GROUNDWATER QUALITY IN GEORGIA FOR 2023

Anthony W. Chumbley and John R. Scroggs

GEORGIA DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
WATERSHED PROTECTION BRANCH
WATERSHED PLANNING AND MONITORING PROGRAM

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CIRCULAR 12AK

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CHAPTER 1 INTRODUCTION

1.1 PURPOSE AND SCOPE

This report, covering the calendar year 2023, is the thirty-seventh of the Circular 12 series. The first 19 reports, Circulars 12A through 12S, summarized the chemical quality of groundwater statewide across Georgia and utilized a static array of sampling stations that were sampled periodically, typically on a semiannual, annual, or biennial basis. The next five reports, Circulars 12T through 12X, dealt with specialized chemical groundwater quality issues: water quality in the Coastal region, water quality available to small public water systems, water quality in the Piedmont/Blue Ridge physiographic province, groundwater uranium in Georgia and groundwater arsenic in Georgia. With this report and its predecessors, Circular 12Y, 12Z and 12AA through 12AJ continuing to monitor the chemical quality of groundwater in Georgia using a static array of periodically sampled stations.

These summaries are among the tools used by the Georgia Environmental Protection Division (EPD) to assess trends in the quality of the State's groundwater resources. EPD is the State organization with regulatory responsibility for maintaining and where possible, improving groundwater quality and availability. EPD has implemented a comprehensive statewide groundwater management policy of anti-degradation (EPD, 1991; 1998). Four components comprise EPD's current groundwater quality assessment program:

1. The Georgia Groundwater Monitoring Network: EPD's Watershed Protection Branch, Source Water Assessment Program, took over the Georgia Groundwater Monitoring Network from the Regulatory Support Program when that program disbanded in 2012. The Monitoring Network is designed to evaluate the ambient groundwater quality of eight aquifer systems present in the State of Georgia. The data collected from sampling of the Groundwater Monitoring Network form the basis for this report.

2. Water Withdrawal Program (Watershed Protection Branch, Water Supply Section): This program provides data on the quantity of groundwater that the residents of Georgia are using.

3. Groundwater sampling at environmental facilities such as municipal solid waste landfills, Resource Conservation Recovery Act (RCRA) facilities, and sludge disposal facilities. The primary agencies responsible for monitoring these facilities are EPD's Land Protection and Watershed Protection Branches.

4. The Wellhead Protection Program (WHP), which is designed to protect areas surrounding municipal drinking water wells from contaminants. The United States Environmental Protection Agency (EPA) approved Georgia's WHP Plan on September 30, 1992. The WHP Plan became a part of the Georgia Safe Drinking Water Rules, effective July 1, 1993. The protection of public supply wells from contaminants is important not only for maintaining groundwater quality, but also for ensuring that public water supplies meet health standards.

Analyses of water samples collected for the Georgia Groundwater Monitoring Network during the period January 2023 through December 2023 and from previous years form the database for this summary. The Georgia Groundwater Monitoring Network is presently comprised of 132 stations, both wells and springs. Nineteen of the stations are scheduled for quarterly sampling; the remainder are scheduled to be sampled yearly. Each sample receives laboratory analyses for chloride, sulfate, fluoride, nitrate/nitrite, total phosphorus, 26 metals, and volatile organic compounds (VOCs). Field measurements of pH, conductivity, and temperature are performed on the sample water from each station. Field dissolved oxygen measurements are made on sample water from wells.

During the January 2023 through December 2023 period, Groundwater Monitoring staff collected 177 samples from 120 wells and 12 springs. A review of the data from this period and comparison of these data with those for samples collected for preceding monitoring efforts indicated that groundwater quality at most of the 132 stations has remained good.

1.2 FACTORS AFFECTING CHEMICAL GROUNDWATER QUALITY

The chemical quality of groundwater is the result of complex physical, chemical, and biological processes. Among the more significant controls are the chemical quality of the water entering the groundwater flow system, the reactions of the infiltrating water with the soils and rocks that are encountered, and the effects of the well-and-pump system.

Most water enters the groundwater system in upland recharge areas and in areas of leakage from adjacent geologic units. Water seeps through interconnected pore spaces and fractures in the soils and rocks until discharged to a surface water body (e.g., stream, lake, or ocean). The initial water chemistry, the amount of recharge, and the attenuation capacity of soils have a strong influence on the quality of groundwater in recharge areas. Chemical interactions between the water and the aquifer host rocks have an increasing significance with longer residence times. As a result, groundwater from discharge areas tends to be more highly mineralized than groundwater in recharge areas.

The well-and-pump system can also have a strong influence on the quality of the well water. Well casings, through compositional breakdown, can contribute metals (e.g., iron from steel casings) and organic compounds (e.g., tetrahydrofurans from PVC pipe cement) to the water. Pumps can aerate the water being drawn up and discharged. An improperly constructed or failing well can offer a conduit that allows local pollutants to enter the groundwater flow system.

1.3 HYDROGEOLOGIC PROVINCES OF GEORGIA

This report defines three hydrogeologic provinces by their general geologic and hydrologic characteristics (Figure 1-1). These provinces consist of:

1. The Coastal Plain Province of south Georgia;
2. The Piedmont/Blue Ridge Province, which includes all of north Georgia but the northwestern corner;
3. The combined Valley and Ridge and Appalachian Plateau Provinces of northwest Georgia.

1.3.1 Coastal Plain Province

Georgia's Coastal Plain Province generally comprises a wedge of loosely consolidated sediments and limestone rock that gently dip and thicken to the south and southeast. Groundwater in the Coastal Plain flows through interconnected pore space between grains and through solution-enlarged voids in carbonate rock.

The oldest outcropping sedimentary formations (Cretaceous) are exposed along the Fall Line (Figure 1-1), 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 of Georgia contains several confined and unconfined aquifers. Confined aquifers are those in which the readily permeable layer of aquifer medium is interposed between two layers of poorly permeable material (e.g., clay or shale). If the water pressure in such an aquifer exceeds atmospheric pressure, the aquifer is artesian. Water from precipitation and runoff enters the aquifers and aquifer systems in their updip outcrop areas, where permeable sediments hosting the aquifer are exposed. Water may also enter the aquifers downdip from the recharge areas through leakage from overlying or underlying aquifers. Most Coastal Plain aquifers are unconfined in their updip outcrop areas, but become confined in downdip areas to the south and southeast, where they are overlain by successively younger rock formations. Groundwater flow through confined Coastal Plain aquifers is generally to the south and southeast, in the direction of dip of the sedimentary layers.

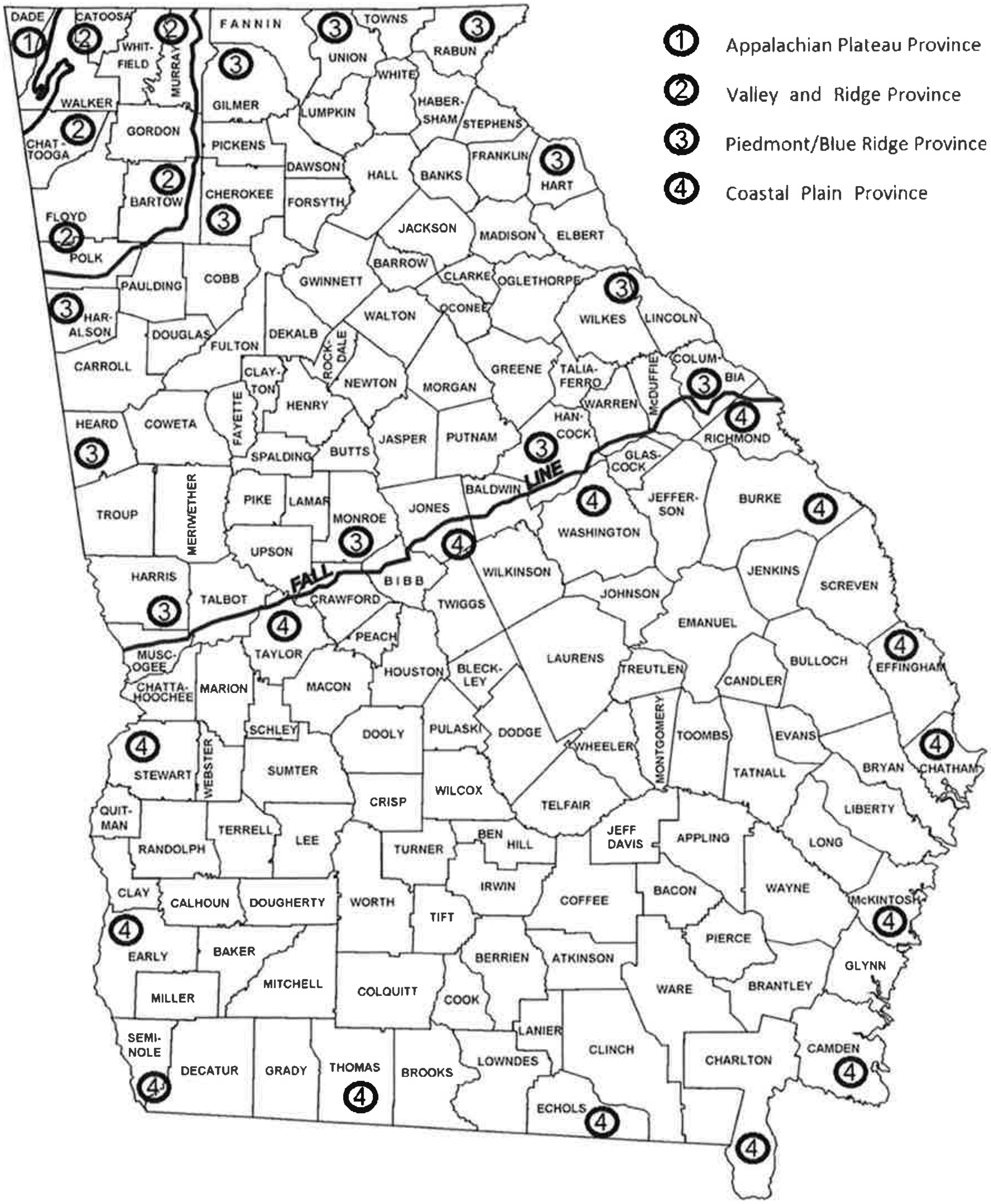

Figure 1-1. The Hydrogeologic Provinces of Georgia

The sediments forming the major aquifer systems in the Coastal Plain range in age from Cretaceous to Holocene. Horizontal and vertical changes in the sediment layers that form these aquifer systems determine the thickness and extent of the aquifer systems. Several aquifer systems may be present in a single geographic area forming a vertical "stack".

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. However, the aquifer systems do extend downdip of the band. A well has been planned to test the Cretaceous aquifer along the Atlantic Coast for water supply development. Southwestern Georgia relies on the upper part of the Cretaceous aquifer system, plus three vertically stacked aquifer systems: the Clayton, the Claiborne, and the Floridan aquifer systems for drinking water supplies. The Miocene/Surficial aquifer system (primarily sands) is the principal shallow aquifer system occupying much of the same broad area occupied by the Floridan aquifer system in central and eastern Georgia. The system is unconfined over most of its inland extent but becomes partly confined both in the coastal area and in the Grady, Thomas, Brooks, and Lowndes County area of South Georgia.

1.3.2 Piedmont/Blue Ridge Province

Though the Piedmont and Blue Ridge Physiographic Provinces differ geologically and geomorphologically, the two physiographic provinces share common hydrogeological characteristics and thus can be treated as a single hydrogeologic province. A two-part aquifer system characterizes the Piedmont/Blue Ridge Province (Daniel and Harned, 1997). The upper part of the system is the regolith aquifer, composed of saprolite and overlying soils and alluvium. The regolith aquifer is unconfined, and the water resides primarily in intergranular pore spaces (primary porosity). The lower aquifer in the Piedmont/Blue Ridge aquifer system is the bedrock aquifer. This aquifer is developed in metamorphic and igneous bedrock (mostly Paleozoic and Precambrian in age); the water resides in fractures and, in the case of marbles, solution-enlarged voids (secondary porosity). In contrast to the regolith aquifer, no intergranular (primary) porosity exists in the bedrock aquifer. The bedrock aquifer is semi-confined with the overlying regolith aquifer media and the bedrock itself offering local confinement to the fractures and voids. The regolith aquifer also serves as the reservoir that recharges the bedrock aquifer.

1.3.3 Valley and Ridge Province

Faulted and folded consolidated Paleozoic sedimentary formations characterize the Valley and Ridge Province. The principal porosity present in aquifer media consists of fractures and solution-enlarged voids in the carbonate rocks; intergranular porosity may be important in some places. Locally, groundwater and surface-water systems closely interconnect. Dolostones and limestones of the Knox Group are the principal aquifers where they occur in fold axes at the centers of broad valleys. The greater hydraulic conductivities of the thick carbonate sections in this province permit higher yielding wells than in the Piedmont/Blue Ridge Province.

1.3.4 Appalachian Plateau Province

Rocks in this province consist of consolidated Paleozoic sediments inclusive of the Mississippian and Pennsylvanian. Faulting and folding are less intense than in the Valley and Ridge province, and sediments tend to be flatter lying and more continuous areally. As in the Valley and Ridge Province, secondary porosity is the most important type of porosity. The highly fractured Fort Payne Chert and the Knox Group are major water-bearing units in this province.

Only a small part of this province extends into Georgia, at the State's far northwest corner (Dade County and parts of Chattooga and Walker Counties). Due to its small extent in Georgia and its lack of monitoring stations for the current project, the Appalachian Plateau Province is combined with the Valley and Ridge Province for the purposes of this report.

1.4 REGIONAL GROUNDWATER PROBLEMS

Data from groundwater investigations in Georgia, including those from the Groundwater Monitoring Network, indicate that virtually all of Georgia has shallow groundwater sufficient for domestic supply. Iron, manganese and aluminum are the only constituents that occur routinely in concentrations exceeding drinking water standards. These metals are mostly naturally occurring and do not pose a health risk. Iron and manganese can cause reddish or yellowish-brown to dark brown or black stains on objects and can give water a bitter metallic taste. Aluminum can cause water to appear cloudy.

In the karstic carbonate terranes of the combined Valley and Ridge/ Appalachian Plateau Province and the Coastal Plain Providence of southwest Georgia, interconnection between the surface water systems and the groundwater systems can be extensive enough such that waters supplying some wells and springs (e.g., Crawfish Spring and Cedartown Spring) have been deemed under direct surface influence, requiring surface water type treatment if used for public supplies.

In the Piedmont/Blue Ridge Province, water available to wells drilled into bedrock consisting of granitic intrusive rocks, granitic gneisses, or hornblende gneiss/ amphibolite assemblages occasionally may contain excessive naturally occurring uranium.

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 neutralize acidic rainwater and from biologically influenced reactions between infiltrating water and soils. Groundwater from the Cretaceous along the coast is typically brackish but may be fresh at some locations.

Nitrate/nitrite concentrations in shallow groundwater from the farm belt in southern Georgia are usually within drinking water standards but are somewhat higher than levels found in other areas of the State.

Three areas of naturally reduced groundwater quality occur in the Floridan aquifer system. The first is the karstic Dougherty Plain of southwestern Georgia. The second is the Gulf Trough area. The third is in the coastal area of east Georgia.

In the Dougherty Plain, as with the carbonate terranes of northwestern Georgia, surface waters and the contaminants they entrain can directly access the aquifer through sink holes.

The Gulf Trough is a linear geologic feature extending from southwestern Decatur County through northern Effingham County and may represent a filled marine current channel (Huddleston, 1993). Floridan groundwater in and near the trough may be high in total dissolved solids and may contain elevated levels of sulfate, barium, radionuclides, and arsenic (Kellam and Gorday, 1990; Donahue et al., 2013).

In the Coastal area of east Georgia, the influx of water with high dissolved solids content can dramatically raise levels of sodium, calcium, magnesium, sulfate, and chloride. In the Brunswick part of the Coastal area, groundwater withdrawal from the upper permeable zone of the Floridan aquifer system results in the upwelling of groundwater with high dissolved solids content from the deeper parts of the aquifer system (Krause and Clarke, 2001). In the Savannah portion of the Coastal area, heavy pumping in and around Savannah and Hilton Head, South Carolina has caused a cone of depression which has induced seawater to enter the Floridan aquifer system in South Carolina and to flow down-gradient toward Savannah. The seawater has not yet reached Savannah and may not reach Savannah for many years. The seawater enters the aquifer system via breaches in the Miocene confining unit along the bottoms of waterways and sand-filled paleochannels offshore of the Beaufort/Hilton Head area of South Carolina in what is referred to as the Beaufort Arch; where the top of the Floridan aquifer system is closer to the ocean water (Foyle et al., 2001; Krause and Clarke, 2001).

CHAPTER 2 GEORGIA GROUNDWATER MONITORING NETWORK

2.1 MONITORING STATIONS

For the period January 2023 through December 2023, attempts were made to place sampling stations in the Coastal Plain Province's six major aquifer systems, in the Piedmont/Blue Ridge Province, and in the Valley and Ridge/ Appalachian Plateau Province (Table 2-1). Stations are restricted to wells or springs that are for the most part tapping a single aquifer or aquifer system. Attempts were made to have some monitoring stations located in the following critical settings:

1. areas of recharge;
2. areas of possible pollution or contamination related to hydrogeologic settings (e.g., granitic intrusions, the Dougherty Plain, and the Gulf Trough);
3. areas of significant groundwater use.

Most of the monitoring stations are municipal, industrial, and domestic wells that have well construction data.

2.2 USES AND LIMITATIONS

Regular sampling of wells and springs of the Groundwater Monitoring Network permits analysis of groundwater quality with respect to location (spatial trends) and 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 groundwater quality. Temporal trends permit an assessment of the effects of rainfall and drought periods on groundwater quality and quantity. Both trends are useful for the detection of non-point source pollution. Non-point source pollution arises from broad-scale phenomena such as acid rain deposition and application of agricultural chemicals on crop lands.

It should be noted that the data of the Groundwater Monitoring Network represent water quality in only limited areas of Georgia. Monitoring water quality at the 132 sites located throughout Georgia provides an indication of groundwater quality at the locality sampled and at the horizon corresponding to the open interval in the well or to the head of the spring at each station in the Monitoring Network. Caution should be exercised in drawing unqualified conclusions and applying any results reported in this study to groundwaters that are not being monitored.

Table 2-1. Georgia Groundwater Monitoring Network, Calendar Year 2023.

Aquifer or Aquifer System	Number of Stations Visited (Samples Taken)	Primary Stratigraphic Equivalents	Age of Aquifer Host Rocks
Cretaceous	21 stations (21 samples)	Ripley Formation, Cusseta Sand, Blufftown Formation, Eutaw Formation, Tuscaloosa Formation, Providence Sand, Steel Creek Formation, Gaillard Formation, Pio Nono Formation	Late Cretaceous
Clayton	5 stations (5 sample)	Clayton Formation	Paleocene
Claiborne	3 stations (3 samples)	Claiborne Group	Middle Eocene
Jacksonian	10 stations (10 samples)	Barnwell Group	Late Eocene
Floridan	35 stations (54 samples)	Ocala Group, Suwanee Limestone	Middle Eocene to Early Oligocene
Miocene/Surficial	6 stations (6 samples)	Hawthorne Group, Miccosukee Formation, Cypresshead Formation	Miocene to Recent
Piedmont/Blue Ridge	45 stations (68 samples)	Various igneous and metamorphic complexes	Precambrian and Paleozoic
Valley and Ridge/ Appalachian Plateau	7 stations (10 samples)	Shady Dolomite, Knox Group, Conasauga Group	Paleozoic, mainly Cambrian, Ordovician

Stations of the Groundwater Monitoring Network are intentionally located away from known point sources of pollution. The stations provide baseline data on ambient water quality in Georgia. EPD requires other forms of groundwater 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.

Groundwater quality changes gradually and predictably in the areally extensive aquifer systems 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 in the surface recharge areas of southern Georgia are of comparatively small extent and more open to interactions with land use activities. The wide spacing of most monitoring stations does not permit equal characterization of water-quality processes in these settings. The quality of water from monitoring stations drawing from unconfined aquifers represents only the general nature of groundwater in the vicinity of the stations. Groundwater in the recharge areas of the Coastal Plain aquifer systems is one of the future drinking-water resources for down-flow areas. Monitoring stations in these recharge areas, in effect, constitute an early warning system of potential future water quality problems in confined portions of the Coastal Plain aquifer systems.

2.3 ANALYSES AND DATA RETENTION

Analyses are available for 177 water samples collected from 132 stations (120 wells and 12 springs) during the period January 2023 through December 2023. In 1984, the first year of the Groundwater Monitoring Network, EPD staff sampled from 39 wells in the Piedmont/Blue Ridge and Coastal Plain Provinces. Between 1984 and 2004, the network had expanded to include 128 stations situated in all three hydrogeologic provinces, with most of the stations being in the Piedmont and Coastal Plain Provinces, the largest hydrogeologic provinces in Georgia.

Groundwater from all monitoring stations is tested for chloride, sulfate, fluoride, nitrate/nitrite, total phosphorus, a variety of metals, and volatile organic compounds (VOCs). Testing for the VOCs was done using the Gas Chromatography / Mass Spectrometry (GC/MS) method (EPA method 524.2). Testing for anions chloride, fluoride and sulfate was done using the Ion Chromatography method (EPA method 300.0). Testing for nitrate/nitrite as total nitrogen was done using the Automated Colorimetry method (EPA method 353.2). Testing for phosphorus was done using the Semi-Automated Colorimetry method (EPA method 365.1). Appendix Table A-9 lists the EPA methods used to test for these analytes along with a reporting limit for each analyte. The results of the chemical tests are reported in this Circular. Before collecting a sample, EPD personnel also observe and record certain field measurements; pH, conductivity, dissolved oxygen, and temperature. This Circular also reports these measurements.

Testing for aluminum, beryllium, calcium, cobalt, iron, potassium, magnesium, manganese, sodium, titanium, and vanadium was undertaken using the inductively coupled plasma (ICP) method (EPA method 200.7 in Table A-9). This method works well for most of the major metals listed above. This method was also used to test for silver, arsenic, barium, cadmium, chromium, copper, nickel, lead, antimony, selenium, thallium, and zinc. The inductively coupled plasma mass spectrometry (ICPMS) method (EPA method 200.8 in Table A-9) was also used to test for the metals mentioned in the previous sentence as well as for molybdenum, silver, tin, arsenic and uranium. The ICPMS method generally gives better results for trace metals.

Pursuant to the Georgia Safe Drinking Water Act of 1977, EPD has established Maximum Contaminant Levels (MCLs) for certain analytes and other parameters, certain of which are included in analyses performed on Groundwater Monitoring samples (EPD, 2009). Primary MCLs pertain to analytes that can adversely affect human health if the maximum concentration for an analyte is exceeded for drinking water. Secondary MCLs pertain to parameters that may give drinking water objectionable, though not health-threatening, properties that may cause persons served by a public water system to cease using the water. Unpleasant taste and the ability to cause stains are examples of such properties. MCLs apply only to treated water offered for public consumption; nevertheless, they constitute useful guidelines for evaluating the quality of untreated (raw) water. Table A-10 in the Appendix lists the Primary and Secondary MCLs for Groundwater Monitoring Network analytes.

Most wells currently on the Monitoring Network have in-place pumps. Using such pumps to purge wells and collect samples reduces the potential for cross-contamination that would attend the use of portable pumps. Pumped wells may affect VOC concentrations of sample water. Two wells, the Miller Ball Park Northeast Well (PA9C) and the Springfield Egypt Road Test Well (MI17), are flowing, which dispenses altogether with pumps and lessens the effects of the pump-well system on sample water.

Sampling procedures are adapted from techniques used by United States Geologic Survey (USGS) and EPA. For wells except PA9C and MI17, EPD personnel purge the wells (EPA recommends removing three to five times the volume of the water column in the well) before collecting a sample to reduce the influence of the well, pump, and plumbing system on water quality. A purge of 15 to 20 minutes is usually sufficient to allow readings of pH, conductivity, temperature, and dissolved oxygen to stabilize and to allow corrosion films on the plumbing to be flushed away.

The apparatus used for monitoring field measurements and collecting samples consists of a garden hose with two branches at its end and a container. One branch conveys water to a container; the other branch allows the water to flow freely. On the container branch, water enters the bottom of the container, flows past the probe of the instrument taking field measurements, and discharges over the top of the container. Such an apparatus minimizes the exposure of the sample water to the atmosphere. Once the field measurements have stabilized, sample containers are then filled with water discharging from the end of the free-flowing branch. Sample waters do not pass through a filter before collection. As a rule, trends for field measurements with increasing purge time include a lowering of pH, conductivity and dissolved oxygen. For shallower wells, the temperature tends to approach the mean atmospheric temperature for the area. For deeper wells rising temperatures due to geothermal heating may become apparent.

Once the sample bottles are filled, they are promptly placed on ice to preserve water quality. EPD personnel transport samples to the laboratory on or before the Friday of the week during which the samples were collected, well before holding time for the samples lapse. Field measurements and analytical results are provided in Tables A-1 through A-8 in the Appendix.

Files at EPD contain records of the field measurements and chemical analyses. Owners of wells or springs receive copies of the laboratory analysis sheets as well as cover letters and laboratory sheet summaries. The cover letters state whether any MCLs were exceeded. The Drinking Water Program's Compliance and Enforcement Unit receives notification of Primary MCL exceedances involving public water supplies.

Station numbering assigns each station a two-part alphanumeric designation, the first part consisting of an alphabetic abbreviation for the aquifer being sampled and the second part consisting of a serial number, sometimes with an alphabetic suffix, the two parts separated by a dash. Some wells were also added from previous sampling and monitoring programs that were previously labeled with a County alphabetic abbreviation instead of an aquifer. In this case the previous identification number was retained for cross reference with previous samples. In order for the groundwater database to be compatible with the Georgia Environmental Monitoring and Assessment System (GOMAS), a Watershed Protection Branch branch-wide water database, the stations were also assigned a three-part alphanumeric designation; the first part being an alphabetic abbreviation "GW" (for groundwater), the second part numeric representing the local river basin and the third part a serial number.

CHAPTER 3 CHEMICAL GROUNDWATER QUALITY IN GEORGIA

3.1 OVERVIEW

Georgia's major aquifer systems are grouped into three hydrogeologic provinces for the purposes of this report: the Coastal Plain Province, the Piedmont/Blue Ridge Province, and the Valley and Ridge/Appalachian Plateau Province.

The Coastal Plain Province comprises six major aquifer systems that are restricted to specific regions and depths within the Province (Figure 3-1). These major aquifer systems commonly incorporate smaller aquifers that can be locally confined. Groundwater Monitoring Network wells in the Coastal Plain aquifer systems are generally located in three settings:

1. Recharge (or outcrop) areas that are located in regions that are geologically updip and generally north of confined portions of these aquifer systems;
2. Updip, confined areas that are located in regions that are proximal to the recharge areas, yet are confined by overlying geologic formations. These are generally south to southeast from the recharge areas;
3. Downdip, confined areas, located to the south or southeast in the deeper, confined portions of the aquifer systems, distal to the recharge areas.

