WATER-RESOURCES ACTIVITIES IN GEORGIA, 1993

By Carolyn A. Casteel and Mary D. Ballew

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U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
3039 Amwiler Road
Suite 130
Peachtree Business Center
Atlanta, GA 30360-2824

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ILLUSTRATIONS

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CONVERSION FACTORS AND ACRONYMS

Conversion Factors

Multiply	by	to obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
	Flow	
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
	Volume	
gallon (gal)	0.003785	cubic meter
	Area	
acre	0.4047	hectare

Temperature in degrees Fahrenheit (° F) can be converted to degrees Celcius

$$C = 5/9\ (°\ F - 32)$$

Acronyms

ACF	Apalachicola-Chattahoochee-Flint River basin
ACT	Alabama-Coosa-Tallapoosa River basin
ARS	Agricultural Research Service U.S. Department of Agriculture
CFC	Chlorofluorocarbons
DR3M	Distributed Rainfall-Runoff model
EPA	U.S. Environmental Protection Agency
EPD	Georgia Department of Natural Resources Environmental Protection Division
GIS	Geographic Information System
GPR	Ground-Penetrating Radar
GWSI	Ground-Water Site Inventory
GWUDS	Georgia Water-Use Data System
MCLB	Marine Corps Logistics Base, Albany, Ga.
NTN	National Trends Network U.S. Department of Agriculture
NWIS	National Water Information System U.S. Geological Survey
PSC	Possible Sources of Contamination
SRS	Savannah River Site
WGL	Albany Water, Gas & Light Commission
USGS	U.S. Geological Survey
VOC	Volatile Organic Compounds

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ABSTRACT

The U.S. Geological Survey, Water Resources Division, conducts nationwide water-resources data collection, investigations, and research in cooperation with Federal, State, local government agencies, and academia. Water-resources activities in Georgia during 1993 and significant accomplishments during 1992 are summarized in this report. Included are the basic mission and program, funding, summary of hydrologic conditions during the 1993 water year, District project objectives, progress, and publications by projects during 1992-93; and a list of selected publications for Georgia.

INTRODUCTION

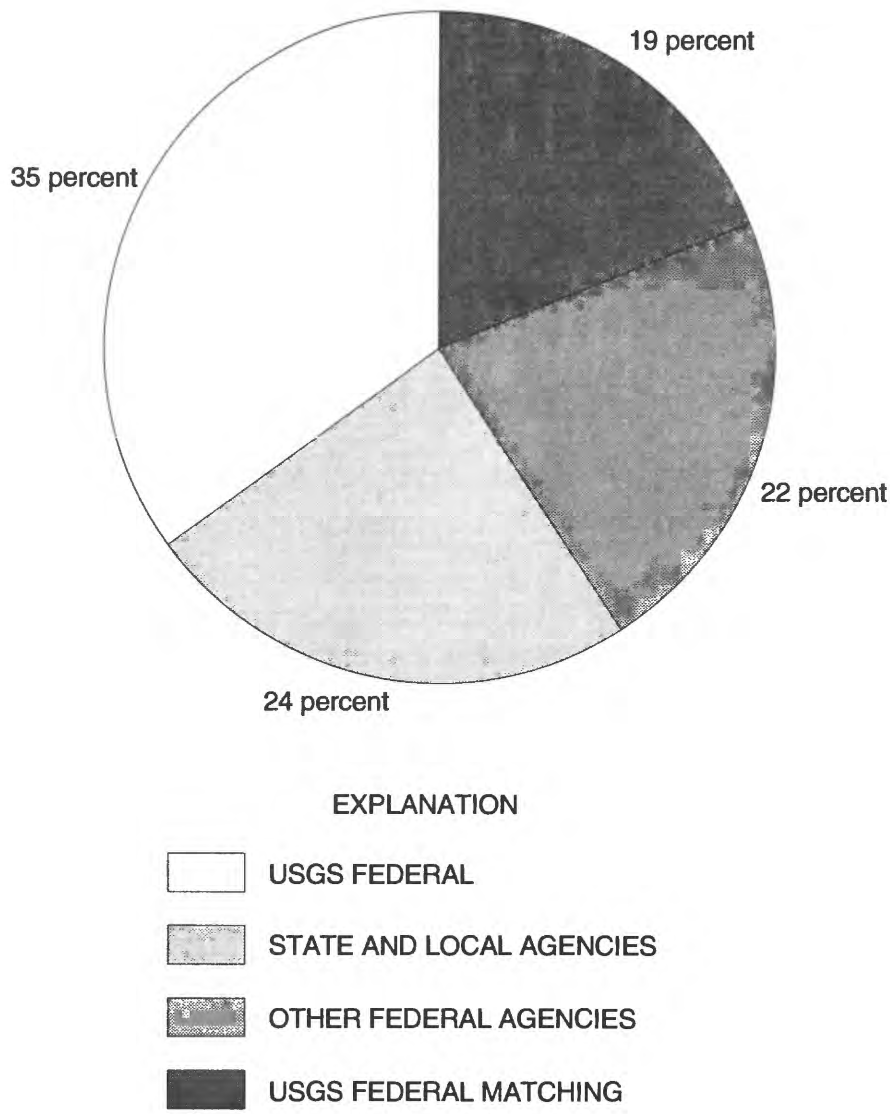
The U.S. Geological Survey (USGS) was established by an act of the U.S.Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific classification of public lands; and examine the geological structure, mineral resources, and products of National domain. An integral part of that original mission includes publishing and disseminating earth-science information needed to understand and manage the energy, land, mineral, and water resources of the Nation.

Since 1879, the research and fact-finding role of the USGS has grown and been modified to meet the ever changing needs of the Nation it serves. As part of that evolution, USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking agency, and the primary source of data on the Nation's surface- and ground-water resources.

USGS, through its Water Resources Division (WRD), 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 Federal agencies to develop and manage the Nation's water resources. This program is carried out nationwide and consists of the collection of basic hydrologic data, areal resource appraisal and interpretive studies, research, analysis and dissemination of the data, and the dissemination of results of investigations through published reports. Much of the work is a cooperative effort in which planning and financial support are shared by State and local governments (fig. 1, table 1).

In 1989, the U.S.Environmental Protection Agency (EPA) placed several military bases in Georgia on its National Priority List of Hazardous Waste Sites. To ensure compliance with EPA mandates, the U.S. Department of Navy, through its respective commands, contracted with a private consulting firm to collect and analyze water-resources data on selected military bases and evaluate potential sources of ground- and surface-water contamination. USGS, Georgia District, is reviewing reports prepared by a consulting firm presenting the results of their water-resources data collection subsequent to submission to the U.S. Navy and the respective military installation.

Water year in USGS reports dealing with surface-water supply is the 12-month period, October 1 through September 30 and is designated by the calendar year in which it ends. Thus, the year ending September 30, 1992, is called the "1992 water year."



TOTAL FUNDS, $7,313,000

Figure 1. Program fund sources, Georgia District, fiscal year 1993.

Table 1. Agencies supporting water-resources investigations in Georgia, fiscal year 1993

State Agencies and Academia

Georgia Department of Natural Resources
- Environmental Protection Division
  - Georgia Geologic Survey
  - Water Protection Branch
  - Water Resources Management Branch

Georgia Forestry Commission
Georgia Department of Transportation
Coastal Georgia Regional Development Center
Georgia Mountains Regional Development Center
South Florida Water Management District
Georgia State University
Georgia Institute of Technology
University of Georgia

Local Agencies

City of Albany
City of Attapulgus
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
Athens-Clarke County
Bibb County
Chatham County-Savannah Metropolitan Planning Commission
Cherokee County Water and Sewage Authority
Chestatee-Chattahoochee Resource Conservation and Development Council
Clayton County Water Authority
DeKalb County
Glynn County
Gwinnett County
Macon Water Authority
Monroe Water, Light, and Gas Commission
Town of Blairsville
St. Johns River Water Management
Tift County Commission

Federal Agencies

U.S. Department of Agriculture
- Agricultural Research Service
- Soil Conservation Service
  - National Carteographic Center

U.S. Department of Defense
- Waterways Experiment Station
- Army Corps of Engineers
  - Mobile District
  - Savannah District
- U.S. Navy
  - Marine Corps Logistics Base
  - Army Construction Engineering Research Laboratory

U.S. Department of Energy
U.S. Department of the Interior
- Fish and Wildlife Service
- National Park Service

U.S. Department of Commerce
- National Weather Service
  - National Oceanic and Atmospheric Administration

U.S. Environmental Protection Agency
U.S. Federal Emergency Management Agency
U.S. Federal Energy Regulatory Commission
Tennessee Valley Authority

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 1941-70 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 1935-74 in a series of Water-Supply Papers entitled, "Ground-Water Levels in the United States." Water-Supply Papers may be persued in the libraries of the principal cities in the United States or may be purchased from U.S. Geological Survey, Earth Science Information Center, Open-File Reports Section, Federal Center, Box 25286, Mail Stop 517, Denver, CO 80225.

USGS also is responsible for the coordination of specific water-data acquisition activities by other Federal agencies. Information on these activities is compiled and consolidated into a central file called the "Catalog of Information on Water Data." State and local agencies and private organizations that have related water-data acquisition activities also contribute information to this catalog. Catalog indexes are published periodically and may be requested free of charge from U.S. Geological Survey, Office of Water Data Coordination, 12201 Sunrise Valley Drive, Reston, VA 22092.

For water years 1961-70, streamflow data were published by the USGS in annual reports on a state-boundary basis. Water-quality records for water years 1964-70 were similarly published either in separate reports or in conjunction with streamflow records.

Beginning with the 1971 water year (October 1, 1970 through September 30, 1971), 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-71-1." These water-data reports may be purchased from the National Technical Information Service, U.S.Department of Commerce, Springfield, VA 22161.

"Water-Resources Data, Georgia, Water Year 1992" (Stokes and McFarlane, 1993) 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 McFarlane (1993) contains stream-discharge records at gaging stations; stage for streams at gaging stations; stage and contents of lakes and reservoirs; water quality for streams at continuous-record stations; peak stream stage and discharge only for crest-stage, partial-record and miscellaneous stream sites; base-flow discharge measurements at miscellaneous stream sites; ground-water levels at selected 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.

This report contains a brief description of water-resources monitoring and investigations by USGS in Georgia during 1992-93 and a list of selected references for Georgia. Additional information can be obtained from the District Chief, U.S. Geological Survey, Peachtree Business Center, 3039 Amwiler Road, Suite 130, Atlanta, GA 30360-2824.

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 (table 1, fig. 1), 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, water quality, 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 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;
- providing scientific and technical assistance in hydrologic fields to 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.

ADDRESSES AND TELEPHONE NUMBERS OF THE GEORGIA DISTRICT OFFICE AND FIELD HEADQUARTERS

District Office (404) 903-9100

Timothy W. Hale, District Chief
U.S. Geological Survey, WRD
Peachtree Business Center
3039 Amwiler Road, Suite 130
Atlanta, GA 30360-2824

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
129 Barnard Street, Suite B-219 *(Shipping and Street Address)*
Juliet Gordon Low Building
Savannah, GA 31401

U.S. Geological Survey, WRD
P.O. Box 8223 *(Mailing Address)*
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

SUMMARY OF HYDROLOGIC CONDITIONS IN GEORGIA

1993 WATER YEAR

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, USGS remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation. USGS programs continue to serve an increasing diversity of water-data users. This section shows a summary of hydrologic conditions in Georgia during the 1993 water year.

Surface-Water Numbering System

Surface-water stations are identified by a numbering system used for all USGS reports and publications since October 1, 1950. Station-identification numbers are assigned according to downstream order, and gaps are left in the series of numbers to allow for new stations that may be established; hence, the numbers are not consecutive. The complete number of each station, such as 02331600 (fig. 2), includes the two-digit Part numer "02" plus the downstream-order number of "331600", which can be from 6 to 16 digits.

Streamflow

Runoff for the 1993 water year (October 1, 1992, through September 30, 1993) was above normal over the entire State of Georgia with the ratio of runoff during the year to long-term mean runoff being greater than 1.00 for all but two stations with more than 10 years of streamflow record. Runoff for the year was comparatively uniform throughout the State, with the runoff ratio averaging about 1.3, 1.4, and 1.35 across northern, central, and southern Georgia, respectively. Runoff was lowest in the northwest corner of the State, where the runoff ratio averaged about 1.1, and highest in east-central Georgia near Savannah, where the runoff ratio averaged about 1.6. For unregulated streams having more than 10 years of streamflow record, the runoff ratio ranged from 0.93 at Penholoway Creek near Jesup in southern Georgia to 1.79 at Yellow River near Snellville in the Metropolitan Atlanta area (Stokes and McFarlane, 1994).

