WATER-RESOURCES ACTIVITIES, GEORGIA DISTRICT, 1991

By Carolyn A. Casteel and Mary D. Ballew

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1992

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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Denver, CO 80225

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CONVERSION FACTORS

Multiply	*by*	*to obtain*
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
acre	0.4047	hectare
square mile (mi^2)	2.590	square kilometer
	Flow	
million gallons per day (Mgal/d)	0.04381	cubic meter per second
	43.81	liter per second
cubic foot per second (ft^3/s)	0.02832	cubic meter per second

WATER-RESOURCES ACTIVITIES GEORGIA DISTRICT, 1991

By

Carolyn A. Casteel and Mary D. Ballew

ABSTRACT

The U.S. Geological Survey, Water Resources Division, conducts Nationwide water-resources data collection, investigations, and research in cooperation with other Federal, State, local government agencies, and academia. The water-resources activities in Georgia during 1991 are summarized showing the basic mission and program, funding, summary of hydrologic conditions during 1990 water year, District project objectives and progress, and list of selected publications.

INTRODUCTION

The U.S. Geological Survey (USGS), through its Water Resources Division, investigates the occurrence, quantity, quality, distribution, and movement of surface and ground water that composes the Nation's water resources. The USGS is the principal Federal water-data agency and, as such, collects and disseminates about 70 percent of the water data currently being used by numerous State, local, private, and other Federal agencies to develop and manage our water resources. This nationwide program is carried out through the district and field offices of the Water Resources Division, and consists of the collection of basic hydrologic data, areal resource appraisal and interpretive studies, research projects, and the analysis and dissemination of the data and results of its investigations. Much of the work is a cooperative effort in which planning and financial support are shared by State and local governments and other Federal agencies. The USGS also is responsible for the coordination of specific water-data acquisition activities by other Federal agencies. Information on these activities is consolidated into a central file known as the "Catalog of Information on Water Data," which is maintained by the USGS. Many State and local agencies and private organizations that have related water-data-acquisition activities also contribute information to this catalog. Indexes to the catalog are published at selected intervals.

This report contains a brief description of the water-resources monitoring and investigations in Georgia in which the USGS participates, and a list of selected references. Additional or more detailed information can be obtained from the District Chief, Water Resources Division, 6481 Peachtree Industrial Blvd., Suite B, Doraville, GA 30360.

"Water-Resources Data--Georgia, 1990" (Stokes and others, 1991) consists of records of stage, discharge, and water quality of streams; stage and contents of lakes and reservoirs; ground-water levels; and precipitation quality. Stokes and others (1991) contains discharge records of gaging stations; stage for gaging stations; stage and contents for lakes and reservoirs; water quality for continuous-record stations; peak stage and discharge only for crest-stage, partial-record stations and miscellaneous sites; base-flow discharge measurements at miscellaneous sites; water levels of observation wells and water quality for precipitation-quality sites. These data represent that part of the National Water Data System collected by the USGS and cooperating local, State, and Federal agencies in Georgia.

Records of discharge and stage of streams, and stage and contents of lakes and reservoirs were first published in a series of USGS Water-Supply Papers entitled, "Surface-Water Supply of the United States." Through September 30, 1960, these Water-Supply Papers were in an annual series and then in a 5-year series for 1961-65 and 1966-70. Records of chemical quality, water temperature, and suspended sediment were published from 1941 to 1970 in an annual series of Water-Supply papers entitled "Quality of Surface Waters of the United States." Records of ground-water levels were published from 1935 to 1974 in a series of Water-Supply Papers entitled, "Ground-Water Levels in the United States." Water-Supply Papers may be consulted in the libraries of the principal cities in the United States or may be purchased from Books and Open-File Reports Section, U.S. Geological Survey, Federal Center, Box 25425, Denver, CO 80225.

For water years 1961 through 1970, streamflow data were published by the USGS in annual reports on a state-boundary basis. Water-quality records for water years 1964 through 1970 were similarly published either in separate reports or in conjunction with streamflow records.

Beginning with the 1971 water year, data for streamflow, water quality, and ground water are published in USGS reports on a state-boundary basis. These reports carry an indentification number consisting of the two-letter State abbreviation, the last two digits of the water year, and the volume number, for example, "U.S. Geological Survey Water-Data Report GA-00-1." These water-data reports may be purchased from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

BASIC MISSION AND PROGRAM

The mission of the Water Resources Division is to provide the hydrologic information and understanding needed for the optimum utilization and management of the Nation's water resources for the overall benefit of the people of the United States. This is accomplished, in large part, through cooperation with other Federal and non-Federal agencies, by

- collecting, on a systematic basis, data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources;
- conducting analytical and interpretive water-resources appraisals describing the occurrence, availability, and the physical, chemical, and biological characteristics of surface and ground water;
- conducting supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science to improve the scientific basis for investigations and measurement techniques and to understand hydrologic systems sufficiently well to quantitatively predict their response to stress, either natural or manmade;
- disseminating the water data and the results of these investigations and research through reports, maps, computerized information services, and other forms of public releases;
- coordinating the activities of Federal agencies in the acquisition of water data for streams, lakes, reservoirs, estuaries, and ground water; and
- providing scientific and technical assistance in hydrologic fields to other Federal, State, and local agencies, to licensees of the Federal Energy Regulatory Commission, and to international agencies on behalf of the U.S. Department of State.

Table 1.--*Agencies supporting water-resources investigations in Georgia*

State Agencies and Academia

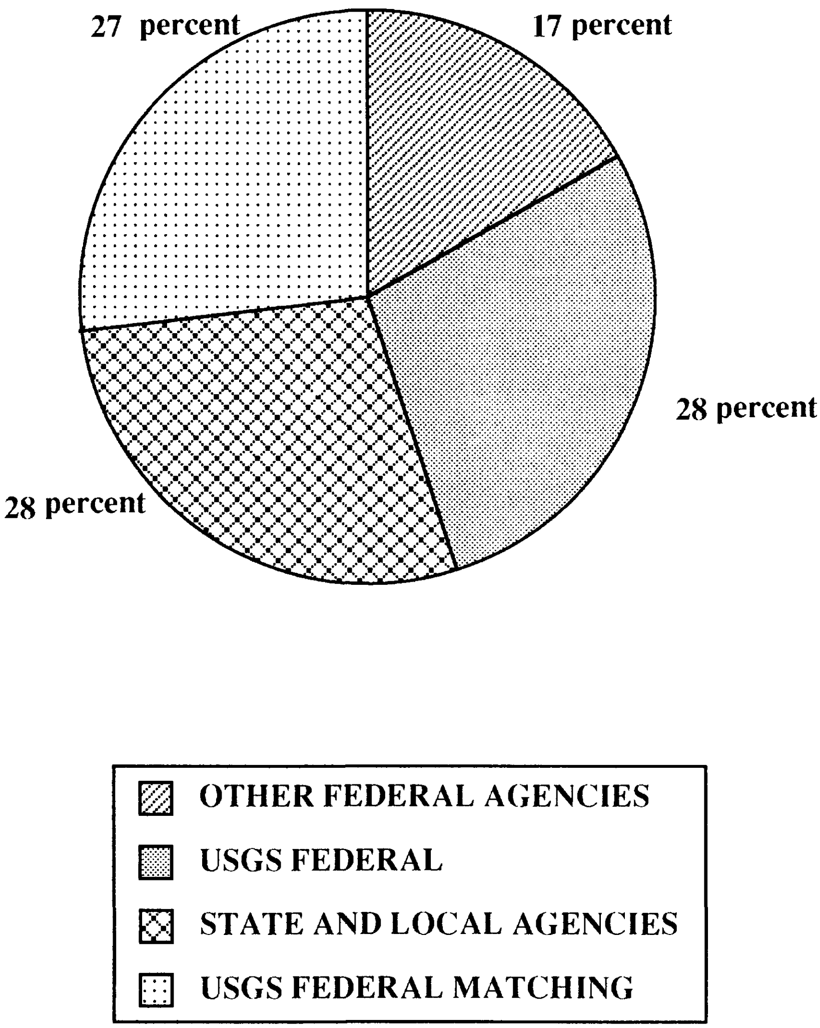
Georgia Department of Natural Resources
  Environmental Protection Division
    Georgia Geologic Survey
    Water Protection Branch
    Water Resources Management Branch
Georgia Department of Transportation
Georgia Mountains Regional Development Center
Georgia State University
Georgia Institute of Technology
University of Georgia

Local Agencies

City of Albany
City of Brunswick
City of Covington
City of Helena
City of Moultrie
City of Springfield
City of Thomaston
City of Thomasville
City of Tifton
City of Valdosta
City of Zebulon
Albany Water, Gas, and Light Commission
Consolidated Government of Columbus
Bibb County
Chatham County-Savannah Metropolitan Planning Commission
DeKalb County
Glynn County
Gwinnett County
Clayton County Water Authority
Macon-Bibb County Water and Sewage Authority
Tifton County Commission
Town of Blairsville

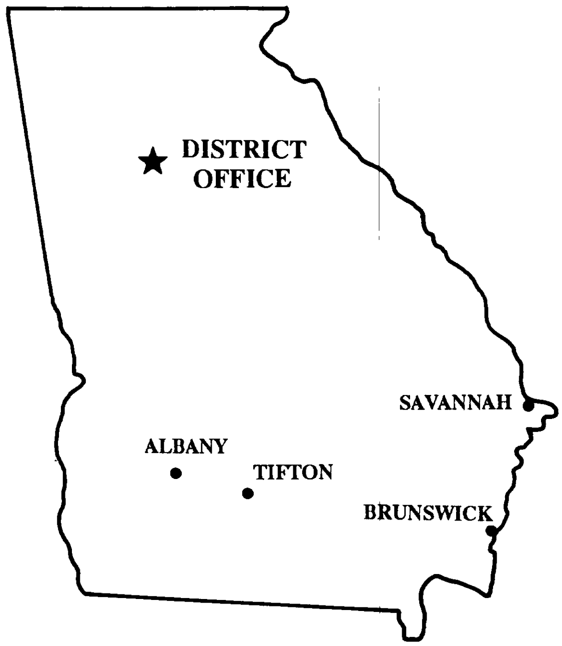
Federal Agencies

U.S. Department of Agriculture
  Agricultural Research Service
U.S. Department of the Army
  Waterways Experiment Station
U.S. Army Corps of Engineers
  Mobile District
  Savannah District
U.S. Department of Commerce
U.S. Department of Energy
U.S. Department of the Interior
  National Park Service
U.S. National Weather Service (NOAA)
U.S. Environmental Protection Agency
U.S. Federal Emergency Management Agency
U.S. Federal Energy Regulatory Commission
Tennessee Valley Authority



TOTAL FUNDS - $5,127,000

Figure 1.--Program fund sources, Georgia District, fiscal year 1991.



