

WORK PLAN FOR THE FLORIDAN AQUIFER SYSTEM PLANNING TEAM

National Water-Quality Assessment Program

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Introduction

The Floridan aquifer system is one of the most productive aquifers in the world. The aquifer system underlies a total area of about 100,000 square miles in southern Alabama, southeastern Georgia, southern South Carolina, and all of Florida (fig. 1). The Floridan aquifer system is composed of a thick sequence of carbonate rocks (limestone and dolomite) of Tertiary age ranging from late Paleocene to early Miocene.

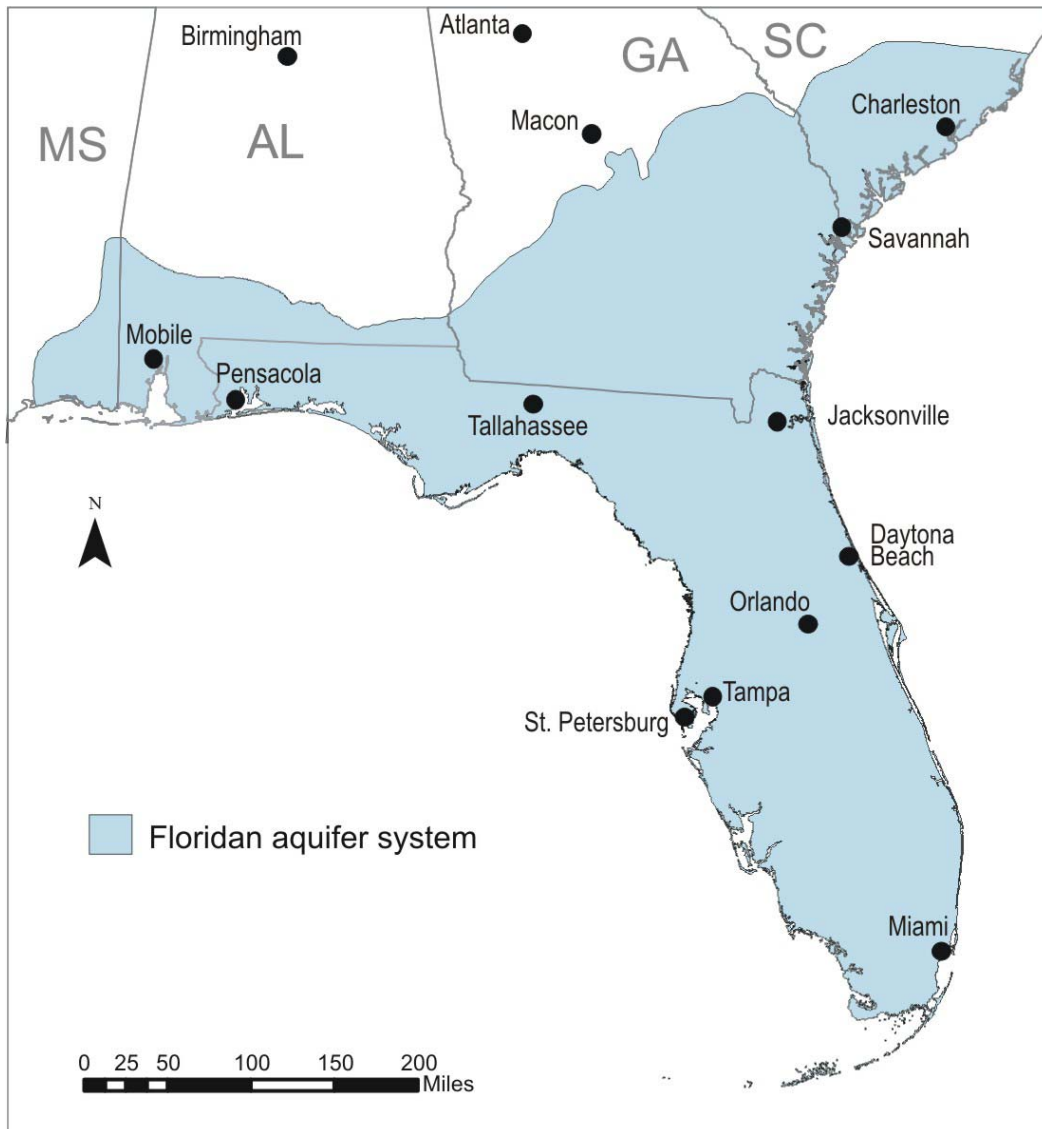


Figure 1. Extent of the Floridan aquifer system.

Purpose and scope

One of the main goals of the National Water-Quality Assessment (NAWQA) aquifer planning teams is to provide better assessment of the water quality of major aquifers and to provide better

products (reports). Because NAWQA study unit boundaries are based on surface-water hydrology, several study units overlie the Floridan aquifer system, including the Apalachicola-Chattahoochee-Flint, Georgia-Florida Coastal Plain, Mobile River and Tributaries, Santee Basin, and Southern Florida (fig. 2). The aquifer stratification, study plans, and report plans are partly the result of discussions between the Floridan aquifer team members and members of the NAWQA National Leadership Team that took place August 20-22, 2001. The purpose of this document is to describe the Floridan aquifer system and describe NAWQA study plans for the Floridan aquifer system, discuss the planned time frame for tasks, and describe the reports planned for Floridan aquifer system studies.

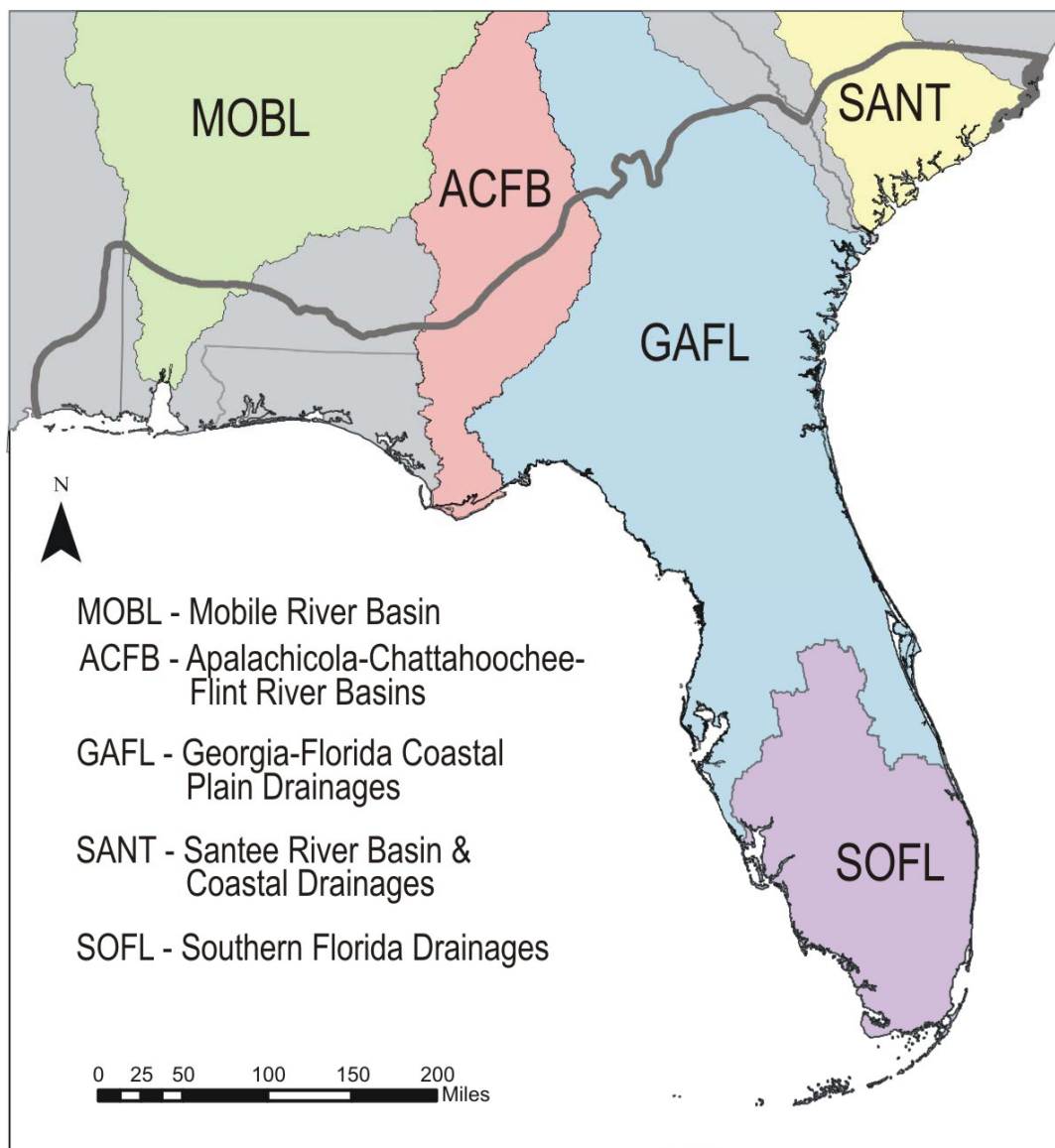


Figure 2. National Water-Quality Assessment study units overlying the Floridan aquifer system.

Description of study area

The Floridan aquifer system encompasses approximately 103,060 square miles in the southeastern U.S. (fig. 1) and is overlain in most areas by the surficial aquifer system (fig.3).



The Surficial aquifer system extends throughout large areas in the Coastal Plain of Florida, Georgia and South Carolina. The Surficial aquifer is the uppermost aquifer in the Northern Atlantic Coastal Plains aquifer system. The surficial aquifer extends over large parts of the Delmarva Peninsula and the eastern coastal plain of North Carolina.