Although annual runoff was quite uniform over the State and well above normal, averaging about 130 to 140 percent of long-term mean runoff, there was considerable variation in monthly mean runoff. The water year was characterized by two distinct flow periods, one higher than normal and the other lower than normal. The 1992 water year ended with flows averaging near 200 percent of normal for September; therefore, the 1993 water year began with flows well above normal. The above normal period lasted from October-April across central and southern Georgia and continued through May in the northern part of the State (Stokes and McFarlane, 1994).

During the high-flow period, monthly mean runoff in northern Georgia ranged from an average of about 110 percent of normal in February and May to an average of about 280 percent of normal in November. Monthly mean runoff ranged from an average of about 110 percent of normal in February in the central and southern parts of the State, to an average of about 310 percent of normal in November in central Georgia and 300 percent of normal in January in southern Georgia. Monthly mean runoff exceeded 400 percent of normal for several stations across the State, but only five stations, located in central and southern Georgia, had peak discharges with less than a 10-percent chance of exceedence. The only areal flooding occurred in mid-January in east-central Georgia, north and west of Savannah, where four of the five stations with notable peak discharges are located. Peak discharges at Black Creek near Blitchton and Ogeechee River near Eden slightly exceeded discharges with a 10-percent chance of exceedence. The Ohoopee River near Reidsville and Canoochee River near Claxton had peak discharges with a 4-percent and 2-percent chance of exceedence, respectively. In southern Georgia, the Alapaha River at Statenville experienced a peak discharge with a 5-percent chance of exceedence. The peak discharges for most of the remaining stations had a chance of exceedence between 20 and 50 percent. However, the peak discharge for almost all stations across northern Georgia had a chance of exceedence greater than 50 percent (Stokes and McFarlane, 1994).

The below-normal runoff period, which began in June in northern Georgia and in May in the central and southern parts of the State, continued for the remainder of the year and showed little or no indication of ending as the water year closed. Throughout the State, the below normal runoff period was characterized by generally declining monthly mean runoff with the minimum daily flow for the majority of streamflow stations occurring during late August or September. There was a discernible gradient in the runoff pattern from north to south. In the northern part of the State, monthly mean runoff for June-September averaged about 65 percent of normal. For May-September, monthly mean runoff in central Georgia, averaged about 60 percent of normal while the average for the southern part of the State was only about 25 percent of normal. The runoff for August-September for Canoochee River near Claxton, located in east-central Georgia, was less than 1 percent of normal. This station was an example of contrasting runoff extremes. The runoff for October-November, the first 2 months of the above normal runoff period, averaged more than 410 percent of normal while the runoff for August-September, the last 2 months of the below-normal runoff period, averaged less than 1 percent of normal (Stokes and McFarlane, 1994).

During the below-normal runoff period, minimum daily flows with a 20-percent chance of exceedence or greater were common throughout the State. Minimum flow for a few stations scattered over the State had a 10-percent chance of exceedence, and there were only three unregulated stations where the minimum flow had less than a 5-percent chance of exceedence. One of these stations, Holly Creek near Chatsworth, in the northwestern part of the State, had a minimum daily flow with approximately a 4-percent chance of exceedence. The other two stations, Ogeechee River near Eden and Canoochee River near Claxton, in east-central Georgia near Savannah, are in the same area which earlier in the year experienced some of the highest flows in the State. The minimum flow at the Ogeechee station was about equal to the flow with a 3-percent chance of exceedence and the minimum flow at the Canoochee station was slightly less than the flow with a 3-percent chance of exceedence. The Canoochee River near Claxton was the only station experiencing a new minimum daily flow, 0.54 cubic foot per second (ft^3/s) on September 29. The previous record low was 0.62 ft^3/s, established in November 1983 (Stokes and McFarlane, 1994).

Water Quality

Water quality was monitored at stations along reaches of the Chattahoochee, Ocmulgee, and Altamaha Rivers during the 1993 water year (fig. 2). Specific conductance (SC), total inorganic nitrogen (TIN), and total phosphorus (TP) in water sampled from these rivers are compared to similar data from the historic reference period (water years 1976-92) (Stokes and McFarlane, 1994).

Water-quality profiles of the Chattahoochee River

The monitoring station at Chattahoochee River near Cornelia (02331600, fig. 2) is in the headwaters of the Chattahoochee River drainage area upstream from Lake Sidney Lanier. Water-quality data at this station are considered representative of surface-water quality in the Blue Ridge physiographic province of northeastern Georgia. At Chattahoochee River near Cornelia, SC values, in microsiemens per centimeter (µs/cm), and TIN and TP concentrations, in milligrams per liter (mg/L), are low for the 1993 median and historic median (water years 1976-92) when compared to those at and downstream from Atlanta. At this station, the 1993 median TIN and TP concentrations (0.36 and 0.06 mg/L, respectively) were considerably more than the historic median concentrations for TIN (0.28 mg/L) and TP (0.03 mg/L). The median value for SC was 28 µs/cm in 1993, which is slightly greater than the median value of 26 µs/cm for the historic period. The greater median values for SC, and TIN and TP concentrations in 1993 may be a result of increasing land development upstream from the Chattahoochee River near Cornelia monitoring station (Stokes and McFarlane, 1994).

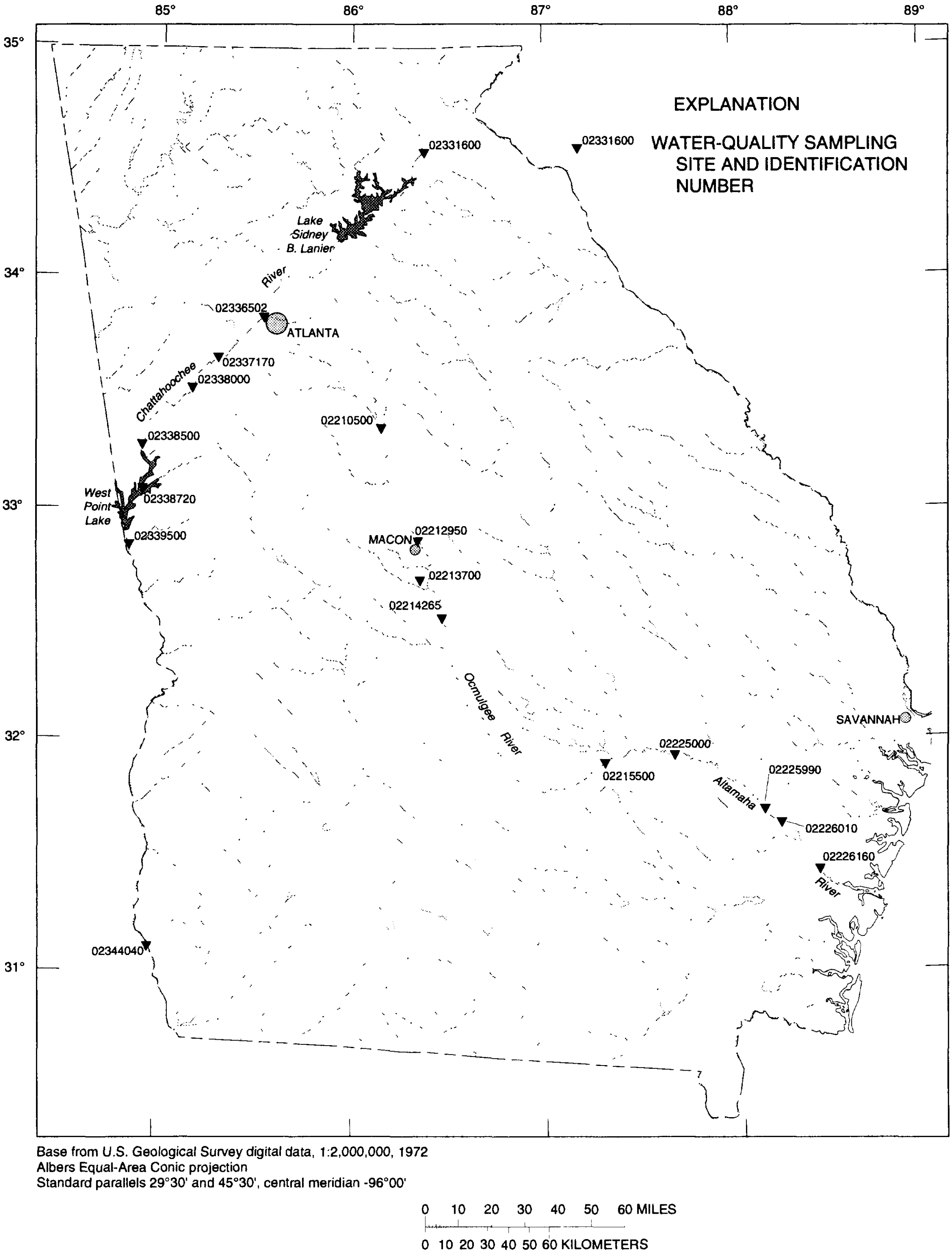


Figure 2. Selected water-quality sampling sites on the Chattahoochee, Ocmulgee, and Altamaha Rivers.

Along a 380-mile (mi) reach of the Chattahoochee River, SC, TIN, and TP data from the monitoring station Chattahoochee River near Cornelia through the monitoring station Chattahoochee River near Steam Mill (02344040, fig. 2) show the combined effects of urban and industrial use, increasing drainage area, and impoundments on the water quality. When compared to Chattahoochee River near Cornelia, the high historic and 1993 median SC values and median TIN and TP concentrations at and downstream from the monitoring station Chattahoochee River (I-285) near Atlanta (02336502, fig. 2) may be attributed to discharge from wastewater-treatment facilities in the Atlanta Metropolitan area, or possibly to nonpoint-source runoff during storm events. General decreases in median TP concentration and median values of SC and TIN concentration downstream from monitoring stations Chattahoochee River near Fairburn (02337170, fig. 2) and Chattahoochee River near Whitesburg (02338000, fig. 2), respectively, may be attributed to (1) dilution by increased streamflow resulting from increased drainage area (no major wastewater discharges are located in this reach); (2) uptake of nitrogen by biota in the Chattahoochee River and West Point Lake, between stations Chattahoochee River at Franklin (02338500) (fig. 2) and Chattahoochee River at West Point (02339500, fig. 2); (3) settling of phosphorus attached to particulate material in West Point Lake; and (4) improved wastewater-treatment facilities in the Metropolitan Atlanta area (Stokes and McFarlane, 1994).

Throughout the profile reach, the historic median values for SC and TP concentrations were nearly the same as those for the previous reference period (1976-91), while the historical median TIN concentrations were slightly less than the median TIN concentrations for 1976-91. Downstream from Chattahoochee River near Cornelia (fig. 2), 1993 median values of SC and TIN and TP concentrations were generally near but less than historic medians. However, the median TP concentration at Chattahoochee River at West Point (fig. 2) and Chattahoochee River near Steam Mill (fig. 2) was significantly greater, about 200 percent of the historic median. Except for the median SC value at Chattahoochee River near Fairburn (fig. 2) and median TP concentrations at monitoring stations Chattahoochee River near LaGrange (02338720, fig. 2) and Chattahoochee River at West Point (fig. 2), the 1993 median SC values and TP and TIN concentrations were less than, and at many stations, significantly less than the 1992 medians. The general decreases in median SC values and TIN and TP concentrations since 1992 may be attributed, in part, to improved management procedures, but are more likely dilution from increased runoff from the basin.

In 1993, runoff for the Chattahoochee River basin was about 130-140 percent of the long-term average and about 150 percent of 1992 runoff. Above normal runoff could also account for 1993 median SC values and TP and TIN concentrations being near but generally less than historic median values. However, even with the increased runoff, the 1993 median TP concentration was significantly greater than the historic median at the West Point and Steam Mill stations. During 1993, the median TIN concentration increased from the minimum (0.36 mg/L) at Chattahoochee River near Cornelia to the maximum (1.24 mg/L) at Chattahoochee River near Whitesburg (fig. 2) and steadily decreased downstream. The median SC value increased from the minimum 28 µs/cm at Chattahoochee River near Cornelia to 82 µs/cm at Chattahoochee River near Whitesburg and decreased steadily downstream from Whitesburg to West Point. The median SC value at Chattahoochee River near Whitesburg was exceeded only by the maximum median SC value (86 µs/cm) at the station near Steam Mill at the downstream end of the profile reach. The median TP concentration increased from the minimum (0.06 mg/L) at Chattahoochee River near Cornelia to a maximum (0.16 mg/L) at Chattahoochee River near Fairburn, and then generally declined downstream. However, there was little difference in median TP concentration at LaGrange, West Point, and Steam Mill stations (fig. 2) (Stokes and McFarlane, 1994).

