Florida Springs Initiative Monitoring Network Report and Recognized Sources of Nitrate

February 2010

Prepared by Debra Harrington, Gary Maddox, P.G., and Richard Hicks, P.G.

Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
Ground Water Protection Section

Acknowledgements:

The authors would like to acknowledge contributions made to this report by Connie Bersok and Kathryn Holland, Springs Initiative Section, for their suggestions and edits; Jing Wang and Teayann Tinsley, Ground Water Protection Section, for assistance in management of springs data and in performing data assessments; and to Linda Lord, Watershed Planning and Coordination Section, for her assistance in developing the report template. Many thanks also to those who provided review comments on the draft document.

For more information on the water quality assessments and data used in the development of this report, please contact:

Debra Harrington
Email: Debra.Harrington@dep.state.fl.us
Phone: (850) 245-8232

For more information on the Springs Initiative Monitoring Network and discharge measurements used in the development of this report, please contact:

Gary Maddox
Email: Gary.Maddox@dep.state.fl.us .
Phone: (850) 245-8511

For more information on the Recognized Sources discussion, please contact:

Richard Hicks
Email : Richard.W.Hicks@dep.state.fl.us
Phone : (850)245-8229

Correspondance to the authors can be mailed to:

Florida Department of Environmental Protection
Ground Water Protection Section
2600 Blair Stone Rd. MS 3575
Tallahassee, FL 32399-2400

EXECUTIVE SUMMARY

The statewide Springs Monitoring Network began in 2001 when the Florida Legislature first provided funding for the Florida Springs Initiative. The purpose of this report is to provide a summary of the first 5 years of monitoring water quality and spring discharge by the Florida Department of Environmental Protection (FDEP). Data available for this report were collected from 2001 through 2006.

The Spring Monitoring Network currently includes quarterly water quality monitoring (at 49 spring vents and 9 underwater conduits that feed springs) and discharge monitoring (at 35 stations near springs). This is the most comprehensive spring water quality monitoring and measurement network in the state and provides information for all of Florida's first magnitude springs and many other springs that are located in state parks. This assessment provides baseline data on general chemistry and discharge that can be used to evaluate influences due to salinity, interaction with surface water, recharge, and discharge. Analysis of these data show some interesting observations related to the impact of human activities on the springs.

Currently, nitrate enrichment stands out as the most pressing issue because of the ecological impacts to spring systems. As of January 2010, 14 springs/spring groups and 10 waterbodies deriving their flow from springs have been identified by FDEP as impaired because of nitrate enrichment. A section of this report is dedicated to evaluating and identifying the sources of nitrate that are causing adverse effects in several of these spring systems.

Key findings of this report are summarized below.

Nutrients

- The introduction of nitrogen is the most obvious stressor to the ecology of springs in Florida, stimulating profuse overgrowth of algae and causing imbalance in ecosystems of spring runs.
  - Primary anthropogenic sources are fertilizer, animal waste, human wastewater, and atmospheric deposition of air emissions;
  - Of the 49 network springs, today only Alexander and Silver Glen Springs (located in the Ocala National Forest) continue to have nitrate concentrations that are near the range of what would be considered true background levels. Detectable nitrate concentrations in springs in remote areas may provide evidence that atmospheric deposition of nitrogen exists as a measurable source;
  - Over 40 percent (21 of 49) of the springs in the network have nitrate median concentrations greater than 1 mg/L. Springs in the network that have the highest nitrate concentrations include Fanning, Troy, Lafayette Blue, Manatee, and Devils Ear (of the Suwannee River Basin Group), Apopka and Rock Springs (of the Middle St. Johns River Basin), Jackson Blue (of the Apalachicola-Chipola River Basin Group) and Lithia Major (of the Tampa Bay Tributaries Basin);

  - The springs with the highest nitrate concentrations are in agricultural areas or areas with a mixture of agricultural and residential development;
  - In 2008, FDEP proposed a nitrogen threshold of 0.35 milligrams per liter (mg/L) for nitrogen in clear water streams, including spring vents (applicable to nitrate and nitrate+nitrite). Based on median nitrate+nitrite values, 36 of the 49 network springs (73 percent) exceed this proposed threshold.
- Phosphorus, the other nutrient essential to aquatic ecosystems, is found at relatively high concentrations in most of the springs due to its natural abundance in ground water.
  - The Hawthorn Group, a geologic unit naturally rich in phosphate and the source of phosphate that is mined in other parts of the state, is in contact with the limestone of the Upper Floridan aquifer, the source of water to nearly all springs in Florida. As a result, both ground water and spring water in all of these areas (except in the Panhandle where the Hawthorn Group is absent) have moderate to high concentrations of orthophosphate, the inorganic form of phosphorus found in these geologic materials;
  - Research has shown that phosphorus does influence algal growth, particularly in concentrations greater than 0.090 mg/L. However, the naturally elevated background concentration in many springs makes it difficult to determine if anthropogenic sources contribute appreciably to phosphorus in springs.
- Potassium, another nutrient evaluated in this report, can come from either anthropogenic or natural sources. However, an analysis of the data indicates that several springs in the network contain potassium concentrations that are from fertilizer or other human-related sources. Research has not shown that potassium alone is a cause of impairment in springs.

Salinity Indicators

- Twenty-five percent (12 of 49) of the springs in the network are significantly influenced by natural sources of saline water. Sodium, chloride, potassium, sulfate, and specific conductance are all chemical indicators of salinity. There are two categories of saline influenced springs based on the source of water:
  - Most of the springs in the network that are located in the Springs Coast Basin of southwest Florida are influenced by salinity to varying degrees due to their proximity to the coast and sea water. These include the Homosassa and Chassahowitzka Springs Groups, among others. The Spring Creek Springs Group of the Ochlocknee-St. Marks Basin are similarly influenced by sea water because of their coastal setting;
  - Another saline influence - deep naturally mineralized ground water in areas near the St. Johns River and in southwestern Florida - is responsible for the saline characteristics of network springs like Salt, Alexander, Volusia Blue and several others.

Ground Water-Surface Water Interaction Indicators

- Some chemical characteristics of spring water can be used to evaluate the sources of water being discharged by springs and their potential vulnerability to surface sources of contamination:
    - Concentrations of analytes such as dissolved oxygen (DO), calcium, sulfate, total dissolved solids, organic carbon, and fecal coliform bacteria can be used to identify springs that may at times have a surface water component (ones that are readily recharged by rainfall) as compared to springs which discharge from deeper, stable ground water sources;
    - Jackson Blue, Rainbow, Fern Hammock, and several other springs have water quality characteristics that suggest they are readily recharged by rainfall and could be highly vulnerable to nearby surface inputs;
    - Springs in the Spring Creek Group are among a subset of springs that often backflow, receiving and later discharging surface water;
    - Springs like Wekiwa and Volusia Blue appear to be discharging water that includes a significant component of deeper, more mineralized ground water. However, the elevated nitrate concentrations in both of these indicate that they are still vulnerable to contamination from surface sources.

Discharge

- Climatic and/or human influences have reduced the discharge of many springs and caused some springs to cease flowing:
    - The value in measuring discharge is that it provides direct information related to the effects of precipitation and ground water withdrawal from springs in susceptible areas;
    - Several examples in the report provide information on long-term trends of discharge relative to other factors. The long historical record for Silver River was used in this report as an example of changes in spring discharge in Silver Springs and the possible causes. Other springs will be included in this type of analysis in the future;
    - Discharge data are also essential when pollutant loads to receiving surface waters are being calculated. As more discharge measurements are made under this program, it will be possible to more thoroughly analyze the impacts of precipitation and water usage on spring flow and water quality.

Recognized Sources of Nitrate in Springs

- Several nutrient-impaired springs in representative areas of the state were evaluated in this report to help understand the range of potential and recognized sources of nitrate causing their impairment. These included Wakulla Spring, Troy Spring, Fanning-Manatee Springs, Ichetucknee Springs Group, Silver Springs Group, Rainbow Springs Group, Wekiva-Rock Springs Group, Volusia Blue Spring and Weeki Wachee Spring.

- Overall, the application of inorganic fertilizers to agricultural lands (row and field crops, hay and silage, and pasture); lawn and turf; and nursery plants provides the most significant per-acre potential for nitrogen inputs to ground water and springs. Recommended fertilization rates published for specific uses (e.g., crops, turf grass) may underestimate actual amounts applied in the more vulnerable spring areas. Soil in these areas has very low fertility and is very permeable. Therefore, fertilizer may need to be re-applied to compensate for nitrogen losses due to leaching and/or denitrification that occur after heavy precipitation:

    - Fertilizer appears to be a significant source of the nitrate at most of these springs. Inorganic fertilizer is the main source of nitrate causing impairment of Jackson Blue Spring and the Rainbow Springs Group and a very significant component in several of the other springs, based on nitrogen isotope data and land use information.

- Application of animal waste to pasture or agronomic crops is a viable means of managing these materials. However, large animal feeding operations (such as poultry farms and dairies) may be challenged by the sheer volume of waste generated by these operations, and the disposal of these wastes in a manner that will maximize nitrogen uptake. Annual volumes of manure generated by dairies and poultry operations are very significant (50,000 lb/yr per cow and 4,000 lb/yr per 1,000 chickens):

    - In two of the springsheds assessed, Troy and Fanning-Manatee, animal waste was a significant source of nitrate in the nutrient-impaired springs, based on nitrogen isotope data and land use information. According to FDEP data, there are 23 poultry farms in the Troy Spring springshed and 8 dairy farms in the combined springshed of Fanning and Manatee Springs.

- Domestic wastewater (reclaimed water) discharged to ground water by wastewater facilities has the potential of contributing significant nitrate loads to springsheds. This is particularly true where there are concentrated areas of residential development in the more vulnerable areas near springs. Domestic wastewater plants can discharge large volumes of treated wastewater to ground water. While nitrogen concentrations are reduced by treatment and land application processes, significant loading of nitrogen to ground water may still occur:

    - In the Wakulla Springs springshed, domestic wastewater from a municipal sprayfield has been proven to be the major source of nitrate causing nutrient impairment of the spring;

    - In the Wekiva-Rock Springs springshed, there are many domestic wastewater facilities that discharge treated water to ground water via sprayfields, rapid infiltration basins and irrigation water to golf courses and other sites. The large volume of wastewater applied by some of these facilities is likely to be contributing to nitrate loading in area ground water and springs.

- Residential land use within more vulnerable areas of springsheds are sources of nitrate in the ground water and springs:

- Higher-density residential areas in which the homes are on individual septic tanks can produce significant inputs of nitrate to ground water. In the springshed of Weeki Wachee Spring, a large area of medium-density residential development on septic tanks produces inputs of nitrate from both septic systems and fertilizers applied to lawns and golf courses. These are considered the primary sources of nitrate causing nutrient impairment of the spring;
- A similar scenario also applies to much of the Wekiva-Rock Springs springshed, which includes large areas of residential development on septic tanks.

- Atmospheric deposition is a source of nitrogen loading to ground water, particularly where ground water is more vulnerable or where there is less vegetative uptake of nitrogen before it leaches into the aquifer. Atmospheric deposition is considered the source of low levels of nitrate found in background springs located in remote areas.

Recommendations

The following are recommended future actions:

- Update the existing springs monitoring plan to better define objectives and establish a well designed network to address specific issues;.
- Include information on ecological effects associated with nitrate enrichment, in addition to water quality and flow;
- Evaluate the existing quarterly monitoring network of springs to potentially include other priority springs that may have issues, provide information from under-represented regions of the state, conduct trend and strategic monitoring, and integrate springs monitoring and restoration with other initiatives within FDEP;
- Collaborate with other organizations that also conduct springs monitoring in order to integrate, to a greater degree, assessments of discharge data in annual reporting; explore the collection of data and information on a larger number of priority springs; and develop consistency in naming conventions and GIS locations for spring monitoring stations.

Table of Contents

List of Figures

List of Tables

INTRODUCTION

Objective

The statewide springs monitoring network began in 2001 when the legislature first provided funding for the Florida Springs Initiative. The purpose of this report is to provide a summary of the first 5 years of monitoring water quality and spring discharge by the Florida Department of Environmental Protection (FDEP). Data available for this report were collected from 2001 through 2006.

Springs Initiative Research and Monitoring Program

The deteriorating condition of springs in Florida was recognized in 1999 by the Governor and FDEP Secretary who directed the formation of a multi-agency Springs Task Force to recommend strategies to protect and restore springs. The task force produced a report, *Florida's Springs: Strategies for Protection and Restoration*, which identified existing problems in Florida's spring systems and produced recommendations for specific steps to address them. The 2001 Florida Legislature provided the initial funding for the Florida Springs Initiative. Since then, the program has used annual appropriates to focus on three broad areas: education and outreach; protection and restoration; and research and monitoring.

The Springs Task Force recommendations led to a variety of research and characterization activities to better understand spring systems, their relationship to the geology and land uses in their capture areas, their water quality, and their discharge. The 2007 springs program update, *2007 Florida Springs Initiative Program Summary and Recommendations,* contains information on the research and monitoring activities performed since the program began. This document can be found at http://www.dep.state.fl.us/springs/reports/files/FSIreport2007FINAL.PDF. The spring water quality and discharge monitoring program described in this report was developed and implemented in response to the Springs Task Force recommendations.

BACKGROUND

Florida Springs

Florida is one of the few places in the world with natural limestone springs and is unique in having the greatest number of first magnitude springs (large springs with discharges historically greater than 100 cubic feet per second). Thirty-nine of Florida's 67 counties have springs, or include areas of land that contribute water to springs (known as springsheds). These 39 counties comprise roughly half of the state's land area. Springs exist in four of the state's Water Management Districts and four of the FDEP regulatory districts. In addition to providing a unique recreational resource, our springs provide important base discharge to rivers and streams, freshwater to estuaries, and critical habitat to plants and animals that are unique to springs. The distribution of springs in Florida is shown in **Figure 1**.

