GEOHYDROLOGY AND SUSCEPTIBILITY OF MAJOR AQUIFERS TO SURFACE CONTAMINATION IN ALABAMA; AREA 6

by Sydney S. DeJarnette and Jo E. Crownover

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 87-4113

Prepared in cooperation with the

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

Tuscaloosa, Alabama

1987

DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS

For use of readers who prefer to use metric (International System) units, conversion factors for inch-pound units used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
gallon per minute (gal/min)	0.06308	liter per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)

Sea level: In this report "sea level" refers to the National Geodetic Vertical DAtum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

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ABSTRACT

The major aquifers in the study area (defined as those with actively pumped public supply wells) are the Coker, Gordo, Eutaw, and Nanafalia aquifers. The recharge areas for these aquifers are in Tuscaloosa, Pickens, Greene, Sumter, and Marengo Counties. The aquifers underlie most of the study area and consist of sand and gravel beds. Water in the aquifers usually occurs under artesian conditions.

The Coker aquifer is the source of public water supplies for the towns of Coker and Gordo, and for the Buhl-Elrod-Holman Water System in Tuscaloosa County. The Gordo and Eutaw aquifers are sources of public water supplies in Pickens, Greene, and Marengo Counties. The Nanafalia aquifer is the source of public water supplies for the towns of Sweetwater and Myrtlewood in Marengo County.

Depressions in the potentiometric surface have developed around Demopolis in the Gordo and Eutaw aquifers partly as a result of ground-water withdrawals. Other depressions and troughs have formed along the major rivers because of ground-water discharge to the rivers.

All the recharge areas for the major aquifers are susceptible to surface contamination throughout most of the study area; however, the recharge areas are in rural settings that are used for timberlands, farms, and pastures. Usually, the depth to the water-bearing zone tapped by a well and the horizontal distance from the outcrop to the well provide a buffer from surface contamination.

Other potential areas susceptible to surface contamination are the permeable terrace and alluvial deposits along major river flood plains, if the potentiometric surface in the underlying aquifer has been depressed. The alluvial deposits are usually in areas of discharge, but if pumpage has caused a depression in the potentiometric surface of the underlying aquifer, the alluvial aquifer will become a source of recharge, allowing water to infiltrate through the alluvium into the underlying aquifer.

INTRODUCTION

The Alabama Department of Environmental Management (ADEM) is developing a comprehensive program to protect aquifers in Alabama from surface contamination that are defined by the U.S. Environmental Protection Agency (EPA) as "Class I and II" aquifers (U.S. Environmental Protection Agency, 1984). The U.S. Geological Survey, in cooperation with ADEM, is conducting a series of geohydrologic studies to delineate the major aquifers and their recharge areas in Alabama. This report delineates recharge areas and describes the geohydrology of the major aquifers in Greene, Marengo, Pickens, Sumter, and Tuscaloosa Counties (see plate 1).

The dependence on ground water in this five-county area of west-central Alabama is not represented accurately in this inventory, which is limited to public supply wells. Most of the area is dependent on domestic supply wells, which are numerous throughout the area. Domestic wells are not limited to pumping from the aquifers termed major aquifers for purposes of this report.

Purpose and Scope

The purposes of the report are to delineate recharge areas and to describe the major aquifers in the study area, and to delineate areas within the recharge areas that are most susceptible to contamination from the surface. Previously-compiled geologic and hydrologic data provide about 75 percent of the data used to evaluate the major aquifers in the area. All wells used for municipal and rural public water supplies were inventoried, and water levels were measured in these wells where possible. Data on water use were compiled during the well inventory. Water-level data were used to construct generalized potentiometric maps of the aquifers. Areas susceptible to contamination from the surface were delineated on the basis of information from topographic maps, other available data, and from field investigation.

Location and Extent of the Area

The study area is in west-central Alabama and comprises an area of about 4,746 mi^2 (square miles). The area includes the city of Tuscaloosa, the towns of Eutaw, Demopolis, Linden, Thomaston, Aliceville, Carrollton, Livingston, York, and numerous other small towns and communities. The total population of the area was 211,998 in 1980 (Alabama Department of Economic and Community Affairs, 1984). The area is partly urban, partly suburban, and partly rural. A large part of the area is dependent on ground water.

Physical Features

The study area includes parts of several physiographic districts (fig. 1). The southeastern part of Tuscaloosa County is in the Birmingham-Big Canoe Valley district of the Alabama Valley and Ridge physiographic section (Sapp and Emplaincourt, 1975). This area is characterized by northeastward-trending ridges and valleys.

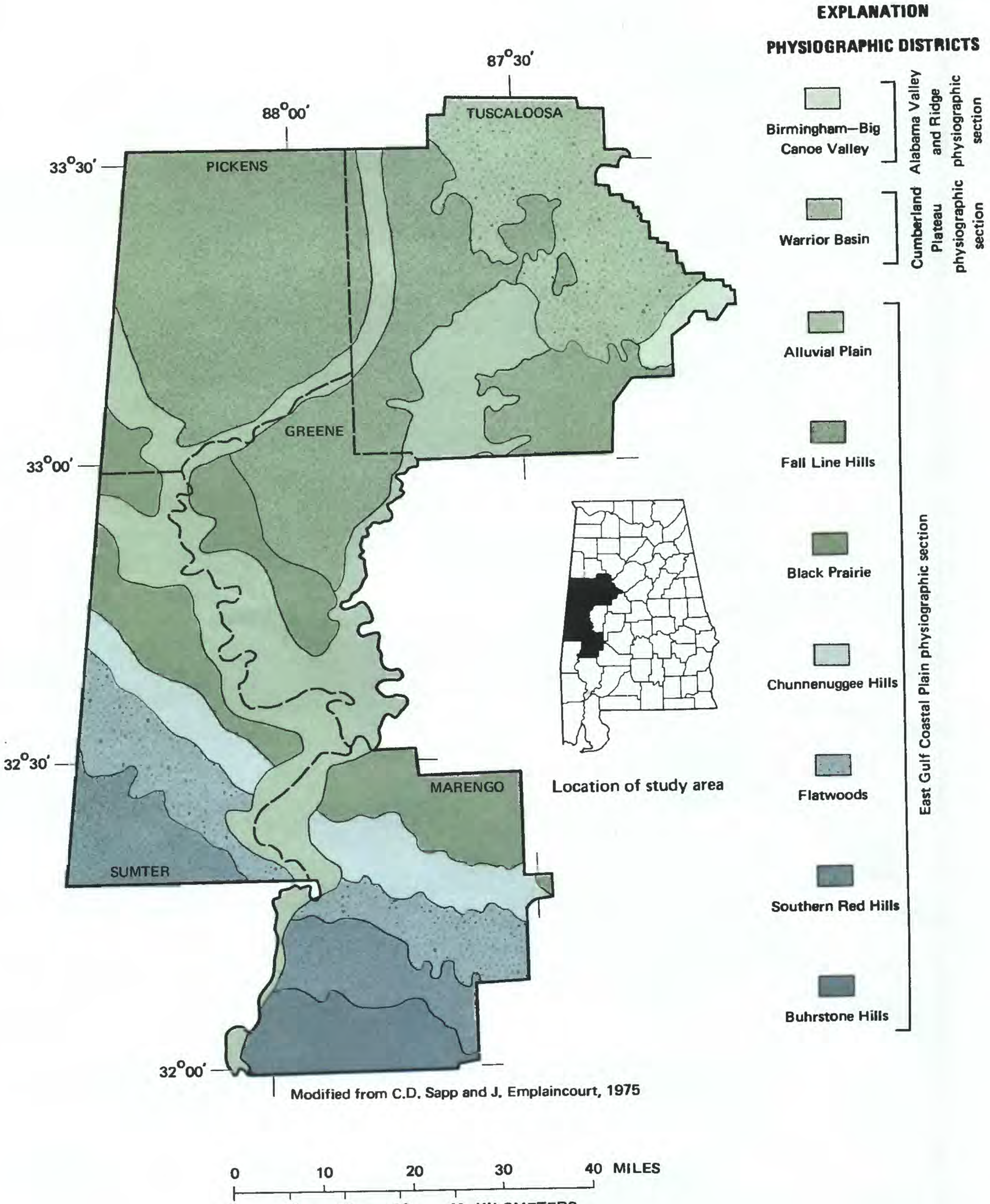

Figure 1.--Physiographic divisions of the study area.

Northeastern Tuscaloosa County is in the Warrior Basin district of the Cumberland Plateau physiographic section. This area is part of a synclinal plateau of moderate relief.

In all five counties in the study area, the parts adjacent to large rivers are in the Alluvial-Deltaic Plain district of the East Gulf Coastal Plain physiographic section. This area is characterized by broad, flat, flood plains and terraces along the Tombigbee, Black Warrior, and Sipsey Rivers.

