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# OPTIMUM WATER MANAGEMENT IN KAOLIN MINING FOR ALUMINUM PRODUCTION


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Co-Principal Investigators



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November 1978



**GEORGIA INSTITUTE OF TECHNOLOGY**
**Atlanta, Georgia 30332**

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INTRODUCTION

Kaolin is a clay consisting of substantially pure kaolinite or related clay minerals which have many industrial uses. The so-called "soft" kaolins are used for coating and filler for high-grade white paper, filler for paints and plastics, and filler in rubber and ceramics. The hard refractory kaolins are used for fire brick, mortar and cement. Kaolin may also be used for the manufacture of aluminum.

The most extensive commercial deposits of kaolin found anywhere in the world exist in a narrow belt reaching across central Georgia along the southeast edge of the Fall Line (See Figure 1). Reserves of kaolin in Georgia alone are estimated at 5 and 15 billion tons with the largest amounts and highest quality being concentrated between Augusta and Macon with new mining reserves continually being identified. The U.S. Bureau of Mines reports that in 1973, 5.8 million tons of kaolin were produced in the United States; in the same year, Georgia produced 4.3 million tons (Patterson, 1974).

The economic importance of these deposits of kaolin is increasing rapidly because of the potential development of a new alumina from kaolin industry. With the cost of importing bauxite escalating rapidly, the use of bauxite as the only important source of alumina for aluminum has placed the United States in a vulnerable position with respect to supplies of this metal. However, a 1974 report by the Industrial Development Division for the Georgia Department of Community Development concluded that the technology is now such that kaolin and bauxite are economically even as a source of alumina for aluminum (Husted, 1974). The problem has previously been the economic advantage of the technology of using bauxite as compared to the technology of using other aluminum-bearing minerals.

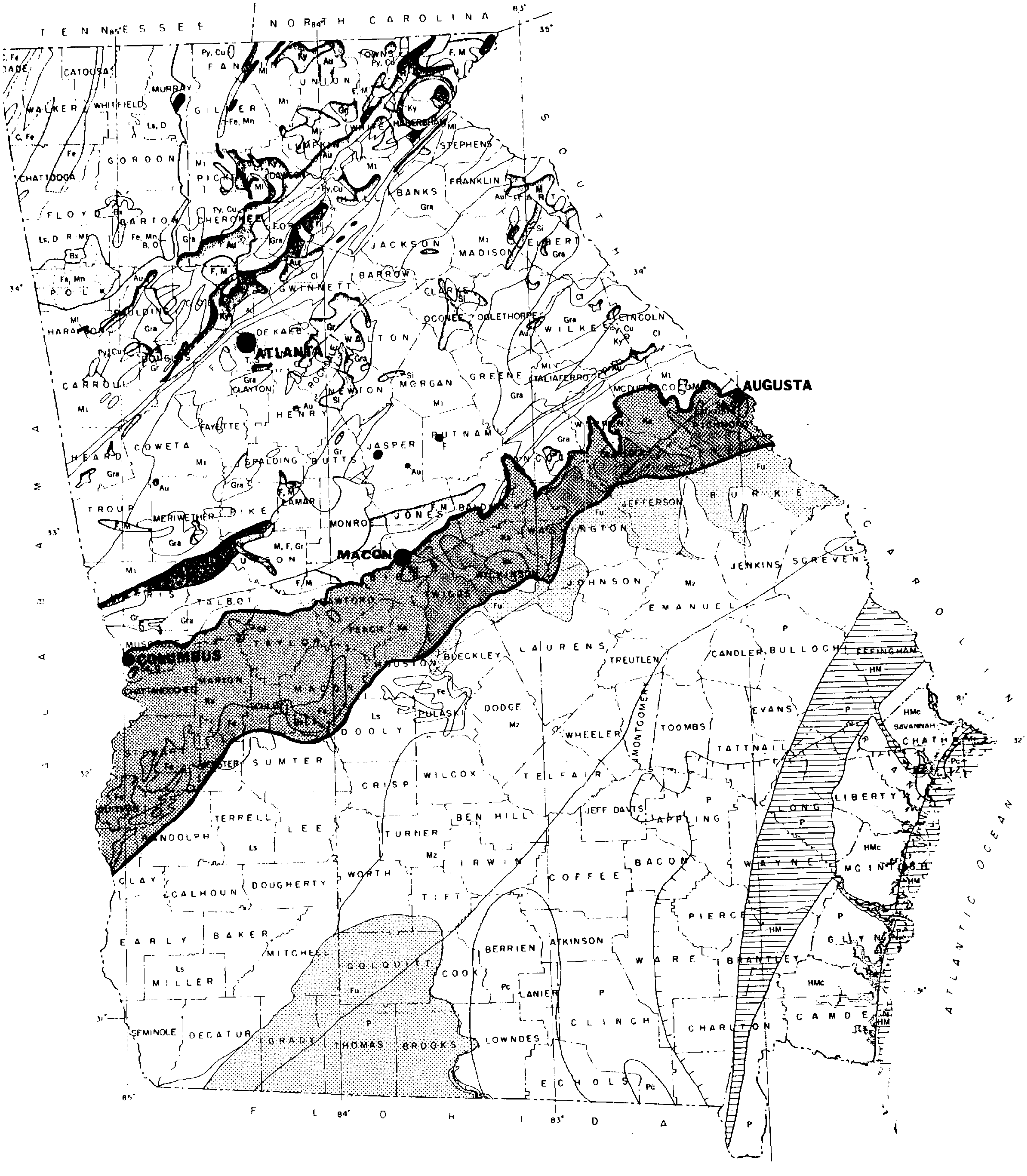



FIGURE 1. Location of the Kaolin Belt in Georgia

It is anticipated that within the next 25 years, developments in the kaolin for alumina mining and processing industry in Georgia could result in the extraction of up to 9000 short tons per day of mined and processed kaolin and up to 3000 short tons per day of processed alumina. Based on commercial plant range capabilities of 300,000 to 1,000,000 tons of alumina production per year, the processing water requirements for this potential expansion are estimated between 3.0 and 25.0 MGD depending on operating capacities and type of processing employed.

The purpose of this portion of the overall study was to examine the relationships between this potential development and the water resources of the kaolin-rich areas of the State of Georgia, concentrating on those counties where the potential was considered greatest. Accordingly, the study area covered by this report has been intentionally limited to a seven-county area located between Augusta and Macon (See Figure 2). This area is composed of Glascock, Jefferson, McDuffie, Twiggs, Warren, Washington and Wilkinson counties. Data were collected to provide a basis for recommending water and wastewater management strategies within the perspective of the concomitant development of satellite industries and supporting populations.

## DESCRIPTION OF THE STUDY AREA

### Physiography

The area covered by this report includes 2718 square miles in east-central Georgia including Glascock, Jefferson, McDuffie, Warren, Twiggs, Washington and Wilkinson counties. The area is divided from North to South by the Ogeechee River, is bounded on the West by the Ocmulgee River, and adjoins on the North, South and East, 13 other counties in Georgia. The north-eastern part of the area lies in the Piedmont Plateau with the remaining area located in the Coastal Plain. Cutting across the northern part of the

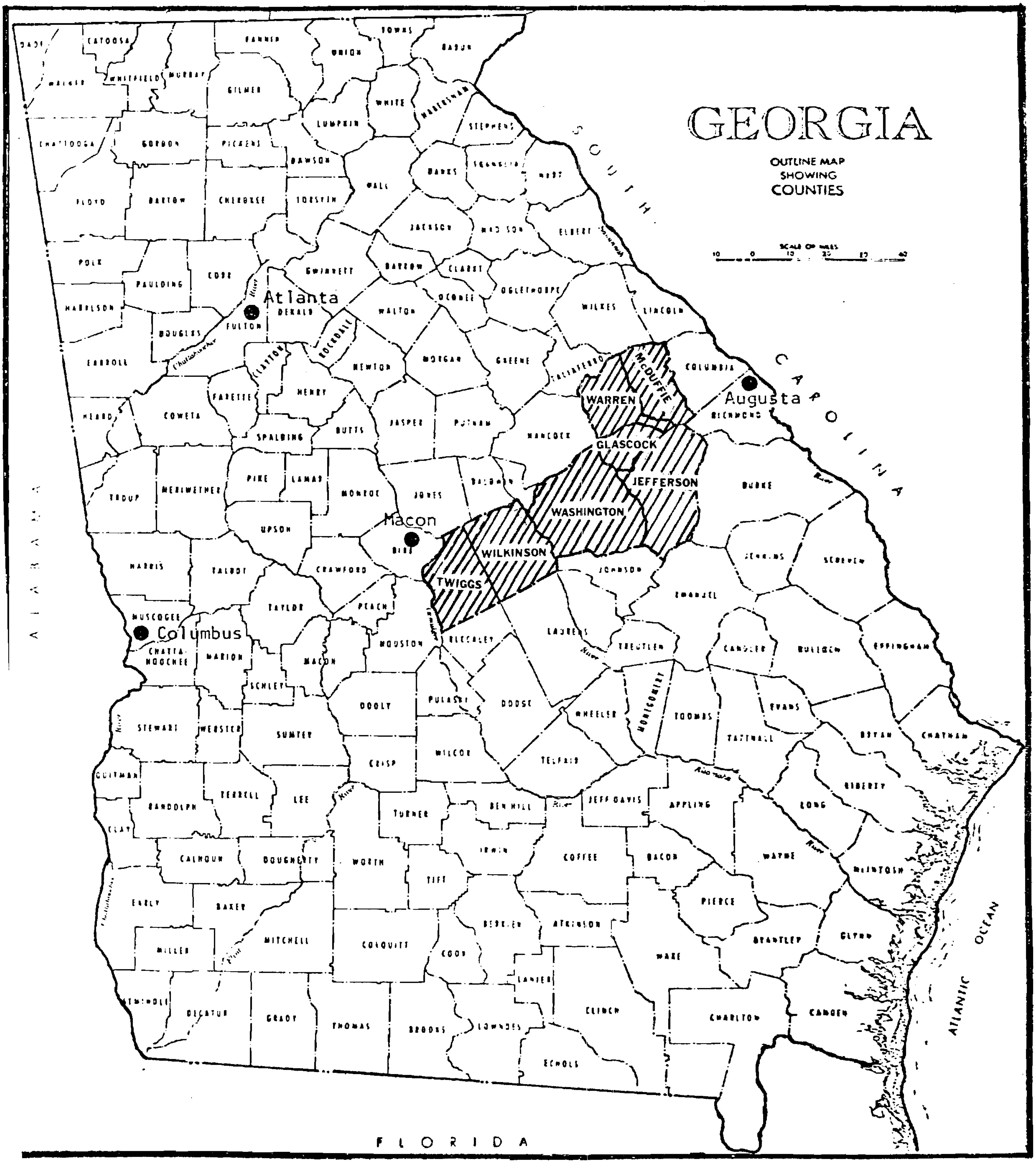



FIGURE 2. Location of Counties Covered by this Report

study area and forming an irregular boundary between the Coastal Plain and the Piedmont Province is a five to 20-mile wide transition zone identified as the Fall Line (See Figures 3-5).

The Piedmont Plateau or province is underlain by an an ancient complex of igneous or metamorphic rocks, and include granites, gneisses, schists, and highly-metamorphosed shales, sandstones, and limestones. They constitute the oldest rocks of the State and have been subjected to intense folding and faulting. The rocks are deeply weathered, and the general topography of the area tends to be smooth. The valleys are broad and shallow and have long gentle slopes. The entire province slopes gradually to the southeast.

Adjacent to the Piedmont Plateau, the Coastal Plain province includes practically all of the State lying south of a line passing through Macon, Augusta, and Columbus. The Coastal Plain, as a region, is a low plain having a gentle southward slope. In comparison to other physiographic divisions of the State, this plain has been subjected to erosion for only a short time, and its topography over a greater part of the area may be described as youthful. On the whole, it is level, although it comprises some hilly and broken areas in the northern part where in some places it is dissected and appears somewhat more mature. None of the hills rise above the general level, and their tops present an even skyline. Underlain by Cretaceous and younger sediments such as sands, clays, marls, and limestones, the Coastal Plain shares the Fall Line as an irregular boundary with the Piedmont province. In this region the sediments of the Coastal Plain thin to the north like a wedge, and meet the ancient crystalline rocks.

Using topography, underlying geologic formations, and soils, the Coastal Plain can be further divided into three distinct physiographic regions. These regions are the Sand Hills, Red Hills, and Tifton Upland.

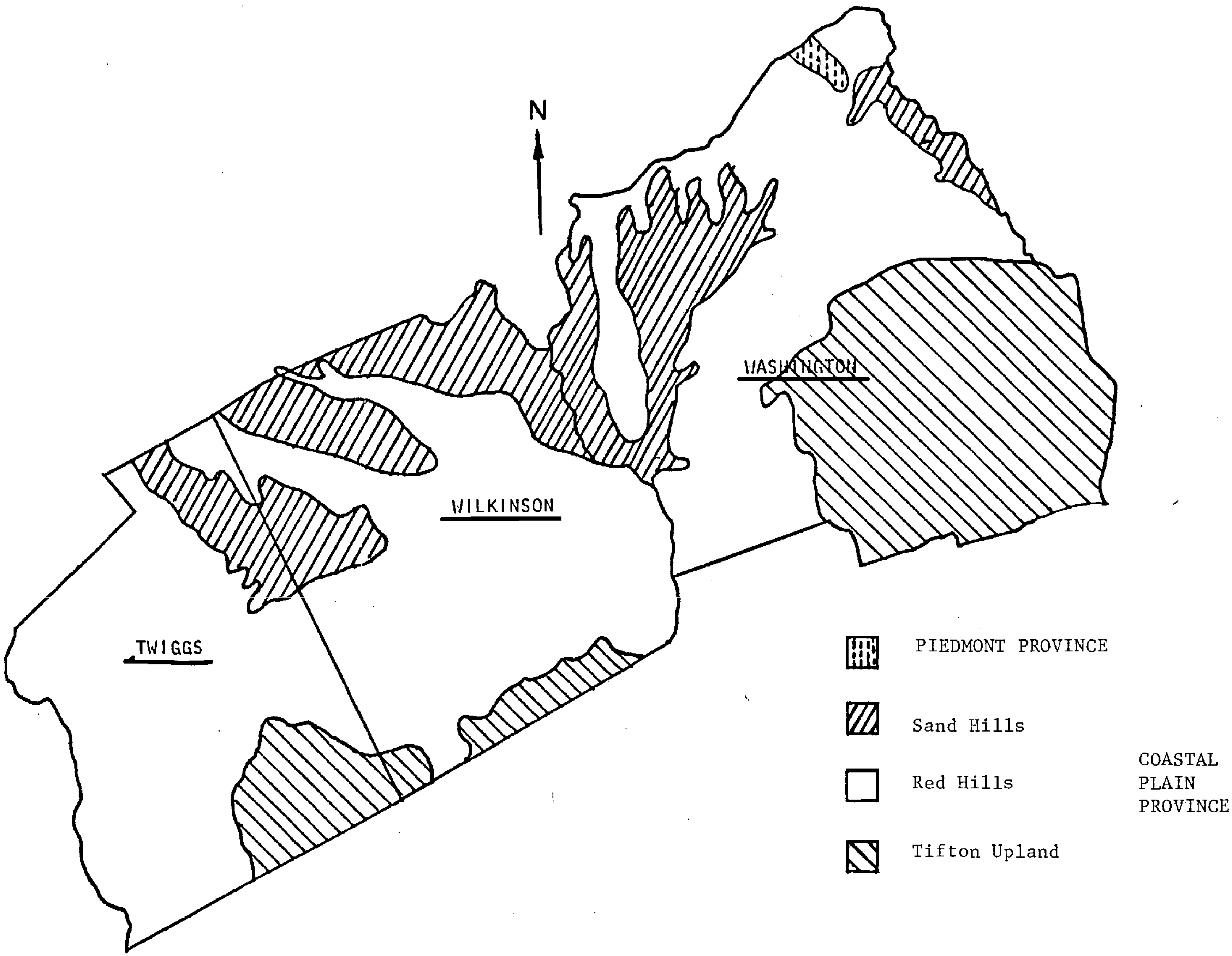



FIGURE 3. Physiographic Regions of East-Central Georgia (Lamoreaux, 1946)

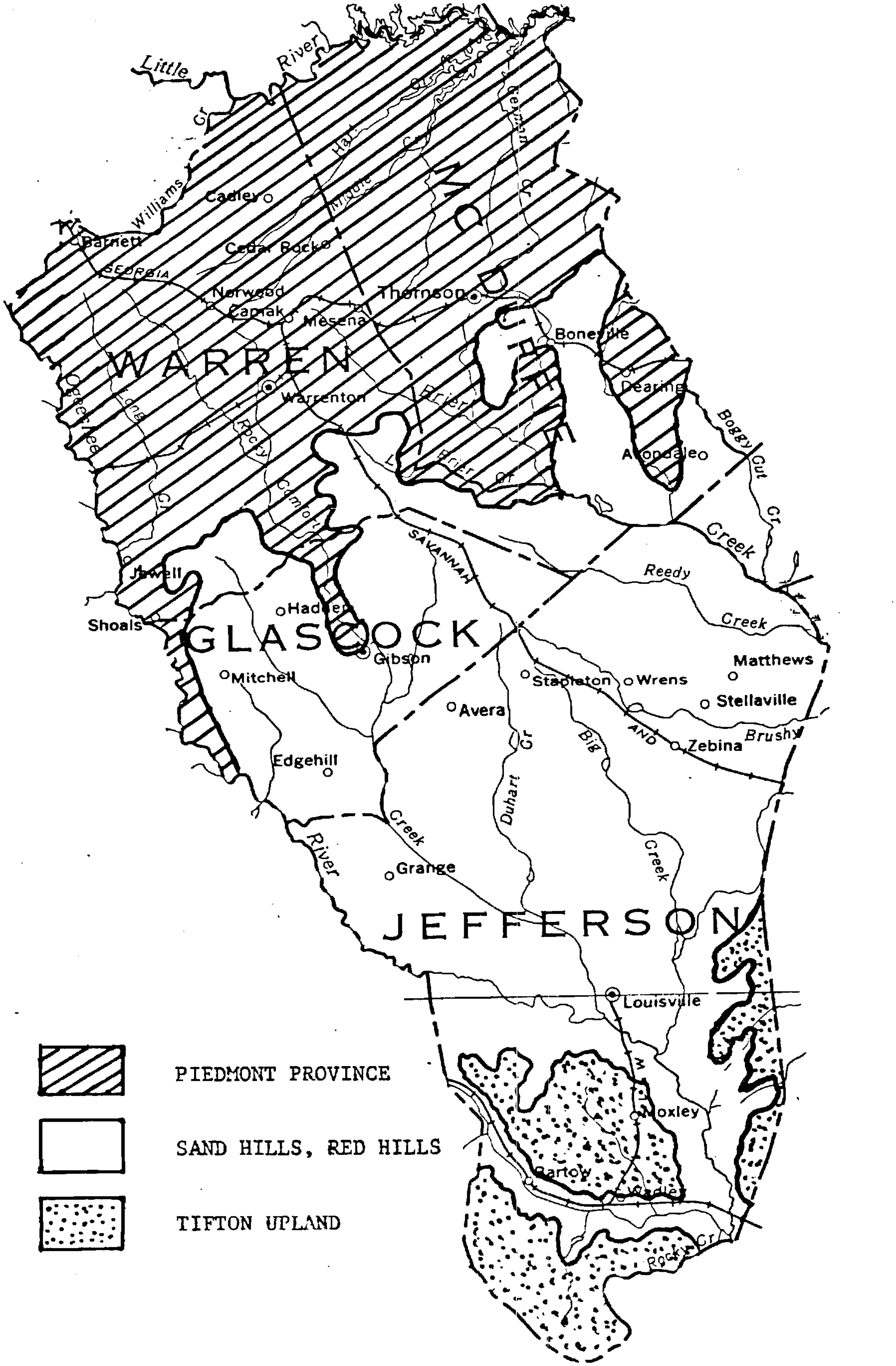



FIGURE 4. Physiographic Regions of East-Central Georgia (Carter,1956)

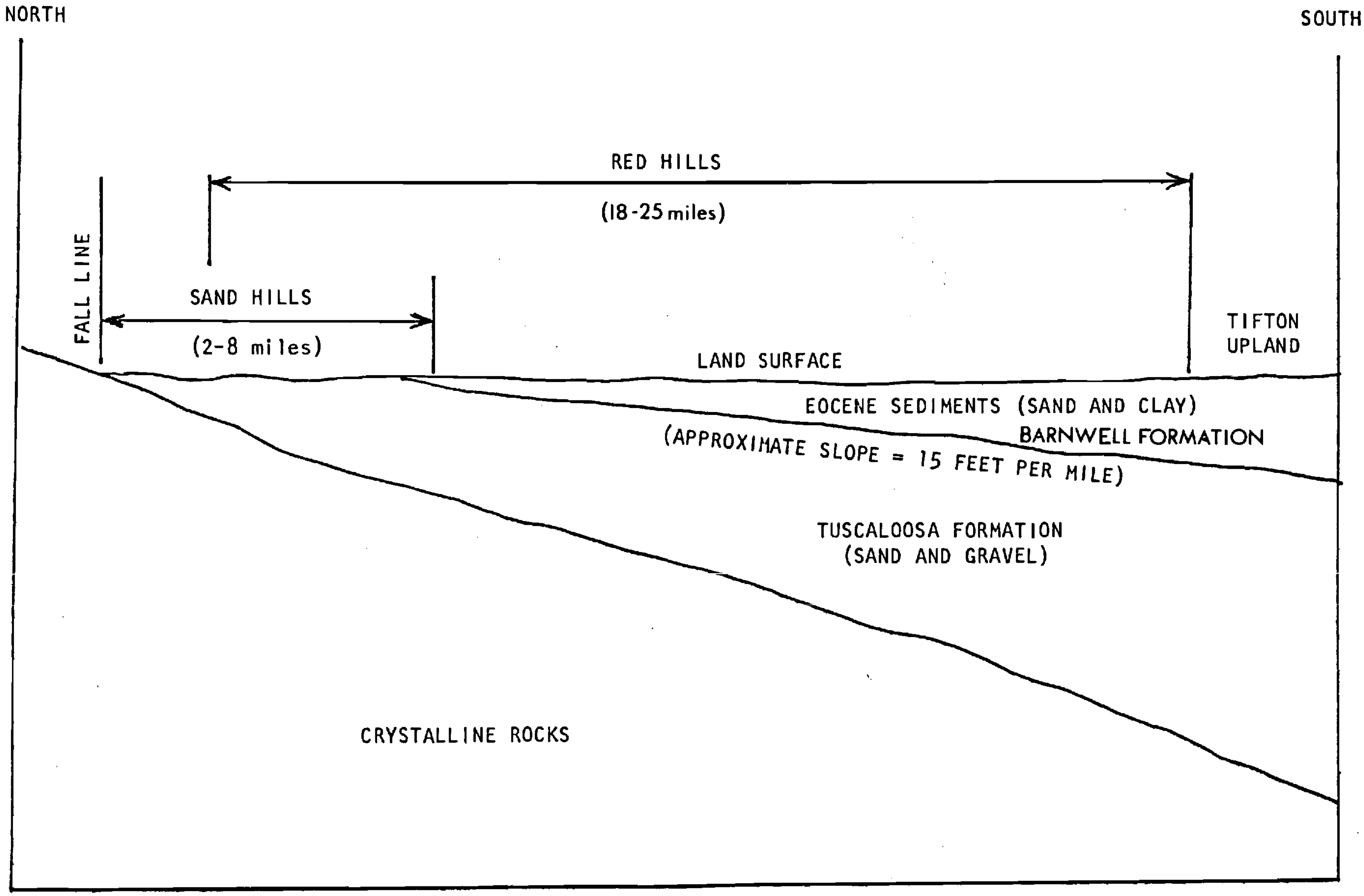



FIGURE 5. Generalized Profile of East-Central Georgia

The Sand Hills area is an irregular belt less than 10 miles wide adjacent to the Fall Line in which the Tuscaloosa formation is exposed. It is characterized by a notable covering of gray to brownish loose sand, which is a residual from the underlying Cretaceous and Eocene formations.

At some points, the Sandy Hills area is overlain by later age deposits. At these points of overlap, the Red Hills project across the Sand Hills creating the discontinuous nature of the belt. The relief in the area rarely exceeds 100 to 150 feet. The topography consists of broad rolling hills with gentle slopes. The soils in the area are light colored sands and sandy loams and are highly productive if fertilized. However, left unfertilized, the soil is poorly productive and tree growth is mainly stunted oak and scattered long leaf pine. Natural drainage is to the southwest and southeast.

The Red Hills, remnants of a former upland plateau, form a belt of hills approximately 20 miles wide across east-central Georgia. They are typically a series of hills capped by brilliant red sands and sandy loams weathered from Eocene and Oligocene rocks. In the northern part of the Red Hills area, streams have cut the former upland plateau into a series of elongated northeast-southwest and northwest-southeast running hills on which little of the original surface remains. In the southern part of the area, the hills broaden out loosing their elongated characteristic. In the central and southern part of the area, some deep gullying has occurred due to the high altitude of the upland plateau above the streams and rivers and the high erosional character of the geologic formations present. Relief throughout the area rarely exceeds 200 feet, although the erosional characteristics of the soils have created areas with relief of 250 feet in some areas of southeast Washington and southwest Wilkinson Counties. Typical elevations range from 500 feet above sea level near Stapleton, in north Jefferson County, to about 320 feet at Louisville, in the southern part of the county. Drainage in this physiographic region is to the southeast and southwest and the soils are only moderately productive.

The Tifton Upland is located south of the Red Hills. The topography consists of gently rolling hills with broad rounded summits. There exists no parallelism of ridges as in the Red Hills and relief rarely exceeds 50 feet. Dissection by streams has occurred only near large rivers where slopes become steeper. In southwest Georgia, the northern limit of the Tifton Upland forms an inland-facing escarpment as much as 150 feet high in some places. This escarpment is not present in the southern part of the study area because later age deposits form only a thin layer over the underlying Eocene rocks. There are many shallow ponds and sinks along the northern margin of the area indicating the presence of limestone near the surface. Weathering of the sand and sandy clay residuums of the Oligocene and Miocene formations that form the Tifton Upland has produced a gray or yellowish gray sandy soil with scattered red ferruginous modules.

Geologic Formations--Water-Bearing Properties

The geology of the Coastal Plain is less complex than that of other parts of the State. The region is underlain by sediments, ranging in age from Upper Cretaceous to Recent, which outcrop in roughly parallel bands, the oldest resting upon crystalline rocks of the Piedmont province and the youngest at the sea coast. The beds dip gently southeastward at rates ranging from about 35 feet per mile at the Fall Line to very little at the coast. Figures 6 and 7 show the geologic formations at the surface of the area, and Table 1 gives a generalized geologic cross-section with summarized information. Figure 8 illustrates the geologic cross-section constructed from wells located at various cities (Georgia Geologic Survey Bulletin 55).

IRWINTON SAND (Ei), up-dip equivalent of Twiggs Clay, Sandersville Limestone, and Cooper Marl. As mapped, also includes younger clastics of indefinite Late Tertiary age. "COOPER MARL" (Ecm). It is now recognized that this unit is not the precise lithologic or biostratigraphic equivalent of type Cooper Marl (Huddlestun, Marsalis & Pickering, 1974). SANDERSVILLE LIMESTONE (Es).

TWIGGS CLAY

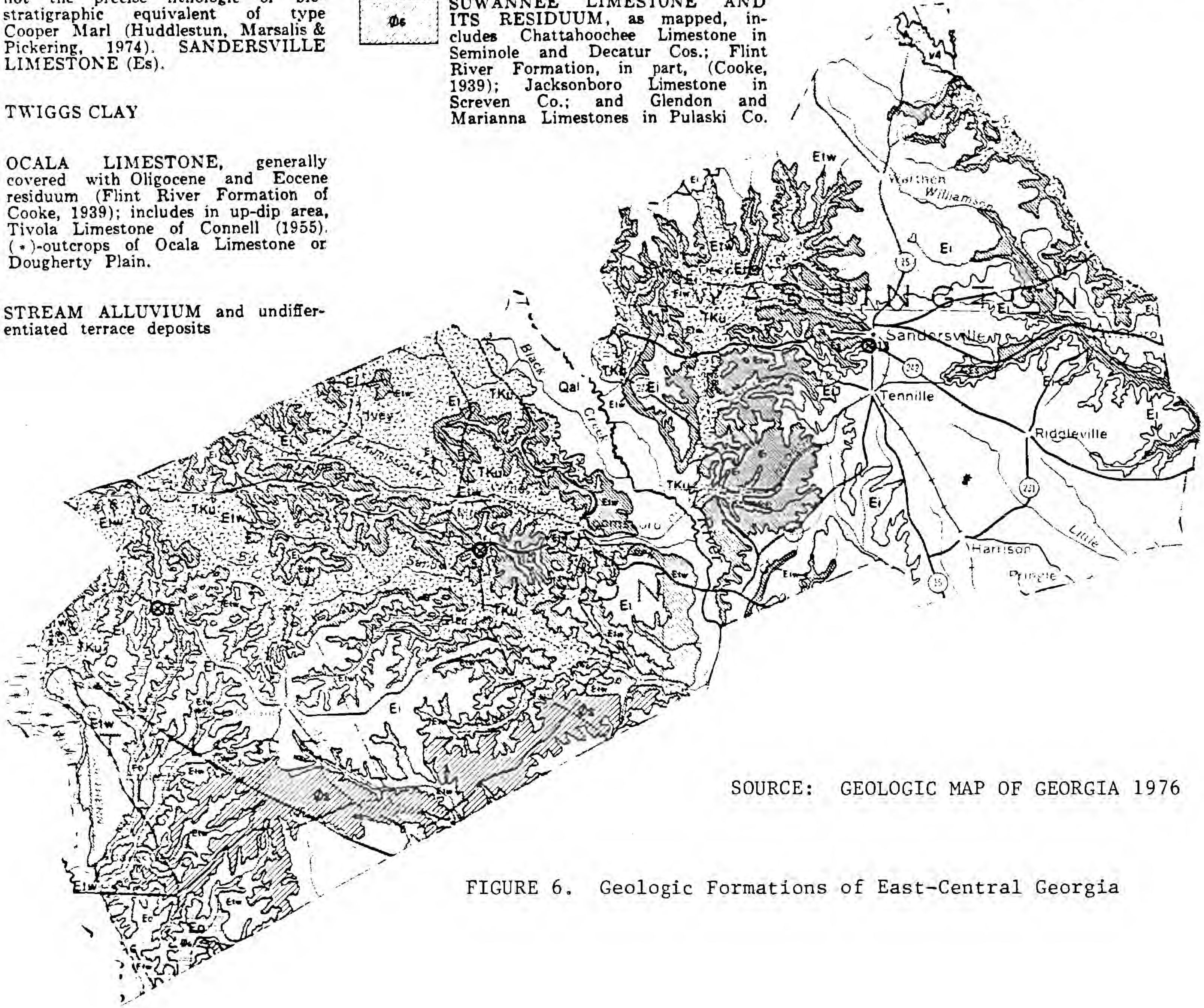
OCALA LIMESTONE, generally covered with Oligocene and Eocene residuum (Flint River Formation of Cooke, 1939); includes in up-dip area, Tivola Limestone of Connell (1955). (•)-outcrops of Ocala Limestone or Dougherty Plain.

STREAM ALLUVIUM and undifferentiated terrace deposits

NEOGENE UNDIFFERENTIATED, includes Altamaha Grit (Dall, 1892); Citronelle Formation (Matson & Berry, 1916); and "Hawthorn Formation" (Cooke, 1939). (•)-outcrops of indurated sandstone and claystone

SUWANNEE LIMESTONE AND ITS RESIDUUM, as mapped, includes Chattahoochee Limestone in Seminole and Decatur Cos.; Flint River Formation, in part, (Cooke, 1939); Jacksonboro Limestone in Screven Co.; and Glendon and Marianna Limestones in Pulaski Co.

LOWER TERTIARY-CRETACEOUS UNDIFFERENTIATED, as mapped includes Middendorf Formation (Sloan, 1904); "Channel Sands" (LaMoreaux, 1946); Tuscaloosa Formation (Cooke, 1939); and "Huber beds" (Buie, informal terminology)




SOURCE: GEOLOGIC MAP OF GEORGIA 1976

FIGURE 6. Geologic Formations of East-Central Georgia

qta QUARTZITE/MICA SCHIST

gr1 GRANITE UNDIFFERENTIATED

gr3 GRANITE/GRANITE GNEISS

gg1 GRANITIC GNEISS UNDIFFERENTIATED

gg4 GRANITE GNEISS/AMPHIBOLITE

v3 FELSIC METAVOLCANICS

v4 UNDIFFERENTIATED METAVOLCANICS/SERICITE PHYLLITE/META-ARGILLITE/QUARTZ MICA SCHIST

v5 META-ARGILLITE/SERICITE PHYLLITE/METAVOLCANICS

mm8 AMPHIBOLITE/BIOTITIC GNEISS/QUARTZ SERICITE SCHIST

pms5 SERICITE SCHIST

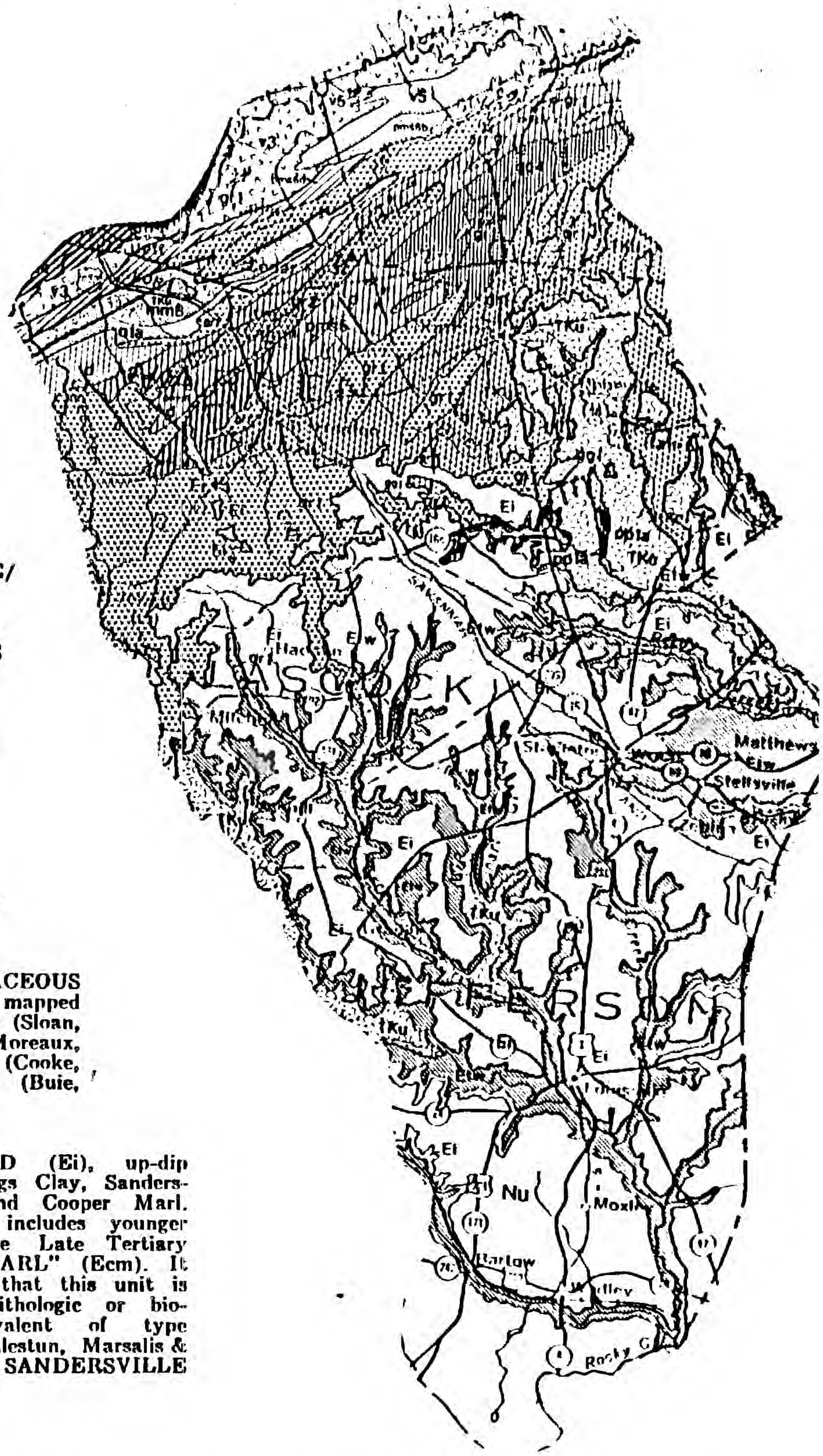
bmsed QUARTZ SERICITE SCHIST/BIOTITIC GNEISS

TKu LOWER TERTIARY-CRETACEOUS UNDIFFERENTIATED, as mapped includes Middendorf Formation (Sloan, 1904); "Channel Sands" (LaMoreaux, 1946); Tuscaloosa Formation (Cooke, 1939); and "Huber beds" (Buie, informal terminology)

Ei Ecm Es IRWINTON SAND (Ei), up-dip equivalent of Twiggs Clay, Sandersville Limestone, and Cooper Marl. As mapped, also includes younger clastics of indefinite Late Tertiary age. "COOPER MARL" (Ecm). It is now recognized that this unit is not the precise lithologic or biostratigraphic equivalent of type Cooper Marl (Huddlestun, Marsalis & Pickering, 1974). SANDERSVILLE LIMESTONE (Es).