The Piedmont/Blue Ridge Province comprises two regional aquifers, the regolith aquifer and the bedrock aquifer (Daniel and Harned, 1997). The regolith aquifer is composed of saprolite – bedrock that has undergone intense chemical weathering -- plus soil and alluvium. The regolith aquifer, highly porous and appreciably permeable, serves as the reservoir that recharges the bedrock. The igneous and metamorphic bedrock exhibits low porosity – nearly all of the porosity is secondary and consists of discontinuous fractures, but can be very permeable as fractures can locally transmit water rapidly. Despite the regional scale of these two aquifers, flow systems are small-scale and localized, in contrast to those of the Coastal Plain.

Paleozoic sedimentary formations characterize the combined Valley and Ridge/Appalachian Plateau Province, although unlike in the Coastal Plain, these sedimentary formations are consolidated and have been subjected to faulting and folding. Also, in contrast to the Coastal Plain Province, the faulting and folding has resulted in the creation of numerous, small-scale localized flow systems in the Valley and Ridge/Appalachian Plateau Province. The major water-bearing units in the province are carbonate rocks. Faulting and fracturing of the carbonates have led to the widespread development of karst features, which significantly enhance porosity and permeability and exert a strong influence on local flow patterns.

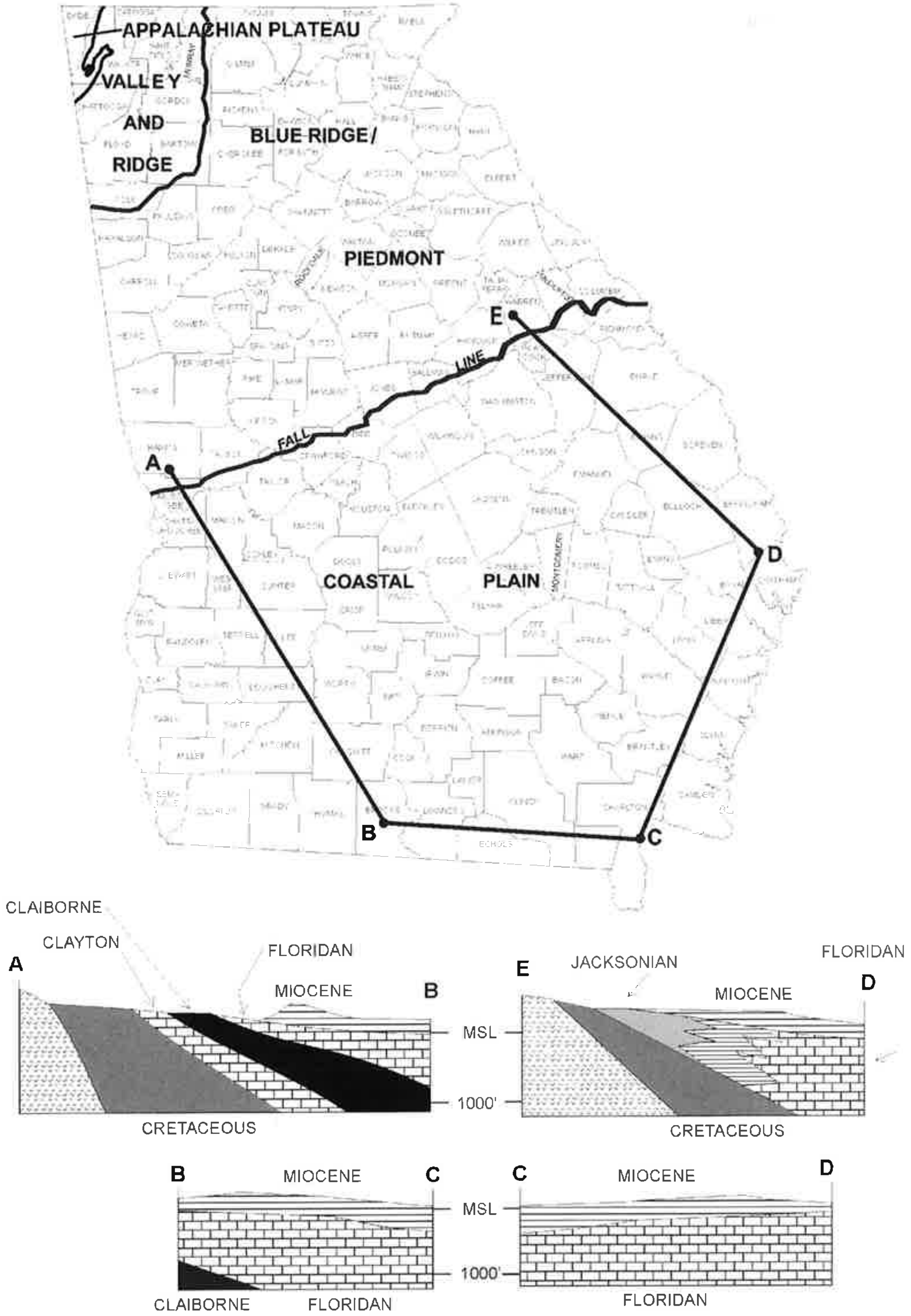

Figure 3-1. The Major Aquifers and Aquifer Systems of the Coastal Plain Province (after Davis, 1990).

3.2 CRETACEOUS AQUIFER SYSTEM

3.2.1 Aquifer System Description

The Cretaceous aquifer system is a complexly interconnected group of aquifer subsystems developed in the late Cretaceous sands of the Coastal Plain Province. These sands outcrop in an extensive recharge area immediately south of the Fall Line in west and central Georgia (Fig. 3-2). In east Georgia, overlying Tertiary sediments restrict Cretaceous outcrops to valley bottoms. Five distinct subsystems of the Cretaceous aquifer system, including the Providence aquifer, are recognized west of the Ocmulgee River (Pollard and Vorhis, 1980). These merge into three subsystems to the east (Clarke et al, 1985; Huddlestun and Summerour, 1996). The aquifer thickens southward from the Fall line, where the clays and sands pinch out against crystalline Piedmont rocks, to a column approximately 2,000 feet thick at the southern limits of the main aquifer use area (limit of current utilization, Figure 3-2). Below the limit of utilization some Cretaceous wells have reached depths of 4,000 feet.

The Providence aquifer, a prominent subsystem of the Cretaceous aquifer system in the western Coastal Plain, is developed in sands and coquinoid limestones at the top of the Cretaceous column. The permeable Providence Formation-Clayton Formation interval forms a single aquifer in the updip areas (Long, 1989) and to the east of the Flint River (Clarke et al., 1983). East of the Ocmulgee River, this joint permeable interval is termed the Dublin aquifer (Clarke et al., 1985). This report treats the Providence aquifer as a part of the Cretaceous aquifer system.

EPD used 21 wells to monitor the Cretaceous aquifer system. Reported depths ranged from 128 feet (K7) to 1025 feet (PD6). All wells except wells MAC1, and MAR1 are local government owned public supply wells. Well MAC1 provides water for a park and well MAR1 produces process water for a sand mining operation. All wells are sampled annually.

3.2.2 Field Parameters

The pHs of sample waters from all 21 wells ranged from 3.91 (K12) to 8.62 (K15A), with a median of 5.45. As a rule, pHs of waters from the deeper wells are basic (pH>7.0), while those from shallower wells are acidic (pH<7.0). Well PD3 seems to be the exception. The sampling pH of 7.71 of well PD3 would be expected for a well about twice the reported depth of 456 feet. Conductivities are available for all 21 wells and ranged from 17 uS/cm (BUR2) to 468 uS/cm (K15A), with a median of 49 uS/cm. As a rule, the deeper wells gave water with the higher conductivities. The temperatures measured should be viewed as approximations of the temperature of the water in the aquifer. Temperatures over all 21 well samples ranged from 17.86 degrees C (K7) to 30.97 degrees C (K15A). Comparing well depths with sample water temperatures shows that the deeper wells generally tend to yield water with higher temperatures. The water temperature can also depend

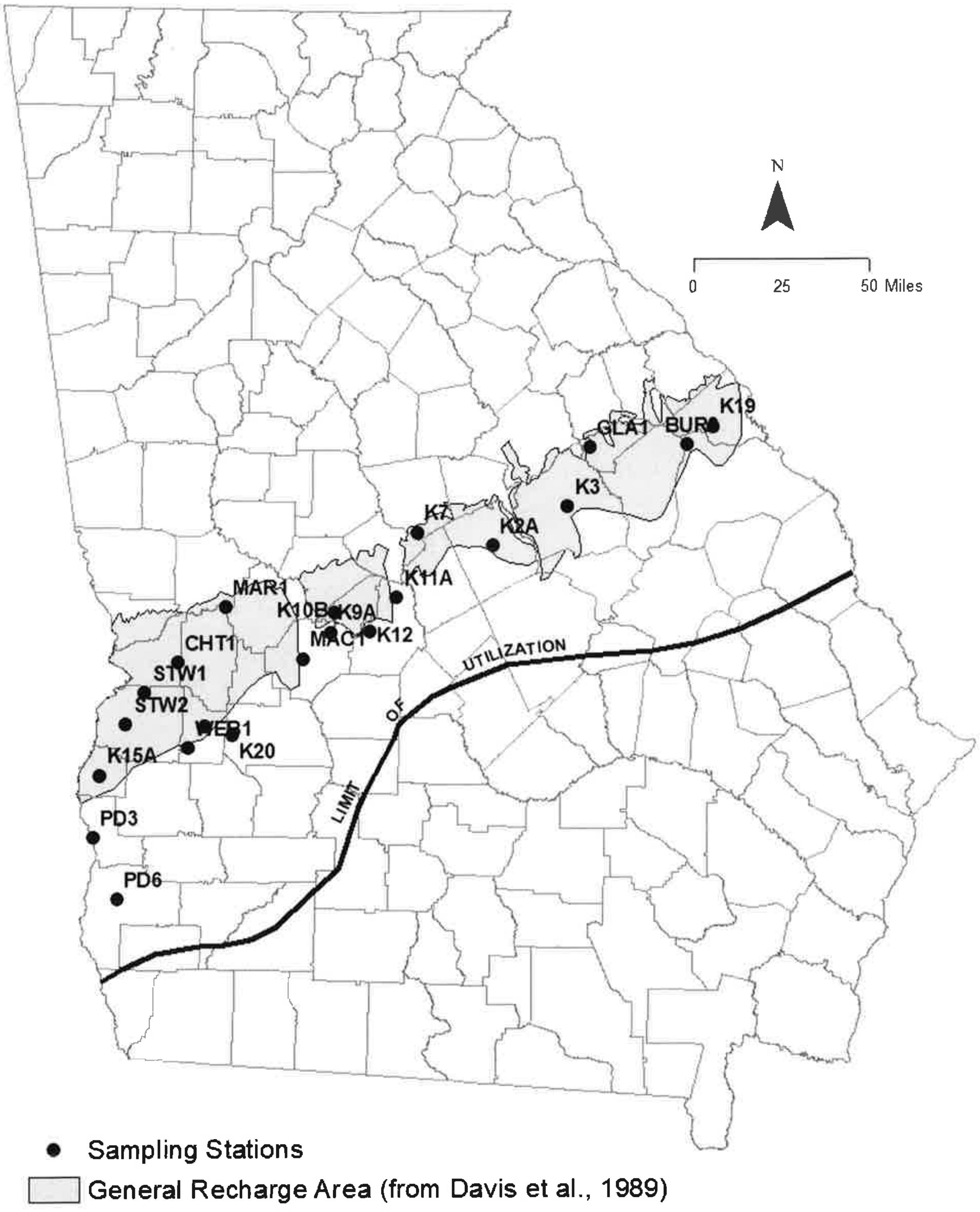

Figure 3-2. Locations of Stations Monitoring the Cretaceous Aquifer System.

somewhat on the time of year measured, since sample water must traverse a zone influenced by surface temperature on its way from the aquifer to the measurement point. Dissolved oxygen measurements are available for 20 of the 21 wells. Concentrations ranged from 0.20 mg/L (K15A) up to 8.32 mg/L (GLA1) where measured. Generally, the dissolved oxygen content of groundwater decreases with depth. Dissolved oxygen measurements can suffer from various interferences and processes that can expose the groundwater to air. An inadequately purged well may deliver water that has been in contact with air in the well bore. Pumping a well's water level down near the pump intake can entrain air into the pumped water. Also, pumping the water level in the well below a recharging horizon allows water to "cascade" or fall freely down the well bore and splash, thereby becoming aerated.

3.2.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Testing for chloride, sulfate, fluoride, combined nitrate/nitrite, total phosphorus, and volatile organic compounds (VOCs) was done for samples from all 21 wells. None of the 21 samples contained detectable chloride. Four samples contained detectable fluoride: well K9A 1.2 mg/L, well PD3 0.72 mg/L, well K15A 0.50 mg/L and well PD6 0.25 mg/L. Wells MAR1 and PD2A had detectable VOCs of chloromethane 0.60 ug/L and chloroform 0.64 ug/L respectively and sulfate was detected in samples from five wells, with all concentrations at or below 51 mg/L (MAR1). Nitrate/nitrite was detected in 12 samples and ranged up to 2.1 mg/L (GLA1). Samples from nine wells contained detectable phosphorus, with concentrations ranging up to 0.42 mg/L (PD2A).

3.2.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

All 21 samples contained detectable sodium, which ranged from 1,000 ug/L (K12 and MAC1) to 110,000 ug/L (K15A). The current high reporting limit for analyzing potassium accounts for the lack of potassium detections. Three wells gave samples with detectable aluminum ranging up to 480 ug/L (K12). Fourteen wells yielded samples containing detectable calcium, and thirteen wells gave samples containing detectable iron. Calcium levels ranged from undetected to 65,000 ug/L (WEB1). Iron levels ranged from undetected to 1,600 ug/L (CHT1), with samples from five wells exceeding the Secondary MCL of 300 ug/L. Five samples contained detectable magnesium, with a maximum value of 4,000 ug/L (PD6). Seven wells gave samples with detectable manganese, with no wells exceeding the Secondary MCL of 50 ug/L. Beryllium, cobalt, potassium, titanium and vanadium remained undetected.

3.2.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analysis found detectable levels of copper, zinc, barium and lead. Barium was detected in 19 of 21 samples with a maximum concentration of 82 ug/L (CHT1). Copper was detected in samples from seven wells with the maximum level at 38 ug/L (K12); zinc was detected in samples from four wells, with the maximum level of 64 ug/L (STW2); lead was detected in samples from five wells, with the maximum level at 3.0 ug/L (K12). The copper and lead levels fell below their respective action levels of 1,300 ug/L and 15 ug/L and zinc below its secondary MCL of 5,000 ug/L. The highest concentrations for these three metals tend to occur in samples with the lowest pHs. These three metals commonly leach into sample water from plumbing and are not necessarily present naturally.

3.3 CLAYTON AQUIFER

3.3.1 Aquifer System Description

The Clayton aquifer system of southwestern Georgia is developed mainly 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 3-3). Aquifer thickness varies, ranging from about 50 feet in the outcrop area to 265 feet in southeastern Mitchell County (Clarke et al., 1984). Both the Flint River to the east and the Chattahoochee River to the west are the areas of discharge for the aquifer in its updip extent. Leakage from the underlying Providence aquifer system and from overlying permeable units in the Wilcox Formation confining zone provides significant recharge in downdip areas (Clarke et al., 1984). As mentioned previously, permeable portions of the Clayton and Providence Formations merge to form a single aquifer in the updip area and east of the Ocmulgee River. East of that river these combined permeable zones are called the Dublin aquifer (Clarke et al., 1985).

3.3.2 Field Parameters

Five wells were sampled annually to monitor the Clayton aquifer system. Wells CT3, CT5A, SUM1 and SUM2 are public supply wells and well CT8 is a private well. These wells vary in depth from 80 feet (CT8) to 367 feet (CT3). The sample waters had a pH range of 4.17 (CT8) to 8.08 (CT5A), an electrical conductivity range of 47 uS/cm (CT8) to 288 uS/cm (SUM2), a temperature range of 17.56 degrees C (CT8) to 21.05 degrees C (CT3) and a dissolved oxygen range of 0.33 mg/L (CT5A) to 5.24 mg/L (CT8).

3.3.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Testing for chloride, sulfate, fluoride combined nitrate/nitrite, total phosphorus, and volatile organic compounds (VOCs) was done for samples from all five wells. No volatile organic compounds were detected in any of the five samples. Sulfate was detected in three samples and ranged from undetected up to 100 mg/L (SUM2). Nitrate/nitrite was detected in three samples and ranged from undetected up to 1.9 mg/L (SUM1). Fluoride was detected in well SUM2 at a level of 0.30 mg/L. No samples contained detectable chloride or phosphorus.

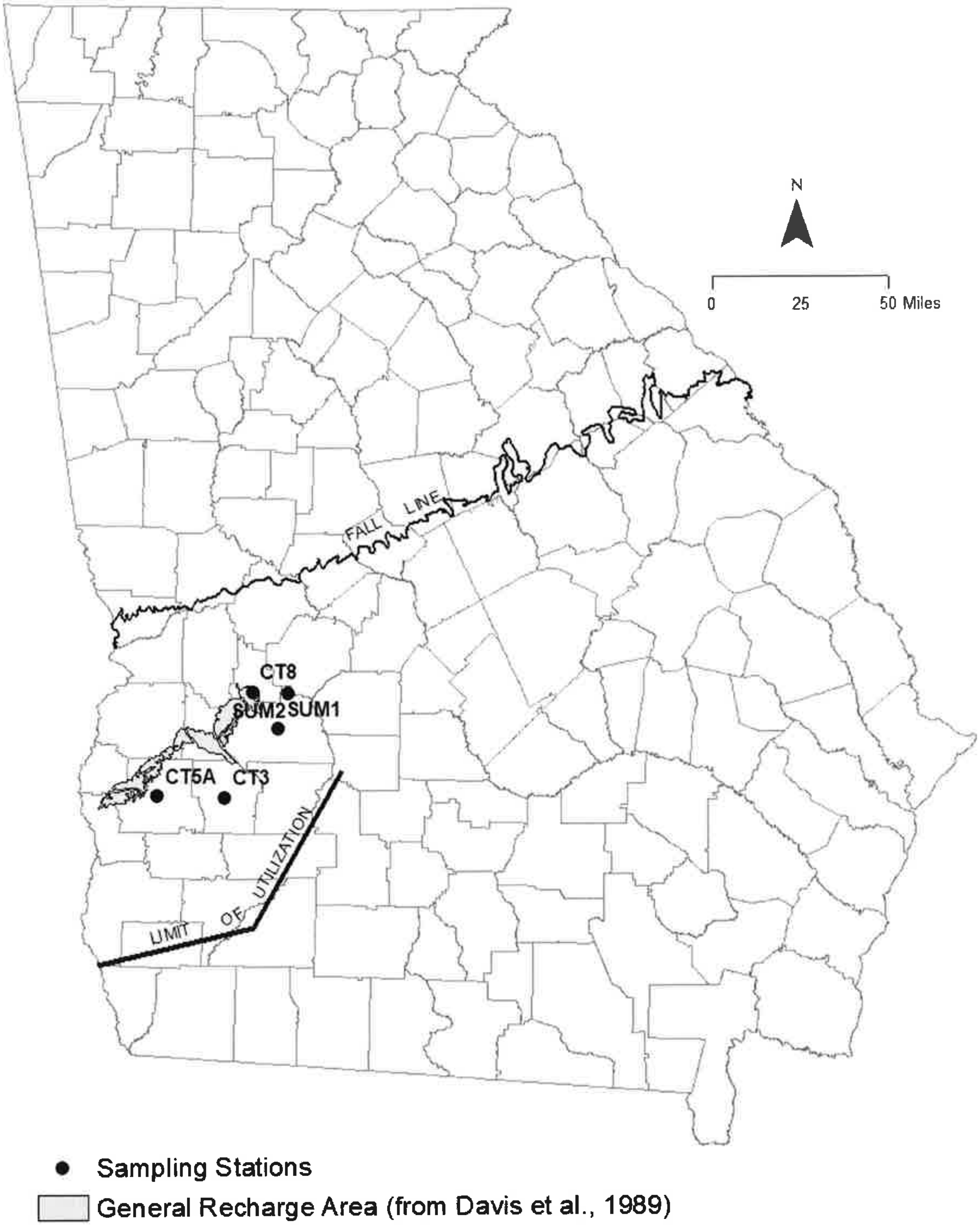

Figure 3-3. Location of the Stations Monitoring the Clayton Aquifer.

3.3.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

All five samples contained detectable sodium ranging from 1,700 ug/L (CT5A) to 10,000 ug/L (SUM1). The current high reporting limit for analyzing potassium accounts for the lack of potassium detections. One well gave a sample with detectable aluminum at a level of 1,300 ug/L (SUM2). Three wells yielded samples containing detectable calcium at levels ranging from undetected to 44,000 ug/L (CT5A) and three wells gave samples containing detectable iron at levels ranging from undetected to 380 ug/L (SUM2) above the iron Secondary MCL of 300 ug/L. Three samples contained detectable magnesium ranging from undetected to 11,000 ug/L (SUM2). Four wells gave samples with detectable manganese with one well (SUM2) exceeding the Secondary MCL of 50 ug/L with a detection of 360 ug/L. Beryllium, cobalt, potassium, titanium and vanadium remained undetected.

3.3.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analysis found detectable levels of nickel, copper, zinc, barium, lead and uranium. Nickel was detected at a concentration of 11 ug/L (SUM2). Barium was detected in all five samples with a maximum concentration of 79 ug/L (SUM2). Uranium was detected in one sample at a concentration of 1.4 ug/L (SUM2). Copper was detected in two samples at a maximum concentration of 12 ug/L (SUM1); zinc was detected in two samples at a maximum concentration of 29 ug/L (SUM2); and lead was detected in three samples at a maximum concentration of 12 ug/L (SUM2). The copper and lead levels all fell below their respective action levels of 1,300 ug/L and 15 ug/L and the zinc levels were below their secondary MCL of 5,000 ug/L; these detections also occurred in the most acidic sample waters.

3.4 CLAIBORNE AQUIFER

3.4.1 Aquifer Description

The Claiborne aquifer is developed primarily in the sandy units in the middle and lower portion of the Middle Eocene Claiborne Group of southwestern Georgia. Claiborne Group sands crop out in a belt extending from northern Early County through western Dooly County. Recharge to the aquifer occurs both as direct infiltration of precipitation in the recharge area and as leakage from the overlying Floridan aquifer system (Hicks et al., 1981; Gorday et al., 1997). The discharge boundaries for the updip portion of the aquifer are the Ocmulgee River to the east and the Chattahoochee River to the west. The aquifer generally thickens to the southeast and is more than 350 feet thick near its downdip limit of utilization (Figure 3-4) (Tuohy, 1984).

The clay-rich upper unit of the Claiborne Group, the Lisbon Formation, acts as a confining layer and separates the Claiborne aquifer from the overlying Floridan aquifer system (McFadden and Perriello, 1983; Long, 1989; Huddlestun and Summerour, 1996). The lower, water-bearing parts of the group had been correlated with the Tallahatta Formation (e.g., McFadden and Perriello, 1983; Long, 1989: Clarke et al., 1996) or more recently, have been divided into two formations, the upper one termed the Still Branch Sand and the lower one correlated to the Congaree Formation (Huddlestun and Summerour, 1996). East of the Ocmulgee River, permeable Congaree-equivalent sands are included in the Gordon aquifer (Brooks et al., 1985).

Three stations, all in or near the recharge area, were available to monitor the Claiborne aquifer. Wells CL2 and CL4A are municipal public supply wells, and well CL8 supplies water for drinking and other purposes for a State forestry nursery. Well CL2 is 315 feet deep, CL4A is 230 feet deep, and CL8 is not known precisely, but is about 90 feet deep.

3.4.2 Field Parameters

The pH of sample water from all the wells were mildly acidic; CL2 at 6.91, CL4A at 6.30 and CL8 at 6.12. Conductivities registered at 77 uS/cm (CL8), 139 uS/cm (CL4A), and 221 uS/cm (CL2); and temperatures registered at 20.40 degrees C (CL4A), 19.47 degrees C (CL8) and 18.66 degrees C (CL2). Dissolved oxygen contents measured at 2.98 mg/L (CL2) and 0.28 mg/L (CL8). Since well CL4A exposes water to air, there was no measurement for dissolved oxygen for the water at this well.

3.4.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Well CL2 was the only station to give a sample with detectable nitrate/nitrite (0.23 mg/L as nitrogen). A sample from well CL4A contained detectable sulfate at 11 mg/L. Samples from two wells contained detectable phosphorus (CL4A at 0.38 mg/L and CL8 at 0.56 mg/L). A sample from well CL2 contained detectable fluoride at 0.34 mg/L. Well CL2 gave a sample with detectable VOCs: chloroform at 1.1 ug/L, bromodichloromethane at .6 ug/L and chlorodibromomethane at .59 ug/L. None of the samples contained detectable chloride.

3.4.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

Calcium and sodium were detected in samples from all three wells. The maximum and minimum calcium concentrations were 43,000 ug/L (CL2) and 10,000 ug/L (CL8). The maximum and minimum sodium concentrations were 1,800 ug/L (CL2 and CL8) and 1,700 ug/L (CL4A). Detectable magnesium occurred only in the samples from well CL8 (1,100 ug/L) and CL4A (2,800 ug/L). Wells CL4A and CL8 gave samples with detectable iron at 1,900 ug/L and 490 ug/L respectively and manganese at 57 ug/L and 54 ug/L respectively. The CL4A and CL8 samples both exceeded the iron Secondary MCL of 300 ug/L and the manganese Secondary MCL of 50 ug/L. Aluminum, beryllium, cobalt, potassium, titanium and vanadium remained undetected.