GEORGIA DISTRICT OFFICE ADDRESSES

District Office (404) 986-6860
Timothy W. Hale, District Chief
U.S. Geological Survey, WRD
6481-B Peachtree Industrial Blvd.
Doraville, GA 30360

Albany Field Headquarters (912) 430-8420
U.S. Geological Survey, WRD
314 Roosevelt Avenue
P.O. Box 1232
Albany, GA 31702

Savannah Field Headquarters (912) 944-4350
U.S. Geological Survey, WRD
125 Bull Street, Room B-10
P.O. Box 8223
Savannah, GA 31412

Tifton Field Headquarters (912) 382-6353
U.S. Geological Survey, WRD
225 Tift Avenue
P.O. Box 721
Tifton, GA 31793

Brunswick Field Headquarters
U.S. Geological Survey, WRD
Brunswick, GA 31521

Figure 2.--Location and addresses of District Office and Field Headquarters.

SUMMARY OF HYDROLOGIC CONDITIONS 1990 WATER YEAR

Streamflow

Runoff for the 1990 water year varied substantially across the State. For unregulated streams having more than 10 years of streamflow record, the ratio of runoff during the 1990 water year to long-term runoff ranged from a little more than 0.3 at Suwannee River near Fargo, in southeastern Georgia; to almost 2.1 at Two Run Creek near Kingston, in the northwestern part of the State. The runoff ratio for a large number of streams in Georgia ranged between 1.2 and 1.6. In the southern part of the State, the runoff ratio for most streamflow stations was from 0.7 to 1.0, and the runoff ratio for stations in northwestern Georgia generally was 1.7 or greater (Stokes and others, 1991).

Except for April, monthly mean runoff across the northern part of the State generally was above normal from October through May; ranging from an average of about 110 percent of normal for May to almost 400 percent of normal for October. In this area, monthly mean flows for April and June through September were below, but generally near, normal. August was the only month in which monthly mean flow averaged as much as 30 percent below normal. In central Georgia, monthly mean flows were at or above normal for the first six months of the year. The monthly mean flows averaged about 270 percent of normal, and about normal for March. For the remaining six months, monthly mean flows averaged near 50 percent of normal, and showed little variability; ranging from 55 percent of normal in May to about 40 percent of normal in July (Stokes and others, 1991).

Monthly mean runoff across the southern part of the State ranged from slightly below normal to well above normal for October through February, and was substantially below normal for the remainder of the year. The monthly mean flows were the highest in January, averaging about 230 percent of normal, and lowest in August and September, when monthly means averaged 10 percent of normal. The monthly mean flows for March and April averaged about 60 and 40 percent of normal, respectively, and were the only months in which monthly means exceeded 25 percent of normal from March through September (Stokes and others, 1991).

Heavy rains over most of the State in early October seemed to remove the threat of drought. However, following the heavy rains in the early part of the water year, east-central and much of southern Georgia were characterized for the remainder of the year by a general lack of rainfall, and near mid-year, once again experienced drought conditions. By mid-summer, severe drought conditions developed in the east-central, southeastern, and southwestern parts of the State. Several long-term stations, which gage much of the flow from east-central and southeastern Georgia, experienced minimum daily flows having recurrence intervals ranging from 20 to more than 50 years. At two of these stations, minimum flows for the period of record were equaled, and at five others, new minimums for the period of record were established. Two long-term stations in the southwestern part of the State experienced minimum daily flows having recurrence intervals greater than 50 years. Across the northern part of the State, most gaging stations generally had minimum flows having recurrence intervals that exceeded two years (Stokes and others, 1991).

The early October rainfall was heaviest in north-central Georgia, and was the first of three storms that produced substantial flooding in the northern part of the State during the 1990 water year. The other two storms occurred in February and March, exactly one month apart. The mid-February flood generally was limited to the northwestern part of the State, but the mid-March flood was much more widespread, covering much of the northern half of the State. The most severe flooding, resulting from the March storm, generally was confined to west-central Georgia, north and east of the Columbus area (Stokes and others, 1991).

The October rainfall, though widespread and quite heavy across much of north Georgia, produced flood peaks at long-term gaging stations having recurrence intervals that generally were 10 years or less because of dry antecedent conditions. Two notable exceptions were the Oconee River near Penfield, where the October flood peak had a recurrence interval greater than 25 years; and Broad River near Bell, having 59 years of record, where the peak discharge was a 50-year flood (Stokes and others, 1991).

The February storm produced heavy rainfall over north-central and northwestern Georgia on February 15 and 16. The rainfall totals generally were 4 to 5 inches (in.), but were much greater in some localized areas. Examples are Chatsworth, in the north-central part of the State, where 8 in. of rainfall occurred; and Summerville, in northwestern Georgia, where more than 11 in. of rainfall were recorded. These heavy rains resulted in severe flooding over much of this part of the State; peak discharge recurrence intervals of 50 years or greater occurred throughout the area. The peak discharge of 36,800 cubic feet per second (ft^3/s) at the Conasauga River at Tilton having a drainage area of 687 square miles (mi^2), had a recurrence interval that exceeded 50 years, and is believed to be the second highest peak flow since 1834. The Chattooga River at Summerville having a drainage area of 193 mi^2, had a peak discharge of 30,100 ft^3/s. This peak discharge had a recurrence interval of about 100 years and was the highest in 53 years of record. In the vicinities of Chatsworth and Summerville, the ratio of the peak discharge to the 100-year discharge for many sites, having drainage areas of 100 mi^2 or less, ranged from 1.0 to more than 2.0. Examples are Harrisburg Creek near Hawkins, drainage area of 13.3 mi^2, and Holly Creek near Chatsworth, drainage area of 64 mi^2, where peak discharges were 1.6 and 2.1 times the 100-year discharges, respectively (Stokes and others, 1991).

During the March storm, rain began to fall in west-central Georgia on the evening of the 15th, and by early morning on the 17th, more than 8 in. of rain had fallen at Columbus. Heavy rain from this storm was widespread, extending well to the north and east of Columbus, and produced moderate flooding over much of the northern half of the State. The most severe flooding occurred in west-central Georgia near Columbus (Stokes and others, 1991).

In much of the State outside the Columbus area, the recurrence interval of the March flood generally was 10 years or less; 10 years was the most common recurrence interval. An exception was the upper Ocmulgee River basin north and west of Macon where the flood generally had recurrence intervals equal to or greater than 25 years. Just outside the area that received 8 in. of rainfall, recurrence intervals were in the 25- to 50-year range. Flooding was most severe within the area that received 8 in. of rainfall, where the peak discharge for most stations exceeded those of the 100-year flood. The ratio of the March flood-peak discharge to the 100-year discharge was greater than 3.0 for several stations. The most notable peak discharge occurred at Upatoi Creek near Columbus, drainage area of 342 mi^2. The peak discharge of 46,300 ft^3/s was approximately 2.7 times the previous maximum discharge for 22 years of record, and 6.5 times the 100-year discharge at Upatoi Creek near Columbus. Flint River near Culloden, drainage area of 1,850 mi^2 in west-central Georgia, had a peak discharge of 80,000 ft^3/s, which was a recurrence interval of 50 years, and the second highest peak discharge in more than 75 years (Stokes and others, 1991).

Water Quality

Stream quality in Georgia is affected by varying geology, land use, and impoundments (J.B. McConnell and G.R. Buell, U.S. Geological Survey, written commun.). The Georgia Department of Natural Resources (GDNR), Environmental Protection Division (EPD), established water-use classifications for streams based on designated beneficial uses, and has assigned specific water-quality standards to support the water-use classifications (Georgia Department of Natural Resources, 1990).

An assessment of Georgia streams indicates that 97 percent of 20,000 stream miles support the designated uses (Georgia Department of Natural Resources, 1990, p. 8). Nonpoint sources (64 percent of the time), point sources from municipalities (10 percent of the time), and industry (20 percent of the time) were identified as the specific causes for less than full support of the designated uses (Georgia Department of Natural Resources, 1990). GDNR is concerned about (1) discharges of nutrients (nitrogen and phosphorus); (2) toxic substances (organic compounds and trace metals; and (3) fecal coliform bacteria (and the potential effect that fecal coliform bacteria may indicate on aquatic life of the receiving streams, reservoirs, and the public health) (Georgia Department of Natural Resources, 1990). GDNR states that controlling toxic substances, erosion and sedimentation, and urban nonpoint-source runoff are the important issues in the future of Georgia (Georgia Department of Natural Resources, 1990).