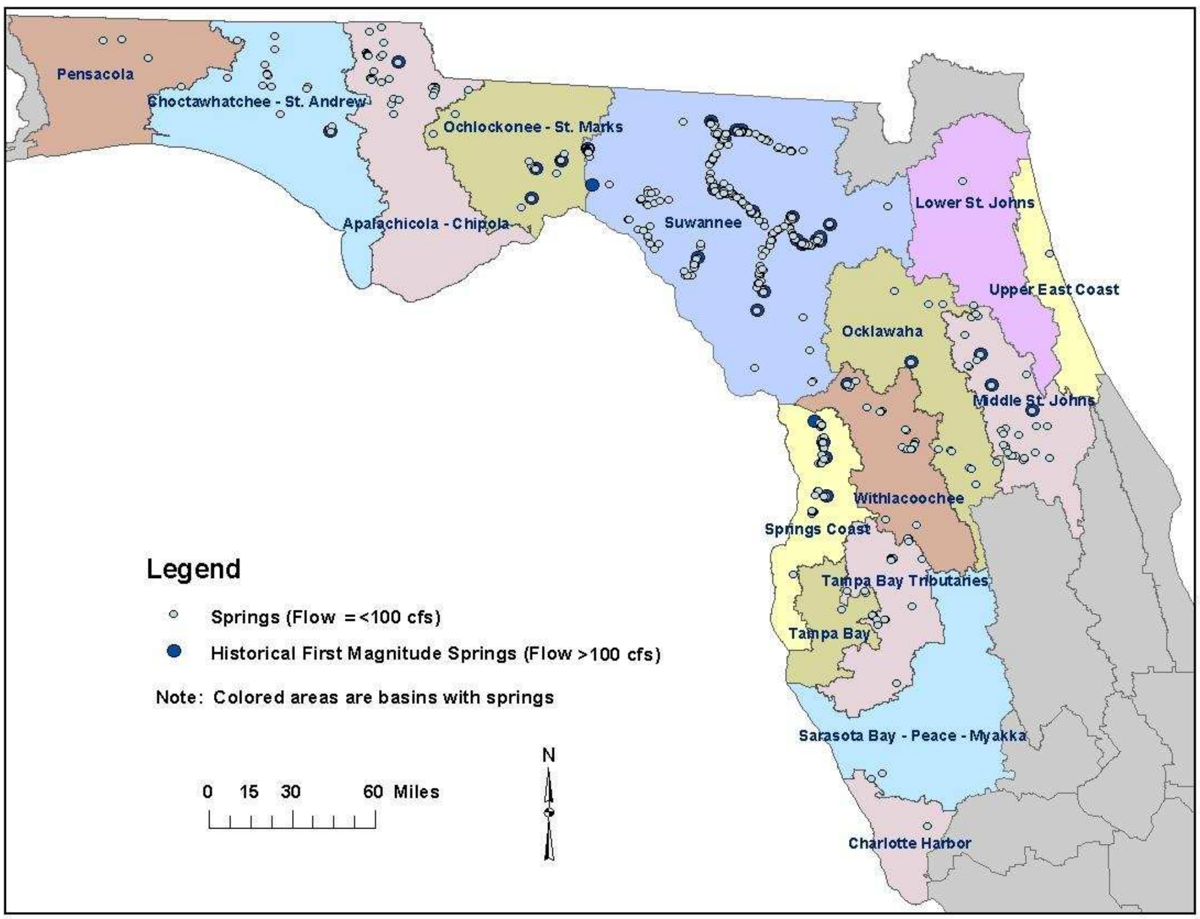


Figure 1: Distribution of Springs in Florida

Between 1950 and 2000, Florida's population has increased five-fold (U.S. Census Bureau, 2005). With growth has come an unavoidable increase in ground water withdrawals, as well as extensive land use changes. During the twentieth century, reductions in discharge have been noted for many of Florida's springs. Incompatible land use practices in vulnerable areas along with increasing ground-water withdrawals have resulted in some springs that have poor water quality or decreased discharges. Since the 1970s, scientists have observed degrading water quality in many of Florida springs, which in many cases may be related to increases in nutrient loadings, specifically nitrogen. Contaminants that reach ground water and are discharged by springs are often related to agricultural and residential fertilizer applications, animal waste, urban stormwater runoff, and human wastewater from septic tanks and wastewater sprayfields.

Spring Issues

Over the years, people who live near springs and visit springs have seen them degrade, in some places due to changes in the amount of water discharged and in others due to algae growth and decreased biological diversity that may stem from degraded water quality. The condition of many springs has also been physically degraded because of poor land management practices or overuse.

Ecological Imbalances Caused by Nutrients

Spring water is generally a composite of mainly ground water and a smaller contribution of water from the surface, depending on the spring. If water from the surface enters the aquifer that is connected to a nearby spring, the water can move quickly through the aquifer and discharge at the spring vent (United States Geological Survey, 2009). Elevated concentrations of nutrients in water discharged from a spring vent can cause ecological imbalances in the spring system. In response to the nutrient enrichment, coupled with other factors, many spring openings (or vents) and their receiving waters have experienced abnormal and profuse growths of algae and/or aquatic vascular plants such as the invasive exotic plant *hydrilla*. This overgrowth may replace native plants and make spring runs less hospitable to fish, snails, crayfish, turtles and other animals that depend on the spring habitat. In some of the more profound examples, such as Silver Springs and Weeki Wachee Spring, algal mat accumulations can be feet in thickness. Nitrate-nitrogen (nitrate) is considered the main chemical indicator of nutrient enrichment of springs and nitrate concentrations have increased dramatically since the 1970s in many of the springs that have been sampled over the decades.

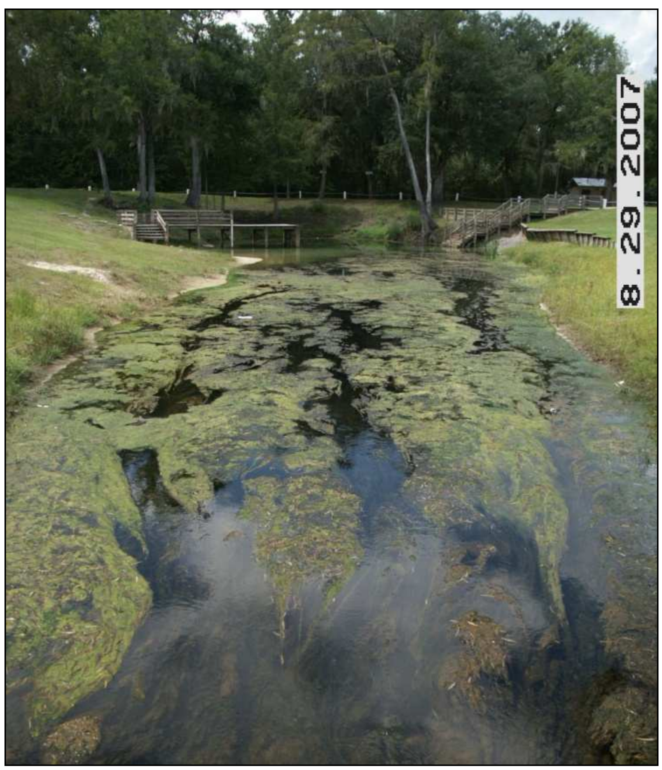
Excessive algal growth has been studied and is considered a “nuisance” in rocky streams when there is a >20% cover (Mattson 2009 pers. comm.). Periphyton (including benthic algae, filamentous algae, *Nitella sp.*, etc.) is commonly used to determine the percent of growth on the stream or creek bottom near springs. Excessive growth of periphyton can inhibit the growth of other submerged aquatic vegetation, which is considered the most important aquatic habitat for fish and other aquatic organisms. Ecosystem indices are used to demonstrate the impairment and include gross primary productivity, net primary productivity, system respiration rate and ecological efficiency.

One algal group of major concern for springs in Florida is the filamentous cyanobacteria, primarily in the genus *Lyngbya* (Stevenson et al, 2007). Studies have shown that, with increased nutrient loading to a waterbody, the cyanobacteria frequently respond most prolifically (Gao, 2008). Increases in *Lyngbya* biomass is a management issue in many Florida springs (Stevenson et al., 2004). The photographs in **Figure 2** show examples of excessive algal growth due to nutrient enrichment.

Biological studies in the past have suggested that excessive algal growth is linked to nutrients in many of our major springs. Laboratory experiments (Cowell and Dawes, 2004) and field studies (Hornsby et al., 2000) indicated that *Lyngbya* biomass and the biomass and diversity of the general cyanobacteria population increased with elevated nitrate concentration, especially when the nitrate concentration was higher than 0.30 mg/L. Field studies indicated that the percent biovolume of cyanobacteria in the algal community also increased with increased total phosphorus (TP) concentrations, especially when the TP concentration was higher than 0.090 mg/L (Potapova and Charles, 2005). However, there has still been uncertainty as to the linkage between algal growth and nutrient concentrations and researchers believe that other factors also contribute. A more recent study by microbiologists (Jennifer et al., 2008) also found that the dense blooms of *Lyngbya* are increasingly responsible for declining water quality and habitat degradation in springs; however it did not find any clear correlation between the presence of *Lyngbya* and ionic strength, inorganic nitrogen, phosphorus or average N/P ratios. Joyner et al. 2008 also mentioned that nutrients and sunlight levels may control the overall biomass but do not affect the distribution of the species that seems to be randomly introduced. They postulated that perhaps birds and humans (recreational swimmers and boaters) may be responsible for accelerating the dispersal of *Lyngbya* filaments.

FDEP is researching some spring specific assessment tools that involve different approaches than the Stream Condition Index (SCI), which was originally designed for freshwater, flowing streams. Springs frequently have lower dissolved oxygen and higher specific conductance than typical freshwater streams, which makes the SCI inappropriate to use. Some of the tools applicable to springs and spring runs include habitat assessment, hydrologic modification scoring, qualitative periphyton collection, rapid periphyton survey and linear vegetation survey.

a) Cyanobacteria (Blue-Green Algae) in Weeki Wachee (left) and Mission Springs (right)



b) Floating Algal Mats in Guaranto Spring

Figure 2: Explosion of Algal Growth in Springs

(Photo of Weeki Wachee and Mission Springs by Aga Pinowska; Guaranto Spring by Joe North; FDEP Bureau of Watershed Restoration).

Reduced Spring Discharges

The source of water discharged by springs in Florida is primarily the Upper Floridan aquifer, the underground limestone reservoir that many thought would provide unlimited amounts of water without adverse effects. Yet, in some areas, springs have stopped flowing or have experienced significant declines in discharge due to declining ground water levels. Declining ground water levels can also be accompanied by water quality changes in springs as they begin to pick up more of the characteristics of deep mineralized zones of ground water in inland areas or seawater in coastal areas. Decreasing spring discharge may also be accompanied by increases in the growth of algae, which could be somewhat related to an increase in available light in a shallower water column and subtle water quality changes.

Fluctuation in discharge of Florida springs is more easily understood when it can be observed over a long period of time. Unfortunately, only a handful of these springs have enough historical discharge data to provide information on long-term trends. The Silver Springs group in the Ocklawaha River Basin is an example that has enough data to evaluate long term changes in discharge, as measured in the Silver River just down river from the spring vents. The Silver River depends almost entirely on discharge from approximately 30 spring vents located along the upper mile of the river; therefore river discharge is approximately equivalent to the cumulative spring discharge. **Figure 3** shows the long-term trend of discharge in Silver River just below the cumulative spring vents (Station 02239501) along with precipitation and population trends. Over the period of measurement, discharge of the Silver River has decreased by more than 250 cubic feet per second (cfs). The net decrease in discharge over the last 56 years (shown with a trend line) reflects a discharge loss equivalent to two minimal first-magnitude springs.

Long-term discharge data for the Silver River show decreases in discharge that occurred in the 1950s, late 1960s and again in the early 2000s. The trends in precipitation and population growth are important keys in determining contributing factors in evaluating these decreases. Periods of low rainfall correspond with most of the time periods during which discharge went down. In particular, a lowering of discharge occurred during a severe period of drought in late 1998 to 2003. While there is only a slight decrease in the long-term precipitation trend, the precipitation data indicate fewer significant episodic events of over 12 inches of monthly rainfall have occurred since the early 1980s. This illustrates the fact that episodic tropical precipitation events make significant contributions to ground water recharge and thus spring discharge.

