

# Tampa Bay Basin Lakes, Rivers, Streams, and Aquifers



## Florida Department of Environmental Protection

*Division of Water Resource Management  
Bureau of Watershed Management  
Watershed Monitoring Section*



Good science is the foundation of the Florida Department of Environmental Protection's (FDEP) programs to assess and protect water quality. FDEP is committed to characterizing the environmental conditions of Florida's freshwater resources through several monitoring programs. This report summarizes the results of investigations of the Tampa Bay Basin's water resources during 2004, using data from the Status Monitoring Network.

## Tampa Bay Basin

The areas of the Tampa Bay Basin considered in this report are Tampa Bay and the surrounding coastal regions to the north and east. Encompassing nearly 400 square miles, Tampa Bay is the largest open-water estuary in Florida. The Port of Tampa, one of three ports located in Tampa Bay, is Florida's largest port. Because the bay averages about 12 feet in depth, man-made shipping channels have been dredged for the safe passage of large ships.

More than 2.3 million people live in the three counties (Hillsborough, Manatee, and Pinellas) directly bordering Tampa Bay, making this the second largest metropolitan area in Florida. The local economy is shaped by agriculture, industry, power generation, the mining of phosphate and minerals, and tourism and recreation.

The Tampa Bay area comprises a variety of habitats, including open-water rubble and reef communities, lush seagrass meadows, coastal hardwood hammocks, pine flatwoods, cypress swamps, wet prairies, saltmarshes, and mangrove fringe. Estuaries such as Tampa Bay, where salt water from the sea and fresh water from rivers and uplands mix, serve as nurseries for young fish, shrimp, and crabs. As many as 40,000 pairs of birds can be found nesting each year along the shores of Tampa Bay. The bay is also home to dolphins, sea turtles, manatees, and more than 200 fish species.

From the 1940s to the present, however, urbanization, dredge and fill, canal construction, airborne pollutants, and shoreline modification have threatened the bay's health. In addition, the overpumping of ground water and drought have resulted in saltwater intrusion and other aquifer impacts. Over the last two decades, citizens, governmental entities, and public-private partnerships have coordinated efforts to restore Tampa Bay's ecological integrity. These efforts include educating the public, planting seagrasses, restoring wetlands and adjacent uplands, constructing stormwater ponds, and backplugging wells to minimize overpumping of the Floridan aquifer.

	<b>Agriculture</b>	<b>Forest</b>	<b>Urban</b>	<b>Wetlands</b>	<b>Other</b>
Land Use (%)	3.7	1.9	59.9	4.5	30.0

The percentage reported as "Other" consists of water, rangeland, barren land, transportation, communication, and utilities.

## **Monitoring Design of the Status Network**

FDEP has worked with the water management districts, local governments, and other entities to establish an Integrated Water Resources Monitoring (IWRM) Program. This program combines surface and ground water monitoring efforts, which consist of water chemistry, biological, and sediment assessments. It is fiscally and logistically prohibitive to sample every river or stream, every lake, or each monitoring well in the state annually; thus, a statistically valid monitoring design is required. The IWRM Program is made up of three levels of monitoring designs: (1) a Status Network monitoring program that allows statistical inferences to be made about all state waters; (2) more intensive basin monitoring used to identify and confirm impaired waterbodies; and (3) site-specific regulatory compliance monitoring.

The Status Network uses a random site monitoring design to assess the state's surface and ground water quality. The objective of this design is to broadly characterize aquatic resources with a known statistical confidence. One sample is collected from each randomly selected point, which is a cost-effective way to provide a wide geographic snapshot of the condition of all waters within a basin. Ambient water quality conditions can vary considerably on a daily and seasonal basis. Accordingly, this monitoring program is not designed to answer site-specific questions about individual lakes, rivers, or streams. The health of specific river and stream segments, lakes, and estuaries is characterized by FDEP's Watershed Assessment Program.

The Status Network divides Florida's waters into 6 resource types. Four of these are surface water: small lakes, large lakes, rivers, and streams. The other 2 are ground water: unconfined and confined aquifers. The Status Network divides the state into 29 basins, and 5 or 6 basins are sampled each year. Approximately 30 samples are collected from each resource type in the selected basins. Thus, in each basin, approximately 120 samples are collected for all types of surface water resources, and 60 samples for both types of ground water resources, in addition to quality assurance samples.

