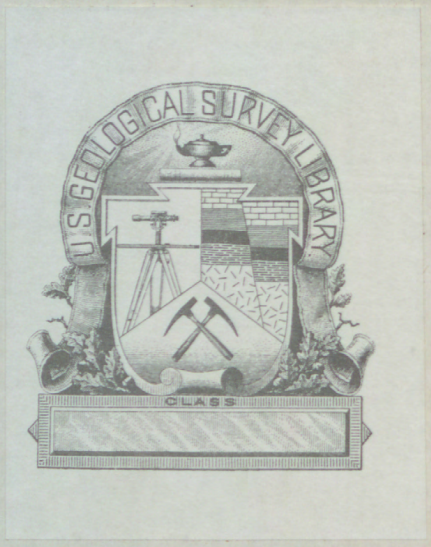
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MANUSCRIPT ROUTING SHEET (WATER RESOURCES DIVISION)

AUTHOR(S): Davis, Marvin E., Sanford, Thomas H., Jr., and Jefferson, Patrick O.

DIVISION NO.: 218-D-71

PROJECT NO.: Ala-6-C

TITLE: Water availability and geology of Hale County, Alabama

NO. PAGES (Incl. tables): 151

NO. ILLUSTRATIONS: 10

(Check one) [X] Final Rept. [ ] Progress Rept. [ ] Abstract [ ] Other

TYPE OF PUBLICATION (WSP, HA, etc.): Geological Survey of Alabama Map Series ~~Open file 75-452~~

TABLES No. 6 No. Pages 103

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WATER AVAILABILITY AND GEOLOGY OF HALE COUNTY, ALABAMA

By Marvin E. Davis, Thomas H. Sanford, Jr., and Patrick O. Jefferson

ABSTRACT

Geologic units that underlie and crop out in Hale County include the Tuscaloosa Group, Eutaw Formation, and Selma Group of Late Cretaceous age, and terrace deposits and alluvium of Quaternary age. The Cretaceous units dip southwest about 35 feet per mile and strike northwest. They consist chiefly of deposits of sand, gravel, chalk, and clay.

Potential sources of large supplies of ground water are major aquifers in the Coker, Gordo, and Eutaw Formations; expected yields are 1.5 mgd (million gallons per day) per well. Aquifers in the Eutaw Formation are the shallowest source of ground water in most of the county.

The average annual runoff originating in Hale County is about 17 inches or 0.82 mgd per square mile. The Black Warrior River, largest potential source of surface water in the county, has an average flow of 5,800 mgd at gaging station 2-4660 near Eutaw and a median annual 7-day low flow of 349 mgd. Elliotts, Fivemile, Big Brush, and Big Prairie Creeks also are potential sources of surface water. These creeks have average flows ranging from 35 to 210 mgd and median annual 7-day low flows in excess of 2 mgd at their lower reaches.

Water from most streams in the county contains less than 10 mg/l (milligrams per liter) chloride and ranges from soft to hard. The mineral content of water from Big Brush Creek is affected by salty water from a flowing well. Ground water from the major aquifers contains less than 250 mg/l chloride, except in the extreme northwestern and west-central parts of the county, and ranges from soft to very hard. Water from the aquifers generally contains iron in excess of 0.3 mg/l except in the southern part of the county.

Water use in Hale County in 1968 was about 3.9 mgd, most of which was ground water. Less than 1 ~~one~~ percent of the potential water resources is being utilized.

INTRODUCTION

A statewide study of the geology and availability of water in Alabama is being conducted by the U. S. Geological Survey in cooperation with the Geological Survey of Alabama. The study is designed to map the surface geology and describe and appraise the availability of surface water and ground water of seven areas corresponding generally to river basins. The work is done and the results published on the basis of county units. The boundaries of the seven areas and the status of the studies in these areas are shown in figure 1.

Figure 1 (caption on next page) belongs near here.

This report is for Hale County and describes the general geology and water availability of part of the study area designated "Water Resources of Upper Tombigbee-Black Warrior River Basin (Ala-6-C)." The purpose of this report is to present (1) basic information on the water resources of Hale County in such a manner that a rapid appraisal and comparison with the water resources of other counties can be made by interested people, and (2) a geologic map at a scale of 1 inch equals 1 mile.

Figure 1. --Status of geologic and water-availability studies in Alabama.

Several published reports containing geologic and hydrologic information for Hale County are listed in the selected references. Previous investigations of the geology and water resources in the county have been confined to small specific areas or included in reconnaissance studies with several other counties. Reports by Peirce and Geurin (1959) and Peirce (1967) contain information on the low flow, average flow, and flow duration of selected streams and discussions of physical and climatological features of Hale County and all or part of 13 other counties in west-central Alabama. Those reports, however, are not presented pictorially so as to compare surface-water data in Hale County with other counties in Alabama.

PHYSIOGRAPHY AND DRAINAGE

Hale County is in the East Gulf Coastal Plain section of the Coastal Plain physiographic province (Fenneman, 1938, p. 65-83). The East Gulf Coastal Plain section is subdivided into physiographic belts extending diagonally across several counties in Alabama. The delineation of the belts is based on distinctive topographic features and generally represent erosional characteristics of outcropping geologic units. Two of these belts are represented in Hale County: the Fall Line Hills and the Black Prairie belt.

The Fall Line Hills belt is underlain by sand, clay, and gravel which, though poorly consolidated, are capable of supporting steep slopes. The topography is fairly rugged and dissected, especially near streams. The Black Prairie belt is represented by gently rolling hills of low relief, and receives its name from the black residual soil formed on underlying chalk beds. Low, flat flood plains border the Black Warrior River and flat to gently rolling terrace uplands extend eastward as far as Moundville and Havana.

The Black Warrior River flows southward along the western boundary of Hale County. Tributaries of the river drain all of the county except for a very small area near Gallion, where the drainage is to the Tombigbee River.

Most streams in Hale County head near the eastern boundary and flow westward to the Black Warrior River. Major streams which drain the Fall Line Hills in the northern part of the county are Elliotts, Gabriel, Fivemile, and Big Brush Creeks; the upper reaches of South Sandy Creek drain the northeast corner. The Black Prairie belt in the southern part of the county is drained by Big Prairie Creek and its tributaries.

GEOLOGY

General Geology

Geologic units that crop out in Hale County are shown on figure 2.

Figure 2 (caption on next page) belongs near here.

The units are of sedimentary origin and consist mainly of sand, gravel, chalk, and clay. These deposits range in age from Late Cretaceous to Quaternary. The Cretaceous Series includes, in ascending stratigraphic order: the Coker and Gordo Formations of the Tuscaloosa Group, the Eutaw Formation, and the Mooreville and Demopolis Chalks of the Selma Group. The Cretaceous deposits strike northwestward across the county and dip southwestward about 35 feet per mile. The total thickness of the Cretaceous deposits in Hale County ranges from about 400 feet in the northeastern part of the county to about 1,900 feet in the southwestern part. The Cretaceous units are overlain in places by sediments of Quaternary age which, on the geologic map, are subdivided into terrace deposits and alluvium (fig. 2).

Figure 2. --Geologic map of Hale County, Alabama.

Cretaceous System

Tuscaloosa Group

The Tuscaloosa Group consists of the Coker and Gordo Formations. The Coker is the lower formation of the Tuscaloosa Group and is the basal unit of the Upper Cretaceous Series in Alabama. The upper part of the Coker Formation is exposed in the upper reaches of South Sandy Creek in the northeastern part of Hale County. The Coker unconformably overlies Paleozoic rocks in the northeastern part of the county and Lower Cretaceous deposits in the remaining part (Boswell and others, 1965, fig. 8). The formation ranges in thickness from about 500 to 600 feet and consists of olive-gray to yellowish-gray mottled sandy clay, and yellowish-gray fine- to coarse-grained sand and gravel. The sands become progressively finer grained and less abundant toward the top of the formation where clay predominates. Massive beds of coarse-grained sand and gravel, as much as 200 feet in thickness, generally constitute the basal part of the formation.

