GEOHYDROLOGY AND SUSCEPTIBILITY OF MAJOR AQUIFERS TO SURFACE CONTAMINATION IN ALABAMA; AREA 4

By Michael Planert and James L. Pritchett, Jr.

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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 "Sea Level Datum of 1929."

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ABSTRACT

The U.S. Geological Survey, in cooperation with the Alabama Department of Environmental Management, is conducting a series of geohydrologic studies to delineate the major aquifers (those which provide water for public supplies) in Alabama, their recharge areas, and areas susceptible to contamination. This report summarizes these factors for two major aquifers in Area 4--Calhoun, Jefferson, St. Clair, Shelby, and Talladega Counties.

The major aquifers in the study area are the Knox-Shady of Cambrian-Ordovician age and the Tuscumbia-Fort Payne of Mississippian age. Highest yields from aquifers are associated with solution openings in carbonate rocks. Springs provide substantial amounts of water for municipal supply; Coldwater Spring provides an average of 17 million gallons per day to the city of Anniston.

All recharge areas for the aquifers are susceptible to contamination from land surface. Two conditions exist in the study area which may cause the aquifers to be highly susceptible to contamination on a local scale: fracturing of rock materials due to faulting and the production of a porous cherty soil through weathering. Where sinkholes are present there may be a direct connection between the land surface and the aquifer. Areas with sinkholes are considered to be extremely susceptible to contamination.

INTRODUCTION

The Alabama Department of Environmental Management (ADEM) is developing a comprehensive program in Alabama to protect ground water defined by the U.S. Environmental Protection Agency (EPA) as "Class I and II" from surface contamination (U.S. Environmental Protection Agency, 1984). The U.S. Geological Survey, in cooperation with ADEM, is conducting a series of geohydrologic studies to delineate recharge areas of the major aquifers in Alabama and areas susceptible to contamination. This report summarizes these factors for major aquifers in Area 4--Calhoun, Jefferson, St. Clair, Shelby, and Talladega Counties (fig. 1).

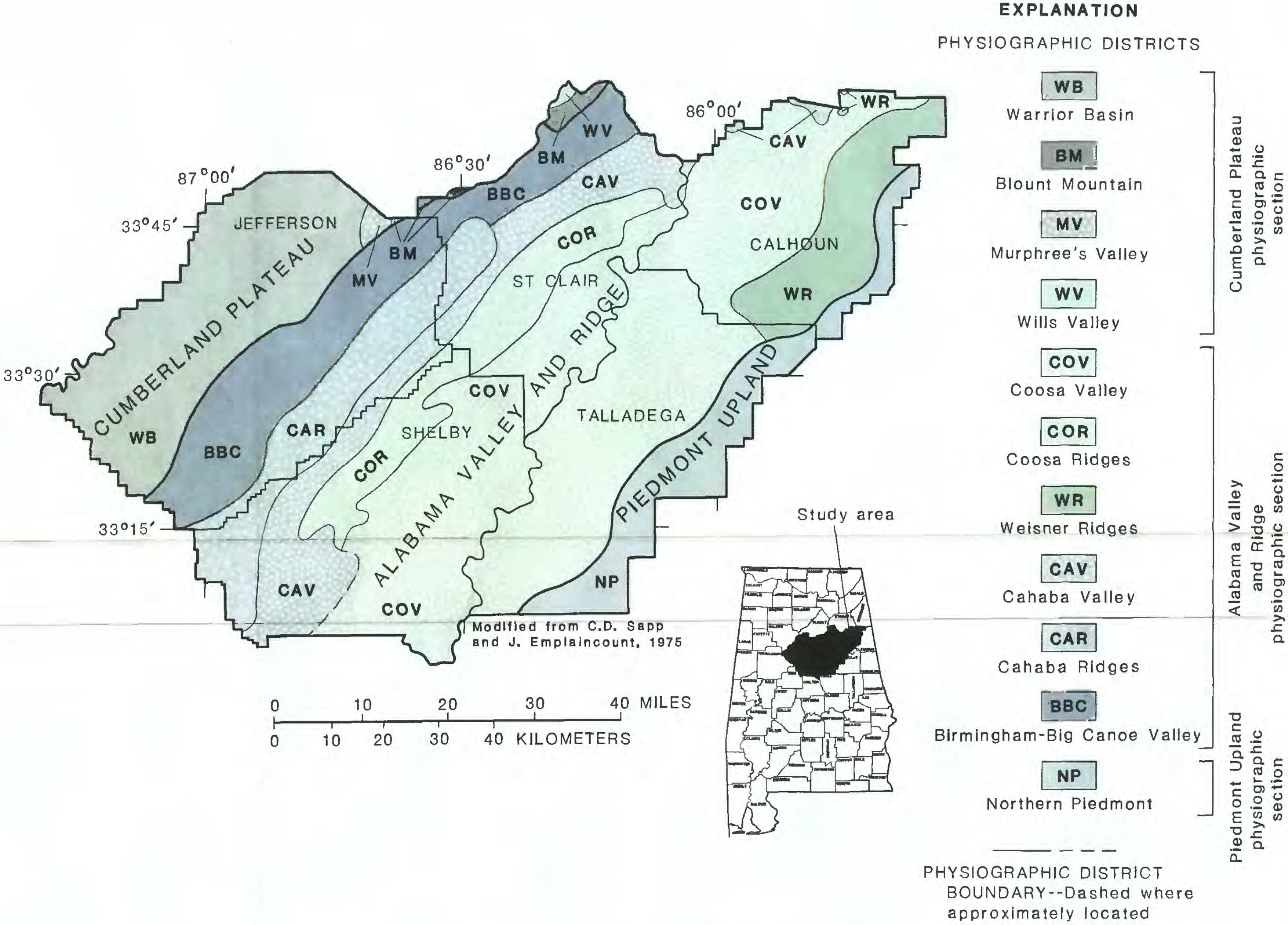

Figure 1.--Physiography of the study area.

Purpose and Scope

The purpose of this report is to describe the geohydrology of the major aquifers in Area 4 and their susceptibility to contamination from the surface. Geologic and hydrologic data compiled as part of previous investigations provided about 90 percent of the data used to evaluate the major aquifers in the area. All wells and springs used for municipal and rural water supplies were inventoried, and water levels were measured in wells where possible. Data on water use were compiled during the well inventory. Water-level data were used to compile generalized potentiometric maps of the aquifers. Areas susceptible to contamination from the surface were delineated partly from topographic maps and other available data, and partly from field investigation.

Location and Physical Features of the Area

The study area is in north central Alabama and comprises 3,929 mi^2 (square miles). The study area has a moist, temperate climate and a mean annual rainfall of about 53 inches per year (U.S. Department of Commerce, 1985). Forest land covers about 72 percent of the area, agricultural acreage 17 percent, and the remainder of the area is mostly urban or wetland acreage. The 1980 population statistics along with predictions for 1990 indicate that about one million people inhabit the study area (Alabama Department of Economic and Community Affairs, 1984). Birmingham comprises the largest urban area with a population in 1980 of about 300,000 people; other major cities in the study area include Anniston, Sylacauga, and Talladega (plate 1).

Physiography

The study area includes parts of three physiographic sections: the Cumberland Plateau, the Alabama Valley and Ridge, and the Piedmont Upland (Fenneman, 1938). Figure 1 shows the locations of these three sections as well as the districts within each of them (Sapp and Emplaincourt, 1975).

The Cumberland Plateau section extends from western Jefferson County to the most western and northern parts of St. Clair County. All but the northeastern part of west Jefferson County is in the Warrior Basin district where altitudes range from 350 feet near the Black Warrior River to over 700 feet along several ridges in the basin. Drainage within the basin is primarily west to Locust Fork of the Black Warrior River and to the Black Warrior River. The northeastern part of west Jefferson County and the northwesternmost corner of St. Clair County are in the Murphree's Valley and Blount Mountain districts where altitudes range from 700 to 1,100 feet. The northernmost area of St. Clair County is in the Wills Valley and Blount Mountain districts where altitudes range from 800 to 1,500 feet. Drainage in these three mountain and valley districts is also primarily west to Locust Fork of the Black Warrior River.

The Alabama Valley and Ridge section extends across the majority of the study area and includes several valley and ridge districts. From west to east, the districts are the Birmingham-Big Canoe Valley, the Cahaba Ridges, the Cahaba Valley, the Coosa Ridges, the Coosa Valley, and the Weisner Ridges. Altitudes in the Birmingham-Big Canoe Valley range from about 500 feet in Jefferson County to about 600 feet in St. Clair County. Drainage is generally west to southwest into the Black Warrior River tributaries across Jefferson County; St. Clair County drainage is primarily east to Big Canoe Creek which flows to the Coosa River.

The Cahaba Ridges trend northeast through parts of Shelby, Jefferson, and St. Clair Counties. Altitudes in the Cahaba Ridges range from about 300 feet in Shelby County to about 1,100 feet in St. Clair County. Drainage from the ridges is southeast to the Cahaba River which flows along the eastern edge of the ridges. The Cahaba Valley district lies to the east of the Cahaba River and extends northward into St. Clair County east of the Birmingham-Big Canoe Valley district. Altitudes in the Cahaba Valley range from 300 feet in Shelby County to 700 feet in St. Clair County and drainage is generally west to the Cahaba River.

The Coosa Ridge district lies east of the Cahaba Valley and consists mainly of the Double Oak Mountains with altitudes as high as 1,400 feet. Westward drainage off the mountains is generally into Cahaba River tributaries; eastward drainage is primarily into Coosa River tributaries. The Coosa Valley district extends from the Coosa Ridge district on the west to the Weisner Ridge district and Piedmont Upland section on the east. Altitudes of about 400 and 500 feet dominate the Coosa Valley west of the Coosa River; but east of the Coosa River, altitudes in the valley range from about 500 feet to as much as 1,540 feet. Drainage from the Coosa Valley district is primarily into the Coosa River.

The Weisner Ridge district, located in the northeastern corner of Talladega County and the eastern part of Calhoun County, consists primarily of the Choccolocco and Coldwater Mountains. Altitudes are as high as 2,100 feet on the crest of Choccolocco Mountain. Drainage from the Weisner Ridge district is into tributaries of the Coosa River, namely Choccolocco, Terrapin, and Tallasseehatchee Creeks.