The remainder of Tuscaloosa County, the majority of Pickens County, and the northern part of Greene County are in the Fall-Line Hills district of the East Gulf Coastal Plain physiographic section. These areas consist mainly of flat to moderately-rolling sandy uplands dissected by deeply-entrenched southward and southwestward flowing streams.

Central Greene County and northern Sumter and Marengo Counties are in the Black Prairie district of the East Gulf Coastal Plain physiographic section. The Black Prairie, named for black soil that is common in the area, is a gently- to moderately-rolling prairie that is characterized by extensive grasslands but very few trees.

Southwest of the Black Prairie in Sumter and Marengo Counties is the Chunnenuggee Hills district of the East Gulf Coastal Plain physiographic section. This area is characterized by sandy cuestas that have fairly steep northward-facing escarpments and gently-to moderately-rolling backslopes.

Southwest of the Chunnenuggee Hills district in Sumter and Marengo Counties is the Southern Red Hills district of the East Gulf Coastal Plain physiographic section. The district is a southward sloping upland of moderate relief which includes the Flatwoods lowland along the northern edge and the rugged Buhrstone Hills in the southern edge in extreme southern Marengo County.

Previous Investigations

Information on the geology of the area was published as early as 1858 in the second biennial report of the Geological Survey of Alabama by Michael Toumey, the first State Geologist. A detailed description of the geology of Alabama and a revised geologic map were published by the Geological Survey of Alabama in 1926 (Adams and others, 1926).

The first information on ground water in the area was published in 1907 (Smith, 1907). Other reports that contain information on the geology and ground-water resources of the area are "Notes on Deposits of Selma and Ripley Age in Alabama" (Monroe, 1941), "Ground Water Resources of the Cretaceous Area of Alabama" (Carlston, 1944), "Geology and Ground Water Resources of Greene County, Alabama" (Wahl, 1966), "Geology and Ground Water Resources of Marengo County, Alabama" (Newton and others, 1961), "Ground-Water Resources of Pickens County, Alabama, a Reconnaissance" (Wahl, 1965), "Water Availability and Geology of Sumter County, Alabama" (Davis and others, 1980), and "Ground-Water Resources and Geology of Tuscaloosa County, Alabama" (Paulson and others, 1962).

Acknowledgments

The authors wish to thank the many persons who have contributed information and assistance during the field investigation and during the preparation of this report. Special appreciation is extended to the waterworks personnel of the ground-water systems in the study area who have helped locate public-supply wells and furnished information on well construction and water use.

GEOHYDROLOGY

Geologic formations that crop out in and underlie the study area range in age from Cambrian to Quaternary (fig. 2). Sedimentary rocks of Paleozoic age crop out in the eastern part of Tuscaloosa County. These rocks range in age from Cambrian to Pennsylvanian. Unconsolidated sedimentary deposits of Late Cretaceous age crop out in the remainder of Tuscaloosa County, all of Pickens and Greene Counties, and in all but southernmost parts of Sumter and Marengo Counties where sedimentary deposits of Tertiary age crop out. Alluvial and terrace deposits overlie older rocks in and adjacent to the flood plains of the Black Warrior, Sipsey, and Tombigbee Rivers and larger streams in the study area. A generalized subsurface section of formations underlying the study area is shown in figure 3. This schematic section does not represent an actual cross section. It is intended to show all the geologic units that crop out in Area 6 and their relative positions. No one cross section could include all these units and lie within the area on a map because of the alignment of the counties within Area 6. A summary of the thickness, lithology, and water-bearing properties of each geologic unit that underlies the study area is given in table 1.

Paleozoic Rocks

Sedimentary rocks that range in age from Cambrian to Pennsylvanian crop out in eastern Tuscaloosa County. Geologic units, from oldest to youngest, include the Brierfield, Ketona, and Bibb Dolomites of Cambrian age, the Knox Dolomite or Knox Group where it is divided of Cambrian and Ordovician age, the Longview, Newala, and Little Oak Limestones of Ordovician age, and the Fort Payne Chert and Floyd Shale of Mississippian age. These rocks, which crop out in an area of about 50 mi^2 in southeastern Tuscaloosa County, are complexly folded and faulted and, except for the Floyd Shale, are deeply weathered. No large-capacity wells have been drilled in this part of Tuscaloosa County, but the limestones and dolomites are potential sources of large water supplies. For example, a municipal spring discharging from the Brierfield Dolomite at the city of Montevallo in nearby Shelby County flowed at a rate of more than 1,000 gal/min (gallons per minute) in 1968, and a well developed in the Brierfield Dolomite in Montevallo had a drawdown in water level of only 32 feet when pumped at 340 gal/min in 1962. The Pennsylvanian age Pottsville Formation crops out in northeastern Tuscaloosa County. The Pottsville Formation consists chiefly of sandstone, conglomerate, siltstone, and shale with beds of coal and underclay. It strikes northwest and dips to the southwest at 30 to 200 ft/mi (feet per mile) (Harkins and others, 1980). Large water supplies generally are not available from the Pottsville Formation and no municipal wells tap the Pottsville within the study area.

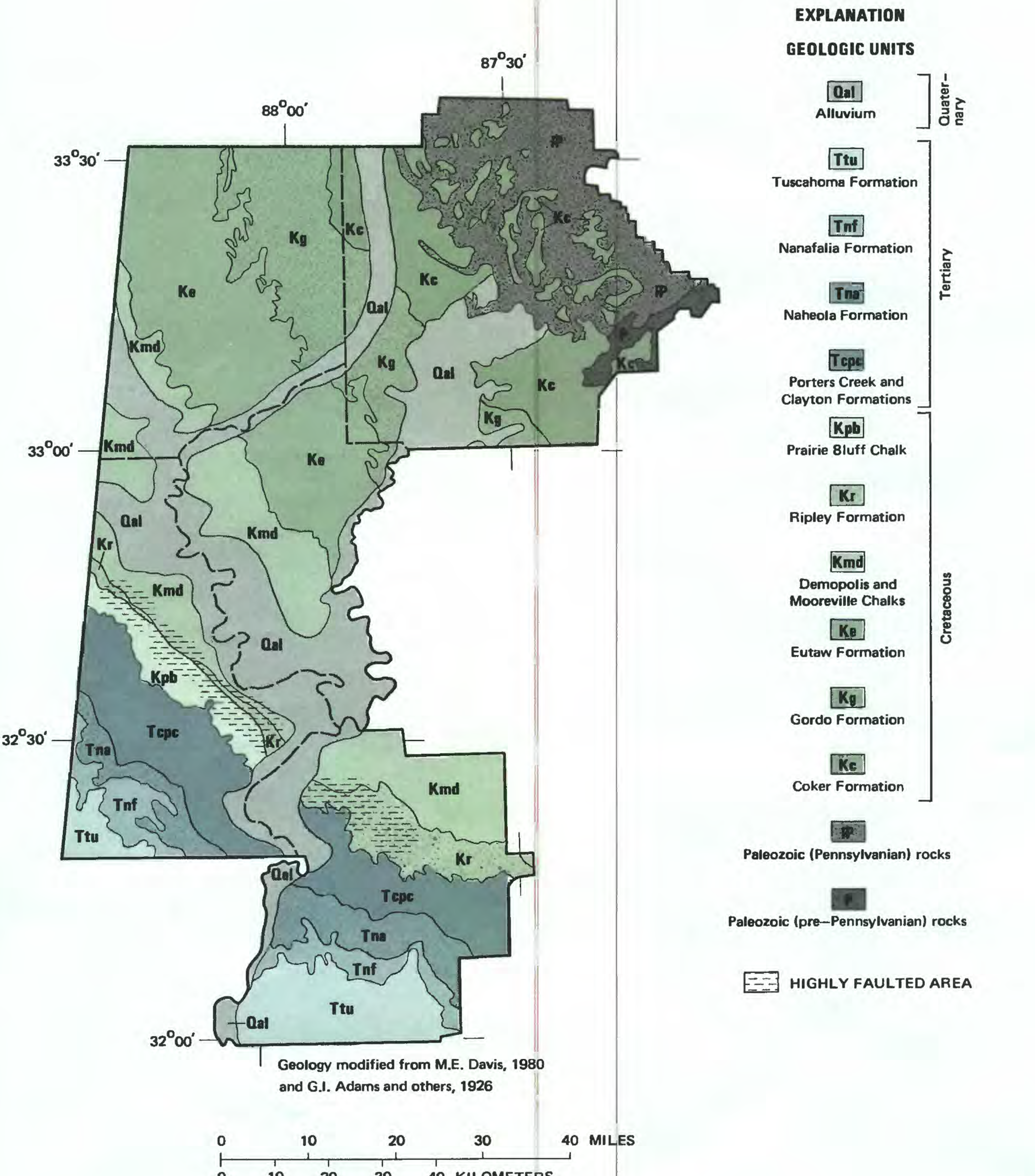

Figure 2.--Generelized geology of the study area.