The Gordo Formation, the upper unit of the Tuscaloosa Group, unconformably overlies the Coker Formation and crops out in a northwestward-trending belt across the northeastern part of the county. The formation ranges in thickness from about 300 to 350 feet in the subsurface and consists of light-gray to mottled red and gray thin-bedded to massive clay and light-tan to brown sand and chert gravel. Poorly sorted coarse-grained sand and chert gravel beds are prevalent in the lower part of the formation. The base of these sand and gravel beds is generally defined as the contact between the Coker and Gordo Formations. The upper part of the formation consists of laminated to massive clay and lenticular beds of sand.

Eutaw Formation

The Eutaw Formation, as mapped in Hale County, includes all beds between the Tuscaloosa Group and the Selma Group. In some counties in western Alabama the deposits between the overlying Selma Group and the underlying Tuscaloosa Group have been designated as the McShan Formation in the lower part and the Eutaw Formation in the upper part. However, because of the difficulty in determining the contact between the McShan and Eutaw Formations in the subsurface and at outcrops east of the Black Warrior River, these deposits were not differentiated in Hale County (fig. 2).

The Eutaw Formation crops out in a northwestward-trending belt 10 to 12 miles wide through the north-central part of the county. The formation is about 400 feet thick in the subsurface and consists of gray to yellowish-brown glauconitic sand, laminated clay, and dark-gray shale. A massive bed of fine- to medium-grained glauconitic sand, which contains fossil shells and locally a few thin beds of light-gray calcareous hard sandstone, comprises the upper part of the formation. The lower part of the formation consists of thin to massive beds of fine- to coarse-grained glauconitic sand interbedded with layers of light-gray to gray laminated clay. Locally, sand beds are thin or absent in the middle part of the formation.

Selma Group

The Mooreville Chalk rests disconformably on the Eutaw Formation and crops out in a northwestward-trending belt about 10 to 12 miles wide in the southern part of Hale County. The formation is about 300 feet thick and consists chiefly of dark bluish-gray fossiliferous silty chalk in the subsurface, which weathers to white or light yellowish gray at outcrops. Two or more beds of hard limestone, separated by soft silty clay, generally are present in the upper 15 to 50 feet of the formation. The basal 3 to 6 feet of the Mooreville Chalk in Hale County is generally composed of compact calcareous fossiliferous sandstone.

The Demopolis Chalk overlies the Mooreville Chalk and crops out in a belt as much as 4 miles wide just north of the southern boundary of Hale County. The unit in Hale County is less than 200 feet thick, which probably includes only the lower part; it is more than 400 feet thick southward in Marengo County. The Demopolis is composed mainly of a light-gray fossiliferous chalk in the subsurface and weathers to very light gray or white at outcrops. The basal part of the Demopolis Chalk consists of a thin bed of fossiliferous silty chalk that contains the index fossil Diploschiza cretacea. The basal beds are overlain by nearly pure chalk which, according to published analyses (Emmons and Hayes, 1904, p. 445-446), contains from 75 to 90 percent calcium carbonate ($CaCO_3$).

Quaternary System

Terrace deposits overlie older rocks along the flanks of the valley of the Black Warrior River and its major tributaries. These alluvial sediments were deposited by ancestral streams and, since their deposition, have been eroded into isolated, benchlike remnants that range in areal extent from a few acres to several square miles at different elevations above the flood plain. The deposits generally are less than 50 feet thick and consist of lenticular beds of poorly sorted gravel, sand, and clay.

Alluvium underlies the flood plains of major streams in Hale County. These deposits consist of lenticular beds of sand, gravel, clay, and silt, and generally are less than 50 feet thick.

The terrace deposits and alluvium merge near the edges of the flood plains and in places the contact between them cannot be distinguished because of lithological similarity; therefore, some of the lower terrace deposits are mapped as alluvium (fig. 3).

SOURCE AND OCCURRENCE OF WATER

The source of all fresh water in Hale County is precipitation which occurs mainly in the form of rain. Annual rainfall averages about 52 inches and is fairly evenly distributed throughout the year. Part of the rainfall runs off directly into streams; part is returned to the atmosphere by evapotranspiration; and part percolates downward to replenish underground reservoirs. The average annual runoff from the county is about 17 inches or 0.82 mgd (million gallons per day) per square mile.

The occurrence of ground water and the flow of streams in Hale County are governed largely by the physical characteristics of geologic units. A summary of the geologic units in the county, their water-bearing characteristics, and chemical quality of water obtained from aquifers are given in table 1.

AVAILABILITY OF WATER

Ground Water

The major aquifers that yield water to wells in Hale County are beds of sand in the Coker, Gordo, and Eutaw Formations. Terrace deposits and alluvium contain sand and gravel aquifers that yield small quantities of water for domestic and stock supplies; however, they may yield larger supplies. The Mooreville and Demopolis Chalks consist of relatively impermeable chalk and clay beds and generally do not yield water to wells; however, they have a significant influence on ground-water conditions because they confine water in underlying aquifers and retard downward percolation of water from overlying aquifers.

The evaluation of the availability of ground water in Hale County is based on records for 308 wells and 2 springs. Their locations are shown on figure 3 and the data collected are tabulated in table 2.

Figure 3 (caption on next page) belongs near here.

Figure 3. --Availability of ground water in Hale County, Alabama.

Water table conditions occur throughout Hale County except in lowland areas near the Black Warrior River and near streams in the outcrop area of the Mooreville and Demopolis Chalks (fig. 2). Where the aquifers are overlain by relatively impermeable beds of chalk, the water becomes confined and is under hydrostatic pressure exerted by the weight of water in the same aquifer at higher elevations. Water in a well tapping a confined aquifer will rise above the top of the aquifer and in lowland areas will flow at the land surface. Such aquifers are termed artesian and the imaginary surface to which the water will rise under artesian conditions is called the potentiometric surface. An artesian well will flow if the potentiometric surface is above the land surface. The area of artesian flow in Hale County is shown on figure 3.

Ground water generally moves from areas of recharge toward areas of discharge. The rate of movement is dependent on the hydraulic gradient and permeability of the aquifer. The direction of flow of ground water in Hale County is generally southwestward and downdip from areas of outcrop. Recharge to the aquifers is derived from rainfall on these outcrop areas within and immediately north of the county.

The generalized bases of the three major aquifers are shown by contour lines on figure 3. A subsurface profile of the southwestward-dipping aquifers and their potentiometric surfaces are shown on figure 4.

Figure 4 (caption on next page) belongs near here.

To estimate the depth below land surface necessary to drill to the base of a major aquifer, add the elevation above mean sea level of the proposed well site to the contour line nearest the site. For example, if the elevation of the well site is 200 feet above sea level and the nearest contour line for the aquifer is 600 feet below sea level, the depth necessary to reach the base of the aquifer would be 800 feet. A compilation of driller's and sample logs are given in table 3.

Figure 4.--Hydrogeologic section A-A', Hale County.

Sand and gravel beds in the Coker Formation comprise a major aquifer throughout Hale County. The formation ranges in thickness from 500 to 600 feet and is composed of about 50 percent sand and gravel. The thicker and coarser grained sand beds generally occur in the lower part of the formation. Data from test wells in counties adjacent to Hale County indicate that the basal 200 feet of the formation is chiefly sand and gravel. Although sand beds throughout the formation yield water, the basal beds of sand and gravel comprise the major aquifer.

