiary formations in Drew County dip to the north and northeast, and some of them tend to thicken downdip toward the center of the basin. No evidence has been found to indicate that the Pliocene (?) deposits have been deformed. In addition to the general dip of the beds to the northeast, there is some indication that local sharp folds or faults are present. An example in the northwestern part of the county is to be seen between the Sigman No. 1 and T. C. Deal No. 1 wells on the cross section, figure 5.

Midway Formation

The Midway formation is the oldest Tertiary formation in the area. Although it is transitional with both the underlying marine Cretaceous deposits and the overlying continental Wilcox formation, its general stratigraphic position and approximate boundaries are among the most easily recognized of the subsurface formations in most well logs and electric logs. According to Spooner (1935, p. 117) the upper few feet consists of sandy clay that is similar in lithology to the overlying beds of the Wilcox formation. For convenience in this report, the top of the Midway has been placed at the base of the lowest well-developed resistivity kick in the electric logs of the Wilcox formation.

In Drew County the Midway formation is about 475 to 665 feet thick, increasing in thickness from southwest to northeast. It lies at depths of about 2,205 feet below the surface in the southwestern part of the county and at about 3,020 feet in the northeastern part. It consists of gray to dark-gray clay, calcareous clay, and limestone in the lower part, and blue and black carbonaceous clay in the upper part; and it contains stringers of sand and limestone near the middle. The upper beds consist of sediments similar to those that accumulate in large swamps formed by oscillations between land and shallow sea conditions.

The materials of the Midway formation generally are relatively impermeable and likely contain only small quantities of brackish to salty water.

Wilcox Formation

The Wilcox formation (Sabine formation of Veatch, 1906) includes most of the nonmarine beds lying between the Midway and Cane River formations, both of which are largely marine. Its contacts with both the underlying Midway and overlying Cane River are gradational. It ranges in thickness from about 710 feet in the southwestern part of the county to about 870 feet in the northwestern part and about 1,140 feet in the northeastern part. It is encountered at about 1,495 feet below the surface in the southwestern part of the county and at about 1,960 feet in the northeastern part.

The extreme lenticularity of the beds and the lithology of the sediments suggest deltaic deposition of the Wilcox formation in Drew County. The materials are chiefly fine- to medium-grained sand and sandy clay, in part lignitic, and carbonaceous clay and lignite containing a few beds of calcareous sand or clay. Beds of fine sand and clay are interbedded throughout the formation, but only in the basal and upper part are massive sand beds common. Sand beds up to 200 feet thick have been reported in some wells. The chocolate-brown color of many of the sandy and carbonaceous beds is distinctive, although gray to black beds also are common.

Some of the sand beds of the Wilcox are important aquifers in other parts of Arkansas, but no well in Drew County is known to obtain water from this formation. Furthermore, the available electric logs indicate that the water contained in the sand beds of this formation in Drew County is probably too saline for most uses.

Claiborne Group

The youngest rocks that underlie all of Drew County belong to the Claiborne group. Fresh and relatively soft water can be obtained from one or more of the formations of this group everywhere in the county and, therefore, they are important ground-water reservoirs in this area.

The rocks of the Claiborne group range in thickness from about 1,171 feet in the southwestern part of the county to about 1,678 feet in the north-central part. They lie at depths of about 100 to 380 feet below the surface. The group generally is divided into four formations as follows, beginning with the oldest: Cane River formation, mostly marine; Sparta sand, mostly nonmarine; Cook Mountain formation, mostly marine; and Cockfield formation, mostly nonmarine. In the absence of paleontologic data, the boundaries of these formations in Drew County had to be based entirely on lithology and are considered to be only approximate. Nevertheless, the formational divisions are useful for the purposes of this report, because the Sparta sand and Cockfield formations generally contain aquifers and the Cane River and Cook Mountain formations generally act as confining beds.

Cane River formation.—The Cane River formation overlies the sand and clay beds of the Wilcox formation. The basal part consists of brown fossiliferous, calcareous, and glauconitic clay and sandy clay and green and brown sand interbedded with light-brown and green glauconitic marl. Spooner (1935, pp. 21-24) suggested that this part is equivalent to the Reklaw member of the Cane River formation of Louisiana and of the Mount Selman formation of Texas. The middle part consists of fossiliferous light-colored sand and clay and interbedded greenish-gray sandy clay containing traces of lignite and glauconite. The upper part consists mostly of gray clay, in part lignitic and glauconitic, and some thin beds of sandy clay. The three parts are generally distinguishable but range considerably in thickness in different parts of the county.

The materials of this formation generally are too fine-grained to be important aquifers, and electric logs indicate that the water contained in the sand beds is likely to be too salty for most uses.

Sparta sand.—The Sparta sand overlies conformably the Cane River formation at depths below the surface ranging from about 705 feet in the northeastern part of the county to about 745 feet in the north-central part. Its thickness appears to range generally between 650 and 700 feet. It is composed of massive beds of white to gray fine- to medium-grained sand, interbedded with thin beds of lignitic clay and sandy clay and a few beds of gray to brown sandy clay and lignite. The beds are lenticular and, therefore, range greatly in thickness within short distances. Drillers' logs and electric logs indicate that in the southern part of the county massive sand beds up to 100 feet thick are interbedded with a few thin beds of sandy clay and clay near the base and middle of the formation. Here, the upper part of the formation consists of alternating beds of sand, sandy clay, and clay. The sand beds are not common and are rarely as much as 20 feet thick. However, in the northern part of the county the sand beds of the upper part of the formation become progressively thicker up to a maximum of about 220 feet. An electric log of an oil-well test in the NW¼SE¼ sec. 29, T. 11 S., R. 4 W., shows the Sparta to be composed almost entirely of sand with a few beds of sandy clay and clay.

In spite of their lenticular and variable nature, the sand beds of the Sparta are believed to be continuous and interconnected under all of Drew County. They constitute one of the most important aquifers in the county and furnish water to public-supply wells at Monticello, at the Prisoner of War Camp east of Monticello, and at Arkansas A. & M. College; to industrial wells at Monticello and Wilmar; to one irrigation well in northern Drew County; and to several domestic wells. The wells range in depth from about 575 to about 980 feet and in yield from 3 to 2,000 gallons a minute. The smaller yields represent pump capacities rather than well capacities. The water is confined beneath relatively impermeable clay beds and rises in the wells to points generally from 60 to 136 feet below land surface.

Cook Mountain formation.—The marine Cook Mountain formation, which overlies the Sparta sand and underlies the Cockfield formation, is difficult to distinguish from the overlying and underlying formations in both drillers' and electric logs. In general it is finer grained than either the Sparta or Cockfield and its clay beds are less lenticular than those in the continental formations. The Cook Mountain formation is shown on the cross sections (figs. 4 and 5) as a persistent band of clay and silt beds separating the two important Tertiary aquifers, and it is of hydrologic importance for this reason. It is quite possible that the boundaries of the formation are inaccurately shown and that the formation is considerably thicker than indicated.

Spooner (1935, p. 123) stated that in Bradley County this formation consists of glauconitic sand, clay, and marl. Drillers' and electric logs indicate that it is similar in Drew County, where it consists chiefly of clay and sandy clay in part calcareous and with a fairly persistent bed of fine sand 10 to 20 feet thick near the middle.

No wells are known to be producing water from the Cook Mountain formation, and it serves chiefly as a confining bed separating the aquifers of the Sparta sand and the Cockfield formation.

Cockfield formation.—The Cockfield formation, youngest of the Caliborne group, is generally gradational with and, on the basis of available logs, not sharply distinguishable from either the underlying Cook Mountain formation or the overlying Jackson formation. It is encountered at 100 feet or less below the surface in the southern part of the county, at about 250 feet in the northeastern part, and at about 320 to 360 feet in the east-central part. Its thickness generally is between 300 and 350 feet, but it seems to be only about 200 to 250 feet thick in the southwestern part of the county. It consists chiefly of fine- to medium-grained gray sand, in part lignitic, interbedded with light- to dark-gray lignitic clay. Individual beds are extremely lenticular and this characteristic, together with its lithology and absence of marine fossils, suggests a deltaic or continental origin.

The basal part of the formation consists of well-developed gray sand beds 15 to 45 feet thick interbedded with a few thin beds of lignitic clay. The middle part consists of lignitic clay 30 to 100 feet thick interbedded with thin beds of lignitic sand. The upper part consists of alternating beds of sand, in part lignitic, and lignitic clay. Some of the sand beds are as much as 15 feet thick. In general the formation appears to be more sandy in the northern part of the county.

Water of fair to good quality can be obtained from the Cockfield formation at most places in Drew County. Locally the upper sand beds yield moderately mineralized water, but less mineralized water is generally available in deeper beds of the Cockfield formation or in the underlying Sparta sand. Many domestic wells draw water from this formation at depths ranging from 194 to 589 feet. Yields are generally adequate although less than those obtained from the Sparta sand, because the water-bearing beds of the Cockfield are finer grained. Reported yields range from 3 to 300 gallons per minute, but with larger pumps considerably larger yields probably could be obtained.

Jackson Formation

The marine Jackson formation, the youngest Tertiary formation in this area, probably is present at the surface or beneath younger deposits generally throughout Drew County except in the extreme southwestern part. Also, there is some evidence from the few well logs available that the Quaternary deposits rest directly upon the Claiborne formation in the southeastern part of the county. The absence of the Jackson here may have been brought about by slight warping and post-Eocene erosion of the Jackson formation, or the Jackson formation may have been channeled through by the ancestral Arkansas River, as shown by Fisk (1944, pl. 10). The Jackson formation rests unconformably upon the Cockfield formation, but the contact is not exposed in Drew County or has not been recognized there. It is overlain on the highest part of Monticello Ridge by Pliocene (?) deposits. Although it is shown on figure 1 to crop out in a wide belt throughout the central part of the county, actual exposures of the beds are not common because of a series of Pleistocene(?) terraces developed below the ridge summit, and because the clay material slumps readily when wet and most of the hill slopes are covered with colluvial material. East of Monticello Ridge the Jackson is covered by 90 to 185 feet of Quaternary material and west of the ridge by a maximum of about 50 feet of Quaternary material. Well logs indicate that the Jackson formation in Drew County ranges in thickness from a featheredge to about 250 feet.

Wilbert (1953, pp. 23 and 24) has divided the Jackson into two formations—the marine White Bluff formation and the continental Redfield formation. Only the marine unit is present in Drew County. The lower part is a calcareous, glauconitic and locally arenaceous grayish to bluish-gray clay which resembles the Caney Point member of Wilbert (1953, pp. 53-69). The upper part is a yellowish- to greenish-gray blocky clay with some beds containing abundant hematite nodules. This probably corresponds to the Rison clay member of Wilbert.

The Jackson formation is chiefly clay, and the few sand beds it contains are very fine-grained. It generally yields only very small supplies of water and in some areas yields virtually no water. Furthermore, the water obtained is moderately to very highly mineralized and generally totally unfit for most purposes. The waters referred to locally as "alum waters" are obtained from wells in the Jackson formation.

Where the clay beds of the Jackson are overlain by reworked Pliocene(?) gravel as a result of terracing or slumping, good water may be obtainable from very shallow wells. An attempt was made to map those areas where reworked materials are sufficiently thick to yield water of better quality, but the exposures are so poor and the gravel so variable in thickness that a very large number of test holes and water analyses would be necessary to outline the areas. It is certain that such areas are few and small and that in places where water from shallow dug wells proves to be highly mineralized it is generally necessary to drill to the Cockfield or Sparta formations for a satisfactory supply.

Pliocene (?) Deposits

The Pliocene(?) deposits cap the accordant summits of Monticello Ridge and lie unconformably upon clay and silt beds of the Jackson formation. The unconformity is expressed chiefly in the weathered character of the Jackson below the contact and in the difference in altitude of the contact from place to place. The eroded surface of the Jackson upon which the Pliocene(?) beds were deposited appears to have had a maximum relief of about 40 or 50 feet in this area. West and northwest of Drew County, much larger areas of Tertiary rocks are capped by similar Pliocene(?) materials, and the Lafayette gravels of former usage of Crowleys Ridge are also similar in lithology and stratigraphic position. The deposits may be remnants of an extensive blanket of fluvial gravel and associated materials distributed by pre-Pleistocene streams across a late Tertiary erosion surface. The total absence from these gravels of pebbles derived from the glacial drift, as contrasted to their abundance in all the Quaternary gravels, supports a Pliocene age for the deposits (Stephenson and Crider, 1916, pp. 98-100). However, because the evidence for a Pliocene age is not conclusive, the deposits are designated as Pliocene(?) in this report.

The deposits have been completely removed from much of the Ridge, and elsewhere they have been much eroded. Where present, they are most commonly 10 to 15 feet thick, but the thickness ranges upward to a maximum of at least 60 feet, as shown by the measured section in T. 11 S., R. 7 W., sec. 21.

The deposits consist principally of cross-bedded sand, gravelly sand, and silty sand containing many pockets and lenses of poorly sorted gravel. They also include a few beds of sandy silt and silty clay, generally containing from a few to many disseminated pebbles. Partly indurated beds are common and consist of friable sandstone and conglomerate and some siltstone and shale. The deposits generally are rust-brown, reddish-brown, or orange, but lenticular beds of mottled white, cream, and purple shale occur locally.

The sands are composed of fine- to coarse-grained subangular to subrounded white and clear quartz grains, some of which are stained by iron oxides. A few of the grains are composed of rose quartz, smoky quartz, and dark minerals. The gravel consists largely of subangular to subrounded gray to light-brown chert fragments but contains also a few pebbles of clear to milky-white quartz. Boulders and cobbles are not common, and the largest one observed had a diameter along its longer axis of a little more than 4 inches.

Because the materials appear to have been deposited on an uneven surface and only a part of the total original thickness is present at any one place, it was not possible to determine a general sequence of deposition of the beds. Some of the best exposed sections are described below.

Section on State Highway 81, about 9.5 miles north of Monticello, near the south edge of sec. 16, T. 11 S., R. 7 W.

	Feet
Soil, sandy, gray	1
Sandstone, crossbedded, friable, fine- to medium-grained, reddish-brown with a few gray reduction spots; contains scattered chert pebbles and gravel lenses	6
Clay, slightly sandy, fissile, white to light-gray	0.5
Sandstone, crossbedded, fine- to medium-grained, rust brown	0.5
Shale, gray to bright purple, in part mottled	1
Conglomerate, cemented chiefly with iron oxide	0.2
Sandstone, very friable, medium- to coarse-grained, light-brown to gray; contains a few pebbles	3
Covered	5
	17.2

The shale and clay beds lense out a short distance to the south and do not occur in the section exposed on the west side of the road.

Section in gravel pit, about 3 miles northwest of Monticello, in sec. 10, T. 12 S., R. 7 W.

	Feet
Gravel, partly consolidated, poorly sorted, brown	8
Sand, compact and weakly cemented, silty, fine- to medium-grained, reddish-brown; contains lenses of gravel and ironstone concretions up to 10 inches in diameter	6
Sand and thin interbedded gravel lenses, crossbedded, medium- to coarse-grained, silty, reddish-brown and mottled by gray clay and sand and purple clay nodules	8
Sandstone, very friable, crossbedded in part, pebbly, medium- to coarse-grained, yellowish-orange to light-brown; contains thin beds of conglomerate cemented chiefly with iron oxides	6
Covered	4
	32

The gravel beds in this pit are very lenticular but occur in every section at one or several horizons. Solution and redeposition of the iron has resulted in a wavy streakiness in the color pattern.

Section in gravel pit, about 1 mile southeast of Monticello, in sec. 1, T. 13 S., R. 7 W.

	Feet
Sand, gravelly, partly consolidated, reddish-orange	1.5
Sand, crossbedded, partly consolilidated, fine- to coarse-grained, light-reddish-brown with some gray mottling; contains stringers of gravel	5
Gravel, sandy, partly consolidated, poorly sorted, reddish-brown; contains lenses of gray clay	4
Sand, silty, crossbedded, reddish-brown	1
Sand, gravelly, crossbedded, partly consolidated, yellowish-orange with purple streaks; contain nodules of purplish-gray clay	2
Sand, fine- to coarse-grained, partly consolidated, reddish-brown to purple	1
Shale, sandy, gray to purple	1
Sand, silty and gravelly, partly consolidated, varigated brown to gray to purple with the gray and purple chiefly in clay nodules and lenses	5
Gravel and sand, partly consolidated, yellowish to dark-brown	5
Sandstone, silty, friable, fine-to meium-grained, reddish-brown with gray mottling	6
Sand, partly consolidated, fine-grained, yellow to orange	5
	36.5

All the beds of the Pliocene(?) deposits are highly lenticular, partly because of their fluvial origin and partly because of repeated periods of cut and fill. Gravel is the most prominent material in the deposits, although sand is more abundant and silt and clay are generally present in considerable quantities. Some of the clay and iron oxide appears to have been drived from long periods of weathering.

Fossils are common in the chert pebbles and include chain and horn corals, crinoid stalks, brachiopods, bryozoans, and others. They are similar to the fossils found in cherty limestone of the Ozark and Ouachita uplands of Arkansas. Silicified wood is also common in the gravel, and stumps and logs several feet in diameter have been reported.

Where sufficiently thick, beds of Pliocene (?) age supply water to shallow domestic wells. Because the sand and gravel beds generally contain considerable silt and clay, however, the yields are small. The quality of the water is generally excellent to moderately mineralized, but in a few wells that may extend through the Pliocene(?) beds into the Jackson formation, the water is highly mineralized. Springs issue from the base of the Pliocene(?) beds, because downward movement of the water is prevented by the underlying shale. Some of the springs are utilized for domestic and stock uses.

Quaternary Deposits

Deposits of Quaternary age (Pleistocene and Recent alluvium) constitute the surface rocks in both eastern and western Drew County (Fig. 1). They overlie unconformably the Jackson formation except in the areas where that formation is absent, where they rest unconformably upon the Cockfield formation. On the State geologic map, the Quaternary deposits are divided into Pleistocene and Recent, the alluvium along the present rivers being considered as Recent and that underlying the terraces as Pleistocene. This is the classification followed in the present report, although the sand and gravel aquifer at the base of the Quaternary seems to be continuous across the terrace boundary. The Quaternary deposits, therefore, can be discussed as a single hydrologic unit.

The deposits range in thickness from a featheredge at the Jackson contact to a maximum of about 175 feet. As shown on the cross sections (figs. 4 and 5), the deposits thicken rapidly eastward from the contact with the Jackson formation to a maximum of about 175 feet within the first mile and then thin gradually to the eastern boundary of the county where they are about 95 feet thick. It seems that the river, which cut away the Tertiary beds and spread the Quaternary alluvium across them, formed its deepest channel rather close to the eastern edge of Monticello Ridge. Because these thicker and coarser channel-fill deposits furnish the largest yields to irrigation wells, the location of the old channel or channels is important. Only its general location can be given on the basis of presently available data, but as additional wells and test holes are drilled its outline can be determined more definitely. It is quite possible that other channels are present in the county, but their location is not yet known. Very little is known of the thickness of the Quaternary deposits west of Monticello Ridge, but available data indicate a maximum thickness of about 40 feet. This means that sufficient thicknesses of sand and gravel to support irrigation wells probably are not present west of the ridge.

The deposits consist of light-brown to gray sand and sand and gravel, reddish-brown fine sand, and gray, yellow, and red silt and clay. Sand and gravel generally constitute about the lower third of the deposits, and in most places the material tends to be finer grained near the top. The sand and gravel commonly is overlain by silt or the fine red sand, and this in turn commonly is capped by gray or reddish-brown clay, silt, and fine sand. In a few places the gravel and sand is interbedded with silt and clay as it is in a section exposed in a road cut about half a mile south of Collins in sec. 36, T. 13 S., R. 5 W., as follows:

	Feet
Clay, silty, yellowish to red; hard when dry	3
Sand, crossbedded, partly cemented, medium- to fine-grained, gray with streaks of light-brown	2
Clay, sandy, gray and red mottled; hard when dry	3
	8

The finer grained deposits overlying the sand and gravel seem to be more commonly gray in the areas mapped as Recent alluvium and more commonly red in the areas mapped as Pleistocene alluvium. No differences were noted in the sand and gravel in the two areas.