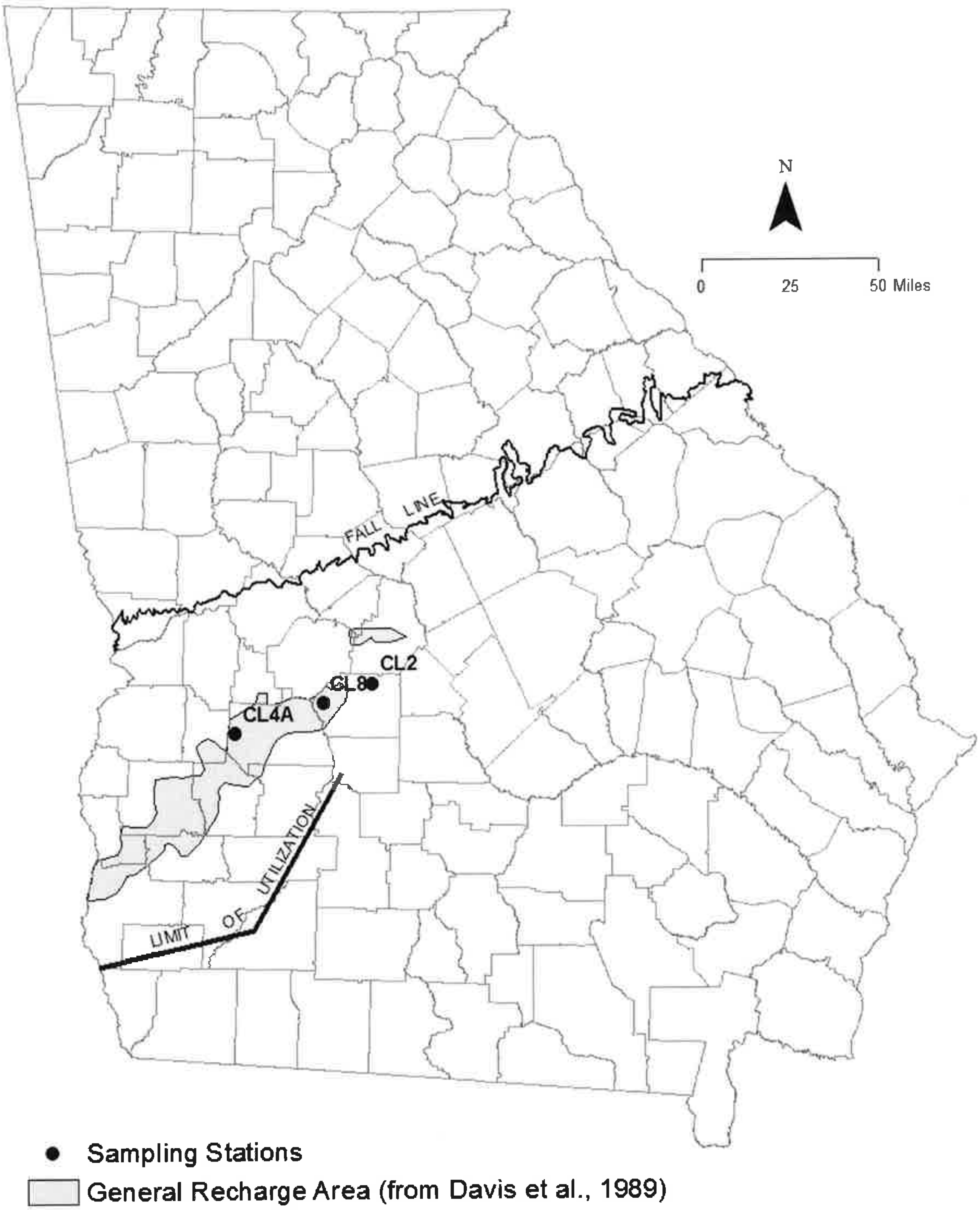

Figure 3-4. Locations of Stations Monitoring the Claiborne Aquifer.

3.4.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analyses found zinc in one sample (CL4A at 11 ug/L) and barium in all three samples. The maximum and minimum barium concentrations were 40 ug/L (CL8) and 10 ug/L (CL4A). Analysis found no other trace metals.

3.5 JACKSONIAN AQUIFER

3.5.1 Aquifer Description

The Jacksonian aquifer system (Vincent, 1982) of central and east-central Georgia is developed primarily in sands of the Eocene Barnwell Group, though isolated limestone bodies are locally important. Barnwell Group outcrops extend from Macon and Crawford Counties (Hetrick, 1990) eastward to Burke and Richmond Counties (Hetrick, 1992). Figure 3-5 shows the extent and most significant Jacksonian recharge areas. Aquifer sands form a northern clastic facies of the Barnwell Group; the sands grade southward into less permeable silts and clays of a transition facies (Vincent, 1982). The water-bearing sands are relatively thin, ranging from 10 to 50 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 the Flint River are the eastern and western discharge boundaries for the updip parts of the Jacksonian aquifer system. The Jacksonian aquifer system is equivalent to the Upper Three Runs aquifer, as discussed by Summerour et al. (1994), page 2, and Williams (2007), "General Hydrogeology" table.

Ten wells were available to monitor the Jacksonian aquifer system. Wells J1B, J8A, J9 and J10 are domestic wells, while all the other wells are public supply wells. All are drilled wells from 90 feet (J1B) to 660 feet (WAS1), where the depth is known, and each is scheduled for annual sampling.

3.5.2 Field Parameters

The pHs for all the wells were basic. The pHs range from 7.31 (J1B) to 8.24 (J9). Conductivities ranged from 177 uS/cm (J9) to 360 uS/cm (J5). Temperatures ranged from 18.42 degrees C for well J4 to 20.44 degrees C for well J9, with water from the deeper wells usually registering higher temperatures. Dissolved oxygen concentrations ranged from 0.36 mg/L for well JEF1 to 5.72 mg/L for well J9 and are usually lowest in the deeper wells.

3.5.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Sample waters from wells J5 and J6 contained detectable sulfate of 12 mg/L and 14 mg/L respectively. Nitrate/nitrite was detected in six of the ten samples ranging from undetected to 2.4 mg/L as nitrogen (J1B), and all measurements were below the Primary MCL of 10 mg/L as nitrogen. Phosphorus was detected in water

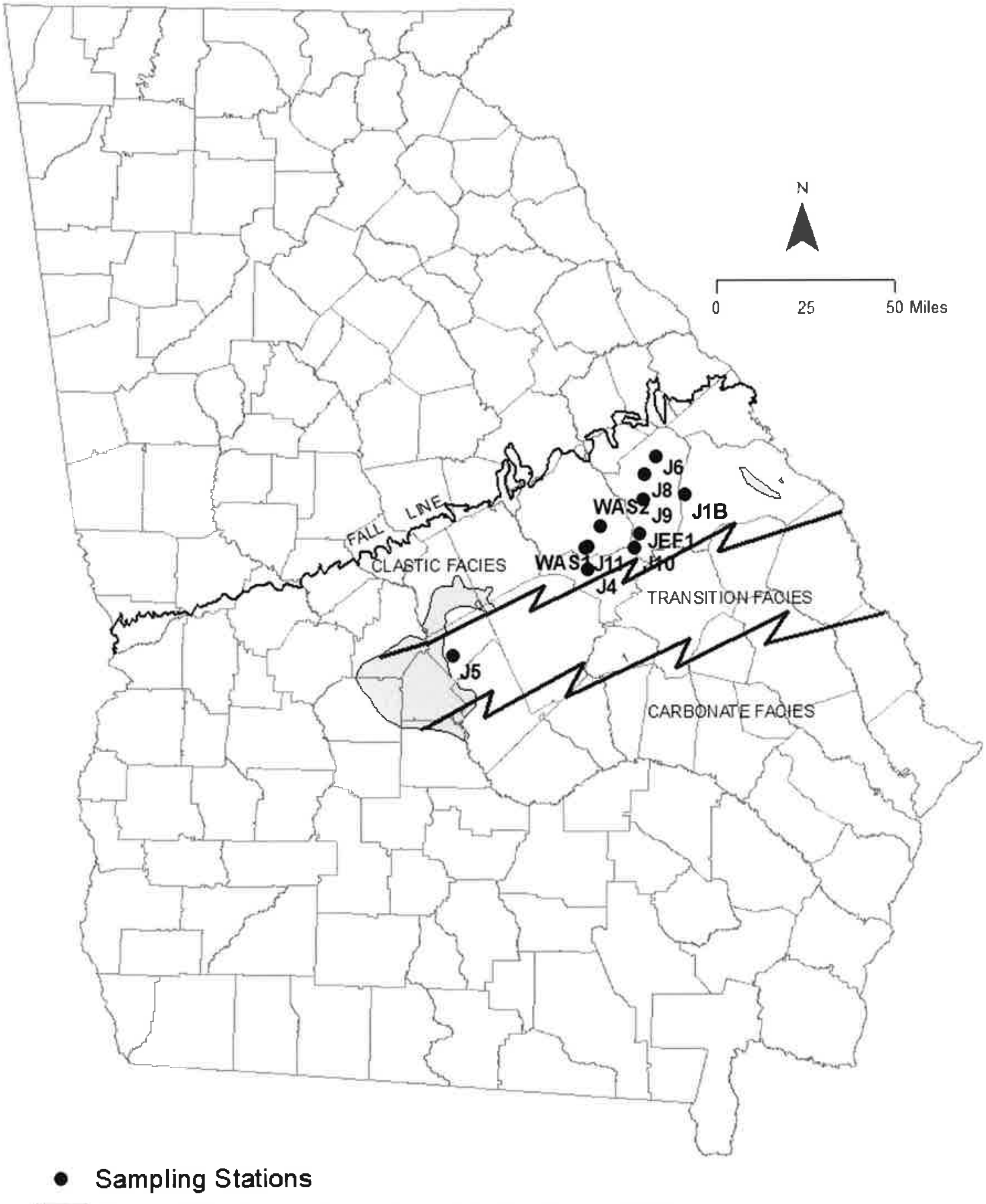

Figure 3-5. Locations of Stations Monitoring the Jacksonian Aquifer.

from five of the ten wells and ranged from undetected to 0.20 mg/L (J10). No sample waters contained detectable chloride. Fluoride was detected in two samples; well J4 at a concentration of 0.33 mg/L and well J6 at a concentration of 0.20 mg/L. Chloroform (disinfectant by-product possibly from leaky check valve) was detected in well J6 at a concentration of 0.71 ug/L.

3.5.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

All ten wells gave waters with detectable calcium from 32,000 ug/L (J9) to 64,000 ug/L (J5). Magnesium was detected in six of the ten wells and ranged from undetected to 2,400 ug/L (J5). Detectable sodium occurred in each sample and ranged from 1,500 ug/L (J9) to 4,100 ug/L (J1B). Aluminum was not detected in any samples this year. Iron was detected in five of the ten wells and ranged from undetected to 220 ug/L (J6). Wells J5, J8A, JEF1 and WAS1 gave a sample containing 37 ug/L, 20 ug/L, 55 ug/L and 11 ug/L manganese respectively. The 55 ug/L sample from well JEF1 exceeded the manganese Secondary MCL of 50 ug/L. According to Kellam and Gorday (1990), the high calcium/magnesium ratios for these wells signifies that they derive most of their recharge from local surface water.

3.5.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

Nine of the ten wells yielded waters containing detectable barium, with a range from undetected (JEF1) to 77 ug/L (WAS1). Zinc was detected in one of the ten samples at a level of 77 ug/L (J6). The copper and lead levels have fell below their respective action levels of 1,300 ug/L and 15 ug/L in the past. Analysis found no other trace metals.

3.6 FLORIDAN AQUIFER SYSTEM

3.6.1 Aquifer System Characteristics

The Floridan aquifer system is developed predominantly in Eocene and Oligocene limestones and dolostones that underlie most of the Coastal Plain Province (Figure 3-6). The aquifer is a major source of groundwater for much of its outcrop area and throughout its downdip extent to the south and east.

The upper water-bearing units of the Floridan are the Eocene Ocala Group and the Oligocene Suwanee Limestone (Crews and Huddlestun, 1984). These limestones and dolostones crop out in the Dougherty Plain (a karstic area in southwestern Georgia) and in adjacent areas along strike to the northeast. In parts of Camden and Wayne Counties, the Oligocene unit is absent and the upper portions of the Floridan are restricted to units of Eocene age (Clarke et al., 1990). The lower parts of the Floridan consist mainly of dolomitic limestone of middle and early Eocene age and pelletal, vuggy, dolomitic limestone of Paleocene age, but extend into the late Cretaceous in Glynn County. The lower portions of the Floridan are hydrologically connected with the upper parts but are deeply buried and not widely used except for some municipal and industrial wells in the Savannah area. From its updip limit, defined by clays of the Barnwell Group, the aquifer system thickens to well over 700 feet in coastal Georgia.

A dense limestone facies occupying the Gulf Trough locally limits groundwater quality and availability (Kellam and Gorday, 1990; Applied Coastal Research Laboratory, 2001). The Gulf Trough may be a filled marine-current channel extending across Georgia from southwestern Decatur County through northern Effingham County. The trough, active beginning in the early Eocene, had ceased operating and filled with sediment in the Miocene.

A groundwater divide separates a smaller southwestward flow regime in the Floridan aquifer system in the Dougherty Plain in southwestern Georgia from the larger southeastward flow regime characteristic for the aquifer system under the remaining part of Georgia's Coastal Plain. Rainfall infiltration in outcrop areas and downward leakage from extensive surficial residuum recharge the Dougherty Plain flow system (Hayes et al., 1983). The main body of the Floridan aquifer system, lying to the east, is recharged by leakage from the Jacksonian aquifer and by rainfall infiltration in outcrop areas and in areas where overlying strata are thin. Significant recharge also occurs in the area of Brooks, Echols, Lowndes, Cook and Lanier counties where the Withlacoochee River and numerous sinkholes breach the upper confining units (Krause, 1979).

Monitoring water quality in the Floridan aquifer system was done by using 34 wells and one spring, with 25 scheduled for sampling on a yearly basis and 10 on a quarterly basis. The total number of samples collected was 54. All 34 wells are drilled wells. Thirty wells are local-government-owned public supply wells. One well supplies industrial process water, one well is a former USGS test well, one a private residence well and the remaining well supplies water for a coastal marina. Depths range from 174 feet (PA25 municipal well) to 1,211 feet (PA9C test well). The one remaining site is Radium Spring in Albany.

3.6.2 Field Parameters

Measurements of pH are available for all samples from all 35 locations and ranged from 6.63 (PA25) to 7.87 (PA6). The median pH is 7.24 and the mean is 7.23. Conductivities are also available for all the samples from all sites and ranged from 155 uS/cm (PA41A) to 954 uS/cm (PA9C) with a median of 315 uS/cm and a mean of 335 uS/cm. Temperatures are available for all sampling events and ranged from 19.98 degrees C (PA27) to 25.98 degrees C (THO2) with a median of 22.66 degrees C and a mean of 22.63 degrees C. The high temperatures reflect the geothermal effect of the deeper wells. Forty-four dissolved oxygen measurements are available from 29 wells. The available measurements range from 0.25 mg/L (PA2, PA23A and PA36) to 5.34 mg/L (MCI1) with a median of 0.58 mg/L and a mean of 1.51 mg/L. No measurements were taken at spring PA59 or at wells PA5, PA9C, PA14A, PA28 and PA60 because the raw water outlets will not permit the attachment of the usual sampling apparatus and exposes sample water to air.

3.6.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Nine Floridan wells yielded 11 samples containing detectable chloride. Chloride concentrations ranged from undetected to 270 mg/L (PA9C), with the 270 mg/L sample exceeding the Secondary MCL of 250 mg/L. The measurement for well PA9C is more than 5 times the next highest concentration of 47 mg/L for well PA4. Well PA9C derives water from the lower part of the Floridan aquifer. Twenty-five samples from 17 wells contained detectable sulfate. Sulfate levels ranged from undetected to 160 mg/L (PA9C). Thirty-eight samples from 24 wells contained detectable fluoride at levels ranging from undetected to 0.80 mg/L (GLY4). Fifteen samples from eight wells and one spring contained detectable nitrate/nitrite. Concentrations ranged from undetected to 2.2 mg/L as nitrogen (spring PA59). There is a general tendency for shallower wells to give samples with higher levels of nitrate/nitrite. Nitrate/nitrite levels in the samples from each quarterly sampled well tend, as a rule, to be similar. Phosphorus was detected in 14 samples from 10 wells. Phosphorus levels ranged up to 0.10 mg/L (wells PA14A and PA20) as total phosphorus. Volatile organic compounds (VOCs), consisting entirely of trihalomethane compounds, were detected in one sample: chloromethane at a level of 0.86 ug/L (PA57). These compounds typically arise as byproducts from disinfection and their presence can indicate the reflux of treated water back down a well or result from sterilizing well plumbing following maintenance. The occasional nature of trihalomethane detections suggests a maintenance related origin. Radium Spring yielded a sample with the VOC trichloroethylene at a level of 0.75 ug/L, which is found in dry cleaning degreasers. Springs are subject to surface contaminations more so than deeper wells.

3.6.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

ICP analyses found detectable levels of calcium, iron, potassium, magnesium, manganese, and sodium. Detectable potassium occurred in one sample from well PA4 at a level of 5,100 ug/L. Failure to find detectable potassium in other samples results from the insensitivity of the testing procedure, as indicated by the high reporting limit of 5,000 ug/L for the metal. Detectable manganese occurred in 16 samples from ten wells. The maximum concentrations of 79 ug/L, 82 ug/L and 83 ug/L occurred in three samples from well PA34D. All samples from quarterly-sampled well PA34D and a sample from annually sampled well PA18 exceeded the Secondary MCL of 50 ug/L. The manganese levels in the samples from each of the quarterly sampled wells vary within a restricted range. Wells giving samples with manganese detections seem clustered in two areas: one in the Cook-Irwin-Lanier County area and the other in the Candler-Emanuel-Jenkins-Telfair-Toombs County area. Iron was detected in 21 samples from 15 wells. Of these, one sample exceeded the Secondary MCL of 300 ug/L; annual well PA9C (1,200 ug/L). The iron contents of samples from quarterly wells PA29, PA34D and PA36 seemed to vary within restricted ranges. Detectable magnesium was found in all samples from

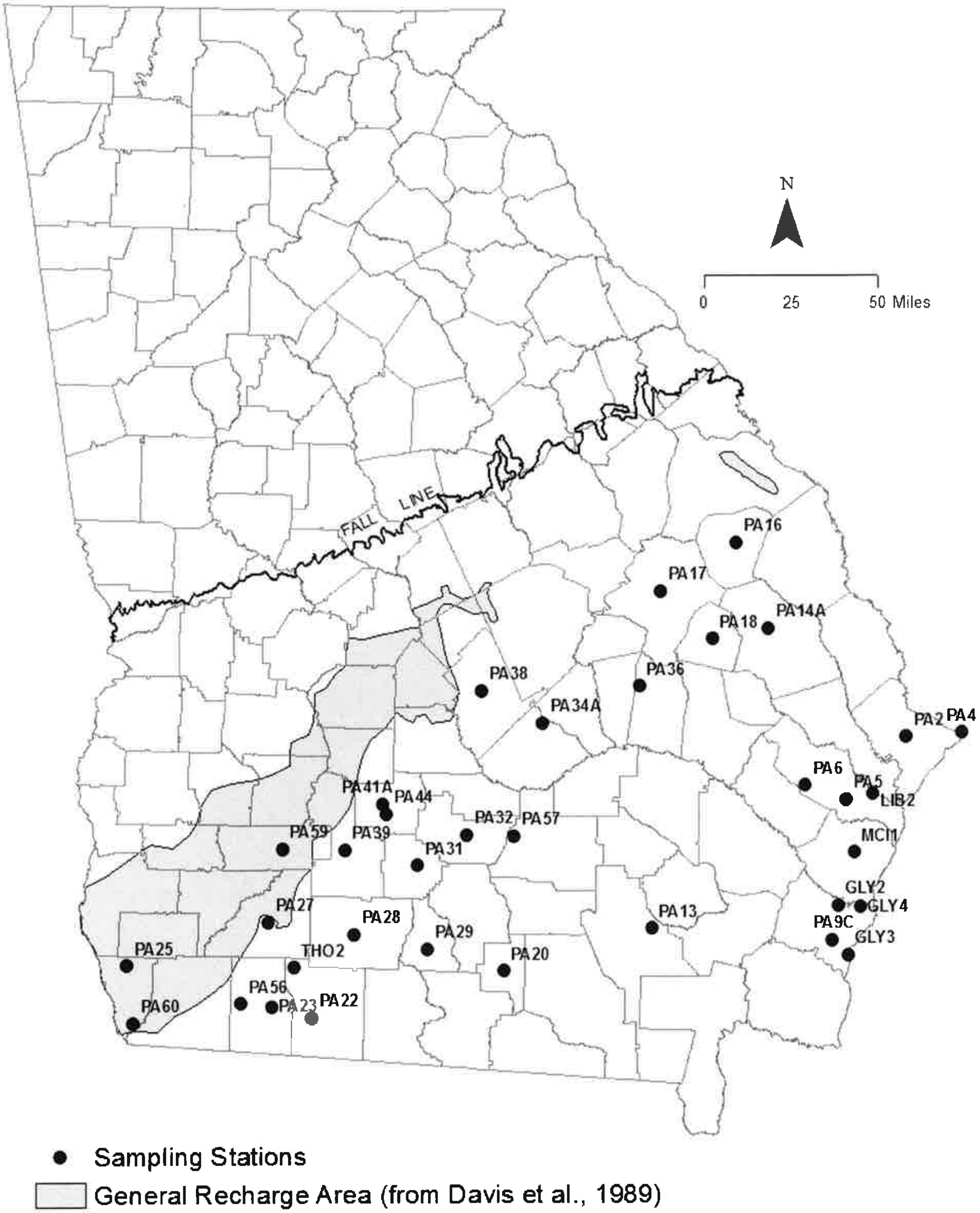

Figure 3-6. Locations of Stations Monitoring the Floridan Aquifer System.
Note: Point PA34A represents wells PA34A, PA34B, PA34C, and PA34D

all wells and spring except for those from quarterly well PA25 and annual well PA60. Magnesium concentrations ranged up to 42,000 ug/L (well PA9C), with a mean of 12,370 ug/L and a median of 11,500 ug/L. Wells PA25 and PA60 are Floridan recharge area wells. Kellam and Gorday (1990) have noted that Ca/Mg ratios are higher in groundwaters from Floridan recharge areas, as is the case with these wells. Magnesium levels in samples from each quarterly well seem to vary within relatively narrow ranges. Calcium was detected in all samples from the 35 Floridan wells and spring. Concentrations ranged from 20,000 ug/L (PA41A) to 65,000 ug/L (PA59), with a mean of 39,037 ug/L and a median of 34,000 ug/L. For samples from quarterly wells, calcium concentrations seem to fall within a narrow range for each well. Sodium was also found in all sample waters from all 35 wells and spring and ranged in concentration from 1,800 ug/L (PA41A) to 140,000 ug/L (PA9C), with a mean of 13,194 ug/L and a median of 7,750 ug/L. Sodium concentrations generally increase with depth. Aluminum was not detected above the Secondary MCL of 50-200 ug/L. Beryllium, cobalt, titanium and vanadium were not detected in any samples.

3.6.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analysis found the following detectable metals in the Floridan samples: zinc, arsenic, molybdenum, barium and uranium. Well PA23A gave two of three samples with detectable arsenic ranging from undetected to 8.2 ug/L. One sample from one well contained detectable zinc; annual well PA60 (96 ug/L). No samples contained detectable copper and lead. Copper and lead detections have been below the action levels of 1,300 ug/L for copper and 15 ug/L for lead. The zinc concentration fell below the Secondary MCL of 5,000 ug/L. Nine samples drawn from quarterly wells PA23A, PA28 and PA56, as well as annual well PA13, contained detectable molybdenum. Well PA28 produced the sample with the highest concentration of 34 ug/L. All four wells are in the Gulf Trough area. Barium was detected in all samples from all wells and spring and ranged in concentration from 3.2 ug/L (PA60) to 240 ug/L in two of three samples from quarterly well PA34D, all below the Primary MCL of 2,000 ug/L. The mean concentration of barium was 80.4 ug/L and the median was 69 ug/L. Barium seems to be more abundant in samples from wells of 400 foot to 700-foot depth range. Uranium was detected in eight samples from four wells and ranged from undetected to 3.0 ug/L in two of three samples from quarterly well PA56.

3.7 MIOCENE/SURFICIAL AQUIFER SYSTEM

3.7.1 Aquifer System Characteristics

The Miocene/Surficial aquifer system is developed in sands of the Miocene Hawthorne Group and of the Pliocene Miccosukee and Cypresshead Formations of the Georgia Coastal Plain (Figure 3-7).

The Hawthorne Group covers most of the Coastal Plain and consists predominantly of sand and clay (Huddlestun, 1988), although carbonate rocks and phosphorites may locally be significant (Huddlestun, 1988; Clarke et al., 1990). Clarke et al., 1990, note that three sequences consisting of a basal dense phosphatic limestone layer, a middle clay layer, and an upper sand layer typify the Miocene section in the coastal area. The sand layers in the two lowermost of the sequences host the lower and upper Brunswick aquifers, which are included in the Miocene/Surficial aquifer system of this report.

The Cypresshead Formation overlies the Hawthorne Group in the Coastal area (from the Atlantic coast to about 45 miles inland) and consists, in updip areas, predominantly of fine to coarse-grained quartz sand and, in downdip areas, interbedded fine sand and clay (Huddlestun, 1988). In the Coastal Plain of far south central and southwestern Georgia, the Miccosukee Formation overlies the Hawthorne Group (Huddlestun, 1988).

The Miccosukee Formation consists predominantly of sand but contains some clay. The characteristic lithology consists of thin-bedded to laminated fine to medium sand with scattered layers or laminae of clay. Also included in the aquifer system are Pleistocene arkosic sands and gravels interbedded with clays and Holocene sands and gravels interbedded with muds. The upper part of the aquifer system is unconfined, whereas the deeper parts of the system may be locally confined and under artesian conditions.

Six annually sampled wells were used to monitor the Miocene/Surficial aquifer system. Wells MI1, MI2A and MI10B are private domestic wells, well WAY1 is a public supply well for a mobile home park and well MI10B is no longer being used as a drinking water source. Well MI16 is used for general purposes at a fire station. Well MI17 originated as a geologic bore hole (a hole drilled for investigating bedrock) that became a flowing well. It is currently used both as a domestic water source and as an augmentation well for maintaining a pond. Well MI2A is a bored well and the remaining five are drilled. Determined depths (actual or approximate) for all six wells range from 70 feet (MI2A) to 400 feet (MI16 and WAY1).

3.7.2 Field Parameters

The pHs of the sample waters from the six wells used to monitor the Miocene/Surficial aquifer system ranged from 4.03 (MI2A) to 7.97 (WAY1). Three of the six wells sampled (MI2A, MI10B and MI17) produced acidic water.

The remaining three wells gave basic water. The acidic water-yielding wells included the three shallowest, while the basic water-producing wells included the three deepest. Conductivities ranged from 95 uS/cm (MI10B) to 417 uS/cm (MI17). Water temperatures ranged from 20.30 degrees C (MI17) to 22.85 degrees C (MI10B). Dissolved oxygen data are available for five of the six wells and range from 0.41 mg/L (MI16) to 6.16 mg/L (MI2A). Valid dissolved oxygen measurements cannot be made on well MI17 since the water is exposed to air before sampling.

3.7.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Chloride registered at 35 mg/L in a sample from the bored well MI2A. The sample from the deepest Miocene well (MI16) provided the only sulfate detection at 37 mg/L. Fluoride was detected in four of the six wells. The concentration ranged from undetected to 0.59 mg/L (MI16). Nitrate/nitrite was detected in the sample water from well MI2A at 5.9 mg/L as nitrogen, which lies in the range of likely human influence (≥ 3.1 mg/L as nitrogen) (Madison and Brunett, 1984). Detectable phosphorus was found in samples from two of the six wells. The concentrations ranged from not detected to 0.29 mg/L (MI10B). One of the samples contained detectable VOCs in the form of chloroform at 1.0 ug/L (MI2A).