During 1993, median TP concentrations for stations in the reach from Chattahoochee River (I-285) near Atlanta through Chattahoochee River at Franklin, ranged from 0.12 to 0.16 mg/L and are much lower than historic median TP concentrations which range from 0.26 to 0.44 mg/L. These decreases in TP concentrations may be the result of a Statewide ban on phosphate detergents which began in the spring of 1990 and/or the result of improved operations of wastewater-treatment facilities in the basin near Atlanta (Stokes and McFarlane, 1994).

Water-quality profiles of the Ocmulgee and Altamaha Rivers

Profiles of SC values and TIN and TP concentrations along reaches of the Ocmulgee and Altamaha Rivers (fig. 2) show the effects of wastewater discharges on river-water quality. Municipal and industrial wastewater discharges to the Ocmulgee River in the Macon Metropolitan area between monitoring stations Ocmulgee River (water intake) at Macon (02212950, fig. 2) and Ocmulgee River near Warner Robins (02213700, fig. 2) may be a contributor to increased TIN and TP concentrations and SC values observed at the Warner Robins station and at monitoring station Ocmulgee River (Highway 86) near Bonaire (02214265, fig. 2). Nonpoint-source runoff during storm events may also contribute to these increases. The general decreases in median TIN and TP concentrations downstream from Ocmulgee River near Warner Robins probably are the result of dilution by increased streamflow and uptake of nutrients by biota. The fluctuations in median SC values between Ocmulgee River near Warner Robins and Altamaha River near Jesup (02225990, fig. 2) may be the influence of dilution by substantial natural ground-water contributions by springs along the middle and lower Ocmulgee River. The significant increase in median SC values at Altamaha River near Gardi (02226010, fig. 2) may be the result of large quantities of water withdrawn from local ground-water sources, used in industrial processes, and then discharged as wastewater into the river between Jesup and Gardi (Stokes and McFarlane, 1994)

Throughout the profile reach, there was little change in historical median SC values and median TP and TIN concentrations from the previous historic period (1976-91). When compared to the historic reference period, median SC values for 1993 are lower, except at monitoring stations, Ocmulgee River at Lumber City (02215500, fig. 2) and Altamaha River near Baxley (02225000, fig. 2), in the lower Ocmulgee and upper Altamaha basins, respectively, and at Altamaha River at Everett City (02226160, fig. 2) at the downstream end of the reach. The median SC value at Altamaha River at Everett City is considerably higher; about 125 percent of the historic median. Except for Ocmulgee River near Warner Robins, Altamaha River near Baxley, and Altamaha River at Everett City stations, median TIN concentration was less than the historic reference period median. The median TIN concentration was slightly greater at the Baxley and Everett City stations (fig. 2) and much greater at the Warner Robins station. The increased median SC value at Altamaha River at Everett City and median TIN concentration at Ocmulgee River near Warner Robins and Altamaha River at Everett City, may be the result of local influences, urbanization upstream from Ocmulgee River near Warner Robins, and industry and recreation along the lower Altamaha River. The generally lower median values of SC and TIN concentrations throughout the reach may be attributed, in part, to above normal runoff. The runoff for 1993 in the Ocmulgee and Altamaha Rivers was about 140-150 percent of the long-term average runoff. Except for Ocmulgee River near Warner Robins and Ocmulgee River (Highway 96) near Bonaire, median TP concentrations in 1993 were very nearly the same as for the historic reference period. At these monitoring stations, downstream from the Macon Metropolitan area, the significant decrease in median TP concentrations may be a result of a Statewide ban on phosphate detergents, effective in the spring of 1990 and/or the result of improved operations of wastewater-treatment facilities in the Macon Metropolitan area (Stokes and McFarlane, 1994).

When compared to 1992, median TP concentrations for 1993 were nearly the same, while median TIN concentrations ranged from significantly less for most stations to slightly more at Ocmulgee River near Warner Robins and Altamaha River at Everett City. Except for Altamaha River at Everett City, which was slightly more than in 1992, median values of SC ranged from slightly to significantly less than 1992 medians. The generally lower median TIN and TP concentrations are probably largely due to increased runoff. The runoff for 1993 in the Ocmulgee and Altamaha Rivers was about 175 percent of 1992 runoff (Stokes and McFarlane, 1994).

Ground Water

Mean ground-water levels for 24 observation wells throughout Georgia ranged from 4.4 feet (ft) lower to 6.1 ft higher in the 1993 water year than in the 1992 water year. In northern Georgia, mean water levels in the crystalline rock aquifers were from 1.3 to 3.4 ft higher in 1993 than in 1992. Along the coast, mean water levels in the Floridan aquifer system were from 2.5 ft lower to 1.2 ft higher in 1993 than in 1992. In the Savannah area, mean water levels in the Floridan aquifer system were from 2.5 ft lower to 0.6 foot (ft) higher in 1993 than in 1992. The mean water level in the shallow water-table aquifer near Savannah was 0.9 ft higher in 1993 than in 1992. In the Jesup and Riceboro areas, mean water levels in the Floridan aquifer system were from 0.9 to 1.2 ft higher in 1993 than in 1992. In the Brunswick and Okefenokee Swamp areas, mean water levels in the Floridan aquifer system were 0.5 ft higher in 1993 than in 1992. In the east-central part of the State, mean water levels in the Floridan aquifer system were 0.5 ft lower in 1993 than in 1992. In the south-central part of the State, mean water levels in the Floridan aquifer system were from about the same to 6.1 ft higher in 1993 than in 1992. In the southwestern part of the State, mean water levels in the Upper Floridan aquifer were from 0.9 ft lower to 0.4 ft higher in 1993 than in 1992. Mean water levels in the Clayton aquifer of southwestern Georgia were from 1.9 to 4.4 ft lower in 1993 than in 1992 (Stokes and McFarlane, 1994).

Additional information concerning ground-water-level fluctuations in the State can be found in USGS Open-File Reports entitled "Ground-Water Conditions in Georgia, 1992", which includes data for calendar year 1992, and "Ground-Water Conditions in Georgia, 1993", which includes data for calendar year 1993.

Water Use

Permitted off-stream withdrawals for the water-use categories of thermoelectric, public supply, and industrial/commercial totaled about 4.8 billion gallons per day (Bgal/d) in 1993, an increase of about 2 percent over 1992 withdrawals. In 1993, 17 thermoelectric plants, the largest water user in Georgia, withdrew about 3.0 Bgal/d. These withdrawals were primarily from surface-water sources and were about 3 percent less than in 1992. About 74 percent of the public-supply withdrawals were from surface-water sources. Permitted withdrawals by 253 industrial/commercial users totaled about 0.93 Bgal/d, an increase of about 0.2 Bgal/d since 1992, and was withdrawn almost equally from ground- and surface-water sources. The major types of industrial users in Georgia include paper, textiles, chemicals, stone/clay, and mining (Stokes and McFarlane, 1994).

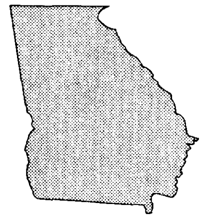
In 1993, hydroelectric power generation, the only instream use compiled by the Georgia Water-Use Program, totaled about 48 Bgal/d for 38 permitted hydroelectric plants in Georgia. The 1993 instream water use was about 97 percent of the use in 1992 (Stokes and McFarlane, 1994).

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
- Published reports during 1992 and 1993

SURFACE-WATER MONITORING, GA001



Location: Statewide

Project Chief: William R. Stokes, III

Period of Project: Continuing

Cooperation: Several 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 assessment of water resources; operation of reservoirs or industries; forecasting; and pollution control and disposal of wastes; and to collect data 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.

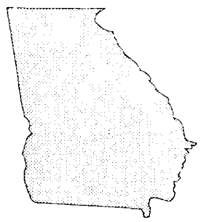
Progress: Data were collected for 124 daily-flow and/or stage stations, 15 reservoir stage and contents stations, 96 crest-stage, partial-record stations, and 7 peak discharge, miscellaneous sites, and published in the 1992 water year data report (Stokes and McFarlane, 1993). Miscellaneous streamflow data, primarily relating to low flow because rainfall was significantly deficient in parts of the State, were provided for an unusually large number of requests by Federal, State, and local government agencies, and the private sector. Two gaging stations were relocated, three gaging stations were reconstructed, and major maintenance was performed on several other gaging stations. Four daily-flow stations were constructed and instrumented for the U.S. Geological Survey's National Water Quality Assessment (NAWQA), Apalachicola-Chattahoochee-Flint (ACF) River basin study. Two daily-flow stations were instrumented with data transmitters, expanding the near-real-time stage-monitoring network to 66 stations. Two daily flow stations, one Benchmark and one National Stream-Quality Accounting Network (NASQAN), were discontinued because of reduced funding. The Surface-Water-Quality Assurance and Georgia District Flood Plans were updated. Preparation of data for publication in the 1993 water year data report was about 45 percent completed in 1993.

Published Reports during 1992 and 1993:

Stokes, W.R., III, McFarlane, R.D., and Buell, G.R., 1992, Water-resources data, Georgia, water year 1991: U.S. Geological Survey Water-Data Report GA-91-1, 527 p.

Stokes, W.R., III, and McFarlane, R.D., 1993, Water-resources data, Georgia, water year 1992: U.S. Geological Survey Water-Data Report GA-92-1, 612 p.

GROUND-WATER MONITORING, GA002



Location: Statewide

Project Chief: Richard E. Krause

Period of Project: Continuing

Cooperation: Several agencies

Problem: Ground-water-level and ground-water-quality data are essential to the management of the State's ground-water reservoirs.

Objectives: To provide a ground-water-level and ground-water-quality data base against which the effects of development are measured to predict ground-water supplies and to manage ground-water resources.

Approach: Water-level data are collected for the various aquifers in the State from a network of observation wells, which includes periodic and continuously recorded data. Well-inventories are made and the data are entered into the Ground-Water Site Inventory files (GWSI). Borehole geophysical data are collected from appropriate wells. Water-quality samples are taken from selected wells for analyses. Ground-water data and information requests on ground-water conditions are completed and reported monthly and annually.

Progress: Continuous water-level recorders were operated at 151 wells. Periodic water-level measurements were made in 708 wells throughout the State. Potentiometric-surface maps were constructed for the Upper Floridan, Claiborne, Clayton, and Dublin-Midville aquifers. Water samples were collected semi-annually from 12 wells in the Savannah area and 80 wells in the Brunswick area for analysis of chloride and specific conductance. The annual ground-water conditions report was published and included 1992 and period-of-record ground-water levels, ground-water-quality trends, and precipitation records from 10 National Weather Service stations (Peck and Cressler, 1993). Monthly reports of ground-water and climatic conditions at key locations in the State were prepared. Well-inventory, water-level, and hydrgeoologic data were entered into the National Water Information System (NWIS). A field inventory of wells was made, and 498 sites were entered into the GWSI data base. Numerous requests for ground-water data were answered during the year.

Published Reports during 1992 and 1993:

Peck, M.F., Joiner, C.N., and Cressler, A.M., 1992, Ground-water conditions in Georgia, 1991: U.S. Geological Survey Open-File Report 92-470, 137 p.

Peck, M.F., and Cressler, A.M., 1993, Ground-water conditions in Georgia, 1992: U.S. Geological Survey Open-File Report 93-358, 134 p.

EVALUATION OF THE EFFECTS OF URBAN STORM RUNOFF ON THE WATER QUALITY OF THE UPPER FLORIDAN AQUIFER NEAR AN ALTERED SINKHOLE, ALBANY, GEORGIA, GA00209

Location: Albany, Georgia

Project Chief: Melinda J. Chapman

Period of Project: 1991-94

Cooperation: Albany Water, Gas, and Light Commission

Problem: The Albany, Ga., area is described as having a karst topography developed over a shallow, carbonate aquifer system known as the Upper Floridan aquifer. The slight relief of the area inhibits rapid stormwater runoff. As a result, flooding, particularly in the downtown area of Albany, is common following periods of heavy rainfall. A system of drainage canals and holding ponds has been developed throughout the area to control stormwater runoff and alleviate local flooding. Also, numerous topographic depressions, some of which may be dormant sinkholes, have been altered to function as temporary holding ponds for stormwater runoff. The degree of interaction between stormwater flow, of unknown water quality, into altered sinkholes (holding ponds) and subsequent recharge to the Upper Floridan aquifer, is not defined.