The Northern Piedmont district of the Piedmont Upland section is located in southeastern Talladega County and most of southeastern Calhoun County. Altitudes range from about 1,900 feet on Talladega Mountain to 500 feet in the valleys to the west. Drainage is primarily into tributaries of the Coosa River.

Previous Investigations

Several published reports on the structure, stratigraphy, and lithology of the study area are of note. Adams and others (1926) provides the descriptive base of most geologic studies in Alabama since its publication. Johnston (1933) presents a comprehensive account of the ground-water resources in the Paleozoic rocks of northern Alabama. Drahovzal and Neathery (1971) updated and revised descriptions of the Middle and Upper Ordovician stratigraphy of the Alabama Appalachians. Thomas (1972) contains a comprehensive description of the Mississippian stratigraphy of Alabama. Neathery (1973) compiled observations of the lithologic relations within the Talladega Group of Alabama. Kidd and Shannon (1978) defined geologic structures in Jefferson County; Thomas (1985) compiled balanced structural sections of northern Alabama.

Reports on ground-water resources, which include geologic mapping and well inventories, have been published for each of the counties in the study area and are listed below:

Calhoun	-	Warman and Causey, 1962
Jefferson	-	Moffett and Moser, 1978
St. Clair	-	Causey, 1963
Shelby	-	Shamburger and Harkins, 1980
Talladega	-	Causey, 1965

These reports provide a broad and useful base of geologic and hydrologic information. In addition to the reports listed above, Davis (1980) contains periodic measurements of ground-water levels in the area from 1952 to 1977. These and other useful ground-water publications are listed in the selected references.

Acknowledgments

Acknowledgment is made to those persons who contributed to the field investigations and data compilation involved in preparation of this report. The assistance of waterworks managers and supervisors of the municipalities within the study area who furnished information on well locations, construction, and water use is greatly appreciated. Appreciation is also extended to Ed Osborne and Paul Moser of the Geological Survey of Alabama who provided updated geologic and ground-water information from unpublished reports on the area.

GEOLOGY

The geology of the study area, along with the diverse physiography, is quite complex due to large-scale tectonic activity, most of which took place during the Appalachian orogeny. Most of the study area is in the Appalachian fold and thrust belt which consists of shallow marine to deltaic Paleozoic sedimentary strata that were deposited on a continental platform (Thomas, 1985). Paleozoic metasedimentary rocks crop out along the southeastern border of the study area, and are separated from the fold and thrust belt by the Talladega fault (fig. 2).

Structure

Strata throughout the study area generally maintain a northeast-southwest strike, and dips are typically trending to the southeast (fig. 3). Across strike, the fold and thrust belt is characterized by three structural domains (Thomas, 1985). Broad flat-bottomed synclines and narrow asymmetric anticlines comprise the northwest domain. The central domain is characterized by folds associated with large thrust-fault ramps. The southeastern domain is characterized by low-angle, broad, multiple-level thrust sheets (Thomas, 1985).

The northwest domain, which coincides with the Cumberland Plateau physiographic section, is represented by the Black Warrior foreland basin (Warrior coal field). The basin is generally underlain by gently dipping rocks of Pennsylvanian age (Pottsville Formation), although several structures are present (Kidd and Shannon, 1978). These structural features are not depicted on the figures because they are of small scale.

The central domain of the fold and thrust belt coincides with the Alabama Valley and Ridge physiographic section and consists of sedimentary rocks that range in age from Cambrian to Pennsylvanian (Kidd and Shannon, 1978). The structures are a series of anticlines and synclines that form northeast-southwest-trending ridges and valleys. Major structures include the Birmingham anticlinorium, Cahaba synclinorium, and the Coosa synclinorium (fig. 3).

The Birmingham anticlinorium is defined along its west-northwestern limb by the Opossum Valley thrust fault which has a displacement of 7,000 feet or more (Kidd and Shannon, 1978). The Cahaba synclinorium is bounded on the northwest by the Birmingham anticlinorium and on the southeast by the Coosa synclinorium. The Helena fault marks the boundary between the Coosa and Cahaba synclinoriums and involves displacement of 10,000 feet or more (Kidd and Shannon, 1978). The Helena is the most extensive fault in the central domain and generally juxtaposes the Cambrian Rome Formation on the east and the Pennsylvanian Pottsville Formation on the west (fig. 2).

The southeastern domain and the Piedmont Upland physiographic section are separated by the Talladega thrust fault (fig. 2). Greenschist metasedimentary rocks of the Talladega slate belt crop out east of the fault and override the trailing part of the fold and thrust belt (Thomas, 1985).

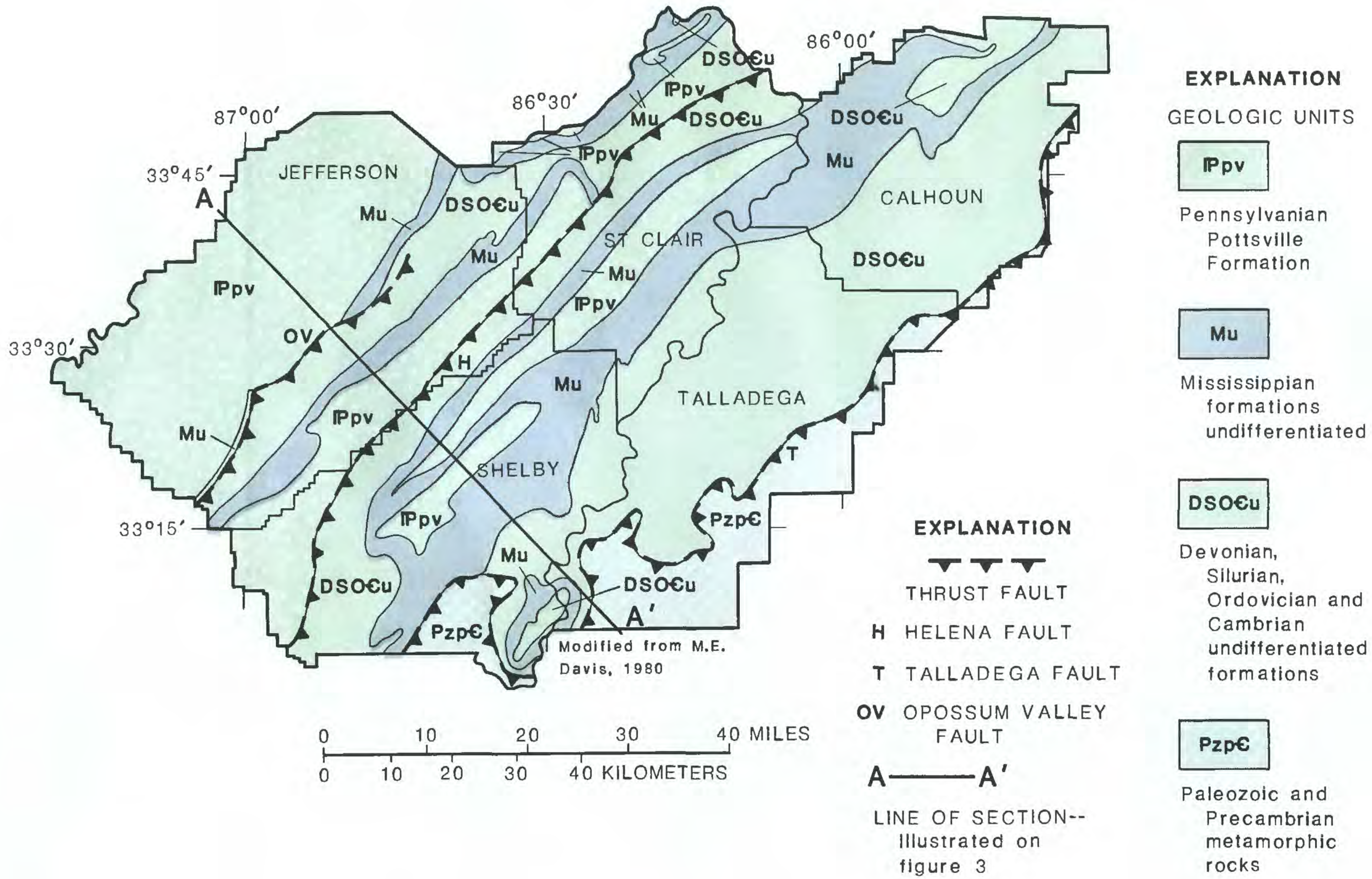

Figure 2.--Generalized geology of the study area.