Drought influence on discharge is amplified by ground water consumption. In fact, increased ground water withdrawals coincident with population growth can be an even more significant factor affecting spring discharge during periods of drought. In some areas of central and southwest Florida, the withdrawals to meet demands of growth on top of drought conditions have caused severe ground water supply issues and could be influencing spring discharge. Discharge volumes from many Florida springs have significantly declined over time, and some have quit flowing altogether. Long-term withdrawals of ground water can lower water levels in the aquifer until there is no longer a sufficient pressure gradient to cause a spring to discharge.In these cases, a spring's discharge can gradually diminish, as in the case of White Springs (aka White Sulphur Springs) in Hamilton County, or the spring can suddenly

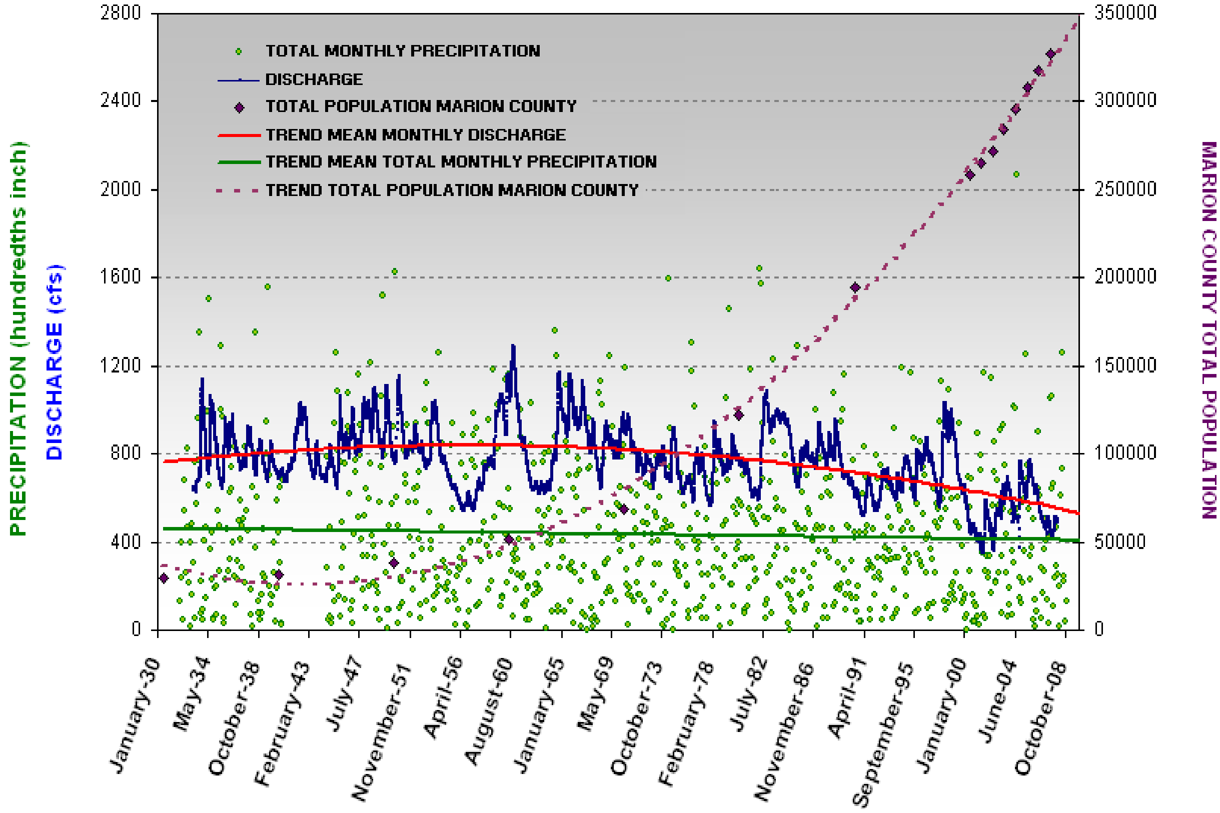


Figure 3: Trends in Silver River Discharge, Precipitation and Population in Marion County, Florida

stop flowing, as in the case of Kissengen Spring in Polk County. In addition, spring discharge can also be reduced or stopped by modifications to the spring pool, such as the construction of walls or dams, and in some cases intentional plugging of the spring vents.

Kissengen Spring was once a second-magnitude spring and a frequently-visited recreational site. It initially showed declining average annual flows and then three years later (1950) abruptly ceased flowing completely. Discharging at a rate as high as 43.6 cfs in 1933, Kissingen Spring had its discharge decline to a 40-year record low of 15 cfs and ceased discharging altogether in 1950. Kissingen Spring stopped flowing at a time when there was a major regional lowering of water levels in the Upper Floridan and intermediate aquifers that corresponded with ground water withdrawals by the phosphate industry (SWFWMD, 2002). Ground water withdrawals for agricultural and public supply needs may have also contributed to the decline of these ground water levels (Rosenau, 1977). **Figure 4** shows photographs of Kissengen Spring before and after it stopped flowing.

(a) Year 1923

(b) Year 2008

Figure 4: Historical and Recent Photographs of Kissingen Springs Site

Note: (a) photo from a postcard published in 1923 (State Archives of Florida); (b) photo taken in 2008 shows former spring pool now dry (Clint Kromhout, Florida Geological Survey).

In the rapidly growing Tampa Bay region, ground water withdrawals have significantly reduced water levels in the Upper Floridan aquifer. Examples of springs in southwest Florida that no longer consistently flow include Bobhill Spring in Hernando County; Palma Ceia , Purity, Eureka and Six Mile Creek Springs in Hillsborough County; Seven Springs in Pasco County; and Phillipi Spring in Pinellas County. The Suwannee River Basin has other stresses on the aquifer, which include withdrawals for agricultural irrigation, phosphate mining and paper mill process water. In the Suwannee River Basin, springs that essentially no longer flow include Pettis Spring in Madison County; Ewing Spring in Taylor County; and White Springs in Hamilton County.

SPRING DATA

Spring Monitoring Network

The current Florida Springs Water Quality Monitoring Network is a fixed-station network consisting of 49 spring vents (**Table 1**) and several wells that intersect underwater conduits. The spring vent data are discussed in this report. These stations represent 23 historical first-magnitude and 9 second-magnitude springs located in the basin groups of northwest, north-central, and central Florida (**Figure 5**). These springs were selected for monitoring because of their value as unique ecological and recreational resources. Most are located in state parks or are on other public lands.

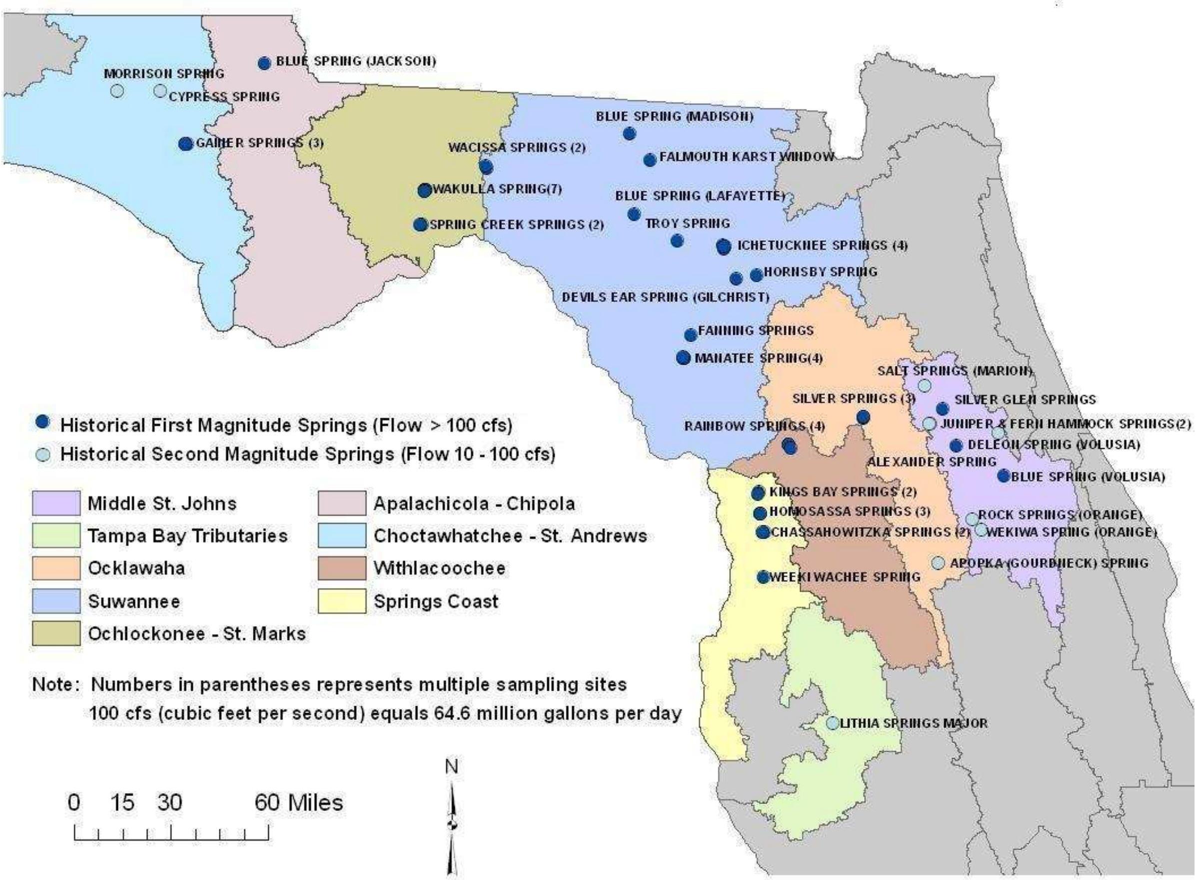


Figure 5: Quarterly Spring Monitoring Station Locations

Table 1: Spring Monitoring Network-Water Quality and Discharge Stations

STATION [1]	WATERBODY NAME	WATER QUALITY		DISCHARGE	
		SAMPLING EVENTS	PERIOD OF RECORD	SAMPLING MEASUREMENTS	PERIOD OF RECORD [2]
Apalachicola - Chipola Basin					
9674	JACKSON BLUE SPRING	21	2001-2006	19	01-2002 - 10-2006
Choctawhatatchee - St. Andrew Basin					
9700	MORRISON SPRING	21	2001-2006	6	07-2002 - 10-2006
9739	GAINER SPRING #1C	21	2001-2006	19	01-2002 - 10-2006 (Gainer Spgs Group)
9740	GAINER SPRING #2	21	2001-2006	19	01-2002 - 10-2006 (Gainer Spgs Group)
9741	GAINER SPRING #3	21	2001-2006	19	01-2002 - 10-2006 (Gainer Spgs Group)
11371	CYPRESS SPRING	12	2002, 2004-2006	14	10-2001 - 10-2006
Middle St. Johns Basin					
9670	ALEXANDER SPRING	21	2001-2006	10	10-2001 - 10-2006
9673	VOLUSIA BLUE SPRING	21	2001-2006	8	10-2001 - 10-2006
9687	SILVER GLEN SPRINGS	21	2001-2006	10	10-2001 - 10-2006
10786	SALT SPRINGS (MARION)	10	2004-2006	10	07-2004 - 10-2006
11390	DELEON SPRING (VOLUSIA)	11	2002, 2004-2006	10	07-2004 - 10-2006
11403	WEKIWA SPRING (ORANGE)	15	2002-2006	10	10-2002 - 10-2006
11456	FERN HAMMOCK SPRINGS	6	2002, 2005-2006	1	Oct-06
11463	JUNIPER SPRINGS	12	2002-2006	9	07-2004 - 10-2006
11479	ROCK SPRINGS (ORANGE)	11	2002, 2004-2006	10	07-2004 - 10-2006
Ochlockonee - St. Marks					
9692	SPRING CREEK RISE MAIN	18	2001-2006	0	n/a
9695	WAKULLA SPRING	21	2001-2006	17	01-2002 - 10-2006
9744	SPRING CREEK RISE #2	19	2001-2006	1	Oct-06
Ocklawaha Basin					
6989	APOPKA SPRING	10	2002-2006	0	n/a
9720	SILVER SPRING MAIN	21	2001-2006	2	07-2006 - 10-2006
9722	BLUE GROTTO SPRING	21	2001-2006	2	07-2006 - 10-2006
11395	RECEPTION HALL SPRING	14	2002-2006	1	Oct-06
Springs Coast Basin					
9704	HOMOSASSA SPRING #2	21	2001-2006	3	01-2005 - 10-2006 (Homosassa Group)
9705	HOMOSASSA SPRING #1	21	2001-2006	3	01-2005 - 10-2006 (Homosassa Group)
9706	HOMOSASSA SPRING #3	21	2001-2006	3	01-2005 - 10-2006 (Homosassa Group)
9707	CHASSAHOWITZKA SPRING MAIN	21	2001-2006	2	07-2006 - 10-2006
9708	CHASSAHOWITZKA SPRING #1	21	2001-2006	9	07-2004 - 10-2006
9709	HUNTER SPRING	21	2001-2006	1	Jul-06
9710	TARPON HOLE SPRING	21	2001-2006	0	n/a
9716	WEEKI WACHEE SPRING	21	2001-2006	4	04-2005 - 10-2006
Suwannee River Basin					
9671	LAFAYETTE BLUE SPRING	14	2001-2006	5	07-2004 - 10-2006
9672	MADISON BLUE SPRING	14	2001-2006	6	07-2004 - 10-2006
9677	DEVILS EAR SPRING (GILCHRIST)	17	2001-2006	2	07-2006 - 10-2006
9678	FANNING SPRINGS	15	2001-2006	7	10-2001 - 10-2006
9681	HORNSBY SPRING	3	2001, 2006	2	07-2006 - 10-2006
9683	MANATEE SPRING	17	2001-2006	9	10-2001 - 10-2006
9694	TROY SPRING	13	2001-2006	5	07-2004 - 10-2006
9713	ICHETUCKNEE HEAD SPRING (COLUMBIA)	18	2001-2006	6	07-2005 - 10-2006
9714	MILL POND SPRINGS (COLUMBIA)	10	2001, 2004-2006	6	07-2005 - 10-2006
9717	BIG SPRING (BIG BLUE SPRING) (JEFFERSON)	18	2001-2002, 2004-2006	9	07-2004 - 10-2006
9719	WACISSA SPRING #2	18	2001-2006	0	n/a
9743	BLUE HOLE SPRING (COLUMBIA)	18	2001-2002, 2004-2006	2	07-2006 - 10-2006
10499	FALMOUTH SPRING	3	2001, 2006	2	07-2006 - 10-2006
11386	MISSION SPRINGS	9	2001-2002, 2004-2006	2	07-2006 - 10-2006
Tampa Bay Tributaries Basin					
11383	LITHIA SPRING MAJOR	12	2002-2006	10	07-2004 - 10-2006
Withlacoochee Basin					
9699	BUBBLING SPRING	21	2001-2006	10	07-2004 - 10-2006
9701	RAINBOW SPRING #1	21	2001-2006	2	07-2006 - 10-2006
9702	RAINBOW SPRING #4	21	2001-2006	2	07-2006 - 10-2006
9721	RAINBOW SPRING #6	21	2001-2006	2	07-2006 - 10-2006

Note:

[1] Station Numbers refer to FDEP Springs Initiative Monitoring Network and OGWIS database.