Ground Water

Mean ground-water levels for 25 observation wells throughout Georgia ranged from 2.2 feet (ft) lower to 3.9 ft higher in the 1990 water year than in the 1989 water year. In northern Georgia, mean water levels in the crystalline rock aquifers were from 1.8 to 1.9 ft higher in 1990 than in 1989. Along the coast, mean water levels generally were lower in the Floridan aquifer system and higher in the shallow water-table aquifer in the 1990 water year than in the 1989 water year. Near Savannah, mean water levels in the Floridan aquifer system were from 0.3 to 2.0 ft lower, and record lows were recorded in three wells in mid-July. The mean water level in the shallow water-table aquifer in Savannah was 0.9 ft higher in 1990 than in 1989. In the Riceboro, Jesup, and Okefenokee Swamp areas, mean water levels in the Floridan aquifer system were from 0.7 to 1.6 ft lower, and record lows were recorded in seven wells in late September. In the Brunswick area, mean water levels in the Floridan aquifer system were 0.8 ft lower in 1990 than in 1989. In the east-central and south-central parts of the State, mean water levels in the Floridan aquifer system were from 1.2 ft higher to 2.2 ft lower in 1990 than in 1989, and record lows were recorded in three wells in August and September of 1990. In the southwestern part of the State, mean water levels in the Floridan aquifer system were from 1.9 to 3.9 ft higher in 1990 than during 1989; however, a record low water level was recorded in one well in late September. Mean water levels in the Clayton aquifer of southwestern Georgia were from 0.4 ft higher to 1.6 ft lower than in 1989 (Stokes and others, 1991).

Additional information concerning ground-water-level fluctuations in the State can be found in U.S. Geological Survey Open-File Reports entitled, "Ground-water conditions in Georgia, 1989", which includes data for calendar year 1989, and "Ground-water conditions in Georgia, 1990", which includes data for calendar year 1990.

Water Use

Millions of gallons of water are withdrawn each year from Georgia's available resources for a variety of uses. Since 1977, the Georgia Water-Use Program, a joint project between the USGS and the Georgia Department of Natural Resources, Environmental Protection Division, Georgia Geologic Survey, has focused on the use of these withdrawals. The primary purpose of the project is to collect and compile information on principal water users in the State. The water-use information, compiled by various Federal, State, and local agencies, is combined into a centralized data base, known as the Georgia Water Use Data System (GWUDS). The GWUDS data base contains permitted and non-permitted water-use information on public-supply, industrial, commercial, domestic, thermoelectric, and hydroelectric use (Stokes and others, 1991).

Georgia law requires a permit for all municipal, industrial, agricultural, and other water users withdrawing more than 100,000 gallons per day. Permitted water users, with the exception of agricultural, also are required to report monthly water withdrawals each year to the Environmental Protection Division, Water Resources Management Branch (Stokes and others, 1991).

In water year 1990, total permitted withdrawal for public-supply, industrial, and thermoelectric use in Georgia was reported at 6,212 million gallons per day (Mgal/d). The 273 permitted public suppliers used about 855 Mgal/d; 74 percent of the water used for this purpose was obtained from surface-water sources. Permitted industrial withdrawal was about 647 Mgal/d; the largest uses were for manufacturing paper, kaolin mining and mineral processing, manufacturing, textile, and chemical production. During water year 1990, 17 thermoelectric power plants withdrew about 4,710 Mgal/d, representing 76 percent of the total permitted withdrawal (Stokes and others, 1991).

GEORGIA DISTRICT PROJECTS

A brief description of current District projects follows, and includes the following information.

- Name
- Number
- Location
- Project chief
- Period of project
- Cooperating agency or agencies
- Problem
- Objectives
- Approach
- Progress

SURFACE-WATER MONITORING, GA001

Location: Statewide

Project Chief: William R. Stokes, III

Period of Project: Continuing

Cooperation: Many agencies

Problem: Surface-water data are needed for purposes of surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development.

Objectives: To collect surface-water data sufficient to satisfy needs for current-purpose uses, such as (1) assessment of water resources; (2) operation of reservoirs or industries; (3) forecasting; (4) pollution control and disposal of wastes; and (4) data collection necessary for analytical studies to define for any location, the statistical properties of, and trends in, the occurrence of water in streams, lakes, and estuaries for use in planning and design.

Approach: Standard methods of data collection are used as described in the series, "Techniques of Water Resources Investigations of the United States Geological Survey." Partial-record gaging stations are used instead of complete-record gaging stations, where the required purpose is served.

Progress: Data were collected for 128 daily-flow and/or stage stations, 15 reservoir stage and contents stations, 94 crest-stage, partial-record stations, and 8 peak discharge, miscellaneous sites, and published in the 1990 water year data report (Stokes and others, 1991). Data were collected for floods that occurred in October 1990 and March 1991. Data were provided for an unusually large number of miscellaneous streamflow and flood data requests by Federal, State, and local government agencies, and the private sector. One daily-flow station was discontinued at the end of calendar year 1990. Major maintenance was performed at several gages severly damaged by flood waters, and one gage was rebuilt that was destroyed by flood waters. Several daily-flow stations were instrumented with voice transmitters, expanding the near-real-time stage-monitoring network to 51 stations. The Surface-Water-Quality Assurance and Georgia District Flood Plans were updated. The Office of Surface Water, Reston, Va., conducted an extensive review of District surface-water activities. Preparation of data for publication in the 1991 water year data report was about 65 percent completed.

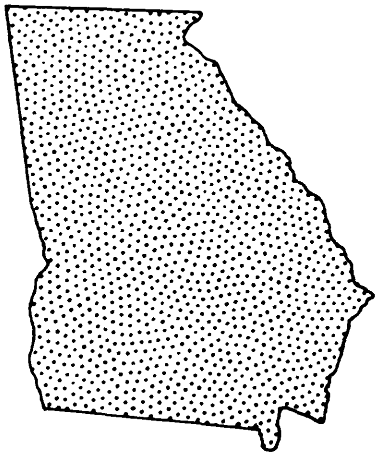
GROUND-WATER MONITORING, GA002

Location: Statewide

Project Chief: John S. Clarke

Period of Project: Continuing

Cooperation: Many agencies



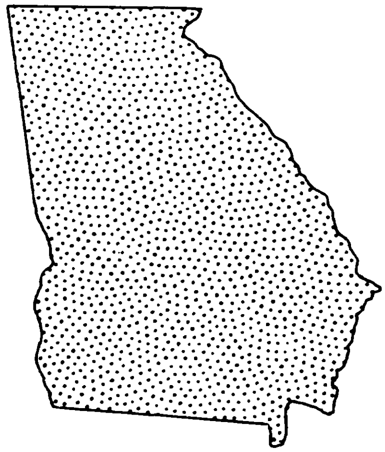
Problem: Monitoring ground-water levels and quality is essential to the management of the State's aquifers. Water-level and water-quality data are needed to evaluate the effects of climatic variations on recharge to and discharge from the aquifers.

Objectives: Collect ground-water-level and quality data throughout the State to (1) provide a data base against which the effects of development are measured, (2) assist in the prediction of future ground-water supplies, and (3) manage the ground-water resources.

Approach: Water-level data are collected for the various aquifers in the State by a network of observation wells that includes periodic observation sites and continuously recorded observation sites. Well-inventory data are entered into the Ground-Water Site Inventory files (GWSI). Borehole geophysical data are collected from available wells. Water-quality samples are taken from selected wells for analyses.

Progress: Continuous water-level recorders were operated at 151 wells. Periodic water-level measurements were made in 952 wells throughout the State. Potentiometric surface maps were constructed for the Upper Floridan, Claiborne, Clayton, and Dublin-Midville aquifers. Water samples were collected monthly from 12 wells in the Savannah area, and semi-annually from 80 wells in the Brunswick area, for analysis of chloride and specific conductance. The annual report was published on ground-water conditions during 1990, recent ground-water levels, ground-water-quality trends, precipitation records from 10 National Weather Service stations, continuous water-level records from 140 wells, periodic water-level mesurements from an additional 1,227 wells, and chloride analyses from 176 wells (Milby and others, 1991). Monthly cooperator reports were prepared outlining ground-water and climatic conditions at key locations in the State. Well-inventory, water-level, and geologic data were entered into the National Water Information System (NWIS). A field inventory of wells was conducted, and 604 additional sites were entered into the GWSI to improve ground-water data coverage in the State. Numerous requests for ground-water data were answered during the year.

QUALITY-OF-WATER MONITORING, GA003



Location: Statewide

Project Chief: William R. Stokes, III

Period of Project: Continuing

Cooperation: Georgia Department of Natural Resources
Environmental Protection Division
Water Protection Branch

Problem: Water-resource planning and water-quality assessment require a Nationwide base of relatively standardized water-quality data. For planning and realistic assessment of the water resources, the chemical and physical quality of the rivers, streams, and ground water must be defined and monitored.

Objectives: To (1) provide a National data base of water-quality information for broad Federal and State planning and action programs, and (2) provide data for the management of rivers, streams, and ground-water resources.

Approach: A network of water-quality stations is operated to provide average chemical concentrations, loads, and time trends as required by planning and management agencies. Water-quality samples are collected periodically throughout the State, and any changes that occur are noted. The Georgia Environmental Protection Division (EPD) provides laboratory services for the analyses of water samples collected cooperatively during the year. The EPD laboratory participates in the U.S. Geological Survey Water-Quality Assurance Program.