Etw TWIGGS CLAY

Nu NEOGENE UNDIFFERENTIATED, includes Altamaha Grit (Dall, 1892); Citronelle Formation (Matson & Berry, 1916); and "Hawthorn Formation" (Cooke, 1939). (•)-outcrops of indurated sandstone and claystone




SOURCE: GEOLOGIC MAP OF GEORGIA 1976

FIGURE 7. Geologic Formations of East-Central Georgia

TABLE 1. Summary of the Coastal Plains Geology of East-Central Georgia (LeGrand, 1956)

| System | Series | Formation | Thickness in area, ft. | General Character | Water Bearing Properties |
|---|---|---|---|---|---|
| | Miocene | Hawthorn Formation | 0 - 125± | Commonly massive, mottled orange and gray coarse sandy clay. | Thin, relatively impervious unit. Yields moderate supplies to dug-wells only. |
| | Oligocene | Suwanee Limestone | 0 - 50 | Cherty limestone and some mottled red clay. | Too thin to be of major importance Solution cavities in limestone yield some water. |
| Tertiary | Eocene | Barnwell Formation | 0 - 220 | Composed chiefly of brilliant red sand grading downward into interbedded yellow sand and gummy clay lamina. Thick beds of fullers earth, typical of basal member, Twiggs clay, thin fossiliferous limestone beds are present throughout formation, though sporadically leached away. | Very permeable. Coarse, loose sands characterizing much of formation, yield bountiful supplies of potable ground water. Extensive outcrop area favors high recharge, artesian water is obtained S.E. from area of outcrop, impermeable basal clay member acts as confining stratum between sands of Barnwell and water bearing strata below. |
| | | McBean Formation | 0 - 150 | Consists of gray and yellow calcareous sand and fossiliferous limestone beds. | Composed of permeable sand and marl beds, but relatively unimportant as an aquifer because of its thinness and limited outcrop area. |
| | Upper Cretaceous | Tuscaloosa Formation | 0 - 850 | Generally composed of pink & white kaolinic micaceous sands. Cross bedded sands are common but thin clay beds are rare. Upper part of formation generally contains considerable white kaolin. | Excellent aquifer. Preponderance of sands allows easy transmission of water in zone of saturation. Deep permeable beds hold artesian water and are a practicable source of water in much of area. Natural recharge of the aquifer is abundant. Water of good quality. |
| Pre-Cretaceous | Crystalline | | | Schist, biotite, gneiss & granite of Precambrian age and porphyriticmuscovite and biotite gneiss of Paleozoic age. | Supplies small private industrial and municipal wells. Individual wells rarely produce over 50 gpm. |

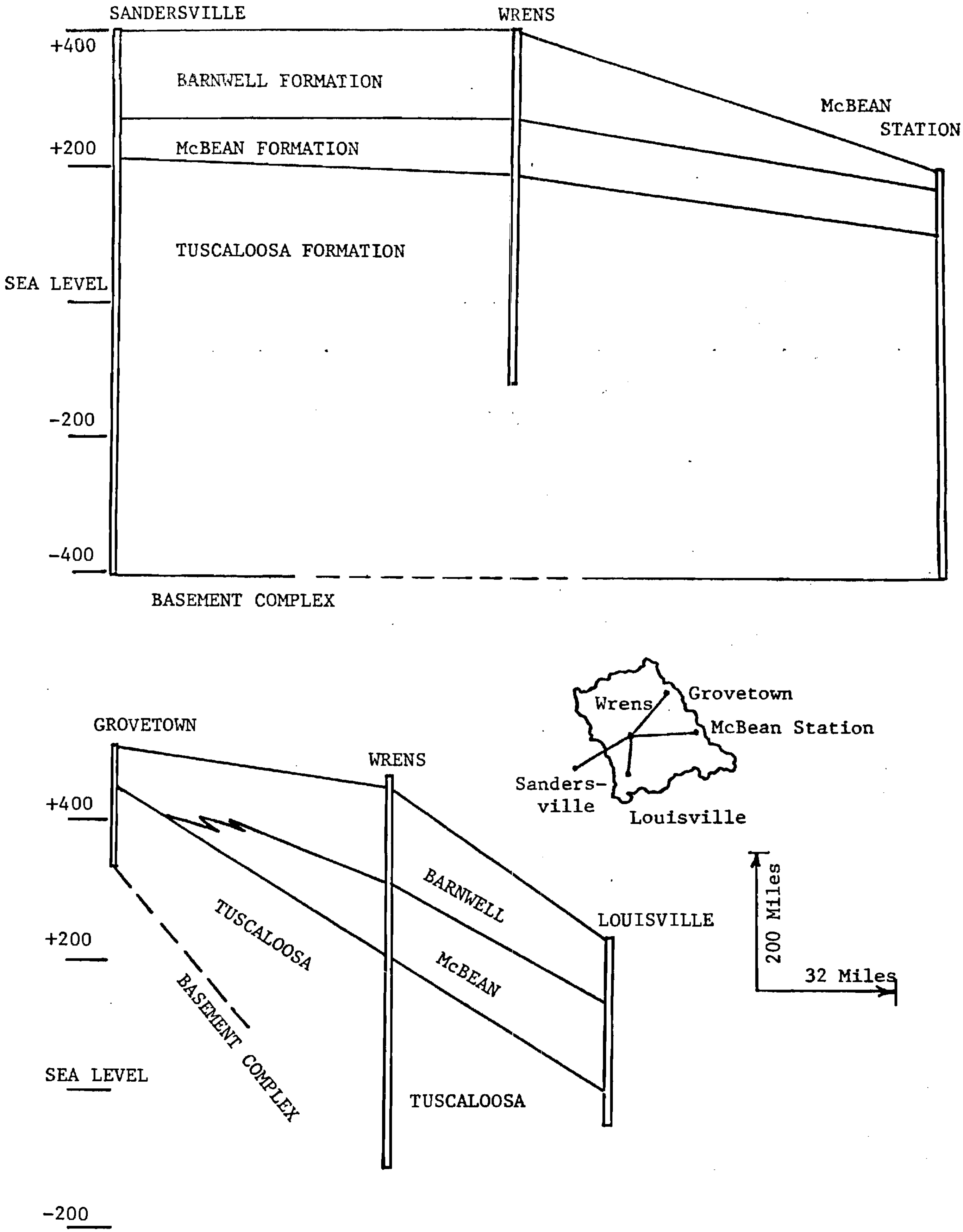



FIGURE 8. Generalized Cross Section Through Wrens, Georgia (Georgia Geologic Survey Bulletin 64)

Throughout Georgia, the basal sedimentary beds of the Coastal Plain lie on crystalline rocks which include granite, granite gneiss, diorite, and diorite gneiss, diabase, hornblende, mica schist, and quartzite. Erosion with time has levelled the edges of the upturned beds. Because of their complexity, these rocks do not have the continuity of water-bearing beds as those of the Coastal Plain. Only rarely do wells produce sufficient ground water for municipal or industrial demands. At many localities in Warren, McDuffie, and other counties of the Piedmont, a series of several wells may be needed.

Following the final metamorphism and uplift of these crystalline rocks, a long period of erosion occurred during which the surface of these rocks was reduced to a peneplane. The Tuscaloosa formation of the Upper Cretaceous Age lies unconformably on the peneplaned crystalline rocks and crops out as shown in Figure 6. Throughout most of east-central Georgia, the clays, sands, and gravel of the Tuscaloosa formation are overlain by deposits of the Eocene Age. During the Eocene Age, 150-200 feet of sand, clay, marl, and limestone were deposited in a shallow marine sea. These deposits, referred to as the Barnwell and the McBean Formations, have been divided into a Twiggs Clay member, Irwinton Sand member, and a thin unnamed sand layer. Lying unconformably on these formations are undifferentiated deposits of Miocene and Oligocene Ages. Some recent alluvium deposits are also present along the river channels. Since the Tuscaloosa and Barnwell formations play an important role in the ground water of the east-central Georgia, they will be dealt with in more detail subsequently.

The McBean formation is composed chiefly of green fossiliferous calcareous sand and marl. Because adequate water supplies have been obtained from the underlying Tuscaloosa and overlying Barnwell formations, the water-bearing properties have never been fully tested. However, in the study area, it is comparatively thin with little outcrop area and therefore has little water supply use. The Eocene formation as a whole dips southeastward at slightly less than 15 feet per mile.

Eocene--Barnwell Formation - The Barnwell formation is an important aquifer in this area and has a greater areal extent than any other formation. Consisting of red ferruginous sand and clay, it has been divided into three parts; the Twiggs Clay member, the Irwinton Sand member, and a thin upper member of coarse red sand with flat round pebbles.

The Twiggs Clay member consists of about 25 to 50 feet of pale green clay and limestone layers. In east-central Georgia it dips southeast about 15 feet per mile. Wells penetrating solution cavities in this aquifer yield supplies of up to 150 gpm, but the water is often high in hardness and dissolved solids.

The Irwinton Sand member consists of beds of fine to coarse loose sand lying unconformably on the Twiggs Clay member. The sands form the upland areas in the Red Hills. This 15 to 50-foot thick member is an excellent source of groundwater because it is underlain by the less permeable Twiggs Clay. It supplies water to many shallow non-artesian wells and deeper artesian wells. Yields are not large but are adequate for rural demands. Down-dip from the outcrop area, the yields from drilled wells increase substantially and may be as much as 300 gpm.

The upper sand member is highly weathered throughout and seldom exceeds 20 feet in thickness. Therefore, it is not a good aquifer. Moreover, the channel sands, which may be a part of the Barnwell Formation but separate the Barnwell and Tuscaloosa Formations at some locations, are discontinuous and do not provide a usable supply of water.

Cretaceous--Tuscaloosa Formation - As shown in Figures 6 and 7, the Tuscaloosa formation is exposed in a belt in eastern Georgia as much as 18 miles wide bordering the Piedmont province. In the western portion of the study area, the belt narrows to two to three miles. It also outcrops as V-shaped exposures in valleys where streams have washed the younger sediments away. In these areas of outcrop, the Tuscaloosa is less than 150 feet in thickness and thins even more to the north. However, at Wrens in Jefferson County, where it is under cover and down-dip, it is 355 feet thick. At Louisville in south Jefferson County, an oil well completely penetrates the Coastal Plain and encounters crystalline rock at 1140 feet below the surface. At this point, the probable thickness of the Cretaceous formation is 790 feet.

The Tuscaloosa formation consists of arkosic sand composed of angular quartz grains, along with white to gray, yellow and pink kaoline and mica. Discontinuing lenses of gray clay are present throughout the formation and balls of pure white kaoline are common.

The coarse, permeable sand and gravel beds of the Tuscaloosa formation are an excellent source of water and the best source for east-central Georgia. Water from these sands, at depths accessible to wells, is extensively used for domestic, municipal, and industrial supplies. In the outcrop area, wells less than 40 feet deep reach large sources of water. The Tuscaloosa deposits become deeper to the south and east because of the inclination of the strata. Wells drilled to the water bearing sands of this formation yield more than 800 gpm for municipal and industrial use at many locations throughout the area. Northwest of a line connecting Sandersville, McIntyre, and Huber, the Tuscaloosa Formation thins updip to the Fall Line. As the sand and gravel beds thin and the catchment decreases, the yield attainable also decreases. Southeast of a line between Huber and Sandersville, supplies of 500 gpm or more may be expected.

Water in the outcrop areas is generally under water-table conditions. However, down-dip and under impermeable beds, the Tuscaloosa formation yields artesian water. In the floodplains of the Ocmulgee and Oconee Rivers and along some of their tributaries, conditions of artesian flow exist. These areas were delineated by LaMoreaux (1946) and have been substantiated by data obtained since the original study. The waters, as well as water in general from the Tuscaloosa formation, are low in dissolved mineral content.

Drainage

Drainage in the study area is influenced by four major rivers and numerous streams as shown in Figures 9 and 10. The Ogeechee River flows in a southeasterly direction dividing the study area north to south as well as forming the country line between Washington, Glascock and Jefferson counties. The river is approximately 100 feet wide and is characterized by low swampy banks. The Ogeechee has two major southeast flowing tributaries. The Little Ogeechee drains the northern portion of Washington County, and Williamson Swamp Creek drains diagonally across eastern Washington County.

The Oconee River, although not the largest river in the study area, has the greatest drainage area. The river flows in a southeasterly direction dissecting the study area and forming the county boundary between Washington and Wilkinson Counties. It is approximately 200 feet wide and is characterized by low swampy banks. At some places, its floodplain is five to six miles wide. Southwest-flowing tributaries are Gumm, Bluff, and Buffalo Creeks. Gumm Creek forms a portion of the boundary between Washington and Baldwin Counties. Buffalo Creek is the largest of the three tributaries. Southeast-flowing tributaries are Commissioners and Big Sandy Creeks. These two major tributaries drain all of Wilkinson and northeast Twiggs Counties as well as portions of Baldwin and Jones Counties to the north of the study area.

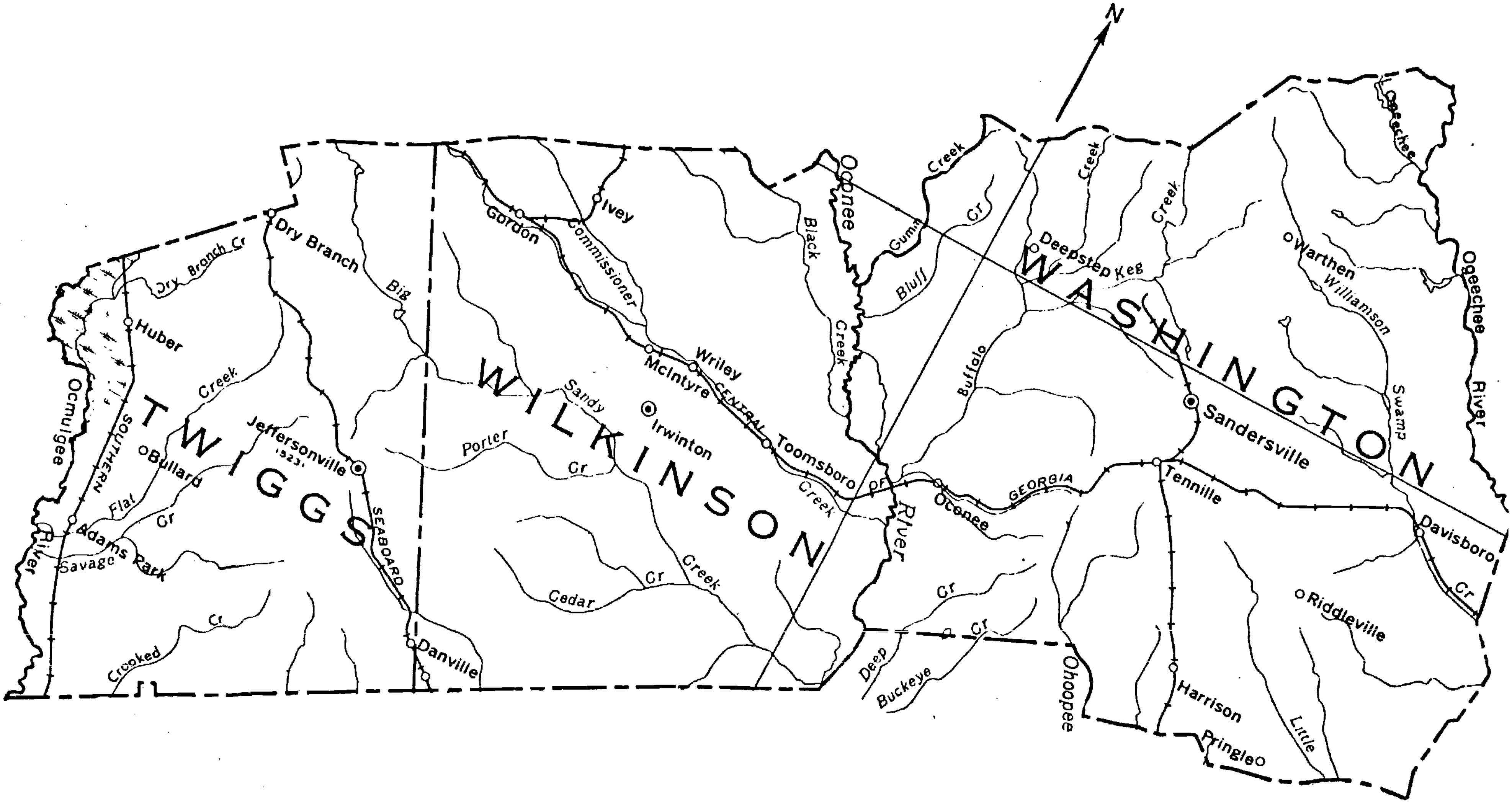



FIGURE 9. Drainage Pattern Base Map for Washington, Wilkinson and Twiggs Counties

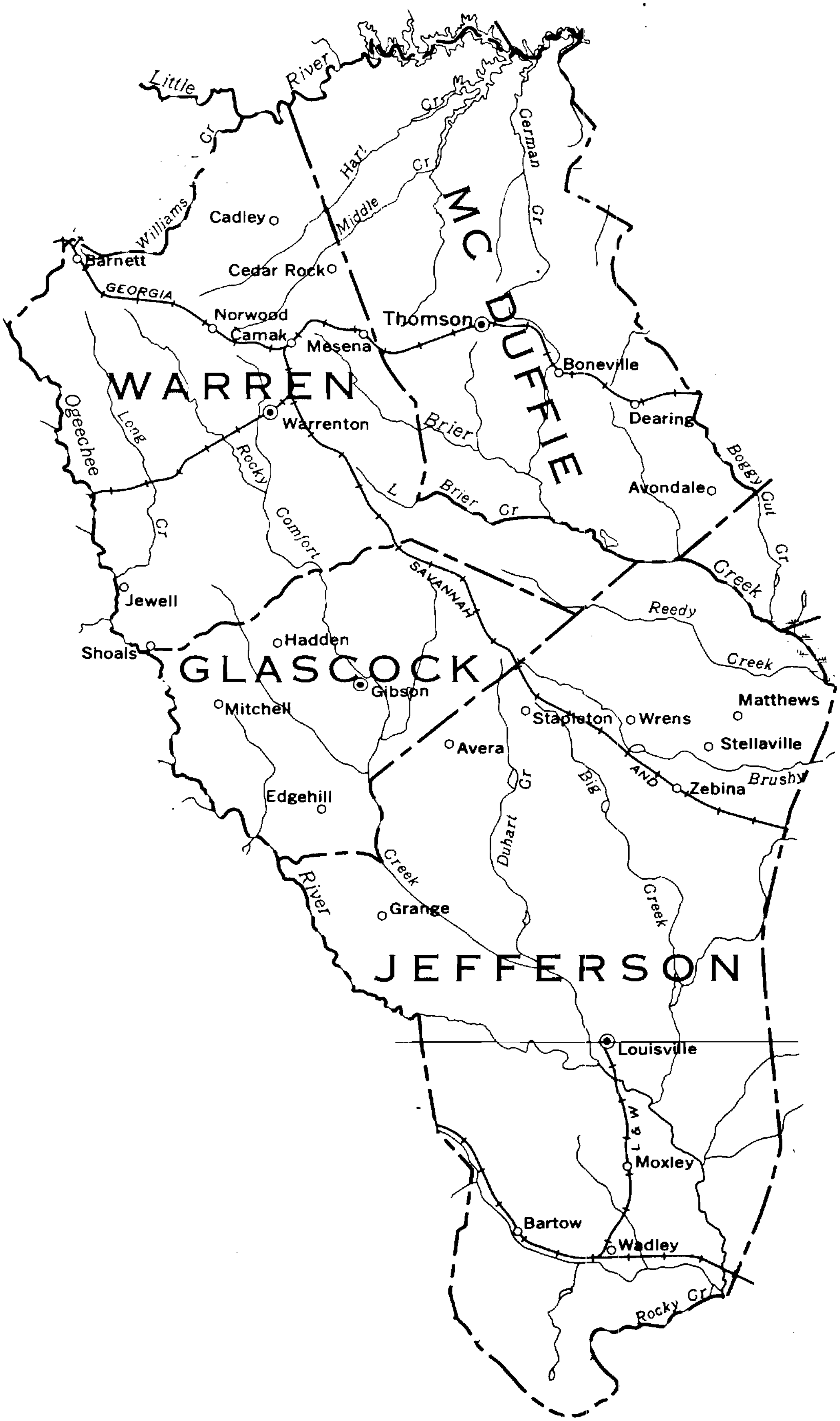



FIGURE 10. Drainage Pattern Base Map for Glascock, Jefferson, Warren and McDuffie Counties

The Ocmulgee River flows in the southeasterly direction forming the western boundary of the study area and the Twiggs County line. The major tributaries from north to south are Dry Branch Creek, Flat Creek, Savage Creek, and Crooked Creek. Flat and Savage Creeks exert the greatest drainage influence flowing southwest diagonally across Twiggs County. The Ocmulgee is comparable in size and nature to the Oconee River with a wide swampy floodplain. The Ocmulgee and Oconee Rivers meet about 45 miles south of the study area to form the Altamaha River.

Tributaries of the Savannah River, which is to the east, drain much of the eastern four counties. The Little River, which forms the northern boundary of Warren and McDuffie counties, drains much of the Piedmont before it empties into the Savannah. Hart, Middle, and German creeks all flow northeast to drain the Piedmont province into the Little River. Briar Creek and Rocky Comfort Creek both drain in a southeasterly direction from Warren, McDuffie and Jefferson counties. They are swift in the Piedmont province and develop swamps as their slope lessens in the south. Other, smaller creeks, such as Big Creek, Bushy Creek, and Reedy Creek, all help to drain the Coastal Plain area.

Climate

The climate of east-central Georgia is typified by long, warm summers and short, mild winters. Snowfall is extremely rare. The average annual temperature is 61°F. During a typical day in January, the temperature ranges from 40° to 62° F and in July from 70° to 93° F. During the year, the temperature drops below 32° F. in the Piedmont area about 50 times; in the Coastal Plain about 10 times. The frost-free growing season of the area is about 240 days.

The mild and humid climate of the area is accompanied by an average annual precipitation of 47 inches which is fairly well distributed throughout the year. The summer months usually receive the largest amount of rain with the fall months receiving the least. Short, heavy, sporadic showers characterize the summer precipitation; steady, gentle winter rains soak the ground and furnish the recharge for ground water storage.

Population

The historical and projected populations of each county are listed in Tables 2 and 3 and are shown graphically in Figures 11 and 12. The Twiggs County statistics were obtained from a report entitled Population - Economic Study Update - 1975 published in 1975 by the Middle Georgia Area Planning and Development Commission. The Washington and Wilkinson County statistics were obtained from a report entitled Oconee Area Economic Base and Population Study published in 1972 by the Oconee Area Planning and Development Commission. The statistics for the remaining counties were obtained from the U.S. Census (1970) and from a report published by the Georgia Office of Planning and Budget entitled Population Projections for Georgia Counties 1900-2000. Specific details on methodologies used to develop these projections are included in each report.

The pattern of population trends in the area has generally followed that of the Southeast. Outmigration from rural to urban areas has occurred on a large scale. Most of the smaller towns are expected to grow, but the rural farm population is expected to continue to decline. The absence of new jobs in rural areas compels young people to seeks jobs in the city where they enter the labor force. Automation on the farm has greatly reduced the number of employees needed and consequently the number of residents in rural locations. The projections for Twiggs, Washington and Wilkinson counties show a reversal in this general trend with a stabilization and moderate

TABLE 2. County Populations; Historical and Projected

| | Twiggs County | | Washinton County | | Wilkinson County | |
|---|---|---|---|---|---|---|
| Year | Population | % Change | Population | % Change | Population | % Change |
| 1940 | 9,117 | | 24,230 | | 11,017 | |
| | | -8.3 | | -13.3 | | -11.0 |
| 1950 | 8,308 | | 21,012 | | 9,781 | |
| | | -4.5 | | - 9.6 | | - 5.5 |
| 1960 | 7,935 | | 18,903 | | 9,250 | |
| | | +3.6 | | - 7.5 | | + 1.5 |
| 1970 | 8,222 | | 17,480 | | 9,393 | |
| | | +1.4 | | +10.0 | | + 5.8 |
| 1980 | 8,335 | | 19,228 | | 9,941 | |
| | | +4.0 | | +10.0 | | + 7.4 |
| 1990 | 8,670 | | 21,150 | | 10,680 | |
| | | +2.8 | | +10.0 | | + 7.1 |
| 2000 | 8,915 | | 23,265 | | 11,440 | |

TABLE 3. County Populations; Historical and Projected

| Year | Glascock County | | Jefferson County | | McDuffie County | | Warren County | |
|---|---|---|---|---|---|---|---|---|
| | Population | % Change | Population | % Change | Population | % Change | Population | % Change |
| 1950 | 3,579 | | 18,855 | | 11,443 | | 8,779 | |
| | | -25.3 | | -7.4 | | +10.3 | | -16.2 |
| 1960 | 2,671 | | 17,460 | | 12,627 | | 7,360 | |
| | | -14.7 | | -1.7 | | +21.0 | | - 9.4 |
| 1970 | 2,280 | | 17,174 | | 15,276 | | 6,669 | |
| | | + .9 | | -2.8 | | + 0.2 | | - 8.5 |
| 1980 | 2,300 | | 16,700 | | 15,300 | | 6,100 | |
| | | + 4.3 | | -2.4 | | + 2.6 | | - 3.3 |
| 1990 | 2,400 | | 16,300 | | 15,700 | | 5,900 | |
| | | - 4.2 | | -6.1 | | - 1.3 | | -11.9 |
| 2000 | 2,300 | | 15,300 | | 15,500 | | 5,200 | |

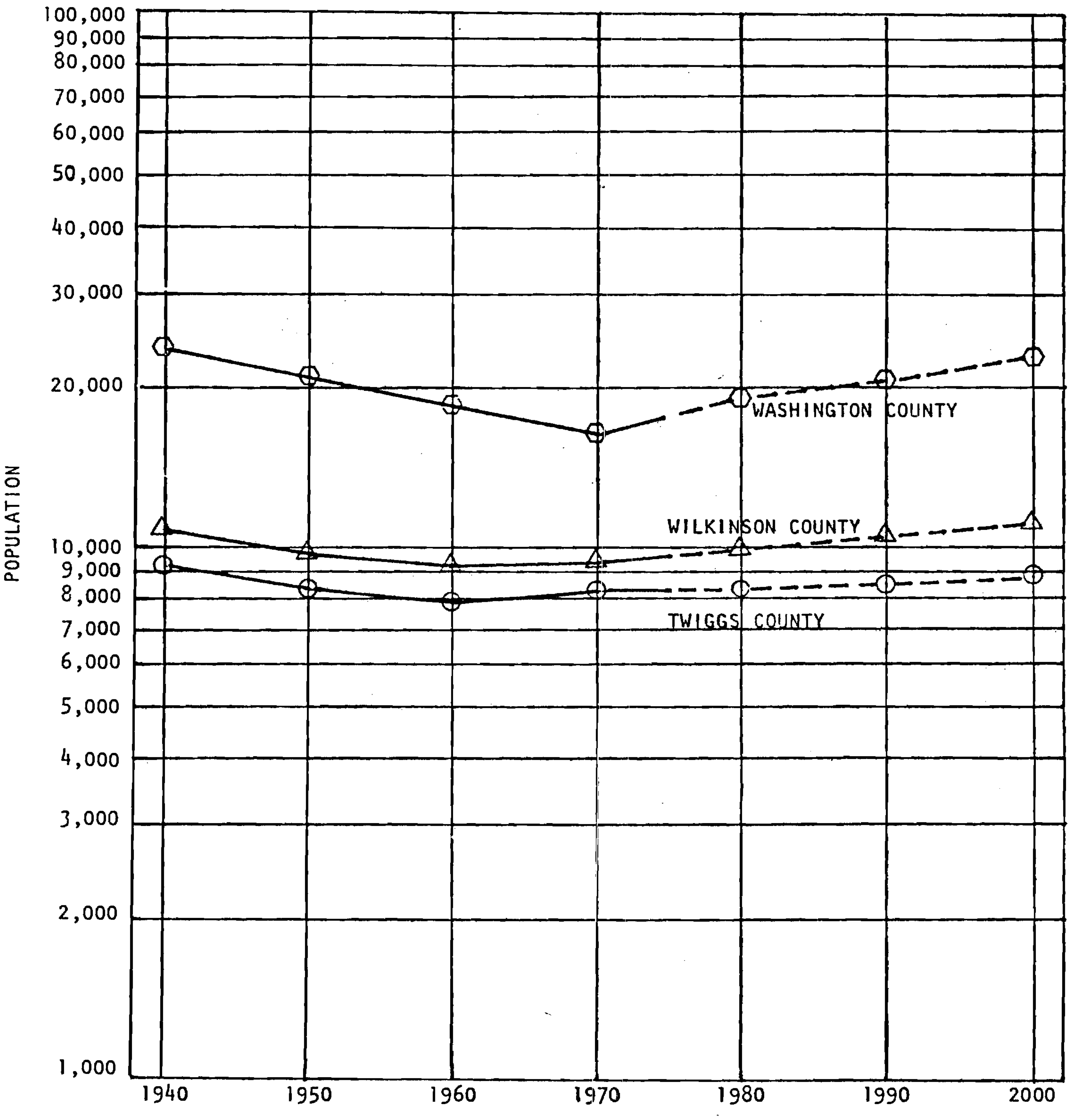



FIGURE 11. Historical and Projected Populations

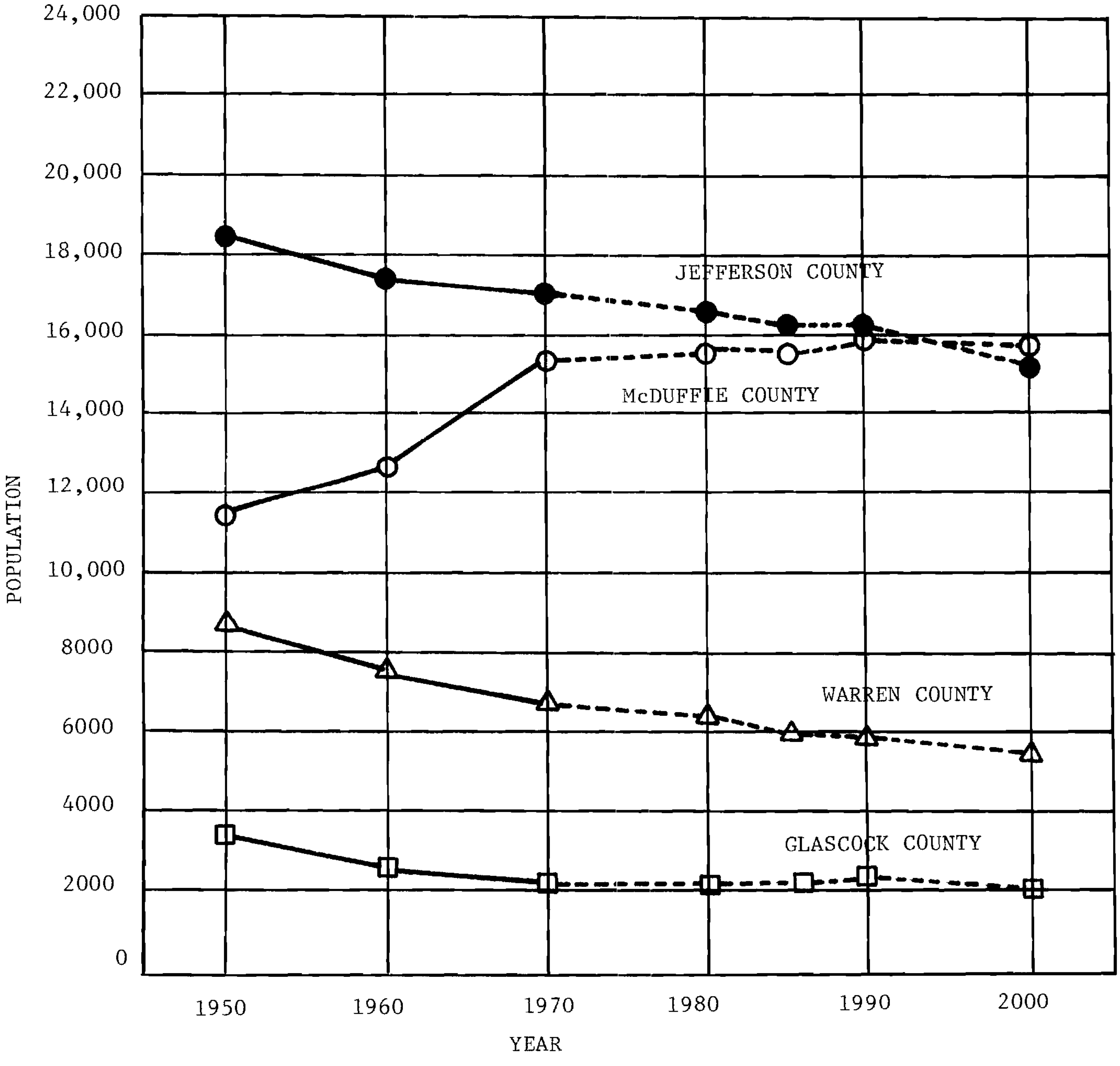



FIGURE 12. Historical and Projected Populations.

growth predicted for the future. Based on a broad economic base of valuable natural resources, these projections seem to be reasonable. The population increases should occur in and around the small towns and cities scattered across the three-county area.

A few of the cities and towns have become convenient locations for small industries. Warrenton and Thomson serve as textile and agricultural centers. Louisville, the old State capital, has large agricultural services and tourist facilities plus some manufacturing. However, since Jeffe son, Glascock and Warren counties are basically agriculture oriented, a population decline is projected.

McDuffie County is not following this trend of decline which is probably related to the fact that Thomason is the city with the largest population in the seven-county area. Also, Thomson is the largest center for commerce in the area. Employment is high in areas of paper and textile products, foods, and rubber and plastic products. The rise of population in this county seems reasonable.

Economic Profile

Historically, the study area of Georgia has depended upon agriculture as the principal economic activity. Field crops, especially cotton, were a major source of income. The production of agricultural goods and first stage processing provided jobs for most of the labor force even as late as 1950. However, since World War II, industrial growth has been experienced, primarily based on minerals, forest resources, and the introduction of textile and apparel mills. Mineral products produced include kaolin, fullers earth, limestone, bauxite, granite, quartz, peat, sand, gravel, and rock. Moreover, agricultural production has become more diversified with a shift from field crops to increased production of timber, livestock, and poultry. Commercial forests of oak, hickory, and various pines occupy approximately 70 percent of the area.

