GROUND-WATER QUALITY IN GEORGIA FOR 1990

by

Sandra Jo Robertson

DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

CIRCULAR 12G

GROUND-WATER QUALITY IN GEORGIA FOR 1990

SANDRA JO ROBERTSON
GROUND-WATER MANAGEMENT PROGRAM

The preparation of this report was financed in part through a grant from the U.S. Environmental Protection Agency under the provisions of Section 106 of the Federal Water Pollution Control Act of 1972, as amended.

GEORGIA DEPARTMENT OF NATURAL RESOURCES
JOE D. TANNER, COMMISSIONER

ENVIRONMENTAL PROTECTION DIVISION
HAROLD F. REHEIS, DIRECTOR

GEORGIA GEOLOGIC SURVEY
WILLIAM H. McLEMORE, STATE GEOLOGIST

ATLANTA
1992

CIRCULAR 12G

TABLE OF CONTENTS

FIGURES

Tables

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report for calendar year 1990 is the seventh annual summary of ground-water quality in Georgia. These evaluations are one of the tools used by the Georgia Environmental Protection Division (EPD) to assess trends in the quality of the State's ground-water resources. EPD is the State organization with regulatory responsibility for maintaining and, where possible, improving ground-water quality and availability. Four components constitute EPD's ground-water quality assessment program. These components include:

1. The Georgia Ground-Water Monitoring Network. This program is maintained by the Geologic Survey Branch of EPD, and is designed to evaluate the ambient ground-water quality of ten aquifer systems throughout the State of Georgia. The data presented in this report were provided by this program.

2. Sampling of public drinking water wells as a part of the Safe Drinking Water Program (Water Resources Management Branch). This program provides data on the quality of ground water that is being used by the residents of Georgia.

3. Special studies that are conducted in order to address specific water quality issues. An ongoing survey of nitrite/nitrate levels in shallow wells located throughout the State of Georgia (currently being conducted by the Geologic Survey Branch) and the development of a Pesticide Monitoring Network (currently being conducted by the Geologic Survey Branch in conjunction with the Department of Agriculture) are examples of this type of study.

4. Sampling of ground water at environmental facilities such as municipal solid waste landfills, RCRA facilities, sludge disposal facilities, etc. EPD's Land Protection, Hazardous Waste Management and Water Protection Branches have the primary responsibility for monitoring these facilities.

Analyses of water samples collected for the Georgia Ground-Water Monitoring Network during calendar year 1990 and from previous years are the data base for this summary. The Georgia Geologic Survey Ground-Water Monitoring Network is comprised of 162 wells and springs which are monitored on a bi-annual, annual or semi-annual basis. Due to a delay of funding from EPA, representative water samples were collected from 89 wells and springs in 1990. The remainder of the wells previously scheduled to be sampled in 1990 will be sampled in 1991 when funds become available. A review of the 1990 data, and comparison of these data with analyses of samples collected as early as 1984, indicates that ground-water quality at most of the 89 sampling sites generally has changed little and remains excellent.

1.2 GROUND-WATER QUALITY CONTROLS

The quality of water from a well is the end result of complex physical and biochemical processes. Some of the more significant controls are the quality and chemistry of the water entering the ground-water flow system, the reactions of infiltrating water with the soils and rocks that are encountered, and the effects of the well and pump system.

Most water enters the ground-water system in upland recharge areas. Water seeps through interconnected pores and joints in the soils and rocks until it is discharged to a surface-water body (e.g., stream, river, lake or ocean). The chemistry and amount of recharging water and the attenuation capacity of soils have a strong influence on the quality of ground water in recharge areas. Chemical interaction of water with the aquifer host rocks has an increasing significance with longer underground residence times. As a result, ground water from discharge areas tends to be more highly mineralized than ground water in recharge areas.

The well and pump system can have a strong influence on the quality of the well water. Well casings can contribute metals (e.g., iron from steel casings) and organic compounds (e.g., tetrahydrofuran from PVC pipe cement) to the water. Pumps often aerate the water being discharged. Improperly constructed wells, on the other hand, can present a conduit for local pollution to enter the ground-water flow system.

1.3 HYDROGEOLOGIC PROVINCES OF GEORGIA

Three hydrogeologic provinces in Georgia are defined by their general geologic and hydrologic characteristics (Figure 1-1). These provinces include:

1. The Coastal Plain Province of south Georgia
2. The Piedmont and Blue Ridge Provinces, which include all but the northwest corner of northern Georgia
3. The Valley and Ridge Province of northwest Georgia

Each of these provinces is described in greater detail below.

1.3.1 Coastal Plain Province

Georgia's Coastal Plain Province is composed of a wedge of loosely consolidated sediments that gently dip and thicken to the south and southeast. Ground water in the Coastal Plain Province flows through interconnected pore space between grains in the host rocks and through solution-enlarged voids. The oldest outcropping sedimentary formations (Cretaceous) are exposed along the Fall Line, which is the northern limit of the Coastal Plain Province. Successively younger formations occur at the surface to the south and southeast.

The Coastal Plain contains the State's major confined (artesian) aquifers. Confined aquifers are those which are overlain by a layer of impermeable material (e.g., clay or shale) and contain water at greater-than-atmospheric pressures. Water enters the aquifers in their up-dip outcrop areas where the permeable rocks of the aquifer are exposed. Many of the Coastal Plain aquifers are unconfined in their up-dip outcrop areas, but become confined in down-dip areas to the southeast, where they are overlain by successively younger rock formations. Ground-water flow through confined Coastal Plain aquifers is generally to the south and southeast, in the direction of dip of the rocks.

Rocks forming the seven major confined aquifers in the Coastal Plain range in age from Cretaceous to Miocene. Horizontal and vertical changes in the permeability of the rock units that form these aquifers and the quality of ground water they contain determine the thickness and extent of the aquifers. Several aquifers may be present in a single geographic area, forming a vertical 'stack'.

Figure 1-1. - The three hydrogeologic provinces of Georgia

The Cretaceous and Jacksonian aquifer systems (primarily sands) are a common source of drinking water within a 35-mile wide band that lies adjacent to and south of the Fall Line. Southwestern Georgia relies on four vertically stacked aquifers (sands and carbonates) for drinking-water supplies: the Providence, Clayton, Claiborne and Floridan aquifer systems. A large area of south-central and southeastern Georgia is served by the Floridan aquifer system (primarily carbonates). The Miocene aquifer system (sands and carbonates) is the principal 'shallow' unconfined aquifer system, becoming confined in the coastal counties, occurring in the broad area underlain by the Floridan aquifer system.

1.3.2 Piedmont and Blue Ridge Provinces

Crystalline rocks of metamorphic and igneous origin (primarily Precambrian and Paleozoic in age) underlie the Piedmont and Blue Ridge Provinces. These two provinces differ geologically, but are discussed together here because they share common hydrologic properties. The principal water-bearing features are fractures, compositional layers and other geologic discontinuities in the rock, as well as intergranular porosity in the overlying soil and saprolite horizons. Thick soils and saprolites are often important as the 'reservoir' that supplies water to the water-bearing fracture and joint systems. Ground-water typically flows from local highlands towards discharge areas along streams. However, during prolonged dry periods or in the vicinity of heavy pumpage, ground water may flow from the streams into the fracture and joint systems.

1.3.3 Valley and Ridge Province

The Valley and Ridge Province is underlain by consolidated Paleozoic sedimentary formations. The permeable features of the Valley and Ridge Province are principally fractures and solution voids; intergranular porosity also is important in some places. Ground-water and surface-water systems are locally closely interconnected. Dolostones and limestones of the Knox Group are the principal aquifers where they occur in the axes of broad valleys. The greater permeabilities of the thick carbonate sections in this Province, in part due to solution-enlarged joints, permit development of more extensive aquifer systems than in the Piedmont and Blue Ridge Province.

1.4 REGIONAL GROUND-WATER QUALITY PROBLEMS

Data from ground-water investigations in Georgia, including the Ground-Water Monitoring Network, indicate that virtually all of Georgia has shallow ground water sufficient for domestic supply. Iron and manganese are the only constituents that occur routinely in concentrations exceeding drinking-water standards. These two naturally-occurring metals can cause staining of objects, but do not pose a health risk.

Only a few occurrences of polluted or contaminated ground waters are known from north Georgia (Table 4-1). Aquifers in the outcrop areas of Cretaceous sediments south of the Fall Line typically yield acidic water that may require treatment. The acidity occurs naturally, and results from the inability of the sandy aquifer sediments to buffer acidic rainwater and acid-producing reactions between infiltrating water and soils and sediments. Nitrite/nitrate concentrations in ground water from the farm belt southeastern Georgia are within drinking-water standards, but are somewhat higher than levels found in other areas of the State.

The Floridan aquifer system includes two areas of naturally-occurring reduced ground-water quality in addition to its karstic plain in southwestern Georgia. The Gulf Trough, a narrow, linear geologic feature extending from southwestern Decatur County through central Bulloch County, typically yields water with high total dissolved solids concentrations. Elevated levels of barium, sulfate and radionuclides have been reported in ground water from the Gulf Trough. High levels of total dissolved solids also are common to the lower section of the Floridan aquifer system along the Georgia coast. Ground-water withdrawals have allowed upconing of brine from deeper parts of the aquifer in the Brunswick area.

2.0 GEORGIA GROUND-WATER MONITORING NETWORK

2.1 MONITORING STATIONS

Stations of the 1990 Ground-Water Monitoring Network include five major aquifer systems of the Coastal Plain Province and unconfined ground-water systems of the Piedmont and Blue Ridge Provinces and the Valley and Ridge Province (Table 2-1). Monitoring stations are located in three critical settings:

1. areas of surface recharge,
2. other areas of potential pollution related to regional activities (agricultural and industrial areas) and
3. areas of significant ground-water use.

The majority of monitoring stations are municipal, industrial and domestic wells that have reliable well-construction data. Many of the monitoring stations that are located in recharge areas are sampled more than once a year in order to more closely monitor changes in water quality. The Monitoring Network also includes monitoring wells in specific areas where the State's aquifers are recognized to be susceptible to contamination or pollution (e.g., the Dougherty Plain of southwestern Georgia and the State's coastal area). These monitoring wells are maintained jointly by the Geologic Survey Branch and the United States Geological Survey.

EPD's concern over pesticides in ground water warranted the addition of 22 shallow wells as monitoring stations and an expanded pesticides analysis program for samples from two other Monitoring Network wells since 1988. The increased number of monitoring stations necessitated a reduction in the frequency of sample collection from some of the other Monitoring Network wells, especially those located in confined aquifers of south-central and coastal Georgia.

2.2 USES AND LIMITATIONS

Regular sampling of wells and springs of the Ground-Water Monitoring Network permits analysis of ground-water quality with respect

Table 2-1. - Georgia Ground-Water Monitoring Network, 1990

AQUIFER SYSTEM	NUMBER OF MONITORING STATIONS	PRIMARY STRATIGRAPHIC EQUIVALENTS	AGE OF AQUIFER FORMATIONS
Cretaceous	20 (11 sampled in 1990)	Ripley Formation, Cusseta Sand, Blufftown Formation, Eutaw Formation, and Tuscaloosa Formation	Late Cretaceous
Providence	4 (0 sampled in 1990)	Providence Sand	Late Cretaceous
Clayton	7 (6 sampled in 1990)	Clayton Formation	Paleocene
Claiborne	9 (0 sampled in 1990)	Tallahatta Formation	Middle Eocene
Jacksonian	10 (7 sampled in 1990)	Barnwell Group	Late Eocene
Floridan	58 (30 sampled in 1990)	Suwannee Limestone, Ocala Group, Bridgeboro Limestone and Claibornian Carbonates	Middle Eocene to Oligocene
Miocene	15 (11 sampled in 1990)	Altamaha Formation and Hawthorne Group	Miocene
Piedmont	18 (12 sampled in 1990)	New Georgia Group, Sandy Springs Group, Laura Lake Mafic Complex, Austell Gneiss, Sand Hill Gneiss, Mulberry Rock Gneiss, Atlanta Group and Lithonia Gneiss	Predominately Paleozoic and Precambrian
Blue Ridge	4 (3 sampled in 1990)	Corbin Gneiss Complex, Snowbird Group, Walden Creek Group, Great Smoky Group and Murphy Marble Belt Group	Predominately Paleozoic and Precambrian
Valley and Ridge	9 (9 sampled in 1990)	Shady Dolomite, Knox Group, and Chickamauga Group	Paleozoic, mostly Cambrian and Ordovician

to location (spatial trends) and with respect to the time of sample collection (temporal trends). Spatial trends are useful for assessing the effects of the geologic framework of the aquifer and regional land-use activities on ground-water quality. Temporal trends permit an assessment of the effects of rainfall and drought periods on ground-water quantity and quality. Both trends are useful for the detection of non-point source pollution. Examples of non-point source pollution include acid rain and regional land-use activities (for example, application of agricultural chemicals on crop lands).

It should be noted that the data of the Ground-Water Monitoring Network are representative of water quality in only limited areas of the State. Monitoring water quality at 89 sites located throughout the State provides an indication of ground-water quality at the localities sampled and at depths corresponding to the screened interval in the well at each station in the Monitoring Network. Caution should be exercised in drawing broad conclusions and applying any results reported in this study to ground waters that are not being monitored.

Wells of the Ground-Water Monitoring Network are intentionally located away from known point sources of pollution. The wells provide baseline data on ambient water quality in Georgia. EPD requires other forms of ground-water monitoring for activities that may result in point source pollution (e.g., landfills, hazardous waste facilities and land application sites) through its environmental facilities permit programs.

Ground-water quality changes gradually and predictably in the areally extensive aquifers of the Coastal Plain Province. The Monitoring Network allows for some definition of the chemical processes occurring in large confined aquifers. Unconfined aquifers in northern Georgia and the surface recharge areas of southern Georgia are comparatively small and more open to interactions with land-use activities. The wider spacing of monitoring stations does not permit equal characterization of water-quality processes in all of these settings. The quality of water from monitoring wells completed in unconfined north Georgia aquifers represents only the general nature of ground water in the vicinity of the monitoring wells. In contrast, ground water from monitoring wells located in surface recharge areas of Georgia Coastal Plain aquifers may more closely reflect the general quality of water that has entered these aquifers. Ground water in the recharge areas of the Coastal Plain aquifers is the future drinking-water resource for down-flow areas. Monitoring wells in these recharge areas, in effect, constitute an early warning system for potential future water quality problems in confined portions of the Coastal Plain aquifers.

2.3 ANALYSES

Analyses are available for 103 water samples collected during 1990 from 86 wells and three springs. Annual analyses of water samples from 28 of the wells span seven years with the addition of the 1990 data. For 1984, the first year of the Ground-Water Monitoring Network, hydrogeologists sampled water from 39 wells located in the Piedmont, Blue Ridge, and Coastal Plain Provinces. Nine of these wells have been sampled each year since 1984. Water samples were collected state-wide from 84 wells and three springs in 1985, 25 wells and three springs in 1986, 123 wells and three springs in 1987, 112 wells and three springs in 1988 and 137 wells and three springs in 1989.

Ground water from all monitoring stations is tested for the basic water quality parameters included in the Monitoring Network's standard analysis. The standard parameters include pH, specific conductivity, chloride, sulfate, nitrite/nitrate, chlorinated pesticides (Organics Screen #2), phenoxy herbicides (Organics Screen #4) and thirty metals (Appendix, Table A-1). Where regional land-use activities have the potential to affect ground-water quality in the vicinity of a monitoring station, additional parameters are tested. These additional chemical screens are listed in the Appendix (Tables A-2, A-3, and A-4). Tables 2-2a and 2-2b summarize the significance of the common major constituents of a water-quality analysis.

The Drinking Water Program of the Georgia Environmental Protection Division has established Maximum Contaminant Levels (MCLs) for some of the parameters that are included in the analyses performed on Ground-Water Monitoring Network samples. Primary Maximum Contaminant Levels are established for parameters that may have adverse effects on the public health when the Primary MCLs are exceeded. Secondary Maximum Contaminant Levels are established for parameters that may give drinking water an objectionable odor or color, and consequently cause persons served by public water systems to discontinue its use. The Primary and Secondary

MCLs for Ground Water Monitoring Network parameters are given in the Appendix.

Table 2-2a. - The significance of parameters of a basic water quality analysis, cations (Wait, 1960)

PARAMETER(S)	SIGNIFICANCE
pH (Hydrogen ion concentration)	pH is a measure of the concentration of the hydrogen ion. Values of pH less than 7.0 denote acidity and values greater than 7.0 indicate alkalinity. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals. A pH range between 6.0 and 8.5 is considered acceptable.
Calcium and magnesium *	Calcium and magnesium cause most of the hardness of water. Hard water consumes soap before a lather will form and deposits scale in boilers, water heaters and pipes. Hardness is reported in terms of equivalent calcium carbonate. The hardness of a water can be estimated by the sum of multiplying the parts per million of calcium by 2.5 and that of magnesium by 4.1. Water Class — Hardness (parts per million) Soft — Less than 60 Moderately Hard — 60 to 120 Hard — 121 to 180 Very Hard — More than 180
Sodium and potassium *	Sodium and potassium have little effect on the use of water for most domestic purposes. Large amounts give a salty taste when combined with chloride. A high sodium content may limit the use of water for irrigation.
Iron and manganese	More than 300 parts per billion of iron stains objects red or reddish brown and more than 50 parts per billion of manganese stains objects black. Larger quantities cause unpleasant taste and favor growth of iron bacteria but do not endanger health.

*Major alkali metals present in most ground waters.

Table 2-2b - The significance of parameters of a basic water quality analysis, anions (Wait, 1960)

PARAMETER(S)	SIGNIFICANCE
Chloride	Chloride salts in excess of 100 parts per million give a salty taste to water. Large quantities make the water corrosive. Water that contains excessive amounts of chloride is not suitable for irrigation. It is recommended that chloride content should not exceed 250 parts per million.
Nitrite/nitrate	Concentrations much greater than the local average may suggest pollution. Excessive amounts of nitrogen in drinking or formula water of infants may cause a type of methemoglobinemia ("blue babies"). Nitrite/nitrate in concentrations greater than 10 parts per million (as nitrogen) is considered to be a health hazard.
Sulfate	Sulfate in hard water increases the formation of scale in boilers. In large amounts, sulfate in combination with other ions imparts a bitter taste to water. Concentrations above 250 parts per million have a laxative effect, but 500 parts per million is considered safe.

In-place pumps are used whenever possible to purge wells and collect water samples. Using these pumps minimizes the potential for cross-contamination of wells. Some wells that are included in the Ground-Water Monitoring Network are continuous water-level monitoring stations and do not have dedicated pumps.

Sampling procedures are adapted from techniques used by the U.S. Geological Survey and the U.S. Environmental Protection Agency. Hydrogeologists purge the wells (3 to 5 volumes of the well column) prior to the collection of a sample to minimize the influence of the well, pump and distribution system on water quality. Municipal, industrial and domestic wells typically require 45 minutes of purging prior to sample collection. Wells without dedicated pumps often require much longer periods of purging.

Hydrogeologists monitor water quality parameters prior to sample collection. Measurements of pH, dissolved oxygen content, specific conductivity, temperature and ionic potential are observed using field instruments. The instruments are mounted in a manifold that captures flow at the pump system discharge point before the water is exposed to atmospheric conditions. Typical trends include a lowering of pH, dissolved oxygen content and specific conductivity, and a transition towards the mean annual air temperature with increased purging time. The hydraulic flow characteristics of unconfined aquifers and pump effects often alter these trends.