### **Lakes**

There are approximately 67 large lakes (over 25 acres) and more than 200 small lakes in the basin. Many small lakes that are sampled are located in the lake-rich area just north of Tampa. Constructed waterbodies, such as golf course lakes, borrow pits, and agricultural ponds in the Tampa Bay area were not sampled as part of this network. Seventeen large lakes were sampled, some more than once—particularly Tarpon Lake (40% of the samples), which is very large. In recent years, ground water overpumping and drought have caused the shrinkage or disappearance of some area lakes, which are generally recharged by lateral ground water seepage, or by high ground water levels.

### **Rivers and Streams**

FDEP and the Southwest Florida Water Management District did not select any rivers in the basin because they are tidally influenced up to the basin's boundaries. The streams and canals that flow into these rivers were selected as the stream resource. Some streams are partially channelized with concrete-lined banks, reducing the availability of habitat for aquatic life. Other streams have been modified to serve as area conduits during storm events. These alterations minimize the streams' natural ability to filter pollutants, which can result in additional impacts to Tampa Bay.

### **Aquifers**

Aquifers are permeable layers of sand, gravel, or rock that contain water. Unconfined aquifers are near the land surface and are easily affected by human activities. Confined aquifers lie below a layer of material, such as fine-grained clay, that generally limits the downward flow of water. Water in confined aquifers usually filters slowly through a layer of earth and is older and less affected by

human activities. FDEP's Watershed Monitoring Section samples ground water in the Tampa Bay Basin through wells in unconfined and confined aquifers.

The upper Floridan aquifer provides much of the potable water (drinking water) in the basin via ground water wells. Over the last few decades, massive development and drought in the Tampa Bay area have caused excess discharge and insufficient recharge of the aquifer. The resulting ground water drawdown precipitates saltwater intrusion and the upconing of sulfate-enriched mineralized water into coastal wells, rendering them unfit for drinking water and sometimes agricultural use.

## Summary and Results

The tables below show the sampling carried out for each resource in the Tampa Bay Basin, in terms of acres of large lakes, number of small lakes, miles of rivers and streams, and number of wells for confined and unconfined aquifers. Not all randomly selected stations can be sampled for various reasons. Those that can be sampled are termed accessible. Those stations that cannot be sampled are considered either dry or inaccessible.

	<b>Large Lakes</b> (≥ 25 acres)	<b>Small Lakes</b> (2.5–25 acres)	<b>Rivers</b>	<b>Streams</b> (All other streams)
Area, Number, Miles	6,191 acres	216 lakes	The only large rivers in the basin are tidally influenced; these were not sampled as part of the freshwater network	212 miles
Accessible	100%	81%		54%
Dry	0%	3%		6%
Inaccessible	0%	16%		40%
# of Samples	30	30		30
	<b>Unconfined Aquifers</b>		<b>Confined Aquifers</b>	
Number of Wells	125		113	
Accessible	74%		64%	
Inaccessible	26%		36%	
Samples	30		30	
	<b>Average Basin Precipitation</b> (1971-2000)		<b>2004 Precipitation in Basin</b>	
Tampa Bay Basin	44.77 inches		59.31 inches	

Rainfall data were obtained from the National Climatic Data Center database for the Tampa International Airport Station.

The discussion and figures below provide results for the basin's surface water and ground water resources for a number of important indicators (see the Definitions and Criteria pages for explanations of the indicators used). As discussed in the Definitions and Criteria page, natural conditions such as higher water temperatures, fresh water and storm water inflows, and soil conditions can affect the results below. Exceedance of a standard or threshold is not necessarily caused by a pollutant.

**Lakes:** Dissolved oxygen (DO) is less than 5 milligrams per liter (mg/L) in 13% of large lakes and 37% of small lakes. Low DO can be harmful to aquatic life. The small lakes were sampled during the summer, when high temperatures reduce oxygen levels. Fecal coliform levels are generally minimal in large lakes, although high in 17% of small lakes. The pH standard for lakes ranges from 6 to 8.5 standard units (su). The pH is low (acidic conditions) in 3% of the large lakes and high (basic conditions) in 7%. Small lakes report low pH in 17% of the resource and high pH in 10%. The levels of un-ionized ammonia meet the standard for both lake resources. The Trophic State

Index (TSI), a combined measure of nutrients and chlorophyll that indicates lake health, shows that nutrients and chlorophyll are higher in small lakes than in large lakes. The TSI is above the standard in 7% of the large lakes and 30% of the small lakes.