The recent industrial expansion has been greatly facilitated by the presence of an abundant supply of high quality groundwater. This readily available supply of water has been especially important in the development if the mineral industry in the area. Primary development in the mineral industry has been with kaolin clays with estimated reserves between 5 and 15 billion tons. Washington County alone is presently the largest producer of kaolin in the United States.

## CURRENT WATER USERS AND TREATMENT SYSTEMS IN THE STUDY AREA

### Current Water Demand

Current water demand was determined using information compiled from previous studies and the permit files of the Water Supply Branch of the Environmental Protection Division (EPD) of the Georgia Department of Natural Resources. The EPD files contain detailed information on municipal water supply systems and surface and groundwater users for the entire State of Georgia.

Information on municipal water supply systems for the seven counties was compiled from the EPD files and is presented in Tables 4 through 8. Information was collected for only Class II systems; i.e., those providing services to at least 100 people. Information presents source and storage facilities by type and size and each well is described by depth, size, year drilled, and yield.

Information on major groundwater users for each of the seven counties was compiled from the EPD files and is presented in Tables 9 though 12. Locations of wells are shown in Figures 13 and 14. Different size circles are used to show the location of these groundwater users and provide a picture of the distribution of groundwater use in the study area. The information was obtained from groundwater use permits required by the state for any user

TABLE 4. Water Supply System for Washington County

| | | Source of Supply | | | | | Storage Facilities | |
|---|---|---|---|---|---|---|---|---|
| County | Owner/Facility | Well No. | Total Depth, ft. | Diam., in. | Year Drilled | Yield, gpm | Type | Size, gal. |
| Washington | American Industrial Clay Co., Sandersville | 1 | 400 | 12/10 | 1969 | 750 | Elevated | 40,000 |
| | | 2 | 385 | 8 | 1961 | 500 | | |
| | | 3 | 420 | 12/10 | 1966 | 750 | | |
| | | 4 | 430 | 12/10 | 1971 | 750 | | |
| | Davisboro | 1 | (not in use due to high concentration of undesirable chemicals) | | | | | |
| | | 2 | 503 | 8 | 1972 | 354 | Elevated | 100,000 |
| | Deepstep | 1 | 200 | - | 1966 | 60 | Pressure | 5,000 |
| | Harrison | 1 | 700 | 8 | 1967 | 800 | Elevated | 75,000 |
| | Oconee | 1 | 311 | 8 | - | 100 | Standpipe | 113,000 |
| | Riddleville | 1 | 500 | 8 | - | 120 | Pressure | 5,000 |
| | Sandersville | 1 | 200 | 6 | UKN | 75 | Elevated | 400,000 |
| | | 2 | 700 | 10 | 1944 | 250 | Ground | 150,000 |
| | | 3 | 550 | 8 | 1953 | 300 | | |
| | | 4 | 400 | 8 | 1960 | 175 | | |
| | | 5 | 750 | 8 | 1960 | 500 | | |
| | | 6 | 550 | 10 | 1966 | 600 | | |
| | Tennille | 1 | 165 | 12 | 1962 | 450 | Elevated | 250,000 |
| | Warthen | 1 | 301 | - | 1971 | 163 | Pressure | 5,000 |

TABLE 5. Water Supply System for Wilkinson County

| | | Source of Supply | | | | | Storage Facilities | |
|---|---|---|---|---|---|---|---|---|
| County | Owner/Facility | Well No. | Total Depth, ft. | Diam., in. | Year Drilled | Yield, gpm | Type | Size, gal. |
| Wilkinson | Allentown | 1 | 525 | 8 | 1965 | 200 | Elevated | 75,000 |
| | Gordon | 1 | – | 8 | 1940 | 100 | Elevated | 200,000 |
| | | 2 | 275 | 6 | 1966 | 230 | | |
| | | 3 | 344 | 6 | 1970 | 500 | | |
| | Irwinton | 1 | 160 | 6 | 1954 | 200 | Elevated | 17,000 |
| | | 2 | 270 | 6 | 1956 | 400 | Ground | 20,000 |
| | | 3 | 260 | 6 | 1972 | 600 | | |
| | Ivey | 1 | 220 | 8 | 1965 | 50 | Pressure | 5,000 |
| | | 2 | 238 | 6 | 1970 | 200 | Pressure | 5,000 |
| | McIntyre | 1 | 230 | – | 1956 | 200 | Elevated | 100,000 |
| | Toomsboro | 1 | 300 | 8 | 1950 | 375 | Ground | 65,000 |
| | | 2 | 300 | 8 | 1955 | 150 | | |

TABLE 6. Water Supply System for Twiggs County

| | | Source of Supply | | | | | Storage Facilities | |
|---|---|---|---|---|---|---|---|---|
| County | Owner/Facility | Well No. | Total Depth, ft. | Diam., in. | Year Drilled | Yield, gpm | Type | Size, gal. |
| Twiggs | Danville | 1 | 795 | 12 | 1965 | 160 | Elevated | 75,000 |
| | Georgia Kaolin Co., Dry Branch | 1 | UKN | UKN | 1945 | 250 | Ground | 20,000 |
| | | 2 | UKN | UKN | 1945 | 170 | | |
| | | 3 | 372 | 10 | 1955 | 450 | | |
| | | 4 | 552 | 10 | 1965 | 600 | | |
| | | 5 | 431 | 12 | 1968 | 800 | | |
| | Jeffersonville | 1 | 570 | 8 | 1957 | N.R. | Clearwell | UKN |
| | J. M. Huber Corp. | 1 | 250 | 8 | 1938 | 584 | Elevated | 75,000 |
| | | 2 | 200 | 8 | 1951 | 584 | | |
| | | 3 | 195 | 8 | 1961 | 632 | | |
| | | 4 | 230 | 12 | 1972 | 1040 | | |
| | North Elementary Complex 1, Dry Branch | 1 | 305 | 6 | 1975 | 60 | Pressure | 500 |
| | North Complex 11, | 1 | 263 | 4 | 1957 | 10 | Pressure | 500 |
| | South Complex 11, Hwy 96 and 358 | 1 | 200 | 4 | - | 10 | Pressure | 500 |
| | Twiggs County Junior High School, Jeffersonville | 1 | 346 | 6 | - | 130 | Elevated<br>Pressure | 10,000<br>500 |

TABLE 7. Water Supply Systems for Glascock and Jefferson Counties

| County | Owner/Facility | Source of Supply | | | | | Storage Facilities | |
|---|---|---|---|---|---|---|---|---|
| | | Well No. | Total Depth, ft. | Diam., in. | Year Drilled | Yield, gpm | Type | Size, gal. |
| GLASCOCK | | | | | | | | |
| | Gibson | 1 | 200 | 8 | 1970 | 157 | Elevated | 165,000 |
| | | 2 | 113 | 8 | 1963 | 52 | | |
| | | 3 | 155 | - | 1960 | 31 | | |
| | Mitchell | 1 | 90 | 8 | 1963 | 50 | Elevated | 40,000 |
| | | 2 | 90 | 8 | 1969 | 30 | | |
| | | 3 | 500 | 18 | - | - | | |
| | | 4 | 355 | 18 | 1968 | 27.4 | | |
| | | 5 | 510 | 20 | 1975 | 12.4 | | |
| | | 6 | 300 | 8 | 1964 | 74.0 | | |
| | | 7 | 145 | 20 | 1975 | 33.1 | | |
| JEFFERSON | | | | | | | | |
| | Avera | 1 | 186 | 8 | - | | Elevated | 60,000 |
| | | 2 | 352 | 8 | 1972 | 350 | | |
| | | 3 | 147 | 8 | - | 50 | | |
| | Bartow | 1 | 370 | | 1967 | 100 | Unknown | 75,000 |
| | | 2 | 415 | | 1969 | 100 | | |
| | | 3 | 385 | | 1969 | 175 | | |
| | Louisville | 1 | 367 | 8 | 1958 | 868 | Elevated | 150,000 |
| | | 2 | 348 | 10 | 1963 | 884 | Ground | 120,000 |
| | Stapleton | 1 | 300 | 8 | 1956 | 50 | Elevated | 135,000 |
| | | 2 | 500 | 8 | 1964 | 75 | | |
| | | 3 | 266 | - | 1964 | 220 | | |
| | Wadley | 1 | 481 | 8 | 1952 | 503 | Elevated | 150,000 |
| | | 2 | 280 | - | 1963 | 300 | | |
| | | 3 | 491 | 8 | 1976 | 703 | | |
| | Wrens | 1 | 150 | 10 | 1941 | 100 | Elevated | 410,000 |
| | | 2 | 150 | 8 | 1950 | 100 | | |
| | | 3 | 150 | 8 | 1965 | 175 | | |
| | | 4 | 200 | 8 | 1970 | 140 | | |

TABLE 8. Water Supply Systems for McDuffie and Warren Counties

| County | Owner/Facility | Source of Supply | | | | | Storage Facilities | |
|---|---|---|---|---|---|---|---|---|
| | | Well No. | Total Depth, ft. | Diam., in. | Year Drilled | Yield, gpm | Type | Size, gal. |
| MCDUFFIE | | | | | | | | |
| | Dearing | 1 | 400 | 6 | 1948 | 90 | Elevated | 100,000 |
| | | 2 | 700 | 6 | 1970 | 40 | | |
| | | 3 | 500 | 6 | 1969 | 36 | | |
| | Kingley Mills | 1 | 379 | 10 | 1950 | 90 | Elevated | 115,000 |
| | | 2 | 383 | 10 | 1950 | 44.5 | | |
| | Thomson | | Surface Supply | | Usery Road Creek<br>Sweetwater Creek | | - | - |
| WARREN | | | | | | | | |
| | Camak | 1 | 610 | 6 | 1975 | 27 | Elevated | 65,000 |
| | | 2 | 620 | 6 | 1946 | 15 | | |
| | Briarwood Academy | 1 | 250 | 6 | 1970 | 12 | Pressure Tank | 1,000 |
| | Norwood | 1 | 600 | 6 | 1977 | 40.5 | Elevated | 625,000 |
| | Warrenton | | Rocky Comfort Creek | | | | | |

TABLE 9. Major Groundwater Users in Washington County

| County | Owner/Facility | Vol., MGD | No. of Wells | Hrs./ Day | Purpose | Use Began |
|---|---|---|---|---|---|---|
| Washington | Anglo-American Clays Corp., Sandersville | 2.88 | 2 | 18 | Process Water | 11/73 |
| | American Industrial Clay Co., Chambers Mine | 0.72 | 1 | 24 | Sanitary Facilities Cooling Water, Process Water | - |
| | American Industrial Clay Co., Franklin Mine | 0.72 | 1 | 24 | Sanitary Facilities Cooling Water, Process Water | - |
| | American Industrial Clay Co., Sandersville | 5.213 | 5 | 24 | Sanitary Facilities Cooling Water, Process Water | 3/58 |
| | Engelhard Minerals and Chemicals Div. Gardener Plant - Oconee | 0.2448 | 3 | 20 | Process Water | 1908 |
| | Engelhard Minerals and Chemicals Div. Washington County Mine | 1.467 | 3 | 20 | Process Water | 1908 |
| | Freeport Kaolin Co. Scott Mine | 2.16 | 3 | 24 | Process Water | 4/76 |
| | Holmes Canning Co.,Sanders-ville | 0.20 | 2 | 10 | Central Water Supply Cooling Water, Process Water | 1946 1960 |
| | Thiele Kaolin Co.,Avant Mine | 1.154 | 3 | 14 | Sanitary Facilities, Process Water, Boiler Feed | 8/71 |
| | Thiele Kaolin Co.,Hall Mine | 0.26 | 1 | 12 | Sanitary Facilities, Cooling Water, Process Water | 6/73 |
| | Thiele Kaolin Co., Main Plant, Sandersville | 1.08 | 1 | 20 | Sanitary Facilities, Process Water, Boiler Feed | - |

TABLE 10. Major Groundwater Users in Wilkinson and Twiggs Counties

| County | Owner/Facility | Vol., MGD | No. of Wells | Hrs./ Day | Purpose | Use Began |
|---|---|---|---|---|---|---|
| Wilkinson | Engelhard Minerals and Chemicals Div. Gibraltor Mine | 1.170 | 2 | 18 | Process Water | 1908 |
| | Engelhard Minerals and Chemicals Div. Klondike Mine | 0.78 | 2 | 13 | Process Water | 1908 |
| | Engelhard Minerals and Chemicals Div.- Main Plant, McIntyre | 6.44 | 7 | 24 | Process Water | 1908 |
| | Gordon | 0.15 | 3 | 12 | Water Supply | 1920 |
| | McIntyre | 0.216 | 1 | 24 | Water Supply | 1956 |
| Twiggs | Cyprus Industrial Minerals, Jeffersonville | 0.72 | 1 | 24 | Sanitary Facilities Process Water | 10/66 |
| | Georgia Kaolin Dry Branch | 4.18 | 9 | 19 | Sanitary Facilities Central Water Supply Process Water | 1937 |
| | J. M. Huber Corp. West of Jeffersonville | 31.3 | 8 | 24 | Consumptive use for Dewatering | 9/68 |
| | J. M. Huber Corp. Huber | 1.77 | 4 | 12 | Sanitary Facilities, Cooling Water, Process Water | 12/38 |
| | Jeffersonville | 0.15 | 2 | 12 | Central Water Supply | 1944 |

TABLE 11. Major Groundwater Users in Glascock and Jefferson Counties

| County | Owner/Facility | Vol., MGD | No. of Wells | Hrs./ Day | Purpose | Use Began |
|---|---|---|---|---|---|---|
| Glascock | Gibson | 0.38 | 3 | - | Municipal Water Supply | 1960 |
| | Mitchell | 0.07 | 7 | - | Municipal Water Supply | 1963 |
| | Theile Kaolin Co. | 0.30 | 2 | 5.5 | Sanitary Facilities<br>Central Water Supply<br>Process Water | 1971 |
| Jefferson | Avera | 0.05 | 3 | - | Municipal Water Supply | 1972 |
| | Bartow | 0.14 | 3 | - | Municipal Water Supply | 1968 |
| | J. M. Huber | 1.47 | 3 | 20 | Process Water | 1965 |
| | J. P. Stevens Kaolin Co. | UNK | 3 | UNK | No Records at EPD | 1962 |
| | Louisville | 1.66 | 2 | - | Municipal Water Supply | 1958 |
| | Stapleton | 0.05 | 3 | - | Municipal Water Supply | 1956 |
| | Wadley | 0.94 | 3 | - | Municipal Water Supply | 1952 |
| | Wrens | 0.50 | 4 | - | Municipal Water Supply | 1941 |

TABLE 12. Major Groundwater Users in McDuffie and Warren Counties

| County | Owner/Facility | Vol., MGD | No. of Wells | Hrs./ Day | Purpose | Use Began |
|---|---|---|---|---|---|---|
| McDuffie | Dearing | 0.13 | 3 | - | Municipal Water Supply | 1948 |
| | Kingley Mills | - | 2 | - | Municipal Water Supply | 1950 |
| Warren | Camak | 0.09 | 2 | - | Municipal Water Supply | 1946 |
| | Briarwood | 1.5 | 1 | - | Municipal Water Supply | 1970 |
| | Norwood | - | 1 | - | Municipal Water Supply | 1977 |

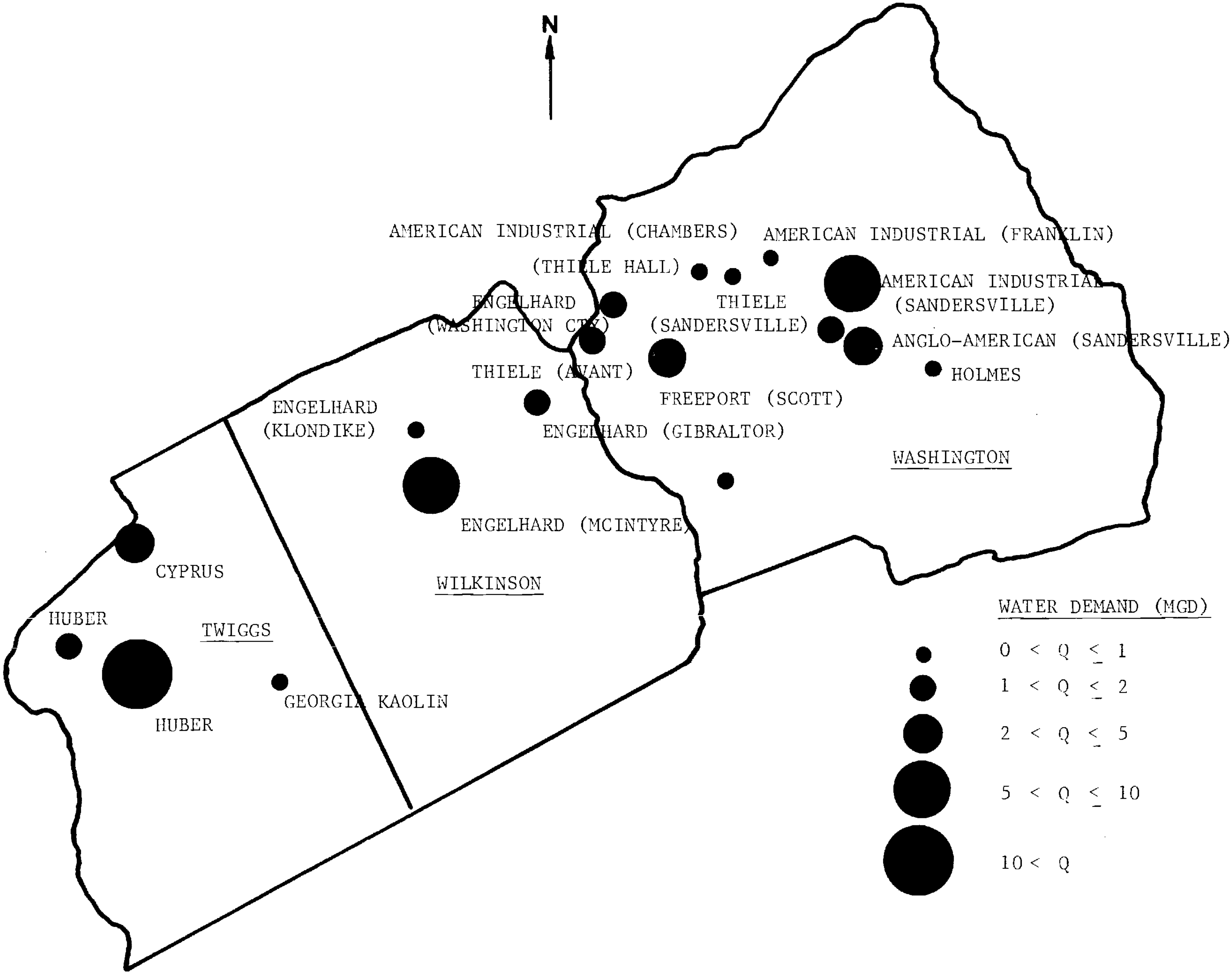



FIGURE 13. Location of Major Groundwater Users in Washington, Wilkinson and Twiggs Counties

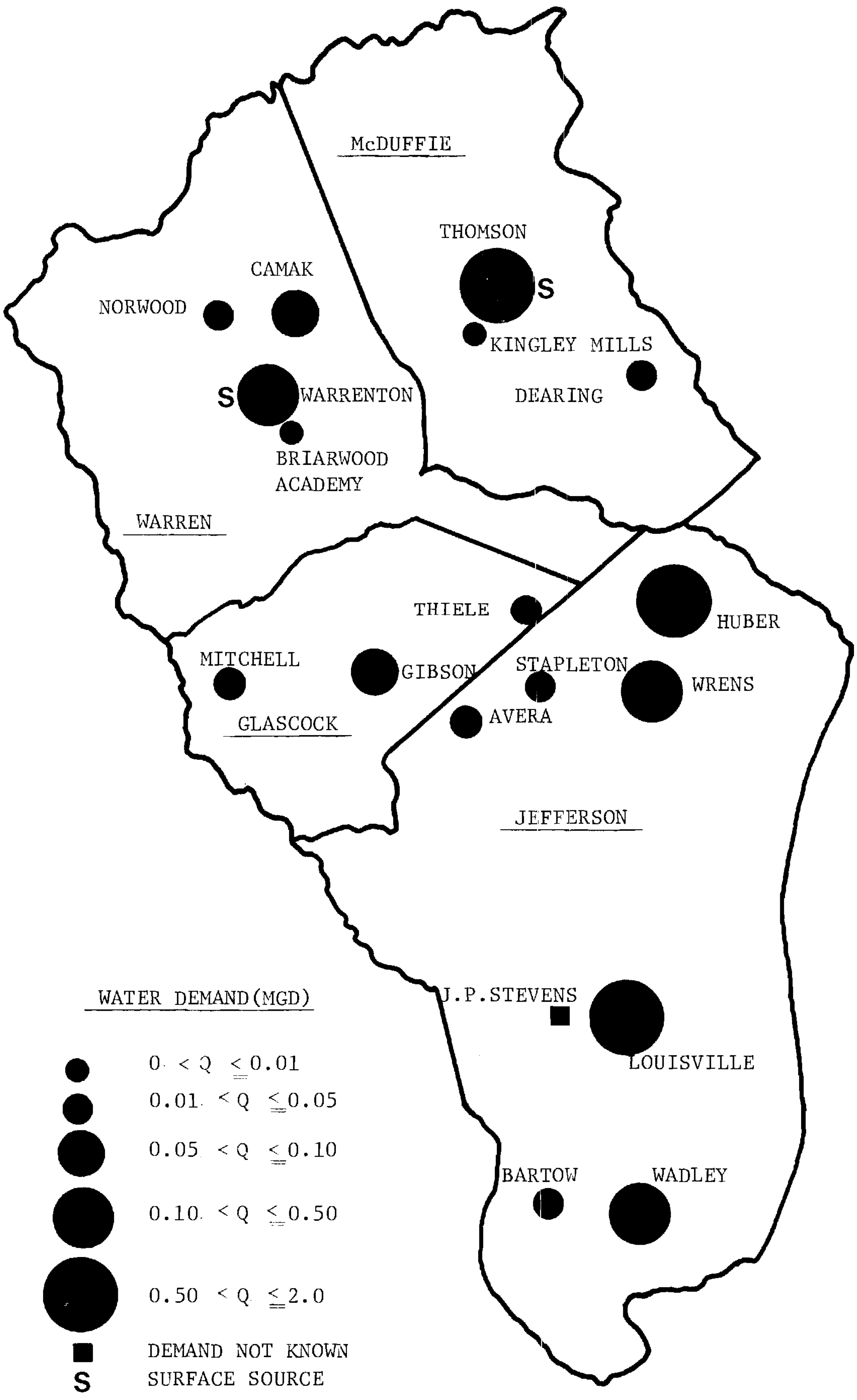



FIGURE 14. Location of Major Ground Water Users in Glascock, Jefferson, McDuffie and Warren Counties.

withdrawing greater than 100,000 gallons per day. The information presented includes the name of the owner or facility, authorized withdrawal, number of wells, hours pumped per day, purpose or use of supply, and the date usage began. Volumes vary from 0.15 to 31.3 MGD. A semi-annual monthly usage report must be filed with the EPD by each user. Presently this usage report appears to be only a formality as the monthly usage figures reported are always the authorized volumes on the permits. Therefore, these values are actually estimates of groundwater withdrawal.

Water Treatment Facilities

Although the availability of water is most important, treatment is often required to provide acceptable supplies for both municipal and industrial activities. Industrial activities in the study area influence the water resources in two ways; either in terms of use or in terms of effluent discharge and associated impact on the environmental receptor or downstream user. Municipal activities exhibit similar influences but, compared to industry, these influences on the water resource are often of lesser magnitude. This would be anticipated to be the case if a new alumina from kaolin industry were established. Depending upon location, such an industrial expansion with its associated influx of population could cause an overloading of existing municipal treatment facilities.

Information on municipal water treatment plants for the seven counties of the study area was compiled from EPD files, Water Quality Management Unit reports, and other earlier reports and is presented in Tables 13 and 14 and Figures 15 and 16. Each treatment facility is described by location, raw water source, rated capacity, average daily flow, type of treatment, and the population served. The last two columns, potential population and percent change in population, are calculated values which can be used as indications

TABLE 13. Municipal Water Treatment Facilities in Washington, Wilkinson and Twiggs Counties

| County | Location | Source | Rated Cap., MGD | Ave. Flow, MGD | Treatment Type | 1970 Population Served | 1970 Population | Potential Population | Population % Change |
|---|---|---|---|---|---|---|---|---|---|
| Washington | Davisboro | Well | 0.5 | 0.1 | C | 480 | 480 | 1600 | 233 |
| | Deepstep | Well | 0.0864 | 0.04 | C | 100 | 100 | 144 | 44 |
| | Harrison | Well | 0.80 | 0.05 | C | 330 | 330 | 3520 | 960 |
| | Oconee | Well | 0.03 | 0.017 | C,K | 260 | 260 | 305 | 17.3 |
| | Riddleville | Well | 0.043 | 0.015 | C | 150 | 105 | 280 | 87 |
| | Sandersville | Well | 2.16 | 0.93 | C,K | 5550 | 5550 | 8600 | 55 |
| | Tennille | Well | 1.296 | 0.248 | C | 1750 | 1750 | 6100 | 248 |
| | Warthen | Well | 0.06 | 0.015 | C,S | 125 | 200 | 333 | 167 |
| Wilkinson | Allentown | Well | 0.72 | 0.035 | C,K | 450 | 295 | 6170 | 1270 |
| | Gordon | Well | 1.0 | 0.25 | C,K,S | 2500 | 2600 | 6670 | 167 |
| | Irwinton | Well | 0.1 | 0.1 | C,K | 750 | 750 | 750 | 0 |
| | Ivey | Well | - | 0.05 | C,K | 350 | 245 | - | - |
| | McIntyre | Well | 0.216 | 0.15 | F,C,K | 1200 | 971 | 1200 | 0 |
| | Toomsboro | Well | - | 0.055 | C,K | 800 | 682 | - | - |
| Twiggs | Danville | Well | 0.075 | 0.025 | C,K | 500 | 500 | 1000 | 100 |
| | Jeffersonville | Well | 0.30 | 0.15 | A,F,C,S | 1300 | 1300 | 1730 | 33 |

Treatment Key:

A - Aeration
C - Chlorination
F - Filteration
K - Corrosion Control
V - Fluoridation
S - Softening

TABLE 14. Municipal Water Treatment Facilities in Glascock, Jefferson, McDuffie and Warren Counties

| County | Location | Source | Rated Cap., MGD | Ave. Flow, MGD | Treatment Type | 1970 Population Served | 1970 Population | Potential Population | Population % Change |
|---|---|---|---|---|---|---|---|---|---|
| Glascock | Gibson | Well | 0.38 | 0.079 | C,K | 700 | 701 | 2245 | 221 |
| | Mitchell | Well | 0.07 | 0.009 | C,K | 75 | 187 | 390 | 108 |
| Jefferson | Stapleton | Well | 0.045 | 0.035 | C,K | 392 | 390 | 390 | - |
| | Louisville | Well | 1.50 | 0.80 | C,K,F | 4000 | 2691 | 5000 | 25 |
| | Wadley | Well | 0.94 | 0.25 | C,V | 2450 | 1989 | 6140 | 151 |
| | Wrens | Well | 0.50 | 0.20 | C | 1628 | 2204 | 2710 | 66.5 |
| | Avera | Well | 0.05 | 0.025 | C,K | 220 | 217 | 290 | 31.8 |
| | Bartow | Well | 0.14 | 0.05 | C | 400 | 333 | 750 | 87.5 |
| McDuffie | Dearing | Well | 0.13 | 0.035 | C | 560 | 555 | 1380 | 146 |
| | Thomson | Surface | 1.0 | 0.5 | F,C,K | 4972 | 6503 | 6630 | 33.3 |
| | Kingley Mills | Well | - | 0.01 | - | 150 | 150 | | |
| Warren | Camak | Well | 0.09 | 0.012 | C | 300 | 224 | 1500 | 400 |
| | Warrenton | Rocky Comfort Ck Surface | 1.5 | .25 | F,C | 2603 | 2073 | 10400 | 300 |

Treatment Key:

A - Aeration
C - Chlorination
F - Filteration
K - Corrosion Control
V - Fluoridation
S - Softening

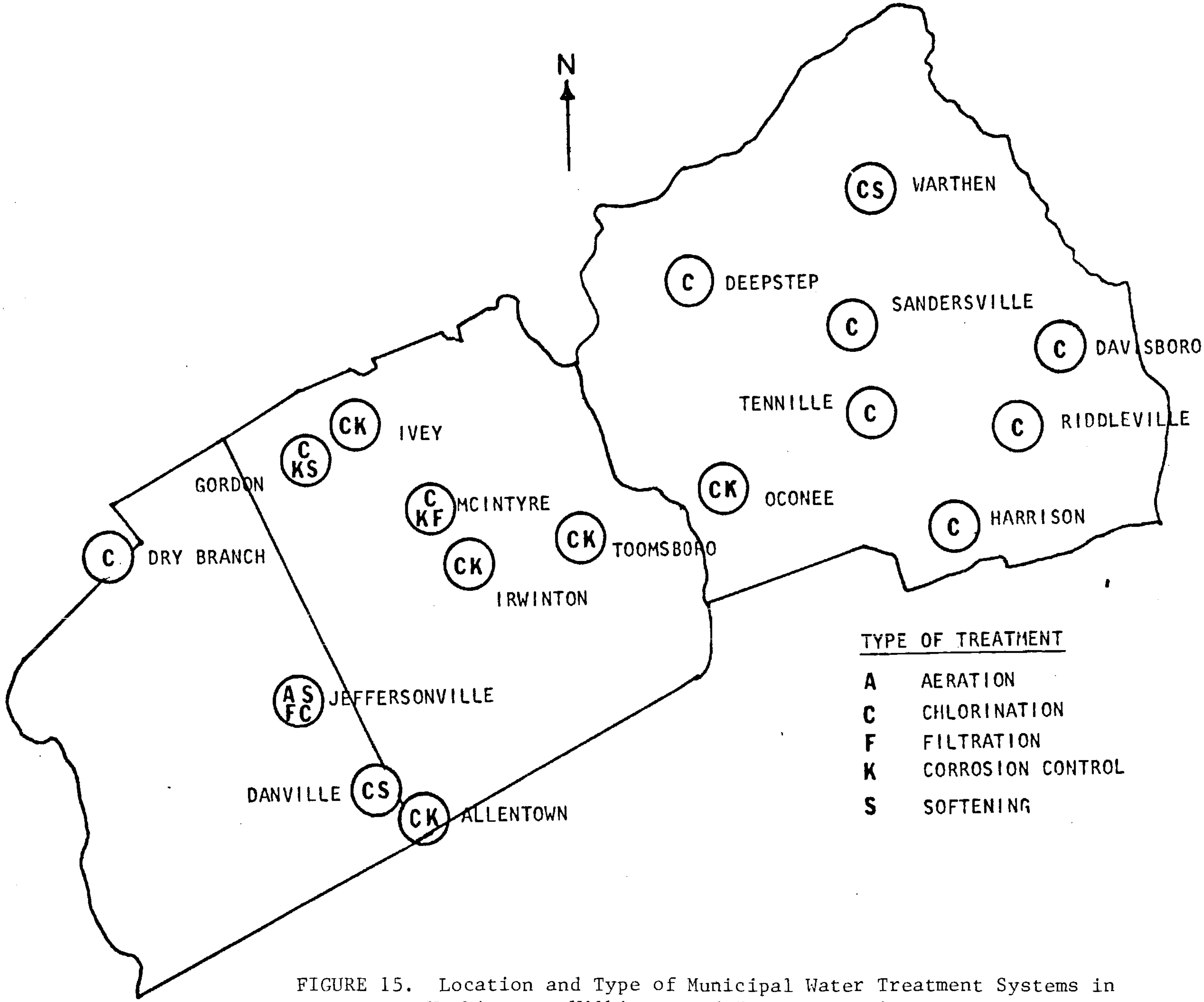



FIGURE 15. Location and Type of Municipal Water Treatment Systems in Washington, Wilkinson and Twiggs Counties

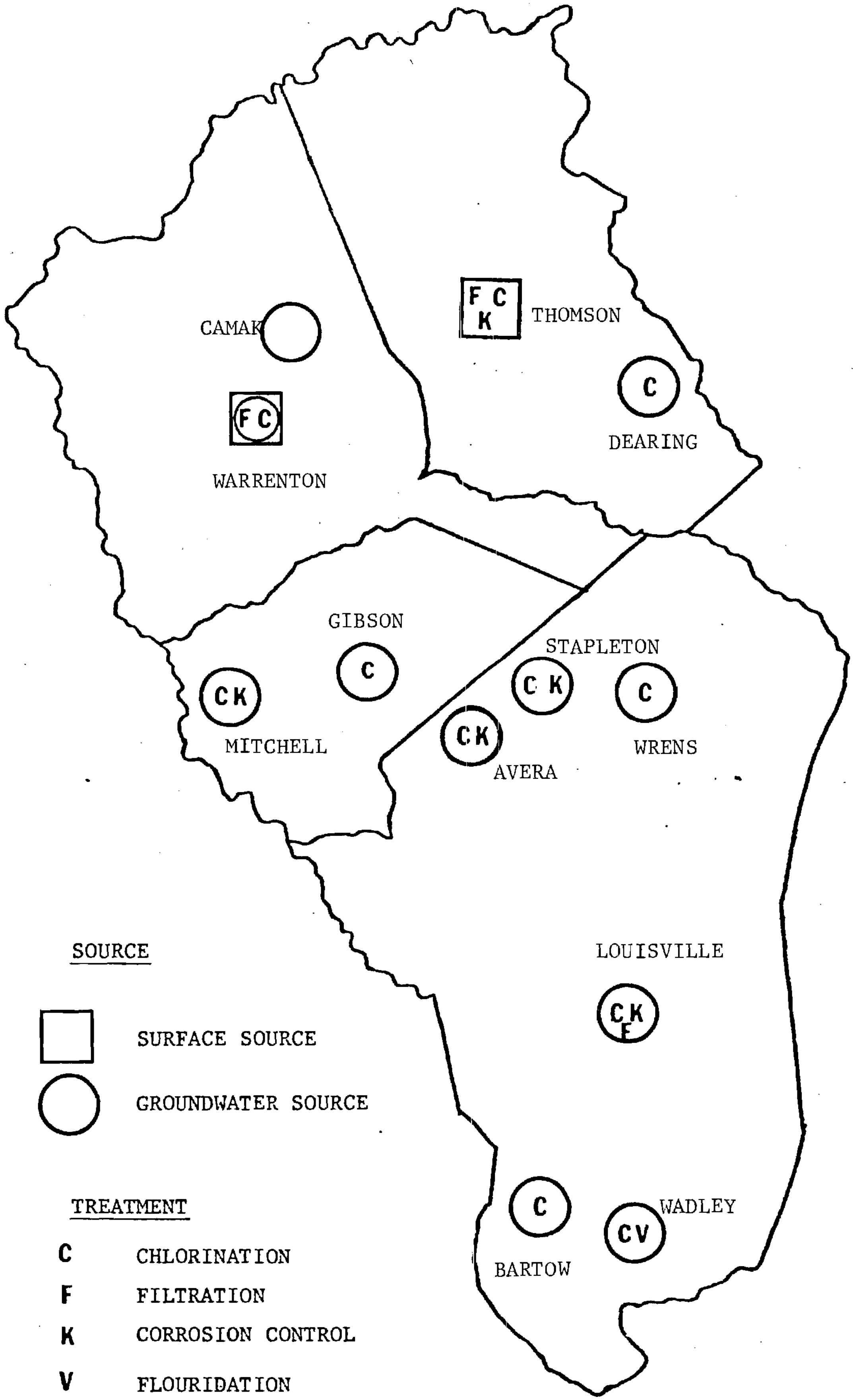



FIGURE 16. Location and Type of Municipal Water Treatment Systems in Glascock, Jefferson, McDuffie and Warren Counties

of population increases. To obtain the potential population, the plant's rated capacity was divided by 150 percent of the current per capita use. The per capita rate is the average flow divided by population served. Hence,

$$\text{Potential Population} = \frac{\text{Rated Capacity}}{1.5\ (\text{Average Flow/Population Served})}$$

The factor 1.5 is included to provide adjustment for peak flow rates. The percent change in population is simply the percent increase from the population served to the potential population. This percent increase can occur without hydraulically overloading the plant. However, it should be noted that the plant can be overloaded in terms of some other functional parameter while not being hydraulically overloaded, but to determine this would require a detailed study of the specific facility under consideration.