Objectives: To determine water quality of urban stormwater runoff and base flow entering a selected holding pond under various climatic and hydrologic conditions; evaluate the hydraulic connection between the holding pond and Upper Floridan aquifer; and evaluate potential effects that urban stormwater runoff may have on water quality of the Upper Floridan aquifer.

Approach: Urban stormwater runoff, base flow, and quality of water entering the holding pond will be monitored under varying climatic and hydrologic conditions. Surface- and ground-water relations will be defined using hydraulic-head data. Water-quality samples will be collected from observation wells drilled into the water-table aquifer and the upper and lower water-bearing zones of the Upper Floridan aquifer.

Progress: An altered sink hole (holding pond) was instrumented to measure inflow, stage, and outflow. An estimated surface-water budget was prepared for the holding pond. A stage-activated automated water sampler was installed on the inflow canal. Stormwater-event samples were collected from six storms (two frontal and four thunderstorms) that were preceded by at least 7 days of dry weather. Samples also were collected during base flow to evaluate the water quality over a range of climatic and hydrologic conditions. Time-integrated samples were collected throughout stormwater-runoff events. Bedload samples were collected from sediment in the bottom of the holding pond and from an upgradient holding pond. Nine monitoring wells were installed in the area adjacent to the holding pond, each tapping the unconfined water-table aquifer or the upper or lower water-bearing zones of the Upper Floridan aquifer. A network of wells tapping the Upper Floridan aquifer was measured at 3-month intervals to evaluate seasonal water-level fluctuations, areas of recharge and discharge, and directions of ground-water flow. Water samples collected from each observation well were used to evaluate the effect of stormwater runoff on ground-water quality. Hydraulic-head data collected from the holding pond and adjacent observation wells were used to evaluate the ground- and surface-water relation.

GEOLOGY AND GROUND-WATER RESOURCES IN THE ZEBULON AREA, GEORGIA, GA00210

Location: Zebulon area, northern Georgia

Project Chief: Melinda J. Chapman

Period of Project: 1991

Cooperation: City of Zebulon, Georgia

Problem: Widespread and rapid population growth in much of the Piedmont physiographic province of northern Georgia has increased demands for water supply. Availability of good-quality ground water in the Piedmont Province general is limited, requiring difficult exploration methods in crystalline rock aquifers in this region (Chapman and others, 1993). The city of Zebulon and surrounding area depend upon Elkins Creek for drinking water supply; however, the Creek may not provide an adequate supply to meet future demands. Elkins Creek also periodically contains high concentrations of iron and manganese (Neil Monroe, city of Zebulon, oral commun., 1991).

Objectives: To evaluate hydrogeologic factors that affect well yield and ground-water quality, and formulate a conceptual framework that aids in the understanding of the availability of ground water in crystalline rock settings.

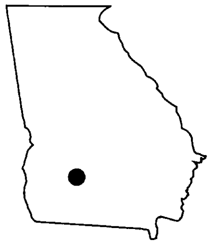
Approach: Available well data were compiled from records of the city of Zebulon, Pike County Health Department, County Extension Office, local well drillers, private well owners, published reports, and the USGS data base. Ground-water-quality samples from wells in the study area were collected and analyzed to determine field parameters of water temperature, specific conductance, pH, and dissolved oxygen. Selected ground-water samples were analyzed for ferrous iron, ferrous plus ferric iron (total), and sulfide concentrations.

Progress: Available well data were compiled from various sources. Three mappable geologic units were delineated to provide a basic understanding of hydrogeologic settings in the Zebulon area. Analyses of well data and ground-water samples indicate that the distribution of well yield and and iron concentration does not seem to be related to a particular rock type (Chapman and others, 1993).

Published reports during 1992 and 1993:

Chapman, M.J., Milby, B.J., and Peck, M.F., 1993, Geology and ground-water resources in the Zebulon area, Georgia: U.S. Geological Survey Water-Resources Investigations Report 93-4161, 27 p.

EVALUATION OF HYDROGEOLOGY AND GROUND-WATER CHEMISTRY OF THE UPPER FLORIDAN AQUIFER NEAR ALBANY, GEORGIA, GA00211



Location: Dougherty County, Georgia and
areas of adjacent counties

Project Chief: Lisa M. Stewart

Period of Project: 1993-95

Cooperation: Albany Water, Gas, and Light Commission

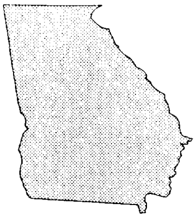
Problem: In the Dougherty County area, ground water is the primary source of water for municipal, industrial, irrigation, domestic, and livestock supply (Fanning and others, 1992). Increased pumpage from the Clayton aquifer has resulted in water-level declines near Albany, Ga., as much as 140 ft since 1940, causing concern over the ability of the deeper aquifers to meet future water-supply demands (Hicks and others, 1987). As an alternative source of water supply, the Albany Water, Gas, and Light Commission (WGL) may install supply wells southwest of the city that tap the Upper Floridan aquifer. However, there is concern that pumping from the Upper Floridan aquifer may induce surface contamination into the aquifer from urban runoff, agricultural practices, or other surface sources.

Objectives: To delineate the hydrogeology of the Upper Floridan aquifer, define the ground-water-flow system in the Upper Floridan aquifer that provides water to the area of potential water-supply development; and evaluate the effect of increased ground-water withdrawal on the water quality of the Upper Floridan aquifer.

Approach: Develop a refined hydrogeologic framework for the Upper Floridan aquifer to characterize water-bearing and confining zones, localized water-table aquifers, areal and vertical distribution of recharge and discharge areas, and spatial distribution of hydraulic properties. The hydrogeologic framework will be developed using environmental isotopes (tritium, tritium/helium ratios), carboflurocarbon (CFC) concentrations, major-ion water chemistry, and lithologic and well-construction data. Also, ground-water quality in the Upper Floridan aquifer in the vicinity of the WGL-planned pumping center will be determined using water sampled from 10 selected wells under prepumping and pumping conditions. Water samples will be analyzed to characterize the water chemistry, and to determine if selected agriculutral chemicals, aldicarb and atrazine, are present in the aquifer.

Progress: Two clusters of three wells each were installed to monitor ground-water levels and ground-water quality within the undifferentiated overburden and the upper and lower water-bearing zones of the Upper Floridan aquifer. Existing wells and springs were inventoried, and 41 sites were selected for sampling and water-level monitoring. Ground-water samples were collected and analyzed for environmental isotopes, CFC concentrations, and major-ion water chemistry. Water-level and lithologic data are being evaluated for construction of potentiometric-surface maps and hydrostratigraphic sections of the Upper Floridan aquifer.

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 provide a National data base of water-quality information for broad Federal and State planning and action programs, and 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 in operation at stream sites throughout the year. The standard four properties (pH, water temperature, dissolved-oxygen concentration, and specific conductance) were collected at four of the flow-through sites, and dissolved-oxygen concentration and temperature were collected at the fifth site. Specific conductance was collected at four of the minimonitor sites, and temperature at the other site. Chemical analyses were made on 1,286 water samples collected from 133 continuing chemical-quality network stations. The continuing network includes one Benchmark and five National Stream Quality Accounting Network (NASQAN) stations. The Benchmark and one NASQAN station were sampled quarterly and the other NASQAN stations were sampled bimonthly. Two water samples from one NASQAN site, Altamaha River at Everett City, and two water samples from the Benchmark station, Falling Creek near Juliette, were analyzed for radio-chemical data. Data for 1992 water year were published in the annual water-data report (Stokes and McFarlane, 1993) (see project GA001); and preparation of 1993 data for publication was 55 percent completed. Program quality-control activities were conducted according to the Georgia District quality-assurance plan. Numerous requests for water-quality data were answered during the year.

Published reports during 1992 and 1993:

Stokes, W.R., III, McFarlane, R.D., and Buell, G.R., 1992, Water-resources data, Georgia, water year 1991: U.S. Geological Survey Water-Data Report GA-91-1, 527 p.

Stokes, W.R., III, and McFarlane, R.D., 1993, Water-resources data, Georgia, water year 1992: U.S. Geological Survey Water-Data Report GA-92-1, 612 p.

SEDIMENT MONITORING, GA004

Location: Statewide

Project Chief: William R. Stokes, III

Period of Project: Continuing

Cooperation:Several agencies

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 provide a National sediment data base for use in broad State and Federal planning and action programs, and 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 two of these stations located in the vicinity of major U.S. Army Corps of Engineers projects. Appropriate distribution of 1992 water year data was made in a timely manner. Data for the 1992 water year were published in the annual water-data report (Stokes and McFarlane, 1993) (see project GA001); and preparation of 1993 data for publication was about 50 percent completed. Funding for one NASQAN and the Benchmark station was discontinued at the end of 1993 water year.

Published Reports during 1992 and 1993:

Stokes, W.R., III, McFarlane, R.D., and Buell, G.R., 1992, Water-resources data, Georgia, water year 1991: U.S. Geological Survey Water-Data Report GA-91-1, 527 p.

Stokes, W.R., III, and McFarlane, R.D., 1993, Water-resources data, Georgia, water year 1992: U.S. Geological Survey Water-Data Report GA-92-1, 612 p.

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 define the chemical quality of wet deposition in Georgia; and 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 Information System (NWIS). 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 of temporal and spatial trends in precipitation chemistry.

Progress: Composite wet-precipitation samples were collected weekly at the Tifton-ARS NTN site, and submitted to the Illinois State Water Survey Central Analytical Laboratory for analysis. Data were entered into the District water-quality files, and published in the 1992 water year data report (Stokes and McFarlane, 1993). The site was inspected for compliance with NADP-NTN operation guidelines by an independent contractor and received an excellent rating.

Publications during 1992 and 1993:

Stokes, W.R., III, McFarlane, R.D., and Buell, G.R., 1992, Water-resources data, Georgia, water year 1991: U.S. Geological Survey Water-Data Report GA-91-1, 527 p.

Stokes, W.R., III, and McFarlane, R.D., 1993, Water-resources data, Georgia, water year 1992: U.S. Geological Survey Water-Data Report GA-92-1, 612 p.

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. A statewide water-use data base is essential to manage water resources and to determine future water-supply needs. To meet this need, water-use data in the files of various Federal, State, and local agencies need to be verified and input into the data base to assure complete coverage of water use in the State.

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

Approach: Water-use data in the files of State and local regulatory agencies and from additional mail surveys 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 are entered into the Georgia Water-Use Data System (GWUDS). The GWUDS file is updated annually to include data on the amount of water used during the previous year, new water users, and any changes in permitted use issued by the State.

Progress: Data for new water users; updates from municipal, industrial, and power-generation withdrawals and returns; and changes in permitted water use were entered into GWUDS. Data sharing between Georgia Environmental Protection Division, Water Resources Management Branch, Ground-Water Program, and U.S. Geological Survey, Office of Surface Water (permitted municipal systems) was continued through a computer system (including permitted ground-water data for municipal and industrial systems). The development of a quality assurance plan for water-use data continued. GWUDS data continued to be merged into the Ground-Water Site Inventory (GWSI) files.

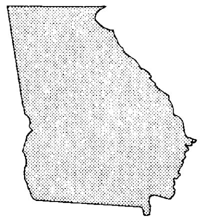
Published Reports during 1992 and 1993:

Fanning, J.L., 1993, Influence of climate on public supply system water use in Georgia *in* proceedings, 1993 Georgia Water Resources Conference, April 20, 21, 1993: Athens, Ga., Institute of Natural Resources, University of Georgia, p. 176-178.

Fanning, J.L., Doonan, G.A., and Montgomery, L.T., 1992, Water use in Georgia by county for 1990: Georgia Geologic Survey Information Circular 90, 116 p.

Marella, R.L., Fanning, J.L., and Mooty, W.S., 1993, Estimated use of water in the Apalachicola-Chattahoochee-Flint River basin during 1990 and trends in water use from 1970 to 1990: U.S. Geological Survey Water-Resources Investigations Report 93-4084, 45 p.

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 design highway bridges and culverts, determine locations for waste-treatment and water-supply facilities, prepare zoning ordinances, and establish flood-insurance rates.