Figure 3. Extent of the surficial aquifer system.

Hydrogeology

The permeability of the carbonate rocks is generally one to several orders of magnitude greater than that of the rocks above and below. The aquifer system generally consists of the following geologic formations, from oldest to youngest: Oldsmar Formation (lower Eocene age), Avon Park Formation (middle Eocene), Ocala Limestone (upper Eocene), Suwannee Limestone (Oligocene), Tampa Limestone (Miocene). The Tampa Limestone is part of the Floridan aquifer system where it contains permeable limestone units that are hydraulically connected to the underlying, older rocks. The thickest and most productive formations are the Eocene age Avon Park Formation and Ocala

Limestone. The Suwannee Limestone of Oligocene age is also a principal source of water but it is thinner and much less areally extensive than the Eocene formations.

The aquifer system is a sequence of hydraulically connected carbonate rocks (principally limestone and dolomite) that generally range in age from Late Paleocene to Early Miocene. The rocks vary in thickness from a thin edge where they crop out to more than 3,500 feet thick where the aquifer is deeply buried (fig. 4, 5). The aquifer system generally consists of an upper aquifer and a lower aquifer, separated by a less permeable confining unit of highly variable properties. In parts of north Florida and southwest Georgia, there is little permeability contrast within the aquifer system. Thus in these areas the Floridan is effectively one continuous aquifer. The upper and lower aquifers are defined on the basis of permeability, and their boundaries locally do not coincide with those for either time-stratigraphic or rock-stratigraphic units. Low-permeability clastic rocks overlie much of the Floridan aquifer system. The lithology, thickness, and integrity of these low-permeability rocks have a controlling effect on the development of permeability and local groundwater flow.

The Floridan aquifer system derives its permeability from openings that vary from fossil hashes and networks to many solution-widened joints to large cavernous openings in karst areas. Diffuse flow dominates where the small openings occur, whereas conduit flow may occur where there are large openings. For the Upper Floridan aquifer, transmissivities are highest (greater than 1 million feet squared per day) in the unconfined karst areas of central and northern Florida. Lowest transmissivities (less than 50,000 feet squared per day) occur in the Florida panhandle and southernmost Florida, where thick clay sections confine the Upper Floridan aquifer.

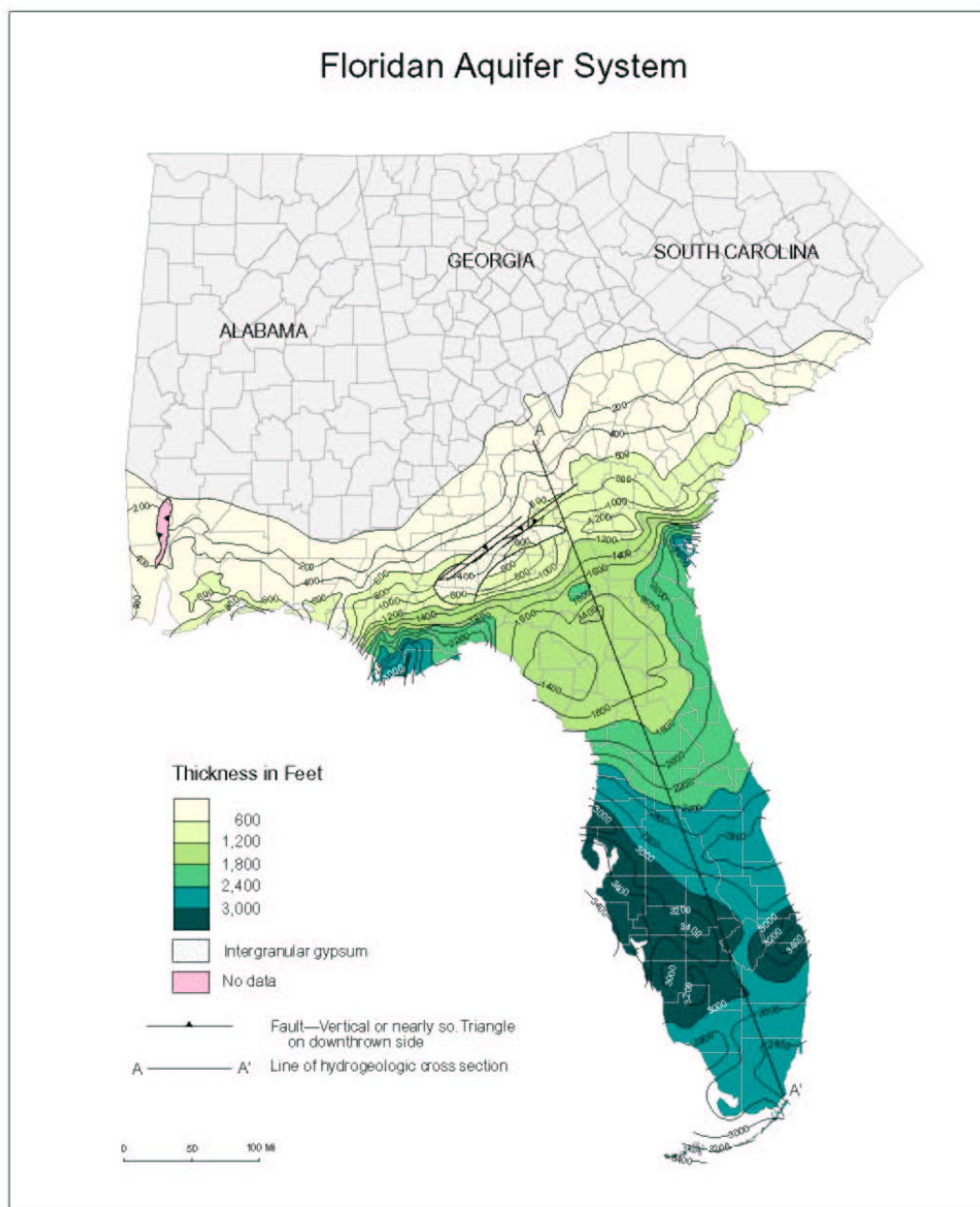


Figure 4. Thickness of the Floridan aquifer system (From Miller, 1990).

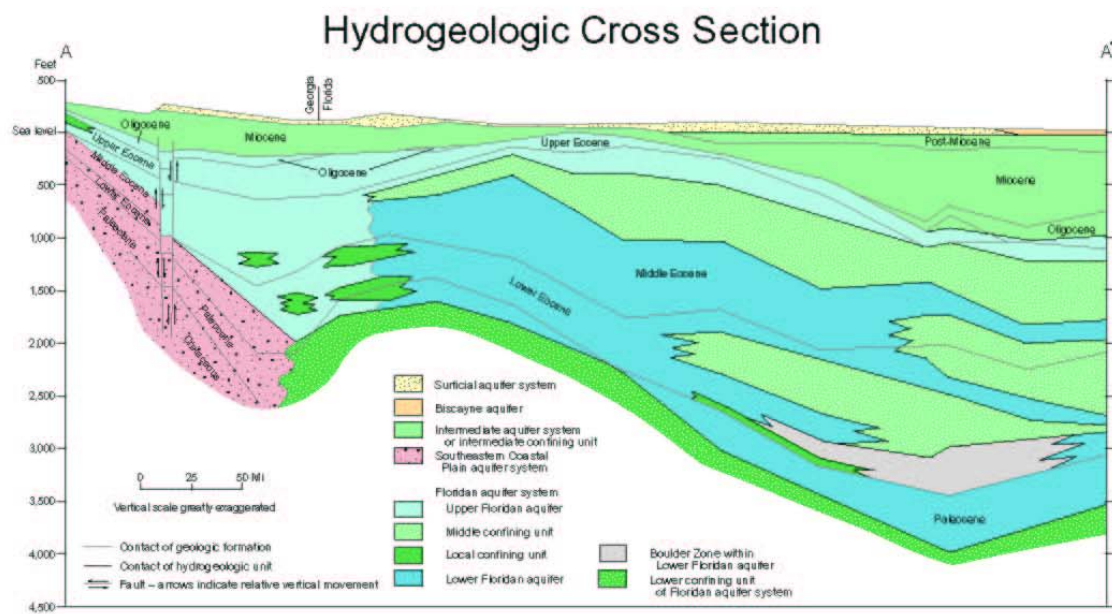


Figure 5. Hydrogeologic cross section through the Floridan aquifer system. (From Miller, 1990).

The Floridan aquifer system generally thickens seaward from a thin edge near its northern limit. The contours represent the thickness of the entire aquifer system. In most places, the Floridan aquifer system can be divided into three units: the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer. The middle confining unit restricts the movement of ground water between the Upper and Lower Floridan aquifers and consists of several separate units. At some locations the confining unit is clay; at others it is a very fine-grained limestone; at still other places it is a dolomite with the pore spaces filled with anhydrite. Few supply wells penetrate beyond the Upper Floridan aquifer because it is so productive and because much of the Lower Floridan aquifer contains saline water. In places, no middle confining unit exists and the aquifer system is highly permeable throughout its vertical extent and is known as the Upper Floridan aquifer.