In the seven-county area, the current (1970) population served by municipal water supplies is approximately 34,800 and the potential population is 77,700. Thus the quantity of treated water available should not create particular problems.

The issue of water quality is another matter. While a detailed evaluation of each of the 29 plants reported is beyond the scope of this report, several assumptions can be set forth. First, any plant currently not in compliance with drinking water standards will be required to upgrade operations whether a new industry develops or not. Furthermore, no plant should violate this requirement due to a population increase which does not cause the plant to exceed its design capacity. Finally, equipment and/or plants will be periodically replaced or rebuilt as they become obsolete or insufficient to meet more rigorous future quality standards. It should be noted that as a result of this last assumption, population projections much past the year 2000 become meaningless when related to existing water treatment plants.

In discussing the treatment facilities in this area, it is necessary to keep in mind the actual extent of treatment. Of the 29 facilities in the seven-county area, nine have only chlorination facilities. Indeed, Bartow in Jefferson County reports treatment only at their No. 1 Well. Another 11 plants have only chlorine addition and pH control. Thus, if water supplies should become insufficient due to a new industry, it appears that the major cost of expansion will be the drilling of new wells.

These assumptions lead to the conclusion that drinking water quality should not be effected by the creation of an alumina from kaolin industry assuming that the industry would cause an influx of about 300 people and that the probable source of water would be the groundwater resource. However, the towns of Thomson and Warrenton draw their water from surface supplies. Should a new industry also utilize this source of water or cause discharges detrimental to the raw water source, these towns might have to install additional treatment facilities.

Kaolin mining companies are the major groundwater users in the study area. Review of the municipal groundwater demand values revealed that the average 1970 use statistics developed by Carter and Johnson (1974), provided the best and most complete estimate of current municipal groundwater demand. For the other estimates, some rated capacity and total water treated values were missing and some others seemed to be questionable. Using the usage figures included in Tables 9 through 12 and the 1970 population served estimates, a per capita usage rate of approximately 94 gallons per day was obtained for each county. This figure pertains only to the incorporated areas included in the data presentation.

Wastewater Treatment Facilities

Information on municipal wastewater treatment facilities for the seven-county area was compiled from EPD files and personal contact and is presented in Table 15. Locations of these plants are also graphically illustrated in Figures 17 and 18 together with type of treatment involved. Wastewater treatment facilities currently serve about 25,200 people with an estimated capacity to serve 34,700 people based upon the same assumptions used to determine potential population under the section on water treatment facilities but not less than the population presently served. This represents a permissable increase of 27.4 percent. However, it should be emphasized that only 33 percent of the current population of the area is served by municipal facilities. Thus existing facilities could become insufficient without a population change within any one county either by expanding services or by population shifts into the urban areas if not by imposition of regulatory requirements.

As with water treatment facilities, wastewater treatment facilities will require capital investments over time to replace equipment or meet new standards whether an alumina industry develops or not. However, unlike the water treatment plants, there are several waste treatment plants that probably do not meet current regulatory standards. Notable is the city of Stapleton which does not have treatment facilities yet reports flow.
In addition, it will be shown that although there are 29 water treatment plants, only 10 communities report wastewater flows. Finally, several plants show large unused capacities but are situated on water quality limited streams. This situation would be of significance if industrial discharge from the alumina from kaolin is planned for these locations.

It may be concluded, therefore, that where treatment plants exist, the creation of an alumina industry employing a few hundred people at a site

TABLE 15. Existing Municipal Wastewater Treatment Facilities

| County | Location | Capacity, MGD | Ave. Flow, MGD | Population Served | Potential Population | Treatment Type | Receiving Stream | Stream Designation | Comments |
|---|---|---|---|---|---|---|---|---|---|
| Washington | Sandersville | 0.50 | - | 5550 | 5550 | A,D | Buffalo Cr. | - | Assume ave. flow=100 gpcd |
| | Tennille | 0.20 | 0.18 | 175 | 175 | P | Dyers Cr. | - | |
| Wilkinson | Gordon | 0.20 | <0.15 | 3700 | 3700 | S | Lt. Commissioners Cr. | - | |
| Glascock | Gibson | 0.21 | 0.08 | 650 | 1130 | P,A,D | Rocky Comfort Cr. | EL | |
| Jefferson | Louisville | 0.40 | 0.01 | 3500 | 5065 | P | Rocky Comfort Cr. | EL | |
| | Louisville | 0.36 | - | | | P | Ogeechee R. | EL | Assume ave. flow=100 gpcd |
| | Stapleton | 0.08 | 0.04 | 390 | 520 | P* | Duhart Cr. | WQL | |
| | Wadley | 0.30 | 0.14 | 2000 | 2860 | P | Williamson Swamp Cr. | EL | |
| | Wrens | 0.28 | - | 1630 | 1870 | S | Bushy Cr. | - | Assume ave. flow=100 gpcd |
| McDuffie | Thomson | 1.00 | - | 5000 | 6660 | S | Little Brier Cr. | - | Assume ave. flow=100 gpcd |
| Warren | Warrenton #1 | 0.22 | 0.10 | 2600 | 4850 | P | Goldens Gr. | WQL | |
| | Warrenton #2 | 0.10 | 0.04 | | | P | Goldens Cr. | WQL | |
| | Warrenton #3 | 0.10 | 0.01 | | | P | Goldens Cr. | WQL | |
| Totals | | 3.95 | 1.91 | 25195 | 32380≠<br>34682⌿ | | | | |

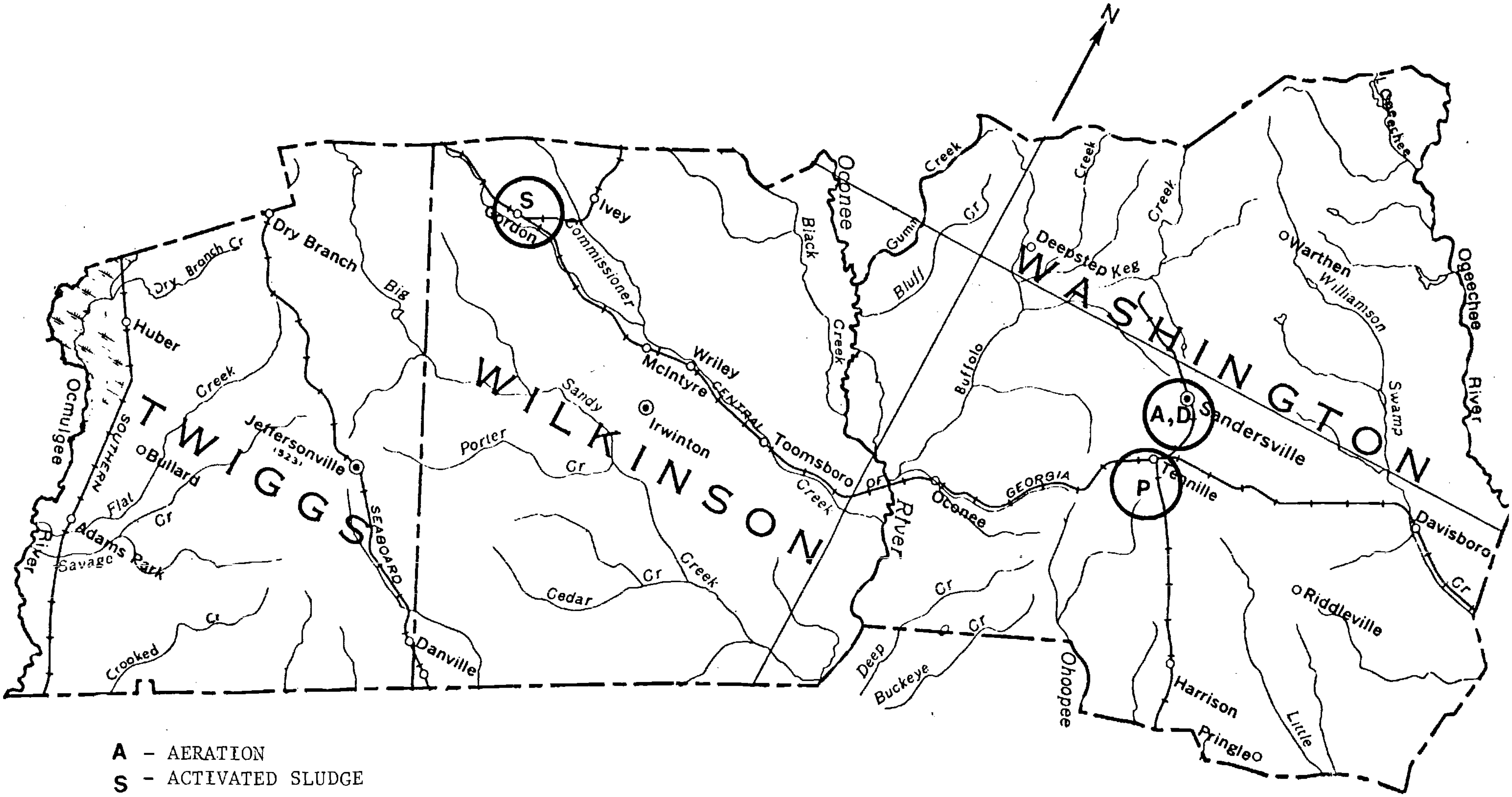
Treatment Key

S - Activated Sludge
P - Waste Stabilization Pond
A - Aeration
D - Disinfection

Stream Designation Key

EL - Effluent Limited
WQL - Water Quality Limited

⌿ Calculated from Totals
≠ Summation of Column
* Planned




**A** - AERATION

**S** - ACTIVATED SLUDGE

**P** - WASTE STABILIZATION POND

**D** - DISINFECTION

FIGURE 17. Location and Type of Wastewater Treatment Facility in Washington, Wilkinson and Twiggs Counties

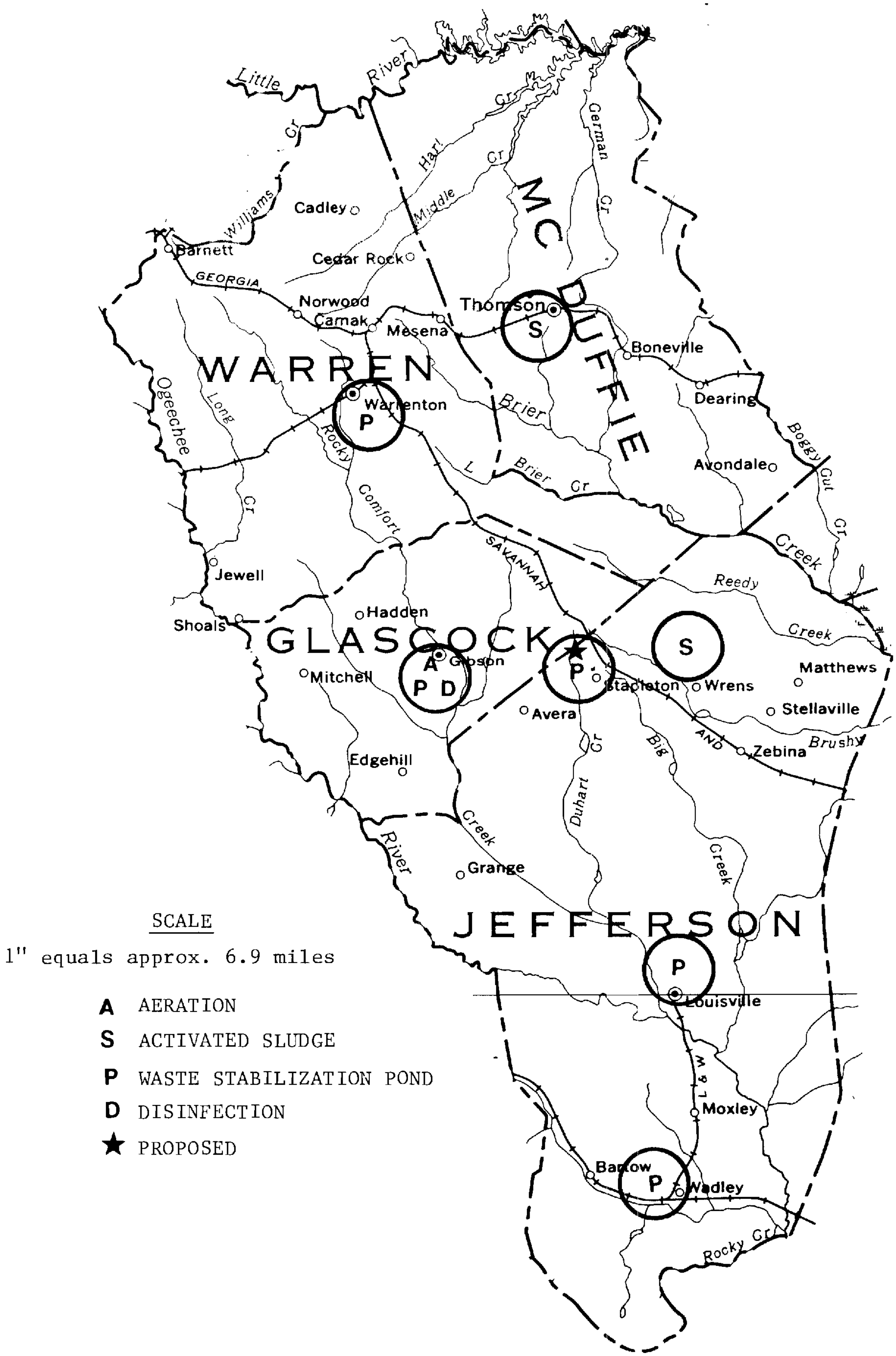



FIGURE 18. Location and Type of Wastewater Treatment Facility in Glascock, Jefferson, McDuffie and Warren Counties

will normally not cause existing plants to be overloaded. However, capital investments for wastewater treatment facilities could be required for any of the following reasons:

1. Influx of population may require the development of a public facility to replace current individual systems;
2. Increased population may cause the current level of treatment at a public facility to become insufficient for discharge into water quality limited streams (particularly at Stapleton);
3. A large increase in population at one locality could overload an existing plant; and,
4. The industry itself would likely be required to pretreat its wastewater effluent prior to discharge.

## ASSESSMENT OF GROUNDWATER RESOURCES

### Data Base

The water-bearing beds of the Barnwell and Tuscaloosa formations have been the major sources of groundwater in east-central Georgia. The Tuscaloosa formation contains the largest supplies of groundwater, but the Barnwell formation also contains many wells because it is shallower. Well data for the seven counties have been compiled in Tables 16 through 22 with the following information presented:

1. Well number
2. Owner
3. Use
4. Depth (feet)
5. Diameter of well (inches)
6. Ground surface elevation (feet - mean sea level datum)

TABLE 16. Information on Wells in Washington County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 131 | J. C. Archer | Private | 185 | 3 | - | 1944 | (-110) | 6 | |
| 132 | T. R. Duggan | Private | 204 | 3 | 475 | 1944 | 455 | 7 | |
| 133 | M. M. Veal | Private | 131 | 8 | 280 | 1942 | 273 | 15 | |
| 134 | J. P. Veal | Private | 178 | 8 | 278 | 1942 | 261 | | |
| 135 | H. B. Avant | Private | 85 | 3 | - | 1944 | (-15) | | |
| 136 | W. Brown | Private | 215 | 3 | - | 1944 | (-65) | | |
| 137 | L. M. Amerson | Private | 253 | 3 | 455 | 1944 | 265 | 15 | |
| 138 | J. H. Taylor | Private | 110 | 2 | 335 | 1944 | 246 | | |
| 139 | Davisboro | Public | 288 | 8 | 295 | 1944 | 285 | 100 | |
| 140 | Sandersville | Public | 760 | 10 | 465 | 1944 | 245 | 500 | |
| 141 | B. Tarbutton | Private | 220 | 4 | - | 1944 | (-65) | 5 | |
| 142 | W. Harris | Private | 85 | 3 | 255 | 1944 | 243 | | |
| 143 | W. Harris | Private | 125 | 3 | 255 | 1944 | 235 | | |
| 144 | B. F. Chambers | Private | 100 | 3 | 265 | 1944 | 255 | | |
| 145 | L. A. Wood | Private | 274 | 8 | 271 | 1944 | 276 | 35 | |
| 146 | G. Hutchings | Private | 304 | 10 | 269 | 1944 | 276 | 270<br>150<br>600 | |
| 147 | Brooks Springs | Private | 425 | - | 256 | 1944 | 276 | 30 | |
| 148 | Edgar Bros. | Industrial | 303 | 8 | 290e | 1944 | 190e | 450 | |
| 149 | Edgar Bros. | Industrial | 249 | 8 | 290e | 1944 | 215e | 250 | |
| 150 | G. S. Garbutt | Private | 95 | 2 | 315e | 1944 | 235e | | |
| 151 | T. J. Veal | Private | 41 | 3 | 293 | 1944 | 280 | 10 | |
| 152 | T. J. Veal | Private | 18 | 3 | 270 | 1944 | 268 | 4 | |
| 153 | B. L. Helton | Private | 110 | 2 | 320 | 1944 | 290 | | |
| 154 | W. H. Avant | Private | 96 | 2 | 348 | 1944 | 333 | | |
| 155 | Deepstep Jr. H.S. | Public | 109 | 3 | 358 | 1944 | 337 | 7.5 | |
| 156 | E. P. Wood | Private | 174 | 4 | - | 1944 | (-100) | | |
| 157 | O. M. Ennis | Private | 312 | 4 | 270e | 1944 | 160e | | |
| 158 | A. J. Hobbings | Private | 450 | 4 | 240e | 1944 | 220e | 13.3 | |
| 159 | N. Tucker | Private | 75 | 3 | 260e | 1944 | 245e | | |
| 160 | A. J. Carr | Private | 244 | 3 | - | 1944 | (-50) | | |

TABLE 16. Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 161 | Edgar Bros. | Industrial | 123 | 2 | 222 | 1944 | 230 | 10 | |
| 162 | Edgar Bros. | Industrial | 123 | 4 | 222 | 1944 | 232 | 60 | |
| 163 | Edgar Bros. | Industrial | 123 | 4 | 221 | 1944 | 230 | 40 | |
| 164 | Edgar Bros. | Industrial | 123 | 2 | 221 | 1944 | 230 | 5 | |
| 165 | Edgar Bros. | Industrial | 82 | 6 | 217 | 1944 | 208 | 60 | |
| 166 | English China Clay | Industrial | 156 | 4 | 218 | 1944 | 230 | 40 | |
| 167 | E. M. Shepherd | Private | 120 | 2 | 218 | 1944 | 221 | 15 | |
| 168 | E. M. Shepherd | Private | 120 | 3 | 225 | 1944 | 230 | 3.5 | |
| 200 | Thiele, Avant 1 | Industrial | 465 | 10 | 265 | 1972 | 224 | 75 | 4.2 |
| 201 | Thiele, Avant 2 | Industrial | 400 | 10 | 265 | 1972 | 217 | 1230 | 6.6 |
| | | | | | | 1975 | 213 | | |
| 202 | Thiele, Avant 4 | Industrial | 152 | 6 | - | 1976 | 215 | 20 | 20 |
| 203 | Englehard, WC1 | Industrial | 320 | 10 | 300 | 1959 | 230 | 468 | 3.2 |
| | | | | | | 1975 | 219 | | |
| 204 | Engelhard, WC2 | Industrial | 373 | 10 | 300 | 1959 | 230 | 336 | 2.3 |
| 205 | Freeport 1 | Industrial | 312 | 10 | - | 1975 | (-63) | 500 | 14.29 |
| 206 | Freeport 2 | Industrial | 315 | 10 | - | 1975 | (-81) | 500 | 18.05 |
| 207 | Freeport 3 | Industrial | 317 | 10 | - | 1976 | (-67) | 500 | 11.90 |
| 208 | Engelhard, Gard 1 | Industrial | 186 | 6 | 220 | 1966 | 220 | 185 | 4.62 |
| 209 | Deepstep, 1 | Public | 200 | - | 302 | 1966 | 247 | 210 | 5.4 |
| | | | | | | 1975 | 256 | | |
| 210 | Am.Ind.Clay, M4B | Industrial | 321 | 10 | 320 | 1967 | 257 | 572 | 7.3 |
| | | | | | | 1975 | 258 | | |
| 211 | Thiele, Hall 3 | Industrial | 315 | 8 | 270 | 1973 | 225 | 503 | 12.5 |
| | | | | | | 1975 | 218 | | |
| 212 | Am.Ind. Clay, M5 | Industrial | 368 | 10 | 270 | 1963 | 263 | 668 | 10.3 |
| 213 | Am.Ind. Clay, P4 | Industrial | 430 | 19 | 414 | 1971 | 230 | 983 | 26.8 |
| 214 | Am.Ind. Clay, P2A | Industrial | 390 | 10 | 435 | 1972 | 224 | 1016 | 29.0 |
| 215 | Am.Ind. Clay, P1B | Industrial | 400 | 10 | 430 | 1968 | 241 | 810 | 19.7 |
| 216 | Am.Ind. Clay, P3 | Industrial | 430 | 10 | 414 | 1966 | 239 | 781 | 13.2 |
| | | | | | | 1975 | 174 | | |
| 217 | Am.Ind. Clay, P5 | Industrial | 410 | 10 | 416 | 1950 | 245 | 400 | 22 |
| 218 | Thiele Plant 1 | Industrial | 700 | 10 | 454 | 1950 | 254 | 400 | |

TABLE 16.Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 219 | Thiele Plant 3 | Industrial | 718 | 10 | 440 | 1961 | 236 | 542 | |
| 220 | Sandersville 4 | Public | 475 | 10 | 451 | 1966 | 241 | 686 | |
| | | | | | | 1969 | | 250 | |
| 221 | Sandersville | Public | 431 | 8 | 465 | - | 331 | | |
| 222 | Sandersville, 5 | Public | 565 | 8 | 480e | 1952 | 390e | | |
| 223 | Tennille | Public | 990 | - | 477 | 1892 | 287 | | |
| 224 | Holmes Canning 1 | Industrial | 318 | 8 | 400 | 1946 | 260 | 150 | 9.2 |
| 225 | Holmes Canning 2 | Industrial | 335 | 8 | 395 | 1973 | 255 | 215 | 10 |
| 226 | Davisboro, 1 | Public | 400 | 8 | 336 | 1966 | 285 | 175 | |
| 227 | Davisboro, 2 | Public | 503 | 8 | 300e | 1972 | 190e | 850 | 7.3 |

e = estimated

TABLE 17. Information on Wells in Wilkinson County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity. gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 131 | I. F. Carr | Private | 115 | 3 | 370 | 1944 | 290 | | |
| 132 | W. G. Aycock | Private | 110 | 2 | 365 | 1944 | 280 | | |
| 133 | J. E. Wood | Private | 110 | 2 | 290 | 1944 | 225 | | |
| 134 | F. Riley | Private | 28 | 36 | 247 | 1944 | 235 | 25 | |
| 135 | C. Daniel | Private | 74 | 3 | 300 | 1944 | 266 | 3 | |
| 136 | D. A. Bloodworth | Private | 22 | 48 | 290 | 1944 | 272 | | |
| 137 | Bill McCook | Private | 72 | 2 | 300 | 1944 | 278 | | |
| 138 | J. T. Bloodworth | Private | 84 | 2 | 338 | 1944 | 263 | | |
| 139 | C. R. Johns | Private | 63 | 2 | 341 | 1944 | 285 | 5 | |
| 140 | M. H. Council | Private | 75 | 2 | 300 | 1944 | 233 | | |
| 141 | V. C. Johns | Private | 26 | 48 | 301 | 1944 | 279 | 6 | |
| 142 | C. C. Johns | Private | 95 | 48 | 377 | 1944 | 289 | | |
| 143 | C. C. Johns | Private | 24 | 48 | 300 | 1944 | 281 | | |
| 144 | O. B. Snow | Private | 100 | 2 | 420 | 1944 | 368 | | |
| 145 | L. J. Dyer | Private | 68 | 2 | 340 | 1944 | 308 | | |
| 146 | J. H. Hardie | Private | 110 | 2 | 400 | 1944 | 319e | | |
| 147 | W. Young | Private | 87 | 2 | 410e | 1944 | 370e | 2 | |
| 148 | J. Humphries | Private | 60 | 48 | 420 | 1944 | 366 | | |
| 149 | A. R. Cobb | Private | 48 | 48 | 400e | 1944 | 362e | | |
| 150 | E. L. Vinson | Private | 205 | 2 | 520 | 1944 | 345 | 3 | |
| 151 | Gordon | Public | 146 | 6 | 340 | 1944 | 322 | 65 | 4.3 |
| 152 | E. E. Miller | Private | 175 | 4 | 325 | 1944 | 322 | 60 | |
| 153 | A. B. Brooks | Private | 65 | 2 | 340e | 1944 | 325e | 3 | |
| 154 | W. B. Richardson | Private | 78 | 2 | 370e | 1944 | 330e | 3 | |
| 155 | J. B. Hornsby | Private | 32 | 36 | 330e | 1944 | 298e | | |
| 156 | E. M. McCook | Private | 64 | 2 | 340 | 1944 | 308 | | |
| 157 | J. R. McCook | Private | 86 | 2 | 305 | 1944 | 277 | | |
| 158 | R. L. Hardie | Private | 85 | 2 | 360 | 1944 | 310 | 7 | |
| 159 | Mt. Carmel School | Public | 82 | 2 | 400 | 1944 | 342 | | |
| 160 | Edgar Bros. #7 | Industrial | 295 | 10 | 370 | 1944 | 325 | 700 | 35.0 |
| 161 | Edgar Bros. #5 | Industrial | 315 | 4 | 285 | 1944 | 230 | 40 | |

TABLE 17. Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 162 | Edgar Bros. #4 | Industrial | 203 | 10 | 308 | 1944 | 272 | 835 | 41.8 |
| 163 | Edgar Bros. #1 | Industrial | 204 | 10 | 260 | 1944 | 220 | 300 | |
| 164 | Edgar Bros. #3 | Industrial | 198 | 10 | 260 | 1944 | 212 | 500 | |
| 165 | Edgar Bros. #2 | Industrial | 185 | 10 | 260 | 1944 | 212 | 600 | |
| 166 | Edgar Bros. #6 | Industrial | 315 | 10 | 380 | 1944 | 275 | 100 | |
| 167 | J. M. Shephard | Private | 121 | 2 | 290 | 1944 | 275 | 12 | |
| 168 | Wilkinson Motor | Private | 70 | 8 | 259 | 1944 | 244 | 300 | |
| 169 | J. T. Stevens | Private | 168 | 2 | 255 | 1944 | 252 | 3 | |
| 170 | W. C. Bentley | Private | 93 | 3 | 297 | 1944 | 332 | | |
| 171 | H. E. Stephens | Private | 60 | 2 | 410 | 1944 | 365 | | |
| 172 | M. H. Wall | Private | 110 | 1 | 230 | 1944 | 208 | 64 | |
| 173 | M. H. Wall | Private | 28 | 4 | 230 | 1944 | 208 | | |
| 174 | Toomsboro T.S. | Public | 88 | 2 | 225 | 1944 | 229 | 2 | |
| 175 | L. L. Curry | Private | 18 | 1 | 230 | 1944 | 216 | 12 | |
| 176 | Wilk. Co. Lumber | Private | 85 | 2 | 223 | 1944 | 225 | 2 | |
| 177 | C. Thompson | Private | 87 | 3 | 200 | 1944 | 240 | 30 | |
| 178 | C. Thompson | Private | 85 | 2 | 205 | 1944 | 240 | 8 | |
| 179 | N. Toller | Private | 87 | 2 | 282 | 1944 | 292 | 3 | |
| 180 | M. B. Beal | Private | 65 | 2 | 272 | 1944 | 285 | 1 | |
| 181 | L. W. Beck | Private | 117 | 2 | 303 | 1944 | 283 | 6 | |
| 182 | L. W. Beck | Private | 195 | 2 | 343 | 1944 | 283 | 5 | |
| 183 | R. W. Culpepper | Private | 250 | 4 | 457 | 1944 | 343 | 8 | |
| 184 | R. W. Culpepper | Private | 265 | 3 | 457 | 1944 | 343 | 12 | |
| 185 | L. W. Bell | Private | 102 | 2 | 322 | 1944 | 260 | 3 | |
| 186 | Pennington | Private | 60 | 48 | 316 | 1944 | 265 | | |
| 187 | J. H. Lavender | Private | 81 | 2 | 310e | 1944 | 220e | 3 | |
| 188 | G. Hatcher | Private | 292 | 2 | 360e | 1944 | 255e | | |
| 189 | W. H. McDonald | Private | 116 | 2 | 330e | 1944 | 260e | 3 | |
| 190 | W. H. McDonald | Private | 86 | 2 | 320e | 1944 | 270e | 3 | |
| 191 | Pierce & Orr | Private | 360 | 2 | 390e | 1944 | 350e | | |
| 192 | Pierce & Orr | Private | 136 | 4 | - | 1944 | (+40) | 60 | |
| 200 | Ga. Kaolin 13 | Industrial | 440 | | 370 | 1965 | 322 | 806 | |
| | | | | | | 1975 | 233 | | |

TABLE 17. Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 201A | Gordon, 1 | Public | 267 | 10 | 360 | 1966 | 344 | 500 | |
| 201B | Gordon, 2 | Public | 344 | | 360 | 1975 | 334 | | |
| 201C | Gordon, 3 | Public | 340 | | 380 | 1974 | 316 | 450 | 4.9 |
| 202 | Ivey | Public | 223 | | 363 | 1968 | 293 | 363 | |
| 203 | Engelhard Klon 1 | Industrial | 300 | | 360 | 1940 | 296 | 500 | 20 |
| 204 | Engelhard Klon 3 | Industrial | 352 | | 315 | 1956 | 240 | 563 | 4.4 |
| 205 | Engelhard Gib 1 | Industrial | 365 | 6 | 355 | 1971 | 229 | 400 | 7.1 |
| 206 | Engelhard Gib 2 | Industrial | 585 | 12 | 425 | 1975 | 295 | 863 | 13.7 |
| 207A | Engelhard 10 | Industrial | 245 | 12 | 262 | 1966 | 244 | 1370 | 13.2 |
| 207B | Engelhard 11 | Industrial | 310 | 12 | 270 | 1966 | 240 | 1230 | 12.8 |
| 207C | Engelhard 12 | Industrial | 464 | 12 | 330 | 1968 | 238 | 770 | 11.7 |
| 207D | Engelhard 13 | Industrial | 495 | 12 | 270 | 1971 | 215 | 1212 | 13.0 |
| | | | | | | 1975 | 215 | | |
| 207E | Engelhard 14 | Industrial | 360 | 12 | 290 | 1973 | 232 | 1040 | 11.4 |
| 207F | Engelhard 15 | Industrial | 305 | 12 | 265 | 1974 | 210 | 1040 | 13.3 |
| 208A | Freeport 1 | Industrial | 350 | | 350 | 1963 | 338 | 150 | |
| 208B | Freeport 2 | Industrial | 351 | | 350 | 1963 | 330 | 500 | |
| 208C | Freeport 3 | Industrial | 348 | | 400 | 1964 | | 447 | |
| | | | | | | 1975 | 380 | | |
| 208D | Freeport 4 | Industrial | 344 | | 340 | 1964 | 320 | 500 | |
| 208E | Freeport 5 | Industrial | 332 | | 340 | 1964 | 320 | 600 | |
| 209 | Freeport Research | Industrial | 325 | | 400 | 1960 | 340 | 120 | 1.5 |
| | | | | | | 1975 | 312 | | |

e = estimated

TABLE 18. Information on Wells in Twiggs County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 131 | C. H. Kitchens | Private | 70 | 48 | 450e | 1944 | 380e | | |
| 132 | Morgan Moore | Private | 76 | 2 | 442 | 1944 | 393 | | |
| 133 | Dan Gardener | Private | 34 | 3 | 400e | 1944 | 330e | | |
| 134 | L. M. Crosby | Private | 85 | 2 | 383 | 1944 | 318 | 6 | |
| 135 | L. M. Crosby | Private | 104 | 2 | - | 1944 | (-85) | 6 | |
| 136 | L. M. Crosby | Private | 52 | 3 | - | 1944 | (-37) | 6 | |
| 137 | Ed Chambers | Private | 82 | 2 | 380e | 1944 | 318 | | |
| 138 | Steve Ethridge | Private | 49 | 2 | 360e | 1944 | 320 | | |
| 139 | H. E. Cannon | Private | 60 | 2 | 390e | 1944 | 348 | | |
| 140 | C. C. Humphries | Private | 76 | 3 | 330e | 1944 | 294 | | |
| 141 | D. Y. Caleb | Private | 20 | 48 | 357 | 1944 | 339 | | |
| 142 | Ga. Kaolin, #4 | Industrial | 291 | 10 | 411 | 1937 | 346 | 500 | 38.5 |
| 143 | Ga. Kaolin, #5 | Industrial | 306 | 10 | 425 | 1944 | 346 | 300 | |
| 144 | Ga. Kaolin, #7 | Industrial | 313 | 10 | 415 | 1941 | 346 | | |
| 145 | Ga. Kaolin, Twisco | Industrial | 238 | 10 | 522 | 1944 | 352 | | |
| 146 | T. J. Johnson | Private | 37 | 2 | 370e | 1944 | 350e | 7 | |
| 147 | A. J. Land, Jr. | Private | 85 | 2 | 389 | 1944 | 311 | 4 | |
| 148 | Ga. Kaolin Co. | Industrial | 158 | 10 | - | 1944 | - | 150 | |
| 149 | Sgoda Corp. | Industrial | 194 | 8 | 272 | 1938 | 266 | 465 | |
| 150 | F. Lawson | Private | 1000 | 8 | 271 | 1944 | 283 | 75 | |
| 151 | M. D. Durden | Private | 138 | 2 | 390 | 1944 | 272 | 7 | |
| 152 | J. C. Solomon | Private | 252 | 3 | 555 | 1944 | 413 | 3 | |
| 153 | Jeffersonville | Public | 533 | 8 | 523 | 1944 | 323 | 50 | |
| 154 | D. C. Howell | Private | 368 | 2 | 480 | 1944 | 330 | | |
| 155 | J. McElrath | Private | 300 | 3 | 285 | 1944 | 325 | 60 | |
| 156 | I. Fitzpatrick | Private | 98 | 4 | 270 | 1944 | 290 | 20 | |
| 157 | M. Fitzpatrick | Private | 43 | 2 | 320 | 1944 | 308 | | |
| 158 | Wembley School | Private | 48 | 2 | 325 | 1944 | 281 | | |
| 159 | Miller Hendrick | Private | 360 | 6 | 258 | 1944 | 272 | | |
| 160 | B. F. Johnson | Private | 82 | 2 | 323 | 1944 | 249 | | |
| 161 | C.A. Little | Private | 160 | 2 | 376 | 1944 | 287 | | |