3.7.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

Samples from all six wells contained calcium, magnesium, and sodium. Calcium levels ranged from 3,600 ug/L (well MI2A) to 45,000 ug/L (well MI17). Magnesium levels ranged from 1,800 ug/L (well MI17) to 14,000 ug/L (well MI16). Sodium levels ranged from 5,900 ug/L (well MI10B) to 18,000 ug/L (well MI2A). Potassium was detected in well MI2A at a concentration of 7,100 ug/L. Iron was detected in the sample from well MI10B at a level of 440 ug/L. The value for well MI10B exceeds the Secondary MCL for iron of 300 ug/L. Manganese was found in samples from five wells: MI1 (11 ug/L), MI17 (13 ug/L), MI2A (13 ug/L), MI10B (32 ug/L), and WAY1 (100 ug/L). The 100 ug/L level exceeds the Secondary MCL for manganese of 50 ug/L. The high iron and manganese levels in water from drilled well MI10B are the reason the residents ceased using the water for household purposes, i.e., cooking, drinking, and laundering. Aluminum was detected in well MI2A at a concentration of 140 ug/L, above the Secondary MCL range of 50-200 ug/L.

3.7.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analyses found detectable copper, zinc, selenium, barium and lead in the Miocene aquifer samples. All six samples contained detectable barium, which ranged in concentration from 20 ug/L (MI1) to 130 ug/L (MI10B). The sample from drilled well MI10B contained selenium at a level of 11 ug/L. Selenium at detectable levels is rare in Georgia's groundwater. Zinc was detected in three of the six samples ranging from undetected to 51 ug/L (MI10B). Copper was detected in well MI2A at a level of 9.6 ug/L and lead in well MI2A at a level of 1.0 ug/L. The copper,

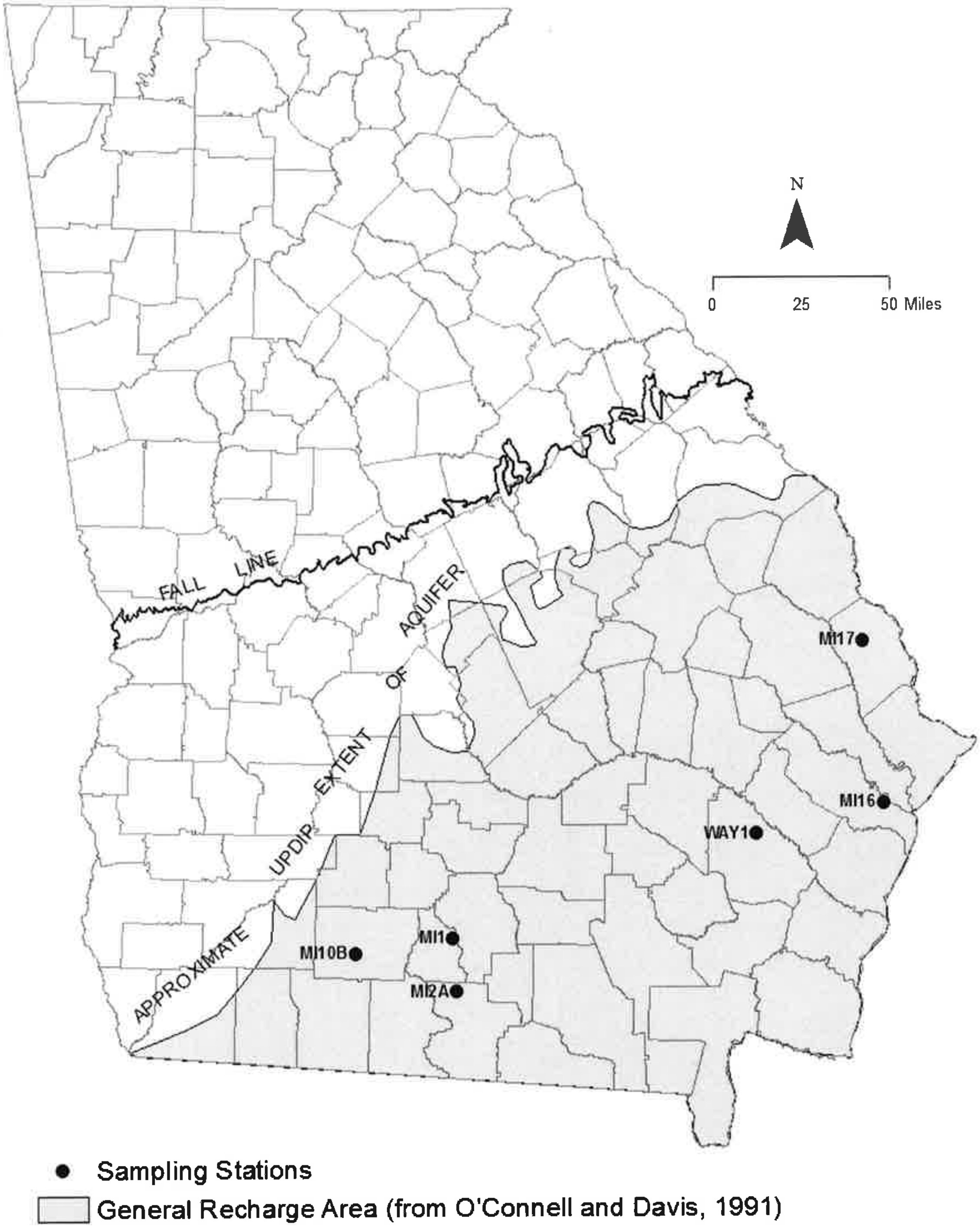

Figure 3-7. Locations of Stations Monitoring the Miocene/Surficial Aquifer System.

lead and zinc in the water samples were likely derived from plumbing. None of the metals exceeded applicable action levels (1,300 ug/L for copper and 15 ug/L for lead) or MCLs (5,000 ug/L Secondary for zinc).

3.8 PIEDMONT/BLUE RIDGE AQUIFER SYSTEM

3.8.1 Aquifer System Characteristics

The Piedmont/Blue Ridge aquifer system in Georgia is part of the Piedmont and mountain aquifer system that extends from New Jersey into Alabama (Daniel and Harned, 1997). The system is unconfined or semiconfined and is composed of two major hydrogeologic units: a) regolith and b) fractured igneous and metamorphic bedrock (Heath, 1980; Daniel and Harned, 1997). Figure 3-8 shows the extent of the system in Georgia.

The regolith hydrologic unit is comprised of a mantle of soil, alluvium in and near stream bottoms and underlying saprolite. Saprolite is bedrock that has undergone extensive chemical weathering in place. Downward percolating, typically acidic, groundwater leaches alkali, alkaline earth and certain other divalent metals from micas, feldspars, and other minerals composing the original rock, leaving behind a clay-rich residual material. Textures and structures of the original rock are usually well-preserved, with the saprolite appearing as a highly weathered version of the original rock. The regolith unit is characterized by high mostly primary porosity (35% to 55%) (Daniel and Harned, 1998) and serves as the reservoir that feeds water into the underlying fractured bedrock. Though it can store a great deal of water, saprolite, owing to its clay content, is relatively impermeable. Saprolite grades downward through a transition zone consisting of saprolite and partially weathered bedrock with some fresh bedrock into fresh bedrock.

The fractured bedrock hydrologic unit is developed in igneous and metamorphic rocks. In contrast to the regolith, the porosity in such rocks is almost totally secondary, consisting of fractures and solution-enlarged voids. In the North Carolina Piedmont, Daniel and Harned (1997) found 1% to 3% porosity typical for bedrock. Fractures consist of faults, breaks in the rock with differential displacement between the broken sections, and joints, breaks in the rock with little or no differential displacement (Heath 1980). Fractures tend to be wider and more numerous closer to the top of the bedrock. Daniel and Harned (1997) noted that at a depth of about 600 feet, pressure from the overlying rock column becomes too great and holds fractures shut. Fracturing in schistose rocks consists mainly of a network of fine, hair-line cracks which yield water slowly. Fractures in more massive rocks (e.g. granitic rocks, diabases, gneisses, marbles, quartzites) are mostly open and are subject to conduit flow. Thus, wells intersecting massive-rock fractures are able to yield far larger amounts of water than wells in schistose rocks or even wells in regolith. Fractures can be concentrated along fault zones, shear zones, late-generation fold axes, foliation planes, lithologic contacts, compositional layers, or intrusion boundaries.

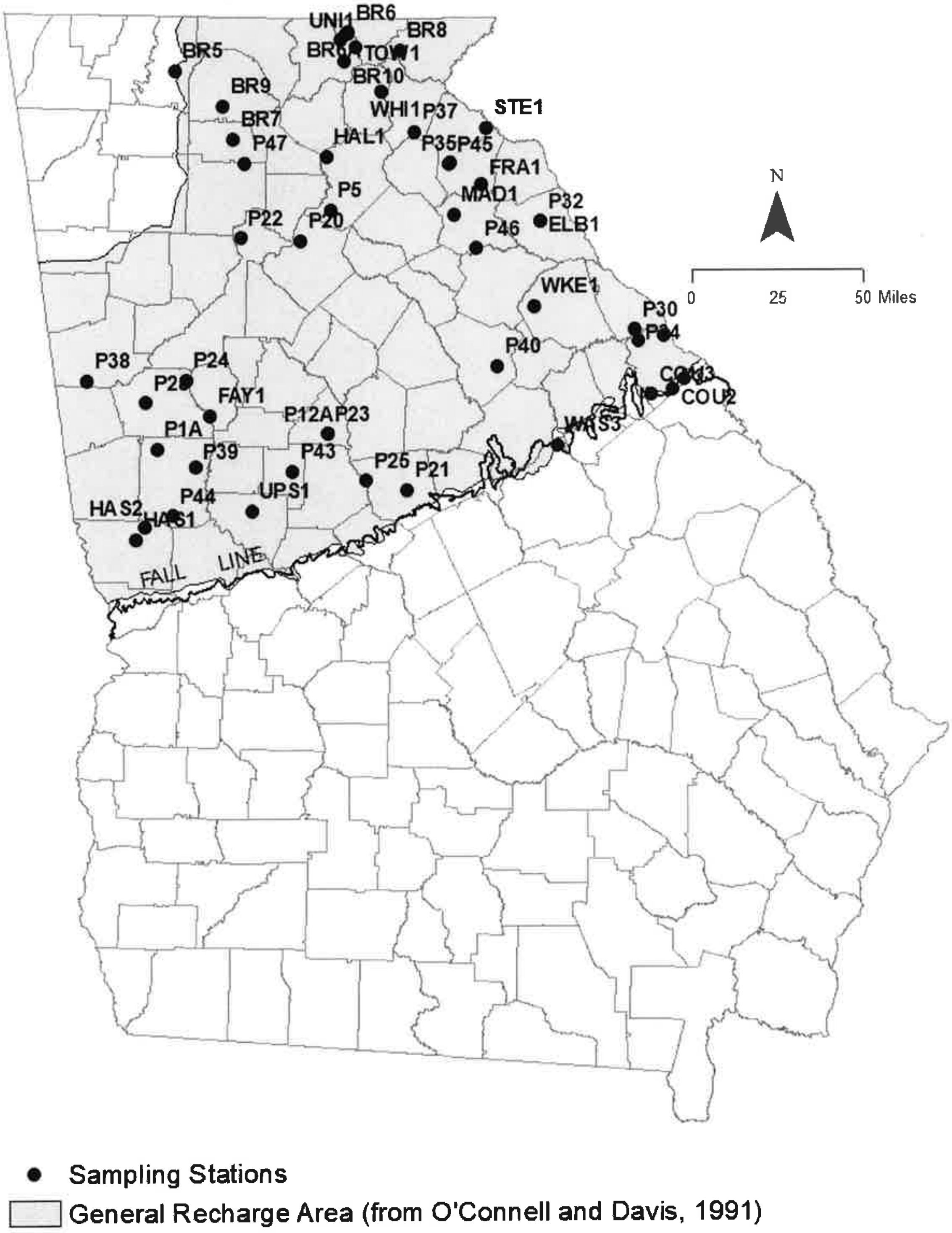

Figure 3-8. Locations of Stations Monitoring the Piedmont/Blue Ridge Aquifer System.

Sixty-eight samples from 39 wells and six springs were used to monitor water quality in the Piedmont/Blue Ridge aquifer system. Thirty-eight of these wells are drilled. Twenty-nine of the 39 wells are public supply wells, and the remaining ten are domestic. One of the 41 wells is bored (P43) and is in domestic use. Of the six springs, four (P12A, P44, HAS2 and TOW1) are mineral springs at State Parks, one (BR7) is free flowing beside a County Road and the last (BR5) is a public supply source. The State Park mineral spring P12A and the following wells are scheduled for sampling on a quarterly basis: P21, P25, P32, P34, P35, P37 and BR1B. The remaining stations are sampled on an annual basis. Where their depths are known, wells deriving water from the bedrock aquifer range in depth from 80 feet (P45) to 705 feet (P24). Domestic bored well P43 (unknown) is the only well drawing from the regolith aquifer, other than the six springs.

3.8.2 Field Parameters

Sixty-eight pH measurements from 45 stations are available for the Piedmont/Blue Ridge aquifer system. The pHs ranged from 4.69 (spring HAS2) to 8.26 (well UPS1). Twenty-eight total samples were basic; all samples from quarterly spring P12A and quarterly wells P32, P35, and BR1B and one sample from wells P24, P30, P44, P47, COU1, COU4, FAY1 18.8, HAL1, MAD1, UPS1, WAS3, BR9 and BR11. The remaining samples were acidic. The mean pH was 6.71 and the median 6.69. Conductivity measurements are available for all 68 samples. Conductivities range from 12 uS/cm (spring HAS2) to 952 uS/cm (well P32). The mean conductivity was 213 uS/cm and the median was 190 uS/cm. Samples with the higher pHs generally tended to have higher conductivities and vice versa. Temperatures were available for all sampled waters and range from 10.38 degrees C (spring TOW1) to 28.47 degrees C (spring P44). The mean temperature was 17.36 degrees C and the median was 17.40 degrees C. Geothermally elevated temperatures are not readily apparent for the Piedmont/Blue Ridge. Latitude, ground elevation, and season appear to have more influence on the sampling temperature. Dissolved oxygen measurements are available for 57 of the 68 samples from 37 of 45 stations. The samples from quarterly spring P12A and annual springs P44, HAS2, BR5, BR7 and TOW1; and wells P39 and FRA1 received no dissolved oxygen measurements since exposure of the sample water to air can render the measurement inaccurate. Dissolved oxygen levels ranged from 0.34 mg/L for well FAY1 18.8 to 6.15 mg/L for well WKE1. The 6.15 mg/L high reading for well WKE1 lies just below the oxygen saturation level (9.50 mg/L) for the temperature at sampling (18.11 degrees C). This reading suggests free-falling (cascading) water in the well or entrainment of air at the pump intake due to a low pumping water level and does not reflect the actual oxygen level in the groundwater. The mean dissolved oxygen level was 2.78 mg/L and the median was 2.59 mg/L.

3.8.3 Major Anions, Non-Metals, and Volatile Organic Compounds

All samples received testing for chloride, sulfate, fluoride, nitrate/nitrite, total phosphorus, and VOCs. Five stations yielded nine samples with detectable chloride: quarterly spring P12A two samples, quarterly well P37 with all four samples; and annual wells P30, WAS3, and WKE1 with one sample each. Well P30 gave the sample with the highest level at 34 mg/L. Detectable fluoride occurred in 17 samples from 12 stations. Most prominent of these samples were quarterly well P32 with four samples at levels between 1.9 mg/L and 2.1 mg/L (equal to or above the Secondary MCL of 2.0 mg/L) and quarterly spring P12A with four samples at levels ranging from 4.0 mg/L to 4.6 mg/L. This last range of levels exceeds or equals the Primary MCL of 4 mg/L for fluoride; the spring water from this station has consistently done so in the past. Historical fluoride levels for spring P12A have ranged from slightly above 4 mg/L to slightly above 5 mg/L. Sulfate was detected in 33 samples from seven quarterly and eight annual stations, with the highest concentration (660 mg/L) occurring in a sample from quarterly well P32. Quarterly spring P12A and quarterly wells P21, P25, P32, P37 and BR1B each have sulfate values that vary within narrow ranges. Nitrate/nitrite was detected in 47 of 68 samples from 33 stations with high concentrations of 3.5 mg/L and 3.0 mg/L as nitrogen for wells WKE1 and P30 respectively. These levels are well below the Primary MCL of 10 mg/L as nitrogen, but within the range of likely human influence (≥ 3.1 mg/L as nitrogen) (Madison and Brunett, 1984). Detectable phosphorus occurred in 36 samples from 26 stations, with the highest concentration of 0.17 mg/L being found in a sample from well P34. Phosphorus concentrations vary within narrow ranges within the samples from quarterly spring P12A and from quarterly wells P21, P25, and P34. Detectable VOCs occurred in samples from wells COU4 (methyl tert-butyl ether (MTBE) 1.3 ug/L), UPS1 (chloroform 2.0 ug/L) and spring BR7 (chloroform 1.6 ug/L). Chloroform, bromodichloromethane and dichloromethane are disinfectant by-products; MTBE and toluene are fuel additives.

3.8.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

ICP analysis found detectable aluminum, calcium, cobalt, iron, potassium, magnesium, manganese and sodium. No beryllium, titanium or vanadium were detected. Calcium was found in all samples except springs HAS2 and TOW1. The probable explanation for no detectable calcium in these springs is probably because the springs flow through a homogeneous quartzite rock. The highest calcium levels ranging from 200,000 ug/L to 270,000 ug/L occurred in the quarterly samples from well P32. The mean calcium concentration was 28,068 ug/L and the median concentration was 18,000 ug/L. As a rule, calcium levels of samples from each quarterly station tend to cluster closely. Magnesium was detected in 62 samples from 39 stations. Magnesium contents of sample waters ranged from not detected up to 41,000 ug/L (well P30). As with calcium, magnesium levels in samples from each quarterly well generally tend to cluster. Samples from annual bedrock wells P38, P43, and BR8; and annual springs HAS2, BR5 and TOW1 contained no detectable magnesium. Sodium was present in 67 of 68 samples and ranged from undetected from spring HAS2 to 39,000 ug/L from spring P12A. Sodium levels for each quarterly well have a general tendency to cluster. The mean sodium concentration was 11,253 ug/L and the median was 7,650 ug/L. Manganese was detected in 41 samples from 22 stations, with a maximum concentration of 320 ug/L (well COU4). Detectable potassium was found in all four samples from one station (well P35) in a range of 6,400 ug/L to 6,800 ug/L. The low sensitivity of the current laboratory testing procedure for potassium probably accounts for the apparent scarcity of this metal. Aluminum was detected in one sample from well P43 at a level of 62 ug/L. Aluminum levels exceeded the Secondary MCL range of 50-200 ug/L in all samples. Iron was detected in 32 samples from 23 stations, with a range from not detected up to 3,700 ug/L (well BR11). This concentration exceeds the Secondary MCL for iron of 300 ug/L. Seven other wells produced seven samples with an iron level greater than the Secondary MCL; P43 (1,600 ug/L), P47 (380 ug/L), COU1 (940 ug/L), HAS1 (340 ug/L), MAD1 (620 ug/L), STE1 (500 ug/L) and WHI1 (1,200 ug/L). Cobalt was detected in well P43 at a concentration of 12 ug/L.

3.8.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analysis of water samples detected the following metals: copper, zinc, barium, lead and uranium. None of the following metals were found in detectable amounts: chromium, nickel, arsenic, selenium, molybdenum, silver, cadmium, tin, antimony and thallium. Copper occurred in six samples from five wells, with a maximum level of 37 ug/L in the sample from well P22. All copper detections occurred in mostly acidic waters, with the highest pH for a sample containing detectable copper registering at 7.64 (BR9). The BR9 sample was the only sample where copper occurred in any neutral or basic waters. Zinc was detected in 10 samples from eight wells, with the maximum level at 71 ug/L from well FAY1. All zinc detections except for wells FAY1 (pH 7.42), MAD1 (pH 7.67) and BR9 (7.64) occurred in acidic waters. Lead was detected in three samples from two wells. All lead detections occurred in acidic water and all lead detections occurred with zinc or copper detections. These three metals commonly leach into sample water from plumbing and are not necessarily present naturally. Barium was a nearly ubiquitous trace metal, detected in 64 samples from 39 wells and five springs. Four samples from quarterly spring P12A contained no detectable barium. The maximum sample concentration was 99 ug/L from well WAS3. No samples exceeded the Primary MCL of 2,000 ug/L. Uranium was detected in 30 samples from 13 wells. Uranium concentrations ranged from not detected up to 24.0 (well P34). No detections of uranium exceeded the Primary MCL of 30 ug/L for uranium. Granitic bedrock is present where these wells are drilled and is the most common bedrock type to host uraniferous water.

3.9 VALLEY AND RIDGE/APPALACHIAN PLATEAU AQUIFER SYSTEM

3.9.1 Aquifer System Characteristics

Since Georgia's portion of the Appalachian Plateau Province extends over such a small area of the State, i.e., its northwestern corner, this report includes that province with the Valley and Ridge Province for purposes of discussion. Bedrock in the combined province is sedimentary, comprising limestones, dolostones, shales, siltstones, mudstones, conglomerates and sandstones (Figure 3-9).

Primary porosity in the province's bedrock is low, leaving fractures and solution-enlarged voids as the main water-bearing structures. The bedrock in the province is extensively faulted and folded, conditions that have served to proliferate fracturing and to segment water-bearing strata into numerous local flow systems, in contrast to the expansive regional flow regimes characteristic of the Coastal Plain sediments. Fractures in limestones and dolostones can become much enlarged by dissolution, greatly increasing their ability to store water.

Zones of intense fracturing commonly occur in carbonate bedrock along such structures as fold axes and fault planes and are especially prone to weathering. Such zones of intense fracturing give rise to broad valleys with gently sloping sides and bottoms covered with thick regolith. The carbonate bedrock beneath such valleys presents a voluminous source of typically hard groundwater.

As in the Piedmont/Blue Ridge Province, the regolithic mantle of soil and residuum derived from weathered bedrock blankets much of the Valley and Ridge/ Appalachian Plateau Province. The water table lying within the regolithic mantle yields soft water ("freestone" water) sufficient for domestic and light agricultural use (Cressler et al., 1976; 1979). The regolithic mantle also acts as a reservoir, furnishing water to the underlying bedrock, which supplies most of the useful groundwater in the province.

Monitoring water quality in the Valley and Ridge/Appalachian Plateau aquifers made use of five springs and two drilled wells (Figure 3-9). Springs VR2A, VR8, VR10 and VR12 are public supply springs. Spring VR3 is a former public supply spring now serving ornamental purposes in a public park. Well VR1 is a public supply well and well VR6A is an industrial process water source. Spring VR8 is scheduled for quarterly sampling, while all the other stations are sampled on an annual basis. All stations tap carbonate bedrock aquifers.

3.9.2 Field Parameters

Sample water pHs ranged from 7.25 for spring VR3 to 8.17 for well VR6A. Conductivities ranged from 213 uS/cm (spring VR12) to 329 uS/cm (spring VR2A). Dissolved oxygen was only taken from one well (VR1) and was measured as 5.94 mg/L. Dissolved oxygen measurements have been made on spring waters at or downstream of spring heads; however, due to atmospheric exposure at the spring heads, these measurements may not validly represent oxygen levels in the water prior to discharge. The temperature measurements ranged from 15.33 degrees C (spring VR3) to 17.27 degrees C (well VR6A). For spring waters, contact with the surface environment may have altered actual water temperatures present at the spring heads, since water temperatures were measured downstream from the springheads.

3.9.3 Major Anions, Non-Metals, and Volatile Organic Compounds

Neither chloride nor fluoride were detected in any of the sample waters. Sulfate was detected in one sample at a level of 16 mg/L in well VR6A. Detectable nitrate/nitrite was present in all sample waters and ranged from 0.35 mg/L as nitrogen in spring VR12 to 1.80 mg/L as nitrogen in spring VR10. Phosphorus was detected in one well: well VR6A (0.02 mg/L). The sample from well VR6A was the only one to contain detectable VOCs. The compounds were 1,1-dichloroethylene at 1.3 ug/L (Primary MCL = 7 ug/L) and tetrachloroethylene at 1.8 ug/L (Primary MCL = 5 ug/L). The two compounds, particularly the chlorinated ethylenes, are used primarily as solvents. The owner/user of well VR6A manufactures barium and strontium compounds and anthraquinone.

3.9.4 Metals by Inductively-Coupled Plasma Spectrometry (ICP)

ICP analysis found calcium and magnesium in all samples, sodium in all samples but one and iron in one sample. Iron was detected in the sample from spring VR8 (22 ug/L), below the Secondary MCL of 300 ug/L. Calcium levels ranged from 25,000 ug/L (spring VR12) to 47,000 ug/L (spring VR2A). Magnesium levels ranged from 12,000 ug/L (spring VR12) to 17,000 ug/L (well VR1). Sodium levels ranged from undetected (spring VR12) to 17,000 ug/L (well VR6A).

3.9.5 Metals by Inductively-Coupled Plasma Mass Spectrometry (ICPMS)

ICPMS analysis found zinc and barium. Detectable barium was present in all 10 samples and ranged from 10.0 ug/L (well VR1) to 380 ug/L (well VR6A). All samples save the one from VR6A have barium levels below 100 ug/L. Well VR6A furnishes process water to a firm that manufactures barium and strontium compounds and is situated in an area that sees the mining and processing of barite. Spring VR10 had a sample with a zinc detection (12.0 ug/L).