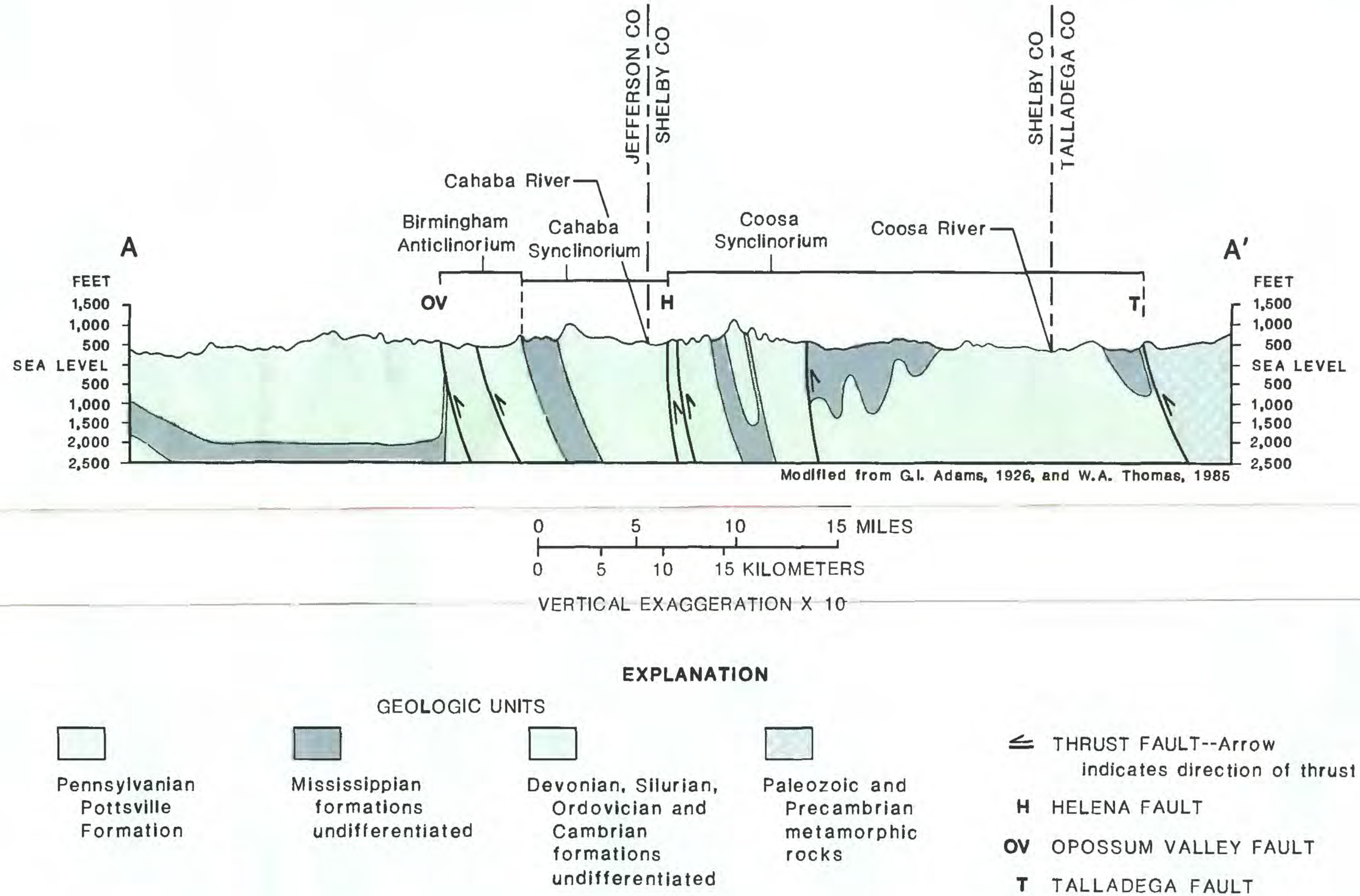

Figure 3.--Generalized geologic section through the study area (line of section shown on figure 2).

Stratigraphy and Lithology

Thomas (1985) divides the Paleozoic sedimentary sequence lying above the Precambrian basement into four major components: a basal Cambrian clastic sequence, a Cambrian-Ordovician carbonate shelf facies, a thin and laterally variable Middle Ordovician to Lower Mississippian sequence of shallow-marine shelf clastic and carbonate rocks, and parts of two Mississippian-Pennsylvanian clastic wedges that prograded over the carbonate shelf. Appalachian thrust faults have displaced the youngest preserved Paleozoic strata, and low grade metamorphism has occurred along and south of the Talladega thrust fault.

The Talladega Belt extends through eastern Calhoun, eastern Talladega, and southeastern Shelby Counties and consists of greenschist metasedimentary clastic and carbonate rocks, which possibly correlate with the Cambrian to Carboniferous rocks of the Valley and Ridge province (Neathery, 1973). The Lay Dam Formation forms the lower part of the Talladega Group, cropping out in Shelby and Talladega Counties. It is made up of coarse clastics such as arkoses, quartzites, conglomerates, and graywackes to the southwest, and finer grained siltstones, sandstones, and limestones to the northeast. The Abel Gap Formation of the Talladega Group (Neathery, 1973), which crops out in Calhoun County, resembles the Lay Dam Formation and is characterized by a thick lens of black siliceous slate. A third major division, the Hillabee Chlorite Schist, crops out east-southeast of the Lay Dam and Abel Gap Formations along the southeastern edge of the study area.

The Cambrian System is represented in the study area by the Chilhowee Group, Shady Dolomite, Rome Formation, and Conasauga Formation. The Chilhowee Group includes the Wilson Ridge Formation and the Weisner Quartzite (Mack, 1980). The Chilhowee crops out in the Weisner Ridges and the Coosa Valley (fig. 1). The Chilhowee Group consists of fluvial to shallow-marine sandstones, conglomerates, and mudstones with thicknesses in excess of 1,300 feet near Sylacauga in Talladega County (Thomas, 1985). The Shady Dolomite overlies the Chilhowee Group and generally forms valleys adjacent to, or occurs low on, Weisner-capped ridges. The Shady Dolomite reaches thicknesses of 500 to 1,000 feet and consists of sandy dolomite and dolomitic limestone. The Rome Formation overlies and crops out in proximity to the Shady Dolomite and in a narrow band east of the Helena thrust fault. Interbedded sandstones, siltstones, and shales make up the Rome which has an estimated thickness of 1,000 feet.

The Conasauga Formation, which crops out extensively throughout the Birmingham-Big Canoe, Cahaba and Coosa Valleys, differs lithologically across the study area. Dolomite is common in the Coosa Valley of Talladega, southeastern St. Clair, and northeastern Shelby Counties. The unit has an estimated thickness of 800 to 1,000 feet near Sylacauga in Talladega County (Thomas and Drahovzal, 1973). Interbedded shale, limestone, and sandstone occur in Calhoun and northern St. Clair Counties, and dolomite, shale, and limestone interbeds persist in Jefferson and southwest Shelby Counties (Thomas and Drahovzal, 1973).

The Knox Group of Cambrian and Ordovician age includes the Copper Ridge Dolomite, Chepultepec Dolomite, Longview Limestone, and Newala Limestone (Thomas and Drahovzal, 1973). The Knox Group overlies the Conasauga Formation and also crops out extensively in the valley areas. The thickness of the unit is approximately 3,900 feet (Thomas, 1985). The lithology ranges from siliceous dolomite in the lower part to fine- to coarse-grained limestones in the upper part.

Drahovzal and Neathery (1971) subdivide the Ordovician system into a dominantly carbonate western facies and a largely clastic eastern facies separated by the Helena thrust fault (fig. 2). In ascending order, the western facies is composed of: the Chickamauga Limestone, Inman Formation, Leipers Limestone, and Sequatchie Formation. The Chickamauga Limestone, Inman Formation, and Leipers Limestone are composed mainly of fine- to coarse-grained, medium- to thick-bedded, pure to argillaceous limestones. These beds are about 260 feet thick at Birmingham in Jefferson County, and thicken northward. The eastern facies is composed of the Lenoir Limestone, Little Oak Limestone, Athens Shale, Greensport Formation, Colvin Mountain Sandstone, and Sequatchie Formation (Drahovzal and Neathery, 1971). The units are dominantly clastic with the exception of the lower part (Lenoir and Little Oak Limestones) which are generally fine- to medium-grained, medium- to thick-bedded limestones which correlate in part to each other and to the Chickamauga Limestone. The combined thickness of the Lenoir and Little Oak Limestones ranges from a feather's edge in Calhoun County to about 800 feet at Odenville in St. Clair County. The Sequatchie Formation, a largely clastic unit, is the youngest Ordovician unit and thins to the southwest and northwest. The unit is only 3 feet thick in Birmingham, Jefferson County (Drahovzal and Neathery, 1971).

Silurian and Devonian outcrops within the study area are limited to a narrow area across Jefferson, northwest St. Clair, and northwest Calhoun Counties. The Silurian age Red Mountain Formation is primarily a clastic unit of interbedded sandstone, siltstone, shale, and hematite with thin interbeds of bioclastic limestone. The maximum thickness of the Silurian rocks is somewhat more than 500 feet (Thomas and Drahovzal, 1973). The Frog Mountain Sandstone of Devonian age is characteristically a medium- to very coarse-grained sandstone. In Calhoun County, the Frog Mountain is locally thick and apparently thickens toward the southeast to possibly as much as 200 feet. In Jefferson County, thicknesses of less than 25 feet are common. The Chattanooga Shale is a widespread black shale of Devonian age, generally less than 30 feet thick.

The Mississippian System in the study area includes a shallow-marine carbonate facies that is bordered on the southeast by a prograding clastic wedge of deltaic to shallow-marine sandstones and shales (Thomas, 1985). The Lower Mississippian Maury Shale, which overlies the Chattanooga Shale, is characterized as a greenish clay shale, and ranges from a few inches to about 3 feet in thickness. The upper Lower and Upper Mississippian rocks include, in ascending order: the Fort Payne Chert, Tuscumbia Limestone, Pride Mountain Formation, Hartselle Sandstone, Bangor Limestone, Floyd Shale, and Parkwood Formation. Some of these units thin or grade laterally into each other and, due to their lithologic complexity, the reader is referred to Thomas (1972) for a more detailed description of the Mississippian stratigraphy.

The Mississippian carbonate facies include the Fort Payne Chert which is primarily a thin-bedded fossiliferous chert and the overlying Tuscumbia Limestone which is a thin-bedded limestone and chert. These units generally crop out on the flanks of structures and have varying thicknesses that tend to thin southwestward in the Warrior basin and southeastward across the fold and thrust belt. Lenses of the Pride Mountain Formation and Hartselle Sandstone overlie the carbonate facies and, through facies changes, have general equivalents in the Floyd-Parkwood sequence. The Floyd-Parkwood clastic sequence progrades from the southwest into a carbonate facies (Bangor Limestone) in the northwestern part of the study area. Thicknesses generally increase southwestward in the Warrior Basin and southeastward across the Appalachians, but areas of maximum thickness (3,500 feet in the Coosa syncline) appear to coincide with structural troughs.

The Pennsylvanian System includes the uppermost part of the Parkwood Formation and the Pottsville Formation, youngest of the Paleozoic rocks, and crops out in the Warrior Basin as well as on the Cahaba and Coosa Ridges. The Pottsville, primarily a ridge-forming sequence of sandstone, shale and coal beds, overlies the Mississippian Bangor Limestone and the Mississippian and Pennsylvanian Parkwood Formation. The thickness of the unit increases southward to a known maximum of about 9,000 feet at the southern end of the Cahaba and Coosa synclines (Thomas, 1972).