TABLE 18. Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 162 | R. W. Edwards | Private | 105 | 2 | 375 | 1944 | 290 | | |
| 163 | J. T. McCormick | Private | 76 | 2 | 363 | 1944 | 302 | | |
| 164 | O. B. Fitzpatrick | Private | 200 | 3 | 380 | 1944 | 230 | | |
| 165 | E. D. Ashley | Private | 83 | 2 | 390 | 1944 | 327 | | |
| 166 | Marion Bapt. Church | Private | 63 | 2 | 380 | 1944 | 332 | | |
| 200 | Ga. Kaolin, #10 | Industrial | 372 | 8 | 400 | 1955 | 340 | 584 | 14.2 |
| | | | | | | 1975 | 340 | | 13.2 |
| 201A | Ga. Kaolin, #12 | Industrial | 552 | 10 | 478 | 1965 | 344 | 608 | 21.0 |
| | | | | | | 1975 | 336 | | |
| 201B | Ga. Kaolin, #13 | Industrial | 490 | 10 | 375 | 1965 | 327 | 806 | 18.3 |
| | | | | | | 1975 | 327 | | |
| 201C | Ga. Kaolin, #14 | Industrial | 325 | 12 | 425 | 1968 | 324 | 935 | 30 |
| | | | | | | 1975 | 324 | | |
| 202 | Ga. Kaolin, #7 | Industrial | - | 10 | 380 | 1974 | 301 | 421 | 30 |
| 203 | Ga. Kaolin, #11 | Industrial | 433 | 10 | 380 | 1955 | 277 | 560 | 21.5 |
| 204 | Cyprus Ind. Min. | Industrial | 560 | 8 | | 1966 | (-240) | 500 | 33.33 |
| 205A | J. M. Huber DW1 | Industrial | 225 | 18 | 326 | 1967 | 295 | 2060 | 52.8 |
| 205B | J. M. Huber DW2 | Industrial | 282 | 18 | 334 | 1968 | 296 | | |
| 205C | J. M. Huber DW2A | Industrial | 280 | 18 | 322 | 1968 | 307 | | |
| 205D | J. M. Huber DW3A | Industrial | 330 | 18 | 361 | 1968 | 294 | | |
| 205E | J. M. Huber DW3B | Industrial | 305 | 18 | 356 | 1968 | 295 | | |
| 205F | J. M. Huber DW5 | Industrial | 290 | 18 | 337 | 1972 | 252 | 3400 | 45.3 |
| 205G | J. M. Huber DW6 | Industrial | 330 | 18 | 402 | 1972 | 254 | 2565 | 24.0 |
| 205H | J. M. Huber DW7 | Industrial | 340 | 18 | 397 | 1972 | 259 | 2830 | 34.5 |
| 206A | J. M. Huber 1 | Industrial | 194 | 8 | 270 | 1938 | 264 | | 23.2 |
| | | | | | | 1975 | 248 | 584 | |
| 206B | J. M. Huber 2 | Industrial | 278 | 8 | 270 | 1951 | 263 | 388 | 32 |
| | | | | | | 1975 | 242 | 584 | |
| 206C | J. M. Huber 3 | Industrial | 195 | 8 | 270 | 1961 | 255 | | 71.5 |
| | | | | | | 1975 | 244 | 632 | |
| 206D | J. M. Huber 4 | Industrial | 230 | 12 | 270 | 1972 | 256 | 1040 | 34.67 |
| | | | | | | 1975 | 226 | | |

e = estimated

TABLE 19. Information on Wells in Glascock County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 1 | G. Denton | Private | 45 | 40 | 540 | 1946 | 508 | | |
| 2 | A. J. Guy | Private | 38 | 36 | 555 | 1946 | 574 | | |
| 3 | F. E. Pebbles | Private | 37 | 36 | 550 | 1946 | 516 | | |
| 4 | G. Counsel | Private | 44.7 | 36 | 485 | 1946 | 444 | | |
| 5 | S. O. Smith | Private | 51 | 36 | 525 | 1946 | 485 | | |
| 6 | Ellis Chalker | Private | 25 | 36 | 487 | 1946 | 470 | | |
| 7 | Glenn Poole | Private | 25.8 | 36 | 505 | 1946 | 486 | | |
| 8 | Ray Johnson | Private | 38.4 | 36 | 540 | 1946 | 509 | | |
| 9 | James Willifred | Private | 64.8 | 24 | 555 | 1946 | 494 | | |
| 10 | Cecil Davis | Private | 48.8 | 36 | 550 | 1946 | 518 | | |
| 11 | H. S. Wilkerson | Private | 49 | 36 | 545 | 1946 | 503 | | |
| 12 | E. O. Hadden | Private | 69 | 40 | 550 | 1946 | 487 | | |
| 13 | C. Rivers | Private | 64 | 36 | 531 | 1946 | 472 | | |
| 14 | J. A. Rivers | Private | 40 | 36 | 500 | 1946 | 466 | | |
| 15 | J. H. Thigpen | Private | 30 | 38 | 510 | 1946 | 490 | | |
| 16 | Blankenship School | Private | 42 | 36 | 458 | 1946 | 423 | | |
| 17 | J. Thompson | Private | 42 | 36 | 481 | 1946 | 443 | | |
| 18 | J. May | Private | 30 | 36 | 310 | 1946 | 294 | | |
| 19 | H. Dickson | Private | 50 | 36 | 405 | 1946 | 365 | | |
| 20 | R. Melber | Private | 60 | 40 | 451 | 1946 | 396 | | |
| 201 | Thiele Kaolin,#1 | Industrial | 153 | 6 | 425 | 1976 | 363 | 87 | 6.21 |
| 202 | Thiele Kaolin,#2 | Industrial | 139 | 6 | 425 | 1976 | 356 | 50 | 1.22 |
| 101 | J. Usery | Private | 25 | 36 | 341 | 1946 | | | |
| 102 | C. Chalker | Private | 45 | 40 | 370 | 1946 | 332 | | |
| 203 | Gibson, #1 | Public | 200 | 8 | 420 | 1971 | 305 | 157 | |
| 204 | Gibson, #2 | Public | 113 | 8 | 350 | 1975 | 274 | 52 | 1.9 |
| 205 | Gibson, #3 | Public | 155 | - | 400 | 1973 | 340 | 31 | .3 |
| 206 | Mitchell, #1 | Public | 90 | 8 | 520 | 1974 | 503 | 50 | |
| 207 | Mitchell, #2 | Public | 90 | 8 | 496 | 1975 | 489 | 30 | |
| 208 | Mitchell, #3 | Public | 500 | 18 | 575 | 1974 | 492 | | |
| 209 | Mitchell, #4 | Public | 355 | 18 | 512 | 1974 | 495 | 27.4 | |
| 210 | Mitchell, #5 | Public | 510 | 20 | 528 | 1975 | 486 | 12.4 | .0639 |
| 211 | Mitchell, #6 | Public | 300 | 8 | 512 | 1975 | 496 | 74.0 | |
| 212 | Mitchell, #7 | Public | 195 | 20 | 535 | 1976 | 473 | 33.1 | .5015 |

TABLE 20. Information on Wells in Jefferson County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 1 | R. Lamb | Private | 86 | 3 | 460 | 1946 | 362 | | |
| 2 | F. Norton | Private | 31 | 36 | 340 | 1946 | 311 | | |
| 3 | L. English | Private | 57 | 40 | 360 | 1946 | 307 | | |
| 4 | H. Jordon | Private | 81 | 40 | 375 | 1946 | 298 | | |
| 5 | W. Dye | Private | 110 | 36 | 410 | 1946 | 306 | | |
| 6 | W. Dye | Private | 100 | 36 | 400 | 1946 | 308 | | |
| 7 | C. Brown | Private | 64 | 36 | 440 | 1946 | 379 | | |
| 8 | C. McGahee | Private | 75 | 36 | 445 | 1946 | 376 | | |
| 9 | M. Simmons | Private | 52 | 36 | 410 | 1946 | 365 | | |
| 10 | P. Dixon | Private | 100 | 3 | 420 | 1946 | 370 | | |
| 11 | M. Kelly | Private | 105 | 3 | 415 | 1946 | 367 | | |
| 12 | R. Beckworth | Private | 55 | 48 | 485 | 1946 | 435 | | |
| 13 | G. Landrum | Private | 80 | 2.5 | 410 | 1946 | 410 | | |
| 14 | R. Wilson | Private | 50 | 36 | 424 | 1946 | 376 | | |
| 15 | E. Rhodes | Private | 65 | 2 | 371 | 1946 | 321 | | |
| 16 | W. Avern | Private | 35 | 36 | 395 | 1946 | 363 | | |
| 17 | L. Hobbs | Private | 60 | 36 | 455 | 1946 | 410 | | |
| 18 | J. Raburn | Private | 51 | 36 | 520 | 1946 | 473 | | |
| 19 | Reedy Creek Church | Private | 52 | 2 | 460 | 1946 | 420 | | |
| 20 | W. Gray | Private | 70 | 36 | 495 | 1946 | 435 | | |
| 21 | S. Arrington | Private | 80 | 2 | 446 | 1946 | 401 | | |
| 22 | W. Millborn | Private | 67 | 36 | 470 | 1946 | 415 | | |
| 23 | L. Poole | Private | 66 | 3 | 460 | 1946 | 415 | | |
| 24 | Town of Wrens | Public | 130 | 12 | 423 | 1946 | 401 | | |
| 25 | J. Bell | Private | 31 | 40 | 370 | 1946 | 352 | | |
| 26 | O. Lancaster | Private | 39 | 36 | 420 | 1946 | 390 | | |
| 27 | E. McNair | Private | 24 | 1.5 | 438 | 1946 | 418 | | |
| 28 | A. Russell | Private | 80 | 2 | 370 | 1946 | 320 | | |
| 29 | M. Pennington | Private | 85 | 40 | 405 | 1946 | 330 | | |

TABLE 20. Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 30 | Thompson Church | Private | 25 | 36 | 390 | 1946 | 368 | | |
| 31 | H. Jones | Private | 30 | 36 | 385 | 1946 | 360 | | |
| 32 | C. Clifton | Private | 38 | 36 | 379 | 1946 | 351 | | |
| 33 | H. King | Private | 35 | 36 | 361 | 1946 | 330 | | |
| 34 | C. Minton | Private | 65 | 3 | 397 | 1946 | 367 | | |
| 35 | M. Henson | Private | 65 | 2.5 | 365 | 1946 | 309 | | |
| 36 | M. Bridges | Private | 77 | 3 | 320 | 1946 | 275 | | |
| 37 | J. Brown | Private | 125 | 3 | 350 | 1946 | 295 | | |
| 38 | A. Barfield | Private | 47 | 40 | 350 | 1946 | 310 | | |
| 39 | R. Beckworth | Private | 50 | 36 | 340 | 1946 | 295 | | |
| 40 | J. Walden | Private | 213 | 3 | 255 | 1946 | 261 | 20 | |
| 41 | R. Farmer | Private | 125 | 3 | 325 | 1946 | 300 | | |
| 42 | Baptist Church | Private | 21.5 | 36 | 321 | 1946 | 307 | | |
| 43 | J. Waters | Private | 170 | 3 | 245 | 1946 | 240 | | |
| 44 | J. Penrow | Private | 36 | 36 | 305 | 1946 | 279 | | |
| 45 | C. Mosely | Private | 200 | 3 | 325 | 1946 | 295 | | |
| 46 | H. Thomas | Private | 189 | 3 | 285 | 1946 | 233 | | |
| 47 | M. Lamb | Private | 25.4 | 36 | 250 | 1946 | 229 | | |
| 48 | M. Overstreet | Private | 110 | 4 | 210 | 1946 | 210 | 15 | |
| 49 | S. Cameron | Private | 215 | 3 | 284 | 1946 | 269 | | |
| 50 | H. Morris | Private | 45 | 36 | 280 | 1946 | 242 | | |
| 51 | J. Greenway | Private | 81 | 2 | 230 | 1946 | 234 | 6 | |
| 52 | B. C. Jordan Co. | Private | 60 | 4 | 218 | 1946 | 227 | | |
| 53 | L. Rachels | Private | 78 | 2.5 | 230 | 1946 | 232 | 5 | |
| 54 | L. Smith | Private | 128 | 1 | 244 | 1946 | 234 | | |
| 101 | J. Duprew | Private | 20 | 40 | 380 | 1946 | 364 | | |
| 102 | C. James | Private | 48 | 6 | 348 | 1946 | 306 | | |
| 103 | J. Norton | Private | 166 | 3 | 360 | 1946 | 300 | | |
| 104 | A. Burch | Private | 350 | 3.5 | 340 | 1946 | 280 | | |
| 105 | P. Hudson | Private | 260 | 3 | 356 | 1946 | 301 | | |
| 106 | J. Davis | Private | 215 | - | 220 | 1946 | 237 | 60 | |
| 107 | Louisville | Public | 35 | 6 | 238 | 1946 | 258 | 75 | |

TABLE 20. Continued

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 108 | E. McNeill | Private | 183 | 4 | 183 | 1946 | 198 | | |
| 109 | Wadley | Public | 445 | 2 | 220 | 1946 | 224 | 35 | |
| 201 | J. M. Huber, #1 | Industrial | 352 | 10 | 484 | 1976 | 322 | 305 | 8.5 |
| 202 | J. M. Huber, #2 | Industrial | 312 | 12 | 426 | 1976 | 306 | | |
| 203 | J. M. Huber, #3 | Industrial | 300 | 12 | 405 | 1976 | 302 | 620 | 14.4 |
| 204 | J. P. Stevens, #1 | Industrial | 486 | - | 315 | 1969 | 255 | 1,200 | |
| 205 | J. P. Stevens, #2 | Industrial | 396 | - | 315 | 1969 | 248 | 1,200 | |
| 206 | J. P. Stevens, #3 | Industrial | 393 | - | 315 | 1969 | 259 | 1,200 | |
| 207 | J. P. Stevens, #4 | Industrial | 425 | - | 315 | 1969 | 260 | 1,200 | |
| 208 | Avera 2 | Public | 352 | 8 | 450 | 1975 | 346 | 350 | 5.8 |
| 209 | Stapleton 3 | Public | 266 | - | 410 | 1975 | 349 | 220 | 1.8 |
| 210 | Wadley 1 | Public | 481 | 8 | 230 | 1975 | 225 | 503 | 8.58 |
| 211 | Wadley 3 | Public | 491 | 8 | 280 | 1975 | 217 | 703 | 12.78 |
| 212 | Wrens 4 | Public | 200 | 8 | 430 | 1974 | 370 | 190 | 6.3 |
| 213 | Bartow 3 | Public | 305 | - | 240 | 1975 | 239 | - | - |
| 214 | Louisville 1 | Public | 367 | 8 | 243 | 1975 | 230 | 860 | - |
| 215 } | Anglo-American 1 | Test | 377 | 2 | 347 | 1971 | - | | |
| 216 | Clay Corp. 2 | Wells | 362 | 4 | 348 | 1971 | - | | |

TABLE 21. Information on Wells in McDuffie County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 1 | E. Reeves | Private | 12 | 36 | 436 | 1946 | 430 | | |
| 2 | H. McGahee | Private | 32 | 30 | 498 | 1946 | 471 | | |
| 101 | J. Hinton | Private | 15 | 30 | 560 | 1946 | 550 | | |
| 102 | S. Anderson | Private | 56 | 36 | 590 | 1946 | 492 | | |
| 103 | M. Ansley | Private | 64 | 30 | 573 | 1946 | 513 | | |
| 104 | L. Watson | Private | 30 | 30 | 496 | 1946 | 471 | | |
| 105 | W. McCorkle | Private | 51 | 36 | 590 | 1946 | 493 | | |
| 106 | V. Brown | Private | 10 | 38 | 489 | 1946 | 485 | | |
| 107 | L. Whitaker | Private | 42 | 36 | 485 | 1946 | 453 | | |
| 108 | L. Whitaker | Private | 29 | 36 | 480 | 1946 | 456 | | |
| 109 | S. Holloman | Private | 35 | 40 | 375 | 1946 | 470 | | |
| 110 | W. McCorkle | Private | 17 | 30 | 398 | 1946 | 336 | | |
| 111 | A. Reeves | Private | 14 | 36 | 345 | 1946 | 332 | | |
| 112 | G. Arrington | Private | 19 | 36 | 340 | 1946 | 326 | | |
| 113 | S. Turner | Private | 30 | 40 | 460 | 1946 | 443 | | |
| 114 | C. Guy | Private | - | 40 | 380 | 1946 | 395 | | |
| 115 | D. Rawborn | Private | 34 | 30 | 490 | 1946 | 462 | | |
| 201 | Dearing 1 | Public | 400 | 6 | 524 | 1974 | 501 | 90 | |
| 202 | Dearing 2 | Public | 700 | 6 | - | 1974 | - | 40 | |
| 203 | Dearing 3 | Public | 500 | - | 530 | 1975 | 486 | 36 | |
| 204 | Kingsley Mill | Public | 379 | 10 | 528 | 1976 | 510 | 90 | |

TABLE 22. Information on Wells in Warren County

| Well No. | Owner | Use | Depth, ft. | Diam., in. | Ground Elevation (ft-MSL) | Year Measured | Water Elevation | Discharge, gpm | Specific Capacity, gpm/ft |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Camp Br. Church | Private | 14 | 36 | 510 | | 500 | | |
| 2 | O. Reeves | Private | 26 | 40 | 505 | | 485 | | |
| 3 | W. Usery | Private | 40 | 38 | 550 | | 515 | | |
| 4 | W. Todd | Private | 35 | 40 | 547 | | 515 | | |
| 5 | W. Todd | Private | 50 | 40 | 550 | | 506 | | |

NOTE: Wells at Camack all drawn water from basement crystalline rock.

7. Water elevation (feet - mean sea level datum)

8. Year measured

9. Discharge (gallons per minute)

10. Specific capacity (gallons per minute per foot)

The well numbers are used to locate each well on Figures 19 through 21 where the Tuscaloosa and Barnwell Formations were differentiated as sources of groundwater resource. The well numbers from 1 to 100 signify that the wells are in the Barnwell formation and that the information was obtained from the report, Geology and Ground Water Resources of Central-East Georgia by LeGrand and Fuercron (1956). Well numbers from 101 to 130 signify wells in the Tuscaloosa formation and that the data are also from the 1956 report. Numbers from 131 to 200 signify that the wells are in the Tuscaloosa formation and that the data are from the Geological Survey of Georgia Bulletin No. 52, Geology and Groundwater Resources of the Coastal Plain of East-Central Georgia, by LaMoreaux (1946). Well numbers from 201 to 299 signify that the information was obtained from the Water Supply Branch files and is of more recent origin. These wells are located in the proper formation columns except in cases where the exact aquifer was not known. The LeGrand and LaMoreaux reports were the principal sources of data on the groundwater resources of the area. The EPD files of the Water Supply Branch were a secondary source of information, with other information abstracted from a current USGS study of the Cretaceous aquifer in Georgia. Some additional data regarding specific locations were obtained from kaolin companies currently operating in the study area.

Anglo-American Study - Some detailed information for groundwater in this area was obtained from the Anglo-American Clays Corporation. Anglo-American is considering locating a kaolin clay processing plant five miles north of Wrens in Jefferson County near Reedy Creek. Jefferson County wells 215 and 216

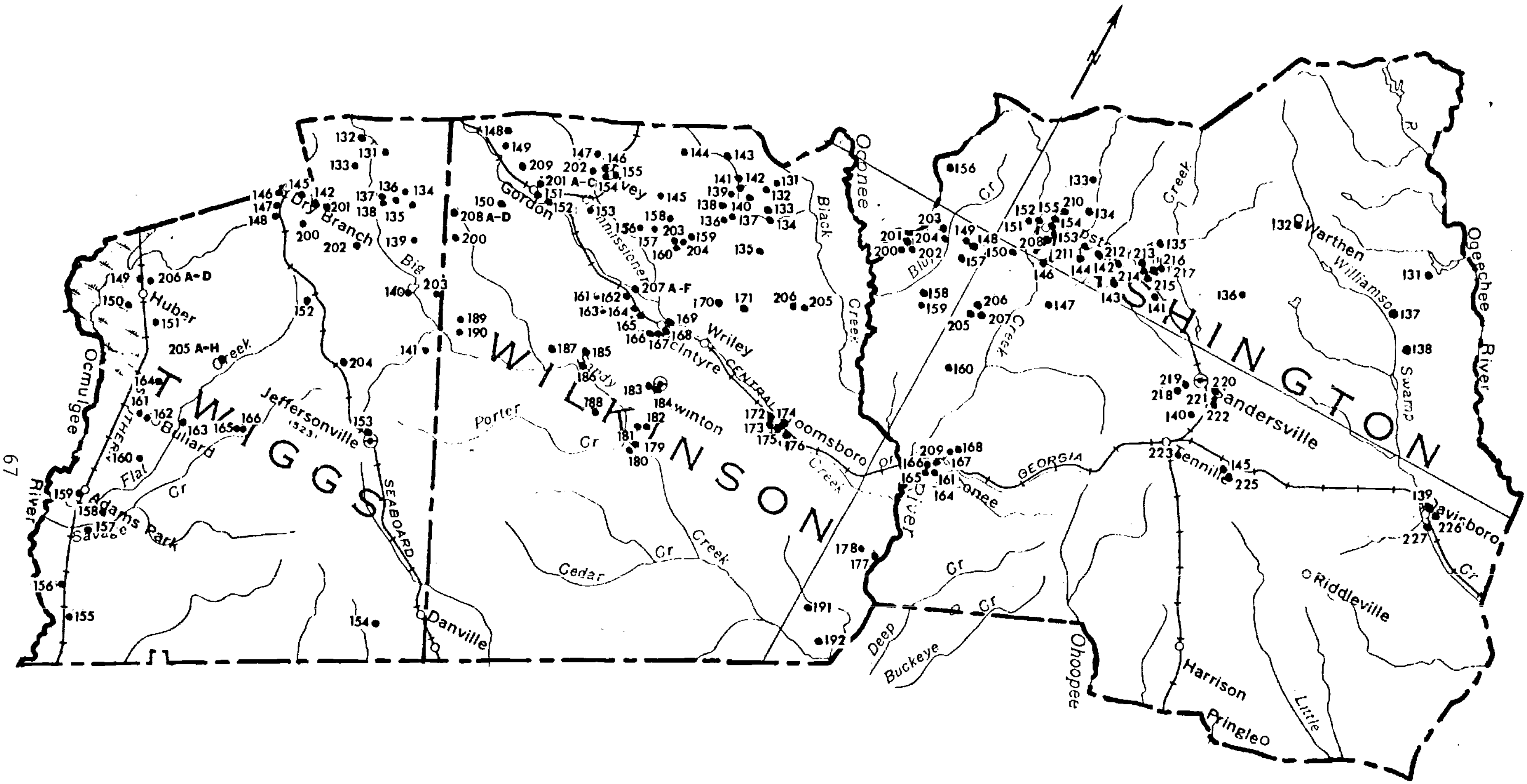



FIGURE 19. Location of Wells Utilizing the Tuscaloosa Formation in Washington, Wilkinson and Twiggs Counties

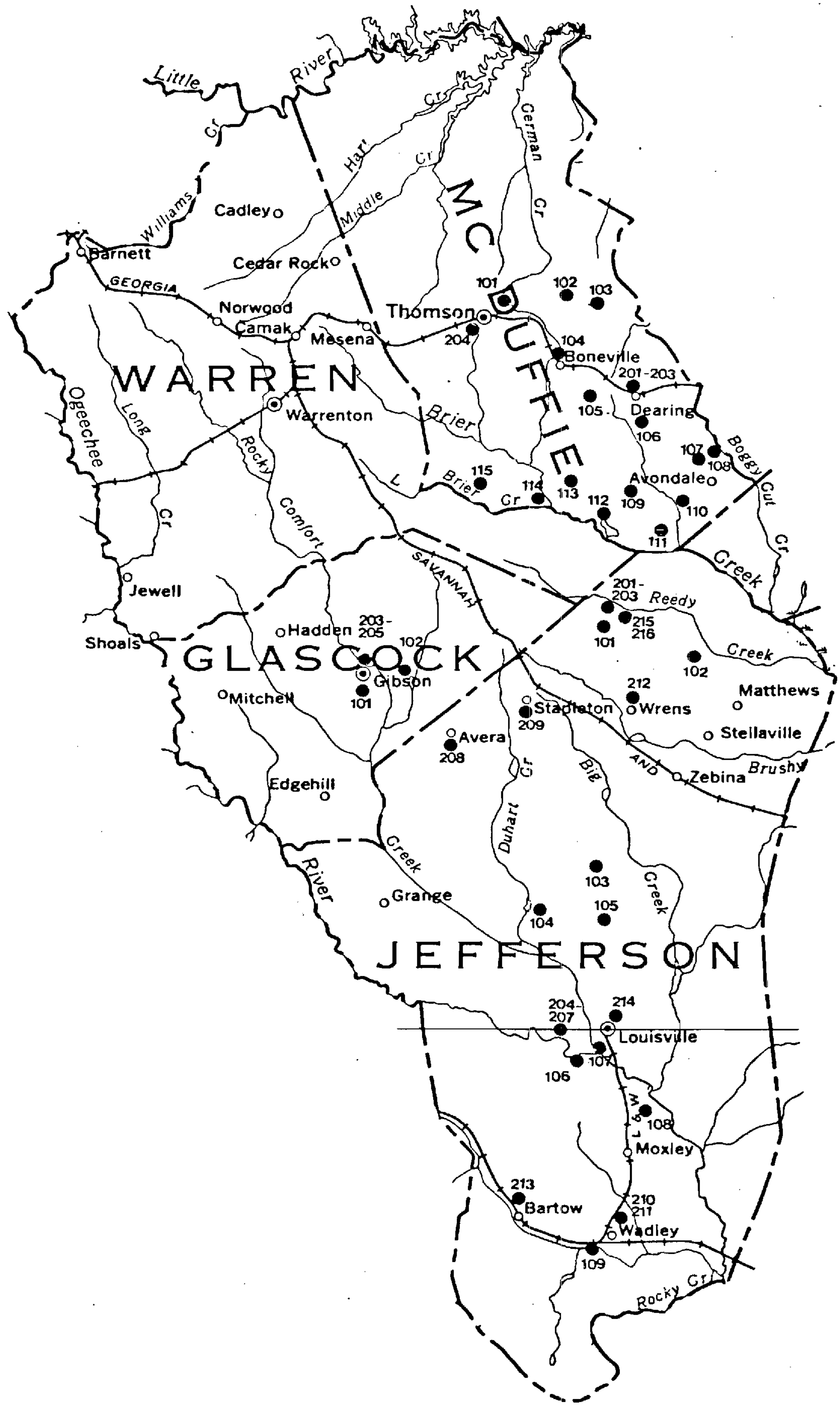



FIGURE 20. Location of Wells Utilizing the Tuscaloosa Formation in Glascock, Jefferson, McDuffie and Warren Counties

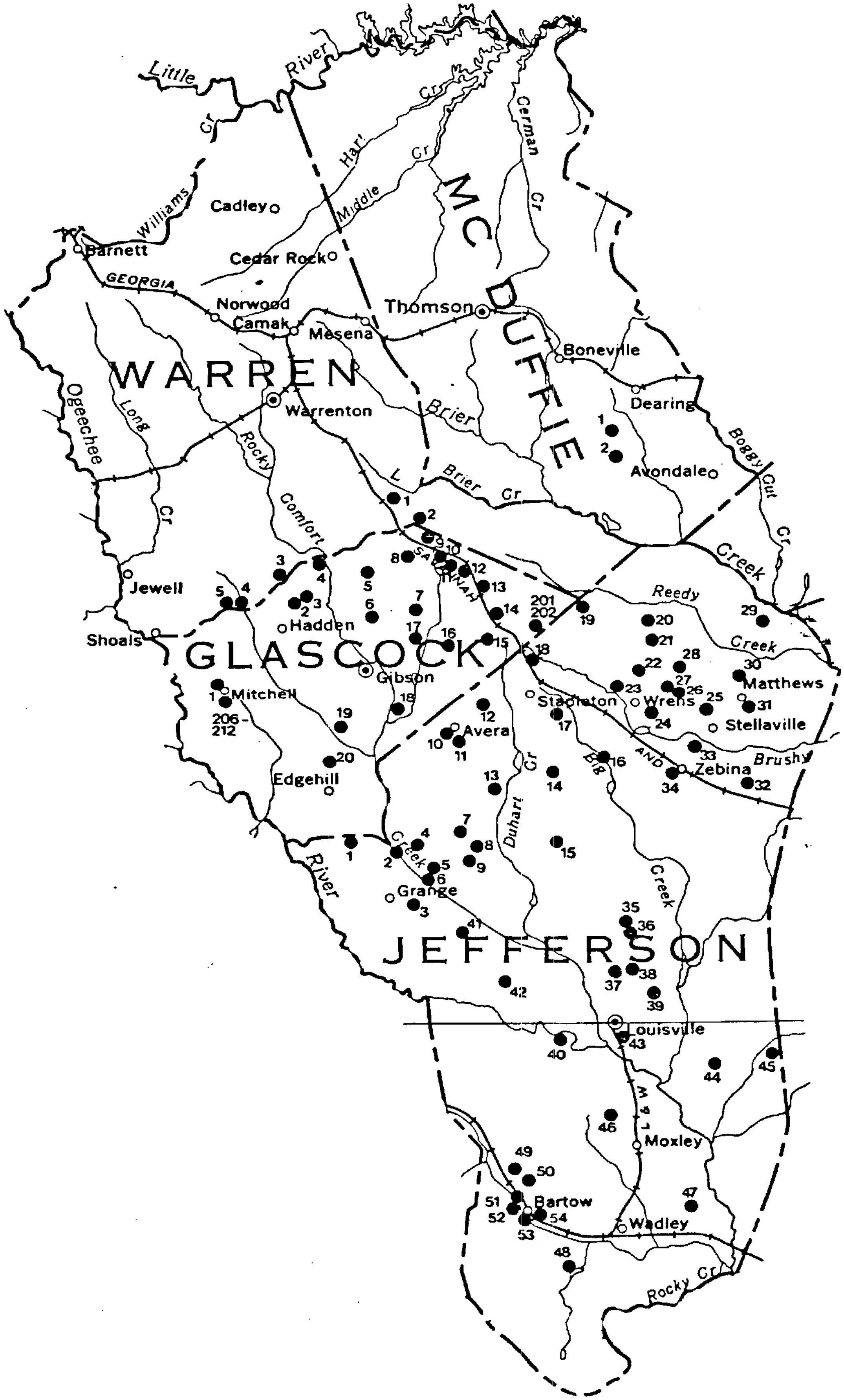



FIGURE 21. Location of Wells Utilizing the Barnwell Formation in Glascock, Jefferson, McDuffie and Warren Counties

of Figure 20 show this location. The plant will require a continuous flow of 1000 gallons of water per minute (gpm) when it begins operations, but it is anticipated that it will need 3300 gpm within 10 years after the plant begins operation.

The potential sources of water supply for Anglo-American in the area are from wells, or from Brier and Reedy creeks or both. Surface water would not be available in the area without substantial and expensive "off-channel" storage facilities. The initial study began with the drilling of five test wells to obtain geologic and hydrologic information. It was found that artesian water existed with a hydrostatic pressure in the wells of 40 to 60 feet. Samples from the well were taken and an electric log was made for correlation to the sample log. The rocks penetrated in the test drilling could be divided into two principal water-bearing beds consisting of heterogeneous sand and gravel separated by lenses of clay having a thickness of 10 to 20 feet. These beds describe the Barnwell, Twiggs Clay and/or McBean and Tuscaloosa formations of this area. Particle size analyses were made of cuttings from the two aquifers. Analyses and evaluation of the information obtained indicated that it is feasible to pump 1000 gpm from two or three wells in the area.

With the additional requirement of 3300 gpm needed, three more wells were drilled in an adjacent property. Similar geologic conditions were found as in the other five wells except that the new wells encountered cleaner, coarser, more permeable sands in the Tuscaloosa formation. In addition, the clay lenses between the two water-bearing beds thin to less than five feet thick in the new area, allowing a good hydrologic connection between the aquifers. A more thorough study after drilling confirmed the fact that the water-bearing units under the new property have better water-bearing characteristics than the same units underlying the first properties that were drilled. Therefore, Anglo-American believed that in a long-range water supply development program, they could expect to produce 3300 gpm from six to eight wells on a sustained basis from the three properties. This would be provided that proper locations, pumping rates of production wells, and spacing are planned and implemented. (No pump test data are available at this time.)

Anglo-American Clay and Thiele Kaolin (Sandersville) - Anglo-American Clay withdraws its process water from the principal artesian aquifer (i.e., Cretaceous Aquifer). Water is also available in some local perched water tables above the kaolin beds, but these local conditions disappear with the removal of the kaolin.

Generalization of the geologic structure throughout the area is not possible. There are many horizons of kaolin resulting in conditions of artesian water and local perched water tables. Throughout Washington, Wilkinson, and Twiggs Counties, there appears to be a confining layer consisting of different grades of clay. Constant reference to lenses of clay appears to be an economic differentiation used by the traditional kaolin companies to distinguish between the different grades of kaolin. In the Deepstep area, the clays are located at about 300 feet-MSL with a dip of approximately 20 feet/mile to the southeast and downdip. As the Tuscaloosa Formation thins out eastward of Buffalo Creek, the high grade kaolins become too deep to mine economically. The deposits are also too deep in northeast Washington County to be of commerical value. The commerical clays are of the Cretaceous Age or younger. The aluminum companies are looking at thick downdip Eocene deposits with approximately 100 feet of overburden over 100 feet of clay.

Anglo-American experienced a dewatering problem just east of the Oconee River in western Washington County and just south of Thiele Kaolin's Avant

Mine. Apparently, Thiele Kaolin is operating just at the upper level of artesian pressure. Anglo-American encountered 65 to 70 feet of artesian head above the kaolin beds. Therefore, due to this potential dewatering problem and the presence of only marginal clay deposits, the site was not developed.

A joint study for Anglo-American and Thiele Kaolin on the Cretaceous aquifer in the Sandersville area showed that the aquifer there is approximately 500 feet deep. Results of the study were:

| | Range | Average |
|---|---|---|
| Storage Coefficient ($x10^{-4}$) | 7.6 - 8.4 | 8.1 |
| Transmissivity (gpd/ft) | 315,000 - 330,000 | 325,000 |
| Yields | 2000 gpm/ft | |
| Specific Capacity Well #1 | 67.5 gpm/ft | |
| Specific Capacity Well #2 | 75 gpm/ft | |

The piezometric head in the vicinity of Deepstep on Buffalo Creek is approximately 240 ft-MSL. Transmissibility tracts are oriented in a NW-SE direction in the Sandersville area.

Water use within the traditional kaolin industry will not increase substantially due to the increased recycling of process water.

Georgia Kaolin (Deepstep) - Georgia Kaolin is presently experiencing some dewatering problems at certain mines. In Washington County at Deepstep and in Twiggs County southeast of Dry Branch (Humphrey's property) three to four feet of artesian head above the clay beds have been experienced. At each site, dewatering at pumping rates of 500-600 gpm are currently required. Georgia Kaolin is conducting additional studies to further delineate these areas of artesian pressure.

The clay is distributed throughout the area in discontinuous lenses shaped like pods, saucers, or elongated ovals (i.e., drainage basins). These are areas of no clay or just a sand/clay mixture in a matrix formation. Between the Ocmulgee and Ogeechee Rivers, the clay exists in lenses.

J. M. Huber Corporation (Huber) - The Huber Mine located east of Huber has a system of 8 wells pumping a total of 31.3 MGD for dewatering. At this site there is approximately 50 feet of artesian pressure head above the clay. Only a few miles north of this area, Huber has operated with little or no dewatering. The artesian water became a problem when the confining clay layer was breached during exploratory drilling. The dewatering system has been operated since 1968 and no adverse effects on local water supplies have been reported. However, it should be emphasized that the dewatering is taking place in the Cretaceous aquifer, while many of the local supplies are withdrawn from shallower aquifers. Huber currently has two observation wells in the area to monitor the effects of this dewatering.