Progress: Five flow-through monitors and five minimonitors were operated at stream sites throughout the year. The standard four properties (pH, water temperature, dissolved-oxygen concentration, and specific conductance) were obtained at four of the flow-through sites, and dissolved-oxygen concentration and temperature were obtained at the fifth site. Specific conductance was obtained at four of the minimonitor sites, and temperature at one site. The continuing chemical-quality network increased substantially, and samples were taken at 133 surface-water sites. All data were furnished currently to cooperators. The continuing network includes one Benchmark and five National Stream Quality Accounting Network (NASQAN) stations. The Benchmark station and one NASQAN station were sampled quarterly, and the other NASQAN stations were sampled bimonthly. Four water samples, two from the NASQAN site, Altamaha River at Everett City, and two from the Benchmark station, Falling Creek near Juliette, were analyzed for radio-chemical data. Data for the 1990 water year were published in the annual water-data report (Stokes and others, 1991) (see project GA001); and preparation of 1991 data for publication was 65 percent completed. Program quality-control activities were conducted according to quality assurance plans. Numerous requests for water-quality data were answered during the year.

SEDIMENT MONITORING, GA004

Location: Statewide

Project Chief: William R. Stokes, III

Period of Project: Continuing

Cooperation: U.S. Army Corps of Engineers
Mobile District

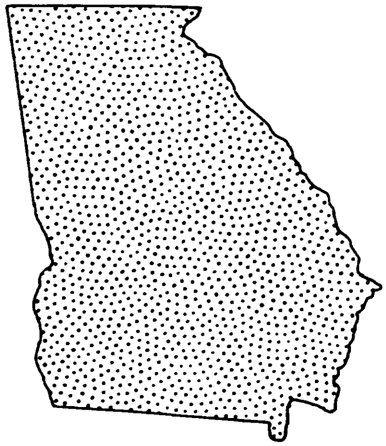
Problem: Water-resource planning and water-quality assessment require a Nationwide base of relatively standardized sediment information. Sediment concentrations and discharges in rivers and streams need to be defined and monitored.

Objectives: To (1) provide a National sediment data base for use in broad State and Federal planning and action programs, and (2) provide data for management of interstate and intrastate waters.

Approach: Establish and operate a network of periodic and stormwater sampling stations to provide spatial averages of sediment concentrations and particle sizes being transported by rivers and streams.

Progress: Periodic collection and analysis of sediment samples continued at 10 continuous-record streamflow stations, and storm events were sampled at five of these stations located in the vicinity of major U.S. Army Corps of Engineers projects. Appropriate distribution of 1990 water year data was made in a timely manner. Data for the 1990 water year were published in the annual water-data report (Stokes and others, 1991) (see project GA001); and preparation of 1991 data for publication was about 50 percent completed.

ATMOSPHERIC DEPOSITION MONITORING, GA005



Location: Statewide

Project Chief: Gary R. Buell

Period of Project: Continuing

Cooperation: U.S. Department of Agriculture
Agricultural Research Service
U.S. Geological Survey
Office of Atmospheric Deposition Analysis

Problem: Data on the chemical quality of atmospheric deposition are needed to provide a baseline against which future changes in atmospheric chemical quality can be evaluated. These data also are an essential input to studies designed for assessment of possible aquatic and terrestrial effects related to atmospheric deposition of strong acids. The anthropogenic influences on precipitation chemical quality and effectiveness of any mitigation strategies cannot be determined without National network coverage.

Objectives: To (1) define the chemical quality of wet deposition in Georgia; and (2) analyze the spatial and temporal variability in the chemical quality of precipitation in Georgia.

Approach: In cooperation with the U.S. Department of Agriculture, Agricultural Research Service (ARS), and the U.S. Geological Survey, Office of Atmospheric Deposition Analysis, precipitation-sampling data from the Tifton ARS National Trends Network (NTN) site will be verified and entered into the National Water Data Storage and Retrieval System (WATSTORE). Weekly composite wet-precipitation samples will be analyzed for pH, specific conductance, and major cations and anions. These data will be analyzed with other regional network data for determination temporal and spatial trends in precipitation chemistry.

Progress: Composite wet-precipitation samples were collected weekly at the Tifton-ARS NTN site, and preliminary results were received from the Illinois State Water Survey Central Analytical Laboratory for 432 of the 446 sample sets, and entered into the District water-quality files, and published in the 1990 water year data report (Stokes and others, 1991).

WATER USE IN GEORGIA, GA007

Location: Statewide

Project Chief: Julia L. Fanning

Period of Project: Continuing

Cooperation: Georgia Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey

Problem: Increases in population, industrial growth, and agricultural productivity have caused concern about the stresses placed on the water resources in Georgia. Consistent and accurate statewide water-use data are essential for the management of the water-use data have not been developed in Georgia. Additionally, water-use data currently in the files of both Federal and State agencies need to be verified and input into computer storage and retrieval.

Objective: To (1) identify sources of water-use data; (2) develop and evaluate techniques for collecting water-use data; (3) identify and implement requirements for a water-use data-handling system in Georgia; and (4) develop methods for the efficient reporting of water-use data.

Approach: Water-use data are collected and compiled for the principal water users in the State including industry, public supply, irrigation, domestic and commercial supplies, and thermoelectric and hydroelectric facilities; and additional data collected from mail surveys are entered into the Georgia Water-Use Data System (GWUDS). The GWUDS file is updated annually to include (1) data on the amount of water used during the previous year, (2) new water users, and (3) any changes in permitted use issued by the State.

Progress: Updates of 1990 data for municipal, industrial, and power-generation withdrawal and returns; and data from new water users entered into the GWUDS. Irrigation estimates were determined using data acquired from the Cooperative Extension Service 1989 irrigation survey. Water-use estimates were determined by county, hydrologic unit, and aquifer; and submitted to the National Water-Use Program for inclusion in USGS Circular [1990 Estimated Use of Water in the United States] (EUOWITUS). A report entitled, "Power Generation with Related Water Use in Georgia" (Fanning and others, 1991) was published by the Georgia Geologic Survey, in cooperation with USGS.

STATEWIDE FLOOD STUDIES, GA059

Location: Statewide

Project Chief: Timothy C. Stamey

Period of Project: Continuing

Cooperation: Georgia Department of Transportation

Problem: Reliable estimates of flood magnitude and flood frequency are required to (1) design highway bridges and culverts, (2) determine locations for waste-treatment and water-supply facilities, (3) prepare zoning ordinances, and (4) establish flood-insurance rates.

Objectives: To collect, analyze, and publish flood data describing the hydrologic and hydraulic characteristics of selected stream reaches and floods to (1) design highway bridges and culverts, (2) determine locations for waste-treatment and water-supply facilities, (3) prepare zoning ordinances, and (4) establish flood-insurance rates.

Approach: To (1) operate a network of crest-stage gages to supplement the statewide gaging-station network and improve the areal distribution of flood data that provide the baseline data for determining the magnitude and frequency of floods on Georgia streams; (2) determine the hydraulic and hydrologic characteristics, including the determination of the flow distribution, backwater, and velocity studies of selected stream reaches; (3) make field measurements, including indirect measurements of peak flows for hydrologically significant floods; and (4) prepare reports describing hydrologically significant floods.

Progress: Floods of February and March 1990 were described for Georgia, Alabama, and Florida (Pearman and others, 1991). Peak discharges were determined by eight indirect measurements. Annual peak-flow data for 52 crest-stage gage sites and about 130 current and discontinued stations were entered into the USGS peak-flow files. Basin characteristics files were updated, and initial analysis results were determined for a Statewide flood-frequency report.

FLOOD-FREQUENCY CHARACTERISTICS OF URBAN STREAMS IN GEORGIA, GA062

Location: Cities of Albany, Moultrie, Thomasville, and Valdosta

Project Chief: Ernest J. Inman

Period of Project: 1978-1995

Cooperation: Georgia Department of Transportation
City of Albany
City of Moultrie
City of Thomasville
City of Valdosta

Problem: A method is needed for estimating the magnitude and frequency of floods occurring in streams in metropolitan areas of Georgia. Urban flood-frequency data are needed for bridge, culvert, and drainage designs, and for flood-mapping studies. Urbanization produces large changes in the flood-runoff characteristics of streams; therefore, natural (rural) basin flood-frequency relations are not applicable to urban and surburban streams. Few hydrologic data are available for streams in metropolitan areas.

Objectives: To (1) collect hydrologic data for selected urban streams in selected metropolitan areas of Georgia, and (2) analyze these data to develop relations to estimate the magnitude and frequency of floods in urban streams throughout the State.

Approach: Selected urban drainage basins will be instrumented to obtain flood-hydrograph and storm-rainfall data in Albany, Moultrie, Thomasville, Tifton, and Valdosta. These basins will represent a range in drainage area (0.2 to 20 mi^2), amount of impervious area, channel slopes, and types of land use. Significant flood-runoff events will be processed for use in calibrating the USGS urban-hydrology model. When the rainfall-runoff model is calibrated for a station, National Weather Service long-term rainfall data will be used to simulate a long-term peak-discharge record for the calibrated sites. Flood frequency at each site then will be defined from the synthesized flood peaks by using the log-Pearson Type III analysis. The multiple-regression method may relate to physical and climatological basin characteristics. Estimates of the magnitude and frequency of floods can be made for an ungaged drainage basin.

Progress: Stage-discharge relations were established at two additional sites, for a total of 22 sites, and rainfall and stage data were collected from the sites. Discharge hydrographs and rainfall hyetographs were plotted for all floods at 20 rated sites.