HYDROLOGY OF THE MAJOR AQUIFERS

The geologic formations of Area 4 can be grouped into two types of major aquifers--the Knox-Shady and the Tuscumbia-Fort Payne. The complex geologic structure has disrupted the regional continuity of the formations so that each major aquifer type occurs repeatedly in different parts of the study area. Individual aquifers are associated with the major valleys in the study area (fig. 1), with the valleys separated by ridges consisting of the more impermeable rock types of sandstone, quartzite, and slate. The same major aquifer type may be present in adjacent valleys but may not be hydraulically connected because of faulting or folding (fig. 3). Rocks classified as aquifers are generally carbonates, and the highest yields are from wells that have intercepted interconnected solution cavities. Individual rock units and their water-bearing properties are described in table 1. Most rocks within the valleys are covered by a mantle of residuum, which is the product of the weathering of the underlying parent material, allowing water to occur under either water-table or artesian conditions within the aquifers.

The ridges dividing the valleys (fig. 1) and the rock types that capped them are as follows: Weisner, quartzite; western edge of the Northern Piedmont, slate; Cahaba, sandstone and conglomerate; and Blount Mountain, sandstone. These rocks are highly resistant to weathering, were unaffected by faulting, and are relatively impermeable. A well drilled in the Weisner Quartzite on Choccolocco Mountain in Calhoun County went to a depth of 305 feet without finding water (Johnson, 1933). The ridges generally have steep slopes and little soil which enhances the rapid runoff of rainfall to the edges of the flatter valleys.

The Knox-Shady aquifer is present in the Coosa, Cahaba, Birmingham-Big Canoe, and Murphree's Valleys. Formations included in the Knox-Shady aquifer are the Weisner Quartzite; Shady Dolomite; Conasauga Formation; Copper Ridge and Chepultepec Dolomites; and the Longview, Newala, Lenoir, and Little Oak Limestones.

The Weisner Quartzite is predominantly a ridge-forming formation in the study area, but there are areas where the sandstone is poorly cemented and the Weisner is water bearing as evidenced by Coldwater Spring with a discharge of 32 Mgal/d (million gallons per day). The water-bearing areas are usually associated with the valleys and not the ridges. The Shady Dolomite is characteristic of the calcareous rocks in the study area where dissolution of the rocks along fractures creates enlarged channels that can yield substantial amounts of water to wells. The Conasauga limestones of the Birmingham-Big Canoe Valley are good water-bearing units with the beds having well developed solution channels. In the Coosa Valley where the formation is shaley, it is not a good aquifer and is used only for domestic supplies.

The Copper Ridge and Chepultepec Dolomites are similar in their water-bearing characteristics. Both have an elaborate system of closely spaced and interconnected solution channels. Weathering results in a cherty soil that is porous and allows rapid infiltration of rainfall.

The Longview, Newala, Lenoir, and Little Oak Limestones have properties similar to the other carbonate units, with water derived from solution channels. Only the Longview has appreciable chert in its weathered soil, but the soil is not as permeable as the underlying dolomites.

As an indication of the variability of the Knox-Shady aquifer's potential, the maximum yields for wells and springs, respectively, are given for the counties where the aquifer is used: Calhoun, 1,100 gal/min (gallons per minute) and 32.0 Mgal/d; Jefferson, 750 gal/min and 3.6 Mgal/d; St. Clair, 400 gal/min and 3.2 Mgal/d; Shelby, 1,600 gal/min and 0.8 Mgal/d; and Talladega, 400 gal/min and 6.9 Mgal/d.

The Tuscumbia-Fort Payne aquifer is present in the Cahaba, Birmingham-Big Canoe, and Murphree's Valleys. Formations included in the Tuscumbia-Fort Payne aquifer are the Fort Payne Chert, Hartselle Sandstone, and Bangor Limestone.

The Fort Payne Chert owes its water-bearing capacity to the fact that the limestone in the cherty beds is easily dissolved, leaving a porous ground-water reservoir. Where the beds have been folded, incipient cracks in the chert have opened, enhancing the porosity of the aquifer. On the gentler slopes of the formation, broken chert fragments have accumulated, creating a highly permeable soil.

The Hartselle Sandstone is well cemented and has only fair porosity throughout most of its outcrop where it yields moderate amounts of water to wells. At Irondale in Jefferson County, however, the sandstone is soft and friable and yields are higher.

The Bangor Limestone, like the other carbonate rocks, has a network of solution channels that are interconnected and can yield large quantities of water. The formation contains sufficient chert to allow the development of a fairly permeable soil.

To indicate the variability of the Tuscumbia-Fort Payne aquifer's potential, the maximum yields for wells and springs, respectively, for the counties where the aquifer is used are: Jefferson, 1,200 gal/min and 0.2 Mgal/d; and St. Clair, 250 gal/min and 2.2 Mgal/d.

Two other aquifers, the Pottsville and Piedmont, are used for water supply within the study area but are not considered major aquifers. The Pottsville aquifer consists of the Pottsville Formation, and the Piedmont aquifer consists of Precambrian and Paleozoic metamorphic and granitic rocks. For information on these aquifers, the reader is referred to the reports in this series covering Area 3 (Stricklin, 1989) and Area 5 (Kidd, 1989).

Recharge and Movement of Ground Water

The source of recharge to the major aquifers is rainfall. Average annual rainfall is about 53 inches per year, but a large part of this is lost either by direct runoff to streams immediately after a rain or by evapotranspiration to the atmosphere. A relatively small part of the total rainfall infiltrates to the water table to recharge the aquifers. The only measurable amount of recharge to the aquifers is that which is discharged to streams. A conservative estimate of recharge can be obtained by examining the base (dry weather) flow of streams. Based on data from six long-term gaging stations within the study area, the estimate for aquifer recharge is about 5 inches per year.

Movement of ground water is controlled by the force of gravity so that water moves from points of higher altitude to points of lower altitude. Ground-water movement can be illustrated by plotting the water levels in wells on a map and contouring the water levels. This produces a potentiometric surface map and, by tracing a line perpendicular to the contours from higher to lower altitudes, one can determine the path that ground water moves through the aquifer. Streams are the most common natural low points on the potentiometric surface map, but within the study area there are numerous springs which occur where the water table intercepts the land surface. The general pattern of ground-water movement for the Knox-Shady aquifers can be determined from the potentiometric surfaces on plate 1. The potentiometric surfaces were constructed for data ranging from 1928 to 1987 and, due to natural annual fluctuations generally being less than 10 feet, the surfaces being contoured at 50 feet intervals should be representative of average conditions within the aquifers. Movement of ground water is primarily from the higher altitudes adjacent to the ridges to the center of the valleys, but there is also "down-valley" movement in the same direction that the streams flow. Incised streams draining the aquifers in the Birmingham-Big Canoe Valley can cause depressions in the potentiometric surfaces, as can be noted at Pinson in northern Jefferson County and just south of Birmingham. But, in the broader Coosa Valley, the potentiometric gradients are smoother reflecting the gentler relief.

Pumping from a well also causes a depression in the potentiometric surface of an aquifer. However, no one withdrawal rate is large enough in the study area to be visible on plate 1. Water-level data for the Tuscumbia-Fort Payne aquifers are too sparse and the outcrop of their formations too narrow to present potentiometric surface maps for these aquifers. The general ground-water flow direction is the same as the surface-water gradient.

Faulting is another important factor that needs to be considered when discussing ground-water flow in the study area, as noted by Johnson (1933, p. 77).

> "In the Appalachian area of northern Alabama, where the rocks are much disturbed, fault planes yield water to drilled wells and supply many springs.
>
> Few faults of large displacement are simple fractures. Their walls are crushed and broken, forming a wide fault zone which may be waterbearing, though the rocks involved are themselves impermeable. Thus, even so poor an aquifer as the Floyd shale may have secondary openings, resulting from faulting, which yield a good water supply, as at Columbiana, in Shelby County, where the Warrior Water Co.'s well, 97 feet deep ending in crumpled Floyd shale near the Talladega slate fault contact, yields 200 gallons of water a minute.
>
> In northern Alabama there are many springs that rise on fault planes. ***Avondale Mills Spring, St. Clair County, is fed by the Fort Payne chert near a fault contact with the Floyd shale and flows at the rate of 500 gallons a minute; Angel Spring, Calhoun County, on a fault between Floyd shale and Copper Ridge dolomite, yields 800 gallons a minute; and Joe McReynolds Spring, in Calhoun County, rises on a fault plane between the Weisner quartzite and the Shady dolomite and flows 500 gallons a minute. In these and many other springs within the area the fault zone acts as a conduit for the movement of ground water."

Information is not available to completely evaluate the importance of faulting on ground-water movement in the study area, but a report (Scott and others, 1987) on Coldwater Spring, which lies on the trace of the Jacksonville Fault, attempted to identify the recharge area for the spring. Based on a potentiometric surface map, the recharge area for the spring was estimated to be about 23 mi^2 (Scott and others, 1987). However, recharge rates determined from ground-water runoff to streams during periods of low flow indicate that the recharge area for the spring could be about 90 mi^2. The discrepancy in the values determined for the recharge area emphasizes the importance faulting may have on ground-water movement throughout the study area.

Natural Discharge and Ground-Water Withdrawals

A large part of aquifer recharge is discharged to streams through seeps and springs. At the driest time of the year, almost 600 Mgal/d of ground water are discharged to the streams in the study area (Hayes, 1978). Pumpage from wells accounts for any other measurable discharge from the aquifer system. For the study area, estimated withdrawals from ground water are as follows: public supply, 43.0 Mgal/d; self-supplied industry, 6.0 Mgal/d; agriculture, 1.5 Mgal/d; and self-supplied domestic, 2.0 Mgal/d (Baker and Mooty, 1987). The estimated total withdrawal of 52.5 Mgal/d is equivalent to 0.3 inches per year of recharge. The largest ground-water users in the study area are Anniston (17.0 Mgal/d), Talladega (4.0 Mgal/d), Leeds (2.5 Mgal/d), Trussville (2.4 Mgal/d), and Alabaster (2.2 Mgal/d). Locations of all public-supply wells and springs are shown on plate 1; pertinent data concerning the wells and springs, including well construction, water levels, and spring flows are presented in table 2.