West of Monticello Ridge the Quaternary deposits consist of reddish-brown sand, sandy gravel, and silt. The following section was observed in a gravel pit in sec. 29, T. 14 S., R. 7 W.:

	Feet
Sandstone, silty, friable, fine- to medium-grained, reddish-brown	3
Sand, partly cemented, crossbedded, gravelly, reddish-brown; contains lenses and stringers of gravel and silty clay	9
	12

The Quaternary deposits are an important source of ground water in Drew County. They furnish an average of about 12 million gallons of water per day, which is about 4 times the total amount now withdrawn from the Tertiary deposits. All but one of the 20 or more irrigation wells in the county obtain water from the Quaternary aquifer. Irrigation wells of capacities ranging from about 300 to more than 2,000 gallons per minute probably can be obtained in most of the area of Quaternary deposits east of Monticello Ridge. Although no attempt has been made to construct irrigation wells in these deposits west of the ridge, the character and thinness of the deposits, as indicated by records of domestic wells, lends little encouragement to such attempts. Domestic wells generally can be obtained in these deposits at an average depth of about 50 feet east of the ridge and about 30 feet west of it.

GROUND WATER

OCCURRENCE OF GROUND WATER

The ground water in Drew County occurs in the small spaces (interstices) between the grains of sand and gravel, silt, and clay, which compose the rock materials. It does not occur in streams like surface water nor in "veins" like some ore deposits. If a hole is dug deep enough, water will seep into it and fill the lower part. The water level in such a hole marks the water table, below which the spaces between the rock particles are completely filled with water. The porosity — the percentage of the volume of the rock mass consisting of such interstices —governs the amount of water that can be stored in any rock. The porosity measures the water-holding capacity of the rock, but the capacity to transmit water and yield it to wells and springs is known as permeability. It is determined by the size, shape, and arrangement of the openings. For example, a bed of fine silt or clay may have a high porosity or water-holding capacity, but, because of the small size of the openings and the adherence of the water to the rock grains, the permeability or water-yielding capacity may be very low. Conversely, well-sorted sand or gravel containing relatively large and interconnected openings will transmit water freely. Therefore, water is generally obtained in wells from the coarse-grained rocks below the water table, and such beds are called aquifers or water-bearing beds. Beds of fine-grained material, such as clay or silt, generally transmit the ground water so slowly that they are called confining beds. Water encountered in an aquifer below a confining bed may rise in the well many feet above the point where it is encountered by the drill or it may flow at the land surface. Such a well is said to be artesian. All the Tertiary aquifers in Drew County yield artesian water, but so far as known none of the wells have ever flowed at the surface.

Although the individual interstices are small, even in the coarser grained materials, and although the volume of these voids rarely exceeds 25 or 30 percent of the total volume of the rock material, there is nevertheless a very large reservoir of fresh water stored in the aquifers in Drew County; because one or more water-bearing beds is present beneath the surface everywhere in the county, and salty water is not encountered above depths ranging from 1,000 to 1,600 feet (fig. 3).

Recharge, Movement, and Discharge of the Ground Water

We speak of ground water as being "stored" in underground "reservoirs," but nearly all usable ground water also is moving slowly from places where water is getting into the aquifer (recharge areas) to places where water is being lost from the aquifer (discharge areas). In Drew County the rate of movement is a few feet to a few tens of feet per year.

The source of the ground water is the precipitation that falls, largely as rain, within the county and upon the outcrop areas of the Tertiary aquifers in adjacent counties to the northwest. The recharge to the aquifers is by direct penetration of rainfall, seepage from streams and ponds, and by inflow of ground water from nearby areas through the deeper aquifers.

Direct penetration of rainfall occurs over most of the county because normally about 53 inches is available annually and because much of the surface soil is sandy to loamy and therefore absorptive. When the moisture in the soil has reached field capacity, additional rainfall that is absorbed seeps downward to the water table to replenish the ground water. Virtually all the recharge to the Pliocene(?) deposits and the shallower beds of the Jackson formation and a large percentage of that to the Quaternary aquifers is from this source. In the southwestern part of the county the aquifers in the Cockfield formation may be close enough to the surface to receive recharge from direct penetration of rainfall.

Recharge from streams and ponds is of minor importance in Drew County, because recharge by direct penetration of rainfall generally keeps the water table sufficiently high that the movement of ground water is toward the streams and ponds. However, should the water table adjacent to such streams and ponds be lowered by pumping to the extent that the hydraulic gradient is reversed, there probably would be considerable recharge from them. At the present time the streams and ponds are probably sources of recharge only during periods of flooding and high water. Ponds constructed above the water table that have not been sealed to prevent downward seepage are sources of recharge.

The Tertiary aquifers receive recharge from subsurface inflow to the area. The Cockfield formation and the Sparta sand crop out northwest, west, and southwest of Drew County, chiefly in Grant, Dallas, Cleveland, Calhoun, and Bradley Counties. Water entering the aquifers by direct penetration of rainfall and by seepage from streams and ponds in these outcrop areas travels down the dip of the beds, and some of it replenishes the water withdrawn by wells from these aquifers in Drew County. It is possible that there is natural discharge of ground water from the Cockfield formation into the Quaternary deposits in both the extreme southwestern and southeastern parts of the county so that some recharge to the Quaternary deposits also may take place by subsurface inflow from adjacent areas.

The movement of ground water in the Pliocene(?) deposits is radially outward from the central part of each outlying mass toward the exposed formational contacts with the underlying clay of the Jackson formation. Therefore, the water table is highest in the central part of each mass, and natural discharge occurs as springs and seeps at the exposed formational contacts.

Very little movement of water occurs in the fine-grained deposits of the Jackson formation, and that is one reason why the waters are generally highly mineralized. What movement there is probably takes place down the dip of the beds, generally toward the east and northeast.

Ground water in the Quaternary deposits generally moves eastward east of Monticello Ridge and westward west of that ridge. This general movement is modified by flow toward and into the main streams; thus, the ground-water movement in these surficial materials generally follows the directions of the surface drainage but, of course, at a much lower rate. Ground water also moves toward discharging wells, and such changes in the natural direction of movement are most noticeable in the vicinity of irrigation wells.

Movement of water in the Tertiary aquifers is down the dip of the beds, which in Drew County is generally eastward except in the southern part of the county where it is northeastward.

Natural discharge of ground water occurs chiefly by evaporation and transpiration where the water table is sufficiently close to the land surface, and by hydraulic discharge through seeps and springs. Ground water is taken into the roots of plants directly from the zone of saturation, or more commonly from the capillary fringe above the water table, and is discharged from the plants by transpiration. The depth from which plants lift ground water varies with the species of plants and the type of soil, but it is generally only a few feet except for plants having long tap roots. Discharge by seeps and springs occurs wherever the water table intersects the surface and where fractures, solution channels, or other openings in the rocks permit artesian water to reach the surface.

Evaporation and transpiration account for large quantities of natural discharge in Drew County, especially from the Quaternary deposits, but also from the Pliocene(?) deposits and from the Jackson formation. Because the water table is there nearest the surface, the areas mapped as Recent alluvium (fig. 1) support the largest transpiration losses of ground water to trees and other vegetation.

The natural discharge by seeps and springs at the contact betwen the Pliocene(?) deposits and the underlying Jackson formation has already been mentioned. Springs and seeps along the main and tributary stream channels discharge large quantities of ground water and largely support the base flow of the streams.

Artificial discharge through wells is discussed in the section on recovery of ground water.

Permeability of the Water-Bearing Materials

The rate of movement of ground water is determined by the size, shape, quantity, and degree of interconnection of the interstices and by the hydraulic gradient. The capacity of a water-bearing material for transmitting water under hydraulic head is known as its permeability. The field coefficient of permeability is defined by Wenzel (1942, p. 7) as the number of gallons of water a day that percolates under prevailing conditions through each mile of water-bearing bed under investigation (measured at right angles to the flow) for each foot of thickness of the bed and for each foot per mile of gradient. The coefficient of transmissibility is a similar measure for the entire thickness of the water-bearing formation and may be expressed as the number of gallons a day transmitted through each strip of the aquifer 1 mile wide and extending the height of the aquifer, under a hydraulic gradient of 1 foot to the mile. It is the field coefficient of permeability multiplied by the thickness of the aquifer.

The coefficient of transmissibility and permeability of the Sparta sand and of a Quaternary aquifer were determined by pumping tests on well 102 and well 1, respectively, by use of the recovery formula of Theis (1935). The formula may be expressed:

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

in which

T = coefficient of transmissibility, in gallons per day per foot

Q = pumping rate, in gallons per minute

t = time since pumping began, in minutes

t′ = time since pumping stopped, in minutes

s = residual drawdown at the pumped well, in feet at time t′.

The residual drawdown (s) is computed by subtracting the static water level before pumping began from water levels during the recovery period. Using semilogarithmic paper, values of the residual drawdown (s) are plotted on the linear scale against corresponding values of t/t′ on the logarithmic scale. The slope of the resulting straight line is obtained simply by taking the change in residual drawdown (Δ s) for one log cycle of t/t′ (for which the value of $\log_{10} t/t'$ is unity), so that the recovery formula may be written

$$T = \frac{264\ Q}{\Delta s}$$

Aquifer test of Sparta sand.—A pumping test was made on well 102 (table 1) at the former Prisoner of War Camp in the SW¼SW¼ NE¼ sec. 32, T. 12 S., R. 6 W., now operated by Arkansas A. and M. College, in order to determine the coefficients of transmissibility and permeability of the Sparta sand. The well was pumped on November 9, 1954, at an average rate of about 450 gallons a minute from 12:55 p. m. to 2:37 p. m. Water-level measurements were made in well 104, situated 1,850 feet from the pumped well. The pumping of well 102, which is 720 feet deep, did not affect the water level in well 104, which is 936 feet deep, indicating that, in this locality at least, there is no direct hydraulic connection between the two aquifers of the Sparta sand developed in the two wells. Water levels in well 101, which is 725 feet deep and 1,810 feet from the pumped well, were affected by the pumping, but owing to difficulties in making water-level measurements in this well and the short period of the pumping test (necessitated by an overheated motor) the data were too meager to be useful. Thus, the coefficient of transmissibility was computed from the recovery measurements in the pumped well only.

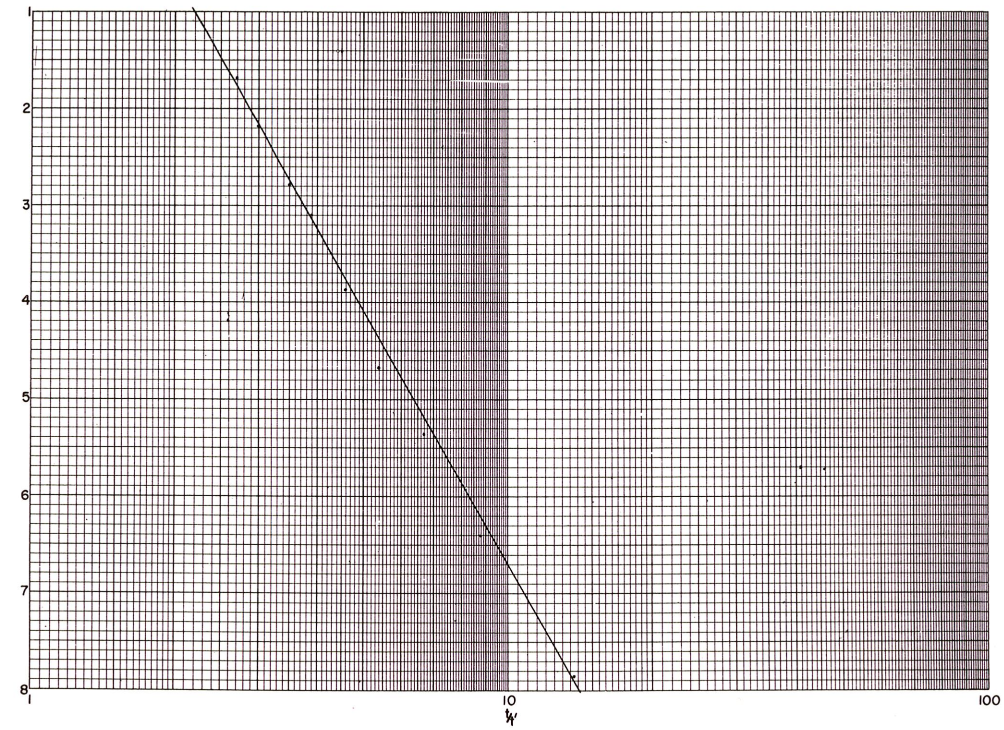
The static water level in the pumped well just before pumping started was 99.77 feet below land surface. After pumping at 450 gpm for 2 hours and 42 minutes the pump was shut down and recovery measurements made as shown in table 4.

TABLE 4

Data on Aquifer Test of the Sparta Sand. Recovery Measurements Made on Well 102 After Being Pumped at 450 gpm.

Time since pumping started (minutes) t	Time since pumping stopped (minutes) t′	t/t′	Depth to water (feet)	Residual drawdown (feet) s	Remarks
			99.77		Static water level
0					Pump started
102	0				Pump stopped
110	8	13.7	107.65	7.88	
115	13	8.8	106.17	6.40	
120	18	6.7	105.12	5.35	
125	23	5.4	104.25	4.48	
130	28	4.6	103.65	3.88	
137	35	3.9	102.87	3.10	
142	40	3.5	102.57	2.80	
152	50	3.0	101.95	2.18	
162	60	2.7	101.46	1.69	
207	105	1.97	100.39	0.62	
227	125	1.81	99.82	0.05	

The plot of the recovery curve is shown in figure 8. Applying the Theis recovery formula to these data gives a value of T (coefficient of transmissibility) of 13,500 gpd/ft., and this divided by the thickness of the aquifer (about 100 feet) gives a coefficient of permeability of about 135 gpd/ft². These values are low as compared to those determined for the Sparta sand in other



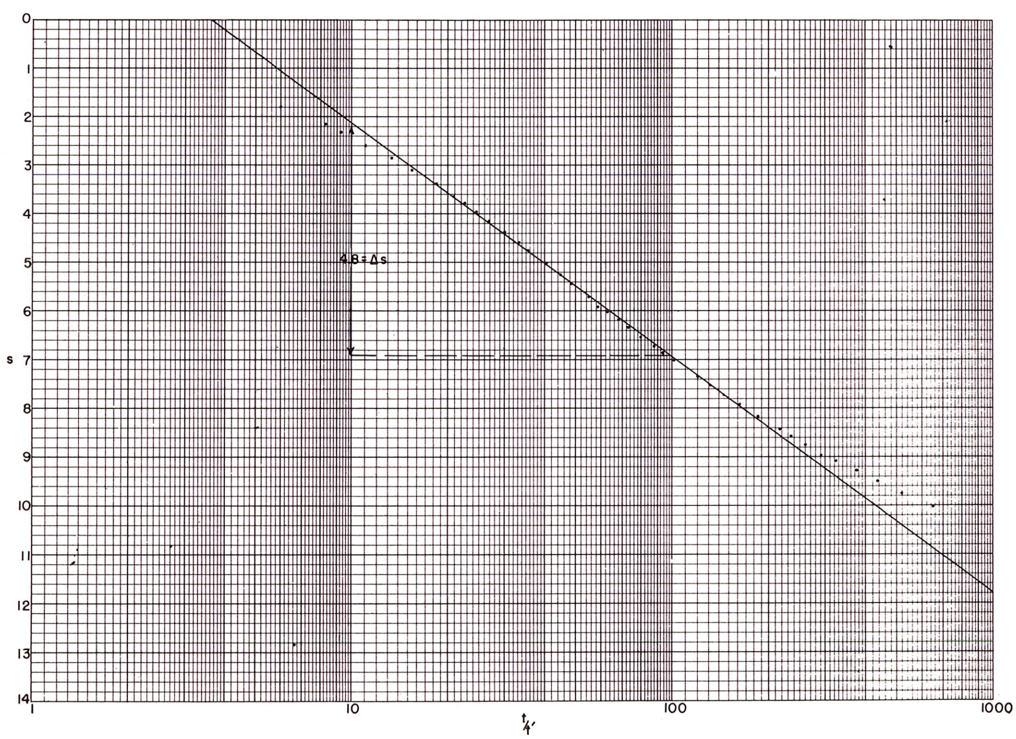
Q = 450 gpm

(Δs for one log cycle = 8.75 ft.)

$T = \frac{264Q}{\Delta s} = \frac{264 \times 450}{8.75} = 13{,}500$ gpd/ft

$P = \frac{13{,}500}{100} = 135$ gpd/ft^2

Figure 8. Recovery Curve for Aquifer Test of the Sparta Sand.



Q = 1,190 gpm

$T = \frac{264Q}{\Delta s} = \frac{264 \times 1{,}190}{4.8} = 65{,}000$ gpd/ft

$P = \frac{65{,}000}{70} = 930$ gpd/ft^2

Figure 9. Recovery Curve for Aquifer Test of the Quarternary Deposits.

parts of Arkansas. For example, at El Dorado, Union County, the transmissibility is about 32,000 gpd/ft. and permeability 80 gpd/ft^2.; at Camden, Ouachita County, T = 30,000 and P = 660; and at Magnolia, Columbia County, T = 62,000 and P = 830.

Aquifer test of Quaternary deposits.—A pumping test was made on well 1 (table 1) on the farm of R. D. Sanford and operated by Max Hill. The pump was operated from 3:00 p. m., on October 28, 1952, to 10:15 a. m., on October 30, 1952. The static water level just before pumping started was 24.38 feet below land surface. After pumping at an average rate of about 1,190 gpm for 43 hours and 15 minutes, the pump was shut down and recovery measurements made as shown in table 5. The plot of the recovery curve is shown in figure 9.

TABLE 5

Data on Aquifer Test of the Quaternary Deposits. Recovery Measurements Made on Well 1 After Being Pumped at 1,190 gpm.

Time since pumping started (minutes) t	Time since pumping stopped (minutes) t'	t/t'	Depth to water (feet)	Residual drawdown (feet) s	Remarks
			24.38		Static water level
0					Pump started
2595	0				Pump stopped
2598	3	865	34.79	10.41	
2599	4	650	34.40	10.02	
2600	5	520	34.13	9.75	
2601	6	435	33.86	9.48	
2602	7	373	33.65	9.27	
2603	8	326	33.46	9.09	
2604	9	290	33.26	8.98	
2605	10	260	33.11	8.73	
2606	11	236	32.95	8.57	
2607	12	217	32.80	8.42	
2609	14	186	32.56	8.18	
2611	16	163	32.31	7.93	
2613	18	145	32.11	7.73	
2615	20	131	31.91	7.53	
2617	22	119	31.72	7.34	
2621	26	101	31.39	7.01	
2623	28	93.6	31.24	6.86	
2625	30	87.5	31.10	6.72	
2628	33	79.5	30.89	6.51	
2631	36	73.2	30.72	6.34	
2634	39	67.5	30.56	6.18	
2637	42	62.7	30.40	6.02	
2640	45	58.6	30.23	5.95	
2643	48	55	30.10	5.72	
2649	54	49.2	29.84	5.46	
2655	60	44.3	29.61	5.23	
2661	66	40.4	29.40	5.02	
2667	72	37	29.22	4.84	
2670	75	35.6	29.13	4.75	
2676	81	33.1	28.98	4.60	
2685	90	29.9	28.77	4.39	
2695	100	26.9	28.54	4.16	
2705	110	24.6	28.35	3.97	
2715	120	22.6	28.17	3.79	
2725	130	20.9	28.04	3.66	
2745	150	18.3	27.78	3.40	
2775	180	15.4	27.48	3.10	
2805	210	13.4	27.24	2.86	
2850	255	11.2	26.97	2.59	
2910	315	9.25	26.69	2.31	
2950	355	8.3	26.54	2.16	
3110	515	6	26.17	1.79	

Applying the Theis recovery formula to these data gives a value of T (coefficient of transmissibility) of 65,000 gpd/ft. Dividing this by the saturated thickness of the aquifer (about 70 feet) gives a coefficient of permeability of about 930 gpd/ft^2 — about half the permeability of the Quaternary deposits in the Grand Prairie region of Arkansas.

It should be noted that both wells on which pumping tests were made are lower in yield than the average wells in the respective aquifers in Drew County. Furthermore, only a single test was made on each aquifer and the determined values for transmissibility and permeability may be far from the average values throughout the county.