Samples are collected once the parameters being monitored in the field stabilize or otherwise indicate that the effects of the well have been minimized. Files at the Georgia Geologic Survey contain records of the field measurements. The sample bottles are filled and then immediately placed in an ice water bath to preserve the water quality. After one to two hours, the bottles are transferred to a dry cooler refrigerated with an ice tray. The hydrogeologists then transport the samples to the laboratories for analysis on or before the Friday of the week in which they are collected. EPD laboratories in Atlanta perform all analyses except for organic chemical screens 1, 2, 3, 4, 5, and 7 (Appendix, Tables A-1 and A-2). The Agricultural Services Laboratory at the University of Georgia in Athens performs these organic screens.

3.0 GROUND-WATER QUALITY IN GEORGIA - 1990

3.1 OVERVIEW

Georgia's ten major aquifer systems are grouped into three hydrogeologic provinces for the purposes of this report.

The Coastal Plain Province is comprised of seven major aquifers that are restricted to specific regions and depths within the Coastal Plain because of their aquifer geometry (Figure 3-1). These major aquifer systems, in many cases, incorporate smaller aquifers that are locally confined. Monitoring wells in the Coastal Plain aquifers are generally located in three settings:

1. Recharge (or outcrop) areas, which are located in regions that are geologically up-dip and generally to the north of confined portions of these aquifers.
2. Up-dip, confined areas, which are located in regions that are proximal to the recharge areas, yet are confined by overlying geologic formations. These areas are generally south to southeast of the recharge areas.
3. Down-dip, confined areas, located to the south and southeast in the deeper, confined portions of the aquifers distal to the recharge areas.

The two major hydrogeologic provinces of north Georgia, the Piedmont/Blue Ridge Province and the Valley and Ridge Province, are characterized by smaller-scale and localized ground-water flow patterns. Deeper regional flow systems are unknown in northern Georgia. Ground-water flow in the Piedmont/Blue Ridge Province is generally controlled by geologic discontinuities (such as fractures) and compositional changes within the aquifer. Local physiographic features, such as hills and valleys, influence local ground-water flow patterns. Many of the factors controlling ground-water flow in the Piedmont/Blue Ridge Province are also present in the Valley and Ridge Province. In addition, widespread development of karst features may significantly enhance porosity and permeability in localized areas, and exert a strong influence on local ground-water flow patterns.

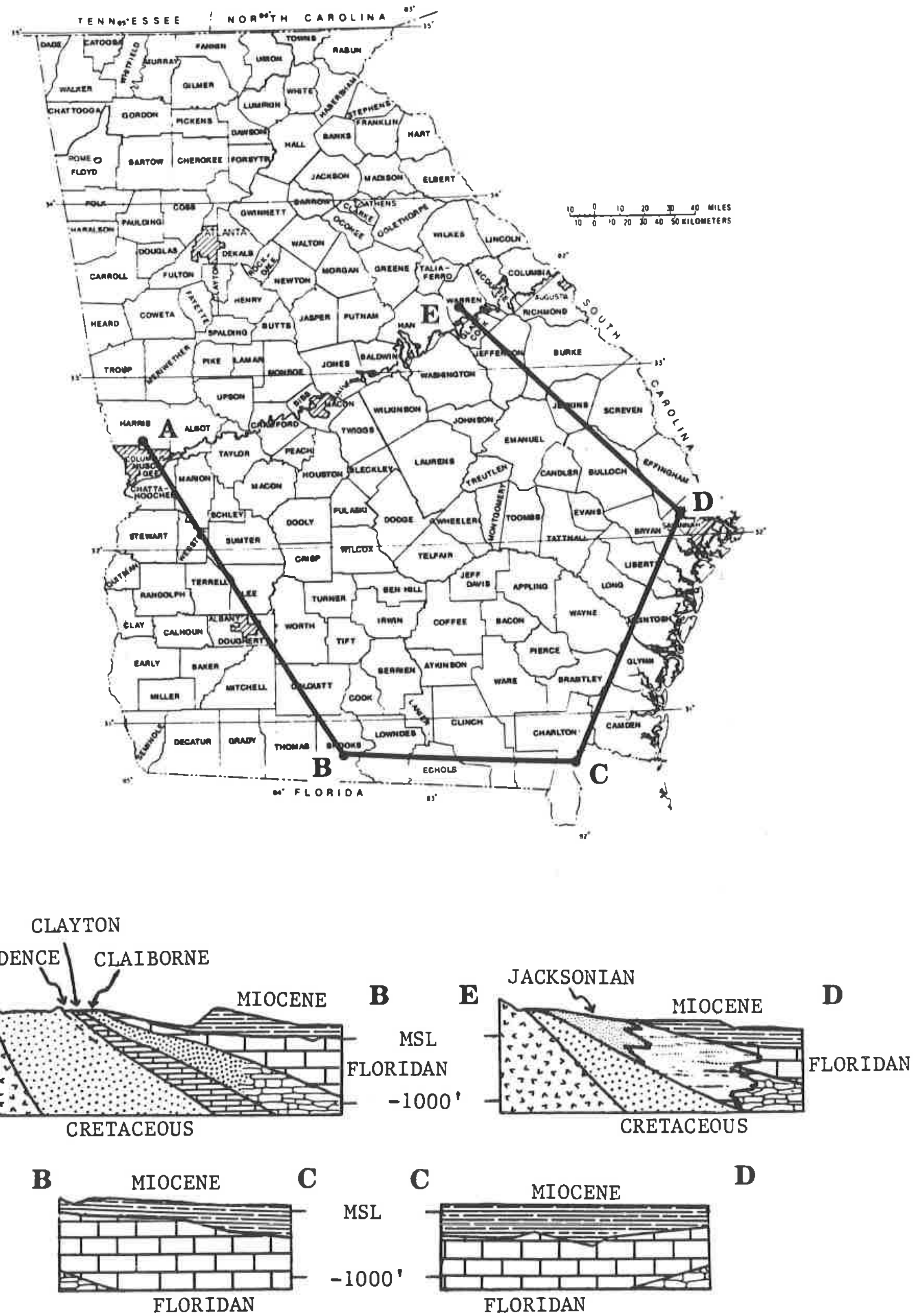


Figure 3-1. - The seven major aquifer systems of the Coastal Plain Province

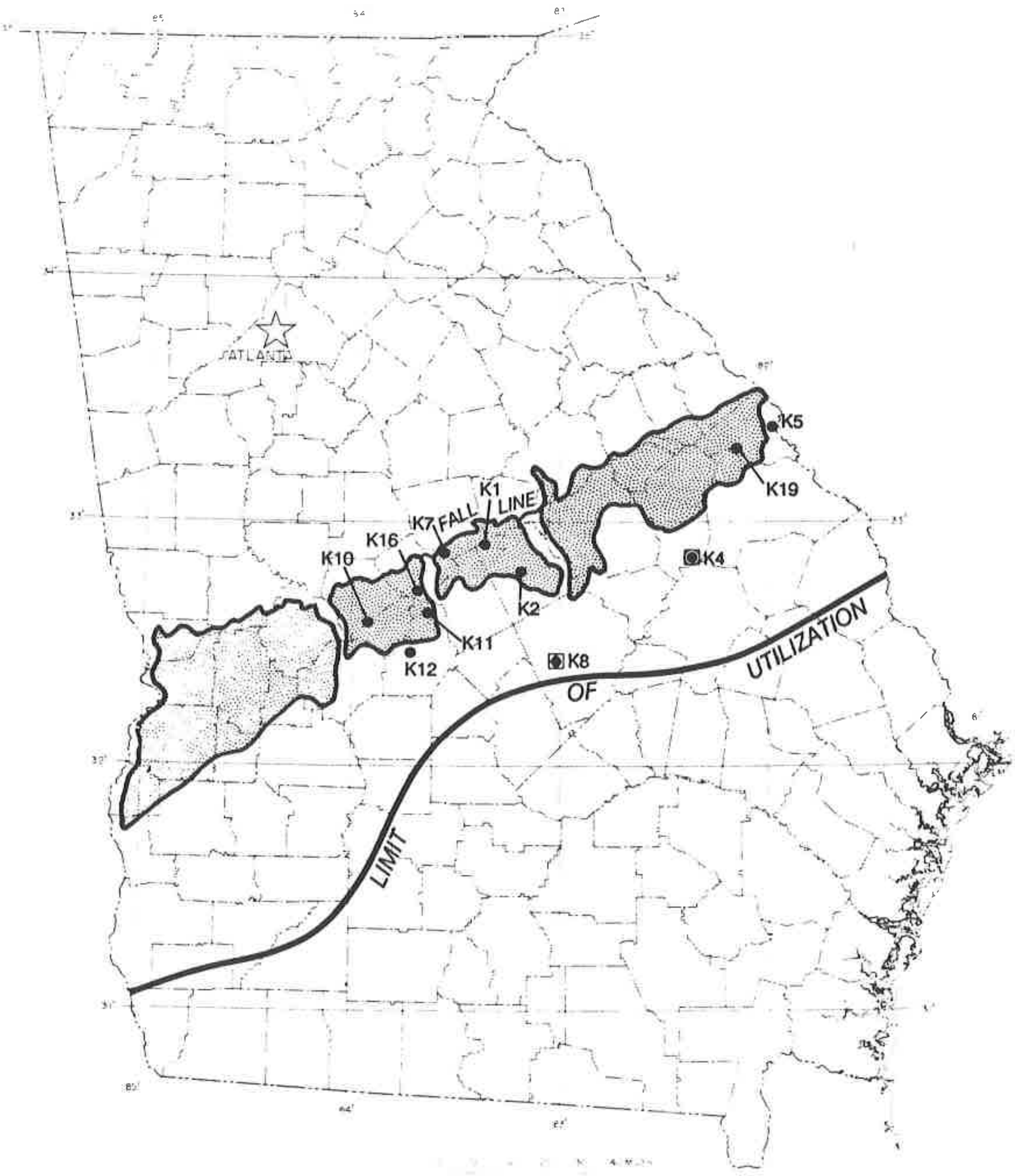
3.2 CRETACEOUS AQUIFER SYSTEM

The Cretaceous aquifer system is a complexly interconnected group of aquifer subsystems consisting of the Late Cretaceous sands of the Coastal Plain Province. These sands crop out in an extensive recharge area immediately south of the Fall Line in west and central Georgia (Figure 3-2). Overlying sediments restrict Cretaceous outcrops to valley bottoms in parts of the northeastern Coastal Plain. Five distinct subsystems of the Cretaceous aquifer system, including the Providence aquifer system, are recognized west of the Ocmulgee River (Pollard and Vorhis, 1980). These merge into three subsystems to the east (Clarke, et al., 1985). Aquifer sands thicken southward from the Fall Line, where they pinch out against crystalline Piedmont rocks, to a sequence of sand and clay approximately 2,000 feet thick at the southern limits of the main aquifer-use area. Leakage from adjacent members of the aquifer system provides significant recharge in down-dip areas.

Water quality of the Cretaceous aquifer system, excluding the Providence aquifer system (discussed separately in this report), was monitored in eleven wells. All of these wells are located in up-dip areas in or adjacent to outcrop and surface recharge areas for the Cretaceous aquifer system. No down-dip wells were sampled during 1990.

Water from the wells in the up-dip area was typically acidic, to the point of being corrosive, and soft. Iron and manganese concentrations were generally low, although one well in Burke County yielded water containing 4 parts per million iron and one well in Laurens County yielded water containing 2.5 parts per million. The State Secondary Maximum Contaminant Level (MCL) for iron is 0.3 parts per million. Concentrations of major alkali metals (calcium, magnesium, potassium and sodium) were generally either low or below detection limits. Other trace metals (aluminum, strontium and zinc) were present in minor amounts. One well in Wilkinson County showed a trace of trichloroethylene and chloroform.

Chloride and sulfate levels were low (less than 3.7 parts per million chloride and 16.5 parts per million sulfate) in all of the samples collected. Water samples from six of the wells contained detectable levels of nitrite/nitrate. The highest value, 1.2 parts per million, was measured in a sample from one well (GWN-K10) in Peach



□ Iron concentrations exceed drinking-water limits
▢ Iron and manganese concentrations exceed drinking-water limits
♦ Very hard water
● Soft water
General recharge area (from Davis, et al., 1988)

Figure 3-2. - Water quality of the Cretaceous aquifer system

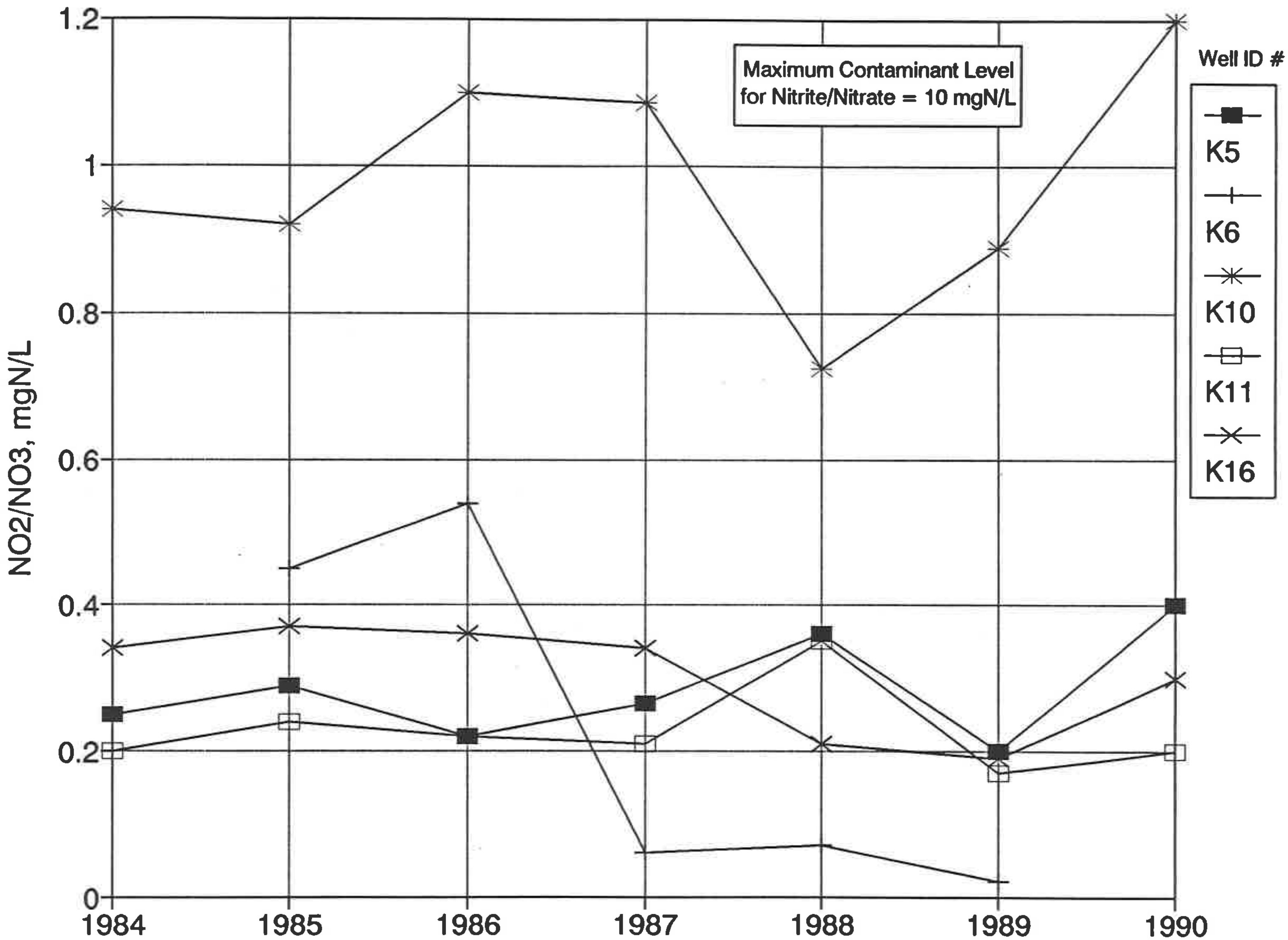


Figure 3-3. - Nitrite/nitrate concentrations in selected wells in the Cretaceous aquifer system

County. Figure 3-3 shows trends in levels of combined nitrite/nitrate (reported as parts per million nitrogen) for wells that have historically yielded water with detectable nitrite/nitrate levels. The majority of these wells show an overall decrease in nitrite/nitrate levels when compared to previous years, one up-dip well (GWN K-5) showed a slight increase.

3.3 PROVIDENCE AQUIFER SYSTEM

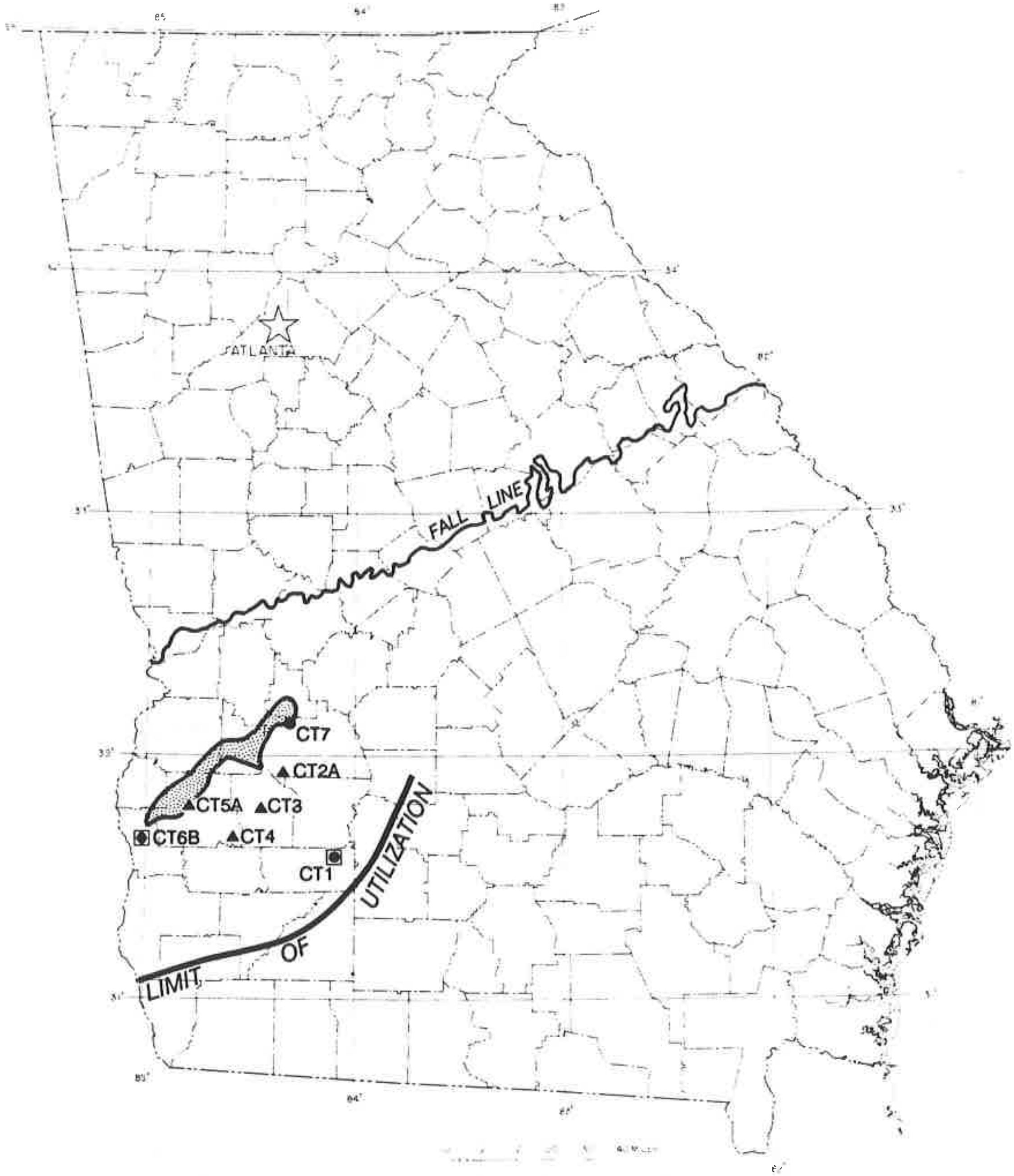
Sand and coquinoid limestone of the Late Cretaceous Providence Formation comprise the Providence aquifer system of southwestern Georgia. Outcrops of the aquifer system extend from northern Clay and Quitman Counties through eastern Houston County. In its up-dip extent, the aquifer system thickens both to the east and to the west of a broad area adjacent to the Flint River. Areas where the thickness of the Providence exceeds 300 feet are known in Pulaski County, and similar thicknesses have been projected in the vicinity of Baker, Calhoun and Early Counties (Clarke, et al., 1983).