SUSCEPTIBILITY OF THE AQUIFERS TO CONTAMINATION

All of the recharge areas for the major aquifers are susceptible to surface contamination (plate 1). The recharge areas occur in the stream valleys where rainfall runoff is much slower than that of runoff on steeper-sloped ridges. Slower runoff allows more infiltration of rainfall and, therefore, provides the means to carry contaminants to the aquifers. Locally (areas too small to show on plate 1) the susceptibility of an aquifer to contamination may be higher because of three factors that can potentially increase the permeability of the aquifer materials or the soils overlying the aquifers.

Faulting enhances the permeability of most rock materials as the stresses during faulting mechanically fracture the rocks. This is apparent from the coincidence of major springs associated with traces of major faults (Johnston, 1933). The increased permeability in fault zones also represents an increase in the potential for surface contamination to enter the aquifer; these areas are designated as highly susceptible to contamination. The identification of these areas in such a geologically complex environment would require a detailed geologic map showing the traces of individual faults and is beyond the scope of this investigation.

When rocks that have a high chert content are weathered, the chert remains unaltered, leaving a residuous soil which is fairly porous, and allows rapid recharge (Johnston, 1933). Again, areas underlain by these soils tend to be more susceptible to surface contamination, but a detailed geologic map or possibly a soils map showing the particular formations or soils of interest would be needed to identify these localized areas.

There are areas within the study area that can be classified as extremely susceptible to contamination and these areas coincide with the locations of sinkholes. Sinkholes are depressions in the land surface caused by the collapse of rock materials into a solution cavity. Sinkholes can provide a direct link to the aquifer system that could allow immediate contamination of the aquifer. Locations of mappable sinkholes are shown on plate 1 with distinction made between smaller and larger (greatest surface dimension greater than 0.2 mile) sinkholes.

SUMMARY AND CONCLUSIONS

The geology of the study area, along with the diverse physiography, is quite complex owing to past large-scale tectonic activity. Most of the study area is in the Appalachian fold and thrust belt which consists of Paleozoic sedimentary strata. Paleozoic metasedimentary rocks crop out along the southeastern border of the study area and are separated from the fold and thrust belt by the Talladega fault.

The geologic formations in Area 4 can be grouped into two types of major aquifers--the Knox-Shady of Cambrian-Ordovician age rocks and the Tuscumbia-Fort Payne of Mississippian age rocks. The complex structure in the area has disrupted the regional continuity of the formations so that individual aquifers are associated with the major valleys in the study area and the same major aquifer type may be present in adjacent valleys but may not be hydraulically connected because of faulting or folding.

Aquifers coincide with the physiographic districts of the Coosa Valley, Cahaba Valley, Birmingham-Big Canoe Valley, and Murphree's Valley. These aquifers are tapped within their outcrop areas where they are also recharged. Most rocks are covered by a mantle of residuum which is a product of the underlying parent material so that water may occur in either water-table or artesian conditions within the aquifers. Highest yields from aquifers are associated with solution openings in carbonate rocks. Springs provide substantial amounts of water for municipal supply with the largest being Coldwater Spring in Calhoun County.

For the study area, estimated withdrawals from ground water are as follows: public supply, 43.0 Mgal/d; self-supplied industry, 6.0 Mgal/d; agriculture, 1.5 Mgal/d; and self-supplied domestic, 2.0 Mgal/d (Baker and Mooty, 1987). The estimated total withdrawal of 52.5 Mgal/d is equivalent to 0.3 inches per year of recharge. The largest ground-water users in the study area are Anniston (17.0 Mgal/d), Talladega (4.0 Mgal/d), Leeds (2.5 Mgal/d), Trussville (2.4 Mgal/d), and Alabaster (2.2 Mgal/d).

All the recharge areas for the aquifers are susceptible to contamination from the surface. Two conditions exist in the study area which may cause the aquifers to be highly susceptible to contamination on a local scale: rock materials are fractured in places due to faulting, and weathered, cherty soils tend to be porous. Where sinkholes are present, there may be a direct connection between the surface and the aquifer; these areas are considered to be extremely susceptible to contamination.

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

Erathem	System	Series	Thickness (feet)	Stratigraphic unit	Lithology	Water-bearing properties
Paleozoic	Pennsylvanian		9,000	Pottsville Formation	Sandstone, shale, and coal beds	Sandstone yields moderate amounts of water to drilled wells. Quality variable, ranging from calcium to sodium bicarbonate in character. Frequently high in iron.
	Mississippian	Upper	3,500	Parkwood Formation	Clay, shale, claystone, and mudstone	Some water of fair quality in sandy intervals. Often high in iron.
				Floyd Shale	Predominantly a dark-gray clay shale	Minor amounts of water. Sufficient for domestic use.
				Bangor Limestone	Oolitic limestone, lower beds may contain a gray clay shale	Abundantly water bearing where solution channels are developed. Supplies many springs. Calcium bicarbonate waters.
				Hartselle Sandstone	Light-colored quartzose sandstone, nearly all fine-grained well-sorted sandstone	Water bearing; variable quality.
				Pride Mountain Formation	Medium- to dark-gray fissile clay shale	Water bearing; variable quality.
				Tuscumbia Limestone	Light-gray micrite and light-gray bioclastic limestone and chert in beds generally more than 1 foot thick	Solution channels feed many large springs and yield adequate water to drilled wells. Cherty subsoil; excellent aquifer. Calcium bicarbonate waters.
		Lower		Fort Payne Chert	Chert and siliceous limestone	
			3	Maury Shale	Green shale	Relatively impermeable and not an aquifer.
	Devonian		30	Chattanooga Shale	Black shale	
			25-200	Frog Mountain Formation	Medium- to very coarse-grained sandstone	Little water; variable quality.
	Silurian		500+	Red Mountain Formation	Interbedded sandstone, siltstone, shale, hematite with thin interbeds of bioclastic limestone	Yields sufficient for domestic use.
	Ordovician		260+	Western facies: Sequatchie Formation, Leipers Limestone, Inman Formation, Chickamauga Limestone	Fine- to coarse-grained, medium- to thick-bedded, pure argillaceous limestone	Yields calcium bicarbonate waters. Shales and argillaceous limestones yield little water.
			1-800	Eastern facies: Sequatchie Formation, Colvin Mountain Sandstone, Greensport Formation, Athens Shale	Dominantly clastic units	Generally not very productive formations. Little water; variable quality.
				Eastern facies: Little Oak Limestone, Lenoir Limestone	Fine- to medium-grained, medium- to thick-bedded limestone	Locally abundantly water bearing. Hard bicarbonate waters but otherwise of quality suitable for most uses.
	Ordovician and Cambrian		3,900	Knox Group: Newala Limestone, Longview Limestone, Chepultepec Dolomite, Copper Ridge Dolomite	Range from siliceous dolostone in the lower part to fine- to coarse-grained limestone in the upper part	Abundantly water bearing. Solution channels supply springs and drilled wells. Water may be moderately hard. The cherty subsoil of the Copper Ridge Dolomite forms an excellent ground-water reservoir. Copper Ridge Dolomite is subject to Ridge Dolomite is subject to having excessive iron concentrations.
	Cambrian		800-1,000	Conasauga Formation	Interbedded shale, limestone, sandstone in Calhoun and St. Clair Counties; with dolostone, shale and limestone in Jefferson and Shelby Counties	The interbedded limestones and sandstone may be highly productive while the dolomite and shales yield little water.
			1,000	Rome Formation	Interbedded sandstone, siltstone and shale	Yields moderate amounts of water of variable quality.
			500-1,000	Shady Dolomite	Sandy dolostone and dolomitic limestone	Aquifer yields abundant calcium and magnesium bicarbonate waters of moderate hardness.
			1,300+	Chilhowee Group: Weisner Quartzite, Wilson Ridge Formation	Fluvial to shallow marine sandstones, conglomerates and mudstones	Water bearing, dependant upon fractures which may yield abundant supplies for domestic use.
	Carboniferous to Cambrian		30,000+	Hillabee Chlorite Schist	Pale-green to light-brown chlorite schist	Generally considered an aquifer adequate only for domestic use.
				Talladega Group: Able Gap Formation	Thick lenses of black siliceous slate, similar to Lay Dam Formation	
				Talladega Group: Lay Dam Formation	Coarse clastics, such as arkoses, quartzites, conglomerates and gray-wackes to the southwest and finer grained siltstone, sandstone, and limestone to the northeast	

Table 2.-- Records of public water supply wells and springs 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.

Water-bearing unit: Ppv, Pottsville Formation; Mb, Bangor Limestone; Mfp, Fort Payne chert; Dst, Talladega Group; Oln, Little Oak and Lenoir Limestones; Onl, Newala and Longview Limestones; On, Newala Limestone; Olv, Longview Limestone; Oc, Chickamauga Limestone; Ou, Ordovician Limestones, undifferentiated; OЄs, Sylacauga Marble; OЄK, Knox Group, undifferentiated; OЄcc, Chepultepec and Copper Ridge Dolomites; OЄcr, Copper Ridge Dolomite; OЄk, Ketona Dolomite; OЄu, Chepultepec, Copper Ridge, and Ketona Dolomites, undifferentiated; Єbf, Brierfield Dolomite; Єc, Conasauga Formation; Єr, Rome Formation; Єs, Shady Dolomite; Єch, Chilhowee Group; Єu, Cambrian, undifferentiated.

Altitude of land surface: Altitudes given in feet above sea level from topographic map or determined by aneroid barometer; altitudes given in feet and tenths determined by instrumental leveling.

Method of lift: C, centrifugal; F, flowing; J, jet; N, none; S, submersible; T, turbine.

Use of well: P, public water supply; U, unused; I, industrial.

* Local well number, "well no. 3" as referred to by the cities and towns.
** Alphanumeric well numbers, "B-5" as used in Geological Survey of Alabama reports.