Fluctuations of Water Levels

It is a common observation that the water level in a well is not constant but rises and falls much as the water level in a lake or surface reservoir rises and falls and generally for the same reason. A record of the water-level fluctuations in wells is, therefore, one of the chief sources of information from which changes in storage in the ground-water reservoir can be determined. In artesian wells especially there are minor fluctuations caused by changes in atmospheric pressure, earthtides, etc., but such changes generally can be distinguished from those caused by changes in storage. A general rise in water levels in any area indicates that the rate of recharge to the aquifer exceeds the rate of discharge, and, conversely, a general decline in water levels indicates that the rate of discharge exceeds the rate of recharge. Water levels always decline in the vicinity of discharging wells, and the larger the quantity pumped the greater the decline. If the water-level depression caused by pumping the wells induces increased recharge or reduces the natural discharge, or both, the water levels may become stabilized for a given rate of pumping. Pumping more water from the same wells or from additional wells will cause additional decline of the water levels. Therefore, records of water-level fluctuations in wells are an important means of knowing if and when the safe yield of an aquifer is being exceeded; hence, the plan is to continue the measurement of water levels in observation wells in Drew County as the development of its ground-water resources proceeds.

Some decline in pressure, and hence in the water levels in wells, has probably occurred in the artesian aquifers of the Sparta sand and Cockfield formation over the years in which wells have been drawing water from them. Even the moderate withdrawals in Drew County would have caused some decline. Also, the aquifers extend into other parts of Arkansas and into northern Louisiana where much larger withdrawals are made. Thus, some decline in water levels probably would have occurred even if no water had been withdrawn from them in Drew County. Unfortunately, however, no information is available as to what the actual decline may have been.

No significant changes in water levels have been noted in the P. O. W. Camp wells that tap the Sparta sand nor in well 184 at Arkansas A. and M. College that taps the Cockfield formation. Well 101 at the Camp had a reported water level of 98 feet when drilled in 1943, and it was 98.42 in September 1954 and 96.5 in March 1955. In well 102, which is the only well pumped regularly, there was no decline in water level from 1950 to 1954, the water level having been 98.40 feet on January 25, 1950, and 98.39 on September 10, 1954. Well 184 at the College had the following water levels: September 1954, 149.90 feet; November 1954, 150.26; March 1955, 149.47.

No continuous declines have been noted in the water levels in the Quaternary deposits. Comparative measures as made on four of the irrigation wells are given in table 6. It is evident from these measurements that withdrawals from wells are not yet sufficiently large to cause progressive lowering of water levels even in the irrigated areas.

TABLE 6

Water-level Measurements in Deposits of Quaternary Age.

Date	Depth to water (feet)
WELL 6	
Oct. 28, 1952	19.32
Nov. 26, 1952	15.60
Dec. 29, 1952	15.42
Jan. 28, 1953	15.18
Feb. 26, 1953	13.94
Apr. 1, 1953	12.72
Apr. 28, 1953	12.57
Apr. 14, 1954	14.86
Sept. 28, 1954	19.40
Oct. 26, 1954	19.10
Nov. 23, 1954	17.49
Dec. 29, 1954	16.90
Jan. 27, 1955	17.18
Feb. 28, 1955	16.11
Mar. 22, 1955	15.72
Apr. 20, 1955	19.90
May 26, 1955	16.12
Sept. 29, 1955	18.62
Oct. 27, 1955	18.20
Nov. 30, 1955	17.90
Dec. 28, 1955	17.76
Jan. 26, 1956	17.70
Feb. 23, 1956	16.09
Apr. 6, 1956	15.84
Apr. 24, 1956	15.93
WELL 13	
May 6, 1953	30.00
Mar. 24, 1955	34.70
WELL 14	
May 11, 1954	37.50
Mar. 24, 1955	37.10
WELL 34	
Mar. 10, 1939	70.00
Mar. 24, 1955	54.85

RECOVERY OF GROUND WATER

Principles of Recovery

When water is withdrawn from a well the water table in the vicinity of the well declines and assumes a form comparable to that of an inverted cone. This is called the cone of depression. An increase in the rate of pumping, in any given well, produces a greater drawdown; as pumping time increases, the decline in water level extends to greater and greater distances so that the water levels in wells from several hundred feet to a mile or more from the pumped well may be lowered somewhat.

The specific capacity of a well is its rate of yield per unit of drawdown and generally is stated in gallons per minute (gpm) per foot of drawdown. For example, well 102 with a measured yield of 750 gpm and a drawdown of 62 feet has a specific capacity of 12.1 gpm per foot of drawdown. When a well is pumped the water level drops rapidly at first and then more slowly until a condition of approximate equilibrium between discharge and recharge is reached. In testing the specific capacity of a well, therefore, it is important to pump the well until the water level remains approximately stationary. 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 bearing on the yield of a well and, hence, on the specific capacity of a well. Drawdown increases the height that water must be lifted in pumping a well, thus increasing the cost of pumping. Other things being equal, the drawdown in a well varies inversely with the permeability of the water-bearing materials.

Well Construction and Types of Pumps

Wells in Drew County are constructed by all the common methods. Dug wells are especially common in the areas of outcrop of the Pliocene (?) deposits and the Jackson formation (fig. 1). Because the least mineralized water in these deposits occurs near the surface and because the permeabilities generally are low, large-diameter dug wells having relatively large storage capacities have proved most practicable. Some wells are driven or bored in these formations also, but most of the wells constructed by these methods are in Quaternary deposits where the water table is relatively close to the surface. The Quaternary deposits generally are sufficiently permeable so that driven and bored wells of small diameter yield ample supplies for domestic purposes. The jetting method of well construction is not widely used in this area, but it is a satisfactory method for the construction of farm wells in the Quaternary deposits. Wells that penetrate the full thickness of the Quaternary gravel and sand, such as irrigation wells, and wells completed in the Tertiary formations generally are drilled.

The dug wells are generally excavated manually with pick and shovel. They range from 18 to 60 inches in diameter and generally are 30 feet or less in depth. They are curbed with wood, tile, or concrete. Both hand augers and power augers are used in boring wells. Hand-augered wells generally extend only a few feet below the water table and are commonly cased with 6- or 8-inch tile. Power-augered wells generally are put through the entire thickness of the aquifer and cased with galvanized iron casing to which is attached a screened well point.

All irrigation, industrial, and public-supply wells and some domestic wells in the area are drilled, using cable-tool or hydraulic rotary rigs. The irrigation wells range in diameter from 8 to 25 inches, and the domestic and public-supply wells from 2 to 10 inches. Because all wells in the county obtain water from relatively unconsolidated deposits, they generally are cased to the bottom of the hole. Commercial well points generally are used in the smaller diameter wells; and locally constructed screens, consisting of wire-wrapped slotted casing, generally are used in the larger wells.

Most of the wells in Drew County that have been drilled in the last several years for municipal or irrigation supplies are gravel packed. In one method of constructing such wells, a large-diameter hole is first drilled and temporarily cased. A well screen or perforated casing is then centered in the hole opposite the water-bearing material and enough blank casing added to reach the surface. The space between the two casings is filled with carefully screened gravel, and all but 20 to 30 feet of the outer casing is pulled from the hole. In another method the hole is drilled to the top of the aquifer, generally by the hydraulic rotary method, the casing is set, and then an underreamer is used to drill a large-diameter hole below the casing. After the screen has been placed in the bottom of the well, gravel is packed around the screen as the well is developed by intermittent pumping.

A packing of well-sorted medium to coarse gravel generally is considered to give the best results, but where the water-bearing material is extremely fine, coarse sand or fine gravel may be preferred. The use of the gravel packing permits the use of coarser screens, even though the aquifer may consist of uniform fine-grained materials.

Irrigation, industrial, and public-supply wells are equipped with turbine pumps powered by butane or diesel engines or electric motors. All deep wells and a few shallow domestic wells are equipped with jet or cylinder pumps powered by electric motors. Other wells have pitcher pumps or simply a rope and bucket.

UTILIZATION OF GROUND WATER

Ground water is used at present in Drew County at an average rate of about 15 million gallons a day. About 12 million gallons per day is withdrawn by 22 irrigation wells and the rest from 10 public-supply wells, 5 industrial wells, and many domestic wells and springs, about 200 of which are listed in table 1.

Domestic Supplies

Shallow wells yielding water suitable for most domestic purposes generally can be obtained in the Quaternary deposits (see Recent and Pleistocene alluvium, fig. 1) and in the Pliocene(?) deposits. On the other hand, much of the water in the Jackson formation is highly mineralized, so that in the outcrop areas of the Jackson it is generally necessary to drill to the underlying Cockfield formation for satisfactory supplies. Even in those areas where usable water is available at shallow depths some domestic wells are drilled to the Tertiary formations, which yield much softer water containing little or no iron.

Public Supplies

Five municipalities in the county have public water systems, all of which are supplied from wells.

Winchester.—This town in northeastern Drew County obtains its water from one well (well 2, table 1) drilled into sands of the Cockfield formation. The water is pumped directly from the well into an overhead tank having a reported capacity of 5,000 gallons. A turbine pump powered by an electric motor pumps the well at a reported maximum daily rate of 20,000 gallons. The water is reported to be of good quality and is not treated.

Tillar.—This town in the northeastern part of Drew County obtains its water from one well (well 7, table 1) drilled into the Sparta sand. The raw water is pumped into a 50,000-gallon surface reservoir, is then treated, and the treated water is pumped into a 50,000-gallon elevated tank. Turbine pumps and electric motors are used, and the estimated maximum daily capacity is 45,000 gallons. The chemical analysis (table 2) indicates a moderately mineralized, soft, sodium bicarbonate water that is typical of the Sparta sand.

Jerome.—This town in the southeastern corner of the county is supplied from one well (well 243, table 1) tapping the Sparta sand(?). The water is pumped directly into a 25,000-gallon elevated tank by a turbine pump and electric motor. The estimated maximum daily pumping rate is 2,700 gallons. The water is reported to be of good quality and is not treated.

Monticello.—This city is situated near the center of the county. It obtains its water supply from two wells (wells 138 and 139, table 1) drilled into the Sparta sand. Electrically powered turbine pumps are used, and the water is stored in a 400,000-gallon surface reservoir. The estimated daily maximum pumping rate is 250,000 gallons. The wells yield a soft, sodium bicarbonate water that contains no iron and is not treated.

The more or less separate community known as University Heights, situated at Arkansas A. and M. College about 2 miles south of Monticello, obtains its water from a well (well 183, table 1) in the Sparta sand. It is reported that an older shallower well in the Cockfield formation will be deepened to the Sparta to serve as an auxiliary source. The water is pumped directly from the well into a 25,000-gallon elevated tank and is served without treatment.

Wilmar.—This town in the west-central part of the county obtains its water from one well (well 160, table 1), but it also is connected with the Ozark-Badger Lumber Co. well (well 161, table 1) for emergency supplies. Both wells are thought to end in the Cockfield formation, the city well near the top at a depth of about 200 feet and the company well near the base at a depth of about 500 feet. The water from the deeper well is less mineralized. Water is pumped directly from well 160 by an electrically powered turbine pump to a 12,000-gallon elevated tank. The water is not treated.

Industrial Supplies

Among the chief industrial users of ground water in Drew County are two lumber companies, a cotton mill, a cottonseed-oil mill, and a pipeline company. All the wells draw soft water from the Sparta sand or Cockfield formation.

Irrigation Supplies

Well water is being used in rapidly increasing amounts for irrigation in Drew County. In 1955 an average of about 12 million gallons a day was used for this purpose. In 1953 the water was used principally to irrigate the 6,900 acres of rice grown in the county. However, 3 years of summer drought (1951 to 1954) necessitated considerable supplemental irrigation of cotton and vegetable crops. Even in years of more nearly normal rainfall, supplemental irrigation of row crops is reported to pay dividends in increased yields, and the drilling of wells for this purpose is likely to increase during the next several years.

The Quaternary deposits are the principal source of the irrigation water and furnish adequate supplies for this purpose throughout their extent east of Monticello Ridge. No irrigation wells have yet been obtained west of the ridge, and the few available logs indicate that the water-bearing sand and gravel is much thinner there than it is east of the ridge. However, much of the area remains to be explored by wells and test holes, and there may be local areas where irrigation wells can be obtained.

One well (well 25) tapping the Sparta sand is used for irrigation. It is reported to be 864 feet deep and to pump 2,000 gpm. Although the specific capacity of this well is not known, wells in the fine-grained Tertiary aquifers generally have large drawdowns when such large quantities of water are pumped. For this reason and because of the expense of drilling the deeper wells, the Tertiary aquifers are not likely to be widely developed for irrigation. Water from the Tertiary deposits can be used to irrigate rice; however, it is unsuitable for the irrigation of many crops because of the high ratio of sodium to calcium and magnesium (fig. 10).

Possibilities for Future Development

Although ground water now plays a large role in the economy of Drew County, the quantities thus far developed are small compared to the quantities potentially available.

Throughout most of the county east of Monticello Ridge wells yielding up to 2,000 gallons a minute can be obtained at depths of less than 200 feet in the Quaternary deposits. The waters contain moderate to large amounts of calcium and magnesium bicarbonate and, therefore, are rather hard. They also commonly contain several parts per million of iron. The hardness and iron content make them less satisfactory for domestic purposes than the waters from the Tertiary deposits, but they generally are excellent for irrigation of most crops. It seems likely that irrigation farming will become much more widely practiced in this large area than it is at present.

The soft water from the Tertiary deposits appears to be available everywhere in the county. In the southwestern and east-central parts, the minimum depth generally is 300 to 350 feet and in the central part about 550 feet. Figure 2 shows in a general way the minimum depth at which water may be obtained from the Cockfield formation throughout the county, and figure 3 shows the approximate maximum depth to which the fresh water extends. At no place in the county is salt water likely to be encountered in the Tertiary aquifers at depths less than 1,000 feet, and beneath a part of Monticello Ridge it would probably be necessary to drill more than 1,600 feet before salt water is encountered.

It is generally impossible to obtain water suitable for domestic purposes from shallow wells in much of the area of outcrop of the Jackson formation; deeper wells to the Cockfield formation or to the Sparta sand are generally needed. If the cost of a deeper well seems prohibitive to a single family, a community well serving several families might be considered. Most of the 2-inch wells in the Tertiary deposits will furnish sufficient water for several families.

QUALITY OF THE GROUND WATER

The chemical character of the ground water in Drew County is indicated in table 2 by 121 analyses of water from selected wells throughout the county from the several aquifers.

The analyses include the dissolved mineral constituents that determine the fitness of the water for municipal, industrial, agricultural, and domestic uses without reference to the sanitary quality of the water. A single sample from a well generally is regarded as being representative of the chemical quality of the water, because the concentration of the dissolved minerals of the water in individual wells is not likely to change appreciably with time. Exceptions to this generality include very shallow wells, where the concentration may be modified by rainfall; wells tapping aquifers that are subject to salt-water encroachment; or wells in aquifers that are recharged by nearby streams that fluctuate in mineral concentration.

The water samples were analyzed according to methods regularly used by the Geological Survey. These methods are essentially the same as, or modifications of, methods described in authoritative publications for the mineral analysis of water samples, such as: American Public Health Association, 1946, Standard methods for examination of water and sewage, 9th ed., and Official Agricultural Chemists, 1950, Methods of analysis of the association of official agricultural chemists, 7th ed.

Chemical Constituents in Relation to Use

The following discussion of the chemical constituents of ground water in relation to use was adapted from publications of the U. S. Geological Survey and is limited to those constituents given in table 2.

Aluminum was determined in only five samples. Of these, three contained no aluminum and the other two contained 0.1 and 0.3 part per million (ppm), respectively.

Silica.—Silica is found in all natural waters, and the use of water for domestic and irrigation purposes is not affected by its presence. However, it is one of the most troublesome constituents in boiler feed water due to the formation of hard silica sale. Silica ranged between 6.6 and 52 ppm in the 16 samples for which this constituent was determined. In general, the samples from the Jackson formation and the Quaternary deposits contained about twice as much silica as those from the Tertiary aquifers.

Iron.—Iron is dissolved from many rocks and soils and commonly also from the pipes through which the water flows. The quantity of this constituent in ground water may differ greatly from one locality to another, even though the waters are derived from the same formation. Waters having a low pH value (high in acidity) tend to dissolve iron readily. Large amounts of iron may interfere with efficient operation of silicate water softeners and may prove more detrimental than either excessive hardness or dissolved solids. Water containing an appreciable amount of iron may produce reddish-brown stains on white porcelain or enameled ware and fixtures and on clothing or other fabrics. The U. S. Public Health Service Drinking Water Standards recommends a maximum of 0.3 ppm of iron and manganese in drinking water for use on interstate carriers. Many industries cannot tolerate any iron in their supply of process water; however, iron is readily removed from most waters by aeration and filtration. Unless otherwise noted, values of iron reported in table 2 are for total iron. The iron content of the waters sampled ranged from 0 to 24 ppm. It is generally low in the waters from Tertiary deposits, ranging from 0 to 1.1 ppm; moderate in those from the Pliocene(?), ranging from 0.06 to 2.6 ppm; and highest from those in the Jackson formation and Quaternary deposits, ranging from 0.04 to 24 ppm.

Calcium and magnesium.—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. Calcium and magnesium are the principal constituents causing 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. The analyses show a range in calcium content from 0.4 to 500 ppm and in magnesium from 0 to 333 ppm. In waters from the Tertiary deposits the calcium content is low, ranging from 0.4 to 6 ppm; in waters from the Quaternary deposits it is moderate, ranging from .9 to 87 ppm; and in waters from the Jackson it is generally high, ranging from 11 to 500 ppm.

Sodium and potassium.—All natural water contains compounds of sodium and potassium in solution. Water that contains less than 5 ppm of the two together is likely to carry almost as much potassium as sodium. As the total quantity of these constituents increases, the proportion of sodium generally becomes much greater.

Moderate quantities of sodium and potassium have little effect on the suitability of water for most uses. However, when their salts make up most of the mineral content, the water may not be satisfactory for irrigation. Water in which sodium makes up more than 60 percent of the cations (on an equivalent-per-million basis) may be injurious to crops when applied to certain types of soil. An irrigation water having a high proportion of sodium will eventually cause the soil to become relatively impermeable because of the dispersion of the colloidal soil particles.

In waters sampled, the sodium ranged from 2.2 to 486 ppm, and both extremes were in water from the Quaternary aquifers. In general, the waters from the Quaternary deposits have low to moderate amounts of sodium, and the waters from the Jackson formation generally contain moderate to large amounts of sodium. The waters from Tertiary aquifers contain only moderate amounts of sodium, but it makes up a high percentage of the cations because these waters contain very little calcium and magnesium. The waters sampled contained from 1.0 to 71 ppm of potassium. Some of the waters containing the larger amounts of potassium also contained large amounts of nitrate. Because these waters came from open dug wells, it appears likely that these constituents came from fertilizer applied to a nearby field, garden, or lawn.

Carbonate and bicarbonate.—Carbonate and bicarbonate occur in water as a result of the solvent action of carbon dioxide in rain or surface water reacting with the minerals present in the earth, such as calcite and dolomite, and forming calcium and magnesium bicarbonates. Carbonate is rarely present in appreciable quantities in natural water. The bicarbonate in water that comes from relatively insoluble rocks may amount to 50 ppm or less; many samples of water from limestones contain 200 to 400 ppm. Bicarbonate in moderate concentration has no effect for most uses; however, large quantities of sodium bicarbonate will cause foaming and priming in boilers.

Bicarbonate is the chief anion in all but the most highly mineralized waters in Drew County. In waters from the several aquifers it had the following ranges: Quaternary, 3 to 341 ppm; Pliocene(?), 0 to 20; Jackson, 0 to 196; Cockfield, 146 to 334; Sparta, 120 to 314.

Sulfate.—Sulfate may be dissolved in large quantities from gypsum, some shales, and deposits of sodium sulfate. When present in large quantities it makes the water unpalatable and it combines with calcium to form a hard boiler scale, calcium sulfate. Sulfate in excessive amounts is common in waters from the Jackson formation, but the sulfate content generally is low to moderate in waters from Quaternary deposits, and is low in waters from the Sparta sand and deeper parts of the Cockfield formation. Its range in the waters from the Sparta was 0.9 to 7 ppm, whereas in waters from the Jackson it was 20 to 3,080 ppm.

Chloride.—Chloride occurs in all natural water and may be present in large amounts because the chlorides of calcium, magnesium, sodium, and potassium are extremely soluble. Chloride in excess of 250 to 500 ppm makes drinking water unpalatable. Large quantities of chloride may affect the industrial use of water by increasing the corrosiveness of waters that contain large quantities of calcium and magnesium.

In the waters analyzed the chloride content was low to moderate. It was lowest in waters from the Tertiary aquifers and highest in some waters from the Quaternary deposits and the Jackson formation. In only one water from a Quaternary deposit did the chloride exceed 500 ppm.