Depths to the base of the Coker Formation range from about 400 feet below land surface in the northeastern part of the county to about 1,900 feet in the southwestern part. The formation is not tapped by wells in the southern part of Hale County because of its excessive depth and because shallower aquifers yield large quantities of water. Data for 35 wells tapping the Coker Formation in the northern part of the county are included in table 2.

Well C-4, which taps the major aquifer, reportedly had a drawdown of 25 feet while producing about 200 gpm (gallons per minute), indicating a specific capacity of 8 gpm per foot of drawdown. The specific capacity of this well indicates a potential production of 1,000 gpm with a pumping level of about 150 feet below land surface. On the basis of these data, it is estimated that wells with capacities of 1.5 mgd could be constructed in the major aquifer of the Coker Formation in Hale County.

Sand and gravel beds in the Gordo Formation are a major aquifer in Hale County. The formation ranges in thickness from about 300 to 350 feet; however, the lower 150 to 200 feet of the formation, which consists predominantly of poorly sorted sand and gravel, is the major aquifer. Sand beds in the upper part of the formation are relatively thin and generally yield only small to moderate quantities of water to wells.

The depth to the base of the Gordo aquifer ranges from 300 feet below land surface in the northern part of the county (fig. 3) to about 1,300 feet in the southwestern part. The aquifer is not tapped by wells in the southern part of the county because of its excessive depth and because large amounts of water are available from the overlying Eutaw aquifer.

Data for 55 wells tapping the Gordo Formation in the northern part of Hale County are included in table 2. Wells P-13 and P-14, completed in the lower part of the Gordo, produce 618 and 545 gpm with drawdowns of 17 and 23 feet, respectively. The specific capacities of these wells indicate a potential production of 1,000 gpm with pumping levels about 150 feet below land surface. In areas of lower elevation where the water level or potentiometric surface is near or above the land surface, it is estimated that the lower part of the formation will yield about 1,000 gpm to individual wells with a pumping level about 50 feet below surface. On the basis of these data, it is estimated that the Gordo aquifer will yield 1.5 mgd to individual wells in central and southern parts of Hale County and will yield smaller quantities in the northern part where the aquifer is sufficiently saturated (fig. 3).

Sand beds in the Eutaw Formation are a major aquifer in Hale County. The formation is about 400 feet thick and consists generally of thin clay and sand beds with thicker and coarser grained sand beds in the lower part. A massive bed of sand occurs in the upper part of the formation; however, it is relatively fine grained and yields less water than the basal sand beds. Composition of the Eutaw Formation is estimated to be about 50 percent sand, although individual sand beds probably do not exceed 60 feet in thickness.

The depth to the base of the Eutaw aquifer ranges from about 300 feet below land surface in the vicinity of Greensboro to about 900 feet in the southwestern part of the county. The Eutaw Formation is not only a source of large water supplies, but is also the shallowest source of ground water for domestic and stock supplies in most of southern Hale County. Data for 225 wells tapping the Eutaw Formation are included in table 2.

Wells P-11 and P-16, completed in the middle part of the Eutaw Formation, yield 80 and 200 gpm respectively. Well S-13, which taps the lower part of the formation, flows 100 gpm. Well V-13, which taps the lower part of the Eutaw, yields 295 gpm. The specific capacities of wells P-11, P-16, and S-13 range from 1.5 to 7 gpm per foot of drawdown. These and other available data indicate that the lower part of the Eutaw Formation will yield 1.5 mgd to individual wells in Hale County generally south of Greensboro, and will yield smaller supplies in the northern part of the county where the aquifer is sufficiently saturated (fig. 3).

Ground water occurs in the terrace deposits and alluvium in Hale County but, because of the heterogeneity of the deposits, individual aquifers are difficult to define. The deposits generally are less than 50 feet thick and consist of lenticular beds of poorly sorted gravel, sand, and clay. In general, aquifers in the deposits yield sufficient water for domestic or stock use. Wells of large capacity probably could be constructed in the low terrace deposits and alluvium along the Black Warrior River where the aquifers are hydraulically connected with the river. Data for nine wells tapping the terrace deposits or alluvium are included in table 1.

A well that will supply 10 gpm is considered adequate for normal domestic needs. All geologic units, except the Mooreville and Demopolis Chalks, that crop out in or underlie Hale County are potential sources of sufficient water for domestic use.

Domestic supplies may be obtained at depths of less than 50 feet from aquifers in terrace deposits and alluvium in the valleys of the Black Warrior River and its major tributaries. In areas of low to moderate relief, north of the Eutaw-Mooreville geologic contact (fig. 2) and east of the flood plain of the Black Warrior River, wells ranging in depth from 50 to 200 feet are required to tap aquifers in outcropping formations that will yield as much as 10 gpm. In areas of high relief, particularly in the northeastern part of the county, wells ranging in depth from 300 to 400 feet may be necessary to tap an aquifer.

In the area of outcrop of the Mooreville and Demopolis Chalks the shallowest source of ground water for domestic supplies generally is from sand beds in the upper part of the underlying Eutaw Formation. Chalk beds overlying the Eutaw Formation generally do not yield water to wells, and alluvium in this area is usually thin and may not yield sufficient quantities of water for domestic supply. Figure 5 shows by

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contour lines the elevation of the top of the Eutaw Formation. To estimate the depth from the land surface to the top of the formation at specific well sites, follow the method outlined in the preceding explanation, whereas depths are determined to the bases of the major aquifers. The depth below land surface to the top of the Eutaw Formation ranges from less than 5 feet near the Eutaw-Mooreville contact (fig. 2) to about 500 feet in the southwestern part of the county. Aquifers, capable of yielding domestic supplies, generally occur less than 100 feet below the top of the formation.

Figure 5. --Elevation of top of Eutaw Formation in southern Hale County, Alabama.

Surface Water

Average Flow

The long-term average flow of a stream, the arithmetic mean of all discharges for a long period of time, is a useful statistic for evaluating the availability of water. Because this statistic should reflect a reasonable balance of wet and dry years, about 20 years of streamflow records are required for adequate definition of average flow. Average flow computations for streams with short-term records can be improved by correlation with nearby streams where longer records are available. Average flows, adjusted to the base period 1940-65, of streams in Hale County are shown on figure 6 as the width between lines along individual

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streams. The Black Warrior River has an average flow of about 5, 200 mgd where it enters the county and about 6, 300 mgd where it leaves. Average flows for Elliotts, Fivemile, Big Brush, and Big Prairie Creeks, at their mouths, are about 35, 90, 165, and 210 mgd, respectively.

Figure 6.--Availability of surface water in Hale County, Alabama.

7-Day Q_2

A streamflow parameter that provides useful information in appraising the low flow of Alabama streams is the median value of the annual 7-day minimum flows--hereafter referred to as the 7-day Q_2. For streams that are not regularly gaged, this parameter can be satisfactorily evaluated from a relatively small amount of streamflow data. As a median value, it is a fairly stable parameter, being the average only of position in an array of items and hence unaffected by extreme values. Also, as a median, it is a good measure of normal conditions. The recurrence interval for a median value in a series of annual events is always known, being equal to 2 years in any form of frequency distribution. Finally, the 7-day period of low flow is short enough to represent flow that is available for the most part without storage, yet is long enough to suppress the effects of abnormally low transient flows of little hydrologic significance that might result from occasional regulations or from natural causes of an accidental nature.

The approximate range of the 7-day Q_2 for streams in Hale County is shown by color pattern on figure 6. The Black Warrior River, largest source of surface water in the county, has a 7-day Q_2 greater than 300 mgd. The lower reaches of Big Brush, Fivemile, Big Prairie, and Elliotts Creeks have 7-day Q_2's greater than 2 mgd. Other streams in the county have 7-day Q_2's less than 2 mgd.