The degree of confinement of the Upper Floridan aquifer is the major hydrogeologic control on the distribution of recharge, discharge, and ground-water flow. In many places, and over most of Florida, the Upper Floridan aquifer is overlain by a sequence of sand, clay, marl, limestone, and dolomite that ranges in thickness from a few feet in parts of west-central and north-central Florida to hundreds of feet in southeastern Georgia, northeast Florida, southeast Florida, and the westernmost part of the panhandle of Florida. The sand is generally the surficial aquifer and the clay and limestone are the intermediate aquifer. Both of these aquifers act as confining units to the Upper Floridan aquifer. The unconfined areas of the Upper Floridan aquifer are located in western parts of north-central Florida (north of Pasco County to Dixie County) (fig. 6).

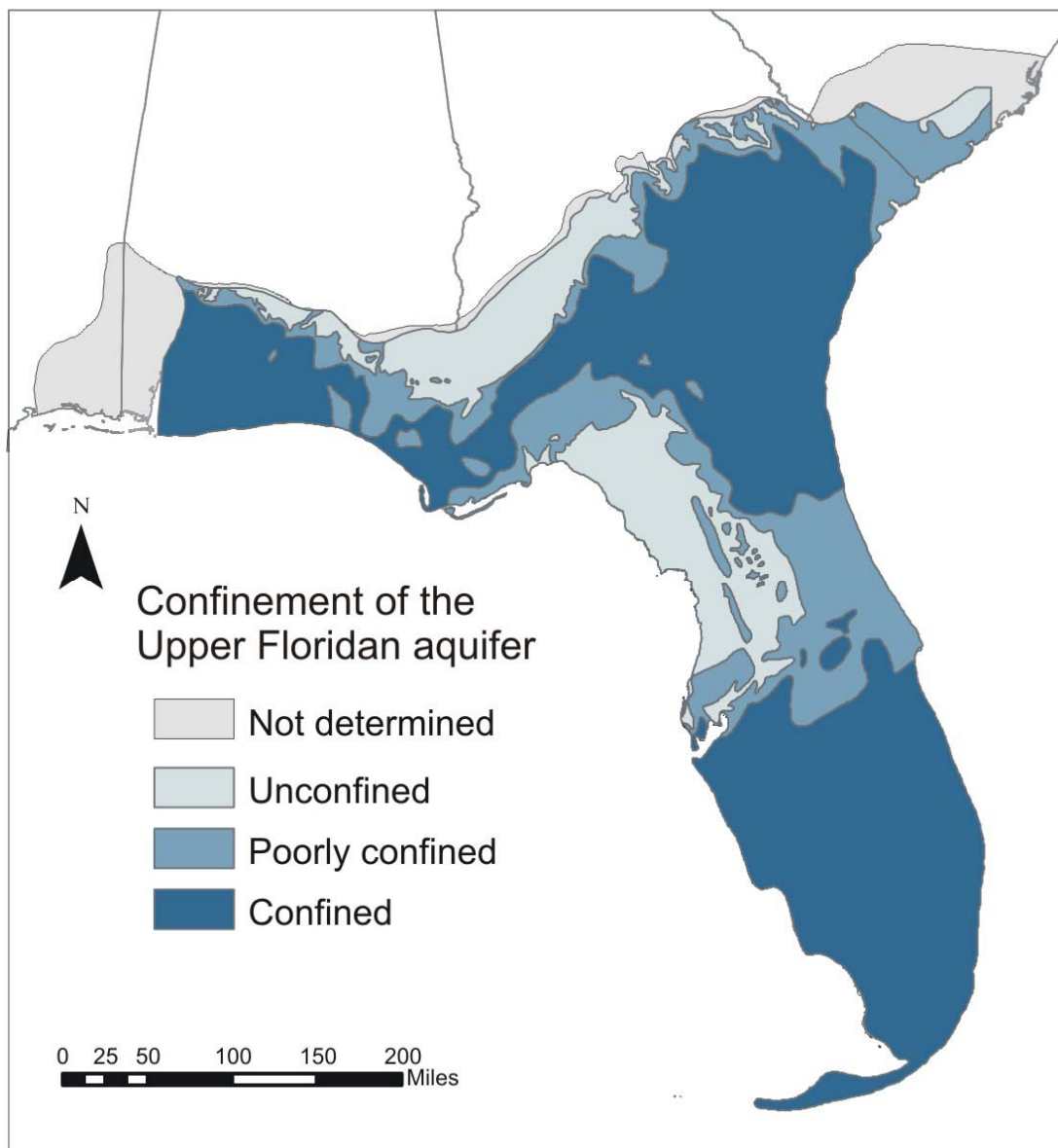


Figure 6. Confined, poorly confined, and unconfined areas of the Upper Floridan aquifer

The major (or general) features of the ground-water flow system in the Upper Floridan aquifer are illustrated by a map of the potentiometric surface of the Upper Floridan aquifer. The altitude and configuration of the potentiometric surface in 1995 shown in the map, with the arrows superimposed on the maps showing the direction of ground-water movement, which generally is perpendicular to the contours. The effect of ground-water withdrawals in the past couple of decades have had a pronounced affect on changes in the potentiometric surface in panhandle Florida, northeastern Florida, southwestern Florida, and in southeastern, coastal Georgia.

Water in the Upper Floridan aquifer moves from areas of high to low altitude on the potentiometric surface. The highest areas on the Upper Floridan aquifer's potentiometric surface are located: 1) in a band where the aquifer is exposed at the land surface near its updip limit and 2) in an area in central peninsular Florida. Water moves coastward from the outcrop area of the aquifer and outward in all directions from the potentiometric surface high in central Florida. Recharge tends to be concentrated in outcrop areas and at potentiometric highs. The thickness of the confining unit greatly affects the distribution of recharge and discharge. Where the aquifer is unconfined or the confining unit is thin, there is substantial hydraulic connection between the aquifer and surface drainage. In north-central Florida and south central Georgia, where the Upper Floridan aquifer is in direct contact with surface water, recharge is estimated to be between 10 to 20 inches per year (fig. 7). Discharge areas are located primarily along the coast.

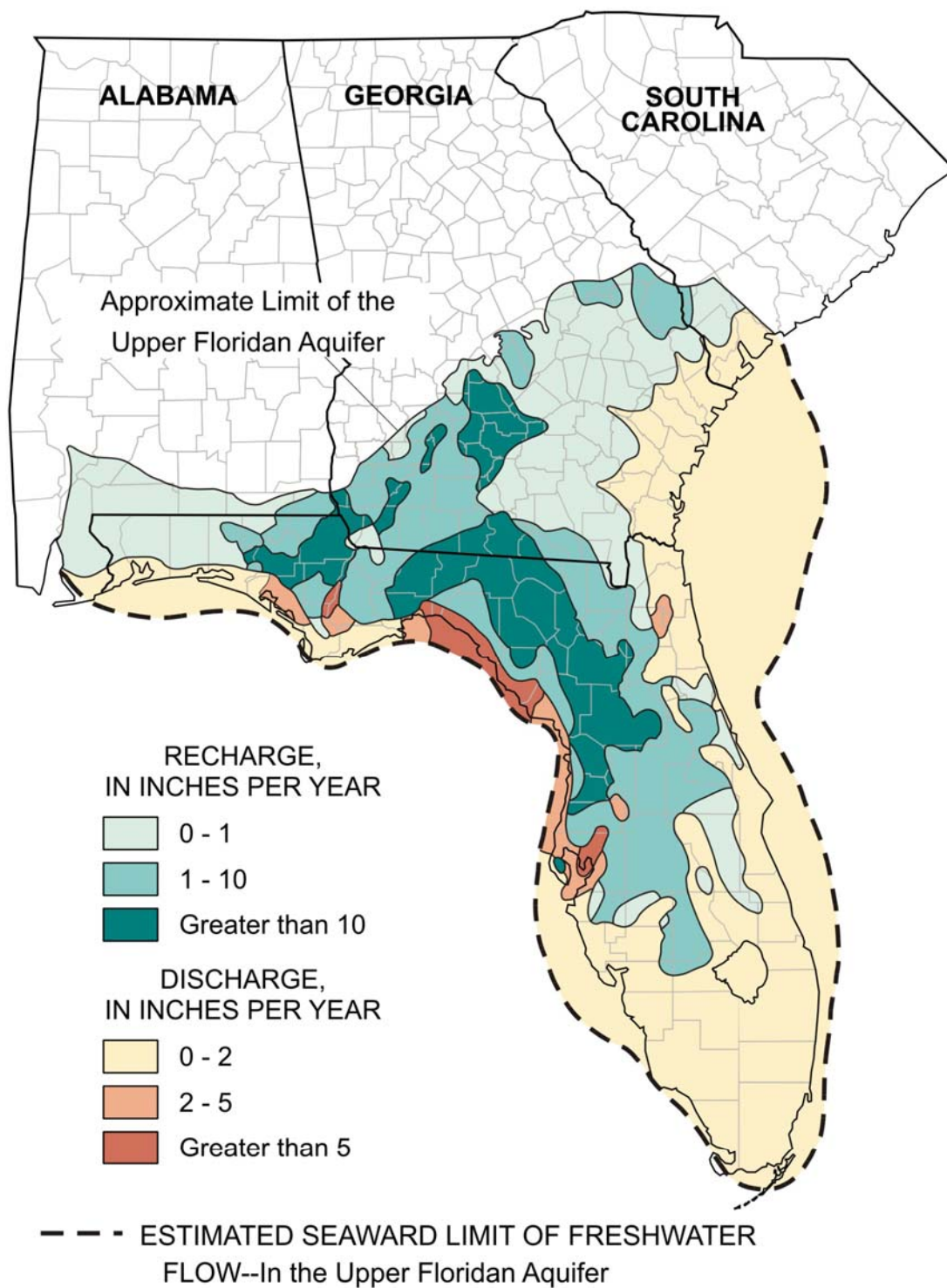


Figure 7. Recharge and discharge areas for the Upper Floridan aquifer (from Bush and Johnston, 1988).