A comprehensive study on the dewatering site was completed in 1967. Another study on the property directly to the north of this site was completed in 1971. Results of these studies were:

| | Range | Average |
|---|---|---|
| Site #1 | | |
| Storage Coefficient ($x10^{-4}$) | 1.07 - 8.23 | 5.74 |
| Transmissivity (gpd/ft) | 221,000 - 276,000 | 247,000 |
| Site #2 (Well #1) | | |
| Storage Coefficient ($x10^{-4}$) | 1.1 - 7.2 | 4.4 |
| Transmissivity (gpd/ft) | 213,000 - 269,000 | 248,000 |
| Site #2 (Well #2) | | |
| Storage Coefficient ($x10^{-4}$) | 1.7 - 8.3 | 5.37 |
| Transmissivity (gpd/ft) | 230,000 - 265,000 | 251,000 |

Copies of these studies were obtained for use in this report.

United States Geological Survey (USGS) - USGS (Doraville) has been concerned with reporting on the Cretaceous aquifer in Georgia. The effort has dealt with the recharge, discharge, and areal distribution of the aquifer and has indicated that there was a major lack of detailed information throughout the study area including: 1) storage and transmissivity data; 2) pumping test data; and, 3) observation wells to assess areal effects. The USGS does have considerable information on the location of the aquifer, its physical dimensions, and its potentiometric surface.

Piezometric Surface

The piezometric surface for the study area was developed using the static water elevations presented in Tables 16 through 22. Using the historical measurements of LaMoreaux and LeGrand as a basis and the more recent data as a verification, the piezometric surface shown in Figures 22 through 24 were developed. Areas of artesian flow have been delineated by LaMoreaux in 1946 for Twiggs, Washington and Wilkinson counties and by LeGrand in 1956 for the remaining counties. According to the interviews with officials of certain kaolin companies, conditions of artesian flow still exist in these areas today. The piezometric surface shows that the major rivers and streams in east-central Georgia receive groundwater from the Cretaceous aquifer.

For Glascock, Jefferson, McDuffie and Warren counties, the piezometric surface of both the Tuscaloosa and Barnwell formations was developed. In the remaining counties, the only formation extensively used is the Tuscaloosa and thus the only piezometric surface included in this report.

Some problems were encountered in the development of the piezometric surface. Some of the water surface elevations appeared to be influenced by pumping of nearby wells (i.e., induced drawdown). At a few locations there appeared to be evidence of perched water table conditions. This condition could be caused by the discontinuous nature of the clay lenses in the Tuscaloosa. Overall the piezometric surfaces shown in the figures represent a good approximation of the actual surface and agrees with the information

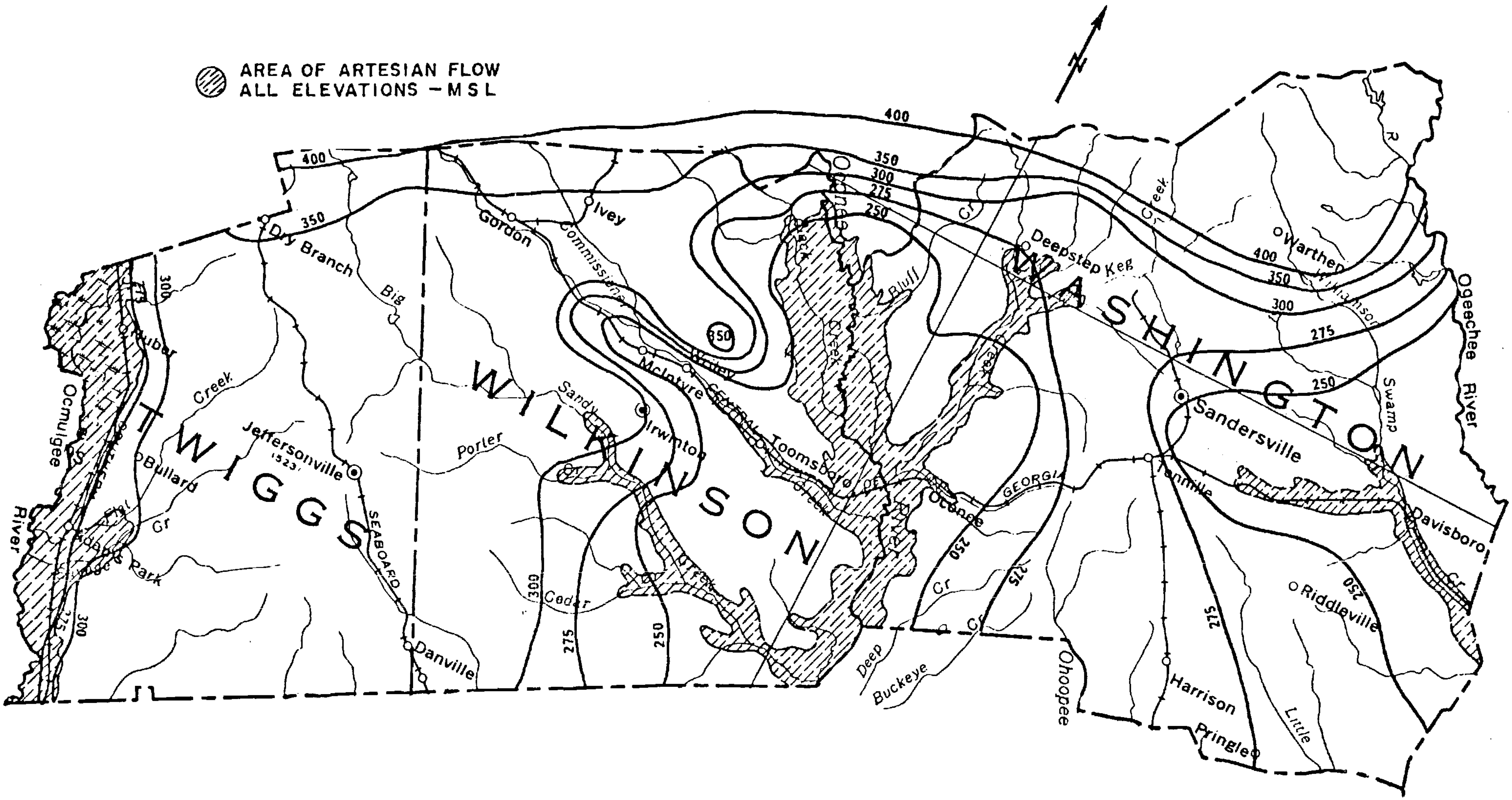



FIGURE 22. Piezometric Surface of the Tuscaloosa Formation in Washington, Wilkinson and Twiggs Counties (Lamoreaux, 1946)

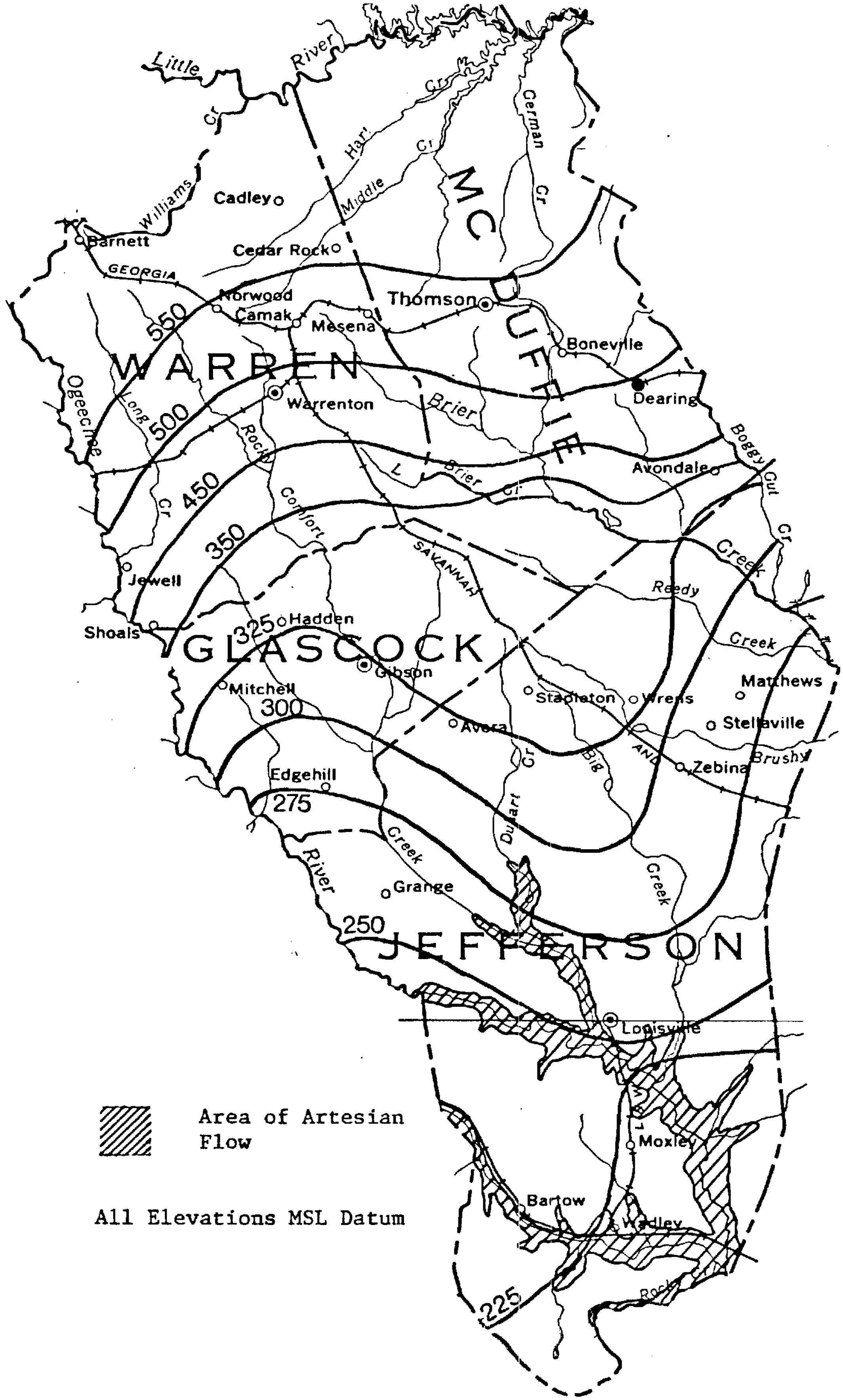



FIGURE 23. Piezometric Surface of the Tuscaloosa Formation in Glascock, Jefferson, McDuffie and Warren Counties (LeGrand, 1956)

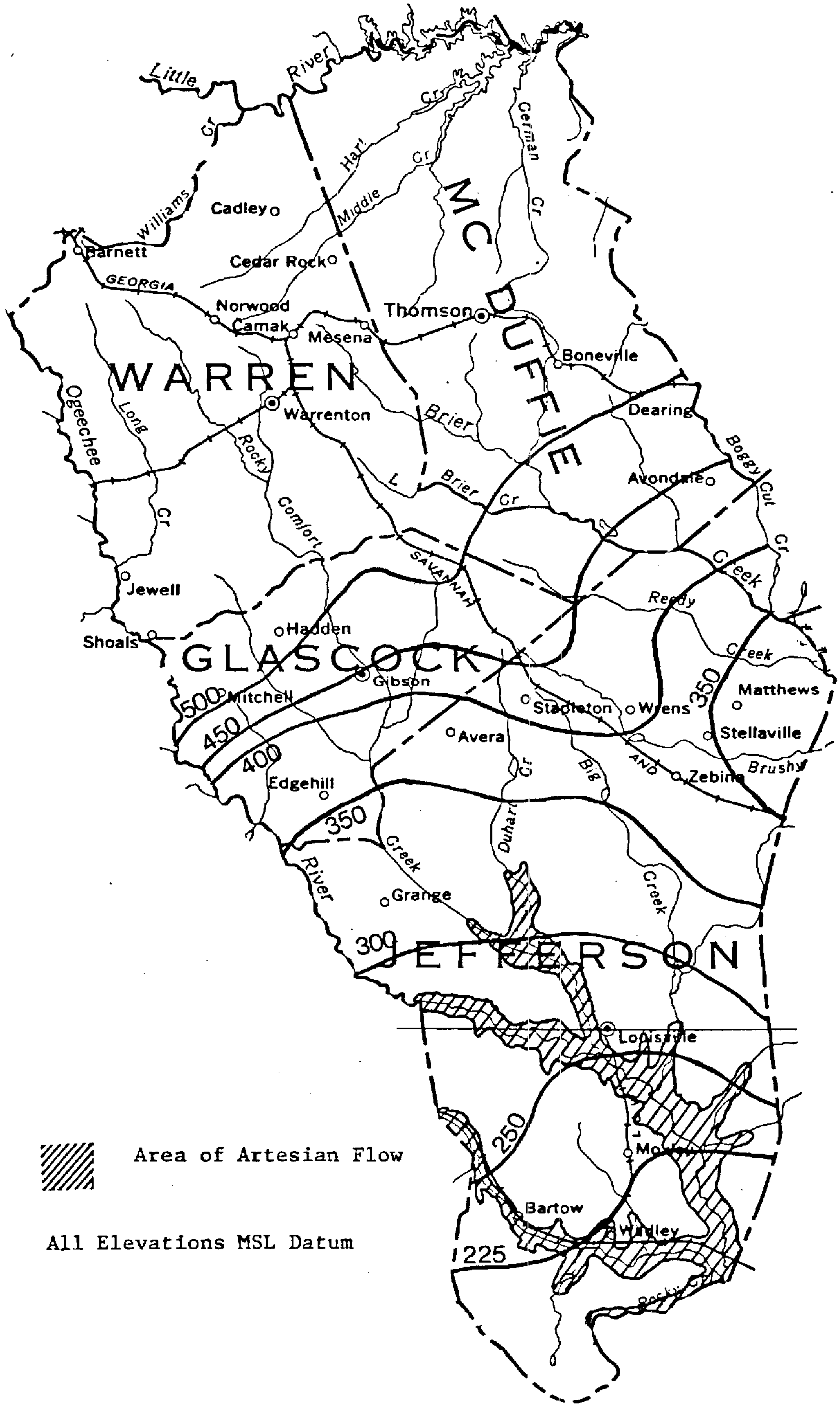



FIGURE 24. Piezometric Surface of the Barnwell Formation in Glascock, Jefferson, McDuffie and Warren Counties (LeGrand, 1956)

obtained by local interviews. The general slope of the piezometric surface in the east-central Georgia area is approximately 15 - 20 feet per mile to the southeast.

Regional Transmissivity

Development of a regional transmissivity for the area was not possible due to a lack of sufficient data. The specific capacities (gpm/ft) presented in Tables 16 through 22 were plotted at their respective locations in Figures 25 and 26, but no regional transmissivity tracts were discernable. In general, the specific capacities appear to increase from north to south across the area with the largest values concentrated in Twiggs County near Huber. The range of values was quite large with most of the values obtained from the well data in the files of the EPD Water Supply Branch. It should be noted that specific capacities are greatly influenced by the quality of well construction.

By using the data that was presented in the reports by Anglo-American Clays Corporation for their best borings, some information on the aquifer characteristics of the area may be calculated. As mentioned previously, Anglo-American Clays drilled eight test wells north of Wrens to obtain data on aquifer conditions. A sieve analysis was conducted on selected samples from the wells. The use of the Fair and Hatch permeability formula (Fair and Hatch, 1933) in conjunction with the sieve analyses can lead to the determination of the specific permeability of the aquifer. The specific permeability is given by:

$$k = \frac{1}{m\left[\frac{(1-\alpha)^2}{\alpha}\left(\frac{\Theta}{100}\Sigma\frac{P}{d_m}\right)^2\right]}$$

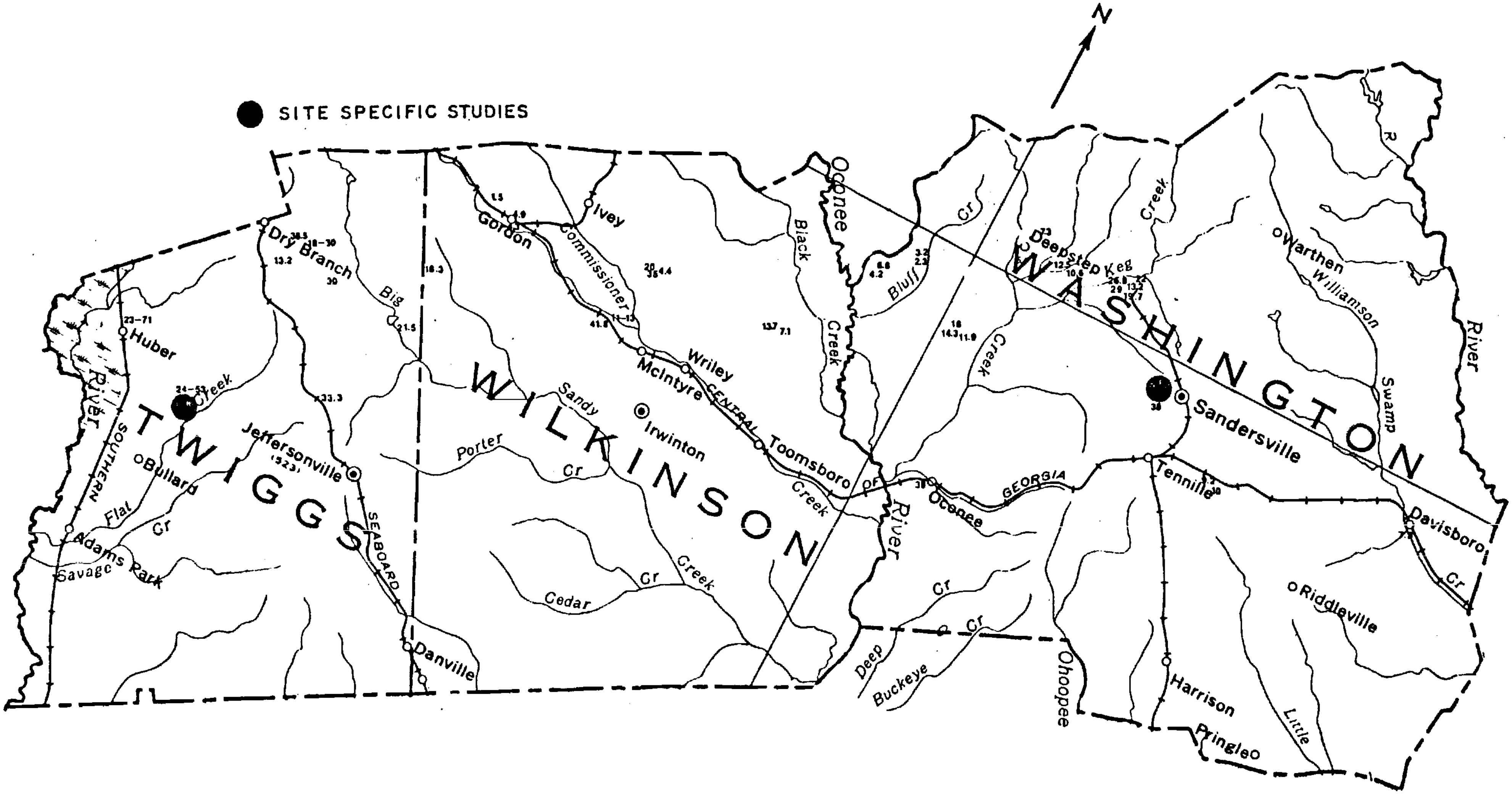



FIGURE 25. Specific Capacities for Washington, Wilkinson and Twiggs Counties

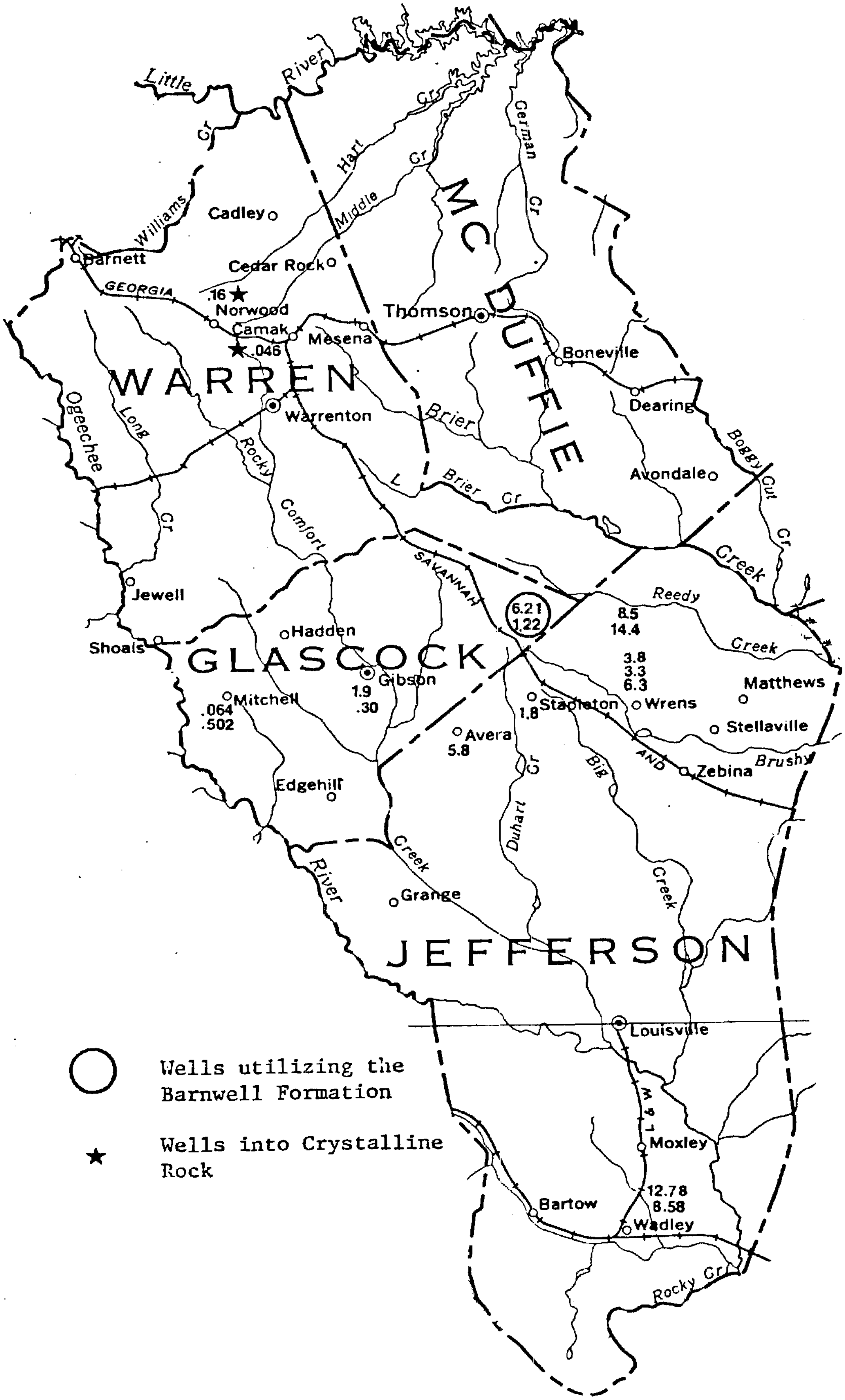



FIGURE 26. Specific Capacities for Glascock, Jefferson, McDuffie and Warren Counties

where;

$\alpha$ is porosity, usually between 30 to 40 percent for most ranges of sand and/or gravel

m is a packing factor, found experimentally to be about 5

$\Theta$ is a sand shape factor, varying from 6.0 for spherical grains to 7.7 for angular grains

P is the percentage of sand held between adjacent sieves

$d_m$ is the geometric mean of rated sizes of adjacent sieves

Once the specific permeability, k, is found, the permeability, K, in the traditional units of gallons per day per square foot can be obtained. Noting that $K = kg/\gamma$, where g is gravity and $\gamma$ is the kinematic viscosity of the fluid, a series of conversion factors will lead from specific permeability, k, to permeability, K. Applying the Fair and Hatch formula to the data from Anglo-American's eight wells and converting to the more desirable K, values of permeability from 900 to 6500 gpd/ft$^2$ for the two aquifers were obtained. By using the information from the well logs and data from the report on the aquifer thickness, transmissivities for the area were calculated and ranged from 80,000 gallons per day/foot to 275,000 gallons per day/foot. The values that were obtained for permeability, and subsequently for transmissivity, are in the range for a good aquifer. However, the results from the Fair and Hatch equation must be used with caution for a larger permeability value may be obtained than is actually present. This is because the fines are often washed out, making the percent of coarse material appear larger, thereby increasing the K value.

Potential Induced Drawdown from Pumping

The most useful information was obtained from the site specific studies at Sandersville and Huber presented earlier in this report. The locations of these studies are shown in Figure 25. Using average values of transmissivity and storage coefficient at each site and assuming an arbitrary continuous withdrawal of 1000 gpm, the drawdown in the piezometric surface in the area adjacent to the center of pumping has been computed for withdrawal periods of 1 month and 1, 5, and 10 years and is shown on Figure 27 for the Sandersville area, Figure 28 for the Huber area, and Figures 29 and 30 for the Wrens area with two different transmissivities. The drawdowns were computed using the Theis nonequilibrium formula as shown below:

$$s = \frac{114.6Q}{T} W(u)$$

where;

$$W(u) = \frac{e^{-u}}{u} du = -0.5772 - \log_e u + u - \frac{u^2}{2x2!} + \frac{u^3}{3x3!} - \frac{u^4}{4x4!}$$

$u = 1.87\ r^2S/Tt.$

s = drawndown, in feet, at any point of observation in the vicinity of a well discharging at a constant rate

Q = discharge, in gallons per minute

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

r = distance, in feet, from discharging well to point of observation

S = coefficient of storage, expressed as a decimal fraction

t = time, in days, since discharge began

The nonequilibrium formula is based on the following assumptions:

1. The aquifer is infinite in areal extent and is homogeneous and isotropic (transmits water in all directions with equal facility);