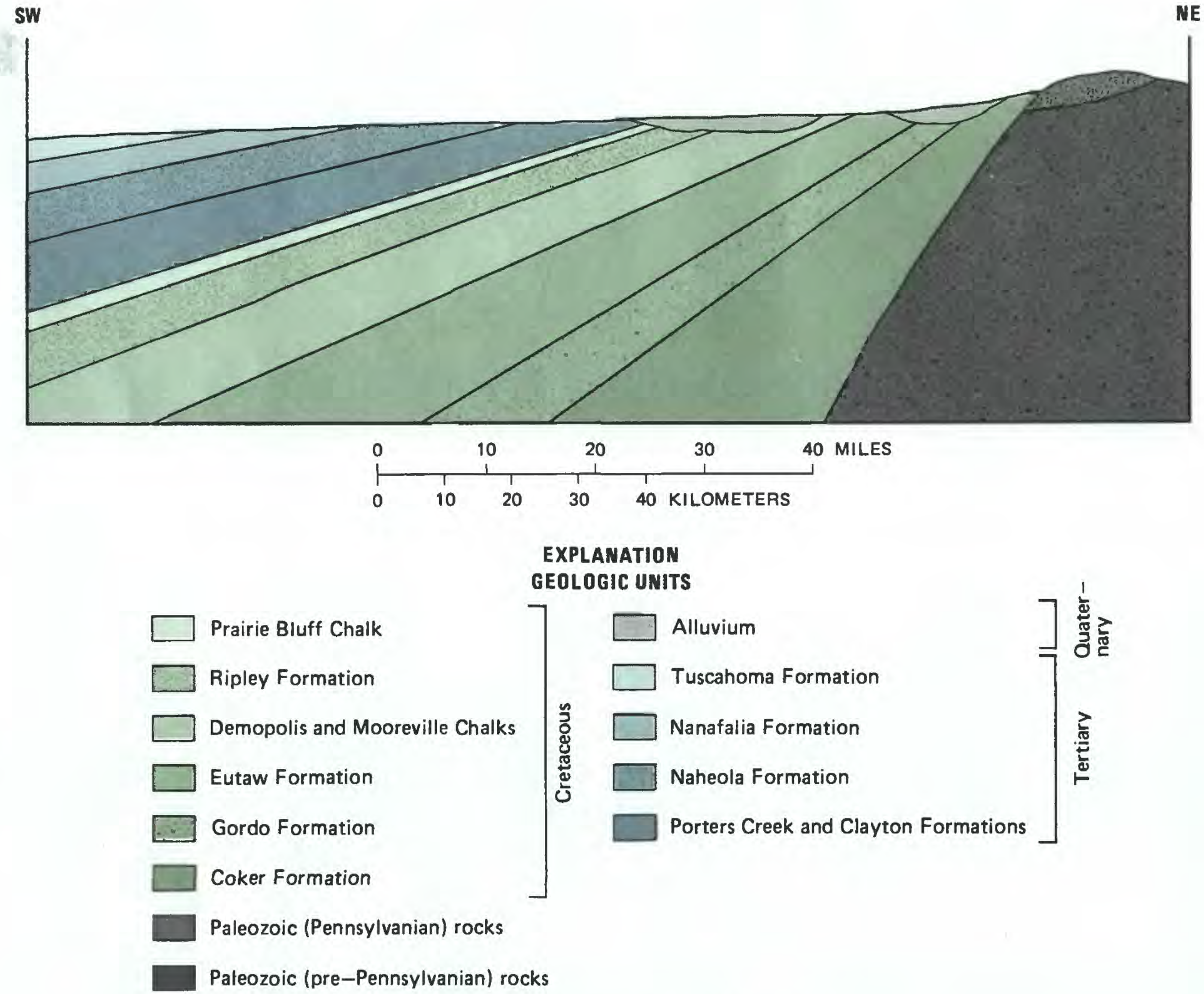

Figure 3.--Generalized geologic section of the study area.

Cretaceous Formations

Coker Formation

The Coker Formation crops out in Tuscaloosa County and in streambeds in eastern Pickens County (see fig. 2). The Coker underlies all of the study area south and southwest of its area of outcrop.

The Coker Formation consists of a basal nonmarine zone of gravel, marine sand and clay. In most parts of the study area, the basal zone is generally separated from the marine sand beds by 50 feet or more of clay. A clay zone is usually present at the top of the Coker. Where this clay exists, it serves as a confining unit between the Coker aquifer and the overlying Gordo aquifer (see figs. 3 and 4). However, over much of the area, the two aquifers are hydraulically connected and are treated as one aquifer referred to as the Tuscaloosa aquifer for purposes of the potentiometric map of this report (fig. 4). The Coker Formation ranges in thickness from less than 100 feet where only the basal beds remain to more than 1,000 feet in southernmost parts of the study area.

The towns of Coker and Gordo, and the Buhl-Elrod-Holman Water System pump from the Coker aquifer. However, the Coker is not used extensively farther downdip where shallower aquifers are available. An electric log of an oil test well in southwestern Pickens County indicates that the Coker contains relatively fresh water to a depth of 1,750 feet in that area (Wahl, 1965).

Gordo Formation

The Gordo Formation overlies the Coker Formation and crops out in southwestern Tuscaloosa County, northeastern Pickens County and in a small part of northeastern Greene County (see fig. 2). Like the Coker, it dips to the southwest and underlies the formations that crop out south of it. The Gordo consists of a basal zone of gravelly sand overlain by alternating lenticular beds of sand and varicolored mottled clay. It ranges in thickness from less than 100 feet at outcrops to nearly 400 feet in the subsurface in the southern part of the study area. The towns of Aliceville, Reform, Faunsdale, and Union pump from the Gordo aquifer.

Eutaw Formation

The Eutaw Formation overlies the Gordo Formation and crops out over the central part of Pickens County, northern Greene County, and a small part of southwestern Tuscaloosa County. The Eutaw consists of upper and lower zones of marine sand separated by a zone of clay. It ranges in thickness from less than 200 to 400 feet where the entire formation is present. The lower part of the formation consists of 30 to 50 feet of glauconitic sand interbedded with sandy clay. The middle part consists of 50 to 150 feet of calcareous clay and sandy clay. The upper part, the Tombigbee Sand Member, consists of 25 to 100 feet of massive glauconitic sand interbedded with calcareous sandstone and sandy limestone. In part of the area the McShan Formation underlies the Eutaw

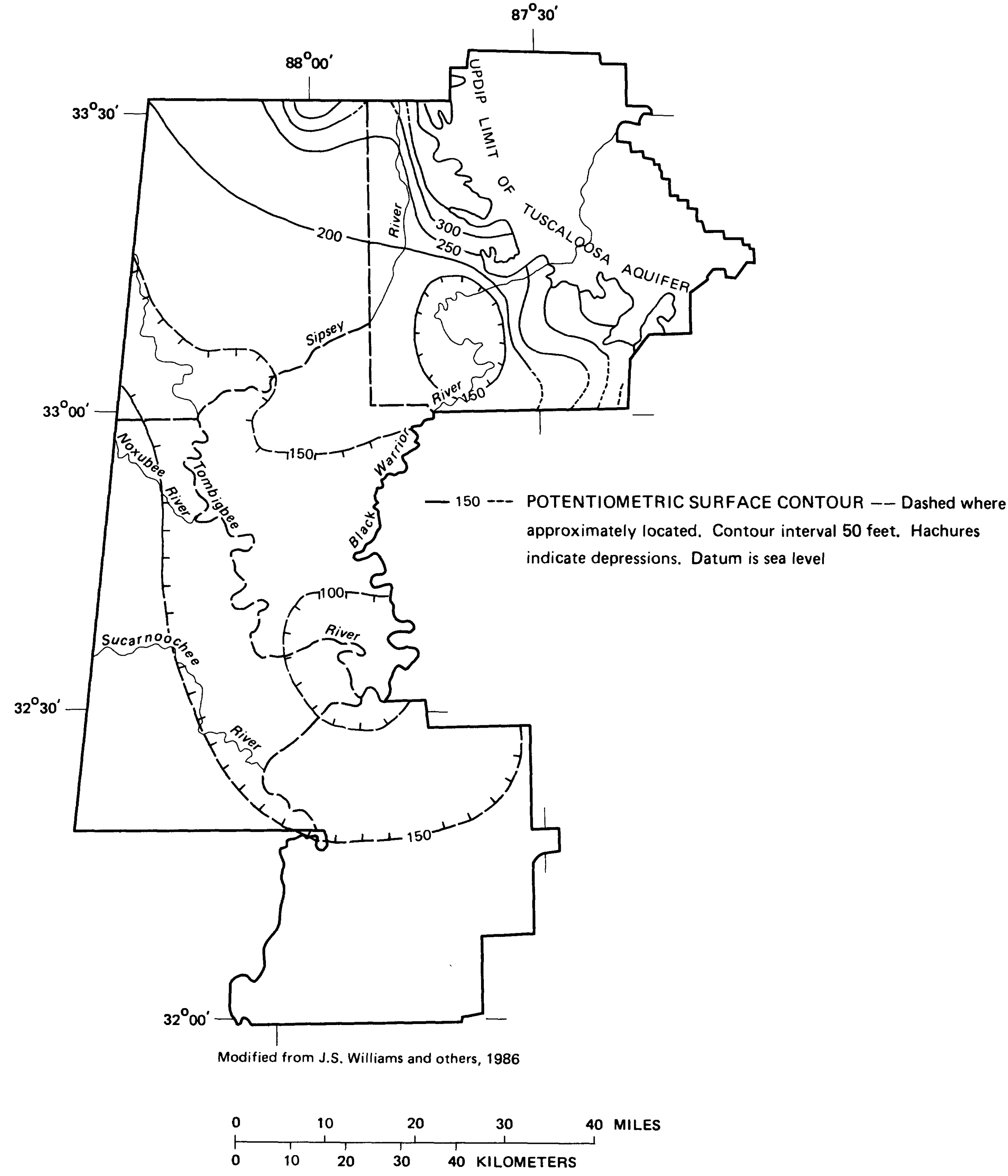

Figure 4.--Potentiometric surface of the Tuscaloosa aquifer, fall 1982.