The permeable Providence Formation-Clayton Formation interval forms a single aquifer east of the Flint River (Clarke, et al., 1983). This same interval is recognized as the Dublin aquifer system to the east of the Ocmulgee River (Clarke, et al., 1985). Outcrop areas and adjacent covered areas to the east of the Flint River, where the aquifer is overlain by permeable sand units, are surface recharge areas. The Chattahoochee River forms the western discharge boundary for this flow system in Georgia.

Water quality in the Providence aquifer system was not monitored during 1990.

3.4 CLAYTON AQUIFER SYSTEM

The Clayton aquifer system of southwestern Georgia is developed in the middle limestone unit of the Paleocene Clayton Formation. Limestones and calcareous sands of the Clayton aquifer system crop out in a narrow belt extending from northeastern Clay County to southwestern Schley County (Figure 3-4). Aquifer thickness varies irregularly, ranging from 50 feet near outcrop areas to 265 feet in southeastern Mitchell County



□ Iron concentrations exceed drinking-water limits
▢ Iron and manganese concentrations exceed drinking-water limits
● Soft water
▲ Moderately hard water
■ Hard water
♦ Very hard water
General recharge area (from Davis, et al., 1988)

Figure 3-4. - Water quality of the Clayton aquifer system

(Clarke, et al., 1984). Both the Flint River, to the east, and the Chattahoochee River, to the west, are areas of discharge for the aquifer system in its up-dip extent. Leakage from the underlying Providence aquifer system and the overlying Wilcox confining zone is significant in down-dip areas (Clarke, et al., 1984). The Clayton Formation and Providence Formation merge to form a single aquifer unit in up-dip areas (Long, 1989). In areas east of the Ocmulgee River, the combination of these two aquifers is referred to as the Dublin aquifer system (Clarke, et al., 1985).

Seven wells were used to monitor water quality of the Clayton aquifer system. These sample stations were located in confined, up-dip areas of the Clayton aquifer.

Six of the water samples were slightly basic and non-corrosive. One well in Sumpter County (GWN-CT-7) sampled acidic at 4.7 standard pH units. The water samples from were moderately hard to hard with the exception of GWN-CT-7 which sampled soft. Manganese levels in the western most well (GWN-CT-6B) have decreased over the last four years. Concentrations of iron in the same well for the same period have also decreased, but remain above Secondary Maximum Contamination levels considered acceptable for public drinking water. Trace amounts of aluminum, barium, bismuth, copper, fluorine, strontium, and zinc were detected along with the major alkali metals.

Chloride content was uniformly low, less than 8.6 parts per million, in all samples. Sulfate levels were less than 16.2 parts per million in the water from all sample stations except for the western most well GWN-CT-6, which measured 49.8 parts per million, adjacent to the Chattahoochee River. Nitrite/nitrate concentrations were below detection limits in all 7 of the samples analyzed. The northeastern most well, GWN-CT-7, showed nitrate/nitrite concentration of 6.3 parts per million which is within acceptable drinking water standards.

3.5 CLAIBORNE AQUIFER SYSTEM

Sands of the Middle Eocene Claiborne Group are the primary members of the Claiborne aquifer system of southwestern Georgia. Claiborne Group sands crop out in a belt extending from northern Early County through western Dooly County. Limited recharge may be derived down-dip in the vicinity of Albany in Dougherty County by leakage from the overlying Floridan aquifer system (Hicks, et al., 1981). Discharge boundaries of the aquifer system are the Ocmulgee River, to the east, and the Chattahoochee River, to the west.

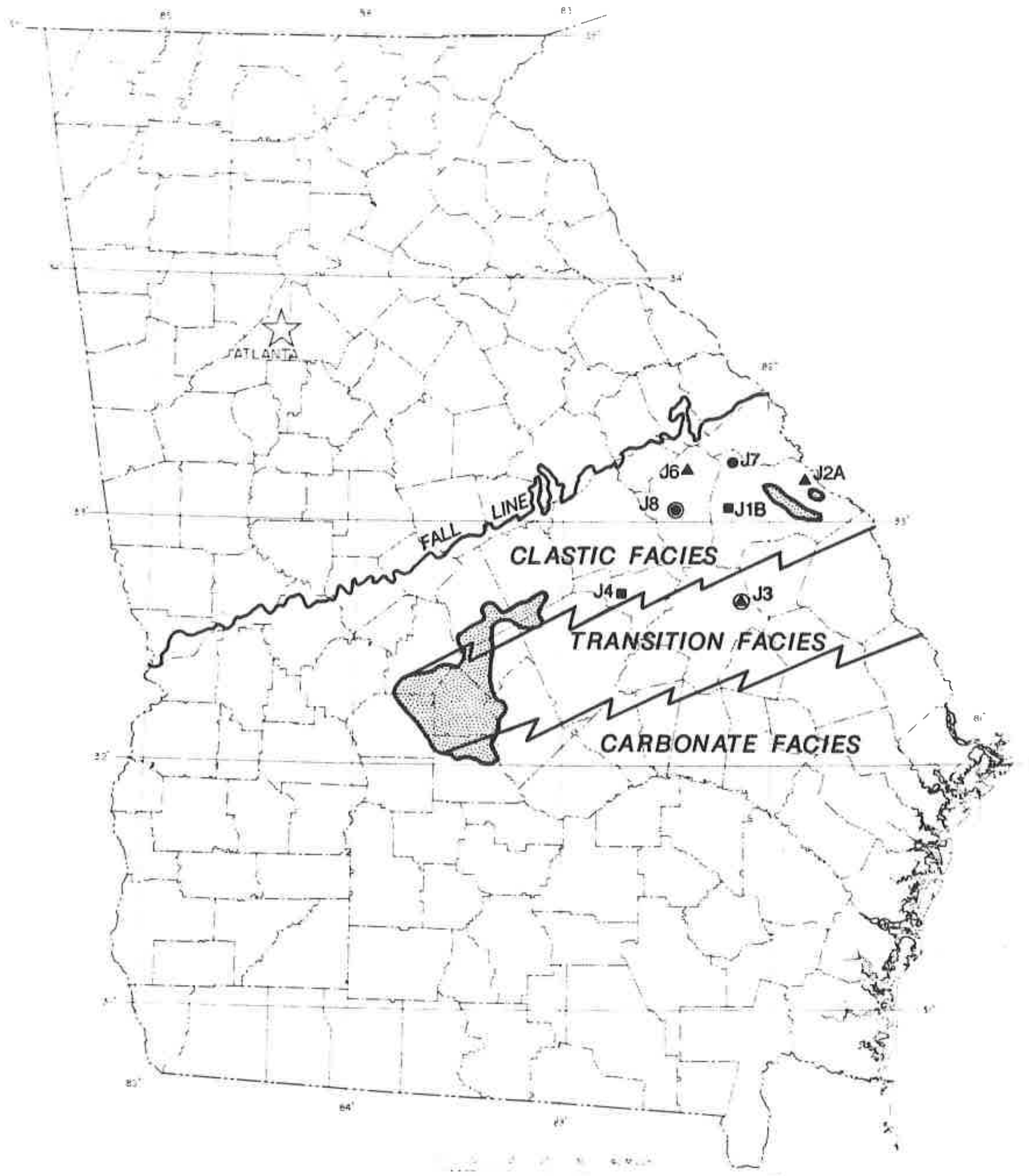
The aquifer generally thickens from the outcrop area towards the southeast, attaining a thickness of almost 300 feet in eastern Dougherty County. In down-dip areas where the Claiborne Group can be divided into the Lisbon Formation above and the Tallahatta Formation below, the Claiborne aquifer system is generally restricted to the Tallahatta Formation, and the Lisbon Formation acts as a confining unit that separates the Claiborne aquifer from the overlying Floridan aquifer (McFadden and Perriello, 1983; Long, 1989). The permeable Tallahatta unit is included in the Gordon aquifer system east of the Ocmulgee River (Brooks, et al., 1985).

Ground-water samples of the Claiborne aquifer system were not collected in 1990.

3.6 JACKSONIAN AQUIFER SYSTEM

The Jacksonian aquifer system of central and east-central Georgia is developed in sands of the Eocene Barnwell Group. Outcrops of sand and clay of the Barnwell Group extend from Macon and Peach Counties eastward to Burke and Richmond Counties (Figure 3-5). Aquifer sands form a northern clastic facies of the Barnwell Group and grade southward into less permeable silts and clays of a transition facies (Vincent, 1982). The water-bearing sands are relatively thin, generally ranging from ten to fifty feet in thickness. Limestones equivalent to the Barnwell Group form a southern carbonate facies and are included in the Floridan aquifer system. The Savannah River and Ocmulgee River are eastern and western discharge boundaries respectively for the up-dip flow system of the Jacksonian aquifer system.

Water quality in the Jacksonian aquifer system was monitored in six wells in the clastic facies and one well in the transition facies. Water from the aquifer system ranged from slightly basic to slightly acidic and varied from soft to hard. Iron levels in all samples were below the Secondary Maximum Contaminant Level for drinking water. Manganese exceeded drinking water limits in water from one transition-facies well



○ Manganese concentrations exceed drinking-water limits
● Soft water
▲ Moderately hard water
■ Hard water
♦ Very hard water
General recharge area (from Davis, et al., 1988)
Facies boundary (from Vincent, 1982)

Figure 3-5. - Water quality of the Jacksonian aquifer system

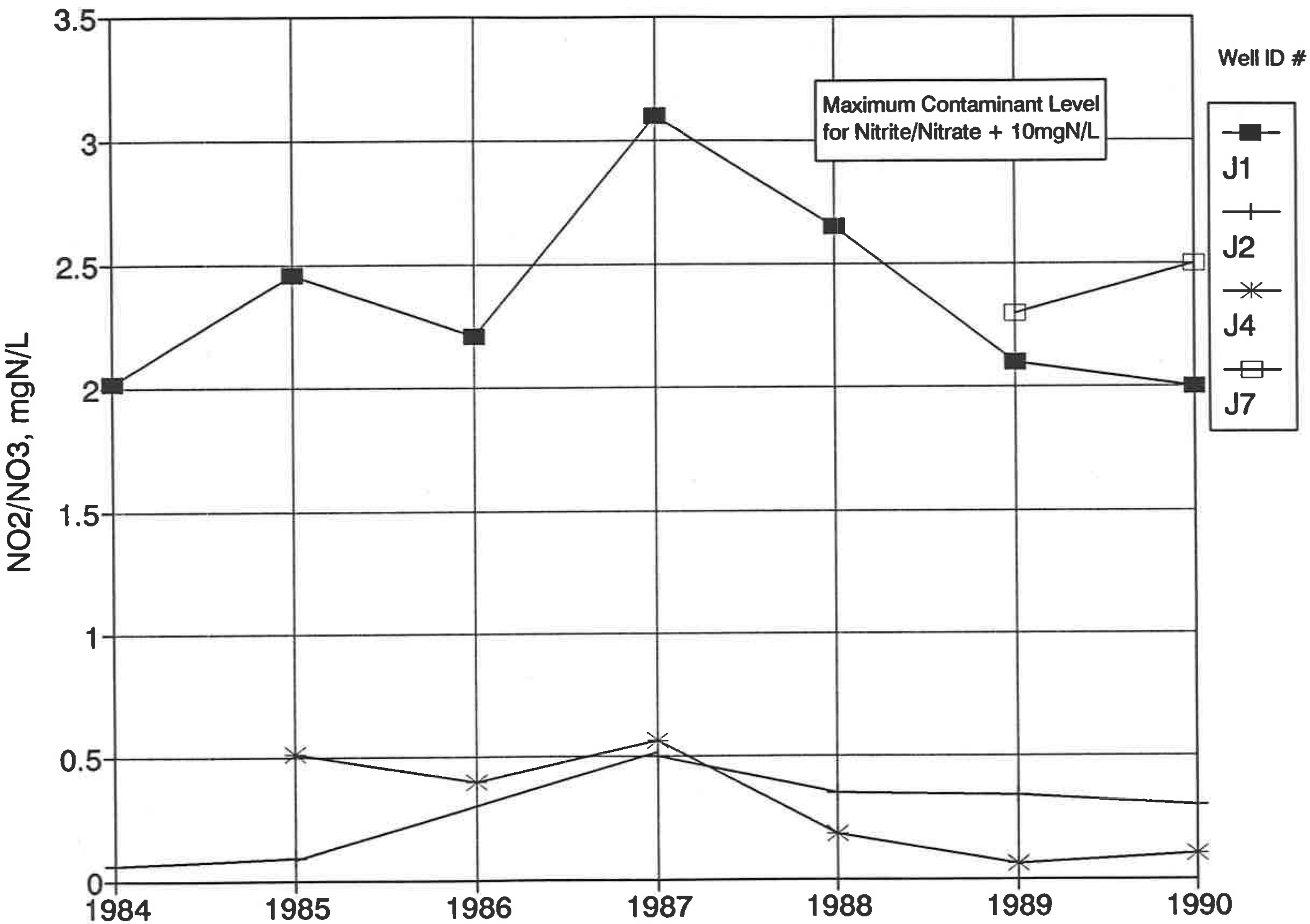


Figure 3-6. - Nitrite/nitrate concentrations in selected wells in the Jacksonian aquifer system

in Emanuel County and one clastic-facies well in Jefferson County. The major alkali metals and aluminum, barium, strontium and zinc were the other common cations.

Chloride and sulfate levels were 11 parts per million or less in all samples. Nitrite/nitrate concentrations ranged from below detection limits up to 2.7 parts per million in the water samples from six of the wells. One clastic-facies well in Jefferson County (GWN-J8) yielded water containing 8.4 parts per million nitrite/nitrate, the highest level yet measured from a Monitoring Network station in the Jacksonian aquifer. These concentrations are within the range of previous measurements from wells in the same area. Figure 3-6 summarizes trends in nitrite/nitrate levels for the Jacksonian aquifer.

3.7 FLORIDAN AQUIFER SYSTEM

The Floridan aquifer system, formerly known as the Principal Artesian aquifer system, consists of Eocene and Oligocene limestones and dolostones that underlie most of the Coastal Plain Province (Figure 3-1). Other units are included locally in the aquifer. The aquifer is a major source of ground water for much of its outcrop area and throughout its down-dip extent to the south and east.

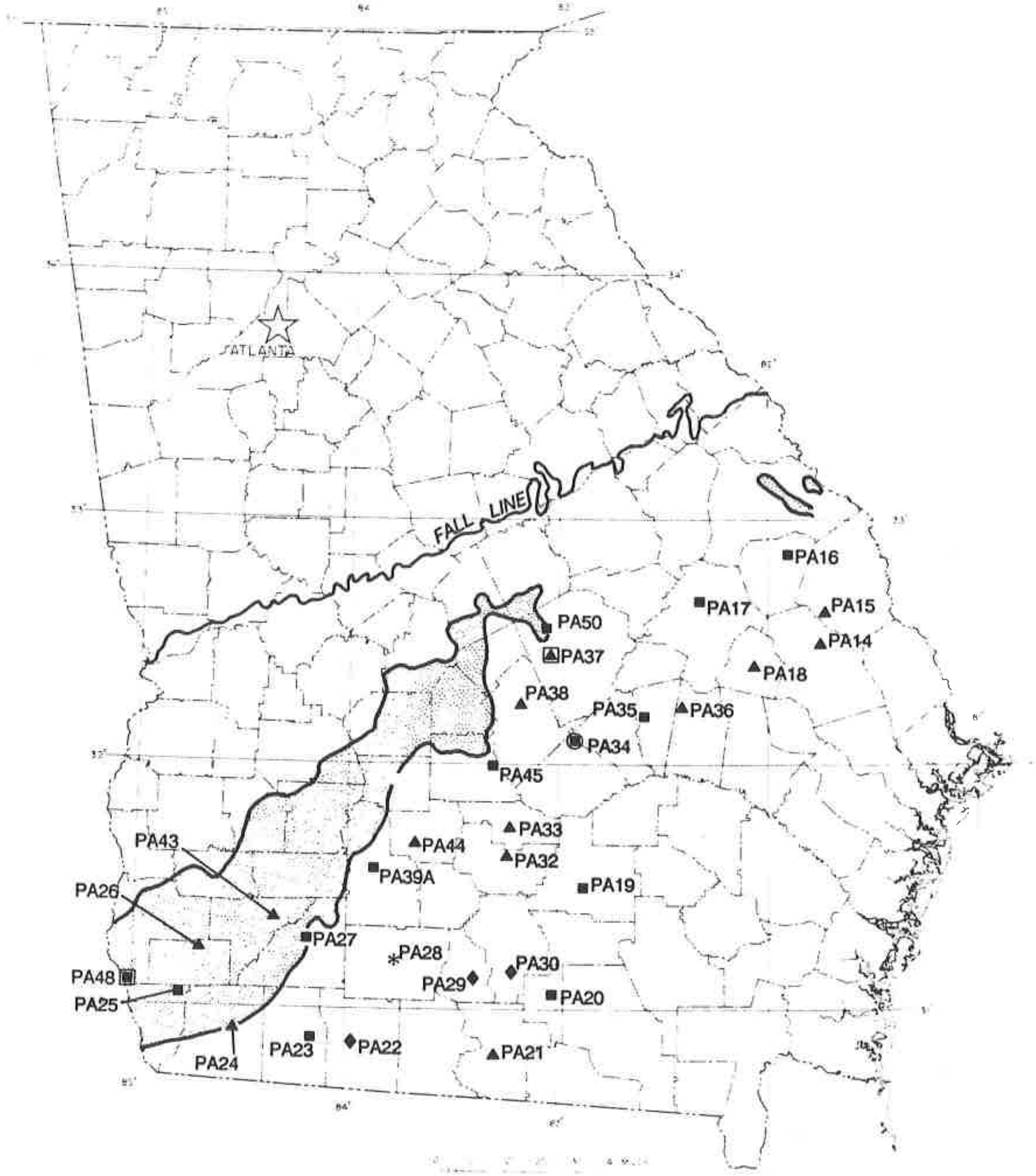
Floridan aquifer system carbonates form a single permeable zone in up-dip areas and two permeable zones in down-dip areas (Miller, 1986). The upper water-bearing units of the Floridan are the Eocene Ocala Group and the Oligocene Suwannee Limestone (Crews and Huddlestun, 1984). These limestones crop out in the Dougherty Plain (a karstic area in southwestern Georgia) and in adjacent areas along strike to the northeast (Figure 3-7). In Camden and Wayne Counties, the Oligocene unit is absent, and the upper part of the Floridan is restricted to units of Eocene age (Clarke et al., 1990). The lower portion of the Floridan, which consists of dolomitic limestone of middle and lower Eocene age and pelletal, vuggy, dolomitic limestone of Paleocene age, is deeply buried and not widely used, except in several municipal and industrial wells in the Savannah area (Clarke et al., 1990). From its up-dip limit, defined in the east by clays of the Barnwell Group, the aquifer thickens to well over 700 feet in coastal Georgia. A dense limestone facies along the trend of the Gulf Trough locally limits ground-water quality and availability (Kellam and Gorday, 1990). The Gulf Trough is a linear depositional feature in the Ocala Group that extends from southwestern Decatur County through central Bulloch County.