2. The coefficients of transmissibility and storage are constant;

3. The aquifer is confined between impermeable beds;

4. The discharging well penetrates the entire thickness of the aquifer; and,

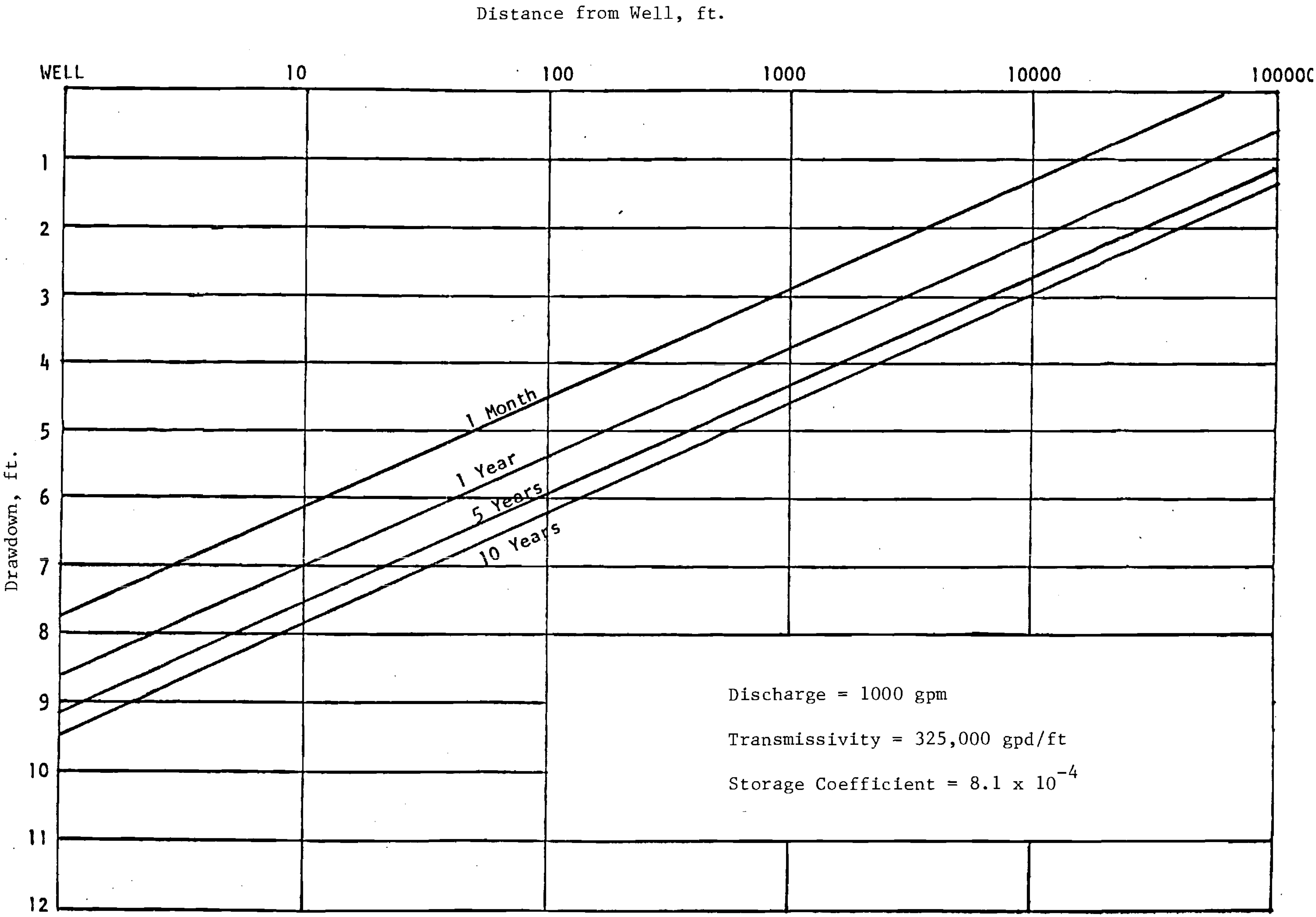



FIGURE 27. Theoretical Drawdown Curves Near Sandersville, Georgia

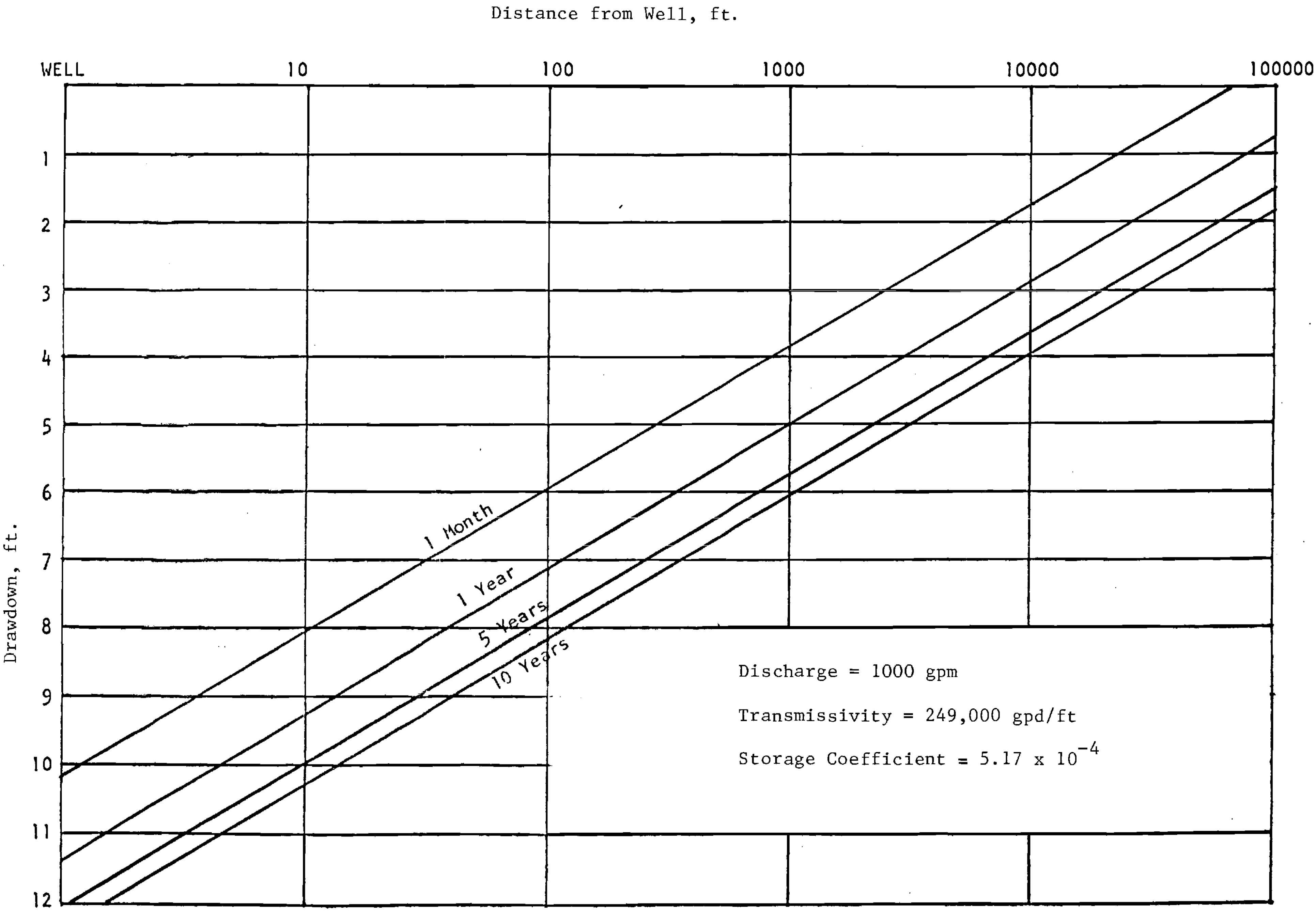



FIGURE 28. Theoretical Drawdown Curves Near Huber, Georgia

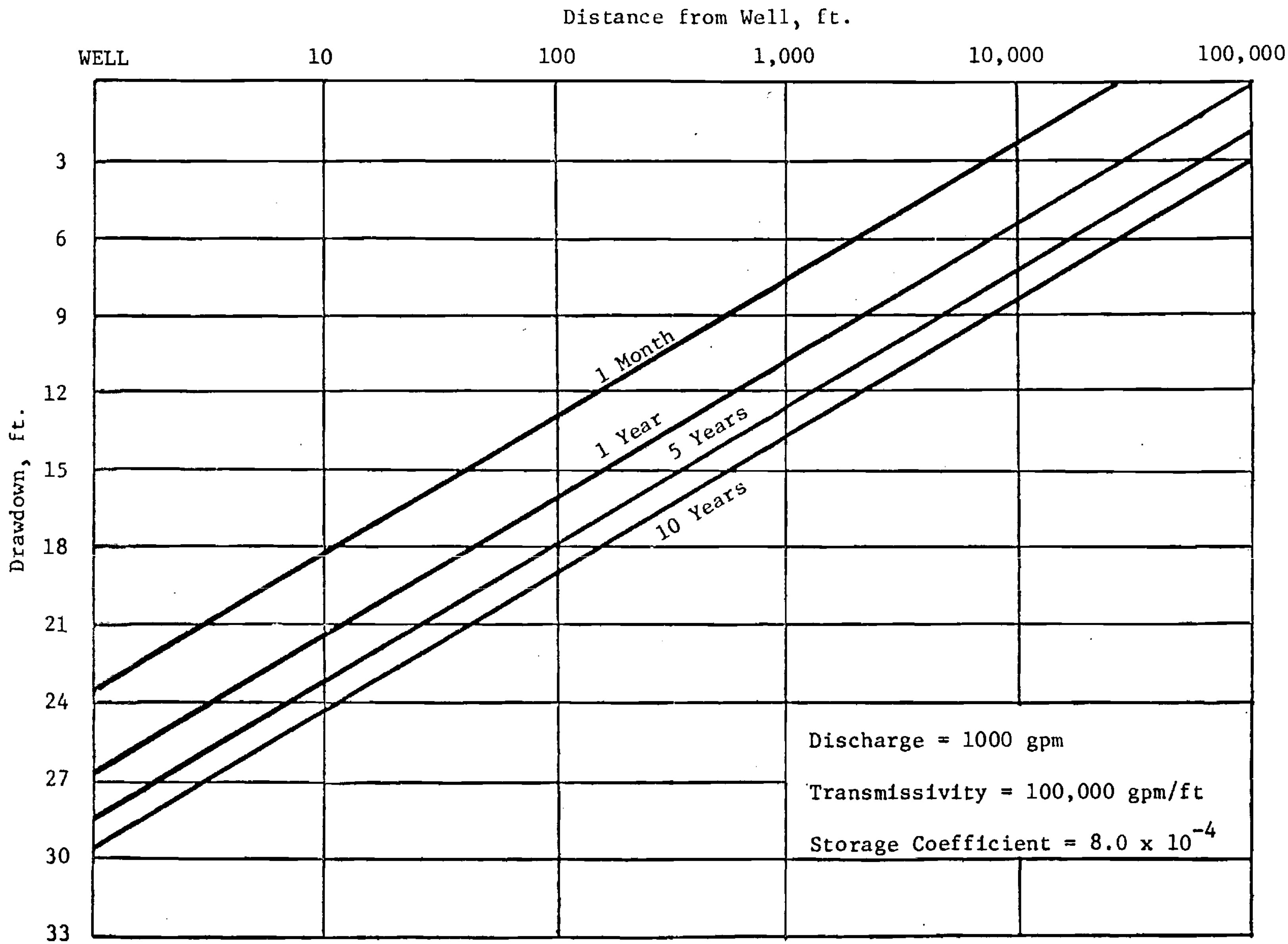



FIGURE 29. Theoretical Drawdown Curves Near Wrens, Georgia

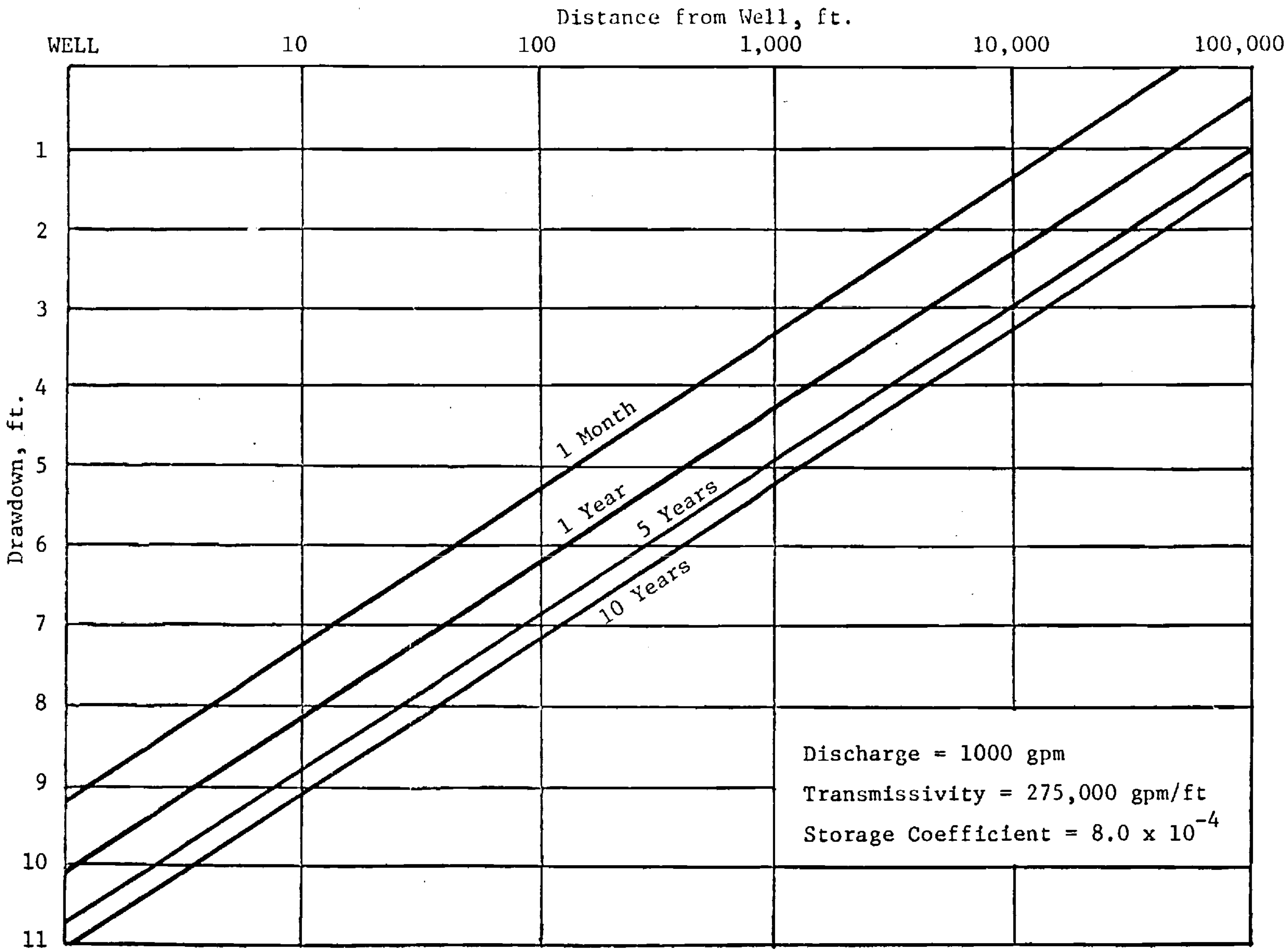



FIGURE 30. Theoretical Drawdown Curves Near Wrens, Georgia

5. The discharged water is released from storage instantaneously with decline in head.

None of these conditions is fully met in nature, and considerable experienced judgment is necessary to decide the extent to which they apply. Despite the restrictive assumptions on which it is based, however, the nonequilibrium formula can be successfully applied to many problems of groundwater flow. The Theis formula has been applied in this area with a high degree of success in projecting water levels that would occur from existing dewatering projects. A few values of theoretical drawdown from the pumping center for Sandersville and Huber are summarized in the table below:

| Location | Distance (mi.) | Theoretical Drawdown, ft. 1 yr. | Theoretical Drawdown, ft. 10 yr. |
|---|---|---|---|
| Sandersville | Well | 8.6 | 9.4 |
| | 0.2 | 3.8 | 4.6 |
| | 2.0 | 2.0 | 2.9 |
| Huber | 0.0 | 11.4 | 12.4 |
| | 0.2 | 5.0 | 6.0 |
| | 2.0 | 2.8 | 3.9 |

More detailed theoretical drawdowns were calculated for the Wrens area to demonstrate the effects of different pumping rates in addition to the time and distance variables. These data are shown in Tables 23 and 24.

Estimates of drawdowns for more than one pumping center can be made by adding the drawdown effects caused by each well. Since drawdowns are directly proportional to pumping rate, the theoretical drawdown at any rate Q can be computed from the curves in Figures 27 through 30 as follows:

$$Q/1000 \times S_{1000} = S_Q$$

where;

$S_{1000}$ is the drawdown at 1000 gallons per minute (gpm)

$S_Q$ is the drawdown at pumping rate Q (gpm)

TABLE 23. Theoretical Drawdowns for Various Pumping Rates at Wrens, Georgia

Transmissivity = 100,000
Storage Coefficient = $8.0 \times 10^{-4}$

| Q, gpm | Distance From Well, mi. | Theoretical Drawdown, ft. 1 Month | 1 Year | 5 Years | 10 Years |
|---|---|---|---|---|---|
| | 0.0 | 16.57 | 18.59 | 19.85 | 20.41 |
| | 0.1 | 6.61 | 8.67 | 9.94 | 10.38 |
| | 0.5 | 4.06 | 6.04 | 7.30 | 7.91 |
| 694 | 1.0 | 3.00 | 5.01 | 5.43 | 6.84 |
| (1 MGD) | 5.0 | .64 | 2.42 | 3.65 | 4.21 |
| | 15.0 | .01 | .87 | 1.93 | 2.48 |
| | 0.0 | 23.87 | 26.77 | 28.60 | 29.42 |
| | 0.1 | 9.52 | 12.49 | 14.33 | 14.96 |
| | 0.5 | 5.85 | 8.70 | 10.52 | 11.40 |
| 1000 | 1.0 | 4.32 | 7.21 | 8.39 | 9.86 |
| | 5.0 | .92 | 3.48 | 5.27 | 6.06 |
| | 15.0 | .02 | 1.25 | 2.78 | 3.58 |
| | 0.0 | 49.73 | 55.79 | 59.58 | 61.28 |
| | 0.1 | 19.84 | 26.02 | 29.84 | 31.18 |
| | 0.5 | 12.19 | 18.13 | 21.94 | 23.75 |
| 2083 | 1.0 | 9.00 | 15.04 | 13.32 | 20.53 |
| (3 MGD) | 5.0 | 1.92 | 7.26 | 10.98 | 12.63 |
| | 15.0 | .03 | 2.61 | 5.80 | 7.46 |
| | 0.0 | 414.51 | 465.04 | 496.60 | 510.72 |
| | 0.1 | 165.35 | 216.89 | 248.69 | 259.84 |
| | 0.5 | 101.56 | 151.10 | 182.64 | 197.96 |
| 17,361 | 1.0 | 75.05 | 125.33 | 111.09 | 171.10 |
| (25 MGD) | 5.0 | 16.01 | 60.54 | 91.52 | 105.27 |
| | 15.0 | .25 | 21.76 | 48.35 | 62.23 |

TABLE 24. Theoretical Drawdowns for Various Pumping Rates at Wrens, Georgia

Transmissivity = 275,000
Storage Coefficient = $8.0 \times 10^{-4}$

| Q, gpm | Distance from Well, mi. | Theoretical Drawdown, ft. 1 Month | 1 Year | 5 Years | 10 Years |
|---|---|---|---|---|---|
| | 0.0 | 6.31 | 7.04 | 7.51 | 7.72 |
| | 0.1 | 2.69 | 3.41 | 3.88 | 4.08 |
| 694 | 0.5 | 1.77 | 2.49 | 2.96 | 3.15 |
| (1 MGD) | 1.0 | 1.36 | 2.09 | 2.55 | 2.75 |
| | 5.0 | .48 | 1.17 | 1.63 | 1.83 |
| | 15.0 | .06 | .57 | .99 | 1.18 |
| | 0.0 | 9.09 | 10.15 | 10.81 | 11.13 |
| | 0.1 | 3.88 | 4.92 | 5.59 | 5.88 |
| 1000 | 0.5 | 2.56 | 3.59 | 4.26 | 4.55 |
| | 1.0 | 1.97 | 3.01 | 3.68 | 3.96 |
| | 5.0 | .69 | 1.68 | 2.35 | 3.96 |
| | 15.0 | .08 | .78 | 1.43 | 1.71 |
| | 0.0 | 18.94 | 21.14 | 22.53 | 23.18 |
| 2083 | 0.1 | 8.09 | 10.25 | 11.65 | 12.24 |
| (3 MGD) | 0.5 | 5.34 | 7.49 | 8.88 | 9.47 |
| | 1.0 | 4.10 | 6.27 | 7.66 | 8.26 |
| | 5.0 | 1.44 | 3.50 | 4.89 | 5.49 |
| | 15.0 | .17 | 1.64 | 2.99 | 3.56 |
| | 0.0 | 157.93 | 176.17 | 187.82 | 193.24 |
| | 0.1 | 67.50 | 85.44 | 97.09 | 102.08 |
| 17,361 | 0.5 | 44.50 | 62.44 | 74.01 | 79.00 |
| (25 MGD) | 1.0 | 34.14 | 52.23 | 63.81 | 68.80 |
| | 5.0 | 12.03 | 29.17 | 40.73 | 45.72 |
| | 15.0 | 1.41 | 13.67 | 24.88 | 29.67 |

## Local Attitudes and Opinions

As part of the effort to determine the impact of the development of an alumina from kaolin industry, interviews were conducted in the areas considered promising for such an enterprise. In addition to the kaolin mining and processing companies, other local industries, city officials, county officials, soil conservation services, and area planning and development commissions were contacted. Included in the survey was a focus on impacts of a new industry on the water resources of the area with emphasis on availability of water and possible water pollution from industrial discharges which appeared to be the greatest area of concern.

For purposes of the interview process, the kaolin belt was divided into four areas including:

1. Jefferson, Glascock and Warren Counties; interviews were conducted in Wrens, Louisville and Augusta
2. Washington County; interviews were conducted in Sandersville and Milledgeville
3. Twiggs and Wilkinson Counties; interviews were conducted in Gordon, McIntyre, Huber, Jeffersonville, Dry Branch and Macon
4. Schley and Sumter Counties; interviews were conducted in Andersonville and Ellaville

Except for Area 4, these areas essentially embrace the study area of concern in this report and considered the most likely for the development of an alumina from kaolin industry.

The results of these interviews can be summarized as follows:

Area 1: It was generally agreed that groundwater would be difficult to obtain in the quantities which would be required (up to 7.0 MGD). Where groundwater has not met local expectations, surface water has been used to supplement the supply, primarily by the erection of storage reservoirs which are fed from streams during rainy periods. A figure of 7.0 MGD or about 5000 gpm exceeds by 2000 gpm the water needs of the kaolin company interviewed and which had indicated difficulty in locating adequate groundwater supplies. Therefore, it could be anticipated that if the maximum of the estimated 3 to 7 MGD water requirement is necessary for the industry, groundwater supplies would need to be augmented by surface water resources.

Area 2: The Fall Line lies just north of the northern border of Washington County. Therefore, the thickness of sediments in this county was considered more than adequate for a good and plentiful water supply. Moreover, Herrick (Georgia Geological Survey Bulletin 70) has identified eleven potential water zones just outside of Sandersville. Local estimates of 1000 gpm were given for areas as distant as 10 miles north and east of Sandersville.

Area 3: There were mixed reactions concerning groundwater availability in the region; the conclusion being that water availability is purely geologic and site-specific. One kaolin mining operator felt that 7 MGD would be difficult to acquire. However, another operator less than 20 miles from the first is currently using 7 MGD pumped from wells within a 1-mile area. In addition, the wells are from 250-350 feet deep and there has been no noticeable drawdown of the water table. Other mining operations in the area have no problems with availability of water, in fact, one particular operation has encountered exceptional dewatering problems. This was caused by a mining error which broke into an area with high artesian pressure. Nearby wells are employed to create cones of depression to allow for continuing operations. Again, the item of concern would center on the removal of that magnitude of water from the ground.

Area 4: This area has encountered no problems with water availability. However, much of the water used is surface water, rather than groundwater; there are a number of creeks plus the Flint River flowing through the area. Neither of the two kaolin mining operations have problems acquiring water or with dewatering the mines. There would be possible problems with using the surface water, particularly the Flint River. One is the installation of a new pulp plant which would be a major water user and discharger. The other is that use of the Flint River is closely regulated. Each of these issues would need to be considered should the potential location of an alumina from kaolin industry be considered for this area.

## ASSESSMENT OF SURFACE WATER RESOURCES

The surface resources of east-central Georgia are usually divided into two categories; the principal streams and the lesser streams. The term "Principal Streams" is used to describe portions of rivers and major creeks that have substantial drainage basins and flows. The term "Lesser Streams" is used for smaller, perennial streams, usually called creeks, and for the headwater portions of rivers. In the seven-county area, the Ogeechee River, Oconee River, Ocmulgee River, Big Sandy Creek, and Briar Creek are considered principal streams.

Due to the large amount of high quality groundwater available throughout the area and the minimal economic costs associated with developing groundwater supplies, the surface water resources of the area have remained virtually undeveloped. There is not much information available regarding the low flows of streams and rivers in the area. The following data indicate some of the information presently being compiled by USGS regarding low flows at a few locations on principal streams in or near the study area:

| River/Stream | Drainage Area, sq. mi. | 7-Day,10-Year Flow, cfs | Flow Per Square Mile |
|---|---|---|---|
| Oconee River near Milledegeville (R) | 2950 | 250 | 0.085 |
| Oconee River near Dublin (R) | 4400 | 570 | 0.13 |
| Oconee River near Mt. Vernon | 5110 | 680 | 0.13 |
| Ocmulgee River at Macon (R) | 2240 | 410 | 0.18 |
| Ogeechee River near Louisville | 800 | 91 | 0.114 |
| Big Sandy Creek near Jeffersonville | 31 | 3.6 | 0.12 |

(R) designates flow is regulated by upstream reservoir.

The flow on the Oconee River at Milledgeville, which is located just north of the study area, is composed of drainage from the Piedmont; while the flow at Dublin, which is located south of the study area, is composed of drainage from the Piedmont and Upper Coastal Plain. The flow on the Oconee River near Mt. Vernon contains drainage from the Piedmont and Upper Coastal Plain as well as the Lower Coastal Plain. The increase in flow and flow per square mile downstream on the Oconee River shows the influence of groundwater on the stream flow. An incremental analysis between the three stations yields a flow of 0.22 $cfs/mi^2$ between Milledgeville and Dublin, but a flow of only 0.15 $cfs/mi^2$ between Dublin and Mt. Vernon. The higher flow between Milledgeville and Dublin verifies that the Oconee River receives groundwater from the Cretaceous Aquifer.

The Ogeechee River rises in the Piedmont province and has a drainage area of 800 square miles and an average flow of 868 cfs or 560 MGD at Louisville, where it is gauged by the USGS. There is a potential for industrial growth in its valleys for the Ogeechee River has rail transportation running along the greater part of it. The combination of heavy duty transportation with good industrial water supplies makes industrial growth promising.

Macon is located just northwest of the study area on the Ocmulgee River, Louisville directly east of the study area on the Ogeechee River, and Jeffersonville in east-central Twiggs County on Big Sandy Creek. The small flow in Big Sandy Creek is probably due to the fact that it does not cut into the highly productive Cretaceous Aquifer, but rather receives its water as drainage from upper channel sands.

Briar Creek, a major tributary of the Savannah River, rises in the Piedmont province but has most of its drainage area in the Fall Line, Sand Hills region. It leaves Jefferson County, however, in the northeast and will not benefit much of the study area.

The predominant characteristics of lesser streams in the physiographic regions are summarized in Table 25.

As mentioned previously, the surface water resources of the area have remained virtually undeveloped. Warrenton, until 1948, obtained its supply of water from wells, but abandoned these in favor of a surface supply from Rocky Comfort Creek. Thomson now derives its municipal water supply from Sweetwater Creek south of the town. An abandoned well more than 500 feet deep in granite originally supplied the town, but because of its meager yield, it has not been used for many years. These two towns need the surface supply because of their location in the Piedmont province. Other communities south of these have a vast supply of groundwater from which to draw. The development of surface streams would require a detailed study of the area, the physiographic area through which they flow, and the characteristics of the stream itself.

TABLE 25. Characteristics of the Lesser Streams in the Physiographic Regions of Georgia

| Characteristic or Feature | Piedmont Province Streams | Fall Line Sand Hill Streams | Tifton Upland Streams |
|---|---|---|---|
| Average Flow, MGD/sq. mi. | 0.4-0.6 | 0.6-1.4 | 0.4-0.6 |
| Flood Flows | flashy frequent and high | infrequent | moderate but long drawn out |
| Dry Season Flows | low for short periods | plentiful flows | low for long periods |
| Channel Gradients | steep | steep | gentle |
| Channels | deep | shallow | swampy |
| Flood Plains | narrow | narrow | wide |
| Storage Sites | many | some | very few |

## FUTURE CONSIDERATIONS

### Future Water Demand

Using the current water demand estimates and the population projections presented in previous sections, a projection of water demand through the year 2000 was developed. The water demand projections for each county are listed in Tables 26 and 27 according to municipal demand and industrial demand with and without the potential alumina from kaolin requirements. These projections were based on the following assumptions:

1. Both municipal and industrial current water demands are accurate;
2. The population projections provide an accurate estimate of potential growth;
3. The potential population increase will occur in and around the cities and towns, exerting a direct demand upon an existing municipal water supply system;
4. Water demand will average approximately 100 gallons per capita per day; and,
5. Industrial demand will not increase substantially due to environmental restrictions encouraging reuse of process water in the kaolin mining and processing industry.

Numerous problems were encountered in the development of the water demand projections. All of these problems affect the accuracy of the projections and, therefore, should be considered when evaluating the data. The base data used to estimate the current water demand were sometimes suspect or not even available. Moreover, the estimate is applicable only to municipal supplies and does not consider any rural demand. However, neglecting rural demand is not unreasonable since rural supplies are usually drawn from shallow groundwater aquifers and the total rural demand

TABLE 26. Projected Water Demand for Washington, Wilkinson and Twiggs Counties

| Year | Type | Washington County Water Use, MGD | Wilkinson County Water Use, MGD | Twiggs County Water Use, MGD |
|---|---|---|---|---|
| 1970 | Municipal | 0.805 | 0.415 | 0.175 |
| | Industrial | 16.1 | 8.4 | 38.0 |
| 1980 | Municipal | 0.980 | 0.470 | 0.186 |
| | Industrial | 16.1 | 8.4 | 38.0 |
| | w/ Alumina-Kaolin | 19-26 | 11-15 | 41-45 |
| 1990 | Municipal | 1.172 | 0.544 | 0.220 |
| | Industrial | 16.1 | 8.4 | 38.0 |
| | w/Alumina-Kaolin | 19-26 | 11-15 | 41-45 |
| 2000 | Municipal | 1.384 | 0.620 | 0.244 |
| | Industrial | 16.1 | 8.4 | 38.0 |
| | w/Alumina-Kaolin | 19-26 | 11-15 | 41-45 |

TABLE 27. Projected Water Demand for Glascock Jefferson, McDuffie and Warren Counties

| Year | Type | Glascock County Water Use, MGD | Jefferson County Water Use, MGD | McDuffie County Water Use, MGD | Warren County Water Use, MGD |
|---|---|---|---|---|---|
| 1970 | Municipal | 0.090 | 1.22 | 2.045 | 0.304 |
| | Industrial | 0.030 | 2.0 | 0 | 0 |
| 1980 | Municipal | 0.090 | 1.173 | 2.050 | .254 |
| | Industrial | 0.03 | 2.0 | 0 | 0 |
| | w/Alumina-Kaolin | 3-7 | 5-9 | 3-7 | 3-7 |
| 1990 | Municipal | .100 | 1.133 | 2.094 | .234 |
| | Industrial | 0.03 | 2.0 | 0 | 0 |
| | w/Alumina-Kaolin | 3-7 | 5-9 | 3-7 | 3-7 |
| 2000 | Municipal | .090 | 1.033 | 2.072 | 0.200 |
| | Industrial | 0.03 | 2.0 | 0 | 0 |
| | w/Alumina-Kaolin | 3-7 | 5-9 | 3-7 | 3-7 |

county-wide would be insignificant when compared with large municipal or industrial uses. The population projections are very optimistic and are generally based on reversal of an existing trend. Nevertheless, using these optimistic growth figures will provide a certain degree of safety in the projected water demand estimate and also potential impacts on wastewater treatment requirements.

Probably the most questionable part of the water demand projections is the constant industrial usage over the next 25 years. Kaolin companies are by far the largest water users in the study area and may not experience any additional water demand in the future. This assumption is based on information obtained from the interviews with officials of certain kaolin companies. Any future increases in demand might be satisfied through shifts in allocation of existing supplies, use of large quantities of water which are presently discharged to streams from dewatering operations, and increased reuse of process water.

The projected municipal and industrial water demand does not include the potential requirements and effects of the alumina from kaolin industry. Preliminary estimates of personnel requirements for development of this new industry are quite small (about 300 people) and should be adequately supplied by the anticipated normal growth in the area. More detailed information on both primary and secondary employment requirements caused by the development of the industry is currently being developed and will be available to allow revision of the preliminary water demand estimates presented in this report if necessary.

Processing water requirements for new alumina from kaolin industry are estimated to be between 3.0 and 7.0 MGD depending on operating capacities and type of processing employed. All the processes are based on alkaline acid methods; nitric, hydrochloric, or sulfuric acid. Pilot plant studies are currently being conducted by the U.S. Bureau of Mines to better define the water use and treatment requirements of each process. For analysis purposes, it was anticipated that production would begin between 1980 and 1985 and in Tables 26 and 27, the potential demand was shown to occur in each county. It is very likely, however, that the development of the industry will eventually take place in only one county; location will be dependent on specific site development information which is currently not available.

Development of an alumina from kaolin industry in Georgia will place a demand on groundwater in the areas where the process plants will be built. The demand for process water has been estimated to range from 3 to as high as 25 MGD depending on process for the extraction of between 3000 and 12,000 tons of kaolin per day. In certain areas of the kaolin belt, kaolin mines that have an elevation below the piezometric head have considerable dewatering operations. In the seven-county area of interest, a company seeking commercial kaolin below the piezometric head may place a demand on the groundwater resources by the need to dewater its mines. However, if the process plant were built near the mine, water removed for dewatering could be used for process water.

The pilot plants that are conducting research on the extraction of the alumina from the kaolin have not yielded sufficient data to determine exact water demands. Anglo-American Clays Corporation estimates a demand of 3300 gpm will be needed in 10 years of starting for its Wrens plant. This is for an ordinary kaolin plant, but it does fall into the 3 to 25 MGD range which had initially been used. Based on the data from Anglo-American, drawdown amounts have been calculated as presented previously in Table 23.

To summarize, for a Q of between 3 and 25 MGD and a transmissivity of 100,000 gpm/ft, the following values were obtained:

| Distance from well, mi. | Theoretical Drawdown, ft. 1 month | 1 year | 5 years | 10 years |
|---|---|---|---|---|
| 0.0 | 50-415 | 56-465 | 60-497 | 62-511 |
| 0.1 | 20-165 | 26-216 | 30-249 | 31-260 |
| 0.5 | 12-101 | 18-151 | 22-182 | 24-198 |
| 1.0 | 9-75 | 15-125 | 13-111 | 21-171 |
| 5.0 | 2-16 | 7-60 | 11-92 | 13-105 |
| 15.0 | 0-.2 | 3-22 | 6-48 | 8-62 |

Kaolin deposits occur in sedimentary beds (Tuscaloosa formation) that overlap and lie unconformably on the crystalline basement rocks. All of the kaolin deposits of east-central Georgia were thought to be of Cretaceous age, but many are now known to be younger (Eocene). The commercial kaolin clay deposits are distributed throughout the area in discontinuous lenses, ranging from a few feet to 50 feet in thickness. The size of deposits, character and uniformity of deposits, and the overburden are all factors that determine if a deposit will be opened for mining. The thickness of a kaolin deposit has an important influence on the mining costs. Deposits of kaolin only 4 or 5 feet thick have been mined under favorable conditions, but as the thickness increases, the mining costs per ton decrease. The quality and uniformity of the deposit are critical factors that must be considered as are the thickness of overburden that can be removed economically from a kaolin deposit which depends upon: the value and thickness of the clay; the character of the overburden; and, other mining and preparation costs. Kaolin beds dip gradually to the southeast about 20-30 feet per mile. Many deposits are too deep to be of commerical value, with established mining companies usually removing up to 100 feet of overburden to reach kaolin of desired quality.

Elevations of commercial kaolin deposits are not available, but since they usually lie between the Tuscaloosa and Barnwell formations, and because the piezometric surface is usually above this location, dewatering problems seem likely. The alumina companies will seek a lower quality kaolin and, thus, may mine a larger and deeper area than traditional companies. Therefore, a need for even more dewatering seems likely. In many cases, an aquifer may be overlain by a confining clay layer which is itself overlain by a kaolin deposit. In this case, the kaolin deposit is below the piezometric surface but will not encounter water unless the impermeable clay layer is either pierced from above or broken by upward artesian pressure from below.

When examining the seven counties, the location of the kaolin dominates over the areas of the best water supply. In McDuffie County, the kaolin deposits are small, isolated lenses, occurring in the southern part of the county in the Tuscaloosa formation. In Glascock County, the kaolin deposits occur principally in the valleys of Rocky Comfort Creek and its tributaries near Gibson. These deposits consist of small lenses of soft kaolin and larger lenses containing hard kaolin. The northern and western parts of the county are underlain by the sands and kaolin of Eocene to Cretaceous ages (Figure 31). Thiele Kaolin Company is operating a plant on Bushy Creek east of Gibson, but reports of operations were not available. Glascock County, for the most part, seems to have a sparse supply of groundwater available for an alumina from kaolin facility.

Warren County, lacking the thick, water-bearing beds of the Tuscaloosa, seems to be an unfavorable area to establish mining or processing plants. Jefferson County, as seen on the Mineral Resources Map (Figure 31), contains kaolin in a small northern strip. The groundwater resources seem to be

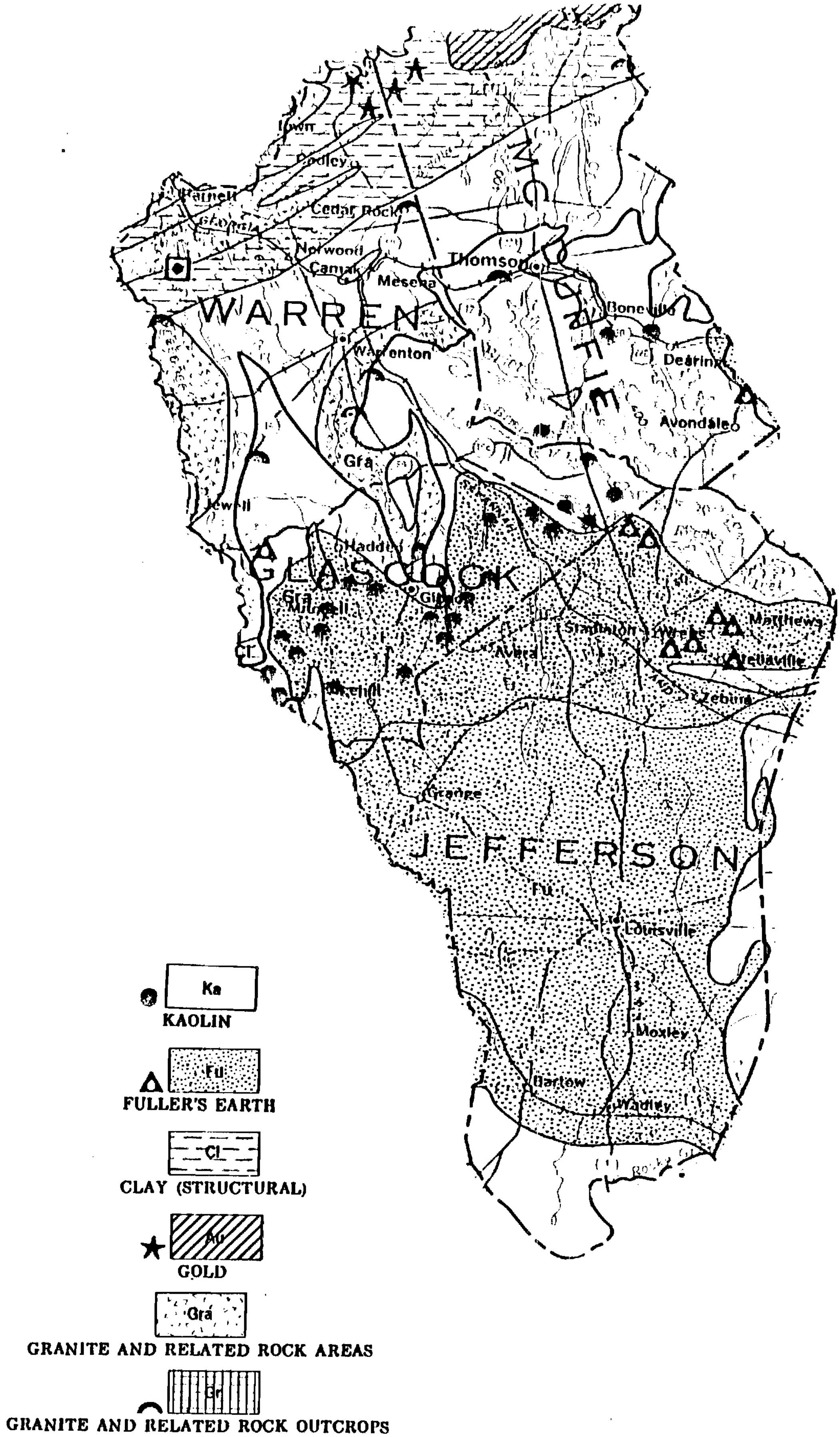


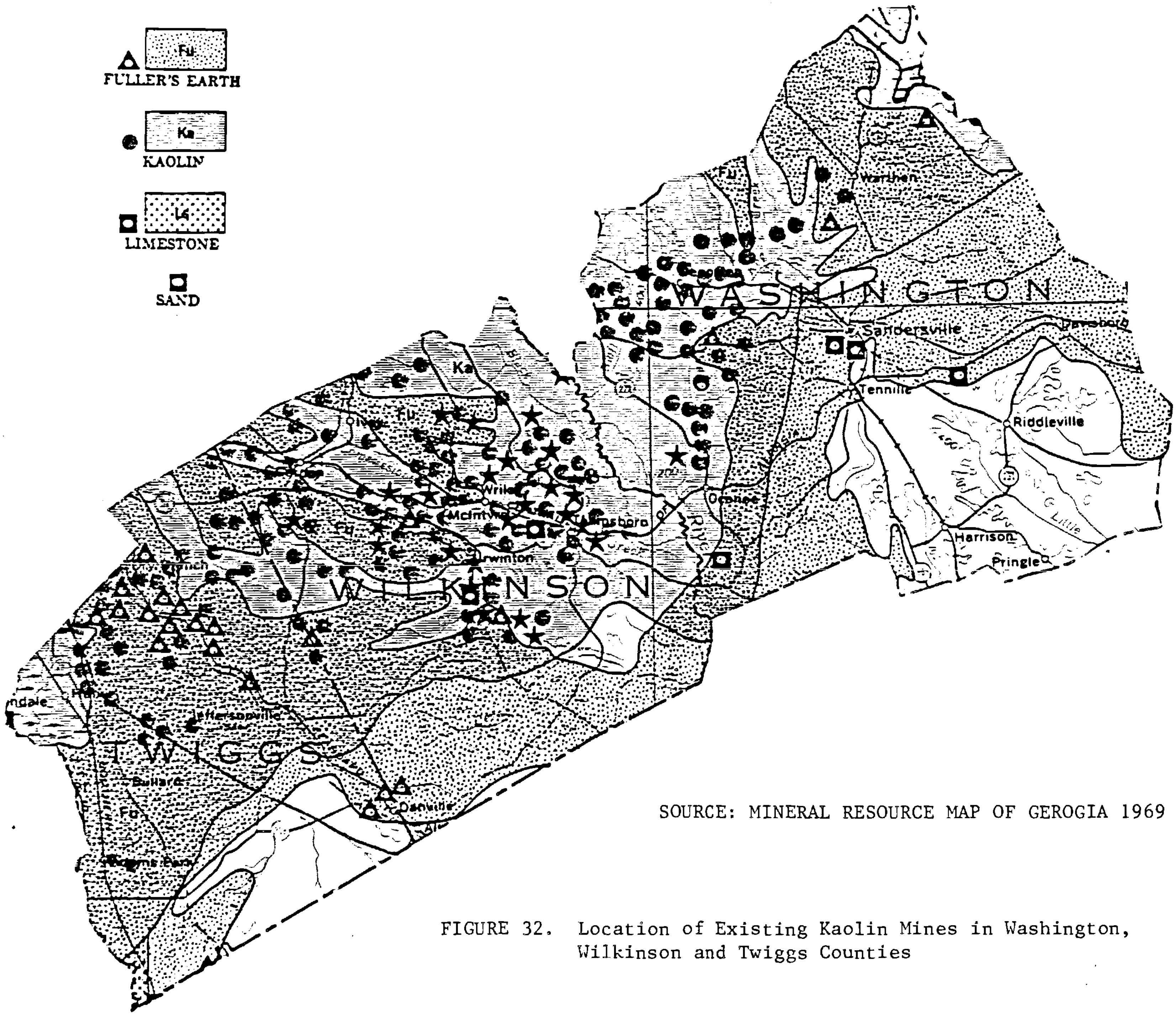

FIGURE 31. Location of Existing Kaolin Mines in Warren, McDuffie, Glascock, and Jefferson Counties

abundantly available, and the test wells of Anglo-American indicate that a pumping rate of 3300 gpm is feasible in this area. The J.M. Huber Corporation is operating near Reedy Creek north of Wrens. They report water to be sparse with a pH of approximately 4.5. Silting is a problem.