Variability of Flow

Flow-duration curves, which show the percentage of time specified flows are equaled or exceeded, depict flow variability. A steeply sloping curve indicates a highly variable streamflow; a flat curve indicates lower variability in flow. The slope of the flow-duration curve reflects the hydrogeologic characteristics of the basin and is useful for comparing the flow characteristics of different streams.

Flow-duration curves for two streams in Hale County are shown in figure 7. For the purpose of comparison, the curves are plotted in

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Figure 7 (caption on next page) belongs near here.

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terms of millions of gallons per day per square mile of contributing drainage area.

Figure 7.--Flow-duration curves for two streams in Hale County for period 1940-56.

The drainage basin of Big Prairie Creek is underlain chiefly by chalk which has relatively low permeability and does not readily store and transmit water. Water discharged from ground-water reservoirs will sustain streamflow during dry periods; however, the lack of ground-water storage and subsequent discharge from the chalk is reflected by the steep slope of the lower end of the flow-duration curve for Big Prairie Creek (fig. 7). The curve for Big Prairie Creek may be considered as characteristic of flow duration of other streams draining the Black Prairie belt in the southern part of the county.

Fivemile Creek drains geologic units that consist primarily of sand, gravel, and clay that have a relatively high capability of storing and transmitting water. Rainfall percolates into the units, is stored, and later is released to the stream during dry periods. This characteristic is reflected by the relatively flat slope in the lower end of the flow-duration curve for Fivemile Creek (fig. 7). The curve for Fivemile Creek may be considered as characteristic of flow duration of other streams draining the Fall Line Hills in the northern part of the county.

QUALITY OF WATER

The chemical quality of water may limit the water's usefulness for particular purposes. Most municipal supplies are selected to insure good quality or are treated to remove objectionable minerals and properties of the water. Quality requirements for industrial water depends on the type of use made of the water. Some industries have quality requirements that are far more exacting than requirements for municipal supplies; other industries use water only for cooling and can use highly mineralized water.

Hard water is objectionable for some uses because it increases soap consumption and may deposit scale in pipes and boilers; soft water under certain conditions may induce corrosion. General terms used in this report to describe hardness of water are: soft, 0-60 mg/l (milligrams per liter); moderately hard, 61-120 mg/l; hard, 121-180 mg/l; and very hard, 181 mg/l or more. Iron in excess of 0.3 mg/l may cause staining of porcelain or enamel fixtures, clothing, or other fabrics. Chloride content also affects the suitability of water for many uses. If chloride is present in sufficient concentration (in excess of 1,000 mg/l), the water has a salty taste.

Ground Water

The chemical character of ground water depends on several variables, such as composition of the aquifer, distance from recharge areas, time the water has been in contact with the aquifer, and the overall pattern of ground-water circulation. An evaluation of chemical analyses available for ground water in Hale County indicates that the water is satisfactory for most uses. The results of chemical analyses of water samples collected from wells and springs in Hale County are given in table 4.

Data for wells tapping the Coker Formation in the northwestern part of Hale County indicate that the water is generally low in chloride content except near the Black Warrior River where the chloride content is in excess of 250 mg/l. An electric log from an oil test well in northeastern Marengo County indicates that fresh water in the Coker extends to a depth of 1, 810 feet. This interpretation indicates that the formation may yield water with less than 250 mg/l in most of the southern part of Hale County. Water from the Coker Formation generally contains more than 0. 3 mg/l iron except in local areas and is very hard in most of the northwestern part of the county.

The chloride content of water from the Gordo Formation is less than 250 mg/l except in the extreme west-central part of the county. Water from the Gordo generally contains more than 0. 3 mg/l iron except in local areas and ranges from soft to very hard.

The chloride content of water from the Eutaw Formation is less than 250 mg/l, except in the extreme west-central part of the county. Figure 8 shows the areal distribution of iron in water from the Eutaw

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Formation. Water containing 0.3 mg/l or less iron occurs in the southern part of the county where wells generally tap the upper part of the formation. The iron content of water from the middle and lower parts of the Eutaw Formation in the central part of the county is more than 0.3 mg/l except in a narrow belt extending northeastward from Greensboro. Water from the Eutaw is generally soft.

Data for wells tapping the terrace deposits and alluvium indicate that the water is low in chloride content and ranges from soft to moderately hard. Water from the terrace deposits and alluvium locally contains iron in excess of 0.3 mg/l.

Figure 8. --Iron content of water from the Eutaw Formation in Hale County, Alabama.

Surface Water

Surface water may undergo changes in chemical quality as it moves rapidly from one environment to another. In general, surface water tends to carry increasing loads of dissolved material as it moves downstream, although the mineral concentration may be reduced by increased runoff or by inflow of less mineralized water. Dissolved minerals in surface water result, in part, from natural causes--the solvent action of water on soil and rock and, in part, from cultural causes--the activities of man that add minerals and other pollutants to the water.

The results of chemical analyses of water collected from streams since September 1965 at network and project stations in Hale County are tabulated in table 5. Chemical-quality records prior to November 1965 have been published in Alabama Geological Survey Circular 36, U. S. Geological Survey Water-Supply Paper 1947, and annual water-quality reports for Alabama.

Water from most streams in the county contains less than 20 mg/l chloride and ranges from soft to hard. Based on chemical analyses of water collected prior to the period for this report, the iron content and color of water in some streams may be objectionable for certain industrial uses.

Water from streams which drain sand and clay deposits in the northern part of Hale County is less mineralized than water from streams which drain calcareous rocks in the southern part of the county. The chloride content and hardness of water from Big Brush Creek is affected by a flowing well (L-6) discharging salty water into Dry Creek, a tributary to Big Brush Creek (fig. 6, inset). Analyses of water samples collected from Big Brush Creek and Dry Creek at specific locations indicate the effects of the chemical quality of the water from the flowing well on water in Big Brush Creek during base flow conditions (table 5).

UTILIZATION OF WATER

The total use of water in Hale County in 1968 was estimated to be about 3.9 mgd, most of which was ground water; surface water was used only for stock supplies. The table below indicates that approximately 68 percent was used for municipal and industrial supplies, 31 percent for rural-domestic and stock supplies, and less than 1 percent for school supplies.

Estimated water use in Hale County, 1968

Use	Gallons per day
Municipal	
Greensboro	1,260,000
Moundville	65,000
Akron	21,000
Industrial	1,390,000
Rural-domestic and stock	1,120,000
Rural schools	21,000
Total use	3,877,000

Wedgeworth Well

The Wedgeworth well (L-6), shown in figure 9, is in the west-central

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Figure 9 (caption on next page) belongs near here.

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part of Hale County near Wedgeworth, Alabama. It was drilled as an oil test well in 1922 to a depth of 1,490 feet (Carlston, 1944, p. 106-108; and table 1). During the drilling of the well a small flow of fresh water was found at a depth of 536 feet and cased off. A water-bearing bed was tapped at a depth of 1,410 feet which yielded about 2,500 gpm of warm salty water. The well was completed as a flowing water well and the water used for recreational purposes.

Figure 9 shows the flow of water from the well in 1922 at a reported rate of 2,500 gpm; and in 1968, at a measured rate of 900 gpm. The measured flow from the well was 1,240 gpm in 1944. The discharge pipe of the well is about 10 feet above the land surface, and the water is used to supply fish ponds.

Figure 9. --Wedgeworth well, Hale County, Alabama, (a) reported flow of 2, 500 gpm in 1922, (b) measured flow of 900 gpm in 1968.