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
1	333457086240801	Camp Sumatauga	--	370	--	--	800	--	--	-	P	*Well no. 3.
2	333458086235201	Camp Sumatauga	C.R. Killian	286	6	--	830	--	--	T	U	Cased 6 in., 0 to 90 ft.
3	333513086234601	Camp Sumatauga	Graves 1972	160	6.25	--	780	--	--	-	P	Well no. 2. Cased 6.25 in., 0 to 100 ft. Screened 6.25 in., 100 to 160 ft.
4	33351308623401	Camp Sumatauga	Graves 1972	175	6.25	--	780	--	--	-	P	Well no. 1. Cased 6.25 in., 0 to 93 ft. Screened 6.25 in., 93 to 175 ft.
5	335715086112901	Town of Steele	1950's	100	--	--	595	--	--	T	P	Well no. 1.
6	335630086121401	Town of Steele	C.D. Pace 1954	250	8	OЄu	690	40	3-25-54	T	P	Well no. 2. B-5**. Cased 8 in.: 0 to 165 ft. Open hole 8 in.: 165 to 250 ft. Drawdown 60 ft after 24 hrs pumping 150 gal/min (1954).
7	334914086443201	Town of Trafford	H.W. Peerson 1950	300	8 6.6	Ppv	480	--	--	N	U	B-1. Casing 8 in.: 0 to 42 ft. Open hole 42 to 300 ft. Drawdown 65 ft after 5 hrs pumping 120 gal/min (1954).
8	334630086282201	Town of Springville	--	--	--	OЄu	710	--	--	F	P	Spring (actually two springs together). 900 gal/min measured (1961).
9	335016086150401	Town of Ashville	--	--	--	OЄu	565	--	--	F	P	Spring. K-3. 670 gal/min measured 1961.
10	335058085513401	Town of Alexandria	--	--	--	Oln	580	--	7-10-85	F,T	P	Spring. F-68. Also known as Seven Springs. Calhoun County Water Authority measured flow 2,000 gal/min.
11	335052085452501	City of Jacksonville	--	--	--	OЄk	627	--	7-15-85	F,T	P	Spring. L-1. Also known as Germania Springs. Estimated flow 2,000 gal/min.

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
12	334851085455201	City of Jacksonville	--	--	--	O€k	651	--	7-15-85	F,T	P	Spring. L-21. Also known as Big Spring. Water supply for city of Jacksonville. Estimated flow 900 gal/min.
13	334556085430401	Girl Scouts of America	--	--	--	€ch	1,140	--	8-21-85	F	P	Spring. K-56. Supplies Girl Scout Camp. Estimated flow 20 gal/min.
14	334453085465201	U.S. Army	--	--	6	€r	720	3.7	7-10-85	S	P	Reilly Lake Fort McClellan
15	334456085484001	Town of Weaver	H.W. Peerson	300	8	€r	778	--	7-09-85	T	U	S-6. Abandoned Weaver, Ala. well. Not measured; no access for tape.
16	334509085491401	Town of Weaver	Carl Pace	409	8	€c	719	--	--	T	P	S-8. Supplies Weaver Ala. system. Not measured; well in use.
17	334435085491901	Ray McMinn	Carl Pace	95	6	€c	711	--	8-02-85	S	P	S-12. Supplies trailer park. Not measured.
18	334447085494801	Town of Weaver	Graves	125	12	€c	720	--	7-09-85	T	P	Supplies Weaver, Ala. system. Not measured; well in use.
19	334258085515501	Emmett Carroll		--	6	O€k	670	64.1	7-24-85	S	P	Supplies nightclub.
20	334333086073501	Town of Ragland	H.W. Peerson 1955	300	8 6	--	490	--	--	T	P	Well no. 2. Cased 8 in.: 0 to 26.5 ft. Open hole 8 in.: 26.5 ft to 245 ft. 6 in.: 245 to 300 ft. Supplementary well
21	334312086081001	Town of Ragland	Dodson 1977	300	8 6	--	500	36.5	6-01-87	T	P	Well no. 1. S-17. Cased 8 in.: 0 to 40 ft. 6 in.: 40 to 140 ft. Open hole 6 in.: 140 to 300 ft.
22	334441086083701	Town of Ragland	H.W. Peerson	305	8	Ppv	492	8	12-07-55	-	U	Abandoned. S-8. Cased 8 in.: 0 to 26.5 ft. Drawdown 80 ft after 24 hrs pumping 100 gal/min (1955).
23	334425086084601	Town of Ragland	--	--	--	--	490	--	--	-	U	Abandoned.
24	334433086084501	Town of Ragland	H.W. Peerson	320	8	Ppv	500	6	12-28-55	-	U	Abandoned. S-7. Cased 8 in.: 0 to 25 ft. Drawdown 84 ft after 24 hrs pumping 130 gal/min (1955).
25	334242086091601	Town of Ragland	Dodson	--	--	--	525	--	--	-	P	TW 79-4. S-18.
26	334058086214801	Town of Odenville	--	--	--	--	700	30	3-01-87	-	P	Well no. 4. Supplementary well (1987).
27	333942086231101	Town of Odenville	--	--	--	--	745	--	--	-	P	Well no. 5.
28	333630086271201	Town of Odenville	--	--	--	--	700	--	--	-	P	Well no. 3. Cooks Springs

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
29	334052086234301	Town of Odenville	R.M. Towns	200	10	Oln	730	25	1960	T	U	Well no. 1. P-12. Reported yield about 100 gal/min (1963). Supplementary well (1987).
30	334034086235601	Town of Odenville	H.W. Peerson 1968	444	8	--	720	--	--	-	U	Well no. 2. Cased 8 in.: 0 to 50 ft. Supplementary well (1987).
31	334057086283901	Town of Margaret	--	--	--	--	660	--	--	-	P	
32	333942086325101	Roddams Trailer Park	--	--	6	--	760	--	--	N	U	Well no. 1.
33	333924086352901	City of Trussville	--	--	--	--	740	--	--	-	P	Well no. 7.
34	333844086360601	City of Trussville	Graves	219	16 14 8	Mb	750	17.5	5-20-69	T	P	Well no. 5. Casing 16 in., 0 to 112 ft; 14 in., 102 to 138 ft; 8 in., 132 to 170 ft.
35	333758086354201	Town of Tussville	H.W. Peerson 1936	186	14 12 10 6	Mb	725	42	1936	T	P	Well no. 1, L-5 Casing 14 in., 0 to 62 ft; 12 in., 62 to 108 ft; 10 in., 108 to 132 ft; 6 in., 132 to 186 ft. Drawdown 22.5 ft after 24 hrs pumping 183 gal/min (1936).
36	333757086354201	City of Trussville	H.W. Peerson 1950	320	10 8 6	--	730	29	1950	T	P	Well no. 2. Casing 10 in., 0 to 60 ft; 8 in., 0 to 160 ft.; 6 in., 0 to 254 ft.
37	333757086354001	City of Trussville	H.W. Peerson 1960	158	16 10	Mb	720	47	4-29-60	T	P	Well no. 3. L-4. Casing 16 in., 0 to 40 ft; 10 in., 0 to 84 ft.
38	333802086355001	City of Trussville	--	--	--	--	725	--	--	-	-	Well no. 4.
39	333849086362901	City of Trussville	--	--	--	--	765	--	--	-	P	Well no. 6.
40	333845086462201	Town of New Castle	--	450	12 6	Ppv	520	--	--	T	P	Casing 12 in., 0 to 50 ft; 6 in., 0 to 50 ft.
41	333220086423101	City of Irondale	Graves	235	6	Mfp	755	--	--	T	P	Well no. 4. Reported pumping 260 gal/min (1987).
42	333227086422201	City of Irondale	Graves	330	6	Mfp	740	--	--	T	P	Well no. 4. Reported pumping 625 gal/min (1977).
43	333224086422201	City of Irondale	H.W. Peerson 1949	250	10	Mb	750	28	8-02-49	T	P	Well no. 1. W-4. Casing 10 in., 0 to 60 ft; Sl 10 in., 166 to 250 ft; open hole. Reported pumping 175 gal/min (1977)
44	333216086421301	City of Irondale	H.W. Peerson 1954	312	10 8	Mb	720	20	9-03-54	T	P	Well no. 2. W-7. Casing 10 in., 0 to 125.4 ft; 8 in., 0 to 209 ft; Sl 8 in. 125 to 200 ft; slotted. Reported pumping 330 gal/min (1977).

Table 7.--Records of public water supply wells and springs in the study area--Continued

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
45	333235086415401	City of Irondele	H.W. Peerson 1964	225	16 12 8	Mb	725	15	1-01-64	-	U	Well no. 3. W-5. Casing 16 in., 0 to 65 ft; 12 in., 0 to 95 ft; 8 in., 0 to 164 ft; SI 10 in., 90 to 160 ft; perforated.
46	333302086413501	Southern Railway	--	--	--	--	730	--	--	-	-	Well no. 2.
47	333307086412901	Southern Railwey		--	--	--	730	--	--	-	-	Well no. 1.
48	333114086333501	City of Leeds	Graves	301	16 12	Ou	660	36.5	1-10-83	T	P	Well no. 3. Casing 16 in., 1 to 227 ft; 12 in., 2 to 227 ft; SI 12 in., 227 to 280 ft; open hole.
49	333218086335001	City of Leeds	--	--	--	Ou	625	--	--	T	P	Rowan Spring. Reported pumping 3/4 Mgal/d (1987).
50	333236086313701	City of Leeds	Graves	195	--	Mfp	660	60.5	7-05-72	T	P	Well no. 1. Casing 18 in., 0 to 150 ft; 12 in., 150 to 170 ft; Screened 10 in., 170 to 175 ft; Jackson Screen.
51	333240086314001	City of Leeds	Graves	245	12 8	Mfp	660	32.5	6-26-72	T	P	Well no. 2. Y-2. Casing 12 in., 0 to 140 ft; 8 in., 135 to 155 ft; Screened 8 in., 155 to 195 ft; liner. Reported pumping 1,000 gal/min (1977).
52	333314086311901	City of Leeds	Dependable	303	18 12	Mfp	720	96.29	7-17-84	T	P	Well no. 4. Casing 18 in., 0 to 210 ft; 12 in., 0 to 210 ft; Screened 10 in., 205-235 ft, perforated; 8 in., 230 to 300 ft; open hole.
53	333450086292701	City of Leeds	--	--	--	OCK	670	--	--	T	P	Weems Spring. Reported pumping 1 Mgal/d (1987).
54	333659086170001	Town of Wattsville	Graves	--	--	--	610	--	--	-	P	Well no. 2.
55	333740086165001	Town of Wattsville	Graves	--	--	--	610	31.94	3-01-87	-	P	Well no. 1. Supplementary well (1987).
56	333420086163801	Pell City	H.W. Peerson 1964	300	--	--	540	--	--	T	P	Well no. B. Casing 6 in., 0 to 140 ft.
57	333416086161701	Pell City	H.W. Peerson 1964	231	12 8	--	545	--	--	T	P	Well no. E. Cased 12 in., 0 to 132 ft; 8 in., 0 to 132 ft. Screened 8 in., 132 to 209 ft.
58	333552086145901	Pell City	Graves 1977	--	10	--	490	25	12-86	T	P	Well no. A. Cased 10 in., 0 to 100 ft.
59	333433086162001	Pell City	H.W. Peerson 1964	253	12 8	--	537	--	--	-	U	Well no. D. LL-11, Cased 12 in., 0 to 101 ft; 8 in., 0 to 120 ft. Screened 8 in., 120 to 253 ft. Supplementary well (1987).