A ground-water divide separates a southwestward flow system in the Floridan aquifer in the Dougherty Plain from the Floridan aquifer system's major southeastward flow system in the remainder of Georgia. Rainfall infiltration in outcrop areas and leakage from extensive surficial aquifers provides recharge to the Dougherty Plain flow system (Hayes, et al., 1983). The main body of the Floridan aquifer system, to the east, is recharged by leakage from the Jacksonian aquifer system and by rainfall infiltration in outcrop areas and in areas where overlying strata are thin. Significant recharge also occurs in the Brooks-Echols-Lowndes Counties area where the Withlacoochee River and numerous sinkholes breach upper confining beds (Krause, 1979).

Ground-water samples were collected from 30 wells completed in the Floridan aquifer system. All of the water samples were neutral to basic and moderately hard to hard. Iron exceeded drinking-water limits in water from three wells. Manganese exceeded drinking-water limits in water from only one well. Aluminum, barium, bismuth, strontium, and zinc were other common trace metals, with molybdenum, copper, tin and titanium occurring less frequently. Barium levels in water samples from a well in Fitzgerald, Ben Hill County, GWN-PA33 exceeded the drinking-water maximum.

Chloride and sulfate concentrations in the water samples commonly were below 10 parts per million. Chloride and sulfate levels were highest (10.4 and 96.2 parts per million, respectively) in water from a Colquitt County monitoring well GWNPA-28. These values, however, are less than when sampled in 1989.

Most of the water samples collected from the recharge area of the Floridan aquifer contained detectable amounts of nitrite/nitrate. Levels of nitrite/nitrate in this area ranged from 0.3 to 2 parts per million. Most of the wells in the confined portion of the Floridan aquifer did not contain detectable levels of nitrite/nitrate. Trends in nitrite/nitrate levels in selected wells in the Floridan Aquifer are presented in Figure 3-8.



□ Iron concentrations exceed drinking-water limits
○ Manganese concentrations exceed drinking-water limits
▲ Moderately hard water
■ Hard water
♦ Very hard water
General recharge area (from Davis, et al., 1988)
* No value

Figure 3-7. - Water quality of the Floridan aquifer system

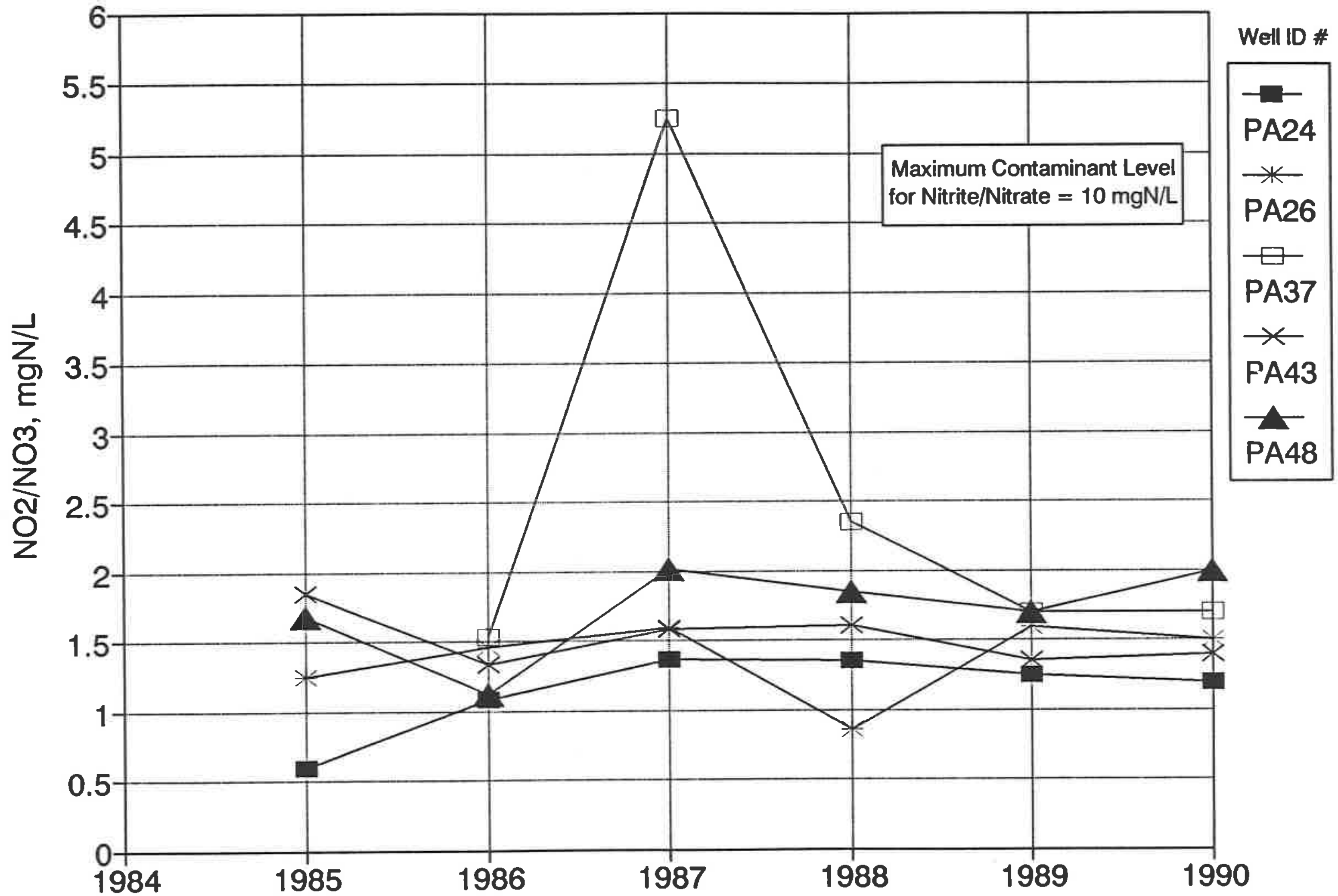


Figure 3-8. - Nitrite/nitrate concentrations in selected wells in the Floridian aquifer system

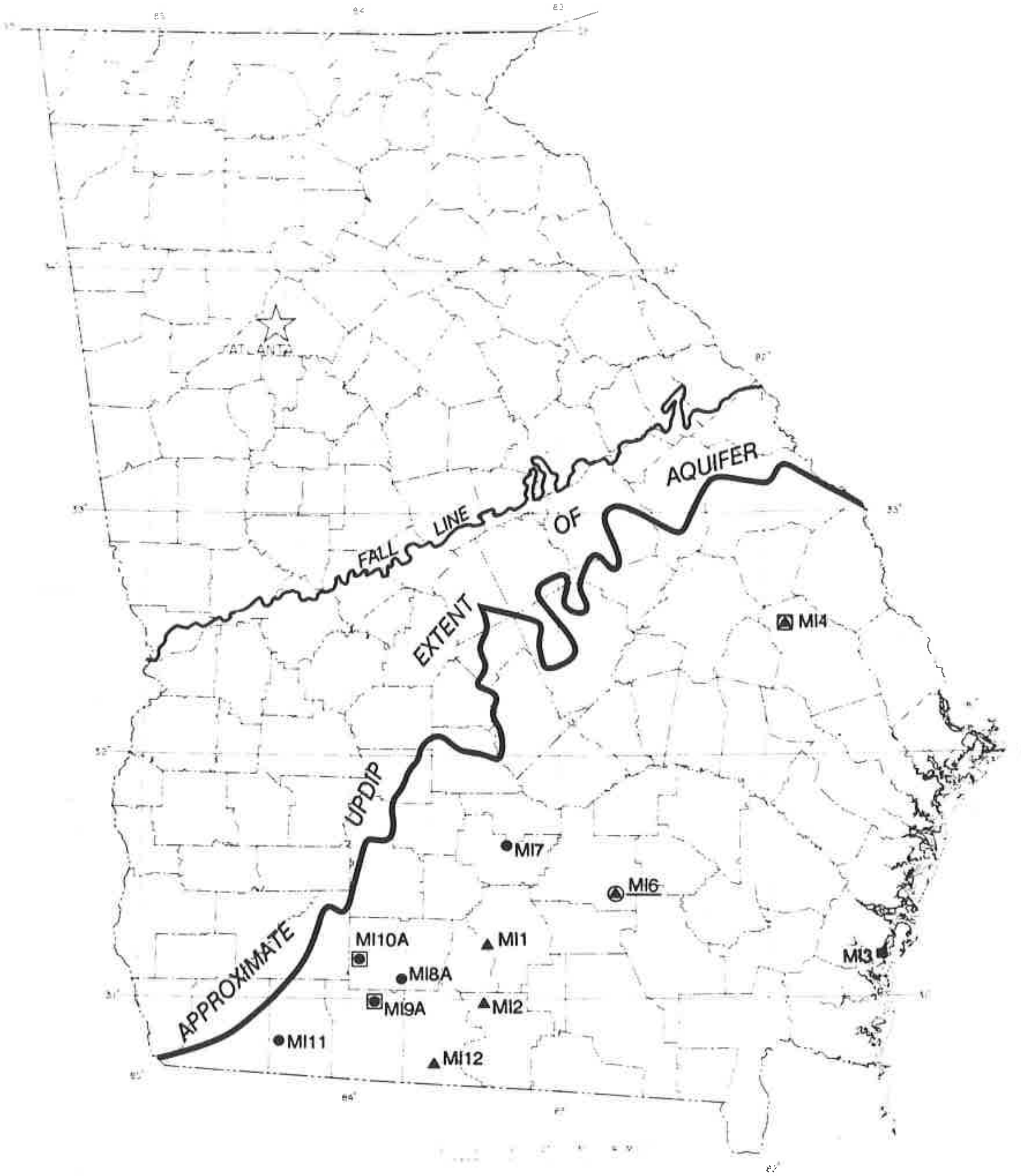
3.8 MIOCENE AQUIFER SYSTEM

Much of south-central and southeastern Georgia lies within outcrop areas of the Miocene Altamaha Formation and Hawthorne Group. Discontinuous lens-shaped bodies of sand, 50 to 80 feet thick, are the main permeable units. Miocene clays and sandy clays are thickest, more than 500 feet, in Wayne County (Watson, 1982).

Areas of confinement exist along the coastal counties. Leakage from overlying surface aquifers into the Miocene aquifer system and, in some areas, from the underlying Floridan aquifer system is significant in the coastal counties (Watson, 1982). Two principal aquifer units are present in the coastal area (Joiner, et al., 1988). Clarke et al. (1990) use the names upper and lower Brunswick aquifers to refer to these two sandy aquifer units.

Water quality of the Miocene aquifer system was monitored in eleven wells. Water samples varied from slightly acidic to slightly basic, with pH values ranging between 4.3 to 7.9 (standard pH units). Most of the water samples were soft to moderately hard, but wells in Brooks, and Glynn Counties yielded hard water. Water samples from five wells in Glynn, Bulloch, Colquitt, and Thomas Counties contained iron at concentrations in excess of acceptable drinking water limits. Manganese was detected above Secondary Maximum Contaminant Levels in water from two wells, one in Bulloch County and one in Coffee County (Figure 3-9). Aluminum, barium, bismuth, strontium, titanium, zinc and the major alkali metals were other commonly detected cations in the Miocene aquifer system water samples. Antimony and copper were less commonly detected trace metals.

Chloride levels were less than 18.5 parts per million in all of the samples analyzed. The highest chloride levels were recorded from stations in Colquitt, Glynn and Coffee Counties. Sulfate was undetectable in a majority of the samples. Levels were highest (33 parts per million) in a Glynn County well, but were 4.4 parts per million or less in all of the other wells. Detectable levels of nitrite/nitrate, ranging from 1.7 to 14 parts per million, were found in six of the eleven wells sampled. A residential well in Coffee County contained 14 parts per million of nitrite/nitrate. This is the only 1990 Monitoring Network well to exceed drinking water limits for nitrite/nitrate.



□ Iron concentrations exceed drinking-water limits
○ Manganese concentrations exceed drinking-water limits
▢ Iron and manganese concentrations exceed drinking-water limits
<u>MI6</u> Nitrate/nitrite concentration exceeds drinking-water limits
● Soft water
▲ Moderately hard water
■ Hard water

Figure 3-9. - Water quality of the Miocene aquifer system

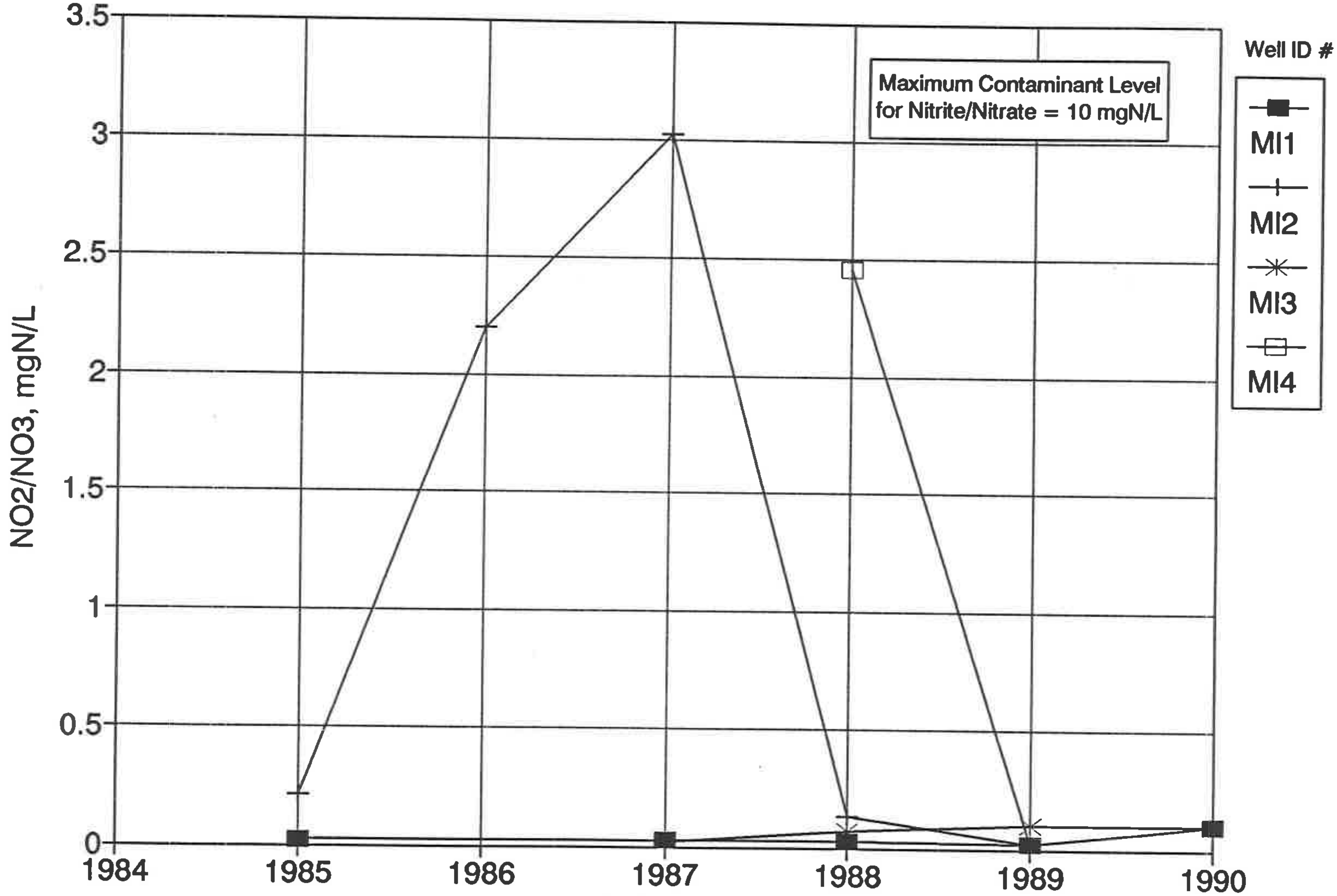


Figure 3-10. - Nitrite/nitrate concentrations in selected wells in the Miocene aquifer system

Figure 3-10 illustrates the trend of detectable nitrite/nitrate in the Miocene aquifer since 1985.

3.9 PIEDMONT/BLUE RIDGE UNCONFINED AQUIFERS

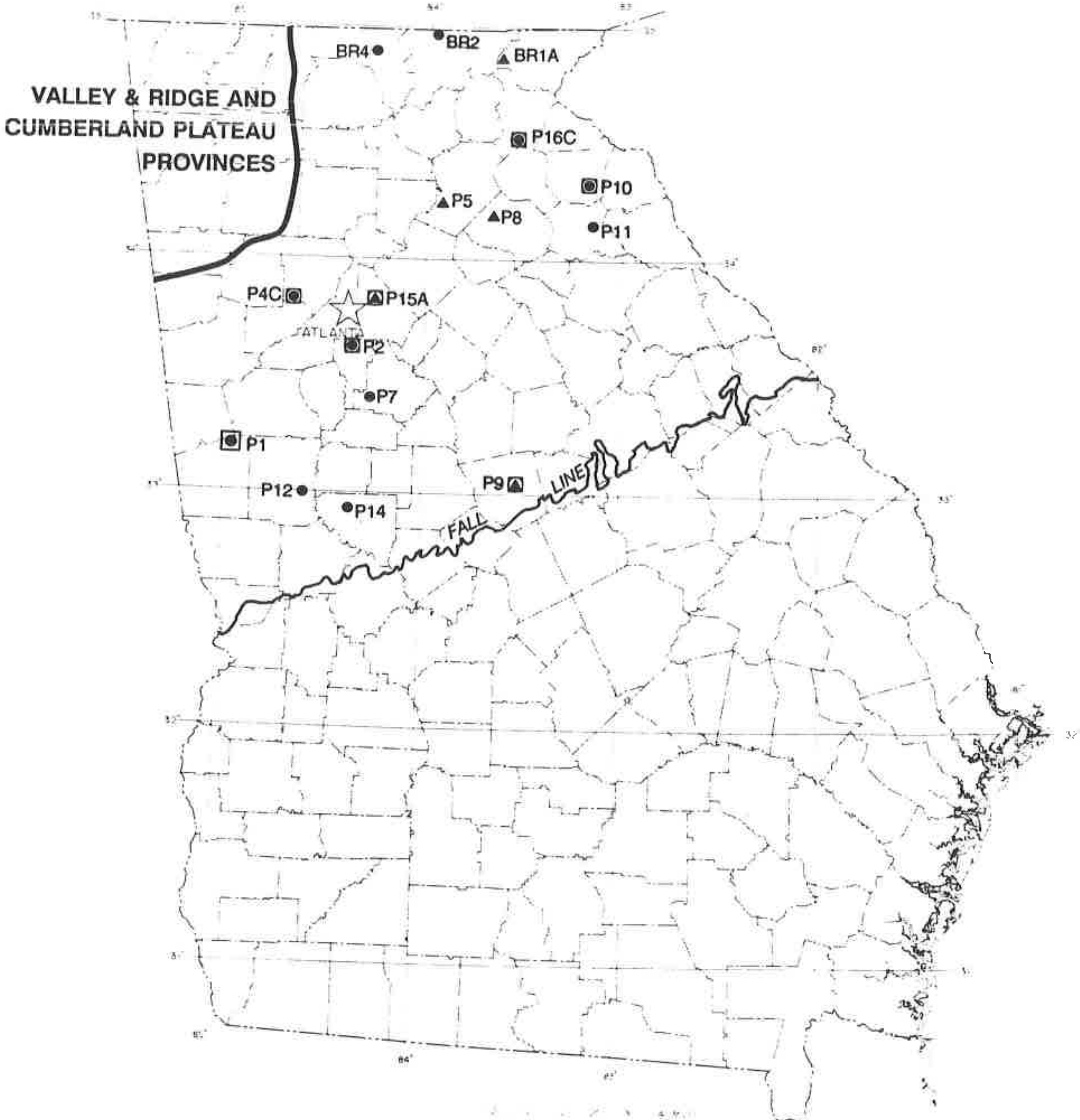
Georgia's Piedmont and Blue Ridge Physiographic Provinces are developed on metamorphic and igneous rocks that are predominately Precambrian and Paleozoic in age. Soil and saprolite horizons, compositional layers and openings along fractures and joints in the rocks are the major water-bearing features. Fracture density and interconnection provide the primary controls on the rate of flow of water into wells completed in crystalline rocks. The permeability and thickness of soils and shallow saprolite horizons determine the amount of discharge that can be sustained.