The elevation of the base of the Coker Formation at well L-6 is estimated to be about 960 feet below sea level and 320 feet above the water-bearing zone which yields most of the water to the well. These data indicate that, at a depth of 1,410 feet, the well taps a water-bearing bed that may be of the Lower Cretaceous Series. The aquifer yielding water to the well at a depth of 536 feet is in the Eutaw Formation.

Analyses of the water from well L-6 are shown in table 4.

WATER BUDGET

A water budget is an accounting of the inflow to, the outflow from, and the changes in storage in a hydrologic unit such as a drainage basin, aquifer, or group of aquifers. Because Hale County is not a true hydrologic unit and available data are not adequate, a precise quantitative evaluation of all variables in the water budget cannot be made. However, an approximate water budget, using known or estimated geologic and hydrologic data, is shown in figure 10. Most of the values are estimates

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Figure 10 (caption on next page) belongs near here.

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and should not be considered as absolute. Approximations used to estimate ground-water underflow and ground water in storage to the base of the Coker Formation are as follows:

Figure 10. --Generalized water budget for Hale County, Alabama.

Average depth to base of Coker Formation	1,150 ft
Average coefficient of transmissivity	200,000 gallons per day per ft 1/
Average hydraulic gradient.	4.5 ft/mile
Average specific yield for sand and gravel deposits .	20 percent
Change in storage	negligible

1/ Information from electric logs, oil-test and water wells, and aquifer tests in Hale County and adjacent counties used to estimate the average coefficient of transmissivity.

The water budget for Hale County includes 14,000,000 million gallons of ground water in storage to the base of the Coker Formation and available to wells, more than 6,300 mgd of water leaving the county as streamflow and underflow, and an estimated use of about 3.9 mgd. From the generalized water budget for Hale County, it is apparent that water use in the county is insignificant when compared to the total available supply of water. An evaluation of potential water supplies available at selected locations in Hale County is given in table 6.

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Table 3.--Sample and drillers' logs of wells in Hale County.

(Driller's log unless specified as sample log.)

Well A-2
Owner: U. S. Forest Service
Driller: W. J. Bozeman and Son

	Thickness (feet)	Depth (feet)
Sand, fine-grained, and gravel, and layers of clay.....	20	20
Rock.....	1	21
Sand and gravel, and layers of clay.....	31	52
Clay.....	2	54
Sand and layers of hard yellow clay.....	20	74
Sand, red.....	12	86
Rock.....	2	88
Clay, red and blue layers.....	30	118
Sand, soft, clean.....	22	140
Clay and rock.....	1	141
Sand, fine-grained, hard.....	30	171
Clay, hard.....	2	173
Sand, fine-grained, hard.....	20	193

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well B-2
Owner: Venoy Terry
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and red clay	10	10
Clay, colored, and sandy clay	10	20
Clay, yellow and hard streak of sand	10	30
Hard streaks and sand	10	40
Clay, yellow, sandy	10	50
Clay, yellow, sandy, and pea gravel	10	60
Clay, yellow, sandy	10	70
Clay, colored	10	80
Clay, colored, and fine sand	10	90
Sand, fine-grained, and colored clay flakes	30	120
Clay and sand	10	130
Sand and clay flakes	15	145
Clay	15	160

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well C-4
Owner: City of Moundville
Driller: Layne-Central Co.

	Thickness (feet)	Depth (feet)
Clay	8	8
Sand, muddy	23	31
Rock	1	32
Sand	10	42
Rock	1	43
Sand, and streaks of clay	9	52
Clay	158	210
Clay, rock, and gravel	17	227
Sand, fine	10	237
Clay	16	253
Sand, packed	5	258
Shale	86	344
Sand, and streaks of soft clay	19	363
Sand, packed, and thin streaks of clay	24	387
Sand, packed (softer than above)	10	397
Sand, packed (cut better)	10	407
Sand, packed	21	428
Clay, sandy	4	432

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well C-4
Owner: City of Moundville
Driller: Layne-Central Co.

Sample Log

	Thickness (feet)	Depth (feet)
Coker Formation		
Sand, yellowish-orange, fine- to coarse-grained, subangular to angular, slightly iron stained.....	22	22
Sand, yellowish-orange, fine to very coarse grained, angular to subrounded, heavily iron stained; mica...	22	44
Sand, yellowish-orange, medium to very coarse grained, angular to well rounded, iron stained, slight amount of weathered chert.....	22	66
Sand, orange, fine to very coarse grained, angular to rounded, iron stained; reddish-brown clay.....	23	89
Sand, light-brown, very fine to coarse-grained, angular to subangular, iron stained, micaceous.....	23	112
Sand, light-brown, very fine to coarse-grained, angular to subangular, iron stained, micaceous; reddish-brown and grayish-orange clay.....	23	135
Sand, yellowish-brown, very fine to medium-grained, angular to subangular, iron stained, micaceous; reddish-brown and grayish-orange clay.....	69	204

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well C-4--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Gravel, fine to medium, quartz and chert pebbles, varicolored, subangular to well rounded; yellowish-brown, very fine to fine-grained, angular to subangular, iron stained sand; red to grayish-orange clay.....	23	227
Clay, light-gray; yellowish-brown fine- to medium-grained angular to subrounded slight iron-stained sand; small to medium quartzose gravel and chert; trace of sandstone.....	22	249
Clay, light-brown to yellowish-brown, very fine to coarse-grained, angular to subrounded, micaceous; slightly iron stained sand.....	23	272
Clay, gray, very micaceous, slightly carbonaceous; lignite; slight amount of sand and gravel.....	22	294
Clay, gray, very micaceous, slightly carbonaceous; lignite; slight amount of sand.....	23	317
Sand, yellowish-brown, very fine to fine-grained, angular, micaceous; gray very micaceous slightly carbonaceous clay.....	23	340
Clay, gray, very micaceous, slightly carbonaceous; yellowish-brown very fine to coarse-grained angular to subangular sand.....	23	363

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well C-4--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Sand, yellowish-brown, medium- to coarse-grained; angular to subrounded, micaceous.....	22	385
Sand, yellowish-gray, medium to coarse-grained, angular to subrounded.....	23	408
Sand, yellowish-gray, medium- to coarse-grained; angular to subrounded, micaceous.....	23	431

Modified from sample description by
Randall Fleming
Geological Survey of Alabama

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well E-6
Owner: City of Akron
Driller: H. W. Peerson Drilling Supply Co.

	Thickness (feet)	Depth (feet)
Clay, sandy	10	10
Clay and gravel	3	13
Clay, and streaks of gravel	7	20
Sand, fine, and gravel (lost returns)	10	30
Clay, sandy, hard	14	44
Sand, coarse	10	54
Clay, red, gummy	8	62
Sand, medium- to coarse-grained	5	67
Gumbo	5	72
Clay, gummy	11	83
Clay, red, gummy	15	98
Sand, medium- to coarse-grained	41	139
Sand, fine- to medium-grained, and streak of rock	5	144
Sand, fine- to medium-grained	2	146
Clay, gummy	3	149
Sand, medium- to coarse-grained	15	164
Sand, medium- to coarse-grained, and thin streaks of clay and rock	21	185
Sand, white, fine-grained	9	194
Clay, hard, gummy	5	199
Sand, medium- to coarse-grained, hard, packed	6	205
Sand, fine- to medium-grained, hard, packed, and streaks of rock	11	216