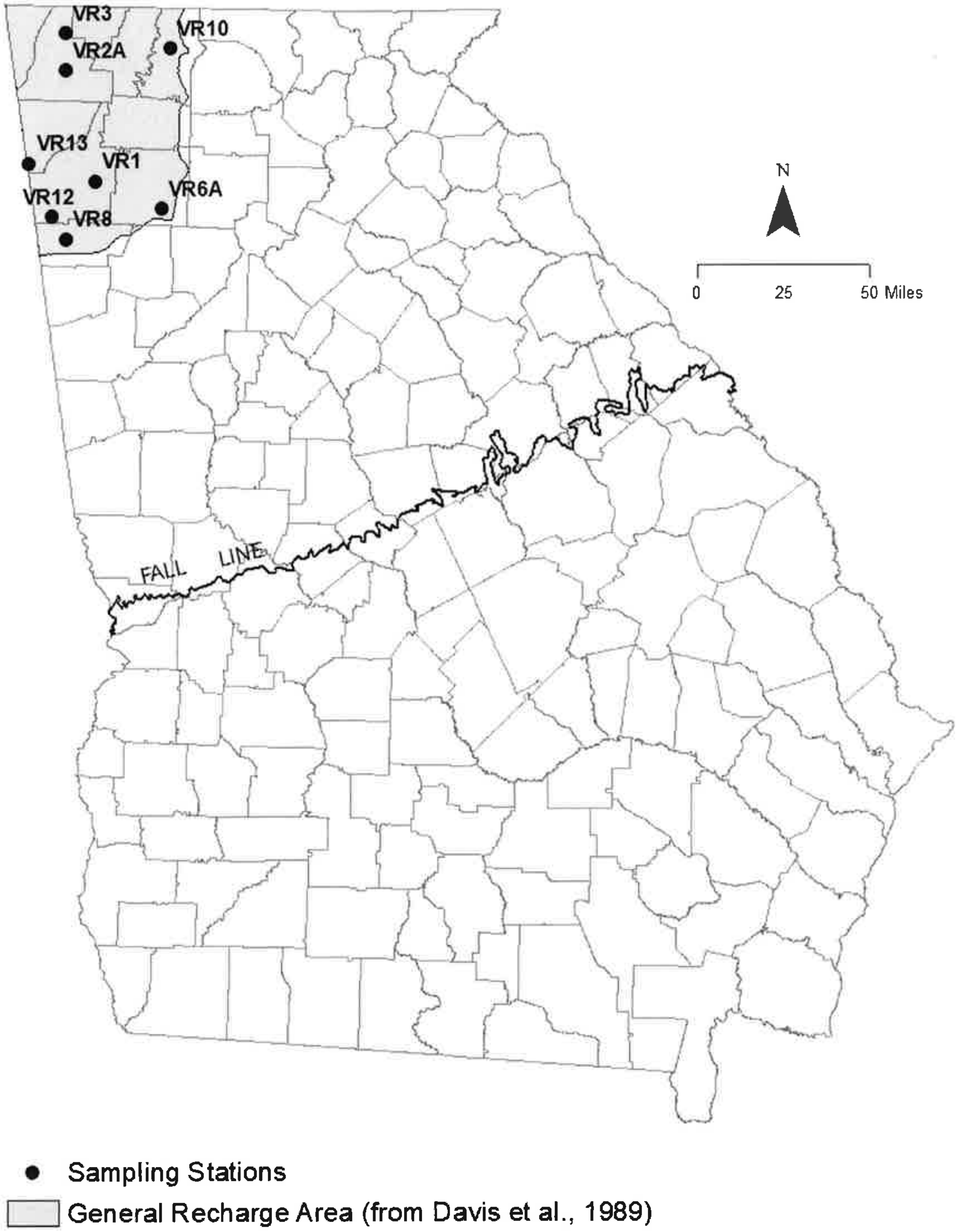

Figure 3-9. Locations of Stations Monitoring the Valley-and-Ridge/Appalachian Plateau Aquifer System.

CHAPTER 4 SUMMARY AND CONCLUSIONS

EPD personnel collected 177 water samples from 120 wells and 12 springs on the Groundwater Monitoring Network during the calendar year 2023. The samples were analyzed for VOCs, chloride, sulfate, fluoride, nitrate/nitrite, total phosphorus, 16 trace metals by ICPMS analysis, and 23 major metals by ICP analysis. All stations now receive analyses for fluoride because one of the stations was known to produce water with excessive levels of fluoride. These wells and springs monitor the water quality of eight major aquifers and aquifer systems as considered for this report in Georgia:

Cretaceous aquifer system,

Clayton aquifer,

Claiborne aquifer,

Jacksonian aquifer

Floridan aquifer system,

Miocene/Surficial aquifer system,

Piedmont/Blue Ridge aquifer system,

Valley and Ridge/Appalachian Plateau aquifer system.

4.1 PHYSICAL PARAMETERS AND pH

4.1.1 pH

The Cretaceous aquifer system, developed in Coastal Plain sands, furnished waters with the overall lowest pHs. This aquifer system featured only four of 21 wells yielding waters with basic pHs.

Not many stations were available to sample wells tapping the Clayton, Claiborne, or Jacksonian aquifers. However, the results are these: 1) Clayton – acidic as expected for updip portions of the aquifer and basic for downdip deeper portions 2) Claiborne – the two of the acidic wells are fairly shallow and updip in sands; and the slightly acidic well is deeper and probably penetrates some limey sand or limestone and is almost neutral; 3) Jacksonian – all eleven wells were basic or nearly neutral – basic and neutral waters should be expected from limey sands.

The Floridan aquifer system, as might be expected for carbonate-rock aquifers, gave waters with mildly acidic to basic pHs. Waters from the Floridan are some of the most basic in pH of any in the study.

The Miocene aquifer system is developed in sands. However, these may include shelly detritus in some places (evident at surface excavations near well MI17 and at coastal well MI16). Dissolution of such detritus can raise the pHs of groundwaters in such areas, giving water from these wells a nearly neutral to mildly basic pH. In places where such shelly matter is not available, waters emerge with low pHs, as at well MI2A.

Sample-water pHs in the Piedmont/Blue Ridge are generally mildly acidic, with 28 out of 68 sample measurements exceeding or equaling a pH of 7.00.

The Valley-and-Ridge/Appalachian Plateau sampling stations are all located in the Valley-and-Ridge sector. With carbonate rocks being the major aquifer media, samples from the sector would be expected to be mildly basic, which all eleven samples taken in the sector were found to be basic. In the past, some of these samples were found to be slightly acidic. The incidence of past acidic waters was probably due to a larger amount of typically acidic precipitation entering the springs' flow systems faster than the carbonate bedrock can neutralize.

The very acidic pHs of the sample waters in the updip portions of the Miocene, Clayton, Claiborne, and, particularly, the Cretaceous/Providence can face metal plumbing with leaching and corrosion problems. Such waters may contain elevated or excessive, but not naturally occurring, levels of lead, copper, and zinc.

4.1.2 Conductivity

Conductivity in groundwaters from the sandy Cretaceous/Providence aquifer system seems to be highest for the deeper wells in the Providence sands near the Chattahoochee River. Overall, conductivities are relatively low, in the range of lower tens of microsiemens.

Similar conductivities can be found in waters from the updip portions of the Clayton and Claiborne aquifers, where the media consist mostly of sand; then higher conductivities in the deeper downdip portions. For the Piedmont/Blue Ridge aquifer system, low conductivities could be associated with groundwaters hosted by quartzites or quartz veins. High conductivities may arise in waters in deep flow regimes where waters are long in contact with granitic and other reactive host rocks.

Conductivities of groundwaters in the Floridan and other carbonate rock aquifers are generally higher than those in siliceous rocks. This condition results from the dissolution of carbonate minerals, in cases augmented by dissolution of intergranular sulfate, where dissolved sulfate will also be present in the water.

4.1.3 Dissolved Oxygen

The measurement of dissolved oxygen contents is beset with some difficulties that can cause spurious values: instrument malfunction; aeration of well water due to cascading; a pump's entraining air at low pumping water levels;

measuring at spring pools or at sampling points that cannot be isolated from the atmosphere. Nevertheless, measured dissolved oxygen generally decreases with well depth.

4.1.4 Temperature

Groundwater temperatures measured under the current sampling procedure are only approximations of the actual groundwater temperature, as some heating can result from the action of pumping and heating or cooling can result from exposure to ambient surface conditions. Nevertheless, groundwaters from shallower wells in the northern part of the State are overall somewhat cooler than those from the southern part; and those from wells much deeper than about 400 to 500 feet show effects from geothermal warming.

4.2 ANIONS, NON-METALS AND VOCS

4.2.1 Chloride and Fluoride

Chloride at currently detectable levels is not too common in ambient groundwaters. Abundance seems to be largest in the deeper Floridan waters, which had detections at nine out of 35 stations. The Floridan occurrences seem restricted to the Gulf Trough and Coastal areas, with the Coastal area sample from well PA9C giving the study's only Secondary MCL exceedance for chloride. The Miocene/Surficial aquifer had one of six stations of less than 100 feet depth giving water with detectable chloride. Chloride is also relatively abundant in Piedmont/Blue Ridge waters, detected at five out of 45 stations.

All water samples now receive testing for fluoride. Abundance seems to be largest in the Floridan waters, detected at 24 of the 35 stations. Miocene sample waters had four detections at six stations and Piedmont/Blue Ridge sample waters had detections at 12 out of 45 stations. The Piedmont/Blue Ridge station P12A, a mineral spring, had the only Primary MCL exceedances and well P32 had the only Secondary exceedances. The lowest incidences of detectable fluoride were in the Cretaceous/Providence aquifer system (4 of 21 stations), the Jacksonian aquifer (2 of 10 stations), the Clayton aquifer (1 of 5 stations) and the Claiborne aquifer (1 of 3 stations).

4.2.2 Sulfate

Sulfate is more widespread than chloride. Sulfate is more abundant in deeper waters, with the shallowest occurrence from Piedmont/Blue Ridge mineral spring P12A (0 feet-deep), along with Cretaceous well MAR1 150 feet-deep. Sulfate seems more abundant in Floridan sample waters, detectable at 17 out of 35 stations. Sulfate is also abundant in the Piedmont/Blue Ridge, occurring in detectable amounts in waters from 15 of 45 stations. The Cretaceous aquifer yielded samples containing detectable sulfate in five out of 21 stations. The Clayton aquifer yielded samples containing detectable sulfate in three out of five stations. Jacksonian sample waters yielded two out of ten stations with detectable sulfate. The samples from Piedmont well P32 yielded the study's highest overall sulfate content and Secondary MCL exceedances. The lowest incidences of detectable sulfate were in the Miocene/Surficial aquifer at one of six stations, the Claiborne aquifer with one of three stations and the Valley and Ridge aquifer with one of seven stations.

4.2.3 Nitrate/Nitrite

Ninety-six (96) samples from 72 of the 132 stations sampled for this project contained detectable nitrate/nitrite. At least one sampling station drawing from each of the aquifers and aquifer systems discussed in this report gave a sample with detectable nitrate/nitrite. The combined substances are most widespread among the Valley and Ridge/Appalachian Plateau, where all stations gave samples containing detectable amounts. The combined substances are also widespread in Cretaceous, Jacksonian, Piedmont/Blue Ridge, Miocene and Floridan waters. The three highest concentrations of nitrate/nitrite (5.9 mg/L well MI2A, 3.5 mg/L well WKE1 and 3.0 mg/L well P30) occurred at Miocene/Surficial and Piedmont stations. All three samples exceeded or equaled the naturally occurring maximum level of 3 mg/L (as nitrogen), a level generally considered to indicate human influence (Madison and Brunett, 1984; Gaskin et al., 2003).

Since nitrate/nitrite, an oxidant, becomes depleted the farther water travels away from oxidizing near-surface environments and into reducing ones, a crude inverse relation exists between the concentration of the combined substances and well depths. The nitrate/nitrite concentrations in Floridan samples illustrate this: the combined substances are undetected in most wells deeper than about 400 feet and reach a maximum concentration of 2.2 mg/L in spring PA59 and 1.7 mg/L and 1.8 mg/L in three of three samples from well PA25, 174 feet deep. The situation in the Piedmont/Blue Ridge is less straightforward, as springs P12A and HAS2 lack detectable nitrate/nitrite in all five samples, and well P24 at 705 feet and well P39 at 600 feet each gave water with concentrations of 0.31 mg/L and 1.00 mg/L respectively.

4.2.4 Phosphorus

Analyses determine only total phosphorus; the method used (EPA Method 365.1) for testing cannot determine how the element is bound. There were only three samples from three stations collected for the Claiborne, however this aquifer registered the highest mean phosphorus content of 0.31 mg/L. Of the more extensively sampled Piedmont/Blue Ridge and Floridan aquifer systems, the former registered a mean phosphorus content of 0.03 mg/L and the latter a content of 0.01 mg/L. The high phosphorus value for the Floridan was 0.10 mg/L (well PA14A and PA20) and the high for the Piedmont/Blue Ridge was 0.17 mg/L (well P34). The highest value for all the aquifers was in the Claiborne aquifer at a level of 0.56 mg/L detected in the sample from station CL8. The apparent low phosphorus content occurred for the Clayton aquifer with no detection from five stations and the Valley and Ridge/Appalachian Plateau aquifer systems with one detection from seven staions.

4.2.5 Volatile Organic Compounds

Volatile organic compounds (VOCs) were found in eleven samples from eleven stations (see Table 4-2). No station exceeded the trihalomethane Primary MCL of 80 ug/L. The trihalomethanes; chloroform, chloromethane, bromodichloromethane and chlorodibromomethane were the most widely occurring of the VOCs. These compounds result from halogen-bearing disinfectants reacting with organic matter naturally present in the water. Two scenarios accompany the occurrence of the compounds. The first involves disinfection of the well and plumbing components incident to maintenance or repairs, as took place in well MI2A. The second scenario involves leaking check valves or foot valves that allow disinfectant-treated water to flow back down the well when pumps are off, as apparently happened with well UPS1.

Well VR6A and spring PA59 yielded waters containing chlorinated ethylene compounds. Sample water from VR6A has also contained detectable chlorinated benzene compounds in the past. The former are used as solvents; in addition to solvent uses, the latter can be used as disinfectants, fumigants, pesticides, and starters for manufacturing other compounds. The owner of well VR6A, Chemical Products Corporation, manufactures barium and strontium compounds.

Well COU4 yielded water containing methyl tert-butyl ether (MTBE; 2-methoxy-2-methyl-propane), which has no MCL. An advisory range of 20 ug/L to 40 ug/L has preliminarily been set due to offensive taste and smell. The compound has been added to motor fuels as an oxygenate (promotes cleaner burning). That use is being curtailed due to the greater water solubility of the compound compared to other fuel components thus its heightened ability to contaminate groundwater. Data on the long-term health effects of the compound are sparse.

4.3 ICP METALS

Analysis using inductively coupled plasma spectrometry (ICP) works well for metals that occur in larger concentrations in groundwater samples. Samples in this study were not filtered, so the method measured analytes that occurred in fine suspended matter as well as those occurring as solutes. The laboratory used the technique to test for aluminum, beryllium, calcium, cobalt, iron, potassium, magnesium, manganese, sodium, titanium, and vanadium. No beryllium, titanium or vanadium occurred in any samples at detectable levels.

4.3.1 Aluminum

Aluminum, a common naturally occurring metal in the State's groundwater may be present in particulate form or as a solute. Current sampling procedures do not allow separate analyses of particulates and solutes. For its Secondary MCL, aluminum is subject to a range of concentrations from 50 ug/L to 200 ug/L, depending on the ability of a water system to remove the metal from water undergoing treatment. The EPD laboratory's reporting level for the metal of 60 ug/L lies within the Secondary MCL range, therefore placing any sample with detectable aluminum within the MCL range.

The metal appears to be most abundant in water samples with acidic pHs and, as a rule, is more concentrated the higher the acidity. The Miocene/Recent aquifer system, updip portions of the Cretaceous/Providence aquifer system, and updip terrigenous clastic-rich portions of the Clayton aquifer are examples. The metal is also abundant in particulate water samples. Aquifers giving mildly basic samples such as the carbonate hosted Floridan aquifer and carbonate portions of the Valley and Ridge/Appalachian Plateau aquifers produce few if any sample waters containing any detectable aluminum. The metal's abundance in bedrock waters from the Piedmont Blue Ridge aquifer system seems also low. Samples from deeper wells with more strongly basic pHs (approaching 8.00) may contain some detectable aluminum.

4.3.2 Iron and Manganese

Iron and manganese are also two more naturally occurring metals in Georgia's groundwater. Both, like aluminum, may occur as fine particulates or as solutes. Both seem more abundant in acidic waters. Manganese also seems more abundant in waters with low dissolved oxygen contents. Sand units (e.g., the Cretaceous and updip Clayton) and shallower igneous/metamorphic bedrock give waters with the highest iron or manganese concentrations. Waters with the lowest concentrations are drawn from carbonate units (e.g., the Floridan and the carbonates in the Valley and Ridge/Appalachian Plateau province), which also usually have the higher pH waters.

4.3.3 Calcium, Magnesium, Sodium, and Potassium

Calcium is most abundant in sample waters from the Jacksonian aquifer with a mean calcium content of 52,100 ug/L for ten samples. Sample waters from the Floridan, the Valley and Ridge and the Piedmont/Blue Ridge aquifer systems also contain high calcium levels. The metal could be considered least abundant in samples from the Cretaceous/Providence aquifer system with a mean calcium content of 7,267 ug/L for 21 samples.

Magnesium appears most abundant in the Valley and Ridge/Appalachian Plateau aquifer system with a 14,800 ug/L mean and least abundant in the Cretaceous/Providence system with a 500 ug/L mean.

Detectable sodium is nearly ubiquitous. The metal is most abundant in waters from the deep Cretaceous wells, the Floridan, the Miocene and the Piedmont/Blue Ridge aquifer systems and least so in waters from the Valley and Ridge, Jacksonian, Clayton and Claiborne aquifer systems.

The testing method used by the EPD laboratory to analyze for potassium is not very sensitive (reporting limit 5,000 ug/L), therefore detectable potassium was found in only six samples from three stations – one sample from one station (MI2A) in the Miocene, one sample from one station (PA4) in the Floridan and four samples from one station (P35) in the Piedmont/Blue Ridge.

Kellam and Gorday (1990) observed that Ca/Mg ratios are highest in the Floridan where recharge areas are closest. Their observation also applies to the Floridan in this study, and a wide range of Ca/Mg ratios from indefinitely large (division by zero or a very small number) near the recharge areas (e.g. PA16, PA17, PA25, PA27, PA38, PA59 and PA60) to 1.29-1.65 in other areas (e.g. PA4, PA9C, GLY2, GLY3, GLY4 and MCI1) of the Floridan farther from the recharge area. However, for carbonate or carbonate-bearing aquifer media in the Valley and Ridge/Appalachian Plateau, Jacksonian, Claiborne, and Miocene/Surficial aquifers and aquifer systems the rule does not seem to apply. The ratios seem to average around 2.2 for the Valley and Ridge/Appalachian Plateau samples and range from 22.7 up to indefinitely large for the Jacksonian. The low number of sampling stations situated in the other aquifers or aquifer systems might cause the differences between Floridan Ca/Mg ratios and ratios for the other aquifers and aquifer systems to be apparent.

4.4 ICPMS METALS

The ICPMS method works well for most trace metals. Sample waters undergoing testing by this method, as with the samples subject to ICP testing, were unfiltered. The EPD laboratory tested for the following trace metals: chromium, nickel, copper, zinc, arsenic, selenium, molybdenum, silver, cadmium, tin, antimony, barium, thallium, lead and uranium. Chromium, silver, cadmium, tin, antimony and thallium remained below detection in all samples. No metals analyzed under the ICPMS method registered any levels above the Primary or Secondary MCLs or action levels.

4.4.1 Chromium and Nickel

Detectable chromium did not occur in any samples this sampling year. Detectable nickel occurred in one sample from one Clayton station (SUM2). These metals do occur naturally occasionally in the sedimentary rocks of the Floridan and Clayton aquifer systems.

4.4.2 Arsenic, Selenium, Molybdenum and Uranium

Arsenic was detected in two of three samples from the Floridan quarterly well PA23A. The Floridan samples came from the Gulf Trough area of Grady County, the scene of other groundwater arsenic detections, some above the Primary MCL (10 ug/L) (Donahue et al., 2012). Selenium was found in a sample from the Miocene aquifer system (well MI10B). Selenium may accompany uranium in deposits formed from the reduction of oxic groundwaters. Ten samples from four Floridan stations contained detectable molybdenum. The stations – PA13, PA23A, PA28 and PA56 – are all wells in or adjacent to the Gulf Trough area. Like selenium, molybdenum can be associated with uranium in deposits formed through the reduction of oxic groundwates (Turner-Peterson and Hodges, 1986). Uranium appears to be most abundant in the Piedmont/Blue Ridge, with thirteen stations giving 30 samples containing detectable uranium, then the Floridan aquifer system with four stations giving eight samples and the Clayton aquifer system giving one sample from one station. Uranium minerals, sometimes accompanied by molybdenum and selenium minerals, can precipitate from oxic groundwaters subjected to strong reduction.

4.4.3 Copper, Lead, and Zinc

Copper, lead, and zinc detections are more numerous in acidic samples. Copper and lead did not exceed their action level nor zinc its Secondary MCL in any samples. Out of a total of 177 samples taken for the study, 27 samples with pHs below 7.00 contained detectable amounts of at least one of these metals. In contrast, only seven samples with basic pHs contained detectable amounts of any of these metals. Past experiences where two samples, each drawn from a different spigot, had different copper, zinc, and lead values, suggest that these metals are, at least in part, derived from plumbing. Therefore, the copper, lead, and zinc levels in the samples are not necessarily representative of those in the ambient groundwater.

4.4.4 Barium

A possible effect of the sensitivity of the testing method, barium detections occur in almost every sample. Because, perhaps, nearby barite deposits and associated mining and processing activities greatly increased the barium level in groundwater at station VR6A, a sample from that station has caused the Valley and Ridge/Appalachian Plateau samples to have one of the highest average barium levels along with samples from the Floridan and Miocene/Surficial aquifer systems. Groundwater containing excessive barium (Primary MCL of 2,000 ug/L) has not been a problem since the in-town public well field, drawing from the Floridan at Fitzgerald, Ben Hill County, closed in 1995.

4.5 CONTAMINATION OCCURENCES

According to the Safe Drinking Water Act (Public Law 93-523, section 1401, Dec. 16, 1974) a "contaminant" is any "physical, chemical, biological, or radiological substance in water" – almost anything except water itself. Some contaminants can be innocuous or even beneficial; others can be undesirable or harmful.

Modeled after limits the EPA has established concerning the quality of water offered for public consumption, the State established limits on certain contaminants in water for public use (Table 4-1). Some contaminants may endanger health if present in sufficient concentrations. Two types of limits apply to such contaminants. The first, the Primary MCL, imposes mandatory limits applying to treated water at the point of its production. The second, the action level, sets forth mandatory limits that regulate copper and lead contents and apply to water at the point where the consumer can partake of it.

Secondary MCLs (Table 4-1) are suggested limits established for substances imparting only unpleasant qualities to water. The unpleasant qualities include bad taste and staining ability as with iron and manganese, and cosmetic effects as with silver.

4.5.1 Primary MCL and Action Level Exceedances

One mineral spring produced samples with a substance that exceeded Primary MCLs or action levels (Table 4-1). The Piedmont mineral spring P12A gave four samples that exceeded the Primary MCL for fluoride (4 mg/L). The spring has, in the past, regularly given samples that fall in a range from 4 mg/L to a little above 5 mg/L fluoride. The fluoride is almost certainly natural.

4.5.2 Secondary MCL Exceedances

Substances occurring in excess of Secondary MCLs (Table 4-1) consisted of manganese, aluminum, iron, chloride, sulfate, and fluoride. Manganese, aluminum, and iron are common naturally occurring metals in Georgia's groundwater.

Manganese equaled or exceeded its MCL in 27 samples from 16 wells. Three of the Piedmont wells were quarterly (P25, P35 and P37); all three (P25, P35 and P37) of the wells gave four samples each with excessive manganese. One Floridan well (quarterly well PA34D) in McRae gave three of three samples that exceeded the MCL for manganese.

The Secondary MCL for aluminum is established as a range, varying from 50 ug/L to 200 ug/L. The range is designed to accommodate varying ability of water treatment facilities at removing aluminum from treated water. This is a consequence of a tradeoff between introducing into treated water coagulants, which contain soluble aluminum, versus impaired removal of suspended aluminum-bearing contaminants. The aluminum present in waters covered by this study is naturally occurring rather than introduced. Of additional note, water in shallow wells may experience an increase in suspended matter (turbidity) during prolonged rain events, which may result in an increased aluminum value because of suspended material. Aluminum excesses, those which exceeded the 50 ug/L level (most groundwater used for public consumption lacks measureable suspended matter) were found in six samples from six wells.

Iron exceeded its Secondary MCL in 18 samples from 18 wells. Iron is another common naturally occurring contaminant in Georgia's groundwater.

Well P32 gave three of three and two of three samples with Secondary MCL exceedances or equivalences of sulfate and fluoride respectively. Well PA9C gave a sample with excessive chloride.

4.5.3 Volatile Organic Compounds

Trihalomethanes are the most common of the VOCs detected (Table 4-2). Chloroform, the most commonly detected of the VOCs, was present in six samples from six stations. The next most common trihalomethane was chloromethane with two detections from two stations and bromodichloromethane and chlorodibromomethane with one detection from one station. In groundwater, these compounds originate as by-products when halogenous disinfectants react with naturally-occurring organic matter present in the water. The disinfectants are introduced to the water through cleaning processes incident to well maintenance or through leaky check valves or foot valves allowing treated water down a well during normal operation.

One station (VR6A) gave a sample containing detectable tetrachloroethylene and 1,1-dichloroethylene. Well VR6A, an industrial process water well, is in an industrial area and is within about two miles of former and current landfills. The former landfills utilized unlined exhausted barite pits. Cressler et al. (1979) had warned of the danger of using these sorts of pits for waste disposal in the Cartersville area because of the karstic bedrock. However, the source of the VOCs at station VR6A is uncertain.

Well COU4 gave a sample with a detection of MTBE, a fuel additive. Spring PA59 gave a sample with a trichloroethylene detection. Trichloroethylene and 1,2 dichloroethylene are commonly used as solvents or degreasers for metal parts, as dry-cleaning solvents and in the manufacturing of a range of fluorocarbon refrigerants.

Table 4-1. Contaminant Exceedances, Calendar Year 2023.

Station	Contaminant	MCL	Type Source	Date Sampled
Primary MCL and Copper/Lead Action Level Exceedances				
P12A	Fluoride = 4.6 mg/L	4 mg/L	mineral spring	11/07/2023
P12A	Fluoride = 4.5 mg/L	4 mg/L	mineral spring	08/24/2023
P12A	Fluoride = 4.5 mg/L	4 mg/L	mineral spring	02/22/2023
P12A	Fluoride = 4.0 mg/L	4 mg/L	mineral spring	05/18/2023
Secondary MCL Exceedances				
SUM2	Manganese = 360 ug/L	50 ug/L	public well	01/26/2023
COU4	Manganese = 320 ug/L	50 ug/L	public well	05/04/2023
WAS3	Manganese = 260 ug/L	50 ug/L	public well	02/08/2023
P43	Manganese = 240 ug/L	50 ug/L	domestic well	01/26/2023
COU1	Manganese = 150 ug/L	50 ug/L	public well	08/10/2023
HAS1	Manganese = 150 ug/L	50 ug/L	public well	02/09/2023
MAD1	Manganese = 140 ug/L	50 ug/L	public well	03/08/2023
P35	Manganese = 120 ug/L	50 ug/L	domestic well	04/04/2023
P35	Manganese = 110 ug/L	50 ug/L	domestic well	07/13/2023
P35	Manganese = 100 ug/L	50 ug/L	domestic well	10/12/2023
P35	Manganese = 100 ug/L	50 ug/L	domestic well	01/11/2023
WAY1	Manganese = 100 ug/L	50 ug/L	public well	10/25/2023
P37	Manganese = 100 ug/L	50 ug/L	public well	01/11/2023
P37	Manganese = 98 ug/L	50 ug/L	public well	10/12/2023
PA34D	Manganese = 83 ug/L	50 ug/L	public well	03/22/2023
PA34D	Manganese = 82 ug/L	50 ug/L	public well	06/29/2023
PA34D	Manganese = 79 ug/L	50 ug/L	public well	09/27/2023
P37	Manganese = 78 ug/L	50 ug/L	public well	04/04/2023
P25	Manganese = 70 ug/L	50 ug/L	public well	02/22/2023

Table 4-1. Contaminant Exceedances, Calendar Year 2023.