Objectives: To collect, analyze, and publish flood data describing the hydrologic and hydraulic characteristics of selected stream reaches that will be used to design highway bridges and culverts, determine locations for waste-treatment and water-supply facilities, prepare zoning ordinances, and establish flood-insurance rates.

Approach: To operate a network of crest-stage gages to supplement the statewide gaging-station network and improve the areal distribution of flood data; determine the hydraulic and hydrologic characteristics, including the determination of the flow distribution, backwater, and velocity studies of selected stream reaches; make field measurements, including indirect measurements of peak flows for hydrologically significant floods; and prepare reports describing hydrologically significant floods.

Progress: A flood-frequency report describing techniques for estimating magnitude and frequency of floods in rural basins in Georgia (Stamey and Hess, 1993) and a flood-data report describing annual peak discharges and stages for gaging stations in Georgia through September 1990 (Hess and Stamey, 1992) were published. Annual peak-flow data were entered into the USGS peak-flow files for 52 current crest-stage sites and about 100 other current and discontinued gaged sites throughout the State.

Published Reports during 1992 and 1993:

Hess, G.W., and Stamey, T.C., 1992, Annual peak discharges and stages for gaging stations in Georgia through September 1990: U.S. Geological Survey Open-File Report 92-113, 277 p.

___1992, Floods on selected streams in the vicinity of Augusta, Georgia, October 12-13, 1990: U.S. Geological Survey Open-File Report 92-37, 11 p.

Stamey, T.C., and Hess, G.W., 1993, Techniques for estimating magnitude and frequency of floods in rural basins of Georgia: U.S. Geological Survey Water-Resources Investigations Report 93-4016, 75 p.

FLOOD-FREQUENCY CHARACTERISTICS OF URBAN STREAMS IN GEORGIA, GA062

Location: Cities of Albany, Atlanta, Athens, Augusta, Columbus, Moultrie, Rome, Savannah, Thomasville, Tifton, and Valdosta

Project Chief: Ernest J. Inman

Period of Project: 1972-97

Cooperation: Georgia Department of Transportation
U.S. Army Corps of Engineers
Savannah District
City of Albany
City of Athens
City of Augusta
City of Columbus
City of Moultrie
City of Rome
City of Savannah
City of Thomasville
City of Tifton
City of Valdosta
Tift County Commission

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 significant changes in the flood-runoff characteristics of streams; therefore, natural (rural) basin flood-frequency relations are not applicable to urban and suburban streams. Few hydrologic data are available for streams in metropolitan areas.

Objectives: To collect hydrologic data for selected urban streams in selected metropolitan areas of Georgia, and analyze these data to develop relations used 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 the cities of Albany, Atlanta, Athens, Augusta, Columbus, Moultrie, Rome, Savannah, Thomasville, Tifton, and Valdosta. These basins represent a range in drainage area (0.04 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 U.S. Geological Survey 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 site. Flood frequency at each site then will be defined from the synthesized annual peaks by using the log-Pearson Type III analysis. Multiple-regression analysis will relate physical and climatological basin characteristics to station flood-frequency data. Estimates of the magnitude and frequency of floods at gaged sites can be extrapolated to ungaged drainage basins.

Progress: Rainfall and stage gages were discontinued at eight stations in Valdosta, two in Albany, four in Moultrie, and six in Thomasville after data needs had been satisfied. Data were edited for 65 rainfall and stage-discharge stations. Discharge hydrographs and rainfall hyetographs were plotted for all flood events at the 65 sites. Crest-stage gages were continued at 27 of the 65 sites.

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

Location: Panola Mountain State Park, Stockbridge, Georgia

Project Chief: Richard P. Hooper

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 evaluate and devise methods for measuring dry deposition and investigate hydrologic and biogeochemical processes that control water chemistry, particularly with respect to the neutralization of acidic atmospheric deposition in the watershed.

Approach: Dry deposition will be evaluated using micrometeorological methods, chemical mass balance, and net chemical transport through the forest canopy (throughfall). Water pathways and related chemical characteristics along select pathways will be evaluated to understand processes controlling water chemistry in watersheds. Primary focus of 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. Composition of above-ground biomass, soils, saprolite, and bedrock also will be evaluated.

Progress: Instrumentation was designed, fabricated, and installed at various depths at four sites along a transect adjacent to the dominant bedrock outcrop to sample physical and chemical data in the regolith. Water samples and soil-moisture-content data were collected routinely. Streamflow control structures and automatic-sampling equipment were installed on an ephemeral stream at the base of a bedrock outcrop, and downstream of two perennial tributaries. Storm sampling of tributaries continued and storm sampling of the watershed outlet was reinstituted to test the hypothesis that peak sulfate concentrations are declining during storms. Routine monitoring of ground-water, soil-water, surface-water, and precipitation-quality stations continued.

Published Reports during 1992 and 1993:

Cappellato, Rosana, Peters, N.E., and Ragsdale, H.L., 1993, Acidic atmospheric deposition and canopy interactions of adjacent deciduous and coniferous forests in the Georgia Piedmont: Canadian Journal of Forest Research, no. 23, v. 6, p. 1114-1124.

Christophersen, Nils, and Hooper, R.P., 1993, Modelling the hydrochemistry of catchments-a challenge for the scientific method: Journal of Hydrology, v. 152, p. 1-12.

Hooper, R.P., 1993, Catchment models and the scientific method *in* Programs and Abstracts, Symposium on Ecosystem Behaviour--Evaluation of Integrated Monitoring in Small Catchments, September 1993: Prague, Czechoslovakia: Prague, Chech Geological Survey, BIOGEOMON, p. 128-129.

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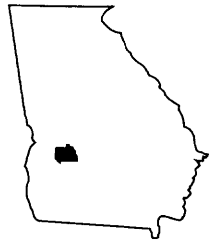
Huntington, T.G., 1993, Streamwater and soil-water chemical response to rainfall variation at a small forested catchment in the Georgia Piedmont [*abs.*]: EOS, Transactions of American Geophysical Union, v. 74, p. 147.

Kendall, Carol, 1992, Temporal, spatial, and species-effects on the oxygen and hydrogen isotopic compositions of throughfall [*abs.*]: EOS, Transactions of American Geophysical Union, v. 74, no. 43, p. 160-161.

Shanley, J.B., 1992, Sulfur retention and release in soils at Panola Mountain, Georgia: Soil Science, v. 153, no. 6, p. 499-508.

Shanley, J.B., and Peters, N.E., 1993, Variations in aqueous sulfate concentrations at Panola Mountain, Georgia: Journal of Hydrology, v. 146, p. 361-382.

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: 1984-94

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 conduct a hydrologic and lithologic evaluation, determine the movement and fate of agricultural chemicals in the unsaturated (including the root zone) and saturated zones, and 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 help identify and correlate strata. Four pits will be excavated and lithology 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 will be determined by laboratory analyses of soil cores.

Progress: Two soil-monitoring transects were established north to south through the planting area to define agrichemical migration pathways from land surface to the saturated zone downgradient of the planting area. Each parallel transect includes four on-site and three off-site (downgradient) monitoring points. Background soil samples were collected in early 1993 from land surface to a depth of about 32 ft at each site prior to agrichemical application during the spring. Soils from the same sites were sampled five times during the 1993 crop season from land surface to a depth of 12 ft and analyzed for pesticide residues, bromide, and nitrate. Water from the saturated zone was sampled on a quarterly basis at 38 downgradient monitoring wells installed to define the movement of agrichemicals in the saturated zone. Significant concentrations of atrazine (maximum, 4.0 micrograms per liter (μg/L) and carbofuran (maximum, 225 μg/L)) were detected in the saturated zone as far as 800 ft downgradient of the planting area (Hicks, 1994). Lesser concentrations of atrazine and carbofuran were detected in wells tapping the saturated zone directly beneath the planting area (Hicks, 1994). Ground-water sampling continued on a quarterly basis. All samples were screened using Amino Assay[1/] (ELISA) methodology and detections were confirmed using gas chromatography. Data assimilation and analysis is underway; and sets are being merged into a data base that will be available to the U.S. Geological Survey user.

Published reports during 1992, 1993, and 1994:

Hicks, D.W., McConnell, J.B., Persinger, H.H., Scholz, J.D., and Hubbard, R.K., 1994, Two-dimensional distribution of a bromide tracer in the unsaturated zone at the Plains, Georgia, research site *in* proceedings, Toxic Substances Hydrology Program, Colorado Springs, Co., September 20-24, 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4014.

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[1]Any use of trade, product, or firm names in this report is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

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

Location: Gwinnett County, Georgia

Project Chief: Ernest J. Inman

Period of Project: 1986-93

Cooperation: Gwinnett County, Georgia

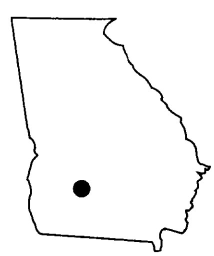
Problem: An ordinance of Gwinnett County requires developers to analyze runoff from land being developed, and provide detention reservoirs so that peak runoff does not exceed predevelopment or natural rates; however, developers are not required to determine the effect of the reservoir outflows on the 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 significantly increase peak flow downstream, 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.

Approach: Stable drainage basins having one or more detention reservoirs were selected for study, and one or more recording rain gages were installed in the basin. A stage recorder was installed to gage the cumulative flow of the entire basin. The Distributed Routing Rainfall-Runoff Model (DR3M) (Alley and Smith, 1982) was calibrated by using observed data, generally for three to five events per year, and was used to simulate several long-term peak discharge data sets with long-term rainfall data from the National Weather Service. The first simulation using the calibrated DR3M model was for an "as is" condition having all detention ponds in place. Subsequent simulations were made by removing one reservoir at a time, until the final simulation was for a "no-detention" condition. Flood-frequency relations using the log-Pearson Type III analysis were developed using the synthesized conditions in a basin and the "as is" condition, and used to determine the effect of existing or proposed detention reservoirs on stream systems.

Progress: First phase of data collection was completed. Discharge hydrographs and rainfall hyetographs were plotted for flood events. Area capacity curves and outflow ratings were verified at detention ponds. Basin characteristics, sub-basin areas, overland-flow slopes, channel lengths and slopes, "n" values for channels and overland-flow areas, and impervious areas for sub-basins were determined. Six sites were calibrated using the DR3M model.

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: 1986-94

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 evalauated. A potential 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.

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

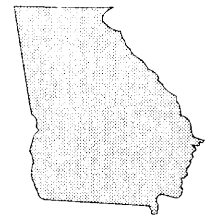
Approach: Perform selected data collection and assimilate available hydrologic information to conceptualize the flow system. Design a finite-element model that simulates surface- and ground-water flow, integrating this model with the finite-element model of the ACF Basin. The model will be calibrated 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: Hydrogeologic data were collected from existing wells and streamflow sites in the vicinity of an area of potential ground-water development near Albany, Ga., west of the Flint River. Data from driller's logs near the area of potential ground-water develoment were compiled from the Dougherty County Public Health Service, Albany, Ga., and entered into the data base describing the distribution of solution features west of the Flint River. Pumping scenarios were simulated using the finite-element model to conceptualize the ground-water-flow system and stream-aquifer interactions.

Published reports during 1992 and 1993:

Torak, L.J., Davis, G.S., Strain, G.A., and Herndon, J.G., 1993, Geohydrology and evaluation of water-resource potential of the Upper Floridan aquifer in the Albany area, Southwestern Georgia: U.S. Geological Survey Water-Supply Paper 2391, 59 p., 2 pl.

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



Location: Statewide

Project Chief: S. Jack Alhadeff

Period of Project: 1987-95

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: Landfills and waste facilities that store hazardous wastes in the Southeastern United States are potential contamination sources of public- and private-water supplies and potential contamination sources of nearby land and atmosphere. A means of screening these locations is needed to identify areas of potential pollution (such as nearby streams and aquifers), correlate the many relevant earth science data bases (such as land use, land cover, lithology, soils, environmental monitoring stations, elevation, and demographic data), and develop analytical models to assist in environmental management decisions.

Objectives: To develop a Statewide geographic information system (GIS) to assist environmental managers, planners, and researchers in making multi-county to multi-state environmental decisions and develop generic GIS data bases at the county level to assist county managers and planners address local environmental issues.

Approach: Organize an interagency team of specialists to capture data, compile, review, and integrate all available information into a digital, spatia,l GIS data base. The team of specialists will perform quality control of the spatial and related tabular data.