**Rivers and Streams:** No rivers were sampled. DO is low in 57% of the streams sampled, which can impair aquatic life. Chlorophyll levels are also high in 13% of streams. Fecal coliform levels exceed the standard in 70% of streams. Un-ionized ammonia and pH are within standards.

**Aquifers:** Arsenic, lead, sodium, and fluoride exceed standards in a few unconfined wells (less than 8%). Total coliform bacteria exceed the standard in 17% of the unconfined wells. The main source of potable water is from the confined Floridan aquifer. Arsenic and fluoride exceed the standard in less than 4% of the confined wells. Sodium is high in 27% of the confined wells, likely from seawater intrusion. Total coliform, which is an indicator of disease-causing organisms, exceeds the standard in 13% of the confined wells.

Surface Water Resource	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Trophic State Index
Large Lakes					
Small Lakes					
Surface Water Resource	Dissolved Oxygen	Fecal Coliform	pH	Un-ionized Ammonia	Chlorophyll
Rivers	The only rivers in the basin are tidally influenced; these were not sampled as part of the freshwater network				
Streams					

Ground Water Resource	Arsenic	Cadmium	Chromium	Lead	Nitrate-Nitrite	Sodium	Fluoride	Total Coliform
Unconfined Wells								
Confined Wells								

**Note:** The gray segments of the pie charts represent the percentage of water resources that meet water quality standards. Blue segments represent the percentage that does not meet the standards. See the Definitions and Criteria pages for more information.

**For more information, contact:**

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## Surface Water Definitions and Criteria

Each indicator listed below was chosen because it has an applicable state criterion, found in *Criteria for Surface Water Quality Classifications, Rules 62-302 and 62-303, Florida Administrative Code (F.A.C.)*.

Indicators	Criterion/Threshold <sup>1</sup>	Designated Use
Fecal Coliform Bacteria	< 400 colonies/100 mL	Recreation
Dissolved Oxygen pH Un-ionized Ammonia Chlorophyll a Trophic State Index (TSI)	≥ 5 mg/L ≥ 6 and ≤ 8.5 standard units ≤ 0.02 mg/L ≤ 20 µg/L Color ≤ 40 PCUs, then TSI ≤ 40 Color > 40 PCUs, then TSI ≤ 60	Aquatic Life

<sup>1</sup> mL – milliliters; mg/L – milligrams per liter; µg/L – micrograms per liter; PCUs – platinum cobalt units

**Fecal coliform bacteria:** The single-sample threshold for fecal coliform is 400 colonies per 100 mL of water. These bacteria can enter water through the discharge of waste from mammals and birds, agricultural and stormwater runoff, and untreated human sewage. Fecal coliform bacteria may indicate that the water is contaminated by other disease-causing organisms.

**Dissolved oxygen (DO):** The state criterion for DO is a minimum of 5 mg/L to maintain healthy conditions for aquatic life. Lower levels do not affect human recreation. Algae and plants produce oxygen through photosynthesis. Oxygen is also dissolved in water by wind and wave action. Respiration by aquatic animals, decomposition, wastewater, stormwater runoff from urban streets or farmland, and failing septic tanks consume oxygen. Natural conditions—such as ground water from springs, water from swamps/wetlands, higher water temperatures, and calm and cloudy weather—can also decrease DO levels in waterbodies.

**pH:** The surface water criterion for pH is between 6 and 8.5 standard units. The pH scale, which ranges from 0 to 14, is a measure of the degree of acidity or alkalinity of a solution. Numbers below 7.0 indicate acidity; numbers above 7.0 indicate alkalinity. The midpoint of 7.0 on the pH scale represents neutrality—that is, a neutral solution is neither acidic nor alkaline. pH affects many chemical and biological processes in water, and aquatic organisms are adapted to a certain range of pH. When pH levels are outside this range, it causes stress to these organisms' physiological systems and can reduce reproduction. Changes in pH can be caused by atmospheric deposition (acid rain), geology, vegetation, and pollution.

**Un-ionized ammonia:** The threshold for un-ionized ammonia is ≤0.02 mg/L. This is calculated from total ammonia and adjusted for temperature, salinity, and pH. Ammonia occurs in different forms: water temperature and pH affect which form is predominant at any given time in an aquatic system. Un-ionized ammonia can be toxic to fish and invertebrates.