Since Washington, Wilkinson and Twiggs counties have been the center of the kaolin mining industry in Georgia, considerable information on the size and location of the kaolin beds has been collected by the kaolin mining companies. The location of existing kaolin mines are shown in Figure 32. An attempt was made to delineate those parts of the three-county area in which dewatering is expected to be a problem. Specific dewatering sites were identified near Huber, Dry Branch, Deepstep, and along the Oconee River. A more accurate delineation of potential dewatering areas was not possible because the exact elevation of the commercial kaolin deposits was not readily available. In areas where suitable quantities of kaolin exist, the main problem of potential alumina from kaolin plants would seem to be the dewatering problem and not the groundwater supply.

Future Wastewater Treatment Impacts

Since the quantity of water required by the alumina from kaolin industry and to be provided from a local source is site specific depending upon location actually selected, it is difficult to predetermine impacts on water resources. Generally, however, sufficient quality water is available in most probable locations which, with appropriate treatment before discharge, will not adversely influence receiving water quality. The impact of the industry on municipal wastewater treatment systems should be negligible but with large discharges to local streams, the overall hydraulic and ecological effects should be considered. Fortunately, the nature of the industry serves to minimize these problems since most of the water use would be for cooling




SOURCE: MINERAL RESOURCE MAP OF GEROGIA 1969

FIGURE 32. Location of Existing Kaolin Mines in Washington, Wilkinson and Twiggs Counties

which can be recovered and recycled. Only about five percent of the estimated 60,000 gallons of water per ton of product is required for makeup. Just how well process water (about 2000 gallons per ton of product) can be treated for recycle or discharge is not known at this time, but the technology is available to protect natural waters from such discharges.

Since water needs for producing alumina are of such magnitude, it is unlikely that a producer would use a city water system as a source of supply. Mine dewatering water and wells located on-site would appear to be the best sources of water supply. Likewise, industrial wastewater treatment would probably be handled on-site because of the character of the process wastes and the potential for recycle. Therefore, it is also unlikely that a producer of alumina from kaolin would discharge process wastes to the municipal treatment system. Moreover, because of the relatively small personnel requirements, discharge of domestic wastes would be insignificant and easily accommodated by existing municipal waste treatment systems.

It may be anticipated that effluent limitations for discharges from an alumina from kaolin industry in Georgia will be controlled by the Georgia Department of Natural Resources, Environmental Protection Division (EPD) and its authority to implement the National Pollutant Discharge Elimination System (NPDES) Permit Program. For this purpose, the environmental standards developed for the "Ore Mining and Processing Point Source Category" (Federal Register, November 6, 1975) and its section on "Bauxite and Other Aluminum Ores" can be used as a guide. Specific details on environmental considerations and regulatory procedures and authorities have been prepared previously in a report titled "Alumina from Kaolin Environmental Considerations" by Ward and Husted (1976).

## SUMMARY AND CONCLUSIONS

1. Water demand for processing alumina from kaolin will be in the range of 3 to 7 MGD. This range represents the requirements for a production rate of from 300,000 tons to 1,000,000 tons of alumina product per year. The amount of this water that can be recycled is not currently known. Better information is expected soon as a result of pilot plant studies that are currently being conducted.
2. The principal aquifer in the seven-county area is the Tuscaloosa formation from which larger quantities of groundwater may be withdrawn. Smaller rural demands may be met by the shallower Barnwell formation.
3. Current withdrawals of groundwater from the principal aquifer are being made for municipal and industrial demands. By far the larger amount of this withdrawal is for industrial demands; a large portion of the industrial withdrawal is for dewatering of kaolin mines. Although some of the water from the dewatering operations is presently used for processing, the majority of the water is simply discharged to the nearest stream. This "waste" represents a potential supply for local municipal demand. Unfortunately, previous attempts to establish this type of operation in the area have failed due to problems with state regulations.
4. Projection of population and municipal use to the year 2000 show that no dramatic increase in municipal demand is expected. However, if new, large industrial withdrawals are made within a radius of several miles of current wells, induced drawdown created by the industrial demand could considerably increase the required lift and hence the cost of municipal pumping. The following table summarizes some of the typical drawdown for each site (i.e., Sandersville, Huber and Wrens for a

demand range of 3-25 MGD:

| Location | Distance from well, mi. | Range of Drawdown, ft. 1 yr. | 10 yrs. |
|---|---|---|---|
| Sandersville | 1.0 | 6-46 | 7-59 |
| | 5.0 | 3-26 | 5-40 |
| | 10.0 | 2-18 | 4-31 |
| Huber | 1.0 | 8-61 | 9-79 |
| | 5.0 | 5-35 | 7-53 |
| | 10.0 | 3-24 | 6-42 |
| Wrens | 1.0 | 15-125 | 21-171 |
| | 5.0 | 7-68 | 13-105 |
| | 15.0 | 3-22 | 8-62 |

5. High rates of withdrawal of groundwater from the principal aquifer may be necessary to dewater alumina-kaolin mines. Pumping rates up to 31 MGD are required to dewater kaolin mines which are now in operation. Data on piezometric levels and elevations of commerical kaolin deposits indicate that dewatering should be anticipated. The alumina-kaolin mines, which may be larger and deeper than the traditional kaolin mines, could require larger amounts of dewatering. Studies are being conducted to provide additional information on this issue.

6. Surface water may provide an additional source of water for future industrial development in the area. Due to the variability of flows in streams throughout the area, the development of surface water supplies requires site specific studies. The interrelationship between surface and groundwater is very important throughout the study area. Streams are not only influenced by natural discharge from the aquifers, but also by the dewatering operations which can add directly to the streamflow. The potential increase in dewatering operations caused by development of kaolin-alumina industry may greatly affect flows in small streams near the mining operations.

7. Industrial wastewater discharge and/or treatment will require particular attention as the industrial processes associated with the alumina from kaolin industry are developed. Discharge limitations will be site specific and will depend upon whether the receiving stream is effluent or water quality limited. Guidelines and technology are available to accommodate these requirements and information is being developed to determine most applicable procedures.

8. Because of the limited personnel requirements of the industry, increases in domestic wastewater discharge should be easily accommodated by existing municipal treatment systems.

9. Water in the kaolin areas west of the Ogeechee River is generally more abundant than east of the Ogeechee River. Some areas east of the Ogeechee River, such as in Warren and McDuffie counties, have only slightly more than sufficient water for present kaolin operations in the immediate vicinity of operations. Water should be sufficient for expanded kaolin operations, however, including that for alumina from kaolin in this area if piped approximately 7 to 10 miles, and more than sufficient, particularly in areas west of the Ogeechee River in the vicinity of operations.

10. Insufficient data is available from wells or test holes drilled to the basement in much of the area east of the Ogeechee. Present information indicates that for wells of 1000 gpm or better, it will be necessary to drill approximately 7 to 10 miles south of the Jefferson-Glascock county line in the area south of Stapleton and Wrens. Additional testing will be necessary to determine if this distance may be shortened.

11. Two years in succession of drought conditions in the kaolin areas has resulted in an increase in irrigation wells which are likely to continue to increase as local financing from crops permits.

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Test Well
Drilled in Glascock County, Georgia
(see location maps)

Drilling was begun on July 10, 1978, by the Grosch Irrigation Company, under state contract 503-0004-590. Three wells were drilled.

One 14-inch well was drilled with a Failing hole master 4000-foot rig, using a soft formation roller bit with six-inch stems. Well was drilled with reverse circulation. A 26 O.D.-inch hole was drilled to 300 feet of depth.

Surface elevation of well was 516 feet above mean sea level.

Casing was 14 inches O.D. in random lengths of 38 to 40 feet and were welded together.

Johnson galvanized irrigator screen, 0.040 slot, was set 285-295 feet and 245-253 feet. Well was gravel packed with #1/4-inch river-washed gravel, using 72 tons to fill to top. Mill slot (1/8 inch) was set on bottom from 300 feet to 295 feet and between the two sections of Johnson irrigator screen, with one additional section of mill slot above the topmost Johnson irrigator screen.

Holes "A" and "B" were drilled on a line having a compass bearing of N 55° E. Well "B" was 50 feet southwest of the 14-inch pump well and well "A" was on line 50 feet southwest of well "B" or 100 feet southwest of the 14-inch pump well. Estimated regional strike was N 40-45° E with a shallow south dip for the formations of the area.

Both holes "A" and "B" were drilled with a Failing 1500 rig using a roller rock soft formation bit using two passes. The first pass was with an 8-inch bit followed by a second pass that reamed with a 13-inch bit to give a 13-inch O.D. hole. Standard threaded pipe in 21-foot lengths using 4-inch couplings was used. Well "A" was drilled to 310 feet. One joint of pipe was set on the bottom with the Johson irrigator screen (0.035 slot) from 285-290 feet followed by two joints of pipe, then five more feet (240-245 feet) of Johnson irrigator screen, then cased to surface. Well "B" was cased in a similar manner with the Johnson irrigator screen (0.035 slot) being from 295-300 feet and 248 to 253 feet. Both "A" and "B" were tested by air reverse flushing to approximately 10 gpm out of the top of the casing.

Pumping prior to test pumping reached a peak of 350 gpm on July 26, 1978.

A 24-hour pump test was run from 8:00 a.m. July 28, 1978, to 8:40 a.m. July 29, 1978. Water pumping rate at both start and finish was 285 gpm.

Difficulty was had with the recording equipment as well as the pump during this test. The pump developed bearing trouble and pumping was not uniform, so the test was repeated August 2-3, 1978.

An analysis of the water at the start and end of pumping is attached.

Several observations and possible conclusions should be made concerning the well.

The wells went through approximately 44 feet of kaolin between 168 feet and 212 feet of depth. Approximately 1/2 ton of bentonite drilling mud was used in drilling the 14-inch well and proportionate amounts in the smaller wells. The result was an undue amount of surging and pumping required to condition the wells. In fact, there is a strong question that the 14-inch well may require extended periods of pumping before it is clear of kaolin and bentonite. The smaller wells were bailed twice before the final pumping.

The nature of the gravel in the formation where the Johnson irrigator screens were placed was coarse and should have yielded more water than was obtained. Hence, a conclusion is that there is a strong possibility of water flow being inhibited by excess kaolin and bentonite.

Because this was a test well, a further conclusion is that future wells should probably not use bentonite drilling mud, particularly if a thick kaolin bed is encountered.

The experience from this well further indicates that where a bed of kaolin is encountered above aquifers, a roller cone rock bit should not be used, but rather a fish-tail bit. A rock bit grinds up the kaolin, causing it to be dispersed in the drilling mud so that it infiltrates the aquifer and blocks water flow. A fish-tail bit slices the clay in chunks, allowing it to be brought to surface and removed before recirculation. A further recommendation is that once a kaolin bed is drilled through, the well should be circulated until clear water emerges before drilling deeper.

The difference in static water level in the well furthest from the pump, and the other two wells could be either (a) difference in aquifers or (b) saturation by kaolin and bentonite from 14-inch well and middle well to the extent of blocking flow from the furthest well to the pump well. This latter view if favored as the aquifer zones in each well appear at about the same level and of the same thickness. It is our opinion also that the aquifers were partially blocked by kaolin and should have yielded more water.

The increase in pH from beginning to end of the 24-hour pump test, on the basis of the rest of the analysis, is believed to be from dissolved $CO_2$.

The search for a suitable well site for the test well revealed that the probability is low that there is sufficient water for an alumina from kaolin operation in most of Glascock County, all of Warren County, and parts of the extreme north of Jefferson County. The most likely area in Glascock County appears in the southeast corner, extending in an area of perhaps a mile wide just west of the railroad to perhaps two miles north of the Jefferson County line.

Three to five hundred gpm per well is likely in this area. West of this area to the Ogeechee River along and north of the Glascock-Jefferson County line, water is sparse.

A further complication reported is that wells north of Wrens become acid (pH $\sim$ 4.5) after pumping and silt up unless continuously and evenly pumped.

Northwest Jefferson County has been insufficiently drilled, but reports of test holes in the area indicate the need for test wells.

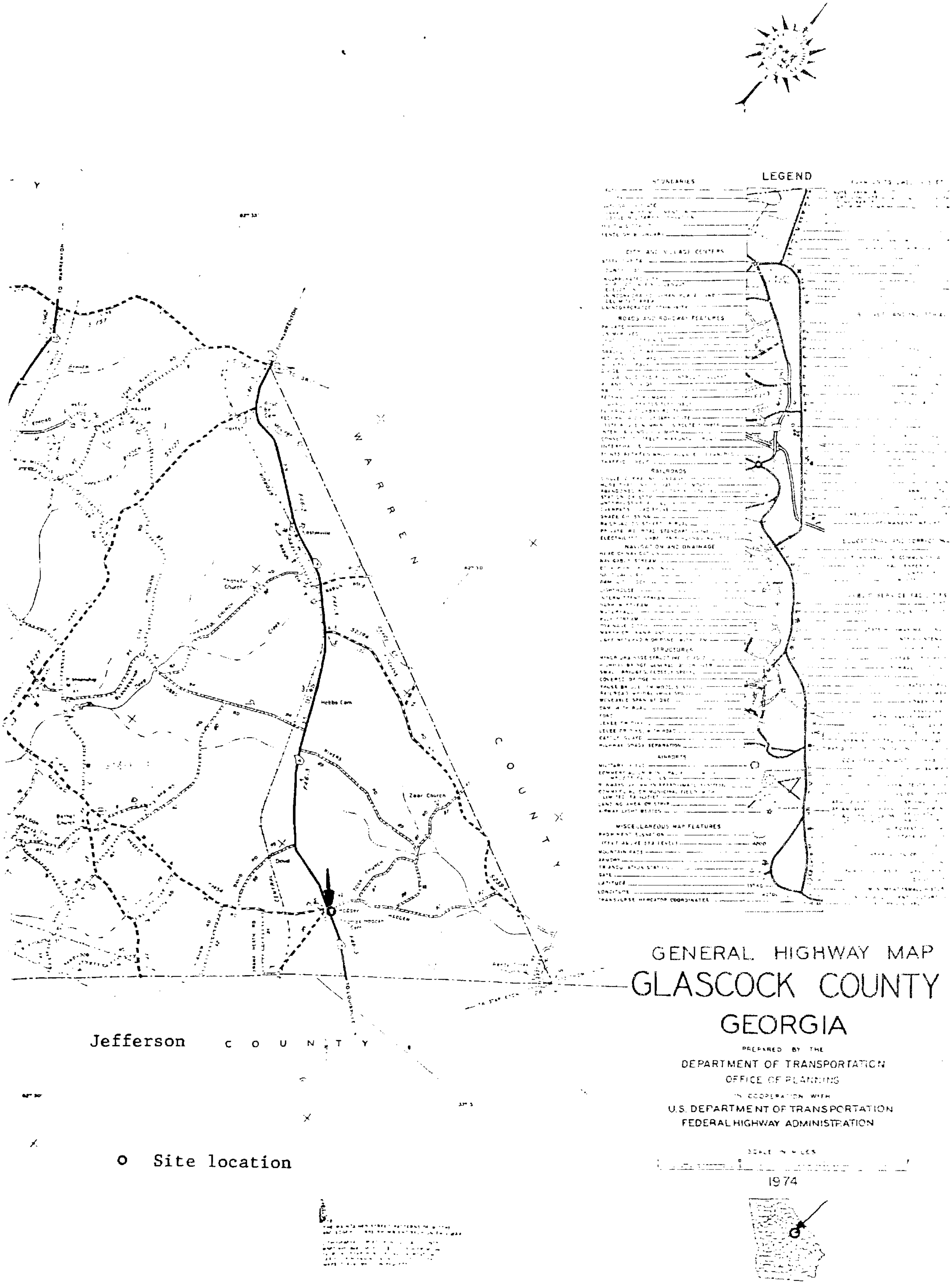
Approximately halfway between Stapleton and Louisville, water appears abundant and yields of 1200 gpm have been realized.

Pump Test
August 2-3, 1978

| | Pump Well | B | A |
|---|---|---|---|
| Static water level | 153 ft | 178 ft | 101 ft |
| August 2 | | | |
| 9:00 hrs | pump started 300 gpm flow | -- | -- |
| 12:25 | | 190 ft | 108.5 ft |
| 13:00 | | 190.3 ft | 108.7 ft |
| 17:00 | | 191.3 ft | 108.9 ft |
| 21:00 | | 194.0 ft | 109.5 ft |
| 24:00 | pump shut down 10 min to add gasoline | 192.5 ft | 108.6 ft |
| August 3 | | | |
| 1:00 | | 193.15 ft | 108.65 ft |
| 5:00 | | 194.05 ft | 108.65 ft |
| 8:30 | | 193.85 ft | 108.80 ft |
| 9:00 | pump rate 234 gpm- when pump shut off | | |
| 9:37 | | 185.05 ft | 106.4 ft |
| 12:00 | 182.5 ft | 181.5 ft | 102.0 ft |

Water temperature from well was 68°F.

The automatic recorder was not working properly. The above water levels were obtained manually. Obstructions in pump well with pump in place and operating prevented checking water level. Water pressure calculations to determine depth proved inaccurate.


LEGEND
GENERAL HIGHWAY MAP
GLASCOCK COUNTY
GEORGIA
PREPARED BY THE
DEPARTMENT OF TRANSPORTATION
OFFICE OF PLANNING
IN COOPERATION WITH
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
1974
WARREN
COUNTY
Jefferson COUNTY
o Site location

Joe D. Tanner
Commissioner

m Pickering, Jr.
Director

Start
8/2/78
0900 hrs

# Department of Natural Resources

Geologic and Water Resources Division
19 Dr. Martin Luther King, Jr. Drive, S. W.
Room 400
Atlanta, Georgia 30334
(404) 656-3214

## WATER ANALYSIS

Laboratory No. 79-52 Date October 12, 1978 County Glascock

Water Well No. ____

Location Well on north side of Ga. Hwy. 16, 1 mile inside Glascock County from Jefferson County line.

Owner Thiele Kaolin Company

Address ____

Submitted by John Husted, Department of Chemical Engineering, Georgia Tech, Atlanta, Georgia 30332

| | | | |
|---|---|---|---|
| pH (standard units) | 5.2 | Sulfate ($SO_4$) | 1 |
| Color (Pt-Co units) | 80 | Chloride (Cl) | 2 |
| Turbidity (Jackson units) | 1,000 | Fluoride (F) | 0 |
| Silica ($SiO_2$) | 10 | Nitrate ($NO_3$) | 0 |
| Iron (Fe) | 0.5 | Phosphate ($PO_4$) | 0 |
| Manganese (Mn) | 0.05 | Alkalinity as $CaCO_3$ | 4 |
| Calcium (Ca) | 1 | Hardness as $CaCO_3$ | 4 |
| Magnesium (Mg) | 0.3 | Dissolved Solids | 20 |
| Sodium (Na) | 2.3 | Bicarbonate ($HCO_3$) | 5 |
| Potassium (K) | 0.5 | | |

Parts per million (ppm) unless otherwise noted

Remarks:

Joe D. Tanner
COMMISSIONER

Sam Pickering, Jr.
DIRECTOR

# Department of Natural Resources

GEOLOGIC AND WATER RESOURCES DIVISION
19 DR. MARTIN LUTHER KING, JR. DRIVE, S. W.
ROOM 400
ATLANTA, GEORGIA 30334
(404) 656-3214

Pump off
8/3/78
0900 hrs

## WATER ANALYSIS

Laboratory No. 79-53 Date October 12, 1978 County Glascock

Water Well No. ____

Location Well on north side of Ga. Hwy. 16, 1 mile inside Glascock County from Jefferson County line.

Owner Thiele Kaolin Company

Address ____

Submitted by John Husted, Department of Chemical Engineering, Georgia Tech, Atlanta, Georgia 30332

| | | | |
|---|---|---|---|
| pH (standard units) | 4.5 | Sulfate ($SO_4$) | 1 |
| Color (Pt-Co units) | 5 | Chloride (Cl) | 2 |
| Turbidity (Jackson units) | 50 | Fluoride (F) | 0 |
| Silica ($SiO_2$) | 10 | Nitrate ($NO_3$) | 0 |
| Iron (Fe) | 0.2 | Phosphate ($PO_4$) | 0 |
| Manganese (Mn) | 0.00 | Alkalinity as $CaCO_3$ | 0 |
| Calcium (Ca) | 1 | Hardness as $CaCO_3$ | 4 |
| Magnesium (Mg) | 0.3 | Dissolved Solids | 17 |
| Sodium (Na) | 1.9 | Bicarbonate ($HCO_3$) | 0 |
| Potassium (K) | 0.5 | | |

Parts per million (ppm) unless otherwise noted

Remarks:

# Well Construction Final Report

Project No — 1 - Pump Well | Well Construction Starting Date — 7-12-78

Rig No — White Rig | Well Construction Completion Date — 7-14-78

Driller — Newt | Final Report Checked & Ok'd by —

PURCHASER State of Georgia

EXACT LOCATION 4 N 3 W off Stapleton in Glascock County CITY ______ STATE GA

WELL NUMBER 1 SIZE HOLE DRILLED 26" CASING OD 14" ID 13½

TYPE CONSTRUCTION V ☒ STRAIGHT ROTARY ☒ REVERSE

## CONCRETE — CASING DATA

No. Screen Blocks Used ______ Feet ______

No. Plain Blocks Used ______ Feet ______

No. Spacer Sets Used ______ Type ☐ Metal ☐ Wood

☐ Separate Plug ☐ Plug-Screen

Comments:

## STEEL — CASING DATA

Screen Casing Used 100' Size ___ Type ___ Feet ___

Plain Casing Used 200' Size ___ Type ___ Feet ___

No. Spacer Sets Used 3 Type ☒ Metal ☐ Wood

☒ Separate Plug ☐ Plug-Screen

Comments:

## CONCRETE — FINISH DATA

Casing Finished ______ ☐ Above ☐ Below Ground Level

Type Gravel Used ______

Gravel Obtained From ______

How Gravel Placed ______ How High ______

Water Proofing Used ☐ Yes ☐ No Amount ______

Sanitary Seal ☐ Yes ☐ No Type ______

Length ______

## STEEL — FINISH DATA

Casing Finished 1 ft ☒ Above ☐ Below Ground Level

Type Gravel Used ______

Gravel Obtained From ______

How Gravel Placed ______ How High ______

Water Proofing Used ☐ Yes ☐ No Amount ______

Sanitary Seal ☐ Yes ☒ No Type 4'x4'x4" Cement

Length 300 ft

Driller's Comments -- In relationship to the drilling & casing of the well

HOLE DRILLED 305 FEET BELOW GROUND LEVEL. WELL MEASURES 300 FEET FROM BOTTOM INSIDE. DATE WELL COMPLETED 7-14-28

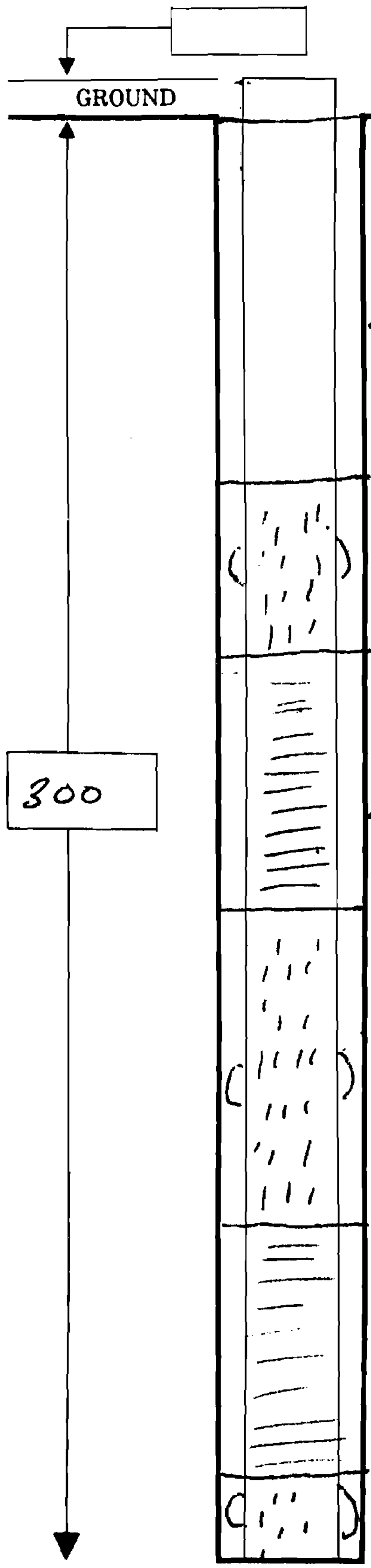
CONSTRUCTION FOREMAN Fred [signature]



FORM #1

# Well Log Data

| 26 HOLE O.D. | 14 CASING O.D. | 13½ CASING I.D. | STATIC W. L. |
|---|---|---|---|




**LIST FORMATIONS BELOW**

200 - to Ground Level Plain

240 - 200 Mill Slot

250 - 240 Johnson Screen

285 - 250 Mill Slot

295 - 285 Johnson Screen

5 ft Mill Slot 300 - 295

Sketch in any special construction notes such as pits, sanitary seals, clay fill, special base, etc.



**PRINT NO.**

# Well Construction Final Report

Project No — 2 = "A"  Well Construction Starting Date — 7-12-78

Rig No — Test Rig  Well Construction Completion Date — 7-14-78

Driller — Jim Walls  Final Report Checked & Ok'd by — ______

PURCHASER State of Georgia

EXACT LOCATION 4 N 3W Glascock County CITY Stapelton STATE GA

WELL NUMBER 2  SIZE HOLE DRILLED 13  CASING OD 4 5/8"  ID 4"

TYPE CONSTRUCTION V  ☒ STRAIGHT ROTARY  ☐ REVERSE

| CONCRETE — CASING DATA | STEEL — CASING DATA |
|---|---|
| No. Screen Blocks Used ______ Feet ______ | Screen Casing Used 10 Size 4" Type ______ Feet ______ |
| No. Plain Blocks Used ______ Feet ______ | Plain Casing Used 300 Size 4" Type ______ Feet ______ |
| No. Spacer Sets Used ______ Type ☐ Metal ☐ Wood | No. Spacer Sets Used ______ Type ☐ Metal ☐ Wood |
| ☐ Separate Plug ☐ Plug-Screen | ☒ Separate Plug ☐ Plug-Screen |
| Comments: ______ | Comments: ______ |

| CONCRETE — FINISH DATA | STEEL — FINISH DATA |
|---|---|
| Casing Finished ______ ☐ Above ☐ Below Ground Level | Casing Finished 1 ft ☒ Above ☐ Below Ground Level |
| Type Gravel Used ______ | Type Gravel Used ______ |
| Gravel Obtained From ______ | Gravel Obtained From ______ |
| How Gravel Placed ______ How High ______ | How Gravel Placed ______ How High ______ |
| Water Proofing Used ☐ Yes ☐ No Amount ______ | Water Proofing Used ☐ Yes ☐ No Amount ______ |
| Sanitary Seal ☐ Yes ☐ No Type ______ | Sanitary Seal ☐ Yes ☒ No Type 4'x4'x4" Cement |
| Length ______ | Length ______ |

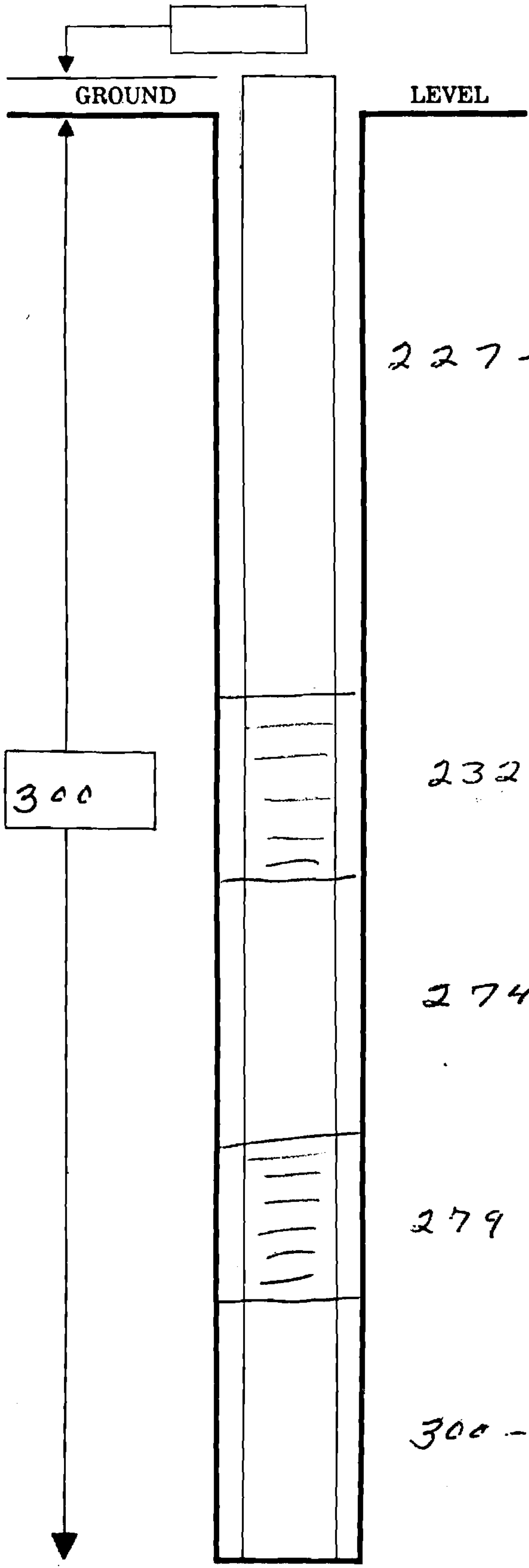
Driller's Comments -- In relationship to the drilling & casing of the well

HOLE DRILLED 315 FEET BELOW GROUND LEVEL. WELL MEASURES 310 FEET FROM BOTTOM INSIDE. DATE WELL COMPLETED 7-14-78

CONSTRUCTION FOREMAN ______

# Well Log Data

| 13 HOLE O.D. | 4 2/8 CASING O.D. | 4 CASING I.D. | STATIC W. L. |
| --- | --- | --- | --- |




**LIST FORMATIONS BELOW**

227 - Ground Level Plain 4"

232 - 227 Johnson SCREEN

274 - 232 Plain 4"

279 - 274 Johnson SCREEN 4"

300 - 279 Plain 4"

**Sketch in any special construction notes such as pits, sanitary seals, clay fill, special base, etc.**



**PRINT NO.**

# Well Construction Final Report

Project No — 3 - "B" Well Construction Starting Date — 7-17-78

Rig No — Test Well Construction Completion Date — 7-24-78

Driller — Jimmy Walls Final Report Checked & Ok'd by —

PURCHASER Ga. Tech.

EXACT LOCATION 4 mi. N. & 3 mi. W. CITY Stapleton STATE Ga.

WELL NUMBER 3 SIZE HOLE DRILLED 13 CASING OD 4 5/8" ID 4"

TYPE CONSTRUCTION V ☑ STRAIGHT ROTARY ☐ REVERSE

| CONCRETE — CASING DATA | STEEL — CASING DATA |
|---|---|
| No. Screen Blocks Used ____ Feet ____ | Screen Casing Used Johnson Size 4" Type Steel Feet 10' |
| No. Plain Blocks Used ____ Feet ____ | Plain Casing Used ____ Size 4" Type Steel Feet 290 |
| No. Spacer Sets Used ____ Type ☐ Metal ☐ Wood | No. Spacer Sets Used 2 Type ☑ Metal ☐ Wood |
| ☐ Separate Plug ☐ Plug-Screen | ☑ Separate Plug ☐ Plug-Screen |
| Comments: | Comments: |

| CONCRETE — FINISH DATA | STEEL — FINISH DATA |
|---|---|
| Casing Finished ____ ☐ Above ☐ Below Ground Level | Casing Finished 300' ☐ Above ☑ Below Ground Level |
| Type Gravel Used ____ | Type Gravel Used Pea Gravel |
| Gravel Obtained From ____ | Gravel Obtained From Lammley |
| How Gravel Placed ____ How High ____ | How Gravel Placed ____ How High Ground level |
| Water Proofing Used ☐ Yes ☐ No Amount ____ | Water Proofing Used ☐ Yes ☐ No Amount ____ |
| Sanitary Seal ☐ Yes ☐ No Type ____ | Sanitary Seal ☐ Yes ☐ No Type ____ |
| Length ____ | Length ____ |

Driller's Comments -- In relationship to the drilling & casing of the well

HOLE DRILLED 300 FEET BELOW GROUND LEVEL. WELL MEASURES ____ FEET FROM BOTTOM INSIDE. DATE WELL COMPLETED 7-24-78

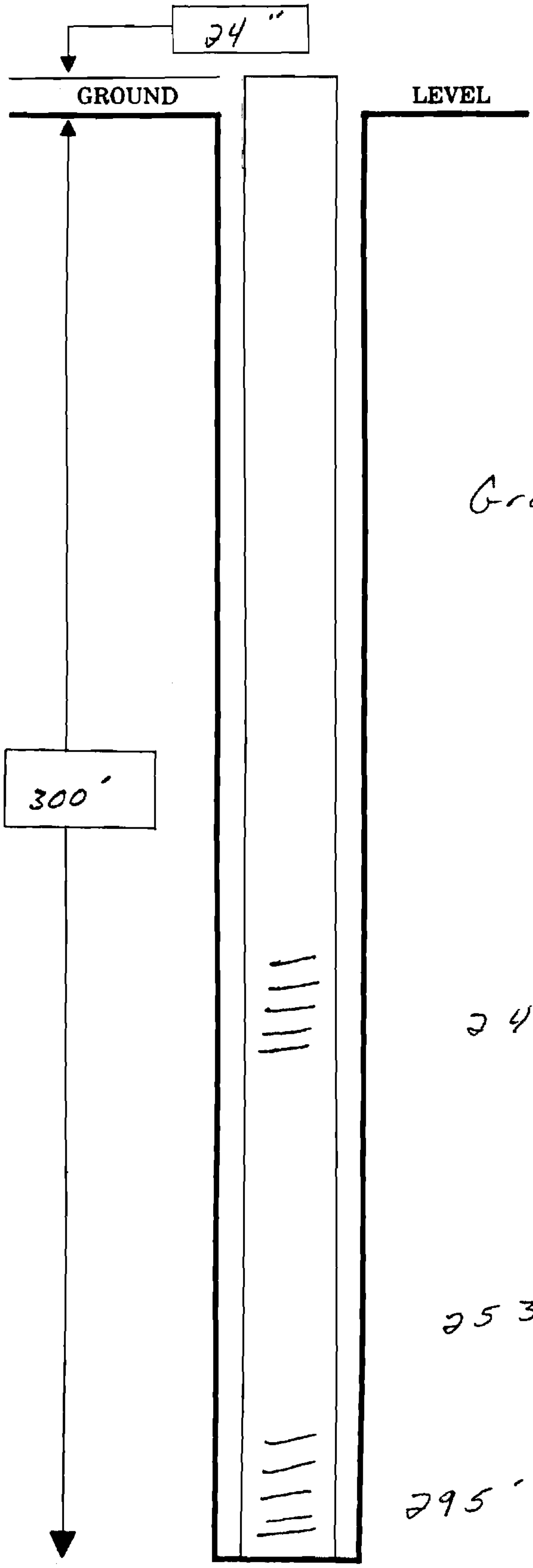
CONSTRUCTION FOREMAN Fred A. Alexander



FORM #1

# Well Log Data

13" HOLE O.D. | 4 5/8" CASING O.D. | 4" CASING I.D. | STATIC W. L.




**LIST FORMATIONS BELOW**

Ground level 248' Plain

248 - 253 Johnson Screen

253 - 295 Plain

295' - 300' Johnson Screen

**Sketch in any special construction notes such as pits, sanitary seals, clay fill, special base, etc.**



**PRINT NO.**