Progress: GIS data bases were developed to determine areas susceptible to ground-water pollution, stream-corridor protection, and high-slope protection on a Statewide basis (information at 1:100,000 to 1:500,000 scale). Digital spatial layers (maps at 1:24,000 scale) were developed to be used in planning and environmental assessment activities by various agencies. These digital layers include soils, geology, elevation, slope, parks, trails and greenways, roads, hydrography, pipelines, land cover and use, wetlands, flood-prone areas, mineral resources, landfills, underground storage-tank sites, hazardous-material-handling businesses, and monitoring and other sites with potential for environmental impact.

Published reports during 1992 and 1993:

Alhadeff, S.J., Dayton, S.F., and Nix, D.L., 1993, Use of geographic information system technology in future land-use planning *in* proceedings of the 25th International Symposium, Remote Sensing and Global Environmental Change, April 4-8, 1993, Graz, Austria: Ann Arbour, Mi., Ciesin Consortium for Earth Science Information Network, Environmental Research Institute, 2 p.

Hipple, D.R., 1992, Lands geotechnically poorly suited for a sanitary landfill: Georgia Geologic Survey, GIS data base, ARC/INFO format, no. GIS-2, 12.4 megabytes.

Sandercock, A.C., 1993, Management strategies for multi-gigabyte Statewide environmental spatial data *in* proceedings of the Symposium on Geographic Information Systems and Water Resources, Mobile, Alabama, March 14-17, 1993: American Water Resources Association, 9 p.

Trent, V.P., 1992, Ground-water pollution susceptibility map of Georgia: Georgia Geologic Survey, GIS data base, ARC/INFO format, no. GIS-1, 6.9 megabytes.

___1993, DRASTIC mapping to determine the vulnerability of ground water to pollution *in* proceedings Symposium on Geographic Information Systems and Water Resources, Mobile, Alabama, March 14-17, 1993: American Water Resources Association, 9 p.

Trent, V.P., and Sandercock, A.C., 1992, Geologic map of Georgia: Georgia Geologic Survey, GIS data base, no. GIS-3, ARC/INFO format, 9.4 megabytes.

WATER-RESOURCE EVALUATION OF THE GLYNN COUNTY, GEORGIA, AREA, GA093

Location: Glynn County, Georgia

Project Chief: L. Elliott Jones

Period of Project: 1987-95

Cooperation: City of Brunswick, Georgia
Glynn County

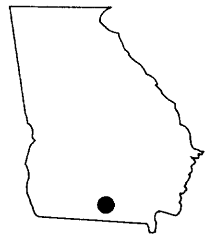
Problem: Saltwater is intruding into the Upper Floridan aquifer in the Brunswick area due to the lowering of the potentiometric surface as a result of ground-water withdrawal. The Upper Floridan aquifer is the principal source of water supply in the area. Understanding the relation between ground-water withdrawal and the movement of saltwater into and through the aquifer is necessary for the effective management of the resource. Other sources of water supply exist in the area, but their potential as alternative water-supply sources needs to be evaluated.

Objectives: To provide the information on the Floridan aquifer system needed to mitigate or reduce saltwater intrusion and to evaluate other ground-water and surface-water sources to determine their suitability for future water supply.

Approach: Describe the flow and transport processes in the Floridan aquifer system by reviewing and analyzing historic and currently collected hydrologic data; and by simulating the ground-water flow and saltwater movement in the area. Use ground-water flow models to test the effect of ground-water-withdrawal scenarios on the rates of movement of water in the area. Evaluate existing data to determine the availability and adequacy of supplemental or alternative water-supply sources.

Progress: Simulation of the ground-water-flow systems continued. A single-layer ground-water-flow model was used to test the hypothesis of fractures and conduits influencing migration pathways in the area. Continuous water-level recorders were operated at 18 sites, and water from 80 wells was sampled in October and April and analyzed for chloride concentration and specific conductance. Borehole geophysical logs were run in three wells and continuous recording specific conductance probes were operated in two wells.

HYDROLOGY OF THE VALDOSTA, GEORGIA, AREA AND EFFECT OF WITHLACOOCHEE RIVER RECHARGE ON THE UPPER FLORIDAN AQUIFER, GA095



Location: South-Central Georgia

Project Chief: James B. McConnell

Period of Project: 1988-93

Cooperation: City of Valdosta, Georgia

Problem: The quality and quantity of water in the Upper Floridan aquifer in the Valdosta, Georgia, area is affected by direct recharge from the Withlacoochee River. Water enters the aquifer along a short reach of the Withlacoochee River where sinkholes have formed in the streambed. The river water receives little filtration as it recharges the Upper Floridan aquifer, and naturally occurring organic material in the river provides a source of energy for the growth of microbiota in the aquifer. The microbiota are catalysts for reactions that produce methane and hydrogen sulfide as the river water mixes with ground water and moves downgradient in the aquifer. Also, humic substances associated with the organic material in the water can form trihalomethanes when the ground water is chlorinated for drinking-water supplies. In addition to water-quality concerns related to natural conditions, ground water in the Upper Floridan aquifer in the Valdosta area may be vulnerable to contamination from human activities in the upstream drainage basin that is transported to the sinkhole area by the river. Both the quality and quantity of water in the aquifer needs to be evaluated for development potential as a source of drinking water supply.

Objectives: To define the hydrogeologic framework and ground-water-flow paths of the Upper Floridan aquifer; determine average rates of recharge from the Withlacoochee River to the Upper Floridan aquifer and the effects of recharge on the ground-water quality in the Valdosta area; and evaluate the development potential of ground-water resources in the area.

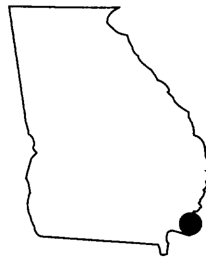
Approach: Hydrologic, lithologic, and water-quality data collected in the Valdosta area by the U.S. Geological Survey since 1963, and data collected as a part of this study were used to examine the geologic framework, water-quality conditions of the Withlacoochee River and Upper Floridan aquifer, and stream-aquifer relations.

Progress: Final report was published describing the hydrogeology, water quality, and water-resources development potential of the Upper Floridan aquifer in an area surrounding Valdosta in South-Central Georgia (McConnell and Hacke, 1993).

Published reports during 1992 and 1993:

McConnell, J.B., and Hacke, C.M., 1993, Hydrogeology, water quality, and water-resources development potential of the Upper Floridan aquifer in the Valdosta area, South-Central Georgia: U.S. Geological Survey Water-Resources Investigations Report 93-4044, 44 p., 2 pls.

HYDROGEOLOGY OF CUMBERLAND ISLAND AND THE IMPACT OF GROUND-WATER WITHDRAWALS AND CHANNEL DEEPENING ON THE FRESHWATER RESOURCES OF THE ISLAND, GA096



Location: Southeastern Georgia

Project Chief: Harold H. Zehner

Period of Project: 1988-93

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 surface-water and ground-water-flow systems. Recent changes in the ground-water-flow system may threaten this balance by increasing saltwater intrusion into the fresh ground-water reservoir. Changes in the flow system result from nearby heavy withdrawal of ground water and deepening of navigation channels around the southwestern and southern end of the island.

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

Approach: Conduct a test-drilling program and collect drill cuttings, core, and borehole geophysical logs. Install a ground-water level and water-quality monitoring program. The 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 surface-water and ground-water relations. Water-level and water-quality data will help to 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 a literature search. Water levels and specific conductance were continuously monitored in 10 wells and tide-stage data were monitored from one gage.

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: 1989-91

Cooperation: Albany Water, Gas, and Light Commission

Problem: Wastes associated with an abandoned manufactured gas plant in Albany may affect ground-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 benzene 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-water systems.

Objectives: To chemically characterize waste contamination of ground water in the study area near an abandoned manufactured gas plant site, evaluate the distribution and concentrations of identified contaminants, and identify potential ground-water-flow pathways of contaminants.

Approach: *Phase I*: Areas of potential contamination were identified by reviewing historical data and on-site conditions; airborne organics and soil gases were screened for volatile organics; wells were drilled to the top of the bedrock; soil and waste samples were collected; shallow monitoring wells were installed; and ground-penetrating radar, electrical resistivity, magnetic, and electromagnetic-terrain conductivity surveys were conducted. *Phase II:* The hydrogeologic framework of the study area was defined; the chemical characteristics of wastes described; deep monitoring wells tapping the Upper Floridan aquifer were installed; borehole geophysical logs were run; and ground water was sampled and analyzed.

Progress: Results of Phase II (Chapman, 1991 and 1993) of the study were published showing possible ground-water contamination in the Upper Floridan aquifer in the vicinity of the abandoned manufactured gas plant in Albany.

Published reports during 1991, 1992, and 1993:

Chapman, M.J., 1991, Evaluation of the hydrogeology and contamination in the vicinity of an abandoned manufactured gas plant in Albany, Georgia: U.S. Geological Survey Water-Resources Investigations Report 91-4178, 48 p.

___1993, Ground-water quality of the Upper Floridan aquifer near an abandoned manufactured gas plant in Albany, Georgia: U.S. Geological Survey Water-Resources Investigations Report 93-4038, 19 p.

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: 1989-93

Cooperation: Chatham County-Savannah Metropolitan Planning Commission

Problem: Ground-water withdrawals from the Floridan aquifer system in the Chatham County area has resulted in a steep cone of depression in the potentiometric surface of the aquifer. Although additional ground-water and surface-water supplies may be available, 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 update and refine hydrologic data necessary to develop a ground-water-flow model of the Chatham County, Georgia, area; simulate ground-water movement, including quantities and location of possible ground-water withdrawals, to determine availability of ground water in the Floridan aquifer system; evaluate the potential for saltwater intrusion into the aquifer system; and assess the availability of surface water as a possible source of fresh water supply.

Approach: Current quantities of ground and surface water used for domestic and industrial purposes were determined. The current configuration of the potentiometric surface and the ground-water-flow system was determined. Sources and availability of surface water were assessed. A ground-water-flow model of the Floridan aquifer system was constructed and the effects of ground-water-management alternatives were analyzed using a digital model.

Progress: Hydrologic data were evaluated and incorporated into a computer model used to estimate the ground-water-development potential in the study area. Hypothetical ground-water withdrawal scenarios were tested showing the effects of increased, decreased, and redistributed pumpage on water levels. Streamflow characteristics for major streams in the study area also were assessed.

Published reports during 1992 and 1993:

Garza, Reggina, and Krause, R.E., 1992, Water-supply potential of major streams and the Upper Floridan aquifer in the vicinity of Savannah, Georgia: U.S. Geological Survey Open-File Report 92-629, 49 p., 19 pl.

____1993, Water-supply potential of the Upper Floridan aquifer in the vicinity of Savannah, Georgia, *in* proceedings of The Geological Society of America, 42nd Annual Meeting, Southeastern Section, Tallahassee, Fla., April 1-2, 1993: Boulder, Co., The Geological Society of America, v. 25, no. 4, p. 16.

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: 1990-94

Cooperation: City of Valdosta, Georgia

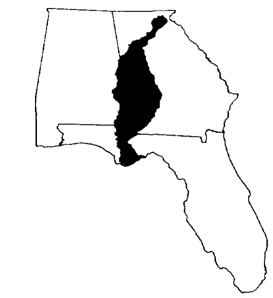
Problem: The potential for entry and movement of contaminants into ground-water systems in karst terranes is difficult to evaluate because the ground-water flow generally does not conform to Darcian principles. Sinks, caves, and karst windows, which are common features in karst terrane, permit direct 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 tracers.

Objectives: To evaluate the effectiveness of chlorofluorocarbons (CFC) to trace ground-water-flow paths and age-date ground water in a karst terrane and 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 about 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. CFC will be used to determine the direction of ground-water flow and mixing patterns, and estimate the age of ground water.

Progress: Monthly water samples and river-water temperatures were collected from 83 well sites in the Valdosta area and 2 sites on the Withlacoochee and Little Rivers. Ground-water samples were analyzed for CFC, chemical constituents, and physical properties. Water temperature at time of recharge suggests highly variable rates of ground-water flow. Variation of dissolved gas concentrations in water from sampled wells show a large range of recharge temperatures, probably related to the seasons that the water recharged the aquifer. Data show that accurate age dating of ground water using CFC may not be possible in the Valdosta area because CFC concentrations in the Withlacoochee River (local source of recharge water) were detected at concentrations much higher than would occur if the river water was in equilibrum with CFC concentrations in the atmosphere. However, elevated CFC concentrations in the Withlacoochee River may become good tracers of modern recharge in the Upper Floridan aquifer (J.B. McConnell, written commun., U.S. Geological Survey, 1993).