Karst Features

The carbonate rocks of the Upper Floridan aquifer are readily dissolved where they are exposed at land surface or are overlain by only a thin layer of confining material. Rainfall absorbs carbon dioxide from the atmosphere and absorbs more carbon dioxide from organic matter in soils as rainfall percolates downward through the soil. Thus rainfall that enters ground water contains weak carbonic acid that is capable of dissolving limestone and dolomite of the Upper Floridan aquifer. This water enters pre-existing openings in the rocks such as pores between grains of limestone or fractures (joints). These small solution openings become large as more of the acidic water moves through the aquifer; eventually the openings may be tens of feet in diameter. The result of dissolution of carbonate rocks is a type of topography name karst (for the Karst Plateau of Yugoslavia) that is characterized by caves, sinkholes, and other types of openings caused by dissolution of limestone (fig. 8). These areas are also characterized by few surface streams. In Florida, this area coincides with the areas in north-central Florida that are unconfined or semiconfined. Here, dissolution of limestone is greatest because water is able to enter and move through the aquifer quickly. Water also discharges to surface water quickly through numerous springs.

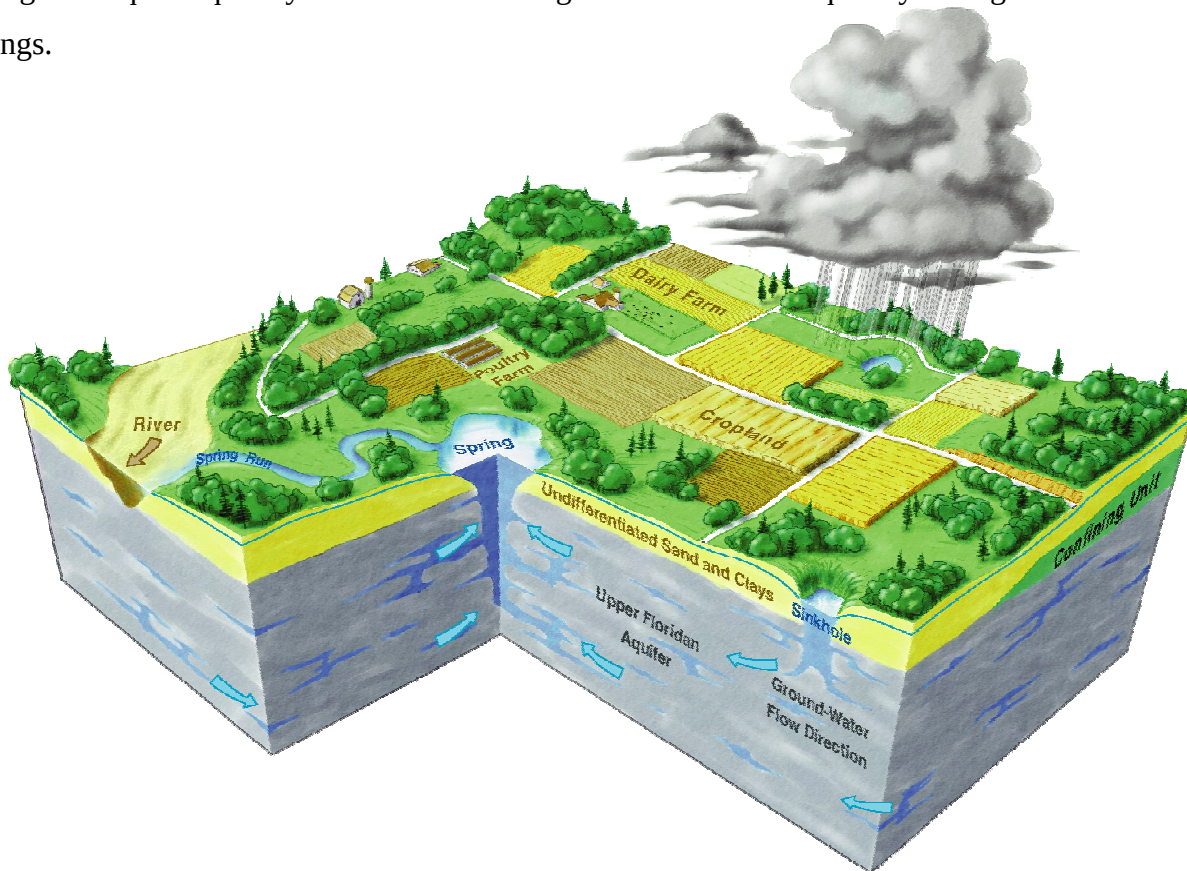


Figure 8. Block diagram of karst features

Springs are common in karst areas and are places where ground water discharges through natural openings in the ground. In north-central Florida, springs have long been one of the most valued natural and scenic resources. Springs integrate water over larger areas than domestic or monitoring wells and an estimated 70-75 percent of discharge from the Upper Floridan aquifer is from springs. The outflows from the springs range from less than 1 gallon per minute to 1.3 billion gallons per day at Spring Creek Springs, a group of submarine spring vents in Wakulla County. The known springs in Florida have a combined outflow amount of nearly 8 billion gallons of water per day. Florida has 27 first-magnitude springs or groups of springs (table1, fig. 9) (with flow greater than or equal to 65 gallons per minute or 100 cubic feet per second) out of a total of 78 in the Nation. All of the springs issue from the Upper Floridan aquifer, and nearly all of them are located in areas where the upper confining unit of the Upper Floridan aquifer is absent or is less than 100 feet thick. The distribution of large springs discharging from the Upper Floridan aquifer is the direct result of dissolution of carbonate rocks, which results in the development of large conduits and caves. Many of these conduits channel the ground water to the point where they are exposed at land surface and become the orifices of major springs.

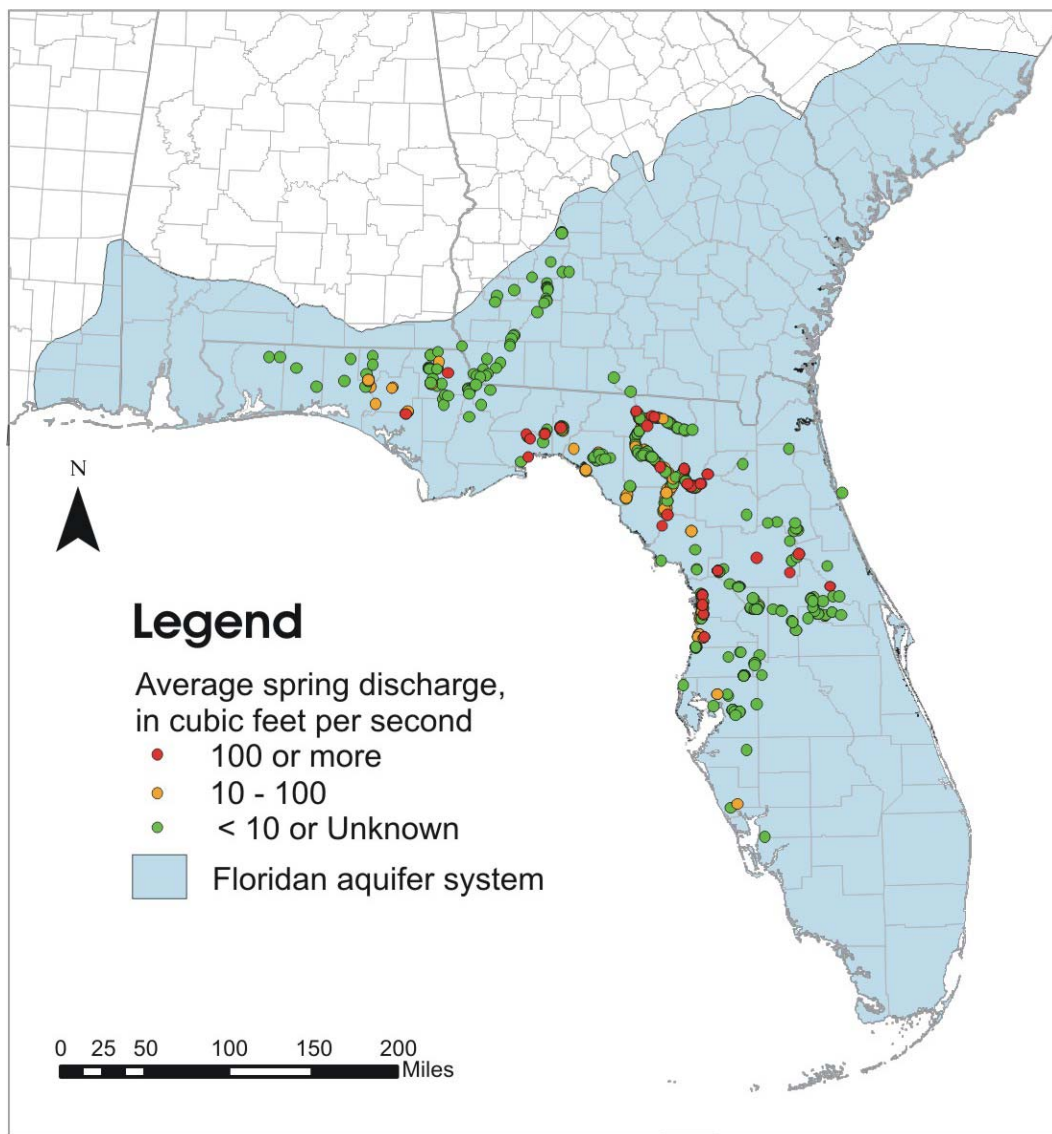


Figure 9. Locations of springs in the Upper Floridan aquifer.

