GEOLOGY AND GROUND-WATER RESOURCES OF THE COASTAL AREA OF GEORGIA

By

John S. Clarke, Charles M. Hacke, and Michael F. Peck

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

BULLETIN 113

ERRATA SHEET

<u>Page 49, figure 22 --</u>
38Q004 should be Lower Floridan aquifer
39Q017 should be Lower Floridan aquifer
39Q018 should be Lower Floridan aquifer

<u>Page 80 --</u>
Well number 4H074 should be 34H074

<u>Page 83 --</u>
Well number 34H391, aquifer should be Lower Floridan (LF).

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Cover Photograph: Sunset at St Marys, Georgia.

[Photograph courtesy of Dean B. Radtke, U.S. Geological Survey]

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Prepared in cooperation with the

Department of the Interior
U.S. Geological Survey
Water Resources Division

and

Department of Natural Resources
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[Plates are in pocket]

ILLUSTRATIONS--Continued

TABLES

CONVERSION FACTORS

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

Multiply inch-pound units	By	To obtain metric units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
	0.003785	cubic meter (m^3)
	Flow	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
million gallons per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
	43.81	liter per second (L/s)
inch per year (in/yr)	25.4	millimeter per year (mm/yr)
gallon per day (gal/d)	3.785	liter per day (L/d)
cubic foot per day (ft^3/d)	0.02832	cubic meter per day (m^3/d)
gallon per acre per day (gal/acre/d)	0.0009352	liter per square meter per day ($L/m^2/d$)

CONVERSION FACTORS--Continued

Multiply	By	To obtain
	Concentration	
part per million (ppm)	1	milligram per liter (mg/L)
	1,000	microgram per liter (μg/L)
	Transmissivity	
square foot per day (ft^2/d)	0.09290	square meter per day (m^2/d)
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Specific capacity	
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]
	Specific conductance	
micromho per centimeter at 25° Celsius (μmhos/cm at $25^{\circ}C$)	1	microsiemens per centimeter at 25° Celsius (μS/cm at $25^{\circ}C$)
	Temperatures	
degree Fahrenheit ($^{\circ}F$)	$^{\circ}C = 5/9\ (^{\circ}F-32)$	degree Celsius ($^{\circ}C$)

Sea level

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

GEOLOGY AND GROUND-WATER RESOURCES OF THE COASTAL AREA OF GEORGIA

By

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ABSTRACT

Ground water is the principal source of water in the 13-county coastal area of Georgia. During 1986, more than 273 million gallons per day was withdrawn from aquifers of early Eocene to post-Miocene age, primarily from the Upper Floridan aquifer of late Eocene and Oligocene age. Ground-water withdrawals since the late 1800's have resulted in long-term water-level declines in the Savannah and Brunswick areas, saltwater encroachment in the Hilton Head area of South Carolina, and upward movement of highly mineralized water in the Brunswick area.

Geologic units in the coastal area consist of limestone, dolomite, and unconsolidated sand and clay that range in age from Late Cretaceous to Holocene. Rocks of early Eocene to Oligocene age predominantly are carbonate, whereas younger rocks are mostly clastic.

Four geophysical marker horizons of late Eocene through Miocene age were mapped and eight local subsurface structural features were identified that may affect the quality of ground water in the Brunswick area. These structural features may be associated with high-angle faults that bound horsts and grabens.

Ground-water pumping in the coastal area is derived from five aquifers that range in depth from 5 to 1,000 feet below land surface. From shallowest to deepest, they are: the surficial, upper Brunswick, lower Brunswick, Upper Floridan, and Lower Floridan aquifers. The upper and lower Brunswick aquifers were delineated and named during the study. With the exception of the surficial aquifer, where water generally occurs under water-table conditions, each of the aquifers contains water under confined (artesian) conditions. Locally, the surficial aquifer includes layers of clay that form confining or semiconfining zones within the aquifer. Cones of depression resulting from pumping for industrial use have developed in the potentiometric surface of the lower semiconfined zone of the surficial aquifer at Brunswick, and in the Upper Floridan aquifer at major pumping centers in the Savannah, Jesup-Riceboro, Brunswick, and Kings Bay-St Marys areas.

The water-bearing properties of the aquifers are variable owing to vertical and lateral variations in lithology. The most productive aquifer is the Upper Floridan, from which well yields of 5,000 to 10,000 gallons per minute are common, and the transmissivity is as high as 500,000 feet squared per day. Wells tapping the surficial and the upper and lower Brunswick aquifers yield from about 2 to 180 gallons per minute. The transmissivity of the surficial aquifer ranges from about 14 to 6,700 feet squared per day, and the lower Brunswick aquifer ranges from about 1,370 to 4,700 feet squared per day. Estimated values of transmissivity for the upper Brunswick aquifer range from 680 to 5,700 feet squared per day. Although there is little available information, the permeability of the Lower Floridan aquifer probably decreases to the west and north of Brunswick towards the Savannah area.

Concentrations of dissolved constituents in water from the surficial, upper Brunswick, lower Brunswick, and Upper Floridan aquifers are within State drinking-water standards over most of the coastal area. Water from the Lower Floridan aquifer is saline and does not meet drinking-water standards over much of the study area. Chloride concentrations in the Upper Floridan aquifer are less than 40 mg/L over most of the coastal area. In the Brunswick area, saline water from deeper zones has intruded the Upper Floridan aquifer over an area of a few square miles, and has been detected in several wells tapping the overlying aquifers. High-angle vertical fractures associated with geologic structural features are believed to provide a pathway for the migration of saltwater from deeper zones into shallower, freshwater zones. In the Savannah area, chloride concentrations generally increase with depth, and saltwater has the potential to enter the Upper Floridan aquifer by encroachment from the sea or possibly by upward leakage from deeper zones. Nevertheless, in the Savannah area, there has been no substantial increase in chloride concentrations during the past 20 years in the wells sampled.

Potential downward leakage from the surficial aquifer to the Upper Floridan is greatest in Bulloch County, where the confining units between the surficial and upper Brunswick aquifers are thinnest, and where the downward hydraulic gradient between the surficial and the Upper Floridan aquifers is greatest. A significant potential for leakage also exists in other upland areas along the western part of the study area, and near the pumping centers at Savannah and Brunswick, where there is a large downward hydraulic gradient.

Previous studies indicated that anomalously high ground-water temperatures occurred in the Brunswick area, which was attributed to upward leakage of water from deeper zones. During this study, geothermal gradients measured at six wells in Chatham County and one well in Bryan County indicate that in wells less than 700 feet deep, the gradient was lower than normal, suggesting downward flow from overlying aquifers. In wells greater than 700 feet deep, the geothermal gradient was greater than normal, possibly indicating some upward flow. Although there appears to be an upward component of flow, the quantities probably are small resulting from the low permeability of the intervening confining units.

INTRODUCTION

The ground-water resources of coastal Georgia are extremely important to the economy of the State of Georgia, as well as the adjoining States of South Carolina and Florida. Nearly all municipal and industrial water users in coastal Georgia obtain their water supplies from wells that tap the Upper Floridan aquifer (formerly called the principal artesian aquifer), which is one of the most productive aquifers in the United States.

During 1986, more than 273 Mgal/d of ground water was withdrawn (primarily from the Upper Floridan aquifer) in the 13-county coastal area of Georgia (fig. 1). This pumping has lowered ground-water levels, and has produced large cones of depression in the Upper Floridan aquifer in the Savannah, Brunswick, Jesup, and St Marys, Ga.-Fernandina Beach, Fla., areas. Water-level declines in these areas have caused concern over protection of the ground-water resource. Potential problems associated with the water-level declines include encroachment of ocean water in the Savannah area, and upward movement of highly mineralized connate water in the Brunswick area. Chloride concentrations in the Upper Floridan aquifer at two locations in the Brunswick area, exceed 2,000 mg/L, which is above the State and Federal drinking water standard of 250 mg/L (Georgia Department of Natural Resources, 1977; U.S. Environmental Protection Agency, 1986).

The 13-county study area covers about 10,000 mi^2 within the Coastal Plain physiographic province (fig. 1). The study area is bounded to the northeast by the Savannah River, to the south by the St Marys River, and to the southeast by the Atlantic Ocean. Although not part of the study area, data and information from adjacent areas in Florida and South Carolina also were used in this investigation.

Purpose and Scope

Ground-water is heavily pumped in parts of Georgia's coastal area. A thorough understanding of the hydrogeology of the area is necessary to properly manage the resource. In response to this need, the U.S. Geological Survey, in cooperation with the Georgia Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, started a detailed hydrologic and water-quality evaluation of the ground-water-flow system in coastal Georgia in 1982. In addition, the surficial aquifer and the aquifers in Miocene sediments were evaluated as potential alternative sources of water. Information from the investigation will be used by the Georgia Department of Natural Resources to better define the freshwater-flow system; to assess the occurrence, movement, and quality of water underlying and locally infiltrating the freshwater-flow system; and to evaluate the effects of geologic structure on the entire flow system in coastal Georgia. With this understanding, the Environmental Protection Division can manage the resource so that contamination of the freshwater part of the aquifers can be minimized, negated, or perhaps even reversed. Portions of this study were funded as part of the Georgia Accelerated Ground-Water Program.

This report is the second in a series that describes findings of the coastal area study. The first report presented data and information available as of July 1983 (Krause and others, 1984), and primarily focused on the Upper Floridan aquifer. For a complete discussion of aquifer terminology for the Floridan aquifer system in the study area, the reader is referred to Miller (1986) and to Krause and Randolph (1989).

This report describes the geohydrologic framework and water quality of the surficial aquifer and aquifers in the Miocene sediments, and updates earlier data and information for the Upper Floridan aquifer. In addition, the report describes the affects of geologic structure on the ground-water-flow system in the Brunswick area and the potential for leakage between aquifers throughout the coastal area. The final phase of the study will use all existing data and information to develop a computer-based mathematical model that will simulate the ground-water-flow system in the study area. The model will be used to assess the potential for additional ground-water development in the study area.

Previous Studies

An extensive list of investigations on the geology and hydrology of the study area was compiled by Krause and others (1984). Krause and Randolph (1989) updated the list and included additional references to investigations that were not within the scope of the earlier report; mainly references to geologic structure and to the geohydrology of aquifer systems other than the Upper Floridan aquifer.

Recent reports about the geology of the coastal area include those by Woolsey (1977) and Huddlestun (1988). These reports delineate and describe the Neogene stratigraphy of the Georgia coast and the inner continental shelf. Recent reports about the hydrogeology of the area include work by Miller (1986), which describes the hydrogeologic framework and updates the stratigraphy of the Floridan aquifer system and overlying sediments. Miller's (1986) investigation included the entire Floridan aquifer system in all of Florida, the Coastal Plain of Georgia, and adjacent parts of Alabama and South Carolina. Thus, it was of regional extent and of general detail and scope. Krause and Randolph (1989) described the hydrogeologic framework, hydraulic characteristics, water quality, and ground-water development of the Floridan aquifer system in southeast Georgia and adjacent parts of Florida and South Carolina. Krause and Randolph (1989), being more local in extent and scope, provided greater detail about the hydrogeologic framework of the Floridan aquifer system in coastal Georgia. Soil and Material Engineers, Inc. (1986a), reported on the ground-water resources in Miocene deposits at Colonels Island and on the ground-water resources in Pliocene to Holocene deposits at Skidaway Island (1986b). Davis and others (1963, 1976) reported on land subsidence in the Savannah area between the 1930's and the 1970's.

Well-Numbering System

Wells discussed in this report are numbered according to a system based on the U.S. Geological Survey index to topographic maps of Georgia (pl. 1). Each 7 1/2-minute topographic quadrangle in the State has been given a number and a letter designation beginning at the southwest corner of the State. Numbers increase eastward and letters increase alphabetically northward. Quadrangles in the northern part of the State are designated by double letters. The letters "I," "O," "II," and "OO" are omitted. Wells inventoried in each quadrangle are numbered consecutively beginning with 1. Thus, the fourth well inventoried in the 34H quadrangle in Glynn County is designated 34H004.

Method of Study

Borehole geophysical logs, lithologic logs, or both, are available for more than 500 wells in the study area. Cores and drill cuttings from five wells were examined

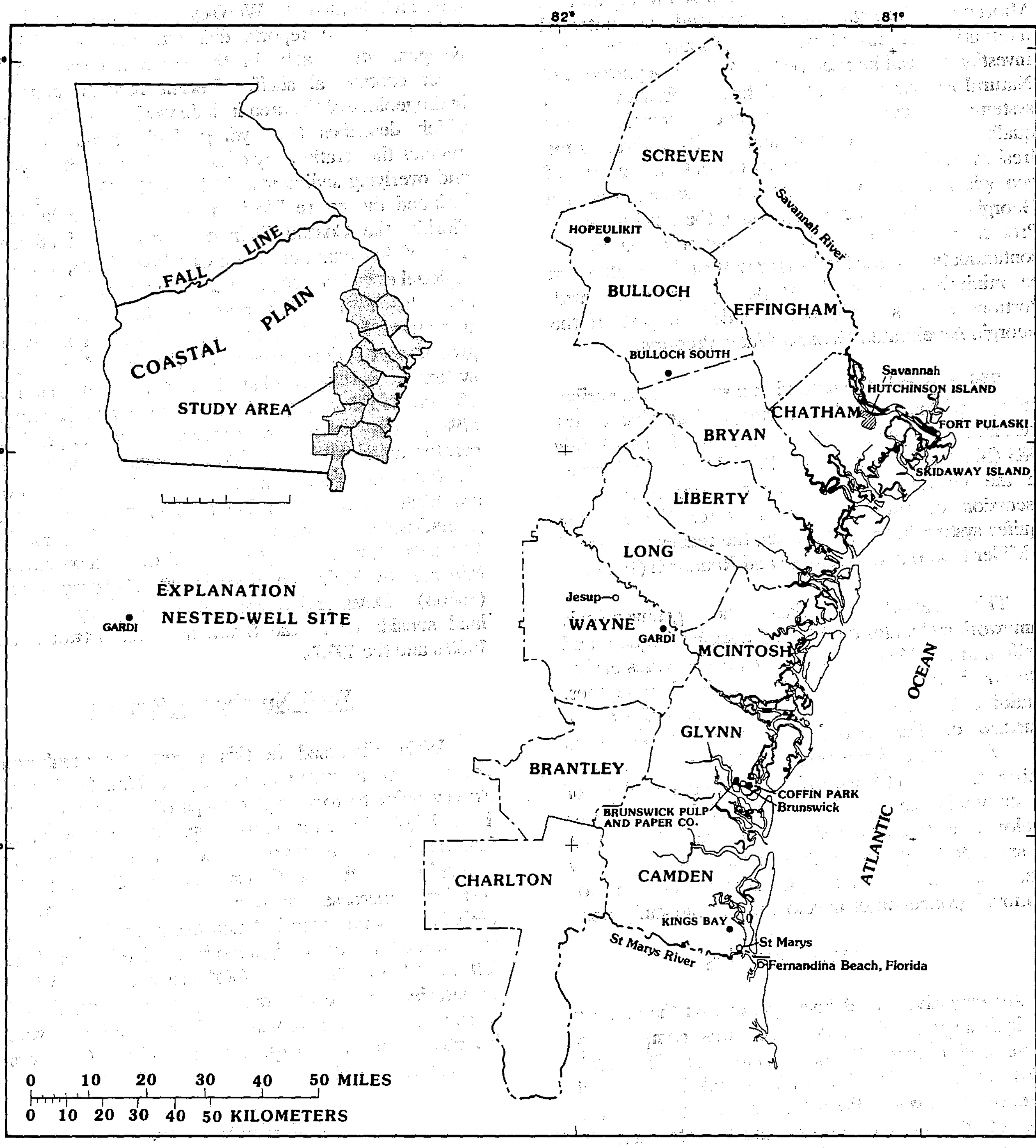


Figure 1.--Location of study area and nested-well sites.

microscopically to determine both their mineralogical and paleontological content. These sample descriptions were matched with patterns on geophysical logs obtained from each of the five wells. The log patterns were then used to correlate geologic strata throughout the study area. Lithologic logs from two cored holes are presented in appendix A at the back of this report. All the above data, supplemented by data from Herrick (1961) and Miller (1986), provided a basis for the delineation of geologic units, aquifers and confining units, and for the construction of geologic sections and maps that show the altitude of the tops of four geophysical marker horizons. In addition, three maps that show the approximate thickness of four of the geologic units were constructed by using data from geophysical and lithologic logs, and by comparing maps that show the altitude of the top of each unit with the altitude of the top of the underlying unit. Selected core samples were analyzed to determine their chemical and radioactive composition.

The water-bearing properties of the Upper Floridan aquifer at Brunswick were determined from time-drawdown and time-recovery data collected during an aquifer test. Additional information of the water-bearing properties of the aquifers was obtained from published and unpublished data. An estimate of the transmissivity of the surficial aquifer was made by using a flow-net analysis.

Maps showing the potentiometric surface of the Upper Floridan aquifer and the water-table surface of the surficial aquifer were constructed based on water-level measurements made in more than 400 wells. Continuous water-level recorders were installed on 21 wells to assess water-level fluctuations and trends in the aquifers. A list of selected well construction information and geophysical logs used in this study is given in appendix B at the back of this report, and the locations of these wells are shown on plate 1.

Water samples were collected from 15 wells and analyzed for selected constituents. These data, together with published and unpublished data from 163 additional wells, were used to determine the median, the 25th and the 75th percentiles, and the maximum and minimum concentrations of selected constituents. In November 1984, water samples from 171 wells were collected for analysis of chloride and for specific-conductance determinations. From these data, a map showing the chloride concentration of water from the Upper Floridan aquifer was prepared. Graphs showing the chloride concentrations in selected wells were plotted to assess water-quality trends.

An assessment of the potential for interaquifer leakage was based on the thicknesses and hydraulic properties of the confining units, head differences between adjacent aquifers, water-level fluctuations and trends, and differences from the normal geothermal gradient. Areas of probable leakage were identified by observing water-quality changes in wells.

Test Well Coring and Drilling Program

As part of this study, 23 test/monitoring wells were constructed or modified during 1982 to 1986 to gain additional geologic, hydrologic, geophysical, and water-quality data in parts of the study area (fig. 1, table 1). In addition, two monitoring wells (33E039 and 33E040) were drilled for the U.S. Navy at the Naval Submarine Base at Kings Bay, Camden County, as part of a ground-water withdrawal permit-application process. Twenty-three of the 25 wells comprise nine nested-well sites: two sites near Brunswick in Glynn County and one site each at Gardi in Wayne County; Hutchinson Island, Skidaway Island, and Fort Pulaski in Chatham County; Hopeulikit in northern Bulloch County; and Denmark in southern Bulloch County. Drill cuttings, cores, paleontologic samples, and geophysical logs were collected at selected test wells, and were used to correlate geologic units, aquifers, and confining units. Two abandoned oil-test wells in Glynn County (33H192 and 33G001), were modified to isolate specific water-bearing zones within the Floridan aquifer system to provide ground-water-level and ground-water-quality information.

Each of the 25 test/monitoring wells was constructed or modified to provide openings to either the Upper or the Lower Floridan aquifer, one of two aquifers in Miocene deposits, or the surficial aquifer. After completion of each well, water samples were collected for chemical analysis and water-level recorders were installed. These 25 wells are now part of the Georgia ground-water-level and ground-water-quality monitoring networks. The lithologic and the geophysical properties of sediments, well-construction characteristics, and vertical head relations at the nested-well sites are shown in plate 2.

Table 1.--Well information at nested-well sites in the coastal area

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface. Available geophysical logs: E, electric; C, caliper; N, neutron porosity; J, natural gamma; U, gamma-gamma; S, acoustic velocity; M, focused resistivity; T, Temperature; X, core; Z, other; G, geologist or sample; F, fluid resistivity; --, data not available]

Well no.	Open interval (ft)	Aquifer	Water level (ft)	Date measured	Available geophysical logs and drilling information
Hopeulikit site, Bulloch County--altitude of land surface is 205 ft					
31U009	160-210	UB	-73.4	05-16-85	--
31U008	315-860	UF,LF	-78.3	05-16-85	C,E,J,U,N,G (McFadden and others, 1986)
Bulloch south site, Bulloch County--altitude of land surface is 120 ft					
32R003	134-155	S	-12.4	05-16-85	--
32R002	420-804	UF	-88.3	05-16-85	C,E,J,U,N,G
Kings Bay site, Camden County--altitude of land surface is 24 ft					
33E040	560-750	UF	+8.3	06-12-87	E,J
33E039	950-1,150	UF	+13.2	06-12-87	--
Hutchinson Island site, Chatham County--altitude of land surface is 6 ft					
37Q185	274-360	UF	-125.3	05-15-86	--
37Q186	1,380-1,520	1/	-77.8	05-15-86	C,E,J,U,N,S,M, X (0-330 ft), G (420-1,520 ft)
Skidaway Island site, Chatham County--altitude of land surface is 10 ft					
37P116	71-85	S	-9.0	04-30-87	--
37P115	211-250	UF	-50.8	04-30-87	--
37P114	262-400	UF	-52.3	04-30-87	--
37P117	112-270	UB,LB,UF	-52.2	04-30-87	--
37P113	700-1,100	LF	-51.5	04-30-87	C,E,J,U,N,F

Table 1.--Well information at nested-well sites in the coastal area--Continued

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface. Available geophysical logs: E, electric; C, caliper; N, neutron porosity; J, natural gamma; U, gamma-gamma; S, acoustic velocity; M, focused resistivity; T, Temperature; X, core; Z, other; G, geologist or sample; F, fluid resistivity; --, data not available]

Well no.	Open interval (ft)	Aquifer	Water level (ft)	Date measured	Available geophysical logs and drilling information
Fort Pulaski site, Chatham County--altitude of land surface is 8 ft					
38Q002	110-348	LB,UF	-34.7	05-14-86	--
38Q004	606-657	LF	-34.3	05-14-86	--
38Q196	870-900	LF	-39.6	05-14-86	--
38Q201	1,358-1,546	1/	-49.9	05-14-86	C,E,F,G,J,N,T, U,Z
Brunswick Pulp and Paper Co. site, Glynn County--altitude of land surface is 7 ft					
33H208	135-155	S	-5.0	05-17-85	--
33H207	620-720	UF	+6.0	05-17-85	C (0-584 ft),E,G
33H206	1,000-1,100	LF	-1.8	05-17-85	C (590-990 ft), J,N,U
Coffin Park site, Glynn County--altitude of land surface is 7 ft					
34H438	192-202	S	-5.8	04-02-87	--
34H437	313-328	UB	-1.0	04-02-87	--
34H445	580-824	UF	+2.0	04-02-87	C,E (580-827 ft)
34H436	1,000-1,103	LF	+6.9	04-02-87	E (10-530 ft),J,U,N
Gardi site, Wayne County--altitude of land surface is 74 ft					
32L017	200-215	S	-40.0	05-13-85	--
32L016	320-340	UB	-51.3	05-13-85	--
32L015	545-750	UF	-55.3	05-13-85	C,SP,G

1/Well taps low-permeability units underlying the Lower Floridan aquifer.

Borehole Geophysical Interpretation and Correlation

Natural gamma-radiation logs provided the main basis for correlation of strata in the study area, and in adjacent parts of Florida and South Carolina. Most wells in the area were cased through much of the strata of interest, thus limiting the types of geophysical data that could be collected. However, because natural gamma rays can penetrate well casing, natural gamma logs were ideal for the correlation of lithologic units from land surface to total well depth.

Selected cores were examined to (1) evaluate the interpretations of natural gamma logs for correlation of units throughout the area, (2) validate the reliability of interpretations of the geophysical logs, and (3) confirm suspected facies changes within the various units. Cores were examined from the following wells:

37Q186	Georgia Geologic Survey Hutchinson Island test well 2,	Chatham County;
31K002	Georgia Geologic Survey test well 2,	Wayne County;
33H188	U.S. Geological Survey test well 26,	Glynn County;
34E001	Georgia Geologic Survey Cumberland Island test well 1,	Camden County; and
39P002	South Georgia Mineral Program Program corehole CH-10/10A	Chatham County.

Lithologic logs of core from wells 37Q186 and 34E001 are listed in appendix A.

Acknowledgments

The authors extend their appreciation to the many well owners, drillers, and managers of municipal and industrial waterworks who readily furnished information about wells. In particular, the writers wish to thank Johnathan Smith of Brunswick Pulp and Paper Company, and the late Woodrow Sapp of Sapp Well Drillers, Brunswick, Ga., for providing helpful information on wells in the area. Appreciation also is extended to those landowners who permitted the installation and monitoring of test wells on their property.

GEOLOGY

Coastal Plain strata in the study area consist of unconsolidated to semiconsolidated layers of sand and clay, and semiconsolidated to very dense, layers of limestone and dolomite. These sediments range in age from Late Cretaceous to Holocene. Coastal Plain strata crop out in discontinous bands that generally are parallel to the Fall Line shown on figure 1. In the study area, the strata generally strike southwest-northeast, and dip and gradually thicken to the southeast, where they reach a maximum thickness of more than 5,500 ft in Camden County (Wait and Davis, 1986). These sedimentary rocks unconformably overlie igneous intrusive rocks and low-grade metamorphic rocks of Paleozoic age, and sedimentary strata and volcanics of Triassic to Early Jurassic age (Chowns and Williams, 1983).

Geologic Units

To avoid confusion and cumbersome terminology in this report, formations of Paleocene to Holocene age that are present in the study area, and that have similar lithologies and equivalent stratigraphic positions, or both, are grouped into informal time-rock units that may include all or parts of several formations (pl. 3). This report focuses mainly on units of late Eocene through Miocene age. Descriptions of other units were derived from published reports. Geologic units in the study area include, in ascending order: the Paleocene unit, the lower Eocene unit, the middle Eocene unit, the upper Eocene unit, the Oligocene unit, the Miocene units C, B, and A, and the post-Miocene unit. The vertical relations of these units in the study area are shown on a series of hydrogeologic sections on plates 4 and 5.

Stratigraphic nomenclature and age assignments used in this study conform to those used by Miller (1986) in order that this report be consistent with previous reports prepared by the U.S. Geological Survey. Detailed stratigraphic studies conducted by the Georgia Geologic Survey have resulted in revised correlations and age assignments of some Coastal Plain stratigraphic units (Huddlestun, 1981, 1988; Huddlestun and Hetrick, 1985). A simplified version of the Georgia Geologic Survey stratigraphy for the study area is included on plate 3. Because this study will serve as a basis for a digital ground-water flow model that is based on Miller's geologic framework, it was deemed more appropriate to follow Miller's nomenclature rather than Huddlestun's.

Paleocene Unit

Data for sediments of Paleocene age in the study area are sparse. Therefore, the authors have relied heavily on the work of Herrick (1961), Herrick and Vorhis (1963), B.W. McNeely (Shell Oil Company, New Orleans, written commun., 1976), and Miller (1986) for information concerning descriptions and stratigraphic markers for this unit. Interpretations of the position of this unit in the stratigraphic column at the Hutchinson Island and Fort Pulaski nested-well sites shown in plate 2 were based largely upon their work.

Sediments of Paleocene age consist of two facies in the study area, a northern clastic facies, and a southern carbonate-evaporite facies. The northern clastic facies was called the Clayton Formation by Herrick and Vorhis (1963, p. 36), Miller (1986, p. B19), and McNeely (written commun., 1976). The southern carbonate-evaporite facies was assigned to the Cedar Keys Limestone by Herrick and Vorhis (1963, p. 36), and was renamed the Cedar Keys Formation by Miller (1986, p. B18-B19). The top of the Clayton Formation generally is marked by a hard, sandy, glauconitic, fossiliferous limestone. The remaining part of the Clayton Formation consists of glauconitic sand, argillaceous sand, and small amounts of medium- to dark-gray clay. According to Miller (1986, p. B19), this part of the Clayton Formation grades upward into the Black Mingo Formation of South Carolina, which consists of dark, carbonaceous clay and thin beds of sand. The Cedar Keys Formation consists of thick beds of anhydrite and dolomite. The Paleocene unit unconformably overlies marl and carbonate sediments of Late Cretaceous age.

According to Herrick and Vorhis (1963, fig. 13), the Paleocene unit attains a maximum thickness of at least 425 ft in the study area. At the Hutchinson Island and Fort Pulaski sites near Savannah (pl. 2), the upper and the lower boundaries of the Formation are based on paleontological descriptions of McNeely (written commun., 1976), for well 36Q318 located about 4.6 mi west of Hutchinson Island.

The depositional environments of the Paleocene unit were marine to marginal marine (Miller, 1986, p. B21-22). Paleocene time marked the beginning of a regional transgression of the sea that lasted through the late Eocene. Clastic sediments of the Clayton Formation were deposited in a shallow marine environment, whereas the Cedar Keys Formation represents a shallow water, carbonate platform environment. The evaporite and dolomite of the Cedar Keys Formation represent an even shallower environment, such as those found in tidal flats (Miller, 1986, p. B18).

Lower Eocene Unit

Sediments of early Eocene age consist of glauconitic limestone and dolomite that Miller (1986, p. B22-B23) included in the Oldsmar Formation. In the northern part of the study area, the upper part of the lower Eocene unit includes a layer of sand. Carbonate sediments of the Oldsmar Formation unconformably overlie clastic sediments of the Paleocene Clayton Formation in the northern part of the area. In the southern part of the area, the lower Eocene unit overlies anhydrites and dolomites of the Paleocene-age Cedar Keys Formation (Miller, 1986, p. B22-B23).

Miller (1986, pl. 5) reported that sediments of early Eocene age attain a maximum thickness of about 800 ft in southeastern Camden County. The lower Eocene unit was found at three nested-well sites drilled in the Savannah area during this study, and ranged in thickness from 120 ft at the Hutchinson Island site to 180 ft at the Fort Pulaski site (pl. 2). In this area, the lower Eocene unit consists of glauconitic limestone and dolomite of the Oldsmar Formation.

The lower Eocene limestone in the southern part of the study area was deposited in warm, shallow, open marine waters of a carbonate bank environment (Miller, 1986, p. B24). The increase in clastic sediments within the unit suggests a more nearshore environment to the north.

Middle Eocene Unit

The middle Eocene unit consists mainly of glauconitic dolomite and limestone of the Avon Park Formation (Miller, 1986, p. B25), which unconformably overlies the lower Eocene Oldsmar Formation. The base of the middle Eocene unit is difficult to distinguish from the underlying lower Eocene unit because the two units are lithologically similar. The primary method for distinguishing the middle Eocene unit is fossil evidence. Microfossils are abundant in the middle Eocene unit, and are listed by Herrick (1961), Herrick and Vorhis (1963, table 6), and Miller (1986, table 1). The most useful and the most easily recognized microfossil for age determination is the foraminifera, *Lepidocyclina antillea Cushman*. This guide fossil is the *Polylepidina* of Herrick (1961) and is synonymous with *L. gardnerae Cole* of Miller (1986, p. B9). The upper boundary of the middle Eocene unit is more easily distinguished from overlying sediments where it is dolomitized.

The middle Eocene unit attains a maximum thickness of slightly more than 1,000 ft in western Glynn and McIntosh Counties, and in southeastern Wayne County (Miller, 1986, pl. 7). The middle Eocene unit was found at the Coffin Park, Brunswick Pulp and Paper Company, Kings Bay, Skidaway Island, Fort Pulaski, and Bulloch South nested-well sites (pl. 2), and the entire thickness was penetrated at the Hutchinson Island and Fort Pulaski sites in the Savannah area (pl. 2). Here, the middle Eocene unit attained a thickness of 700 and 540 ft, respectively.

The depositional environment of the Avon Park Formation was a shallow, carbonate platform covered by warm, open marine water (Miller 1986, p. B28). According to Miller (1986, p. B28), some of the dolomite is indicative of a sabkha or tidal-flat environment.

Upper Eocene Unit

The upper Eocene unit in most of the study area consists of the Ocala Limestone. The Ocala is a massive, fossiliferous limestone that contains bryzoan remains, foraminiferal tests, and mollusk shells. Small amounts of glauconite are present in the lower part of the limestone. In northern Screven and Bulloch Counties, the unit is characterized by an increase in clastic sediments. North of the study area, the upper Eocene unit consists of the largely clastic Barnwell Formation. The upper Eocene unit unconformably overlies dolomite and limestone of the middle Eocene Avon Park Formation (Miller, 1986, p. B25).

The fossils in the Ocala Limestone have been identified and listed in reports by Herrick (1961), Herrick and Vorhis (1963), and Miller (1986, table 1). The most distinctive and useful of these microfossils for age determination and stratigraphic placement is the foraminifera, *Asterocyclina nassauensis Cole*. The most useful of the larger fossils is the mollusk, *Amusium ocalanum Dall.*

Glauconite in the lower part of the Ocala Limestone also is a useful stratigraphic marker because it produces a relatively high peak of radiation on natural gamma logs owing to the presence of potassium-40 in the glauconite. This glauconitic zone is recognized on point-resistance logs as a zone of relatively low electrical resistance. The glauconitic part of the Ocala is persistent throughout the study area, and may be equivalent to the lower division of the Ocala of Herrick and Vorhis (1963, p. 19).

The upper Eocene unit is more than 200 ft thick throughout the study area, and in some places it is more than 400 ft thick. The exact thickness of the upper Eocene unit is not known at most places because the majority of wells do not penetrate the base of the unit.

The depositional environment of the upper Eocene unit in the study area was a warm, shallow water, carbonate bank similar to that of the underlying carbonate sediments. To the north and the west, this unit grades into a more clastic, near-shore facies consisting of sand and clay.

Oligocene Unit

Sediments of the Oligocene unit consist of buff-colored, porous limestone that contains foraminiferal tests (mainly miliolids), micrite, and nonparticulate, ubiquitous phosphate (see lithologic descriptions, appendix A). The guide fossil for the Oligocene in the study area is the foraminifera, *Pararotalia mexicana mecatepecensis Nuttall*, formerly *Rotalia mexicana*, (Sever, 1966). The unit unconformably overlies the upper Eocene Ocala Limestone (pl. 3).

The Oligocene unit is distinguished from the underlying bryzoan-rich, upper Eocene Ocala Limestone by an abundance of miliolid foraminifera, and from the overlying Miocene carbonate sediments by the absence of particulate phosphate. The difference in phosphate content between the Oligocene limestone and the overlying Miocene carbonate sediments appears as a sharp decrease in gamma activity on the natural gamma log. However, Wait and Gregg (1973,

p. 5) reported the presence of particulate phosphate in Oligocene limestone in the Brunswick area. In the Savannah area, an infilling of particulate phosphate was observed in a feature that probably was either a burrow or a root hole that penetrated the top 15 ft of the Oligocene limestone in a core from well 37Q186 (pl. 2, appendix A). The infilled material, however, was considered Miocene in age because it was lithologically the same as the overlying phosphatic dolomite of Miocene age. Because the observations made by Wait and Gregg (1973) probably were based on well cuttings, it is possible that the reported presence of particulate phosphate was due to a similar infilling.

The lithology, thickness, and stratigraphic position of the Oligocene unit correlates well with the stratigraphic framework established in previous studies; however, Miller (1986, pl. 10) did not recognize the presence of Oligocene limestone on Cumberland Island. During this investigation, however, it was determined that Oligocene limestone was present in well 34E001 on Cumberland Island based on the response of the natural gamma log of the well and the presence of miliolid foraminifera in the core interval 532 to 534 ft (appendix A).

The Oligocene unit reaches a maximum thickness of about 120 ft at well 34J047 at Darien, McIntosh County (section F-F', pl. 5). The unit is absent in western and southern Camden County, and locally in southern Wayne County (pl. 7). In places where the Oligocene unit is absent, the altitude of the top of the upper Eocene unit (pl. 6) is the same as the altitude of the base of the Miocene unit (pl. 7). The Oligocene unit generally increases in thickness from west to east (pl. 4) and from south to north (pl. 5).

The limestone of the Oligocene unit was deposited in a carbonate bank environment. In updip areas, the unit is characterized by an increase in clastic sediments, which is indicative of a marginal marine environment.

Miocene Units

Sediments of Miocene age consist of three similar depositional sequences that are each bounded above and below by an unconformity. Each sequence comprises a geologic unit that consists of a basal carbonate layer, a middle clay layer, and an upper sand layer. Because the lithology of each of the units is similar, they can only be differentiated from one another by stratigraphic position, by limited paleontologic evidence, and by geophysical characteristics. The units were named after three geophysical markers (see the section, Geophysical Markers) and are, in ascending order, Miocene units C, B, and A (pl. 3). The base of each unit is defined by the geophysical marker of the same designation, thus, the base of unit C is recognized by the C marker, and so forth.

The lithology, thickness, and stratigraphic position of the three units best fit the stratigraphic framework of McCollum and Herrick (1964); units C, B, and A correlate with the lower, middle, and upper Miocene divisions, respectively. Reports by Woolsey (1977) and Huddlestun (1988) give ages for the three units as early Miocene, late early Miocene, and middle Miocene, respectively. Miller (1986, B35-B38) regarded the Miocene in Georgia as mostly middle Miocene in age, but recognized that strata of late Miocene and early Miocene age possibly were present. Because the exact ages of the units are unresolved, all Miocene strata are considered as middle Miocene in this report (pl. 3). At the nested-well sites, the total thickness of Miocene sediments ranged from about 65 ft at the Fort Pulaski site near Savannah, to more than 335 ft at the Brunswick sites (pl. 2).

The Miocene sediments unconformably overlie limestone of Oligocene age in most of the study area. However, in some areas where Oligocene limestone is absent, Miocene sediments unconformably overlie the Ocala Limestone of late Eocene age (pl. 2). (See map showing altitude of the base of the Miocene, pl. 7.)

Unit C

In most of the study area the basal carbonate layer of unit C consists of sandy, phosphatic dolomite or limestone that contains the molds of mollusks. The basal carbonate layer grades upward into the middle clay layer, which consists of alternating laminae of silty clay and clayey silt. These laminae contain fish remains; circular molds of diatoms similar to *Coscinodiscus sp.*; silt consisting of dolomite rhombs and angular quartz; very fine, well rounded, shiny brown to black, phosphatic sand; and very fine mica. The middle clay layer grades upward into the upper sand layer, which consists of poorly sorted, very fine to granule-size quartz sand and some phosphate grains and dolomite rhombs. Interpretations of geophysical logs at the nested-well sites in the Savannah area (pl. 2), indicate that the middle clay layer and upper sand layer are absent, probably owing to erosion. Only the lower part of the basal carbonate layer is present, and it consists of sandy, phosphatic limestone that contains mollusk shells, foraminiferal tests, and shark's teeth.

Unit C ranges in thickness from about 10 ft at the Hutchinson Island site and 3 ft at the Fort Pulaski site near Savannah, where only the lower part of the basal carbonate layer is present (pl. 2), to more than 160 ft in northeastern and southeastern Glynn County and in southeastern McIntosh County (pl. 10). The entire sequence of unit C is preserved in the Brunswick area at the Coffin Park and the Brunswick Pulp and Paper Company nested-well sites, where the unit ranges in thickness from 120 to 130 ft (pl. 2). Northeast from Brunswick and parallel to the coast, the three lithologic layers thin, and in the Savannah area, all but the lower part of the basal carbonate layer are absent.

The lithology, thickness, and stratigraphic position of unit C correlate with the lower Miocene of McCollum and Herrick (1964). The basal carbonate layer of unit C also correlates with the the Tampa Limestone of Counts and Donsky (1963, table 1; p. 28-29.), with the Parachucla Formation of Woolsey (1977) and Huddlestun (1988) in the Savannah area, and with the Edisto Formation of Ward (DuBar and others, 1980) in South Carolina. Unit C correlates with the lower section of the lower and the middle Miocene of Wait (1965) and Wait and Gregg (1973, fig. 2; p. 3-4).

Unit B

Unit B, like unit C, consists of a basal carbonate layer, a middle clay layer, and an upper sand layer. The lithology of each of these layers is similar to those in unit C. The basal carbonate layer consists of dolomite and limestone that contain very fine to coarse clear quartz sand, shiny brown to black phosphatic sand, and molds of mollusk shells. In the Savannah area, the basal carbonate layer consists of limestone that contains both quartz and phosphatic sand, mollusk shells, foraminiferal tests, and shark's teeth (see core description, well 37Q186, appendix A). The basal carbonate layer grades upward into a middle clay layer that consists of alternating laminae of phosphatic silty clay and clayey silt. These laminae contain silt-size quartz grains, dolomite rhombs, phosphate grains, mica, and fish teeth and scales. Circular molds of diatoms, similar to those found in the middle clay layer of unit C, also are present. The middle clay layer is overlain by an upper sand layer that consists mostly of poorly sorted, very fine to coarse quartz sand. No fossils were found in this layer, and the uppermost part contains little phosphate, carbonate, or clay. However, very thin dolomite layers are present in the uppermost part of the sand layer.

Unit B ranges in thickness from about 30 ft at the Fort Pulaski site in Chatham County (pl. 2) to about 220 ft in northeastern Brantley and south-central Wayne Counties (pl. 11). The greatest thickness of the unit is found in a structural low located northwest of Brunswick (pls. 8 and 11). The total thickness of unit B increases to the south, west, and northwest of Fort Pulaski (pls. 4, 5, and 11).

The lithology, thickness, and stratigraphic position of unit B correlate with the Hawthorn Formation of Counts and Donsky (1963, table 1; p. 29-30) and with the middle Miocene of McCollum and Herrick (1964). Unit B also correlates with the upper part of the lower and the middle Miocene of Wait (1965) and Wait and Gregg (1973, fig. 2); with part of the Hawthorn Formation of Miller (1986, table 2), and with the Marks Head Formation of Woolsey (1977) and Huddlestun (1988). In the Savannah area, it is difficult to distinguish the basal carbonate layer of unit B from that of unit C because they are lithologically similar, and because the upper sand and the middle clay layers of unit C are absent in this area (pl. 2). The two Miocene units can only be distinguished by the use of paleontological evidence or borehole geophysical logs.

Unit A

Unit A, the uppermost of the three Miocene units, also consists of a basal carbonate layer, a middle clay layer, and an upper sand layer. The lithology of the lower carbonate layer is similar to that of units B and C, and consists of sandy, phosphatic limestone or dolomite that contains the molds of mollusks. The sand grains consist of very fine to coarse, clear quartz and brown to black phosphate. However, at Savannah, the matrix material around most of the phosphate grains consists of clay instead of dolomite, which is the matrix material in the carbonate layers of units B and C (see the lithologic description for well 37Q186, appendix A). The clay matrix indicates a nearer-to-shore transitional facies between the basal carbonate and the overlying middle clay layer. The middle clay layer consists of alternating clay and silt laminae that contain fish remains and the molds of diatoms similar to those found in the middle clay layers of units B and C. In the northwestern part of the study area, geophysical logs indicate an increase in sand content in the middle clay layer, thus representing a transition to the near-shore facies of the overlying upper sand layer. This transition is shown at the Hopeulikit site in plate 2. The upper sand layer consists of very fine to coarse, poorly sorted quartz sand similar to the upper sand layers of units B and C.

Unit A ranges in thickness from about 20 ft at the Fort Pulaski site near Savannah to about 90 ft at the Coffin Park and Brunswick Pulp and Paper Company sites in Brunswick (pl. 2). Although the top of the unit was not mapped, it is assumed that unit A, like units B and C, thickens to the south, west, and northwest of Fort Pulaski. It also is assumed that unit A is thickest in the vicinity of the structural low north of the city of Brunswick, where the underlying units reach their maximum thickness (pls. 10 and 11).

The lithology, thickness, and stratigraphic position of unit A correlates with the upper Miocene sediments of McCollum and Herrick (1964), and the uppermost part of the lower and middle Miocene and the lowermost part of the upper Miocene of Wait (1965) and Wait and Gregg (1973, fig. 2). The unit is included in the Hawthorn Formation of Counts and Donsky (1963, table 1; p. 29-30) and Miller (1986, pl. 2), and correlates with the Coosawhatchie Formation of Woolsey (1977) and Huddlestun (1988).

Depositional Environments

The Miocene sediments of the study area represent three similar depositional sequences of upward-coarsening sediments indicative of three cycles of transgression and regression. The sequences correspond to Miocene units C, B, and A. Each sequence, or cycle of deposition, began with carbonate deposition in open marine water of shallow to moderate depth. Micritic to fossiliferous limestone was deposited, and subsequently was dolomitized. The dolomitization process created a coarser-grained carbonate rock that in many places consists of euhedral crystals of calcium magnesium carbonate. Some clastic material was supplied to the basin, as indicated by the presence of quartz sand commonly found in the dolomite. Sea water and bottom muds were enriched by phosphate, probably brought into the depositional basin by cold, upwelling currents. Phosphate was concentrated into small pellets by the digestive action of bottom-dwelling marine animals.

As the sea regressed, fine clastic sediments, such as silt and clay were deposited. Lamination of these deposits indicates that the sea floor was periodically swept by mild currents that removed clay-size particles, which allowed silt and fine sand to be deposited. As the currents abated, clay laminae were deposited in areas of calmer water, and phosphate continued to accumulate. Diatom molds commonly found in the clayey sediments indicate that the marine waters were relatively cool.

Fine to medium sand was deposited at the end of each cycle (or at the top of each sequence) as the sea regressed further. The presence of phosphate, megafossils, and microfossils in the sand layers indicate that they were deposited under open marine conditions. Following regression of the sea and sand deposition, the next depositional cycle began with transgression of the sea and deposition of the next layer of carbonate rocks.

Post-Miocene Unit

In this report, sediments of Pliocene, Pleistocene, and Holocene age were not differentiated because of a lack of geophysical, lithologic, and paleontologic data needed to define their boundaries. Therefore, for convenience, these sediments have been grouped into a single unit called the post-Miocene unit. A brief summary of these units follows.

The post-Miocene unit consists of phosphatic, micaceous, and clayey sand of Pliocene age; arkosic sand and gravel containing discontinuous clay beds of Pleistocene age; and mud, sand, and gravel of Holocene age. According to Miller (1986, p. B38), post-Miocene sediments generally can be divided into a basal sequence of marginal to shallow marine beds overlain by a series of sandy, marine terrace deposits that are in turn capped by a thin layer of fluvial sand or residuum, or both. The post-Miocene unit ranges in thickness from about 30 ft at the Bulloch South site to about 180 to 200 ft at the Coffin Park, Brunswick Pulp and Paper Company, Kings Bay, and Gardi sites (pl. 2).

Pliocene Series

Pliocene sediments in the southern half of the study area mainly consist of phosphatic, micaceous, clayey sand (Herrick, 1961). In the Brunswick area, Pliocene sediments consist of coquina and coarse sand about 40 ft thick, which is equivalent to the Charlton Formation of Veatch and Stephenson (1911), Herrick (1965, fig. 2), and Wait and Gregg (1973, p. 3). Miller (1986, plate 2; p. B39) extended the shelly sand unit of the Raysor Formation of South Carolina into Georgia, and equated it stratigraphically with the Charlton Formation in southeastern Georgia. Huddlestun (1988) placed the Charlton Formation in the Miocene, and reduced it in rank to a member of the Coosawhatchie Formation of the Hawthorn Group.

Samples collected for age determination at Hutchinson Island indicate that Pliocene sediments may be absent in the Savannah area. At well 37Q186 at Hutchinson Island (pl. 2, appendix A), wood fragments collected about 15 ft above the top of Miocene unit A (25 ft deep) were dated by using carbon-14. The wood fragments were dated at about 5,000 years B.P., or Holocene in age (H.W. Markewich, U.S. Geological Survey, written commun., 1986).

Pleistocene Series

The Pleistocene sediments consist of arkosic sand and gravel containing some discontinuous clay beds. Herrick (1965, p. 6; fig. 2) described the Pleistocene sediments as consisting of a basal sand, tongues of lignitic and fossiliferous clay, and an overlying micaceous sand that ranged in thickness from 10 to 60 ft. Herrick (1965) found no definitive foraminifera for age determinations, but indicated that others had found mammal remains and mollusk shells of Pleistocene age. Miller (1986, pl. 2; p. B39) described the Pleistocene sediments as consisting of brown sands containing carbonaceous and shell material underlying terraces. Sands in the Savannah area are equivalent to the Waccamaw Formation of South Carolina; however, locally, Pleistocene sediments may be absent in the Savannah area as indicated by the age determinations of wood fragments found in well 37Q186 at Hutchinson Island, described earlier.

Holocene Series

Holocene sediments consist of mud, sand, and gravel associated with streams, estuaries, and lagoonal deposits. Residuum, beach, and dunal deposits are included in the Holocene.

Geophysical Markers

Four geophysical markers used to delineate units of Miocene, Oligocene, and late Eocene age, have been termed the A, B, C, and D markers. These markers originally were identified in the Glynn County area by Wait (1962), in the Chatham County area by McCollum and Counts (1964), and in the area between, by Wait (1970), primarily on the basis of natural gamma logs. During the current study, it was confirmed that these markers extend from Glynn County throughout most of the coastal area. The markers also are identifiable on other borehole geophysical logs including the point-resistance electric log and the neutron porosity log. Examples of the geophysical markers are shown at the nested-well sites in plate 2.

Three of the markers (A, B, and C) are layers of high natural gamma radiation. The primary cause of the higher radiation is the presence of uranium-238 incorporated in the crystal lattice of the phosphate found in these layers. Natural gamma radiation is emitted through the decay of uranium-238, thorium-232, and potassium-40. As uranium-238 decays into its daughter products, it emits energy in the form of alpha, beta, or gamma radiation. The natural gamma log measures the gamma energy emitted during the decay process. Analyses of cores from wells 37Q186 and 31K002 show the presence of uranium-238 and its daughter products in phosphatic sediments near the various markers.