Ground-water samples were collected from thirteen wells in the Piedmont Province and three wells in the Blue Ridge Province. Figure 3-11 shows the locations of the monitoring stations. Water from wells in the crystalline-rock aquifers was generally slightly acidic and soft to moderately hard. Iron and manganese levels exceeded drinking-water limits in water samples from seven of the Piedmont wells. Manganese exceeded drinking water levels in one of the Blue Ridge wells. Figures 3-12 and 3-13 show trends in iron and manganese concentrations for wells that have historically yielded water with high levels of these metals. Aluminum, barium, bismuth and zinc were common trace metal constituents. Cobalt and fluorine were also present in minor amounts.

Chloride and sulfate concentrations in the water samples were typically below 20 parts per million. A Piedmont well in Jones County showed a sulfate value of 45.6 parts per million. Nitrite/nitrate was detectable in water from eight of the wells. All of these wells yielded water with nitrite/nitrate levels less than 2.6 parts per million. Figure 3-14 shows that nitrite/nitrate concentrations have remained approximently the same since 1984.

3.10 VALLEY AND RIDGE UNCONFINED AQUIFERS

Soil and residuum form low-yield unconfined aquifers across most of the Valley and Ridge Province of northwestern Georgia. Valley bottom



□ Iron concentrations exceed drinking-water limits
○ Manganese concentrations exceed drinking-water limits
▢ Iron and manganese concentrations exceed drinking-water limits
• Soft water
▲ Moderately hard water
▪ Hard water

Figure 3-11. - Water quality of the Piedmont/Blue Ridge unconfined aquifers

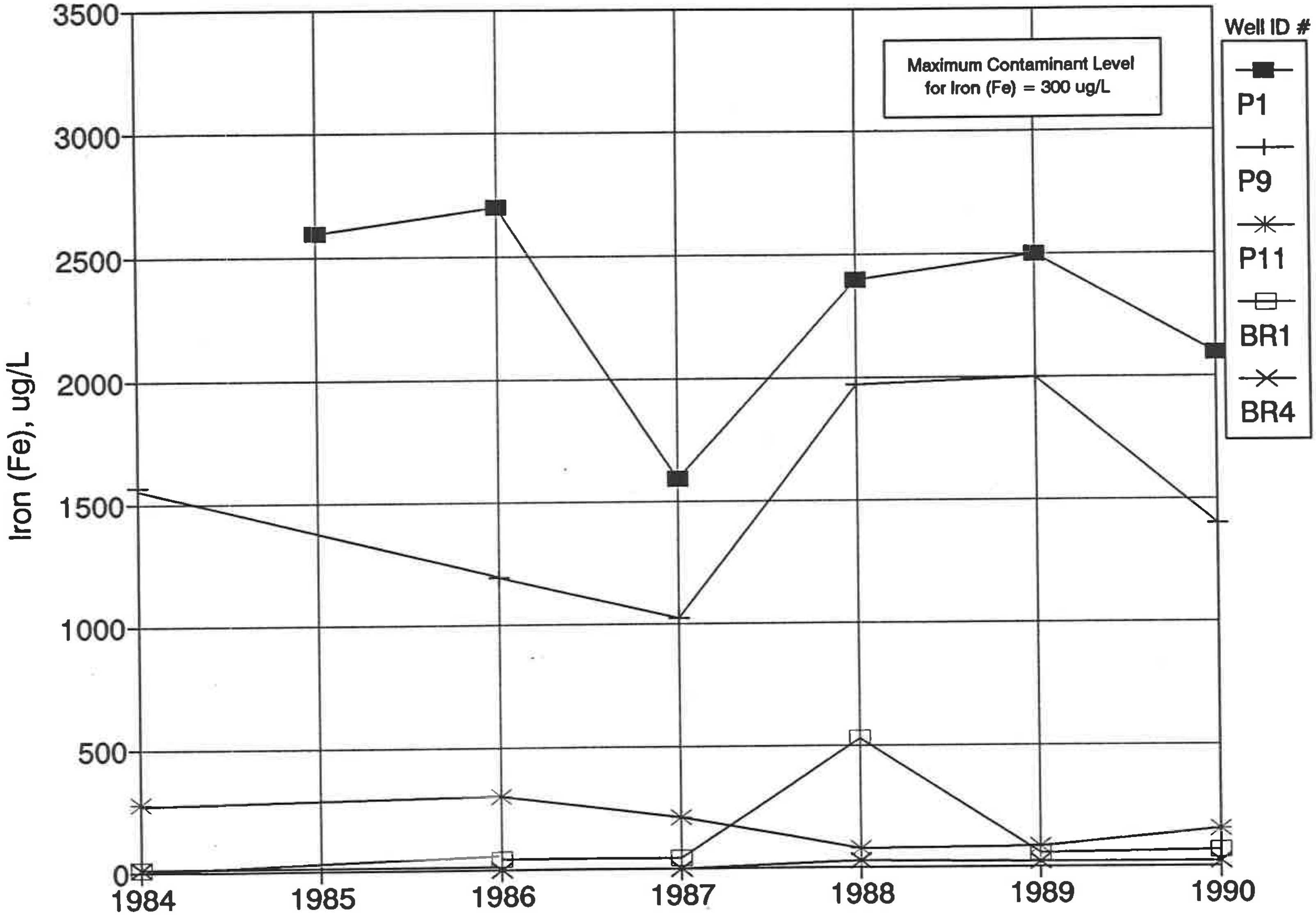


Figure 3-12. - Iron concentrations in selected wells in the Piedmont and Blue Ridge aquifer systems

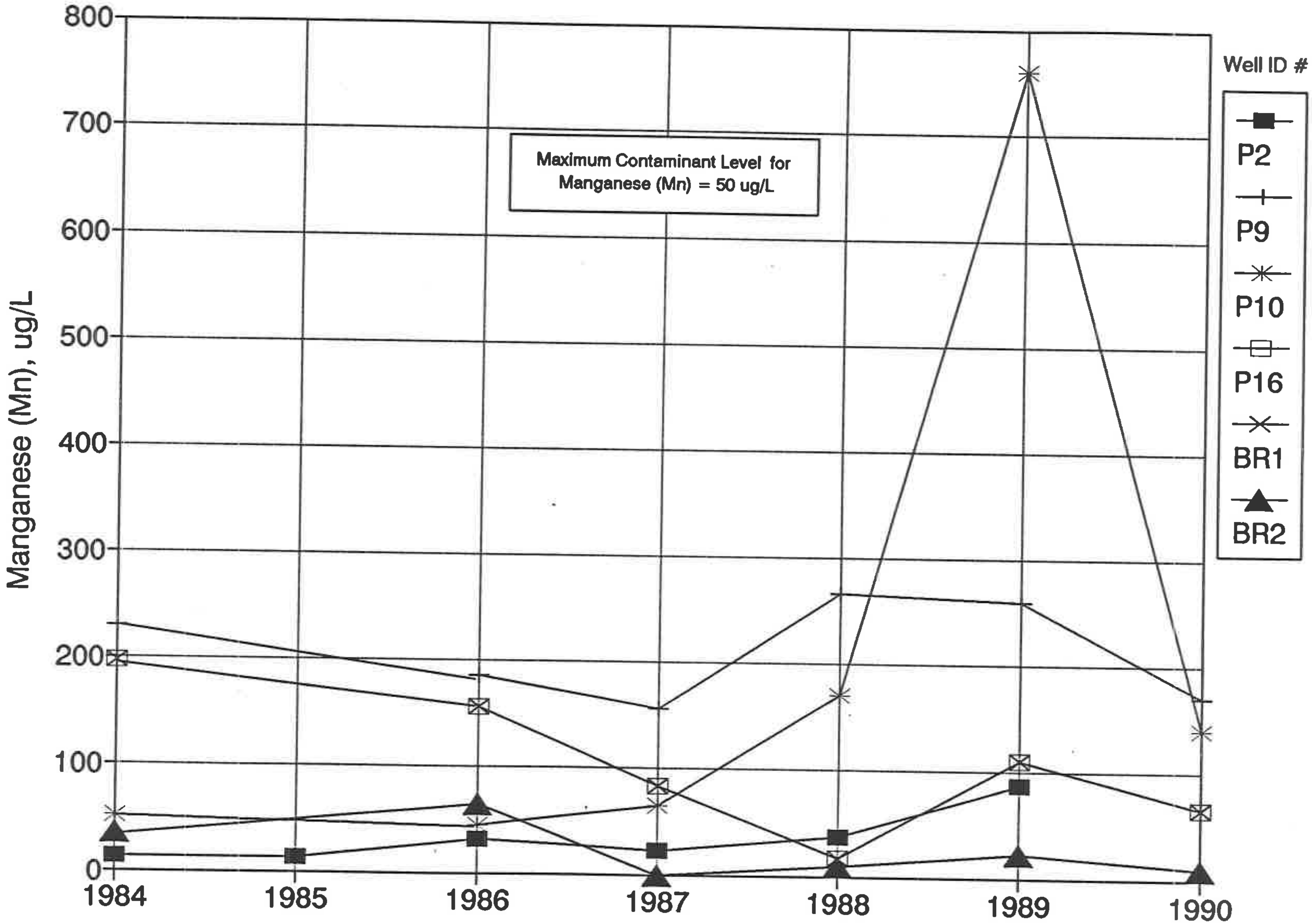


Figure 3-13. - Manganese concentrations in selected wells in the Piedmont and Blue Ridge aquifer systems

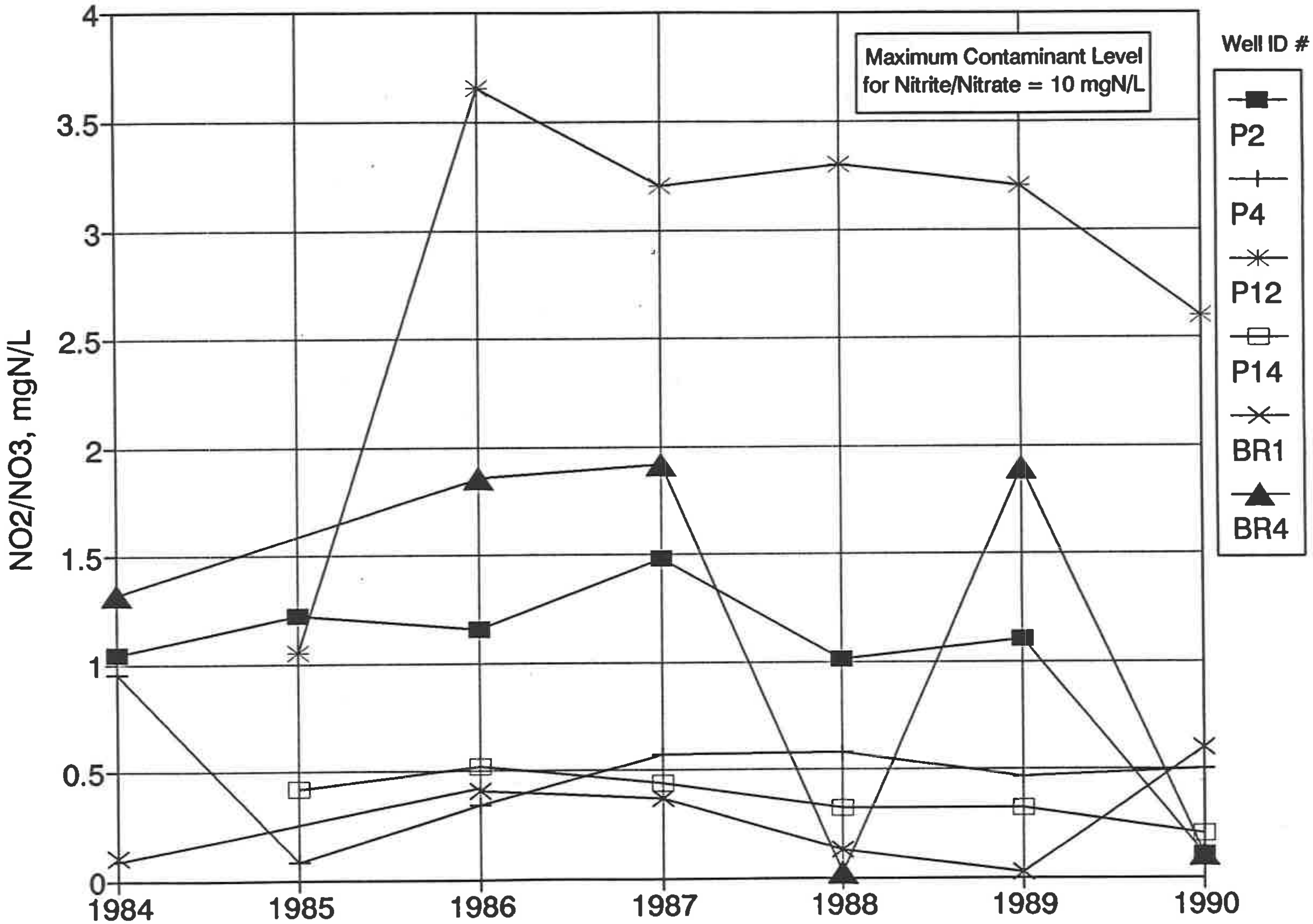


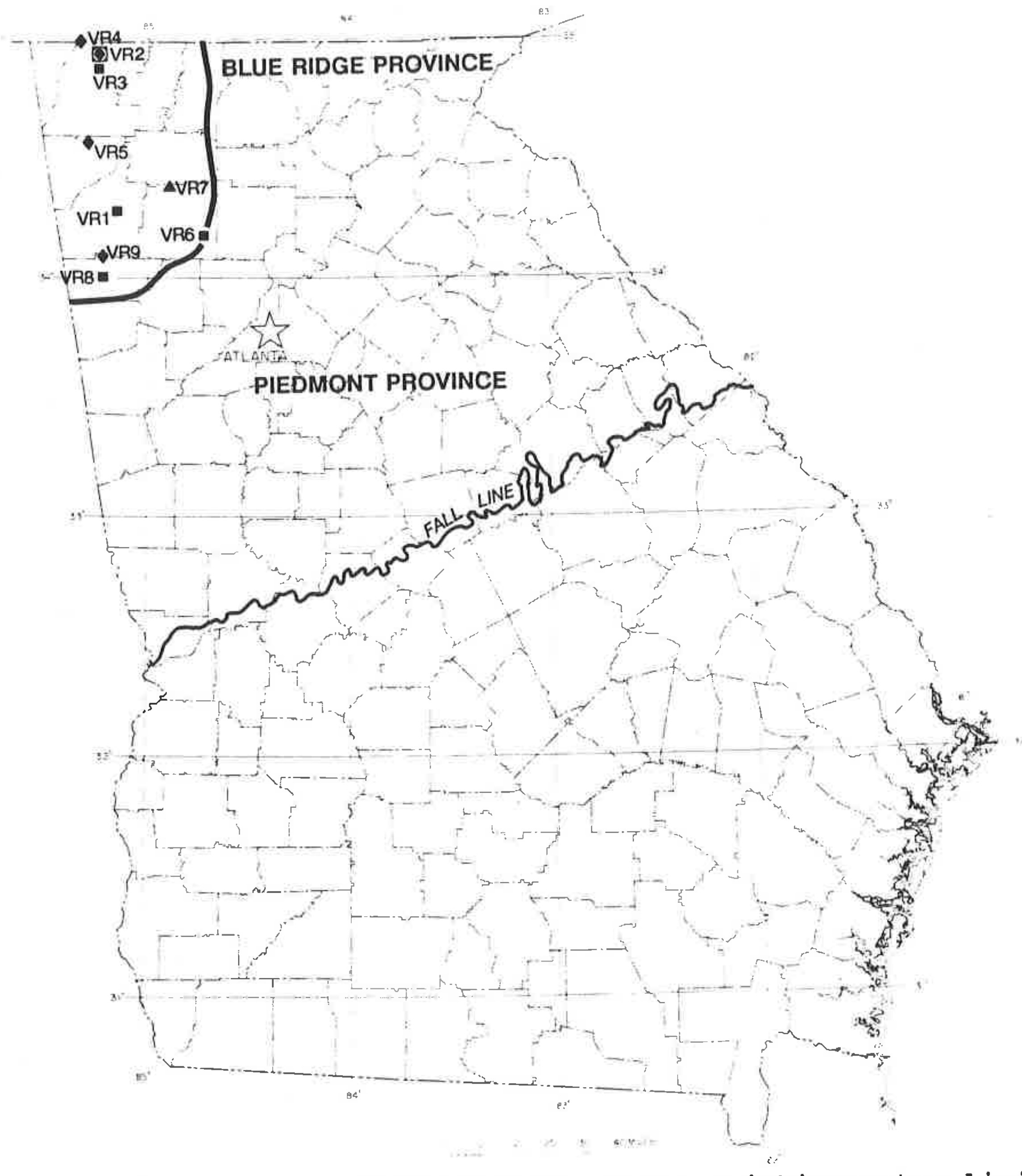
Figure 3-14. - Nitrite/nitrate concentrations in selected wells in the Piedmont and Blue Ridge aquifer systems

outcrops of dolostones and limestones of the Cambro-Ordovician Knox Group are the locations of most higher-yielding wells and springs that are suitable for municipal supplies.

Water quality in the Valley and Ridge unconfined aquifers was monitored in six wells and three springs located across the Province (Figure 3-15). Three of these wells and all three springs produced water from Knox Group carbonates. The other wells represent water quality in the Ordovician Chickamauga Group of Walker County and the Cambrian Shady Dolomite of Bartow County. Water from the Valley and Ridge monitoring stations was typically basic and moderately hard to very hard. Iron and manganese concentrations exceeded drinking-water limits in one of the water samples analyzed (GWN-VR-2). Aluminum, barium, bismuth, and strontium were the most common trace metal constituents. Less commonly detected trace metals included copper and zinc.