Formation (Conant and Monroe, 1945), but for the purposes of this report it is combined with the Eutaw Formation and forms the Eutaw aquifer (Newton and others, 1961).

The Eutaw is the most extensively used aquifer in the study area; it is pumped in downdip areas where it is overlain by the Mooreville and Demopolis Chalks (discussed below) in addition to its outcrop area. The towns of Eutaw, Boligee, Forkland, Demopolis, Linden, and Thomaston pump from the Eutaw.

Mooreville Chalk

The Mooreville Chalk overlies the Eutaw Formation, and crops out in southwestern Pickens County, northern Sumter County, and central Greene County (fig. 2). The Mooreville consists of about 400 to 420 feet of chalk, calcareous clay, sandy clay and limestone. The Arcola Limestone Member of the Mooreville, at the top of the unit, consists of two to four thin beds of limestone separated by clay and sandy clay. The Mooreville Chalk is relatively impermeable and is not a source of water in the study area. The chalk is an upper confining layer for the upper Eutaw aquifer. However, the Mooreville and the overlying Demopolis Chalk and Ripley Formation are extensively faulted in parts of Sumter and Marengo Counties (see fig. 2), which may allow water to move through the chalk.

Demopolis Chalk

The Demopolis Chalk overlies the Mooreville Chalk, and crops out in extreme southwest Pickens County, northern Sumter County, and northern Marengo County (fig. 2). The Demopolis consists of about 400 to 440 feet of chalk, calcareous clay, and sandy clay. It is relatively impermeable and is not an aquifer in the study area.

Ripley Formation

The Ripley Formation overlies the Demopolis Chalk and crops out in central Marengo and Sumter Counties (fig. 2). The Ripley Formation consists of fine grained fossiliferous calcareous clayey sand. The lower part locally contains thin beds of calcareous sandstone. The formation ranges in thickness from 150 to 220 feet in the study area. The Ripley is a minor aquifer in the study area.

Prairie Bluff Chalk

The Prairie Bluff Chalk overlies the Ripley and crops out in a narrow belt at the southern margin of the Ripley Formation in Sumter and Marengo Counties. It consists of fossiliferous sandy chalk and clay and generally ranges in thickness from 60 feet in Sumter County to 10 feet in Marengo County. The Prairie Bluff is relatively impermeable, and is not an aquifer in the study area.

Tertiary Formations

Tertiary deposits in the study area are limited to the Clayton, Porters Creek, and Naheola Formations of the Midway Group and the Nanafalia and Tuscahoma Formations of the Wilcox Group.

Clayton and Porters Creek Formations

The Clayton Formation overlies the Prairie Bluff Formation in Sumter and Marengo Counties. It consists of silty calcareous clay, clayey sandstone, and silty chalk in Sumter County; and sandy chalk and calcareous clayey sand in Marengo County. The Porters Creek Formation overlies the Clayton Formation and crops out in a belt southwest of the Clayton in central Sumter and Marengo Counties. The Porters Creek consists of massive gray marine clays. The clay produces a low-lying topography called the "Flatwoods." The combined thickness of the Clayton and Porters Creek Formations in Sumter and Marengo Counties is 270 to 370 feet. Neither unit is a major aquifer in Sumter or Marengo Counties.

Naheola Formation

The Naheola Formation overlies the Porters Creek Formation and crops out southwest of it in Marengo and Sumter Counties. It consists of fine- and coarse-grained sand, silty clay, and beds of lignite. It is about 120 feet thick and is not a major aquifer in the study area.

Nanafalia Formation

The Nanafalia Formation crops out southwest of the Naheola Formation in Marengo and Sumter Counties. It consists of sand, sandy marl, sandy clay, and lignite. The Nanafalia is about 150 to 200 feet thick in Sumter and Marengo Counties and is tapped by the city wells of Myrtlewood and Sweetwater in southern Marengo County.

Tuscahoma Formation

The Tuscahoma Formation crops out in southernmost Marengo County and southwestern Sumter County. The contact with the overlying Hatchetigbee Formation lies outside the study area to the south. The Tuscahoma consists of about 275 feet of clay, fine- to coarse-grained sand, and fossiliferous glauconitic marl. It is not a major aquifer in the study area.

Quaternary Deposits

Quaternary alluvial deposits overlie older formations throughout a large part of the study area (fig. 2). These deposits, which underlie flood plains of present and ancestral large streams, consist mainly of gravel, sand, silt, and clay. Alluvial deposits along the flood plains of the Black Warrior, Sipsey, and Tombigbee Rivers are shown on the geologic map (fig. 2). Remnants of older alluvial deposits (usually mapped as high terrace deposits) are not shown on the geologic map, but form relatively flat uplands in several parts of the study area. The alluvial deposits generally range in thickness from 30 to 60 feet. They are not a major aquifer in the study area.

HYDROLOGY OF THE MAJOR AQUIFERS

The major aquifers in the study area are sand and gravel beds in the Coker, Gordo, Eutaw, and Nanafalia Formations. Water in these aquifers occurs under artesian conditions in most parts of the study area. Municipal wells that tap the major aquifers are shown in table 2 and their locations are shown on plate 1.

Recharge and Movement of Ground Water

Rainfall, which averages about 50 inches per year, is the source of recharge to the major aquifers. A large part of the rainfall runs off during and directly after rainstorms or is returned to the atmosphere by evaporation and transpiration of trees and other plants; a small part infiltrates to the water table to recharge aquifers. The recharge area for the Coker aquifer is mainly in Tuscaloosa County; the Gordo aquifer mainly in Pickens and Tuscaloosa Counties; and the Eutaw aquifer in Pickens and Greene Counties. The recharge area for the Nanafalia aquifer is in Sumter and Marengo Counties (see plate 1). These recharge areas consist largely of rolling sandhills, parts of which are wooded and parts cultivated. In Tuscaloosa and Pickens Counties remnants of high terrace deposits overlie significant parts of the recharge areas. These terrace remnants form relatively flat, permeable landscapes that impede runoff and probably increase recharge to the aquifers. Alluvial deposits overlie the major aquifers along the flood plains in the Black Warrior, Sipsey, and Tombigbee Rivers. These permeable deposits may provide increased recharge to the aquifers. Water moves downdip from areas of recharge to areas of natural discharge or areas of ground-water withdrawals, generally perpendicular to the potentiometric contour lines shown on figures 4, 5, and 6.

Natural Discharge and Ground-Water Withdrawals

The aquifers discharge through seeps and springs to provide the base (dry weather) flow of streams. Discharge to the rivers also occurs where streams are entrenched into the aquifers. Discharge to streams can occur by upward leakage through the confining unit between aquifers or by passing through fractures in the Mooreville and Demopolis Chalks (Gardner, 1981). Most of the remainder of the discharge is through wells. The largest pumping center in the study area is the city of Demopolis. In 1985, it was estimated to pump 1.3 Mgal/d (million gallons per day). The other pumping centers in the study area pump less than 1 Mgal/d each.