NATIONAL WATER QUALITY ASSESSMENT PROGRAM--THE APALACHICOLA-CHATTAHOOCHEE-FLINT RIVER BASIN STUDY, GA102



Location: Apalachicola-Chattahoochee-Flint River Basin

Project Chief: David J. Wangsness

Period of Project: 1990-96

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, sediments, metals, pesticides, and other organic compounds associated with substantial population growth, urban development, and 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 future 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 provide a consistent description of current water-quality conditions for surface- and ground-water resources, define long-term trends (or lack of trends) in water quality, and identify and describe, as possible, the major factors that affect observed water-quality conditions and trends in the ACF River basin.

Approach: A project team will be assembled, a multi-disciplinary project work plan will be developed, and existing data will be summarized and analyzed. A 3-year period of intensive data collection, analysis, and interpretation will begin in 1993. A surface- and ground-water monitoring network will be established; 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: Project team, work plan, and data base containing surface-water, ground-water, biological, water-quality data, and agricultural statistics for the ACF River basin were assembled. Study design was modified to emphasize effects of land use on surface- and ground-water quality. Well inventory was conducted to locate potential sampling points. Nine surface-water monitoring sites were selected and samples collected weekly to monthly. Representative samples of fish, algal, and benthic invertebrate communities were collected, and instream and riparian habitats were measured at 36 sites. Water-quality samples were collected at about 65 synoptic sites. Bed-sediment and tissue samples were collected at 41 sites and analyzed for select metals and organic compounds. Nutrients, major ions, pesticides, organic carbon, volatile organic compounds, and selected radionuclides were analysed for in samples from 43 new wells representing agricultural land use in the Coastal Plain physiographic province. An additional 14 wells were drilled in this area adjacent to an agricultural field to determine the movement of nutrients, major ions, and pesticides in a shallow ground-water-flow system.

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: 1990-93

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 to the stream in the watershed as well as the interactions between the soil and 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 investigate processes that control the movement and solute composition of water along hydrologic pathways that produce streamflow in a forested Piedmont watershed; determine relative contributions from a variety of sources of solutes observed in streamwater, including primary mineral weathering, cation exchange, and atmospheric deposition; and investigate 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. Intensive (or event-based) and extensive characterizations will determine the physics and chemistry of soil and water at both the plot (10- to 100-$meter^2$ 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: Instrumentation for intensive sampling of physical and chemical data in the regolith was designed, installed, and monitored at four sites along a transect adjacent to a dominant bedrock outcrop to determine physical and chemical characteristics of water in saturated and unsaturated zones. These data augmented the continuous monitoring of streamflow and ground-water levels at other sites in the catchment. Forest productivity was evaluated from surveys of 0.04-hectare plots at 67 previously established sites. Stems of several trees were cored to determine their dendrochronology and chemistry. Cations and carbon content, and sulfate absorption were determined for soils sampled at various depths at five sites along five transects of the watershed and at an old growth site in Atlanta. Precipitation, streamwater-quality trends, and watershed-mass balance were determined for major solutes. Three main tributaries sampled during storm events indicate major controls on streamwater chemistry by the two primary bedrock types in the catchment.

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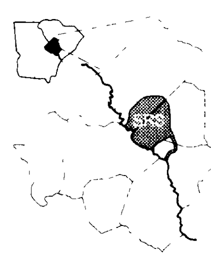
GROUND-WATER FLOW AND QUALITY IN THE VICINITY OF THE SAVANNAH RIVER AT THE SAVANNAH RIVER SITE, GEORGIA AND SOUTH CAROLINA, GA104



Location: East-Central Georgia and
adjacent parts of South Carolina

Project Chief: John S. Clarke

Period of Project: 1991-96

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).

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

Approach: Clusters of coreholes and wells will be constructed in Georgia and South Carolina to provide hydrogeologic data, including vertical and lateral head gradients, hydraulic properties of hydrogeologic units, and water quality. Additional data will be collected by conducting aquifer tests to estimate hydraulic characteristics of aquifers and confining units, analyzing water from selected wells tapping the major aquifers, mapping potentiometric surfaces of major aquifers, installing recorders to determine water-level fluctuations and trends, analyzing low streamflow conditions to develop a quantitative hydrologic budget relating to ground-water flow and streamflow in the Savannah River, 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 and simulate pumping scenarios to determine where underflow may occur.

Progress: Pertinent data and reports from other Federal, State, and local agencies were compiled and reviewed. Well inventory was completed, new coreholes and wells were drilled, and several hundred existing wells in the area were added to the Ground Water Site Inventory data base. Potentiometric- surface maps of Cretaceous and Tertiary-age aquifers were constructed using inventory of flowing wells in the Savannah River Valley to define conditions near the Savannah River. Hydrogeologic sections parallel to and transecting the Savannah River were completed. Paleontologic analyses were continued on core samples from selected test wells. Hydrogeologic framework was developed using geologic, water-level, aquifer-test, and water-quality data. Thickness of alluvium and depth of river incision into geologic formations was assessed in the Savannah River Valley. Aquifer tests were conducted in selected wells to determine hydraulic properties of hydrogeologic units.

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QUALITY OF STORM-WATER RUNOFF IN DEKALB COUNTY, GEORGIA, GA106

Location: DeKalb County, Georgia

Project Chief: Ernest J. Inman

Period of Project: 1991-98

Cooperation: DeKalb County, Georgia

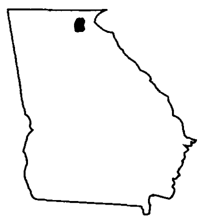
Problem: The U.S.Environmental Protection Agency (EPA) determined that metropolitan areas define and control the water-quality impact of urban storm-water runoff (U.S. Environmental Protection Agency, 1990). DeKalb County, Ga., is in the Metropolitan Atlanta area and storm-water runoff data from selected sewers are needed to comply with permit application requests for wastewater disposal.

Objective: To: characterize storm-water quality for representative urban land uses; estimate storm-event mean concentrations and annual pollutant loads of the cumulative discharges to designated receiving waters; and assist in designing a monitoring program for representative data collection.

Approach: A six-site network for characterization of storm-water runoff quality will be established to provide hydrologic data and analyses in the metropolitan area of DeKalb County. A statistical technique developed by the U.S. Geological Survey (Driver and Tasker, 1990; Tasker, Gilroy, and Jennings, 1991) will be used to predict storm loads, annual constituent loads, and mean concentrations in urban storm water, according to the requirements for Part II of the EPA's storm-water permit application (U.S. Environmental Protection Agency, 1990). Pertinent land-use data needed in the regression equations used to predict storm loads and concentrations will be provided as part of a Geographic Information System study currently being conducted by the USGS, in cooperation with DeKalb County (see GA 091).

Progress: Six sites were selected and stage-discharge relations were established to evaluate storm-water runoff in selected storm sewers and relate storm-water-quality characteristics to land use in the drainage basin. Rain gages, samplers, and stage gages were installed at 6 sites and 18 flood events were sampled and submitted to the USGS Laboratory for water-quality determinations.

RECONNAISSANCE EVALUATION OF SURFACE- AND GROUND-WATER QUALITY IN THE WHITE CREEK AND MOSSY CREEK WATERSHEDS, WHITE COUNTY, GEORGIA, GA107



Location: White County, Georgia

Project Chiefs: Michael F. Peck and Jerry W. Garrett

Period of Project: 1992-93

Cooperation: Chestatee-Chattahoochee Resources Conservation and Development Council

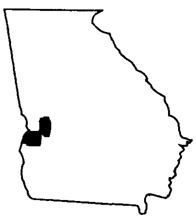
Problem: The White Creek and Mossy Creek watersheds are heavily used for livestock operations. In 1985, the Georgia Environmental Protection Division identified White Creek as having water-quality problems that include fecal coliform, high turbidity, and high concentrations of suspended solids, nitrogen, and phosphorus. It is likely that Mossy Creek has similar water-quality problems. These streams are tributaries to the Chattahoochee River which flows into Lake Sidney Lanier, the primary source of drinking water for the majority of Georgia's population. A major source of contaminants in the study area is manure from livestock operations. Manure production in the watersheds is about 9.8 million tons per year, most of which is spread over 5,000 acres of the study area. Other sources of contaminants are livestock feeding and loafing areas located near streams, erosion of stream banks where livestock have access to streams, and poultry carcass disposal pits.

Objective: To describe water-quality conditions in White and Mossy Creek watersheds and identify stream reaches and wells having water quality that has been affected by nonpoint-source contributions.

Approach: Water-quality data collected by sampling of streams and wells will be used to describe current surface- and ground-water-quality conditions. The data will be used to identify areas in the White and Mossy Creek watersheds where the quality of surface and ground waters may be adversely affected by nonpoint-source pollutant contributions. Sampling of streams and wells consisted of collecting water samples from 31 stream sites and 24 wells. Current land-use data provided by the cooperator will be used to select sampling sites. Streams will be sampled during baseflow and high flow conditions. Bedrock (deep) and regolith (shallow) wells will be sampled in early spring.

Progress: Thirty-one stream sampling sites were selected based upon upstream land use. Water samples were collected from streams during baseflow (September 30 to October 1, 1992) and high-flow (January 12, 1993) conditions and analyzed for ammonia-nitrogen, nitrite plus nitrate nitrogen, orthophosphate phosphorus, and turbidity. Instantaneous yields of nitrite plus nitrate nitrogen and orthophosphate phosphorus were calculated in both watersheds. Ground-water samples were collected from 16 wells tapping the crystalline bedrock and 8 wells tapping the regolith during March 23-30, 1993. Water samples collected from wells in both watersheds were analyzed for ammonia-nitrogen, nitrite plus nitrate nitrogen, and orthophosphate phosphorus.

ASSESSMENT OF AIR POLLUTANT LOADINGS AND RESULTANT WATER QUALITY IMPACTS IN STEWART AND MARION COUNTIES, GEORGIA,GA108



Location: Stewart and Marion Counties, Georgia

Project Chief: Thomas G. Huntington

Period of Project: 1992-93

Cooperation: Georgia Forestry Commission

Problem: The extent to which the atmospheric deposition of acidifying substances affects water quality, soil fertility, and forest health has not been thoroughly evaluated for southern pine ecosystems in Georgia. Certain areas within these ecosystems are experiencing ongoing pine beetle infestations of unprecedented persistence. Also, the potential role of acidic deposition as an additional stress to an ecosystem in Georgia has not been evaluated.

Objective: To measure precipitation and dry deposition chemistry to assess the possibility that excessive sulfur deposition has resulted in water-quality impacts and soil-chemical changes that may adversely affect forest conditions and determine the sulfur status of the soil, surface water, and soil water by using a long-term model to evaluate past and future soil-acidification rates.

Approach: Precipitation and canopy throughfall samples will be collected to estimate wet (gaseous aerosols) and dry (gaseous particulates) deposition and the net effect of the canopy on throughfall chemistry. Estimates of total (wet plus dry) deposition will be compared with other regional estimates to determine if the ecosystem has an unusually high level of sulfur deposition. Surface- and soil-water chemical data will be compared between affected and unaffected areas to determine if sulfate retention occurs and the data will be used to calibrate an acidification model. Soil-chemical and physical data will be compared betwen affected and unaffected areas.

Progress: Two sites, one near Lumpkin in Stewart County and the other near Buena Vista, Marion County, were selected and instrumented with automatic wet/dry collectors and throughfall collection funnels. Weekly composite precipitation and throughfall samples were collected and analyzed for sulfur and nitrogen deposition beneath loblolly pine canopies. Geographic Information System (GIS) coverages were compiled, including major soil associations, geology, land use, and topography, and will be compared to known incidences of Southern Pine beetle infestation. Sulfur dioxide and ozone ambient air concentrations were monitored in Stewart County and were compared to those measured in Metropolitan Atlanta. Surface-water samples were collected from numerous small streams, including tributaries to the Hannahatchee, Hichitee, Kinchafoonee, Upatoi, Grass, Turner, Muckalee, and Buck Creeks, and tributaries to the Chattahoochee River. Soil samples were collected from paired plots in 28 uninfested and 28 infested sites in Stewart and Marion Counties. Soils were analyzed for selected chemical properties.