Fluoride.—Fluoride is of interest in domestic water supplies, chiefly because of its effect upon teeth. It has been shown that fluoride in drinking water in a concentration of about 1.0 ppm effectively reduces the incidence of dental caries in small children (Dean et al., 1941). However, quantities in excess of 1.5 to 2 ppm may cause a dental defect known as mottled enamel when the water is consumed by children during the formation of their permanent teeth. In the 18 samples analyzed for this constituent, 4 showed none and the fluoride content of the others ranged from 0.1 to 2.2 ppm.

Nitrate.—Nitrate generally is present in natural water in relatively small quantities. Its presence in excessive amounts may indicate contamination by sewage and other organic matter, as it represents the final stage of oxidation in the nitrogen cycle. Several studies have indicated that an excessive nitrate content in water used in feeding may be the cause of infant cyanosis and that nitrate content in excess of about 45 ppm (as NO_3) probably should be regarded as unsafe for use in infant feeding (Comley, 1945). Most of the waters sampled contained less than 5 ppm of this constituent, and none of the waters from Tertiary deposits exceeded this amount. Most of the waters having high concentrations of nitrate came from open wells that may have been polluted by surface water which had been in contact with fertilizer applied on crops or lawns near the wells.

Dissolved solids.—The amounts of dissolved solids listed in table 2 represent approximately the dissolved mineral constituents in the water plus small amounts of organic matter and any water of crystallization. The amounts and character of these solids depend on the solubility and types of rocks with which the water has been in contact. With the exception of that which is hard or which contains excessive amounts of iron or manganese, water containing less than 500 ppm of dissolved solids generally is satisfactory for most domestic uses. Water containing more than 1,000 ppm of dissolved solids is likely to include certain constituents that make it unsuitable for domestic uses and that containing more than 2,000 ppm may be injurious to some plants when used for irrigation.

In the samples analyzed the dissolved solids ranged from 28 to 4,780 ppm. Waters having more than 500 ppm were from the Jackson formation or from Quaternary deposits near the Jackson contact.

Hardness.—Hardness probably is one of the most important factors to be considered when choosing a water supply for either municipal, industrial, or domestic use. It is easily recognized by the increased quantity of soap required to produce lather, by the formation of the insoluble curd that is objectionable in all washing processes, and by the deposits of insoluble salts formed when the water is heated or evaporated. In addition to its soap-consuming characteristic, hard water is objectionable because of the formation of scale in boilers, water heaters, radiators, and pipes, with a resulting loss in efficiency of heat transfer, possible boiler failure, and reduction in rates of flow.

Calcium and magnesium generally are the chief causes of hardness. Iron and aluminum, and also certain other metals, cause hardness, but generally they are present in much smaller quantities than calcium and magnesium. When present as bicarbonate or normal carbonates, the hardness is called carbonate hardness, when present in the form of sulfate, chloride, nitrate, and other soluble salts of calcium and magnesium, it is called noncarbonate hardness.

Water that has less than 60 ppm of hardness generally is rated as soft and suitable for most uses without further softening. Water having a hardness ranging between 60 and 120 ppm may be considered moderately hard, but this amount does not seriously interfere with the use of water for many purposes, except in high-pressure steam boilers and in some industrial processes. Water with hardness ranging from 120 to 200 ppm is considered hard. Where the hardness is in the upper range, laundries and some industries may profitably soften their supplies. Water with hardness greater than 200 ppm needs some softening before it can be used satisfactorily for most purposes, though in some areas much harder water is used without treatment, especially for domestic purposes.

Total hardness in the waters analyzed ranged between 1 and 2,620 ppm. For waters from the Sparta and most of those from the Cockfield, the range was from 1 to 23 ppm. The wells in the Pliocene(?) deposits also generally yield soft water with a hardness less than 60 ppm. The waters from the Quaternary deposits have a wide range in hardness, generally between 25 and 250 ppm. The waters from the Jackson are hard, the hardness generally ranging between 90 and 2,000 ppm.

Specific conductance.—The specific conductance of a water, a measure of its capacity to conduct a current of electricity, is dependent on the concentration and degree of ionization of the different minerals present. Although the conductance value does not give an indication of the relative quantities of the different constituents, it does give an indication of the total quantity of the dissolved minerals. The conductance is of particular use in those instances where the dissolved solids are not determined, since, for Arkansas waters, the dissolved-solids value (expressed in ppm) is usually roughly half the conductance value (expressed in micromhos). The specific conductance of waters analyzed from Drew County ranged from 31.5 to 5,490 micromhos.

Hydrogen-ion concentration (pH).—The degree of acidity or alkalinity of water is indicated by the hydrogen-ion concentration, expressed in terms of pH, and is related to the corrosive properties of water. The pH must be known for proper treatment for coagulation at water-treatment plants. The pH is the logarithm (to the base 10) of the reciprocal of the hydrogen-ion concentration. For practical purposes, the pH scale ranges between the numbers 0 and 14, denoting various degrees of acidity or alkalinity. A pH of 7 is considered neutral. Values below 7 and approaching 0 are increasingly acid, and values from 7 to 14 are increasingly alkaline. As the pH becomes less than 7 and especially less than about 5, the water becomes more corrosive to metals.

The pH in the samples analyzed ranged from 3.3 to 8.8. In general, the waters from the Tertiary deposits are slightly alkaline with a pH of 8 or more. Most of the water from wells in the Jackson formation is acid, the pH being as low as 3.3 and averaging 5.4 in 22 samples. Some of the waters from the Pliocene(?) deposits also are somewhat acid, the pH ranging from 4.1 to 7.7. The waters from Quaternary deposits generally are neutral or nearly so.

Chemical Characteristics of the Ground Waters in the Several Formations

Both the character and the concentration of the dissolved mineral load of any ground water are determined by the kind and amount of soluble minerals in the rocks through which the water has traveled and the length of time it has been in contact with such minerals. A rather high degree of similarity in waters from the same formation would be expected, and that this is so in Drew County can be seen in the bar diagram (fig. 10), which is a graphical representation of the chemical analyses of waters from representative wells in each of the principal water-bearing formations. The analyses selected for the diagram are characteristic of the respective formations in both character and concentration except those from the Jackson formation. In order to plot them to the same scale as those from other formations, it was necessary to select analyses that indicate the general character of most of the samples from the Jackson formation but the lowest concentrations.

Quaternary deposits.—Throughout Arkansas the waters in deposits of Quaternary age are typically calcium or calcium and magnesium bicarbonate waters. In Drew County this typical character generally is modified by appreciable amounts of sodium chloride. The waters generally are only moderately mineralized, and, except for moderate hardness and local high iron content, they are satisfactory for domestic and irrigation purposes. As some soils in Arkansas require addition of lime, the use of waters from the Quaternary deposits high in calcium bicarbonate is beneficial, because the calcium bicarbonate is added to the soil on evaporation or transpiration of the water. The few water samples from the Quaternary deposits that were highly mineralized generally came from wells ending close to the contact with the Jackson formation. It is possible that some of the wells extend through the alluvium into the Jackson or that some highly mineralized water from the underlying Jackson finds its way into the alluvium.

Pliocene(?) deposits.—Waters from the Pliocene(?) deposits generally are only slightly mineralized but contain all the common mineral constituents. They generally have a pH below 7, the average pH of 9 samples being 6.4 They generally are satisfactory for domestic purposes, but the more acid waters may be corrosive to pipes and plumbing fixtures.

Jackson formation.—Most of the wells in the Jackson formation yield highly mineralized water, but there is a great range in concentration and some range in character. Nearly all the samples had moderate to high concentrations of sulfate and some were high in chloride. Appreciable quantities of all the cations, calcium, magnesium, and sodium, generally are present, and the waters commonly are acidic. Some wells in the Jackson formation about 2 or 3 miles west of Monticello yield good water, but it is possible that most of the water may be derived from Pleistocene terrace material or colluvial material.

Most of the water from this formation is not fit for domestic use, and the more highly mineralized water is not suitable even for watering stock. Locally, the water is described as "alum water." Satisfactory water for domestic uses in the outcrop area of the Jackson formation is obtained from rainwater stored in cisterns or from deep wells in the Cockfield formation or Sparta sand.

Cockfield formation.—Waters from this formation are typically sodium bicarbonate waters of moderate mineralization. Being soft and low in iron they are highly satisfactory for domestic and municipal supplies. A few of the wells that yield highly mineralized water, thought to end in the upper beds of the Cockfield formation, may be drawing from sand beds in the lower part of the Jackson formation. There appears to be a general improvement in quality of water with depth in the Cockfield formation.

Sparta sand.—Waters from the Sparta sand also are sodium bicarbonate waters of low mineralization. They contain little or no iron and generally are even softer than the Cockfield waters. They are therefore excellent for domestic and municipal supplies.

Waters from both Tertiary aquifers have a high percentage of sodium compared to calcium and magnesium and are likely to prove unsatisfactory for continued irrigation of most crops.

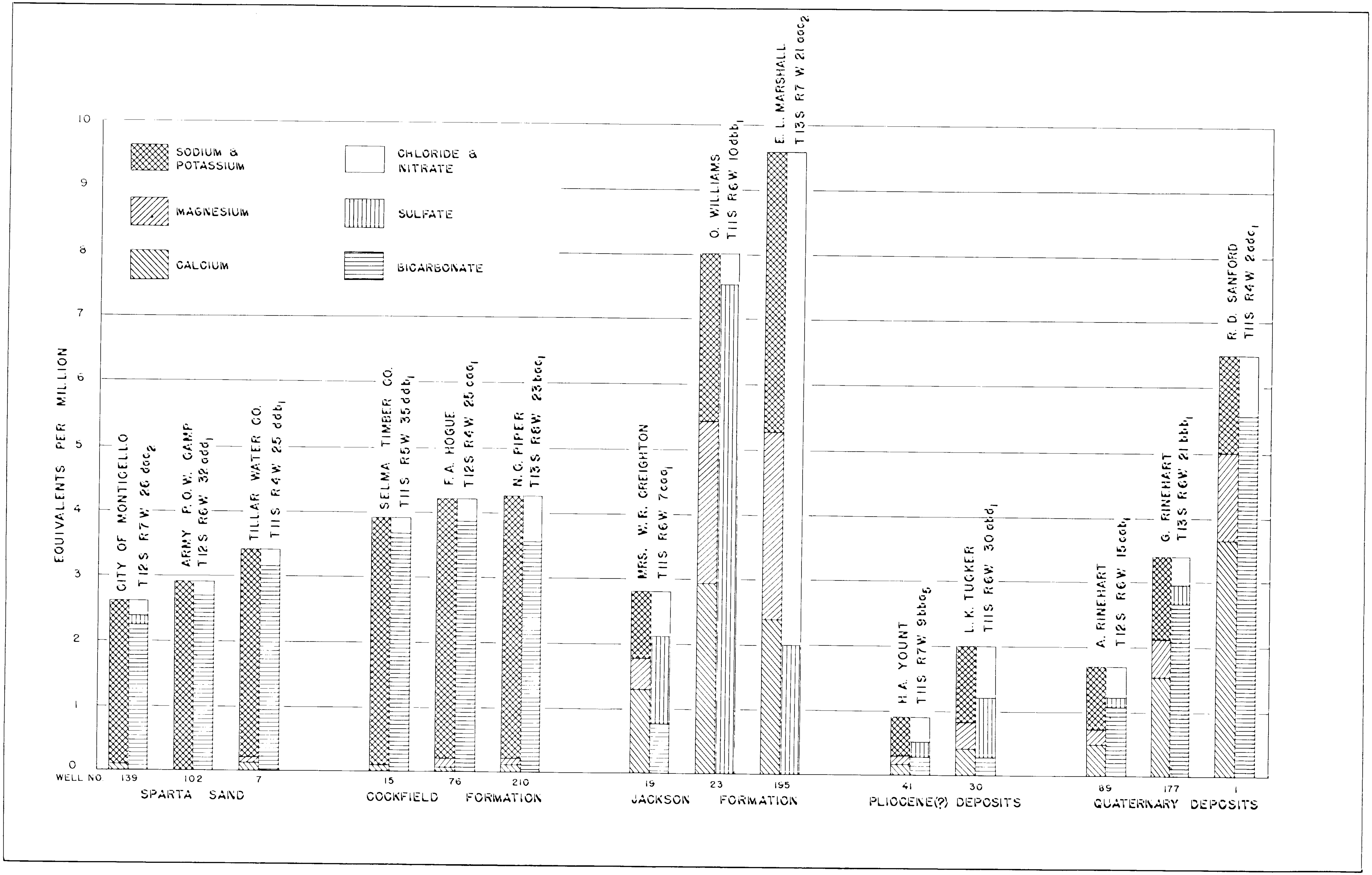


Figure 10. Bar diagram illustrating typical chemical character of ground water from the several aquifers.

LOGS OF WELLS

Listed in the following pages are the logs of 10 wells. They are presented as they were reported by the drillers.

WELL 7

Owner: Tillar Water Co.
Location: NW¼SE¼SE¼ sec. 25, T. 11 S., R. 4 W.

	Thickness (feet)	Depth (feet)
Clay	20	20
Sand	80	100
Gumbo	30	130
Boulders	2	132
Gumbo	219	351
Sand	20	371
Gumbo	11	382
Fine-packed sand	30	412
Gumbo	57	469
Hard-packed sand	32	501
Tough gumbo	21	522
Sand	15	537
Gumbo	8	545
Sandy clay	20	565
Sand	56	621
Gumbo	1	622

WELL 25

Owner: Harold Scroggins
Location: NE¼SW¼SW¼ sec. 11, T. 11 S., R. 6 W.

	Thickness (feet)	Depth (feet)
Soil	2	2
Sandy clay	38	40
Fine red sand	30	70
Blue sandy shale	91	161
Hard shale	19	180
Rock	1	181
Sandy shale	102	283
Sandstone	5	288
Gumbo	1	289
Rock	2	291
Gumbo	9	300
Rock	1	301
Blue shale	95	396
Sand	4	400
Tough shale	94	494
Rock	1	495
Blue shale	5	500
Rock	1	501
Shale with boulders	39	540
Fine sand, some breaks	60	600
Fine sand	40	640
Lignite	6	646
Sand	6	652
Gumbo	6	658
Tough shale	12	670
Fine sand	6	676
Gumbo	8	684
Fine sand	3	687
Gumbo	28	715
Fine muddy sand	24	739
Gumbo	2	741
Fine hard sand	21	762
Shale	2	764
Fine hard salt and pepper sand	60	824
Gumbo	6	830

WELL 101

Owner: Army P. O. W. Camp
Location: SE¼NW¼NE¼ sec. 32, T. 12 S., R. 6 W.

	Thickness (feet)	Depth (feet)
Soil	1	1
Clay	44	45
Red sand	12	57
Sandy clay	21	78
Good sand	62	140
Sand, some gravel	40	180
Soft rock	7	187
Rough boulders	18	205
Soft sandy shale	140	345
Hard shale	63	408
Sandy shale	28	436
Hard shale	64	500
Sandy shale	70	570
Gumbo	32	602
Boulders	2	604
Sand	57	661
Shale break	9	670
Good sand	55	725

WELL 102

Owner: Army P. O. W. Camp
Location: SE¼SE¼NE¼ sec. 32, T. 12 S., R. 6 W.

	Thickness (feet)	Depth (feet)
Soil	4	4
Soft sandy clay	27	31
Streaks of hard clay	36	67
Fine sand	52	119
Coarser sand	56	175
Muddy sand	24	199
Tough gumbo	20	219
Shaley gumbo (rock at 220 ft.)	21	240
Sandy shale	38	278
Streaks of gumbo	19	297
Sandy shale	11	308
Gumbo and hard shale	13	321
Hard shale (rock at 337 ft.)	16	337
Hard and soft gumbo	34	371
Sandy shale	34	405
Soft and hard gumbo	63	468
Gumbo	22	490
Boulders	2	492
Hard sandy shale	31	523
Gumbo and shale	11	534
Fine sand	26	560
Hard gumbo	15	575
Soft shale	37	612
Hard packed sand	48	660
Fine water sand	24	684
Sandy shale	10	694
Water sand	26	720

WELL 104

Owner: Army P. O. W. Camp
Location: SE¼NW¼SE¼ sec. 32, T. 12 S., R. 6 W.

	Thickness (feet)	Depth (feet)
Sandy loam	5	5
Red sand	19	24
Sandy red clay	20	44
Coarse red sand	26	70
Sandy clay	30	100
Fine sand	60	160
Coarse sand	22	182
Clay	8	190
Shale	22	212
Clay rock	3	215
Sandy shale	35	250
Soft sandy shale	22	272
Fine sandy shale	40	312
Tough, sticky shale	33	345
Shale with sand streaks	15	360
Real fine sand	8	368
Boulders	3	371
Shale with sand streaks	70	441
Shale	29	470
Soft gumbo	7	477
Sandy shale	29	506
Rock	22	528
Shale	18	546
Gumbo	35	581
Sandy shale	57	638
Packed sand	47	685
Shale	6	691
Sand	4	695
Soft sandy shale	120	815
Hard gumbo	20	835
Hard shale	19	854
Soft shale	16	870
Fine packed sand	73	943

WELL 138

Owner: City of Monticello
Location: SW¼NE¼SE¼ sec. 26, T. 12 S., R. 7 W.

	Thickness (feet)	Depth (feet)
Sandy clay	36	36
Tough clay	41	77
Hard rock	1	78
Hard streak	6	84
Tough clay	126	210
Boulders	4	214
Clay	6	220
Sand	38	258
Clay, streaked with shale	97	355
Clay	54	409
Shale	17	426
Hard rock	4	430
Sand	6	436
Shale	37	473
Sand	18	491
Shale	21	512
Clay	41	553
Fine sand	95	648
"Breaks" (interbedded sand and clay?)	3	651
Fine white sand	63	714
Tough clay	29	743
Fine sand	55	798
Gumbo	22	820

WELL 141

Owner: Monticello Cotton Mills
Location: SE¼SW¼SE¼ sec. 26, T. 12 S., R. 7 W.

	Thickness (feet)	Depth (feet)
Top soil	1	1
Fine sand	45	46
Sandy shale	79	125
Rock	1	126
Sandy shale	7	133
Shale	21	154
"Hard spot"	1	155
Shale	8	163
Sandy shale	11	174
Hard shale	33	207
Sand	5	212
Sandy shale	3	215
Hard shale	7	222
Sandy shale	26	248
Rock	1	249
Fine sand	6	255
Rock	5	260
Sand	1	261
Rock	1	262
Shale	6	268
Sand	19	287
Sandy shale	3	290
Clay	3	293
Rock	1	294
Shale	34	328
Sand	3	331
Sandy shale	48	379
Fine sand	11	390
Shale	39	429
Fine sand	2	431
Sandy shale	31	462
Rock	1	463
Shale	41	504
Sand	7	511
Sandy shale	52	563
Gumbo	10	573
Shale	17	590
Fine sand	31	621

WELL 183

Owner: Arkansas A & M College
Location: NE¼SW¼NE¼ sec. 10, T. 13 S., R. 7 W.

	Thickness (feet)	Depth (feet)
Red clay	25	25
Gumbo	38	63
Rock	1	64
Gumbo	35	99
Boulders	1	100
Gumbo	60	160
Rock	1	161
Gumbo	18	179
Sand rock	11	190
Gumbo	110	300
Sand boulders	14	314
Sticky shale	143	457
Sandy shale	6	463
Fine muddy sand	37	500
Hard shale	47	547
Fine sand	13	560
Good sand	59	619
Break (probably interbedded shale)	6	625
Good sand	79	704
Clay	1	705

WELL 185

Owner: Mrs. P. Briscoe
Location: SW¼NW¼SW¼ sec. 11, T. 13 S., R. 7 W.

	Thickness (feet)	Depth (feet)
Gravel bed	10	10
Clay	50	60
Fine sand	11	71
Clay	47	118
Shale	108	226
Rock	1	227
Shale	17	244
"Break" (interbedded sand and shale?)	13	257
Shale	28	285
Sandy shale	24	309
Shale	17	326
Rock	1	327
Gumbo	15	342
Shale	88	430
Boulders	3	433
Sandy shale	24	457
Rock	1	458
Gumbo	23	481
Rock	1	482
Gumbo	41	523
Loose sand	4	527
Sandy shale	23	550
Hard sand	13	563
Sandy shale	19	582
Hard, salt and pepper sandstone	26	608
Gumbo	33	641
Sand streak	2	643
Sandy shale	22	665
Hard sand	7	672

WELL 190

Owner: L. Vawter
Location: SE¼SE¼NE¼ sec. 15, T. 13 S., R. 7 W.