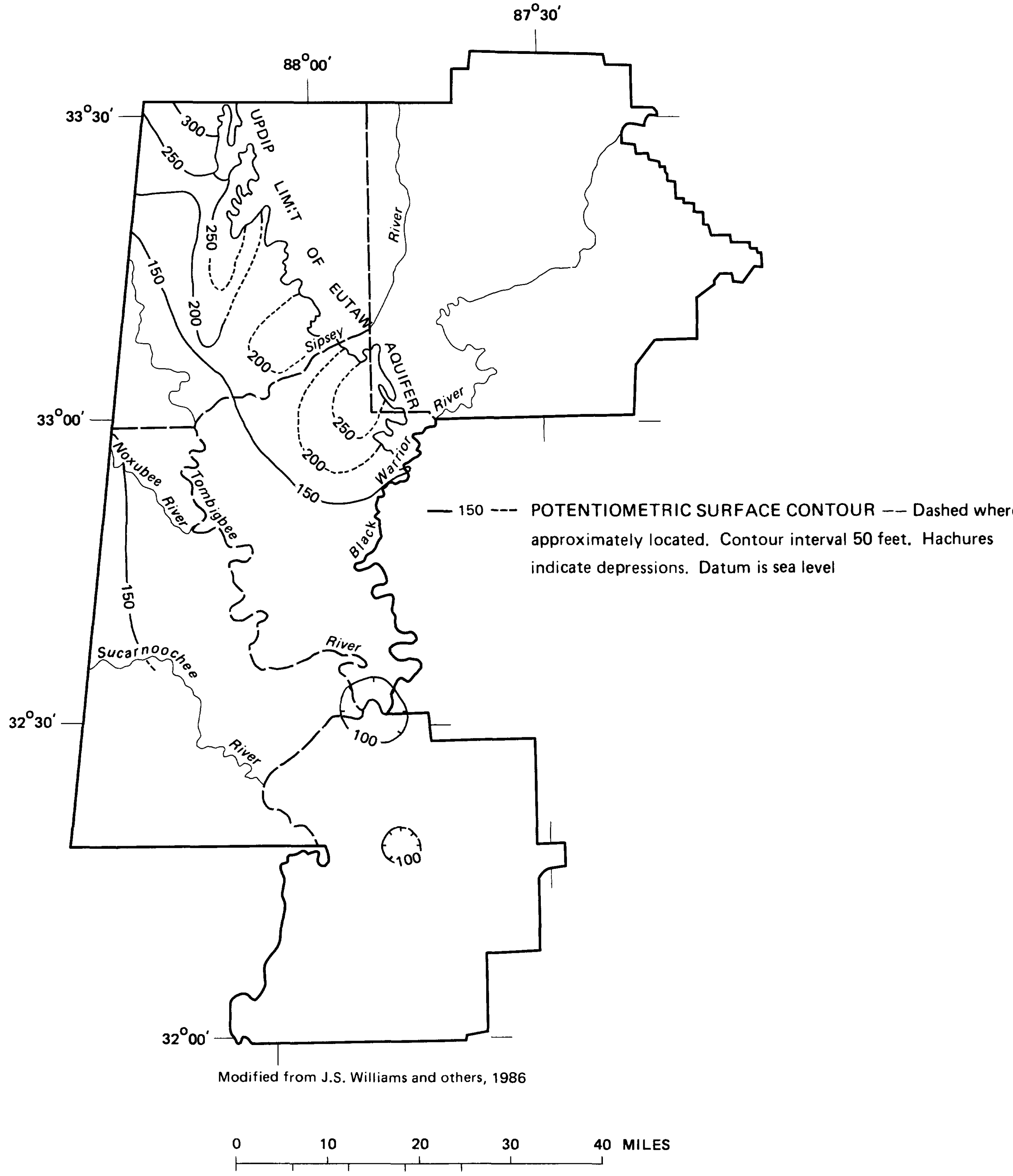

Figure 5.--Potentiometric surface of the Eutaw aquifer, fall 1982.

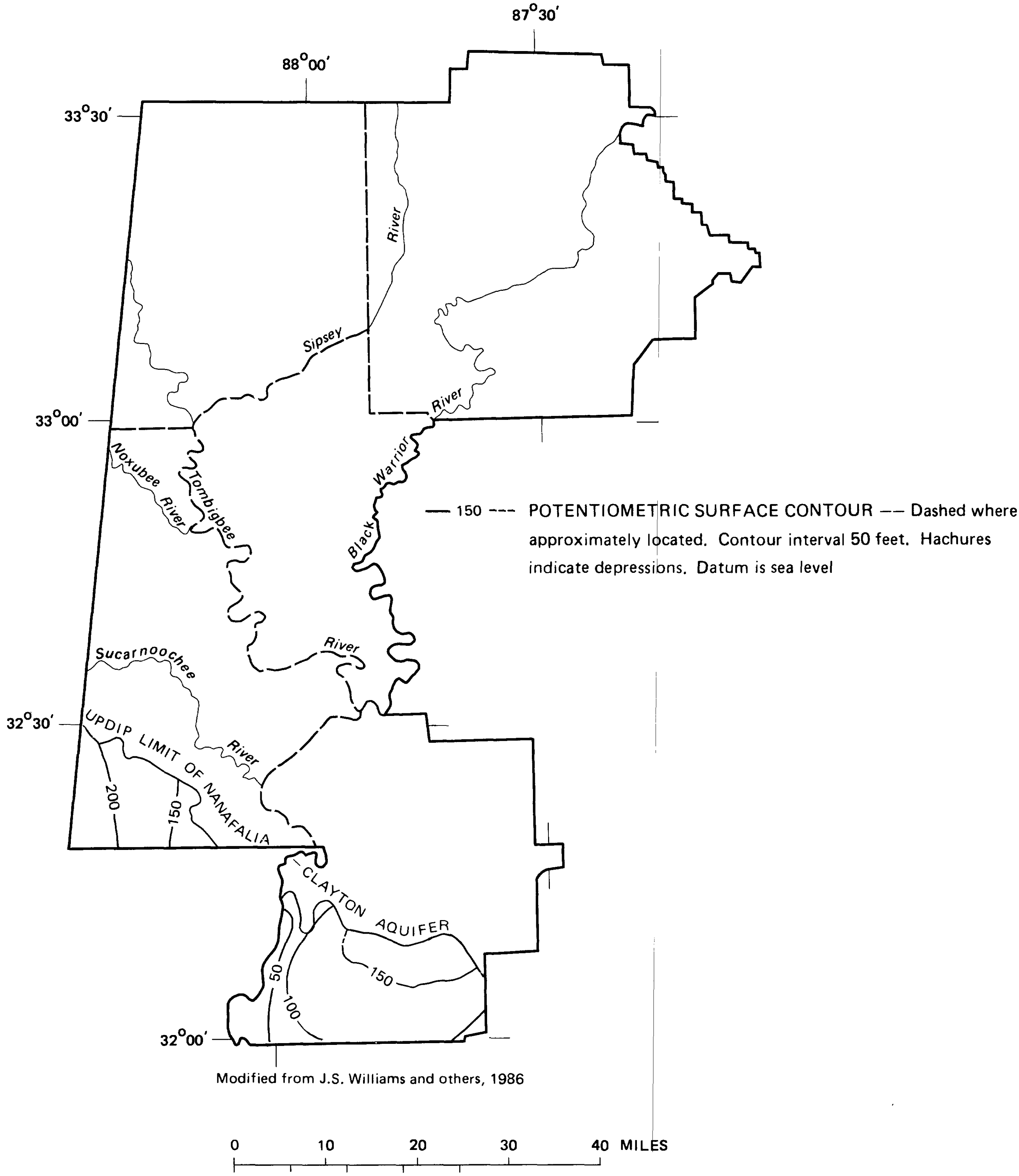

Figure 6.--Potentiometric surface of the Nanafalia—Clayton aquifer, fall 1982.

Wells are used for domestic, stock, industrial, and irrigation purposes. The amount of water used for these purposes was estimated to be 7.7 Mgal/d in 1982 (Baker, 1983). A significant amount of water is lost from the aquifers through flowing artesian wells. For example, about 3.2 Mgal/d was discharging through wells that flow in Tuscaloosa County in 1958 (Miller and Causey, 1958); about 2.7 Mgal/d in Greene County in 1965 (Wahl, 1966); about 2 Mgal/d in Pickens County in 1963 (Wahl, 1965); and more than 1 Mgal/d in Marengo County in 1961 (Newton and others, 1961). Many wells which formerly flowed have ceased to flow as a result of lowering of the potentiometric surface of the aquifers.

Effects of Withdrawals from the Aquifers

Long-term withdrawals of water from the major aquifers have resulted in lowering of the potentiometric surface and formation of depressions on the potentiometric surface of water in the aquifers. Depressions have formed in the Coker and Gordo aquifers (fig. 4) at Demopolis and in the vicinity of the Black Warrior River south of Tuscaloosa. A depression also exists at Demopolis in the Eutaw aquifer (fig. 5). The depressions at Demopolis are partly a result of pumping in both aquifers there. However, these and the depression on the Black Warrior River and the trough-like depression in the Nanafalia aquifer along the Tombigbee River (fig. 6) also reflect natural discharge to the rivers.

SUSCEPTIBILITY OF THE AQUIFERS TO SURFACE CONTAMINATION

All recharge areas for the major aquifers in the study area are susceptible to surface contamination (plate 1). However, throughout most of the study area the recharge areas are in rural settings that are used for timberlands, farms, or pastures. Usually, the depth of the water-producing zone being tapped and its horizontal distance from the aquifer outcrop provide some buffer from surface contamination (table 2). Shallow wells in outcrop areas are more susceptible, but none are considered highly susceptible. The areas most susceptible to future contamination are the flood plains of the Black Warrior, Sipsey, and Tombigbee Rivers, which are underlain by terrace and alluvial deposits that are in hydraulic connection with the major aquifers.