ACID RAIN, DRY DEPOSITION, AND TERRESTRIAL PROCESSES RESEARCH AT PANOLA MOUNTAIN STATE PARK, GEORGIA, GA085

Location: Panola Mountain State Park, Stockbridge

Project Chief: Norman E. Peters

Period of Project: 1984 - continuing

Cooperation: None. [U.S. Geological Survey, Research Funds]

Problem: Acidic atmospheric deposition (acid rain) may be responsible for acidification of some surface waters in the eastern United States (Peters, 1987). This acidification may have deleterious effects on fauna and flora through changes in the chemical regime. Atmospheric deposition of acids occurs as wet precipitation, including rain, snow, and sleet, and as dry deposition including impaction of aerosols, gravity settling of large particles, and gaseous transfer. The processes need to be further defined that control acidification of surface water.

Objectives: To (1) evaluate and devise methods for measuring dry deposition; and (2) investigate terrestrial processes that control water chemistry, particularly with respect to the production of acidic atmospheric deposition by the watershed.

Approach: Dry deposition will be evaluated using micrometeorological methods, chemical mass balance, and net chemical transport through the forest canopy (throughfall). The water pathways and related chemical characteristics along select pathways will be evaluated to understand processes controlling water chemistry in the watershed. Primary focus of the sampling will identify variations in flow and related chemistry of precipitation, soil water, throughfall, ground water, and surface water on short time scales during storms. The composition of the above-ground biomass, soils, saprolite, and bedrock also will be evaluated.

Progress: Precipitation at Panola Mountain is acidic and is dominated by sulfuric and nitric acids (average sulfate to nitrate ratio in equivalents is 2.5). However, precipitation is neutralized by reactions in the deciduous forest canopy during storms (Cappellato, 1991). The acidity of precipitation increases as the precipitation passes through the coniferous forest canopy. The increase in acidity results from the washoff of acidic dry deposition and leaching of organic acids in the forest canopy. Also, runoff collected on the granite outcrop is more acidic than the precipitation, and is likewise caused by washoff of acidic dry deposition (Peters, 1987). Estimates of the acidic dry deposition contribution of total atmospheric deposition range from 33 percent from a mass balance of runoff from the granite outcrop, to about 50 percent from net throughfall estimates of sulfate flow. Although the rapid and large decreases in streamwater alkalinity have been observed at the basin outlet, the acidic runoff from a granite outcrop in the headwaters, moving rapidly downstream, is effectively neutralized by mixing with older, more alkaline soil and ground water. Soils at the base of the outcrop have higher water-soluble sulfate than those in the interior of the watershed (Shanley, 1989). In streamwater, large increases in sulfate concentrations accompany the decreases in alkalinity. High sulfate concentrations were observed in ground water in the headwaters of the watershed.

MOVEMENT AND FATE OF AGRICULTURAL CHEMICALS IN THE SURFACE AND SUBSURFACE ENVIRONMENTS, SOUTHWEST GEORGIA, GA087

Location: Ty Ty Creek, Sumter County

Project Chief: David W. Hicks

Period of Project: 1984-1994

Cooperation: U.S. Department of Agriculture
Agricultural Research Service
U.S. Geological Survey
Toxic Substances Hydrology Program

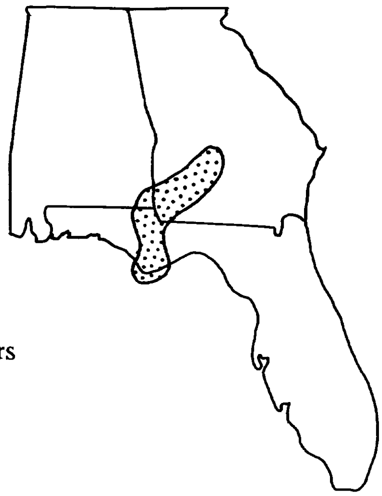
Problem: Increased demand for agricultural products has resulted in widespread multicropping in southwestern Georgia that requires an application of myriad organic and inorganic chemicals. These chemicals are being applied in recharge areas and may move into aquifers used for water supplies. Movement and fate of agricultural chemicals in the ground, or of the potential for degrading the quality of water in aquifers, need to be determined.

Objectives: To (1) conduct a hydrologic and lithologic evaluation, (2) determine the movement and fate of agricultural chemicals in the unsaturated (including the root zone) and saturated zones, and (3) improve processes to describe the infiltration rate and chemical nature of ground-water recharge in the unsaturated zone by using existing computer models.

Approach: Two test plots, located in a highly permeable, interfluve part of the study area, will be instrumented, and 30 to 40 test wells will be installed. Lysimeters and ceramic soil-moisture collectors will be installed in the unsaturated zone, and ground-penetrating radar (GPR) will identify and correlate strata. Four pits will be excavated and described. The infiltration rate and flow paths will be evaluated in the unsaturated zone along a transect extending from the interfluve area to the toe-slope area in the watershed. Aquifer testing will determine hydraulic properties of the saturated zone and the hydraulic conductivity of the unsaturated zone.

Progress: The lateral component of transport was evaluated in the unsaturated zone. The second application of potassium bromide tracer was applied in March 1991 to the plot area coincident with the planting and agrichemical application. Since March 1991, more than 1,575 soil samples were analyzed in the District laboratory to evaluate transport in the unsaturated zone. An additional 160 samples were analyzed as a part of the project quality-assurance program. Laboratory analyses include gravimetric soil moisture, bulk density, specific conductance, and bromide concentration. Data from 44 slug tests were analyzed, and the aquifer hydraulic properties were estimated. Reports were published on the preliminary geologic and hydrologic evaluation of a small watershed near Plains, Ga., (Hicks and others, 1991a) and on the movement and fate of agricultural chemicals in the surface and subsurface environments near Plains, southwestern Georgia (Hicks and others 1991b). A preliminary evaluation of the significance of non-vertical transport in the unsaturated zone was presented at the U.S. Geological Survey, Toxic Hydrology Symposium, Monterey, Calif. (Hicks and others, 1989).

EFFECTS OF GROUND-WATER PUMPING ON STREAMFLOW IN THE LOWER PART OF THE APALACHICOLA, CHATTAHOOCHEE, AND FLINT (ACF) RIVER SYSTEM, ALABAMA, FLORIDA, AND GEORGIA, GA089



Location: Alabama, Florida, and Georgia

Project Chief: Lynn J. Torak

Period of Project: 1986-1990

Cooperation: U.S. Army Corps of Engineers
Mobile District
Alabama Department of Economic and Community Affairs
Florida Department of Economic and Community Affairs
Georgia Department of Natural Resources

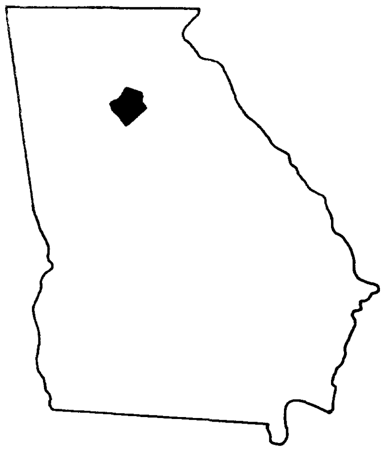
Problem: The limited surface- and ground-water resources of the ApalachicolaChattahoochee-Flint River (ACF) basin have caused concern about potential conflicts over water use in the three-State area. Water levels in the Upper Floridan aquifer are influenced by the surface-water network throughout most of the basin, and pumpage from the ground-water system has the potential to affect streamflow. The hydrologic ramifications of drought conditions, fisheries production, navigation, wetlands, and freshwater-saltwater equilibria in Apalachicola Bay on the stream-aquifer system cause concern for responsible utilization and management of water resources within the basin.

Objectives: To (1) improve the definition of stream-aquifer relations in the parts of the basins where ground-water withdrawals are significant, (2) develop a conceptual model of the flow system that incorporates the hydrologic processes pertinent to evaluating surface- and ground-water components and the important hydrologic stresses to the flow system, (3) simulate the surface- and ground-water systems by using a digital flow model, and (4) test alternative management schemes for anticipated multiple uses of the water resources in the basin through simulation.

Approach: Review literature and unpublished information describing the surface- and ground-water systems in the ACF basin. Gather, analyze, and compile hydrologic data to refine the conceptualization of the flow system and to prepare input for the digital model. Design and construct a finite-element model that incorporates points of observation, stresses, aquifer geometry, and surface-water features. Perform model calibration and validity checks to observed data and simulate alternative management scenarios by inputting anticipated water-use demands to the model.

Progress: Stream-aquifer relations were simulated, and sensitivity analyses were performed on the hydrologic factors affecting the ground-water-flow system in the ACF basin. Reports are in preparation that describe stream-aquifer relations, sensitivity of hydrologic components to stress, and water budgets for the ground- and surface-water-flow system.

EFFECTS OF FLOOD DETENTION RESERVOIRS, GWINNETT COUNTY, GEORGIA, GA090



Location: Gwinnett County, Georgia

Project Chief: Ernest J. Inman

Period of Project: 1986-1993

Cooperation: Gwinnett County, Georgia

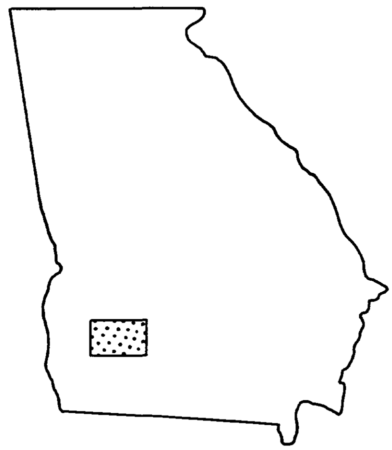
Problem: An ordinance of Gwinnett County requires developers to analyze runoff from land being developed, and provide detention reservoirs so that peak runoff does not exceed predevelopment or natural rates; however, developers are not required to determine the effect of the reservoir outflows on the receiving streams. Reservoir outflow may actually increase flood peaks downstream in some instances because of changes in the magnitude and timing of the flows. If reservoir outflows are significantly increased, the effect would be contrary to the intent of the ordinance.