Station	Contaminant	MCL	Type Source	Date Sampled
Secondary MCL Exceedances Continued				
P37	Manganese = 66 ug/L	50 ug/L	public well	07/13/2023
P25	Manganese = 65 ug/L	50 ug/L	public well	08/24/2023
P25	Manganese = 63 ug/L	50 ug/L	public well	05/18/2023
P25	Manganese = 62 ug/L	50 ug/L	public well	11/07/2023
PA18	Manganese = 61 ug/L	50 ug/L	public well	03/22/2023
CL4A	Manganese = 57 ug/L	50 ug/L	public well	01/11/2023
JEF1	Manganese = 55 ug/L	50 ug/L	public well	01/25/2023
CL8	Manganese = 54 ug/L	50 ug/L	public well	01/11/2023
SUM2	Aluminum = 1,300 ug/L	50-200 ug/L	public well	01/26/2023
K12	Aluminum = 480 ug/L	50-200 ug/L	public well	09/28/2023
K9A	Aluminum = 280 ug/L	50-200 ug/L	public well	02/08/2023
MI2A	Aluminum = 140 ug/L	50-200 ug/L	domestic well	07/27/2023
K2A	Aluminum = 77 ug/L	50-200 ug/L	public well	08/10/2023
P43	Aluminum = 62 ug/L	50-200 ug/L	domestic well	01/26/2023
BR11	Iron = 3,700 ug/L	300 ug/L	domestic well	09/28/2023
CL4A	Iron = 1,900 ug/L	300 ug/L	public well	01/11/2023
CHT1	Iron = 1,600 ug/L	300 ug/L	public well	07/26/2023
P43	Iron = 1,600 ug/L	300 ug/L	domestic well	01/26/2023
PA9C	Iron = 1,200 ug/L	300 ug/L	former test	11/08/2023
WHI1	Iron = 1,200 ug/L	300 ug/L	public well	06/15/2023
STW1	Iron = 1,100 ug/L	300 ug/L	public well	07/26/2023
MAC1	Iron = 950 ug/L	300 ug/L	public well	11/21/2023
COU1	Iron = 940 ug/L	300 ug/L	public well	08/10/2023
K11A	Iron = 680 ug/L	300 ug/L	public well	08/10/2023
MAD1	Iron = 620 ug/L	300 ug/L	public well	03/08/2023

Table 4-1 Continued. Contaminant Exceedances, Calendar Year 2023.

Station	Contaminant	MCL	Type Source	Date Sampled
Secondary MCL Exceedances Continued				
STE1	Iron = 500 ug/L	300 ug/L	public well	03/08/2023
CL8	Iron = 490 ug/L	300 ug/L	public well	01/11/2023
MI10B	Iron = 440 ug/L	300 ug/L	domestic well	07/27/2023
K3	Iron = 420 ug/L	300 ug/L	public well	08/09/2023
P47	Iron = 380 ug/L	300 ug/L	domestic well	12/20/2023
SUM2	Iron = 380 ug/L	300 ug/L	public well	01/26/2023
HAS1	Iron = 340 ug/L	300 ug/L	public well	02/09/2023
PA9C	Chloride = 270 mg/L	250 mg/L	former test	11/08/2023
P32	Sulfate = 660 mg/L	250 mg/L	domestic well	07/13/2023
P32	Sulfate = 520 mg/L	250 mg/L	domestic well	10/12/2023
P32	Sulfate = 100+ mg/L	250 mg/L	domestic well	04/04/2023
P32	Fluoride = 2.1 mg/L	2 mg/L	domestic well	07/13/2023
P32	Fluoride = 2.0 mg/L	2 mg/L	domestic well	10/12/2023

(The alphabetic prefix in a station number indicates the aquifer/aquifer system tapped: CL=Claiborne, J=Jacksonian, K=Cretaceous, P=Piedmont/Blue Ridge, PA=Floridan, CT=Clayton, VR=Valley and Ridge, M=Miocene)

Table 4-2. VOC Detection Incidents, Calendar Year 2023.

Station	Constituents	Primary MCL	Type Source	Date Sampled
MAR1	chloromethane = 0.6 ug/L	See note (Page A-33)	industrial	07/26/2023
PA57	chloromethane = 0.86 ug/L	See note (Page A-33)	public	07/13/2023
CL2	chloroform = 1.1 ug/L	See note (Page A-33)	public	02/08/2023
	bromodichloromethane = 0.60 ug/L			
	chlorodibromomethane = 0.59 ug/L			
PA59	trichloroethylene = 0.75 ug/L	5 ug/L	spring	05/04/2023
MI2A	chloroform = 1.0 ug/L	See note (Page A-33)	domestic	07/27/2023
PD2A	chloroform = 0.64 ug/L	See note (Page A-33)	public	01/11/2023
J6	chloroform = 0.71 ug/L	See note (Page A-33)	public	02/08/2023
COU4	MTBE = 1.3 ug/L	No MCL	public	05/04/2023
UPS1	chloroform = 2.0 ug/L	See note (Page A-33)	public	04/05/2023
BR7	chloroform = 1.6 ug/L	See note (Page A-33)	spring	06/15/2023
VR6A	1,1 dichloroethylene = 1.3 ug/L	7 ug/L	industrial	03/23/2023
	tetrachloroethylene = 1.8 ug/L	5 ug/L		

4.6 GENERAL QUALITY

A review of the analyses of the water samples collected during calendar year 2023 indicates that the chemical quality of groundwater sampled for most of the Groundwater Monitoring Network stations is quite good.

However, as mentioned in Chapter 1, areas of elevated risk for low-quality groundwater exist:

1) Valley and Ridge/Appalachian Plateau Province – surface influence;
2) Piedmont/Blue Ridge Province – in areas excluding the eastern metavolcanic terranes - uranium:
3) Coastal Plain agricultural areas – high nitrate/nitrite;
4) Coastal Plain, Dougherty Plain – surface influence;
5) Coastal Plain, Gulf Trough – high total dissolved solids, especially sulfate – high radionuclides, high barium, high arsenic;
6) Coastal Plain, Atlantic coast area – saline water influx.

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LABORATORY AND STATION DATA

Tables A-1 through A-8 list the values for both laboratory parameters and field parameters for each well or spring. The following abbreviations are used on these tables:

Parameters and Units of Measure

Cl = chloride
cond. = conductivity
diss O2 = dissolved oxygen
F = fluoride
ICP = inductively coupled plasma (emission) spectroscopy
ICPMS = inductively coupled plasma/mass spectrometry
mg/L = milligrams per liter
mgN/L = milligrams per liter as nitrogen
NA = not available; not analyzed

ND = not detected
NG = not given
NOx = nitrate/nitrite
P = total phosphorus
SO4 = sulfate
Temp. = temperature
ug/L = micrograms per liter
uS/cm = microSiemenses per centimeter
VOC = volatile organic compound

Volatile Organic Compounds

1,1dce = 1,1-dichloroethylene
bdcm = bromodichloromethane
dbcm = dibromochloromethane
pce = tetrachloroethylene
cb = chlorobenzene
MTBE =methyl tert-butyl ether
TTHM =total trihalomethanes

mdcb = m-dichlorobenzene
odcb = o-dichlorobenzene
pdcb = p-dichlorobenzene
tbm = bromoform
tcm = chloroform
tce =trichloroethylene
dcm =dichloromethane

Table A-9 gives the reporting limits for the various analytes. The abbreviations used for Tables A-1 through A-8 also apply to Table A-9.

Table A-1. Groundwater Quality Analyses for Cretaceous/Providence Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-K2A **Wilkinson**	Irwinton Well #4	400	NG	NG	8/10/2023	4.41	49	1.02	19.40	ND	ND	10	ND	0.34	0.03
GWN-K3 **Washington**	Sandersville Well #7B	697	NG	NG	8/9/2023	5.56	118	0.30	21.18	ND	ND	12	ND	ND	0.08
GWN-K7 **Jones**	Jones County #4	128	NG	NG	9/28/2023	4.62	31	6.67	17.86	ND	ND	ND	ND	0.81	ND
GWN-K9A **Macon**	Marshallville Well #2	550	NG	NG	2/8/2023	4.09	44	1.04	19.05	ND	ND	ND	1.2	0.06	ND
GWN-K10B **Peach**	Fort Valley Well #6	600	NG	NG	7/12/2023	5.25	18	NA	18.79	ND	ND	ND	ND	0.76	ND
GWN-K11A **Houston**	Warner Robins Well #2	540	NG	NG	8/10/2023	5.17	25	6.87	20.63	ND	ND	ND	ND	1.00	ND
GWN-K12 **Houston**	Perry/Holiday Inn Well	550	NG	NG	9/28/2023	3.91	46	1.36	19.85	ND	ND	ND	ND	ND	ND
GWN-K15A **Quitman**	Georgetown Well #3	NG	NG	NG	3/23/2023	8.62	468	0.20	30.97	ND	ND	ND	0.50	ND	0.07
GWN-K19 **Richmond**	Hephzibah/Murphy Street Well	484	NG	NG	10/26/2023	4.59	21	5.99	19.58	ND	ND	ND	ND	0.20	ND
GWN-K20 **Sumter**	Plains Well #7	1000	NG	NG	1/11/2023	7.21	115	0.25	29.15	ND	ND	ND	ND	ND	0.18
GWN-BUR2 **Burke**	Keysville #1	NG	NG	NG	8/10/2023	4.85	17	4.91	20.25	ND	ND	ND	ND	0.08	ND
GWN-CHT1 **Chattahoochee**	Camp Darby Well	NG	NG	NG	7/26/2023	5.45	47	0.35	22.06	ND	ND	ND	ND	ND	0.05
GWN-GLA1 **Glascock**	Mitchell #3	NG	NG	NG	8/9/2023	4.28	44	8.32	20.13	ND	ND	ND	ND	2.1	ND
GWN-MAC1 **Macon**	Whitewater Creek PK #1	NG	NG	NG	11/21/2023	5.72	61	1.96	19.88	ND	ND	ND	ND	ND	0.26
GWN-MAR1 **Marion**	Unimin #1	150	NG	NG	7/26/2023	5.88	172	1.66	20.51	chloromethane=0.6	ND	51	ND	0.55	ND
GWN-STW1 **Stewart**	Louvale Community Well	NG	NG	NG	7/26/2023	4.65	28	0.37	18.78	ND	ND	ND	ND	ND	ND
GWN-PD2A **Early**	Preston Well #4	205	NG	NG	1/11/2023	5.68	49	7.41	19.57	chloroform=0.64	ND	ND	ND	1.4	0.42

Table A-1. Groundwater Quality Analyses for Cretaceous Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-K2A **Wilkinson**	ND	ND	7.6	ND	ND	ND	ND	ND	ND	ND	ND	8.8	ND	ND	ND	77	ND	4,900	ND	95	ND	ND	ND	2,300	ND	ND
GWN-K3 **Washington**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30	ND	1.3	ND	ND	ND	20,000	ND	420	ND	1,400	40	2,100	ND	ND
GWN-K7 **Jones**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	20	ND	ND	ND	ND	ND	2,300	ND	55	ND	ND	13	2,500	ND	ND
GWN-K9A **Macon**	ND	ND	20	17	ND	ND	ND	ND	ND	ND	ND	3.6	ND	2	ND	280	ND	ND	ND	180	ND	ND	ND	1,100	ND	ND
GWN-K10B **Peach**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,300	ND	ND
GWN-K11A **Houston**	ND	ND	21	23	ND	ND	ND	ND	ND	ND	ND	10	ND	1.4	ND	ND	ND	1,200	ND	680	ND	ND	23	2,300	ND	ND
GWN-K12 **Houston**	ND	ND	38	23	ND	ND	ND	ND	ND	ND	ND	6.4	ND	3.0	ND	480	ND	ND	ND	170	ND	ND	12	1,000	ND	ND
GWN-K15A **Quitman**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,000	ND	ND	ND	ND	ND	110,000	ND	ND
GWN-K19 **Richmond**	ND	ND	11	ND	ND	ND	ND	ND	ND	ND	ND	6.7	ND	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	1,200	ND	ND
GWN-K20 **Sumter**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2,700	ND	ND	ND	ND	ND	23,000	ND	ND
GWN-BUR2 **Burke**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.8	ND	ND	ND	ND	ND	ND	ND	48	ND	ND	ND	1,300	ND	ND
GWN-CHT1 **Chattahoochee**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	82	ND	ND	ND	ND	ND	2,800	ND	1,600	ND	ND	20	1,300	ND	ND
GWN-GLA1 **Glascock**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	1,100	ND	ND	ND	ND	ND	4,500	ND	ND
GWN-MAC1 **Macon**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	49	ND	ND	ND	ND	ND	6,300	ND	950	ND	ND	16	1,000	ND	ND
GWN-MAR1 **Marion**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	34,000	ND	ND
GWN-STW1 **Stewart**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	36	ND	ND	ND	ND	ND	ND	ND	1,100	ND	ND	14	1,400	ND	ND
GWN-PD2A **Webster**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	21	ND	ND	ND	ND	ND	4,900	ND	22	ND	ND	ND	3,400	ND	ND

Table A-1. Groundwater Quality Analyses for Cretaceous/Providence Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-PD3 **Clay**	Fort Gaines Well #2	456	NG	NG	5/3/2023	7.71	359	0.27	21.92	ND	ND	ND	0.72	ND	ND
GWN-PD6 **Early**	Blakely Well #4	1025	NG	NG	5/3/2023	7.51	335	0.24	25.82	ND	ND	13	0.25	ND	ND
GWN-STW2 **Stewart**	Providence Canyon SP Well	NG	NG	NG	7/26/2023	6.69	191	2.88	23.63	ND	ND	11	ND	0.06	0.09
GWN-WEB1 **Webster**	Weston Well #1	NG	NG	NG	3/23/2023	6.78	318	2.43	19.09	ND	ND	ND	ND	0.45	0.05
	Aquifer Low Range					3.91	17	0.20	19.40		0	0		0	0
	Aquifer High Range					8.62	468	8.32	30.97		0	51		2.1	0.42
	Aquifer Median (ND=0)					5.45	49	1.51	20.13		0	0		0.06	0
	Aquifer Mean (ND=0)					5.65	122	2.73	21.34		0	5		0.37	0.06

Table A-1. Groundwater Quality Analyses for Cretaceous Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-PD3 **Clay**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.8	ND	ND	ND	ND	ND	6,100	ND	ND	ND	1,100	ND	82,000	ND	ND
GWN-PD6 **Early**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.4	ND	ND	ND	ND	ND	8,300	ND	21	ND	4,000	ND	69,000	ND	ND
GWN-STW2 **Stewart**	ND	ND	6.2	64	ND	ND	ND	ND	ND	ND	ND	7.5	ND	ND	ND	ND	ND	26,000	ND	50	ND	2,400	ND	8,700	ND	ND
GWN-WEB1 **Webster**	ND	ND	7	ND	ND	ND	ND	ND	ND	ND	ND	17	ND	ND	ND	ND	ND	65,000	ND	ND	ND	1,600	ND	1,800	ND	ND
Aquifer Low Range												0						0		0		0	0	1,000		
Aquifer High Range												82						65,000		1,600		4,000	40	110,000		
Aquifer Median (ND=0)												7.8						2,300		48		0	0	2,300		
Aquifer Mean (ND=0)												16.1						7,267		257		500	7	16,914		

Table A-2. Groundwater Quality Analyses for Clayton Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-CT3 **Terrell**	Dawson Crawford Street Well	367	NG	NG	4/20/2023	7.97	261	0.46	21.05	ND	ND	12	ND	ND	ND
GWN-CT5A **Randolph**	Cuthbert Well #3	355	NG	NG	4/20/2023	8.08	254	0.33	19.88	ND	ND	12	ND	ND	ND
GWN-CT8 **Schley**	Weathersby House Well	80	NG	NG	1/26/2023	4.17	47	5.24	17.56	ND	ND	ND	ND	1.7	ND
GWN-SUM1 **Sumter**	Briarpatch MHP Well #1	NG	NG	NG	1/26/2023	4.99	71	4.64	19.60	ND	ND	ND	ND	1.9	ND
GWN-SUM2 **Sumter**	Andersonville #1	230	NG	8	1/26/2023	4.97	288	1.06	19.16	ND	ND	100	0.30	0.38	ND
	Aquifer Low Range					4.17	47	0.33	17.56		0	0		0	0
	Aquifer High Range					8.08	288	5.24	21.05		0	100		1.9	0
	Aquifer Median (ND=0)					4.99	254	1.06	19.60		0	12		0.38	0
	Aquifer Mean (ND=0)					6.04	184	2.35	19.45		0	25		0.8	0

Table A-2. Groundwater Quality Analyses for Clayton Stations.
Part B: Metals.

Station No. County	Chro-mium ug/L	Nick-el ug/L	Cop-per ug/L	Zinc ug/L	Arsen-ic ug/L	Selen-ium ug/L	Molyb-denum ug/L	Silver ug/L	Cad-mium ug/L	Tin ug/L	Anti-mony ug/L	Barium ug/L	Thal-lium ug/L	Lead ug/L	Ura-nium ug/L	Alumi-num ug/L	Beryl-lium ug/L	Calcium ug/L	Co-balt ug/L	Iron ug/L	Potas-sium ug/L	Magne-sium ug/L	Manga-nese ug/L	Sodium ug/L	Tita-nium ug/L	Vana-dium ug/L
GWN-CT3 **Terrell**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.9	ND	ND	ND	ND	ND	40,000	ND	30	ND	4,700	ND	7,300	ND	ND
GWN-CT5A **Randolph**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	ND	ND	ND	ND	ND	44,000	ND	27	ND	4,100	20	1,700	ND	ND
GWN-CT8 **Schley**	ND	ND	10	ND	ND	ND	ND	ND	ND	ND	ND	18	ND	1.7	ND	ND	ND	ND	ND	ND	ND	ND	21	3,200	ND	ND
GWN-SUM1 **Sumter**	ND	ND	12	13	ND	ND	ND	ND	ND	ND	ND	15	ND	1.6	ND	ND	ND	ND	ND	ND	ND	ND	15	10,000	ND	ND
GWN-SUM2 **Sumter**	ND	11	ND	29	ND	ND	ND	ND	ND	ND	ND	79	ND	12	1.4	1,300	ND	23,000	ND	380	ND	11,000	360	2,500	ND	ND
Aquifer Low Range												7.9						0		0		0	0	1,700		
Aquifer High Range												79						44,000		380		11,000	360	10,000		
Aquifer Median (ND=0)												15						23,000		27		4,100	20	3,200		
Aquifer Mean (ND=0)												27						21,400		87		3,960	83	4,940		

Table A-3. Groundwater Quality Analyses for Claiborne Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-CL2 **Dooly**	Unadilla Well #3	315	315	24	2/8/2023	6.91	221	2.98	18.66	chloroform=1.1 bromodichloromethane=0.6 chlorodibromomethane=0.59	ND	ND	0.34	0.23	ND
GWN-CL4A **Sumter**	Plains Well #8	230	NG	NG	1/11/2023	6.30	139	NA	20.40	ND	ND	11	ND	ND	0.38
GWN-CL8 **Dooly**	Flint River Nursery Office Well	90	NG	NG	1/11/2023	6.12	77	0.28	19.47	ND	ND	ND	ND	ND	0.56
	Aquifer Low Range					6.12	77	0.28	18.66		0	0		0	0
	Aquifer High Range					6.91	221	2.98	20.40		0	11		0.23	0.56
	Aquifer Median (ND=0)					6.30	139	1.63	19.47		0	0		0	0.38
	Aquifer Mean (ND=0)					6.44	146	1.63	19.51		0	4		0.08	0.31

Table A-3. Groundwater Quality Analyses for Claiborne Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-CL2 **Dooly**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	ND	ND	ND	43,000	ND	ND	ND	ND	ND	1,800	ND	ND
GWN-CL4A **Sumter**	ND	ND	ND	11	ND	ND	ND	ND	ND	ND	ND	10	ND	ND	ND	ND	ND	19,000	ND	1,900	ND	2,800	57	1,700	ND	ND
GWN-CL8 **Dooly**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	40	ND	ND	ND	ND	ND	10,000	ND	490	ND	1,100	54	1,800	ND	ND
Aquifer Low Range												10						10,000		0		0	0	1,700		
Aquifer High Range												40						43,000		1,900		2,800	57	1,800		
Aquifer Median (ND=0)												14						19,000		490		1,100	54	1,800		
Aquifer Mean (ND=0)												21						24,000		797		1,300	37	1,767		

Table A-4. Groundwater Quality Analyses for Jacksonian Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-J1B **Jefferson**	McNair House Well	~90	NG	NG	5/17/2023	7.31	278	3.01	19.24	ND	ND	ND	ND	2.4	0.04
GWN-J4 **Johnson**	Wrightsville #4	520	NG	8	1/25/2023	7.86	287	4.62	18.42	ND	ND	ND	0.33	0.57	0.02
GWN-J5 **Bleckley**	Cochran #3	307	NG	NG	1/25/2023	7.59	360	0.45	20.09	ND	ND	12	ND	ND	0.02
GWN-J6 **Jefferson**	Wrens #4	200	NG	NG	2/8/2023	7.48	239	0.39	18.54	chloroform=0.71	ND	14	0.20	ND	0.11
GWN-J8A **Jefferson**	Kahn House Well II	100	NG	NG	2/8/2023	7.81	297	0.43	19.47	ND	ND	ND	ND	ND	ND
GWN-J9 **Jefferson**	Henley 1 Louisville	175	NG	NG	5/17/2023	8.24	177	5.72	20.44	ND	ND	ND	ND	1.9	ND
GWN-J10 **Jefferson**	Henley 2 Bartow	175	NG	NG	5/17/2023	7.53	258	2.34	18.76	ND	ND	ND	ND	0.43	0.20
GWN-JEF1 **Jefferson**	Bartow #1	345	NG	NG	1/25/2023	7.76	340	0.36	19.36	ND	ND	ND	ND	ND	ND
GWN-WAS1 **Washington**	Harrison #1	660	NG	NG	5/17/2023	7.96	311	1.09	19.75	ND	ND	ND	ND	0.07	ND
GWN-WAS2 **Washington**	Riddleville #1	NG	NG	NG	1/25/2023	7.81	303	5.53	19.20	ND	ND	ND	ND	0.14	ND
	Aquifer Low Range					7.31	177	0.36	18.42		0	0		0	0
	Aquifer High Range					8.24	360	5.72	20.44		0	14		2.4	0.20
	Aquifer Median (ND=0)					7.79	292	1.72	19.30		0	0		0.11	0.01
	Aquifer Mean (ND=0)					7.74	285	2.39	19.33		0	3		0.55	0.04

Table A-4. Groundwater Quality Analyses for Jacksonian Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-J1B **Jefferson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	22	ND	ND	ND	ND	ND	51,000	ND	77	ND	ND	ND	4,100	ND	ND
GWN-J4 **Johnson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	ND	ND	ND	ND	ND	50,000	ND	ND	ND	2,200	ND	3,100	ND	ND
GWN-J5 **Bleckley**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.9	ND	ND	ND	ND	ND	64,000	ND	150	ND	2,400	37	3,100	ND	ND
GWN-J6 **Jefferson**	ND	ND	ND	77	ND	ND	ND	ND	ND	ND	ND	9.8	ND	ND	ND	ND	ND	43,000	ND	220	ND	1,300	ND	3,500	ND	ND
GWN-J8A **Jefferson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.2	ND	ND	ND	ND	ND	59,000	ND	ND	ND	ND	20	2,500	ND	ND
GWN-J9 **Jefferson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.1	ND	ND	ND	ND	ND	32,000	ND	24	ND	ND	ND	1,500	ND	ND
GWN-J10 **Jefferson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23	ND	ND	ND	ND	ND	48,000	ND	ND	ND	ND	ND	2,500	ND	ND
GWN-JEF1 **Jefferson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	62,000	ND	69	ND	1,800	55	3,100	ND	ND
GWN-WAS1 **Washington**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	77	ND	ND	ND	ND	ND	55,000	ND	ND	ND	2,100	11	2,900	ND	ND
GWN-WAS2 **Washington**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	35	ND	ND	ND	ND	ND	57,000	ND	ND	ND	1,100	ND	2,400	ND	ND
Aquifer Low Range												0						32,000		0		0	0	1,500		
Aquifer High Range												77						64,000		220		2,400	55	4,100		
Aquifer Median (ND=0)												12.5						53,000		12		1,200	0	3,000		
Aquifer Mean (ND=0)												20.6						52,100		54		1,090	12	2,870		

Table A-5. Groundwater Quality Analyses for Floridan Stations.
Part A: Station Identification , Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-PA2 **Chatham**	Savannah Well #13	1004	NG	NG	6/15/2023	7.64	253	0.25	24.05	ND	ND	ND	0.45	ND	0.03
GWN-PA4 **Chatham**	Tybee Island Well #1	402	NG	NG	6/15/2023	7.49	679	0.32	22.90	ND	47	66	0.76	ND	ND
GWN-PA5 **Liberty**	Interstate Paper Well #1	810	NG	NG	6/14/2023	7.20	324	NA	24.28	ND	ND	35	0.56	ND	ND
GWN-PA6 **Liberty**	Hinesville Well #5	806	NG	NG	10/25/2023	7.87	288	0.97	24.41	ND	ND	25	0.58	ND	0.02
GWN-PA9C **Glynn**	Miller Ball Park North East Well	1211	NG	NG	11/8/2023	7.74	954	NA	22.94	ND	270	160	0.62	ND	0.02
GWN-PA13 **Ware**	Waycross Well #3	775	NG	NG	4/20/2023	7.27	412	0.31	25.72	ND	12	55	0.40	ND	ND
GWN-PA14A **Bulloch**	Statesboro Well #4	413	NG	NG	3/22/2023	7.43	235	NA	22.52	ND	ND	ND	0.25	ND	0.05
					6/29/2023	7.32	230	NA	22.83	ND	ND	ND	0.24	ND	0.10
					9/27/2023	7.10	239	NA	23.30	ND	ND	ND	0.18	ND	0.02
GWN-PA16 **Jenkins**	Millen Well #1	500	NG	NG	8/9/2023	6.75	294	1.67	21.97	ND	ND	10	ND	ND	ND
GWN-PA17 **Emanuel**	Swainsboro Well #7	260	NG	NG	8/10/2023	6.72	237	3.75	21.27	ND	ND	ND	ND	0.04	ND
GWN-PA18 **Candler**	Metter Well #2	540	NG	NG	3/22/2023	7.27	214	0.36	21.69	ND	ND	ND	0.22	ND	0.02
GWN-PA20 **Lanier**	Lakeland Well #2	340	NG	NG	4/20/2023	7.44	360	0.27	22.05	ND	ND	67	0.41	ND	0.10
GWN-PA22 **Thomas**	Thomasville Well #6	400	NG	NG	4/19/2023	7.00	419	4.40	22.70	ND	ND	71	0.45	0.26	ND
GWN-PA23A **Grady**	Cairo #11	465'	NG	NG	2/22/2023	7.23	326	0.31	22.60	ND	ND	29	0.42	ND	ND
					5/4/2023	7.20	328	0.31	22.70	ND	ND	28	0.39	ND	ND
					8/24/2023	7.25	319	0.25	22.95	ND	ND	29	0.38	ND	ND
GWN-PA25 **Seminole**	Donalsonville / 7th Street Well	174	NG	NG	2/22/2023	6.95	311	5.18	21.31	ND	ND	ND	ND	1.8	ND
					5/3/2023	6.75	311	4.72	21.42	ND	ND	ND	ND	1.7	ND
					8/24/2023	6.63	308	4.64	21.70	ND	ND	ND	ND	1.8	ND