Chloride ranged in concentration from 2.3 to 18.6 parts per million and were typically less than five parts per million. Sulfate concentrations averaged at 5.69 parts per million. Water samples from Catoosa and Walker County contained 23.8 parts per million sulfate and 54 parts per million sulfate respectively. Detectable levels of nitrite/nitrate were present in all but one of the water samples. Concentrations ranged from .3 to 3.1 parts per million in water from eight of the wells and springs. Figure 3-16 shows nitrite/nitrate levels measured in 1990 were generally within previously established ranges for water from these monitoring stations. Four of the stations showed moderate decreases in nitrite/nitrate levels since 1989, while three stations showed slight to moderate increases over the same period.

Several volatile organics were found in GWN-VR2 when it was sampled August 14, 1990 (Appendix, 1990 Groundwater Quality Analysis of the Valley and Ridge Unconfined Aquifer System). It should be noted that the water from this well is used only for cooling water and is not being used as a drinking water source.



- □ Iron and manganese concentrations exceed drinking-water limits
- ▲ Moderately hard water
- ■ Hard water
- ♦ Very hard water

Figure 3-15. - Water quality of the Valley and Ridge unconfined aquifers

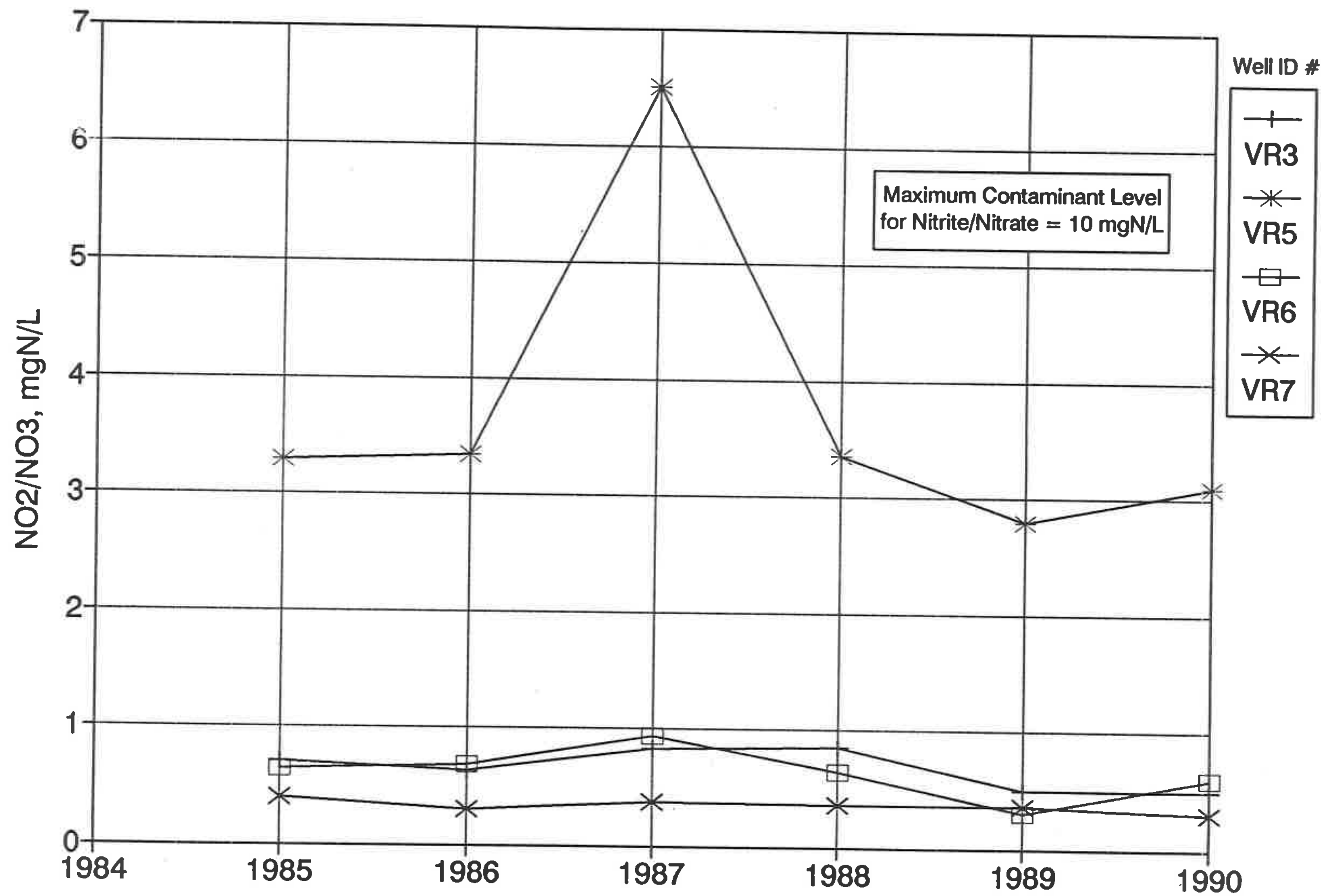


Figure 3-16. - Nitrite/nitrate concentrations in selected wells and springs in the Valley and Ridge aquifer system

4.0 SUMMARY AND CONCLUSIONS

Hydrogeologists collected 103 water samples for analysis from 86 wells and three springs for the Ground-Water Monitoring Network in 1990. These wells and springs represent eight major aquifer systems:

Cretaceous aquifer system,
Clayton aquifer system,
Jacksonian aquifer system,
Floridan aquifer system,
Miocene aquifer system,
Piedmont unconfined aquifer,
Blue Ridge unconfined aquifer and
Valley and Ridge unconfined aquifers.

Analyses of water samples collected in 1990 were compared with analyses for the Ground-Water Monitoring Network dating back to 1984, permitting the recognition of temporal trends. Table 4-1 lists the major contaminants and pollutants that were detected at stations of the Ground-Water Monitoring Network during 1990. Although isolated ground-water quality problems were documented during 1990 at specific localities, the quality of water from the majority of the Ground-Water Monitoring Network stations remains excellent.

Only one well, a domestic well in the Miocene aquifer, yielded water samples in 1990 with nitrite/nitrate concentrations exceeding the Primary Maximum Contaminant Level of 10 parts per million Nitrogen. Samples from Coastal Plain aquifers with the highest nitrite/nitrate levels were, in most cases, from wells in outcrop areas.

Spatial and temporal limitations of the Ground-Water Monitoring Network preclude the identification of the exact sources of the increasing levels of nitrogen compounds in some of Georgia's ground water. Nitrite/nitrate originates in ground water from direct sources and through oxidation of other forms of dissolved nitrogen. Some nitrite/nitrate may come from natural sources, and some may be man-made. The most common sources of man-made dissolved nitrogen are septic systems, agricultural wastes and fertilizers (Freeze and Cherry, 1979). Dissolved nitrogen is also present in rainwater, derived from terrestrial vegetation and volatilization of fertilizers (Drever, 1988). The conversion of other nitrogen species to nitrate occurs in aerobic environments (i.e. recharge areas). Anaerobic conditions, as are commonly developed along the flow path of ground water, foster the denitrification process. However, this process is inhibited by the lack of denitrifying bacteria in ground water (Freeze and Cherry, 1979).

Iron and manganese were the most commonly detected metals in the samples analyzed. Although minor increases or decreases in levels of iron and manganese were noted for some stations, no long-term trends in concentrations of these metals were documented for the majority of the wells and springs sampled.

The presence of organic compounds was again documented in water from a few of the wells sampled. Because of the sporadic nature of the occurrence of organic compounds in most of these wells, spatial and temporal trends in levels of organic pollutants cannot be defined at this time.

Table 4-1 - Contaminants and pollutants detected exceeding MCL during 1990 in stations of the Ground-Water Monitoring Network, by aquifer.

Aquifer	Well ID, parameter, and detected value *	
Cretaceous	GWN-K4	Iron = 4,000 ug/L
		Manganese = 150 ug/L
	GWN-K8	Iron = 2,500 ug/L
Clayton	GWN-CT1	Iron = 330 ug/L
	GWN-CT6B	Iron = 1,000 ug/L
Jacksonian	GWN-J3	Manganese = 110 ug/L
	GWN-J8	Manganese = 66 ug/L
Floridan (Principal Artesian)	GWN-PA17	Iron = 610 ug/L
	GWN-PA33	Barium = 2,200 ug/L
	GWN-PA34	Manganese = 99 ug/L
	GWN-PA37	Iron = 630 & 560 ug/L
Miocene	GWN-MI3	Iron = 630 ug/L
	GWN-MI4	Iron = 430 & 1,000 ug/L
		Manganese = 99 & 120 ug/L
	GWN-MI6	Manganese = 77 ug/L
		NO_2/NO_3 = 14.0 mgN/L
	GWN-MI9A	Iron = 320 ug/L
	GWN-MI10A	Iron = 560 ug/L
Piedmont	GWN-P1	Iron = 2,100 ug/L
		Manganese = 55 ug/L
	GWN-P2	Iron = 2,700 ug/L
		Manganese = 77 ug/L
	GWN-P4C	Iron = 500 ug/L
		Manganese = 690 ug/L
	GWN-P9	Iron = 1,400 ug/L
		Manganese = 170 ug/L
	GWN-P10	Iron = 11,400 ug/L
		Manganese = 140 ug/L
	GWN-P15A	Iron = 400 ug/L
		Manganese = 120 ug/L
	GWN-P16C	Iron = 1,500 ug/L
		Manganese = 66 ug/L
Blue Ridge	GWN-BR1	Manganese = 81 ug/L
Valley and Ridge	GWN-VR2	Iron = 310 & 410 ug/L
		Manganese = 700 ug/L

* Two values indicate two sampling dates.

5.0 REFERENCES CITED

Brooks, R., Clarke, J.S., and Faye, R.E., 1985, Hydrogeology of the Gordon Aquifer System of East-Central Georgia: Georgia Geologic Survey Information Circular 75, 41 p.

Clarke, J.S., Brooks, R., and Faye, R.E., 1985, Hydrogeology of the Dublin and Midville Aquifer Systems of East-Central Georgia: Georgia Geologic Survey Information Circular 74, 62 p.

Clarke, J.S., Faye, R.E., and Brooks, R., 1983, Hydrogeology of the Providence Aquifer of Southwest Georgia: Georgia Geologic Survey Hydrologic Atlas 11, 5 pl.

Clarke, J.S., Faye, R.E., and Brooks, R., 1984, Hydrogeology of the Clayton Aquifer of Southwest Georgia: Georgia Geologic Survey Hydrologic Atlas 13, 6 pl.

Clarke, J.S., Hacke, C.M., and Peck, M.F., 1990, Geology and Ground-Water Resources of the Coastal Area of Georgia: Georgia Geologic Survey Bulletin 113, 106 p., 12 pl.

Crews, P.A., and Huddlestun, P.F., 1984, Geologic Sections of the Principal Artesian Aquifer System, in Arora, R., editor, Hydrogeologic Evaluation for Underground Injection Control in the Coastal Plain of Georgia: Georgia Geologic Survey Hydrologic Atlas 10, 41 pl.

Davis, K.R., Donahue, J.C., Hutcheson, R.H., and Waldrop, D.L., 1988, Most Significant Ground-Water Recharge Areas of Georgia: Georgia Geologic Survey Hydrologic Atlas 18, 1 pl.

Drever, J.I., 1988, The Geochemistry of Natural Waters: Prentice-Hall, Englewood Cliffs, N.J., 437 p.

Environmental Protection Division, 1989, Rules for Safe Drinking Water, Chapter 391-3-5, Revised June 1989, Georgia Department of Natural Resources 63 p.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Prentice-Hall, Englewood Cliffs, N.J., 604 p.

Hayes, L.R., Maslia, M.L., and Meeks, W.C., 1983, Hydrology and Model Evaluation of the Principal Artesian Aquifer, Dougherty Plain, Southwest Georgia: Georgia Geologic Survey Bulletin 97, 93 p.

Hicks, D.W., Krause, R.E., and Clarke, J.S., 1981, Geohydrology of the Albany Area, Georgia: Georgia Geologic Survey Information Circular 57, 31 p.

Joiner, C.N., Reynolds, M.S., Stayton, W.L., and Boucher, F.G., 1988, Ground-Water Data for Georgia, 1987: United States Geological Survey Open-File Report 88-323, 172 p.

Kellam, M.F., and Gorday, L.L., 1990, Hydrogeology of the Gulf Trough Apalachicola Embayment Area, Georgia: Georgia Geologic Survey Bulletin 94, 74p.

Krause, R.E., 1979, Geohydrology of Brooks, Lowndes, and Western Echols Counties, Georgia: United States Geological Survey Water-Resources Investigations 78-117, 48 p.

Long, A. F., 1989, Hydrogeology of the Clayton and Claiborne Aquifer Systems: Georgia Geologic Survey Hydrologic Atlas 19, 6 pl.

McFadden, S.S., and Perriello, P.D., 1983, Hydrogeology of the Clayton and Claiborne Aquifers in Southwestern Georgia: Georgia Geologic Survey Information Circular 55, 59 p.

Miller, J.A., 1986, Hydrogeologic Framework of the Floridan Aquifer System in Florida and Parts of Georgia, Alabama, and South Carolina: United States Geological Survey Professional Paper 1403-B, 91 p.

O'Connell, D.B., and Davis, K.R., 1991, Ground-Water Quality in Georgia for 1989: Georgia Geologic Survey Information Circular 12F, 115 p.

Pollard, L.D., and Vorhis, R.C., 1980, The Geohydrology of the Cretaceous Aquifer System in Georgia: Georgia Geologic Survey Hydrologic Atlas 3, 5 pl.

Sever, C.W., 1966, Reconnaissance of the Ground Water and Geology of Thomas County, Georgia: Georgia Geologic Survey Information Circular 34, 14 p.

Vincent, R.H., 1982, Geohydrology of the Jacksonian Aquifer in Central and East Central Georgia: Georgia Geologic Survey Hydrologic Atlas 8, 3 pl.

Wait, R.L., 1960, Source and Quality of Ground Water in Southwestern Georgia: Georgia Geologic Survey Information Circular 18, 74 p.

Watson, W., 1982, Aquifer Potential of the Shallow Sediments of the Coastal Area of Georgia, in Arden, D.D., Beck, B.F., and Morrow, E., Editors, Second Symposium on the Geology of the Southeastern Coastal Plain (March, 1979): Georgia Geologic Survey Information Circular 53, pp. 183-194.

APPENDIX

APPENDIX: ANALYSES OF SAMPLES COLLECTED DURING 1990 FOR THE GEORGIA GROUND-WATER MONITORING NETWORK

All water quality samples that are collected for the Georgia Ground-Water Monitoring Network are subjected to a Standard Analysis which includes tests for five 'indicator' parameters, twelve common pesticides and industrial chemicals and thirty metals. Analyses for additional parameters may be included for samples that are collected from an area where a possibility of ground-water pollution exists due to regional activities. These optional screens include tests for agricultural chemicals, coal-tar creosote, phenols and anilines and volatile organic compounds (Tables A-1 through A-4). Because parameters other than the five 'indicators' and eight of the metals of the Standard Analysis were detected very rarely, other parameters are listed in the appendix only when they were detected.

For this appendix, the following abbreviations are used:

SU	=	standard units
mg/L	=	milligrams per liter (parts per million)
mgN/L	=	milligrams per liter (parts per million), as nitrogen
ug/L	=	micrograms per liter (parts per billion) and
umho/cm	=	micromhos per centimeter
U	=	less than (below detection limit). Where this abbreviation is used for a figure that is a calculated average, the average is below the typical detection limit for the parameter
D	=	for minimum values reported for a parameter, indicates that the parameter was detected below the usual detection limit (usually used when the minimum would otherwise be below the detection limit)

Underlined values listed for a parameter in the water quality data summaries indicates that the parameter was detected at levels above the Maximum Contaminant Level (MCL) listed in the Rules for Safe Drinking Water. Values that are both underlined and enclosed in parentheses indicate detected pollutants for which no MCL has been established.

Table A-1. - Standard water-quality analysis: indicator parameters, Organic Screens #2 and #4 and ICP metal screen

Parameter	Typical Detection Limit / MCL *
pH	(NA) SU
Spec. Cond.	1.0 / NA umho/cm
Chloride	0.1 / 250 mg/L $_2$
Sulfate	2.0 / 250 mg/L $_2$
Nitrite/ nitrate	0.02 / 10 mg/LN $_1$
ORGANIC SCREEN #2	
(Chlorinated Pesticides)	
Dicofol	0.10 / NA ug/L
Endrin	0.03 / 0.2 ug/L $_1$
Lindane	0.008 / 4.0 ug/L $_1$
Methoxychlor	0.30 / 100 ug/L $_1$
PCB's	0.60 / NA ug/L
Permethrin	0.30 / NA ug/L
Toxaphene	1.20 / 5.0 ug/L $_1$
ORGANIC SCREEN #4	
(Phenoxy Herbicides)	
2,4-D	5.2 / 100 ug/L $_1$
Acifluorfen	0.2 / NA ug/L
Chloramben	0.2 / NA ug/L
Silvex	0.1 / 10 ug/L $_1$
Trichlorfon	2.0 / NA ug/L
ICP METAL SCREEN	
Calcium	1.0 / NA mg/L
Magnesium	1.0 / NA mg/L
Sodium	1.0 / NA mg/L
Potassium	5.0 / NA mg/L

Parameter	Typical Detection Limit / MCL *
ICP SCREEN, Cont.	
Silver	30 / 50 ug/L $_1$
Aluminum	50 / NA ug/L
Arsenic **	10 / 50 ug/L $_1$
Gold	10 / NA ug/L
Barium	10 / 1000 ug/L $_1$
Beryllium	10 / NA ug/L
Bismuth	30 / NA ug/L
Cadmium	5.0 / 10 ug/L $_1$
Cobalt	10 / NA ug/L
Chromium	10 / 50 ug/L $_1$
Copper	20 / 1000 ug/L $_2$
Iron	10 / 300 ug/L $_2$
Manganese	10 / 50 ug/L $_2$
Molybdenum	10 / NA ug/L
Nickel	20 / NA ug/L
Lead	25 / 50 ug/L $_1$
Antimony	40 ug/L
Selenium **	5 / 10 ug/L $_1$
Tin	20 / NA ug/L
Strontium	10 / NA ug/L
Titanium	10 / NA ug/L
Thallium	40 / NA ug/L
Vanadium	10 / NA ug/L
Yttrium	10 / NA ug/L
Zinc	20 / 5000 ug/L $_2$
Zirconium	10 / NA ug/L

** Analyzed by atomic absorption graphite furnace

* MCL = Maximum Contaminant Level from the Georgia Rules for Safe Drinking Water, 1989 ($_1$ = Primary, $_2$ = Secondary, NA = no MCL established)

Table A-2. - Additional water-quality analyses: cyanide, mercury and Organic Screens #1, #3, #5 and #7

Parameter		Typical Detection Limit	Parameter		Typical Detection Limit
Cyanide		0.05 ug/L	Mercury		0.2 / 2.0 ug/L *

ORGANIC SCREEN #1

(Herbicides (H)/Insecticides (I))

Atrazine	H	0.30 ug/L	Malathion	I	1.40 ug/L
Azodrin	I	1.00 ug/L	Metolachlor	H	1.00 ug/L
Chlorpyrifos	I	0.80 ug/L	Metribuzin	H	0.90 ug/L
Dasanit	I	0.60 ug/L	Mevinphos	H	1.40 ug/L
DCPA	H	0.01 ug/L	Parathion (E)	I	0.08 ug/L
Demeton	I	1.00 ug/L	Parathion (M)	I	0.10 ug/L
Diazinon	I	1.00 ug/L	Pebulate	H	0.60 ug/L
Dimethoate	I	0.50 ug/L	Pendimethalin	H	0.80 ug/L
Di-Syston	I	1.00 ug/L	Phorate	I	1.00 ug/L
Eptam	H	0.50 ug/L	Profluralin	H	0.90 ug/L
Ethoprop	I	0.50 ug/L	Simazine	H	0.90 ug/L
Fonophos	I	0.50 ug/L	Sutan	H	0.70 ug/L
Guthion	I	2.00 ug/L	Trifluralin	H	1.00 ug/L
Isopropalin	H	1.00 ug/L	Vernam	H	0.50 ug/L

ORGANIC SCREEN #3

Dinoseb 0.10 ug/L (Herbicide)

ORGANIC SCREEN #5

(Herbicides (H)/Insecticides (I))

Carbaryl	I	10.0 ug/L	Linuron	H	1.0 ug/L
Carbofuran	I	2.0 ug/L	Methomyl	I	3.0 ug/L
Diuron	H	1.0 ug/L	Monuron	H	1.0 ug/L
Fluometuron	H	1.0 ug/L			

ORGANIC SCREEN #7

EDB 1.0 ug/L (fumigant, gasoline additive)

* Primary Maximum Contaminant Level for Mercury.