[2] Period of record for quarterly manual discharge measurements may include data gaps.

Spring water quality samples are collected quarterly by a Florida Geological Survey (FGS) sampling team that is dedicated to springs monitoring. Most of these samples are collected from spring vents, but a few are collected from wells that intersect spring conduits. Chemical and field analytes collected routinely at each station on a quarterly basis are shown in **Table 2**. In addition to the core analytes, trace metals have been collected on a multi-year rotating basis.

Table 2: Spring Water Quality Sampling Analytes

Analytes included in quarterly monitoring		Analytes included in special surveys	
Calcium	D, T	Aluminum	D, T
Magnesium	D, T	Arsenic	D, T
Sodium	D, T	Barium	D, T
Potassium	D, T	Boron	D, T
Chloride	D, T	Cadmium	D, T
Sulfate	D, T	Cobalt	D, T
Fluoride	D, T	Chromium	D, T
Alkalinity as CaCO3	D, T	Copper	D, T
Nitrate + Nitrite	D, T	Iron	D, T
Ammonia	D, T	Manganese	D, T
Kjeldahl Nitrogen	D, T	Nickel	D, T
Total Phosphorous	D, T	Lead	D, T
ortho-Phosphate	D	Selenium	D, T
Specific Conductance	D	Tin	D, T
Organic Carbon	T	Strontium	D, T
Dissolved Solids	T	Zinc	D, T
Suspended Solids	T		
Turbidity	T		
Color	T		
Total Coliform	T		
Fecal Coliform	T		
Enterococci	T		
Water Temperature	X		
pH	X		
Specific Conductance/Salinity	X		
Dissolved Oxygen	X		
Secchi Depth	X /1		
Estimated Sample Depth	X		
Stage	X /1		
Discharge	X /1		

Notes:
T=total, unfiltered sample
D=dissolved, filtered sample
X=field measurement
/1=not collected at all stations

As part of the Springs Initiative Monitoring Program, the U.S. Geological Survey (USGS) is contracted to collect stage and/or discharge data at 35 stations near springs. **Table 3** contains a list of these sites and their pertinent data. Most of them are “real-time” sites, with up-to-the-minute data available online at http://waterdata.usgs.gov/fl/nwis/current/?type=discharge&group_key=NONE.

In addition, the program measures discharge to coincide with water quality sampling at some of the network springs. Spring stations with discharge data are shown in **Table 1**. Discharge is measured manually at these stations within 24 hours of water quality sampling. The FGS and

Table 3: Fixed Station Discharge Measurement Sites Associated with Springs

U.S. Geological Survey Station	Waterbody	Real-time Data Availability	Measurement Frequency	Period of Record
02358975 [1]	Jackson Blue Spring near Marianna	Yes	continuous	4/2003 – present
02327022 [1]	Wakulla River near Crawfordville	Yes	continuous	10/2004 – present
02327030 [1]	Spring Creek near Spring Creek	Yes	continuous	new gage
02327033 [1]	Lost Creek near Arran	Yes	continuous	1928-1981; 10/1988 – present
02326993 [1]	Fisher Creek near Tallahassee	Yes	continuous	new gage
02320250 [1]	Troy Spring near Branford	Yes	continuous	1942–1995; 1998; 3/2002 – present
02322685 [1]	Ichetucknee Head Spring	Yes	continuous	2/2002 – present
02322687 [1]	Cedar Head Spring	Yes	continuous	2/2002 – present
02322688[/1]	Blue Hole Spring	Yes	continuous	2/2002 – present
02322691[/1]	Mission Group	Yes	continuous	2/2002 – present
02322694[/1]	Devil's Eye Spring	Yes	continuous	2/2002 – present
02322695 [1]	Mill Pond Spring	Yes	continuous	2/2002 – present
02322698 [1]	Ichetucknee River at Dampier's Landing	Yes	continuous	2/2002 – present
02322699 [1]	Coffee Spring	No	7 measurements per year	2/2002 – present
02322700 [1]	Ichetucknee River at U.S. 27	Yes	continuous	2/2002 – present
02323502 [1]	Fanning Spring near Wilcox	Yes	continuous	1930-1998; 6/2001 – present
02323505[1]	Little Fanning Spring near Wilcox	no	7 measurements per year	
02323566[1]	Manatee Spring near Chiefland	Yes	continuous	1932-1998; 1/2001 – present
02310545[1]	Weeki Wachee River near Weeki Wachee	Yes	continuous	1984-85; 10/2000 – present
02310650[1]	Chassahowitzka Springs nr Homosassa Springs	Yes	continuous	1964-1978; 1985; 1988; 1997 – present
02310678[1]	Homosassa Springs near Homosassa	Yes	continuous	1931-33; 1936; 1956; 1961; 1963-1978; 1988-89; 10/1995 – present
02310747[1]	Crystal River at Bagley Cove near Crystal River	Yes	continuous	10/2002 – present
02236160[1]	Silver Glen Springs near Astor	Yes	continuous	11/2002 – present
02235500	Blue Springs near Orange City, FL	Yes	continuous	3/1932 – present
02239500	Silver River near Ocala, FL	Yes	continuous	10/1932 – present
02302000	Crystal Springs near Zephyrhills, FL	Yes	continuous	10/1934 – present
02306000	Sulphur Springs at Sulphur Springs, FL	Yes	continuous	1917, 1929, 1930-35, 1945-46, 1956 – present
02310660	Ruth Springs Run near Homosassa, FL	Yes	continuous	5/2006 – present
02310675	Hidden River near Homosassa, FL	Yes	continuous	1/1997 – present
02310690	Halls River near Homosassa, FL	Yes	continuous	10/2000-11/2003; 6/2006 – present
02312764	Gum Springs near Holder, FL	Yes	continuous	10/2003 – present
02313100	Rainbow River at Dunnellon, FL	Yes	continuous	1899; 1905; 1907; 1917; 1929 – present
02319302	Madison Blue Spring near Blue Springs, FL	Yes	continuous	1932; 1946; 1956; 1961; 1963; 1974; 1977; 1985; 1990-91; 1993; 1995-96; 1998; 2/2002 – present
02326900	St. Marks River near Newport	Yes	continuous	1956-1994; 7/1996 – present
02235000	Wekiva River near Sanford, FL	Yes	continuous	10/1931 – present

Notes: [1] - Funded by Springs Initiative the Northwest Florida Water Management District (NWFWMD) began collecting discharge measurements in July 2004, and since July 2006, the USGS has collected these data.

In addition to water quality and discharge measurements, quarterly to biannual bioassessments are performed in selected spring runs by the FDEP Environmental Assessment Section. These bioassessments include assessing riparian zone health, habitat description, biological sampling and limited water quality sampling. Reports on the biological assessments produced by the Environmental Assessment Section are available online from FDEP at http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp.

Quality Assurance

Water quality sampling procedures are outlined in the *Springs Initiative Monitoring Standard Operating Procedures*, which adhere to the FDEP standard operating procedures for sampling and analysis program activities (http://www.floridadep.org/labs/qa/sops.htm). All water quality samples collected through this effort are analyzed by the FDEP Central Chemistry Laboratory, a facility certified by the National Environmental Laboratory Accreditation Program.

Adherence to standard field protocols is verified by periodic internal and external field audits of the sampling program. These field audits are carried out by Springs Initiative staff, working with the Environmental Assessment Section. Assessment of field measurement accuracy is accomplished through internal (FDEP) and external (USGS) field reference sample programs. Formalized procedures for computerized and manual data review, developed for the FDEP Status Network, are also applied to spring monitoring program data.

Data Management

Water quality samples are tracked from the field to the laboratory via the FDEP Automated Data Management (ADM) program. Analytical results are transferred electronically from the FDEP Laboratory Information Management System (LIMS) to the FDEP Watershed Monitoring Section, where they are processed and merged with corresponding field data, and linked to the corresponding site data. Computerized accuracy and completeness checks are automatically run, in addition to a variety of other quality assurance checks. Data files are then manually checked using field sheets and results from the computerized reviews to identify obvious random or systematic errors.

After preliminary data review for a project is completed, a copy of the project file is transferred to the samplers for their review. A project review is completed and then the data are considered “release quality”, ready to be made available to the general public. The Springs Initiative network data used in this report are from 2001 through 2006.

Manual discharge data from quarterly sampling sites have been collected by FGS, NWFWMD and USGS staff. These measurements are performed using USGS standard operating procedures for collecting stream profile discharge. USGS fixed-station (“real-time”) discharge measurements are collected from automated stations using index-velocity or stage-discharge gages. Acoustic Doppler profiling sondes are used at some locations.

All field measurements and water quality data collected through the quarterly Springs Network are housed in the FDEP Oracle-based Generalized Water Information System (OGWIS). From here, data are periodically uploaded to Florida STORET and are also exported to Hydroport, a ground-water quality data retrieval and analysis tool currently under development. Data included in this report represents a subset that met the quality assurance standards for the program.

SUMMARY OF RESULTS FOR KEY ANALYTES

Nutrients

Nutrient over-enrichment causes the impairment of many surface waters, including springs. The two major nutrient groups monitored include nitrogen (N) and phosphorus (P). Nitrogen and phosphorus are essential nutrients to plant life, including algae. For aquatic vegetation and algae to grow, both nutrients have to be present. In fact, one can be present in excess but if the other is not present, overgrowth of vegetation or algae is not likely to occur. Historically, many spring systems have had sufficient phosphorus to cause an overabundance of plant growth but this was limited by very low concentrations of nitrogen.

Nitrogen is found in several forms and is ubiquitous in the environment. Nitrate (NO_3) is the form of nitrogen that occurs in the highest concentrations in ground water and springs. Nitrite-nitrogen (NO_2) is an intermediate form of nitrogen that is almost entirely converted to nitrate in the nitrogen cycle. While nitrate and nitrite are frequently analyzed and reported together as one concentration (nitrate+nitrite-nitrogen), the nitrite contribution is always insignificant. Historically nitrogen was only a minor constituent of spring water and typical nitrate concentrations in Florida were less than 0.2 mg/L until the early 1970s. Since then, nitrate concentrations of greater than 1 mg/L can be found in many springs. With sufficient phosphorus in the water column, seemingly low nitrogen concentrations can actually cause a significant shift in the balance of spring ecological communities, leading to the degradation of biological systems due to overgrowth of algae and sometimes aquatic plants.

Research into the relationship of nutrients to algal growth in springs has provided basis for some science-based values that can serve as thresholds. In an FDEP-funded study, Michigan State University researchers found that algal species reductions occurred at nitrogen concentrations below 0.591 mg/L for the algal genus *Vaucheria* spp. and below 0.250 mg/L for the more prevalent *Lyngbya wollei* (Stevenson et al., 2007). Another reference threshold was provided in documentation supporting spring run-related Total Maximum Daily Loads (TMDLs) for the Wekiva River and Rock Springs Run by FDEP (Gao, 2008). This Wekiva River/Rock Springs Run TMDL was based on a nitrogen threshold of 0.286 mg/L, established at a level that would reduce overall periphyton biomass concentration to an acceptable level. Another example of a nitrate threshold was used for the TMDL developed for the Suwannee River and several springs. This method employed a change point analysis that was performed to help understand the functional relationship between periphyton growth and nitrate concentration (Hallas and Magley, 2008). It provided a statistical analysis of the range of nitrate concentrations over which periphyton growth would occur. Based on the combined body of this research, FDEP has proposed a surface water standard for nitrogen in clear water streams (including spring vents) of 0.35 mg/L, which applies to both nitrate and nitrate+nitrite and is based on the FDEP assessment methodology using binomial statistics (set forth in Chapter 62-303.533, F.A.C).

Ammonia-nitrogen is seldom detected in spring water because of its tendency to transform degrade rapidly to other nitrogen forms. However, when detected, it can be an important indicator of sources of potential contamination. As organic nitrogen decomposes, it converts first to ammonia, then to nitrite plus nitrogen gas, and finally to nitrate. This process is shortened if the nitrogen is from an inorganic source like fertilizer or the atmosphere. The nitrification process can be incomplete in areas of poor drainage or high water-table conditions, in which case some ammonia can be transported to ground water and remain somewhat stable for a period of time.