The recharge areas of the minor aquifers (the Paleozoic rocks, the Ripley, Naheola, and Tuscahoma Formations) are also susceptible to contamination from the surface. However, they are not included in the susceptible area on the map because they do not contain actively pumped public supply wells within the study area. Some of these aquifers, notably the Paleozoic limestone, contain public supply wells outside the area in neighboring counties, and are potential sources of public supply within the study area. For instance, the Paleozoic limestone is recharged in Tuscaloosa County and is the source of public supply for the city of West Blocton in adjacent Bibb County.

The terrace and alluvial deposits overlie and recharge the major aquifers along major streams in the study area. The alluvial sediments permit water to move downward from the land surface to the aquifers, especially areas where the potentiometric surfaces in the aquifers being recharged have been lowered by pumpage. In the study area, the depressions formed by pumpage on the potentiometric surfaces of the major aquifers are not in direct contact with alluvial aquifers. Figures 4 and 5 show depressions in the potentiometric surface of the Tuscaloosa and Eutaw aquifers at Demopolis. Figure 2 shows the alluvium that overlies the Mooreville and Demopolis Chalks near Demopolis. The chalk between the Eutaw aquifer and the alluvial aquifer should retard vertical movement of water or contaminants in this and similar areas. However, it has been determined by Gardner (1981) that water moves up from the Tuscaloosa and Eutaw aquifers through fractures in the chalk. Therefore, if pumping at Demopolis or similar areas lowers the potentiometric surface sufficiently, water and possible contaminants could flow downward from the alluvial aquifer to the Eutaw aquifer below.

SUMMARY AND CONCLUSIONS

The major aquifers in the study area (defined as those with actively pumped public supply wells) are the Coker, Gordo, Eutaw, and Nanafalia aquifers. The recharge areas for these aquifers are in Tuscaloosa, Pickens, Greene, Sumter, and Marengo Counties. The aquifers underlie most of the study area and consist of sand and gravel beds. Water in the aquifers usually occurs under artesian conditions.

The Coker aquifer is the source of public water supplies for the towns of Coker and Gordo, and for the Buhl-Elrod-Holman Water System in Tuscaloosa County. The Gordo and Eutaw aquifers are sources of public water supplies in Pickens, Greene, and Marengo Counties. The Nanafalia aquifer is the source of public water supplies for the towns of Sweetwater and Myrtlewood in Marengo County.

Depressions in the potentiometric surface have developed around Demopolis in the Coker, Gordo, and Eutaw aquifers, partly as a result of ground-water withdrawals. Other depressions and troughs have formed along the major rivers because of ground-water discharge to the rivers.

All the recharge areas for the major aquifers are susceptible to surface contamination throughout most of the study area; however, the recharge areas are in rural settings that are used for timberlands, farms, and pastures. Usually, the depth to the water-bearing zone tapped by a well and the horizontal distance from the outcrop to the well provide a buffer from surface contamination.

Other potential areas susceptible to surface contamination are the permeable terrace and alluvial deposits if the potentiometric surface in the underlying aquifer has been depressed. The alluvial deposits are usually in areas of discharge, but if pumpage has caused a depression in the potentiometric surface of the underlying aquifer, the alluvial aquifer will become a source of recharge.

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Table 1.--Generalized section of geologic formations in the study area, and their water-bearing properties

Erathem	System	Series	Group	Geologic unit	Thickness (ft)	Lithology	Water-bearing properties	Quality of water
Cenozoic	Quaternary	Holocene		Alluvium	0-60	Clay, silt, sand, and gravel	Supplies water to shallow dug wells and driven wells in the flood plains of the major streams and rivers. Adjacent to major streams, where induced recharge is possible, large quantities of water can be withdrawn from these beds.	Water is soft and generally has a chloride content of less than 41 mg/L. Locally contains iron in excess of 0.3 mg/L.
		Pleistocene		Terrace deposits	100	Clay, silt, sand, and gravel	Will yield 10 gal/min or more to individual wells where saturated sands are of sufficient thickness.	
	Tertiary	Paleocene	Wilcox Group	Tuscahoma	275	Sand, crossbedded; laminated silty clay and sand; fine-grained glauconitic beds of sand; two sandy glauconitic fossiliferous marl zones near the middle of the formation	Upper part of formation is a fair aquifer. Sand beds in lower parts of formation are good aquifers and supply water for domestic and farm use.	Water is soft to hard, generally has a chloride content of less than 250 mg/L, and may locally have an iron content in excess of 0.3 mg/L.
				Nanafalia Formation	150-200	Interbedded clay, claystone, and glauconitic sandy fossiliferous marl; crossbedded micaceous sand and thin-bedded sandy silt in lower 5 to 50 ft	Very good aquifer; supplies water to many drilled artesian wells south of the area of outcrop of the formation.	Water generally is soft to hard and contains less than 700 mg/L dissolved solids and 100 mg/L chloride. Locally, water contains iron in excess of 0.3 mg/L.
			Midway Group	Naheola Formation	120	Sand and sandy marl; fine- to medium-grained, glauconitic in upper 10-30 ft; fine-grained interlaminated sand and silty clay and beds of fine-grained sand in lower 70 to 90 ft	Upper sand beds yield small supply of water to dug wells and a few drilled wells for domestic and farm use. Lower part of formation is relatively impermeable and is not known to yield water to wells in the area.	Water generally is soft and conteins less than 45 mg/L chloride. Locally, water contains iron in excess of 0.3 mg/L.
				Porters Creek Formation	200	Marl, fossiliferous in upper 25 ft; massive clay, silty sand, sandstone, and massive calcareous clay in lower 175 ft	Relatively impermeable and not an aquifer. A few dug wells in the outcrop area of formation tap water in upper weathered zone.	
				Clayton Formation	70-170	Limestone, chalky, argillaceous in upper 20 to 40 ft; sandy fossiliferous limestone; medium-grained micaceous sand, and calcareous micaceous sandy silt in lower part	Wells developed in weathered sandy limestone beds in this formation may supply adequate water of moderate hardness for domestic and farm use.	Water is generally soft to moderately hard and low in dissolveld solids and chloride contents.

Table 1.--Generalized section of geologic formations in the study area, and their water-bearing properties (continued)

Erathem	System	Series	Group	Geologic unit	Thickness (ft)	Lithology	Water-bearing properties	Quality of water
Mesozoic	Cretaceous	Upper Cretaceous	Selma Group	Prairie Bluff Chalk	10-60	Silty and sandy fossiliferous chalk and calcareous clay	Relatively impermeable; not a source of water.	
				Ripley Formation	150-200	Fine- to coarse-grained glauconitic sand, sandy fossiliferous clay and thin beds of fossiliferous calcareous sandstone and sandy limestone	Because these beds are fine-grained and micaceous, the development of wells is sometimes difficult.	Water generally is soft to moderately hard and contains less than 250 mg/L chloride and 1,000 mg/L dissolved solids. Locally, water contains iron in excess of 0.3 mg/L.
				Demopolis Chalk	0-440	Fossiliferous chalk; sandy silty fossiliferous chalk, and silty fossiliferous calcareous clay	Relatively impermeable; not a source of water supply.	
				Mooreville Chalk	0-420	Upper 10 to 20 ft consists of beds of dense limestone about 1 ft thick seperated by fossiliferous sandy chalk; lower part consists of fossiliferous silty to fine sandy chalk and calcareous sandy fossiliferous clay	Relatively impermeable; not a source of water supply.	
				Eutaw Formation (includes McShan Formation)	0-400	Upper part consists of medium-grained crossbedded glauconitic sand interbedded with silty clay; lower part consists of medium to very coarse grained glauconitic sand interbedded with laminated to thin-bedded micaceous sandy clay	Will yield 2 Mgal/d or more to individual wells. Excellent aquifer.	Soft to hard but generally is soft to moderately hard. Iron in excess of 0.3 mg/L in some locations. Contains less than 250 mg/L of dissolved solids in its northern extent, increasingly higher to the south. Chloride content exceeds 1,000 mg/L in the southern part of the aquifer.
			Tuscaloosa Group	Gordo Formation	0-400	Poorly sorted coarse-grained sand and chert gravel in lower part of formation; upper part consists of laminated to massive clay and lenticular sand beds	Will yield 1 to 2 Mgal/d or more to individual wells. Excellent aquifer.	Soft to moderately hard and contains less than 200 mg/L of dissolved solids. Commonly contains iron in excess of 0.3 mg/L. May be sufficiently mineralized in the southern extent of the aquifer to be objectionable to other uses.
				Coker Formation	0-1,000	Sand, very fine to coarse grained; basal sand 100 to 200 ft thick and is generally gravelly. Partly carbonaceous sandy clay	Potential source of 1 Mgal/d or more to individual wells. Excellent aquifer.	Soft to hard and contains less than 250 mg/L of dissolved solids in northern part of the aquifer. May be sufficiently mineralized to be objectionable for some uses in the southern extent of the aquifer. Iron levels often exceed 0.3 mg/L.
	Pennsylvanian			Pottsville Formation	2,800+	Sandstone, siltstone, and shale, interbedded with conglomerite, coal, and underclay; orthoquartzite at the base and subgraywacke at the top. Shale, silty; numerous coal beds and underclays	Water occurs in joints, fractures, and bedding planes; yields sufficient for domestic use; no large capacity wells have been drilled in the study area.	Soft to hard. Iron content may exceed 0.3 mg/L.
Paleozoic	Mississippian to Cambrian			Floyd Shale, Fort Payne Chert, Little Oak Limestone, Newala Limestone, Longview Limestone, Knox Dolomite (part), Bibb Dolomite, Ketona Dolomite, and Brierfield Dolomite	1,000+	Dolomite, limestone, chert, and shale	Potential source of large water supplies from limestones and dolomites; no large-capacity wells have been drilled in the study area.	Moderately hard to hard. Dissolved solids generally less than 300 mg/L. Iron content is usually less than 0.3 mg/L.