Table A-5. Groundwater Quality Analyses for Floridan Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-PA2 **Chatham**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.3	ND	ND	ND	ND	ND	22,000	ND	ND	ND	9,000	ND	18,000	ND	ND
GWN-PA4 **Chatham**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.4	ND	ND	ND	ND	ND	36,000	ND	ND	5,100	28,000	ND	57,000	ND	ND
GWN-PA5 **Liberty**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	33	ND	ND	ND	ND	ND	26,000	ND	ND	ND	15,000	ND	16,000	ND	ND
GWN-PA6 **Liberty**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	ND	25,000	ND	ND	ND	12,000	ND	14,000	ND	ND
GWN-PA9C **Glynn**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	54	ND	ND	ND	ND	ND	62,000	ND	1,200	ND	42,000	17	140,000	ND	ND
GWN-PA13 **Ware**	ND	ND	ND	ND	ND	ND	8.2	ND	ND	ND	ND	71	ND	ND	ND	ND	ND	43,000	ND	ND	ND	18,000	ND	15,000	ND	ND
GWN-PA14A **Bulloch**	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	6.0 6.7 4.2	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	34,000 34,000 33,000	ND ND ND	ND ND ND	ND ND ND	6,300 6,300 6,100	ND ND ND	7,300 7,400 7,000	ND ND ND	ND ND ND
GWN-PA16 **Jenkins**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.8	ND	ND	ND	ND	ND	51,000	ND	37	ND	3,500	40	5,300	ND	ND
GWN-PA17 **Emanuel**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	180	ND	ND	ND	ND	ND	46,000	ND	ND	ND	1,700	ND	3,200	ND	ND
GWN-PA18 **Candler**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	24	ND	ND	ND	ND	ND	30,000	ND	ND	ND	3,400	61	10,000	ND	ND
GWN-PA20 **Lanier**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	26	ND	ND	ND	ND	ND	44,000	ND	120	ND	17,000	12	4,400	ND	ND
GWN-PA22 **Thomas**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	24	ND	ND	1.2	ND	ND	48,000	ND	ND	ND	23,000	ND	8,000	ND	ND
GWN-PA23A **Grady**	ND ND ND	ND ND ND	ND ND ND	ND ND ND	8.2 ND 5.7	ND ND ND	17 14 15	ND ND ND	ND ND ND	ND ND ND	ND ND ND	140 150 140	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	34,000 33,000 31,000	ND ND ND	ND ND ND	ND ND ND	17,000 17,000 16,000	ND ND ND	11,000 11,000 11,000	ND ND ND	ND ND ND
GWN-PA25 **Seminole**	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	8 7.9 8.2	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	64,000 62,000 61,000	ND ND ND	ND ND ND	ND ND ND	ND ND ND	ND ND ND	3,700 3,500 3,500	ND ND ND	ND ND ND

Table A-5, Continued. Groundwater Quality Analyses for Floridan Stations.
Part A: Station Identification , Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-PA27 **Mitchell**	Camilla Industrial Park Well	360	NG	NG	11/21/2023	7.35	252	1.68	19.98	ND	ND	ND	ND	0.57	0.02
GWN-PA28 **Colquitt**	Moultrie Well #1	750	NG	NG	2/22/2023	7.41	427	NA	23.56	ND	ND	90	0.64	ND	ND
					5/4/2023	7.54	574	NA	23.85	ND	11	72	0.63	ND	ND
					8/24/2023	7.36	428	NA	23.63	ND	ND	35	0.62	ND	ND
GWN-PA29 **Cook**	Adel Well #6	405	NG	NG	1/10/2023	7.21	411	0.36	22.01	ND	ND	88	0.27	ND	0.04
					4/19/2023	7.27	420	0.49	22.07	ND	ND	91	0.32	ND	0.04
					7/13/2023	7.03	418	0.33	22.03	ND	ND	100	0.25	ND	0.04
GWN-PA31 **Tift**	Tifton Well #6	652	NG	NG	4/20/2023	7.22	273	0.83	21.89	ND	ND	ND	ND	ND	ND
GWN-PA32 **Irwin**	Ocilla Well #3	637	NG	NG	1/10/2023	7.23	206	0.31	20.78	ND	ND	ND	ND	ND	ND
GWN-PA34D **Telfair**	McRae Well #4	NG	NG	NG	3/22/2023	6.93	336	0.37	22.02	ND	ND	ND	ND	ND	ND
					6/29/2023	6.89	329	0.38	22.22	ND	ND	ND	ND	ND	ND
					9/27/2023	6.95	335	0.31	21.99	ND	ND	ND	ND	ND	ND
GWN-PA36 **Toombs**	Vidalia Well #1	808	NG	NG	3/22/2023	7.07	225	0.31	23.18	ND	ND	ND	0.37	ND	ND
					6/29/2023	7.12	222	0.27	23.75	ND	ND	ND	0.29	ND	ND
					9/27/2023	7.33	223	0.25	23.53	ND	ND	ND	0.25	ND	ND
GWN-PA38 **Dodge**	Eastman Well #4	410	NG	NG	9/27/2023	7.28	224	4.41	20.73	ND	ND	ND	ND	0.28	ND
GWN-PA39 **Worth**	SylvesterWell #1	196	NG	NG	7/12/2023	6.86	292	2.48	22.74	ND	ND	ND	ND	ND	ND
GWN-PA41A **Turner**	Ashburn #4	600	NG	NG	7/12/2023	7.09	155	0.27	22.62	ND	ND	ND	0.37	ND	ND
GWN-PA44 **Turner**	Sycamore Well #2	501	NG	NG	1/10/2023	6.95	190	3.28	21.11	ND	ND	ND	0.21	0.28	ND
					4/19/2023	7.44	191	3.21	21.47	ND	ND	ND	0.24	0.25	ND
					7/13/2023	6.98	189	3.22	21.48	ND	ND	ND	ND	0.24	ND

Table A-5, Continued. Groundwater Quality Analyses for Floridan Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-PA27 **Mitchell**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	ND	ND	ND	48,000	ND	ND	ND	1,400	ND	1,900	ND	ND
GWN-PA28	ND	ND	ND	ND	ND	ND	15	ND	ND	ND	ND	100	ND	ND	ND	ND	ND	33,000	ND	ND	ND	19,000	ND	27,000	ND	ND
Colquitt	ND	ND	ND	ND	ND	ND	34	ND	ND	ND	ND	120	ND	ND	ND	ND	ND	54,000	ND	69	ND	25,000	ND	27,000	ND	ND
	ND	ND	ND	ND	ND	ND	17	ND	ND	ND	ND	98	ND	ND	ND	ND	ND	33,000	ND	ND	ND	19,000	ND	26,000	ND	ND
GWN-PA29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	52,000	ND	32	ND	18,000	13	3,500	ND	ND
Cook	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	54,000	ND	39	ND	20,000	14	3,900	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	53,000	ND	40	ND	19,000	11	3,900	ND	ND
GWN-PA31 **Tift**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	70	ND	ND	1.6	ND	ND	44,000	ND	ND	ND	8,300	ND	2,600	ND	ND
GWN-PA32 **Irwin**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	75	ND	ND	ND	ND	ND	33,000	ND	120	ND	5,000	28	2,300	ND	ND
GWN-PA34D	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	230	ND	ND	ND	ND	ND	51,000	ND	240	ND	10,000	83	4,800	ND	ND
Telfair	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	240	ND	ND	ND	ND	ND	50,000	ND	230	ND	10,000	82	4,800	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	240	ND	ND	ND	ND	ND	49,000	ND	220	ND	9,800	79	4,600	ND	ND
GWN-PA36	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	140	ND	ND	ND	ND	ND	28,000	ND	21	ND	5,600	35	11,000	ND	ND
Toombs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	120	ND	ND	ND	ND	ND	29,000	ND	27	ND	5,400	36	11,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	130	ND	ND	ND	ND	ND	28,000	ND	21	ND	5,200	35	10,000	ND	ND
GWN-PA38 **Dodge**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	110	ND	ND	ND	ND	ND	44,000	ND	ND	ND	1,300	ND	2,000	ND	ND
GWN-PA39 **Worth**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	100	ND	ND	ND	ND	ND	41,000	ND	37	ND	11,000	19	2,900	ND	ND
GWN-PA41A **Turner**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	67	ND	ND	ND	ND	ND	20,000	ND	ND	ND	7,000	ND	1,800	ND	ND
GWN-PA44	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	140	ND	ND	1.3	ND	ND	31,000	ND	ND	ND	4,200	ND	2,200	ND	ND
Turner	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	140	ND	ND	1.3	ND	ND	32,000	ND	ND	ND	4,600	ND	2,400	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	140	ND	ND	1.3	ND	ND	31,000	ND	ND	ND	4,300	ND	2,200	ND	ND

Table A-5, Continued. Groundwater Quality Analyses for Floridan Stations.
Part A: Station Identification , Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-PA56 **Grady**	Whigham / Davis Avenue Well	604	NG	NG	2/22/2023	7.26	411	1.14	22.88	ND	36	20	0.24	0.09	ND
					5/4/2023	7.33	407	1.11	22.98	ND	36	21	0.24	0.09	ND
					8/24/2023	7.18	405	0.95	22.92	ND	37	21	0.21	0.07	ND
GWN-PA57 **Coffee**	Ambrose Well #2	600	465	10	1/10/2023	7.46	252	0.86	22.31	ND	ND	ND	0.32	ND	ND
					7/13/2023	7.42	249	0.43	22.74	chloromethane=0.86	ND	ND	0.23	ND	ND
GWN-PA59 **Dougherty**	Radium Spring	0	NA	NA	5/4/2023	6.97	320	NA	20.20	trichloroethylene=0.75	ND	ND	ND	2.2	ND
GWN-PA60 **Seminole**	Smith House Well	NG	NG	NG	5/3/2023	6.90	212	NA	21.96	ND	ND	ND	ND	0.96	ND
GWN-GLY2 **Glynn**	Hofwyl Broadfield Well	NG	NG	NG	10/25/2023	7.48	544	3.77	25.55	ND	28	110	0.62	ND	ND
GWN-GLY3 **Glynn**	Jekyll Island #5	850	NG	NG	11/8/2023	7.73	423	0.67	21.26	ND	16	78	0.65	ND	0.03
GWN-GLY4 **Glynn**	Hampton River Marina	750	NG	NG	11/8/2023	7.64	511	1.31	23.73	ND	27	110	0.80	ND	ND
GWN-LIB2 **Liberty**	Fort Morris Well	500	NG	NG	6/14/2023	7.20	328	0.26	22.87	ND	ND	43	0.59	ND	ND
GWN-MCI1 **McIntosh**	Sapelo Gardens SD #1	660	NG	NG	10/25/2023	7.79	412	5.34	24.64	ND	12	71	0.62	ND	0.02
GWN-THO2 **Thomas**	Waverly Four Corners #1	900	NG	NG	4/19/2023	7.50	253	0.26	25.98	ND	ND	ND	0.45	ND	ND
	Aquifer Low Range					6.63	155	0.25	19.98		0	0		0	0
	Aquifer High Range					7.87	954	5.34	25.98		270	160		2.2	0.10
	Aquifer Median (ND=0)					7.24	315	0.58	22.66		0	0		0	0
	Aquifer Mean (ND=0)					7.23	335	1.51	22.63		10	28		0.20	0.01

Table A-5, Continued. Groundwater Quality Analyses for Floridan Stations.
Part B: Metals.

Station No. County	Chro-mium ug/L	Nick-el ug/L	Cop-per ug/L	Zinc ug/L	Arsen-ic ug/L	Selen-ium ug/L	Molyb-denum ug/L	Silver ug/L	Cad-mium ug/L	Tin ug/L	Anti-mony ug/L	Barium ug/L	Thal-lium ug/L	Lead ug/L	Ura-nium ug/L	Alumi-num ug/L	Beryl-lium ug/L	Calcium ug/L	Co-balt ug/L	Iron ug/L	Potas-sium ug/L	Magne-sium ug/L	Manga-nese ug/L	Sodium ug/L	Tita-nium ug/L	Vana-dium ug/L
GWN-PA56 **Grady**	ND	ND	ND	ND	ND	ND	8.8	ND	ND	ND	ND	150	ND	ND	3.0	ND	ND	33,000	ND	ND	ND	20,000	ND	22,000	ND	ND
	ND	ND	ND	ND	ND	ND	8.9	ND	ND	ND	ND	150	ND	ND	2.9	ND	ND	33,000	ND	21	ND	20,000	ND	22,000	ND	ND
	ND	ND	ND	ND	ND	ND	9.5	ND	ND	ND	ND	150	ND	ND	3.0	ND	ND	32,000	ND	ND	ND	19,000	ND	21,000	ND	ND
GWN-PA57 **Coffee**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	150	ND	ND	ND	ND	ND	23,000	ND	ND	ND	13,000	ND	7,800	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	160	ND	ND	ND	ND	ND	24,000	ND	ND	ND	14,000	ND	7,700	ND	ND
GWN-PA59 **Dougherty**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	ND	65,000	ND	ND	ND	1,600	ND	2,800	ND	ND
GWN-PA60 **Seminole**	ND	ND	ND	96	ND	ND	ND	ND	ND	ND	ND	3.2	ND	ND	ND	ND	ND	43,000	ND	ND	ND	ND	ND	3,100	ND	ND
GWN-GLY2 **Glynn**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	48	ND	ND	ND	ND	ND	43,000	ND	240	ND	26,000	ND	26,000	ND	ND
GWN-GLY3 **Glynn**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	44	ND	ND	ND	ND	ND	36,000	ND	28	ND	23,000	32	15,000	ND	ND
GWN-GLY4 **Glynn**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.6	ND	ND	ND	ND	ND	38,000	ND	ND	ND	27,000	ND	25,000	ND	ND
GWN-LIB2 **Liberty**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	28	ND	ND	ND	ND	ND	27,000	ND	100	ND	15,000	ND	16,000	ND	ND
GWN-MCI1 **McIntosh**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	59	ND	ND	ND	ND	ND	33,000	ND	48	ND	21,000	ND	18,000	ND	ND
GWN-THO2 **Thomas**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	120	ND	ND	ND	ND	ND	21,000	ND	90	ND	14,000	ND	12,000	ND	ND
Aquifer Low Range												3.2						20,000		0		0	0	1,800		
Aquifer High Range												240						65,000		1,200		42,000	83	140,000		
Aquifer Median (ND=0)												69						34,000		0		11,500	0	7,750		
Aquifer Mean (ND=0)												80.4						39,037		55		12,370	11	13,194		

Table A-6. Groundwater Quality Analyses for Miocene Stations.
Part A: Station Identification , Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-MI1 **Cook**	Adel/McMillan	220	NG	NG	7/27/2023	7.07	235	0.99	22.56	ND	ND	ND	0.43	ND	ND
GWN-MI2A **Lowndes**	Boutwell House Well	70	NG	NG	7/27/2023	4.03	183	6.16	21.79	chloroform=1.0	35	ND	ND	5.9	ND
GWN-MI10B **Colquitt**	Calhoun House Well	150	NG	NG	7/27/2023	6.05	95	1.26	22.85	ND	ND	ND	0.43	ND	0.29
GWN-MI16 **Liberty**	Liberty County East District Fire Station Deep Well	400	NG	NG	6/14/2023	7.10	314	0.41	22.03	ND	ND	37	0.59	ND	ND
GWN-MI17 **Effingham**	Springfield Egypt Road Test Well	120	NG	NG	6/15/2023	6.93	417	NA	20.30	ND	ND	ND	ND	ND	ND
GWN-WAY1 **Wayne**	Raintree TP Main Well	400	NG	NG	10/25/2023	7.97	224	0.99	21.61	ND	ND	ND	0.22	ND	0.06
	Aquifer Low Range					4.03	95	0.41	20.30		0	0		0	0
	Aquifer High Range					7.97	417	6.16	22.85		35	37		5.9	0.29
	Aquifer Median (ND=0)					7.00	230	0.99	21.91		0	0		0	0
	Aquifer Mean (ND=0)					6.53	245	1.96	21.86		6	6		1	0.06

Table A-6. Groundwater Quality Analyses for Miocene Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-MI1 **Cook**	ND	ND	ND	32	ND	ND	ND	ND	ND	ND	ND	20	ND	ND	ND	ND	ND	22,000	ND	ND	ND	13,000	11	6,500	ND	ND
GWN-MI2A **Lowndes**	ND	ND	9.6	ND	ND	ND	ND	ND	ND	ND	ND	27	ND	1.0	ND	140	ND	3,600	ND	ND	7,100	2,100	13	18,000	ND	ND
GWN-MI10B **Colquitt**	ND	ND	ND	51	ND	11	ND	ND	ND	ND	ND	130	ND	ND	ND	ND	ND	6,900	ND	440	ND	4,400	32	5,900	ND	ND
GWN-MI16 **Liberty**	ND	ND	ND	15	ND	ND	ND	ND	ND	ND	ND	26	ND	ND	ND	ND	ND	26,000	ND	ND	ND	14,000	ND	16,000	ND	ND
GWN-MI17 **Effingham**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23	ND	ND	ND	ND	ND	45,000	ND	ND	ND	1,800	13	8,200	ND	ND
GWN-WAY1 **Wayne**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	32	ND	ND	ND	ND	ND	23,000	ND	ND	ND	8,100	100	11,000	ND	ND
Aquifer Low Range												20						3,600		0		1,800	0	5,900		
Aquifer High Range												130						45,000		440		14,000	100	18,000		
Aquifer Median (ND=0)												27						22,500		0		6,250	13	9,600		
Aquifer Mean (ND=0)												43						21,083		73		7,233	28	10,933		

Table A-7. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-P1A **Meriwether**	Luthersville Well #3	185	NG	NG	4/5/2023	6.56	97	4.92	17.47	ND	ND	ND	ND	0.94	0.07
GWN-P5 **Hall**	Flowery Branch Well #1	240	NG	NG	6/14/2023	6.70	193	5.69	16.62	ND	ND	ND	ND	1.5	0.03
GWN-P12A **Butts**	Indian Spring	0	NG	NG	2/22/2023	7.46	294	NA	17.28	ND	10	25	4.5	ND	ND
					5/18/2023	7.77	282	NA	17.48	ND	ND	24	4.0	ND	ND
					8/24/2023	7.77	276	NA	19.18	ND	ND	26	4.5	ND	0.03
					11/7/2023	7.73	272	NA	17.99	ND	10	27	4.6	ND	0.02
GWN-P21 **Jones**	Gray/Bragg Well	405	NG	NG	2/22/2023	6.78	297	1.36	18.71	ND	ND	27	ND	0.26	0.03
					5/18/2023	6.81	321	0.88	18.72	ND	ND	25	ND	0.25	0.03
					8/24/2023	6.76	319	1.54	18.78	ND	ND	28	ND	0.22	0.03
					11/7/2023	6.84	310	2.21	18.73	ND	ND	26	0.21	0.25	0.03
GWN-P22 **Fulton**	Rahbar Well	200	NG	NG	6/14/2023	4.91	44	4.49	16.67	ND	ND	ND	ND	1.1	ND
GWN-P24 **Coweta**	The Gates Well #1	705	NG	NG	7/26/2023	7.61	281	1.27	19.43	ND	ND	15	0.49	0.31	0.04
GWN-P25 **Jones**	Jarrell Plantation Staff House Well	NG	NG	NG	2/22/2023	6.41	216	4.08	18.02	ND	ND	17	ND	0.15	0.09
					5/18/2023	6.36	221	3.84	18.34	ND	ND	16	ND	0.14	0.11
					8/24/2023	6.44	224	3.44	18.49	ND	ND	18	ND	0.13	0.10
					11/7/2023	6.35	217	2.27	18.04	ND	ND	17	ND	0.14	0.11
GWN-P28 **Coweta**	Willow Court Well	NG	NG	NG	7/26/2023	6.11	133	3.61	17.89	ND	ND	ND	ND	1.9	0.07
GWN-P30 **Lincoln**	Fizer House Well	220	NG	NG	5/4/2023	7.15	518	0.94	18.56	ND	34	31	ND	3.0	ND
GWN-P32 **Elbert**	Cecchini Deep Well	400	NG	NG	4/4/2023	8.03	952	5.98	16.62	ND	ND	>100	1.9	ND	ND
					7/13/2023	8.07	948	0.96	20.83	ND	ND	660	2.1	ND	ND
					10/12/2023	7.78	939	1.23	18.44	ND	ND	520	2.0	ND	ND
GWN-P34 **Columbia**	Mistletoe State Park Cottage Area Well	NG	NG	NG	2/8/2023	5.46	74	4.74	17.85	ND	ND	11	ND	0.50	0.12
					5/4/2023	6.51	189	4.17	18.02	ND	ND	23	ND	0.32	0.17
					8/10/2023	5.76	71	4.37	18.79	ND	ND	ND	ND	0.49	0.07
					10/26/2023	5.57	66	4.78	18.09	ND	ND	ND	ND	0.67	0.09

Table A-7. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-P1A **Meriwether**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	47	ND	ND	ND	ND	ND	12,000	ND	ND	ND	2,400	ND	4,600	ND	ND
GWN-P5 **Hall**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	43	ND	ND	ND	ND	ND	28,000	ND	ND	ND	5,200	ND	3,800	ND	ND
GWN-P12A **Butts**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16,000	ND	ND	ND	2,600	21	39,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16,000	ND	ND	ND	2,600	20	38,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16,000	ND	ND	ND	2,700	20	39,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	16,000	ND	ND	ND	2,700	20	39,000	ND	ND
GWN-P21 **Jones**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	10	ND	ND	37,000	ND	ND	ND	8,400	ND	15,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	9.7	ND	ND	35,000	ND	ND	ND	8,000	ND	14,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	9.8	ND	ND	36,000	ND	ND	ND	8,400	ND	15,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	8.8	ND	ND	35,000	ND	ND	ND	8,200	ND	14,000	ND	ND
GWN-P22 **Fulton**	ND	ND	37	ND	ND	ND	ND	ND	ND	ND	ND	29	ND	1.6	ND	ND	ND	1,500	ND	ND	ND	1,500	ND	2,900	ND	ND
GWN-P24 **Coweta**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.0	ND	ND	2.5	ND	ND	38,000	ND	ND	ND	4,700	ND	11,000	ND	ND
GWN-P25 **Jones**	ND	ND	5.2	ND	ND	ND	ND	ND	ND	ND	ND	21	ND	ND	11	ND	ND	18,000	ND	96	ND	6,200	70	17,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23	ND	ND	9.8	ND	ND	16,000	ND	150	ND	5,600	63	16,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	22	ND	ND	12	ND	ND	18,000	ND	110	ND	6,100	65	17,000	ND	ND
	ND	ND	5.3	ND	ND	ND	ND	ND	ND	ND	ND	22	ND	ND	9.7	ND	ND	17,000	ND	140	ND	5,700	62	17,000	ND	ND
GWN-P28 **Coweta**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	27	ND	ND	ND	ND	ND	9,800	ND	ND	ND	3,300	ND	9,000	ND	ND
GWN-P30 **Lincoln**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.1	ND	ND	ND	ND	ND	31,000	ND	ND	ND	41,000	ND	21,000	ND	ND
GWN-P32 **Elbert**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.9	ND	ND	12	ND	ND	270,000	ND	30	ND	1,200	14	33,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.7	ND	ND	12	ND	ND	260,000	ND	ND	ND	1,100	14	32,000	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0	ND	ND	17	ND	ND	200,000	ND	ND	ND	1,500	15	28,000	ND	ND
GWN-P34 **Columbia**	ND	ND	ND	25	ND	ND	ND	ND	ND	ND	ND	24	ND	ND	10	ND	ND	7,100	ND	ND	ND	3,800	11	8,800	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	24	ND	ND	14,000	ND	ND	ND	6,700	ND	13,000	ND	ND
	ND	ND	ND	14	ND	ND	ND	ND	ND	ND	ND	28	ND	1.9	3.4	ND	ND	3,000	ND	ND	ND	2,100	19	5,900	ND	ND
	ND	ND	ND	10	ND	ND	ND	ND	ND	ND	ND	28	ND	1.5	4.5	ND	ND	3,600	ND	ND	ND	2,200	12	6,400	ND	ND