GEOSTATISTICAL EVALUATION OF VADOSE-ZONE FLOW AND TRANSPORT PROCESSES, GA109

Location: Plains, Georgia

Project Chief: Lynn J. Torak

Period of Project: 1992-94

Cooperation: Georgia Department of Natural Resources
Environmental Protection Division

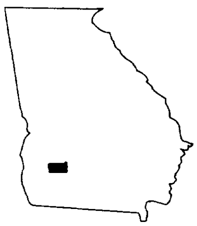
Problem: Knowledge of the fate of chemical constituents in the vadose zone resulting from surface application of agricultural chemicals is limited because of inadequate soil-property characterization, especially with respect to spatial variability, and a lack of models appropriate for describing vadose-zone solute-transport processes. Complex heterogeneities of soil types and properties often result in uncertainty in soil-property parameterization despite rigorously controlled field experimentation. Deterministic models of vadose-zone processes often are unable to satisfactorily simulate water or solute movement over field-scale distances and times. Accurate soil-property characterization at the local, field scale will be required to define subsurface processes governing flow dynamics, solute transport, and geochemical and biological reactions.

Objective: To develop and apply a geostatistical method to quantitatively define the three-demensional spatial variability and physically based or statistical correlations between field measurements of saturated hydraulic conductivity, moisture content, and solute concentration; apply Monte Carlo simulation and statistical methods to quantitatively define the effect of spatial variability in field measurements on water flow and solute transport in the vadose zone and provide estimates of the potential range of flow and solute-transport variations; and evaluate the vertical and horizontal dispersion characteristics of a conservative tracer within a probabilistic framework and the suitability of selected deterministic flow and solute-transport model equations to describe vadose-zone processes.

Approach: The study will consist of deterministic-model and spatial-simulation-technique selection, geostatistical analysis of field-measured data, Monte Carlo simulation of water flow and solute transport, and deterministic-model-output analysis. A deterministic model or models will be selected on the basis of predefined hydrologic criteria to investigate the relation between unsaturated hydraulic conductivity and moisture content. Spatial-simulation techniques will be evaluated on the basis of their ability to generate a relatively large number of equally probable spatial distributions (realizations) of vadose-zone hydraulic properties consistent with the field (measured) data. Geostatistical analysis of measured values of saturated hydraulic conductivity, moisture content, and travel concentration will be performed to quantitatively define the three-dimensional spatial variability of these data and any physically based or statistical correlations. Monte Carlo simulations will be used to provide an ensemble of realizations of vadose-zone properties and tracer concentration that are equally as probable as the realization provided by the field measurments. Ensemble behavior will be compared with field data to determine the accuracy of model output, its potential range of variation, and the adequacy of the sampling network.

Progress: Geostatistical-simulation techniques were researched to provide an assessment of the "state of the science" as a preliminary to development and application of techniques for the field problem. Variations of Monte Carlo techniques, turning-band methods, and optimization also were researched and evaluated for suitability in meeting study objectives.

INSTALLATION RESTORATION PROGRAM, MARINE CORPS LOGISTICS BASE, ALBANY, GEORGIA, GA111



Location: Albany, Georgia

Project Chief: Harold H. Zehner

Period of Project: 1992-95

Cooperation: U.S. Navy
Marine Corps Logistics Base, Albany

Problem: The U.S. Environmental Protection Agency (EPA) placed the Marine Corps Logistics Base (MCLB), Albany, Ga., on its National Priorities List of hazardous waste sites in 1989. Spills of polychorinated biphenol (PCB), volatile organic compounds, and heavy metals are being investigated because of requirements under the Navy Hazardous Waste Facility Permit. Contamination has been found in ground water and soil samples on the MCLB, and 24 potential sources of contamination (PSC) have been identified. People in housing and farming areas near the northern and southwestern perimeter of the MCLB rely on wells to supply drinking and irrigation water. The northern perimeter of MCLB needs to be evaluated to determine if the domestic wells in this area are hydraulically downgradient from PSC described at disposal and landfill areas.

Objective: To review data and reports by a private consulting firm contracted by the U.S. Navy that describes the geology, hydrology, and extent of subsurface transport of hazardous-waste compounds at various PSC; and evaluates proposals for remedial action if the U.S. Navy and regulatory agencies determine that health hazards are sufficient to warrant such actions.

Approach: The U.S. Navy has contracted with a private consulting firm to collect and analyze ground- and surface-water data from various PSC areas at MCLB. The consulting firm will describe the geology, hydrology, and extent of subsurface transport of hazardous-waste compounds from PSC areas. USGS will review hydrologeologic data reports by the consulting firm as the reports are submitted to the U.S. Navy.

Progress: Hydrogeologic information collected by the consulting firm were reviewed by USGS. Various progress reports by the consulting firm were reviewed and technical meetings were attended by USGS.

INSTALLATION RESTORATION PROGRAM, U.S. NAVAL BASE, KINGS BAY, GEORGIA, GA112

Location: U.S. Naval Base, Kings Bay, Georgia

Project Chief: Harold H. Zehner

Period of Project: 1992-95

Cooperation: U.S. Navy
Naval Base, Kings Bay, Georgia

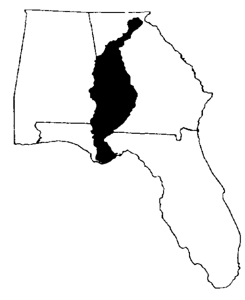
Problem: Three waste-spill sites at the U.S. Naval Base, Kings Bay, Ga., are being investigated because of requirements under the Navy Hazardous Waste Facility Permit. One site is a closed landfill and the other two sites are closed disposal areas. Volatile organic compounds are being transported through the shallow (less than 100-foot depth) aquifer from the closed landfill site to a housing area adjacent to U.S. Navy property. The contaminated ground water from the shallow aquifer is used for irrigation of lawns and gardens.

Objective: To review data and reports and oversee data collection of a private consulting firm contracted by the U.S. Navy that describes the geology, hydrology, waste-trench boundaries, and extent of subsurface transport of hazardous-waste compounds at various sites; and evaluate proposals for remedial action if the U.S. Navy and regulatory agencies determine that health hazards are sufficient to warrant such actions.

Approach: The U.S. Navy has contracted with a private consulting firm to collect and analyze ground- and surface-water data from specific sites at Kings Bay Naval Base. The consulting firm will describe the geology, hydrology, and extent of subsurface transport of hazardous-waste compounds. U.S. Geological Survey will review hydrogeologic data and reports by the consulting firm as the reports are submitted to the U.S. Navy, and occassionally oversee field data collection.

Progress: Hydrogeologic data collected by the consulting firm were reviewed by U.S. Geological Survey. Various progress reports by the consulting firm were reviewed and technical meetings were attended by U.S. Geological Survey. he U.S. Navy requested USGS attend technical review and public-information meetings.

GROUND-WATER RESOURCES, APALACHICOLA-CHATTAHOOCHEE-FLINT RIVER BASIN, GA114



Location: Southwestern Georgia, southeastern Alabama, and panhandle of northern Florida

Project Chief: Richard E. Krause

Period of Project: 1993-95

Cooperation: Georgia Department of Natural Resources
Environmental Protection Division
U.S. Army Corps of Engineers
Mobile District

Problem: The Apalachicola-Chattahcochee-Flint (ACF) River basin contains dynamic hydrologic systems (hydrosystems) consisting of aquifers, streams, reservoirs, and flood plains. These hydrosystems are stressed by natural hydrologic and climatic factors, and also by man. It is difficult to assess water availability and resultant effects of water use within the basin because of diversity and complexity within the hydrosystems and stresses imposed on them. The strong relation between surface water and ground water dictates that they be considered as a single hydrologic entity. In response to an increased demand for water, state and federal agencies have proposed new projects to develop water resources and revise operating practices within the basin. Conflicts over water rights have arisen among private water-user groups, the states, and various federal agencies. A study is needed to describe ground-water availability and the effects of conflicting uses on the finite water resources in the basin.

Objective: To qualitatively evaluate how changes in surface- and ground-water levels affect surface- and ground-water availability in Alabama; identify areas where ground-water resources are over or under utilized; qualitatively and quantitatively determine how current and future ground-water withdrawals in the Coastal Plain physiographic province part of the basin will affect surface-water flow to the Apalachicola River and Apalachicola Bay, particularly during critical low-flow periods such as droughts; and develop water budgets to describe the volume of water entering and exiting the area or state that include processes such as recharge by precipitation and surface- and ground-water inflow and outflow.

Approach: Develop scope of work for "Ground-Water Supply Element" of the Comprehensive Study for the ACF/Alabama-Coosa-Tallapoosa (ACT) River Basins, one of 14 elements comprising the overall study. Divide ACF River basin into four subareas on basis of major hydrologic and physiographic divisions and need for analysis of water budgets by subarea. Assess present level of hydrogeologic, climatologic, and water-use information and determine its suitability to describe ground-water-resource availability and degree of utilization, functioning of the hydrosystem, and stream-aquifer relations. Describe physical setting, physiography, climate, and hydrogeology. Describe hydraulic properties of aquifers and stream-aquifer relations. Summarize water use according to municipal, industrial, and agricultural categories by using data from other study elements and scopes of work, as available. Analyze streamflow data to determine baseflow (ground-water) component. Describe hydrologic processes governing ground- and surface-water flow on a conceptual level. Describe recharge, leakage, lateral inflow and outflow, and aquifer-storage mechanisms qualitatively in conceptual terms. Simulate ground-water-flow system in lower part of ACF River basin and describe flow-system response to stresses and boundary conditions. Compile quantitative estimates for volumetric rates of aquifer recharge and of ground and surface water entering and exiting each subarea. Simulate effects of natural and man-induced stress in southwestern Georgia and southeastern Alabama on surface-water flow to Apalachicola River and Apalachicola Bay. Simulate hydrologic conditions of low to high ground-water pumpage, dry and normal conditions of vertical leakage from source layers overlying the Upper Floridan aquifer or other water-bearing units represented by digital modeling and river stage corresponding to streamflow that is equaled or exceeded 98, 95, and 50 percent of the time. Determine change in aquifer discharge to streams (change in stream flow) resulting from simulation of these hydrologic conditions. Describe the availability and degree of utilization of ground-water resources, potential for using ground water in place of surface water, and effects of changing ground- and surface-water levels on ground-water availability. Using simulation results, where appropriate, assess potential for increased ground-water development.

Progress: Project planning documents developed for each of the four subareas received approval from the Technical Coordination Group of cooperators. Literature and data searches began to assess appropriateness of available data. Various methodologies were assessed to estimate ground-water contributions to streamflow and modifications were made to the computer program (RECESS) that estimates recharge to make the technique more useful for the study.

Streamflow recessions for most gaging stations in the study area were analyzed and specific recessions were selected for hydrograph separation for estimating recharge. Major droughts of record for the study area were identified and flow conditions defined for gaging stations and miscellaneous measurement sites in each subarea. Compilation of data for input into MODFE (Torak, 1992a,b), the ground-water-flow model used to analyze stream-aquifer relations in the lower ACF basin, has been completed. A generic annotated outline of reports for the subsreas has been prepared, introductory parts of the reports have been written, and preliminary lists of illustrations prepared.

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For those interested in forthcoming reports, subscription to the monthly catalog, "New Publications of the U.S. Geological Survey," is available free upon request to the U.S. Geological Survey, 582 National Center, Reston, VA 22092. Surface-water annual data reports may be purchased from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. The U.S. Government Printing Office also has limited publications available for sale.

Selected publications on water resources in Georgia by USGS and various Federal and State and local agencies; and private organizations are listed in the following section. For publications from other Federal, State, and local agencies; and private organizations, please contact the respective agency or organization. Many of the publications are available for inspection at the office of the U.S. Geological Survey, Atlanta, Ga., and at the larger public and university libraries.

GEORGIA DEPARTMENT OF NATURAL RESOURCES

GEORGIA GEOLOGIC SURVEY

Circular No. 1 is a complete list of Georgia Geologic Survey reports and may be obtained free upon request from the Georgia Geologic Survey. Reports of the Georgia Geologic Survey may be purchased at cost from the State Geologist, Georgia Geologic Survey, 19 Martin Luther King, Jr., Drive, S.W., Atlanta, GA 30334; or may be inspected in the office of the Georgia Geologic Survey.

GIS DATA BASES

GIS data bases are available in ARC/INFO format and may be purchased at cost from the State Geologist, Georgia Geologic Survey (address above) on 4 x 6 inch-150 Megabyte cartridge Note that ARC/INFO is a GIS software developed by the ESRI Corporation, Redlands, Calif.

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