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well E-6--Continued

	Thickness (feet)	Depth (feet)
Gumbo, hard, gummy	10	226
Gumbo, and streaks of rock	15	241
Clay, sandy	10	251
Sand, brownish, medium-grained	16	267
Sand, brownish, coarse-grained	20	287
Clay	2	289
Sand, medium- to coarse-grained, and streaks of clay	19	308
Sand, medium- to coarse-grained	20	328
Sand, brown, medium- to coarse-grained	21	349
Sand, medium- to coarse-grained	11	360
Sand, fine- to medium-grained, and streaks of clay	9	369
Sand, fine- to medium-grained	15	384
Clay, gumbo	6	390
Clay, fine-grained, hard, packed, sandy	36	426
Sand, fine- to medium-grained, and thin streaks of clay	5	431
Gumbo, and streaks of hard fine-grained sand	57	488
Clay, finely sandy	47	535
Gumbo	3	538
Gumbo, tough	16	554

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well E-11
Owner: H. A. Bailey
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Clay, red and yellow.....	10	10
Clay, yellow.....	2	12
Sand.....	23	35
Clay.....	5	40
Sand and clay.....	30	70
Sand, clay, and rock.....	10	80
Sand and clay.....	20	100
Sand.....	20	120
Sand, clay, and rock.....	10	130
Sand and clay.....	20	150
Clay.....	8	158
Sand.....	2	160
Sand and clay.....	20	180
Sand, clay, and rock.....	10	190
Sand.....	10	200
Sand, clay, and rock.....	30	230
Sand and clay.....	30	260
Clay.....	30	290
Sand.....	30	320
Clay.....	40	360

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well E-11--Continued

	Thickness (feet)	Depth (feet)
Sand	27	387
Clay	8	395
Sand	5	400
Clay	30	430
Sand	50	480

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well F-2
Owner: Clifton Abernathy
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and red clay	10	10
Clay, red and yellow	10	20
Sand	40	60
Sand and clay	10	70
Sand	30	100
Sand and clay	10	110
Sand	10	120
Sand and clay	10	130
Clay	20	150
Rock and clay	30	180
Clay	10	190
Clay, and sand	10	200
Clay	10	210
Rock and sand	10	220
Sand	20	240
Sand, yellow	10	250
Sand	20	270
Sand, yellow	20	290
Sand, white	10	300
Sand, coarse-grained	10	310
Clay	100	410
Sand	30	440

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well I-7
Owner: H. G. Williams
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and red clay	10	10
Clay and sand, red	10	20
Sand, red, and brown clay	10	30
Clay, brown, and sand	10	40
Sand, brown, and yellow clay	10	50
Sand, brown, and blue clay	10	60
Clay, blue, and brown sand	10	70
Sand, brown, and blue rock	10	80
Rock, blue	30	110
Rock, blue, and sand	10	120
Sand	10	130

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well J-2
Owner: Ollie Perry
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and red clay	10	10
Clay, red	22	32
Clay and brown sand	10	42
Clay, yellow	40	82
Sand, brown, and sandrock	20	102
Sand, brown, and blue clay	10	112
Clay, blue, and sand	40	152
Sand and clay	8	160
Sand, fine-grained, and clay	10	170
Sand, fine- to coarse-grained, and clay	10	180
Sand	5	185
Clay	5	190
Clay	15	205
Sand	13	218
Clay	2	220
Sand	15	235
Clay	52	287
Sand	3	290
Sand, and streaks of clay	10	300
Sand	15	315
Clay	12	327
Sand	3	330
Sand, and streaks of clay	20	350
Sand, yellow, and rock	10	360
Sand, yellow	30	390

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well J-16
Owner: Gazelle Thomas
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and red clay	10	10
Clay, red	12	22
Clay, red, sandy	10	32
Clay, blue and gray	10	42
Clay, blue	40	82
Clay, blue, and streak of sand	10	92
Clay, blue	30	122
Clay, blue, and sand	10	132
Clay, blue, sand, and rock	10	142
Clay, blue, and sand	20	162
Clay, blue	8	170
Clay, blue, and streaks of fine-grained sand	20	190
Clay, blue, and streaks of sand and rock	10	200
Clay, blue	10	210
Clay, blue and streaks of sand	10	220
Clay, blue	10	230
Clay, blue, and sand	30	260
Clay, blue, and coarse-grained sand	10	270
Clay, blue, and sand	20	290

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well K-1
Owner: Murry Harris
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and clay	10	10
Sand	20	30
Sand and blue rock	10	40
Rock, blue	50	90
Clay, blue, and sand	10	100
Clay, blue	30	130
Sand, fine, and blue rock	10	140
Sand and blue rock	10	150
Sand	20	170
Clay, blue and white	10	180
Clay	10	190

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well L-6
Owner: Turpin Vise
Driller: Calvin Engle

	Thickness (feet)	Depth (feet)
Loam, sandy	38.5	38.5
Clay, blue	15	53.5
Sand, blue	282.5	336
Clay	54	390
Sand, gray	146	536
Sand and blue gumbo clay	64	600
Clay, blue, gumbo	25	625
Sand, white	120	745
Clay, blue, gumbo	70	815
Sand, red	190	1,005
Sand, red, and red gumbo clay	310	1,315
Sand, red	75	1,390
Clay, red, gumbo	20	1,410
Clay, red, chalky, very soft	80	1,490

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well L-8
Owner: W. D. Moore
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and clay	10	10
Clay, blue	40	50
Clay, blue, and small streak of sand	20	70
Clay, blue, and sand	190	260
Sand and blue clay	10	270
Sand	5	275
Clay	25	300
Clay and streak of sand	10	310
Clay and sand	30	340
Sand	5	345
Clay	55	400
Clay and sand	20	420
Sand	30	450

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well M-3
Owner: U. S. Corps of Engineers
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Fill, reddish clay, and yellow sand.....	10	10
Sand, yellow.....	20	30
Clay, blue, and thin streak of rock.....	30	60
Sand, rock, and clay.....	10	70
Clay.....	30	100
Sand.....	5	105
Clay.....	53	158
Sand.....	12	170
Clay.....	6	176
Sand and clay.....	14	190
Clay.....	20	210
Clay and fine-grained sand.....	90	300

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well N-4
Owner: W. L. Pharis
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and sand	10	10
Sand	10	20
Sand and blue rock	10	30
Rock, blue	20	50
Rock, blue, and sand	20	70
Sand and shell rock	10	80
Sand and hard rock	10	90
Sand and blue rock	10	100
Sand	30	130
Rock, blue	40	170
Rock, blue, and sand	40	210
Sand and shell rock	10	220
Sand, shell rock, and blue rock	40	260
Sand and blue rock	10	270
Rock, blue, and sand	70	340
Sand and shell rock	10	350
Rock, blue, and sand	20	370
Sand and shell rock	10	380
Sand	10	390
Sand and blue rock	20	410
Clay	10	420

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well N-16
Owner: H. M. Wurm
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and sand	10	10
Sand	10	20
Sand and gravel	5	25
Clay, blue	15	40
Clay, blue, and sandrock	10	50
Clay, blue, and sand	10	60
Sand	10	70
Sand and clay	10	80
Sand and rock	10	90
Sand and clay	10	100
Sandrock and clay	10	110
Clay	60	170
Clay and sand	150	320
Sand and rock	10	330
Clay and sand	30	360
Clay, rock, and sand	30	390
Sand	10	400

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well O-23
Owner: Mrs. Katherine Mosley
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Clay, white	10	10
Clay, white and blue	10	20
Clay, blue	80	100
Clay, blue, sandy	30	130
Clay, blue, sandy, and rock	10	140
Clay, blue	80	220
Clay, blue, and small streak of sand	10	230
Clay, blue	20	250
Clay, blue, and sand	10	260
Sand and clay	10	270
Sand, fine-grained, clay, and rock	30	300
Sand, fine-grained, and clay	70	370
Sand and clay	10	380
Sand, clay, and rock	10	390
Sand and clay	20	410
Clay and sand (coarse sand at 418 feet)	8	418
Sand, coarse-grained	2	420
Sand, medium-grained	10	430
Sand, brownish, medium-grained	10	440
Sand, coarse-grained (clay at 448 feet)	8	448