Phosphorus, the other essential nutrient governing algal growth in aquatic systems, has a critical concentration that is much lower than the nitrogen threshold. Stevenson et al. (2007) found that when nitrogen was present at elevated concentrations, the phosphorus thresholds for *Vaucheria* spp. and *Lyngbya wollei* were 0.026 and 0.033 mg/L, respectively. Phosphorus in water can originate from natural sources, primarily phosphate-rich subsurface material. For the Wekiva River and Rock Springs Run TMDLs, the conservative phosphorus threshold was established at 0.065 mg/L (Gao, 2008). This target phosphorus threshold used by Gao (2008) was higher than what may be appropriate for other springs because the Wekiwa and Rock Springs are in the Middle St. Johns Basin where phosphorus concentrations are naturally elevated in the Upper Floridan aquifer. Anthropogenic sources of phosphorus include fertilizers, animal waste, human wastewater, biosolids, and industrial wastewater effluent. The tendency for phosphorus to leach to ground water at a particular application or disposal site is based on soil characteristics and phosphorus application rates. Phosphorus tends to readily adsorb to clay and organic material in soil and is more likely to be mobile in sandy soil or areas where the soil adsorptive capacity for phosphorus has been exceeded. However, inputs of phosphorus from anthropogenic sources affecting ground water and springs are not easily traced because a significant amount of phosphorus in ground water and springs comes from natural sources. Ambient phosphorus concentrations in ground water in the recharge areas or springsheds of springs are frequently higher than the algae-based thresholds offered by Stevenson et al. (2007).

Another major nutrient, potassium (K), occurs naturally under some conditions, but under others it can be an indicator of human impacts. Common inorganic agricultural fertilizers contain nitrogen, phosphorus and potassium (N-P-K) as their major components. Potassium can readily move through ground water and when nitrate and potassium concentrations are both elevated in spring samples, the source is often inorganic fertilizers. However, potassium can also be present from land application of manures and municipal wastewaters. The fate of potassium once it infiltrates to the ground water is controlled mainly by cation exchange where the affinity of geologic material for potassium is greater than for calcium, magnesium and/or sodium. Potassium is also a significant component of sea water, thus springs near the coastline or those discharging water from deeper mineralized ground water would be naturally high in potassium. Elevated potassium can serve as a good indicator of anthropogenic impacts where sea water influence is not an issue. In a following section of this report, the potassium–sodium (K-Na) ratio is discussed as a possible way to differentiate between natural and anthropogenic sources.

Nitrogen

The spring monitoring program includes data for ammonia and nitrate+nitrite, which are summarized in **Table 4**. The median values for nitrate+nitrite and ammonia for the entire 2001-2006 monitoring period are shown and compared to medians for 2006, the most recent complete year of data. Most springs have not had detectable concentrations of ammonia and the ones that did had ammonia at very low concentrations. Detectable concentrations of ammonia were found consistently (at low levels) in DeLeon and Volusia Blue Springs (Middle

Table 4: Ammonia and Nitrate+Nitrite in Spring Network (2001-2006)

BASIN & SPRING NAME	Ammonia (610)						Nitrate+Nitrite as N (630)					
	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	0.005	0.005	0.08	0.005	0.005	0.08	0.34	**3.3**	3.7	3	**3.35**	3.7
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	0.005	0.005	0.012	0.005	0.005	0.005	0.34	**0.36**	0.42	0.35	**0.375**	0.39
Gainer Spring #1C	0.005	0.005	0.038	0.005	0.005	0.005	0.15	0.18	0.24	0.18	0.195	0.2
Gainer Spring #2	0.005	0.005	0.035	0.005	0.005	0.005	0.18	0.23	0.25	0.21	0.23	0.23
Gainer Spring #3	0.005	0.005	0.015	0.005	0.005	0.005	0.19	0.2	0.21	0.19	0.21	0.21
Morrison Spring	0.005	0.005	0.005	0.005	0.005	0.005	0.15	0.165	0.19	0.15	0.16	0.17
Middle St. Johns Basin												
Alexander Springs	0.005	0.005	0.018	0.005	0.005	0.005	0.029	0.053	0.065	0.045	0.055	0.059
DeLeon Spring	0.012	0.041	0.092	0.027	0.0555	0.072	0.58	**0.99**	1.3	0.58	**0.795**	1.1
Fern Hammock Springs	0.005	0.005	0.015	0.005	0.005	0.013	0.078	0.0865	0.09	0.078	0.0845	0.088
Juniper Springs	0.005	0.005	0.012	0.005	0.005	0.005	0.073	0.089	0.094	0.089	0.0895	0.091
Marion Salt Springs	0.005	0.005	0.018	0.005	0.005	0.013	0.09	0.1	0.11	0.092	0.093	0.096
Rock Springs	0.005	0.005	0.013	0.005	0.005	0.005	1.3	**1.5**	1.8	1.3	**1.3**	1.6
Silver Glen Springs	0.005	0.005	0.022	0.005	0.005	0.005	0.046	0.049	0.055	0.046	0.0485	0.049
Volusia Blue Spring	0.005	0.005	0.096	0.005	0.0155	0.058	0.31	**0.645**	1.1	0.42	**0.61**	0.79
Wekiwa Spring	0.005	0.005	0.029	0.005	0.005	0.005	0.29	**1.4**	1.7	0.97	**1.035**	1.5
Ochlockonee - St. Marks												
Spring Creek Rise #1	0.005	0.038	0.091	0.058	0.058	0.058	0.018	0.14	0.27	0.23	0.23	0.23
Spring Creek Rise #2	0.005	0.0195	0.06	0.011	0.0355	0.06	0.016	0.17	0.27	0.016	0.103	0.19
Wakulla Spring	0.005	0.005	0.005	0.005	0.005	0.005	0.37	**0.69**	1	0.51	**0.555**	0.66
Ocklawaha Basin												
Apopka Spring	0.005	0.005	0.041	0.005	0.005	0.005	4.1	**4.55**	5.1	4.4	**4.5**	4.7
Blue Grotto Spring	0.005	0.005	0.07	0.005	0.005	0.038	1.3	**1.5**	3.2	1.5	**1.5**	1.7
Reception Hall Spring	0.005	0.005	0.029	0.005	0.005	0.005	1.2	**1.4**	2.6	1.4	**1.55**	1.6
Silver Spring Main	0.005	0.005	0.1	0.005	0.005	0.1	0.91	**1.1**	1.2	0.99	**0.995**	1.2
Springs Coast Basin												
Chassahowitzka Spring #1	0.005	0.005	0.005	0.005	0.005	0.005	0.49	**0.575**	0.65	0.53	**0.6**	0.63
Chassahowitzka Spring Main	0.005	0.005	0.014	0.005	0.005	0.005	0.43	**0.53**	0.61	0.51	**0.56**	0.57
Homosassa Spring #1	0.005	0.0155	0.028	0.01	0.0135	0.02	0.18	**0.51**	0.57	0.49	**0.51**	0.52
Homosassa Spring #2	0.018	0.0285	0.034	0.022	0.0335	0.034	0.43	**0.5**	0.53	0.45	**0.49**	0.51
Homosassa Spring #3	0.005	0.005	0.014	0.005	0.005	0.01	0.49	**0.54**	0.6	0.53	**0.53**	0.54
Hunter Spring	0.005	0.005	0.015	0.005	0.005	0.005	0.34	**0.39**	0.47	0.4	**0.41**	0.42
Tarpon Hole Spring	0.005	0.005	0.031	0.005	0.005	0.01	0.093	0.185	0.21	0.15	0.185	0.2
Weeki Wachee Main Spring	0.005	0.005	0.067	0.005	0.005	0.005	0.66	**0.765**	0.93	0.75	**0.765**	0.78
Suwannee River Basin												
Big Spring	0.005	0.005	0.029	0.005	0.005	0.005	0.1	0.165	0.19	0.16	0.17	0.18
Blue Hole Spring	0.005	0.005	0.08	0.005	0.005	0.005	0.51	**0.695**	0.79	0.72	**0.755**	0.79
Devil's Ear Spring	0.005	0.005	0.017	0.005	0.005	0.005	1.1	**1.6**	2	1.5	**1.65**	1.7
Falmouth Spring	0.005	0.005	0.005	0.005	0.005	0.005	0.39	**1.1**	1.1	1.1	**1.1**	1.1
Fanning Springs	0.005	0.005	0.037	0.005	0.005	0.005	3.7	**5.2**	6.3	4.8	**4.85**	5.5
Hornsby Spring	0.005	0.005	0.011	0.005	0.005	0.005	0.3	**0.48**	0.68	0.48	**0.58**	0.68
Ichetucknee Head Spring	0.005	0.005	0.015	0.005	0.005	0.01	0.66	**0.77**	0.84	0.74	**0.8**	0.83
Lafayette Blue Spring	0.005	0.0085	0.059	0.005	0.005	0.012	1.7	**2.2**	2.7	1.7	**2.3**	2.5
Madison Blue Spring	0.005	0.005	0.028	0.005	0.005	0.005	0.97	**1.5**	2	1.3	**1.5**	1.5
Manatee Spring	0.005	0.005	0.014	0.005	0.005	0.005	1.6	**1.8**	2	1.7	**1.8**	2
Mill Pond Spring	0.005	0.005	0.012	0.005	0.005	0.005	0.31	**0.46**	0.56	0.46	**0.52**	0.56
Mission Spring	0.005	0.005	0.005	0.005	0.005	0.005	0.37	**0.58**	0.64	0.58	**0.61**	0.64
Troy Spring	0.005	0.005	0.012	0.005	0.005	0.005	1.1	**2.2**	3	1.8	**2.2**	2.6
Wacissa Spring #2	0.005	0.005	0.012	0.005	0.005	0.012	0.24	**0.4**	0.47	0.34	**0.41**	0.43
Tampa Bay Tributaries Basin												
Lithia Springs Major	0.005	0.005	0.011	0.005	0.005	0.011	2.2	**2.9**	5.5	2.2	**2.8**	5.5
Withlacoochee Basin												
Bubbling Spring	0.005	0.005	0.018	0.005	0.005	0.011	1.1	**1.3**	1.5	1.4	**1.4**	1.5
Rainbow Spring #1	0.005	0.005	0.015	0.005	0.005	0.005	0.96	**1.35**	1.8	1.7	**1.75**	1.8
Rainbow Spring #4	0.005	0.005	0.013	0.005	0.005	0.005	1.3	**1.5**	1.9	1.7	**1.7**	1.7
Rainbow Spring #6	0.005	0.005	0.011	0.005	0.005	0.005	0.9	**1.1**	1.2	1.1	**1.1**	1.1

Values in red are higher than the Nitrate+Nitrite threshold of 0.35 mg/L proposed criterion

St. Johns River Basin), Spring Creek Rise #1 and #2 (Ochlocknee-St. Marks River Basin), Homosassa Spring #1 and #2 (Springs Coast Basin) and Lafayette Blue (Suwannee River Basin Group). DeLeon Spring and Spring Creek Rise #1 had the highest ammonia concentrations. Overall, ammonia concentrations for 2006 were essentially the same as the median values for the 2001 to 2006 period, which suggests that there are no significant trends in ammonia for the springs with detections.

As discussed previously, elevated nitrate-nitrogen is an issue for most of Florida's springs that have been sampled. A following section in this report includes a discussion on the recognized sources of nitrate in some of the more significantly impacted springs. **Appendices A** and **B** provide a summary of nitrate concentrations in all springs in Florida that have nitrate data and their locations. Depending on location, the nitrogen found in ground water and spring water has been found by isotope analyses to be from inorganic sources such as fertilizer, organic sources such as human wastewater or animal manure, or a combination of the two (Katz, 1999; Katz, 2005; Kendall, 1998). The network springs represent the majority of the springs in the state and their data indicate that elevated nitrate (expressed as nitrate+nitrite-total) is a widespread problem, as is shown by data from the network springs in **Figure 6**.

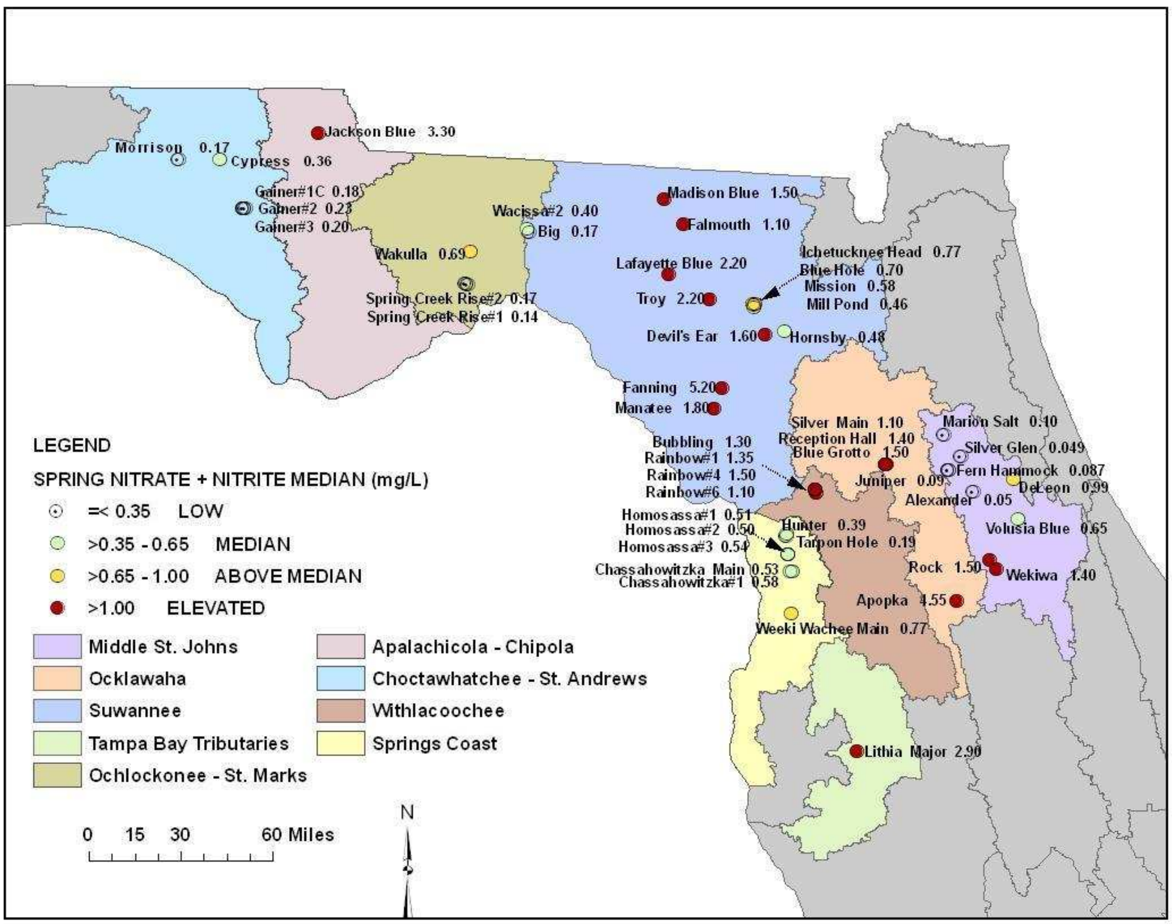


Figure 6: Median Concentrations of Nitrate+Nitrite in Spring Network (2001-2006)

Three benchmarks can be used to evaluate nitrate-nitrogen data in this report: the median value for all network springs, the proposed nitrate criterion for clear streams, and the natural background nitrate concentration. The median nitrate+nitrite concentration for all springs in the network combined was 0.65 mg/L. This median is almost twice as high as the proposed FDEP criterion of 0.35 mg/L. Based on the proposed standard, about two-thirds (almost 74 percent) of the network springs have median nitrate+nitrite concentrations high enough to promote algal growth problems.