The A and B markers are associated with two highly phosphatic carbonate beds within the Miocene section, and are identified as peaks of natural gamma radiation. The two markers also are distinctive on point-resistivity logs as two highly resistant layers in the Miocene section. They are overlain by a much less resistive clay-silt layer, and they overlie a less resistive sand layer. These two markers lie a few feet above the unconformities separating Miocene units A and B, and B and C.

The C marker represents the base of the Miocene sediments in the study area, and occurs at the contact between the shallowest limestone and the overlying phosphatic dolomite. The phosphatic dolomite is distinctive in core, cuttings, and geophysical logs, and was considered by Veatch and Stevenson (1911) and Wait (1965) to mark the base of the Miocene. No particulate phosphate is found below the C marker, except in burrows or root holes filled with Miocene sediments. Where the limestone underlying the C marker is Oligocene in age, it is slightly radioactive and slightly phosphatic as indicated by moderate natural gamma radiation on geophysical logs, and by a weak and ubiquitous reaction with ammonium molybdenate reagent used to test for the presence of phosphate. Where the underlying limestone is late Eocene in age, it is free from phosphate, and the level of natural gamma radiation is negligible. The C marker is indicated by a sharp increase in radiation on the natural gamma log. The C marker was picked on the log at the bottom of the sharp peak instead of the tip of the peak, in contrast to markers A and B, which were picked at the tips of the peaks. The C marker, like both the A and B markers, corresponds to a highly resistant carbonate on the point-resistance log.

The D marker is the uppermost point of reduced natural gamma radiation below the C marker. This marker defines the top of the Ocala Limestone of late Eocene age, which is a relatively pure, phosphate-free limestone. The D marker defines the contact of the Ocala Limestone with the overlying, slightly phosphatic and slightly radioactive Oligocene limestone in most of the study area. The C and D markers coincide in a small area in the southern part of the study area and in adjacent northeast Florida where Oligocene limestone is absent. In this area, the basal Miocene carbonate layer is in contact with the underlying upper Eocene Ocala Limestone. The D marker is the first sharp rise in electrical resistance below the C marker on the point-resistance log, and indicates a layer of dense, low-permeability limestone.

Configuration of Geophysical-Marker Horizons

In the coastal area, units of late Eocene through Miocene age generally dip from north to south and strike from west to east. Maps showing the altitudes of the geophysical markers D, C, B, and A described earlier, were constructed by using data from more than 500 wells, and are shown in plates 6, 7, 8 and 9. Each of the marker horizons generally dip southward from the northern part of the study area to just north of the city of Brunswick. South of Brunswick, the horizons dip northward, thus, forming a structural low having its axis lying north of Brunswick. In Camden County, the horizons dip eastward.

Geologic Structure

In the coastal area, the major structural features are the Southeast Georgia Embayment and the Gulf Trough (fig. 2). Of lesser significance in the coastal area, but affecting the Southeast Georgia Embayment, is Florida's Peninsular Arch (fig. 2). These features affected the distribution, geometry, and lithologic characteristics of sediments in the coastal area.

The Southeast Georgia embayment is an east- to northeast-plunging synclinal feature that extends from northeastern Florida into southeastern Georgia and offshore. According to Miller (1986), the feature subsided at a moderate rate and was filled with Lower Cretaceous clastic sediments, followed by deposition primarily of Upper Cretaceous and lower Tertiary carbonate sediments, followed by deposition of lower Tertiary and Quaternary clastic rocks. Gravity and magnetic anomalies related to the basement rocks have been mapped in the area, and may indicate faulting of the basement rocks (Long, 1974; Zietz, 1982). Displacement of basement rocks, which affected the overlying Coastal Plain sediments, was reported at Augusta, Ga., about 40 mi northwest of the study area (Prowell and O'Connor, 1978, p. 23). Faulting of Miocene and Eocene sediments near Jacksonville, Fla., about 20 mi south of the study area, was reported by Leve (1966, 1983). Prowell (1983) presents an index of faults of Cretaceous and Cenozoic age in the eastern United States.

A projection of the northeast-trending Gulf Trough (Herrick and Vorhis, 1963) may cross the northwestern part of the study area into Bulloch County (fig. 2; Miller, 1986). The Gulf Trough has an adverse affect on the ground-water-flow system in southwestern Georgia as evidenced by low well yields, low transmissivity, high dissolved-solids concentrations, and steepened potentiometric gradients in the Upper Floridan aquifer (Zimmerman, 1977). Similar effects occur in the vicinity of the Gulf Trough in eastern Georgia (Krause and Randolph, 1989). Various opinions as to the nature and origin of the Gulf Trough have been expressed by previous investigators, and Patterson and Herrick (1971) presented the following summary of these differing views: (1) the feature represents a buried submarine valley, (2) it is a graben, (3) it is a syncline, or (4) it is a buried solution valley of strait filled with fine-grained sediments. Miller (1986) considers the Gulf Trough to be a series of both isolated and connected grabens. The Georgia Geologic Survey currently is conducting a study to assess the nature and the origin of the Gulf Trough and its effect on the ground-water-flow system (Kellam and Gorday, 1989).

In addition to the major structural features described above, seven local structural features were identified during this study. These structural features, only two of which had been described prior to this study, were detected as highs and lows on the four structure contour maps of the D, C, B, and A geophysical-marker horizons (pls. 6-9), and the seven geologic sections that traverse the study area (pls. 4, 5). The structural features discussed here and shown in figure 2 are based solely on geologic evidence. These features were not delineated on the maps of Herrick and Vorhis (1963) and those of Miller (1986) because of the sparse data previously available. The structural features have been numbered one through eight from south to north, and will be discussed in that order (fig. 2).

Structural feature 1 is a dome at Woodbine in Camden County. The dome is evident as a high on the four structure contour maps (pls. 6-9), and the greatest known altitude is found at well 32F008 (section F-F', pl. 5). The slope of sediments away from the dome ranges from about 18 ft/mi on the D marker horizon (pl. 6) to about 10 ft/mi on the A-marker horizon (pl. 9), indicating increased relief and slope with depth. The dome also is evident as an area of slightly reduced thickness of Miocene unit B (pl. 11).

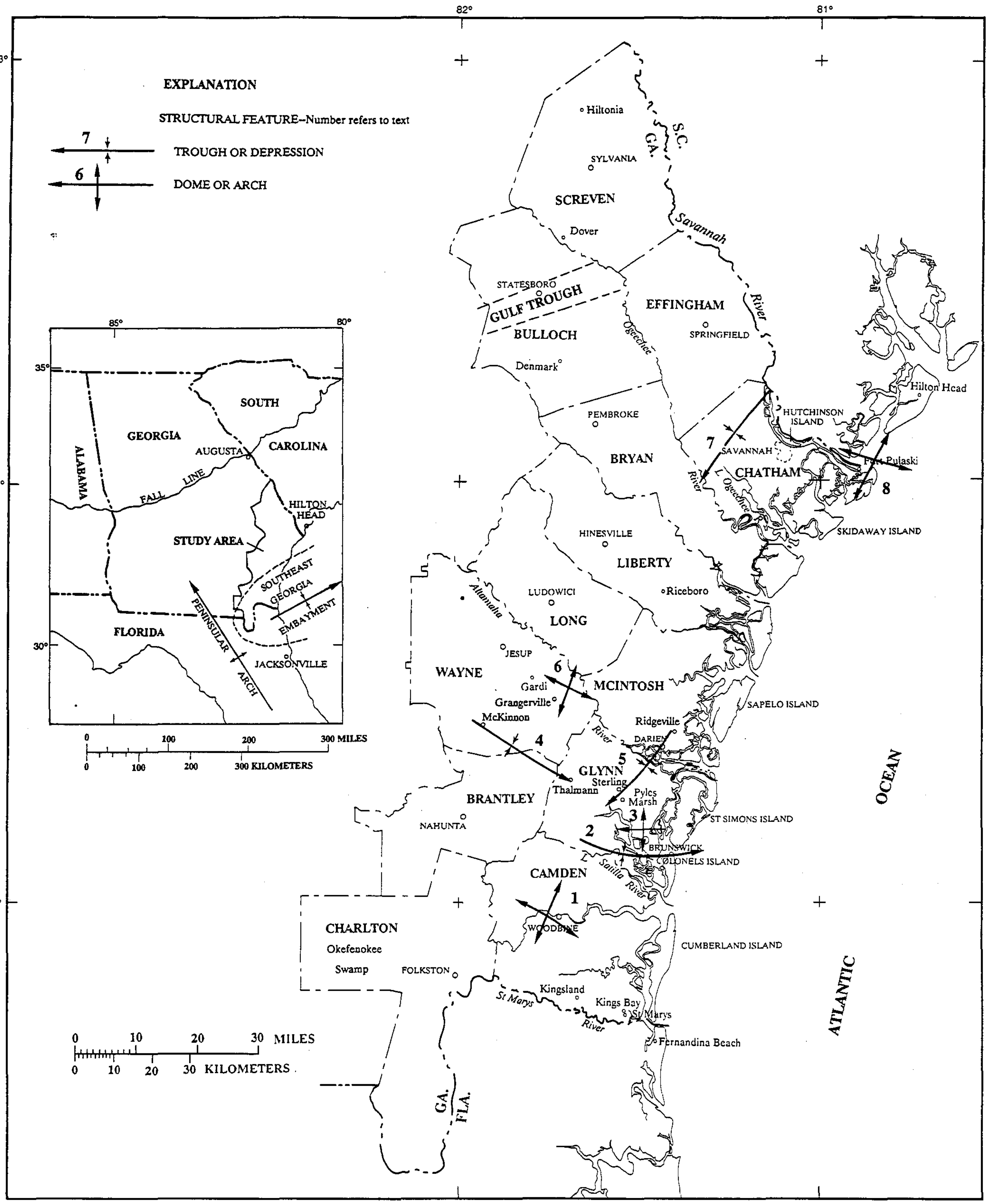
Structural feature 2 is an east-west, elongated depression in the southern part of Glynn County. The depression is evident as a low on the four structure contour maps (pls. 6-9) and at or near wells 33H188 on section E-E' (pl. 4), 33H186 on section F-F', and 34G016 on section G-G' (pl. 5). The northern flank of the depression is steeper on the map showing the D-marker horizon (pl. 6) than on the A-marker horizon map (pl. 9). Although the D-marker horizon was mapped by using fewer control points than were used for the A-marker horizon, particularly on the southern side of the depression, the gross shape of the depression is discernible on both maps. The feature also is evident as an area of increased thickness of Miocene units C and B (pls. 10 and 11).

Structural feature 3 is an east-west trending arch in east-central Glynn County. This feature is evident on the four structure contour maps (pls. 6-9) as an elongated high that has greater relief on the northern flank. The greatest known altitude of the arch is found at well 34H374 on section C-C' (pl. 4), and the greatest relief is shown on the D-marker horizon map (pl. 6). The western edge of the feature was defined by data from well 33H141 on section F-F' (pl. 5).

The two most prominent structural features on the four structure contour maps (pls. 6-9) are features 4 and 5, which are depressions. Feature 4 (fig. 2) extends southeast from McKinnon to Thalmann, and is evident between wells 31K002 and 31J003 on section E-E' (pl. 4). Feature 5 (fig. 2) extends southwest from Ridgeville to just west of Pyles Marsh, and is evident at well 34K080 on section F-F' and well 34K092 on section G-G' (pl. 5). The two features also are evident as areas of increased thickness of Miocene units C and B (pls. 10 and 11). Slope and relief are greatest on the D-marker horizon map (pl. 6), and least on the A-marker horizon map (pl. 9).

Structural feature 6 is a dome northeast of Grangerville in Wayne County, and is evident as a high on the four structure contour maps (pl. 6-9). As with the other features, the deeper the mapped horizon, the steeper the slope and the greater the increase in relief. The feature also is evident as an area of thinning of Miocene unit C (pl. 10).

Structural feature 7 is a depression in western Chatham County that trends to the southwest from the Savannah River. The feature originally was named the Ridgeland Basin by Heron and Johnson (1966), and subsequently was called the Ridgeland trough by Colquhoun and others (1969). This feature is evident at well 36Q318 on section A-A' (pl. 4). Although the feature is not prominent on the A-marker horizon map (pl. 9), as with the previous features, steeper slopes and greater relief are shown on the D-, C-, and B-marker horizon maps (pls. 6, 7, and 8).



Base from U.S. Geological Survey,
State base map 1:1,000,000, 1970

Figure 2.--Structural features in the coastal area of Georgia and adjacent parts of Florida and South Carolina.

Structural feature 8 is a structural high, originally named the Beaufort High by Heron and Johnson (1966) and subsequently called the Beaufort Arch by Colquhoun and others (1968). The feature is centered at Hilton Head Island, S.C., and trends to the south parallel to the coast (Woolsey, 1977). The feature appears as a rise between wells 36Q318 and 39Q003 on section A-A' (pl. 4) and between wells 37P010 and 38Q203 on section G-G' (pl. 5). Only the western side of this feature can be seen on the four structure contour maps (pls. 6-9). The Beaufort Arch interrupts the regional southward dip of the Coastal Plain sediments, and forms the eastern limb of the southwesterly-plunging Ridgeland trough (feature 7, fig. 2). The Beaufort Arch also is evident as the area of minimum thickness of Miocene units C and B (pls. 10 and 11).

Interpretation of Structural Features

The eight structural features may be horst and graben features associated with high-angle faults, or may be the result of solution, erosion, nondeposition, or deposition patterns. Although the presences of faults was not observed in any wells in the study area, it is one possible explanation for the structural features previously described. Solution, erosion, nondeposition, and deposition patterns are not considered likely explanations for the eight structural features because of the persistence of the structural features through geologic time, the steep relief of the structures, and the large areas covered by the features. If solution or erosion had removed material at times other than periods indicated by unconformities, later deposition of clastic material would likely have filled in solution openings in the underlying carbonate rocks, and would have resulted in a flatter surface than illustrated by the three Miocene units C, B, and A (pls. 7, 8, and 9).

Evidence to support faulting as a mechanism for the development of the structural features includes (1) anisotropy of the Upper Floridan aquifer (see section on Upper Floridan aquifer); (2) high-angle fractures in Cretaceous carbonate rocks, as shown on the acoustic televiewer log for well 33H188 (fig. 3); (3) anomalous temperature gradients (see section on Geothermal Gradient); and (4) elevated concentrations of chloride in ground water (see section on "Water Quality").

These factors, together with the persistence-with-depth of the structures, support faulting as a cause of the structures. The discovery of the Belair Fault zone (Prowell and O'Connor, 1978) in the Augusta, Ga., area, faults in the Jacksonville, Fla., area (Leve, 1966, 1983), and the regional tectonism that caused those faults lends additional support to the possibility of faulting in the coastal area.

The altitude differences of the various geophysical marker horizons, as well as the differences in thicknesses between horizons, suggest these structures developed as early as Paleocene and as late as Miocene time. For example, in the vicinity of the Beaufort Arch (feature 8, fig. 2), Paleocene through Miocene sediments are thinner and are structurally higher at the Fort Pulaski site than at the Hutchinson Island site (pl. 2).

GROUND-WATER RESOURCES

The principal source of water for all uses in the coastal area is the Floridan aquifer system, which consists of two principal units; the Upper and the Lower Floridan aquifers (Miller, 1986; Krause and Randolph, 1989) (see pl. 3). The Upper Floridan aquifer is one of the most productive aquifers in the United States. However, the Lower Floridan, although it contains permeable zones, is limited by its excessive depth and locally poor water quality, and in places, generally low productivity. Secondary sources of water in the coastal area include the surficial aquifer, and the upper and the lower Brunswick aquifers (defined in this report). During 1986, these aquifers collectively yielded an estimated 273 Mgal/d in the coastal area, about 80 percent of which was for industrial use (G.L. Doonan, U.S. Geological Survey, oral commun., 1986).

Hydrologic Setting

Average annual precipitation in the coastal area ranged from less than 46 in. in eastern Chatham County and Bulloch County to 54 in. in Glynn, Camden, and Charlton Counties for the period 1941-70 (Carter and Stiles, 1982). Maximum rainfall generally occurs during July-September. Average annual runoff for the period 1941-70 ranged from 10 in. in Chatham and southern Effingham Counties to more than 14 in. in northern Screven County (Carter and Stiles, 1982). Evapotranspiration rates ranged from 31 to 40 in/yr over the study area (Krause and Randolph, 1988). The highest annual evapotranspiration rates occur in the

Okefenokee Swamp area in Charlton County. Evapotranspiration rates are greatest during the summer growing season.

Recharge to the confined ground-water-flow system is from precipitation in and near parts of the outcrop areas of the confined aquifers. The recharge area for the Floridan aquifer system is northwest and west of the study area. Recharge areas for the upper and the lower Brunswick aquifers are near the outcrop area of Miocene sediments shown on plates 7 and 8. Recharge to the unconfined surficial aquifer occurs throughout its area of occurrence.

Natural discharge from the ground-water-flow system occurs as flow to streams and springs in the upgradient areas of confined aquifers, and as vertical leakage into adjacent units where head gradients are favorable. Ground water also is discharged offshore and to wells in the coastal area.

Water levels in each aquifer fluctuate as a result of recharge to and discharge from the aquifer. Recharge varies in response to precipitation, evapotranspiration, and surface-water infiltration into the aquifers. Discharge varies in response to changes in natural flow from the aquifers to streams and springs, evapotranspiration, leakage into adjacent aquifers, and withdrawal from wells.

Surficial Aquifer

The surficial aquifer consists of interlayered sand, clay, and thin limestone beds of the post-Miocene unit and the upper sand unit of Miocene unit A. Water in the aquifer generally is under water-table conditions throughout the study area, and is confined below by dense, phosphatic limestone or dolomite, and phosphatic silty clay of Miocene unit A. Locally, the aquifer includes layers of clay that range in thickness from 5 to 40 ft (pl. 2). Where these clay layers are thick and areally extensive, they act as confining units, and water in the aquifer locally is under confined or artesian conditions. In Camden and Charlton Counties, the upper sand unit of Miocene unit A is overlain and confined by carbonate and clay sequence of low permeability. Locally in the Brunswick area, aquifer tests indicate that the deeper parts of the aquifer are under confined to semiconfined conditions owing to the presence of clay confining units. At Skidaway Island in Chatham County, the aquifer is divided into two water-bearing units, an upper unconfined sand zone and a lower semiconfined sand zone that are separated by a clay semiconfining layer (Soil and Materials Engineers, Inc., 1986b). At Skidaway Island, the upper sand zone extends from land surface to depths of about 10 to 40 ft, whereas the lower sand zone is at depths ranging from 35 to 90 ft below land surface. Generally, the aquifer includes zones of confinement where it is thickest.

The thickness of the surficial aquifer is somewhat less than the total thickness of Miocene unit A and the post-Miocene unit. For example, at the nested-well sites, the thickness of the surficial aquifer ranges from about 65 ft at the Skidaway Island site to about 230 ft at the Gardi site; whereas the total thickness of Miocene unit A and the post-Miocene unit is about 120 ft at the Skidaway Island site and 300 ft at the Gardi site (pl. 2).

Mapping the saturated thickness of the surficial aquifer throughout the coastal area was not possible owing to a lack of data. However, a map showing the approximate thickness of Miocene unit A and the post-Miocene unit, which comprise the surficial aquifer, was constructed from thickness data at 589 wells (pl. 12). The map does not take into account changes in altitude and topography between well sites, which, because the surficial aquifer extends to land surface, has a pronounced affect on the thickness. The combined thicknesses of the two units range from less than 80 ft in eastern Chatham County to more than 380 ft in western Wayne and northeastern Glynn Counties. The thickness of the sediments exceeds 300 ft in southeastern Camden County, and in a belt extending through Glynn, Camden, Brantley, Wayne, and McIntosh Counties.

Hydraulic Properties

Wells tapping the surficial aquifer reportedly yield from about 2 to 180 gal/min. The highest yield was reported at well 34H416 in the Bay Street area of Brunswick. This 12-in.-diameter well is cased to a depth of 117 ft in the lower part of the post-Miocene unit, and completed as an open-hole well to a total depth of 240 ft in the upper part of Miocene unit A. In the Brunswick area, Wait (1965, p. E22) reported yields of about 5 to 20 gal/min from 2-in.-diameter wells that tapped sands of Pleistocene age (post-Miocene unit), which are part of the surficial aquifer. These wells ranged from 12 to 50 ft deep. Also in Brunswick, a network of 65 wells tapping sediments of the same age

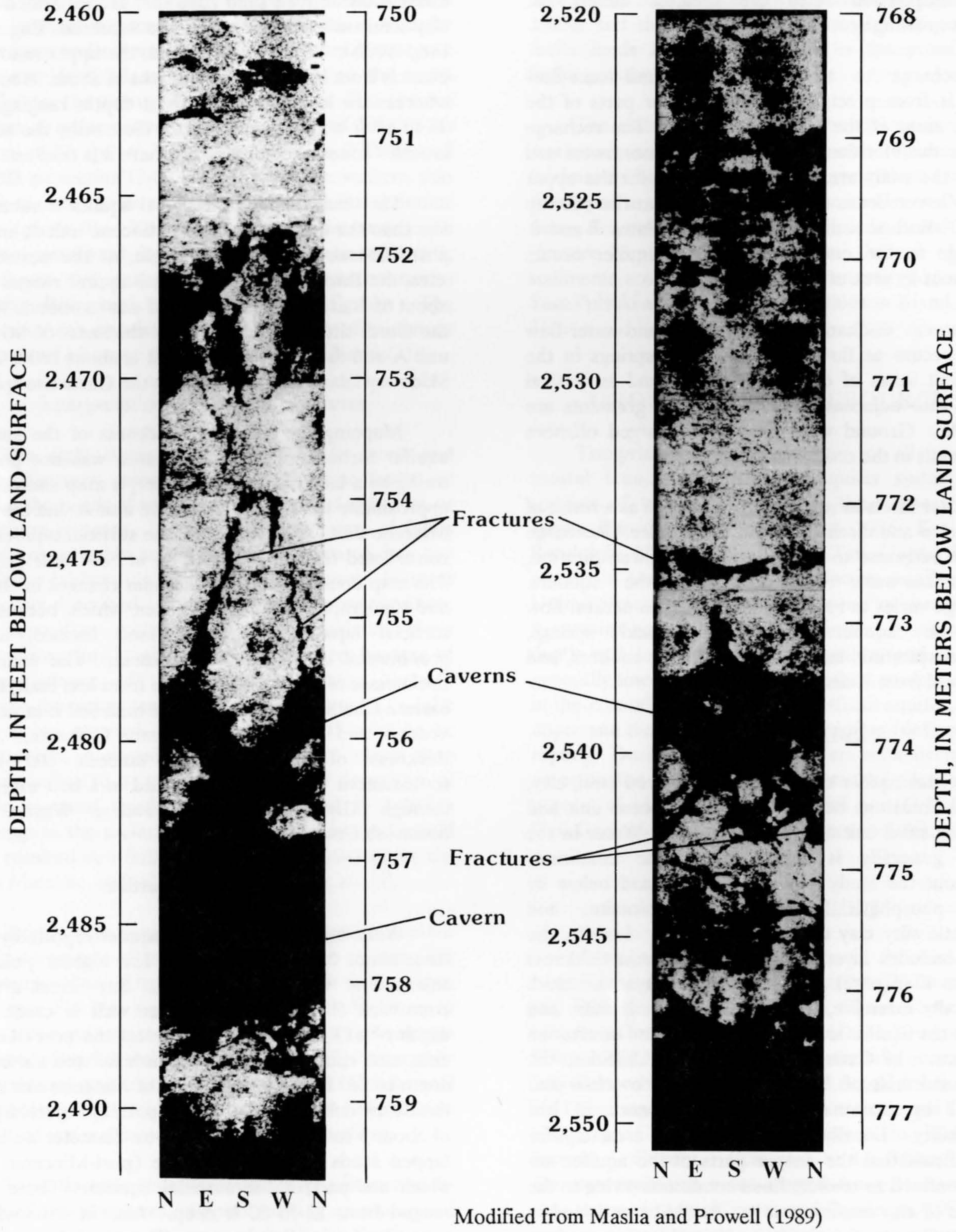


Figure 3.--Acoustic televiewer log at well 33H188, Colonels Island, Glynn County.

was used to dewater a construction site (Wait, 1965, p. E23). These wells ranged from 15 to 20 ft deep and yielded an average of 3 to 8 gal/min. When the 30-day dewatering operation began, the 65 wells withdrew an estimated 500 gal/min. After several days of pumping, the yield decreased to about 200 to 250 gal/min, which suggests that a negative boundary condition was reached during this period; discharge exceeded available recharge.

The water-bearing properties of the surficial aquifer are variable because of vertical and lateral variations in lithology. Estimated transmissivities range from about 14 to 6,700 ft^2/d. Brown (1984) reported transmissivity values for the surficial aquifer of 700 ft^2/d from an aquifer test conducted near Kingsland, Camden County, Ga., and estimated transmissivity values of 100 to 1,000 ft^2/d in adjacent Nassau County, Fla.

Three aquifer tests were conducted in the Brunswick area using wells 33J031 and 34H387, and a network of pumped wells used for a dewatering operation (Gregg and Zimmerman, 1974). Well 33J031 and the network of wells tapped sediments of Pleistocene age, and well 34H387 tapped sediments, probably of Pliocene age. The wells were pumped at rates that ranged from 37 to 140 gal/min, and the specific capacity ranged from 5 to 12 (gal/min)/ft. Transmissivity values estimated from the three aquifer tests ranged from 960 to 1,300 ft^2/d in the Pleistocene sediments to 6,700 ft^2/d in the Pliocene sediments. The two tests in the Pleistocene sediments indicated that the storage coefficient was highly variable and ranged from 0.09 to 0.0001, indicative of unconfined to confined conditions, respectively (Gregg and Zimmerman, 1974). The latter value is characteristic of an artesian system, and most likely is lower than the typical storage coefficient of the surfical aquifer over most of the coastal area.

To obtain an estimate of the areal transmissivity of the lower semiconfined zone of the surficial aquifer in the Brunswick area, an analysis was made by using the "closed-contour" method described by Lohman (1972, p. 46-47). This method assumes steady-state conditions and no vertical leakage into or from the aquifer. The analysis was based on the potentiometric surface of the lower semiconfined zone of the surficial aquifer for May 1985 (figure not shown). During this period, an estimated 0.16 Mgal/d was withdrawn from the aquifer at well 34H416. The withdrawal produced a cone of depression that covered an area of about 10 mi^2. The estimated transmissivity was about 530 ft^2/d. The comparatively low transmissivity of the aquifer accounted for the large drawdown and the cone of depression produced by the comparatively small withdrawal.

At Skidaway Island, Chatham County, Soil and Materials Engineers, Inc., (1986b) conducted an evaluation of the surficial aquifer and estimated its hydraulic properties. Most of the wells tapping the surficial aquifer on the island are 1.25 in. in diameter, are from 16 to 75 ft deep, and yield as much as 40 gal/min, but on the average are pumped at a rate of 10 to 20 gal/min. Estimates of hydraulic properties were obtained from grain-size analyses, lithologic logs, and one aquifer test. In the upper, unconfined water-bearing zone of the aquifer, the hydraulic conductivity ranged from 2 to 65 ft/d and the transmissivity ranged from 14 to 1,100 ft^2/d. In the lower, semiconfined water-bearing zone, the hydraulic conductivity ranged from 40 to 400 ft/d, and the transmissivity ranged from 150 to 6,000 ft^2/d.

Ground-Water Pumpage

The surficial aquifer is used primarily for domestic lawn irrigation throughout most of the coastal area, except in some rural sections where it is the principal source of drinking water (Watson, 1982). On Skidaway Island east of Savannah, about 20,000 to 230,000 gal/d are withdrawn from the upper sand water-bearing zone, and about 100,000 to 625,000 gal/d are withdrawn from the lower sand water-bearing zone for irrigation and for ground-water heat pumps (Soil and Materials Engineers, Inc., 1986b). At the Kings Bay Naval Submarine Base in southeastern Camden County, about 129,000 gal/d is used for showers and latrines (R.S. Lynch, Russel and Axon Engineers, written commun., 1979).

The major user of the surficial aquifer in Glynn County is a small industry in the Bay Street area of Brunswick that withdrew about 0.16 Mgal/d in 1986. High chloride concentrations in the Upper Floridan aquifer in that area renders the water unfit for most uses, and thus, the surficial aquifer is used as an alternate source of water. An industrial user in Wayne County withdrew about 0.86 Mgal/d in 1986.

Water Levels

A map showing the estimated configuration of the water-table of the surficial aquifer in the coastal area was constructed by using water-level data from three observation wells and 12 auger holes (fig. 4). Water-level altitudes (river stages) at 18 locations along major rivers and streams were considered coincident with the altitude of the water-table and were used as data points. In the rest of the area, the water-table was estimated by using data from Krause (1982), in which land and water-level altitudes estimated from topographic contour maps were used to estimate the altitude of the water table. Krause (1982, p. 10) estimated that the water table was from 15 to 20 ft below land surface in upland areas, above an altitude of 200 ft. The water table was estimated to be less than 5 ft below land surface in areas along the coast, and it was estimated to be at sea level in marsh and estuarine areas (Krause, 1982).

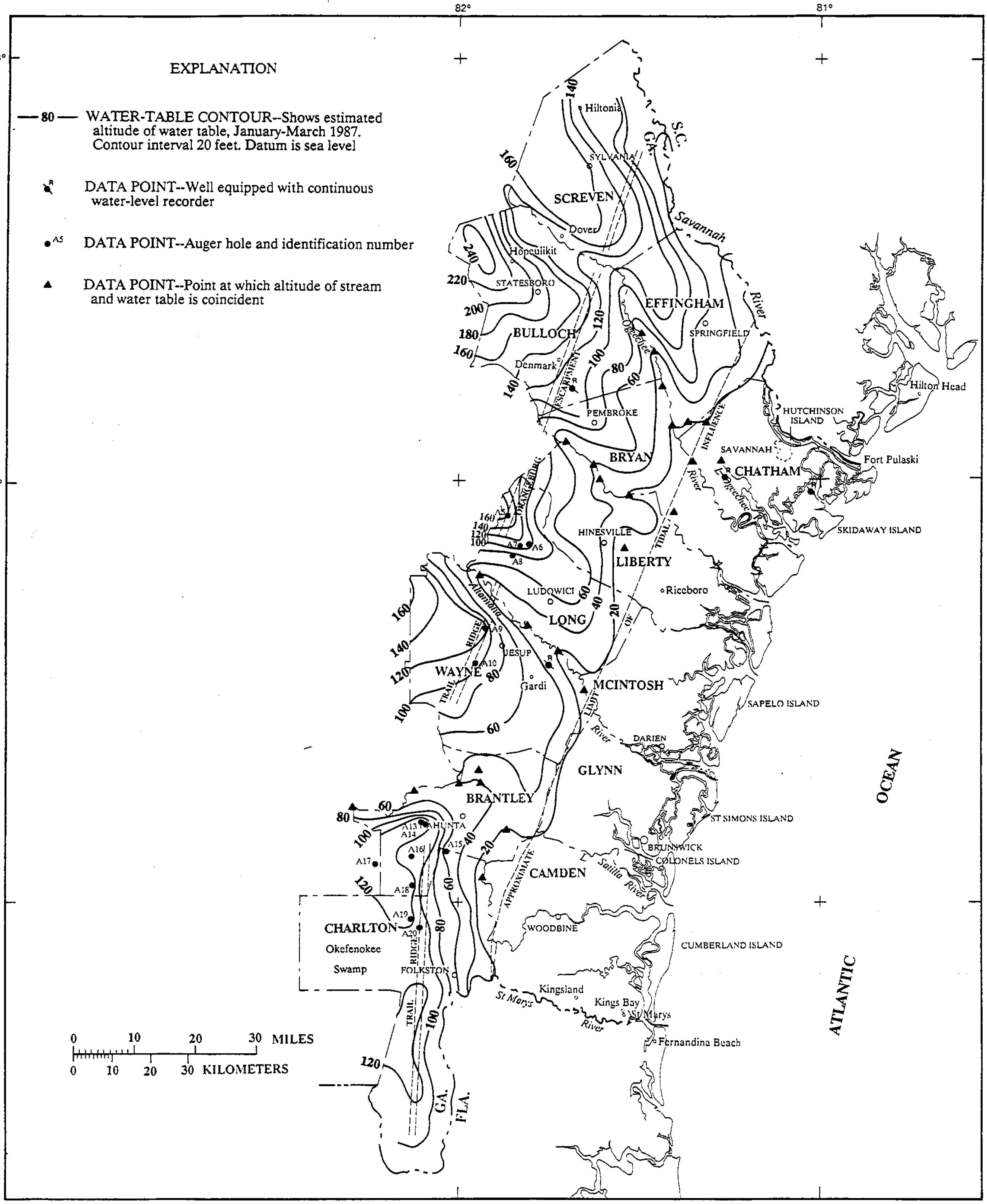
The configuration of the water-table generally is a subdued replica of the land surface, and primarily is controlled by streams and by the configuration of the land surface. Water-table gradients generally are steep in the western part of the coastal area where topographic relief is greater, and more gradual in the eastern part of the area, where there is little topographic relief. The steeper gradient in the western part of the coastal area largely is owing to the effects of the Orangeburg Escarpment-Trail Ridge, a pronounced geomorphic feature that represents a Pleistocene shoreline. The feature extends from Charlton County northeastward into Bulloch County, and has a steep slope between the crest of the escarpment and the next lower terrace and valley floors. The difference in relief is reflected on the water-table map as a steepening of the gradient, especially between the 60- and 160-ft contours.

The configuration of the water table near the present shoreline and estuaries is influenced by tidal changes. Most of the tidal effects occur east and southeast of the 20-ft water-level contour (fig. 4). A line showing the approximate landward extent of tidal influence was plotted based on data from major rivers (fig. 4). The tidal limit for the Altamaha and Satilla Rivers was based on water-quality data (salinity) from Brooks and McConnell (1983). The tidal limit for the St Marys, Ogeechee, and Savannah Rivers was based on observations by T.W. Hale and W.R. Stokes, III (U.S. Geological Survey, oral commun., 1987), and on water-quality data from Dr. Herb Windam (Skidaway Institute, oral commun., 1987). Tidal effects on ground-water levels will be most pronounced near the coastal estuaries and rivers. Water levels in wells near tidal waters respond to changes in tide by movement of tidal water into and out of an unconfined aquifer, and by compression and expansion of a confined aquifer and its confining layers owing to the weight of the incoming or outgoing tidal waters (Gregg, 1966).

The depth to the water table is greatest in the vicinity of topographic highs, and least in the lowland areas adjacent to rivers, streams, estuaries, and marshes. For example, in upland areas in Wayne County, the water table was as much as 40 ft below land surface (well 32L017), whereas in the lowland area near the Little Ogeechee River in Chatham County, the water table at well 35P094 was from 5.5 to 11.5 ft below land surface during 1978-87.

The surficial aquifer is recharged nearly everywhere by rainfall. Much of the precipitation that infiltrates the ground and recharges the surficial aquifer is discharged to nearby streams. Areas of natural discharge are represented on the water-table map by contours that form a "V-shape" upstream, which indicates that the gradient is toward the stream. The response of the water level in the surficial aquifer to rainfall is illustrated by the hydrographs for well 35P094 in Chatham County (fig. 5) and well 32R003 in Bulloch County (fig. 6). At well 35P094, recharge by rainfall is reflected by a sharp rise in the water level followed by a gradual decline that represents evapotranspiration and natural drainage of recharge water into the aquifer. The water-level response at well 32R003 is less pronounced because the well taps a deeper part of the surficial aquifer (134 to 155 ft) where semiconfined conditions occur as a result of a clay confining unit. The annual water-level fluctuation during 1986 was 7.6 ft at well 35P094 and 5.1 ft at well 32R003.

Withdrawals of about 0.16 Mgal/d for industrial use at the south end of the Brunswick peninsula have caused a cone of depression to develop in the potentiometric surface of the lower, semiconfined zone of the surficial aquifer. The lowest water level near the center of the cone of depression was about 18 ft below sea level under pumping conditions. Because few water levels were measured, the cone of depression is poorly defined, and accordingly, is not mapped. Similar cones



Base from U.S. Geological Survey,
State base map 1:1,000,000, 1970

Figure 4.--Estimated water-table surface of the surficial aquifer in the coastal area.

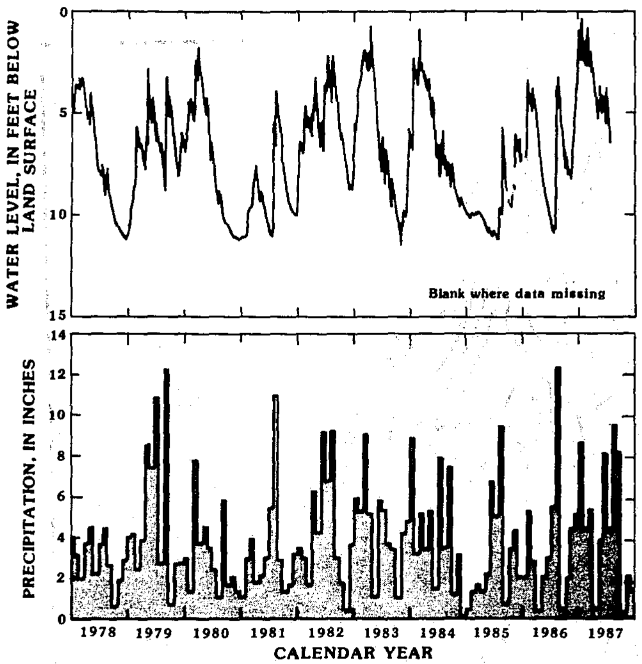


Figure 5.--Daily mean water levels in the surficial aquifer at well 35P094, and total monthly rainfall at National Weather Service Station, Savannah WSO AP Chatham County, 1978-87.

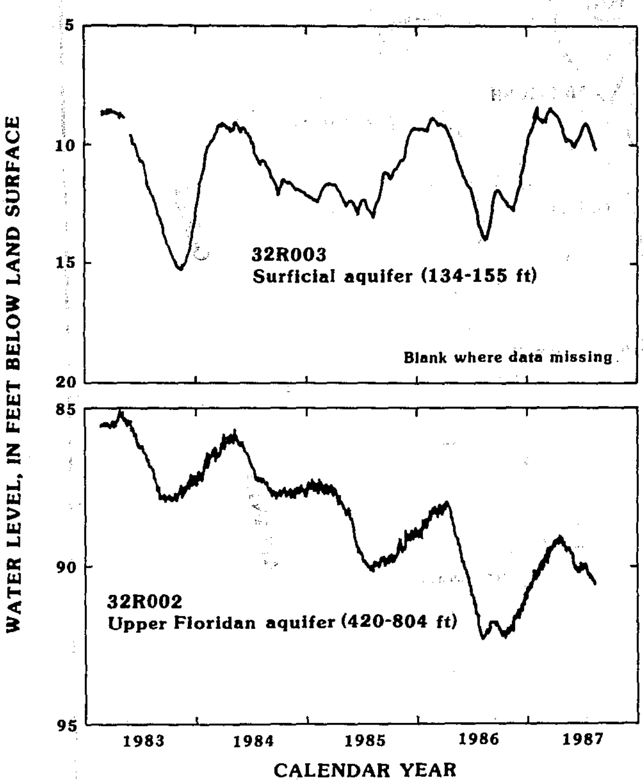


Figure 6.--Daily mean water levels in the surficial and Upper Floridan aquifers, Bulloch South site, Bulloch County, 1983-87.

of depression are believed to exist around other areas of pumping, such as that for industrial use in Wayne County.

Water-level fluctuations in the surficial aquifer in the Brunswick area are shown by the hydrographs for well 33H208 at the Brunswick Pulp and Paper Company site (fig. 7) and well 34H438 at the Coffin Park site (fig. 8). Both wells are influenced by nearby pumping from the surficial aquifer and by rainfall. In addition, although not discernible on the long-term hydrographs, the water level also responds to tidal fluctuations. Several sharp water-level rises on the hydrographs correspond to reductions in industrial pumping from the Upper Floridan aquifer, which may indicate some connection between the aquifers.

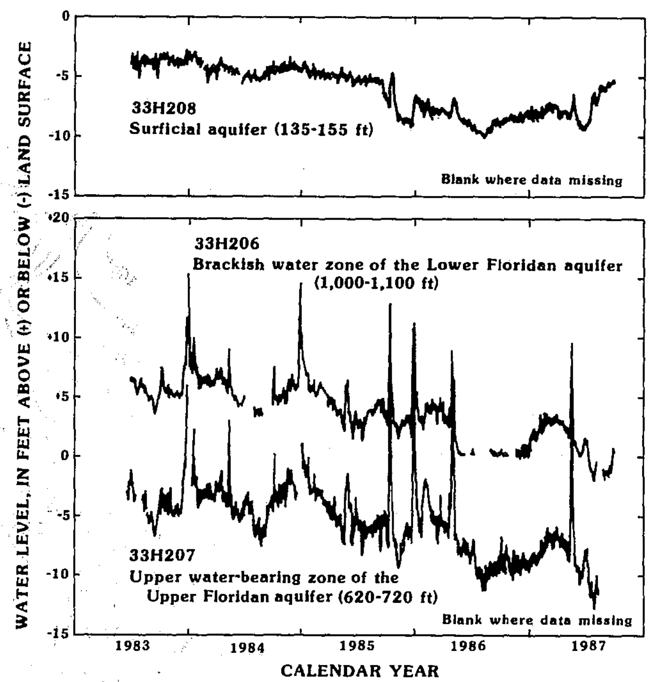


Figure 7.--Daily mean water levels in the surficial aquifer and the upper water-bearing zone and brackish-water zone of the Floridan aquifer system, Brunswick Pulp and Paper Company site, Glynn County, 1983-1987.

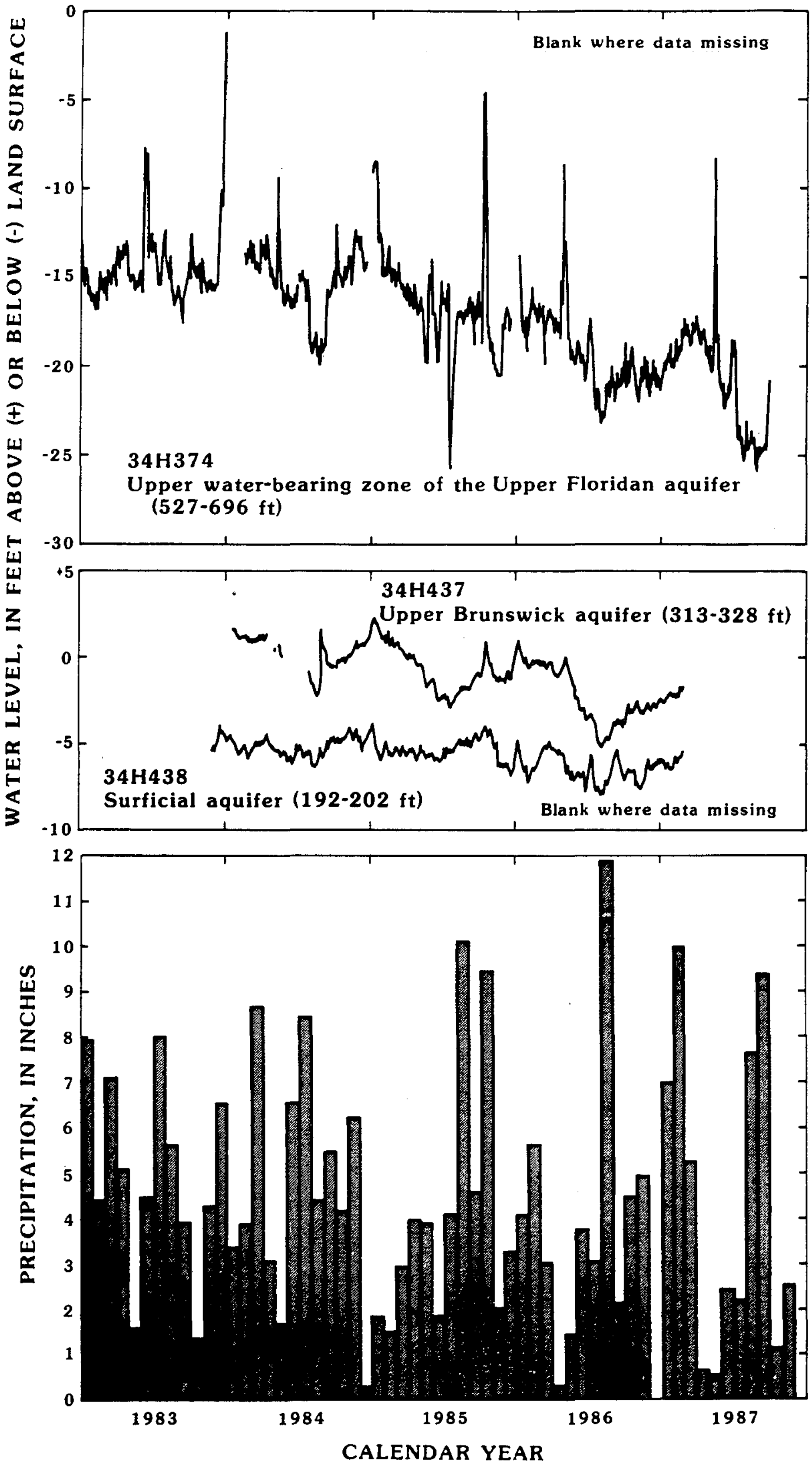


Figure 8.--Daily mean water levels in the upper water-bearing zone of the Upper Floridan aquifer and the surficial and upper Brunswick aquifers, Coffin Park site, and total monthly rainfall at the National Weather Service station at Brunswick, 1983-87.

The surficial aquifer is used for industrial supply in the Jesup area, and water-level fluctuations reflect changes in nearby pumping (fig. 9). Although there is ground-water withdrawal from the surficial aquifer at Jesup, its effect on the water level in well 32L017 cannot be evaluated because of insufficient data.

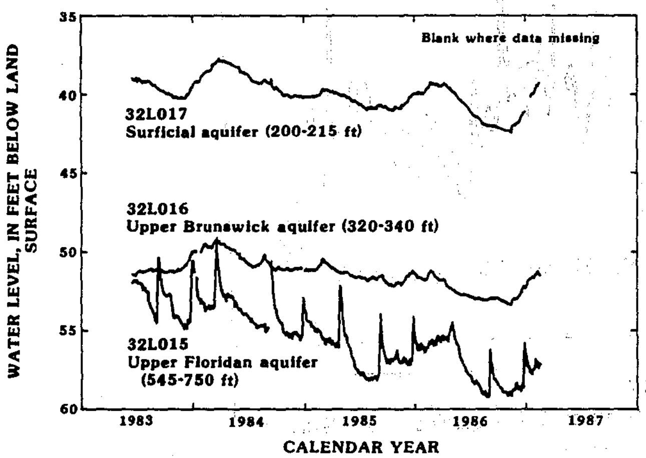


Figure 9.--Daily mean water levels in the surficial, upper Brunswick, and Upper Floridan aquifers at the Gardi site, Wayne County, 1983-87.

Aquifers in Miocene Sediments

There are two principal aquifers of Miocene age in the coastal area: the upper and the lower Brunswick aquifers (defined in this report), which were previously referred to by well drillers as the "first flow" and "second flow," respectively (Wait, 1965). Previous regional studies of the Floridan aquifer system by Miller (1986) and Krause and Randolph (1988) combined all Miocene sediments into the "upper confining unit" of the Upper Floridan aquifer. The present study evaluated water-bearing zones within the Miocene sediments as potential secondary aquifers in the coastal area.

Upper Brunswick Aquifer

The upper Brunswick aquifer is herein named for rocks identified in well 33H206 at the Brunswick Pulp and Paper Company site in Brunswick, Glynn County (pl. 2). At this well, the aquifer consists of poorly sorted, fine to coarse, slightly phosphatic and dolomitic quartz sand of Miocene unit B.

Approximate depths below land surface to the top of the aquifer may be estimated by subtracting the altitude of the A-marker horizon (pl. 9) from the altitude of the land surface shown on U.S. Geological Survey 7 1/2-minute topographic maps. The top of the aquifer is a few feet below the A-horizon marker, which is within the confining unit overlying the aquifer. Depths below land surface to the top of the aquifer at the nested-well sites range from about 88 ft at Fort Pulaski, Chatham County, to 340 ft at Kings Bay, Camden County (pl. 2). Generally, the aquifer is shallowest near the Beaufort Arch (feature 8, fig. 2) and deepest along the depression in northeastern Glynn County near Sterling (feature 5, fig. 2).

The thickness of the upper Brunswick aquifer is somewhat less than the total thickness of Miocene unit B shown on plate 11, because the mapped unit includes the thickness of the confining basal carbonate and the middle clay layers, which are not part of the upper Brunswick aquifer. For example, the aquifer ranges in thickness from about 20 ft at the Chatham County nested-well sites to about 150 ft at the Gardi site, Wayne County (pl. 2). These thicknesses are less than the total thickness of unit B at each site (30 to 83 ft, and 160 ft, respectively).

Lower Brunswick Aquifer

The lower Brunswick aquifer is herein named for rocks identified at well 33H206 at the Brunswick Pulp and Paper Company site in Brunswick, Glynn County (pl. 2). At this well, the aquifer consists of poorly sorted, fine to coarse, phosphatic, slightly dolomitic sand of Miocene unit C. The lower Brunswick aquifer is absent in the Savannah area and in Bulloch County because the permeable upper sand layer of Miocene unit C has been eroded away or was never deposited.