Table 1. Summary of discharge for first-magnitude springs in the Upper Floridan aquifer.

[Discharge measurements are in cubic feet per second]

Map Number	NAME	Florida County	Average discharge¹	Single discharge²
1	Alapaha River Rise	Hamilton	608	
2	Alexander Spring	Lake	102	
3	Chassahowitzka Springs	Citrus	139	
4	Crystal River/Kings Bay Springs	Citrus	878	
5	Devil's Ear Spring	Gilchrist		206
6	Falmouth Spring	Suwannee	145	
7	Fanning Spring	Levy	113	
8	Gainer Springs	Bay	159	
9	Holton Spring	Hamilton	243	
10	Homosassa Springs	Citrus	192	
11	Hornsby Spring	Alachua	148	
12	Ichetucknee Springs	Columbia	360	
13	Jackson Blue Springs	Jackson	189	
14	Kini Spring	Wakulla	150	
15	Madison Blue Spring	Madison	106	
16	Manatee Spring	Levy	178	
3317	Rainbow Springs	Marion	711	
18	Santa Fe Spring	Union		150
19	Silver Glen Springs	Marion	106	
20	Silver Springs	Marion	799	
21	Siphon Creek Rise	Gilchrist		120
22	Spring Creek Springs	Wakulla	2000	
23	St. Marks River Rise	Leon	517	
24	Treehouse Spring	Alachua		406
25	Troy Spring	Lafayette	152	
26	Volusia Blue Spring	Volusia	158	
27	Wacissa Springs	Jefferson	388	
28	Wakulla Spring	Wakulla	391	
29	Weeki Wachee Spring	Hernando	174	
¹ From Rosenau and others, 1977				
² From Scott and others, 2002				

Population

The population in areas overlying the Floridan aquifer system was approximately 20 million in 2000 (U.S. Census, 2000). The majority of the population is located in northern and coastal parts of Florida (fig.10). Major cities overlying the Floridan aquifer system include Tampa, Orlando, St. Petersburg, Jacksonville, and Miami, FL, Savannah, GA, and Charleston, SC. (fig.1). Of these cities, Miami and Charleston do not rely on the Floridan aquifer system for drinking water. An estimated 10 million people rely on the Floridan aquifer system for drinking water (Richard Marella, U.S. Geological Survey, written commun., 2002) including the cities of Tampa, Orlando, St. Petersburg, and Jacksonville, FL and Savannah, GA.

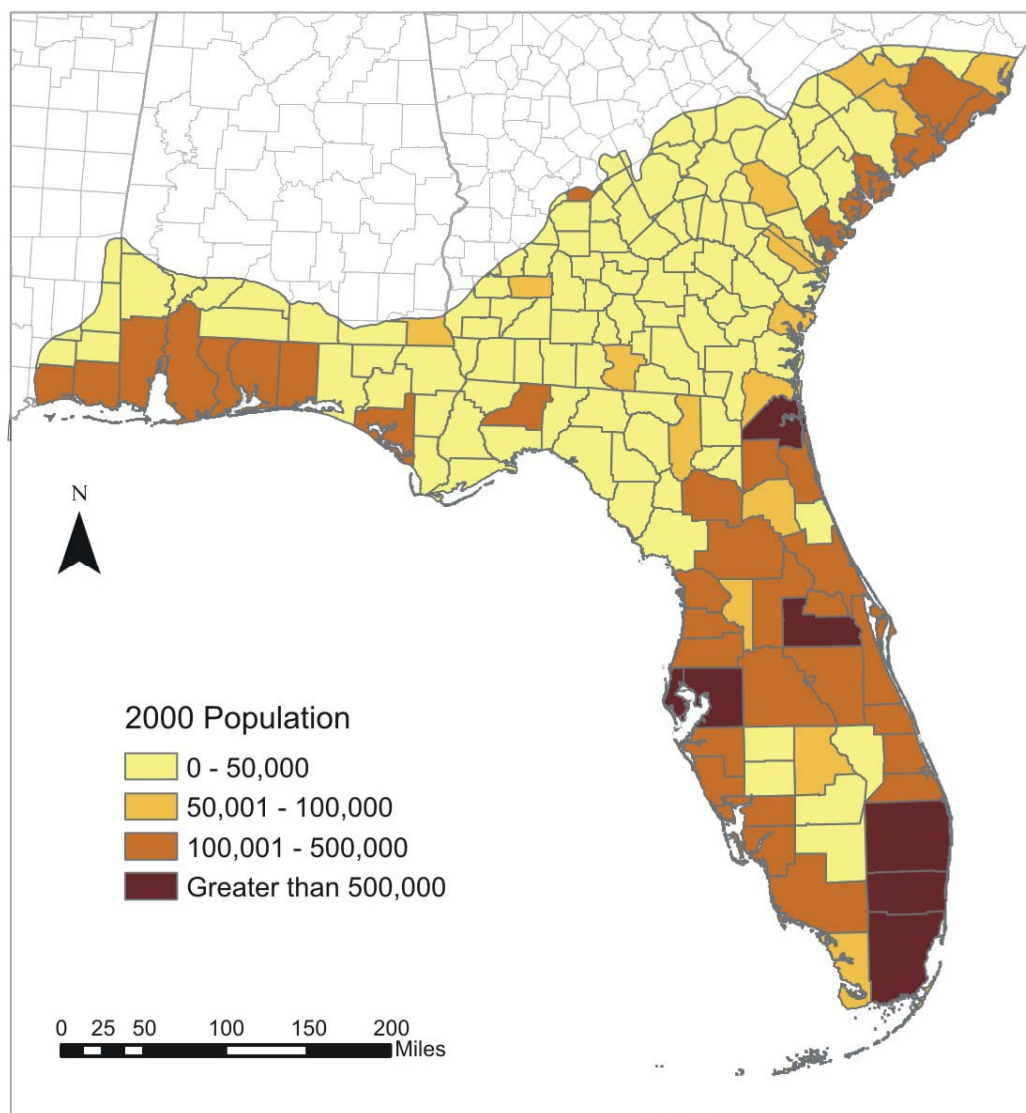


Figure 10. Population in areas overlying the Floridan aquifer system (from U.S. Census, 2000).

Water use

The Upper Floridan aquifer has long been a valuable source of plentiful, good-quality drinking water. Nearly 10 million people rely on the Upper Floridan aquifer for their water supplies (Richard Marella, U.S. Geological Survey, oral commun., 2002). The abundant supply of ground water in the Upper Floridan aquifer is vital to the state's important tourism and agricultural industries in Florida and Georgia. Because of differences in the distribution of population and agricultural areas, water use varies greatly.

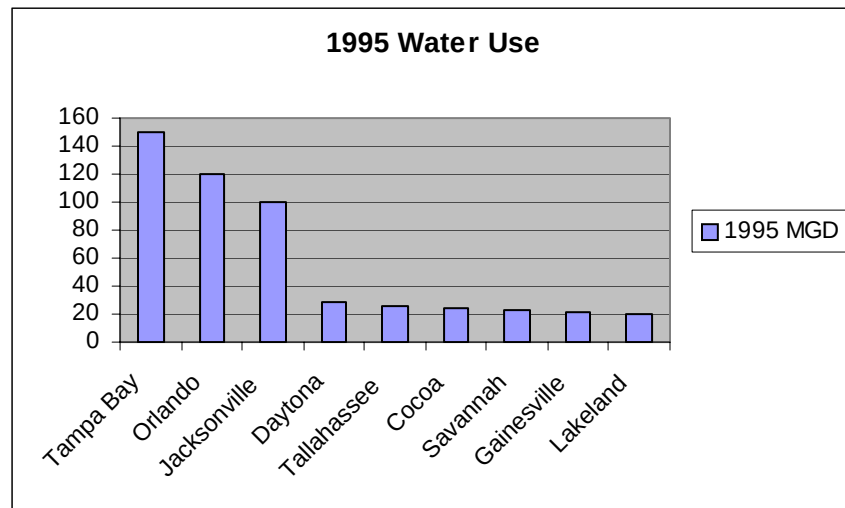


Figure 11. Largest ground-water withdrawals by water utility, 1995.

Most of the drinking water use for the Floridan aquifer system is related to the population distribution and is concentrated in the GAFL with minor amounts in ACFB, SANT, and SOFL (figs. 11 and 12). Water use in the SANT is 86% from SW and 14% GW. Most domestic wells in the Floridan aquifer system in the SANT are drilled to the top of limestone then drilled 10-15 feet deeper leaving an open hole in the limestone. Most of the GW use in the ACFB study unit is from the Floridan aquifer system and is used for agricultural irrigation. The aquifer system is unconfined in the ACFB. The ACFB completed a MAS in the Floridan aquifer system. The well types were: 10 domestic supply, 10 water level, 4 small public supply, and 2 unused. In addition, 15 springs were sampled. An agricultural LUS was located in the surficial aquifer overlying the Floridan aquifer system.