The third benchmark is the nitrate-nitrogen concentration in background springs. In a pristine setting, the concentration of nitrate in a spring is at least an order of magnitude lower than the proposed nitrate standard of 0.35 mg/L. Based on data from multiple sources, there are presently only a small number of springs in the state with sufficient data that exhibit nitrate concentrations close to background conditions as shown in **Table 5**. The concentrations of nitrate+nitrite in these springs are believed to be primarily due to atmospheric deposition since they are mostly located in remote settings such as national forests or away from land use activities considered as nitrogen sources. Some springs previously considered as background springs have had increases in their nitrate concentrations to the point that they are no longer considered as such. This may be due to increases in atmospheric deposition of nitrogen from anthropogenic sources or to other factors such as nearby septic systems at campgrounds. More information on springs with background water quality with respect to nutrients can be found in **Appendix C**.

Only 2 of the 49 network springs (3 percent) have nitrate+nitrite concentrations that are at or below background when combining other sources of data with the network data. The lowest nitrate+nitrite concentrations for first and second magnitude springs included in the monitoring network (**Figure 6)** were found in the Ocala National Forest. Silver Glen, Fern Hammock, and Alexander Springs, all located in the Middle St. Johns Basin, have relatively lower nitrate-nitrogen concentrations due to their remote locations and the absence of regional sources of contamination. Other relatively lower concentrations are also found in the western panhandle in the Choctawhatchee River–St. Andrew Bay Basin Group with Cypress Spring, Morrison Spring and the Gainer Group. These lower concentrations correspond with land uses that include less agriculture and lower population density. Morrison and Cypress Spring are located in a dense gum and cypress forest. The Gainer Group is located where there are heavily forested lands, some in public ownership.

Jackson Blue, Fanning, Apopka and Lithia Major Springs are among the most nitrate-laden springs in the network, with nitrate+nitrite concentrations approaching 3 mg/L or higher. Of these, Fanning Spring has the highest nitrate+nitrite concentration. It is noteworthy that these three springs are located in areas that include agriculture and/or former agricultural areas undergoing urbanization.

Jackson Blue Spring (**Figure 6**), in the Chipola River Basin of the Apalachicola-Chipola River Basin Group, has the highest nitrate concentration of all first magnitude springs in the state, and thus provides the highest loading of nitrate to its receiving surface water, Merritts Mill Pond. The source area of Jackson Blue Springs includes areas of intensive farming in northern Jackson County and southern Alabama.

The Suwannee River Basin Group (equivalent to the area covered by the Suwannee River Water Management District) has more springs than any of the other basins and the nitrate+nitrite concentrations vary geographically across the area. Springs in the least-developed western part of the area have much lower nitrate+nitrite concentrations in

Table 5: Nitrate+Nitrite Concentrations in Background Springs with Available Data

Spring	Basin	County	Magnitude	Nitrate+Nitrite Median (mg/L)
Alexander Spring	Middle St. Johns	Lake	1	0.044
Beecher Spring	Middle St. Johns	Putnam	2	0.007
Clifton Springs	Middle St. Johns	Seminole	3	0.009
Copper Spring	Suwannee	Dixie	2	0.010
Green Cove Springs	Lower St. Johns	Clay	2	0.002
Mud Spring (Putnam)	Middle St. Johns	Putnam	3	0.022
Newport Spring	Ochlocknee – St. Marks	Wakulla	3	0.005
Orange Spring (Marion)	Ocklawaha	Marion	3	0.004
Satsuma Spring	Middle St. Johns	Putnam	3	0.007
Silver Glen Springs	Middle St. Johns	Marion	1	0.046
Snail Springs	Middle St. Johns	Lake	5	0.015
Sun Eden Spring	Ocklawaha	Lake	4	0.030
Suwannee Springs	Suwannee	Suwannee	2	0.020
Sweetwater Springs	Middle St. Johns	Marion	2	0.037
Waldo Spring	Suwannee	Taylor	3	0.007
Washington Blue Spring (Choctawhatchee)	Choctawhatchee–St. Andrew	Washington	2	0.027
Welaka Spring	Lower St. Johns	Putnam	3	0.034
Background Springs	**Overall Median**			**0.015**
Statewide Springs	**Overall Median**			**0.670**
First-magnitude Springs	**Overall Median**			**0.570**

Note:
Sources of data include FDEP, water management districts and the USGS. Springs in **BOLD** are included in the FDEP Spring Network. Background springs have nitrate-nitrogen levels < 0.05 mg/L.

comparison to many springs in the rest of the basin. Generally the northern, central and eastern regions of the area all have springs with elevated nitrate+nitrite concentrations (**Figure 6**). These regions include a significant amount of agricultural land uses, especially the Middle Suwannee Basin, which includes dairies, hay fields, row crops and poultry farms.

The Ocklawaha River Basin includes Silver Springs, a group of springs that has the largest aggregate discharge of all springs in Florida. Silver Spring Main, Reception Hall and Blue Grotto Spring are the main springs in the Silver Spring Group. These all have nitrate+nitrite concentrations greater than 1 mg/L and lie to the east of an urban area as well as numerous horse farms and other agricultural properties. Further south in the Ocklawaha River Basin is Apopka Spring (located in Lake Apopka), which has an elevated median nitrate+nitrite concentration of 4.55 mg/L. Apopka Spring is surrounded by a region of historically intensive agricultural land uses, including row crops, nurseries and citrus groves. Ground water in this area also has very high nitrate concentrations in localized areas.

The Rainbow Springs Group, in the Withlacoochee River Basin, consists of a cluster of spring vents in the northern portion of the basin. The Rainbow Springs Group includes multiple springs that have nitrate+nitrite concentrations greater than 1 mg/L. These springs create the headwaters of the Rainbow River which flows southward to the Withlacoochee River. Sources of nitrogen in this area include historical agricultural lands, large horse farms and thoroughbred training facilities, transitioning to smaller ranchettes and urban residential development.

The Springs Coast Basin includes eight springs in the network that are within the Chassahowitzka, Kings Bay, Homosassa, and Weeki Wachee spring groups. Seven of the network springs in the Springs Coast Basin have nitrate+nitrite concentrations that exceed 0.35 mg/L. Further to the south in the Tampa Bay Tributaries Basin, Lithia Major Spring, the furthest south of all springs in the network, has a nitrate+nitrite median of 2.9 mg/L. Agricultural and urban landscapes, including residential turf grass, ornamental plants, and golf courses, are past and present sources of the nitrogen in these basins.

Phosphorus

Phosphorus is measured as both total phosphorus and orthophosphate by the spring monitoring program. Total phosphorus consists of organic and inorganic fractions. The soluble inorganic form of phosphorus is orthophosphate. Since there is very little organic phosphorus in ground water, with few exceptions, only the inorganic form of phosphorus, orthophosphate, is found in springs. Orthophosphate is also the natural form of phosphorus found in geologic material and the form of phosphorus found in conventional fertilizers. Throughout much of Florida, the Miocene-age Hawthorn Group is a massive geologic unit that is naturally rich in phosphorus. This material lies on top of the porous and permeable limestone of the Upper Floridan aquifer in which most spring systems occur and it can provide a continuing source of phosphorus to the ground water.

The natural abundance of phosphorus varies across the state and as a result background ground water concentrations vary. **Table 6** provides a summary of median orthophosphate concentration in ground water of the surficial, intermediate and Floridan aquifer systems in the eight basin groups that have springs. The Suwannee, Ocklawaha, Middle St. Johns, Withlacoochee, and Tampa Bay Tributaries basins all have elevated concentrations of

Table 6: Summary of Background Orthophosphate Concentrations in Ground Water

Basin	Median Orthophosphate Concentrations in Aquifer Systems (mg/L) 1985-2006		
	Surficial	**Intermediate**	**Floridan**
Apalachicola-Chipola	0.275	0.1	0.04
Choctawhatchee-St. Andrew Bay	0.025	0.008	0.012
Middle St. Johns	0.049	0.105	0.067
Ochlocknee-St. Marks	0.025	0.05	0.0255
Ocklawaha	0.146	0.089	0.056
Springs Coast	0.116	N/A	0.027
Suwannee	0.066	0.092	0.061
Tampa Bay Tributaries	0.088	0.011	0.034
Withlacoochee	0.074	0.002	0.058

Note: Ground water data from the FDEP historical Background and current Probabilistic monitoring networks

orthophosphate in ground water from one or more aquifers, in comparison to the phosphorus thresholds proposed by Stevenson, et al. (2007). In the Suwannee River Basin Group, all three aquifers have elevated orthophosphate, with median concentrations as high as 0.092 mg/L. In the Middle St. Johns Basin, median orthophosphate concentrations in ground water were as high as 0.105 mg/L. Phosphorus is usually higher in the intermediate aquifer as shown in the data for most basins. The intermediate-aquifer wells are representative of ground water from the Hawthorn Group, which provides a significant source of orthophosphate.

Springs in the Suwannee River Basin Group and the Middle St. Johns River Basins had the highest orthophosphate concentrations, with many of them having phosphorus concentrations higher than the 0.03 mg/L median value as shown in **Figure 7**. A summary of median orthophosphate concentrations in the individual springs is provided in **Table 7**.

The springs in the network with the highest orthophosphate concentrations are Wekiwa, Rock, Hornsby, Volusia Blue, Fanning, Lithia Springs Major, Ichetucknee Group, DeLeon, Alexander, Lafayette, and Big Springs. Springs in the Choctawhatchee-St. Andrew Basin, similar to ground water, have low concentrations of phosphorus. Overall most spring orthophosphate concentrations in 2006 were relatively unchanged compared to median values for 2001-2006, so no significant trends are obvious for this 5-year period. Also, there is no obvious correlation between orthophosphate and nitrate concentration in these data (**Figure 8**).

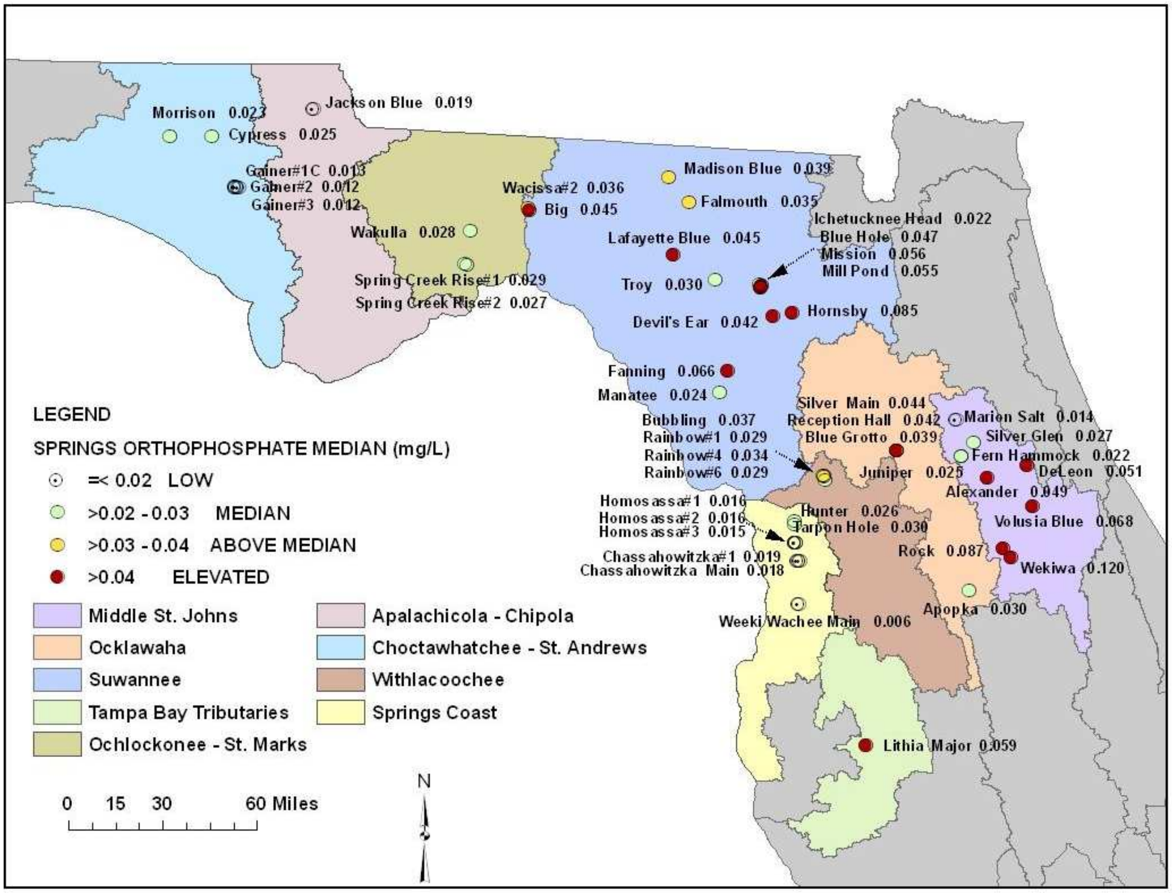


Figure 7: Median Orthophosphate Concentrations in Spring Network (2001-2006)