Approximate depths below land surface to the top of the aquifer may be estimated by subtracting the altitude of the B-marker horizon (pl. 8) from the altitude of the land surface shown on U.S. Geological Survey 7 1/2-minute topographic maps. The top of the aquifer is a few feet below the B-marker horizon, which is within the overlying confining unit. Depths to the top of the aquifer at the nested-well sites range from about 400 ft at the nested-well sites in Glynn County to about 460 ft at Gardi, Wayne County (pl. 2). Generally, the aquifer is at its greatest depth below land surface in the depression near Sterling in northeastern Glynn County (feature 5, fig. 2).

The thickness of the lower Brunswick aquifer is somewhat less than the total thickness of Miocene unit C mapped on plate 10, because the mapped unit includes the thickness of the confining basal carbonate and the middle clay layers, which are not part of the upper Brunswick aquifer. For example, the aquifer ranges in thickness from about 36 ft at the Gardi nested-well site in Wayne County to about 70 ft at the Coffin Park site in Glynn County (pl. 2). The total thickness of Miocene unit C at the two sites is 62 and 130 ft, respectively.

Hydraulic Properties

Because few individual wells tap the upper or the lower Brunswick aquifers, little information is available on their water-bearing properties. Most available data are from aquifer tests at Colonels Island, Glynn County.

Reported well yields for the two aquifers range from 3 to 180 gal/min. Near the turn of the century, the lower Brunswick aquifer at Brunswick, yielded 100 to 250 gal/min from flowing wells (McCallie, 1898). At Brunswick, well 34H446 (appendix A) taps both the upper and the lower Brunswick aquifers, and currently produces about 180 gal/min.

Soil and Material Engineers, Inc., (1986b) conducted two aquifer tests in wells tapping the lower Brunswick aquifer (their "basal Miocene aquifer") at Colonels Island in Glynn County, during June and July 1986. During each test, drawdown was measured in the pumped well and was analyzed by using the modified nonequilibrium formula of Cooper and Jacob as discussed in Ferris and others (1962). The first test was conducted in well 33H223, which had a 4-in.-diameter PVC screen in the interval 498 to 548 ft. Prior to the test, the well had a water level of 5.2 ft above land surface and the well flowed. The average discharge for the 8-hr test was 49 gal/min and the maximum drawdown was 19.96 ft, which resulted in a specific capacity of 2.5 (gal/min)/ft. After the pump was shut off, the well returned to flowing conditions within 41 sec, and completely recovered within 70 sec. Test results indicated that the transmissivity at this well was about 2,000 ft^2/d. The open interval in well 33H223 was 50 ft, indicating that the average hydraulic conductivity of the aquifer in the screened interval was about 40 ft/d. The screen was placed in the most productive part of the aquifer and received water along both horizontal and curved flowlines, thus the computed hydraulic conductivity represented a maximum value. A minimum hydraulic conductivity value of 20 ft/d was computed by dividing the transmissivity (2,000 ft^2/d) by the total thickness of the aquifer (100 ft).

The second test was conducted in well 33G028 that had a 6-in.-diameter stainless-steel screen in the interval from 390 to 473 ft. Prior to pumping, the well flowed at about 40 gal/min. The average discharge for the 24-hr test was 122 gal/min and the maximum drawdown was 15.1 ft, which resulted in a specific capacity of 8.1 (gal/min)/ft. After the pump was shut off, the well returned to flowing conditions within 7 sec. Test results indicated that the transmissivity of the lower Brunswick aquifer at well 33G028 was about 4,700 ft^2/d. The open interval in the well was 83 ft, indicating that the hydraulic conductivity of the aquifer in the screened interval was about 57 ft/d. Because the lower Brunswick aquifer is about 90 ft thick at Colonels Island, this test was representative of most of the saturated thickness of the aquifer. The hydraulic conductivity of the lower Brunswick aquifer at Colonels Island, Glynn County ranged from about 20 to 57 ft/d, and averaged 38 ft/d. An estimate of the maximum transmissivity for the lower Brunswick aquifer was computed by using an average hydraulic conductivity of 38 ft/d and multiplying it by the aquifer thickness at each of the nested-well sites (pl. 2). Values ranged from about 1,368 ft^2/d at the Gardi site in Wayne County), where the aquifer is thinnest, to about 2,740 ft^2/d at the Coffin Park site in Glynn County, where the aquifer is thickest.

Although there are no available data on hydraulic properties of the upper Brunswick aquifer in Georgia, an estimate of its transmissivity was obtained by using the aquifer thickness multiplied by the hydraulic conductivity determined from tests run in the lithologically similar lower Brunswick aquifer. Multiplying the average hydraulic conductivity of 38 ft/d by the aquifer thickness at each of the nested-well sites (pl. 2) resulted in transmissivity values that ranged from about 680 ft^2/d at the Skidaway Island site, where the aquifer is thinnest (about 18 ft) to about 5,700 ft^2/d at the Gardi site, where the aquifer is thickest (about 150 ft).

Ground-Water Pumpage

Most wells that withdraw water from the upper and the lower Brunswick aquifers are multi-aquifer wells that also tap the deeper Upper Floridan aquifer. During this study, 175 multi-aquifer wells tapping the upper and/or the lower Brunswick aquifers and tapping the Upper Floridan aquifer were inventoried (appendix B). Multi-aquifer wells are abundant in the study area because of the common, past practice among well drillers to drill through the first carbonate layer, set casing, and then continue to drill into the Upper Floridan aquifer, leaving the well as open hole below the casing. Few wells currently are constructed in this manner because it has been recognized that clastic sediments of Miocene and younger age may cave into the borehole.

In the Bay Street area of Brunswick, high chloride concentrations in water from the Upper Floridan aquifer necessitated the use of water from shallower aquifers as alternate water supplies. In this area, a small industry that uses water from a well that taps both the upper and the lower Brunswick aquifers (well 34H446, appendix B) withdrew an estimated 0.2 Mgal/d in 1986.

The lower Brunswick aquifer on Colonels Island in Glynn County currently is being considered as an alternative water supply to the Upper Floridan aquifer by the Georgia Ports Authority. This was necessitated over concern that additional withdrawals from the Upper Floridan aquifer near Brunswick could accelerate saltwater intrusion into the aquifer from deeper zones. Currently (1988), there is one water-supply well on the island that taps the lower Brunswick aquifer, which is capable of producing about 0.17 Mgal/d. A report by Soil and Materials Engineers, Inc., (1986a) concluded that on the island, the upper and the lower Brunswick aquifers (their "Miocene aquifer system") potentially could supply from 4.5 to 6 Mgal/d.

Water Levels

Water-level fluctuations and trends in the upper and the lower Brunswick aquifers are similar. In some places, such as the Coffin Park site, Glynn County, pumping from the Upper Floridan aquifer causes water-levels in the upper and the lower Brunswick aquifers to respond (fig. 8). The upper Brunswick aquifer at the Gardi site near Jesup (pl. 2), lies at a depth of about 300 ft (well 32L016), and is separated from the surficial aquifer by a dense carbonate and clay confining unit that is about 28 ft thick. Since 1983, the water-level trend in the upper Brunswick aquifer has been slightly downward at the Gardi site, and similar to that in the underlying Upper Floridan aquifer (fig. 9).

In areas where the upper and the lower Brunswick aquifers are not as deeply buried and are distant from pumping centers of the Upper Floridan aquifer, water levels primarily respond to seasonal climatic changes, although regional pumping probably has some influence. The upper Brunswick aquifer in Bulloch County is about 95 ft below land surface at the Hopeulikit site (pl. 2), and is near the area where the Miocene units crop out at land surface. The hydrograph for well 31U009 (fig. 10) indicates that seasonal water-level fluctuations in the upper Brunswick aquifer are similar to those in the Upper Floridan. The seasonal water-level decline in the spring and summer is augmented by pumping from the Upper Floridan for irrigation in the area. In addition, the similarity in water-level trends between the upper Brunswick and the Upper Floridan aquifers, shown in figure 10, probably results from hydraulic connection between the two aquifers. This hydraulic connection is the result of a greater percentage of sand in the confining unit underlying the upper Brunswick aquifer in Bulloch County than in coastward areas, such as Wayne County.

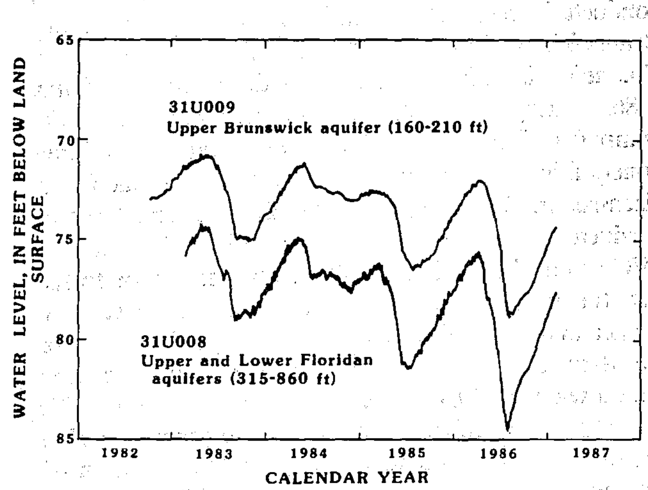


Figure 10.--Daily mean water levels in the upper Brunswick and Upper and Lower Floridan aquifers, Hopeulikit site, Bulloch County, 1983-87.

Water levels in the upper and the lower Brunswick aquifers in the Brunswick area, show almost no seasonal fluctuations, and primarily are influenced by changes in nearby pumping from the Upper Floridan aquifer. In this area, the aquifers are not widely used, are distant from the outcrop areas, are deeply buried (about 280 and 400 ft below land surface, respectively), and are separated from the surficial aquifer by a clayey confining unit that is 52 ft thick (pl. 2). Long-term water-level trends in the Brunswick area are illustrated by the hydrograph for well 32H001, which taps both the upper and the lower Brunswick aquifers (fig. 11). In 1939, the hydraulic head was about 49 ft above land surface and the well flowed at a rate of about 30 gal/min. By 1986, the head had declined more than 44 ft, and was less than 5 ft above land surface. This decline corresponded to increased pumping and water-level declines in the Upper Floridan aquifer, primarily in the Brunswick area. During 1959-81, the water level in the Upper Floridan aquifer declined about 20 ft in well 33H052, and the water level in the upper and the lower Brunswick aquifers declined about 17 ft in well 32H001; both declines resulted primarily from increased pumping from the Upper Floridan. In both wells, the water-level rise in 1982, which continued into 1984, largely was the result of about a 10 Mgal/d decrease in industrial pumping from the Upper Floridan. The similarity in water-level fluctuations in the aquifers indicate that there is hydraulic connection between the upper and the lower Brunswick and the Upper Floridan aquifers in the Brunswick area.

Floridan Aquifer System

The Floridan aquifer system, formerly known as the principal artesian aquifer in Georgia, consists of interbedded clastics and marl in the updip area and massive limestone and dolomite more than 2,000 ft thick in the downdip area (Krause and Randolph, 1989). The Floridan aquifer system, primarily of Eocene age, is hydraulically connected in varying degrees, but has been divided into the Upper and Lower Floridan aquifers in most of the study area.

Upper Floridan Aquifer

In the coastal area, the Upper Floridan aquifer primarily consists of limestone of the Oligocene unit and limestone and dolomite of the upper Eocene unit. Generally, the uppermost part of the aquifer is most permeable, and it consists of vuggy, highly fossiliferous limestone of Oligocene (where present) and late Eocene age (Ocala Limestone).

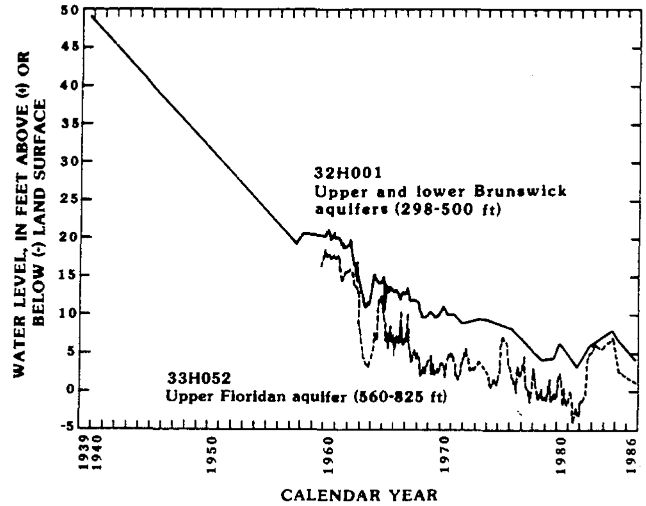


Figure 11.--Periodic water levels in the upper and lower Brunswick aquifers at well 32H001, and in the Upper Floridan aquifer at well 33H052, Glynn County, 1939-86.

The top of the Upper Floridan aquifer is defined as the top of the Oligocene unit, and where Oligocene sediments are absent, by the top of the upper Eocene unit. Thus, the top of the aquifer throughout the study area coincides with the C-marker horizon (pl. 7). In parts of Camden and Wayne Counties, the Oligocene unit is absent, and the top of the aquifer consists of limestone of late Eocene age. Depths to the top of the aquifer below land surface may be estimated by subtracting the altitude of the base of the Miocene (pl. 7) from the altitude of the land surface shown on U.S. Geological Survey 7 1/2-minute topographic maps. Depths to the top of the aquifer at the nested-well sites range from about 110 ft at the Fort Pulaski site in Chatham County to about 530 ft at the Kings Bay site in Camden County (pl. 2). Generally, the aquifer is shallowest near the Beaufort Arch (feature 8, fig. 2) in the northeastern part of the study area, and deepest along the depression in northeastern Glynn County near Sterling (feature 5, fig. 2).

According to Miller (1986, pl. 28), the Upper Floridan aquifer ranges in thickness from less than 200 ft in Effingham County to more than 700 ft in southeastern Camden County, near the Kings Bay nested-well site. At the other nested-well sites, the aquifer ranges in thickness from about 250 to 260 ft at the Skidaway and Fort Pulaski sites, respectively, in Chatham County (pl. 2) to about 460 ft at the Brunswick Pulp and Paper Company site in Glynn County (pl. 2).

Permeable Zones

The Upper Floridan aquifer in the study area consists of several permeable water-bearing zones that are separated by layers of dense limestone or dolomite that act as semiconfining units (pl. 2). These low-permeability units have persisted because they do not allow vigorous circulation of ground water. Circulation is more rapid through vuggy, fossiliferous zones of high primary porosity thus forming the water-bearing zones as secondary permeability has developed. The limestone of the low-permeability zones probably is dolomitized in part and is highly micritic in part (Miller, 1986).

McCollum and Counts (1964) conducted flowmeter tests in wells in the Savannah area to determine water-yielding zones in the Floridan aquifer system. Five freshwater-bearing zones were delineated (McCollum and Counts, 1964). Krause and Randolph (1989) assiged the upper two zones to the Upper Floridan aquifer and the lower three zones to the Lower Floridan aquifer. The flowmeter tests indicated that about 70 percent of the flow was from the upper two zones. At Skidaway Island, zone 1 is near the top of the upper Eocene unit, and is about 44 ft thick (pl. 2). Zone 2 is near the bottom of the upper Eocene unit, and is about 35 ft thick at Skidaway Island. McCollum and Counts (1964) reported that zones 1 and 2 merge into one unit in southwestern South Carolina.

The Upper Floridan is comprised of two freshwater permeable zones in the Brunswick area, the "upper and the lower water-bearing zones" as described by Wait and Gregg (1973). These zones are shown for the Coffin Park and the Brunswick Pulp and Paper Company nested-well sites (pl. 2). The thickness of the upper water-bearing zone ranges from about 85 to 180 ft, and the thickness of the lower water-bearing zone ranges from about 15 to 110 ft. The two zones are separated by a low-permeability, semiconfining unit that ranges in thickness from about 150 to 200 ft, and which partially restricts flow between the zones. Outside the Brunswick area, the areal extent of the semiconfining unit is not well known because of lack of data. However, the unit has been identified as far south as Kings Bay in Camden County (pl. 2), but has not been recognized as far west as Jesup in Wayne County.

Hydraulic Properties

The Upper Floridan aquifer is most productive where it is thickest, and where secondary permeability is most developed. Based on field values from aquifer tests and results of model simulation (Krause and Randolph, 1989), transmissivity of the aquifer ranges from less than 10,000 ft^2/d in the area of the Gulf Trough in Bulloch County to more than 500,000 ft^2/d in the Charlton County area. Reported well yields of 5,000 to 10,000 gal/min are common in Camden, Wayne, and Glynn Counties.

During this study, an aquifer test was conducted at a well drilled for the city of Brunswick near the Coffin Park nested-well site (pl. 2). The test involved one pumping well (34H445) that withdrew 1,530 gal/min; and two observation wells (34H085 and 34H344), all three of which tapped the upper water-bearing zone. Well 34H085 is 410 ft from the pumped well, and well 34H344 is 3,570 ft from the pumped well. Water-level response data for both the 24-hour pumping period and the 19-hour recovery period were analyzed by using the Theis formula for nonleaky confined aquifers with fully penetrating wells (Lohman, 1972, p. 15). Data for well 34H344 were not analyzed because they could not be matched to an appropriate type curve owing to minimal response to the pumped well and to interferences caused by tidal influence, pumping from other wells, or leakage from adjacent zones or through fractures. The transmissivity at well 34H085, computed from time-drawdown data, was about 33,000 ft^2/d, whereas the transmissivity computed from time-recovery data was about 40,000 ft^2/d (R.B. Randolph, U.S. Geological Survey, written commun., 1987). The storage coefficient computed from the time-drawdown data was 4.7×10^{-4}, and from the time-recovery data was 5.7×10^{-4}.

Previous studies have shown that the Upper Floridan aquifer in the Brunswick area is moderately anisotropic (Maslia, 1987), whereas in the Jesup area (Randolph and others, 1985) and elsewhere in the coastal area, it is less anisotropic. Where the hydraulic properties of an aquifer vary with direction, the aquifer at that point is considered anisotropic. Anisotropy of the carbonate rocks in the Brunswick area probably is influenced by solution openings in the rock. These openings are believed to have been formed by the dissolution of carbonate material as ground water flows preferentially along joints and nearly vertical fractures in the rock. The northeastward elongation of the cone of depression at Brunswick (fig. 12) probably demonstrates the effect of the anisotropy. Although no faults have been positively identified, Maslia and Prowell (1988) have mapped locations of inferred faults. The principal direction of flow also corresponds to the orientation of a major structural depression (feature 5, fig. 2) located north of Brunswick.

Ground-Water Pumpage

During 1986, about 600 Mgal/d was withdrawn from the Upper Floridan aquifer in the Coastal Plain of Georgia, of which, about 273 Mgal/d or 46 percent, was withdrawn in the coastal area. Major pumping centers in the coastal area include the Savannah, Jesup, Riceboro, Brunswick, and Kings Bay-St Marys areas. With the exception of the Savannah area, pumping in these areas mainly is for industrial supply. In the Savannah area, pumping is about evenly divided between industrial and public supply. Withdrawals from the aquifer during 1986 were about 73 Mgal/d in the Savannah area, 83 Mgal/d in the Brunswick area, 81 Mgal/d in the Jesup and Riceboro areas, and 36 Mgal/d in the Kings Bay-St Marys area (Clarke and others, 1987).

Water Levels

The May 1985 potentiometric surface of the Upper Floridan aquifer is characterized by a generally coastward gradient interrupted by a series of cones of depression that have resulted from large withdrawals from the Upper Floridan aquifer (fig. 12). The cones of depression are at the major pumping centers of Savannah, Jesup, Brunswick, and St Marys, Ga.-Fernandina Beach, Fla. Despite similar rates of withdrawal, the size of the cone of depression at Savannah is substantially larger than in other coastal areas because the transmissivity of the aquifer at Savannah is lower (Krause and Hayes, 1981). For example, the transmissivity in the Brunswick area ranges from 40,000 to 200,000 ft^2/d, whereas the reported average transmissivity at Savannah is about 28,000 to 33,000 ft^2/d (Krause and Randolph, 1989).

Ground-water withdrawals at the pumping centers and elsewhere in the coastal area have resulted in water-level declines since development of the aquifer began in the late 1800's. Prior to development, the head in the Upper Floridan aquifer was from about 20 to 150 ft above sea level in the study area (Johnston and others, 1980). By 1985, the water level in the center of pumping at Savannah had declined to more than 20 ft below sea level (fig. 12). Similarly, in the center of pumping at Brunswick, the water level had declined to more than 10 ft below sea level by 1985. Long-term water-level trends in the Upper Floridan aquifer are shown for the Savannah area in figure 13 and for the Brunswick area in figures 11 and 14.

Because the Upper Floridan aquifer is deeply buried in the coastal area and is far from its outcrop area, its water level is not directly influenced by contemporaneous precipitation. The water level is, however, affected by increased withdrawals that occur during hot, dry periods. Water levels in the Savannah, Jesup, Brunswick, and St Marys areas also show direct responses to pumping from the Upper Floridan aquifer. Temporary reductions in industrial pumping in these areas are reflected by peaks on the hydrographs shown in figures 7, 8, and 14 for the Brunswick area, figure 9 for the Jesup area, and figures 15 and 16 for the Savannah area. At Brunswick, a reduction in industrial pumpage of about 10 Mgal/d in 1982 resulted in a water-level recovery of about 10 ft at well 33H133, which taps the upper water-bearing zone, and about 8 ft in well 33H127, which taps the lower water-bearing zone (fig. 13). Water levels in the two zones continued to rise until early 1984 when they began to decline again. For a complete discussion of water-level fluctuations in the Upper Floridan aquifer, the reader is referred to Clarke (1987) and Clarke and others (1987).

The Upper Floridan in the northwestern part of the study area is close to its recharge area, is distant from pumping centers, and is less deeply buried. Water levels in this area respond less to coastal pumping and more to local precipitation changes and to local pumping as illustrated by the water-level trend in well 32R002 (fig. 6).

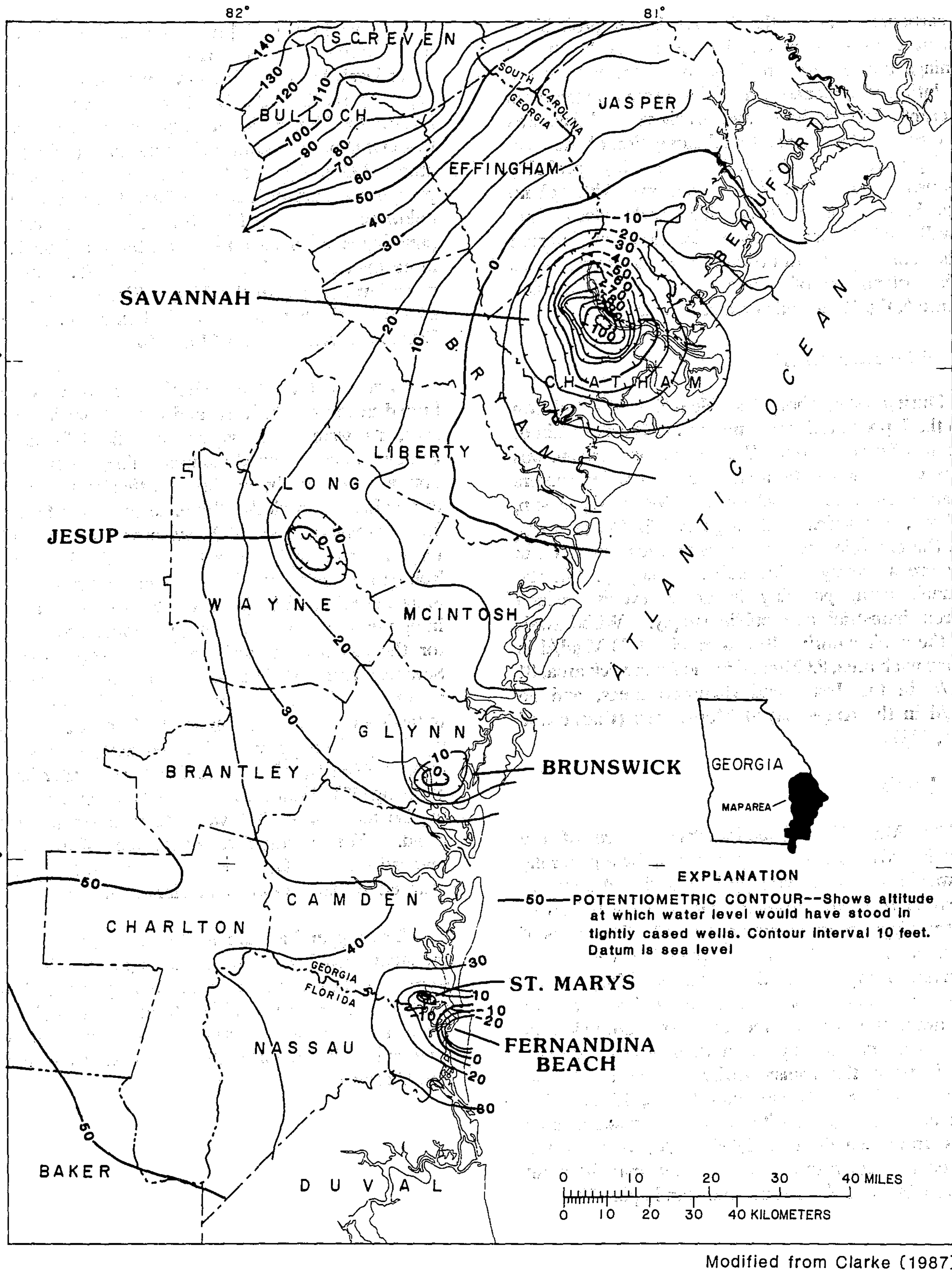


Figure 12.--Potentiometric surface of the Upper Floridan aquifer in the coastal area, May 1985.

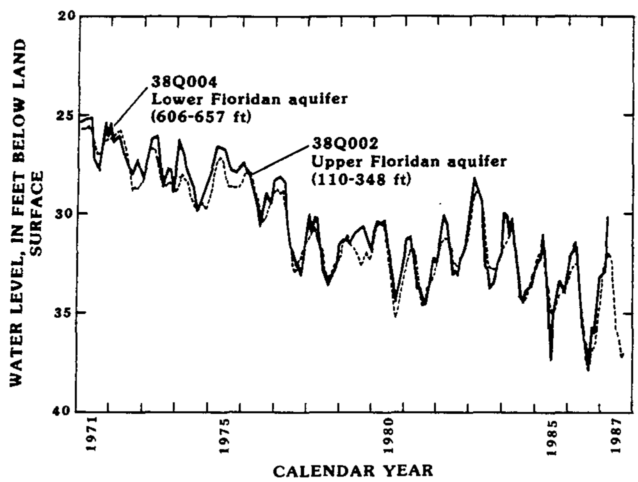


Figure 13.--Monthly mean water levels in the Upper Floridan aquifer at well 38Q002 and in the Lower Floridan aquifer at well 38Q004, Fort Pulaski, Chatham County, 1971-87.

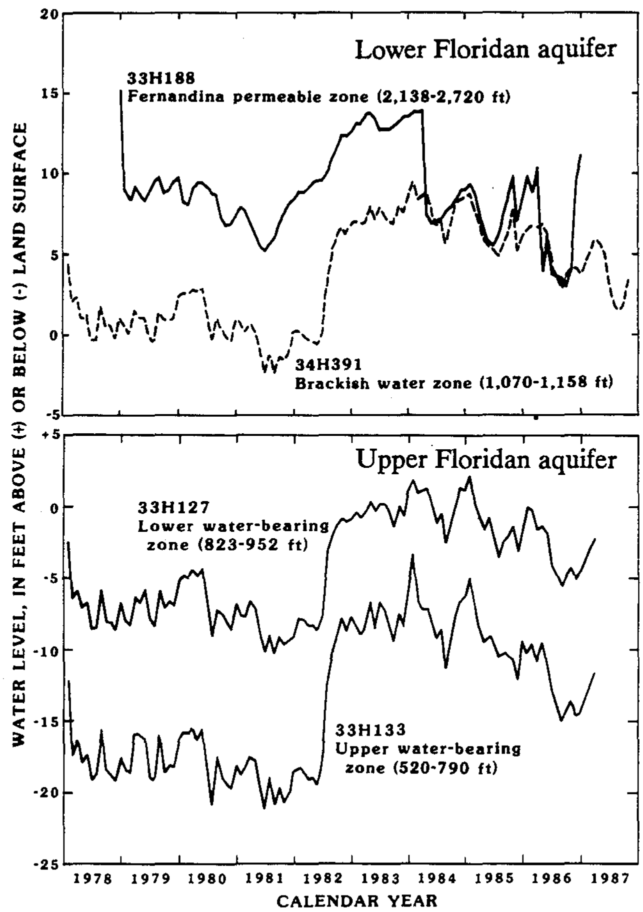


Figure 14.--Monthly mean water levels in the brackish-water zone and Fernandina permeable zone of the Lower Floridan aquifer, and in the upper and lower water-bearing zones of the Upper Floridan aquifer, Glynn County, 1978-87.

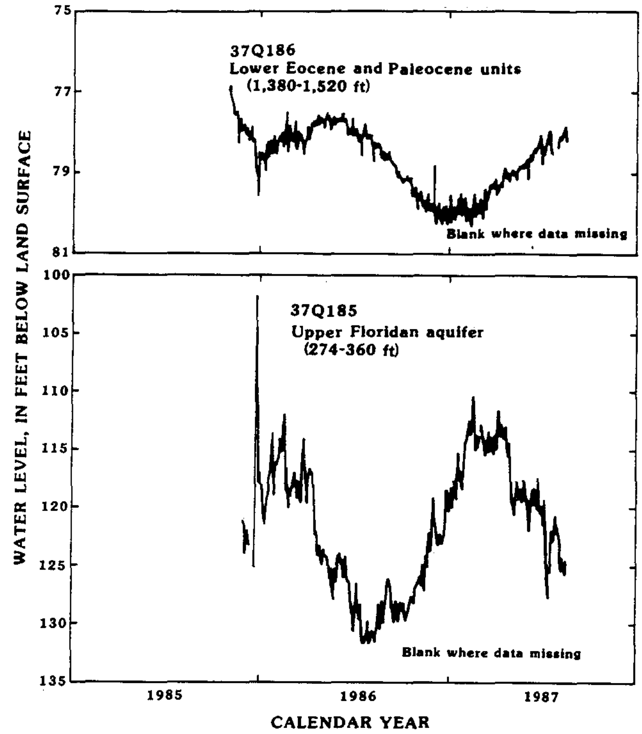


Figure 15.--Daily mean water levels in the Paleocene unit in well 37Q186 and in the Upper Floridan aquifer in well 37Q185, Hutchinson Island, Chatham County, 1985-87.

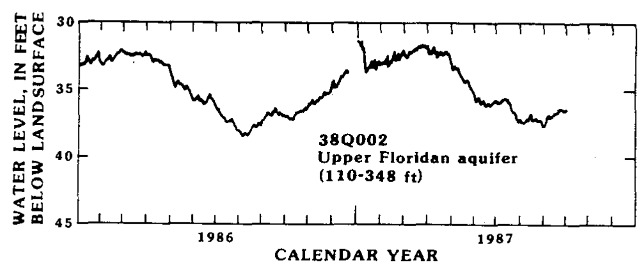


Figure 16.--Daily mean water levels in the Upper Floridan aquifer at well 38Q002 and in the Paleocene unit and late Cretaceous-age rocks at well 38Q201, Fort Pulaski, Chatham County, 1986-87.

Lower Floridan Aquifer

The Lower Floridan aquifer consists of dolomitic limestone, primarily of the middle and lower Eocene units. The Lower Floridan includes coarsely pelletal, vuggy, commonly dolomitized limestone of the Paleocene unit and deeper units of Late Cretaceous age locally in the Brunswick area (Miller, 1986, p. B70). Because few wells penetrate the Lower Floridan, information is sparse.

Depth to the top of the aquifer below land surface ranges from 570 to 765 ft in the Savannah area to about 1,000 ft in the Brunswick area (pl. 2). For further definition of the top of the aquifer, see Miller (1986) and Krause and Randolph (1989).

The aquifer ranges in thickness from less than 100 ft in the northern part of the study area to nearly 2,500 ft locally in the Brunswick area (Miller, 1986, pl. 32). At the nested-well sites, information on the thickness of the aquifer is limited to the Savannah area and the Hopeulikit site in Bulloch County (pl. 2). In the Savannah area, the aquifer ranges in thickness from 120 ft at Skidaway Island to 195 ft at Hutchinson Island. The aquifer is about 180 ft thick at the Hopeulikit site.

Permeable Zones

The Lower Floridan contains low-permeability zones that act as semiconfining units similar to those in the Upper Floridan aquifer. Locally, these semiconfining units divide the Lower Floridan into individual permeable zones. The permeability of the Lower Floridan generally decreases to the west and to the north of Brunswick, and is extremely low in the Savannah area.

The Lower Floridan is comprised of at least three separate water-bearing units in the Brunswick area (Krause and Randolph, 1989). They are, in descending order, the "brackish-water zone" and "deep freshwater zone" of Gregg and Zimmerman (1974), and the "Fernandina permeable zone" of Krause and Randolph (1989). The brackish-water zone and the deep freshwater zone consist of limestone and dolomite of the middle Eocene unit, and are described by Gregg and Zimmerman (1974, pl. 1). The Fernandina permeable zone consists of pelletal, recrystallized limestone and finely crystallized dolomite of the lower Eocene and Paleocene units. The zone extends from northeastern Florida into McIntosh County, Ga. The zone includes rocks of Late Cretaceous age in the Brunswick area. The zone ranges in thickness from about 100 ft in the Jacksonville, Fla., area to more than 500 ft at Brunswick, Ga. (Krause and Randolph, 1989).

In the Savannah area, zones 3, 4, and 5 of McCollum and Counts (1964) that have relatively higher permeability and that are within the middle Eocene unit were assigned to the Lower Floridan aquifer by Krause and Randolph (1989). These zones were first identified through flowmeter tests conducted by McCollum and Counts (1964). The tests indicated that zone 3 yielded from 2 to 8 percent, and zones 4 and 5 yielded from 3 to 20 percent of the total yield to multi-aquifer wells that tapped all five zones.

Hydraulic Properties

Because few wells tap the Lower Floridan aquifer, little information is available on its water-bearing properties. Krause and Randolph (1989) estimated from geophysical logs and thickness data that the transmissivity of the Lower Floridan ranges from 2,000 to 216,000 ft^2/d over most of the coastal area. Observations recorded during pumping of test wells for water-quality sampling and flowmeter tests conducted by McCullum and Counts (1964) indicate that the transmissivity is significantly lower in the Savannah area.

Vertical variations in the water-bearing properties of the Lower Floridan aquifer were demonstrated by pumping several test wells in Chatham County. Well 37P113 at Skidaway Island (pl. 2) tapped the upper part of the Lower Floridan, and yielded an estimated 25 gal/min and had a drawdown of 25.7 ft, which resulted in a specific capacity of 0.97 (gal/min)/ft. Well 38Q196 tapped the lower part of the aquifer at Fort Pulaski (pl. 2) and yielded about 5 to 10 gal/min and had a drawdown of about 52.4 ft, which resulted in a specific capacity of about 0.10 to 0.19 (gal/min)/ft. Transmissivity values of less than 100 ft^2/d were estimated by applying these specific capacity values to the modified nonequilibrium formula of Cooper and Jacob (1946) as described in Ferris and others (1962) and by using a storage coefficient ranging between 1×10^{-5} and 1×10^{-4}.

Ground-Water Pumpage

The Lower Floridan is not widely used for water supply in coastal Georgia because it is deeply buried, it contains saline water in much of its area of occurrence, and because the overlying Upper Floridan is an excellent source of good quality water. The aquifer supplied an estimated 0.01 Mgal/d to the town of Hiltonia in Screven County in 1980, through multi-aquifer wells that tapped both the Upper and the Lower Floridan (R.B. Randolph, U.S. Geological Survey, written commun., 1987). In Allendale, Beaufort and Jasper Counties, S.C., the aquifer supplied 4.01, 3.41, and 0.016 Mgal/d, respectively, in 1980. The Lower Floridan is extensively developed in northeast Florida (Krause and Randolph, 1989).

Water Levels

The water level in the Lower Floridan aquifer primarily is influenced by pumping from the Upper Floridan aquifer. Withdrawal of water from the Upper Floridan induces upward flow from the Lower Floridan.

Although well yields are low, the Lower Floridan is tapped along with the Upper Floridan in several municipal and industrial wells in the Savannah area (appendix B). Water-level fluctuations and trends in the Lower Floridan are nearly identical to those in the Upper Floridan, which indicates hydraulic connection between the aquifers, as can be seen on the hydrograph in figure 13.

Although the Lower Floridan is not used in the Brunswick area, water-level fluctuations in the aquifer are closely related to those in the overlying Upper Floridan aquifer. Water from the Lower Floridan moves upward into the heavily pumped Upper Floridan by leaking through conduits, solution-enlarged fractures, or possibly faults in the otherwise low-permeability semiconfining unit. The water level in the brackish-water zone and the Fernandina permeable zone of the Lower Floridan showed the same trend during 1978-87 as the upper and the lower water-bearing zones of the Upper Floridan (fig. 14). Well 34H391 taps the brackish-water zone and shows almost immediate response (indicated by spikes and peaks on the hydrograph) to reductions in industrial pumping from the Upper Floridan. The similarity in water-level trends shown in figure 14 for well 34H391; well 33H188, which taps the Fernandina permeable zone; and wells 33H133 and 33H127, which tap the Upper Floridan, suggests hydraulic connection between the aquifers.

Water levels in sediments underlying the Floridan aquifer system in the Savannah area may be affected by local pumping from the Floridan or by pumping from aquifers of equivalent age outside the Savannah area, or both. Well 37Q186 at Hutchinson Island taps dense argillaceous limestone of the lower Eocene unit and the Paleocene unit in the interval 1,380 to 1,520 ft below the Lower Floridan aquifer (pl. 2). The water level in well 37Q186 seems to show a delayed response to water-level changes in the Upper Floridan aquifer, which is heavily pumped in the Savannah area (fig. 15).

Confining Units

The confining unit between the surficial and the upper Brunswick aquifers consists of silty clay and dense, phosphatic limestone or dolomite of Miocene unit A (pl. 3). The unit ranges in thickness from about 15 ft at the Hopeulikit site in northern Bulloch County to about 70 to 90 ft at the nested-well sites at Brunswick in Glynn County (pl. 2). In the Brunswick area, Wait and Gregg (1973) determined from laboratory analysis that the vertical hydraulic conductivity of undisturbed cores of the confining unit ranged from 5.3×10^{-5} to 1.3×10^{-4} ft/d at well 34H132 (table 2).

The upper and the lower Brunswick aquifers are separated by a confining unit that consists of silty clay and dense, phosphatic limestone or dolomite of Miocene unit B (pl. 3). The confining unit ranges in thickness from about 10 ft at the Gardi site in Wayne County to about 50 ft at the nested-well sites in the Brunswick area (pl. 2).

The confining unit between the lower Brunswick and the Upper Floridan aquifers consists of silty clay and dense phosphatic limestone or dolomite of Miocene unit C (pl. 3). The confining unit ranges in thickness from about 20 ft at the Gardi site to about 40 ft at the nested-well sites in the Brunswick area (pl. 2). The vertical hydraulic conductivity of undisturbed cores of the confining unit at Brunswick, as determined from laboratory analysis, ranges from 1.07×10^{-2} to 1.74 ft/d (Wait and Gregg, 1973, table 9) (table 2).

Table 2.--Hydraulic conductivity of core samples, Savannah and Brunswick areas

[Geologic unit: PM, Post-Miocene unit; A, Miocene unit A; B, Miocene unit B; C, Miocene unit C; O, Oligocene unit; UE, upper Eocene unit; ME, middle Eocene unit; LE, lower Eocene unit. Analyses in Chatham County from Furlow (1969); analyses at wells 34H132 and 33H114 from Wait (1965); analyses at well 34H337 from Wait and Gregg (1973); --, no horizontal]

Site no.	Interval (ft)	Lithology	Geologic unit	Hydraulic conductivity (ft/d)	
				Vertical	Horizontal
Chatham County					
38Q203	106	Sandy clay with pebbles	B	1.2×10^{-4}	8.0×10^{-5}
	114	Sandy clay	B	6.7×10^{-5}	9.4×10^{-5}
	122	do.	B	1.2×10^{-4}	1.3×10^{-4}
	142	Chalky limestone	O	1,070	1,738
38Q202	103	Sandy clay	B	1.3×10^{-5}	9.4×10^{-5}
38P015	114	Clay	A	4.0×10^{-4}	--
	120-136	Calcareous sand	B	1.3×10^{-2}	--
	141	Clay	B	1.3×10^{-3}	--
	146	do.	B	1.1×10^{-4}	--
	151	do.	B	5.3×10^{-5}	--
	164	do.	B	4.0×10^{-4}	--
	168	Sandy clay	B	5.3×10^{-5}	--
	196	Chalky limestone	O	8.0	--
	211-214	do.	O	8.0×10^{-4}	--
	226-241	do.	O	4.0×10^{-3}	--
38P016	122	Sandy clay	B	2.7×10^{-4}	--
	132	Sand	B	5.3×10^{-4}	--
	141	do.	B	1.1×10^{-3}	--
	159	Sandy clay	C	5.3×10^{-5}	--
39P003	96	Sandy clay	B	1.3×10^{-2}	--
	102	do.	B	2.7×10^{-4}	--
	111	do.	B	1.3×10^{-4}	--
	119	do.	B	4.0×10^{-4}	--
39P002	123	Clay	B	2.7×10^{-4}	4.0×10^{-4}

Table 2.--Hydraulic conductivity of core samples, Savannah and Brunswick areas--Continued

[Geologic unit: PM, Post-Miocene unit; A, Miocene unit A; B, Miocene unit B; C, Miocene unit C; O, Oligocene unit; UE, upper Eocene unit; ME, middle Eocene unit; LE, lower Eocene unit. Analyses in Chatham County from Furlow (1969); analyses at wells 34H132 and 33H114 from Wait (1965); analyses at well 34H337 from Wait and Gregg (1973); --, no horizontal]

Site no.	Interval (ft)	Lithology	Geologic unit	Hydraulic conductivity (ft/d)	
				Vertical	Horizontal
Glynn County					
34H132	166-185	Fine sandy, silty clay	A	5.3×10^{-5}	--
	229-232	do.	A	1.3×10^{-4}	--
	475-478	Fine argillaceous sand	C	1.07	--
	496-497	do.	C	1.74	--
	519-539	Fossiliferous limestone	O	0.94	--
	560-580	do.	UE	1.2	--
	642-662	do.	UE	6.68	--
	682-702	do.	UE	18.72	--
	744-765	do.	UE	.4	--
	867-888	Dolomitic limestone	UE	2.7×10^{-2}	--
	970-990	do.	UE	4.0×10^{-2}	--
	1,046-1,051	do.	ME	1.3×10^{-5}	--
	1,053-1,065	do.	ME	4.0×10^{-5}	--
	1,072-1,084	do.	ME	5.3×10^{-5}	--
	1,134-1,154	do.	ME	2.7×10^{-4}	--
33H114	615-635	Fossiliferous limestone	UE	.67	--
	708-712	do.	UE	21.39	--
	800-812	do.	UE	1.3×10^{-3}	--
	900-912	Dolomitic limestone	UE	1.3×10^{-4}	--
33H337	118-128	Clay	A	.27	--
	178-188	do.	A	1.07	--
	547-567	Fine grained sandstone	C	1.07×10^{-2}	--
	567-587	Sandy limestone	O	.4	--
	587-607	Fossiliferous limestone	UE	160.4	--
	678-698	do.	UE	120	--
	779-799	Limestone	UE	6.68	--
	935-954	do.	LE	8.0×10^{-6}	--
	1,088-1,105	do.	LE	4.0×10^{-6}	--
	1,490-1,503	do.	LE	5.3	--

The Upper Floridan aquifer in the Savannah area and in Bulloch County is confined above by silty clay and dense phosphatic limestone or dolomite of Miocene unit B and Miocene unit C. The lower Brunswick aquifer is absent in these areas, and the confining unit above the Upper Floridan ranges in thickness from about 14 ft at the Fort Pulaski site to 120 ft at the Bulloch south site (pl. 2). Analyses of undisturbed cores in the Savannah area (Furlow, 1969) indicated the vertical hydraulic conductivity of this confining unit ranged from 5.3×10^{-5} to 1.3×10^{-2} ft/d, and the horizontal hydraulic conductivity ranged from 8.0×10^{-5} to 4.0×10^{-4} ft/d (table 2). The ratio of vertical to horizontal hydraulic conductivity at three of the sites ranged from 0.14 to 1.5, with the exception of one site, where vertical values were substantially less than horizontal values. The differences in ratio between the sites demonstrates the highly variable, anisotropic, hydraulic properties of the confining units.

The Upper and the Lower Floridan aquifers are separated by a semiconfining unit that consists of dense, dolomitic limestone of the middle Eocene unit (pl. 3). The unit ranges in thickness from about 40 ft in northern Bulloch County and in the Brunswick area, to about 160 to 280 ft in the Savannah area (pl. 2). The semiconfining unit has variable hydraulic properties in the Brunswick area. The vertical hydraulic conductivity of undisturbed cores of the confining unit at Brunswick was determined from laboratory analysis and ranged from 4.0×10^{-6} to 5.3×10^{-5} ft/d (Wait and Gregg, 1973, table 9; Wait, 1965, table 8) (table 2). Although the unit has a very low primary hydraulic conductivity, joints and fractures in the rock have produced zones of substantially higher secondary hydraulic conductivity. The presence of these openings is indicated at Brunswick by (1) acoustic televiewer logs that show fractures and solution openings in the rock (fig. 3), (2) rapid response of water levels in wells that tap the Lower Floridan (brackish-water and Fernandina permeable zones) to pumping from the Upper Floridan, and (3) high chloride concentrations in the Upper Floridan that resulted from the upward movement of saline water from the Fernandina permeable zone.

The Lower Floridan aquifer is confined below by argillaceous to arenaceous rocks of the Paleocene unit (pl. 3). In the Brunswick area, micritic limestone and argillaceous limestone of Late Cretaceous age mark the base of the aquifer (Miller, 1986, p. B46). The Fernandina permeable zone of the Lower Floridan is confined above by microcrystalline, locally gypsiferous dolomite and finely pelletal micritic limestone of early and middle Eocene age. The confining unit overlying the Fernandina permeable zone in the Brunswick area is fractured, which provides conduits for saline water to move upward from the Fernandina zone into shallower, heavily pumped zones (Krause and Randolph, 1989). These fractures are apparent on the acoustic televiewer log for well 33H188 in Glynn County (fig. 3).

The water-bearing properties of the confining unit underlying the Lower Floridan aquifer in the Savannah area were determined during water-quality sampling in wells 37Q186 at Hutchinson Island and 38Q201 at Fort Pulaski (pl. 2). Well 37Q186 taps glauconitic limestone and calcareous sand in the lower part of the lower Eocene unit and the Paleocene unit. During sampling, the well yielded about 5 to 10 gal/min and had a drawdown of 45 ft, giving it a specific capacity of about 0.1 to 0.2 (gal/min)/ft. Well 38Q201 taps argillaceous and glauconitic limestone of the Paleocene unit, and possibly sediments of Late Cretaceous age that are stratigraphically equivalent to the Fernandina permeable zone of Krause and Randolph (1988). Pumping the well produced a yield of about 1.0 to 1.5 gal/min with a drawdown of 42.4 ft, for a specific capacity of about 0.04 (gal/min)/ft. The estimated transmissivity of the confining unit, based on the specific capacity data at the two wells, was about 10 to 60 ft^2/d.

Head Differences

The series of nested-well sites (pl. 2, table 1) was established to determine the vertical head relations between aquifers in areas where the Upper Floridan aquifer is stressed by pumping. At these sites, the effects of withdrawals were assessed in each of the water-bearing zones, and a head difference determined, which can be computed by comparing water levels listed in table 1. With the exception of the Glynn County sites, the heads in the surficial, upper Brunswick, and lower Brunswick aquifers are higher than in the Upper Floridan aquifer, which indicates a potential for downward leakage over most of the coastal area.