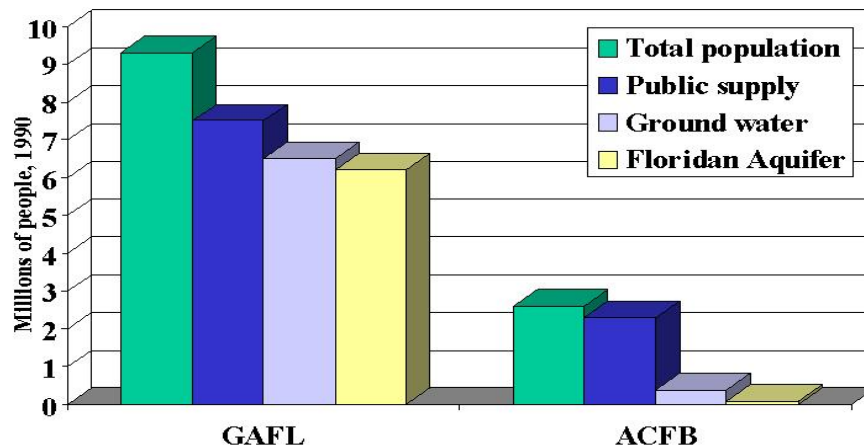


Figure 12. Total population and population utilizing various sources of ground water.

Saltwater encroachment in ground-water supplies is a concern in coastal areas of Florida, Georgia, and South Carolina, because these areas are underlain by saltwater at depth in the major aquifers. Saltwater encroachment into freshwater aquifers has several possible mechanisms, including 1) presence of pockets of relicts seawater in the aquifers; 2) lateral movement of saltwater in coastal areas; 3) upconing of saltwater from deeper zones below the pumping zone; 4) upward leakage of saltwater from deeper zones through uncased or improperly constructed wells; and 5) upward leakage of saltwater from deeper zones through breached confining units or through joints, faults or collapse features. These mechanisms are activated by the pumping of large amounts of ground water.

Despite concerns about ground-water quality, quantity, declining water levels in some areas, and saltwater encroachment, the Upper Floridan aquifer has large areas that contain large quantities of high quality water for public supplies. This includes areas where the aquifer is thick, transmissivities are high, recharge amounts are large, and water quality is unaffected by saltwater encroachment. Because these areas include areas where the aquifer is unconfined and karst features such as sinkholes and springs occur, ground-water flow velocities are fast, these areas are extremely vulnerable to contamination from surface sources. Potential sources of contamination include waste disposal impoundments, underground storage tanks, drainage wells, septic tanks, landfills, hazardous waste sites and agricultural chemicals.

Water quality

The natural water quality of ground water in aquifers is related to the quality of recharge water, the mineralogy of soils and aquifer sediments, the residence time in the ground-water flow system, and the presence of nearby saline water. Ground water moving through aquifers generally reaches chemical equilibrium with the aquifer sediments. Accordingly, natural ground water quality changes very little over time. Also, ground water generally contains higher concentrations of dissolved minerals than surface runoff and stream water because it remains in contact with the aquifer sediments for much longer periods. Human activity also affects ground water quality. Florida's unique hydrogeologic features of a thin soil layer, high water table, porous limestone, and large amounts of rainfall, coupled with its rapid population growth, result in a ground water resource extremely vulnerable to contamination.

Aquifers composed of readily dissolved limestone and that receive recharge from overlying aquifers (rather than rainfall), such as the Upper Floridan aquifer also have higher dissolved solids concentrations. Chloride concentrations are sometimes higher in the intermediate and Upper Floridan aquifer because of longer residence times of water in the ground- water flow system and the presence of saline water in coastal areas. The spatial distribution of chloride and dissolved solids concentrations in the Upper Floridan aquifer show that most of the high concentrations are in southern Florida and in areas along the coast. In testing of 91 public water supplies from various aquifers in Florida in 1983-84, concentrations of chloride were below 100 mg/L in nearly 90% of supplies and only 4% exceeded the recommended drinking water level of 250 mg/L (Irwin and others, 1985).

Water-quality Issues

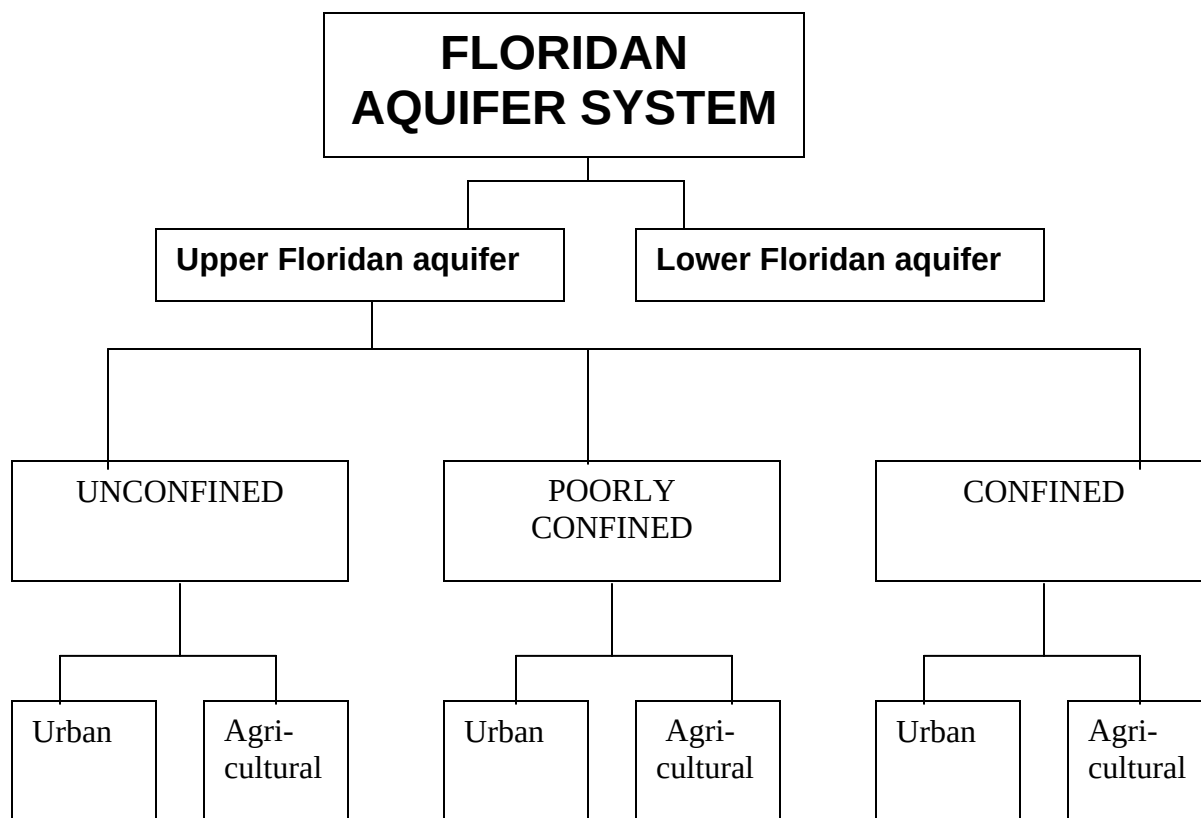
Water-quality issues are related to the susceptibility of the aquifer, some of which include:

- In unconfined and poorly confined areas, karst features, such as sinkholes and conduits, provide direct pathways for contamination
- Interaction with surface water and rehydration of wetlands near public supply well fields cause elevated DOC which can lead to formation of trihalomethanes during disinfection with chlorine
- Elevated nutrients and pesticides in the aquifer, in springs, and the Suwannee River; antibiotics were detected in the river
- Emerging contaminants detected in Tampa public supply well
- Radon has been elevated in many parts of the aquifer, especially in poorly confined (semiconfined) and confined areas because of the confining unit composition.

Study Area Stratification

The degree of confinement of the Upper Floridan aquifer is the major hydrogeologic control on the amount of recharge, discharge, and ground-water flow. The Upper Floridan aquifer's unique hydrogeologic features of a thin soil layer, high water table, porous limestone, and large amounts of rainfall, coupled with its rapid population growth, result in a ground water resource extremely vulnerable to contamination. Degree of confinement of the Upper Floridan aquifer (the primary drinking water unit) was the first level of stratification for water-quality assessments in the Floridan aquifer and will be used to prioritize and select major land-use study areas (fig. 13). The major land uses of concern for water-quality issues, urban and agriculture, are the second level of stratification (to be used for land-use studies).

Figure 13. Stratification for Floridan aquifer system studies.



Study Plans

Studies completed in Cycle I

Ground-water studies were completed by the ACFB, GAFL, SANT, and SOFL in the Floridan aquifer system and in the surficial aquifers overlying the Floridan aquifer system. Although the Floridan aquifer system ranks higher in water use for public supply and domestic use than the surficial aquifers, the number of studies completed in Cycle I were much fewer in the Floridan aquifer system than the surficial aquifers.

Floridan aquifer system

In Cycle I of the NAWQA program (1991-2000), studies were completed in the Floridan aquifer system by the ACFB, GAFL, and SANT (Table 2, fig. 14). The ACFB completed a major aquifer study in southwestern Georgia using a mixture of domestic, monitoring and irrigation wells. Several springs were also sampled. The GAFL completed a ground-water/surface water interaction study in north-central Florida along the Suwannee River. Fifteen newly-installed monitoring wells were sampled along with several springs. SANT did a Major Aquifer Study (MAS) in the Floridan aquifer of 30 domestic wells and a subset is slated to be re-sampled in the NIT Cycle II plan as part of the Trends networks.

Table 2. Studies completed in the Floridan aquifer system in Cycle I.