Objective: To define the effectiveness of existing and proposed detention reservoirs in reducing flood-runoff peaks in downstream reaches of streams in Gwinnett County. The Distributed Routing Rainfall-Runoff Model (DR3M) (Alley and Smith, 1983) will be calibrated by using observed data, generally for three to five events per year, and will be used to simulate several long-term peak discharge data sets with long-term rainfall data from the National Weather Service.

Approach: Stable drainage basins having one or more detention reservoirs will be selected for study, and one or more recording rain gages will be installed in the basin. A water-stage recorder will be installed to gage the cumulative flow of the entire basin. The first simulation using the calibrated DR3M model will be for an "as is" condition having all detention ponds in place. Subsequent simulations will be made by removing one reservoir at a time, until the final simulation is for a "no-detention" condition. Flood-frequency relations using the log-Pearson Type III analysis will be developed using the synthesized storage-free conditions in a basin. Thus, the effect of existing or proposed detention reservoirs for a stream system can be analyzed.

Progress: Stage-discharge relations were established at six sites. Data were collected and processed on a near-current basis. Discharge and rainfall hydrographs were plotted for all floods. Area-capacity curves were established at all detention ponds.

HYDROLOGY OF THE UPPER FLORIDAN AQUIFER IN THE ALBANY, GEORGIA AREA, AN ANALYSIS FROM DIGITAL MODELING, GA091



Location: Albany, Georgia

Project Chief: Lynn J. Torak

Period of Project: 1986-1992

Cooperation: Albany Water, Gas, and Light Commission

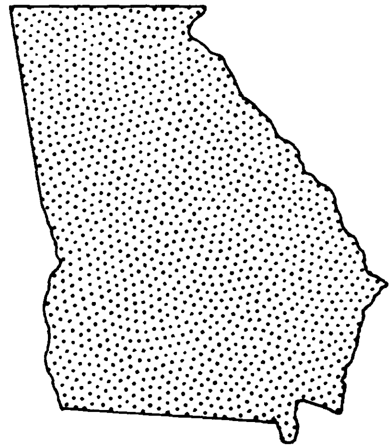
Problem: Population growth and changes in farming practices have led to increased ground-water use in southwest Georgia, causing water levels in the principal aquifers to decline 40 to 100 ft since the 1950's. Withdrawals from these aquifers are approaching limits of hydrologic and economic feasiblilty; therefore, the development potential of alternative sources of fresh water needs to be evlauated. A promising alternative, the Upper Floridan aquifer, is a major source of water for industry and irrigation, but has not been developed extensively as a public-supply source, partly because of concern over potential ground-water contamination.

Objectives: To (1) define components of the ground-water-flow system and quantify stream-aquifer relations, (2) evaluate the development potential of the Upper Floridan aquifer in the Albany area as a source of ground water for public supply, and (3) assess the effects of current and future withdrawals of ground water from the Upper Floridan on the stream-aquifer system.

Approach: Perform selected data collection and assimilate available hydrologic information to conceptualize the flow system. Design a finite-element model that simulates surface- and ground-water flow, integrating this model with the finite-element model of the ACF Basin (see project GA089). The model will be calibrated by using data collected at observation points. Selected ground-water-development scenarios will be simulated to assess the Upper Floridan aquifer as a source of water for public supply.

Progress: An evaluation of water-resource potential of the Upper Floridan aquifer was published (Torak and others, 1991). A sensitivity analysis was performed on 18 hydrologic factors affecting steady-state ground-water flow. The sensitivity analysis indicates that hydraulic head shows high sensitivity to well pumpage, and low sensitivity to changes in stage and boundary coefficient for Cooleewahee Creek (located near of an area of potential ground-water development). Ground-water levels show high sensitivity to hydraulic head that controls regional flow, and low sensitivity to the corresponding boundary coefficient, indicating that regional flow probably influences ground-water levels in a manner similar to that of a specified-head (Dirichlet) boundary rather than a head-dependent (Cauchy-type) boundary. A preliminary geostatistical analysis on the data of hydraulic head and aquifer transmissivity shows a spatial drift or trend in hydraulic head associated with regional ground-water flow from the northwest, north, and northeast of the Flint River. Although drift or trend was eliminated from the data by using water-level residuals (computed minus measured water levels) based on the calibrated finite-element model, use of uncalibrated residuals during experimental variography yielded better defined spatial-correlation structures than structures obtained by using calibrated residuals. Improvements to the estimation of aquifer transmissivity were obtained by using co-kriging and available data of uncalibrated residuals.

DEVELOPMENT OF STATE GEOGRAPHIC INFORMATION SYSTEM TO SUPPORT ENVIRONMENTAL MANAGEMENT ACTIVITIES IN GEORGIA, GA092



Location: Statewide

Project Chief: S. Jack Alhadeff

Period of Project: 1987-1992

Cooperation: Georgia Department of Natural Resources
Environmental Protection Division
Georgia Geologic Survey
Georgia Mountains Regional Development Center
DeKalb County
U.S. Department of Agriculture
Soil Conservation Service
National Cartographic Center
U.S. Environmental Protection Agency

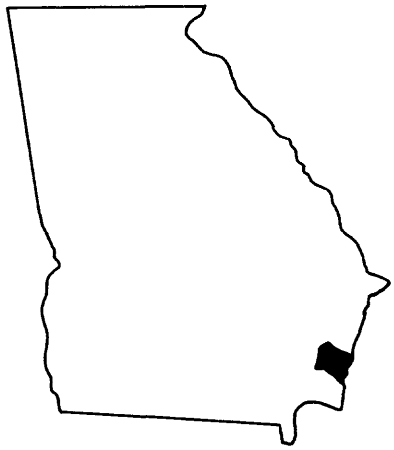
Problem: Waste landfills and facilities generate, transport, and store hazardous wastes in the Southeast, including Georgia. Every waste landfill and facility is a potential contamination source of public- and private-water supplies, and a potential contamination source of nearby land and atmosphere. A means of screening these locations is needed to (1) identify areas of potential pollution (such as nearby streams and aquifers), (2) correlate the many relevant earth science data bases (such as land use, land cover, lithology, soils, environmental monitoring stations, elevation, and demographic data), and (3) develop analytical models to assist in environmental management decisions.

Objectives: To develop for use by water managers, planners, and researchers--(1) a statewide geographic information system (GIS) to assist in making multi-county environmental decisions, (2) a GIS data base at the state or multi-state level that provides tools to determine water-quality trends, site regional reservoirs, locate areas unsuitable for locating sanitary landfills, process environmental permits and delineate areas susceptible to ground-water contamination [a modified DRASTIC model] (U.S. Environmental Protection Agency, 1987), and (3) a GIS data base at the county level to address delineation and protection of wetlands, surface-water supplies, ground-water recharge areas, stream corridors, stormwater quality, and other environmental concerns.

Approach: Organize an interagency team of specialists to digitize, compile, review, and transform the GIS data base. The team of specialists will perform quality assurance and quality control of the spatial and related tabular data. Construction, development, and review of GIS data base or model scenarios will determine the assessments of environmental resources.

Progress: GIS data bases are being developed to (1) determine areas susceptible to ground-water pollution on a Statewide basis, and (2) support minimum protection standards and water-quality monitoring for storm-water management in DeKalb County. The U.S. Environmental Protection Agency; U.S. Department of Agriculture, Soil Conservation Service; and the USGS developed a Memorandum of Understanding that can be used as a Nationwide example for developing and sharing GIS data bases. GIS Exchange was formed to ensure the storage, quality assurance, documentation, and distribution of GIS data bases in the Southeast; and consists of representatives from Federal, State, and local agencies.

RELATION OF FLOW AND TRANSPORT PROCESSES TO CONCEALED FAULTS AND FRACTURED ZONES IN A MULTI-LAYERED CARBONATE AQUIFER SYSTEM, GA093



Location: Glynn County, Georgia

Project Chief: Gregory C. Mayer

Period of Project: 1987-1992

Cooperation: City of Brunswick, Georgia
Glynn County

Problem: Significant reduction of the potentiometric surface of the carbonate aquifer system near Brunswick is allowing saline water from underlying aquifers to move upward into freshwater zones. The saline water moves vertically through a complex multi-layered carbonate aquifer system thought to contain vertical faults and extensive fracture zones. These structural features are thought to be the conduits for the upward moving saline water. Effective management of the water resources is important to the area's development.

Objectives: To (1) better understand and describe the flow and transport processes in a multi-layered carbonate aquifer system that is characterized by concealed faults and fractures zones, (2) predict the effect of different ground-water withdrawal scenarios on a representative carbonate aquifer system, and (3) evaluate alternative ground-water-management practices in the carbonate aquifer system within the constraints of minimized reduction of the potentiometric surface and saltwater intrusion.