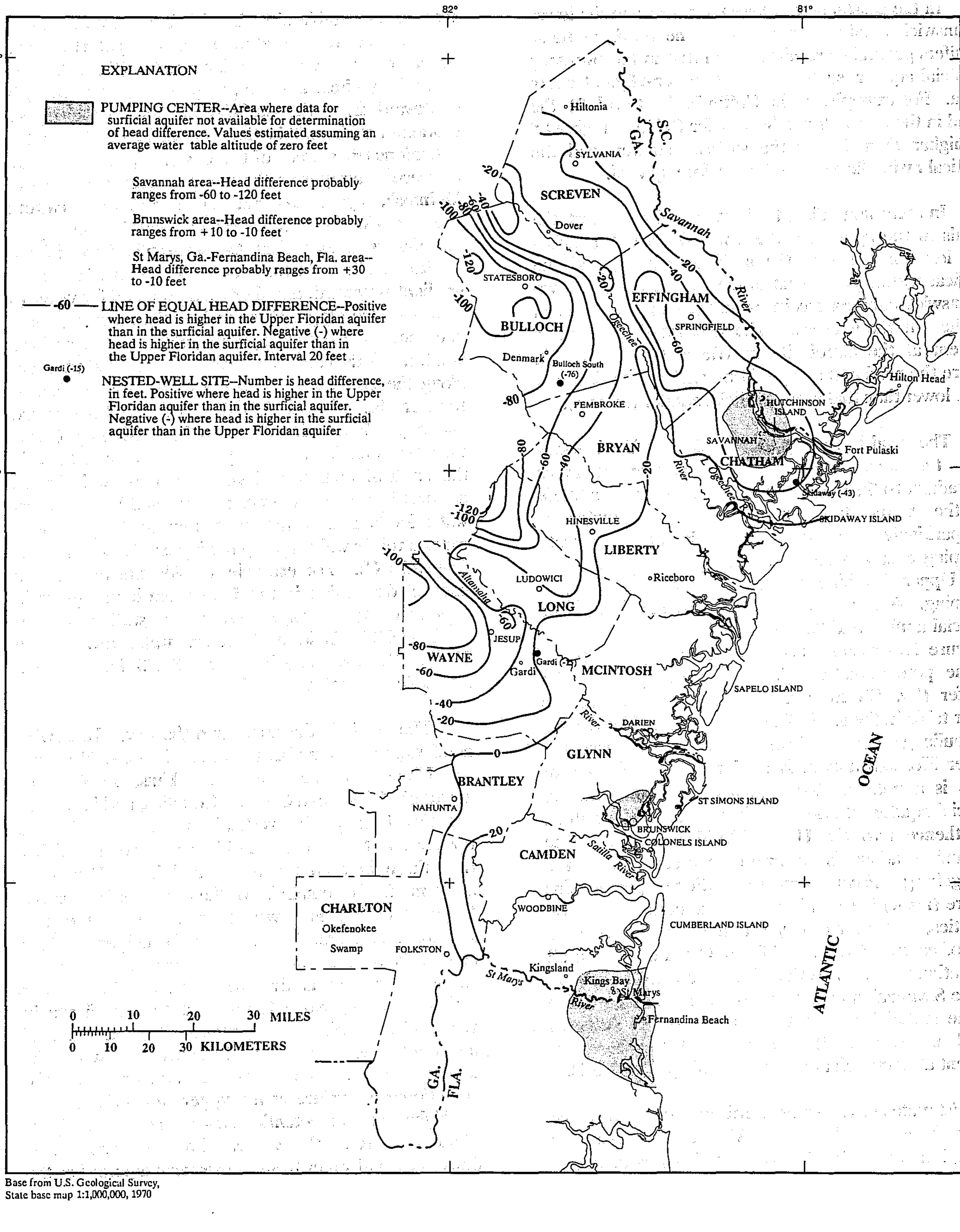
In the coastal area, where the upper and the lower Brunswick aquifers are confined, the heads in those aquifers generally are higher than that in the overlying surficial aquifer, such as in the Camden-Glynn County area. For example, at the Coffin Park site (pl. 2), the head in the upper Brunswick aquifer (table 1) is about 5 ft higher than that in the surficial aquifer, and the vertical hydraulic gradient is therefore upward.

In areas upgradient to the west and northwest, the heads in the upper and the lower Brunswick aquifers are less than that in the surficial aquifer, and the vertical hydraulic gradient is downward; thus, the two Brunswick aquifers receive recharge from the surficial aquifer in these areas. The downward gradient is evident at the Gardi site in Wayne County (pl. 2), where the head in the upper Brunswick aquifer is about 11 ft lower than that in the surficial aquifer (table 1).

The head in the Upper Floridan aquifer is lower than the head in the surficial aquifer in areas upgradient to the west and northwest where the altitude of the water table in the surficial aquifer is comparitively high, and locally in areas beneath pumping centers where the potentiometric surface of the Upper Floridan aquifer has been lowered by pumping. A map of the head difference between the surficial aquifer and the Upper Floridan aquifer, shown in figure 17, was constructed by subtracting the altitude of the potentiometic surface of the Upper Floridan aquifer (fig. 12) from the estimated altitude of the water table in the surficial aquifer (fig. 4). The vertical hydraulic gradient is downward in areas where the Upper Floridan aquifer has a lower head, and where there is a potential for downward leakage from the surficial aquifer into the underlying Brunswick aquifers, and thence into the Upper Floridan aquifer. The hydraulic gradient is downward in areas west of the Orangeburg Escarpment-Trail Ridge geomorphic feature (fig. 4) in central Brantley and eastern Charlton Counties; northwest of Glynn and McIntosh Counties; west of central Bryan and Liberty Counties; and in all of Chatham County. Although contours are not shown for the Savannah area in figure 4 because of sparse data for the surficial aquifer, water levels at the Skidaway Island nested-well site indicate that the hydraulic gradient at Savannah also is downward (pl. 2, table 1).

Estimates of the vertical hydraulic gradient in the Savannah, Brunswick, and St Marys, Ga.-Fernandina Beach, Fla., areas (fig. 17), were made by assuming an average water-table altitude of 0 ft, and by comparing that altitude to the altitude of the potentiometric surface of the Upper Floridan aquifer (fig. 12). The hydraulic gradient at these pumping centers probably is downward from the surficial aquifer to the Upper Floridan aquifer within the cone of depression in the potentiometric surface of the Upper Floridan (fig. 12). Conversely, away from the pumping centers in most of McIntosh, Glynn, and Camden Counties, and in eastern Brantley County, the hydraulic head in the Upper Floridan is higher than the hydraulic head in the surficial aquifer. In these areas, the vertical hydraulic gradient is upward, and there is a potential for water to flow from the Upper Floridan into the overlying upper and lower Brunswick aquifers and into the surficial aquifer. This condition occurs in unstressed areas along the coast, such as some of the barrier islands (eastern St. Simons Island, northern Cumberland Island, and Jekyll Island), where the head in the Upper Floridan is comparatively high, and the water table in the surficial aquifer is low. The upward hydraulic gradient in unstressed areas is illustrated by comparing water levels in wells tapping the surficial aquifer with water levels in wells tapping the Upper Floridan aquifer (appendix C). For example, outside the area of the cone of depression in the Upper Floridan aquifer in Glynn County, the water level in the surficial aquifer (well 34H428) is lower than the water level in the Upper Floridan aquifer (well 34H371), and the hydraulic gradient is upward.

The heads in the upper and the lower Brunswick aquifers generally are between those in the surficial and the Upper Floridan aquifers. Thus, in most of McIntosh, Glynn, and Camden Counties, and in eastern Brantley County, the vertical hydraulic gradient is upward and the head in the Upper Floridan is higher than those in both the upper and lower Brunswick aquifers. In the remainder of the area, the head in the Upper Floridan is lower than those in the two Brunswick aquifers. The head in the Upper Floridan aquifer is 5 ft lower than the head in the upper Brunswick aquifer at the Hopeulikit site in northern Bulloch County, and 4 ft lower at the Gardi site in Wayne County (pl. 2). Both sites are located in upland areas in the western part of the study area, where the water table in the surficial aquifer and the potentiometric surface of the upper Brunswick aquifer are higher than the potentiometric surface of the Upper Floridan. Here, the vertical hydraulic gradient is downward, and water from the surficial aquifer has the



Base from U.S. Geological Survey, State base map 1:1,000,000, 1970

Figure 17.--Estimated difference in head between the Upper Floridan aquifer and the surficial aquifer.

potential to move downward into the upper and the lower Brunswick aquifers, and thence into the Upper Floridan aquifer. Conversely, at the Coffin Park site in Brunswick, the hydraulic head of the Upper Floridan is about 3 ft higher than the hydraulic head of the upper Brunswick aquifer (pl. 2). Here, water from the Upper Floridan has the potential to move into the upper and the lower Brunswick aquifers, and thence into the surficial aquifer. Although no data are available, it is assumed that there is a slight head difference between the upper and the lower Brunswick aquifers, and that the direction of the hydraulic gradient between the two aquifers is the same as that between the surficial aquifer and the Upper Floridan aquifer.

The head in the Lower Floridan aquifer throughout much of the study area is higher than that in the Upper Floridan aquifer, and the vertical hydraulic gradient is upward. Where the aquifers are recharged, northwest of the study area, the gradient is downward (Krause and Randolph, 1988). The hydraulic gradient between the Upper and the Lower Floridan in the Savannah area is slightly upward at Skidaway Island (0.8 ft) and at Fort Pulaski (0.4 ft) (pl. 2, table 1). The hydraulic gradient between the two water-bearing zones of the Upper Floridan aquifer, and the brackish-water zone and the Fernandina permeable zone of the Lower Floridan aquifer in the Brunswick area generally is upward, as can be seen on the hydrographs shown in figure 14.

The head difference between the Floridan aquifer system and underlying semiconfining units is more than 10 ft and the gradient is downward at the Fort Pulaski site as indicated by the hydrographs shown on figure 16. This downward gradient probably is the result of the greater density of water in the deeper units owing to higher total dissolved solids concentrations, although regional pumping from the deeper aquifers outside the Savannah area may also have an effect. The head in the Paleocene unit underlying the Floridan aquifer system at Hutchinson Island is 40 to 50 ft higher than those of the Floridan.

Geothermal Gradient

Anomalous temperature distributions may be caused by the spatial redistribution of heat by moving ground water (Freeze and Cherry, 1979, p. 508). The vertical distribution of water temperatures in a well can provide indirect information about the vertical movement of water. The geothermal gradient is a measure of the change in temperature with increase in depth, and generally is expressed in degrees Celsius per 100 ft. The normal geothermal gradient is representative of natural conditions prior to development, where the temperature change with depth is affected solely by the increase in temperature of native rock, and where there is no suspected vertical movement of ground water. A geothermal gradient lower than normal at a given depth generally indicates downward flow of cooler water from shallower aquifers, whereas a geothermal gradient greater than normal indicates upward flow of warmer water from deeper aquifers. For further discussion of the relations between the geothermal gradient and leakage between aquifers, the reader is referred to Grahm and Parks (1986, p. 27).

Wait and Gregg (1973, p. 25) reported anomalously high ground-water temperatures in the Brunswick area in places contaminated by high concentrations of chloride. Their estimates were based on the normal geothermal gradient of about 0.8°C per 100 ft, as determined at two oil-test wells located in areas of minimal pumping. Computed values indicated that the upper water-bearing zone of the Upper Floridan aquifer, between the depths of 500 to 650 ft, had a water temperature equivalent to a depth of about 1,600 ft. Wait and Gregg (1973) postulated that because some cooling occurs as deeper and shallower waters mix, the source of high-chloride water probably was deeper than 1,600 ft, which was later confirmed by test drilling at Colonels Island (well 33H188, appendix B) (Gill and Mitchell, 1979).

Geothermal gradients in the Savannah area were determined at six wells in Chatham County and at one well in Bryan County (table 3). The seven wells were located within the area of the cone of depression in the Upper Floridan aquifer. The gradient at each well was determined by comparing the temperature of the water at depth to the average-annual air temperature at Savannah (19.7°C), which approximates the temperature of ground water in the upper part of the well. The gradient measured at well 36Q318 was 0.85°C per 100 ft, and the gradient at well 36R041 was 0.83°C per 100 ft. Both measured gradients were close to the normal geothermal gradient (0.8°C per 100 ft) determined by Wait and Gregg (1973) in the Brunswick area. The gradient was lower than normal in wells less than 700 ft deep, indicating downward flow from overlying aquifers. This is supported by head-difference data, which indicates a downward hydraulic gradient from the surficial aquifer to the Upper Floridan aquifer in the area (pl. 2, fig. 17). The geothermal gradient in wells 37P113, 37Q186, and 38Q201 was higher than normal, indicating upward flow. Although the temperature measured in well 37P113 was at a depth of 1,100 ft, the temperature was indicative of water from a depth of about 1,512 ft. Similarly, the temperature measured at well 37Q186 at a depth of 1,520 ft was indicative of a depth of 2,238 ft. The temperature measured at well 38Q201 at a depth of 1,542 ft was indicative of ground water from a depth of 1,850 ft. In the Savannah area, upward flow from deeper zones is supported by head-difference data from nested-well sites, which indicate an upward hydraulic gradient into the Upper Floridan aquifer. Although there is an upward component of flow, the quantities are assumed to be small owing to the low permeability of the intervening confining units.

Table 3.--Ground-water temperatures and gradients, Savannah area
[Average annual air temperature 19.7°C]

County	Well no.	Open-hole interval (ft)	Depth (ft)	Temper-ature (°C)	Temperature gradient (°C per 100 ft)
Bryan	35P010	96-417	417	22.15	0.59
Chatham	36Q318	1/2,921-3,407	3,393	48.60	.85
	36R041	0-1,000	1,000	28.03	.83
	37P113	700-1,100	1,100	31.80	1.10
	37Q083	220-645	613	22.60	.47
	37Q186	1,380-1,520	1,520	37.60	1.18
	38Q201	1,358-1,546	1,542	34.50	.96

1/Open interval after initial construction; well later modified to an open interval of 354-840 ft.

Interaquifer Leakage

Interaquifer leakage is important in the coastal area because of its impact on water quality. Saltwater intrusion and upward leakage of connate water into pumped freshwater zones of the Upper Floridan aquifer are issues of concern to resource managers in the coastal area.

The confining units overlying and underlying the Upper Floridan aquifer are not impermeable, and some interchange of water occurs naturally between the Upper Floridan and shallower or deeper aquifers. The rate and volume of leakage depends on the thickness and hydraulic conductivity of the confining unit, and the difference in hydraulic head between the aquifers. The potential for leakage between aquifers is highest where the intervening confining unit is thinnest, where the hydraulic conductivity is highest, and where the vertical hydraulic head difference is greatest.

The potential for downward leakage from the surficial aquifer is greatest in Bulloch County, where the confining units separating the surficial and upper Brunswick aquifers are thinnest, and where the downward hydraulic gradient between the surficial and the Upper Floridan aquifers is greatest. Hydraulic connection among the aquifers in this area is evidenced by similar water-level fluctuations and trends in the aquifers. A high potential for leakage also exists in other upland areas along the western part of the study area, and near the pumping centers at Savannah and Brunswick where there is a large, downward hydraulic gradient. Furlow (1969) estimated the effects of proposed phosphate-ore mining in the Savannah area on the rate of saltwater leakage into the Upper Floridan aquifer. Based on the hydraulic conductivity of the Miocene confining units and the downward hydraulic gradient, Furlow (1969) concluded that if 100 ft of overburden were removed by mining phosphate in the Savannah area, about 160 (gal/acre)/d of saltwater would leak into the Oligocene limestone, which is part of the Upper Floridan aquifer.

A submarine escarpment in Miocene sediments, west of the barrier islands may provide a direct connection between seawater and the upper Brunswick aquifer. Harding and Woolsey (1975) found an escarpment in Pliocene and Miocene sediments that generally parallels the coast west of the barrier islands south of the Savannah area. The escarpment, named the Sea Island Escarpment by Huddlestun (1988, p. 18), has breached Miocene sediments that are equivalent in age to sediments that overlie and form the upper Brunswick aquifer. Permeable sand and gravel of Pliocene age (unnamed Raysor-equivalent shelly sand of Huddlestun, 1988, p. 117) have accumulated along the face of the escarpment. Because the hydraulic head in the upper and lower Brunswick aquifers is at or above sea level in most of the study area, water from the aquifers probably is in equilibrium with, or is discharging to the sea in the vicinity of the escarpment. However, if the hydraulic gradient were reversed as a result of increased withdrawals and associated water-level declines in the aquifers, saltwater encroachment could occur.

The rate of leakage between the surficial and the upper Brunswick aquifers was estimated at two nested-well sites by using the following modification of Darcy's Law (Ferris and others, 1962, p. 111):

$$Q = K' I A \quad (1)$$

where

Q	is the rate of leakage in cubic feet per day,
K'	is the vertical hydraulic conductivity of the confining unit in feet per day,
I	is the hydraulic gradient in feet per foot, and
A	is the cross-sectional area in square feet.

A cross-sectional area (A) of 1 ft^2 and an average vertical hydraulic conductivity (K') of 9×10^{-5} ft/d were used for the confining unit between the surficial and the upper Brunswick aquifers to calculate the rate of leakage. The confining unit at the Gardi site was about 28 ft thick, and the head difference between the aquifers was 11.3 ft, which produced a leakage rate of 3.6×10^{-5} ft^3/d (2.8×10^{-4} gal/d). At the Coffin Park site, the confining unit was 70 ft thick, and the head difference between the aquifers was 4.8 ft, which produced a leakage rate of 6.2×10^{-6} ft^3/d (4.6×10^{-5} gal/d). These rates indicated that about 12 (gal/acre)/d would leak through the confining unit at the Gardi site, and about 2 (gal/acre)/d would leak through the unit at the Coffin Park site.

Water Quality

The quality of water in the surficial, the upper and lower Brunswick, and the Upper Floridan aquifers generally is good. The Lower Floridan aquifer and deeper water-bearing zones generally yield water of poor quality.

A graphic summary of selected chemical constituents in the ground water is shown in figure 18. The summary is based on fluoride, calcium, chloride, sulfate, sodium, dissolved solids, hardness (as calcium carbonate), potassium, iron, and magnesium analyses of water samples collected from 1940 to 1986. The chemical analyses listed in table 4 represent only a fraction of the total number of water samples collected from wells that tap the Upper Floridan aquifer; the total number of analyses were too numerous to list. Information concerning these wells are stored in the U.S. Geological Survey's National Water Information System (NWIS). Where more than one analysis was available for a site, the median value was utilized for the statistical analysis.

Surficial Aquifer

Water-quality data for the surficial aquifer are limited. Analyses of water samples from 30 wells in Chatham, Glynn, Camden, Wayne, and Bulloch counties indicate that the water is low in dissolved solids, ranges in hardness from soft to hard, and is suitable for most uses (table 4). The boxplots in figure 18 show that water from the surficial aquifer has low median concentrations of fluoride (0.03 mg/L), calcium (35 mg/L), magnesium (4.0 mg/L), chloride (28 mg/L), sulfate (12 mg/L), sodium (10.6 mg/L), dissolved solids (128 mg/L), and potassium (1.4 mg/L).

The median concentration of dissolved iron in the surficial aquifer was 500 ug/L, which exceeded the recommended drinking-water standard of 300 ug/L (Georgia Department of Natural Resources, 1977; U.S. Environmental Protection Agency, 1986). A maximum dissolved iron concentration of 5,100 ug/L was detected in well 37P136 at Skidaway Island, Chatham County, and concentrations that ranged from 1,270 to 4,980 ug/L were measured in five wells at the Naval Submarine Base, Kings Bay, in Camden County. Staining of pavement by iron in ground water has been reported in the Skidaway Island area, where well water is used for lawn irrigation (Soil and Materials Engineers, Inc., 1986b).

The median chloride concentration (28 mg/L) in water from the surficial aquifer was below the State recommended drinking-water standard of 250 mg/L (Georgia Department of Natural Resources, 1977). With the exception of water from one well in the

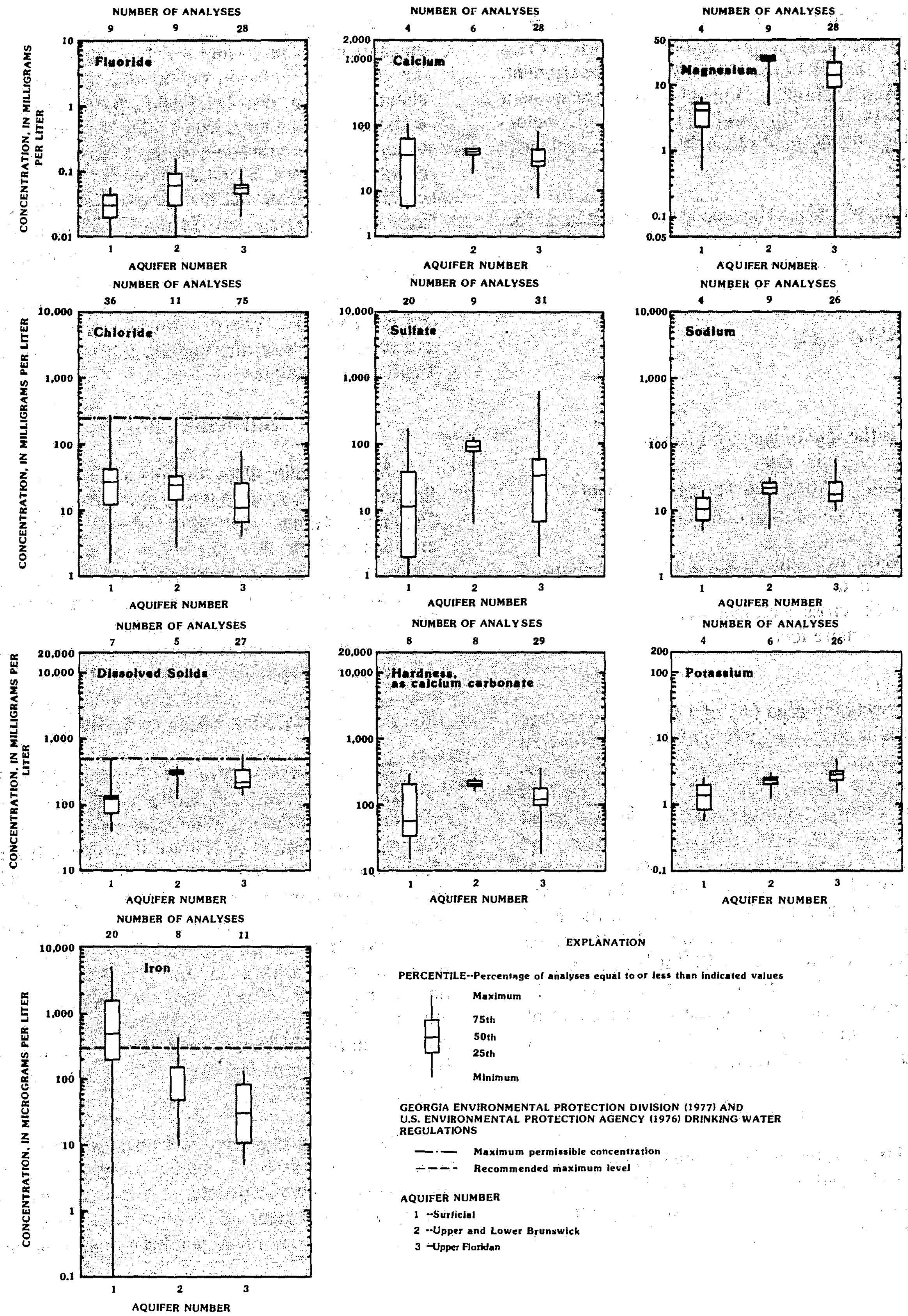


Figure 18.--Boxplots of selected chemical constituents.

Brunswick area that had a chloride concentration of 270 mg/L, the chloride concentration in wells sampled in the Brunswick area during October 1987 ranged from 9.3 to 52 mg/L (appendix C). The chloride concentration at Kings Bay in Camden County ranged from 10.3 to 42.8 mg/L, and at Skidaway Island in Chatham County, it ranged from 25 to 180 mg/L (table 4). Counts and Donsky (1963) reported that the chloride concentration of water from wells tapping sand of Pleisotocene age (surficial aquifer) in the Savannah area ranged from 5 to 352 mg/L.

The surficial aquifer is susceptible to saltwater encroachment in areas near the coast, or near tidal rivers and estuaries where the water table in the aquifer is at or below sea level. For example, at Skidaway Island, the specific conductance (which, at this site, provides an indication of dissolved solids and chloride ion concentration) of water from the surficial aquifer is highest along the outer margins of the island that border the salt marshes and estuaries (Soil and Materials Engineers, Inc., 1986b).

Chloride concentrations in the surficial aquifer exceeded 50 mg/L at St. Simons Island and in the southern part of Brunswick. During October 1987, the concentration in the southern part of Brunswick at well 34H416 was 270 mg/L, which exceeded State drinking-water standards (appendix C). At well 35H053 on St. Simons Island, the chloride concentration during October 1987 was 52 mg/L. Both wells are located in areas where pumping has produced cones of depression in the potentiometric surface of the lower semiconfined zone of the surficial aquifer. During 1984-87, the chloride concentration in well 34H416 in the southern part of Brunswick increased from less than 10 mg/L to more than 270 mg/L (fig. 19). This increase may indicate either upward leakage of water from the Upper Floridan and the upper and the lower Brunswick aquifers into the surficial aquifer, or saltwater encroachment from an estuary, located about 1,200 ft west of the well. The probable cause of the high chloride concentrations at this well is upward leakage from the underlying aquifers either naturally through the semiconfining units or through a failed well casing. This assumption is supported by evidence of an upward hydraulic gradient in the area, and by the high chloride concentration in the underlying aquifers (greater than 2,000 mg/L in the Upper Floridan aquifer).

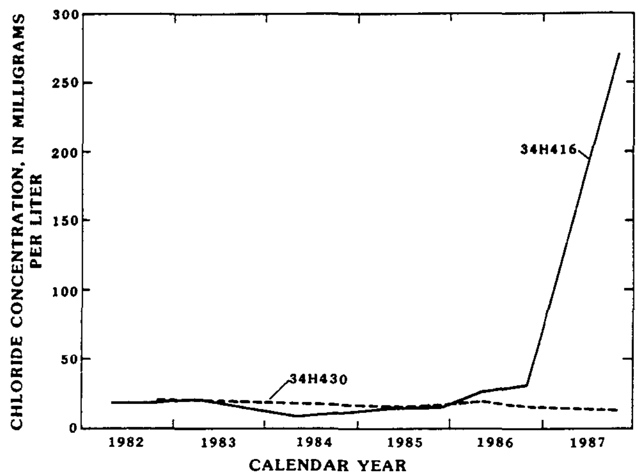


Figure 19.--Graph showing chloride concentration in the surficial aquifer at wells 34H416 and 34H430, Glynn County, 1982-87.

Chloride concentrations in the surficial aquifer in the northern part of Brunswick, at well 34H430, showed little change from 1982 to 1987 (fig. 19). Although chloride concentrations in the Upper Floridan aquifer near well 34H430 are greater than 1,500 mg/L, chloride has not contaminated the surficial aquifer in this area because the hydraulic gradient is downward, and upward leakage has not occurred.

Aquifers in Miocene Sediments

Few wells tap only the upper or the lower Brunswick aquifers, and so water-quality data are sparse. Analyses of water samples from 10 wells that tap either or both aquifers, in Bulloch, Charlton, Glynn, and McIntosh counties indicate that the water is hard to very hard (median concentration, 210 mg/L) and has relatively high concentrations of dissolved solids (median concentration, 326 mg/L), but is suitable for most uses (table 4, fig. 18). Analyses of water from four wells in the Brunswick area indicate that the water is a calcium magnesium bicarbonate type. The upper and the lower Brunswick aquifers have low median concentrations of fluoride (0.6 mg/L), calcium (39 mg/L), magnesium (26 mg/L), chloride (25 mg/L), sulfate (88 mg/L), sodium (22 mg/L), potassium (2.3 mg/L), and iron (50 ug/L) (fig. 18).

Chloride concentrations in the upper and the lower Brunswick aquifers in most of the Brunswick area met the Georgia Environmental Protection Division (1977) drinking-water standard of 250 mg/L. Chloride concentrations in the southern part of Brunswick (Bay Street area), however, exceeded the 250 mg/L limit for drinking water. Well 34H446 in the Bay Street area, taps both the upper and the lower Brunswick aquifers, and in October 1987, water from the well had a chloride concentration of 250 mg/L (appendix C). This relatively high concentration probably can be attributed to upward leakage from the underlying Upper Floridan aquifer, which contains water that has chloride concentrations in excess of 2,000 mg/L in this area.

The quality of water in the upper and the lower Brunswick aquifers may be affected by high levels of natural radioactivity associated with phosphatic zones in the Miocene units. Analyses of radioelements in ground water from the upper and the lower Brunswick aquifers in the study area are not available. However, analyses of water samples from wells that tapped phosphatic water-bearing zones that are lithologically and stratigraphically similar to the upper and the lower Brunswick aquifers in Wheeler, Ben Hill, Tift, and Montgomery Counties northwest of the study area, indicated radioelement levels exceeded State drinking-water standards. Levels of combined radium-226 and radium-228, and gross alpha particle activity in the wells exceeded EPA and State drinking-water standards (Clarke and McConnell, 1987). Analyses of core samples from well 37Q186 at Hutchinson Island, Chatham County (pl. 2), and from well 31K002, Wayne County indicated that these phosphatic zones contained small amounts of the radioelements potassium-40, lead-212, bismuth-214, lead-214, radium-226, uranium-235, and uranium-238. In addition, gamma-spectral logs from four wells in the coastal area indicated the presence of uranium-238 daughter products in the Miocene sediments (T.A. Taylor, U.S. Geological Survey, oral commun., 1987).

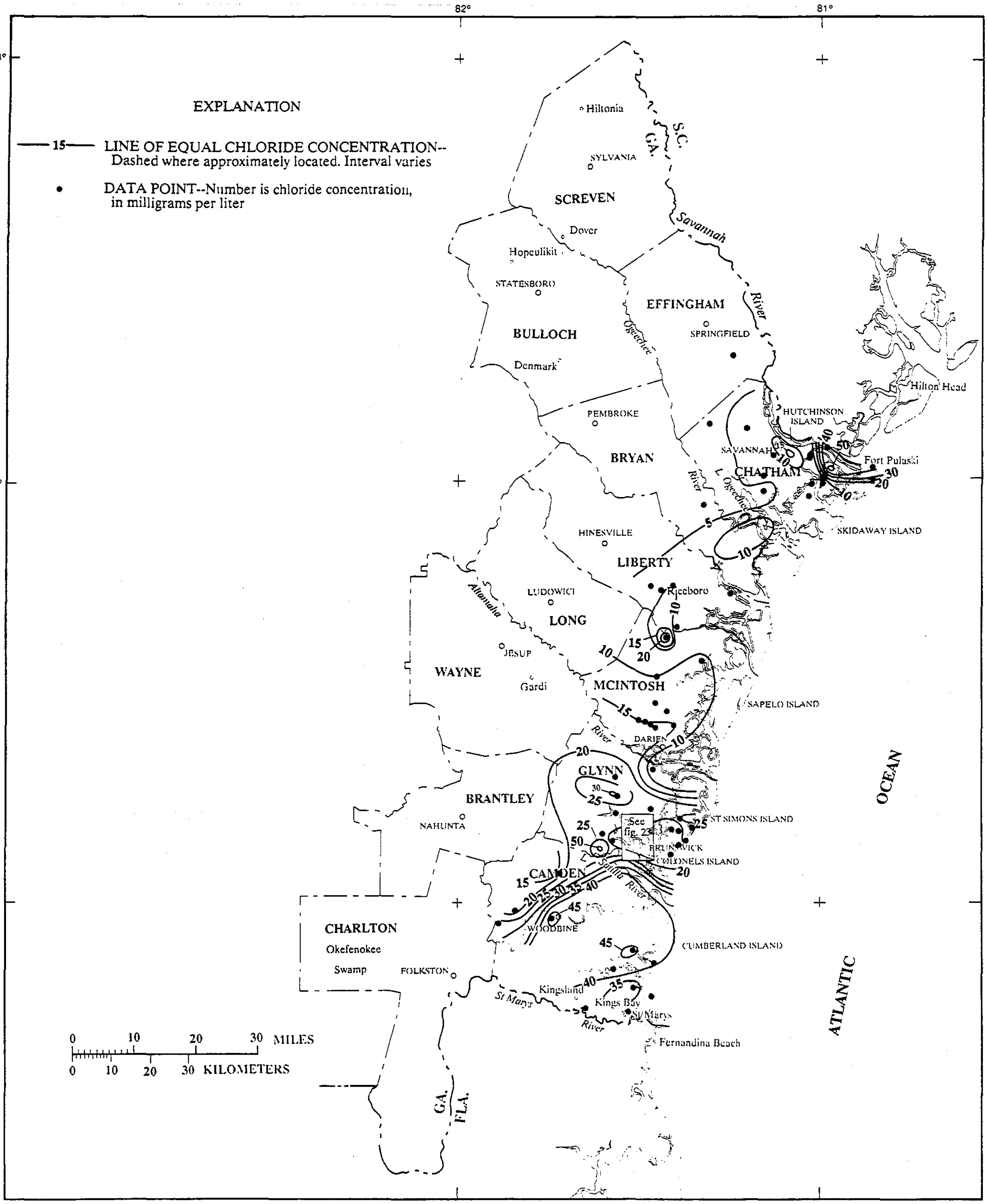
Floridan Aquifer System

Analyses of water samples from 75 wells indicate that over most of the coastal area, the Upper Floridan aquifer yields a calcium magnesium bicarbonate type water that is suitable for most uses. In part of the Brunswick area, the quality of water has been degraded by intrusion of saline water from deep zones. The boxplots of selected chemical constituents for the Upper Floridan aquifer, shown in figure 18, represent ambient water-quality conditions, that is, the plots were made using analyses of water samples only in areas where the quality of water has not been degraded by human activities. Thus, analyses in the area of chloride contamination in Brunswick have been excluded from the boxplots. The boxplots indicate that water in the Upper Floridan aquifer ranges from soft to very hard (median concentration, 125 mg/L), and has low median concentrations of fluoride (0.55 mg/L), calcium (27.5 mg/L), magnesium (14.75 mg/L), chloride (11 mg/L), sulfate (33 mg/L), sodium (17.75 mg/L), dissolved solids (215 mg/L), potassium (2.78 mg/L), and iron (30 μg/L).

Water-quality information for the Lower Floridan aquifer is limited. Locally, in parts of the Brunswick area, water in the upper part of the Lower Floridan is brackish (brackish-water zone). Underlying the brackish water is a zone of relatively fresh water called the deep freshwater zone by Gregg and Zimmerman (1974, p. D13). Underlying the deep freshwater zone is the Fernandina permeable zone. Water from the Fernandina permeable zone does not meet State drinking-water standards throughout its areal and vertical extent. Analyses of water from well 33H188 in Glynn County and well 37P113 in Chatham County indicate that the water from the lower Floridan is very hard, alkaline, and a sodium chloride or calcium magnesium chloride type that is high in dissolved solids (table 4). Water from the aquifer contains concentrations of chloride, sulfate, dissolved solids, and manganese that exceed Georgia Environmental Protection Division recommended limits and standards for safe drinking water (1977). Dissolved constituents generally increase in concentration with depth.

Chloride Concentration

Water samples from 148 wells that tap the Upper Floridan aquifer were collected in November 1984, and were analyzed for chloride and specific conductance (appendix C). A map showing the distribution of chloride concentrations was prepared from these analyses (fig. 20). Because of vertical differences in water quality, analyses used to prepare the map were limited to those for the upper water-bearing zone in the Brunswick area, and the uppermost part of the aquifer that consists of the Oligocene unit and the upper Eocene unit in the Savannah area.



Base from U.S. Geological Survey, State base map 1:1,000,000, 1970

Figure 20.--Chloride concentrations in the Upper Floridan aquifer in the coastal area, October-November 1984.

Chloride concentrations in the Upper Floridan in most of the coastal area are less than 40 mg/L. Chloride concentrations are relatively low because, in most places, the aquifer (1) is deeply buried, (2) is overlain by a confining unit of low permeability, (3) has sufficient hydraulic head to prevent landward migration of the freshwater-saltwater interface (saltwater encroachment), and (4) flow was sufficiently active to flush out connate water.

Water from the Lower Floridan aquifer is saline and unsuitable for human consumption in much of the study area. For example, the chloride concentration of water from the Fernandina permeable zone in well 33H188 in Glynn County, ranged from 20,000 mg/L in the upper part (Gill and Mitchell, 1979) to 30,000 mg/L in the lower part (Krause and Randolph, 1988). The source of the high chloride concentrations is incomplete flushing of connate water in the rocks rather than saltwater encroachment (Gill and Mitchell, 1979; Krause and Randolph, 1989).

Locally, chloride concentrations in the Lower Floridan aquifer are less than the 250 mg/L drinking-water standard. For example, at well 34H436 in Brunswick, the chloride concentration in water from the upper part of the Lower Floridan is 31 mg/L (appendix C). The lower concentrations may be the result of greater flushing of the aquifer owing to its high permeability.

Improperly constructed or abandoned wells with ruptured well casings can cause higher chloride concentrations, which may account for some of the locally higher concentrations in the Upper Floridan, especially in areas of minimal pumping (fig. 20). An example of the effect that an improperly constructed well can have on chloride concentrations is illustrated by the chloride graph for well 33G001 in western Glynn County (fig. 21). Well 33G001 was drilled in March 1954 to a total depth of 2,050 ft, cased to 694 ft, and completed as an open hole for oil-test purposes. When originally constructed, the well tapped both the Upper Floridan and the Lower Floridan aquifers. Because of an upward head gradient in the area, saline water from the Lower Floridan aquifer flowed up the well bore and discharged to the Upper Floridan, which resulted in an anomalously high chloride concentration in the Upper Floridan near the well (fig. 20). In October 1982, the well was modified to tap only the Upper Floridan by plugging the borehole from 1,457 to 1,482 ft. Prior to modification, in April 1982 the well yielded water having a chloride concentration of 2,385 mg/L (fig. 21). Following modification, in October 1982 the chloride concentration decreased to 220 mg/L, and by October 1986 the concentration decreased to 51 mg/L. The decrease in concentration after well modification was attributed to isolation of the Upper Floridan aquifer and its flushing by lateral freshwater flow. Gregg and Zimmerman (1974) reported that similar problems associated with well construction occurred at the Babcock and Wilcox Inc., and Hercules Inc., well fields, and at the Massey oil-test well (33G003), southwest of Brunswick.

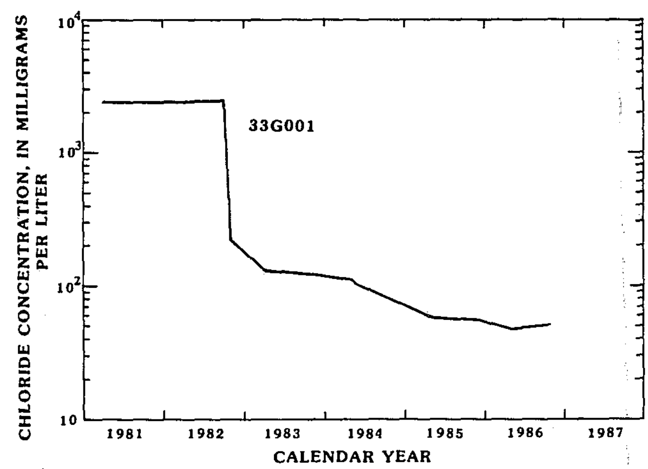


Figure 21.--Chloride concentration in the Upper Floridan aquifer at well 33G001, Glynn County, 1978-87.

Saltwater has the potential to enter the Upper Floridan aquifer in the Savannah area by encroachment from the sea or by upward leakage from deeper zones. McCollum and Counts (1964, p. D16-D20) reported that chloride concentrations in the Upper Floridan aquifer are high to the east and northeast of the center of pumping in Savannah. Chloride concentrations greater than 2,500 mg/L were reported by McCollum (1964) at Parris Island, S.C., about 30 mi northeast of Savannah, Ga. McCollum and Counts (1964, p. D19) estimated that at a pumping rate of 62 Mgal/d it would take about 400 years for saltwater from the Parris Island, S.C., area to reach the pumping center at Savannah, Ga. Clarke and others (1985) reported that in the Upper Floridan there had been no substantial increase in chloride concentrations in water samples collected in wells in the Savannah area during the past

20 years. The chloride graphs in figure 22 indicate that chloride concentrations in the Upper Floridan aquifer are relatively stable.

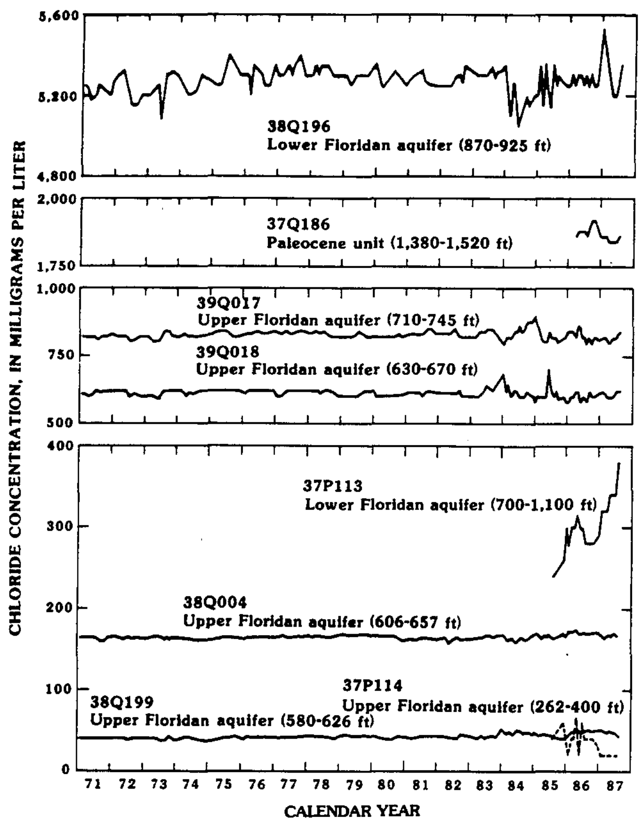


Figure 22.--Chloride concentration in the Upper and Lower Floridan aquifers and the Paleocene unit in the Savannah area, 1971-87.

Although saltwater encroachment has not inhibited use of the Upper Floridan aquifer in the Savannah area, a digital ground-water model developed by Randolph and Krause (1984) indicated that a 25-percent increase in pumping in the Savannah area could result in a 30-ft water-level decline at the center of pumping at Savannah. A decline of this magnitude would lower the potentiometric surface of the Upper Floridan aquifer to about 150 ft below sea level, thus increasing the potential for saltwater intrusion. Current pumpage at Savannah is about 70 Mgal/d, and the water level in the Upper Floridan aquifer is about 120 ft below sea level at the center of the cone.

The chloride graphs shown in figure 22 also indicate that chloride concentrations generally increase with depth in the Savannah area. For example, well 38Q199 taps the Upper Floridan between the depths of 580 to 626 ft, and yields water having a chloride concentration of about 50 mg/L. Well 38Q196 taps the Lower Floridan between the depths of 870 to 925 ft, and yields water having a chloride concentration of about 5,200 mg/L. Well 38Q201 (graph not shown) taps units of Paleocene and Late Cretaceous age underlying the Lower Floridan aquifer between the depths of 1,358 to 1,546 ft, and yields water having a chloride concentration of about 18,000 mg/L. The increase in chloride concentration with depth probably is attributed to incomplete flushing of the aquifer, possibly because of the lower permeability of the deeper zones and their greater distance from the recharge area.

To determine the water-quality distribution with depth at Skidaway Island (pl. 2), a fluid-resistivity log was run, and grab samples were collected at well 37P113 (table 4). The 1,100-ft-deep well is cased to a depth of 700 ft and completed as an open hole in the Lower Floridan aquifer. The fluid-resistivity log indicated that the highest resisitivity (freshest water) occurred just below the casing between the depths of 715 to 720 ft (pl. 2). A sharp decrease in resistivity from 725 to 745 ft, which continues (although less pronounced) to about 800 ft, marked the approximate position of a freshwater-brackish water interface. From 800 to 1,100 ft there was little, if any, change in resistivity, which indicated no change in chloride concentration. A similar decrease in resistivity was observed on the 16-in. formation-resistivity log between 710 and 740 ft.

The top of the Lower Floridan aquifer in well 37P113 is 610 ft below land surface. Water samples collected from the well at discrete depths of 715 ft and 1,070 ft contained chloride concentrations of 180 and 5,000 mg/L, respectively, which indicated that the upper 115 to 135 ft of the Lower Floridan contained relatively fresh water. However, the low permeability of the uppermost part of the Lower Floridan and the potential for upward movement of brackish water from deeper zones makes pumping from this zone undesirable. Water samples collected from the open interval 700 to 1,100 ft had chloride concentrations that increased from 240 mg/L in 1985 to 380 mg/L in 1987 (fig. 22). This is the only well in the Savannah area that has shown an increase in chloride concentration, which may indicate that water from deeper zones is moving upward as a result of pumping in the area. The relatively low concentration for the entire open interval, when compared to the 5,000 mg/L grab sample collected at 1,070 ft, may result from either freshwater dilution, or from the possibility that the grab sample was obtained from a low-permeability zone that contributed little to the total yield of the well.

The freshwater-brackish water transition zone in well 37Q186 at Hutchinson Island (pl. 2) was estimated to be at about 900 ft below land surface, based on the response of the 16-in. formation-resistivity log. The estimate was based on the assumption that, given similar lithologic properties, the formation-resisitivity log would show a similar decrease in resistivity at the saltwater interface, as was observed at the Skidaway Island site (pl. 2). Analyses of water samples collected from the completed well (open interval 1,380 to 1,520 ft) showed chloride concentrations of about 1,800 mg/L during 1986-87 (fig. 22).

The Upper Floridan aquifer in the Brunswick area has been intruded by saline water, which has rendered the aquifer unfit for most uses over an area of a few square miles. A map showing the chloride concentration in the upper water-bearing zone of the Upper Floridan aquifer in the Brunswick area for October-November 1984 was modified from Clarke and others (1985, p. 141) based on new information obtained from test wells (fig. 23).

Chloride concentrations in the upper water-bearing zone of the Upper Floridan aquifer in the Brunswick area (fig. 23), have been affected by ground-water pumping that has resulted in water-level declines of as much as 25 to 65 ft since the late 1800's. These declines have allowed saline water (20,000 to 30,000 mg/L dissolved chloride) from the Lower Floridan aquifer to migrate upward into water-bearing zones of the Upper Floridan aquifer at three known locations, and to move downgradient toward centers of pumping (fig. 23).

Chloride concentrations in the upper water-bearing zone in the Bay Street and north Brunswick areas have increased to more than 2,000 mg/L. According to Gill and Mitchell (1979), the source of saline water--determined during drilling of test well 26 (33H188) on Colonels Island--is a cavernous limestone at 2,140 to 2,720 ft below land surface, which is part of the Fernandina permeable zone of the Lower Floridan aquifer. Upward movement of saline water from this zone has been facilitated by the natural, upward hydraulic gradient that has increased as a result of pumping from the Upper Floridan aquifer by industrial users in the area.

The presence of fractures and suspected faults in the rock probably provide pathways for the movement of water between water-bearing zones in the Floridan aquifer. Gregg and Zimmerman (1974) reported that localized contamination of the upper and the lower water-bearing zones in the Bay Street area indicated that there was a narrow zone of high vertical permeability that allowed saline water to move upward near and probably south of well 34H337. Krause and Randolph (1988) described the vertical intrusion as occurring through localized conduits, with lateral migration of contaminated water occurring along discrete, narrow zones. The areas of chloride contamination correspond to the locations of several structural features previously described. The east-west orientation of the chloride plume corresponds to the orientation of a major structural arch at Brunswick (feature 3, fig. 2); the area of high concentration at Bay Street corresponds to a small dome; and the area outside the chloride plume, in the southern part of the Brunswick penninsula, where chloride concentrations exceed 50 mg/L, corresponds to a major structural depression (feature 2, fig. 2). High-angle, vertical fractures associated with these features may provide a pathway for the migration of chloride from deep zones. The "T-shape" orientation of the chloride plume and the abrupt change in concentration over a short distance may be evidence of the effects of fractures and possible faults on the aquifer and not simple upconing. Maslia and Prowell (1989) discuss the impacts of inferred faults on the ground-water flow systems at Brunswick. Krause and Randolph (1989) provide a detailed discussion of saltwater intrusion in the Floridan aquifer system in the area.