[From Berndt and others, 1998; Frick and others, 1998; and Hughes and others, 2000]

Study Unit	Study component	Location	Types of sites sampled	Number of sites	Sampling period
ACFB	Major aquifer study	Southwestern Georgia	Domestic, irrigation, and community supply wells, and springs	26 wells, 15 springs	1995
GAFL	Urban land use study	Ocala and Tampa, Florida	Monitoring wells	7 in Ocala, 9 in Tampa	1995
GAFL	Ground-water/surface water interaction	North-central Florida along Suwannee River	Monitoring wells and springs	15 wells, 11 springs	1995
SANT	Major aquifer study	Southern South Carolina	Domestic wells	30 wells	1999

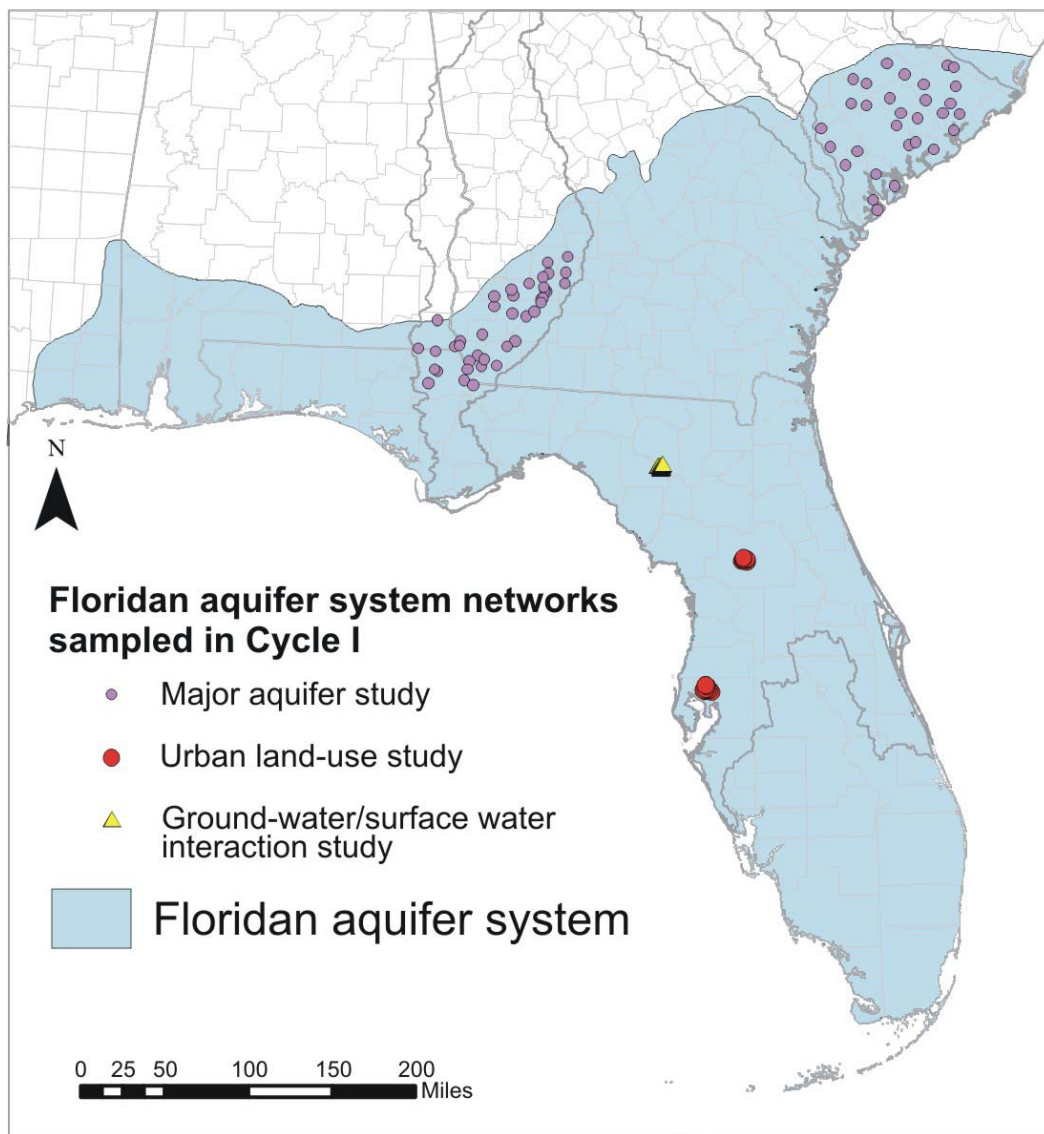


Figure 14. Ground-water networks sampled in the Floridan aquifer system in Cycle I.

Surficial aquifers

Several studies were also completed in surficial aquifers overlying the Floridan aquifer system in Cycle I (Table 3, fig. 15). The ACFB and GAFL study units each completed an agricultural Land-Use Study (LUS) in southwestern Georgia in the surficial aquifer overlying the Floridan aquifer system. These studies were done in adjacent counties and results are summarized in Frick and Crandall (1995) and Crandall (1996). The GAFL also completed a major aquifer survey in the surficial aquifer overlying the Floridan aquifer using domestic wells in southern Georgia and northern Florida (Crandall and Berndt, 1996). An agricultural study was also completed by the SANT in the surficial aquifer overlying the Floridan aquifer system (Hughes and others, 2000).

Table 3. Studies completed in surficial aquifers overlying the Floridan aquifer system in Cycle I.

[From Berndt and others, 1998; Frick and others, 1998; Hughes and others, 2000; and McPherson and others, 2000]

Study Unit	Study component	Location	Types of sites sampled	Number of sites	Sampling period
ACFB	Agricultural land use study	Southwestern Georgia	Domestic, irrigation, and community supply wells, and springs	37 wells plus 4 background wells	1993-94
ACFB	Flowpath study	Southwestern Georgia	Monitoring wells, springs, and tile drains	32 wells, 3 springs, 3 drains	1993-97
GAFL	Major aquifer study	Southern Georgia and northern Florida	Monitoring wells and springs	37 wells	1993
GAFL	Agricultural land use study	Southwestern Georgia	Monitoring wells	23 wells	1994
GAFL	Urban land-use study	Ocala and Tampa, Florida	Monitoring wells	9 in Ocala, 7 in Tampa	1995
SANT	Agricultural land-use study	Southern South Carolina	Domestic wells	30 wells	1999
SOFL	Major aquifer survey (Biscayne aquifer)	Southeastern Florida	Public supply wells	30 wells	1998
SOFL	Agricultural land-use study	South-central Florida	Monitoring wells	30 wells	1998
SOFL	Urban land-use study	Fort Lauderdale, Florida	Monitoring wells	38 wells	1997

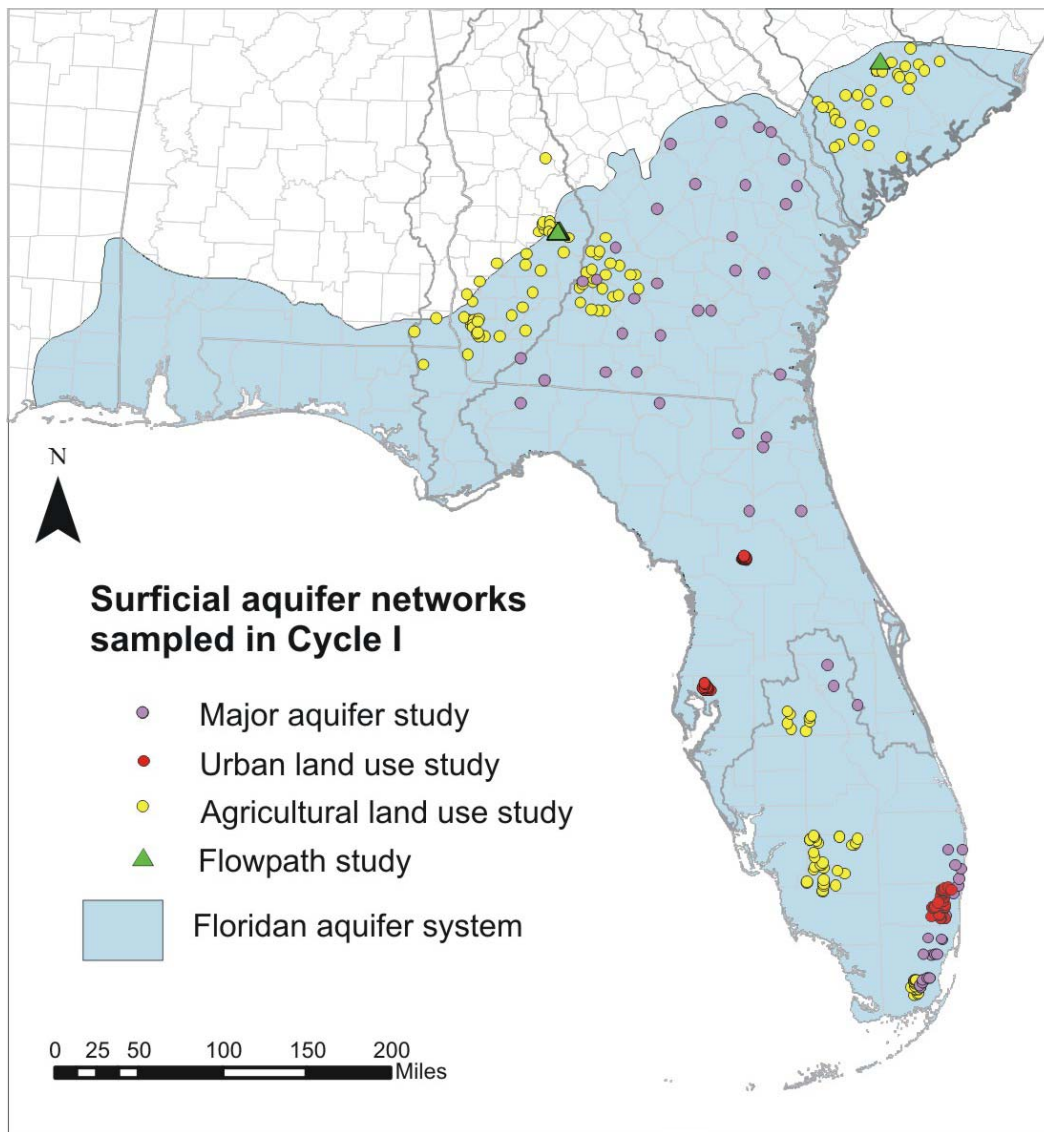


Figure 15. Ground-water networks sampled in the surficial aquifer system in Cycle I.