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
60	333452086161701	Pell City	--	--	--	--	600	--	--	N	U	Well no. C. Abandoned, sandy.
61	333640086124601	Town of Riverside	Graves 1977	--	12	--	510	--	--	-	P	Well no. 2.
62	333633086124201	Town of Riverside	Graves 1977	--	12	--	500	--	--	-	P	Well no. 1.
63	333614086090001	Town of Lincoln	Graves	175	10	O€k	498	27 32	9-24-72 1-15-86	T	P	AA-02. Cased 10 in., 0 to 45 ft. 260 gal/min. Drawdown of 12 ft after pumping 24 hrs at 503 gal/min (1972).
64	333642086065001	Town of Lincoln	Carl Pace	260	8	O€k	529	60.45	1-14-86	T	P	Well no. 2. C-13. Cased 8 in., 0 to 90 ft. 300 gal/min (1962).
65	333352086053001	Talladega Industrial Park	Graves 1985	349	10	O€k	525	53.76 31.2	1-23-86 3-11-87	T	P	Well no. 3. Casing 12.75 in., 0 to 147 ft. Drawdown of 57 ft after pumping for 30 hrs at 703 gal/min.
66	333437D86031901	Talladega Industrial Park	U.S. Base	126	8	--	530	45	6-02-87	T	P	Well no. 1. Reported pumping 250 gal/min (1987).
67	333437086031601	Talladega Industrial Park	Graves	300	6	--	530	11.2 42	3-87 6-02-87	T	P	Well no. 2. Cased 10 in., 0 to 100 ft; 6 in., below. Reported pumping 250 gal/min (1987).
68	333610085553301	City of Anniston	--	--	--	€s	590	--	--	F,T	P	Spring. W-12. Supplies city of Anniston. USGS gaging station. Also known as Coldwater Spring.
69	333603085504401	W.H. McClean	Dingler	80	6	€ch	660	41.2	8-01-85	S	P	Supplies Don Lee Trailer Park.
70	333918085444301	Camp Lee United Methodist Church	Carl Pace	65	6	€s	805	6.7	7-25-85	S	P	Supplies Camp Lee.
71	333854085400301	Spring Valley Foods	Adams & Massey	190	6	€s	750	--	8-21-85	S	P	Well no. 2. Supplies processing plant.
72	333853085400401	Spring Valley Foods	Adams & Massey	201	6	€s	760	60.8	8-21-85	S	P	Well no. 1. Supplies processing plant.
73	333142085571401	City of Munford	Carl Pace	275	6	O€k	645	106.33 100.32 106.73 120	1-16-80 4-23-85 10-24-85 3-10-87	N	U	Well no. 1. F-7. Cased 6 in., 0 to 120 ft. Reported pumping 75 gal/min (1977)/
74	333120085572001	City of Munford	Carl Pace 1960	300	8	O€k	685	135 95.68	1-15-86 3-09-87	T S	P P	Well no. 2. G-12. Cased 8 in., 0 to 100 ft. Reported pumping 75 gal/min (1977).
75	332853085551401	Camp Mac	--	200	--	--	760	--	--	-	P	Well no. 1.
76	332851085551101	Camp Mac	--	240	--	--	760	--	--	-	P	Well no. 2.
77	332850085550701	Camp Mac	--	150	--	--	780	--	--	-	P	Well no. 3.

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
78	332447086031001	Town of Talladega	Carl Pace 1957	360	10	OCk	686	35 109.62	1957 1-23-86	T	P	Black Snake well. Casing 10 in., 0 to 130 ft; 6 in., 150 to 169 ft. 350 gal/min. Reported pumping 350 gal/min (1987).
79	332639086053601	Town of Talladega	Graves	380	8	--	600	75	6-02-87	T	P	Well no. 5. Bingham Street well. Reported pumping 450 gal/min (1987).
80	332643086054701	Town of Talladega	Carl Pace 1955	203	10	Cc	580	29.09	3-11-87	T	P	Well no. 3. Sloan Avenue well. M-9. Cased 10 in., 0 to 202 ft. Drawdown of 27 ft pumping at 1,100 gal/min.
81	332628086060001	Town of Talladega	--	--	10	Cu	560	43 26	6-02-87	T	P	Well no. 2. Harmon Park well. Reported pumping 625 gal/min (1987).
82	332615086070401	Town of Talladega	Graves	195	12	Cu	498	76.86 120	4-20-77 1-23-86	T	P	Well no. 4. Grant Street well. M-04. Cased 12 in., 0 to 148 ft. Reported capacity of 850 gal/min (1986).
83	332613086091401	Griffin Park	--	--	--	--	500	71.5	3-87	-	P	Well no. 1.
84	332613086092901	Griffin Park	--	--	--	--	520	71.15	3-87	-	P	Well no. 2.
85	332911086061101	Jackson Trace Estates	--	--	--	--	700	--	--	-	P	
86	333209086123701	Mays Bend Water Cooperative	H.W. Pearson 1965	186	14 10 8	--	545	--	--	T	P	Cased 14 in., 0 to 52 ft; 10 in., 0 to 175 ft; screened 8 in., 175 to 186 ft.
87	333101086132801	River Terrace Estates	--	--	--	--	550	--	--	-	P	Briarwood well.
88	333050086133401	River Terrace Estates	--	--	--	--	565	--	--	-	P	Magnolia well.
89	332931086140801	Lake Front Estates	Graves	--	--	--	560	--	--	-	P	
90	332901086152101	Lake Front Estates	Graves	--	--	--	500	--	--	-	P	
91	332650086161601	Camp Cosby	Graves	--	--	--	490	--	--	-	P	Well no. 1. Reported pumping 250 gal/min in summer (1987).
92	332647086162301	Camp Cosby	Graves	--	--	--	520	--	--	-	P	Well no. 2.
93	332633086174001	Alpine Bay	--	170 300	12	--	510	50	6-01-87	T	P	Cased 12 in., 0 to 300 ft; 16 in., 0 to 60 ft. 800 gal/min.
94	332828086165201	Country Club Estates	--	300	6	--	500	--	--	-	P	
95	332833086203001	Town of New London	Graves 1981	210	16 12 8	--	500	--	--	-	P	

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
96	332550086255101	Graves/ Sterrett-Vandiver Water	Graves 1982	300	9	--	550	33.25	10-03-82	T	P	Well no. 2. Cased 9 in., 0 to 9 ft; open hole, 9 to 300 ft. 140 gal/min test.
97	332541086255601	Graves/ Sterrett-Vandiver Water	Graves	175	8 6	--	540	31.5	8-15-73	T	P	Well no. 1. Cased 8 in., 0 to 170 ft. Reported pumping 200 gal/min (1987).
98	33234108624401	Vincent Water Works Board	--	--	--	Oni	435	--	--	F,C	P	Spring, G-2. Reported 715 gal/min flow (1968).
99	331941086252601	Harpersville Water Board	Graves 1980	210	12	Oni	465	--	7-22-80	T	P	Test well no. 10. Main well. Cased 12 in., 0 to 102 ft; open hole, 102 to 210 ft. Reported pumping 150 gal/min (1987).
100	332030086261701	Harpersville Water Board	-- 1960	92	6	Oni	455	17	1960	S	P	G-10. Supplemental well. Reported pumping 60 gal/min (1960).
101	332104086273901	Westover Water and Fire Protection Authority	Associated Drillers 1968	314	10	Oni	485	34.4 45	7-22-68 3-87	T	P	Well no. 1. Cased 10 in., 0 to 20 ft. 280 gal/min, 19.5 ft drawdown, 2 hr test (1970).
102	332156086344801	Westover Water and Fire Protection Authority	Graves 1979	300	6.25	--	525	3.16	1-15-79	T	P	Well no. 2. Cased 6.25 in., 0 to 53 ft. Drawdown 22 ft; pumping 200 gal/min (1979).
103	332457086395701	State of Ala. Highway Dept.	Ala. Highway Dept. 1968	285	6	Ppv	630	30.5	2-25-68	S	U	Rest area on Highway 280. Cased 6 in., 0 to 210 ft; open hole, 210 to 285 ft. Rest area closed (1986).
104	332228086415901	Double Oak Mountain State Park	--	--	--	--	--	--	--	-	P	Fish camp well - State lake Supplies to Pelham. Reported pumping 275 gal/min (1987).
105	332201086425201	Double Oak Mountain State Park	--	--	--	--	530	--	--	-	P	Test well - park use only.
106	332109086502701	Mars Hill Trailer Park	James McCarty	145	6	--	460	--	--	-	P	Well C.
107	332106086503401	L. Hollis Trailer Park	--	--	--	--	480	--	--	-	P	Well no. 2.
108	332107086503601	L. Hollis Trailer Park	--	350	--	--	480	--	--	-	P	Well no. 1.
109	332111086503401	L. Hollis Trailer Park	James McCarty	--	--	--	480	--	--	-	P	Well no. 3.
110	332114086503101	Mars Hill Trailer Park	James McCarty	245	--	--	500	--	--	J	P	Well B. Supplementary well (1987).