Changes in chloride concentrations in the Upper Floridan aquifer in the contaminated area of Brunswick (fig. 23) are attributed to the changing distribution of local pumping that shifts ground-water gradients, which in turn, alters the direction of chloride migration. For example, chloride concentrations in the upper and the lower water-bearing zones in the Bay Street area generally increased during 1971-75 and decreased

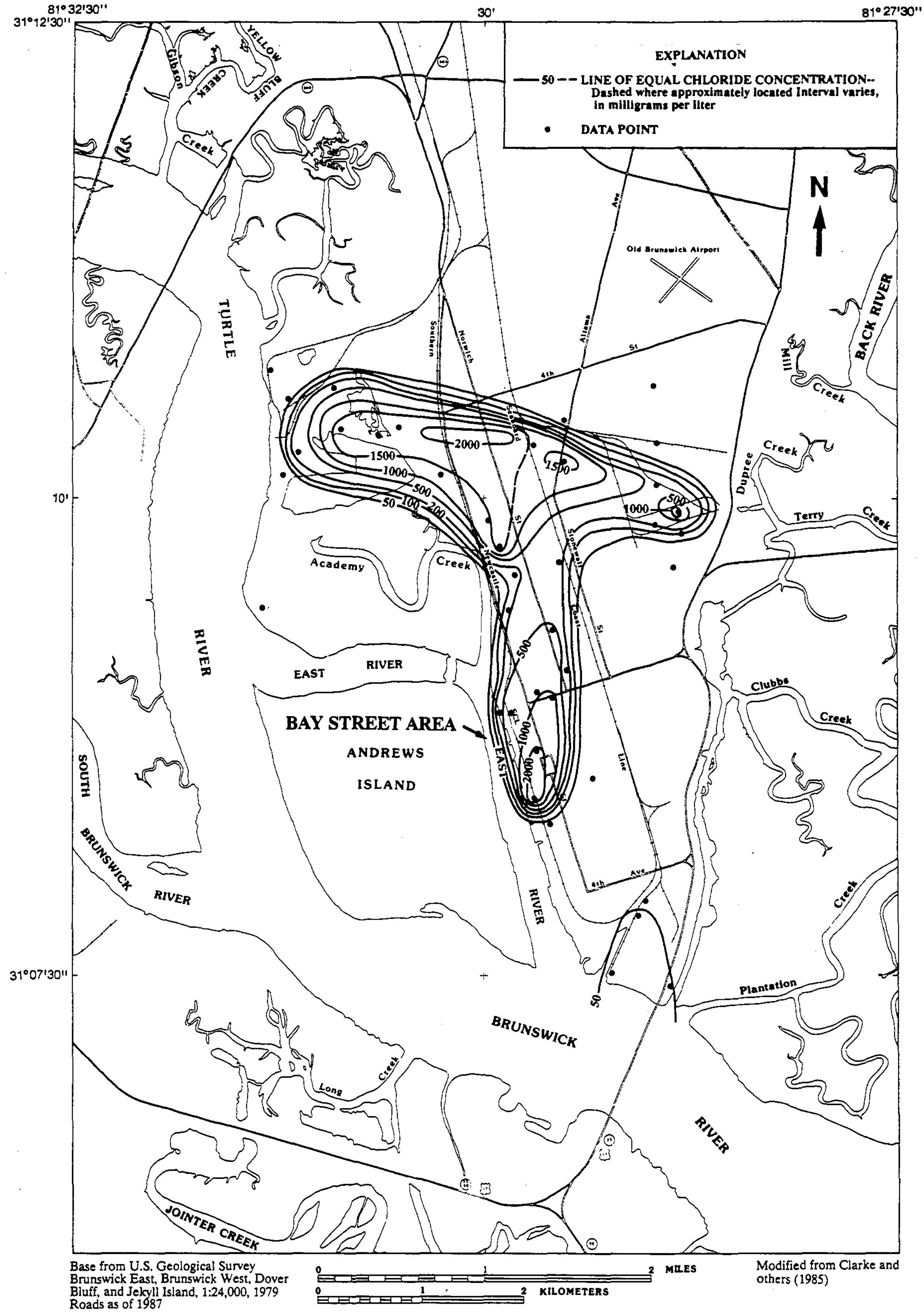


Figure 23.--Chloride concentrations in the upper water-bearing zone of the Upper Floridan aquifer in the Brunswick area, October-November 1984.

during 1976-87 (fig. 24). Chloride concentrations in the brackish-water zone in the Bay Street area generally increased during 1971-82 and decreased during 1982-87. The large fluctuation in chloride concentrations during the 1970's reflect changes in pumping in the Bay Street area. Following the 1970's, pumping in the area was reduced substantially, and the magnitude of the fluctuations decreased. The chloride concentration in the upper water-bearing zone in the north Brunswick area at well 33H133 increased during 1971-87, and at well 34H132 increased during 1971-83 and decreased during 1983-87 (fig. 25). Concentrations in the lower water-bearing zone showed a slight increase during 1971-87. These fluctuations are a result of changes in the distribution of pumping between the two largest industrial users in the area; pumping from each water-bearing zone changes periodically.

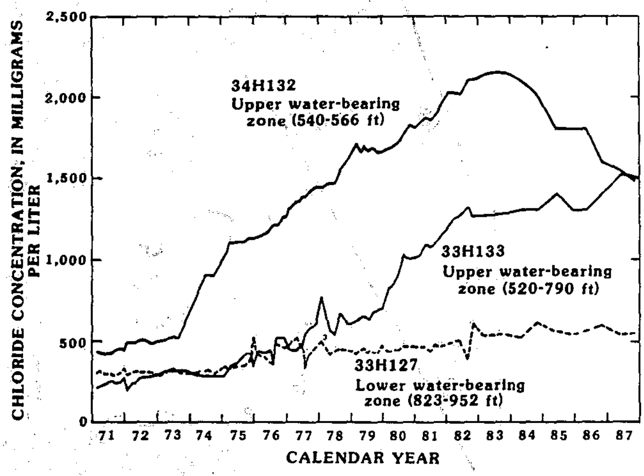


Figure 25.--Chloride concentration in the upper and lower water-bearing zones of the Upper Floridan aquifer in the north Brunswick area, 1971-87.

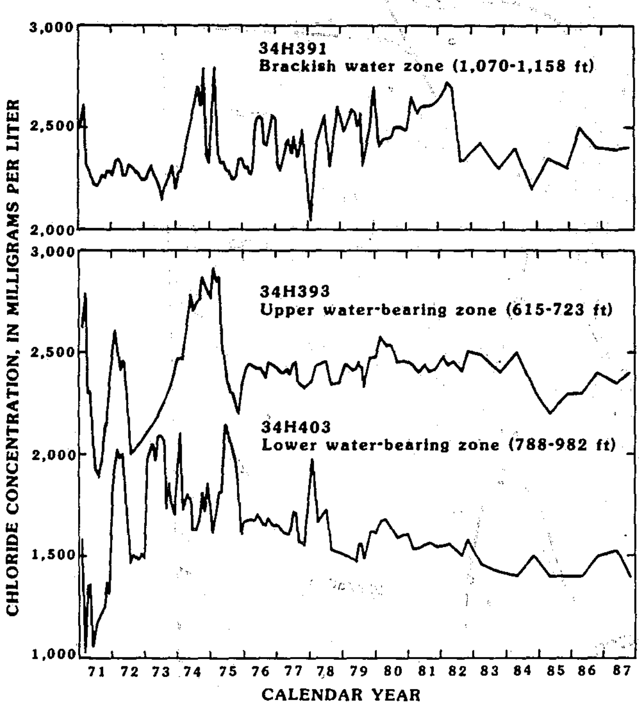


Figure 24.--Chloride concentration in the brackish-water zone of the Lower Floridan aquifer, and in the upper and lower water-bearing zones of the Upper Floridan aquifer in the Bay Street area of Brunswick, 1971-87.

Under conditions of diffuse upconing of saline water, chloride concentrations would be expected to increase with depth, which is the case in the uncontaminated area of Brunswick. However, data for the contaminated area of Brunswick (figs. 24, 25) indicate that chloride concentrations decrease with depth. Upconing would imply that the highest chloride concentrations in the water would be directly beneath the pumped wells in the area(s) of greatest ground-water pumping. However, the highest chloride concentrations are more than 10,000 ft south of the areas of greatest withdrawals in Brunswick (fig. 23). Consequently, contamination due to simple upconing below pumped wells is not the mechanism by which high-chloride water is contaminating the freshwater zones of the Upper Floridan aquifer in the Brunswick area (Maslia and Prowell, 1989). Higher concentrations in the upper water-bearing zone in the contaminated area may indicate that fractures, possible faults, or other localized zones of high vertical permeability have facilitated movement of water into the currently pumped upper water-bearing zone.

SUMMARY AND CONCLUSIONS

Ground-water is the principal source of water in the 13-county coastal area of Georgia. During 1986, more than 273 Mgal/d was withdrawn from aquifers of early Eocene to post-Miocene age, primarily from the Upper Floridan aquifer of late Eocene and Oligocene age. Ground-water withdrawals since the late 1800's have resulted in water-level declines and localized occurrences of saltwater encroachment in the Savannah area, and upward movement of highly mineralized connate water in the Brunswick area.

Geologic units in the 10,000 mi^2 coastal area consist mainly of limestone, dolomite, and unconsolidated sand and clay that range in age from lower Cretaceous through Holocene. Rocks of upper Eocene to Oligocene age are predominantely carbonates, whereas younger rocks are mostly clastic. Units of Miocene, Oligocene, and late Eocene age are delineated throughout the coastal area from four geophysical markers termed the A, B, C, and D markers. Formations of Paleocene to Holocene age that have similar lithologies and equivalent stratigraphic positions, or both, were grouped into informal time-rock units that may include all or parts of several formations. Geologic units in the study area include, in ascending order; the Paleocene unit, the early Eocene unit, the middle Eocene unit, the late Eocene unit, the Oligocene unit, Miocene units C, B, and A, and the post-Miocene unit.

Units of late Eocene through Miocene age in the coastal area generally dip from north to south and strike from southwest to northeast. The major structural feature in the study area is the Southeast Georgia Embayment, an east- to northeast-plunging synclinal feature that extends from northeastern Florida into southeastern Georgia and offshore. Eight local structural features were identified in addition to the Southeast Georgia Embayment. These domal, arch, trough, and depression features may be associated with high-angle faults that bound horsts and grabens.

The principal source of ground water in the coastal area is the Upper Floridan aquifer. Secondary aquifers include the surficial, the upper and the lower Brunswick, and the Lower Floridan aquifers.

The surficial aquifer consists of sediments of Miocene and post-Miocene age that range in thickness from less than 65 to more than 230 ft. Post-Miocene sediments consist of phosphatic, micaceous, and clayey sand containing wood fragments of Pliocene age; arkosic sand and gravel containing discontinuous clay beds of Pleistocene age; and mud, sand, and gravel of Holocene age.

The water-bearing properties of the surficial aquifer are variable as a result of vertical and lateral variations in lithology. Estimated transmissivities ranged from about 14 to 6,700 ft^2/d. Wells tapping the aquifer yield from about 2 to 180 gal/min, and primarily are used for domestic lawn irrigation, except in some rural sections where it is the principal source of drinking water. In Glynn County, the aquifer is used as an alternate source of water in the Bay Street area of Brunswick, where use of the Upper Floridan aquifer is limited by high chloride concentrations.

Water in the surficial aquifer generally occurs under unconfined or water-table conditions throughout the study area. The aquifer locally includes layers of clay that act as confining units, and the water is under confined to semiconfined conditions. The configuration of the water-table generally is a subdued replica of the land surface, and is controlled mainly by surface streams. Industrial pumping at the south end of the Brunswick peninsula has resulted in the development of a cone of depression in the potentiometric surface of the lower semiconfined zone of the aquifer.

The surficial aquifer is vulnerable to surface contamination because the upper part of the aquifer is unconfined and is overlain by a sandy overburden. The lower part of the aquifer locally is semi-confined by clay beds that restrict the downward movement of contaminants. The aquifer is susceptible to saltwater encroachment in areas near the coast, tidal rivers, or estuaries where the water level in the aquifer is at or below sea level.

Water from the surficial aquifer is soft to very hard, low in dissolved solids, and suitable for most uses. Upward leakage from underlying aquifers through semiconfining units or through failed well casings, has resulted in elevated chloride levels in the Bay Street area of Brunswick.

Two Miocene depositional sequences form the upper and the lower Brunswick aquifers. Each sequence forms a geologic unit that consists of a basal carbonate layer, a middle clay layer, and an upper sand layer. The units are, in ascending order, Miocene unit C and unit B. The upper Brunswick aquifer consists of the upper sand layer of Miocene unit B, and ranges in thickness from about 20 ft in the Savannah area to 150 ft near Gardi in Wayne County. The lower Brunswick aquifer consists of the upper sand layer of Miocene unit C, and ranges in thickness from 36 ft near Gardi to 70 ft in the Brunswick area. The lower Brunswick aquifer is absent in the Savannah and Bulloch County areas.

Reported well yields for the upper and the lower Brunswick aquifers range from 3 to 180 gal/min. The transmissivity of the lower Brunswick aquifer ranges from about 1,370 to 4,700 ft^2/d, and the hydraulic conductivity ranges from about 20 to 57 ft/d, with an average of 38 ft/d. Estimated values of transmissivity for the upper Brunswick aquifer range from 680 ft^2/d where the aquifer is thinnest, to 5,700 ft^2/d where the aquifer is thickest. Most wells that withdraw water from the aquifers are multi-aquifer wells that also tap the deeper Upper Floridan aquifer. In the Bay Street area of Brunswick, high chloride concentrations in water from the Upper Floridan aquifer necessitated the use of the surficial and the upper and the lower Brunswick aquifers as alternate water supplies.

The upper Brunswick aquifer is confined above by dense phosphatic limestone or dolomite, and phosphatic silty clay of Miocene unit A. The confining unit ranges in thickness from 15 ft in northern Bulloch County to 70 to 90 ft in the Brunswick area. The reported vertical hydraulic conductivity of the confining unit in the Brunswick area ranges from 5.3×10^{-5} to 1.3×10^{-4} ft/d.

The upper and the lower Brunswick aquifers are separated by a confining unit that consists of silty clay and dense, phosphatic limestone or dolomite of Miocene unit B. The confining unit ranges in thickness from about 10 ft in Wayne County to about 50 ft in the Brunswick area.

Fluctuations and trends in water levels in the upper and the lower Brunswick aquifers are similar, and they primarily respond to seasonal climatic changes, although regional pumping also has some influence. In some places where the aquifers are deeply buried and where they are near sites of pumping from the Upper Floridan, such as near Coffin Park, Glynn County, water levels respond to the pumping.

Water from the upper and the lower Brunswick aquifers is hard to very hard, calcium magnesium bicarbonate type that is relatively high in dissolved solids, but is suitable for most uses. Chloride concentrations generally meet State and Federal drinking-water standards; however, the concentration in one well in the Bay Street area of Brunswick exceeded standards, possibly owing to upward leakage from the underlying Upper Floridan aquifer.

The upper and the lower Brunswick aquifers are vulnerable to saltwater encroachment near a submarine escarpment in Miocene sediments that was filled with permeable sand and gravel of Pliocene age west of the barrier islands along the coast and south of Savannah. The hydraulic head of the aquifers is above sea level over most of the study area, and water from the aquifers is discharged into the sea in the vicinity of the escarpment. If the hydraulic gradient were reversed because of increased withdrawals and associated water-level declines in the aquifers, saltwater encroachment could occur.

The quality of water in the upper and the lower Brunswick aquifers may be affected by high levels of natural radioactivity in phosphatic sediments of the Miocene units. Analyses of core samples indicated that the sediments contain low concentrations of potassium-40, lead-212, bismuth-214, lead-214, radium-226, uranium-235, and uranium-238.

Sediments of the Oligocene unit and upper Eocene unit form the Upper Floridan aquifer. Upper Eocene sediments in the study area primarily consist of the Ocala Limestone, a massive fossiliferous limestone. Oligocene sediments consist of buff-colored, porous limestone that contains nonparticulate, amorphous phosphate, and unconformably overlies upper Eocene limestone. Oligocene sediments are absent in western and southern Camden County. The Upper Floridan aquifer ranges in thickness from less than 200 ft in Effingham County to more than 700 ft in southeastern Camden County.

In the coastal area, the Upper Floridan aquifer consists of several water-bearing zones. These water-bearing zones are bounded above and below by low permeability layers of dense limestone or dolomite, which act as semiconfining units.

Transmissivity of the Upper Floridan aquifer ranges from less than 10,000 ft^2/d to more than 500,000 ft^2/d. An aquifer test conducted at Brunswick indicated that the transmissivity of the upper water-bearing zone ranged from about 33,000 to 40,000 ft^2/d, and the storage coefficient ranged from 4.7×10^{-4} to 5.7×10^{-4}.

The Upper Floridan is confined above by silty clay and dense phosphatic limestone or dolomite of Miocene unit C. The confining unit ranges in thickness from about 20 ft in Wayne County to 40 ft in the Brunswick area. The reported vertical hydraulic conductivity of the confining unit at Brunswick, determined from laboratory analysis of undisturbed cores, ranges from 1.1×10^{-2} to 1.7 ft/d. In the Savannah area and in Bulloch County, the aquifer is confined above by silty clay and dense phosphatic limestone or dolomite of Miocene unit B and Miocene unit C. The lower Brunswick aquifer is absent in these areas, and the confining unit above the Upper Floridan ranges in thickness from about 14 to 120 ft. In the Savannah area, the reported vertical hydraulic conductivity of the confining unit ranged from 5.3×10^{-5} to 1.3×10^{-2} ft/d.

The potentiometric surface of the Upper Floridan aquifer is characterized by a general coastward gradient interrupted by a series of cones of depression caused by pumping. The cones of depression are at the pumping centers of Savannah, Jesup, Brunswick, and St Marys, Ga.-Fernandina Beach, Fla. Ground-water withdrawals have resulted in substantial water-level declines; 120 ft below sea level at Savannah, and 10 ft below sea level at Brunswick.

The Upper Floridan aquifer is deeply buried in the coastal area and is far from its outcrop area, thus ground-water levels are not influenced directly by contemporaneous precipitation. Water levels are affected by increased withdrawals that occur during hot, dry periods. In the northwestern part of the study area, where the aquifer is less deeply buried, close to its recharge area, and distant from pumping centers, water levels respond less to pumping along the coast, and more to local precipitation changes and local pumping.

The Upper Floridan aquifer yields a calcium magnesium bicarbonate type water that is suitable for most uses. Chloride concentrations are less than 40 mg/L over most of the coastal area, primarily because the aquifer (1) is deeply buried, (2) is overlain by a relatively impermeable confining unit, (3) has sufficient hydraulic head to prevent saltwater encroachment, and (4) flow has been sufficiently active to flush out connate water. Locally, chloride concentrations are above background levels, and in the Brunswick area, concentrations exceed State drinking-water standards. The higher concentrations are attributed to improperly constructed or abandoned wells and upward movement of highly mineralized water.

Saltwater has the potential to enter the Upper Floridan aquifer in the Savannah area by encroachment from the sea or by upward leakage from deeper zones. Chloride concentrations in the Savannah area have not increased during the past 20 years. Chloride concentrations generally increase with depth in the Savannah area as a result of incomplete flushing of the aquifer, possibly because of the lower permeability of deeper zones and their greater distance from the recharge area.

Chloride has intruded the Upper Floridan aquifer in parts of the Brunswick area, rendering water from the aquifer unfit for most uses. Ground-water pumping resulting in water-level declines, and a natural upward hydraulic gradient has allowed high-chloride water from the Lower Floridan aquifer to migrate upward. Areas of chloride contamination correspond to several structural features. High-angle vertical fractures and possible faults associated with the features may provide pathways for the upward migration of chloride.

The confining units above and beneath the Upper Floridan aquifer are leaky, and water may naturally migrate between the Upper Floridan and shallower or deeper aquifers. Leakage rates and volumes are dependant on the thickness and hydraulic conductivity of the confining unit, and the head difference between the aquifers. The potential for leakage is greatest where the intervening confining unit is thinnest, has the greatest hydraulic conductivity, and has the greatest vertical hydraulic gradient. Estimated rates of leakage per square foot of area between the surficial and the upper Brunswick aquifers ranged from 6.2×10^{-6} ft^3/d (4.6×10^{-5} gal/d) at Brunswick in Glynn County, to 3.6×10^{-5} ft^3/d (2.8×10^{-4} gal/d) at Gardi in Wayne County.

Potential downward leakage from the surficial aquifer to the Upper Floridan is greatest in Bulloch County, where the confining units between the surficial and upper Brunswick aquifers are thinnest, and where the downward hydraulic gradient between the surficial and the Upper Floridan aquifers is greatest. A high potential for leakage also exists in other upland areas along the western part of the study area, and near the pumping centers at Savannah and Brunswick, where there are large, downward hydraulic gradients.

Sediments of the middle and lower Eocene units form the Lower Floridan aquifer. The lower Eocene unit consists of glauconitic limestone and dolomite, and the middle Eocene unit mainly consists of glauconitic dolomite and limestone. The aquifer includes coarsely pelletal, vuggy, commonly dolomitized limestone of the Paleocene unit and units of Late Cretaceous age in the Brunswick area. The Lower Floridan ranges in thickness from less than 100 ft in the northern part of the study area, to nearly 2,500 ft locally in the Brunswick area.

The Lower Floridan contains low-permeability zones that act as semiconfining units, and that locally, divide the aquifer into separate permeable zones. In the Brunswick area, the aquifer consists of the brackish-water zone, the deep freshwater zone, and the Fernandina permeable zone.

The estimated transmissivity of the Lower Floridan aquifer ranges from 2,000 to 216,000 ft^2/d over most of the Coastal area. The permeability of the Lower Floridan generally decreases to the west and north of Brunswick, and is extremely low in the Savannah area where the estimated transmissivity is less than 100 ft^2/d. The Lower Floridan is not widely used for water supply in coastal Georgia because it is deeply buried, and it contains saline water in much of its area of occurrence.

The Lower Floridan aquifer is semiconfined above by dense dolomitic limestone of the middle Eocene unit that ranges in thickness from about 40 ft in northern Bulloch County and in Brunswick, to about 160 to 280 ft in the Savannah area. The semiconfining unit has variable hydraulic properties in the Brunswick area. The vertical hydraulic conductivity at Brunswick ranged from 4.0×10^{-6} to 5.4×10^{-5} ft/d. Although the unit has a very low hydraulic conductivity developed from interstitial openings, joints and fractures in the rock have produced zones of substantially higher secondary hydraulic conductivity.

The Lower Floridan aquifer is confined below by argillaceous to arenaceous rocks of the Paleocene unit. The Fernandina permeable zone of the Lower Floridan is confined above by microcrystalline, locally gypsiferous dolomite and finely pelletal micritic limestone of early and middle Eocene age. The confining unit overlying this zone contains fractures in the Brunswick area, along which saline water moves upward into shallower, heavily pumped zones. The estimated transmissivity of the confining unit below the aquifer at Savannah was about 10 to 60 ft^2/d.

The water level in the Lower Floridan aquifer primarily is influenced by pumping from both the Upper and the Lower Floridan aquifers. Withdrawal of water from the Upper Floridan induces upward leakage from the Lower Floridan. Water levels in zones underlying the Floridan aquifer system in the Savannah area seem to respond to local pumping from the Floridan or from other aquifers of equivalent age outside the Savannah area, or both.

Water from the Lower Floridan aquifer is very hard, alkaline, and high in dissolved solids. Concentrations of chloride, sulfate, dissolved solids, and manganese exceed State drinking-water standards. Dissolved constituents generally increase in concentration with depth. Fluid-resistivity logs at Skidaway Island indicate that the upper part of the aquifer contains relatively fresh water, but low permeability and the potential for upward movement of brackish water makes pumping from this zone undesirable.

The head in the Lower Floridan aquifer is higher than in the Upper Floridan aquifer over most of the coastal area, and the vertical hydraulic gradient is upward. The hydraulic gradient between the Lower Floridan aquifer and underlying units is downward in part of Chatham County, and probably is the result of the greater density of water in the deeper units owing to higher total dissolved concentrations, although regional pumping from the lower units outside the Savannah area also may have an affect.

Previous studies indicated that anomalously high ground-water temperatures occurred in the Brunswick area, which was attributed to upward leakage of water from deeper zones. During this study, geothermal gradients measured at six wells located within the cone of depression at Savannah indicate that in wells less than 700 ft deep, the gradient was lower than normal, which indicated downward flow from overlying aquifers. In wells greater than 700 ft deep, the geothermal gradient was higher than normal, which indicated upward flow. Although there was an upward component of flow, the quantities were small because of the low permeability of the intervening confining units.

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APPENDICES

APPENDIX A.--Lithologic descriptions from selected wells

[Lithologies listed in parentheses estimated from interpretation of borehole geophysical logs]

Depth (ft)	Description
	37Q186 Hutchinson Island Test Well 2, Chatham County
	POST-MIOCENE UNIT
0-8	Clayey sand, poorly sorted, calcareous, with interstitial clay. Abundant purplish-black organic material.
0-10	Clayey sand, moderately sorted, very fine to medium quartz grains.
10-16	Clayey silt, very plastic.
16-18	Silty clay, light gray.
18-25	Wood and peat material, purplish-brown with some clay and quartz sand.
25-41	No recovery.
41-44	Clayey silt, blue gray. Grades downward into a fairly clean, well-sorted, fine quartz sand.
44-54	No recovery (probably sand).
	MIOCENE UNIT A
54-55	Sand, poorly sorted with minor amounts of dark minerals and clay. Phosphate grains and fish scales present at 55 ft.
55-64	No recovery (probably sand).
64-70	Micaceous clayey silt, mostly quartz, plastic in texture, grading downward into silty clayey sand with brown, well rounded, very fine phosphate grains.
70-71	No recovery (probably sand).
71-74	Clay, fossiliferous, very fine, well-rounded, dark brown phosphate sand with some fish scales.
	MIOCENE UNIT B
74-82	Clayey silty sand, well-sorted, very fine angular quartz grains. Thin laminations of mica are present along with diatom molds and bone fragments.
82-85	Silty clay, diatomaceous, laminated, slightly phosphatic, with minor amounts of mica.
85-90	Silty sand with clay and mica. Not as well laminated as 82-85 ft and greater percentage of sand with depth.
90-98	No recovery (probably sand).
98-118	Interlaminated silty clay and clayey silt with some fish remains and diatoms increasing in phosphate and clay with depth. Clay brecciated at 114-118 ft.
118-119	Sand, very fine, angular, with some fractures in bedding.
119-124	Silty clay, phosphatic, with bone fragments and very fine to fine, rounded phosphate grains. Some diatoms present.
124-130	Clayey phosphate sand, poorly sorted with very fine, well-rounded, brown phosphate grains. Silt consists of dolomite rhombs with some quartz grains. Some quartz sand is present.
130-131	Sandy dolomite, fossiliferous, phosphatic, sugary texture. Sand very fine, well-rounded, predominantly phosphatic, brown to black. Pectens, other pelecypods and gastropods present, moldic porosity.

[Lithologies listed in parentheses estimated from interpretation of borehole geophysical logs]

Depth (ft)	Description
	37Q186 Hutchinson Island Test Well 2, Chatham County--Continued
	MIOCENE UNIT B--Continued
131-132	Dolomitic sand, argillaceous, poorly sorted, mostly brown to black phosphate grains and quartz grains.
132-133	Dolomite, very dense, non-phosphatic, sabkha type, interbedded with dolomitic sand.
133-141	No recovery (probably sand).
141-144	Dolomitic sand, phosphatic, very fine to coarse, angular to well rounded, mostly clear grains with some black to brown phosphate grains. Thin beds of dolomite occur as dense non-phosphatic layers and as very fine-sand size euhedral rhombs, similar to 132-133 ft.
144-161	No recovery (probably sand).
161-171	Dolomitic sand, slightly phosphatic, very fine to fine, clear quartz with brown well-rounded phosphate grains and silt-size dolomite rhombs, gradational into lithology of 171-201 ft.
171-201	Sandy clay, phosphatic, mostly composed of quartz sand and euhedral dolomite rhombs. Clear, angular, very fine quartz sand with well-rounded, fine to very fine, phosphate grains. The sand also occurs as laminae graditional into lithology of 201-211 ft.
201-211	Clay, phosphatic, with some very fine quartz sand and silt. Shark's tooth at 202 ft.
211-219	Limestone, fossiliferous (arenaceous, argillaceous, very phosphatic), contains large black phosphate masses with poorly-sorted sand inclusions and some microfossils, burrow-like structures with infilling of highly phosphatic material at 213 ft (base of unit B at 213 ft).
219-220	No recovery (probably limestone).
220-224	Same as 211-219 ft, except lowermost 2 ft, which appears to be about 90 percent phosphate.
	OLIGOCENE UNIT
224-226	No recovery (probably limestone).
226-238	Limestone, dense, fossiliferous, ubiquitous phosphate, blue gray, grading downward into a sandy limestone. Upper Miocene sediments filling burrow-like structures in the Oligocene material.
238-241	No recovery (probably limestone).
241-251	Sandy limestone, glauconitic with microfossils, mainly foraminifera with fine to very fine, clear quartz sand, becoming sandier with depth.
251-260	Limestone, sandy, with a trace of glauconite and some pyrite. Microfossils, mostly foraminifera, grades downward to higher sand content and greater porosity.
260-263	No recovery.
263-268	Sandy limestone, trace of fine to very fine, clear, angular quartz sand with some layers containing gastropods and pelecypods.
268-270	Limestone, fossiliferous, dense, moldic porosity increasing downward.
270-281	No recovery (probably limestone).
281-283	Limestone, fossiliferous, consisting mostly of intraclasts of well-rounded limestone with some dark minerals. Also, foraminifera and pelecypods are present.
283-285	No recovery (probably limestone).
285-295	Limestone, fossiliferous, light-colored, moldic porosity with gastropods and foraminifera (miliolids).
295-297	Limestone, fossiliferous, sugary texture with very fine, sand-size euhedral calcite. Ostracods, bryozoans and foraminifera are present.

[Lithologies listed in parentheses estimated from interpretation of borehole geophysical logs]

Depth (ft)	Description
	37Q186 Hutchinson Island Test Well 2, Chatham County--Continued
	OLIGOCENE UNIT--Continued
295-301	No recovery (probably limestone).
310-315	Not cored.
315-316	No recovery (probably limestone).
316-320	Limestone, fossiliferous, buff-colored, sugary texture. Pelecypods, coral, foraminifera, and ostracods present, with a slight trace of phosphate and some very large vugs.
320-322	No recovery (probably limestone).
	UPPER EOCENE UNIT
322-329	Limestone, fossiliferous, hard, dense consisting mostly of bioclasts of bryozoans and echinoid spines with foraminifera.
329-335	No recovery (probably limestone).
	34E001 Cumberland Island Test Well 1, Camden County
	POST-MIOCENE UNIT
0-96	Core not available for examination.
96-100	Clayey dolomite with sand consisting of very fine to medium, angular to subangular quartz and very fine to fine, subrounded, black phosphate grains. Phosphate occurs ubiquitously in dolomite.
100-104	No recovery (probably sand).
104-107	Sandy dolomite, euhedral rhombs with poorly-sorted, fine to medium quartz sand. Phosphatic, similar to 96-100 ft.
107-110	No recovery (probably sand).
110-112	Clayey sandy dolomite consisting of silt-size, euhedral dolomite rhombs, very fine, sub-angular, clear quartz sand, and phosphate grains. Fossils present as molds of pectens, phosphate increases in content and grain size from sand to pebbles.
112-130	No recovery. Geophysical logs indicate 126-128 ft may be dense phosphatic dolomite similar to 112 ft. Two ft of this type lithology was recovered at top of run, and may possibly be residual material from previous zone of no recovery.
130-135	Dolomitic sand that grades downward into clayey, sandy, pebbly dolomite. Phosphate content and grain size increased downward and is fossiliferous in places similar to 104-107 ft.
135-137	No recovery (probably sand).
137-159	Phosphatic dolomite with variable amounts of quartz and phosphate sand. Lithology similar to 104-107 ft and gradational into a dolomitic sand at 159 ft, containing very fine sand-size dolomite rhombs.

[Lithologies listed in parentheses estimated from interpretation of borehole geophysical logs]

Depth (ft)	Description
	34E001 Cumberland Island Test Well 1, Camden County--Continued
	MIOCENE UNIT A
159-180	No recovery (probably sand).
180-181	Dolomitic sand similar to 159 ft.
181-191	No recovery (probably sand).
191-197	Dolomitic sand, fine to medium, subangular, clear quartz. Dolomite consists of silt to fine sand-size rhombs with clay. Phosphate grains occur as sand and pebbles, subangular to subrounded.
197-202	No recovery (probably sand).
202-204	Dolomitic sand similar to 191-197 ft. Grades downward into sandy dolomite.
204-207	Sandy dolomite similar to 137-159 ft.
207-210	No recovery (probably sand).
210-214	Sandy dolomite similar to 137-159 ft.
214-218	No recovery (probably sand).
218-219	Sandy dolomite similar to 137-159 ft.
219-224	Silty sand, dolomitic, phosphatic quartz arenite, poorly sorted, very fine to coarse, angular to subrounded, clear quartz with grains of phosphate and dolomite rhombs.
224-232	No recovery (probably sand).
232-236	Dolomite sand, very fine sand-size euhedral rhombs of dolomite and fine to very coarse quartz sand. Some phosphate grains present, and laminae of dolomite at the base of this interval.
236-250	No recovery (probably sand).
250-253	Sand, dolomitized micrite, quartz arenite, poorly sorted clear quartz with fine sand-size dolomite rhombs and some sand-size grains of phosphate. Grades downward into a sandy dolomite consisting of very fine sand-size dolomite rhombs with poorly sorted clear quartz sand. Laminae present in the dolomite.
253-254	Loose quartz granules containing silt-size dolomite rhombs.
254-259	No recovery (probably sand).
259-260	Dolomitic sand, similar to top of 250-253 ft.
260-261	Poorly-sorted quartz sand, possibly caving from upper zones.
261-263	Laminated sandy dolomite and dolomitic sand similar to 250-253 ft, except a minor amount of clay is present.
263-289	No recovery (probably sand).
289-293	Sandy dolomite, argillaceous, arenaceous, slightly phosphatic fossiliferous micrite. Dolomite occurs as silt-size rhombs with very fine to fine angular, clear quartz. Sand with phosphate also present as laminations in the dolomite. Fossils consist of diatoms and possible skeletal fish remains.
293-310	Laminated, silty, dolomitc and phosphatic clay containing molds of diatoms. Laminae are alternating layers of silty clay and clayey silt. Phosphate occurs as very fine sand-size grains. Silt consists of quartz and euhedral dolomite rhombs with some mica.
310-320	No recovery (probably clay).

[Lithologies listed in parentheses estimated from interpretation of borehole geophysical logs]

Depth (ft)	Description
	34E001 Cumberland Island Test Well 1, Camden County--Continued
	MIOCENE UNIT A--Continued
320-331	Same lithology as 293-310 ft.
331-333	No recovery (probably clay).
333-348	Same lithology as 293-310 ft.
348-360	No recovery (probably clay).
360-374	Lithology gradational from the laminated silty clay of 293-310 ft to a fossiliferous, clayey, sandy, phosphatic dolomite. Complete fossil Venus shell at 360 ft, fish teeth and bone fragments throughout. Clayey phosphorite noted at 373 ft, phosphate granules at 374 ft.
	MIOCENE UNIT B
374-375	No recovery (probably sand).
375-377	Sandy dolomite with small percentage of phosphate grains.
377-382	No recovery (probably sand).
382-386	Fossiliferous, sandy, phosphatic dolomite. Fossils are chalky fragments and molds of mollusk shells.
386-400	No recovery (probably sand).
400-404	Dolomitic sand consisting of some clay and fine to medium subangular, clear quartz, and silt to very fine sand-size dolomite rhombs, slightly phosphatic as grains and as ubiquitous occurence.
404-410	No recovery (probably sand).
410-418	Sandy, slightly phosphatic clay with silt laminae. Sand grains are very fine to fine, angular quartz containing very thin beds of possible gypsum (white spheres). This lithology is in direct contact with underlying laminated dolomitic clay.
418-432	No recovery (probably clay).
432-434	Sandy phosphatic clay. Sand is very fine, angular, clear quartz and very fine phosphate grains.
434-437	Dense, phosphatic dolomite and laminated clay. Dolomite present as silt-size rhombs. Phosphate present as very fine sand-size grains increasing in content downward.
437-440	Highly phosphatic, sandy dolomite containing phosphate pebbles and intraclasts of other lithologies. Sand grains consist of both phosphate and quartz. Dolomite occurs as silt-size rhombs.

[Lithologies listed in parentheses estimated from interpretation of borehole geophysical logs]

Depth (ft)	Description
	34E001 Cumberland Island Test Well 1, Camden County--Continued
	MIOCENE UNIT C
440-446	Clayey sand that grades downward into a sandy, laminated clay similar to 293 ft. Molds of diatoms present. Gypsum bloom on core, phosphate increases downward.
446-449	Phosphatic, sandy dolomite contains very fine to medium, angular quartz sand and rounded phosphate grains. Phosphate and clay content increase with depths, possibly some burrow-like structures present.
449-470	No recovery (probably sand).
470-475	Bioturbated, black, laminated, phosphatic and dolomitic clay that grades downward into a dense fossiliferous, phosphatic dolomite. Fossils occur as molds of gastropods and pelecypods. Quartz sand is present, very fine to fine. Dolomite occurs as silt-size rhombs.
475-480	No recovery (probably clay).
480-489	Phosphatic clay interlaminated with silty sand similar to 470 ft grading downward into a phosphatic dolomite consisting of varying amounts of sand, silt, clay, calcium carbonate and phosphate. Phosphate content greater at 486 ft. Dolomite occurs as distinct silt to mostly ery fine, sand-size euhedral rhombs; fossiliferous.
489-510	No recovery (probably dolomite).
510-515	Fossiliferous, chalky dolomite, burrowed with shark's tooth at 510 ft. Not as phosphatic as previous lithologies. Dolomite occurs as individual euhedral rhombs.
515-520	No recovery (probably dolomite).
520-524	Phosphatic dolomite similar to 489 ft.
524-531	No recovery (probably dolomite).
	OLIGOCENE UNIT
531-533	Sandy, fossiliferous, phosphatic limestone. Fossils consist of abundant miliolids. This zone appears to have been part of an old erosional surface where the limestone has been weathered to a rubble, and partially phosphatized. Phosphate grains in one type of material but not in miliolid limestone. Phosphatic dolomite infilling limestone.
533-548	No recovery (probably limestone).
	UPPER EOCENE UNIT
548-549	Limestone.
549-556	Fossiliferous limestone composed of bryzoan remains and some pecten shells. Nonphosphatic, druzy calcite present.
556-560	No recovery (probably limestone).
560-563	Same lithology as 549-556 ft, only softer.
563-600	No recovery (probably limestone).

Appendix B.–Record of selected construction information and available geophysical logs for wells in the study area.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Brantley County									
28H004	Sandow, J.T.	310822	820917	125	12- -1971	520	550	UF	--
29H002	Lee, H.	311317	820528	130	07- -1974	595	620	UF	--
30H003	Okefenokee Rural Electric	311217	815817	62	1953	578	650	UF	--
30H005	Ga. DOT, Nahunta	311228	815733	65	08- -1974	618	700	UF	--
30H010	Humble/Union Bag 085	311352	815329	75	03-10-1959	0	860	TH	A,D,E,G
30H016	Nahunta, GA 2	311205	815850	66	1964	509	677	LB,UF	E,J,C
30J003	W.F. Hellemn no. ST-1	311726	815735	42	03-20-1961	0	4,512	TH	G
31H004	Satilla River Est. 2	310859	815129	55	10-01-1973	617	764	UF	E,F,J,T
31H005	KOA Campground	311219	815119	53	05-20-1974	612	745	UF	D
31J001	Poore, Earl E.	311517	814536	49	1972	168	200	S	--
31J002	Humble/Brown 01	311931	815205	71	10-16-1959	141	994	S,UB,LB,UF	A,D,E,G
31J003	Humble/Harrison	311853	814511	41	06-23-1959	392	1,043	UB,LB,UF	A,D,E,G
31J004	Humble/Union Bag 087	311534	815053	57	03-19-1959	62	955	S,UB,LB,UF	A,D,E,G
31J005	Humble/Union Bag 071	311742	815053	74	04-03-1958	0	770	TH	A,E,G
Bryan County									
34P012	USA Ft. Stewart Fire Tower	315842	812255	14	1937	160	400	UB,LB,UF	--
34P014	USA Ft. Stewart Firing Range	315800	812438	18	07-13-1943	327	446	LB,UF	E,J
34P019	USA Ft. Stewart Ditch Aban.	315855	812736	20	--	96	305	UB	E,J
34R032	Deloach, Cooper	320805	812923	80	1962	158	238	UB	E,J
34R039	Gardener, J.S.	321145	812603	76	1965	360	480	UF	--
34R040	Davis, J.A.	321352	812649	65.70	1927	86	309	S,UB,LB	E,J
34R049	Ga. DOT, I-16 mile post 144	321008	812638	80	1984	297	398	UF	C,E,J
34R050	Ga. DOT, I-16 mile post 141	321142	812841	81	1984	359	415	UF	C,E,J,T
35N021	Internat. Paper Co.	315022	811613	17	02-22-1940	160	500	S,UB,LB,UF	--
35N025	Internat. Paper Co.	315011	811627	18	12-01-1932	292	465	UB,LB,UF	E,J
35N035	Internat. Paper Co.	315132	811655	21	04-06-1940	160	452	S,UB,LB,UF	E,J
35N059	Ga. DNR, Field Hdqs.	314708	811514	18	--	340	605	UB,LB,UF	--
35N064	Humble/Darieng 01	314910	811525	10	03-16-1958	0	650	TH	A,E,G
35N065	Humble/Blige 01	315133	811644	19	03-15-1958	0	724	TH	A,E,G
35P010	I.P.C., Ford Clinic	315634	811828	11	1930	96	417	S,UB,LB,UF	E,J
35P015	Casey, I.C.	315731	811816	19	1962	85	266	S,UB,LB	E,J
35P020	Interedec, Ford, Y.B.	315630	811732	6	--	402	535	UF	C,E,J
35P025	Interedec, Ford, S.C.	315508	811609	7	--	359	450	UF	C,E,J
35P040	Fort, Leon Skate Rink	315558	811932	11	--	100	459	S,UB,LB,UF	C,E,J
35P057	Internat. Paper Co.	315356	812143	20.38	05-07-1942	290	425	LB,UF	E,J
35P078	USA Ft. Stewart Rec. Area 2	315911	812215	10	07-13-1943	325	450	UF	--
35P099	Richmond Hill No. 1	315618	811908	19	07-03-1973	360	620	UF	D
35P100	Ga. DNR, Fish Hatchery	315724	811858	11	11-22-1978	401	702	UF	--
35P106	Interedec, Ford, S.F.	315634	811747	11	--	437	456	UF	C,E,J,C,E,J
35P107	Interedec, Ford 5/84	315519	811636	10	05-24-1984	412	529	UF	C,E,J
35Q001	USA Ft. Stewart at river	320122	812016	17	1926	82	426	S,UB,LB,UF	E,J
36N002	Wedincamp, F.W. 1	314729	811209	11	1941	154	292	S,UB,LB	E,J
36P006	Ga. DNR, Richmond Hill	315326	811157	15	10-27-1941	150	656	S,UB,LB.UF	E,J
36P091	Ga. DNR, Richmond Hill Park	315300	811042	11	11-01-1970	340	550	UF	--
36P093	Rust Homes, Inc.	315314	811219	12	1971	385	610	UF	--

Appendix B.–Record of selected construction information and available geophysical logs for wells in the study area–Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Bulloch County									
30S001	New Hope Elementary School	322015	815406	233	11-01-1954	495	560	UF	D,G
30U002	Portal, Ga. 2	323217	815559	297	--	395	596	UF	--
31S007	Nelville, Dr.	321856	815111	180	04- -1959	380	525	UF	--
31S008	Hodges, R.	321627	814616	156	12-27-1965	390	435	UF	--
31T007	Georgia Southern 1	322530	814656	243	04-01-1938	384	565	UF	--
31T010	Statesboro, Ga. 2	322700	814646	227	09- -1912	320	555	UF	--
31T011	Statesboro, Ga. 5 (1965-T)	322722	814623	202	1966	434	534	UF	--
31T023	Brooks Instrument 1	322903	814502	170	12-17-1942	282	465	UF	D
31U008	Hopeulikit TW 1	323123	815116	205	08-01-1982	315	860	UF,LF	C,D,E,G,J,
31U009	Hopeulikit TW 2	323123	815116	205	08-01-1982	160	210	UB	--
32R002	Bulloch South TW 1	321240	814115	120	09-01-1982	420	804	UF	C,D,E,G,J, N,U,X
32R003	Bulloch South TW 2	321240	814115	120	09-01-1982	134	155	S	--
32T003	Statesboro Air Field	322843	814430	155	1942	294	345	UF	D
32T013	Brooklet, Ga. 1	322242	813944	155	1931	302	510	UF	D
32T015	Lee, Frank	322832	814133	185	10-01-1978	110	520	S,UB,UF	--
Camden County									
30F004	Harrell, G.C.	305713	815308	65	07- -1972	485	700	UF	--
30G003	Miller, S.T.	310559	815316	25	07-18-1972	495	724	LB,UF	E,J
30G004	John Buie 1	310230	815248	65	03-27-1948	0	4,960	TH	G,E
31E001	Brown, E.	304830	814812	22	1958	400	500	LB,UF	--
31E005	Silcox, O.	304814	815109	20	1936	409	433	UB,LB,UF	C,E,J,C,E,J
31E012	Union Camp B1	305107	815130	22	09-14-1970	1,500	4,590	LF	G
31F017	Wilson, R.	305859	815010	15	--	--	600	UF	--
31F022	Van, J.	305623	814835	20	05- -1973	422	650	UF	--
31G011	Buie Estate, J.A.	310044	814819	11	06-15-1939	--	360	LB	E,J
31G015	Walker, R.	310130	814705	20	05-06-1971	353	520	LB,UF	E,J
31G018	Humble/Kelly 1	310657	814809	12	09-19-1959	230	800	UB,LB,UF	E,G,A
32E004	Gross, E. (1956)	304804	814054	26	1956	--	450	LB	--
32E010	Hercules Inc., Seals	305217	814218	17	1956	340	350	LB	E,J
32E030	Standard Oil Kingsland	304737	814119	31	06-01-1959	70	75	S	--
32E032	Gross, E. (1950)	304809	814046	27	1950	466	516	UF	E,J
32E033	Ga. Welcome Center	304516	813859	18.25	09- -1974	420	600	LB,UF	--
32E037	James Lowe	305041	813806	10	--	--	645	UF	J
32F001	Johnson, L.E.	305546	814225	16	09- -1969	472	566	UF	--
32F008	Williams, H.	305804	814413	9	12- -1965	399	783	UF	--
32F041	Hamilton, Fred, Sr.	305810	814343	12	--	18	26	S	--
32F051	Billyville	305542	814020	23	--	192	456	S,UB,LB,UF	E,J
32F052	BP & P Seals Swamp No. 1	305250	814012	20	--	--	435	LB	J
32G004	West, Joyce	310413	814335	15	08- -1964	527	792	UF	E,J
32G007	Buie, J.A.	310145	814409	16	1962	432	600	LB,UF	--
32G015	Bryson, Edward	310648	814151	20.83	09- -1966	522	726	UF	E,J
32G016	Humble/Atkinson 1	310419	814405	18	09-17-1959	204	834	S,UB,LB,UF	E,G,A
32G017	Humble/Union Bag 080	310658	814348	16	04-18-1958	0	850	TH	E,G,A

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Camden County--Continued									
32G036	Powers, Mr.	310542	814325	20	1968	292	424	S,UB,LB	E,J
32G037	Middleton, O.P.	310354	814242	15	06- -1968	316	366	UB,LB	E,J
32G038	Berry, Elmer	310557	814251	15	07- -1968	508	635	UF	J,E
32G039	Strickland, Clyde	310203	814432	15	05-06-1971	362	522	LB,UF	E,J
32G042	Humble/Union Bag 101	310434	814135	16	09-12-1959	0	842	TH	--
32G044	Humble/Union Bag 092	310627	813944	13	07-24-1959	0	881	TH	E,G,A
33D004	Floyd, E.	304348	813239	10	1952	400	600	UB,LB,UF	--
33D006	Gilman Paper Co. 8	304416	813236	9	11-01-1963	560	1,199	UF	D,E,J
33D022	Gilman Paper Co. 3	304401	813237	10	08-03-1950	517	860	UF	J,C,F,T,V
33D048	Gilman Paper Co. 9	304408	813234	13	10-01-1970	530	1,041	UF	D
33D049	Gilman Paper Co. 6	304418	813325	15	02-01-1955	520	1,259	UF,LF	D
33D050	Gilman Paper Co. 5	304411	813319	15	11-04-1953	529	1,215	UF,LF	D,G
33D058	Gilman Paper Co. 7	304408	813233	13	1960	530	1,041	UF	--
33D061	Gilman Paper Co. 11	304401	813236	15	11-28-1981	550	1,088	UF	--
33D063	Gilman Paper Co. 10	304432	813230	15	06-30-1980	560	1,099	UF	--
33E002	Rayonier, Inc.	304627	813712	22	1930	80	474	S,UB	E,J
33E003	USN Kings Bay Refill Station	304751	813201	9.70	03-02-1958	302	470	UB,LB,UF	E,J
33E004	USN Kings Bay Etowah	304910	813238	16	1958	186	516	S,UB,LB,UF	E,J
33E007	David, G.H.	304510	813438	18	04-01-1964	525	770	UF	--
33E008	Crooked River State Park	305037	813323	16	--	263	470	UB,LB,UF	E,J
33E009	American Legion, St Marys	305045	813346	12	1930	250	565	S,UB,LB,UF	--
33E018	USN Kings Bay Club	304800	813105	10	04-01-1937	145	486	S,UB,LB,UF	E,J
33E023	Norieka, Richard	305031	813427	16	1961	450	650	LB,UF	--
33E027	USN Kings Bay TW 1	304756	813111	10	02-08-1979	555	990	UF	J
33E037	Dr. Carl Drury, Laurel IS	304913	813531	10	--	--	575	UF	J
33E038	Brunswick Pulp and Paper	305157	813156	12	--	66	340	S,UB	E,J
33E039	USN Kings Bay obser. no. 1	304750	813353	24	11-01-1985	950	1,150	UF	A,D,E,J
33E040	USN Kings Bay obser.	304748	813353	24	11-01-1985	560	750	UF	A,D,E,J
33E041	USN Kings Bay well A	304730	813425	30	12-14-1976	15	18	S	--
33E042	USN Kings Bay well B	304700	813223	18	12-17-1976	12	15	S	--
33E043	USN Kings Bay well C	304838	813158	16	12-17-1976	16	19	S	--
33E044	USN Kings Bay well D	304854	813315	23	12-15-1976	17	19	S	--
33E045	USN Kings Bay well E	304810	813351	25	12-16-1976	15	18	S	--
33F001	Brunswick Pulp and Paper, Cabin Bluff	305314	813103	9	1959	483	760	LB,UF	--
33F002	Union Carbide 2	305514	813056	10	09-20-1963	513	806	LB,UF	D,E,J
33F003	Union Carbide 3	305710	813155	20	09-14-1963	508	847	UF	D
33F004	Union Carbide1	305611	813028	12	08-29-1963	515	806	UF	D
33F014	Brunswick Pulp and Paper	305428	813104	6	--	180	306	S,UB	E,J
33F015	Brunswick Pulp and Paper	305530	813536	28	--	169	332	S,UB	E,J
33F016	Brunswick Pulp and Paper	305718	813244	20	--	90	306	S,UB	J
33F017	Union Carbide 4	305538	813054	12	12-01-1981	534	832	UF	D
33G005	Episcopal Center Camp	310312	813225	7	1960	572	783	UF	E,J
33G006	Kirby, TW SR	310106	813145	12	1953	387	817	UB,LB,UF	--
33G011	Hardy Swamp 01	310208	813546	21	--	243	456	S,UB,LB	E,J
33G012	W. Piney Bluff 01	310111	813323	10	--	186	449	S,UB,LB	E,J
33G013	Dover Bluff 01	310122	813049	10	--	225	320	S,UB	E,J