Table 7: Orthophosphate and Potassium in Spring Network (2001-2006)

	Orthophosphate (671)						Potassium (937)					
BASIN & SPRING NAME	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	0.012	0.019	0.022	0.012	0.014	0.017	0.25	0.3	0.36	0.3	0.32	0.36
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	0.023	0.0245	0.027	0.024	0.024	0.025	0.35	0.4	0.45	0.37	0.425	0.45
Gainer Spring #1C	0.01	0.013	0.015	0.01	0.011	0.013	0.23	0.27	0.37	0.27	0.285	0.33
Gainer Spring #2	0.01	0.012	0.016	0.01	0.011	0.012	0.23	0.26	0.34	0.23	0.3	0.34
Gainer Spring #3	0.002	0.012	0.014	0.009	0.0095	0.012	0.24	0.26	0.29	0.25	0.285	0.29
Morrison Spring	0.021	0.023	0.029	0.021	0.021	0.022	0.55	0.57	0.62	0.57	0.59	0.6
Middle St. Johns Basin												
Alexander Springs	0.043	**0.049**	0.052	0.049	**0.0495**	0.05	3.24	**3.7**	4.2	3.6	**3.785**	4
DeLeon Spring	0.036	**0.051**	0.065	0.047	**0.0505**	0.052	3.9	**4.8**	6.8	3.9	**4.05**	4.8
Fern Hammock Springs	0.022	0.022	0.033	0.022	0.022	0.024	0.25	0.265	0.32	0.25	0.27	0.32
Juniper Springs	0.019	0.0245	0.027	0.024	0.0245	0.026	0.24	0.26	0.32	0.26	0.29	0.31
Marion Salt Springs	0.01	0.014	0.015	0.01	0.0135	0.015	28.7	**37.4**	40.4	31.1	**36.2**	40.4
Rock Springs	0.082	**0.0865**	0.092	0.084	**0.0875**	0.092	1.2	**1.3**	1.4	1.3	**1.4**	1.4
Silver Glen Springs	0.022	0.0265	0.037	0.024	**0.0255**	0.028	7.2	**8.7**	9.4	7.2	**8.215**	8.8
Volusia Blue Spring	0.058	**0.068**	0.079	0.063	**0.0655**	0.069	3.9	**5.755**	8.6	4.7	**5.405**	7.7
Wekiwa Spring	0.088	**0.12**	0.13	0.1	**0.125**	0.13	1.58	**1.7**	1.74	1.6	**1.7**	1.74
Ochlockonee - St. Marks												
Spring Creek Rise #1	0.008	0.0295	0.035	0.032	**0.032**	0.032	10.9	**79.55**	229	39.2	**39.2**	39.2
Spring Creek Rise #2	0.016	0.027	0.033	0.025	**0.0265**	0.028	6.7	**35.5**	196	10.8	**96.4**	182
Wakulla Spring	0.014	0.028	0.034	0.016	**0.026**	0.03	0.5	0.56	0.69	0.55	0.61	0.69
Ocklawaha Basin												
Apopka Spring	0.01	0.03	0.032	0.022	**0.029**	0.032	1.00	**1.3**	1.8	1.3	**1.3**	1.35
Blue Grotto Spring	0.03	**0.039**	0.055	0.037	**0.0385**	0.055	0.59	0.63	0.73	0.63	**0.685**	0.73
Reception Hall Spring	0.034	**0.042**	0.046	0.036	**0.0365**	0.039	0.58	**0.66**	0.76	0.66	**0.685**	0.76
Silver Spring Main	0.03	**0.044**	0.049	0.042	**0.042**	0.043	0.52	0.58	0.68	0.56	0.575	0.58
Springs Coast Basin												
Chassahowitzka Spring #1	0.015	0.019	0.024	0.015	0.0165	0.019	1.21	**2.5**	5.8	2.2	**4.45**	5.6
Chassahowitzka Spring Main	0.014	0.018	0.022	0.014	0.0155	0.019	2	**7.6**	19.9	8	**15.95**	19.9
Homosassa Spring #1	0.013	0.016	0.022	0.014	0.014	0.015	14.2	**21.55**	30.3	19.2	**22.2**	26.9
Homosassa Spring #2	0.008	0.016	0.023	0.012	0.013	0.015	29.1	**35.7**	41.4	31.7	**37.35**	38.5
Homosassa Spring #3	0.01	0.015	0.021	0.013	0.013	0.013	4.1	**7.1**	12.9	4.3	**8.9**	11.6
Hunter Spring	0.017	0.026	0.03	0.017	0.022	0.025	0.67	**1.25**	2.1	1.3	**1.6**	1.7
Tarpon Hole Spring	0.014	0.03	0.035	0.024	0.0275	0.03	4.1	**9.3**	35.5	7.2	**14.15**	35.5
Weeki Wachee Main Spring	0.002	0.006	0.013	0.006	0.006	0.006	0.21	0.325	0.38	0.32	0.365	0.38
Suwannee River Basin												
Big Spring	0.041	**0.045**	0.057	0.041	**0.045**	0.047	0.35	0.415	0.6	0.41	0.445	0.46
Blue Hole Spring	0.038	**0.047**	0.053	0.039	**0.045**	0.047	0.29	0.35	0.48	0.34	0.355	0.41
Devil's Ear Spring	0.038	**0.042**	0.053	0.038	**0.0395**	0.041	0.4	0.43	0.52	0.41	0.455	0.5
Falmouth Spring	0.033	**0.035**	0.035	0.035	**0.035**	0.035	0.26	0.36	0.45	0.26	0.355	0.45
Fanning Springs	0.058	**0.066**	0.076	0.064	**0.0655**	0.066	2.4	**3.1**	4	3.6	**3.65**	4
Hornsby Spring	0.075	**0.085**	0.088	0.085	**0.0865**	0.088	1	**1**	1.1	1	**1.05**	1.1
Ichetucknee Head Spring	0.019	0.022	0.024	0.019	0.0205	0.023	0.075	0.14	0.22	0.14	0.17	0.18
Lafayette Blue Spring	0.04	**0.045**	0.061	0.042	**0.044**	0.047	0.84	**1**	1.3	1.1	**1.19**	1.2
Madison Blue Spring	0.03	**0.0395**	0.052	0.036	**0.037**	0.038	0.4	0.485	0.99	0.41	0.47	0.62
Manatee Spring	0.018	0.024	0.027	0.018	0.022	0.025	1	**1.1**	1.4	1.3	**1.3**	1.4
Mill Pond Spring	0.047	**0.055**	0.058	0.047	**0.0555**	0.057	0.5	0.56	0.71	0.56	0.62	0.65
Mission Spring	0.048	**0.056**	0.061	0.048	**0.055**	0.057	0.45	0.5	0.56	0.47	0.5	0.56
Troy Spring	0.024	0.030	0.059	0.026	0.029	0.03	0.79	**1.2**	1.57	1.1	**1.3**	1.57
Wacissa Spring #2	0.03	**0.036**	0.037	0.032	**0.0325**	0.037	0.38	0.42	0.5	0.39	0.465	0.5
Tampa Bay Tributaries Basin												
Lithia Springs Major	0.056	**0.0595**	0.064	0.06	**0.062**	0.064	0.78	**0.86**	1	0.79	**0.86**	0.87
Withlacoochee Basin												
Bubbling Spring	0.03	**0.037**	0.04	0.033	**0.034**	0.037	0.075	0.17	0.19	0.15	0.16	0.19
Rainbow Spring #1	0.022	0.029	0.034	0.024	**0.027**	0.029	0.055	0.12	0.16	0.055	0.115	0.14
Rainbow Spring #4	0.029	**0.034**	0.041	0.029	**0.0325**	0.034	0.055	0.13	0.18	0.055	0.13	0.18
Rainbow Spring #6	0.022	0.029	0.036	0.023	**0.027**	0.029	0.14	0.29	0.34	0.29	0.305	0.32

Values in red are higher than the Springs Initiative network median of 0.030 mg/L for phosphorus/orthophosphate and 0.63 mg/L for potassium.

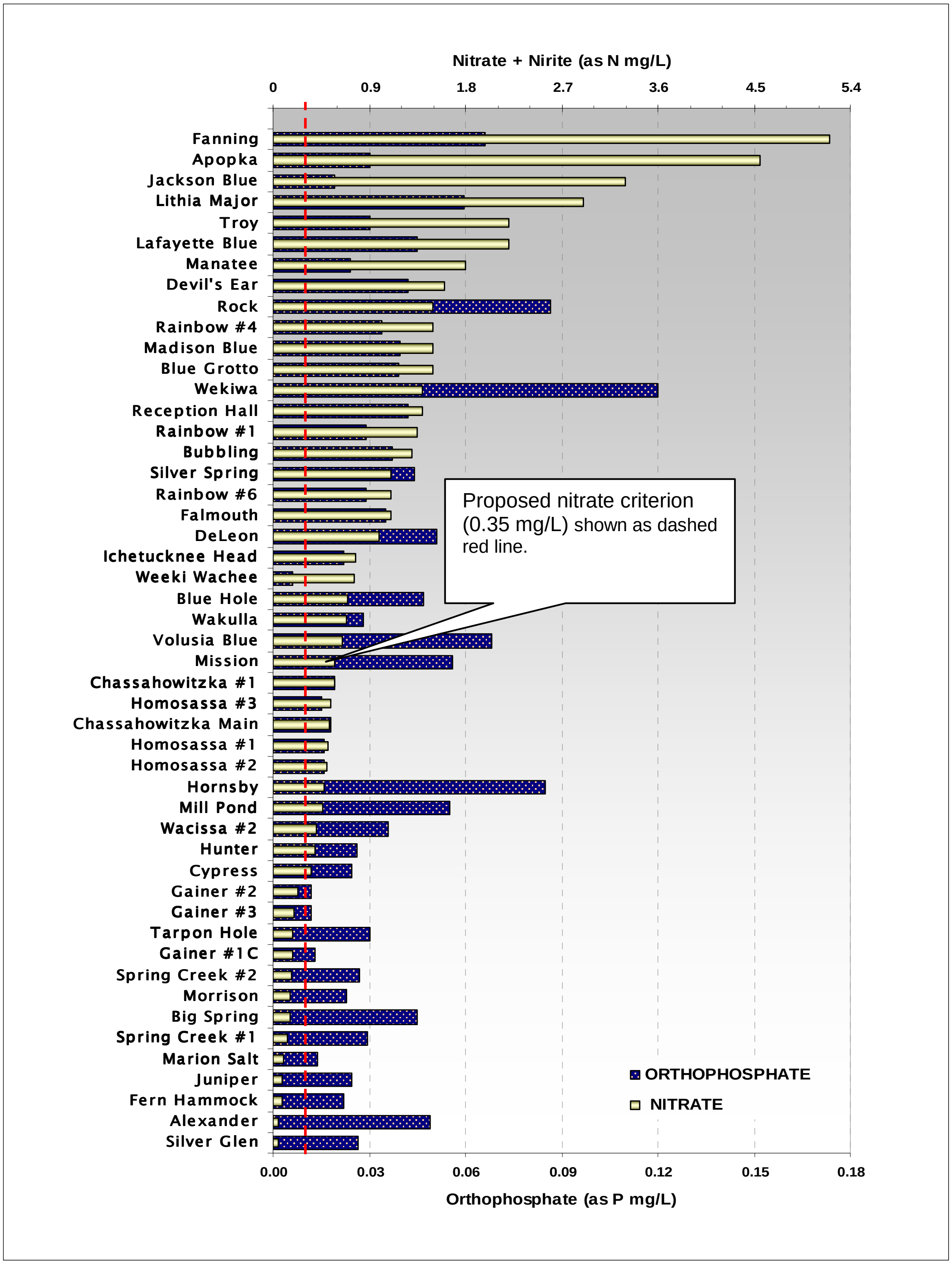


Figure 8: Nitrate and Orthophosphate in Network Springs (2001-2006)

Potassium

Potassium has been measured as total and dissolved potassium in the monitoring network. There was little difference between the results for dissolved and total forms in the descriptive statistics and this discussion refers to total concentrations. As discussed previously, potassium can serve as an indicator of either saline water influence or contamination from sources such as fertilizers. Median potassium values for the network springs are shown in **Table 7** and the distribution of potassium in the spring network is shown in **Figure 9**.