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
111	332113086503301	Mars Hill Trailer Park	James McCarty	300	6	--	500	--	--	S	P	Well A. Supplementary well (1987).
112	332243087010201	Hercules Plant	H.W. Peerson 1954	300	8	Oc	460	10	1955	T	I	KK-1.
113	331822087001501	Roupes Valley Water and Fire Protection Authority	--	87	--	--	635	50	3-20-87	-	-	Well no. 3
114	331706087015201	Roupes Valley Water and Fire Protection Authority	--	--	14	--	554	81.8	5-01-75	S	U	Well no. 2. Casing 14 in., 0 to 140 ft; 10 in., 0 to 210 ft; Sl 10 in., 180 to 210 ft perforated.
115	331657087020001	Roupes Valley Water and Fire Protection Authority	Graves 1973	142	16 10 8	--	550	89.9	12-26-76	T	P	Well no. 1. Casing 16 in., 0 to 100 ft; 10 in., 0 to 140 ft; Sl 8 in., 138 to 168 ft perforated.
116	331525086511401	City of Helena	Graves	80	--	--	440	50	6-05-87	T	P	Well no. 2. Reported pumping 80 gal/min (1987).
117	331630086503001	City of Helena	Graves	160	12	--	455	90	6-05-87	T	P	Well no. 3. Reported pumping 325 gal/min (1987).
118	331628086492701	City of Helena	Graves 1987	200	16	--	505	80	6-05-87	T	P	Well no. 4. New well, not yet in production.
119	331742086501401	City of Helena	H.W. Peerson 1951	400	8	O€k	420	2.4	6-20-68	T	P	Well no. 1. M-7. Cased 8 in., 0 to 65 ft. Reported pumping 180 gal/min (1987).
120	331850086483601	City of Pelham	H.W. Peerson	--	--	--	440	--	--	T	P	Cross Creek Well.
121	332014086473701	City of Pelham	H.W. Peerson 1963	205	10	O€cr	490	65	1968	T	P	Indian Hills. J-11. Cased 10 in., 0 to 149 ft. Drawdown 10 ft after 24 hrs pumping 270-300 gal/min (1963).
122	332007086452401	City of Pelham	State of Alabama	--	--	--	480	--	--	-	P	Indian trails.
123	331859086470601	City of Pelham	Graves 1982	202.46	12	--	565	--	--	T	P	Obley Well. Cased 12 in., 0 to 140 ft.
124	331654086491601	City of Pelham	H.W. Peerson 1965	145	12 8	On	460	19	11-30-65	T	P	King Valley Well. M-8. Cased 12 in., 0 to 90 ft; 8 in., 90 to 145 ft. Reported 300+ gal/min capacity (1968).
125	331432086493401	City of Alabaster	H.W. Peerson 1957	74	8	On	480	15.0	1-01-57	T	P	Well no. 1. W-1. Cased 8 in., 0 to 54 ft; open hole, 8 in., 54 to 74 ft. Reported pumping 160 gal/min (1980).

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
126	331420086493701	City of Alabaster	H.W. Peerson 1964	179	12 10	Olv	600	33.0	7-02-64	T	P	Well no. 2. W-2. Cased 12 in., +5 to 51 ft; 10 in., +5 to 62 ft; open hole below. Drawdown 24 ft after 24 hrs pumping 450 gal/min (1964). Reported pumping 300 gal/min (1980).
127	331356086495201	City of Alabaster	Feguson and H.W. Peerson 1945	606	6	--	500	--	--	-	P	Well no. 3. W-17 Cased 6 in., 0 to 100 ft.
128	330630086514301	University of Montevallo	Graves 1977	305	16 10	--	475	75	12-02-77	T	P	Used mostly for irrigation. Cased 16 in., 0 to 80 ft; 10 in., 0 to 136 ft.
129	330609086514501	University of Montevallo	H.W. Peerson 1962	157	121 10	Ꞓbf	420	56	8-13-62	T	P	AA-8. Cased 12 in., 0 to 50 ft; 10 in., 0 to 80 ft. Reported pumping 300 gal/min (1987).
130	330512086522201	Town of Wilton	--	--	--	OꞒk	400	--	--	C	P	Spring. JJ-2. Reportedly pumped at 200 gal/min, 4 to 5 hrs per day (1980).
131	330540086520401	City of Montevallo	Graves 1986	425	16 10	--	435	51.35	4-87	T	P	Test well no. 2. Tested 750 gal/min. Reported pumping 400 gal/min (1987).
132	330557086515801	City of Montevallo	--	--	--	Ꞓbf	390	--	--	T	P	Shoal Creek Spring. AA-7. Reported pumping 600 gal/min (1987).
133	330628086505901	City of Montevallo	Graves 1983	375	14	--	460	93.0	4-87	T	P	Well no. 1. Tested 750 gal/min. Reported pumping 400 gal/min (1987).
134	330831086473101	City of Calera	H.W. Peerson 1966	100	12 10	Ꞓbf	495	36	9-19-66	T	P	Well no. 2, stand by well. BB-4. Cased 12 in., 0 to 56 ft; 10 in., 52 to 79 ft. Reported pumping 450 to 500 gal/min (1987).
135	330945086481401	City of Calera	Graves	200	14	--	485	25	3-17-87	T	P	Well no. 1. Cased 14 in., 0 to 87 ft. Reported pumping 830 gal/min (1987).
136	331402086290301	Wilson-ville Water System	H.W. Peerson 1939	125	10 8	OꞒcc	435	16.1	7-30-68 6-24-81	T	P	Well no. 1. T-1 Cased 10 in., 0 to 22 ft; 8 in., 0 to 85 ft 10 in. Drawdown 9.24 ft while pumping 183 gal/min (1941).
137	331342086284501	Wilson-ville Water System	Virginia Well and Supply 1959	500	10	Onl	435	7.8	7-30-68 6-24-81	T	P	Well no. 2. S-1 Cased 10 in., 0 to 22 ft. Drawdown 240 ft after 18 hrs pumping 90 gal/min (1959).

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
138	331645086210701	Town of Childersburg	H.W. Peerson 1971	310	10	OЄk	405	12.43	2-04-86	T	P	Well no. 4. Yarbrough Trailer Court well. V-08. Cased 10 in., 0 to 275 ft; open hole, 275 to 310 ft.
139	331655086203401	Town of Childersburg	Virginia Well and Supply Co. 1959	425	12 10	OЄk	401	--	--	T	P	Well no. 1. V-10. Cased 12 in., 0 to 52 ft; 10 in., 52 to 71.3 ft. Drawdown 46 ft after 48 hrs pumping 450 gal/min (1962). Not in use in 1986.
140	331719086200601	Town of Childersburg	Graves	200	18 12	OЄk	425	39.3 41.39	4-04-80 2-04-86	T	P	Well no. 5. Killough Height well. V-07. Cased 18 in., 0 to 63 ft; 12 in., 63 to 77 ft. Drawdown 39 ft after 72 hrs pumping 300 gal/min (1986).
141	331756086205301	Town of Childersburg	Graves	300	6	OЄk	455	31.7 32.95	10-30-75 2-04-86	T	P	Well no. 2 or Pine Crest well. V-06. Cased 6 in., 0 to 45 ft. Drawdown 9 ft after 72 hrs pumping (1986).
142	331700086123501	Town of Sycamore	Graves 1983	198	10	--	560	--	10-17-83	-	P	Well no. 2. Cased 10 in., 0 to 160 ft; open hole, 160 to 198 ft.
143	331529086122601	Town of Sycamore	Graves	212	8	--	500	--	--	-	P	Well no. 1. Cased 8 in., 0 to 60 ft.
144	331248086144001	City of Sylacauga	Graves	--	12	OЄk	500	31.56 58.5	4-30-69 2-20-86	T	P	Country Club well. AA-01
145	331017086150901	Avondale Mills	--	--	--	--	545	--	--	-	P	Ice plant well.
146	330959086150801	City of Sylacuga	H.W. Peerson 1953	388	12	OЄs	560	33 105	2-05-54 2-20-86	T	P	Park well. AA-22. Cased 12 in., 0 to 137 ft. Drawdown 100 ft after 72 hrs pumping 900 gal/min (1954).
147	330942086145601	City of Sylacauga	Graves	--	--	OЄs	580	114.5	2-20-86	T	P	Main Avenue well. AA-02.
148	330711086171001	Lake Tate Assoc.	Carl Pace	200	6	Dst	798	72	2-24-86	T	P	Cased 6 in., 0 to 160 ft.
149	331102086161301	Avondale Mills		560	4	OЄs	510	10	10-22-28	-	P	Walco well. AA-13. Pumped at 100 gal/min. Not in use in 1987.
150	331317086192201	Town of Childersburg	H.W. Peerson 1969	300	8 6	OЄk	500	40 76.5	9-01-82 2-04-86	T	P	Well no. 3. Cased 8 in., 0 to 227 ft; screen 6 in., 202 to 277 ft.
151	330720086322801	Columbiana Water Works	Southern Supply 1968	219	10	On	435	0.4 18	8-21-68 3-87	T	P	Well no. 1. DD-5. Cased 10 in., 0 to 93 ft. Drawdown 7.5 ft after 24 hrs step test with final rate of 825 gal/min (1968).

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

Well no.	Geographic coordinate number	Well owner	Driller and year completed	Depth of well (feet)	Diameter of well (inches)	Water bearing unit	Altitude of land surface (feet)	Water level: Above or below land surface (feet)	Water level: Date of measurement	Method of lift	Use of site	Remarks
152	330719086322401	Columbiana Water Works	H.W. Peerson 1968	219	16 12	On	435	3.5	8-21-68	T	P	Well no. 2. DD-3. Cased 16 in., 0 to 19 ft; 12 in., 0 to 93 ft. Drawdown 3.5 ft after 24 hrs step test with final rate of 400 gal/min (1968).
153	330404086341801	Columbiana Water Works	Graves 1979	250	14	--	440	37	6-04-87	T	P	Well no. 3. Cased 14 in., +2 to 76 ft. Reported pumping 225 gal/min (1979).
154	330354086341601	Columbiana Water Works	Graves 1982	300	12	--	455	37	3-87	T	P	Well no. 4. Cased 12 in., +2 to 122 ft; uncased 12 in. in rock, 122 to 199 ft; uncased 6 in. in rock, 199 to 300 ft. Reported pumping 300 gal/min (1982).