	Thickness (feet)	Depth (feet)
Red and gray nodular clay	20	20
Bluish black gumbo	280	300
Gumbo with a little fine sand	10	310
Gumbo	90	400
Gumbo with "rock" and white limestone	60	460
Gumbo	23	483
Sand	42	525
Rock	1	526
Sand with clay stringers	14	540
Rock	1	541
Fine gray sand	29	570
Salt and pepper sand	19	589

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Table 1. Records of Wells in Drew County, Arkansas

The location number gives the township, range, and section. The lowercase letters—a, b, c, and d—indicate the well location within the section; the first letter denotes the 160-acre tract, the second the 40-acre tract, and the third the 10-acre tract. Reported water levels are given to nearest foot; measured water levels to nearest tenth of a foot. Use: D, domestic; Irr, irrigation; Ind, industrial; S, stock; PS, public supply; U, unused.

Well no.	Location no.	Owner	Driller	Date completed	Type of well	Depth (feet)	Diameter (inches)	Water-bearing unit	Depth to water below land surface (feet)	Date of measurement	Method of lift	Reported yield (gpm)	Use	Remarks
	T. 11 S., R. 4 W.													
1	2adc1	R. D. Sanford	Lilly Bros.	1951	Drilled	97	24-10	Quaternary	12	1-?-52	Turbine	1,350	Irr	See chemical analysis
2	2ccb1	City of Winchester	Maingory & Graham	1916	Drilled	556	6	Cockfield	16	1916	Turbine	80	PS	
3	5daa1	Arkansas Land & Cattle Co.	H. S. Ragland	1954	Drilled	115±	14-10	Quaternary	20	7-?-54	Turbine	2,000	Irr	
4	6ccb1	Arkansas Land & Cattle Co.	H. S. Ragland	1954	Drilled	88	14-10	Quaternary	18	7-?-54	Turbine	1,800	Irr	
5	24bdd1	French Bros.	H. S. Ragland?		Drilled	100±	18-10	Quaternary			Turbine	1,375	Irr	See chemical analysis
6	25dab1	Taylor A. Prewitt	H. S. Ragland	1947	Drilled	112	18-8	Quaternary	19.61	8-13-52	Turbine	1,400	Irr	See chemical analysis
7	25ddb1	Tillar Water Co.	Layne-Arkansas	1916	Drilled	720	4-3	Sparta	20.00	7-31-52	Turbine	340	PS	See chemical analysis and log
	T. 11 S., R. 5 W.													
8	1dad1	Arkansas Land & Cattle Co.	H. S. Ragland	1954	Drilled	108	14-10	Quaternary	19	7-?-54	Turbine	2,000	Irr	
9	8cbc1	E. Henley	Ruffin?	1950	Jetted	60±	3-1¼	Quaternary			Cylinder	4	D	See chemical analysis
10	21cdc1	John Moore	F. Mellor	1951	Drilled	770	2	Sparta	55	1951	Jet	400	D	See chemical analysis
11	21ddd1	V. G. Moore	H. Etheridge	1952	Drilled	145	2	Quaternary	40	1952	Jet	100	D	
12	27aad1	T. W. Scifres	H. Etheridge	1952	Drilled	120	2½-2	Quaternary	40.73	10-13-54	Centrifugal	200	D	See chemical analysis
13	28add1	V. G. Moore	Lilly Bros.	1953	Drilled	140	18-8	Quaternary	39	5-?-54	Turbine	1,000	Irr	
14	28cdb1	John Moore	Lilly Bros.	1954	Drilled	143	18-8	Quaternary	37.10	3-?-55	Turbine	1,000	Irr	
15	35ddb1	Selma Timber Co.	F. Mellor	1945	Drilled	500±	2	Cockfield	52	1945	Air lift	30	Ind	See chemical analysis
16	35ccb1	G. L. Hall		1947	Driven	80	2	Quaternary	40	1947	Cylinder	50	D	
17	36dcd1	W. J. Eason	F. Mellor	1950	Drilled	425	2½	Cockfield	52	1950	Jet	100	D	
	T. 11 S., R. 6 W.													
18	6aaa1	Raymond Strickland		1954	Dug	14.6	30	Jackson	10.32	10-19-54	Manual		D	See chemical analysis
19	7caa1	W. R. Creighton		1934	Dug	16.6	30	Jackson	13.70	10-19-54	Manual		D	See chemical analysis
20	8bad1	Cager McGough		1950	Bored	37.8	8	Jackson	18.62	10-15-54	Manual		D	See chemical analysis
21	8bbd1	Prentiss Sweeney	H. Etheridge	1952	Drilled	480	2	Cockfield	160.00	1952	Cylinder	100	D	See chemical analysis
22	9bda1	O. E. Tucker			Dug	14.1	24	Jackson	10.90	10-15-54	Manual		D	
23	10dbb1	Omeagur Williams		1945	Bored	29.9	8	Jackson	19.82	10-18-54	Manual		D	See chemical analysis
24	11cab1	B. E. Mullis	Hoover		Drilled	85.8	8-6	Quaternary	63.45	10-18-54	Manual		D	
25	11ccb1	Harold Scroggins	Layne-Arkansas	1942	Drilled	864	18-10	Sparta	60	1942	Turbine	2,000	Irr	See chemical analysis and log
26	17bdc1	A. D. Tucker		1914	Dug	22.3	30	Jackson(?)	14.78	10-20-54	Jet		D	
27	20bab1	T. E. Posey		1948	Driven	16	2	Jackson(?)			Jet		D	
28	26cdb1	T. O. Appleberry	Ruffin	1954	Jetted	110	2	Quaternary			Jet	60	D, S	
29	27ccc1	Ethel Brinkley		1940	Dug	52.1	30	Quaternary	39.94	10-20-54	Manual		D, S	
30	30abd1	L. K. Tucker			Dug	25.5	30	Pliocene(?)	15.76	10-20-54	Manual		D	See chemical analysis
31	30adb1	L. K. Tucker			Dug	22.4	30	Jackson	12.36	10-20-54	Jet		D	See chemical analysis
32	31ddd1	V. Trotter		1950	Bored	28.0	8	Quaternary	9.90	10-20-54	Manual		D	
33	34bcc1	J. W. Spade		1944	Bored	59.2	8	Quaternary	49.20	3-30-54	Manual		D	See chemical analysis
34	34dba1	Mrs. B. Luperman	Layne-Arkansas	1939	Drilled	175±	18-10	Quaternary	70	1939	Turbine	1,400	Irr	
	T. 11 S., R. 7 W.													
35	4cdb1	C. B. Mitchell	H. Etheridge	1951	Drilled	482	2	Cockfield	160	1951	Jet	40	D, S	See chemical analysis
36	4cdc1	Tom Mitchell	H. Etheridge	1953	Drilled	450	2	Cockfield	150	1953	Jet	40	D, S	
37	6dcc1	Miliner			Bored	20.0	24	Jackson	13.4	10-6-53	Manual		D	
38	6dcd1	Fred Mitchell			Bored	21.5	24	Jackson	7.05	10-6-53	Manual		D	
39	7bbd1	Urban Calhoun	H. Etheridge	1953	Drilled	670	2	Sparta	90	1953	Cylinder	60	D, S	See chemical analysis
40	9baa1	G. E. Meeks			Dug	19.4	30	Pliocene(?)	16.66	1-4-55	Manual		D, S	
41	9bba1	H. A. Yount			Spring			Pliocene(?)				2	D, S	See chemical analysis
42	11abd1	L. H. Leonard			Dug	23.5	30	Pliocene(?)	22	10-19-54			U	
43	11dcb1	E. A. Brown			Dug	21.6	24	Pliocene(?)	14.25	10-8-53	Manual		D, S	
44	14baa1	S. A. Millen			Dug	19.1	20	Jackson	14.6	10-8-53	Manual		D	See chemical analysis
45	14dcc1	B. O. Adams		1949	Dug	11.3	30	Jackson(?)	8.24	10-20-53	Manual		D	
46	15cdd1	Bill Henry		1953±	Dug	19.6	40	Pliocene(?)	17.93	10-20-53	Manual		D	
47	16baa1	I. L. Hoffman		1954	Bored	43.5	8	Jackson	16.25	1-4-55	Manual		S	See chemical analysis
48	18cdc1	M. J. Handley			Spring			Pliocene(?)					D, S	See chemical analysis
49	21aac1	Waddell			Dug	23.1	18	Pliocene(?)	14.47	9-29-53	Manual		D	
50	21acc1	Henry Shultz			Spring			Pliocene(?)				3	D	Yield fluctuates with weather
51	21add1	Henry Shultz		1950	Bored	47.0	8	Pliocene(?)			Air lift	20	D	
52	22baa1	B. Henry			Spring			Pliocene(?)					U	
53	25aaa1	Roth Rabb		1945	Bored	28.7	8	Pliocene(?)	24.97	10-20-54	Manual		D	
54	25bbb1	J. N. Hughes	Roth	1946	Drilled	400±	2	Cockfield			Cylinder	10	D	See chemical analysis. Inadequate yield
55	25cca1	G. C. Pevey			Dug	13.9	30	Jackson	13.52	10-8-53	None		S	See chemical analysis
56	26aad1	Hoover			Dug	25.4	20	Jackson	18-15	10-8-53	Manual		D	
57	26dbc1	Sigmond			Spring			Pliocene(?)					D	
58	27bdc1	James Sipes			Spring			Pliocene(?)				3±	D	Yield fluctuates with weather
59	27bdd1	B. D. Ross		1951	Drilled	55	2	Pliocene(?)			Jet		D	
60	29cba1	Z. Richardson			Dug	22.7	30	Pliocene(?)	21.09	10-21-53	Manual		D	
61	35aad1	David Swift			Spring			Pliocene(?)					D	See chemical analysis
62	36aad1	W. G. Myhand		1928	Dug	25.0	36	Jackson	9.91	10-20-54	Manual		D, S	"Alum water"
	T. 11 S., R. 8 W.													
63	9cab1	Rex Woodward			Dug	18.7	36-2	Quaternary	6.45	2-4-54	Cylinder	50	D	See chemical analysis
64	11dcc1	L. McKoewn			Dug	21.5	18	Jackson	15.05	10-6-53	Manual		D	"Alum water"
65	11ddd1	E. R. Harper	H. Etheridge	1952	Drilled	580	2	Sparta	90	1952	Cylinder	3	D, S	See chemical analysis

Table 1. Records of Wells in Drew County, Arkansas (Continued)

Well no.	Location no.	Owner	Driller	Date completed	Type of well	Depth (feet)	Diameter (inches)	Water-bearing unit	Depth to water below land surface (feet)	Date of measurement	Method of lift	Reported yield (gpm)	Use	Remarks
66	13ddc1	Conway Groce			Dug	23.0	24	Jackson	11.55	10-6-53	Manual		D, S	
67	14bba1	L. McKeown	H. Etheridge	1952	Drilled	655	2	Sparta	75	10-6-53	Cylinder	3	D	See chemical analysis
68	15bbd1	Floyd Sullivan		1915 ±	Dug	17.5	40	Quaternary(?)	14.37	1-4-55	Centrifugal	5	D	See chemical analysis
69	27cac1	R. Rhodes	F. Mellor	1947	Drilled	221	4	Cockfield(?)			Jet	3	D	
70	28cac1	J. Kubeth		1946	Dug	23.5	26	Quaternary	22.30	1-3-55	Manual		D	
71	28ddc1	J. M. Beaty	F. Mellor	1947	Drilled	208	4	Cockfield(?)			Jet	4	D	See chemical analysis
72	34aba1	Frank Riviere			Dug	14.7	36	Quaternary	7.65	2-4-53	Cylinder		D	See chemical analysis
	T. 12 S., R. 4 W.													
73	8bbc1	Mrs. May Erwin		1944 ±	Bored	54.8	8	Quaternary	42.67	10-3-54	Manual		D	
74	18bda1	V. J. Whitaker	F. Mellor	1952	Drilled	134	2	Quaternary			Jet	200	D	See chemical analysis
75	20acc1	W. L. Courtney	H. Etheridge	1953	Drilled	123	2	Quaternary	40	3-?-53	Jet	250	D, S	
76	25caa1	F. A. Hogue	F. Mellor	1947	Drilled	368	2	Cockfield	40	1947	Jet	5	D	See chemical analysis
77	26daa1	H. E. Whitaker	F. Mellor	1948	Drilled	300 ±	2	Cockfield			Jet	5	D	
	T. 12 S., R. 5 W.													
78	1abc1	Selma School District	F. Mellor	1951	Drilled	765	2	Sparta			Jet	10	PS	
79	1bba1	M. B. Smith	W. M. Barrett	1930	Drilled	107	3	Quaternary	37	1948	Jet	2	D	See chemical analysis
80	6abc1	M. L. Sigmund			Dug	30.9	8	Quaternary	24.62	10-13-54	Manual		D	
81	11cba1	J. V. Lowe	H. Etheridge	1950	Drilled	80.0	2½-2	Quaternary	60	1954	Jet	100	S	See chemical analysis
82	11cba2	B. E. Lowe	H. Etheridge	1953	Drilled	262	2½-2	Cockfield	60	1953	Jet	600	D, S	See chemical analysis
83	12bdd1	J. R. Barrett, Jr.		1954	Drilled	75	2	Quaternary	50	3-?-54	Jet	50	D	
84	19dac1	Etta Hensley	J. H. Harvey		Bored	39.2	8	Quaternary	27.66	10-19-54	Jet		D	
	T. 12 S., R. 6 W.													
85	7cdd1	Lyndle Hogue		1943	Bored	31.6	8	Quaternary	22.61	10-15-54	Manual		D	
86	14acd1	Barnett Miles	H. S. Ragland	1946	Drilled	165 ±	12-8	Quaternary	48	1946	Turbine	1,800	Irr	
87	14cba1	Denzle McCauley	H. S. Ragland	1944	Drilled	162	18-20	Quaternary	45	1944	Turbine	2,000	Irr	
88	14dab1	Barnett Miles	H. S. Ragland	1948	Drilled	165 ±	12-8	Quaternary			Turbine	1,500	Irr	
89	15cab1	Aloys Rinehart	H. S. Ragland	1941	Drilled	170	24-10	Quaternary	11	1941	Turbine	1,800	Irr	See chemical analysis
90	15cdb1	Aloys Rinehart	H. S. Ragland	1946	Drilled	170	18-10	Quaternary	11	1946	Turbine	1,100	Irr	
91	15dba1	Denzle McCauley	H. S. Ragland	1942	Drilled	160	18-10	Quaternary			Turbine	2,000	Irr	
92	16aad1	S. Ridgell	C. Witacker	1953	Bored	64.4	8	Quaternary	63.75	10-11-54	Manual		D	See chemical analysis
93	18baa1	Charles Davis			Bored	27.7	8	Quaternary	20.72	10-15-54	Manual		D	
94	19cca1	Don Long	H. Etheridge	1951	Drilled	480	2	Cockfield	130	1951	Cylinder	3	D	
95	19ccd1	J. W. Tidwell		1951	Bored	14	12	Jackson(?)			Pitcher		D	
96	29bda1	N. Watson		1946	Dug	19.2	36	Jackson	18.17	10-14-54	None		D	
97	29dab1	Henry Ross	H. Etheridge	1950	Drilled	85	2	Quaternary			Jet	10	D	See chemical analysis
98	30daa1	C. V. Hartz	H. Etheridge	1954	Drilled	366	2	Cockfield	138.70	9-10-54	Jet	4	D	See chemical analysis
99	13aac1	R. Whitehead			Bored	69.8	8	Quaternary	40.68	10-26-54	Manual		D	Not used for drinking
100	31ddc1	N. E. Chambers		1899	Dug	18.1	36	Quaternary	3.00	2-3-54	Jet	4	D	See chemical analysis
101	32abd1	Army P. O. W. Camp	Layne-Arkansas	1943	Drilled	725	12-8	Sparta	98.42	9-10-54	Turbine	567	U	See log
102	32add1	Army P. O. W. Camp	Layne-Arkansas	1942	Drilled	720	12-8	Sparta	98.39	9-10-54	Turbine	740	PS	See log and chemical analysis
103	32cbb1	H. H. Lair		1951	Bored	37.3	6	Quaternary	26.44	10-26-54	Manual		D	
104	32dbd1	Army P. O. W. Camp	Layne-Arkansas	1942	Drilled	936	12-8	Sparta	98.34	9-10-54	Turbine	179	U	See log
	T. 12 S., R. 7 W.													
105	1cbb1	A. R. Kimbro			Dug	22.0	30	Jackson	10.98	10-8-53	Manual		D	See chemical analysis
106	1cbc1	G. R. Slocum		1948	Drilled	575	3.5	Cockfield(?)	100	1948	Jet	3	D, S	See chemical analysis
107	1cbc2	G. R. Slocum			Dug	11.9	30	Jackson	1.20	10-20-53	Jet		S	
108	1ccc1	A. R. Mahan			Dug	18.3	30	Jackson	15.90	10-3-54	Manual		D	
109	2acc1	T. Swift			Spring			Pliocene(?)				3	D	
110	2bdb1	E. Moore			Spring			Pliocene(?)				3⅓	D	
111	3bac1	J. P. Jones			Spring			Pliocene(?)				3⅓	D	
112	3bcc1	V. V. Goodwin		1948	Dug	17.3	30	Pliocene(?)	12.45	10-21-53	Manual		D	"Alum water"
113	4bbb1	J. A. Arnold		1936	Dug	19.5	40	Pliocene(?)	15.10	10-21-53	Manual		D	See chemical analysis
114	4bdd1	Ardis White		1938	Dug	16.3	30	Jackson	14.52	10-21-53	Manual		D	See chemical analysis
115	7bba1	Joe Hood			Bored	23.8	8	Jackson	15.92	1-3-55	Manual		D	
116	8cbb1	Poland Burton			Dug	17.4	30	Pliocene(?)	14.55	10-7-53	Manual		D	
117	10bdb1	Cecil Barnett			Dug	34.0	24	Pliocene(?)	32.05	10-6-53	Manual		D	
118	10ccb1	J. W. Halley		1953	Dug	25.0	30	Jackson(?)	18.00	10-6-53	Manual		D	
119	10cdc1	Cecil Major			Dug	13.1	24	Jackson(?)	11.80	10-6-53	Manual		D	
120	10dac1	E. Nowlin	H. Etheridge	1954	Drilled	306	3-2	Cockfield(?)			Jet	3	D	
121	12bab1	B. L. Williams		1950	Driven	20	1¼	Jackson(?)			Jet	4	D	
122	12bbb1	T. W. McGoff			Dug	24.0	30	Jackson(?)	13.38	10-8-53	Manual		D	
123	12cbb1	E. H. Lyle	F. Mellor(?)	1947	Drilled	350	2	Cockfield(?)			Jet	60	D	
124	13aad1	E. R. Allen		1951	Bored	37.1	8	Jackson	32.65	10-15-54	Manual		D	See chemical analysis
125	14ada1	C. M. Hughes		1900 ±	Dug	37.7	30	Jackson	28.66	10-18-54	Manual		U	"Alum water"
126	15aca1	J. W. Coates			Dug	20.8	36	Jackson	14.20	1-5-55	Manual		D	
	T. 12 S., R. 7 W.													
127	15adc1	K. W. Carpenter	H. Etheridge	1952	Drilled	470	2	Cockfield	160	1952	Cylinder	4	D	See chemical analysis
128	15ccb1	J. L. Mitchell		1952	Dug	17.5	18	Jackson	15.50	10-7-53	Manual		D	See chemical analysis. "Alum water"
129	15cdb1	H. Mitchell		1928	Dug	11.4	24	Pliocene(?)	10.00	10-7-53	Manual		D	See chemical analysis
130	16ada1	S. B. Robinson		1951	Dug	25.1	30	Pliocene(?)	19.85	10-7-53	Manual		D	

Table 1. Records of Wells in Drew County, Arkansas (Continued)