Table A-3. - Additional water-quality analyses: Organic Screens #8 and #9

ORGANIC SCREEN #8
(Extractable Organics: Coal-tar Creosote)

Parameter	Typical Detection Limit
Naphthalene	10 ug/L
2-Chloronaphthalene	10 ug/L
Acenaphthylene	10 ug/L
Acenaphthene	10 ug/L
Fluorene	10 ug/L
Phenanthrene	10 ug/L
Anthracene	10 ug/L
Fluoranthene	10 ug/L
Pyrene	10 ug/L
Benzo(A)Anthracene	10 ug/L
Benzo(B)Fluoranthene	10 ug/L
Benzo(K)Fluoranthene	10 ug/L
Benzo-A-Pyrene	10 ug/L
Indeno(1,2,3-CD)Pyrene	10 ug/L
Benzo(GHI)Perylene	10 ug/L

ORGANIC SCREEN #9
(Extractable Organics: Phenols and Aniline)

Parameter	Typical Detection Limit
Aniline	10 ug/L
2-Chlorophenol	10 ug/L
2-Nitrophenol	10 ug/L
Phenol	10 ug/L
2,4-Dimethylphenol	10 ug/L
2,4-Dichlorophenol	10 ug/L
2,4,6-Trichlorophenol	10 ug/L
Parachlorometa Cresol	10 ug/L
2,4-Dinitrophenol	50 ug/L
4,6-Dinitro-O-Cresol	50 ug/L
Pentachlorophenol	20 ug/L
4-Nitrophenol	50 ug/L

Table A-4. - Additional water-quality analyses: Organic Screen #10

ORGANIC SCREEN #10
(Volatile Organics)

Parameter		Typical Detection Limit / Primary MCL
Methylene chloride		5 ug/L / NA
Trichlorofluoromethane		1 ug/L / NA
1,1-Dichloroethylene		1 ug/L / 7 ug/L
1,1-Dichloroethane		1 ug/L / 5 ug/L
1,2-Trans-dichloroethylene		1 ug/L / NA
Chloroform *	(* Indicates a tri-	1 ug/L / *
Dichlorobromomethane *	halomethane compound;	1 ug/L / *
Chlorodibromomethane *	MCL for total trihalo-	1 ug/L / *
Bromoform *	methanes = 100 ug/L)	1 ug/L / *
1,2-Dichloroethane		1 ug/L / NA
1,1,1-Trichloroethane		1 ug/L / 200 ug/L
Carbon tetrachloride		1 ug/L / 5 ug/L
1,2-Dichloropropane		1 ug/L / NA
Trans-1,3-dichloropropene		1 ug/L / NA
Trichloroethylene		1 ug/L / 5 ug/L
Benzene		1 ug/L / 5 ug/L
1,1,2-Trichloroethane		1 ug/L / NA
Cis-1,3-dichloropropene		1 ug/L / NA
1,1,2,2-Tetrachloroethane		1 ug/L / NA
Tetrachloroethylene		1 ug/L / NA
Toluene		1 ug/L / NA
Chlorobenzene		1 ug/L / NA
Ethylbenzene		1 ug/L / NA
Acetone		10 ug/L / NA
Methyl ethyl ketone		10 ug/L / NA
Carbon disulfide		1 ug/L / NA
Vinyl chloride		10 ug/L / 2 ug/L
Isopropyl acetate		1 ug/L / NA
2-Hexanone		1 ug/L / NA
Methyl isobutyl ketone		1 ug/L / NA
Styrene		1 ug/L / NA
Xylene (Total of o, m, and p-xylenes)		1 ug/L / NA

1990 Groundwater Quality Analyses of the Cretaceous Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-K1	4.8	1 U	1 U	1.4	0.5 U	28	10 U	2.1	2.6	0.2	10 U	10 U	23	Al = 38 Chloroform = 1 Trichloroethylene = 4.2	10
Well Name: Englehard Kaolin Company #2, Gordon County: Wilkinson Date Sampled: 1990/08/08															
GWN-K2	4.7	1.3	1 U	1.4	0.5 U	32	10 U	2.1	3.8	0.2	10 U	10 U	27		10
Well Name: Irwinton #2 County: Wilkinson Date Sampled: 1990/08/08															
GWN-K4	7	8.6	1.7	13	5.2	<u>4,000</u>	<u>150</u>	1.9	8	0.1 U	370	150	116		1, 3, 5
Well Name: Usgs Midville Experiment Station TW 1 County: Burke Date Sampled: 1990/01/24															
GWN-K5	5.6	1 U	1 U	1 U	5 U	20 U	10 U	1.2	2 U	0.4	10 U	10 U	28		Hg, 8, 9
Well Name: Richmond County #101, Augusta County: Richmond Date Sampled: 1990/09/25															
GWN-K5	6	1 U	1 U	1.6	5 U	20 U	10 U	1.6	2 U	0.4	10 U	10 U	18		Hg, 8, 9
Well Name: Richmond County #101, Augusta County: Richmond Date Sampled: 1990/12/13															
GWN-K7	5.2	1.8	1 U	1.3	0.5 U	20 U	10 U	2.4	2 U	0.1 U	14	11	21		
Well Name: Jones County #4, Macon County: Jones Date Sampled: 1990/08/09															

1990 Groundwater Quality Analyses of the Cretaceous Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-K8	7	43	1.7	2.9	3.2	2,500	27	2.2	16.5	0.1 U	82	180	230		1, 5, 10
Well Name: Mohasco Corp, Laurens Park Mill #3, East Dublin; County: Laurens; Date Sampled: 1990/01/25															
GWN-K10	5	1.3	1 U	2.9	0.5 U	20 U	10 U	3.7	2 U	1.2	10 U	10 U	54		10
Well Name: Fort Valley #1; County: Peach; Date Sampled: 1990/08/09															
GWN-K10	5.1	1.1	1 U	3.2	2 U	20 U	25 U	3	0.8	0.1 U	10 U	10 U	29		10
Well Name: Fort Valley #1; County: Peach; Date Sampled: 1990/01/22															
GWN-K11	4.9	1 U	1 U	1.3	2 U	20 U	25 U	1.2	2 U	0.2	10 U	10 U	16		10
Well Name: Warner Robins #1A; County: Houston; Date Sampled: 1990/01/22															
GWN-K11	4.9	1 U	1 U	1 U	0.5 U	20 U	10 U	1.2	1	0.2	10 U	10 U	16		10
Well Name: Warner Robins #1A; County: Houston; Date Sampled: 1990/08/09															
GWN-K11	4.9	1 U	1 U	1 U	5 U	46	10 U	1.3	1.1	0.23	10 U	10 U	16		10
Well Name: Warner Robins #1A; County: Houston; Date Sampled: 1990/11/28															

1990 Groundwater Quality Analyses of the Cretaceous Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-K12 Well Name: Perry, Holiday Inn Well County: Houston Date Sampled: 1990/01/22	4.3	1 U	1 U	1.4	2 U	160	25 U	1.8	7.8	0.1 U	10 U	10 U	48	Al = 330 Zn = 45	1, 5, 10
GWN-K12 Well Name: Perry, Holiday Inn Well County: Houston Date Sampled: 1990/11/28	4	1 U	1 U	1.1	5	190	12	1.7	8.1	0.1 U	10 U	10 U	47	Al = 390 Zn=38	1, 5, 10
GWN-K16 Well Name: Packaging Corporation of America, North Well County: Bibb Date Sampled: 1990/01/22	5.4	1 U	1 U	5.7	2 U	20 U	25 U	2.3	2.5	0.3	10 U	10 U	30		10
GWN-K16 Well Name: Packaging Corporation of America, North Well County: Bibb Date Sampled: 1990/08/09	5.4	1 U	1 U	4.8	0.5 U	22	10 U	2.4	2.5	0.3	10 U	10 U	29		10
GWN-K16 Well Name: Packaging Corporation of America, North Well County: Bibb Date Sampled: 1990/11/28	5.3	1 U	1 U	5	5 U	30	10 U	2.6	2.6	0.28	10 U	10 U	35		10

1990 Groundwater Quality Analyses of the Cretaceous Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-K19	5.2	1 U	1 U	1 U	5 U	20 U	10 U	1.6	2 U	0.1 U	10 U	10 U	20		10
Well Name: Hephzibah, Murphy Street Well (#3) County: Richmond Date Sampled: 1990/09/25															
Average:	5.26	1.53	1.07	2.83	2.74	43	22.17	2.01	3.85	0.256	14.47	27.27	44.61		
Maximum:	7	43	1.7	13	5.2	4,000	150	3.7	16.5	1.2	370	180	230		
Minimum:	4	1	1	1	0.5	20	10	1.2	0.8	0.1	10	10	16		
Standard Deviation:	7.78	1.83	.232	2.96	2.02	52.3	32.65	6.68	3.93	0.256	17.43	50.36	51.87		

1990 Groundwater Quality Analyses of the Clayton Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-CT1	7.7	11	5.1	41	5 U	330	14	1.9	10.4	0.1 U	10 U	270	251	Bi = 38 F = 0.3	
Well Name: Turner City Monitoring Well County: Dougherty Date Sampled: 1990/11/7															
GWN-CT2A	7.7	40	2.9	5.5	5 U	180	10 U	1.4	16.2	0.02 U	10 U	290	243	Al = 56 Zn = 35	1, 3, 5
Well Name: Burton Thomas Residence Well County: Sumter Date Sampled: 1990/10/23															
GWN-CT3	7.7	40	4.2	6.9	5 U	20 U	10 U	1.9	12	0.02 U	10 U	440	248	Al = 49 Bi = 29	
Well Name: Dawson, Crawford Street Well County: Terrell Date Sampled: 1990/10/24															
GWN-CT4	7.7	44	3.3	4.6	5 U	140	10 U	1.7	8.7	0.02 U	11	300	242	Al = 58	
Well Name: C. T. Martin TW 2 County: Randolph Date Sampled: 1990/10/24															
GWN-CT5A	7.7	44	3.9	1.3	5 U	70	34	1.9	10.5	0.02 U	17	160	248	Al = 63 Bi = 22	1, 3, 5, 10
Well Name: Cuthbert #3 County: Randolph Date Sampled: 1990/10/24															
GWN-CT6B	7.2	126	3.5	6.9	5 U	1,000	27	7.1	49.8	0.1 U	33	160	563		
Well Name: Fort Gaines Test Well County: Clay Date Sampled: 1990/10/25															

1990 Groundwater Quality Analyses of the Clayton Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
WELL ID#															
GWN-CT7	4.7	3.3	4.6	1.3	5 U	250	13	8.6	2 U	6.3	24	58	82	Al = 160 BI = 28 Cu = 40 Zn = 110	1, 5
Well Name: Moore Well															
County: Sumter															
Date Sampled: 1990/10/23															
Average:	7.12	44.04	3.92	9.64	5	165	16.85	4.72	15.65	0.94	16.4	239.7	268		
Maximum:	7.7	126	5.1	41	5	1000	34	8.6	49.8	6.3	33	440	563		
Minimum:	4.7	3.3	2.9	1.3	5	20	10	1.4	2	0.02	10	58	82		
Standard Deviation:	1.1	39.79	0.767	14.02		114.32	9.67	3.88	15.64	2.36	9.00	124.44	143.76		

1990 Groundwater Quality Analyses of the Jacksonian Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-J1B	7.3	55	1 U	3.5	5 U	20 U	10 U	8.8	2 U	1	23	27	280	Al = 68	1, 3, 5
Well Name: M. Horton Residence Well County: Burke Date Sampled: 1990/09/25															
GWN-J1B	7.3	54	1 U	4.3	5 U	22	10 U	11	2 U	2.1	21	25	233		1, 3, 5
Well Name: M. Horton Residence Well County: Burke Date Sampled: 1990/12/13															
GWN-J2A	7.2	41	1 U	1.9	5 U	22	37	2.5	2 U	0.3	56	49	175	Al = 74 Zn = 110	1, 3, 5, 10
Well Name: Oakwood Village MHP #2 County: Burke Date Sampled: 1990/12/13															
GWN-J3	7.9	36	5.7	12	2 U	130	110	7.9	1.4	0.1 U	730	290	257		1, 5, 10
Well Name: J. W. Black Residence Well, Canoochee County: Emanuel Date Sampled: 1990/01/24															
GWN-J4	7.5	47	2.3	3.9	2 U	20 U	25 U	2.5	6.7	0.1 U	11	180	249		1, 5
Well Name: Wrightsville #4, North Myrtle Street Well County: Johnson Date Sampled: 1990/01/25															
GWN-J4	7.5	47	2.3	3.1	5 U	20 U	20	2.7	7	2.7	10 U	190	260	Al = 64	1, 5
Well Name: Wrightsville #4, North Myrtle Street Well County: Johnson Date Sampled: 1990/08/08															

1990 Groundwater Quality Analyses of the Jacksonian Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
WELL ID#															
GWN-J4	7.5	45	2.3	3.7	5 U	20 U	12	2.9	7.3	0.1 U	10 U	180	248	Al = 78	1, 5
Well Name: Wrightsville #4, North Myrtle Street Well County: Johnson Date Sampled: 1990/12/05															
GWN-J6	6.9	26	1 U	1.2	5 U	170	12	1.6	7.3	0.1 U	14	97	143		1, 5, 10
Well Name: Wrens #4 County: Jefferson Date Sampled: 1990/09/25															
GWN-J6	6.7	26	1 U	2	5 U	160	12	2.4	8.8	0.2 U	13	90	119	Al = 50	1, 5, 10
Well Name: Wrens #4 County: Jefferson Date Sampled: 1990/12/13															
GWN-J7	5.1	2.3	1.4	4	5 U	34	13	8.2	2 U	2.5	22	15	42	Linuron = 1	1, 5
Well Name: Templeton Livestock Well County: Burke Date Sampled: 1990/12/13															
GWN-J8	5.4	8.7	1.5	5.5	5 U	43	66	10.3	2 U	8.4	38	20	85	Al = 120	1
Well Name: Kahn Residence Well County: Jefferson Date Sampled: 1990/12/13															
Average:	6.93	35.27	1.88	4.1	4.45	60.1	29.72	5.52	4.4	1.6	21.8	105.7	190		
Maximum:	7.9	55	5.7	12	5	170	110	11	8.8	8.4	730	290	280		
Minimum:	5.1	2.3	1	1.2	2	20	10	1.6	2	0.1	10	15	42		
Standard Deviation:	8.95	17.63	1.4	2.89	1.21	61.04	31.51	3.67	2.93	2.48	14.8	91.61	81.6		

1990 Groundwater Quality Analyses of the Floridan Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-PA14	7.9	34	4.9	7.6	2 U	20 U	43	2.9	5.5	1	36	190	218		
Well Name: Statesboro #7 County: Bulloch Date Sampled: 1990/01/23															
GWN-PA15	7.9	26	7.9	11	3.8	28	25 U	2.4	2 U	0.1 U	10 U	380	232		Cn
Well Name: King Finishing Company, Fire Pump Well, Dover County: Screven Date Sampled: 1990/01/23															
GWN-PA16	7.6	48	3	5.6	2.6	28	30	3.8	6.7	0.1 U	10 U	190	264		1, 5
Well Name: Millen #1 County: Jenkins Date Sampled: 1990/01/23															
GWN-PA17	7.7	48	1.7	3.8	3 U	<u>610</u>	17	2.6	2 U	0.1 U	160	130	242	Al = 880	
Well Name: Swainsboro #7 County: Emanuel Date Sampled: 1990/01/24															
GWN-PA18	7.9	31	3.2	12	2.2	20 U	49	5.7	7	0.1 U	26	240	212		
Well Name: Metter #2 County: Candler Date Sampled: 1990/01/22															
GWN-PA19	7.7	48	19	11	2	34	25	8.1	74.5	0.1 U	58	460	339		
Well Name: Douglas #4 County: Coffee Date Sampled: 1990/02/14															

1990 Groundwater Quality Analyses of the Floridan Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-PA20 Well Name: Lakeland #2 County: Lanier Date Sampled: 1990/02/14	7.7	47	16	4.6	2 U	20 U	10 U	3.2	67.4	0.1 U	29	190	310		10
GWN-PA21 Well Name: Valdosta #1 County: Lowndes Date Sampled: 1990/02/14	7.5	34	4.3	4	2	21	10	4.2	35	0.1	44	54	188	Al = 38 Cu = 24	5, 8, 9, 10
GWN-PA22 Well Name: Thomasville #6 County: Thomas Date Sampled: 1990/02/21	7.6	45	20	8.2	2 U	20 U	10 U	6.9	70	0.1 U	24	380	380		
GWN-PA23 Well Name: Cairo #8 County: Grady Date Sampled: 1990/02/21	7.7	34	16	11	2.4	20 U	10 U	5.3	31.6	0.1 U	140	320	328	Mo = 43	10
GWN-PA24 Well Name: Bainbridge #1 County: Decatur Date Sampled: 1990/02/21	7.7	38	3.2	2	2 U	20 U	10 U	2.9	2 U	1.2	10 U	37	214		1, 3, 5, 7, 10
GWN-PA24 Well Name: Bainbridge #1 County: Decatur Date Sampled: 1990/08/21	7.8	40	3.7	1.7	0.5 U	20 U	10 U	3.4	0.9	1.2	10 U	39	220		1, 3, 5, 7, 10

1990 Groundwater Quality Analyses of the Floridan Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-PA25	7.4	55	1 U	3.9	2 U	20 U	10 U	4.5	2 U	1.2	10 U	25	275		Cn, 1, 3, 5, 10
Well Name: Donalsonville, East 7th Street Well County: Seminole Date Sampled: 1990/02/21															
GWN-PA25	7.6	55	1 U	3.6	0.5 U	20 U	10 U	7	0.6	1.3	10 U	27	284	Al = 68	Cn, 1, 3, 5, 10
Well Name: Donalsonville, East 7th Street Well County: Seminole Date Sampled: 1990/08/21															
GWN-PA26	7.5	45	1 U	2.3	2 U	20 U	10 U	3.2	2 U	1.5	10 U	20	224		1, 3, 5, 10
Well Name: Colquitt #3 County: Miller Date Sampled: 1990/02/21															
GWN-PA26	7.6	46	1 U	1.9	0.5 U	20 U	10 U	4.1	0.8	1.9	10 U	21	235	Al = 70	
Well Name: Colquitt #3 County: Miller Date Sampled: 1990/08/21															
GWN-PA27	7.4	47	1.3	2	2 U	20 U	10 U	2.4	2 U	0.3	12	40	232	Sn = 34	1, 3, 5, 8, 9, 10
Well Name: Camilla New Well (#4) County: Mitchell Date Sampled: 1990/02/20															
GWN-PA28	7.7	*	*	*	*	*	*	10.4	96.2	0.1 U	*	*	471		
Well Name: Moultrie #1 County: Colquitt Date Sampled: 1990/02/21															