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well O-23--Continued

	Thickness (feet)	Depth (feet)
Clay	2	450
Sand, coarse-grained, and streaks of medium-grained sand	10	460
Sand, medium-grained	40	500
Sand, medium-grained	5	505
Clay	53	558
Sand, fine-grained	2	560
Sand	18	578
Clay	12	590
Sand and clay	20	610
Sand	30	640
Sand and gravel	10	650
Clay and sand	10	660
Sand	25	685
Clay	15	700
Sand and streaks of rock	20	720
Sand	17	737
Clay and rock	13	750
Sand	10	760
Sandrock	10	770
Sandrock and sand	20	790

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-9
Owner: Clarence Curb
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and red clay	10	10
Clay, red, and yellow sand	10	20
Sand, yellow	20	40
Clay, yellow	10	50
Clay, blue	10	60
Clay, yellow, and sand	20	80
Clay, blue, sandy	70	150
Clay, blue	30	180
Clay, blue, and rock	20	200
Clay, blue, and sand	10	210
Clay, blue, and rock	10	220
Clay, blue, and streaks of sand	30	250
Clay, blue	10	260
Clay, blue, and streaks of sand	40	300
Sand, white	10	310
Sand, white, and blue clay	10	320
Clay, blue, rock, and sand	10	330
Clay, blue, and sand	10	340
Clay, blue	10	350
Clay, blue, and sand	20	370
Sand	20	390

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-13
Owner: City of Greensboro
Driller: Layne-Central Co.

	Thickness (feet)	Depth (feet)
Clay, sandy	86	86
Rock	1	87
Clay and sand	102	189
Clay, and streaks of rock	51	240
Chalk	14	254
Clay and sand	21	275
Clay, and streaks of rock	6	281
Clay and sand	123	404
Clay, red	22	426
Rock	1	427
Clay, red	78	505
Sand	15	520
Clay, red	2	522
Sand	21	543
Clay	3	546
Sand	28	574
Clay	13	587
Sand, and streaks of sandy clay	16	603
Sand and clay	7	610
Sand	73	683
Clay	2	685
Sand	13	698
Clay	3	701
Sand, hard, and streaks of clay	17	718

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-14
Owner: City of Greensboro
Driller: Layne-Central Co.

	Thickness (feet)	Depth (feet)
Fill	2	2
Clay, sandy	48	50
Sand, blue, fine-grained, and streaks of clay	14	64
Rock	2	66
Limerock	9	75
Sand, blue, fine-grained	9	84
Sand and clay	23	107
Shale, blue	21	128
Clay	3	131
Sand, and streaks of clay	13	144
Clay	19	163
Sand, blue, fine-grained	8	171
Clay and soapstone	37	208
Soapstone	10	218
Clay	10	228
Shale, sandy	7	235
Clay	18	253
Sand	9	262
Shale	7	269
Sand, blue, fine-grained, hard, and streaks of shale	17	286
Shale	30	316
Sand, fine-grained, hard	12	328
Clay, hard	32	360

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-14--Continued

	Thickness (feet)	Depth (feet)
Sand	3	363
Clay	2	365
Sand	2	367
Clay	4	371
Sand	16	387
Clay, red	105	492
Sand	12	504
Clay	9	513
Sand	12	525
Clay	2	527
Sand	30	557
Clay	12	569
Sand	20	589
Clay	11	600
No record	112	712

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-14
Owner: City of Greensboro
Driller: Layne-Central Co.

Sample Log

	Thickness (feet)	Depth (feet)
Eutaw Formation		
Sand, yellow, fine-grained, and trace of mica and glauconite	20	20
Sand, yellow, fine-grained, subangular, glauconitic, and trace of mica	22	42
Sand, yellow, fine-grained, glauconitic, and trace of mica	23	65
Sand, gray, fine-grained, and trace of glauconite; small amount of gray siltstone	24	89
Sand, gray, fine-grained, and trace of glauconite; small amount of gray micaceous siltstone	23	112
Clay, gray, sandy, slightly micaceous; small amount of glauconite	21	133
Sand, gray, fine-grained, glauconitic, slightly micaceous	22	155
Silt, gray, slightly sandy	21	176
Silt, gray, micaceous, glauconitic, lignitic, slightly sandy	22	198
Clay, gray, micaceous, glauconitic, sandy	23	221
Sand, gray, very fine grained, silty, micaceous	37	258

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-14--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Sand, gray, fine-grained, micaceous, slightly glauconitic	30	288
Sand, gray, fine-grained, micaceous, slightly micaceous	22	310
Sand, gray, fine-grained, subrounded, micaceous; siltstone	23	333
Claystone, gray, sandy, laminated, micaceous, glauconitic	22	355
Sand, gray, fine-grained, subrounded to subangular, micaceous, glauconitic; small amount of siltstone	21	376
No record	47	423
Gordo Formation		
Claystone, red, yellow, and gray, micaceous, slightly glauconitic	22	445
Clay, red, yellow, and gray, micaceous	45	490
Sand, red and yellow, fine-grained, subrounded to rounded	23	513
Sand, red, yellow, and purple, fine-grained, subrounded; red, yellow, and purple clay	23	536
Sand, yellow and red, very fine grained, angular	23	559

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well P-14--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Sand, yellow to varicolored, very fine to coarse-grained, rounded	21	580
Sand, yellow and red, medium- to coarse-grained, subrounded to rounded	22	602
Sand, yellow, subrounded, and traces of magnetite and glauconite	21	623
Sand, yellow, medium-grained, subangular	22	645
Sand, yellow, very fine to fine-grained, subangular, and traces of magnetite and glauconite	22	667
Sand, yellow, medium- to coarse-grained, subangular	23	690
Coker Formation		
Sand, yellow, medium-grained, subangular; small amount of red ferruginous clay balls	12	702
Sand, yellow, medium-grained, subrounded; small amount of gray clay	10	712

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well R-15
Owner: Stral Co.
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and clay	10	10
Clay	5	15
Rock, blue	55	70
Sand, blue, and salt and pepper clay	10	80
Sand, blue, clay, and shell rock	10	90
Sand, "salt and pepper"	3	93
Shellrock, hard	3	96
Sand, "salt and pepper"	4	100
Clay, blue, sandy	20	120
Clay, blue, sandy, and "salt and pepper" sand	10	130
Sand, "salt and pepper," and blue clay	10	140
Clay, blue, and streaks of sand	20	160
Sand	5	165
Clay	5	170
Clay, blue	60	230
Clay, blue, and sand	10	240
Sand and blue clay	10	250
Clay, blue, and streaks of sand	10	260
Sand, "salt and pepper," and streaks of shell rock	10	270
Clay, sandy, sand, and hard shell rock	10	280
Clay, sandy, sand, and blue clay	10	290
Clay, blue, sandy clay, and shell rock	10	300
Clay, blue, sandy, and streaks of sand	10	310

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well R-15--Continued

	Thickness (feet)	Depth (feet)
Sand, and streaks of shell rock.....	10	320
Sand, shell rock, and blue clay.....	20	340
Sand and shell rock.....	10	350
Sand, shell rock, and blue clay.	10	360
Clay, sandy, and sand.....	10	370
Sand and blue clay.....	30	400
Sand.....	50	450
Sand and blue clay.....	10	460