Approach: The migration of saline water into the upper water-bearing zone will be simulated using a modified two-dimensional (areal) coupled flow and transport finite-element model. Analytical solutions for flow and transport in multi-layered aquifers will be modified and compared with field data for the area to determine if such techniques are applicable. Additional wells outside the Brunswick area in Glynn County will be modified or constructed to obtain data on water levels and chloride concentrations in the lower water-bearing zone. A numerical code will be developed that accounts for leakage through fractures in a multi-layered system. The calibrated model may be used to simulate the effects of withdrawals on ground-water levels and saltwater intrusion.

Progress: Hydrogeologic framework of the carbonate aquifer system was reviewed, and the conceptual and digital models were found to be in agreement. The ground-water-flow modeling report was reviewed and modified. Continous water-level recorders were operated at 18 sites, and 80 wells were sampled and analyzed for chloride and specific conductance in October and November 1989, and April 1990. Maps were constructed showing chloride concentrations. Borehole geophysical logs were run in one well. Water levels were measured and inventoried in 140 wells tapping aquifers overlying the Upper Floridan aquifer, and 90 samples were analyzed for nitrate and chloride.

HYDROGEOLOGY OF CUMBERLAND ISLAND AND THE IMPACT OF CHANNEL DEEPENING ON THE FRESHWATER RESOURCES OF THE ISLAND, GA096

Location: Southeastern Georgia

Project Chief: Harold H. Zehner

Period of Project: 1988-1993

Cooperation: Georgia State University
U.S. Department of the Interior
National Parks Service

Problem: The environmental balance of Cumberland Island is dependent upon freshwater in the ground-water-flow system. Recent changes in the ground-water-flow system may threaten the balance of the environment of Cumberland Island by increasing the saltwater intrusion into the ground-water-flow system. The changes in the ground-water-flow system include the (1) nearby heavy withdrawal of ground water, (2) potential for future increases in withdrawal, and (3) deepening of navigation channels around the southwestern and southern end of the island.

Objectives: To (1) define the ground- and surface-water-flow systems by concentrating on the shallow aquifers, (2) delineate those parts of the island where saltwater intrusion may be induced by channel deepening, (3) monitor changes in the quality and quantity of freshwater to the ground- and surface-water-flow systems, and (4) evaluate management alternatives that may minimize undesirable changes to the hydrologic environmental balance of the island.

Approach: Install a ground-water-level and water-quality-monitoring network to collect drill cuttings, core, and borehole geophysical logs. The water-quality-monitoring network will include three to four nested sites that each contain wells open to individual water-bearing zones. A water budget will be developed and used to define ambient ground- and surface-water relations, and help determine the position and the configuration of the freshwater-saltwater interface.

Progress: Saltwater intrusion into Cumberland Island aquifers and in similar settings was researched using existing data and literature search. Water levels and specific conductance were continuously monitored in 10 wells.

EVALUATION OF THE MIGRATION AND FATE OF CONTAMINANTS AT AN ABANDONED MANUFACTURED GAS PLANT AT ALBANY, GEORGIA, GA097

Location: Albany, Georgia

Project Chief: Melinda J. Chapman

Period of Project: 1989-1991

Cooperation: Albany Water, Gas, and Light Commission

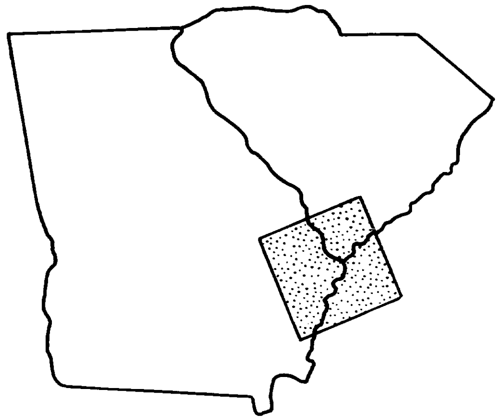
Problem: Wastes associated with an abandoned manufactured gas plant in Albany may affect ground-water and surface-water quality in the area. Tars, oils, and spent-oxide wastes are contaminants commonly associated with the gas manufacturing process. Tars or oils containing high levels of carcinogenic compounds, such as benene and polynuclear aromatic hydrocarbons, and spent-oxide wastes containing sulfuric acid, arsenic, and complexed cyanides, may pose health risks. In addition, surface and underground tanks at the site could allow tar, oil, and liquid wastes to leak into the ground- and surface-water systems.

Objectives: To (1) determine the waste contamination in the study area near an abandoned manufactured gas plant site, (2) evaluate the distribution and concentrations of identified contaminants, (3) identify potential ground-water-flow pathways of contaminants that may affect public health or environmental quality.

Approach: *Phase I*: (1) Identify areas of potential contamination by reviewing historical data and on-site conditions; (2) screen for airborne organics and soil gases for volatile organics; (3) drill to the top of the bedrock and collect soil and waste samples; (4) conduct ground-penetrating radar, electrical resistivity, magnetic, and electromagnetic-terrain conductivity surveys; and (5) install shallow monitoring wells. *Phase II*: (1) Define the hydrogeologic framework of the study area; (2) describe the chemical characteristics of wastes; (3) install deep monitoring wells tapping the Upper Floridan aquifer; (4) run borehole geophysical logs; and (5) sample and analyze ground water.

Progress: Ground water was sampled from wells tapping the shallow water-bearing zone and the Upper Floridan aquifer, and analyzed for volatile and semivolatile organic compounds and inorganic constituents. Ground-water levels and specific conductance were monitored in all wells. Mandatory 8-hour hazardous-waste health and safety training and medical examinations were completed for project personnel. A monitor well was drilled into the lower unit of the lower water-bearing zone of the Upper Floridan aquifer. Results of *Phase I* (Chapman and others, 1990), and *Phase II* of the study were published (Chapman, 1991) showing possible ground-water contamination in the Upper Floridan aquifer in the vicinity of an abandoned manufactured gas plant in Albany.

ASSESSMENT OF THE WATER RESOURCES OF THE CHATHAM COUNTY, GEORGIA AREA, GA100



Location: Chatham County, Georgia, and adjacent areas of Georgia and South Carolina

Project Chief: Reggina Garza

Period of Project: 1989-1992

Cooperation: Chatham County-Savannah Metropolitan Planning Commission

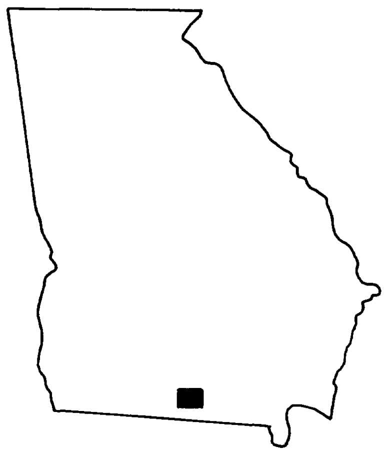
Problem: Ground-water pumping from the Floridan aquifer system in the Chatham county area has resulted in a steep cone of depression near the top of the aquifer. Additional ground water probably can be developed, and surface water may be available, but the quantity, quality, withdrawal rates, and source of future supplies, are unknown and need to be assessed. This information is critical to the development of a water-resource management plan for Georgia and South Carolina, and local water-resource managers.

Objectives: To (1) update and refine hydrologic data and information necessary to develop a ground-water flow model of the Chatham County, Georgia area, (2) simulate the ground-water development potential of the Floridan aquifer system in the area, including quantities and location of possible ground-water withdrawals, (3) evaluate the potential for saltwater intrusion into the Floridan aquifer system, and (4) assess the availability of surface water as a possible source of fresh water supply.

Approach: Determine current amounts of ground and surface water used for domestic and industrial purposes. Determine current configuration of the potentiometric surface and the ground-water-flow system. Analyze water-level trends as related to water-use patterns. Determine distribution of chlorides in the Upper Floridan aquifer. Determine sources and availability of surface water. Develop a ground-water-flow model of the Floridan aquifer system; and analyze the effects of ground-water-mangement alternatives on the aquifer by using digital-model analyses.

Progress: The water-supply potential of the Floridan aquifer system was evaluated in the coastal area of Georgia (Randolph and others, 1990). Non-permitted water use was evaluated and incorporated into a computer model to define the ground-water-development potential and determine streamflow characteristics for major streams in the study area. Hypothetical ground-water scenarios were developed showing increased, decreased, and redistributed pumpage.

USE OF CHLOROFLUOROCARBONS TO ASSESS THE CONTAMINATION POTENTIAL OF A LIMESTONE AQUIFER IN A KARST TERRANE, GA101



Location: South-Central Georgia

Project Chief: James B. McConnell

Period of Project: 1990-1992

Cooperation: City of Valdosta, Georgia

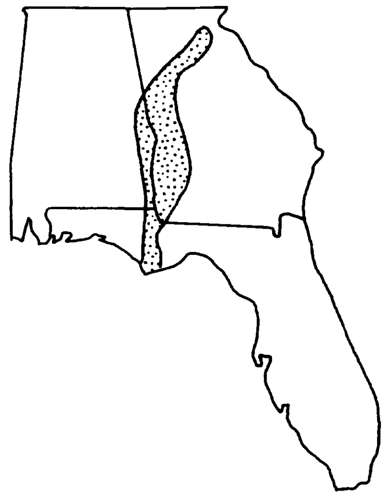
Problem: The potential of ground-water systems for entry and movement of contaminants in karst terranes cannot be properly evaluated using Darcian principles, because ground-water flow often does not obey Darcy's law. Sinks, caves, and karst windows, which are common features in karst terrane, permit direct access of contaminants to the aquifer. Once contaminants enter the aquifer, their direction and rate of movement are highly uncertain because of the labyrinth of solution channels and cavities. Tracers of ground-water flow such as tritium, carbon-14, or other environmental isotopes, and dyes that have been used in karst areas to assess the contamination potential, often are not adequate for that purpose.