Well no.	Location no.	Owner	Driller	Date completed	Type of well	Depth (feet)	Diameter (inches)	Water-bearing unit	Depth to water below land surface (feet)	Date of measurement	Method of lift	Reported yield (gpm)	Use	Remarks
131	19aaa1	Tidwell			Bored	31.0	12	Jackson	12.83	10-7-54	Manual		D	"Alum water"
132	20dad1	T. Hudspeth		1947	Dug	25.4	14	Jackson(?)	22.55	10-8-53	Manual		D	
133	21dcc1	Charles Beard		1950	Dug	13.9	12	Jackson(?)	Dry	10-8-53	Manual		D	
134	21dcc2	Charles Beard	Star City Drilling Co.	1954	Drilled	580	3-2	Cockfield(?)	138	1954	Jet	6	D	
135	21dcd1	R. H. Donaldson			Dug	14.7	30	Jackson	11.35	10-8-53	Jet		D	
136	21ddc1	L. F. Wright	H. Etheridge	1952	Drilled	575	2	Sparta(?)	160	1952	Jet	6	D	See chemical analysis
137	25abc1	J. G. McCandless	D. E. Bennett		Dug	15.4	10	Jackson	12.30	10-13-54	Manual		S	See chemical analysis. "Alum water"
138	26dac1	City of Monticello	Layne-Arkansas	1938	Drilled	860	6	Sparta	138	1938	Turbine	860	PS	See log
139	26dac2	City of Monticello	Layne-Arkansas	1949	Drilled	880	6	Sparta	160	1949	Turbine	900	PS	See chemical analysis
140	26dad1	Drew Cotton Seed Oil Mill	Hartwell Co.(?)	1899(?)	Drilled	800	6	Sparta	145	1899(?)	Turbine		Ind	
141	26dcd1	Monticello Cotton Mills	Layne-Arkansas	1951	Drilled	621	6	Sparta	166	1951	Turbine	300±	Ind	See chemical analysis and log
142	29dad1	Harris Hales			Dug	15.8	30	Jackson(?)	10.10	12-16-54	Manual		D	See chemical analysis
143	29dad2	Harris Hales			Bored	32.3	8	Jackson(?)	24.72	12-16-54	Manual		D	See chemical analysis
144	30dbd1	Winston Gardner		1950	Dug	7.8	12	Jackson(?)	6.69	2-8-54	Manual		D	See chemical analysis
145	30dbd1	Winston Gardner	H. Etheridge	1952	Drilled	502	2	Cockfield	30	1952	Cylinder	3	D	See chemical analysis
	T. 12 S., R. 8 W.													
146	3adc1	J. A. Kulbeth		1914±	Dug	15.6	30	Quaternary(?)	14.00	1-3-55	Manual		D	
147	9bdb1	P. Herring			Dug	17.1	36	Quaternary(?)	12.00	2-4-54	Jet		D	See chemical analysis
148	10aad1	C. H. Stafford			Dug	18.0	18	Jackson	Dry	10-7-53	Manual		S	"Alum water"
149	12cda1	G. W. Avery		1904(?)	Dug	14.7	30	Quaternary(?)	13.62	1-3-55	Manual		D	
150	13bac1	W. B. Leggett		1920±	Dug	19.1	40	Quaternary(?)	14.15	1-3-55	Centrifugal		D	See chemical analysis
151	14ada1	L. Hood			Dug	19.6	30	Quaternary(?)	7.50	10-7-53	Manual		D	
152	15bcd1	C. H. Stafford			Dug	24.2	36	Quaternary(?)	22.41	12-16-54	Manual		D	
153	19abc1	Dale Allison		1937	Dug	19.0	30	Quaternary	3.00	2-4-53	Manual		D	See chemical analysis
154	22aba1	Joe Dickson		1932	Dug	16.5	30	Quaternary	15.42	12-16-54	Manual		D	
155	26cdd1	D. McKinstry			Dug	15.1	30	Quaternary	13.88	12-16-54	Manual		D	
156	27aba1	W. M. Robinson			Dug	16.3	30	Quaternary	15.52	12-16-54	Manual		S	
157	27ccd1	W. L. Stiles	H. Etheridge	1951	Drilled	235	2	Cockfield(?)	40	1951	Jet	6	D	See chemical analysis
158	27cdc1	P. D. McLemore	F. Mellor	1953	Drilled	240	2	Cockfield(?)	40	1953	Jet	10	D	See chemical analysis
159	27cdc2	Mississippi River Fuel Corp.	Layne-Arkansas	1949	Drilled	505	2.5	Cockfield(?)	40	1949	Jet	10	D	See chemical analysis
160	33bac1	City of Wilmar	Hartwell Co.(?)	1902(?)	Drilled	194±	4	Cockfield(?)			Turbine	200	PS	See chemical analysis
161	34bbb1	Ozark-Badger Lumber Co.	Layne-Arkansas	1946	Drilled	502.5	8-6	Cockfield(?)	28	1948	Turbine	300	Ind	See chemical analysis
162	35baa1	S. P. Thomasson			Dug	13.8	30	Quaternary	13.81	12-16-54	Manual		D	
	T. 13 S., R. 4 W.													
163	6bda1	H. Humphery			Bored	50.5	8	Quaternary	37.73	10-20-54	Manual		D	
164	34adc1	A. Rhinehart	D. Carnahan	1947	Drilled	100±	18-10	Quaternary	12	1947	Turbine	2,100	Irr	
	T. 13 S., R. 5 W.													
165	18dad1	J. D. Tucker	H. Etheridge	1954	Drilled	113	2	Quaternary	38	1954	Jet	10	D	
166	19abc1	L. Fleming			Bored	40.8	6	Quaternary	38.67	12-1-54	Manual		D	
167	28bdb1	C. Garrison			Bored	57.3	8	Quaternary	34.85	2-3-54	Manual		D	See chemical analysis
168	33cbc1	Crossett Lumber Co.	H. Etheridge		Drilled	80	2	Quaternary			Centrifugal	20	D	
169	36bda1	B. Talley	H. Etheridge	1952	Drilled	119	2	Quaternary	30	1952	Jet	20	D	
	T. 13 S., R. 6 W.													
170	4bcb1	A. Flemister		1944	Bored	90±	2	Quaternary			Jet	20	D	See chemical analysis
171	5bac1	J. T. Jackson	Star City Drilling Co.	1955	Drilled	680	2	Sparta(?)	89	1955	Jet	7	D	
172	6cdb1	J. Tranihan		1951	Dug	18.7	30	Jackson	10.45	2-2-54	Manual		D	See chemical analysis
173	7cac1	Davey			Dug	23.5	30	Jackson	8.50	2-3-54	Manual		D	See chemical analysis
174	12bbd1	S. R. Berry			Bored	43.6	12	Quaternary(?)	32.25	2-3-54	Manual		D	See chemical analysis
175	17bbb1	E. P. Mobley			Dug	29	30	Jackson	27.03	12-1-54	Manual		D	See chemical analysis
176	21acc1	George Rinehart	Floyd Yoder	1941	Drilled	170±	24-10	Quaternary	70	1952	Turbine	1,200	Irr	
177	21bbb1	George Rinehart	H. S. Ragland	1942	Drilled	171	24-8	Quaternary	70	1953	Turbine	1,000±	Irr	See chemical analysis
	T. 13 S., R. 7 W.													
178	2acc1	C. Nichols			Driven	27.0	2	Pliocene(?)			Jet	10	D	See chemical analysis
179	2dac1	W. W. Cruce			Dug	25.0	30	Pliocene(?)	15.09	2-3-54	Manual		D	See chemical analysis
180	4aba1	R. McKinney	H. Etheridge	1946	Drilled	750	2	Sparta			Cylinder	3	D	See chemical analysis
181	10aad1	H. J. Eickhof	H. Etheridge	1949	Drilled	516	2	Cockfield	180(?)	1953	Cylinder	7	D	See chemical analysis
182	10acc1	R. Hudson	F. Mellor	1947	Drilled	525	2	Cockfield			Cylinder	3	D	See chemical analysis
183	10bca1	Arkansas A. & M. College	Layne-Arkansas	1940	Drilled	830	10-8	Sparta	140	1942	Turbine	360	PS	See chemical analysis and log
184	10bca2	Arkansas A. & M. College	Layne-Arkansas	1931	Drilled	530	6-3	Cockfield	149.90	9-9-54	None		U	
185	11cbc1	Mrs. P. Biscoe	Layne-Arkansas	1950	Drilled	649	6-4	Sparta	178	1950	Turbine	20	PS	See chemical analysis and log
186	11ccb1	V. Borchardt	H. Etheridge	1953	Drilled	545	2	Cockfield	160	1953	Cylinder	5	D	See chemical analysis
187	11ccc1	C. C. Smith	F. Mellor	1951	Drilled	525	2	Cockfield			Cylinder	7	D	See chemical analysis
188	12baa1	L. Paranto			Spring			Pliocene(?)				2½	D	See chemical analysis
189	13bbc1	C. C. Thompson, Jr.			Spring			Pliocene(?)				3	D	
190	15add1	L. Vawter	H. Etheridge	1954	Drilled	589	2	Cockfield(?)	143.28	10-12-54	Jet	6	D	See log
191	16cba1	E. W. Bryden	H. Etheridge	1953	Drilled	450	2	Cockfield	127	1953	Cylinder	5	D	See chemical analysis
192	16cdb1	A. V. Ramsey		1854±	Dug	18.6	30	Jackson(?)	3.44	2-10-53	Cylinder		D	See chemical analysis
193	18bba1	G. David			Dug	15.8	30	Jackson	14.76	12-15-54	Manual		U	Water too mineralized for use
194	21aac1	E. L. Marshall	Star City Drilling Co.		Drilled	760	2	Sparta	136.31	9-19-54	Jet	3	D, Irr	See chemical analysis
195	21aac2	E. L. Marshall		1929	Dug	29.3	8	Jackson	17.00	10-4-54	Manual		D	See chemical analysis

Table 1. Records of Wells in Drew County, Arkansas (Continued)

Well no.	Location no.	Owner	Driller	Date completed	Type of well	Depth (feet)	Diameter (inches)	Water-bearing unit	Depth to water below land surface (feet)	Date of measurement	Method of lift	Reported yield (gpm)	Use	Remarks
196	23cbb1	D. C. Sanderlin	F. Mellor	1948	Drilled	400 ±	2	Cockfield(?)			Cylinder	5	D	See chemical analysis
197	24bdd1	L. K. Wilson		1904 ±	Dug	21.1	30	Jackson	11.63	2-3-54	Manual		S	See chemical analysis
198	24dac1	Mary Ashbury			Dug	16.1	36	Jackson	11.93	11-29-54	Manual		D	
199	24ddb1	Triangle Pipeline Co.	F. Mellor	1950	Drilled	552	4-2	Cockfield			Turbine	64	D, Ind	
200	28bab1	Ray Maxwell			Dug	14.8	30	Jackson(?)	3.35	2-10-54	Manual		D	See chemical analysis
201	31cca1	B. Montgomery		1952	Dug	27.1	30	Quaternary	25.37	12-10-54	Manual		D	
	T. 13 S., R. 8 W.													
202	3ddd1	W. H. Hodges			Dug	16.6	30	Quaternary	13.19	12-15-54	Centrifugal		D	
203	6ada1	W. Daniels			Dug	13.1	18	Quaternary	12.67	12-16-54	Manual		D	See chemical analysis
204	10cbb1	A. C. Trimble	Star City Drilling Co.	1954	Drilled	346	2	Cockfield	40	1954	Jet	6	D	
205	10cbc1	J. W. Smith		1946	Dug	15.4	48	Quaternary	12.04	2-4-54	Manual		D	See chemical analysis
206	13cbc1	G. W. Haney			Dug	17.7	30	Quaternary	14.34	12-15-54	Manual		D	
207	16dad1	Guy Watts		1890	Dug	17.9	30	Quaternary	9.4	2-4-53	Manual		D, S	See chemical analysis
208	19baa1	W. N. Standard		1952	Driven	21.0	1¼	Quaternary	11	1952	Pitcher		D	See chemical analysis
209	23adb1	Green Hill Parsonage			Dug	14.5	30	Quaternary	4.05	2-9-54	Manual		D	See chemical analysis
210	23bac1	N. C. Piper	H. Etheridge	1951	Drilled	323	2	Cockfield	60	1954	Cylinder	5	D	See chemical analysis
211	23bdd1	H. Watts	H. Etheridge	1951	Drilled	300	2	Cockfield	60	1954	Jet	5	D	See chemical analysis
212	25acc1	L. Webb		1933	Dug	14.6	30-2	Quaternary	13.02	12-15-54	Jet		D	
213	33bcc1	Ray Jones			Dug	17.9	48	Quaternary	14.65	2-4-54	Manual		D	See chemical analysis
214	35cbc1	R. Pace	Star City Drilling Co.	1954	Drilled	343	2	Cockfield			Jet	6	D	
215	35cbc2	R. Pace			Dug	31.3	24	Quaternary	29.68	9-9-54	Manual		S	See chemical analysis
	T. 14 S., R. 5 W.													
216	12abc1	J. Larkin	H. Etheridge	1950	Drilled	119	2½	Quaternary	43	1950	Jet	6	D	See chemical analysis
217	20baa1	Crossett Lumber Co.			Bored	46.8	8	Quaternary	37.28	12-2-54	Manual		U	
218	20bad1	W. C. Roper	H. Etheridge	1941	Drilled	68	2	Quaternary			Cylinder	10	D	See chemical analysis
219	26abb1	J. Hollinger			Bored	48.0	6	Quaternary	41.20	10-26-54	Manual		D	See chemical analysis
	T. 14 S., R. 6 W.													
220	12cca1	DeArmond Hunting Camp			Bored	44.0	8	Quaternary	39.02	12-1-54	Manual		D	
221	16cdc1	Claude Green	J. M. Ofallon	1933	Bored	85	2	Quaternary	68	12-1-54	Cylinder		D	See chemical analysis
	T. 14 S., R. 7 W.													
222	6 acc1	Guy Daugherty			Dug	14.3	30-2	Quaternary	11.09	12-15-54	Cylinder		D	See chemical analysis
223	16bba1	J. G. Chapman		1944	Drilled	392	2	Cockfield	100	1954	Cylinder	6	D	See chemical analysis
224	17 acb1	Hurbert Jones		1927	Dug	12.0	40	Quaternary	10.12	12-13-54	Manual		D	
225	18abd1	A. H. Chapman			Dug	19.5	30	Quaternary	4.70	2-10-54	Jet		D, S	See chemical analysis
226	18cbb1	Mrs. B. Cowan			Dug	14.0	40	Quaternary	11.31	12-13-54	Manual		D	See chemical analysis
227	26baa1	Town of Ladelle		1913	Drilled	500 ±	6	Cockfield	100	1954	Jet	10	PS	See chemical analysis
228	27aca1	A. M. Gumpert		1932	Dug	17.8	30	Pliocene(?)	13.82	11-29-54	Jet		D	
229	28bba1	Terrel Spencer		1934	Dug	14.7	30	Quaternary	9.65	12-6-54	Jet		D	
230	29ccd1	W. A. Cowan		1949	Dug	21.5	30	Quaternary	9.60	2-10-54	Manual		D	See chemical analysis
231	32dbb1	Dan Harden			Dug	15.8	30	Quaternary	13.03	11-29-54	Manual		D	See chemical analysis
	T. 14 S., R. 8 W.													
232	1aba1	Crossett Lumber Co.	Echols	1948	Drilled	460	4-2	Cockfield	25	1948	Jet	25	D	See chemical analysis
233	9aba1	R. C. Rodgers			Dug	15.5	30	Quaternary	12.50	2-4-54	Jet		D	See chemical analysis
234	10acc1	Roy Mayo		1929	Dug	19.7	36	Quaternary	18.32	12-10-54	Manual		D	
235	22bba1	Flo Mae Brown			Dug	13.8	30	Quaternary	11.68	12-7-54	Manual		D	See chemical analysis
236	25aaa1	Ed Grubbs		1951	Dug	15.1	30-2	Quaternary	12.00	12-7-54	Jet		D	
237	28cdc1	C. Ellis		1954	Dug	19.0	48-2	Quaternary	12	1954	Jet		D	
238	29aaa1	W. E. Eubanks		1902	Dug	18.2	30	Quaternary	11.88	2-4-54	Cylinder		D	See chemical analysis
239	36cac1	C. L. Daniels			Dug	15.7	48	Quaternary	15.27	12-14-54	Manual		D	
	T. 14 S., R. 9 W.													
240	13dca1	R. H. Glennon	Farmer Supply Co.	1951	Driven	17	1¼	Quaternary	14	1951	Jet		D	
	T. 15 S., R. 4 W.													
241	12add1	C. Wayman	Layne-Arkansas(?)	1942	Drilled	980	8	Sparta			Turbine	2,100	D, Irr	See chemical analysis
242	12dda1	C. Wayman	Layne-Arkansas(?)	1942	Drilled	760	18-8	Sparta			Turbine	1,800	D, Irr	See chemical analysis
243	13bda1	Town of Jerome	H. S. Ragland		Drilled	650	12-4	Sparta(?)			Turbine	300	PS	
	T. 15 S., R. 5 W.													
244	18dda1	B. T. Towles	H. Etheridge	1954	Drilled	35.0	3	Quaternary	18	1954	Pitcher		D	
	T. 15 S., R. 6 W.													
245	18ddd1	G. A. LaGrone			Driven	14.2	2	Jackson(?)	11.49	12-3-54	Manual		D	
	T. 15 S., R. 7 W.													
246	4dbc1	J. Boyd			Bored	92.3	6	Quaternary	60.71	11-29-54	Manual		D	See chemical analysis
247	6aab1	M. Junior			Dug	17.7	30	Quaternary	15.76	12-7-54	Manual		D	Goes dry in dry weather
248	8bac1	J. M. Martin	H. Etheridge	1953	Drilled	640	2	Sparta	120	1953	Cylinder	5	D	See chemical analysis
249	8bba1	C. Ingram		1944	Dug	9.4	30	Quaternary	7.54	12-7-54	Manual		D	
250	17baa1	C. F. Lewis		1855 ±	Dug	17.5	48	Quaternary	12.27	11-29-54	Manual		D	
251	17ccd1	C. Fairchild		1950	Bored	37.8	8	Quaternary	19.62	2-10-54	Manual		D	See chemical analysis
	T. 15 S., R. 8 W.													
252	1ddb1	W. White			Dug	14.5	30	Quaternary	12.02	12-7-54	Centrifugal		D	
253	5aab1	J. W. Glennon		1939	Driven	22.0	1¼	Quaternary	11-78	12-7-54	Jet		D	
254	11cdd1	O. E. Dawkins			Dug	14.7	36	Quaternary	13.84	12-7-54	Manual		D	See chemical analysis
255	16cdb1	B. Miller		1947	Driven	50	1¼	Quaternary			Pitcher		D	

Table 2. Analyses of Water from Wells in Drew County, Arkansas

(In parts per million except pH and as indicated)

Values reported for dissolved solids above 1,000 ppm are sums of determined constituents.