**Chlorophyll a\*:** The threshold for chlorophyll is ≤ 20 µg/L. Chlorophyll is the pigment that allows algae and plants to convert sunlight into organic compounds during the process of photosynthesis. Excess nutrients, such as nitrogen and phosphorus, can stimulate algal blooms. Excess algae sink to the bottom and decay, using up the oxygen that other plants and organisms require to survive. High concentrations of chlorophyll reduce water clarity and limit the light available to shallow-water ecosystems.

**Trophic State Index (TSI)\*:** TSI and chlorophyll are the primary measures used to assess nutrient impairment in a waterbody. There are two thresholds for TSI, based on the color of a lake. Dark water lakes with a mean color greater than 40 PCUs are impaired when their annual mean TSI exceeds 60. Clear and low-color lakes with a mean color less than or equal to 40 PCUs are impaired when their annual mean TSI exceeds 40. TSI is measured using chlorophyll, nitrogen, and phosphorus concentrations. A 10-unit increase or decrease in the index represents a doubling or halving of algal cells, respectively.

\* Both TSI and chlorophyll a are not standards, but thresholds used to estimate the impairment of state waters. These thresholds are used in the analysis of Status Network data, based on single samples within a basin at a predetermined time of the year. The analysis and representation of these data are not intended to infer the verification of impairment, as defined in Rule 62-303, F.A.C., in these waters.

## Aquifer Definitions and Criteria

The table below shows the thresholds for eight indicators regulated under drinking water standards.

Indicators	Criterion/Threshold	Designated Use
Arsenic	≤ 10 µg/L	Potable Water (Drinking Water)
Cadmium	≤ 5 µg/L	
Chromium	≤ 100 µg/L	
Lead	≤ 15 µg/L	
Nitrate–Nitrite	≤ 10 mg/L	
Sodium	≤ 160 mg/L	
Fluoride	≤ 4 mg/L	
Total Coliform Bacteria (# /100 mL)	≤ 4 (sample maximum)	

**Arsenic, cadmium, chromium, and lead** are all naturally occurring metals in the earth's crust. These and other metals are used in manufacturing and can be produced and used in pesticides, preservatives, and industrial operations. They may enter water as a pollutant. Florida has primary standards (criteria) for these metals to protect human health. Excess levels in drinking water can cause adverse health effects.

**Nitrate–nitrite** is used in fertilizer and is found in sewage and wastes from human and/or farm animals. Florida's drinking water standard is 10 mg/L for nitrate and 1 mg/L for nitrite. In addition, to allow for the fact that the toxicity of nitrate and nitrite are additive, the standard for the sum of nitrate and nitrite is 10 mg/L. In the long term, nitrates and nitrites have the potential to cause serious adverse effects in humans.

**Sodium** (salt) has a drinking water standard to protect individuals who are susceptible to sodium-sensitive hypertension or diseases that cause difficulty in regulating body fluid volume. Sodium is monitored so that individuals on sodium-restricted diets may take the sodium in their water into account. Drinking water contributes only a small fraction (less than 10%) of an individual's overall sodium intake.

**Fluoride**, a natural element, is added to drinking water systems to reduce dental cavities. Prolonged exposure to levels above 4 mg/L may result in crippling skeletal fluorosis, a serious bone disorder. Lower levels may cause dental fluorosis when children are developing teeth. In its moderate and severe forms, dental fluorosis is a brown staining and/or pitting of the permanent teeth.

**Total coliform bacteria** are common in the environment and are generally not harmful. The presence of these bacteria in drinking water, however, is an indicator that disease-causing organisms may be present. The U.S. Environmental Protection Agency (EPA) and Florida have set an enforceable drinking water standard for total coliform of 4 counts per 100 mL to reduce the risk of adverse health effects. Drinking water that meets this standard is usually not associated with a health risk from disease-causing bacteria and is considered safe.