Studies proposed by NIT plan for Cycle II

The NAWQA Trend Network for ground water is designed to address the following objectives:

1. Determine long-term trends and changes in the concentrations of NAWQA target constituents in (a) 16 principal aquifer systems of the U.S. that have high use for drinking water and are representative of major aquifer lithologies, and (b) recently recharged ground water upgradient of these principal aquifers in a nationally representative range of hydrologic and land-use settings.
2. Determine the effects of urbanization on the concentrations and distributions of NAWQA target constituents in shallow or recently recharged ground water.
3. Determine the effects of long-term changes in agricultural management practices on the concentrations and distributions of NAWQA target constituents in shallow or recently recharged ground water.

The following characteristics are used in selecting studies and determining sampling strategies:

Sources--Representative coverage of the major agricultural and urban land uses of the nation

Transport Processes--Representative coverage of the diversity of hydrologic environments of the nation, as represented by hydrologic landscapes and other hydrogeologic characteristics

Effects--Representative coverage of the principal aquifers of the nation that are most heavily used as sources of drinking water by metropolitan and rural populations.

The main focus of the NAWQA trend network design is to resample, by a three-tiered sampling strategy, selected Cycle I ground-water studies. Additional new studies (not conducted during Cycle I) will be added to the NAWQA trends network after completing their initial status assessment in Cycle II. These selected new studies are necessary to improve coverage of the range of source, transport and effect conditions found across the United States.

Floridan aquifer system

The NIT plan recommends that two major aquifer studies be re-sampled in the Floridan aquifer system, one in the ACFB (acfbus1) and the other in the SANT (santsus2). The NIT plan recommends initiating three or more major aquifer studies in the Floridan aquifer system in the GAFL study unit to reflect the high water use in that area. Budget constraints will restrict that two of the three new major aquifer studies be initiated in the GAFL—one in the unconfined areas for the Upper Floridan aquifer and one in the poorly confined (semiconfined) areas.

Surficial aquifers

The NIT plan recommends that one major aquifer study be re-sampled in the Biscayne aquifer in the SOFL (soflsus1). The Biscayne aquifer overlies the Floridan aquifer in southeastern Florida. The Floridan aquifer is not potable in this area. The NIT plan also recommends that one urban land-use study be initiated in the surficial aquifer in the West Palm Beach (north of soflsus1) or Fort Myers in southwestern Florida.

Aquifer team recommendations for Cycle II

Floridan aquifer system

The aquifer team agrees with the NIT plan and recommends initiating two major aquifer studies in the GAFL—one in the unconfined areas and the other in poorly confined areas. These areas represent the areas of highest water use for public supply from the Floridan aquifer system. The aquifer team also agrees with the NIT plan and recommends re-sampling the major aquifer study in the ACFB (acfbSus1). The team does not agree with the NIT plan to include the SANT MAS network (santSus2) in the NAWQA Trends network or re-sampling that major aquifer study in Cycle II because the Floridan aquifer system is minimally used in the SANT (for public supply or agricultural irrigation). Rather, the team recommends including one of the new major aquifer studies in the GAFL (gaflSus2) in the NAWQA Trends network. The gaflSus2 network is located in central Florida in the unconfined portion of the aquifer in areas with high population, high water use, and relatively high vulnerability of the aquifer.

Surficial aquifers

The aquifer team agrees with the NIT plan and recommends re-sampling the agricultural land-use studies in ACFB (acfbSusag1) and GAFL (gaflSuscr1), re-sampling the major aquifer study in the SOFL (soflSus1) and initiating an urban land-use study in the SOFL in the Fort Myers area in southwestern Florida. The Fort Myers area is recommended over the West Palm Beach area because the surficial aquifer in the Fort Myers area has different hydrogeology than the Biscayne aquifer whereas the surficial aquifer in the West Palm Beach area is minimally different from the Biscayne aquifer (that is being studied by soflSus1).

Coordination of Floridan aquifer plans with other NAWQA networks and studies

Study of water-quality in the Floridan aquifer system are greatly enhanced by topical studies and other studies in NAWQA. Recommendations and plans of the Floridan aquifer system planning team in this document have focused on the status and trends component of the NAWQA program. NAWQA topical studies, source-water assessments and flow path studies will provide a wealth of information on the impacts of urbanization and water usage on the water quality of the Floridan aquifer system.

Topical studies

The GAFL is involved in two NAWQA topical studies—the transport of anthropogenic and natural contaminants to supply wells (TANC) and the bioaccumulation of mercury in aquatic ecosystems (Hg). The primary goal of the TANC topical study is to determine sources and transport of contamination sources to aquifers that are major sources of water supply across the Nation. Specific objectives of TANC include:

- Assess human activities, and hydrologic and geologic factors that are related to sources
- Determine hydrologic factors that affect transport
- Identify important chemical characteristics and transformation processes
- Evaluate effects of well characteristics and well-field management

(Sandra Eberts, U.S. Geological Survey, written commun., 2002).

Criteria used for selection of NAWQA study areas in the TANC topical study include:

- Overlies an important regional water-supply aquifer
- Nests within an area scheduled for re-sampling [of major aquifer study or urban land-use networks]
- Ground water is a critical source of drinking water
- Ground water is vulnerable to contamination
- Water-quality issues are related to human activities

(Sandra Eberts, U.S. Geological Survey, written commun., 2002).

The TANC topical study in the GAFL is being conducted in the Floridan aquifer system in the Tampa area. The Tampa area is one of the most densely populated areas underlying the Floridan aquifer system and is located in unconfined and poorly confined areas of the Upper Floridan aquifer. The population of the Tampa-St. Petersburg-Clearwater metropolitan statistical area

(MSA) was 2.3 million people in 1999. The population is also rapidly growing—the percent change in population from 1990 to 1999 was 10.2 percent (U.S. Census Bureau, 2000). The TANC study in the GAFL will provide critical information on the impacts on water quality of a heavily used portion of the Upper Floridan aquifer that is also extremely vulnerable to contamination.

The Hg topical study is concerned primarily with fish, sediment, and water in streams and does not involve the Floridan aquifer system, except peripherally where streams receive large amounts of ground-water inputs (usually via springs). One GAFL site for the Hg topical study is the Santa Fe River near White Springs, which does receive the majority of its water flow from springs.

Source water assessments for drinking water

Two source water assessment studies are planned for the Floridan aquifer system in the Tampa area. Wells to be sampled for this study include public supply wells comprising the upper 25th-percentile of water withdrawals for the Floridan aquifer system in the Tampa area. A total of 30 public supply wells will be sampled in the Tampa area in FY03.

Flow path studies

One flow path study is planned in the GAFL in the Tampa area and is being coordinated with the TANC topical study. This will consist of 20 wells installed in clusters of 2-3 wells over a short distance (typically less than 0.5 miles). Another flow path study is planned in the ACFB north of Albany, GA. This will be in an area of the Claiborne aquifer which directly overlies the Floridan aquifer system and is in the recharge area for the Floridan aquifer system. No confining unit is present so this flow path study will assess impacts of agricultural land use on water quality in recharge water to the Floridan aquifer system.

Report Plans

One of the critical needs identified by the planning team members is a compilation of water use data for the year 2000. A 4-page fact sheet on 2000 water use from the Floridan aquifer system (with the majority of the data available on a web page) is to be started in late FY02 and completed in FY03. Water-quality studies on the Floridan aquifer system began as early as 1993, however the number of studies completed in Cycle I (before FY2001) were not sufficient to provide even a cursory analysis of water quality in the Floridan aquifer system. In FY2002, the GAFL completed two new MAS's and one Urban land-use study (Tampa area) in the Upper Floridan aquifer in areas of high population, high water use, and relatively high vulnerability of the aquifer. The ACFB has also re-sampled its MAS in the Floridan aquifer system. Two possible report products are possible here, one would be a USGS WRIR on water quality in the Tampa metropolitan area and adjacent areas of the poorly confined and unconfined areas of the Upper Floridan aquifer, authored by Scott McBride and Marian Berndt, and another USGS WRIR (or proceedings paper) on water quality of the Upper Floridan aquifer throughout its areal extent (including studies from ACFB, SANT, and GAFL) comparing urban to agricultural areas and high use to low use areas.

In summary, three reports are planned products from the Floridan aquifer team:

- 1) Water use fact sheet by Marella and Berndt (FY03) (Draft in review 3/21/03)
- 2) Water quality in the Floridan aquifer system in the Tampa metropolitan area and surrounding areas, by McBride and Berndt (FY03)
- 3) Water quality in the Floridan aquifer system in Florida, Georgia, and South Carolina, by Berndt, McBride, Crandall, Hughes, and Frick (FY04)

Report number 2 could also be a 4- to 6-page fact sheet that could be included as a chapter in report number 3. This would allow this data to be published in late FY03 or early FY04 rather than wait until report number 3 is completed in FY04.

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