Objectives: To evaluate the capability of chlorofluorocarbons (CFC) to trace ground-water-flow paths and to age-date ground water in a karst terrane. Specifically, CFC may be used to (1) determine the direction of ground-water flow and mixing patterns, (2) estimate the age of ground water, and (3) evaluate the performance and sensitivity of CFC as a ground-water tracer and age-dating tool compared to tritium, carbon-14, and other enviromental isotopes.

Approach: Select a study site near Valdosta to test the tracer capability of CFC. Water will be sampled from 50 to 60 wells tapping the Upper Floridan aquifer in the vicinity of suspected or known recharge, and along predicted flow paths downgradient of known sinks on the Withlacoochee River. Sample sites will be selected using existing potentiometric-surface maps and water-quality data.

Progress: Existing wells were inventoried, and 83 wells were selected for sampling. Ground-water samples were analyzed for CFC, chemical constituents, and physical properties. Also, water levels were measured in wells in the study area.

NATIONAL WATER QUALITY ASSESSMENT (NAWQA) PROGRAM-- THE APALACHICOLA-CHATTAHOOCHEE-FLINT (ACF) RIVER BASIN STUDY, GA102



Location: Apalachicola-Chattahoochee-Flint River Basin

Project Chief: David J. Wangsness

Period of Project: 1990-1996

Cooperation: None. [U.S. Geological Survey, Federal Funds]

Problem: Atlanta, Ga., has been one of the fastest growing metropolitan areas in the Nation during the last decade. Point and non-point sources of nutrients, pesticides, sediments, metals, and organic compounds associated with substantial population growth and urban development, together with intensive agricultural activities, are affecting the surface- and ground-water quality of the Apalachicola-Chattahoochee-Flint (ACF) River basin. Continued development not only affects the water quality, but is causing concern that supplies may not be adequate to meet the requirements of water users. Apalachicola Bay, a major commerical fishery at the mouth of the basin, is sensitive not only to the quality of the inflow, but to the quantity necessary to maintain an estuarine environment.

Objectives: To (1) provide a consistent description of current water-quality conditions for surface- and ground-water resources, (2) define long-term trends (or lack of trends) in water quality, and (3) identify, describe, and explain, as possible, the major factors that affect observed water-quality conditions and trends.

Approach: A project team will be assembled, an extensive project work plan will be developed, and existing data will be summarized and analyzed. A three-year period of intensive data collection, analysis, and interpretation will begin in 1993. A long-term monitoring network will be established for trend analysis; synoptic surveys will be conducted to better define sources of contaminants; and selected sites will undergo an intensive process-oriented study to provide a better understanding of the cause and effect relation between man and the environment. Intensive data collection and interpretation will be followed by a period of report writing and low-level sampling and analysis.

Progress: The project team was assembled and includes specialists in hydrogeology, data-base management, geography/GIS, geochemistry, aquatic ecology, and field-collection techniques. The major objectives of the NAWQA program were described in an informational fact sheet (Wangsness and Frick, 1991). A workplan was drafted; and one internal document was prepared that summarizes the occurrence and distribution of organic compounds; and recommends approaches to the study design. A liaison committee was formed to coordinate between USGS personnel and other interested scientists and water-management organizations, and to discuss priority water-quality issues and products. The liaison committee consists of representatives from Federal, State, and local agencies, and academia and the private sector who have water-resource responsibilities. NAWQA data base was designed, and existing data were retrieved from USGS; U.S. Environmental Protection Agency; U.S.Department of Agriculuture, Soil Conservation Service; and data bases from other Federal and State agencies.

WATER, ENERGY, AND BIOGEOCHEMICAL BUDGETS AT THE PANOLA MOUNTAIN RESEARCH WATERSHED, GA103

Location: Panola Mountain State Park, Stockbridge, Georgia

Project Chief: Norman E. Peters

Period of Project: 1990-1993

Cooperation: None. [U.S. Geological Survey, Research Funds]

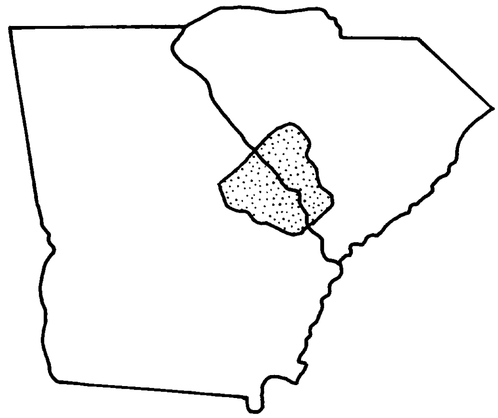
Problem: Watersheds are composed of chemically distinct environments. Consequently, a mechanistic determination of streamwater chemistry requires an understanding of the hydrologic pathways in the watershed as well as the interactions between the soil and the water. The combination indicates that to understand streamwater chemistry, it is important to understand soil solution chemistry. Yet, the regulation of soil-solution chemistry is poorly understood, because, in part, the principles of thermodynamics governing solubility and the theory of ion exchange, absorption, and kinetics cannot be readily applied to complex natural systems.

Objectives: To (1) investigate processes that control the movement and solute composition of water along hydrologic pathways that produce streamflow in a forested Piedmont watershed; (2) determine relative contributions of a variety of sources, including primary mineral weathering, cation exchange, and atmospheric disposition, to cations observed in streamwater; and (3) investigate the processes controlling the regulation of soil-solution chemistry.

Approach: Research will be conducted at the Panola Mountain Research Watershed, a 41-hectare forested watershed in the Panola Mountain State Park, Stockbridge. Intensive (or event-based) and extensive characterizations will determine the physics and chemistry of water and soil at both the plot (10- to 100-m^2 area), and sub-catchment (4- to 20-hectare area) scales. Extensive characterizations will focus on spatial distributions of physical and chemical characteristics of soils and water in plots distributed throughout the watershed.

Progress: Several transects were identified for extensive soil characterization and soil-solution sampling to address various controls on soil chemistry and physics, and soil-solution genesis. Soil-solution genesis includes weathering, differences in vegetation, bedrock geology, effect on runoff from the bedrock outcrop, and differences in soil-moisture content. Sites were located along each transect and 150 soil samples from 25 sites were processed. Sample splits were analyzed from heavy isotope abundances, grain-size distributions, and a series of soil-chemical characteristics, such as sulfate absorption, cation-exchange capacity, and base saturation. Instrumentation for intensive soil-solution sampling and soil-moisture content was fabricated, and will be installed during fall 1991 at four sites on a transect near the bedrock outcrop in the headwaters.

GROUND-WATER FLOW AND QUALITY IN THE VICINITY OF THE SAVANNAH RIVER AT THE SAVANNAH RIVER SITE, GEORGIA AND SOUTH CAROLINA, GA104



Location: Western central Georgia and
adjacent parts of South Carolina

Project Chief: John S. Clarke

Period of Project: 1991-1996

Cooperation: U.S. Department of Energy
Georgia Department of Natural Resources

Problem: Ground water originating in the vicinity of the Savannah River Site (SRS) in South Carolina flows westward, and is thought to discharge into the Savannah River. It may be possible that hazardous wastes from SRS may contaminate aquifers in South Carolina, and flow under the Savannah River into aquifers in Georgia. Insufficient data are available to determine the relation between the aquifers in South Carolina (eastern side of the river) and Georgia (western side of the river).

Objective: To evaluate (1) the potential for water-borne contaminants (radionuclides, volatile organic compounds, and trace metals) from SRS to infiltrate to ground water and flow through aquifers in South Carolina, beneath the Savannah River, and into Georgia; and (2) conditions under which such flow may occur.

Approach: Clusters of coreholes and wells will be constructed to provide hydrogeologic and water-quality data in Georgia and South Carolina. Data will include vertical and lateral head gradients, hydraulic properties of hydrogeologic units, and water quality. Additional data collection will include (1) conducting aquifer tests to estimate hydraulic characteristics of aquifers and confining units, (2) analyzing of water from selected wells tapping the major aquifers, (3) mapping potentiometric surfaces of major aquifers, (4) installing of recorders to determine water-level fluctuations and trends, (5) analyzing of low streamflow conditions to develop a quantitative hydrologic budget relating to ground-water flow and streamflow in the Savannah River, and (6) collecting and analyzing ground-water samples to determine the age of water along selected flow lines. A 3-dimensional ground-water-flow model will be developed to assess the occurrence or the potential for underflow. The ground-water-flow model also will test pumping scenarios to determine where underflow may occur.

Progress: A data search was completed on existing files of the Georgia Department of Natural Resources, Georgia Environmental Protection Division, the USGS, and local drillers. Wells were inventoried in Burke and Screven Counties, Ga., and entered into NWIS. A field reconnaissance was completed on potential drilling sites in Burke County, Ga., to determine ownership, site access, and topography. Paleontologic samples were collected from one borehole in Burke County, Ga., and furnished to USGS, Paleontology and Stratigraphy Branch, Reston, Va., for analysis. Base-flow measurements determined areas of significant ground-water discharge into the Savannah River.

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GEORGIA DEPARTMENT OF NATURAL RESOURCES
GEORGIA GEOLOGIC SURVEY

(*formerly* known as Georgia Department of Natural Resources, Department of Mines, Mining and Geology; Georgia Earth and Water Division; and Georgia Geological Survey)

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OTHER PUBLICATIONS

For publications from other Federal, State, and local agencies; and private organizations, please contact the respective agency or organization.

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