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Camden County--Continued									
34D003	Cumberland Isl. no. 1	304448	812804	20	--	--	368	--	--
34E001	Cumberland Isl. GGS TW 01	304522	812813	17	--	540	640	UF	J,G,X,D
34E002	Cumberland Isl. Plumb Orch.	305122	812756	17	1904	--	600	UF	--
34E003	Cumberland Isl. Greyfield	304646	812809	14	1931	538	730	UF	--
34E010	Cumberland Isl. no. 32	304610	812809	10	--	550	750	UF	J
34F002	Hernley, Mr.	305614	812445	7	1966	554	684	UF	E,J
34F004	Botsford, Mr.	305630	812443	10	1966	571	743	UF	E,J
34F005	Kingsley 1	305709	812441	10	1966	547	638	UF	E,J
34F007	Richardson, Mr.	305739	812436	10	1967	519	580	UF	E,J
34F008	Hunter, Mr.	305745	812524	10	1966	554	683	UF	E,J
34F010	Generals Mound	305659	812516	5	1960	562	784	UF	E,J
34F011	Platt, Mr.	305813	812505	10	1967	537	702	UF	E,J
34F012	Pomeroy, Mr.	305824	812435	10	1967	498	698	LB,UF	E,J
34F013	Cumberland Isl. no. 16	305438	812441	10	--	--	368	--	J
34G040	Sam Lewis Marine Farm	310036	812755	8	1960	584	777	UF	E,J
Charlton County									
27E002	USGS OK 08	304943	822138	116	1964	465	591	UF	E,J
27E003	Ga. DNR, S. Foster Park	304929	822146	117	10- -1966	470	660	UF	--
27E004	USGS OK 09	304943	822138	116	05-01-1978	498	700	UF	--
28D001	USF&W, Chesser Island	304256	820921	128	1976	471	595	UF	D,E
29F001	Drury, J.	305849	820713	145	08-19-1975	690	740	UF	--
30E002	Varn, L.	304937	815426	12	--	260	300	UB	--
30E004	O.C. Mizell 1	304723	815916	20	08-01-1963	--	825	--	G
30E007	Humphreys obs. 1	305228	815935	91.70	04-20-1965	560	918	UF	--
Chatham County									
35P085	Ga. DOT, U.S. 17-Chevis	315948	811536	15.55	1932	120	420	UF	--
35P091	International Paper Co.	315736	811519	10	06-23-1943	153	420	S,UB,UF	--
35P094	USGS-UGA obs. well	315950	811612	18.67	09-01-1954	14	15	S	--
35Q043	Regency Mobile Home Park	320158	811518	11.32	09-20-1970	316	600	UF	D
35R017	Johnson, K.	320825	811935	42	1957	303	425	LB	E
35R018	Bloomingdale Nursery	320823	811933	38	1948	140	345	S,UB,UF	--
35R025	Bloomingdale, Ga. 1	320738	811755	20	02-09-1966	319	565	UF	D,G
36N006	Ga. DNR, Ossabaw Buckhead	314741	810750	10	--	197	239	S,UB	C,E,J,C,E,J
36P021	Drifton Stuart no. 2 (195)	315826	811255	16	02-14-1957	200	325	UB	E,D
36P036	Savannah, Ga. 36	315922	810845	18	11-18-1960	252	414	UF	E,J
36P087	Pine Grove Subdivision	315930	811322	18.14	07-01-1963	260	460	UF	--
36P090	Savannah, Ga. 23	315809	810917	20	08-03-1970	323	639	UF	--
36P094	Savannah, Ga. 26	315630	810859	18	1979	308	580	UF	--
36Q001	Union Camp 03	320610	810732	11	10-01-1936	219	947	UF,LF	D,J
36Q002	Union Camp 04	320558	810746	11	10-28-1936	237	1,012	UF,LF	D,E,J
36Q005	GAF Corp. 1	320657	810757	11	09-01-1938	234	608	UF	D
36Q007	Garden City, Ga. 1	320712	810900	7.64	05-01-1954	225	740	UF	D

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Chatham County--Continued									
36Q008	Layne Atlantic	320530	810850	9.91	1953	250	406	UF	E,J
36Q013	Savannah, Ga. 18	320709	811143	34.27	09-01-1942	269	681	UF	D
36Q014	Savannah, Ga. 19	320729	811139	45.06	1945	250	680	UF	--
36Q017	Howard Johnsons Motel	320314	810850	12	08-05-1953	294	448	UF	E,J,T
36Q019	Ga. DOT, U.S. 17, Ga. 307	320137	811323	10.02	11-13-1940	400	540	UF	--
36Q020	Morrison, H.J.	320018	811248	13.38	948	330	365	UF	E,J
36Q032	Hercules, Inc. 03	320516	810853	10	03-01-1956	275	1,006	UF,LF	D
36Q038	Meddin Package Co. 2	320457	810744	15	12-09-1960	246	533	UF	E
36Q040	Ga. Port Authority	320709	810834	19.80	08-01-1942	251	640	UF	E,J
36Q060	Hall, Mary	320528	811029	25	1957	272	384	UF	E,D
36Q283	Pooler, Ga. 1	320656	811459	22.79	01-20-1947	280	610	UF	D
36Q287	US Army, Hunter 03	320003	810912	40	1951	324	370	UF	D
36Q288	US Army, Hunter 05	320001	811104	11	12-01-1956	85	380	S,UB	D,E
36Q300	Carlton Co.	320536	811219	18	--	--	510	UF	--
36Q318	Pooler TW 1	320701	811319	20	1/06-01-1975	354	840	UF	B,C,E,G,J,N
36Q328	Garden City no. 5, 1986	320515	811022	24	04-01-1986	320	497	UF	J,E,D
36R001	Savannah Elec. Power Co. 1	320853	810849	15.83	08-01-1956	280	966	UF,LF	D,E
36R004	Union Carbide Co.	321034	810928	12.74	1898	60	305	S,UB,UF	E,J
36R006	Port Wentworth Corp. 1	320759	811103	40	10-01-1956	271	1,088	UF,LF	C,E,G,J
36R008	Port Wentworth, Ga. 2	320920	810952	16.10	1923	200	502	UB,UF	--
36R041	VPI, DOE 044, Sav. Airport	320809	811221	19	08-10-1980	0	1,000	TH	C,J,N,E,S,O
37N004	Ga. DNR, Ossabaw Willow Pond	314609	810507	6	1929	149	429	S,UB,UF	C,E,J
37N005	Ga. DNR, Ossabaw Rockets	314624	810605	6	1929	--	209	--	J
37N006	Ga. DNR, Ossabaw Middle Pla.	314803	810646	10	--	107	275	S,UB	C,E,J
37N009	Ga. DNR, Ossabaw USCG	314544	810525	11	--	199	509	UB,UF	C,E,J
37P002	Funk, A.J. 2	315947	810251	11	07-01-1962	208	344	UF	E,J
37P003	Featherston, W.H.	315851	810618	23	1961	190	323	UB,UF	E,J
37P005	Forest City Gun Club	315840	810542	20	12-30-1957	232	353	UF	E,J
37P006	Savannah, Ga. 13	315948	810705	18	04-01-1954	270	1,000	UF,LF	G
37P009	Johnson, D., Isl. Hope	315857	810302	9.80	1927	160	521	UB,UF	--
37P010	Harmon, Jack	315557	810512	8.08	1952	200	406	UB,UF	E,J
37P012	Gordon, Roy	315621	810721	15	1963	68	238	S,UB	E,J
37P013	Bethesda Orphanage	315733	810533	11	07-21-1947	241	606	UF	D
37P064	Linskey, M.P.	315716	810648	15	1957	230	345	UF	E
37P083	Ocean Science Center	315916	810113	9	10-01-1970	234	485	UF	--
37P086	Burnside View Subdivision	315547	810458	10	05-25-1971	273	600	UF	--
37P087	Landings no. 1	315700	810144	12	12-06-1972	286	600	UF	D
37P113	Skidaway Institute TW 1	315906	810112	10	08-24-1983	700	1,100	LF	C,E,F,G,J,N,T,U,V
37P114	Skidaway Institute TW 2	315906	810112	10	08-11-1983	262	400	UF	--

1/ Well originally open hole from 2,921 to 3,407 ft.

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Chatham County--Continued									
37P115	Skidaway Institute TW 3	315906	810112	10	08-16-1983	211	250	UF	--
37P116	Skidaway Institute TW 4	315906	810112	10	08-17-1983	71	85	S	--
37P117	Roebling Quarters	315914	810134	10	1935	112	270	UB,UF	C,E,J
37P118	GGS Bull., 82 CH-1	315920	810250	12	--	--	278	--	J,G
37P119	Hetherington, Thomas	315708	810102	10.50	07-25-1985	41	46	S	--
37P120	Owen, Tom	315641	810125	9	06-24-1985	12	16	S	--
37P121	Weber, Whitney	315627	810157	18.50	06-01-1984	20	23	S	--
						51	53	S	--
						55	58	S	--
37P122	Etz, Bill	315541	810158	10.50	04-05-1983	50	55	S	--
						70	75	S	--
37P123	Farrell, Hugh	315543	810223	16	08- -1985	57	62	S	--
						67	72	S	--
37P124	Storms, Jack	315617	810230	10.60	05-19-1986	55	65	S	--
37P125	Reinhardt, Rick	315636	810217	11.50	05-16-1986	55	62	S	--
37P126	Cole, James	315702	810154	10	04-15-1986	32	37	S	--
						49	54	S	--
37P127	Womack, Jack	315412	810250	12	03-20-1985	15	20	S	--
37P128	Olney, Jim	315417	810259	12	12-07-1983	28	31	S	--
						44	49	S	--
37P129	Demacher, Don	315544	810246	8.50	05-28-1986	55	65	S	--
37P130	Bloom, Roland	315403	810254	12	07-27-1983	15	20	S	--
37P131	Paul Hylbert	315407	810249	12	12-03-1984	50	54	S	--
37P132	Degenhart, Bill	315426	810315	12	04-10-1984	38	48	S	--
37P133	Cubbedge, Tom	315537	810321	10.50	11-07-1985	60	65	S	--
37P134	Earhart, Brandt	315445	810227	7.50	--	45	52	S	--
37P135	Loften, Dennis	315511	810335	5.50	12-03-1985	33	38	S	--
						54	57	S	--
37P136	Browne, Stanley	315503	810255	14.50	04-30-1986	65	75	S	--
37P137	The Landings, Main Square	315539	810243	11.50	01-15-1985	56	66	S	--
37P138	The Settlement Villa	315647	810139	12	12-01-1985	27	34	S	--
37P139	South Harbor Townhomes An	315442	810417	9.50	04-22-1985	41	51	S	--
37Q001	Union Camp Paper Corp. 05	320612	810718	10	12-14-1938	227	1,010	UF,LF	C,D,E,T
37Q003	Union Camp Paper Corp. 02	320611	810710	11	08-03-1950	224	1,000	UF,LF	D,E
37Q006	Colonial Oil Ind., Inc.	320604	810702	12.10	1906	150	378	UB,UF	--
37Q010	US Postal Service 02	320440	810535	42	07-01-1958	274	695	UF	E,G,D
37Q012	Lucas Theater	320442	810521	42.63	1938	252	504	UF	--
37Q015	Savannah Gas Co. 1	320440	810457	18.98	04-01-1940	241	695	UF	--
37Q016	SCL Railroad Docks	320433	810427	4.70	1940	260	500	UF	E,J
37Q017	Standard Oil Co.	320443	810237	5.60	08- -1940	230	652	UF	D,G
37Q019	American Cyanamid Co.,2	320451	810143	9.88	02- -1954	210	644	UF	E
37Q022	Savannah, Ga. 02 (obs.)	320400	810549	40.60	09-16-1960	270	798	UF	E,J
37Q024	Savannah, Ga. 02	320421	810651	14.90	1916	180	540	UB,UF	D
37Q030	Savannah, Ga. 07	320249	810507	15.90	1921	250	525	UF	--
37Q031	Savannah, Ga. 09	320219	810614	19.51	05-01-1941	267	710	UF	D
37Q032	Savannah, Ga. 01	320132	810449	25.20	05-01-1954	300	1,000	UF,LF	D

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Chatham County--Continued									
37Q033	Derst Baking Co.	320258	810728	18.77	11-03-1947	258	568	UF	D
37Q034	Benedictine School	320029	810522	27.57	09-01-1955	100	327	S,UB,UF	E,J
37Q038	Savannah, Ga. 08	320325	810404	27.60	1935	260	595	UF	D
37Q040	Savannah, Ga. 11	320350	810335	30.40	12-01-1943	240	697	UF	D
37Q042	Thunderbolt, Ga. 02	320152	810301	12	08-01-1929	150	516	UB,UF	--
37Q043	USPHS, Oatland Isl.	320257	810123	18	05-28-1947	208	592	UF	--
37Q066	Savannah, Ga. 16	320439	810302	11	06-10-1941	256	650	UF	D,E,G
37Q072	Grays Subdivision	320247	810036	12	09-03-1960	183	348	UF	E
37Q083	Carribbean Lumber (83)	320515	810526	5.50	07-01-1941	220	645	UF	--
37Q085	SCL Railroad Docks	320519	810506	6	1925	139	500	UB,UF	C,E,J,T
37Q090	Great Dane Tr. Mfg. Co.	320528	810637	8.40	11-25-1947	235	570	UF	D
37Q160	East Pines Subdivision	320321	810055	10	12-01-1965	182	400	UF	D
37Q162	Savannah, Ga. 05 (new)	320354	810553	41	11-11-1970	265	903	UF	D
37Q175	Sav. Ele. Power Co., OP 2	320317	810716	15	06- -1957	276	561	UF	C,J,L,T,D
37Q182	Thunderbolt, Ga. 7-80	320138	810314	22	07-01-1980	300	506	UF	C,E,F,J,L,N, E,F,J,L,N,U
37Q183	Thunderbolt, Ga. 8-84	320202	810311	21	07-01-1984	298	496	UF	E,G,J
37Q184	Candler Hospital	320146	810557	23	06-13-1985	290	600	UF	C,J,L,E
37Q185	Hutchinson Island TW 1	320622	810637	6	06-05-1985	274	360	UF	C,T,E,J
37Q186	Hutchinson Island TW 2	320622	810637	6	10-08-1985	1,380	1,520	--2/	C,E,X,J,T, S,N
38P001	Savannah, Ga. 21	315930	805920	9	12-01-1962	168	427	UF	--
38P002	Wilmington Park Subdivision	315947	805937	11	10-01-1957	165	427	UF	E,J
38P010	Parson, H. & J.	315324	805742	8	1939	83	151	S,UB	C,E,J
38P012	Savannah, Ga. 22	315943	805911	12	02-01-1968	230	576	UF	D
38P013	Petit Chou TW 01	315639	805539	8	10-11-1968	251	271	UF	J,X,G
38P015	S. Ga. Mineral PRGM CH-1	315826	805954	5	--	0	270	TH	E,J,X
38P016	GGS Bull. 82, D-1	315707	805910	8	--	--	173	--	J,G
38P018	GGS Bull. 82 CH-2, GGS 134	315911	805914	15	--	--	212	--	J,G
38Q001	USNPS, Ft. Pul. (PIC)	320150	805402	7.80	1943	352	535	UF	E,J
38Q002	USNPS, Ft. Pul. (PIL)	320201	805411	8.10	05-01-1940	110	348	UF	J,D
38Q003	USGS TW 01	320151	805404	7.70	05-01-1954	0	1,435	TH	E,G
38Q004	USGS TW 04	320151	805405	7.68	07-07-1959	606	657	LF	--
38Q006	USGS TW 06	320355	805845	7.45	12-09-1960	145	842	UF,LF	D,C,E,G,J
38Q012	Southwinds Subdivision	320029	805742	10	02-01-1962	148	545	UF	D,E
38Q013	Walthour, H., Estate	320045	805829	4.70	1930	97	235	S,UB	E,J
38Q116	USNPS, Ft. Pulaski	320135	805333	5	1962	140	374	UF	E,J
38Q190	Savannah, Ga. 20	320042	805839	5.80	11-01-1962	147	474	UF	E,J
38Q196	USGS TW 01, PT 2	320151	805404	8	--	870	900	LF	--
38Q199	USGS TW 06, PT 1	320355	805845	7.45	1960	600	626	UF	--
38Q201	GGS TW Ft. Pulaski (1986)	320150	805406	7	02-19-1986	1,358	1,546	--2/	C,E,F,G,J, N,T,U,Z

2/ Well taps low-permeability units underlying the Lower Floridan aquifer.

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Chatham County--Continued									
38Q202	S.Ga. Minerals Prog., CH-4A	320054	805317	5	--	0	178	TH	J,X
38Q203	S.Ga. Minerals Prog., CH-1	320151	805551	5	--	0	206	TH	J,E,X
38Q205	State of Georgia	320145	805757	13	--	--	159	--	J,G
39P001	Savannah Beach 03	315942	805057	9	03-01-1949	160	645	UF	--
39P002	S.Ga. Mineral Prog., CH-10-10A	315916	805105	7	--	0	234	TH	X,J,G
39P003	GGS Bull 82 D-6 (1969)	315901	805213	8	--	--	129	--	J,G
39Q001	Savannah Beach	320124	805101	12.71	09-01-1942	197	575	UF	E,G
39Q003	USGS TW 07, PT 3	320122	805101	7	10-09-1961	129	600	UF	D,E,G,J
39Q006	Savannah Beach 01 (39)	320041	805032	10	1939	124	402	UB,UF	--
39Q016	USGS TW 07	320122	805102	7	10-09-1961	0	745	--	D,E,G,J
39Q017	USGS TW 07, PT 1	320122	805101	7	10-09-1961	710	745	LF	--
39Q018	USGS TW 07, PT 2	320122	805102	7	--	630	670	LF	--
39Q022	S. Ga. Mineral Prog. CH-1	320024	805206	5	--	0	202	TH	J,X
Effingham County									
34R036	Central of Georgia Railroad	320836	812244	32	1926	272	441	UF	--
34S007	S. Ga. Minerals Prog. EF-1	322129	812611	77	08-11-1965	0	300	TH	J,E,X,G
34U006	Burns, A.L.	323206	812718	130	11-11-1978	--	240	LB,UF	--
34U008	Thompson, R.L.	323002	812530	130	1976	262	296	UF	--
35R024	Page, Roy	320852	812034	39	--	312	420	LB,UF	E
35R026	Lakeside Park	320940	811952	59	04-25-1969	311	472	UF	--
35S003	Boy Scout Camp	322102	811603	20	--	42	260	S,UB,UF	--
35S004	S. Ga. Mineral Prog. EF-2	322202	811716	63	--	0	174	TH	E,J,X,G
35U005	S. Ga. Mineral Prog. EF-6	323115	811537	91	--	0	194	TH	E,X,G
36S004	Westwood Heights, 1	321523	811336	61	--	303	580	UF	--
36S022	Rincon, Ga. 02	321722	811402	61	--	281	500	UF	--
36S027	Ft. Howard Paper Co. 03	322001	811221	66.99	04-10-1986	278	502	UF	C,E,S,J,T,F
Glynn County									
31H006	Humble/Union Bag 079	310913	814532	14	04-17-1958	0	910	TH	E,G
31H007	Humble/Union Bag 097	311051	814558	18	08-27-1959	375	884	UB,LB,UF	A,D,E,G
31H008	Humble/Union Bag 081	311216	814547	44	04-20-1958	0	914	TH	E,G
31H009	Humble/Union Bag 096	311353	814536	66	08-24-1959	330	960	UB,LB,UF	A,D,E,G
32H001	Brunswick P&P Bladen	311445	814238	19.18	1938	298	500	UB,LB	E,J
32H017	Roads End Camp	311155	814252	20.17	1948	245	442	UB,LB	E,J
32H024	Lamar, Stafford	310918	814008	18.48	02- -1939	214	518	S,UB,LB	E,J
32H026	Osborn, N.B.	311053	813812	20.92	03-01-1957	292	445	S,UB,LB	E,J
32H032	Union Bag Camp ST-1	310820	813820	10	05-28-1961	0	4,642	TH	G,E
32H036	Livingston, J.L.	311130	813932	16	1910	260	318	S,UB	E,J
32H037	Curry, C.K.	310739	813739	31	1962	286	570	S,UB,LB	C,E,J
32H038	Humble/Union Bag 077	311003	814149	16	04-12-1958	0	910	TH	A,E,G
32H039	Humble/Union Bag 093	310924	814008	17	08-16-1959	351	896	UB,LB,UF	A,D,E,G
32H040	Humble/Union Bag 100	311211	814324	18	09-11-1959	264	920	S,UB,LB,UF	A,D,E,G
32H041	Humble/Union Bag 076	311254	814025	12	04-10-1958	0	900	TH	A,E,G

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued									
32H042	Humble/Union Bag 089	311343	813921	16	06-26-1959	357	967	UB,LB,UF	A,D,E,G
32H043	Humble/Union Bag 078	310820	813813	14	04-16-1958	20	820	S,UB,LB,UF	A,E,G
32H045	Humble/Union Bag 073	311444	813758	13	04-05-1958	0	780	TH	E,G,A
32J001	Nail, G.A.	311812	814125	16	11- -1957	413	699	UB,LB,UF	E,J
32J003	Harrison, Connie	311728	814133	18.72	1950	700	840	UF	--
32J012	Humble/Union Bag 091	311559	813837	12	07-24-1959	385	935	UB,LB,UF	A,D,E,G
32J013	Humble/Union Bag 075	311644	814027	15	04-09-1958	0	840	TH	A,E,G
32J014	Humble/Union Bag 072	311504	814351	17	04-04-1958	0	740	TH	A,E,G
32J015	Arnet Field	311840	814058	15	--	314	483	UB	E,J
33G001	Curry Oil Test	310711	813637	8.43	[3]/10- -1982	694	1,457	UF	C,E,F,G,J, N,P,T,V
33G002	Massey Lake Well	310711	813240	8.23	1949	570	660	UF	E,J
33G003	Massey Oil Test Well	310646	813224	12.67	11-25-1953	610	921	UF	A,C,E,G,J,K
33G008	USGS TW 15	310701	813202	7.46	12-01-1966	599	702	UF	E,G,J
33G026	SCM no. 2 (South)	310640	813245	10	--	622	825	UF	--
33G027	GPA-2	310519	813141	10	06-24-1986	503	555	LB	D,G,E,J
33G028	GPA-3	310629	813233	10	07-04-1986	390	473	UB,LB	D,G,J,E
33H003	Madge Merritt Garden Club	310759	813554	9.62	1959	147	480	S,UB	E,J
33H010	Cowan, George	310900	813415	6.30	02-01-1937	332	414	UB,LB	E
33H013	Watts, W.H.	310817	813330	10	--	504	700	UF	--
33H021	Blythe Island	310946	813325	9	1939	297	514	UB,LB,UF	E,J
33H035	Camp Tolochee	311119	813402	7.71	1960	580	720	UF	E,J
33H038	Camp Glynn	311239	813405	9.05	04-01-1962	621	780	UF	E,J
33H041	Daniel, A.R.	311451	813247	20.06	1960	659	802	UF	E,J
33H046	American Creosoting	311429	813157	11	1958	50	80	S	--
33H052	Anderson, L.L.	311405	813214	10.17	1957	560	825	UF	--
33H061	Metro Dvlp. Corp. (H.B. Sawtell)	311311	813136	18	1918	598	988	LB,UF	E,J,T,U,C
33H079	Hamilton, R.L.	311233	813110	8.73	1960	623	741	UF	E,J
33H095	Roberts, Ernest	311156	813041	12.96	1961	546	760	UF	E,J
33H100	Jenkins Theatre	311129	813021	12.44	1958	540	777	UF	E,J
33H102	LCP Inc., 02	311111	813019	14.71	1920	447	983	LB,UF	D,E,J
33H104	LCP Inc., 04	311114	813035	8	1920	535	600	UF	--
33H105	LCP Inc., 05	311116	813056	8	12-01-1956	534	1,064	UF	D
33H106	LCP Inc., 06	311046	813117	8	08-01-1956	496	775	LB,UF	D
33H108	Brunswick P&P 01	311027	813113	12.60	06-01-1937	492	871	LB,UF	C,D,E,J
33H109	Brunswick P&P 02	311023	813112	14	1937	488	900	LB,UF	C,D,E,J
33H110	Brunswick P&P 03	311041	813046	6.85	1937	494	1,050	LB,UF	D
33H111	Brunswick P&P 04	311039	813118	7	04-01-1948	492	1,043	LB,UF	E,J
33H112	Brunswick P&P 05	311007	813113	11.24	09-01-1950	517	1,019	UF	E,J
33H113	Brunswick P&P 06	310955	813117	10	11-01-1955	550	1,076	UF	D,G
33H114	Brunswick P&P 08	311027	813106	9.74	06-01-1960	560	1,006	UF	E,J,T

[3]/Well originally drilled 03-25-54 to a total depth of 2,050 ft.

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued									
33H115	Brunswick P&P 07	311036	813055	8.59	1960	560	947	UF	E,J
33H116	Brunswick P&P 09	311020	813054	6.36	12-07-1960	557	928	UF	E,J
33H117	Brunswick P&P 10	311018	813039	10.95	12-10-1960	558	1,033	UF	E,J,Z
33H118	Brunswick P&P 11	311008	813058	6.59	1961	550	1,003	UF	C,E,J,T
33H120	Palmetto Cemetery N.	311036	813026	11.88	--	514	571	UF	E,J
33H127	USGS TW 03	311006	813016	6.15	08-01-1962	823	952	UF	C,E,J,N,T, U,V
33H130	Selden Park	311021	813031	10.79	04-01-1963	530	700	UF	C,E,F,J,N, T,U
33H131	Jenkins, S.O. (pasture)	311429	813426	3.53	1963	600	766	UF	E,J
33H132	Oak Bluff Subdivision	311323	813203	20.96	10-01-1963	499	736	LB,UF	E,J
33H133	USGS TW 06	311006	813016	6.71	03-01-1964	520	790	UF	C,E,V
33H134	Ballard Fire Station	311212	813024	17.44	04-21-1964	537	700	LB,UF	E,J
33H135	Oquinn Trailer Park	311100	813012	16.08	07-01-1964	568	857	UF	E,J
33H136	Taylor Methodist Church	311249	813003	20.63	--	562	684	UF	E
33H137	Self, S.B.	311223	813114	8	07-01-1965	626	743	UF	E,J
33H138	Zell, Richard	310826	813326	7.81	1966	408	460	UB	E,J
33H139	Oquinn, Wyllie, Jr.	310738	813327	9.12	1963	595	784	UF	E,J
33H140	Sapp, H.A.	310846	813529	18.36	08-01-1965	557	763	UF	E,J
33H141	USGS TW 12	311044	813231	12.55	10- -1966	558	720	UF	E,G,J
33H144	Pure Oil Service Station	311212	813033	17	04-01-1967	561	635	UF	E,J
33H145	Justice, Clifford	311003	813003	14	--	372	514	LB,UF	E,J
33H146	Johnson Arco Laundry	311048	813008	14	1961	529	800	UF	E,J
33H147	Barnes, Robert D.	310956	813511	13	1967	418	570	UB,LB,UF	E,J
33H148	Whorton Farms	311345	813127	29	1958	630	762	LB,UF	E,J
33H149	Escambia Corp.	311432	813141	13	1968	644	732	UF	E,J
33H150	Havenwood Nursery	311331	813031	15	1968	490	501	UB,LB	E,J
33H152	Thomas, A.L.	311328	813032	16	04-01-1968	608	713	LB,UF	E,J
33H153	Stutts, T.J.	310852	813356	7	05-01-1969	546	684	UF	E,J
33H154	USGS TW 18	311022	813029	10.20	07-01-1969	817	989	UF	A,C,E,J,N,T, U,V
33H155	Sapp, Woodrow	311246	813048	11	04-01-1970	582	706	UF	E,J
33H164	Tidewater Construction Co.	310847	813431	10	1971	570	695	UF	--
33H165	Kessie, Ralph	311110	813237	9	04-01-1971	561	748	UF	E,J
33H167	Beasley-Mims	311030	813011	13	1940	515	549	LB,UF	E,J
33H168	Hudley, Robert	311217	813002	16	10-01-1971	569	691	UF	E,J
33H174	Northwood Estate Subdivision	311408	813057	30	10-01-1972	670	793	UF	E,J
33H175	BWK, Glyndale 1	311255	813123	17	02-01-1973	632	811	UF	E,J,T
33H176	KOA Campground	310842	813452	16	07-12-1973	583	763	UF	E,J
33H177	Spaulding Trailer Park	310740	813613	15	08- -1973	580	750	UF	--
33H179	Dennard, Tom	310948	813608	20	04- -1975	555	700	UF	--
33H180	Thomas, R.E.	311107	813000	15	03-22-1974	575	710	UF	--
33H184	Humble/Union Bag 094	311353	813653	12	08-18-1959	282	944	S,UB,LB,UF	A,D,E,G
33H185	Humble/Union Bag 074	311433	813046	33	04-07-1958	0	983	TH	A,E,G
33H186	Humble/Bell 01	310817	813539	19	09-03-1959	100	901	S,UB,LB,UF	A,D,E,G
33H187	Humble/Harper 01	311000	813613	30	08-20-1959	295	955	S,UB,LB,UF	A,D,E,G
33H188	USGS TW 26	310809	813235	9.37	10-01-1978	2,138	2,720	LF	C,E,F,J,N, P,S,T,U,Z

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued									
33H189	Brunswick P&P 02 (new)	311014	813108	5	05- -1979	540	900	UF	--
33H190	Brunswick Glyndale 002	311255	813125	16.4	05-01-1980	650	820	UF	--
33H192	Davis, W.K., UC 1 Oil Test	311345	813704	10	07-12-1981	1,320	1,894	LF	C,E,F,J,N, P,S,T,U
33H193	Davis Oil Test Supply	311345	813704	10	02- -1981	600	700	UF	--
33H194	Hatfield, Maurice W.	311205	813111	10	1977	88	180	S	--
33H195	Pineridge Baptist Church	311233	813019	20	--	135	155	S	--
33H196	Brunswick Concrete Co.	311326	813047	16	1972	87	200	S	--
33H198	Nail, H.O.	311326	813205	20	04-01-1982	152	180	S	--
33H201	Carlin, Buddy	311441	813237	20	--	176	240	S	--
33H202	O'Neal, Carl E.	310823	813328	9	11-01-1981	142	200	S	--
33H203	Jack's Minit Market	310829	813507	15	1980	180	230	S	--
33H205	Harris, Aaron Lamar	310847	813707	30	1979	168	222	S	--
33H206	USGS-GGS-BP&P South TW 01	310925	813122	7	02-23-1983	1,000	1,100	LF	C,E,F,G,J, N,V
33H207	USGS-GGS-BP&P South TW 02	310925	813122	7	02-02-1983	620	720	UF	C,E,J,N,U
33H208	USGS-GGS-BP&P South TW 03	310925	813122	7	02-24-1983	135	155	S	--
33H209	Glynn Co. Rec. Dept. Blythe	310912	813253	10	03- -1982	540	640	UF	J
33H211	USGS-BP&P 01	311027	813113	12.60	10-31-1984	590	630	UF	E,J,C,D
33H212	USGS-BP&P 11 (lower)	311008	813058	6.59	12-13-1984	870 940 980	890 950 990	UF	J,E,C,T
33H213	USGS-BP&P 11 (upper)	311008	813058	6.59	12-13-1984	550	800	UF	J,E,C,T
33H214	USGS-BP&P 09 (lower)	311020	813054	6.36	12-05-1984	895	915	UF	E,J
33H215	USGS-BP&P 09 (upper)	311020	813054	6.36	12-05-1984	557	800	UF	E,J
33H216	USGS-BP&P 10 (lower)	311018	813039	10.95	01-23-1985	1,010	1,030	UF	J,E
33H217	USGS-BP&P 10 (middle)	311018	813039	10.95	01-23-1985	885	905	UF	J,E
33H218	USGS-BP&P 10 (upper)	311018	813039	10.95	01-23-1985	557	800	UF	J,E
33H219	Golden Gate Christian Acad.	311349	813152	22	11-27-1984	654	736	UF	C,E,J
33H220	Ga. Ports Auth. Fire well	310739	813231	12	06-01-1984	620	756	UF	C,E,J,S,T,V
33H223	GPA-1	310741	813227	12	06-11-1986	498	548	LB	D,G,E,J
33J008	Bar None Ranch	311906	813338	13.24	01-15-1962	634	900	UF	E,J
33J013	Glynn Farms (pond)	311524	813646	13	--	373	487	UB,LB	E,J
33J026	Young, S.L.	311741	813409	13.13	12-07-1965	680	900	UF	E,J
33J027	Blackerby, D.G.	312000	813535	17.08	1961	590	788	UF	E,J
33J028	Woodmen of the World	311506	813342	10	--	654	823	UF	E,J
33J033	Glynn Farms	311915	813511	22	1959	212	395	S,UB	E,J
33J034	Girl Scout Camp	311619	813005	25	1959	660	780	UF	--
33J035	Knight, James	311619	813113	25	10-15-1973	570	576	LB	E,J,T
33J038	Humble/Union Bag 061	312000	813212	15	02-25-1958	0	1,528	TH	A,D,E,G
33J039	Humble/Union Bag 090	311748	813124	35	07-18-1959	345	1,132	S,UB,LB, UF	A,D,E,G
33J040	Humble/Glynn Farms 1	311916	813509	22	07-27-1959	285	1,058	S,UB,LB, UF	A,D,E,G
33J041	Humble/Schluter 1	311524	813607	6	07-21-1959	285	924	S,UB,LB, UF	A,D,E,G

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued									
33J042	Humble/Union Bag 062	312222	813728	14	02-27-1958	0	1,540	TH	A,D,E,G
33J043	Sterling Oil Test Supply	311633	813241	20	11-28-1978	662	800	UF	C
33J044	USGS TW 27	311633	813240	20	01-11-1979	1,079	1,910	UF,LF	C,D,E,G,H, J,N,Q
33J045	Panam-Union Camp 01	312155	813414	13	08-06-1970	0	4,435	TH	E,S
33J046	Jack's Minit Mart, Sterling	311619	813341	12	1977	126	175	S	--
33J047	Jones, Jimmy	311830	813314	20	04-01-1982	159	179	S	--
33J048	Gibbs, Charlie	311827	813441	16	11-01-1981	154	200	S	--
33J049	Stewart, Norman	311512	813032	31	06-01-1979	195	280	S	--
33K005	Shadron, S.	312521	813609	9.78	1966	426	590	LB,UF	E,J
34G001	Babcock and Wilcox	310726	812858	8.79	1943	589	1,006	LB,UF	C,E,J,Z
34G002	Ga. DOT, Lanier Bridge	310727	812853	10.05	1956	585	750	UF	C,E,J
34G003	Jekyll Island 18	310610	812928	5.69	09-01-1958	494	692	LB,UF	E,J
34G004	Jekyll Island 17	310331	812647	6.31	08-01-1961	552	780	UF	E,J
34G006	Jekyll Island 20	310249	812538	10.85	--	370	464	UB,LB	E,J
34G007	Jekyll Island 15	310115	812558	12.75	--	380	396	UB	E,J
34G008	Jekyll Island 12	310117	812538	8.20	10-01-1959	510	718	LB,UF	--
34G009	Jekyll Island 24	310103	812540	10	06-01-1955	561	706	UF	G
34G016	Jekyll Island 22	310607	812415	9.88	09- -1957	555	773	LB,UF	E,J
34G017	Jekyll Island 13	310658	812501	7.03	08-01-1957	502	715	LB,UF	E,J
34G020	Jekyll Island 23	310510	812516	10.02	08-01-1957	529	755	UF	D,E,J,C
34G029	Jekyll Island 03	310509	812439	16.76	07- -1963	526	766	LB,UF	E,J,C
34G030	Jekyll Island 08	310342	812450	7.32	06-02-1964	526	785	UF	E
34G031	Jekyll Island 01	310403	812422	15.85	08-01-1965	532	780	LB,UF	E,J
34G032	Jekyll Island 10	310413	812520	11.97	05-30-1966	544	766	UF	E,J
34G033	Jekyll Island 09	310418	812447	13	06-01-1966	540	686	UF	E,J
34G034	Quarantine Island	310653	812820	7	09-27-1983	231	462	S,UB,LB	E,J
34G035	Jekyll Island 04	310134	812508	10	05-01-1969	545	685	UF	C,E,G,J
34G036	USGS TW 23	310643	812920	7.50	08-01-1970	1,062	1,140	LF	C,E,J,Z
34H003	Paulk, R.	311432	812653	10.22	1955	585	730	UF	E,J
34H010	Twin Courts Motel	311344	812731	10	09-08-1958	575	694	UF	C,J,E
34H012	Brunswick, Ga. Fletc.	311407	812834	24	--	620	850	UF	-
34H013	Brunswick Fletc.	311354	812818	20	06-20-1941	610	1,063	UF	E,J
34H025	Brunswick Glynco Annex	311326	812826	19.47	12-01-1959	620	820	UF	E,Z
34H038	Tomlinson, J.E.	311155	812824	11	1951	526	664	LB,UF	E,J
34H060	Caravel Corp.	311016	812834	8.90	--	496	571	LB,UF	E,J
34H061	Benton Bros. Storage	311010	812838	9.68	1917	152	520	S,UB	E,J
34H062	Dixie-Obrien (front)	311005	812827	8.70	1959	554	810	UF	C,E
34H064	Dixie-Obrien (back)	311003	812824	8.56	1930	491	632	LB,UF	E,J
34H065	Hercules, Inc., A	310950	812851	11	1920	455	664	LB,UF	C,E,J
34H066	Hercules, Inc., B	310951	812849	11	1920	384	646	LB,UF	C,E,J
34H067	Hercules, Inc., C	310949	812848	10	1921	500	668	UF	--
34H070	Hercules, Inc., F	310955	812850	10	08-01-1929	557	887	UF	D
34H071	Hercules, Inc., H	310951	812846	10	10-01-1939	560	890	UF	C,D,E,J,T
34H073	Hercules, Inc., J	310951	812857	12	08-01-1942	547	890	UF	C,E,G,J
34H074	Hercules, Inc., K	310959	812844	10	03-08-1946	560	894	UF	C,D,E,J,Z

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. –, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued..									
34H075	Hercules, Inc., L	311002	812837	9	02-01-1945	560	895	UF	C,D,E,J
34H076	Hercules, Inc., M	310959	812901	13	02-01-1950	480	911	LB,UF	–
34H077	Hercules, Inc., N	311007	812903	15	08-14-1953	555	932	UF	D,E,J,C,F
34H078	Hercules, Inc., O	310948	812852	10	09-27-1955	545	890	UF	C,D,E,J
34H079	Hercules, Inc., P	310958	812839	9	08-26-1957	549	912	UF	D
34H082	Thon, L.L.	310927	812859	10.13	1949	550	656	UF	E,J
34H085	Brunswick Coffin Park	310906	812846	6.98	12-01-1938	514	623	UF	C,D,E,J
34H088	Knight, Ann	310839	812910	7.79	–	316	427	UB,LB	E,J
34H089	Lang Planing Mill	310830	812904	5.83	–	521	567	LB,UF	E,J
34H090	Purcell, Della	310822	812913	9.29	1928	496	592	LB,UF	J
34H091	Brunswick North Shipyard	310753	812901	6.08	06-01-1942	619	736	UF	C,J,E
34H094	Brunswick South Shipyard	310731	812913	9.03	07-01-1942	568	787	LB,UF	D
34H095	Georgia Pacific	310734	812919	5	06-25-1959	489	805	LB,UF	–
34H097	Ga. Ports Authority (Main Office)	310755	812927	7.04	1960	584	751	UF	E,J
34H098	Jekyll Island Packing	310801	812934	7.64	02-01-1958	556	780	LB,UF	E,J
34H100	Riley, Barney	310806	812925	11.35	1960	595	786	UF	E,J
34H104	Royalls, Ed	310817	812941	5	–	358	404	S	E,J
34H110	Lewis Crac Co. 4	310827	812943	6.60	1957	582	780	UF	C,E,J
34H112	Abbott Ice House	310841	812941	8.58	08-01-1960	540	780	UF	C,E,F,J,N, T,U
34H117	Whorton Crab	310852	812954	6.70	1956	528	747	UF	E,J
34H118	Brunswick, 1525 Grant Street	310859	812949	17.02	1912	508	980	LB,UF	C,E,F,J,N, T,U,Z
34H119	Brunswick (Old J49)	310859	812949	16.73	1918	380	428	UB,LB	E,J
34H120	Brunswick, F Street	310858	812952	10.44	04-01-1942	476	955	LB,UF	C,E,G,J
34H122	Coastal Bank	310859	812941	13.72	1960	448	573	LB,UF	C,E,F,J,N, T,U
34H125	USGS TW 01	310906	812931	11.57	1960	535	604	UF	C,E,G,J
34H128	Firestone	310919	812935	11	1960	519	700	UF	E,J
34H129	Glynn Cleaners	310922	812936	10.93	1956	537	747	UF	E,J
34H132	USGS TW 02	311020	812952	14	1962	540	1,103	–	D,E,F,J
34H133	Brunswick Goodyear Park	311035	812858	12	1943	520	800	UF	–
34H134	Brunswick Villa	311051	812955	12.67	04-01-1943	518	942	LB,UF	E,J
34H136	Ramsey, Ben	311159	812915	13.37	08-01-1959	526	692	S,UB,LB	E,J,E,J
34H144	J. Torras Cswy. Maint. Shop	310947	812652	11	1925	–	300	S,UB	–
34H145	Bennett, George	311005	812615	5.64	1948	391	430	UB,LB	E,J
34H146	Wilson, Arthur	311015	812542	8.38	1939	362	453	UB,LB	E,J
34H160	Sea Island Golf (59)	310840	812421	7.94	05-01-1959	580	1,052	UF	C,D,E,J
34H193	Mallory Park	310820	812337	10	–	435	437	LB	E,J
34H204	Glynn Co. Casino	310802	812341	10.14	1949	540	750	LB,UF	–
34H205	SSI Lighthouse	310801	812337	9.87	1927	477	608	LB,UF	E,J
34H238	Jackson	310825	812300	9	1960	150	406	S,UB,LB, UF	E,J
34H261	Shearouse, Fred (1960)	310948	812244	8	03-14-1960	–	428	–	J
34H289	Whittle, Lucian	311021	812233	6	1950	536	653	LB,UF	E,J
34H318	Mendenhall, W.C.	311212	812237	18.74	1955	614	766	UF	E,J

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued									
34H320	Gentile, Benny	311224	812231	19.56	1960	577	685	UB,LB,UF	E
34H328	USPS Ft. Frederica	311319	812329	12.38	12-01-1937	600	640	UF	--
34H334	USGS TW 04	310938	812853	8.33	09-01-1962	800	980	UF	D,E,J,T
34H337	USGS TW 05 (PT 1)	310824	812942	8.85	05-01-1963	567	919	LB,UF	C,D,E,J
34H338	Beverly Shores Oxidation	311227	812830	16.07	06-01-1962	576	767	UF	E,J,V
34H339	Georgia Motor Lodge	311306	812755	14.48	02-01-1963	581	755	UF	E,J
34H341	Brockington, Alfred	311232	812230	13.94	12-01-1962	855	993	UF	E,J
34H343	USNPS Ft. Frederica	311324	812318	9.83	07-01-1963	480	670	LB,UF	E,J
34H344	USGS TW 07	310938	812852	8.29	04-01-1964	504	770	UF	C,D,E
34H345	American National Bank	310857	812935	12	1964	560	780	UF	E,J
34H346	Sea Island Yacht Club	310952	812444	7.77	1962	546	800	LB,UF	E,J
34H347	Roberts, L.D.	310949	812806	6.90	10-01-1963	520	750	UF	E,J
34H348	Quick Clean Laundry	311024	812932	12.80	03-01-1964	536	787	UF	E,J
34H350	Engle, Marvin	311059	812404	6.48	1963	450	576	LB,UF	E,J
34H351	Twin Oaks Drive-In	310956	812949	16.63	08-01-1964	524	760	UF	E,J
34H354	USGS TW 08	310924	812952	13.76	06-01-1965	804	1,003	UF	C,E,F,J,N, T,U
34H355	USGS TW 09	310924	812952	13.98	06-01-1965	523	785	UF	C,E,F,G,N, T,U
34H356	Lewis Crab Co. 5	310827	812942	8.16	07-01-1965	578	624	UF	C,E,J,T
34H357	Troupe Creek Marina	311342	812701	7.29	04-01-1965	595	774	UF	E,J
34H358	Olsens Yacht Yard	311007	812458	5.55	02-01-1966	589	765	UF	E,J
34H359	Beverly Shores, 4	311224	812837	18.93	02- -1965	565	740	UF	--
34H361	Middleton Estates	311120	812248	12.90	1966	577	724	UF	E,J
34H362	Bloodworth, F.H.	311024	812419	13.67	06-01-1965	576	803	UF	E,J
34H363	USGS TW 10	310822	812958	2	06-01-1966	612	744	UF	A,E,J
34H364	Kennedy, R.L.	310819	812940	9.55	--	234	402	S	E,J
34H366	First Baptist Church	310848	812932	8.19	1956	529	791	UF	E,J
34H368	Sea Harvest Packing	311347	812720	9.09	07-01-1966	588	788	UF	E,J
34H369	Glynn Co. Golf Course	311437	812842	23.23	08-27-1966	642	796	UF	C,D,E,J
34H370	Ellzey, C.M.	311028	812739	7.58	1966	569	743	UF	E,J
34H371	USGS TW 11	310818	812936	9.49	10-01-1966	606	700	UF	E,G,J
34H372	Harrington, L.	310832	812921	10.83	11-01-1963	566	733	UF	E,J
34H373	USGS TW 13	310940	812933	9.28	10-01-1966	512	719	UF	E,G,J
34H374	USGS TW 14	310953	812959	17.02	11-01-1966	527	696	UF	E,G,J
34H376	St. Francis Xavier Church	310841	812938	6.55	12-01-1966	543	660	UF	E,J
34H377	Stopchuck, Mike	311108	812829	9.06	11-01-1966	522	630	UF	E,J
34H378	Seapak Corporation	310915	812307	15	01-31-1967	530	810	LB,UF	J,E
34H379	Harris, A.M., Sr.	310805	812916	11	1967	140	500	S,UB,LB	C,E,J
34H380	McGraw, R.O.	310928	812944	15	--	348	440	UB,LB	E,J
34H381	Beggs, R.	310959	812325	10	1967	496	630	UF	C,E,J
34H382	Rushing, Alton	311032	812841	9	1959	546	690	UF	E,J
34H383	Derry, Inez	311154	812300	10	06-01-1967	590	758	UF	E,J
34H384	Brunswick Country Club	311319	812758	13	05-01-1967	594	792	LB,UF	E,J
34H385	Champion, E.M. (1)	311016	812942	14	1948	500	572	LB,UF	E,J
34H386	Tollison, H.K.	310907	812907	11.76	1961	612	773	UF	E,J