Well no.	Location no.	Owner	Depth (feet)	Water-bearing unit	Date of collection	Temp. (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Non-carbonate	Specific conductance (micromhos at 25°C)	pH
	T. 11 S., R. 4 W.																						
1	2adc1	R. D. Sanford	97	Quaternary	8-12-52	65	25	10	74	16	34	2.0	0	341	2.3	26	0.2	1.6	346	250	0	573	7.9
5	24bdd1	French Bros.	100±	Quaternary	8-13-52	65	--	15	--	--	--	--	17	256	5	18	--	0	--	227	0	495	8.5
6	25dab1	T. A. Prewitt	112	Quaternary	9-24-52	65	--	24	--	--	--	--	2	192	7	22	--	0	--	162	1	367	8.3
7	25ddb1	Tillar Water Co.	720	Sparta	8-11-52	75.5	15	.27	2.2	.8	73	1.4	0	197	1	5.2	.3	1.6	203	9	0	307	8.1
	T. 11 S., R. 5 W.																						
9	8cbc1	E. Henley	60±	Quaternary	3-30-54	61	--	.09	--	--	--	--	0	64	1	82	--	15	--	82	30	431	6.5
10	21cdc1	John Moore	770	Sparta	10-12-54			.32	1.0	.2	78	--	0	189	6.8	8.0	--	.7	197	3	0	334	8.1
12	27aad1	T. W. Scifres	120	Quaternary	10-13-54	68		4.3	8.4	2.6	12	--	0	50	4.9	8.8	--	.5	107	32	0	117	7.1
15	35ddb1	Selma Timber Co.	500±	Cockfield	10-11-54	77	7.7	.17	1.8	.1	87	1.2	0	229	1.2	5.5	.3	.5	246	5	0	366	7.8
	T. 11 S., R. 6 W.																						
18	6aaa1	Raymond Strickland	14.6	Jackson	10-19-54	69	36	1.9	257	113	52	14	0	196	952	70	1.0	1.7	1,590	1,110	945	1,960	6.6
19	7caa1	W. R. Creighton	16.6	Jackson	10-19-54	66		.62	26	5.9	24	--	0	46	66	20	--	10	256	89	51	320	7.6
20	8bad1	Cager McGough	37.8	Jackson	10-15-54	66		19	252	107	80	12	0	0	1,330	18	--	.7	1,800	1,070	1,070	2,270	3.3
21	8bbd1	Prentiss Sweeney	480	Cockfield	3-30-54	65	--	.05	--	--	--	--	9	284	1	7.2	--	1.2	--	11		464	8.5
23	10dbb1	Omeagur Williams	29.9	Jackson	10-18-54	69		.81	59	30	57	--	0	2	367	16	--	.2	658	270	269	803	4.7
25	11ccb1	Harold Scroggins	864	Sparta	7-28-53	79	13	.10	.4	0	68	1.5	0	170	.9	4.8	.1	.7	174	1	0	265	8.0
30	30abd1	L. K. Tucker	25.5	Pliocene(?)	10-20-54	67		.35	8.6	4.8	28	--	0	20	42	26	--	1.2	183	41	25	244	7.1
31	30adb1	L. K. Tucker	22.4	Jackson	10-30-54	--	49	7.3	461	227	362	16	0	0	2,380	310	2.2	3.1	3,810	2,080	2,080	4,360	4.1
33	34bcc1	J. W. Spade	59.2	Quaternary	3-30-54	64	--	.24	--	--	--	--	0	8	87	20	--	.5	--	52	45	290	6.5
	T. 11 S., R. 7 W.																						
35	4cdb1	C. B. Mitchell	482	Cockfield	12-16-53	--	--	.04	--	--	--	--	20	334	1	16	--	1.8	--	16	0	638	8.8
39	7bbd1	Urban Calhoun	670	Sparta	10-21-53	73	--	.03	--	--	--	--	0	120	3	2.8	--	.4	--	15	0	194	7.9
41	9bba1	H. A. Yount	Spring	Pliocene(?)	1- 4-55	60	--	.83	3.2	1.6	14	--	0	20	11	10	--	6.2	110	15	0	116	7.4
44	14baa1	S. A. Millen	19.1	Jackson	10-20-53	65	--	.12	--	--	--	--	0	68	282	118	--	9.0	--	300	244	1,110	6.5
47	16baa1	I. L. Hoffman	43.5	Jackson	1- 4-55	68	--	1.2	341	206	165	12	0	0	2,210	46	--	1.7	2,990	1,700	1,700	3,240	3.6
48	18cdc1	M. J. Handley	Spring	Pliocene(?)	10-21-53	71	--	1.2	--	--	--	--	0	20	49	58	--	.6	--	81	65	351	5.7
54	25bbb1	J. N. Hughes	400±	Cockfield	10-20-53	66	--	.91	6.1	.8	--	--	8	304	1	13	--	24	--	19	0	508	8.4
55	25cca1	G. C. Pevey	13.9	Jackson	10-20-53	65	--	.36	--	--	--	--	0	0	447	34	--	7.2	--	394	394	1,010	4.5
61	35aad1	David Swift	Spring	Pliocene(?)	10-21-53	71	--	.25	--	--	--	--	0	6	15	4.5	--	.7	--	12	7	70.9	5.7
	T. 11 S., R. 8 W.																						
63	9cab1	Rex Woodward	18.7	Quaternary	2- 4-54	--	--	.29	--	--	--	--	0	36	23	196	--	120	--	117	87	938	6.6
65	11ddd1	E. R. Harper	580	Sparta	12-16-53	--	--	.19	--	--	--	--	4	114	3	2.8	--	1.2	--	15	0	197	8.5
67	14bba1	L. McKeown	655	Sparta	12-16-53	--	--	.04	--	--	--	--	4	122	5	3.5	--	.9	--	23	0	230	8.4
68	15bbd1	Floyd Sullivan	17.5	Quaternary(?)	1- 4-55	60	--	.33	153	79	106	--	0	2	812	58	--	4.8	1,210	707	706	1,620	4.7
71	28ddc1	J. M. Beaty	208	Cockfield(?)	12-17-53	--	--	.37	--	--	--	--	4	181	464	107	--	3.9	--	151	0	1,560	8.4
72	34aba1	Frank Riviere	14.7	Quaternary	2- 4-54	--	--	.36	--	--	--	--	0	29	105	16	--	3.9	--	80	56	557	7.0
	T. 12 S., R. 4 W.																						
74	18bda1	V. J. Whitaker	134	Quaternary	10-21-54	--	--	18	22	6.9	18	--	0	89	6.6	31	--	.4	180	83	10	256	7.8
76	25caa1	F. A. Hogue	368	Cockfield	10-21-54	--	--	.42	1.1	1.0	92	--	11	217	2	12	--	2.0	229	17	0	411	8.7
	T. 12 S., R. 5 W.																						
79	1bba1	M. B. Smith	107	Quaternary	10-12-54	--	--	20	8.5	3.9	14	--	0	63	3.7	9.0	--	.5	110	37	0	134	8.0
81	11cba1	J. V. Lowe	80	Quaternary	10-14-54	--	--	13	17	6.6	15	--	0	108	3.1	9.0	--	.7	118	70	0	185	7.5
82	11cba2	B. E. Lowe	262	Cockfield	10-14-54	--	--	.15	14	3.4	104	--	12	281	1.4	9.0	--	1.5	304	49	0	487	8.5
	T. 12 S., R. 6 W.																						
89	15cab1	Aloys Rinehart	170	Quaternary	7-28-53	66	52	.57	9.5	3.2	21	1.2	0	72	3.8	16	.2	.2	151	37	0	186	6.5
92	16aad1	S. Ridgell	64.4	Quaternary	10-13-54	68	--	.19	9.7	3.0	21	--	0	56	3.5	22	--	.5	141	37	0	179	7.7
97	29dab1	Henry Ross	85	Quaternary	10-14-54	--	--	2.6	17	6.1	25	--	0	105	6	22	--	.4	178	68	0	237	8.0
98	30daa1	C. V. Hartz	366	Cockfield	10- 3-54	--	--	.27	3.5	1.0	108	--	8	244	9.9	15	--	.7	275	13	0	441	8.4
100	31ddc1	N. E. Chambers	18.1	Quaternary	2- 3-54	52	--	.56	--	--	--	--	0	10	22	25	--	21	--	20	12	130	6.8
102	32add1	Army P.O.W. Camp	720	Sparta	9-10-54	--	6.6	.10	0.4	0.1	67	1.0	4	160	.6	4.5	.3	.7	174	1	0	277	8.3
	T. 12 S., R. 7 W.																						
105	1cbb1	A. R. Kimbro	22	Jackson	10-21-53	68	--	1.4	--	--	--	--	0	0	1,720	488	--	7.1	--	1,040	1,040	4,300	4.3
106	1cbc1	G. R. Slocum	575	Cockfield(?)	10-21-53	69	--	.08	1.8	.8	--	--	6	210	1	5.5	--	1.9	--	8	0	348	8.4
113	4bbb1	J. A. Arnold	19.5	Pliocene(?)	10-20-53	66	--	.22	--	--	--	--	0	0	40	79	--	128	--	158	158	644	4.1
114	4bdd1	Ardis White	16.3	Jackson	10-21-53	70	--	3.7	--	--	--	--	0	0	1,540	282	--	2.4	--	1,180	1,180	3,250	3.7
124	13aad1	E. R. Allen	37.1	Jackson	10-15-54	65	--	14	500	333	449	18	0	0	3,080	400	.4		4,780	2,620	2,620	5,490	3.5
127	15adc1	K. W. Carpenter	470	Cockfield	12-16-53	58	--	.03	--	--	--	--	12	243	1	8.5	--	1.8	--	12	0	433	8.8
128	15ccb1	J. L. Mitchell	17.5	Jackson	10-21-53		--	17	--	--	--	--	0	0	1,570	50	--	2.1	--	925	925	2,550	3.6
129	15cdb1	H. Mitchell	11.4	Pliocene(?)	10-21-53	71	--	.11	--	--	--	--	0	14	7	3.5	--	10	--	20	9	75.1	6.4
136	21ddc1	L. F. Wright	575	Sparta(?)	12-16-53	--	--	0	--	--	--	--	3	146	3	4.5	--	1.3	--	4	0	253	8.4
137	25abc1	J. G. McCandless	15.4	Jackson(?)	10-13-54	--	--	.27	29	20	80	71	0	29	59	152	1.0	105	653	154	130	941	7.3
139	26dac2	City of Monticello	880	Sparta(?)	2-10-54	79	12	0	1.4	.1	58	1.4	1	140	3.2	3.5	.3	2	161	4	0	255	8.3
141	26dcd1	Monticello Cotton Mills	621	Sparta(?)	2-12-54	81	12	.11	.8	.2	55	1.1	0	142	1	2.8	0	1	155	3	0	231	7.6
142	29dad1	Harris Hales	15.8	Jackson(?)	12-16-54	64	--	.54	6.5	3.8	16	--	0	20	22	10	--	16	104	32	15	157	7.3
143	29dad2	Harris Hales	32.3	Jackson(?)	12-16-54	--	--	.15	11	20	38	36	0	1	54	50	--	128	389	110	109	596	5.4
144	30dbd1	Winston Gardner	7.8	Jackson(?)	2- 9-54	52	--	.67	--	--	--	--	0	56	69	21	--	7.5	--	92	46	307	7.4
145	30dbd2	Winston Gardner	502	Cockfield	2- 9-54	--	--	.23	--	--	--	--	0	200	2	10	--	2	--	4	0	326	7.9
	T. 12 S., R. 8 W.																						
147	9bdb1	P. Herring	17.1	Quaternary(?)	2- 4-54	49	--	3.8	--	--	--	--	0	21	130	198	--	115	--	159	142	1,260	6.9
150	13bac1	W. B. Leggett	19.1	Quaternary(?)	1- 3-55	63	--	.47	5.6	5.5	23	--	0	3	7	46	--	15	136	37	34	223	6.5

Table 2. Analyses of Water from Wells in Drew County, Arkansas (Continued)

(In parts per million except pH and as indicated)

Values reported for dissolved solids above 1,000 ppm are sums of determined constituents.

Well no.	Location no.	Owner	Depth (feet)	Water-bearing unit	Date of collection	Temp. (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Non-carbonate	Specific conductance (micromhos at 25°C)	pH
153	19abc1	Dale Allison	19.0	Quaternary	2- 4-54	59	----	.06	----	----	----	----	0	52	23	38	----	6	----	31	0	238	7.3
157	27ccd1	W. L. Stiles	235	Cockfield(?)	2- 8-54	----	----	.22	----	----	----	----	0	184	393	54	----	2.4	----	105	0	1,270	8.1
158	27cdc1	P. D. McLemore	240	Cockfield(?)	2- 9-54	----	----	0	----	----	----	----	0	242	145	64	----	0	----	56	0	908	7.7
159	27cdc2	Miss. River Fuel Corp.	505	Cockfield(?)	2- 9-54	----	----	.10	----	----	----	----	0	229	40	25	----	2.3	----	20	0	490	8.0
160	33bac1	City of Wilmar	194±	Cockfield(?)	2- 9-54	68	10	.09	6.0	1.0	124	2.7	0	283	24	14	.6	4.5	338	19	0	539	8.0
161	34bbb1	Ozark-Badger Lumber Co.	502.5	Cockfield(?)	2- 9-54	74	12	.06	1.0	0.1	71	1.3	0	176	1.2	7.5	.2	1.1	194	3	0	305	7.5
	T. 13 S., R. 5 W.																						
167	28bdb1	C. Garrison	57.3	Quaternary	2- 3-54	----	----	.52	----	----	----	----	0	29	22	16	----	12	----	55	31	280	7.0
	T. 13 S., R. 6 W.																						
170	4bcb1	A. Flemister	90±	Quaternary	10-26-54	----	----	.31	12	5.0	15	----	0	70	2	17	----	1.3	142	50	0	172	7.9
172	6cdb1	J. Tranihan	18.7	Jackson	2- 2-54	66	----	.08	----	----	----	----	0	2	514	32	----	.2	----	399	397	1,060	5.0
173	7cac1	Davey	23.5	Jackson	2- 3-54	60	----	.07	----	----	----	----	0	0	268	37	----	17	----	250	250	766	4.0
174	12bbd1	S. R. Berry	43.6	Quaternary(?)	2- 3-54	62	----	.43	----	----	----	----	0	28	5	232	----	1.5	----	117	94	824	6.5
175	17bbb1	E. P. Mobley	29	Jackson	12- 1-54	66	----	2.4	44	22	74	----	0	32	17	220	----	1.8	507	200	174	859	7.2
177	21bbb1	George Rinehart	171	Quaternary	7-28-53	66	50	2.2	31	7.4	29	1.6	0	166	11	14	.2	.3	228	108	0	323	6.9
	T. 13 S., R. 7 W.																						
178	2acc1	C. Nichols	27	Pliocene(?)	2- 3-54	60	----	.20	----	----	----	----	0	16	1	19	----	43	----	54	41	201	6.9
179	2dac1	W. W. Cruce	25	Pliocene(?)	2- 3-54	66	----	.29	----	----	----	----	0	6	2	83	----	16	----	52	47	352	6.7
180	4aba1	R. McKinney	750	Sparta	3-30-54	----	----	.13	----	----	----	----	0	208	4	7.5	----	.2	----	10	0	357	8.2
181	10aad1	H. J. Eickhof	516	Cockfield	2-10-54	----	----	.13	----	----	----	----	2	161	12	5.8	----	.8	----	6	0	286	8.3
182	10acc1	R. Hudson	525	Cockfield	3-30-54	----	----	.31	----	----	----	----	2	157	18	4.8	----	0	----	9	0	292	8.3
183	10bca1	Ark. A. & M. College	830	Sparta	2-10-54	73	12	.03	1.0	.1	68	1.2	0	172	5.8	5.0	0	1.2	188	3	0	293	7.7
185	11cbc1	Mrs. P. Biscoe	649	Sparta	2-10-54	71	----	1.1	----	----	----	----	3	150	3	5.5	----	.6	----	5	0	262	8.3
186	11ccb1	V. Borchardt	545	Cockfield	2-10-54	----	----	.25	----	----	----	----	2	146	4	5.2	----	.8	----	4	0	258	8.4
	T. 13 S., R. 7 W.	(Con.)																					
187	11ccc1	C. C. Smith	525	Cockfield	2-10-54	----	----	.04	----	----	----	----	0	158	2	5.2	----	2.8	----	6	0	273	7.9
188	12baa1	L. Paranto	Spring	Pliocene(?)	3-30-54	58	----	2.6	----	----	----	----	0	9	2	28	----	4.8	----	16	9	138	7.7
191	16cba1	E. W. Bryden	450	Cockfield	2-10-54	----	----	.11	----	----	----	----	0	193	15	12	----	1.1	----	10	0	366	8.2
192	16cdb1	A. V. Ramsey	18.6	Jackson(?)	2-10-54	56	----	.27	----	----	----	----	0	57	20	10	----	4.5	----	40	0	171	7.9
194	21aac1	E. L. Marshall	760	Sparta	10- 3-54	77	----	.44	1.4	.2	79	----	8	178	7	8	----	.4	232	4	0	328	8.6
195	21aac2	E. L. Marshall	29.3	Jackson	10- 3-54	----	----	.34	48	23	121	----	0	8	95	240	----	46	661	214	208	1,110	6.9
196	23cbb1	D. C. Sanderlin	400±	Cockfield	3-30-54	----	----	.25	----	----	----	----	0	228	263	57	----	.6	----	44	0	1,120	7.8
197	24bdd1	L. K. Wilson	21.1	Jackson	2- 3-54	----	----	.11	----	----	----	----	0	5	297	128	----	10	----	317	313	1,030	5.5
200	28bab1	Ray Maxwell	14.8	Jackson(?)	2-10-54	62	----	.09	----	----	----	----	0	10	4	6	----	2.1	----	4	0	43.2	7.0
	T. 13 S., R. 8 W.																						
203	6ada1	W. Daniels	13.1	Quaternary	12-16-54	56	----	1.1	3.2	3.5	18	----	0	10	17	18	----	5.6	119	22	14	155	7.1
205	10cbc1	J. W. Smith	15.4	Quaternary	3-29-54	65	----	2.3	----	----	----	----	0	17	1	89	----	76	----	88	74	587	6.8
207	16dad1	Guy Watts	17.9	Quaternary	2- 4-54	60	----	.04	----	----	----	----	0	39	2	44	----	40	----	63	31	307	7.4
208	19baa1	W. N. Standard	21	Quaternary	12-15-54	66	----	2.7	2.3	1.4	54	----	0	108	3	22	----	8	460	12	0	281	8.2
209	23adb1	Green Hill Parsonage	14.5	Quaternary	2- 9-54	----	----	.08	----	----	----	----	0	4	20	40	----	75	----	78	75	355	5.7
210	23bac1	N. C. Piper	323	Cockfield	2-10-54	----	12	.09	2.4	.5	92	1.7	2	218	1.2	20	0	1.4	252	8	0	406	8.3
211	23bdd1	H. Watts	300	Cockfield	3-30-54	----	----	0	----	----	----	----	0	214	2	17	----	.4	----	15	0	405	7.9
213	33bcc1	Ray Jones	17.9	Quaternary	3-29-54	62	----	.13	----	----	----	----	0	11	1	32	----	2.4	----	17	8	185	6.7
215	35cbc2	R. Pace	31.3	Quaternary	9- 9-54	65	----	5.7	17	7.7	58	----	0	23	108	48	----	3.1	314	74	55	453	7.3
	T. 14 S., R. 5 W.																						
216	12abc1	J. Larkin	119	Quaternary	10-26-54	----	----	7.2	14	5.5	19	----	0	68	2	32	----	1.3	156	58	2	220	7.9
218	20bad1	W. C. Roper	68	Quaternary	12- 2-54	66	----	4.2	32	11	28	----	0	34	2	112	----	2.4	263	125	97	445	7.4
219	26abb1	J. Hollinger	48	Quaternary	10-26-54	----	----	.59	8.8	3	34	----	0	21	2	43	----	34	237	34	17	255	7.2
	T. 14 S., R. 6 W.																						
221	16cdc1	Claude Green	85	Quaternary	12-1-54	62	----	23	22	8.6	34	----	0	163	2	20	----	.3	184	90	0	320	7.6
	T. 14 S., R. 7 W.																						
222	6acc1	Guy Daugherty	14.3	Quaternary	12-15-54	----	----	1.1	.9	2.2	2.2	2.1	0	5	5	5	----	3.5	28	11	7	45.9	6.7
223	16bba1	J. G. Chapman	392	Cockfield	2-10-54	----	9.7	.15	2.5	1.1	76	2.2	0	175	16	10	0	1.8	216	11	0	338	8.2
225	18abd1	A. H. Chapman	19.5	Quaternary	2-10-54	62	----	1.2	----	----	----	----	0	13	42	29	----	16	----	33	22	267	6.8
226	18cbb1	Mrs. B. Cowan	14	Quaternary	12-14-54	----	----	.25	.9	1.3	3.4	----	0	6	3	4.5	----	2.3	50	8	3	31.5	6.8
227	26baa1	Town of Ladelle	500±	Cockfield	12-17-53	----	----	1.7	----	----	----	----	0	284	2	50	----	2.3	----	598	365	1,740	8.0
230	29ccd1	W. A. Cowan	21.5	Quaternary	3-30-54	61	----	0	----	----	----	----	0	102	7	161	----	46	----	147	63	870	7.7
231	32dbb1	Dan Harden	15.8	Quaternary	11-29-54	61	----	.21	1.1	.4	11	----	0	9	2	12	----	3.5	58	4	0	58.4	6.7
	T. 14 S., R. 8 W.																						
232	1aba1	Crossett Lumber Co.	460	Cockfield	2-10-54	----	----	.09	----	----	----	----	2	210	179	58	----	2.8	----	86	0	890	8.3
233	9aba1	R. C. Rodgers	15.5	Quaternary	2- 4-54	59	----	.09	----	----	----	----	0	21	10	59	----	14	----	31	14	353	7.1
235	22bba1	Flo Mae Brown	13.8	Quaternary	12- 7-54	62	----	2.1	45	19	486	----	0	44	7	845	----	2.6	1,430	190	154	2,900	7.3
238	29aaa1	W. E. Eubanks	18.2	Quaternary	2- 4-54	62	----	.20	----	----	----	----	0	34	3	117	----	16	----	46	18	514	7.0
	T. 15 S., R. 4 W.																						
241	12add1	C. Wayman	980	Sparta	9-14-52	76	----	.55	----	----	----	----	17	271	1	114	----	.2	----	10	0	821	8.6
242	12dda1	C. Wayman	760	Sparta	9- 7-52	----	----	.41	----	----	----	----	3	314	4	126	----	1.3	----	12	0	879	8.3
	T. 15 S., R. 7 W.																						
246	4dbc1	J. Boyd	92.3	Quaternary	11-29-54	65	----	.52	87	26	82	----	0	165	248	84	----	.5	602	324	189	1,010	7.6
248	8bac1	J. M. Martin	640	Sparta	2-10-54	----	11	.29	1.9	.4	184	2.0	0	425	5.4	38	.6	2.5	464	6	0	749	8.0
251	17ccd1	C. Fairchild	37.8	Quaternary	2-10-54	----	----	2.1	----	----	----	----	0	230	1,000	428	----	2.7	----	1,190	1,000	3,190	8.0
	T. 15 S., R. 8 W.																						
254	11cdd1	O. E. Dawkins	14.7	Quaternary	12- 7-54	59	----	.42	4.8	3.4	24	----	0	10	4	40	----	13	134	26	18	190	6.9