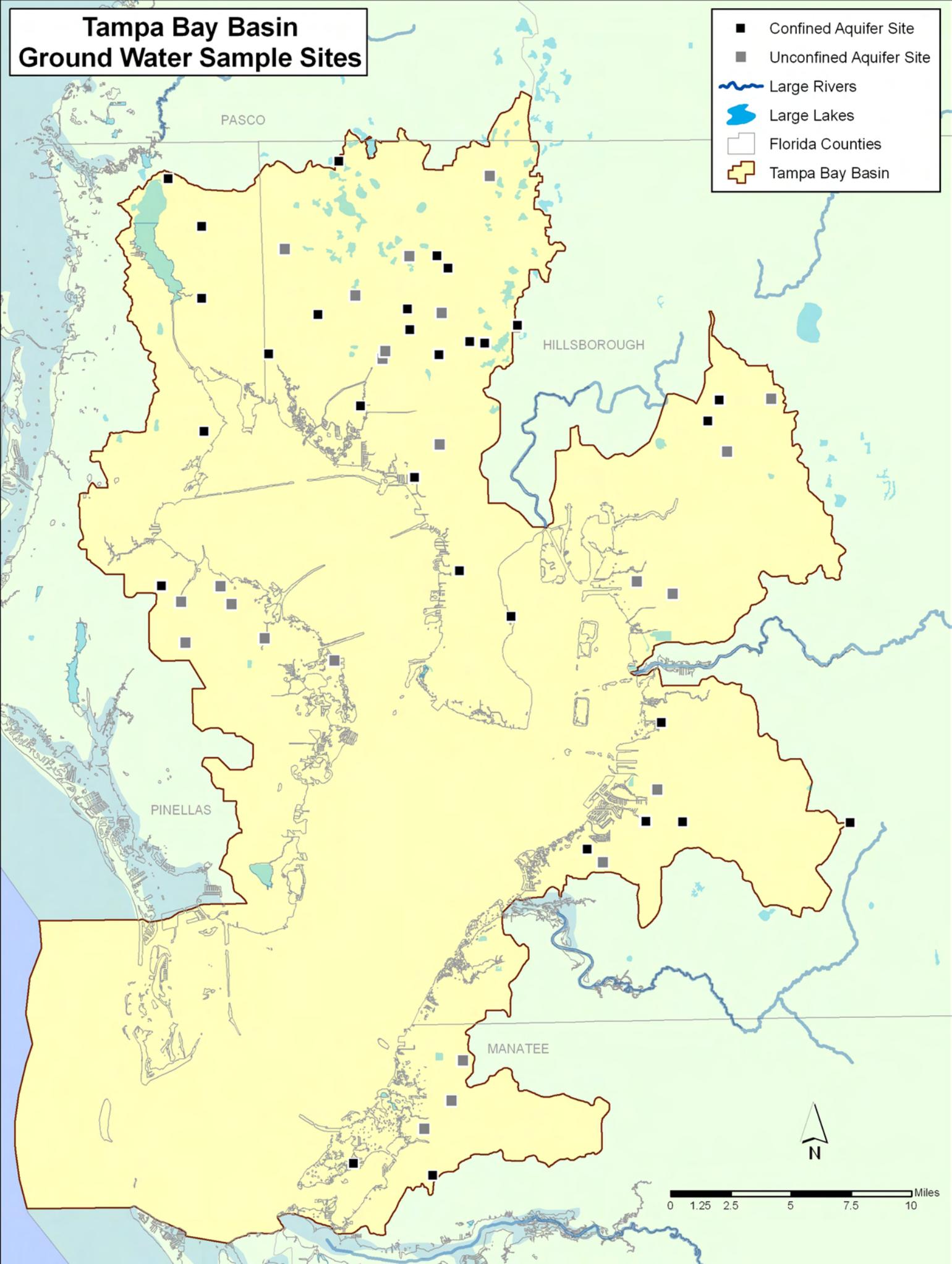
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## Data Management

Data management procedures and data quality objectives for the Watershed Monitoring Section's Status Monitoring Network are contained in two documents: [Data Management Standard Operating Procedures](#) and [Data Analysis Protocols for Cycle Two of the Status Network, Years 2004-2008](#).

# Tampa Bay Basin Ground Water Sample Sites

- Confined Aquifer Site
- Unconfined Aquifer Site
- ~ Large Rivers
- ~ Large Lakes
- Florida Counties
- ⊕ Tampa Bay Basin



# Tampa Bay Basin Surface Water Sample Sites

- Small Lake Site
- Large Lake Site
- ▲ Small Stream Site
- ◆ Large River Site (no resource)
- ~ Small Streams
- ~ Large Rivers (no resource)
- Large Lakes
- Florida Counties
- ⊕ Tampa Bay Basin