* Sample was lost before screen could be run

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-PA29 Well Name: Adel #6 County: Cook Date Sampled: 1990/02/14	7.7	55	18	4.4	2 U	69	29	4	79.6	0.1 U	15	370	325		Cn, 1, 5, 10
GWN-PA30 Well Name: Nashville Mills #2, Amoco Fabrics Company County: Berrien Date Sampled: 1990/02/14	7.9	45	16	5	2 U	2 U	2 U	4.6	66.5	0.1 U	55	240	284	Zn = 24	
GWN-PA32 Well Name: Ocilla #3 County: Irwin Date Sampled: 1990/02/14	7.7	32	4.1	2.9	5 U	160	25	2.4	2 U	0.1 U	74	140	177		
GWN-PA33 Well Name: Fitzgerald Well C County: Ben Hill Date Sampled: 1990/02/13	7.9	24	8.3	2.9	2 U	20 U	25 U	2.2	2 U	0.1 U	2,200	260	152		10
GWN-PA34 Well Name: McRae #1 County: Telfair Date Sampled: 1990/12/04	7.5	49	9.7	5.3	5 U	180	99	2.7	8.2	0.1 U	260	690	321	Al = 85 BI = 50	
GWN-PA35 Well Name: Mount Vernon New Well County: Montgomery Date Sampled: 1990/12/ 4	7.7	28	12	6.2	5 U	58	30	4	7.9	0.1 U	90	460	268		

1990 Groundwater Quality Analyses of the Floridan Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-PA36 Well Name: Vidalia #1 (Sixth Street Well) County: Toombs Date Sampled: 1990/12/04	7.8	28	5.1	12	5 U	22	37	2.8	3.5	0.1 U	140	350	225	Al = 46	
GWN-PA37 Well Name: Hogan Monitoring Well County: Laurens Date Sampled: 1990/01/25	7.5	46	1 U	1.3	3 U	<u>630</u>	11	1 U	2 U	1.7	16	25	227	Tl = 43 Zn = 77	
GWN-PA37 Well Name: Hogan Monitoring Well County: Laurens Date Sampled: 1990/12/05	7.5	44	1 U	2.4	5 U	<u>560</u>	10 U	1.7	6.1	3.3	14	22	233	Al = 93 Zn = 32	
GWN-PA38 Well Name: Eastman #4 County: Dodge Date Sampled: 1990/12/04	7.6	44	1.3	2.5	5 U	20 U	10 U	2.7	0.8	0.2	110	89	226	Al = 77	
GWN-PA39A Well Name: Sylvester #2 County: Worth Date Sampled: 1990/ 8/21	7.6	51	5.3	3	5 U	20 U	10 U	2.3	0.9	0.1 U	170	290	284	Al = 60	1, 3, 5, 10
GWN-PA43 Well Name: Newton #1 County: Baker Date Sampled: 1990/02/21	7.5	46	1 U	2.9	2 U	20 U	10 U	3.2	2 U	1.4	10 U	41	234		1,3,5,10

1990 Groundwater Quality Analyses of the Floridan Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected ug/L	Other Screens Tested
UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm		
WELL ID#															
GWN-PA43	7.7	46	1.1	2.6	0.5 U	20 U	10 U	4.6	0.9	1.5	10 U	46	232	Al = 59	1, 3, 5, 10
Well Name: Newton #1															
County: Baker															
Date Sampled: 1990/08/21															
GWN-PA45	7.6	48	3.5	2.4	2 U	60	10 U	2.6	3.8	0.1 U	16	210	2.4	Al = 38	1, 3, 5, 10
Well Name: Abbeville #2															
County: Wilcox															
Date Sampled: 1990/02/13															
GWN-PA48	7.6	50	1 U	2.1 U	0.5 U	20	10 U	3.6	0.4	2	10 U	26	238	Al = 79	Cn, 1, 3, 5, 10
Well Name: Doug Harvey TW 1															
County: Early															
Date Sampled: 1990/08/20															
GWN-PA50	7.5	59	1.4	2.9	5 U	87	10 U	5.5	5.2	1.1	40	170	286	Al = 120 Zn = 21	1, 5
Well Name: Reynolds Residence Well															
County: Laurens															
Date Sampled: 1990/12/ 5															
Average:	7.66	42.6	6.1	4.65	3.11	86.67	19.85	3.72	15.27	0.651	54.21	188.73	255.68		
Maximum;	7.9	59	590	12	5	610	99	10.4	96.2	3.3	2,200	690	471		
Minimum:	7.4	24	1	1.3	0.5	20	10	1	0.6	0.1	10	20	152		
Standard Deviation:	0.148	9.13	6.12	3.25	2.12	166.6	17.5	1.97	25.4	0.8	63.24	165.28	63.45		

1990 Groundwater Quality Analyses of the Miocene Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-MI1 Well Name: McMillan Residence Well County: Cook Date Sampled: 1990/02/14	7.9	24	13	7.5	2	20 U	25 U	2.8	3.8	0.1 U	21	120	173	Zn = 22	10
GWN-MI1 Well Name: McMillan Residence Well County: Cook Date Sampled: 1990/08/21	7.9	24	14	6.8	0.5 U	25	26	2.3	1	0.1 U	21	130	237	Al = 29 Bi = 14	Cn, 1, 5, 10
GWN-MI2 Well Name: Boutwell Residence Well County: Lowndes Date Sampled: 1990/02/14	6	3.1	1	2.6	2	20 U	25 U	2.6	2 U	0.1 U	10 U	10 U	26		1, 5, 8, 9, 10
GWN-MI2 Well Name: Boutwell Residence Well County: Lowndes Date Sampled: 1990/08/21	5.7	3	1	2.3	0.5 U	20 U	10 U	2.9	3.7	0.1 U	10 U	10 U	39		1, 5, 8, 9, 10
GWN-MI3 Well Name: Coffin Park TW 3 County: Glynn Date Sampled: 1990/08/07	7.6	70	12	21	0.5 U	<u>630</u>	24	18.5	33	0.1 U	15	510	504	Al = 130 Bi = 14 Zn = 120	10
GWN-MI4 Well Name: Hopeulikit TW 2 County: Bulloch Date Sampled: 1990/01/23	7.2	16	5	7.5	3 U	<u>430</u>	<u>99</u>	2.9	4.4	0.1 U	82	88	140	Al = 91	

1990 Groundwater Quality Analyses of the Miocene Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-MI4 Well Name: Hopeulikit TW 2 County: Bulloch Date Sampled: 1990/08/07	7.3	18	5.5	6	0.5 U	<u>1,000</u>	<u>120</u>	3.1	4.4	0.1 U	88	100	172	Al = 110 Sb = 37	
GWN-MI6 Well Name: Williams Residence Well County: Coffee Date Sampled: 1990/12/ 4	5.1	10	7.9	6.3	5 U	20 U	<u>77</u>	13.2	2 U	<u>14</u>	210	90	17	Al = 360 Bi = 48	
GWN-MI7 Well Name: Chaudoin Residence Well County: Irwin Date Sampled: 1990/10/09	4.3	3.8	3.7	4	5 U	20 U	11	9.4	2 U	7.7	64	42	108	Al = 430 Bi = 14 Zn = 20	1
GWN-MI8A Well Name: S. Berry Residence Well County: Colquitt Date Sampled: 1990/10/10	4.5	5.4	4.3	6.1	5 U	130	33	12.8	2 U	9.2	89	50	135	Al = 980 Bi = 20 Zn = 36	1, 5
GWN-MI9A Well Name: H. Murphy Garden Well County: Thomas Date Sampled: 1990/10/18	5.4	3.8	2.4	4.9	5 U	<u>320</u>	32	6.8	2 U	4.7	30	26	72	Al = 600 Bi = 17 Cu = 24 Tl = 28	
GWN-MI10A Well Name: R. Burgess Residence Well County: Colquitt Date Sampled: 1990/10/10	5.2	1 U	2.7	4	5 U	<u>560</u>	10 U	10.2	2 U	3.3	34	21	73	Al = 1500 Tl = 52	1, 5

1990 Groundwater Quality Analyses of the Miocene Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-MI11	5.2	1.8	1.4	4.2	5 U	220	10 U	6.9	2 U	1.7	32	15	49	Al = 400 Tl = 10	1
Well Name: Harrison Residence Well County: Grady Date Sampled: 1990/10/10															
GWN-MI12	7.4	49	1.4	1.9	5 U	130	13	3.9	2 U	0.1 U	12	41	244		1, 5
Well Name: Herzog Greenhouse Well County: Brooks Date Sampled: 1990/10/09															
Average:	6.19	12.57	5.37	6.07	3.14	195.8	36.78	7.02	4.73	2.1	51.3	57.15	114		
Maximum:	7.9	70	14	21	5	1,000	120	18.5	33	14	210	510	504		
Minimum:	4.3	1	1	1.9	2	20	10	2.3	1	0.1	10	10	17		
Standard Deviation:	1.3	13.76	4.58	4.68	2.05	220.7	35.5	5.1	4.94	3.19	54.3	43	76.6		

1990 Groundwater Quality Analyses of the Piedmont Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-P1	6.3	8.1	2.5	9.3	5 U	2,100	55	1 U	2 U	0.1 U	10 U	94	113		
Well Name: Luthersville New Well County: Meriwether Date Sampled: 1990/09/19															
GWN-P2	6.7	17	1.8	11	5 U	2,700	77	1.2	8.5	0.1 U	36	100	146	Zn = 530	
Well Name: Riverdale, Delta Drive Well County: Clayton Date Sampled: 1990/11/21															
GWN-P4C	6.3	19	3.4	33	5 U	500	690	17.4	9.7	0.5	77	270	270	Co = 13 Zn = 37	8, 9, 10
Well Name: Barton Brands, Inc. #3 County: Fulton Date Sampled: 1990/09/18															
GWN-P5	6.8	26	3.9	1.6	5 U	20 U	10 U	1.6	1.5	0.1 U	33	96	148	Al = 50	
Well Name: Flowery Branch #1 County: Hall Date Sampled: 1990/11/20															
GWN-P7	6.5	12	4.7	7.9	5 U	20 U	10 U	2.2	3.7	0.2	54	75	138	Zn = 36	
Well Name: Hampton #6 County: Henry Date Sampled: 1990/09/18															
GWN-P8	7	32	9	9.5	5 U	20 U	10 U	2.4	4.9	0.3	10 U	88	250	Al = 48	
Well Name: Wayne Poultry Company #4, Pendergrass County: Jackson Date Sampled: 1990/11/20															

1990 Groundwater Quality Analyses of the Piedmont Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-P9 Well Name: Gray #4 County: Jones Date Sampled: 1990/08/08	6.2	16	8	13	0.5 U	1,400	170	9.4	45.6	0.1 U	35	120	2.7	Al = 65 Bi = 12 Co = 10	10
GWN-P10 Well Name: Franklin Springs Well County: Franklin Date Sampled: 1990/09/10	5.9	4.9	3.6	5.9	5 U	11,400	140	2.6	1	0.9	15	60	97		
GWN-P11 Well Name: Danielsville #2 County: Madison Date Sampled: 1990/11/20	6.6	12	5.1	7.1	5 U	150	20	2.8	2.8	0.7	11	35	131	Zn = 22	
GWN-P12 Well Name: Nabisco Plant Well #1, Woodbury County: Meriwether Date Sampled: 1990/09/18	6.2	12	2.6	13	0.5 U	20 U	10 U	12.1	3.6	2.6	46	82	158	Zn = 370	
GWN-P14 Well Name: Upson County, Sunset Village Well #1 County: Upson Date Sampled: 1990/09/19	6.2	1 U	1 U	1 U	5 U	91	10 U	1.4	0.5	0.2	30	10 U	17		
GWN-P15A Well Name: Bolton Garden Well County: Dekalb Date Sampled: 1990/12/17	7.2	20	4.7	8.1	5 U	450	120	8.8	7.6	0.2 U	65	97	157	F = 0.3 mg/L Zn = 98 Al = 21	

1990 Groundwater Quality Analyses of the Piedmont Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
WELL ID#															
GWN-P16C	6.6	8.6	1.8	2.4	5 U	1,500	66	2.5	18.8	0.1 U	10 U	54	72		10
Well Name: Mt. Airy #4, Chase Road Well															
County: Habersham															
Date Sampled: 1990/ 9/10															
Average:	6.44	14.05	3.95	9.55	4.25	756	52.3	4.71	5.08	0.49	30.58	90.3	140		
Maximum;	7	32	9	33	5	11,400	170	17.4	45.6	2.6	77	270	270		
Minimum:	5.9	1	1	1	0.5	20	10	1	0.5	0.1	10	10	2.7		
Standard Deviation:	0.311	8.71	2.45	8.45	1.75	986	54.2	5.3	5.4	0.715	21	64.21	72		

1990 Groundwater Quality Analyses of the Blue Ridge Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-BR1A	6.9	21	1.7	4.7	0.5 U	66	81	1.9	0.6	1	20	170	134		10
Well Name: Hiawassee #7															
County: Towns															
Date Sampled: 1990/09/11															
GWN-BR2	5.8	2.8	1.1	2.7	5 U	56	10	1.2	1.9	0.1 U	35	32	44		
Well Name: Notla Water Authority #3															
County: Union															
Date Sampled: 1990/09/11															
GWN-BR4	6.5	9.4	2.1	7.1	5 U	20 U	10 U	5.3	15.3	0.1 U	10 U	87	93		Cn, 10
Well Name: Morganton Old Well															
County: Fannin															
Date Sampled: 1990/09/11															
Average:	6.4	11.07	1.63	4.83	3.5	47.3	33.6	2.8	5.9	0.4	21.7	96.3	90.3		
Maximum:	6.9	21	2.1	7.1	5	66	81	5.3	15.3	1.0	35	170	134		
Minimum:	5.8	2.8	1.1	2.7	0.5	20	10	1.2	0.6	0.1	10	30	44		
Standard Deviation:	0.56	9.21	0.503	2.2	2.6	24.2	40.99	2.2	8.14	.52	12.6	69.47	45		

1990 Groundwater Quality Analyses of the Valley And Ridge Unconfined Aquifer System

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-VR1 Well Name: Kingston Road Well, Rome County: Floyd Date Sampled: 1990/08/15	7.8	38	13	1.1	0.5 U	27	10 U	1.7	1	0.4	12	27	234	Al = 90 Bi = 16	10
GWN-VR2 Well Name: Tri-County Hospital Well - Ft. Oglethorpe County: Catoosa Date Sampled: 1990/ 1/30	6.7	51	19	26	3 U	<u>310</u>	21	3.3	23.8	0.1 U	26	64	481	Al = 320 Cu = 37	
GWN-VR2 Well Name: Tri-County Hospital Well - Ft. Oglethorpe County: Catoosa Date Sampled: 1990/08/14	6.9	74	25	16	0.5 U	<u>410</u>	<u>700</u>	18.6	15.2	0.6	36	84	554	Al = 110 Bi = 33 Benzene = 413 Tetrachloroethylene = 2.4 Toluene = 137.8 Ethylbenzene 11.1 O-xylene = 62.3 P-xylene = 41.2 Naphthalene = 9	10
GWN-VR3 Well Name: Chickamauga, Crawfish Springs County: Walker Date Sampled: 1990/ 1/30	7.5	29	11	2.2	3 U	20 U	10 U	1.7	2.7	0.1 U	68	25	217	Al = 60	10
GWN-VR3 Well Name: Chickamauga, Crawfish Springs County: Walker Date Sampled: 1990/08/14	7.6	30	14	1 U	0.5 U	20 U	10 U	1.4	1.9	0.5	87	10 U	241		

1990 Groundwater Quality Analyses of the Valley And Ridge Unconfined Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected	Other Screens Tested
UNITS / WELL ID#	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm	ug/L	
GWN-VR4	7.3	85	21	18	0.5 U	160	23	12.8	54	0.1 U	130	760	572	Al = 120 Bi = 23	
Well Name: American Thread Company #4 County: Walker Date Sampled: 1990/08/14															
GWN-VR5	7.1	78	4.1	5.6	0.5 U	20 U	10 U	9.6	3.1	3.1	120	190	410		10
Well Name: Chattooga County #4 County: Chattooga Date Sampled: 1990/08/14															
GWN-VR6	7.8	29	17	6	0.5 U	20 U	10 U	4.2	4.3	0.6	630	140	270	Al = 73 Zn = 53	10
Well Name: Chemical Products Corporation, East Well County: Bartow Date Sampled: 1990/08/14															
GWN-VR7	7.6	30	15	1 U	0.5 U	20 U	10 U	1.2	1.2	0.3	35	25	235	Al = 68	10
Well Name: Adairsville, Lewis Spring County: Bartow Date Sampled: 1990/08/14															
GWN-VR8	7.6	34	16	1	0.5 U	20 U	10 U	1.7	1.7	0.4	13	22	262	Al = 52	
Well Name: Cedartown Spring County: Polk Date Sampled: 1990/08/15															

1990 Groundwater Quality Analyses of the Valley And Ridge Unconfined Aquifer System Continued

PARAMETER	pH	Ca	Mg	Na	K	Fe	Mn	Cl	SO4	NO2 &NO3	Ba	Sr	Spec. Cond.	Other Parameters Detected ug/L	Other Screens Tested
UNITS	SU	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	mg/L	mg/L	mgN/L	ug/L	ug/L	umho/cm		
WELL ID#															
GWN-VR9	7.6	38	13	1.1	0.5 U	27	10 U	2.3	2	0.7	12	27	273	Al = 90 Bi = 16	
Well Name: Polk County #2 County: Polk Date Sampled: 1990/08/15															
Average:	7.41	46.9	15.28	7.2	0.954	95.81	12.4	5.318	5.69	0.67	53.9	125	340		
Maximum:	7.8	85	25	26	3	410	700	18.6	54	3.1	630	760	572		
Minimum:	6.7	29	4.1	1	0.5	20	10	2.3	1	0.1	12	10	217		
Standard Deviation:	0.364	21.7	5.47	8.75	1.01	138	5.08	5.8	7.61	0.85	44.84	218	136		

For convenience in selecting our reports from your bookshelves, they are color-keyed across the spine by subject as follows:

Red	Valley and Ridge mapping and structural geology
Dk. Purple	Piedmont and Blue Ridge mapping and structural geology
Maroon	Coastal Plain mapping and stratigraphy
Lt. Green	Paleontology
Lt. Blue	Coastal Zone studies
Dk. Green	Geochemical and geophysical studies
Dk. Blue	Hydrology
Olive	Economic geology
	Mining directory
Yellow	Environmental studies
	Engineering studies
Dk. Orange	Bibliographies and lists of publications
Brown	Petroleum and natural gas
Black	Field trip guidebooks
Dk. Brown	Collections of papers

Colors have been selected at random, and will be augmented as new subjects are published.

Publications Consultant: Patricia Allgood

$421/100