Table 2.--Records of public water-supply wells in the study area

NOTE: Well numbers correspond to those shown on plate 1.

Geographic coordinate number: Lat (DDMMSS) Long (DDMMSS) sequential number (xx).

Depth of well and water level: Depth of well given in feet; reported water levels are in feet above (-) or below land surface; measured water levels are in feet and tenths.

Well diameter: casing diameter in inches.

Water-bearing unit: Kc, Coker Formation; Kg, Gordo Formation, Ke, Eutaw Formation; Tnf, Nanafalia Formation; Qal, alluvial deposits.

Altitude of land surface: Altitudes given in feet above sea level, from topographic map or determined by aneroid barometer.

Method of lift: N, none; S, submergible; T, turbine.

Use of well: N, none; P, public water supply.

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
1	324519088014601	Town of Boligee	F.C. Null	620	4	Ke	120	- 8.5	05/11/65	N	N	Flow 18 gal/min with 7 ft of drawdown on 05/11/65
2	324519088014601	Town of Boligee	Graves Drilling Co. 06/17/77	1415	8 4	Kg	120	- 2	06/15/77	N	N	Well 1 casing: 8 in. from surface to 1,240 ft. 4 in. from 1,200 to 1,345 ft. 4 in. screen from 1,345 to 1,365 ft. Drawdown 389 ft after pumping 108 gal/min for 24 hrs on 06/15/77.
3	325028087531301	City of Eutaw	Layne-Central Co. 10/16/52	441	16 10	Ke	212	84.97 89.34	05/06/85 04/18/86	T	P	Well 3 casing: 16 in. from surface to 390 ft. 10 in. from 331 to 394 and 426 to 435 ft. 10 in. screen from 394 to 435 ft. Drawdown 32 ft after 8 hrs pumping 460 gal/min.
4	325026087532601	City of Eutaw	Layne-Central Co. 1940	306	12 8	Ke	205	84	1940	T	N	Well 1 casing: 12 in. from surface to 262 ft. 8 in. screen from 264 to 306 ft. Drawdown 26 ft when pumping 75 gal/min. Well not used since 1950. Pumps sand.
5	325026087524901	City of Eutaw	Layne-Central Co. 01/09/50	389	12 6	Ke	166	34.4	06/24/65	T	P	Well 2 casing: 12 in. from surface to 325 ft. 6 in. from 329 to 379 ft. Drawdown 22 ft after 8 hrs pumping 250 gal/min.
6	325142087543601	City of Eutaw	Powell Drilling Co., Inc. 04/29/83	410	18 10	Ke	252	79.4	04/29/83	T	P	Well 4 casing: 18 in. from surface to 371 ft. 10 in. from 324 to 374 f ft. 10 in. screen from 374 to 410 ft. Drawdown 81 ft after pumping 700 gal/min for 24 hrs.
7	323625087495301	Town of Forkland	Graves Well Drilling Co., Inc. 06/10/77	723	6 4	Ke	100	flows	03/30/77	T	P	Casing: 6 in. from surface to 640 ft. 4 in. from 624 to 723 ft. 4 in. screen from 650 to 660 ft and from 670 to 685 ft.

Table 2.--Records of public water-supply wells in the study area (continued)

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measure-ment	Method of lift	Use of well	Remarks
8	325432087514701	Greene County Dog Racing Track, Eutaw	Causey Drilling Co., Inc. 05/18/77	425	4	Kg	200	46.4	08/15/77	S	P	Well 1 casing: 4 in. from surface to 405 ft. 2 in. screen from 405 to 425 ft. Drawdown 7 ft after pumping 40 gal/min for 28 hrs on 05/10/77.
9	325435087515001	Greene County Dog Racing Track, Eutaw	Causey Drilling Co., Inc. 06/09/77	420	4	Kg	200	48.52	09/10/77	S	P	Well 2 casing: 4 in. from surface to 400 ft. 2 in. screen from 400 to 420 ft. Drawdown 22 ft after pumping 75 gal/min for 24 hrs on 09/10/77.
10	324910087535501	Greene County Housing Authority, Eutaw	Graves Drilling Co., Inc. 09/74	1197	10	Ke	165	8	03/10/75	T	P	Casing: 10 in. from surface to 1,088 ft. 6 in. screen from 1,090 to 1,130 ft. Drawdown 500 ft after pumping 375 gal/min for 12 hrs on 03/10/75.
11	330309087563901	Town of Union	Graves Drilling Co., Inc. 07/26/78	374	6.25	Kg	210	40.65	07/26/78	S	P	Casing: 6.25 in. from surface to 275 ft. 4 in. from 254 to 314 ft. 4 in. screen from 316 to 374 ft. Drawdown 33 ft after pumping 225 gal/min for 24 hrs on 07/26/78.
12	323012087492701	City of Demopolis	Layne-Central Co. 1951	1002	18	Ke	160	49.3 77 82	12/11/58 1970 1985	T	P	Well 2: Screen from 882 ft to 942 ft. Drawdown 190 ft after pumping 560 gal/min for 11 hrs on 12/11/57.
13	323006087481701	City of Demopolis	Layne-Central Co. 1959	980	18 8	Ke	174	65 65 72 85	1959 1960 1970 1985	T	P	Well 3: Screen from 900 to 970 ft. Drawdown 62.5 ft after pumping 554 gal/min for 8 hrs in 1959.
14	323123087501201	City of Demopolis	Layne-Central Co. 1931	926	8	Ke	90	- 8.3	07/10/67	T	P	Well 1: Estimated flow 150 gal/min on 07/10/67. Well reworked in about 1980.
15	323013087471401	City of Demopolis	Layne-Central Co. 02/20/69	993	18	Ke	145	29 29 42	02/20/69 01/09/78 10/10/85	T	P	Well 4 casing: 18 in. to 900 ft. 8 in. below. Screen from 903 to 913 ft, from 918 to 958 ft, and from 963 to 983 ft. Drawdown 74 ft after pumping 500 gal/min for 24 hrs.
16	322615087354501	City of Faunsdale	Powell Drilling Co. 11/22/78	1035	8	Kg	305	130 172.3	11/78 1982	T	P	Screen from 990 ft to 1,031 ft. Drawdown 40 ft after pumping 150 gal/min for 24 hrs.

Table 2.--Records of public water-supply wells in the study area (continued)

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
17	321825087475101	City of Linden	Gray Artesian Well Co. 1925	1245	6	Ke	149			T	N	Well 1 casing: 6 in. from surface to 1,165 ft. 6 in. screen from 1,165 to 1,245 ft.
18	321925087475601	City of Linden	Acme Drilling Co. 08/04/60	1200	15	Ke	112	- 15	1960	T	P	185 ft of 6 in. screen between 915 and 1,200 ft. Estimated drawdown 156 ft after pumping 300 gal/min for several hours in 1960.
19	321800087475001	City of Linden	Layne-Central Co. 03/08/48	1109	12 6	Ke	139	.40.2 4.95 39.63	04/25/56 07/11/67 05/02/84	T	P	Well 3 casing: 12 in. from surface to 1,002 ft. 6 in. from 922 to 1,107. Screen: 6 in. from 1,002 to 1,017, 1,027 to 1,057, 1,067 to 1,087, and 1,092 to 1,097 ft. Yield 125 gal/min on 11/10/47.
20	321935087474601	City of Linden	Layne-Central Co. 10/30/70	1122	16 8	Ke	100	29.57	05/10/85	T	P	Casing: 16 in. from surface to 922 ft. 8 in. from 822 to 927 ft. 8 in. screen from 927 to 932, 942 to 947, 962 to 967, 991 to 1,001, 1,011 to 1,031, 1,047 to 1,052, and 1,062 to 1,112 ft. Drawdown 175 ft after pumping 305 gal/min for 8 hrs on 08/12/71.
21	320523087533901	Town of Myrtlewood	J.D. Huff 07/18/78	180	8	Tnf	155	20	11/28/78	T	P	Casing: 8 in. from surface to 158 ft. 6 in. screen from 158 to 178 ft.
22	320545087520001	Town of Sweetwater	Tom Smith Artesian Well Co. 05/71	142	12 6	Tnf	170	38 55	1972 1986	T	P	Casing: 12 in. from surface to 87 ft. 6 in. from 60 to 90 ft. 6 in. screen from 90 to 115 ft. Drawdown 46 ft after pumping 77 gal/min for 6 hrs on 04/01/72.
23	321616087373501	City of Thomaston	Layne-Central Co. 08/10/67	1085	10 6	Ke	210	78	11/03/67	T	P	Well 2 casing: 10 in. from surface to 985 ft. 6 in. from 925 to 985 ft. 6 in. screen from 990 to 1,010 ft and 1,035 to 1,075 ft. Drawdown 274 ft after pumping 100 gal/min for 8 hrs on 11/03/67.