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued..									
34H387	College Pl. Methodist Church	311115	812913	16	1964	100	120	S	--
34H388	Reu, A.H.	311419	812319	10	03-01-1963	631	804	UF	E,J
34H389	Golden Shores 5	310852	812951	8.11	01-11-1968	524	737	UF	E
34H390	Hercules Inc., Parking Lot	310947	812838	10	1968	407	409	LB	E,J
34H391	USGS TW 16	310818	812942	7.13	04-01-1968	1,070	1,158	UF	A,C,E,J
34H392	Brunswick Jr. College	311108	812905	16	05-01-1968	541	660	UF	C,E,J
34H393	USGS TW 17	310825	812942	6.95	10-01-1968	615	723	UF	A,C,E,J
34H395	Hall, Jim	311032	812243	14	1968	300	573	S,UB,LB, UF	E,J
34H397	Sea Island Golf (69)	310839	812422	10	1969	484	1,061	LB,UF	E,J
34H398	King Shrimp Co.	310749	812904	7	07-20-1969	622	720	UF	C,E,J
34H399	USGS TW 19	310749	812920	5.54	09-01-1969	1,075	1,218	UF	A,C,E,F,J,Z
34H400	USGS TW 20	310936	812949	12.50	09-01-1969	524	756	UF	A,C,E,J
34H401	USGS TW 21	310945	812955	13.16	09-01-1969	525	756	UF	A,C,E,J
34H402	USGS TW 22	310945	812955	13.21	09-01-1969	815	946	UF	A,C,E,J,Z
34H403	USGS TW 24	310822	812942	9.56	09-01-1970	788	982	UF	A,C,E,J,N, T,Z
34H405	Suddath Van Lines	311422	812654	10	1971	585	702	UF	E,J
34H406	Camp Islander	311354	812236	10	1971	621	721	UF	E,J
34H408	Van Diviere Oil Co.	311200	812945	17.99	08-01-1971	588	703	UF	E,J
34H409	Thrower, Charles	311346	812644	8.05	09-01-1971	605	728	UF	E,J
34H410	Laws, John, Sr.	311211	812746	6.50	09-01-1971	577	724	UF	E,J
34H411	Hercules Inc., R	311003	812857	13	05-01-1972	540	698	UF	E,J
34H412	Hercules Inc., Q	311019	812922	15	11-02-1972	548	630	UF	C,D,E,J
34H413	Hercules Inc., S	310951	812846	10	02-27-1973	550	838	UF	C,D,E,T
34H414	King & Prince Hotel	310938	812350	15	07-01-1973	556	708	UF	E,J,T
34H416	Lewis Crab Co. 6	310827	812943	8	08-15-1969	117	240	S	--
34H424	Hercules Inc., T	311011	812931	15	02-13-1976	550	745	UF	C,D,E,F,J,N, T,U
34H425	Hercules Inc., U	311016	812858	12	05-12-1976	550	700	UF	D
34H426	USGS TW 25	310938	812852	8.30	10-01-1976	1,027	1,211	LF	--
34H427	Champion, E.M. (02)	311016	812942	14	11-01-1977	500	640	LB,UF	--
34H428	UGA Marine Extension Serv.	310816	812939	10	05-21-1980	152	180	S	--
34H429	First Baptist Church (shallow well)	310851	812932	9	1981	140	160	S	--
34H430	Champion, E.M. (shallow well)	311016	812942	15	1977	100	200	S	--
34H431	Riley, Joe	311220	812852	16	1972	113	180	S	--
34H432	Griffin, Fred	311139	812255	12	1977	140	260	S	--
34H434	Glynn County Courthouse	310911	812941	10	1982	530	670	UF	J
34H435	ABC Home & Health Service	311121	812811	8	--	--	697	--	J
34H436	Coffin Park TW 1	310901	812844	6.62	10-20-1983	1,000	1,103	LF	C,E,F,G,J, N,P,S,T,V
34H437	Coffin Park TW 2	310901	812844	7	11-01-1983	313	328	UB	--
34H438	Coffin Park TW 3	310901	812844	7	11-09-1983	192	202	S	--
34H439	USGS TW 02 (PT 1)	311021	812952	13.91	1974	540	566	UF	--

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

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Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Glynn County--Continued..									
34H443	Lewis Crab Co. 7	310828	812942	8	03-01-1986	236	450	S,UB,LB	--
34H445	Brunswick Coffin Park PS	310902	812843	7	12-20-1986	580	824	UF	C,D,E,J,T
34H446	East Coast Ice Co.	310829	812945	8	1982	380	450	UB,LB	--
34J009	Newhope Plantation	311811	812651	9.39	1960	580	780	LB,UF	E,J
34J021	Job Corp.	311525	812717	16.84	05-01-1954	602	998	LB,UF	C,E,J,T
34J025	Altama Plantation (1966)	312007	812939	17	1966	633	716	UF	E,J,T
34J029	Wilder, H.	311854	812751	5.27	1969	686	866	UF	C,E,J
34J048	Humane Society	311509	812641	13.96	05-01-1970	605	702	LB,UF	E,J
34J049	Glynco Jetport	311557	812746	24.55	08-01-1970	640	788	UF	E,J
34J050	Altama Plantation 71	311939	812846	22	04-01-1971	688	824	UF	E,J
34J051	Ga. DOT, I-95 Rest Area	311647	812925	34.70	12-10-1971	709	839	UF	E,J,T
34J052	Humble/Union Bag 055	311745	812709	21	02-03-1958	0	1,589	TH	A,D,E,G
34J054	King, Ronnie	311539	812615	15	07-15-1983	620	700	UF	J
34J055	Sylvia, Bob	311540	812620	15	1978	144	220	S	--
35H012	Sea Island Gun Club (old)	311049	812129	6.18	--	514	640	LB,UF	E
35H014	Sea Island County 1	311053	812102	7	08-01-1928	553	721	LB,UF	E,J
35H037	US Coast Guard Station	310845	812226	9.87	--	580	704	UF	E,J
35H040	Verney, G.	311331	812119	11.70	10-02-1962	611	800	UF	E,J
35H042	Sea Island County, 22nd Street (old)	311146	812013	7.22	05-01-1963	580	1,042	UF	E,G,J,T
35H044	Sea Island County Gun Club (new)	311049	812128	6	09- -1966	598	789	UF	E,J
35H045	Sea Palms Hole 1	311200	812212	14.63	1967	607	796	UF	C,E,J
35H046	Sea Palms Hole 14	311123	812218	8.60	1967	626	799	UF	E,J
35H047	Olsen, O.H.	311102	812228	7	07-01-1967	583	752	UF	E,J
35H050	Sea Island County (36th Street)	311220	811927	8	02-23-1973	560	820	UF	E,J
35H053	Churchill, Phillip	311140	812212	10	1977	147	360	S	--
35H054	Bledsoe, B.E.	311158	812212	15	1979	80	100	S	--
35H055	Smith, Teddie E.	311342	812143	17	--	--	750	--	J
35J003	Humble/Taylor 01	311516	812058	13	09-07-1959	260	1,075	S,UB,LB,UF	A,D,E,G
35J004	Hagen, Dr. Arthur R.	311640	812037	10	07-01-1981	700	800	UF	--
35J005	Pendergast	311653	812028	10	01-06-1983	677	739	UF	J
Liberty County									
32N007	Liberty County Road and Revenue	314631	813804	90	10- -1965	538	689	UF	--
32N010	Johnson, C.	314917	813742	95	10-24-1967	506	700	UF	--
32N012	Mobley, H.L.	314857	813854	95	1967	546	720	UF	--
32N013	Deal, J.	314946	814120	85	11- -1969	503	600	UF	--
33M003	Jones, R.	314323	813005	16	11- -1966	416	600	UF	--
33M007	Humble/Union Bag 009	314322	813033	16	10-21-1957	0	730	TH	A,E,D,G
33N044	Kelly, J.	314910	813059	10.55	1957	333	460	S,UB,LB,UF	E,J
33N076	Mingledorff, F.	315043	813530	54	08-10-1963	440	682	UF	E,J
33N084	Hinesville, Ga. 03	315056	813455	22	1969	403	710	UF	D
33N085	Smith, F.	315003	813632	88	05-01-1968	485	600	UF	--
33N089	Burke, L.	314552	813721	80	09-08-1969	560	660	UF	--

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

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Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Liberty County--Continued									
33N091	Barrett, C.L.	314846	813026	22	04-23-1971	406	500	UF	--
33N092	Humble/Quaterman 01	315206	813434	29	03-17-1958	0	676	TH	A,E,D
33N093	Humble/Union Bag 024	314536	813653	68	11-15-1957	0	825	TH	A,E,D,G
33N094	Humble/Union Bag 039	314928	813027	21	12-17-1957	0	1,505	TH	A,E,D,G
33N095	Humble/Union Bag 040	314625	813029	17	12-19-1957	0	723	TH	A,E,D,G
33N096	Humble/Union Bag 041	314643	813323	16	12-20-1957	0	750	TH	A,E,D,G
33N097	Humble/Union Bag 044	314512	813121	17	01-07-1958	0	1,410	TH	A,E,D,G
33P019	USA Ft. Stewart Evans Heliport	315728	831011	31	08-18-1967	406	592	UF	A,C,D,E,G,J
34M019	Interstate Paper Co. (535')	314431	812542	13.95	01-17-1939	200	535	S,UB,LB,UF	E,J
34M020	Interstate Paper Co. (453')	314438	812457	9.78	02-09-1939	140	453	S,UB,LB,UF	E,J
34M021	Interstate Paper Co. (445')	314442	812434	13.84	02-09-1939	145	445	S,UB,LB,UF	E,J
34M043	Union Camp Paper Corp.	314333	812247	12	--	--	372	--	--
34M049	Riceboro Presbyterian Church	314412	812603	18.96	03-30-1965	447	700	UF	--
34M050	Kearsey, E.E.	314340	812529	19	08-16-1966	462	705	UF	E,J
34M051	Interstate Paper Co., Rust	314438	812425	12	10- -1966	427	810	UF	--
34M052	Interstate Paper Co., Rust	314435	812439	13	12- -1966	418	810	UF	--
34M053	Interstate Paper Co., Rust	314428	812453	12	03-28-1967	438	788	UF	E,J
34M054	USGS TW 02	314343	812519	19	01-27-1967	467	802	UF	E
34M056	Cooper, E.B.	314451	812757	20	09-01-1966	463	660	UF	--
34M057	Interstate Paper Co.	314439	812425	10	08-18-1966	189	606	S,UB,LB,UF	E,J
34M075	Standard Oil, I-95 & U.S. 1	313908	812341	10	09-20-1971	428	604	UF	E,J
34M083	Humble/James, WM 01	314324	812513	17	03-19-1958	0	750	TH	A,E,G
34M084	Humble/Minson, R 01	314240	812726	19	10-19-1957	0	750	TH	A,D,E,G
34M085	Humble/Union Bag 010	314241	812241	19	10-22-1957	0	785	TH	A,D,E,G
34M086	Humble/Lambert 01	314132	812433	15	10-18-1957	0	800	TH	A,D,E,G
34M087	Humble/Union Bag 058	314000	812617	22	02-09-1958	0	775	TH	A,D,E,G
34M088	Humble/Barton 01	314408	812822	14	02-10-1958	0	755	TH	A,D,E,G
34M089	Bruce, Bill	314426	812616	16	1939	196	310	S,UB	C,E,J
34N029	Union Camp Paper Corp.	314913	812611	21	06-13-1961	80	304	S,UB	E,J
34N088	Midway, Ga.	314757	812602	11	04-01-1966	400	662	UF	E
34N089	USGS TW 01	315214	812353	17	1967	410	789	UF	E,J
34N091	Young, J.	314829	812917	21	12-08-1968	400	600	UF	--
34N094	Humble/Union Bag 012	314624	812244	17	10-24-1957	0	749	TH	A,D,E,G
34N095	Humble/Union Bag 043	314731	812813	15	01-04-1958	0	750	TH	A,D,E,G
34N096	Humble/Union Bag 011	314528	812727	15	10-23-1957	0	720	TH	A,D,E,G
34N097	Humble/Union Bag 038	314915	812607	17	12-12-1957	0	800	TH	A,D,E,G
34P024	Gill, J.F.	315346	812531	18	1915	280	417	LB,UF	E,J
35M027	Blount	314352	811533	4	1940	385	590	UF	E,J
35M040	Jelks & Rogers 01	314114	812046	21	1953	163	4,264	LF	E,G,J
35M041	Tippens, Sam J.	314419	811928	26	06-03-1971	407	614	UF	E,J
35M043	Humble/Union Bag 103	314352	812210	7	09-26-1959	100	851	S,UB,LB,UF	A,D,E,G
35M044	Humble/Reikes 01	314412	811901	16	12-21-1957	0	725	TH	A,D,E,G
35M045	Humble/Stevens 01	314233	811655	9	10-02-1959	85	750	S,UB,LB,UF	A,D,E,G
35N061	Humble/Union Bag 104	314530	811816	22	10-03-1959	0	750	TH	A,D,E,G
35N062	Humble/Union Bag 013	314649	811812	30	10-25-1957	--	807	--	A,D,E,G
35N063	Humble/Union Bag 105	314531	812050	28	10-04-1959	0	750	TH	A,D,E,G
35N068	Ashburn, T.N. (swim pond)	314844	812119	10	--	0	600	--	J

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Liberty County--Continued									
36L001	Noble Foundation, St. Catherine (south end)	313627	811040	6	--	173	309	S,UB,LB	E
36M004	Noble Foundation, St. Catherine (power house)	314008	810933	13	1930	352	580	UF	E
36M013	Yellow Bluff Fishing Camp	314236	811423	15	06-01-1938	310	425	UB,LB,UF	E,J
36M018	Caines, W.W.	314401	811410	7	09- -1969	420	600	UF	--
36M020	Noble Foundation, St. Catherine (greenhouse)	313905	810934	11	1969	349	501	UF	C,E,J
Long County									
31M003	Humble/Altam. Land Co. 03	314005	814523	38	05-10-1959	0	819	TH	A,E
31M004	Humble/Altam. Land Co. 04	314203	814642	41	05-11-1959	0	800	TH	A,E
31M007	Humble/J.E. Parker, no. 01	314331	815223	52	11-03-1959	0	795	TH	A,E
31M008	Humble/Savannah River, Lum Corp., 01	314021	814747	34	04-26-1959	0	822	TH	A,E
31M025	Humble/Altam. Land Co., 05	314223	814834	41	10-27-1959	0	763	TH	A,E
31M029	Humble/Savannah River, Lum Corp., 02	314233	815058	38	05-13-1959	0	770	TH	A,E
31N005	Humble/Parker, J.E., no. 2	314532	815020	44	11-07-1959	163	764	S,UB,LB,UF	A,E,D,G
32L001	Humble/Savannah Lum Corp., 03	313426	814109	28	05-16-1959	0	799	TH	A,E
32L002	Humble/Savannah River Lum Corp., 04	313607	814144	21	05-17-1959	0	812	TH	A,E
32L003	Humble/Savannah River Lum Corp., 05	313308	813847	23	05-19-1959	0	830	TH	A,E
32L018	Humble/Savannah River Lum Corp., 06	313606	814343	42	05-22-1959	0	817	TH	A,E
32L019	Humble/Union Bag 030	313454	813842	23	11-24-1957	0	825	TH	A,E
32M001	Ludowici, GA, 1	314240	814441	66	06-01-1939	495	579	UF	D,G
32M002	Ludowici, GA, 2	314232	814434	62	1972	493	635	UF	--
32M003	Humble/Altam. Land Co., 01	313857	814400	31	05-08-1959	0	825	TH	A,E,D,G
32M005	Humble/Union Bag 023	314235	813739	69	11-13-1957	0	840	TH	A,E,D,G
32M006	Humble/Union Bag 025	314349	814146	64	11-17-1957	0	843	TH	A,E,D,G
32M009	Deloach, J.R.	313859	814119	46	12- -1969	510	610	UF	--
32M010	Humble/Union Bag 026	314109	814023	82	11-18-1957	0	825	TH	A,E,D,G
32M011	Humble/Union Bag 027	314133	814339	68	11-19-1957	0	825	TH	A,E,D,G
32M012	Humble/Union Bag 028	313921	814141	31	11-21-1957	0	775	TH	A,E,D,G
32M013	Humble/Union Bag 029	313734	814021	27	11-22-1957	0	775	TH	A,E,D,G
33L001	Humble/Union Bag 020	313442	813411	22	11-10-1957	0	800	TH	E,G
33L002	Humble/Union Bag 021	313724	813556	57	11-11-1957	0	825	TH	E,G
33L003	Humble/Union Bag 059	313541	813535	23	02-17-1958	0	795	TH	E,G
33M001	Humble/Union Bag 005	314100	813156	22	10-11-1957	0	784	TH	A,E,D,G
33M002	Humble/Union Bag 006	314335	813424	21	10-12-1957	0	755	TH	A,E,D,G
33M004	USGS TW 03	313854	813604	61.24	11-10-1967	538	870	UF	--
33M005	Humble/Union Bag 014	313849	813134	18	11-03-1957	0	755	TH	A,E,D,G
33M006	Humble/Union Bag 022	314003	813703	62	11-12-1957	0	800	TH	A,E,D,G
33M010	Humble/Union Bag 060	313949	813405	19	02-19-1958	0	1,363	TH	A,E,D,G

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
McIntosh County									
33K009	Eastside Fishing Club	312814	813619	24	1950	456	598	LB,UF	E,J
33K012	Davis,Edgar	312955	813610	2	11- -1959	458	660	LB,UF	E,J
33K016	Terrell, Mrs. Phillip	312659	813117	12	12- -1957	444	664	LB,UF	E,J
33K019	Goodrich, D.	312553	813001	12	08- -1972	590	720	UF	--
33K020	Humble/Ft. Barrington	312850	813653	13	10-05-1959	36	820	--	A,D,E,G
33K021	Humble/Union Bag 034	312728	813352	13	10-30-1957	0	810	TH	A,D,E,G
33K022	Humble/Union Bag 054	312849	813118	12	01-27-1958	0	1,492	TH	A,D,E,G
33K023	Humble/Union Bag 033	312953	813303	19	11-28-1957	0	800	TH	A,D,E,G
33K024	Humble/Union Bag 032	312920	813614	41	11-26-1957	0	795	TH	A,D,E,G
33K025	Humble/Union Bag 035	312729	813004	12	12-02-1957	0	865	TH	A,D,E,G
33K026	Humble/Savannah River Lum Corp., 07	312501	813209	17	09-22-1959	380	1,020	UB,LB,UF	A,D,E,G
33K027	Gail, Sammy	312609	813414	18	11-01-1981	552	710	UF	--
33L010	Union Camp Paper Corp.	313219	813149	19	1933	382	532	UF	E,J
33L027	Davis, E.	313020	813544	20	03-01-1968	465	700	UF	--
33L072	Humble/Union Bag 002	313723	813009	15	10-05-1957	0	780	TH	E,G
34J027	Darien, Ga. (1968)	312158	812530	21	01- -1968	658	799	UF	J,E
34J028	Ga. DNR Game & Fish Commission	312102	812651	4.03	--	561	598	LB	E,J
34J046	Pack, John	312227	812539	22	1958	559	618	LB,UF	E,J
34J047	Boone Seafood Co.	312156	812559	4	1970	683	806	UF	E,J
34K008	Blackburn, George	312508	812911	14	12- -1957	642	764	UF	E,J
34K012	Middleton, C.T.	312805	812910	19	1957	446	700	LB,UF	--
34K073	Howard, P.J.	312506	812816	45	1959	643	780	UF	--
34K079	Fisher, W.	312244	812506	22	1965	687	791	UF	E,J
34K080	Pearling Ind. Shoe Factory	312435	812730	28	1964	638	797	UF	E,J
34K081	Oquinn, C.	312439	812737	31	1952	630	850	UF	--
34K082	Young, E.L.	312531	812925	10	12- -1966	604	740	UF	E,J
34K083	Poppell, T.	312709	812529	41	1967	612	765	UF	--
34K084	Fischette, Mike	312503	812348	25	10-01-1968	610	780	UF	--
34K085	Ga. DOT, I-95 Weigh Station	312817	812715	19.58	11-01-1968	453	604	LB,UF	D,E,J,N
34K086	Dykes, W.L.	312417	812231	8	06- -1970	582	760	UF	E,J
34K087	Newburn, Joe	312350	812235	6	06- -1970	603	687	UF	A,E,J
34K091	Carter	312319	812251	7	1970	583	738	UF	E,J
34K092	Harper & Kimbrell	312303	812251	7	1970	582	760	UF	E,J
34K095	Fisher, C.M.	312254	812443	20	06- -1973	629	730	UF	--
34K100	Humble/Union Bag 037	312718	812316	15	12-08-1957	0	925	TH	E,G,A
34L027	Ware, G.	313217	812527	7	1955	301	641	UB,LB,UF	E,J
34L048	Williams, W.E. and F.B.	313054	812455	22	1958	495	575	UF	E,J
34L059	Warsaw Lumber Co.	313522	812937	15	1925	172	472	S,UB,LB,UR	E,J
34L060	Union Camp Paper Corp.	313531	812458	27	1971	426	760	UF	--
34L061	Standard Oil Co.	313155	812648	20	02- -1972	466	593	UF	E,J
34L066	Humble/Union Bag 048	313620	812612	17	01-16-1958	0	755	TH	E,G
34L070	Union Camp Sapelo Forest	313531	812457	25	--	136	394	S,UB,LB	C,E,J
34L071	Eelonia, Ga., 4/84	313031	812618	15	04-28-1984	618	634	UF	C,E,J

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
McIntosh County--Continued..									
34M001	Stebbins, C.H.	313814	812342	14	--	170	471	S,UB,LB,UF	C,E,J
34M070	King, Charles	313820	812903	12	12-02-1966	427	660	UF	E,J
34M076	Proudfoot, G.F. (home)	313749	812512	21	08- -1972	462	700	UF	--
35K062	Sapelo Research Foundation Long Tabby	312553	811656	6	1967	528	725	UF	E,J
35K063	Sapelo Research Foundation Air Strip	312456	811726	6	1967	60	364	S,UB,LB	E,J
35K064	Johnson, Benny	312517	811609	7	1967	320	372	UB,LB	E,J
35K065	Sapelo Research Foundation Mainland	312717	812152	4	1967	578	726	UF	E,J
35K068	Pease Island Development	312632	812209	9	1965	577	766	UF	E,J
35K069	Gore, S.	312840	812053	11	09- -1971	570	703	UF	E,J
35K071	Bolton, George	312845	812040	11	1982	486	638	LB,UF	C,E,J
35L067	Holt, V.	313325	812149	8	12-05-1966	436	586	LB,UF	E,J
35L068	Mitchell and Neighbors	313419	811926	18	07- -1969	485	640	UF	--
35L071	Proudfoot, H.S.	313722	811858	14	08- -1970	442	601	LB,UF	E,J
35L072	Stafford, T.A.	313309	812204	14	02-19-1970	483	604	UF	E,J
35L078	Harris Neck, Gould L.	313719	811542	7	--	204	359	S,UB,LB	C,E,J
35L080	Julienton, Thorpe, H.	313336	811806	18	1912	395	582	LB,UF	C,E,J
35L081	Julienton, Middle Road	313410	811737	15	1939	416	699	LB,UF	C,E,J
35M013	US Fish and Wildlife Harris Neck 01	313823	811542	16.30	1942	376	553	LB,UF	--
35M014	US Fish and Wildlife Harris Neck Airfield	313759	811613	20	01-23-1964	452	621	UF	D,C,E,J
35M015	US Fish and Wildlife Harris Neck Airfield	313806	811625	14	1941	366	557	LB,UF	E,J
35M046	Humble/Union Bag 007	313810	812215	17	10-14-1957	0	725	TH	A,D,E,G
36K001	Reynolds, R.J.	312611	811421	12	1960	520	780	UF	E,J
36K004	US Fish and Wildlife Blackbeard Island 04	312923	811233	12	03- -1935	439	709	LB,UF	E,J,G,D
36L007	US Fish and Wildlife Blackbeard Island 05	313205	811205	7	1966	20	301	S,UB,LB	E,J
36L008	US Fish and Wildlife Blackbeard Island 01	313135	811222	8	11-15-1934	397	520	LB,UF	E,J,E,J
36L009	US Fish and Wildlife Blackbeard Island 02	313053	811223	10	12-29-1934	408	533	UF	E,J
36L010	US Fish and Wildlife Blackbeard Island 03	313020	811226	13	02-14-1935	431	617	UF	D,E,J
36L011	Sapelo Research Foundation (pond)	313030	811402	8	1968	273	339	UB,LB	E,J

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
__Screven County__									
31V007	Collins, Leslie W.	323954	814837	155	1960	80	147	UF	--
31V008	Smith, Bobby	323847	814625	192	1959	177	207	UF	--
31V012	Lee, T.W.	323924	814650	231	05-01-1962	198	230	UF	--
31V014	Newton, Walton	323828	814716	167	10-01-1958	154	167	UF	--
31V017	Johnston, Floyd	323945	814945	129	1963	160	249	UF	--
31V018	Wommack, Lincoln	323911	814952	114	1963	50	105	UF	--
31W002	Brabb, Albert	324958	814506	291	10-01-1958	221	245	UF	--
31W014	Doyle, B.H.	325011	814602	312	1956	220	360	UF	--
31X001	Continental Can	325335	814530	204	1967	168	175	UF	--
32U001	Robinson, Willett	323715	814024	242	07-01-1961	254	275	UF	--
32U004	Anderson, B.H.	323542	814303	170	1962	195	225	UF	--
32U005	Hunter, William F.	323514	813848	212	09-01-1962	286	290	UF	--
32U016	Wyant, W.W.	323435	814255	100	--	90	255	UF	--
32U017	King Finishing Mfg. 01	323608	814423	155	1965	1,266	1,326	D	D,E,J
32U019	King Finishing Mfg. 03	323604	814411	150	09-10-1971	1,253	1,323	D	D,E,J
32V001	Pye, O.J., Jr.	324037	814128	211	04-01-1959	147	255	UF	--
32V003	Evans, Hezzie	324031	814046	209	12-01-1961	168	187	UF	--
32V007	Rowell, H.G.	323813	814153	223	--	260	265	UF	--
32V012	Burke, David H.	323824	814316	202	1955	--	220	UF	--
32V013	Armett School	323923	814202	232	1954	208	301	UF	--
32V031	Waters, G.C., Jr.	324250	813735	253	1959	185	270	UF	--
32V035	Peavy, Elliot	323749	813900	214	1966	210	250	UF	--
32V039	Evans, Mrs. C.	324238	813730	245	1962	210	268	UF	--
32W001	Basemore, C.	324629	814225	244	06- -1961	189	210	UF	--
32W002	L.A. Thigpen Construction Co.	324624	813942	235	11-01-1960	133	202	UF	--
32W006	Waters, Mrs. A.F.	324855	814001	122	12-01-1959	122	186	UF	--
32W065	Brannen, J.R.	325055	813806	179	1959	100	202	UF	--
32W070	Sylvania, Ga., 04	324503	813916	187	--	227	257	UF	--
32X035	Griffin, Marion	325339	814000	165	11-12-1969	85	100	UF	--
33U021	Newington, Ga. (1966)	323525	813011	150	--	186	245	UF	--
33U023	Oliver, Ga. 02 (1968)	323116	813204	114	07-01-1968	242	322	UF	--
33U024	Screven Oil Test 1933-34	323009	813254	75	1934	215	608	UF	C,E,J
33V005	Evans, Mrs. J.J.	323856	813346	215	06- -1959	200	260	UF	--
33V011	Boykins, Vernon L.	324234	813020	148	06-01-1958	140	187	UF	--
33V020	Hunters, W.H.	323747	813216	162	1959	203	236	UF	--
33V021	Lee, M.P.	324118	813453	225	07-01-1963	189	225	UF	--
33W001	Weaver, J.K.	324756	813345	132	1942	82	84	UF	--
33X013	Screven County Millhaven School	325538	813529	137	1954	200	300	UF	--
33X022	Carter, Saddie	325713	813454	148	1962	150	210	UF	--
34U001	McCain-Pryor 1	323506	812538	125	06-13-1963	0	2,677	TH	G,D
34V004	Boddiford, B.R.	324145	812935	163	12- -1962	148	210	UF	--

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Wayne County									
29K002	Thomas, Lindsey G.	312845	820146	118	03-23-1955	557	750	UB,LB,UF	D
29L005	Lake Lindsey Grace	313402	820228	110	1975	645	800	UF	--
29M001	Odum, Ga.	313950	820143	160	1955	525	725	UF	--
29M002	State of Georgia Correction Department	314026	820714	169	09- -1968	450	750	UF	--
29M004	Oquinn, R.	314451	820023	162	1963	620	710	UF	--
29N003	Anderson, F.	314824	820304	178	1958	550	660	UF	--
30K004	Brunswick Pulp and Paper Mears 1	312719	815253	55	02-26-1974	662	770	UF	C,E,F,J, N,T,U
30K016	Scott and Mean 1-C	312718	815253	61	03-26-1975	0	4,500	TH	G
30K017	Humble/Bennett 01	312958	815847	108	04-14-1959	0	830	TH	E,G,A
30K018	Humble/Davis 01	312533	815901	88	05-03-1959	0	774	TH	E,G,A
30K019	Humble/Rodgers 01	312858	815402	50	06-18-1959	0	905	TH	E,G,A
30L003	Johnson, H.	313701	815434	105.77	08-19-1963	472	594	UB,LB,UF	E,J
30L009	Jesup Industrial Park	313457	815447	106	09-01-1967	532	651	LB,UF	C,E,J
30L011	Aspinwall, C.	313041	815944	123	10-01-1970	594	732	UF	--
30L012	Parkerson, B.D.	313618	815703	152	12-01-1970	614	700	UF	--
30L013	Jesup, Georgia Industrial Park	313457	815448	105	1967	650	696	UF	--
30L014	Jones, Dr. Charles	313423	815301	105	05-01-1983	584	720	UF	--
30L016	Humble/Jones 01	313700	815345	82	10-09-1959	0	850	TH	A,E,D,G
30L017	Humble/Green 01	313341	815851	113	04-24-1959	0	920	TH	A,E,D,G
30M003	Harrison, R.	313935	815459	112	06-01-1962	503	620	LB,UF	--
30M004	Wayne County-Oglethorpe Landing	314316	815409	100	08-01-1963	505	638	UF	E
30M005	Waters, L.L.	313829	815333	105	11- -1968	497	655	UF	--
30M007	Miles, F.C.	314250	815745	107	06-01-1967	540	700	UF	--
30M011	Ganus, L.	313756	815621	153	06- -1967	519	640	UF	--
30M012	Forbes, Thomas	314037	815936	150	05-21-1974	603	720	UF	E,J
30M013	Miles Brothers Stockyard	313941	815446	112	03-18-1974	582	696	UF	E,J
30N001	Wayne County-Mitchell Landing	314659	815853	65	1963	533	660	UF	E
30N002	Anderson, L.	314512	815802	166	06-01-1967	591	724	UF	E,J
31K001	Brunswick Peninsular Corporation	312330	814831	55	12-17-1944	0	4,626	TH	G
31K002	Ga. DNR Wayne 02 (test hole)	312712	815131	55	05-03-1974	0	686	TH	E,J
31K003	H-3	312320	814505	55	--	--	431	--	J
31L001	Brunswick Pulp and Paper J. Mears 2	313102	815220	55	03-11-1975	587	691	UF	--
31L002	Humble/Kicklighter 01	313651	814759	45	06-12-1959	0	799	TH	A,E,D,G
31L003	Humble/Grantham 01	313630	814948	63	04-27-1958	0	800	TH	A,E
31L004	Humble/Lee Williamson 01	313518	814646	37	05-24-1959	0	775	TH	A,E,D,G
31L005	Humble Union Bag no. 64 1	313317	814652	61	03-06-1958	0	855	TH	E
31L009	Humble/Hopkin Brothers 05	313119	814622	72	06-06-1959	0	852	TH	A,E,D,G
31L010	Humble/Union Bag 106	313128	814912	59	10-13-1959	0	857	TH	A,E,D,G
31L011	Humble/Union Bag 069	313009	815015	63	04-01-1958	0	837	TH	A,E,D,G

Appendix B.--Record of selected construction information and available geophysical logs for wells in the study area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; D, Dublin aquifer; TH, test hole only, no aquifer tapped. Type of geophysical logs available: A, time; B, collar; C, caliper; D, driller's; E, electric; F, fluid resistivity; G, geologist; H, magnetic; J, natural gamma; K, dipmeter; L, lateral log; N, neutron porosity; O, micro-lateral log; P, photo video; S, acoustic velocity; T, temperature; U, gamma-gamma; V, fluid velocity; X, core; Z, other. --, data not available]

Well no.	Well name	Latitude	Longitude	Altitude of land surface (ft)	Date well constructed	Top of open interval (ft)	Bottom of open interval (ft)	Aquifer code	Type of available logs
Wayne County--Continued..									
31M006	Smith, Ned	314016	815112	98	04-01-1970	560	670	UF	--
31M009	ITT Rayonier D 01	313942	815039	100	04-01-1952	480	1,010	UF	D,G
31M010	ITT Rayonier D 02	313934	815023	85	09-03-1952	486	1,010	UF	D
31M011	ITT Rayonier D 03	313924	815010	88.50	10- -1952	460	998	UF	--
31M012	ITT Rayonier D 04	313911	815001	83	10-20-1952	488	1,010	UF	D
31M013	ITT Rayonier D 05	313859	814959	75	06- -1956	500	1,000	UF	--
31M014	ITT Rayonier D 06	313911	815020	81	07- -1956	493	1,000	UF	--
31M015	ITT Rayonier D 07	313924	815033	95	06-01-1956	478	1,000	UF	D
31M016	ITT Rayonier D 08	313931	815051	100	1956	480	1,000	UF	--
31M018	ITT Rayonier S 02	313937	815040	92	06-01-1963	163	183	S	--
31M019	ITT Rayonier S 01	313936	815036	96	06-01-1963	180	204	S	--
31M020	ITT Rayonier S 04	313930	815035	96	02-03-1964	180	200	S	--
31M021	ITT Rayonier S 03	313927	815031	96	1964	172	191	S	--
31M022	Connie-Kicklighter	313817	815106	92	1973	540	691	UF	--
31M024	Adams, C.C.	313850	815108	95	02- -1971	560	650	UF	--
31M030	ITT Rayonier D 09	313830	814959	78.10	05-01-1971	500	855	UF	--
31M031	ITT Rayonier D 10	313806	814939	64.10	07- -1971	515	850	UF	--
31M032	ITT Rayonier D 11	313749	814917	63.20	09- -1971	510	937	UF	--
31M033	Williams, D.	313958	815207	97	12- -1970	557	708	UF	--
31M034	Boykin, E.	313743	815158	84	02- -1974	455	580	UF	--
32K007	Brunswick Pulp and Paper Mt. Pleasant	312549	814032	55	01- -1957	605	618	UF	E,J
32K014	Brunswick Pulp and Paper Land Co.	312555	814039	57	09-01-1982	600	700	UF	--
32K015	Humble/Union Bag 066	312425	814200	53	03-21-1958	0	927	TH	E,G,A
32K016	Humble/Union Bag 063	312916	814148	47	03-04-1958	0	835	TH	E,G,A
32K017	Humble/Hopkins Bros. 07	312948	814043	49	06-14-1959	0	756	TH	E,G,A
32L004	Martin, M. and L.	313018	814119	40	03- -1971	546	700	UF	--
32L005	Hopkins no. 2	313252	814336	74	12-08-1977	1,364	2,070	LF	A,C,D,E, F,G,H,I,J, K,M,N,T,U
32L006	Hopkins, C.D., no. 1 (1976)	313215	814357	75	04-30-1976	0	3,198	TH	T,N,E,J, U,C
								F,G	
32L007	Humble/Mary Anderson 01	313342	814457	46	06-10-1959	0	812	TH	A,E
32L009	Humble/Hopkins Bros. 06	313109	814157	54	06-07-1959	0	792	TH	A,E
32L010	Humble/Hopkins Bros. 09	313125	814455	68	10-12-1959	0	860	TH	A,E
32L011	Humble/Union Bag 067	313255	814236	67	04-26-1958	0	1,601	TH	A,E
32L013	Humble/Union Bag 088	313215	814112	47	06-08-1959	0	807	TH	A,E
32L014	Union Camp Paper 01	313112	814102	49	11-22-1960	--	--	TH	G
32L015	Gardi TW 1	313252	814336	74	04-20-1983	545	750	UF	E,J
32L016	Gardi TW 2	313252	814336	74	04-26-1983	320	340	UB	--
32L017	Gardi TW3	313252	814336	74	05-03-1983	200	215	S	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality Chloride (mg/L)	Specific conductance	Date sampled
Brantley County							
28H004	UF	125	-80.25	05-17-85	--	--	--
29H002	UF	130	-83.80	05-17-85	--	--	--
30H003	UF	62	-25.55	05-17-85	--	--	--
30H005	UF	65	-25.30	05-20-85	--	--	--
31H005	UF	53	-14.95	05-17-85	--	--	--
31J001	S	49	-16.60	05-13-85	--	--	--
Bryan County							
34P012	UB,LB,UF	14	-20.57	05-13-85	--	--	--
34P014	LB,UF	18	-19.82	05-13-85	--	--	--
34R039	UF	76	-65.20	05-14-85	--	--	--
35N021	S,UB,LB,UF	17	-27.68	05-13-85	--	--	--
35N059	UB,LB,UF	18	-27.80	05-13-85	5.7	289	11-02-84
35P057	LB,UF	20	-27.20	05-13-85	--	--	--
35P078	UF	10	-19.65	05-13-85	--	--	--
35P099	UF	19	-31.52	05-13-85	4.3	210	11-01-84
35P100	UF	11	-27.40	05-13-85	--	--	--
36N002	S,UB,LB	11	-18.29	05-13-85	4.3	270	11-02-84
36P091	UF	11	-31.47	05-13-85	--	--	--
36P093	UF	12	-32.06	05-13-85	12	262	11-02-84
Bulloch County							
30S001	UF	233	-155.05	05-15-85	--	--	--
30U002	UF	297	-169.40	05-15-85	--	--	--
31S007	UF	180	-131.29	05-16-85	--	--	--
31S008	UF	156	-114.08	05-16-85	--	--	--
31T007	UF	243	-158.46	05-16-85	--	--	--
31T010	UF	227	-137.60	05-16-85	--	--	--
31T011	UF	202	-129.75	05-16-85	--	--	--
31T023	UF	170	-71.92	05-16-85	--	--	--
32T003	UF	155	-68.73	05-16-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Bulloch County--Continued.							
32T013	UF	155	-97.07	05-16-85	--	--	--
32T015	S,UB,UF	185	-107.93	05-16-85	--	--	--
Camden County							
30F004	UF	65	-23.02	05-15-85	27	519	11-02-84
31E001	LB,UF	22	+18.10	05-15-85	--	--	--
31F017	UF	15	+21.30	05-15-85	19	486	11-02-84
31F022	UF	20	+21.00	05-15-85	31	538	11-02-84
32E004	LB	26	+13.30	05-15-85	--	--	--
32E033	LB,UF	18.25	+17.70	05-15-85	37	700	11-02-84
32F008	UF	9	+33.50	05-15-85	48	627	11-02-84
32G004	UF	15	+19.80	05-15-85	14	292	11-03-84
32G007	LB,UF	16	+22.20	05-15-85	--	--	--
32G015	UF	20.83	+16.50	05-15-85	--	--	--
33D004	UB,LB,UF	10	-5.37	05-15-85	--	--	--
33D006	UF	9	--	--	42	700	11-02-84
33D022	UF	10	-70.07	05-14-85	--	--	--
33D048	UF	13	-25.37	05-14-85	--	--	--
33D049	UF,LF	15	--	--	37	690	11-02-84
33D050	UF,LF	15	--	--	30	685	11-02-84
33D058	UF	13	-25.50	05-14-85	--	--	--
33D061	UF	15	-89.02	5-14-85	77	830	11-02-84
33D063	UF	15	--	--	36	685	11-02-84
33E002	S,UB	22	--	--	38	708	11-02-84
33E004	S,UB,LB,UF	16	+18.00	05-15-85	37	654	11-21-84
33E007	UF	18	+2.70	05-15-85	--	--	--
33E009	S,UB,LB,UF	12	+25.00	05-15-85	38	633	11-02-84
33E023	LB,UF	16	+23.00	05-15-85	42	638	11-02-84
33E027	UF	10	--	--	32	467	11-02-84
33F001	LB,UF	9	+26.00	05-15-85	46	626	11-01-84
33F002	LB,UF	10	+26.35	05-21-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Camden County--Continued.							
33E027	UF	10	--	--	32	467	11-02-84
33F001	LB,UF	9	+26.00	05-15-85	46	626	11-01-84
33F002	LB,UF	10	+26.35	05-21-85	--	--	--
33F003	UF	20	+13.20	05-21-85	--	--	--
33F004	UF	12	+19.75	05-21-85	--	--	--
33F017	UF	12	+26.76	05-21-85	--	--	--
33G005	UF	7	+28.00	05-15-85	41	528	11-03-84
33G006	UB,LB,UF	12	+25.70	05-15-85	41	412	11-03-84
34E002	UF	17	+16.40	05-13-85	41	675	11-01-84
34E003	UF	14	+12.50	05-13-85	38	275	11-01-84
34E009	UF	17	+4.60	05-13-85	--	--	--
34E010	UF	10	+13.60	05-13-85	41	665	11-01-84
Charlton County							
27E003	UF	117	-71.70	05-17-85	--	--	--
27E004	UF	116	-68.40	05-17-85	--	--	--
28D001	UF	128	-84.15	05-16-85	--	--	--
29F001	UF	145	-94.40	05-17-85	--	--	--
30E002	UB	12	--	--	32	594	11-21-84
30E007	UF	91	-51.37	05-17-85	--	--	--
Chatham County							
35P085	LB,UF	15.55	-40.58	05-20-85	--	--	--
35P091	S,UB,UF	10	-27.99	05-20-85	4.2	233	11-01-84
35P094	S	18.67	-10.87	05-31-85	--	--	--
35Q043	UF	11.22	-38.87	05-21-85	--	--	--
35R018	S,UB,UF	38	-46.62	05-20-85	4.3	226	11-01-84
35R025	UF	20	-45.10	05-20-85	4.9	220	11-01-84
36P087	UF	18.14	-47.70	05-16-85	--	--	--
36P090	UF	20	-70.90	05-21-85	4.0	195	10-31-84

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Chatham County--Continued.							
36P094	UF	18	-47.80	05-21-85	--	--	--
36Q005	UF	11	-118.00	05-20-85	--	--	--
36Q007	UF	7.64	-102.10	05-20-85	--	--	--
36Q008	UF	9.91	-116.62	05-20-85	--	--	--
36Q013	UF	34.27	-95.52	05-21-85	5.5	134	10-31-84
36Q014	UF	45.06	-125.77	05-21-85	--	--	--
36Q019	UF	10.02	-43.10	05-20-85	--	--	--
36Q020	UF	13.38	-48.72	05-21-85	--	--	--
36Q283	UF	22.79	-54.67	05-20-85	5.0	214	11-01-84
36Q287	UF	40	-92.94	05-20-85	5.4	237	11-02-84
36Q300	UF	18	-70.13	05-20-85	--	--	--
36R008	UB,UF	16.1	-83.10	05-20-85	--	--	--
37P005	UF	20	-70.70	05-21-85	10	202	10-31-84
37P006	UF,LF	18	-71.73	05-21-85	13	232	10-31-84
37P009	UB	9.8	-57.15	5-21-85	6.3	214	10-31-84
37P013	UF	11	--	--	4.8	208	10-31-84
37P083	UF	9.0	-53.29	05-21-85	--	--	--
37P086	UF	10	-41.00	05-21-85	5.6	225	10-31-84
37P087	UF	12.5	-51.55	05-21-85	7.2	247	10-31-84
37P113	LF	10	-53.50	05-20-85	340	1,480	11-07-84
37P114	UF	10	-54.08	05-20-85	5.3	224	11-07-84
37P115	UF	10	-52.89	05-20-85	31	206	11-07-84
37P116	S	10	-8.42	05-20-85	--	--	--
37Q012	UF	42.63	-138.90	05-20-85	--	--	--
37Q015	UF	18.98	-119.29	05-21-85	10	220	10-31-84
37Q016	UF	4.7	-95.10	05-21-85	--	--	--
37Q017	UF	5.6	-75.90	05-20-85	--	--	--
37Q024	UB,UF	14.9	-118.20	05-21-85	12	243	10-29-84
37Q030	UF	15.9	-106.50	05-21-85	--	--	--
37Q031	UF	19.51	-105.00	05-21-85	--	--	--
37Q032	UF,LF	25.2	-106.95	5-20-85	16	246	10-29-84
37Q033	UF	18.77	-108.69	05-23-85	5.3	217	11-01-84
37Q034	S,UB,UF	27.7	-85.86	05-23-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Chatham County--Continued.							
37Q038	UF	27.6	-113.70	05-22-85	15	226	10-29-84
37Q040	UF	30.4	-116.10	05-21-85	11	240	10-30-84
37Q042	UB,UF	12	-72.40	05-23-85	--	--	--
37Q043	UF	18	-74.22	05-23-85	5.8	220	10-29-84
37Q066	UF	11	-93.90	05-21-85	8.7	210	10-29-84
37Q090	UF	8.4	-124.35	5-23-85	12	260	12-31-84
37Q160	UF	10	-53.80	05-23-85	6.1	209	10-24-84
37Q162	UF	41	-138.90	05-21-85	--	--	--
38P001	UF	9	-45.30	05-20-85	8.6	217	10-31-84
38P012	UF	12	-50.20	05-21-85	9.2	218	10-29-84
38Q001	UF	7.8	-33.27	05-23-85	--	--	--
38Q002	UF	8.1	-33.50	05-16-85	--	--	--
38Q004	LF	7.68	--	--	51	426	10-30-84
38Q190	UF	5.8	-47.10	05-21-85	25	232	10-30-84
38Q199	UF	7.45	-51.20	05-16-85	45	396	10-30-84
39P001	UF	9	-40.76	05-16-85	23	--	10-30-84
39Q001	UF	12.71	-34.12	05-16-85	45	445	10-30-84
39Q003	UF	7	-28.22	05-16-85	--	--	--
39Q006	UB,UF	10	-30.89	05-16-85	53	620	10-30-84
39Q017	LF	7	-29.50	05-16-85	960	6,560	10-30-84
39Q018	LF	7	-29.91	05-16-85	660	3,600	10-30-84
Effingham County							
34U006	UF	130	-67.60	05-16-85	--	--	--
34U008	UF	130	-83.10	05-16-85	--	--	--
35R026	UF	59	-58.30	05-20-85	--	--	--
36S004	UF	61	-72.62	05-16-85	--	--	--
36S022	UF	61	-68.60	05-16-85	4.1	207	11-03-84

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

					Water quality -		
Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Chloride (mg/L)	Specific conductance	Date sampled
<u>Glynn County</u>							
32H001	UB,LB	21	+6.80	05-13-85	--	--	--
32J003	UF	18.72	+11.60	05-13-85	--	--	--
33G001	UF	8.43	+21.80	05-13-85	31	492	11-02-84
33G002	UF	8.23	+13.20	05-13-85	78	745	11-02-84
33G003	UF	12.67	+12.00	05-13-85	27	498	11-03-84
33G008	UF	7.46	+14.70	05-13-85	--	--	--
33G026	UF	10	--	--	28	446	11-03-84
33H013	UF	10	+9.50	05-13-85	23	391	11-03-84
33H035	UF	7.71	-8.70	05-13-85	--	--	--
33H038	UF	9.05	+8.30	05-13-85	21	--	11-01-84
33H046	S	11	-3.20	05-13-85	9.5	360	10-14-87
33H052	UF	10	+2.65	05-13-85	--	--	--
33H079	UF	8.73	+1.30	05-13-85	--	--	--
33H100	UF	12.44	-13.83	05-14-85	--	--	--
33H104	UF	8.0	--	--	24	445	11-02-84
33H105	UF	8.0	-10.80	05-20-85	--	--	--
33H110	LB,UF	6.85	--	--	370	1,650	11-02-84
33H113	UF	10	--	--	120	834	11-02-84
33H114	UF	9.74	--	--	410	1,750	11-02-84
33H115	UF	8.59	--	--	370	1,640	11-02-84
33H120	UF	11.88	-20.20	05-14-85	--	--	--
33H127	UF	6.15	-12.08	05-14-85	610	2,110	10-26-84
33H130	UF	10.79	-20.67	05-14-85	1,900	6,110	10-29-84
33H133	UF	6.71	-3.81	05-14-85	1,300	4,570	10-29-84
33H139	UF	9.12	+9.80	05-13-85	19	464	11-03-84
33H141	UF	12.55	-5.78	05-14-85	18	414	10-30-84
33H149	UF	13	-0.10	05-13-85	--	--	--
33H154	UF	10	-24.85	05-14-85	470	1,850	10-29-84
33H164	UF	10	+9.00	05-13-85	18	448	11-01-84
33H174	UF	30	-18.75	05-15-85	--	--	--
33H177	UF	15	+13.90	05-13-85	67	724	11-02-84

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Specific conductance	Date sampled
Glynn County--Continued.							
33H179	UF	20	+1.65	05-13-85	21	451	11-03-84
33H180	UF	15	-19.15	05-15-85	--	--	--
33H189	UF	5	--	--	430	1,810	11-02-84
33H190	UF	17	-6.28	05-13-85	--	--	--
33H192	LF	10	+19.00	05-13-85	--	--	--
33H193	UF	10	+14.50	05-13-85	--	--	--
33H194	S	10	-4.90	05-13-85	10	420	10-14-87
33H195	S	20	-14.00	05-13-85	--	--	--
33H196	S	16	-8.20	05-13-85	--	--	--
33H198	S	20	-13.00	05-13-85	12	375	10-14-87
33H201	S	20	-12.05	05-13-85	9.3	340	10-12-87
33H202	S	9	-3.60	05-13-85	12	40	10-14-87
33H203	S	15	-8.33	05-13-85	13	470	10-14-87
33H205	S	30	-21.35	05-13-85	13	400	10-14-87
33H206	UF	7	+1.80	05-17-85	280	1,270	10-30-84
33H207	UF	7	-6.72	05-17-85	18	449	10-30-84
33H208	S	7	-6.00	05-17-85	--	--	--
33H209	UF	10	+2.15	05-13-85	19	448	11-01-84
33H211	UF	12.6	-27.83	05-13-85	--	--	--
33H212	UF	6.59	-18.76	05-13-85	1,000	4,400	10-13-87
33H213	UF	6.59	-25.76	05-14-85	42	690	10-13-87
33H214	UF	6.36	-57.39	05-13-85	1,300	5,300	10-13-87
33H215	UF	6.36	-28.37	05-13-85	1,900	6,800	10-13-87
33H216	UF	10.95	-6.24	05-17-85	1,700	6,000	10-13-87
33H217	UF	10.95	-33.00	05-17-85	1,500	5,800	10-13-87
33H218	UF	10.95	-22.70	05-13-85	2,100	7,800	10-13-87
33J013	UB,LB	13.	-20.00	11-08-60	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Glynn County--Continued.							
33J026	UF	13.13	+5.80	05-13-85	21	449	11-03-84
33J028	UF	10.	+6.95	05-13-85	30	477	11-03-84
33J034	UF	25.	-12.22	05-13-85	--	--	--
33J043	UF	20	-0.50	05-15-85	--	--	--
33J044	UF,LF	20	-1.24	05-15-85	31	492	11-03-84
33J046	S	12	-0.20	05-13-85	--	--	--
33J047	S	20	-6.76	05-13-85	--	--	--
33J048	S	16	-2.00	05-13-85	--	--	--
33J049	S	31	-20.60	05-13-85	12	410	10-14-87
33K005	LB,UF	9.78	+7.45	05-13-85	17	405	11-03-84
34G001	LB,UF	8.79	+8.65	05-14-85	--	--	--
34G002	UF	10.05	+8.60	05-14-85	58	650	11-02-84
34G003	LB,UF	5.69	+15.80	05-14-85	100	756	11-02-84
34G004	UF	6.31	+27.33	05-14-85	21	496	11-02-84
34G008	LB,UF	8.2	--	--	37	533	11-02-84
34G009	UF	10	+29.80	05-14-85	--	--	--
34G017	LB,UF	7.03	+19.50	05-14-85	18	--	11-02-84
34G020	UF	10.02	+20.50	05-14-85	--	--	--
34G036	LF	7.5	+17.80	05-14-85	240	1,330	11-02-84
34H012	UF	24	+13.95	05-14-85	--	--	--
34H025	UF	19.47	--	--	24	454	11-03-84
34H062	UF	8.70	-12.12	05-16-85	--	--	--
34H065	LB,UF	11	--	--	50	1,530	11-01-84
34H067	UF	10	--	--	97	661	11-01-84
34H070	UF	10	--	--	1,100	3,510	11-01-84
34H073	UF	12	--	--	200	1,120	11-01-84
34H074	UF	10	-12.90	05-17-85	--	--	--
34H075	UF	9	--	--	28	467	11-01-84
34H076	LB,UF	13	-13.02	05-17-85	230	1,180	11-01-84
34H078	UF	10	--	--	68	572	11-01-84
34H079	UF	9	-9.25	05-17-85	110	712	11-01-84