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well S-1
Owner: Mrs. Taylor
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and yellow clay	10	10
Clay, yellow and blue	10	20
Clay, blue	10	30
Clay, blue, and sandrock	10	40
Clay, blue, and sand	10	50
Sand, fine-grained	10	60
Sand, and streak of rock	30	90
Sand and rock	10	100
Sand and clay	10	110
Clay	10	120
Sand	20	140
Sand and rock	10	150
Sand and clay	10	160
Clay	40	200
Sand	10	210
Clay, sand, and rock	10	220
Sand and rock	10	230
Sand and clay	30	260
Sand and rock	10	270
Sand, clay, and rock	10	280
Clay	10	290

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well S-1--Continued

	Thickness (feet)	Depth (feet)
Clay and sand	10	300
Clay, sand, and rock	10	310
Clay and sand	10	320
Clay, sand, and rock	20	340
Clay and sand	30	370
Sand	20	390
Sand and rock	20	410
Sand	40	450
Sand and clay	10	460
Clay	95	555
Sand	9	564
Clay	10	574
Sand	12	586
Clay	17	603
Sand	33	636
Clay	8	644
Sand	56	700

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well S-11
Owner: R. K. Greene
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil, red clay, and white limerock	10	10
Limerock, white	8	18
Rock, blue	142	160
Rock, blue, and hard streaks	20	180
Rock, blue	15	195
Sand and shell rock	5	200
Sand	10	210
Sand and sandy clay	20	230
Rock	2	232
Clay, green, sandy	8	240
Mud, gray, gummy, and sandy clay	10	250
Clay, green, sandy	10	260
Sand and clay	20	280
Clay, sandy, and sand	10	290
Clay, sandy	10	300
Clay, sandy, and sand	10	310
Clay, blue, gummy	40	350
Sand and sandy clay	10	360
Sand, clay, and thin streak of rock	20	380
Shale	10	390
Sand, shale, and streak of rock	10	400

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well S-11--Continued

	Thickness (feet)	Depth (feet)
Sand, with streaks of clay	10	410
Sand, and thin layers of rock	10	420
Rock, sandy, and clay	10	430
Rock, shale, and sand	10	440
Rock and green shale	10	450
Rock, shale, and gravel	10	460
Gravel, shale, and streak of rock	10	470
Shale, and some sand	10	480
Shale	10	490
Shale and sand	10	500
Rock and shale	10	510
Shale and green sand	10	520
Shale and clay	20	540
Shale and gummy clay	10	550
Sand (water bearing)	10	560
Sand	20	580
Shale	20	600

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well V-13
Owner: Southern Natural Gas Co.
Driller: Layne-Central Co.

	Thickness (feet)	Depth (feet)
Soil	2	2
Chalk	513	515
Clay, sandy	17	532
Rock	2	534
Clay, sandy	7	541
Chalk, soft	71	612
Sand, gray, hard	25	637
Chalk	59	696
Sand, and streaks of clay	10	706
Clay, hard	58	764
Shale, sandy	32	796
Clay	71	867
Sand, and streaks of shale	21	888
Sand, packed	2	890
Clay	5	895
Sand, packed	6	901
Clay	5	906
Sand, packed	17	923
Clay	19	942

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well W-3
Owner: E. E. Causey
Driller: Black Belt Drilling Co.

	Thickness (feet)	Depth (feet)
Soil and brown clay	10	10
Clay, yellow and blue	10	20
Clay, blue	150	170
Clay, blue, and streaks of sand	10	180
Sand, and thin layers of rock	10	190
Sand, clay, and rock	10	200
Sand	6	206
Rock	2	208
Sand	2	210
Sand and clay	20	230
Clay	10	240
Clay and sand	10	250
Sand	14	264
Rock	3	267
Clay	3	270
Sand and clay	20	290
Clay	40	330
Clay and sand	10	340
Sand and clay	20	360
Sand	10	370

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well W-3--Continued

	Thickness (feet)	Depth (feet)
Clay	30	400
Clay and sand	10	410
Clay	10	420
Clay and sand	20	440
Clay and rock	10	450
Clay and sand	50	500
Clay, sand, and rock	10	510

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well W-14
Owner: M. W. McKee
Driller: F. C. Null

Sample log

	Thickness (feet)	Depth (feet)
Mooreville Chalk		
Chalk, light olive-gray, silty, micaceous, fossiliferous; pale-yellowish-orange poorly indurated very fine oolitic limestone; trace lignite.....	23	23
Chalk, light olive-gray, silty, micaceous, fossiliferous, pyritic; pale yellowish-orange poorly indurated very fine oolitic limestone; trace phosphate nodules.....	23	46
Chalk, light olive-gray, silty, micaceous, pyritic, fossiliferous with Kyphopyxa christneri; trace phosphate nodules.....	23	69
Chalk, light olive-gray, silty, micaceous, fossiliferous, pyritic; trace phosphate and siderite.....	23	92
Chalk, light olive-gray, micaceous, pyritic, fossiliferous; trace phosphate.....	23	115
Chalk, light olive-gray, micaceous, pyritic, very fossiliferous; trace lignite.....	23	138
Chalk, light-gray, micaceous, fossiliferous, pyritic.....	46	184
Chalk, light-gray, micaceous, fossiliferous, pyritic; trace lignite and siderite.....	46	230

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well W-14--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Chalk, light-gray, micaceous, fossiliferous; trace pyrite	23	253
Chalk, light-gray, micaceous, fossiliferous, pyritic; trace limonite	23	276
Chalk, very light gray, micaceous, pyritic, fossiliferous	23	299
Eutaw Formation		
Chalk, very light gray, micaceous, pyritic, fossiliferous; yellowish-gray very fine to fine-grained angular to subangular highly glauconitic fossiliferous pyritic sand	46	345
Chalk, light-gray, micaceous, fossiliferous; trace siderite; yellowish-gray very fine to fine-grained angular to subangular glauconitic fossiliferous sand	23	368
Sand, yellowish-gray, very fine to fine-grained, angular to subangular, glauconitic, slightly fossiliferous; trace phosphate	23	391
Sand, yellowish-gray, very fine to medium-grained, angular to subangular, glauconitic, fossiliferous; trace pyrite and phosphate	23	414

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well W-14--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Siltstone, light-gray, calcareous, micaceous; yellowish-gray very fine to medium-grained angular to subangular glauconitic fossiliferous sand.....	23	437
Sand, yellowish-gray, very fine to medium-grained, angular to subrounded, glauconitic, fossiliferous; trace phosphate nodules.....	23	460
Sand, yellowish-gray, very fine to medium-grained, angular to subrounded, glauconitic, fossiliferous; medium-gray micaceous clay; trace lignite and phosphate.....	46	506
Sand, yellowish-gray, very fine to medium-grained, angular to subrounded, glauconitic, fossiliferous; medium light-gray micaceous clay; trace pyrite.....	23	529
Clay, medium light-gray, micaceous, silty; yellowish-gray very fine to medium-grained angular to subrounded glauconitic fossiliferous sand; trace phosphate and pyrite.....	23	552
Sand, yellowish-gray, very fine to medium-grained, angular to subrounded, glauconitic, fossiliferous; medium light-gray micaceous silty clay; trace phosphate.....	46	598

Table 3.--Sample and drillers' logs of wells in Hale County--Continued.

Well W-14--Continued

Sample Log

	Thickness (feet)	Depth (feet)
Sand, yellowish-gray, very fine to medium-grained, angular to subrounded, glauconitic, fossiliferous; medium light-gray micaceous silty clay; medium-brown siltstone; trace lignite and phosphate.....	23	621
No record.....	46	667
Sand, grayish-orange-pink, fine to medium-grained; angular to subrounded, glauconitic; medium light-gray micaceous silty clay; trace phosphate.....	23	690
No record.....	90	780

Modified from sample description by
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