Table 2.--Records of public water-supply wells in the study area (continued)

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measure-ment	Method of lift	Use of well	Remarks
24	321601087372801	City of Thomaston	F.C. Null 03/01/50	1235	8 6	Ke	185	37.7	02/22/56	T	P	Well 1 casing: 8 in. from surface to 234 ft. 6 in. from 219 to 1235 ft. 6 in. screen from 1,190 to 1,230 ft. Drawdown 75.7 ft after pumping 46 gal/min for 24 hrs on 02/21/56.
25	330741088091101	City of Alice-ville	Layne-Central Co. 1943	443	12 8	Kg	198	27	1943	T	N	City well casing: 12 in. from s surface to 393 ft. 8 in. screen from 393 to 443 ft.
26	330713088100501	City of Alice-ville	Layne-Central Co. 12/21/42	489	12 8	Kg	169	- 3	1943	T	P	P.O.W. well 1 casing: 12 in. from surface to 429.5 ft. 8 in. from 368 to 434.5 ft. 8 in. screen from 434.5 to 484.5 ft. Draw-down 59 ft after pumping 700 gal/min for 36 hrs.
27	330712088100701	City of Alice-ville	Layne-Central Co. 12/14/42	359	12 8	Ke	173	13	10/43	T	P	P.O.W. well 2 casing: 12 in. from surface to 300 ft. 8 in. from 236.5 to 305 ft. 8 in. screen from 305 to 355 ft. Drawdown 60 ft after pumping 650 gal/min for 36 hrs on 05/21/47.
28	330718088085501	City of Alice-ville	Acme Drilling Co. 05/24/72	421	16 8	Kg	182	30	09/05/72	T	P	Well 1 casing: 16 in. from surface to 302 ft. 8 in. casing from 252 to 299 ft and 335 to 390 ft. 8 in. screen from 299 to 335 ft and 390 to 421 ft.
29	331555088054801	City of Carroll-ton	Layne-Central Co. 1935	160	18 8	Kg	271	62.28	04/16/86	N	N	Casing slotted 135 to 160 ft.
30	331555088054802	City of Carroll-ton	Layne-Central Co. 07/27/48	163	10 6	Kg	271			N	N	Casing: 10 in. from surface to 120.75 ft. 6 in. from 97 to 139.5 ft. 6 in. screen from 139.5 to 160 ft. Drawdown 18 ft after pumping 160 gal/min for 4 hrs on 08/17/48.
31	331914087541401	City of Gordo	Gray Artesian Well Co.	460	6	Kc	278	35 81.41	11/02/50 04/16/86	T	N	Casing: 6 in. from surface to 400 ft. Screen from 400 to 460 ft.

Table 2.--Records of public water-supply wells in the study area (continued)

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measure-ment	Method of lift	Use of well	Remarks
32	331915087535001	City of Gordo	Layne-Central Co. 05/23/62	143	16 8	Kc	239	- 14.5	03/13/63	T	P	Well 2 casing: 16 in. from surface to 121 ft. 8 in. from 59 to 124 ft. 6 in. screen from 124 to 144 ft. Drawdown 52 ft after pumping 200 gal/min for 24 hrs on 08/06/63.
33	331918087540001	City of Gordo	H.W. Peerson Drilling Co. 07/27/50	186	8	Kc	242	- 2	09/19/51	T	P	Well 1 casing: 8 in. from surface to 124 ft. 6 in. screen from 124 to 166 ft.
34	331848087531401	City of Gordo	Graves Drilling Co. 1978	132	12 8	Kc	277.5	21.3	10/05/78	T	P	Well 3 casing: 12 in. from surface to 112 ft. 8 in. inner casing to 112 ft. 6 in. screen from 112 to 132 ft. Drawdown 45 ft after pumping 160 gal/min for 26.5 hrs on 10/06/78.
35	330353088150001	Pickens County Water System, Cochrane	Weldon Drilling Co., Inc. 09/15/83	705	8 4	Ke	160	94	09/15/83	T	P	Casing: 8 in. from surface to 609 ft. 4 in. screen from 609 ft to 689 ft. Yield: 8 gal/min per ft of drawdown on 09/15/83.
36	331337088155501	Pickens County Water System, Pickens-ville	Layne-Central Co. 08/04/76	480	12.75 6	Ke	230	76	09/01/76	T	P	Casing: 12.75 in. from surface to 4 415 ft. 6 in. from 365 to 420 ft. 6 in. screen from 420 to 470 ft. Drawdown 33 ft after pumping 205 gal/min for 4 hrs on 04/19/77.
37	332229088005601	City of Reform	Layne-Central Co. 1956	88	6	Kg	238			T	N	Well 2.
38	332237088010801	City of Reform	Graves Drilling Co. 01/26/83	92	16	Kg	244	12.75	01/31/83	T	P	Casing: 16 in. from surface to 59.75 ft. 8 in. screen from 59.75 to 92 ft. Draw-down 3.5 ft after pumping 310 gal/min for 4 hrs on 01/31/83.
39	331058087342501	City of Tusca-loosa	Layne-Central Co. 05/11/62	92	16	Kc	175	20	05/11/62	T	N	Drawdown 42 ft after pumping 500 gal/min for 96 hrs.
40	331058087342502	City of Tusca-loosa	Layne-Central Co. 07/03/62	70	16	Kc	175	6	07/03/62	T	N	Drawdown 42 ft after pumping 500 gal/min for 120 hrs.
41	331058087342503	City of Tusca-loosa	Layne-Central Co. 08/08/62	98	16	Kc	175	29	08/08/62	T	N	Drawdown 52 ft after pumping 350 gal/min for 48 hrs.

Table 2.--Records of public water-supply wells in the study area (continued)

Well number	Geographic coordinate number	Well owner	Drilled by	Well depth (feet)	Well diam. (inches)	Water bearing unit	Altitude of land surface	Water level above (-) or below Land Surface Datum	Date of measurement	Method of lift	Use of well	Remarks
42	331058087342504	City of Tuscaloosa	Layne-Central Co. 08/03/62	88	16	Kc	175	5	08/03/62	T	N	Drawdown 60 ft after pumping 500 gal/min for 48 hrs.
43	330927087361501	City of Tuscaloosa	Layne-Central Co. 04/71	142	12	Kc	130	11	04/01/71	T	N	Screen from 112 to 132 ft. Drawdown 52 ft after pumping 703 gal/min for 8 hrs.
44	330927087361601	City of Tuscaloosa	Layne-Central Co. 01/71	162	12	Kc	130	10	01/22/71	T	N	Screen from 132 to 152 ft.
45	330906087363901	City of Tuscaloosa	Layne-Central Co. 02/71	149	12	Kc	130	12	02/16/71	T	N	Screen from 119 to 139 ft. Drawdown 38 ft after pumping 536 gal/min for 1 hr.
46	331450087412101	Town of Coker	Graves Drilling Co. 07/21/67	182	4	Kc	180	37.36	09/21/67	T	P	Screen from 162 to 182 ft. Drawdown 20 ft after pumping 125 gal/min for 8 hrs 28 min.
47	331446087411701	Town of Coker	Graves Drilling Co. 04/15/74	205	4	Kc	180	42.5	03/28/74	T	P	Drawdown 27.5 ft after pumping 169 gal/min for 8 hrs.
48	331526087480201	Buhl-Elrod-Holman Water System	Graves Drilling Co. 04/02/85	108	4	Qal	240	Ground Level	03/13/85	S	P	Well 1. Screen from 67 to 107 ft. Drawdown 55 ft after pumping 100 gal/min for 24 hrs.
49	331526087480202	Buhl-Elrod-Holman Water System	Graves Drilling Co. 04/02/85	336	4	Kc	240	49.2	03/13/85	S	P	Well 2. Screen from 284 to 335 ft. Drawdown 80 ft after pumping 140 gal/min for 24 hrs.

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