Table A-7 Continued. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-P35 **Franklin**	O'Connor Well	150	NG	NG	1/11/2023	7.22	194	0.54	16.46	ND	ND	ND	ND	0.07	ND
					4/4/2023	7.26	202	2.24	16.89	ND	ND	ND	ND	ND	ND
					7/13/2023	7.23	204	0.46	17.32	ND	ND	ND	ND	ND	ND
					10/12/2023	7.13	204	1.85	16.91	ND	ND	ND	ND	ND	ND
GWN-P37 **Habersham**	Mt. Airy/City Hall Well	500	NG	NG	1/11/2023	6.47	291	2.66	16.83	ND	24	26	ND	0.59	ND
					4/4/2023	6.41	265	4.52	16.78	ND	21	21	ND	1.4	ND
					7/13/2023	6.46	272	5.21	16.89	ND	22	24	ND	0.89	ND
					10/12/2023	6.49	288	2.52	16.95	ND	21	25	ND	0.47	ND
GWN-P38 **Carroll**	Roopville Well #1	230	NG	NG	4/5/2023	4.99	49	3.74	18.25	ND	ND	ND	ND	1.7	ND
GWN-P39 **Meriwether**	Gay Well #1	600	NG	NG	4/5/2023	6.67	78	NA	17.59	ND	ND	ND	ND	1.0	0.05
GWN-P40 **Greene**	Siloam Well #2	300	NG	NG	5/4/2023	6.05	81	5.37	19.31	ND	ND	ND	0.26	1.3	0.11
GWN-P43 **Lamar**	Reeves House Well	NG	NG	NG	1/26/2023	5.91	104	0.58	16.64	ND	ND	ND	ND	0.03	ND
GWN-P44 **Meriwether**	Warm Spring at FD Roosevelt SP	0	NG	NG	2/9/2023	7.23	189	NA	28.47	ND	ND	ND	ND	0.25	ND
GWN-P45 **Franklin**	Wilson Family Well	80	NG	NG	7/13/2023	6.13	108	4.61	17.29	ND	ND	ND	ND	0.26	0.08
GWN-P47 **Cherokee**	Voudy House Well	525	NG	NG	12/20/2023	7.47	200	2.27	16.27	ND	ND	ND	0.29	ND	ND
GWN-COU1 **Columbia**	Windy Acres Mobile Home Park Well #1	180	NG	NG	8/10/2023	7.29	123	0.94	19.45	ND	ND	ND	ND	ND	0.16
GWN-COU4 **Columbia**	Tradewinds Marina Well	NG	NG	NG	5/4/2023	7.11	381	0.66	18.35	MTBE=1.3	ND	ND	0.41	0.05	ND
GWN-ELB1 **Elbert**	Beaverdam Mobile Home Park Well #1	250	NG	NG	4/4/2023	6.45	192	2.24	16.86	ND	ND	18	ND	1.5	0.09
GWN-FAY1 18.8 **Fayette**	Lone Oak Well	NG	NG	NG	7/26/2023	7.42	282	0.34	18.54	ND	ND	52	0.60	ND	ND
GWN-FRA1 **Franklin**	Victoria Bryant State Park Well #101	NG	NG	NG	3/8/2023	5.59	48	NA	16.29	ND	ND	ND	ND	0.89	0.02
GWN-HAL1 **Hall**	Leisure Lake Village Well #1	380	NG	NG	3/8/2023	7.94	280	0.95	16.25	ND	ND	54	0.26	0.02	ND

Table A-7 Continued. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-P35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30	ND	ND	1.0	ND	ND	19,000	ND	200	6,400	5,800	100	7,500	ND	ND
Franklin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	32	ND	ND	1.2	ND	ND	21,000	ND	180	6,800	7,000	120	7,800	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30	ND	ND	1.2	ND	ND	20,000	ND	220	6,600	6,400	110	7,600	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	33	ND	ND	1.1	ND	ND	20,000	ND	210	6,700	6,300	100	7,700	ND	ND
GWN-P37	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	15	ND	ND	1.1	ND	ND	34,000	ND	95	ND	6,600	100	7,200	ND	ND
Habersham	ND	ND	ND	11	ND	ND	ND	ND	ND	ND	ND	21	ND	ND	ND	ND	ND	29,000	ND	98	ND	7,000	78	7,700	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	18	ND	ND	ND	ND	ND	31,000	ND	52	ND	6,800	66	7,100	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	36,000	ND	40	ND	6,600	98	7,500	ND	ND
GWN-P38 **Carroll**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	21	ND	ND	ND	ND	ND	2,000	ND	22	ND	ND	27	5,900	ND	ND
GWN-P39 **Meriwether**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	38	ND	ND	ND	ND	ND	5,500	ND	ND	ND	1,300	ND	6,700	ND	ND
GWN-P40 **Greene**	ND	ND	ND	24	ND	ND	ND	ND	ND	ND	ND	19	ND	ND	2.2	ND	ND	5,200	ND	ND	ND	1,000	ND	8,600	ND	ND
GWN-P43 **Lamar**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	30	ND	ND	ND	62	ND	12,000	12	1,600	ND	ND	240	5,400	ND	ND
GWN-P44 **Meriwether**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	51	ND	ND	ND	ND	ND	18,000	ND	ND	ND	10,000	ND	2,000	ND	ND
GWN-P45 **Franklin**	ND	ND	16	ND	ND	ND	ND	ND	ND	ND	ND	20	ND	ND	ND	ND	ND	9,300	ND	41	ND	3,100	ND	7,100	ND	ND
GWN-P47 **Cherokee**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	ND	ND	ND	23,000	ND	380	ND	5,000	38	9,800	ND	ND
GWN-COU1 **Columbia**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	33	ND	ND	ND	ND	ND	9,300	ND	940	ND	3,400	150	7,200	ND	ND
GWN-COU4 **Columbia**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	ND	ND	1.6	ND	ND	57,000	ND	190	ND	6,600	320	20,000	ND	ND
GWN-ELB1 **Elbert**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	40	ND	ND	2.2	ND	ND	21,000	ND	ND	ND	3,600	ND	11,000	ND	ND
GWN-FAY1 18.8 **Fayette**	ND	ND	ND	71	ND	ND	ND	ND	ND	ND	ND	17	ND	ND	ND	ND	ND	34,000	ND	67	ND	3,300	21	17,000	ND	ND
GWN-FRA1 **Franklin**	ND	ND	ND	16	ND	ND	ND	ND	ND	ND	ND	15	ND	ND	ND	ND	ND	3,700	ND	41	ND	1,100	ND	4,600	ND	ND
GWN-HAL1 **Hall**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	85	ND	ND	ND	ND	ND	40,000	ND	ND	ND	4,300	ND	8,800	ND	ND

Table A-7 Continued. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-HAS1 **Harris**	Valley Inn Well	NG	NG	NG	2/9/2023	6.56	147	2.69	18.74	ND	ND	ND	ND	0.07	0.05
GWN-HAS2 **Harris**	F D Roosevelt State Park Spring	0	NA	NA	2/9/2023	4.69	12	NA	16.43	ND	ND	ND	ND	ND	ND
GWN-MAD1 **Madison**	Ila Well #1	650	NG	NG	3/8/2023	7.67	191	0.89	17.88	ND	ND	11	0.36	ND	0.03
GWN-STE1 **Stephens**	Lake Harbor Shores Well #4	378	NG	NG	3/8/2023	6.45	141	2.99	16.92	ND	ND	ND	ND	0.23	0.03
GWN-UPS1 **Upson**	Country Village Well #13	NG	NG	NG	4/5/2023	8.26	174	1.77	18.49	chloroform=2.00	ND	ND	0.23	0.10	0.06
GWN-WAS3 **Washington**	Hamburg State Park	200	NG	NG	2/8/2023	7.67	238	0.44	18.84	ND	12	ND	ND	ND	ND
GWN-WHI1 **White**	Sweetwater Coffee House	NG	NG	NG	6/15/2023	6.48	97	4.12	15.97	ND	ND	ND	ND	0.88	0.07
GWN-WKE1 **Wilkes**	Rayle #1	NG	NG	NG	1/11/2023	6.34	155	6.15	18.11	ND	12	ND	ND	3.5	0.09
GWN-BR1B **Towns**	Young Harris/ Swanson Road Well	265	NG	NG	3/9/2023	7.39	187	0.77	15.61	ND	ND	23	ND	0.03	ND
					6/15/2023	7.19	165	3.17	15.36	ND	ND	19	ND	0.12	ND
					9/28/2023	7.59	178	3.81	15.37	ND	ND	21	ND	0.07	ND
					12/7/2023	7.26	178	1.67	15.24	ND	ND	21	ND	0.10	ND
GWN-BR5 **Murray**	Chatsworth/ Nix Spring	0	NA	NA	3/23/2023	5.43	32	NA	13.62	ND	ND	ND	ND	0.32	0.04
GWN-BR6 **Towns**	Young Harris College Well	NG	NG	NG	9/28/2023	5.32	84	3.61	19.34	ND	ND	ND	ND	1.3	ND
GWN-BR6A **Towns**	Young Harris Main Street Well	NG	NG	NG	6/15/2023	6.67	202	0.83	15.19	ND	ND	36	ND	0.44	0.02
GWN-BR7 **Pickens**	Jasper Spring	0	NG	NG	6/15/2023	5.28	75	NA	15.18	chloroform=1.6	ND	ND	ND	1.2	ND
GWN-BR8 **Rabun**	Goldmine Landing Well	NG	NG	NG	9/28/2023	5.94	25	4.51	14.15	ND	ND	ND	ND	ND	ND
GWN-BR9 **Gilmer**	Jacobs House Well	NG	NG	NG	12/7/2023	7.64	115	1.59	14.19	ND	ND	ND	0.28	0.03	0.03
GWN-BR10 **Union**	Willer House Well	NG	NG	NG	3/9/2023	6.67	63	4.49	14.11	ND	ND	ND	ND	ND	0.05

Table A-7 Continued. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-HAS1 **Harris**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	20,000	ND	340	ND	2,400	150	7,600	ND	ND
GWN-HAS2 **Harris**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
GWN-MAD1 **Madison**	ND	ND	ND	26	ND	ND	ND	ND	ND	ND	ND	6	ND	ND	ND	ND	ND	22,000	ND	620	ND	4,300	140	10,000	ND	ND
GWN-STE1 **Stephens**	ND	ND	ND	33	ND	ND	ND	ND	ND	ND	ND	40	ND	ND	2.9	ND	ND	13,000	ND	500	ND	5,300	ND	7,900	ND	ND
GWN-UPS1 **Upson**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.9	ND	ND	ND	ND	ND	25,000	ND	ND	ND	4,000	ND	6,200	ND	ND
GWN-WAS3 **Washington**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	99	ND	ND	7.5	ND	ND	27,000	ND	64	ND	2,700	260	19,000	ND	ND
GWN-WHI1 **White**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	61	ND	ND	ND	ND	ND	8,900	ND	1,200	ND	1,700	12	8,800	ND	ND
GWN-WKE1 **Wilkes**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	82	ND	ND	ND	ND	ND	14,000	ND	23	ND	1,800	ND	13,000	ND	ND
GWN-BR1B **Towns**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	86	ND	ND	8.6	ND	ND	23,000	ND	ND	ND	5,100	21	4,200	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	85	ND	ND	7.2	ND	ND	21,000	ND	ND	ND	4,800	11	3,800	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	87	ND	ND	8.2	ND	ND	22,000	ND	ND	ND	4,900	14	3,900	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	84	ND	ND	8.0	ND	ND	20,000	ND	ND	ND	4,800	14	3,900	ND	ND
GWN-BR5 **Murray**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	2,500	ND	ND	ND	ND	ND	2,300	ND	ND
GWN-BR6 **Towns**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	50	ND	ND	ND	ND	ND	4,900	ND	ND	ND	1,900	28	5,300	ND	ND
GWN-BR6A **Towns**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	42	ND	ND	ND	ND	ND	27,000	ND	43	ND	2,600	39	6,400	ND	ND
GWN-BR7 **Pickens**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25	ND	ND	ND	ND	ND	6,100	ND	86	ND	3,000	39	2,800	ND	ND
GWN-BR8 **Rabun**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.8	ND	ND	ND	ND	ND	2,100	ND	ND	ND	ND	ND	1,600	ND	ND
GWN-BR9 **Gilmer**	ND	ND	6.7	42	ND	ND	ND	ND	ND	ND	ND	8.7	ND	ND	ND	ND	ND	13,000	ND	150	ND	1,900	ND	6,000	ND	ND
GWN-BR10 **Union**	ND	ND	5.6	ND	ND	ND	ND	ND	ND	ND	ND	34	ND	ND	ND	ND	ND	5,100	ND	26	ND	1,600	ND	5,400	ND	ND

Table A-7 Continued. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-BR11 **Union**	Willer Store Well	NG	NG	NG	9/28/2023	7.61	146	2.07	15.53	ND	ND	15	ND	ND	0.03
GWN-TOW1 **Towns**	Brasstown Bald Spring	0	NA	NA	3/9/2023	4.99	14	NA	10.38	ND	ND	ND	ND	0.36	ND
GWN-UNI1 **Union**	Bryant Cove Well #2	605	48	NG	3/9/2023	6.88	106	3.25	15.89	ND	ND	ND	ND	ND	0.03
	Aquifer Low Range					4.69	12	0.34	10.38		0	0		0	0
	Aquifer High Range					8.26	952	6.15	28.47		34	660		3.5	0.17
	Aquifer Median (ND=0)					6.69	190	2.59	17.40		0	0		0.15	0.02
	Aquifer Mean (ND=0)					6.71	213	2.76	17.36		2	29		0.46	0.03

Table A-7 Continued. Groundwater Quality Analyses for Piedmont-Blue Ridge Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-BR11 **Union**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	29	ND	ND	ND	ND	ND	16,000	ND	3,700	ND	2,800	50	5,500	ND	ND
GWN-TOW1 **Towns**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	22	1,100	ND	ND
GWN-UNI1 **Union**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	12,000	ND	ND	ND	1,400	ND	6,900	ND	ND
Aquifer Low Range												0						0		0		0	0	0		
Aquifer High Range												99						270,000		3,700		41,000	320	39,000		
Aquifer Median (ND=0)												21						18,000		0		3,350	14	7,650		
Aquifer Mean (ND=0)												27.6						28,068		171		4,354	41	11,253		

Table A-8. Groundwater Quality Analyses for Valley-and-Ridge/Appalachian Plateau Stations.
Part A: Station Identification, Date of Sampling, Field Parameters, VOCs, Anions, and Non-Metals.

Station No. County	Well Name	Well Depth feet	Casing Depth feet	Well Size Inches	Date sampled	pH	cond. uS/cm	diss O2 mg/L	Temp °C	VOCS ug/L	Cl mg/L	SO4 mg/L	F mg/L	NOx mg N/L	P mg/L
GWN-VR1 **Floyd**	Floyd County Kingston Road Well	280	NG	NG	9/14/2023	7.72	271	5.94	16.32	ND	ND	ND	ND	0.74	ND
GWN-VR2A **Walker p**	LaFayette Lower Big Spring	0	NG	NG	6/29/2023	7.39	329	NA	15.40	ND	ND	ND	ND	1.40	ND
GWN-VR3 **Walker**	Chickamauga Crawfish Spring	0	NG	NG	6/29/2023	7.25	279	NA	15.33	ND	ND	ND	ND	0.89	ND
GWN-VR6A **Bartow**	Chemical Products Corp. South Well	300	NG	NG	3/23/2023	8.17	309	NA	17.27	1,1 - dichloroethylene = 1.3 tetrachloroethylene = 1.8	ND	16	ND	0.85	0.02
GWN-VR8 **Polk**	Cedartown Spring	0	NG	NG	3/23/2023	7.85	271	NA	16.34	ND	ND	ND	ND	0.81	ND
					6/29/2023	7.54	275	NA	16.39	ND	ND	ND	ND	0.75	ND
					9/14/2023	7.61	283	NA	16.37	ND	ND	ND	ND	0.74	ND
					12/7/2023	7.99	279	NA	16.32	ND	ND	ND	ND	0.74	ND
GWN-VR10 **Murray**	Eton Spring	0	NG	NG	3/23/2023	7.49	276	NA	15.98	ND	ND	ND	ND	1.8	ND
GWN-VR12 **Floyd**	Cave Spring	0	NG	NG	6/29/2023	7.69	213	NA	15.63	ND	ND	ND	ND	0.35	ND
	Aquifer Low Range					7.25	213	5.94	15.33		0	0		0.35	0
	Aquifer High Range					8.17	329	5.94	17.27		0	16		1.8	0.02
	Aquifer Median (ND=0)					7.65	278	5.94	16.32		0	0		0.78	0
	Aquifer Mean (ND=0)					7.67	279	5.94	16.14		0	2		0.91	0

Table A-8. Groundwater Quality Analyses for Valley-and-Ridge/Appalachian Plateau Stations.
Part B: Metals.

Station No. County	Chromium ug/L	Nickel ug/L	Copper ug/L	Zinc ug/L	Arsenic ug/L	Selenium ug/L	Molybdenum ug/L	Silver ug/L	Cadmium ug/L	Tin ug/L	Antimony ug/L	Barium ug/L	Thallium ug/L	Lead ug/L	Uranium ug/L	Aluminum ug/L	Beryllium ug/L	Calcium ug/L	Cobalt ug/L	Iron ug/L	Potassium ug/L	Magnesium ug/L	Manganese ug/L	Sodium ug/L	Titanium ug/L	Vanadium ug/L
GWN-VR1 **Floyd**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	10	ND	ND	ND	ND	ND	30,000	ND	ND	ND	17,000	ND	1,800	ND	ND
GWN-VR2A **Walker**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	91	ND	ND	ND	ND	ND	47,000	ND	ND	ND	14,000	ND	1,600	ND	ND
GWN-VR3 **Walker**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	87	ND	ND	ND	ND	ND	34,000	ND	ND	ND	15,000	ND	1,300	ND	ND
GWN-VR6A **Bartow**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	380	ND	ND	ND	ND	ND	26,000	ND	ND	ND	15,000	ND	17,000	ND	ND
GWN-VR8 **Polk**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	32,000	ND	ND	ND	15,000	ND	1,400	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	33,000	ND	ND	ND	15,000	ND	1,400	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	13	ND	ND	ND	ND	ND	34,000	ND	22	ND	15,000	ND	1,400	ND	ND
	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	31,000	ND	ND	ND	15,000	ND	1,300	ND	ND
GWN-VR10 **Murray**	ND	ND	ND	12	ND	ND	ND	ND	ND	ND	ND	52	ND	ND	ND	ND	ND	33,000	ND	ND	ND	15,000	ND	2,400	ND	ND
GWN-VR12 **Floyd**	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	12	ND	ND	ND	ND	ND	25,000	ND	ND	ND	12,000	ND	ND	ND	ND
Aquifer Low Range												10						25,000		0		12,000	0	0		
Aquifer High Range												380						47,000		22		17,000	0	17,000		
Aquifer Median (ND=0)												13						32,500		0		15,000	0	1,400		
Aquifer Mean (ND=0)												68						32,500		2		14,800	0	2,960		

Table A-9. Analytes, EPA Analytical Methods, and Reporting Limits.

Analyte	Reporting Limit/ EPA Method	Analyte	Reporting Limit/ EPA Method
Vinyl Chloride	0.5 ug/L / 524.2	Dichlorodifluoromethane	0.5 ug/L / 524.2
1,1-Dichloroethylene	0.5 ug/L / 524.2	Chloromethane	0.5 ug/L / 524.2
Dichloromethane	0.5 ug/L / 524.2	Bromomethane	0.5 ug/L / 524.2
Trans-1,2-Dichloroethylene	0.5 ug/L / 524.2	Chloroethane	0.5 ug/L / 524.2
Cis-1,2-Dichloroethylene	0.5 ug/L / 524.2	Fluorotrichloromethane	0.5 ug/L / 524.2
1,1,1-Trichloroethane	0.5 ug/L / 524.2	1,1-Dichloroethane	0.5 ug/L / 524.2
Carbon Tetrachloride	0.5 ug/L / 524.2	2,2-Dichloropropane	0.5 ug/L / 524.2
Benzene	0.5 ug/L / 524.2	Bromochloromethane	0.5 ug/L / 524.2
1,2-Dichloroethane	0.5 ug/L / 524.2	Chloroform	0.5 ug/L / 524.2
Trichloroethylene	0.5 ug/L / 524.2	1,1-Dichloropropene	0.5 ug/L / 524.2
1,2-Dichloropropane	0.5 ug/L / 524.2	Dibromomethane	0.5 ug/L / 524.2
Toluene	0.5 ug/L / 524.2	Bromodichloromethane	0.5 ug/L / 524.2
1,1,2-Trichloroethane	0.5 ug/L / 524.2	Cis-1,3-Dichloropropene	0.5 ug/L / 524.2
Tetrachloroethylene	0.5 ug/L / 524.2	Trans-1,3-Dichloropropene	0.5 ug/L / 524.2
Chlorobenzene	0.5 ug/L / 524.2	1,3-Dichloropropane	0.5 ug/L / 524.2
Ethylbenzene	0.5 ug/L / 524.2	Chlorodibromomethane	0.5 ug/L / 524.2
Total Xylenes	0.5 ug/L / 524.2	1,2-Dibromoethane	0.5 ug/L / 524.2
Styrene	0.5 ug/L / 524.2	1,1,1,2-Tetrachloroethane	0.5 ug/L / 524.2
p-Dichlorobenzene	0.5 ug/L / 524.2	Bromoform	0.5 ug/L / 524.2
o-Dichlorobenzene	0.5 ug/L / 524.2	Isopropylbenzene	0.5 ug/L / 524.2
1,2,4-Trichlorobenzene	0.5 ug/L / 524.2	1,1,2,2-Tetrachloroethane	0.5 ug/L / 524.2

Table A-9, Continued. Analytes, EPA Analytical Methods, and Reporting Limits.

Analyte	Reporting Limit/ EPA Method	Analyte	Reporting Limit/ EPA Method
Bromobenzene	0.5 ug/L / 524.2	Total Phosphorus	0.02 mg/L / 365.1
1,2,3-Trichloropropane	0.5 ug/L / 524.2	Fluoride	0.20 mg/L / 300.0
n-Propylbenzene	0.5 ug/L / 524.2	Silver	10 ug/L / 200.7 (ICP)
o-Chlorotoluene	0.5 ug/L / 524.2	Aluminum	60 ug/L / 200.7
1,3,5-Trimethylbenzene	0.5 ug/L / 524.2	Arsenic	80 ug/L / 200.7
p-Chlorotoluene	0.5 ug/L / 524.2	Barium	10 ug/L / 200.7
Tert-Butylbenzene	0.5 ug/L / 524.2	Beryllium	10 ug/L / 200.7
1,2,4-Trimethylbenzene	0.5 ug/L / 524.2	Calcium	1000 ug/L / 200.7
Sec-Butylbenzene	0.5 ug/L / 524.2	Cadmium	10 ug/L / 200.7
p-Isopropyltoluene	0.5 ug/L / 524.2	Cobalt	10 ug/L / 200.7
m-Dichlorobenzene	0.5 ug/L / 524.2	Chromium	20 ug/L / 200.7
n-Butylbenzene	0.5 ug/L / 524.2	Copper	20 ug/L / 200.7
1,2-Dibromo-3-chloropropane	0.5 ug/L / 524.2	Iron	20 ug/L / 200.7
Hexachlorobutadiene	0.5 ug/L / 524.2	Potassium	5000 ug/L / 200.7
Naphthalene	0.5 ug/L / 524.2	Magnesium	1000 ug/L / 200.7
1,2,3-Trichlorobenzene	0.5 ug/L / 524.2	Manganese	10 ug/L / 200.7
Methyl-tert-butyl ether (MTBE)	0.5 ug/L / 524.2	Sodium	1000 ug/L / 200.7
Chloride	10 mg/L / 300.0	Nickel	20 ug/L / 200.7
Sulfate*	10 mg/L / 300.0	Lead	90 ug/L / 200.7
Nitrate/nitrite*	0.02 mg/L as Nitrogen / 353.2	Antimony	120 ug/L / 200.7

Table A-9, Continued Analytes, EPA Analytical Methods, and Reporting Limits.

Analyte	Reporting Limit/ EPA Method	Analyte	Reporting Limit/ EPA Method
Selenium	190 ug/L / 200.7	Selenium	5 ug/L / 200.8
Titanium	10 ug/L / 200.7	Molybdenum	5 ug/L / 200.8
Thallium	200 ug/L / 200.7	Silver	5 ug/L / 200.8
Vanadium	10 ug/L / 200.7	Cadmium	0.7 ug/L / 200.8
Zinc	20 ug/L / 200.7	Tin	30 ug/L / 200.8
Chromium	5 ug/L / 200.8 (ICPMS)	Antimony	5 ug/L / 200.8
Nickel	10 ug/L / 200.8	Barium	2 ug/L / 200.8
Copper	5 ug/L / 200.8	Thallium	1 ug/L / 200.8
Zinc	10 ug/L / 200.8	Lead	1 ug/L / 200.8
Arsenic	5 ug/L / 200.8	Uranium	1 ug/L / 200.8

* **Note:** Reporting limits for sulfate and nitrate/nitrite are subject to change. A sample with a concentration of either analyte greater than certain ranges may need to be diluted to bring the concentration within the analytical ranges of the testing instruments. This dilution results in a proportional increase in the reporting limit.

Table A-10. Analytes, Primary MCLs (A), and Secondary MCLs (B).

Analyte	Primary MCL	Secondary MCL	Analyte	Primary MCL	Secondary MCL
Vinyl Chloride	2 ug/L	None	p-Dichlorobenzene	75 ug/L	None
1,1-Dichloroethylene	7 ug/L	None	o-Dichlorobenzene	600 ug/L	None
Dichloromethane	5 ug/L	None	1,2,4-Trichlorobenzene	70 ug/L	None
Trans-1,2-Dichloroethylene	100 ug/L	None	Chloroform (1)	Total 1,2,3,4 = 80 ug/L	None
Cis-1,2-Dichloroethylene	70 ug/L	None	Bromodichloromethane (2)	Total 1,2,3,4 = 80 ug/L	None
1,1,1-Trichloroethane	200 ug/L	None	Chlorodibromomethane (3)	Total 1,2,3,4 = 80 ug/L	None
Carbon Tetrachloride	5 ug/L	None	Bromoform (4)	Total 1,2,3,4 = 80 ug/L	None
Benzene	5 ug/L	None	Chloride	None	250 mg/L
1,2-Dichloroethane	5 ug/L	None	Sulfate	None	250 mg/L
Trichloroethylene	5 ug/L	None	Nitrate/nitrite	10 mg/L as Nitrogen	None
1,2-Dichloro-propane	5 ug/L	None	Fluoride	4 mg/L	2 mg/L
Toluene	1,000 ug/L	None	Aluminum	None	50 -200 ug/L
1,1,2-Trichloroethane	5 ug/L	None	Antimony	6 ug/L	None
Tetrachloroethylene	5 ug/L	None	Arsenic	10 ug/L	None
Chlorobenzene	100 ug/L	None	Barium	2000 ug/L	None
Ethylbenzene	700 ug/L	None	Beryllium	4 ug/L	None
Total Xylenes	10,000 ug/L	None	Cadmium	5 ug/L	None
Styrene	100 ug/L	None	Chromium	100 ug/L	None

Table A-10, Continued. Analytes, Primary MCLs (A), and Secondary MCLs (B).

Analyte	Primary MCL	Secondary MCL	Analyte	Primary MCL	Secondary MCL
Copper	Action level = 1,300 ug/L$^{(C)}$	1000 ug/L	Selenium	50 ug/L	None
Iron	None	300 ug/L	Silver	None	100 ug/L
Lead	Action level = 15 ug/L$^{(C)}$	None	Thallium	2 ug/L	None
Manganese	None	50 ug/L	Zinc	None	5,000 ug/L
Nickel	100 ug/L	None	Uranium	30 ug/L	None

Notes:

(A) Primary MCL = Primary Maximum Contaminant Level, a maximum concentration of a substance (other than lead or copper) allowed in public drinking water due to adverse health effects.

(B) Secondary MCL = Secondary Maximum Contaminant Level, a maximum concentration of a substance suggested for public drinking water due solely to unpleasant characteristics such as bad flavor or stain-causing ability.

(C) Action Level = the maximum concentrations of lead or copper permitted for public drinking water as measured at the user's end of the system. Water issuing from at least ninety percent of a representative sample of user's end outlets must contain copper or lead concentrations at or below their respective action levels.

mg/L = milligrams per liter.

ug/L = micrograms per liter.