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Glynn County--Continued.							
34H085	UF	6.98	-2.72	05-14-85	17	417	11-01-84
34H091	UF	6.08	--	--	30	476	11-02-84
34H094	LB,UF	9.03	--	--	62	616	11-02-84
34H095	LB,UF	5	+10.80	05-17-85	--	--	--
34H097	UF	7.04	+4.80	05-14-85	--	--	--
34H112	UF	8.58	-3.05	05-14-85	2,200	7,100	10-31-84
34H117	UF	6.70	-3.82	05-14-85	400	1,620	10-31-84
34H118	LB,UF	17.02	-10.84	05-14-85	--	--	--
34H122	LB,UF	13.72	-9.65	05-14-85	--	--	--
34H125	UF	11.57	-9.09	05-14-85	280	1,570	10-29-84
34H128	UF	11.00	-9.73	05-14-85	630	2,550	10-31-84
34H133	UF	12.00	--	--	33	453	11-03-84
34H144	S,UB	11.00	-5.88	05-16-85	--	--	--
34H204	LB,UF	10.14	+13.00	05-16-85	15	285	11-01-84
34H328	UF	12.38	+0.33	05-16-85	--	--	--
34H334	UF	8.33	-1.14	05-14-85	910	3,100	10-29-84
34H344	UF	8.29	-11.79	05-16-85	15	417	10-29-84
34H345	UF	12.00	-9.10	05-14-85	1,500	5,290	10-31-84
34H347	UF	6.90	-1.75	05-16-85	--	--	--
34H348	UF	12.80	--	--	31	413	11-02-84
34H354	UF	13.76	-5.17	05-14-85	1,100	3,750	10-29-84
34H355	UF	13.98	-13.64	05-14-85	180	961	10-29-84
34H357	UF	7.29	+4.15	05-16-85	--	--	--
34H358	UF	5.55	+7.35	05-16-85	18	416	11-01-84
34H370	UF	7.58	+1.94	05-16-85	16	427	11-03-84
34H371	UF	9.49	+1.35	05-14-85	15	426	10-29-84
34H372	UF	10.83	-6.13	05-14-85	16	434	10-30-84
34H373	UF	9.28	-14.29	05-14-85	220	1,170	10-29-84
34H374	UF	17.02	-19.70	05-14-85	1,300	4,380	10-29-84

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

					Water quality		
Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Chloride (mg/L)	Specific conductance	Date sampled
Glynn County--Continued.							
34H381	UF	10	+3.90	05-16-85	16	405	11-01-84
34H383	UF	10	+3.35	05-16-85	25	446	11-01-84
34H389	UF	8.11	--	--	830	2,780	11-02-84
34H391	UF	7.13	-4.12	05-14-85	2,200	7,060	10-31-84
34H392	UF	16	-14.20	05-14-85	--	--	--
34H393	UF	6.95	--	--	2,300	7,340	11-02-84
34H398	UF	7	--	--	58	566	11-02-84
34H399	UF	5.54	-0.30	05-14-85	6,600	71,900	10-30-84
34H400	UF	12.5	-17.30	05-14-85	160	929	10-29-84
34H401	UF	13.16	-18.90	05-14-85	1,800	5,710	10-29-84
34H402	UF	13.21	-9.36	05-14-85	1,800	5,710	10-29-84
34H403	UF	9.56	-2.50	05-14-85	1,500	5,050	10-30-84
34H410	UF	6.5	+2.65	05-16-85	26	746	11-03-84
34H411	UF	13	--	--	410	1,440	11-01-84
34H412	UF	15	-13.50	05-17-85	34	431	11-01-84
34H413	UF	10	-14.90	05-17-85	--	3,610	11-01-84
34H416	S	8.3	-18.00	08-16-69	270	1,250	10-09-87
34H424	UF	15	-15.53	05-17-85	1,600	5,150	10-29-84
34H425	UF	12	-11.90	05-17-85	17	433	11-01-84
34H426	LF	8	+2.00	05-14-85	800	2,750	10-29-84
34H427	LB,UF	14	-18.40	05-14-85	1,400	5,290	10-30-84
34H428	S	10	-28.25	05-14-85	13	450	10-13-87
34H429	S	9	-16.30	05-14-85	28	480	10-13-87
34H430	S	15	--	--	13	460	10-12-87
34H431	S	16	-7.80	05-14-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Glynn County--Continued.							
34H432	S	12	-8.75	05-16-85	49	580	10-13-87
34H436	UF	7	+6.40	05-14-85	31	526	10-30-84
34H437	UB	7	-0.67	05-14-85	--	--	--
34H438	S	7	-6.10	05-14-85	21	470	10-10-87
34H439	UF	14	-17.34	05-14-85	2,000	7,670	10-30-84
34H443	S,UB,LB	8	--	--	800	2,750	10-09-87
34H446	UB,LB	8	--	--	250	1,220	10-09-87
34J021	LB,UF	16.84	-3.45	05-16-85	--	--	--
34J029	UF	5.27	+8.80	05-16-85	8.0	257	11-03-84
34J051	UF	34.7	-22.48	05-16-85	--	--	--
34J055	S	15	-10.75	05-16-85	--	--	--
35H037	UF	9.87	+11.20	05-16-85	21	440	11-01-84
35H044	UF	6	+9.80	05-16-85	23	458	11-01-84
35H053	S	10	-14.50	05-16-85	52	600	10-13-87
35H054	S	15	-14.24	05-16-85	30	420	10-13-87
35J004	UF	10	+2.75	05-16-85	--	--	--
Liberty County							
32N010	UF	95	-73.80	05-16-85	--	--	--
32N012	UF	95	-78.76	05-16-85	--	--	--
32N013	UF	85	-74.00	05-16-85	--	--	--
33M003	UF	16	-14.70	05-17-85	--	--	--
33N084	UF	22	-18.15	05-16-85	--	--	--
33N085	UF	88	-79.76	05-16-85	--	--	--
33N089	UF	80	-72.66	05-16-85	--	--	--
33N091	UF	22	-18.00	05-17-85	--	--	--
33P019	UF	31	-25.02	05-16-85	--	--	--
34M049	UF	18.96	-21.20	05-17-85	6.7	301	10-31-84
34M051	UF	12	--	--	10	303	10-31-84
34M052	UF	13	-24.22	05-17-85	--	--	--
34M056	UF	20	-23.05	05-17-85	6.4	291	10-31-84

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

					Water quality		
Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Chloride (mg/L)	Specific conductance	Date sampled
Liberty County--Continued.							
34M075	UF	10	-9.37	05-17-85	8.8	339	10-31-84
34N091	UF	21	-20.85	05-17-85	4.8	237	10-30-84
36M018	UF	7	-14.72	05-17-85	6.9	317	10-30-84
Long County							
32M001	UF	66	-51.88	05-14-85	--	--	--
32M002	UF	62	-49.70	05-14-85	--	--	--
32M009	UF	46	-32.45	05-14-85	--	--	--
McIntosh County							
33K016	LB,UF	12	-0.30	05-17-85	--	--	--
33K019	UF	12	+1.30	05-17-85	15	433	10-31-84
33K027	UF	18	-5.29	05-17-85	--	--	--
33L010	UF	19	-7.60	05-17-85	--	--	--
33L027	UF	20	-9.71	05-17-85	--	--	--
34K012	LB,UF	19	-5.73	05-17-85	--	--	--
34K073	UF	45	-0.75	05-17-85	15	455	10-31-84
34K081	UF	31	-15.52	05-17-85	16	546	10-31-84
34K082	UF	10	--	--	15	440	10-31-84
34K083	UF	41	-27.20	05-17-85	13	428	10-31-84
34K084	UF	25	-15.22	05-17-85	15	521	11-01-84
34K085	LB,UF	19.58	-7.74	05-17-85	11	360	11-01-84
34K086	UF	8	--	--	19	541	10-31-84
34K095	UF	20	-10.26	05-17-85	19	541	11-31-84
34L048	UF	22	-7.88	05-17-85	--	--	--
34L060	UF	27	-20.64	05-17-85	--	--	--
34L061	UF	20	-6.14	05-17-85	10	351	11-01-84
34M070	UF	12	-7.45	05-17-85	--	--	--
34M076	UF	21	-17.00	05-17-85	24	342	10-31-84
35K069	UF	11	-3.87	05-17-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
McIntosh County--Continued.							
35L067	LB,UF	8	-5.45	05-17-85	--	--	--
35L068	UF	18	-10.62	05-17-85	11	398	10-31-84
Screven County							
31V007	UF	155	-25.67	05-14-85	--	--	--
31V008	UF	192	-69.79	05-14-85	--	--	--
31V012	UF	231	-111.59	05-14-85	--	--	--
31V014	UF	167	-47.97	05-14-85	--	--	--
31V017	UF	129	-1.80	05-14-85	--	--	--
31V018	UF	114	+7.60	05-14-85	--	--	--
31W002	UF	291	-141.02	05-14-85	--	--	--
31W014	UF	312	-160.20	05-14-85	--	--	--
31X001	UF	204	-34.36	05-15-85	--	--	--
32U001	UF	242	-130.16	05-14-85	--	--	--
32U004	UF	170	-61.72	05-14-85	--	--	--
32U005	UF	212	-107.80	05-14-85	--	--	--
32U016	UF	100	-3.50	05-14-85	--	--	--
32V001	UF	211	-87.02	05-15-85	--	--	--
32V003	UF	209	-87.40	05-15-85	--	--	--
32V007	UF	223	-114.90	05-15-85	--	--	--
32V012	UF	202	-86.32	05-15-85	--	--	--
32V013	UF	232	-108.65	05-15-85	--	--	--
32V031	UF	253	-137.00	05-15-85	--	--	--
32V035	UF	214	-103.00	05-15-85	--	--	--
32V039	UF	245	-138.10	05-15-85	--	--	--
32W001	UF	244	-106.20	05-16-85	--	--	--
32W002	UF	235	-127.90	05-14-85	--	--	--
32W006	UF	122	-19.90	05-14-85	--	--	--
32W065	UF	179	-81.10	05-14-85	--	--	--
32W070	UF	187	-90.20	05-15-85	--	--	--
32X035	UF	165	-38.93	05-15-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Water quality: Chloride (mg/L)	Water quality: Specific conductance	Water quality: Date sampled
Screven County--Continued.							
33U021	UF	150	-72.40	05-15-85	--	--	--
33U023	UF	114	-29.27	05-15-85	--	--	--
33V005	UF	215	-121.80	05-15-85	--	--	--
33V011	UF	148	-63.49	05-15-85	--	--	--
33V020	UF	162	-78.57	05-15-85	--	--	--
33V021	UF	225	-123.40	05-15-85	--	--	--
33W001	UF	132	-49.80	05-16-85	--	--	--
33X013	UF	137	-33.90	05-16-85	--	--	--
33X022	UF	148	-24.85	05-16-85	--	--	-
34V004	UF	163	-82.60	05-14-85	--	--	--
Wayne County							
29K002	UB,LB,UF	118	-76.95	05-13-85	--	--	--
29L005	UF	110	-83.35	05-13-85	--	--	--
29M001	UF	160	-115.45	05-13-85	--	--	--
29M002	UF	169	-121.19	05-13-85	--	--	--
29M004	UF	162	-125.18	05-13-85	--	--	--
29N003	UF	178	-139.59	05-13-85	--	--	--
30L011	UF	123	-91.95	05-13-85	--	--	--
30L012	UF	152	-118.44	05-13-85	--	--	--
30L013	UF	105	-82.35	05-13-85	--	--	--
30L014	UF	105	-78.40	05-13-85	--	--	--
30M003	LB,UF	112	-92.68	05-13-85	--	--	--
30M005	UF	105	-81.64	05-13-85	--	--	--
30M007	UF	107	-78.44	05-13-85	--	--	--
30M011	UF	153	-124.15	05-13-85	--	--	--
30N002	UF	166	-131.28	05-13-85	--	--	--
31M006	UF	98	-86.90	05-13-85	--	--	--
31M009	LB,UF	100	-107.38	05-14-85	--	--	--
31M010	LB,UF	85	-100.01	05-14-85	--	--	--
31M011	LB,UF	88.5	-98.08	05-14-85	--	--	--
31M012	LB,UF	83	-111.18	05-14-85	--	--	--

Appendix C.--Ground-water-level, chloride, and specific conductance data from selected wells in the coastal area--Continued.

[Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan. Water level: +, above land surface; -, below land surface; Specific conductance, in microsiemans per centimeter at 25°C; --, no data available]

					Water quality		
Well no.	Aquifer	Altitude (ft)	Water level (ft)	Date measured	Chloride (mg/L)	Specific conductance	Date sampled
Wayne County--Continued.							
31M013	UF	75	-68.20	05-14-85	--	--	--
31M014	LB,UF	81	-98.27	05-14-85	--	--	--
31M015	LB,UF	95	-106.45	05-14-85	--	--	--
31M016	LB,UF	100	-110.20	05-14-85	--	--	--
31M018	S	92	-36.83	06-00-63	--	--	--
31M019	S	96	-44.00	06-00-63	--	--	--
31M020	S	96	-68.00	02-03-64	--	--	--
31M021	S	96	-65.00	01-00-64	--	--	--
31M022	UF	92	-87.43	05-13-85	--	--	--
31M024	UF	95	-92.97	05-13-85	--	--	--
31M030	UF	78.1	-107.90	05-14-85	--	--	--
31M031	UF	64.1	-99.38	05-14-85	--	--	--
31M032	UF	63.2	-72.85	05-14-85	--	--	--
31M033	UF	97	-85.98	05-13-85	--	--	--
31M034	UF	84	067.91	05-13-85	--	--	--
32K014	UF	57	-35.40	05-13-85	--	--	--
32L004	UF	40	-20.00	05-13-85	--	--	--
32L005	LF	74	--	--	170	1,540	11-03-84

See separate envelope
for Plates 1-12 and Table 4.

Prepared in cooperation with the
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Base from U.S. Geological Survey
State base map, 1970

LOCATION OF TEST WELLS AND OTHER SELECTED WELLS IN COASTAL GEORGIA

LITHOLOGIC AND GEOPHYSICAL PROPERTIES OF SEDIMENTS, WELL-CONSTRUCTION CHARACTERISTICS, AND HEAD RELATIONS AT NESTED-WELL SITES IN THE COASTAL AREA

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

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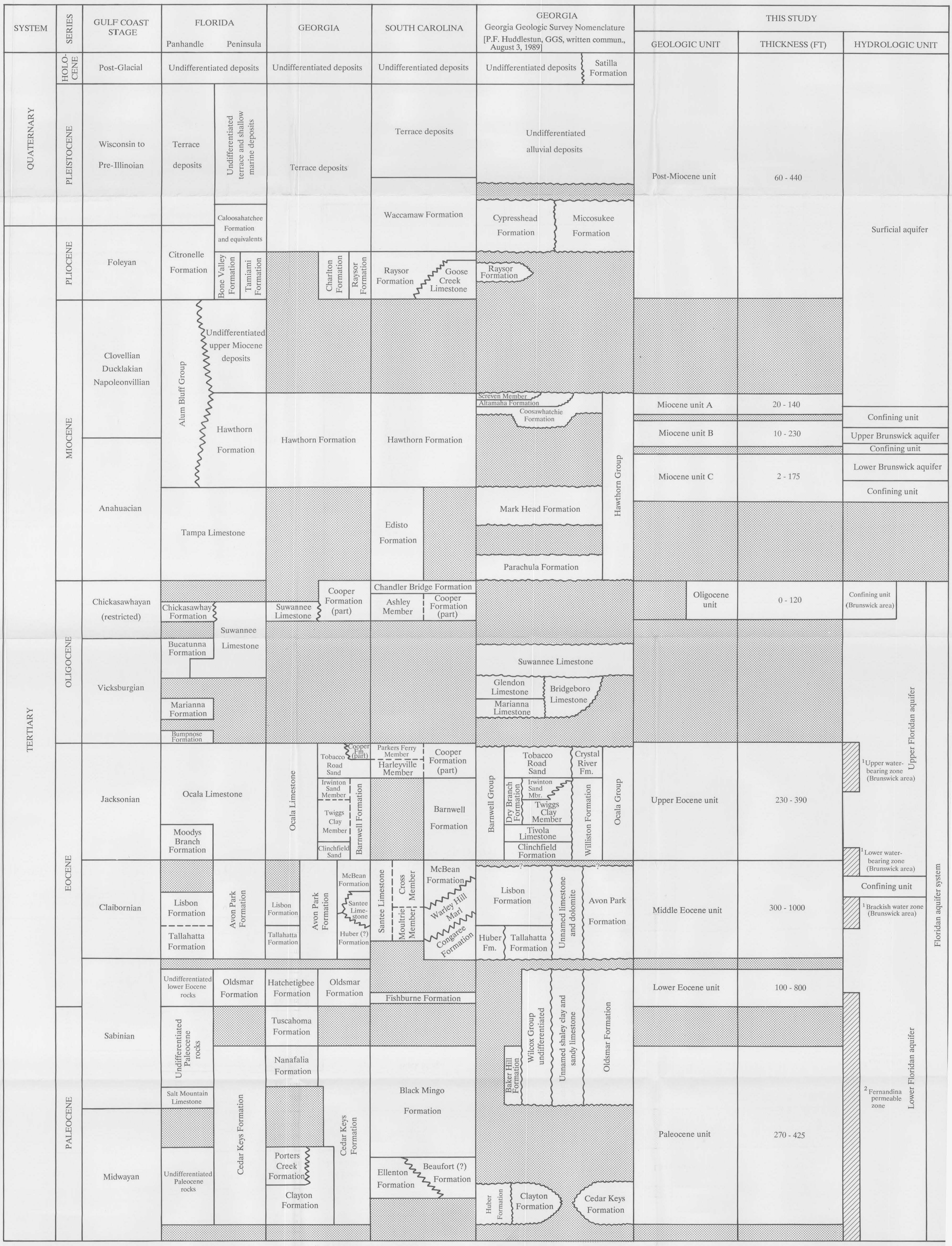
BULLETIN 113
PLATE 3



[1]Gregg and Zimmerman (1974).
[2]Krause and Randolph (1989).

Modified from Miller (1986)

GENERALIZED CORRELATION OF GEOLOGIC AND HYDROLOGIC UNITS OF TERTIARY AND QUATERNARY AGE IN GEORGIA AND ADJACENT PARTS OF FLORIDA AND SOUTH CAROLINA

Prepared in cooperation with the
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GEOLOGIC SECTIONS A-A', B-B', C-C', D-D', AND E-E', COASTAL GEORGIA

GEOLOGIC SECTIONS F-F' AND G-G', COASTAL GEORGIA

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

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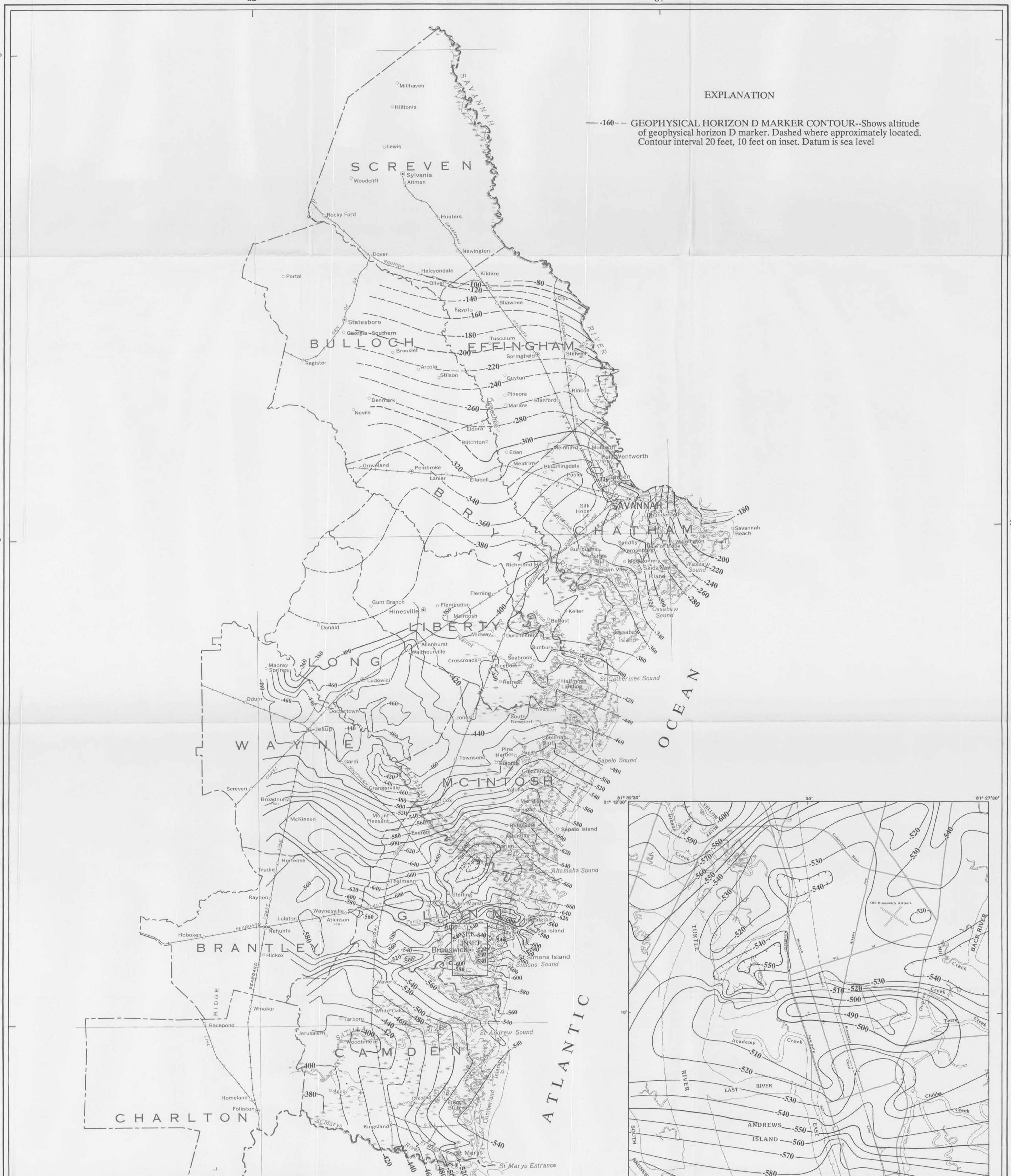

Base from U.S. Geological Survey
State base map, 1970

0 10 20 30 MILES
0 10 20 30 KILOMETERS

ALTITUDE OF GEOPHYSICAL HORIZON D IN THE COASTAL AREA, GEORGIA

Base from U.S. Geological Survey
State base map, 1970

Outcrop area from Geologic Map of Georgia, 1976

0 10 20 30 MILES
0 10 20 30 KILOMETERS

ALTITUDE OF GEOPHYSICAL HORIZON C IN THE COASTAL AREA, GEORGIA

ALTITUDE OF GEOPHYSICAL HORIZON B IN THE COASTAL AREA, GEORGIA

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

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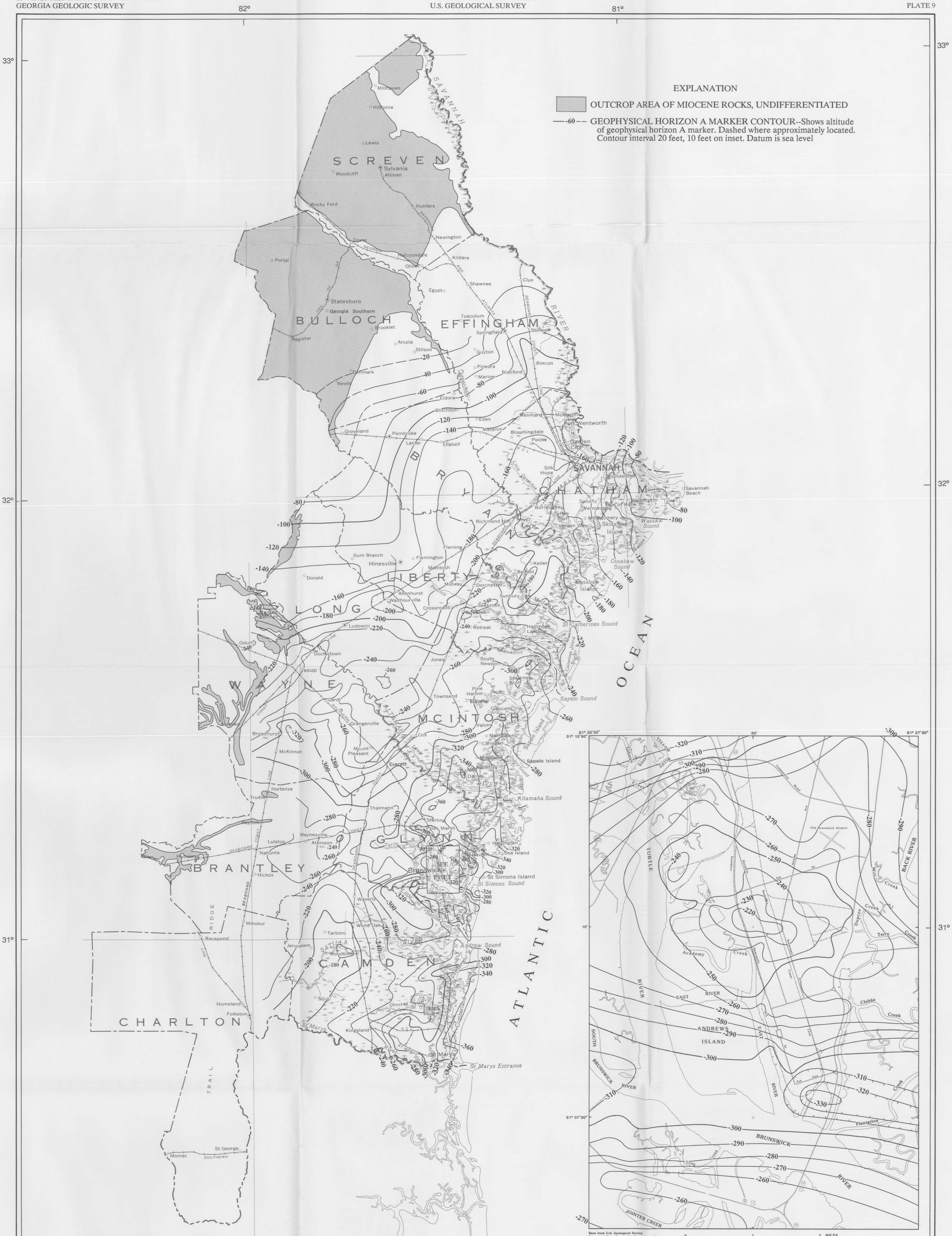
BULLETIN 113
PLATE 9

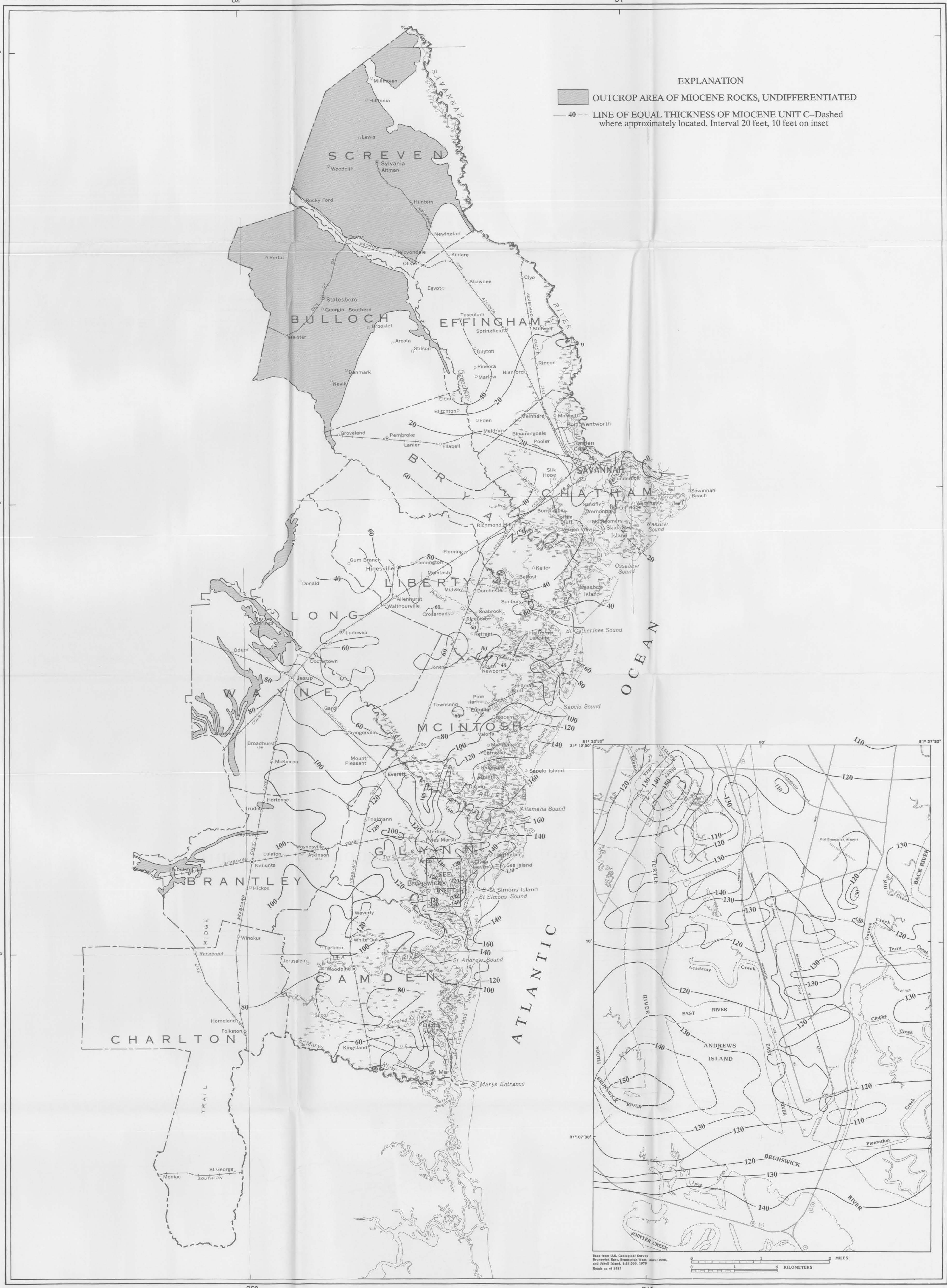


Base from U.S. Geological Survey
State base map, 1970

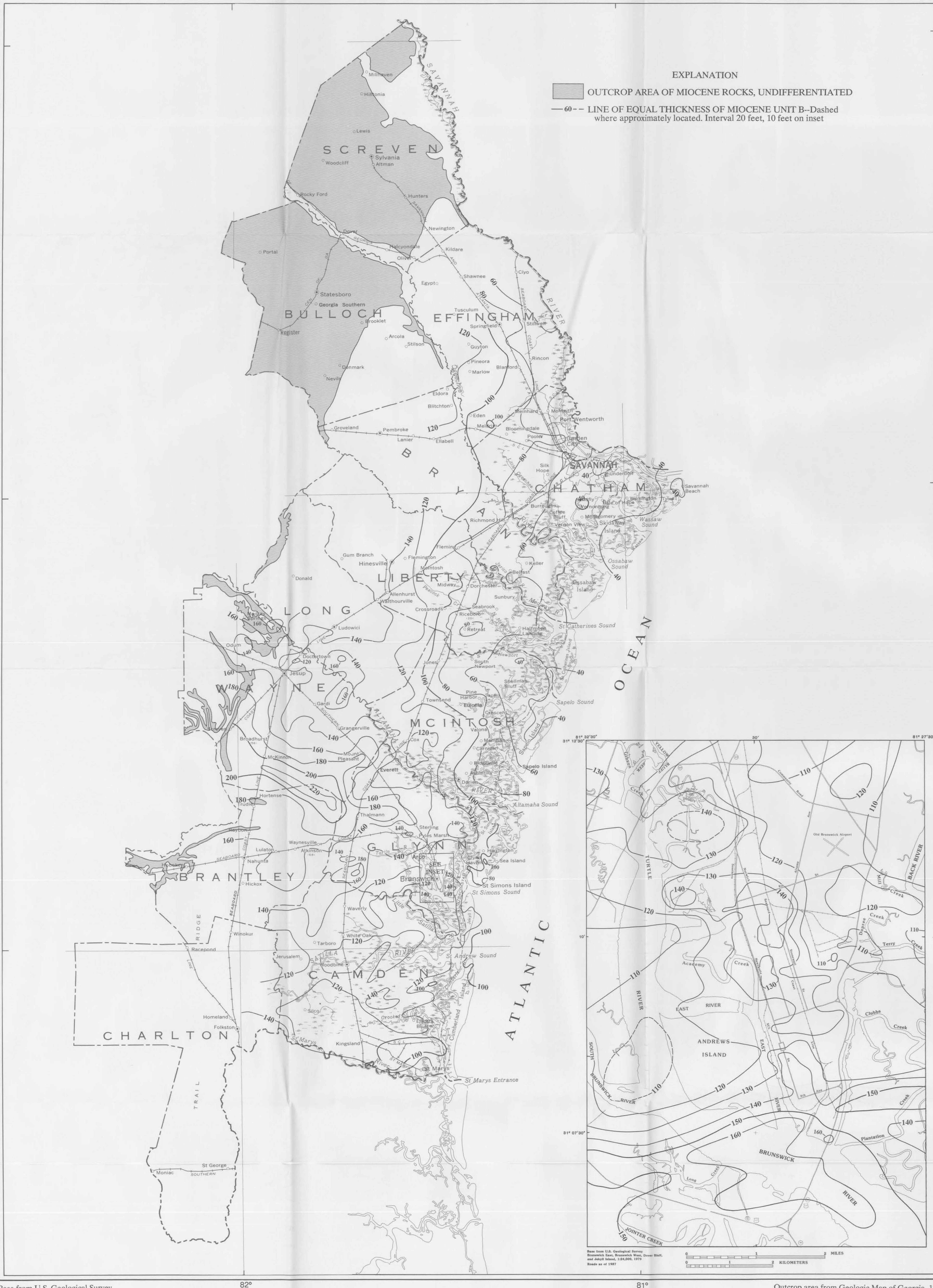
Outcrop area from Geologic Map of Georgia, 1976

0 10 20 30 MILES
0 10 20 30 KILOMETERS

ALTITUDE OF GEOPHYSICAL HORIZON A IN THE COASTAL AREA, GEORGIA



THICKNESS OF MIOCENE UNIT C IN THE COASTAL AREA, GEORGIA



Base from U.S. Geological Survey
State base map, 1970

0 10 20 30 MILES

Outcrop area from Geologic Map of Georgia, 1976

ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

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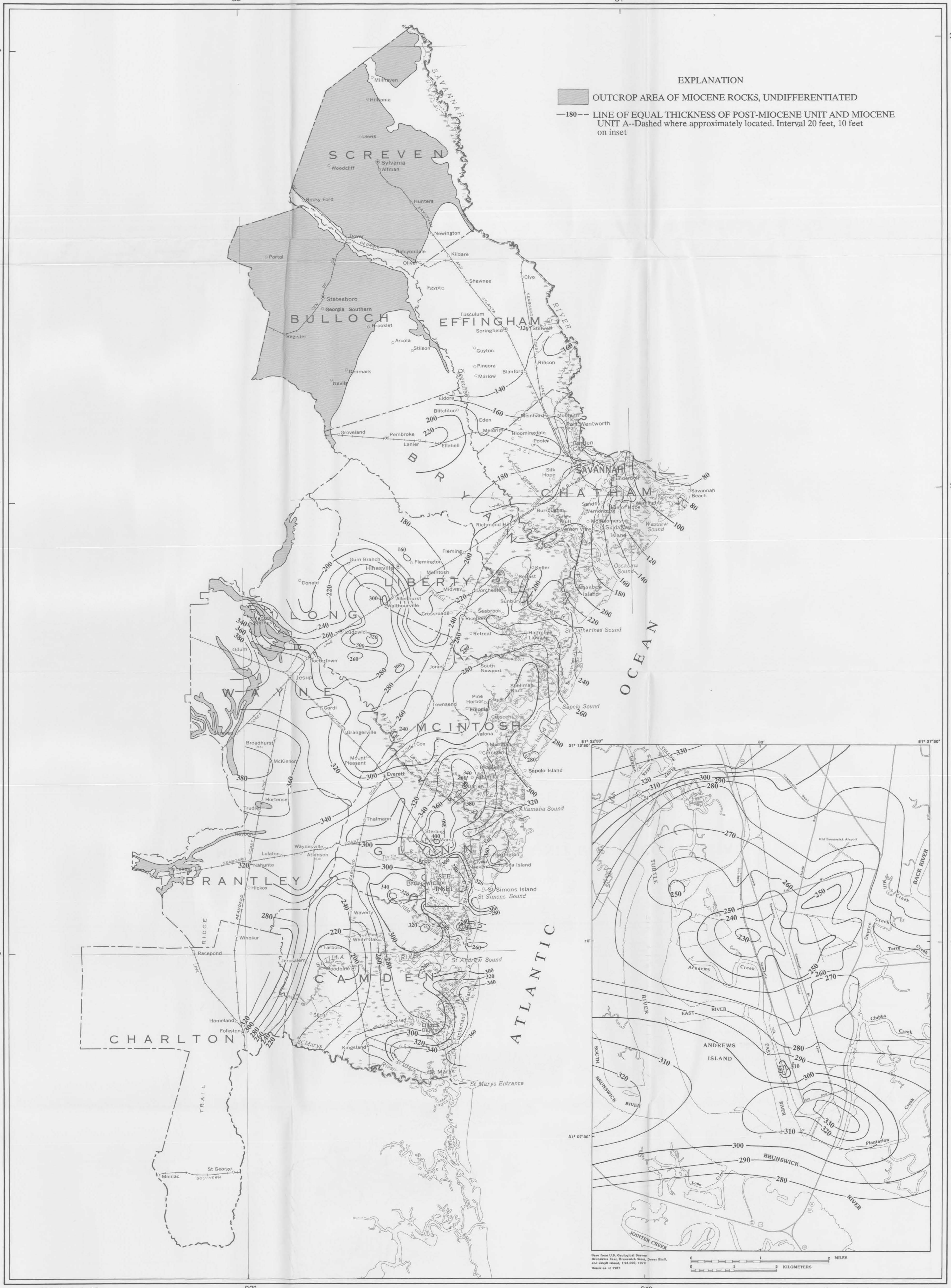
U.S. GEOLOGICAL SURVEY



Base from U.S. Geological Survey
State base map, 1970

Outcrop area from Geologic Map of Georgia, 1976

0 10 20 30 MILES
0 10 20 30 KILOMETERS

THICKNESS OF MIOCENE UNIT A AND POST-MIOCENE UNIT IN THE COASTAL AREA, GEORGIA

Table 4.--Chemical analyses of ground water from selected wells in the coastal area

[<0.1, less than 0.1. Aquifer: S, surficial; UB, upper Brunswick; LB, lower Brunswick; UF, Upper Floridan; LF, Lower Floridan; Dissolved constituents: SiO_2, silica; Ca, calcium; Mg, magnesium; Na, sodium; K, potassium; HCO_3, bicarbonate; $CaCO_3$, calcium carbonate; SO_4, sulfate; Cl, chloride; F, fluoride; NO_3, nitrate; Cd, cadmium; Cr, chromium; Cu, copper; Fe, iron; Pb, lead; Mn, manganese; Hg, mercury; Se, selenium; Sr, strontium; Zn, zinc. T, thief sample collected during drilling. Specific conductance: In microsiemens per centimeter at 25°C. Temperature: temperature of water, in degrees Celsius. --, no sample analyzed. Analyses by U.S. Geological Survey]

				Milligrams per liter											Micrograms per liter										Dissolved solids (mg/L)		Hardness as $CaCO_3$ (mg/L)				
Well no.	Sampled interval (ft)	Aquifer	Date sampled	SiO_2	Ca	Mg	Na	K	HCO_3	Alkalinity as $CaCO_3$	SO_4	Cl	F	NO_3	Cd	Cr	Cu	Fe	Pb	Mn	Hg	Se	Sr	Zn	Residue at 180°C	Sum of constituents	Ca+ Mg	Non-carbonate	Specific con-ductance	pH	Temperature
Brantley County																															
31H005	612-745	UF	08-17-85	39	41	22	22	1.8	153	125.46	71	23	0.6	<0.01	--	--	--	130	--	<1	--	--	420	--	320	--	--	--	1/456	7.8	25.2
Bryan County																															
35P099	360-620	UF	08-07-85	43	32	5	12	1.6	135.6	111.2	5.7	4.8	.3	.01	--	--	--	130	--	6	--	--	310	--	175	--	--	--	1/245	8.0	23.8
Bulloch County																															
31U009	160-210	UB	08-06-86	49	18	5	5.4	1.3	86.3	70.8	6.7	3.1	.4	<.02	--	--	--	450	--	100	--	--	98	--	131	--	--	--	1/147	7.4	20.8
32R003	134-155	S	08-09-86	25	4.7	0.5	5.1	2.4	28.4	23.29	2.7	2.9	.2	<.02	--	--	--	910	--	12	--	--	36	--	42	--	--	--	64	6.1	19.1
Camden County																															
32E030	70-75	S	04-16-65	--	50	4.1	9.1	1.1	165	--	8	15	.3	--	--	--	--	--	--	--	--	--	--	--	--	179	142	--	1/308	7.6	--
32F041	18-28	S	04-16-65	--	96	6.4	19	0.6	276	--	31	39	.2	--	--	--	--	--	--	--	--	--	--	--	--	346	266	--	1/570	7.5	--
33E002	80-474	S,UB	11-02-84	--	--	--	--	--	--	--	--	38	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1/675	7.9	--
33E039	950-1,150	UF	2/02-13-86	34.7	75.7	33.5	3/30	3/3	--	160	163	38	.56	--	--	--	--	--	--	--	--	--	--	--	466	573.6	320	160	1/670	7.0	17.6
33E040	560-750	UF	2/02-13-86	36.1	74.9	35.4	3/25	3/3	--	166	159	45	.51	--	--	--	--	--	--	--	--	--	--	--	463	581.4	316	150	1/650	6.8	19.8
33E041	15-18	S	4/02-17-77	--	--	--	--	--	--	--	71	10.3	<.01	--	0.94	152	10.5	4,980	15.4	--	5.4	--	--	252	71	--	43	--	132	4.8	--
33E042	12-15	S	4/02-17-77	--	--	--	--	--	--	--	12	42.8	<.01	--	.21	11.7	5.1	2,760	8.0	--	4.1	--	--	186	125	--	33	--	182	4.8	--
33E043	16-19	S	4/02-17-77	--	--	--	--	--	--	--	166	40.0	.54	--	.94	12.2	6.3	1,270	15.4	--	5.0	--	--	278	474	--	304	--	740	6.6	--
33E044	17-19	S	4/02-17-77	--	--	--	--	--	--	--	23	28.5	<.01	--	.67	46.1	5.9	2,790	15.4	--	3.8	--	--	250	144	--	49	--	262	5.0	--
33E045	15-18	S	4/02-17-77	--	--	--	--	--	--	--	<5	24	<.01	--	.48	4.4	5.9	1,650	32.6	--	4.8	--	--	262	85	--	16	--	151	4.0	--
Charlton County																															
27E003	470-660	UF	08-14-85	36	68.4	34.4	59.2	3.6	322.7	264.61	61.6	72.1	1	<.01	--	--	--	59	--	2	--	--	620	--	535	--	--	--	786	7.3	21.7
30E002	260-300	UB	11-21-84	--	--	--	--	--	--	--	--	32	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	594	1/8.2	--
Chatham County																															
36P090	323-639	UF	08-07-85	43	22	8.8	13	2.3	127.9	104.88	4.7	4.4	.5	.01	--	--	--	10	--	<1	--	--	360	--	154	--	--	--	231	8.1	23.7
37P087	286-600	UF	08-06-85	37	22	11	17	2.3	143.1	117.34	14.	8.1	.5	<.01	--	--	--	10	--	<1	--	--	480	--	181	--	--	--	268	8.0	23.3
37P113	715T	LF	10-03-83	20	12	14	150	9.2	--	--	77	180	1.1	--	--	--	--	--	--	--	--	--	1,700	--	521	--	--	--	981	1/8.1	27.5
37P113	1,070T	LF	10-03-83	39	200	220	--	78	--	--	1,600	5,000	2.8	--	--	--	--	--	--	--	--	--	19,000	--	10,600	--	--	--	16,600	1/8.0	31.5
37P119	41-46	S	5/08-15-86	--	--	--	--	--	--	--	1.3	41	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	170	7.6	25
37P120	12-16	S	5/08-15-86	--	--	--	--	--	--	--	44	28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	190	6.4	26
37P121	20-23,51-53, 55-58	S	5/08-19-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6/1,500	--	--	--	--	--	--	--	--	--	--	100	6.7	26
37P122	50-55,70-75	S	5/08-20-86	--	--	--	--	--	--	--	<1	28	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	210	7.9	25
37P123	57-62,67-72	S	5/08-14-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6/250	--	--	--	--	--	--	--	--	--	--	140	7.4	26
37P124	55-65	S	5/08-20-86	--	--	--	--	--	--	--	<1	28	--	--	--	--	--	6/200	--	--	--	--	--	--	--	--	--	--	230	7.6	24
37P125	55-62	S	5/08-14-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	145	7.1	26
37P126	32-37,49-54	S	5/08-20-86	--	--	--	--	--	--	--	<1	34	--	--	--	--	--	6/200	--	--	--	--	--	--	--	--	--	--	235	7.9	25
37P127	15-20	S	5/09-04-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	145	6.1	23
37P128	28-31,44-49	S	5/08-15-86	--	--	--	--	--	--	--	21	180	--	--	--	--	--	6/280	--	--	--	--	--	--	--	--	--	--	340	7.4	25
37P129	55-65	S	5/08-20-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6/200	--	--	--	--	--	--	--	--	--	--	135	7.1	25
37P130	15-20	S	5/09-04-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	135	5.3	22
37P131	50-54	S	5/08-19-86	--	--	--	--	--	--	--	<1	120	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	420	7.5	25
37P132	38-48	S	5/08-22-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6/150	--	--	--	--	--	--	--	--	--	--	245	7.4	24
37P133	60-65	S	5/08-15-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6/210	--	--	--	--	--	--	--	--	--	--	195	7.7	25
37P134	45-52	S	5/08-19-86	--	--	--	--	--	--	--	<1	52	--	--	--	--	--	6/500	--	--	--	--	--	--	--	--	--	--	245	7.4	26
37P135	33-38,54-57	S	5/08-20-86	--	--	--	--	--	--	--	<1	34	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	295	7.3	26
37P136	65-75	S	5/08-19-86	--	--	--	--	--	--	--	<1	27	--	--	--	--	--	6/5,100	--	--	--	--	--	--	--	--	--	--	100	7.1	26
37P137	56-66	S	5/08-20-86	--	--	--	--	--	--	--	<1	25	--	--	--	--	--	6/790	--	--	--	--	--	--	--	--	--	--	155	7.7	25
37P138	27-34	S	5/08-20-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6/500	--	--	--	--	--	--	--	--	--	--	195	7.6	25
37P139	41-51	S	5/08-20-86	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	245	7.7	26
39Q001	197-575	UF	08-06-85	38	25	18	48	3.8	145.2	119.1	67	43	.7	<.01	--	--	--	5	--	<1	--	--	1,100	--	325	--	--	--	503	8.0	23.2

Editor: Patricia Allgood

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