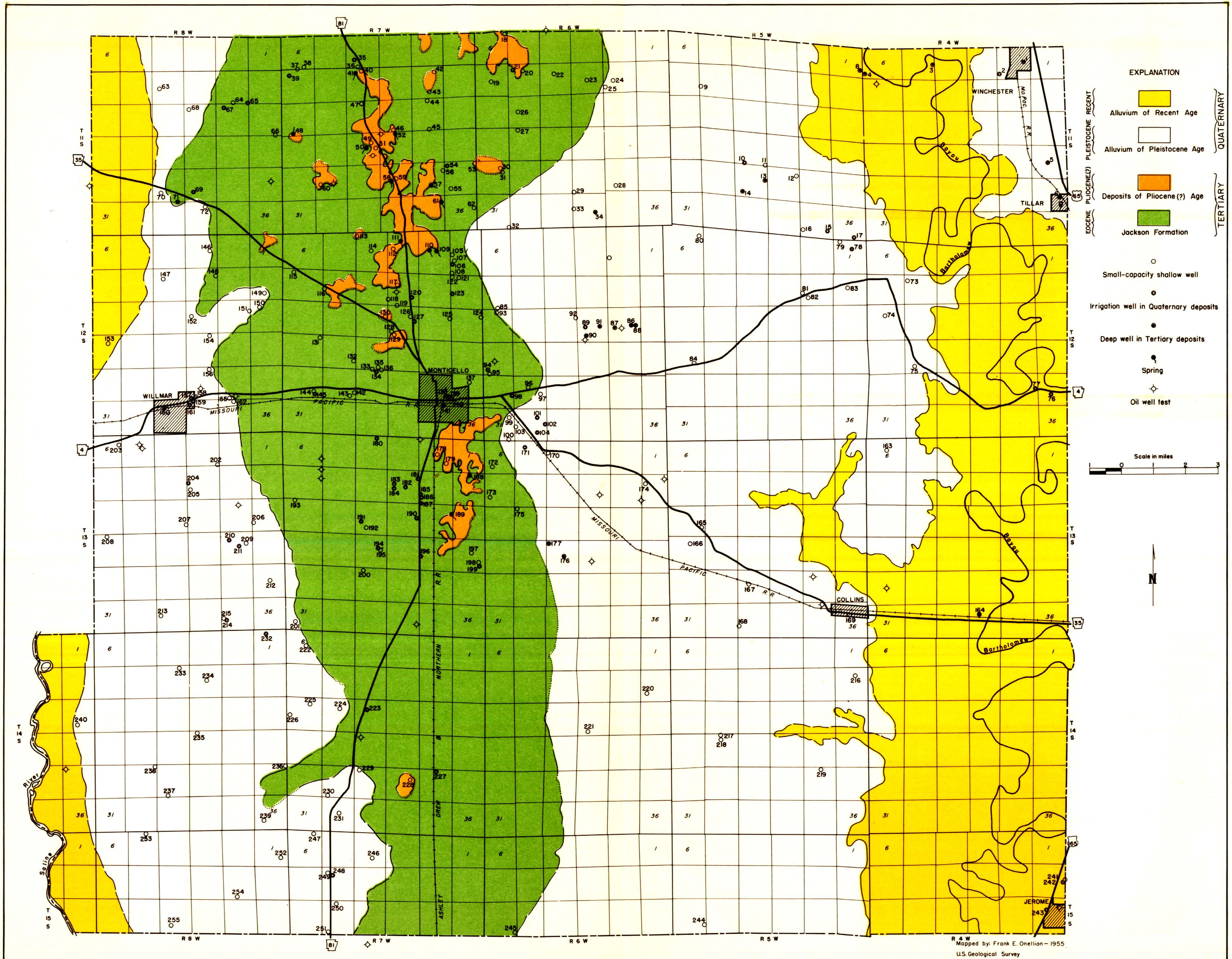

Figure 1. Map of Drew County, Ark., showing geology and locations of wells.

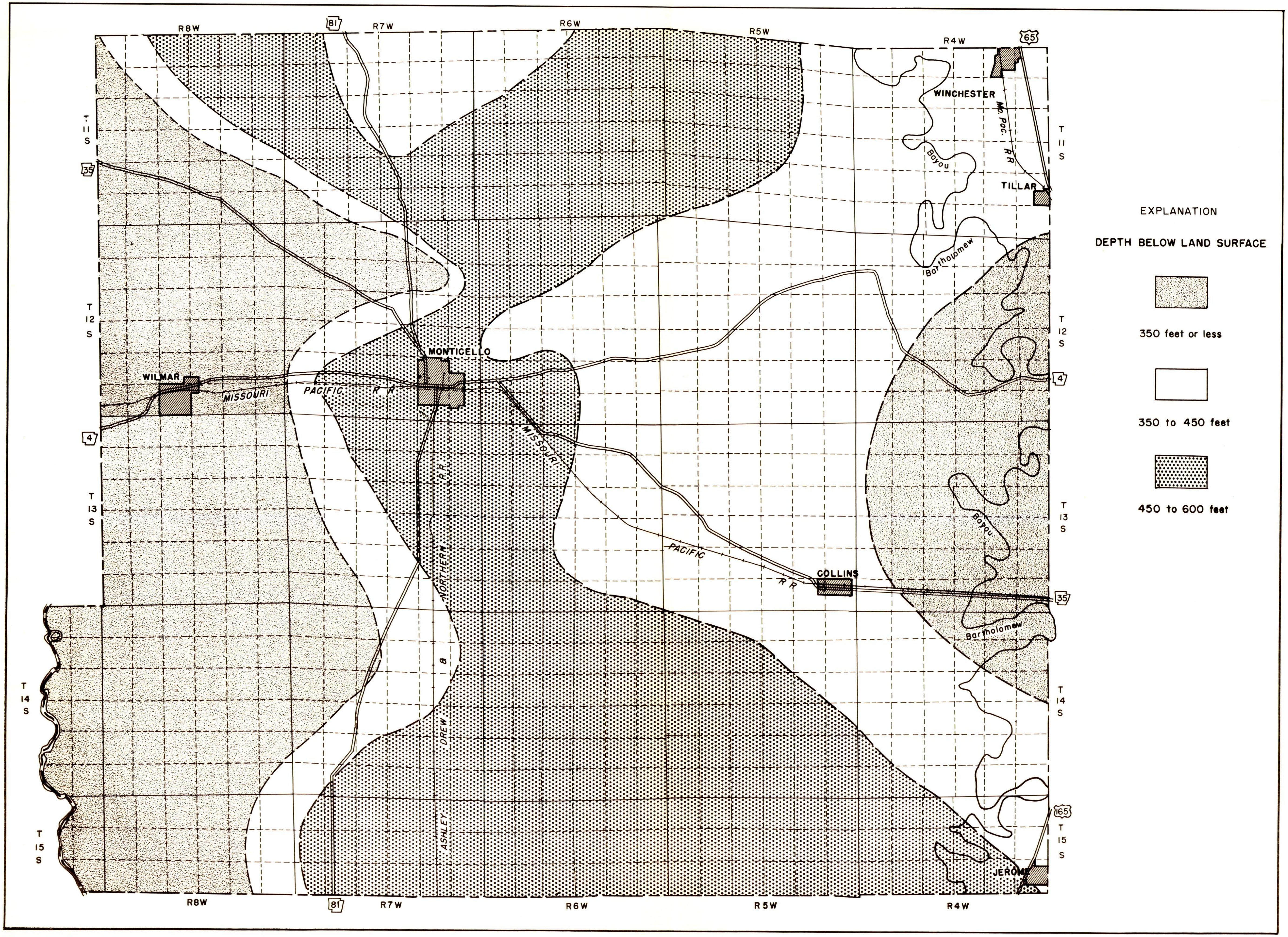

Figure 2. Map of Drew County, Ark., showing average minimum depths at which soft water may be obtained from wells in Tertiary deposits.

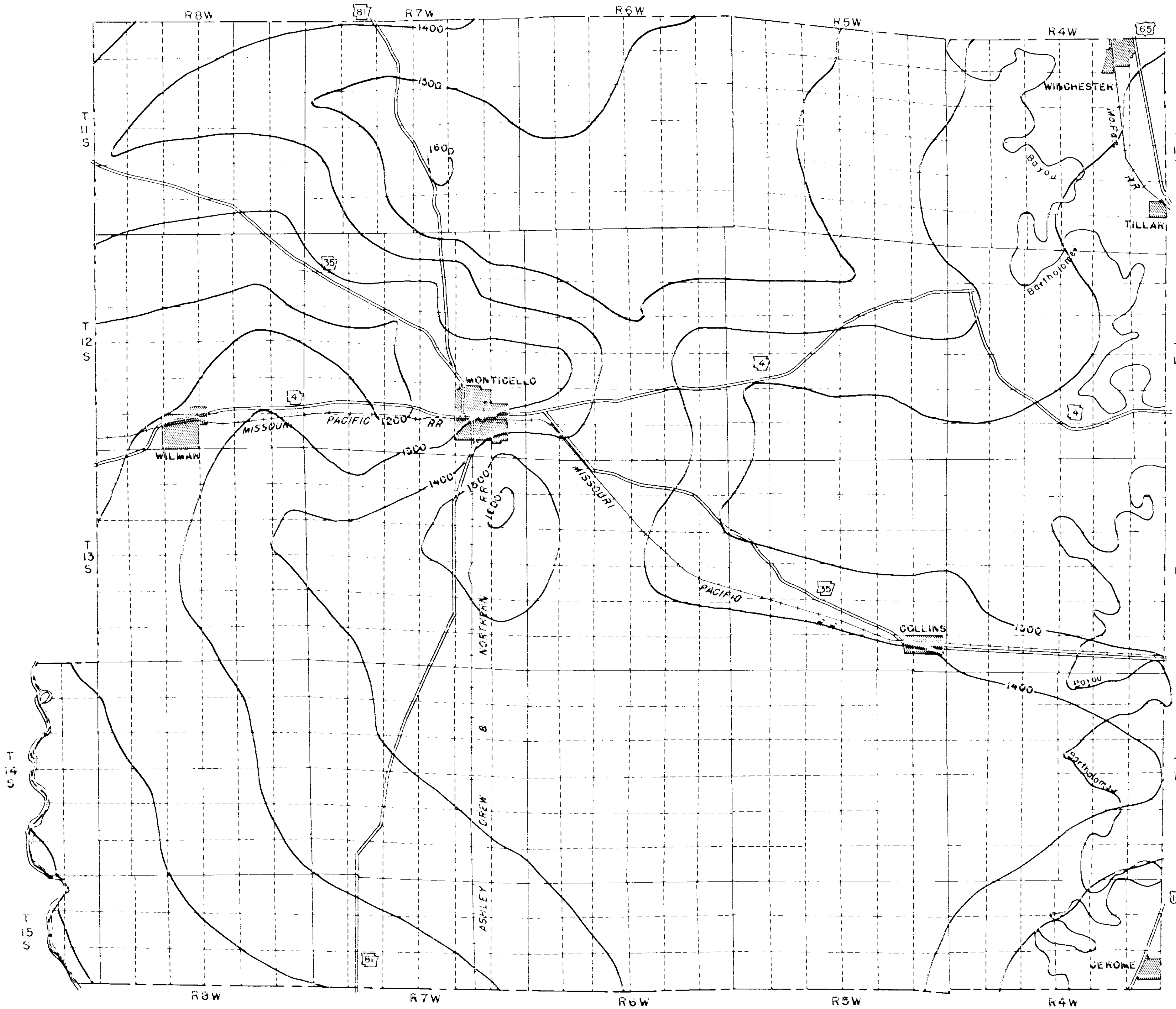

Figure 3. Map of Drew County, Ark., showing probable maximum depths at which fresh water may be obtained from wells.

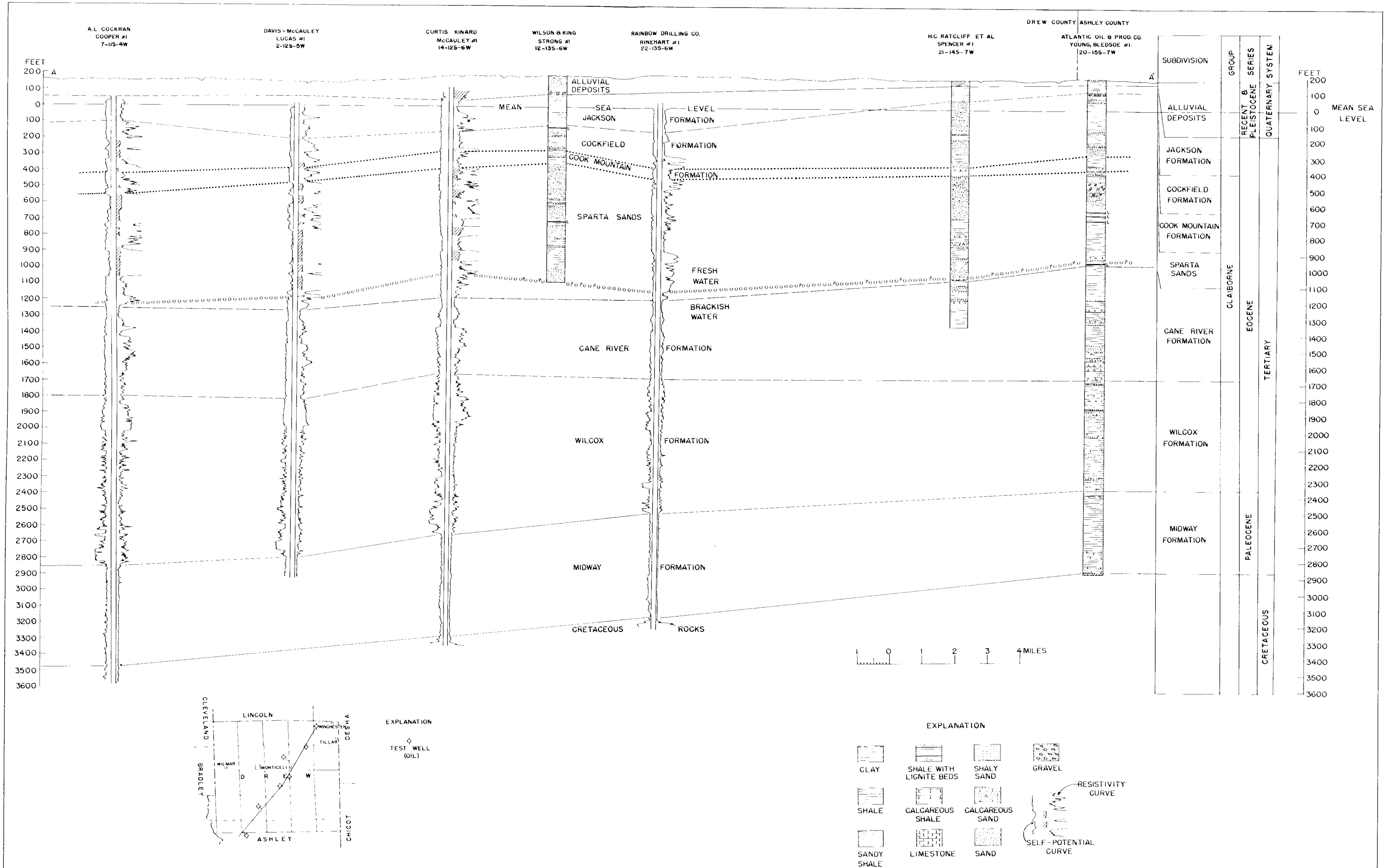

Figure 4. Generalized geologic section southwestward across Drew County, showing deposits of Tertiary and Quaternary age.

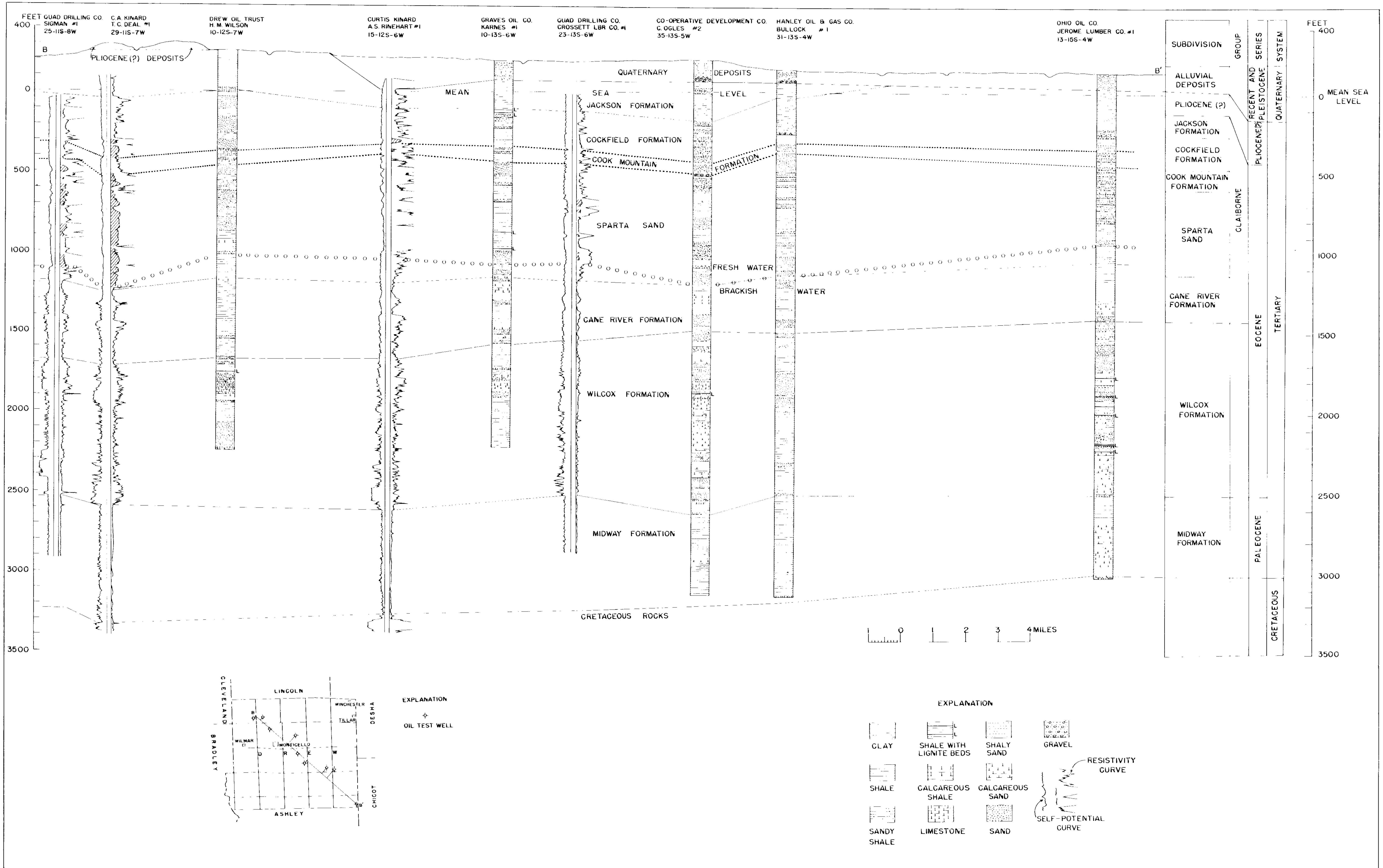

Figure 5. Generalized geologic section southeastward across Drew County, showing deposits of Tertiary and Quaternary age.