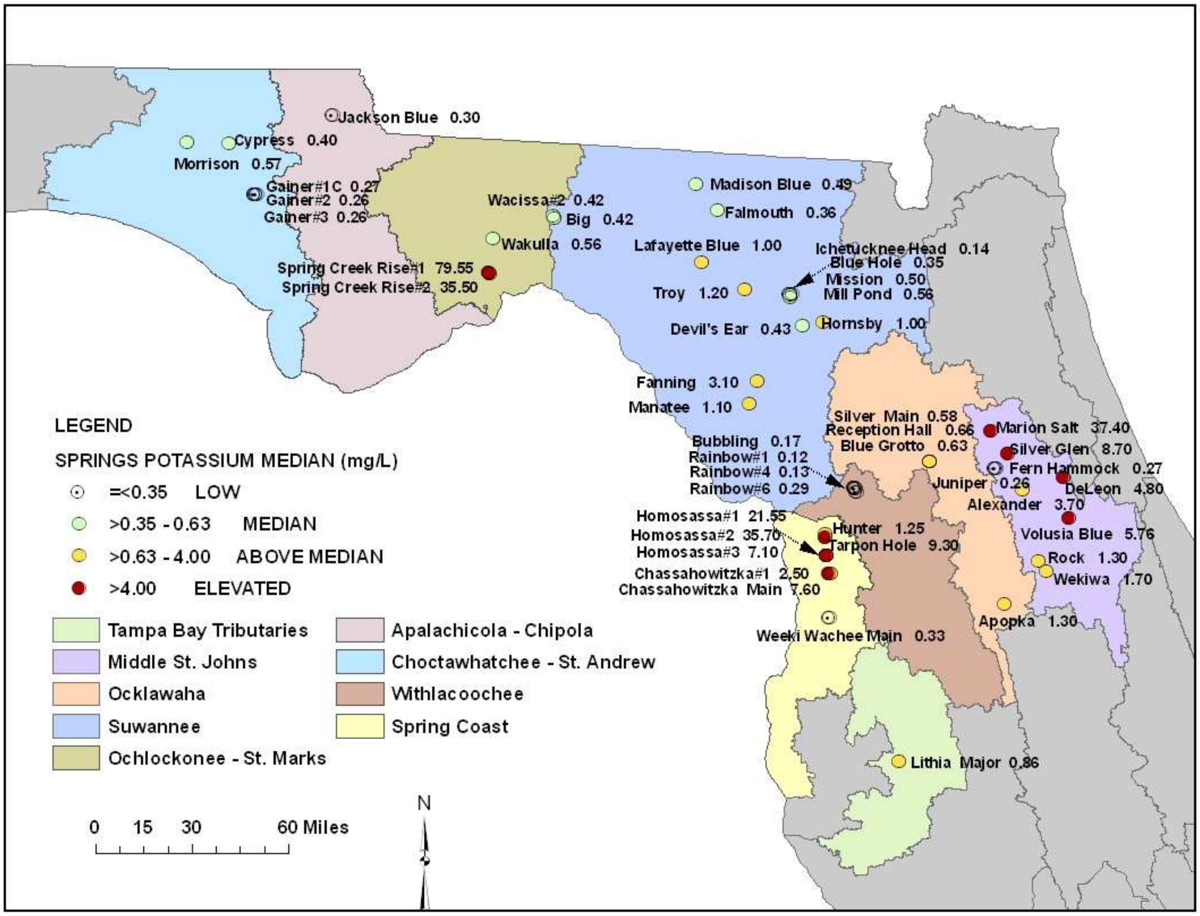


Figure 9: Median Potassium Concentrations in Spring Network (2001-2006)

Potassium is one of the major components of seawater, which commonly has potassium concentrations as high as 390 mg/L. In network springs, the highest concentrations are found in springs in coastal regions and in interior regions where deep ground water is highly mineralized. The Springs Coast Basin has many coastal springs in tidal areas subject to seawater influences. These include Homosassa Springs #1, #2, and #3, Tarpon Hole and Chassahowitzka Main Spring, which all have elevated potassium. In the Springs Coast Basin, most of the samples exceeded the median for potassium in the network springs (0.63 mg/L). Potassium in the two Spring Creek Springs (#1 and #2) located in a tidal creek along the coast line of the Ochlocknee-St. Marks River Basin is also elevated. However, these springs function tidally and saline water from the estuary often backflows into them for periods of time. So when discharging, the Spring Creek Springs often are discharging recycled seawater.

Ground water and many springs in the Middle St. Johns River Basin have elevated potassium concentrations due to another type of natural occurrence. The Floridan aquifer system along and beneath the St. Johns River corridor is naturally highly mineralized with relict saline water from past higher sea level stages, which has a tendency to migrate upward (Boniol, 2008; Spechler and Halford, 2001). The springs within this area discharge ground water that is enriched in potassium as well as sodium and chloride. Most of the ground water samples from the FDEP ambient monitoring wells in the Middle St. Johns Basin, regardless of aquifer, exceed the spring network median for potassium of 0.63 mg/L because of the naturally mineralized water.

The relationship between potassium and sodium, along with other chemical data, can sometimes be used to help differentiate between naturally occurring potassium due to salinity and potassium from other sources. The premise is that sodium and potassium concentrations in salinity-influenced springs should be similarly proportional where the potassium-sodium ratio is less than 0.04:1. Based on that assumption, potassium-sodium ratios higher than 0.04:1 may indicate that the potassium is not associated with salinity but may instead be from an anthropogenic source such as inorganic fertilizer, septic tanks, animal manure and/or land-applied wastewater. **Table 8** provides a more detailed breakdown of springs showing that those with saline influence have a predominance of naturally occurring potassium (potassium-sodium ratio <0.04:1) compared to those with higher potassium-sodium ratios. **Table 8** also shows springs with potential correlation between elevated potassium, high potassium-sodium ratios and elevated nitrate. Where fertilizer is a source of nitrate, potassium may also be elevated.

Figure 10 is a graph showing potassium and nitrate concentrations along with potassium-sodium ratios. The springs with the highest potassium-sodium ratios (>0.20:1), correspond with some of the highest spring nitrate-nitrogen concentrations throughout the state. The comparison of nitrate, potassium and the potassium-sodium ratios may help identify those springs that are degraded from recent or historical fertilizer use.

Table 8: Significant Potassium Concentrations in Springs and their Correlation with Sodium and Nitrate+Nitrite

Spring	Basin	Potassium median (mg/L)	Sodium median (mg/L)	Potassium-Sodium Ratio X:1	Nitrate median (mg/L)
Potassium Mainly Due to Saline Water Influence (Potassium-Sodium Ratio <0.04:1)					
Alexander	Middle St. Johns	3.7	133	0.03	0.05
Marion Salt	Middle St. Johns	37.4	1200	0.03	0.10
Sliver Glen	Middle St. Johns	8.7	253	0.03	0.05
Spring Creek #2	Ochlockonee- St. Marks	35.5	1021	0.03	0.17
Tarpon Hole	Springs Coast	9.3	268	0.03	0.19
Chassahowitzka #1	Springs Coast	2.5	66	0.04	0.58
Chassahowitzka Main	Springs Coast	7.6	211	0.04	0.53
Homosassa #1	Springs Coast	21.6	588	0.04	0.51
Homosassa #3	Springs Coast	7.1	194	0.04	0.54
Hunter	Springs Coast	1.3	33	0.04	0.39
Spring Creek #1	Ochlockonee- St. Marks	79.6	2170	0.04	0.14
Volusia Blue	Middle St. Johns	5.8	155	0.04	0.65
Potassium Potentially Due to Anthropogenic Sources (Potassium-Sodium Ratios 0.10:1-0.20:1)					
Blue Grotto	Ocklawaha	0.63	6.6	0.10	1.50
Fern Hammock	Middle St. Johns	0.27	2.7	0.10	0.09
Juniper	Middle St. Johns	0.26	2.6	0.10	0.09
Reception Hall	Ocklawaha	0.66	6.7	0.10	1.40
Wakulla	Ochlockonee-St. Marks	0.56	5.3	0.11	0.69
Mill Pond	Suwannee	0.56	5.0	0.11	0.46
Blue Hole	Suwannee	0.35	3.0	0.12	0.70
Hornsby	Suwannee	1.00	8.5	0.12	0.48
Devils Ear	Suwannee	0.43	3.6	0.12	1.60
Big Spring	Suwannee	0.42	3.3	0.12	0.17
Cypress	Suwannee	0.40	3.1	0.13	0.36
Wacissa	Suwannee	0.42	3.2	0.13	0.40
Mission	Suwannee	0.50	3.8	0.13	0.58
Falmouth	Suwannee	0.36	2.6	0.14	1.10
Gainer #3	Choctawhatchee-St. Andrew	0.26	1.8	0.15	0.20
Madison Blue	Suwannee	0.49	3.3	0.15	1.50
Gainer #1C	Choctawhatchee-St. Andrew	0.27	1.7	0.16	0.18
Gainer #2	Choctawhatchee-St. Andrew	0.26	1.6	0.17	0.23
Jackson Blue	Apalachicola-Chipola	0.30	1.8	0.17	3.30
Wekiwa	Middle St. Johns	1.70	9.8	0.17	1.40
Potassium Most Likely Due to Anthropogenic Sources (Potassium-Sodium Ratio >0.20:1)					
Lafayette Blue	Suwannee	1.00	4.88	0.20	2.20
Apopka	Middle St. Johns	1.30	5.70	0.23	4.55
Rock	Middle St. Johns	1.30	5.20	0.25	1.50
Manatee	Suwannee	1.10	4.19	0.26	1.80
Morrison	Choctawhatchee-St. Andrew	0.57	1.86	0.31	0.17
Troy	Suwannee	1.20	3.10	0.39	2.20
Fanning	Suwannee	3.10	5.42	0.57	5.20

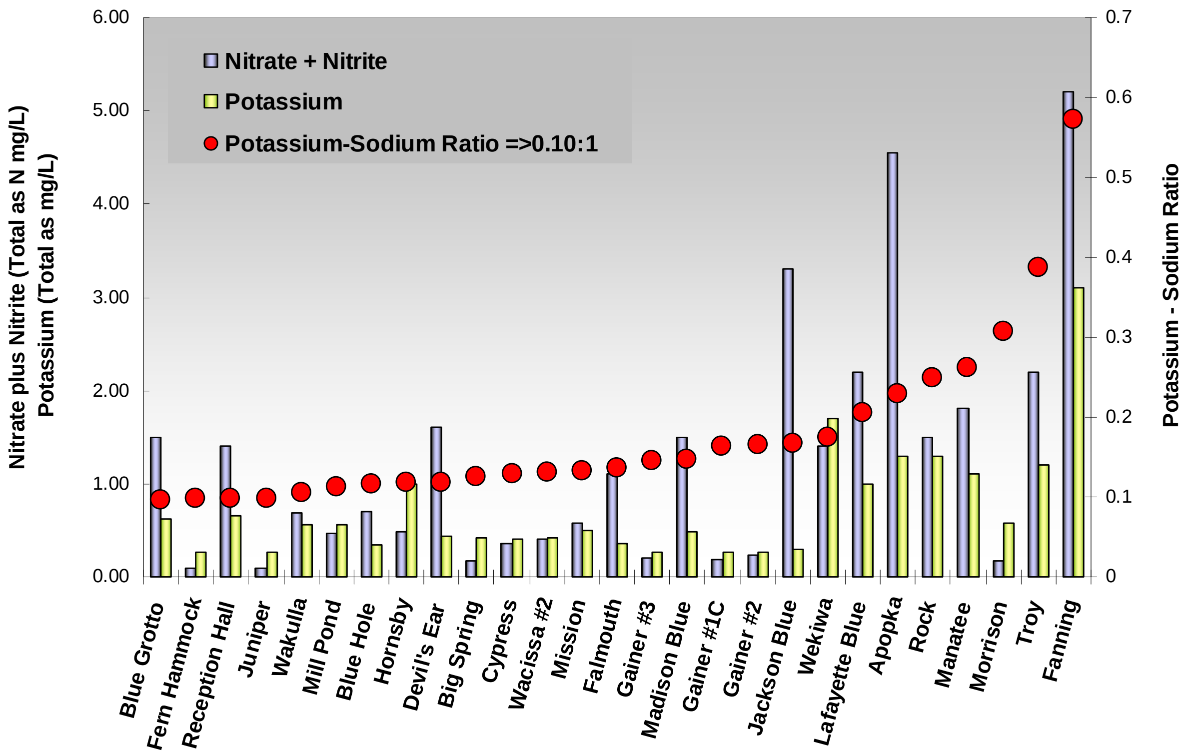


Figure 10: Potassium and Nitrate+Nitrite Concentrations and Potassium-Sodium Ratios in Select Springs

Salinity Indicators

Although most springs are considered to be fresh waters, fresh and saline characteristics are important to document to evaluate changes in spring chemistry. Springs can be characterized based on their salinity analyte levels and mineral content. Salinity analytes commonly used as indicators include chloride, sodium, sulfate, and specific conductance. Concentrations of these indicators can in some cases be used to identify ground water chemistry changes due to drought and/or anthropogenic influences. Increasing trends in these salinity indicators could be caused by lack of recharge during low-rainfall periods, over pumping the aquifer, or a combination of the two. Coastal springs that are tidally influenced cannot be easily evaluated for any trends in salinity since the concentrations vary with the tidal cycle. However, long-term increasing trends for salinity indicators in coastal springs could indicate saltwater intrusion.

Sodium and chloride are the major saline components of seawater. Elevated sodium concentrations shown on **Figure 11** are generally limited to springs in coastal areas and springs within the Middle St. Johns River Basin, where the Floridan aquifer system is naturally saline due to sea water that was trapped in carbonate host rocks during past higher sea level stands. For the most part, the same springs that have elevated potassium also have elevated sodium and chloride due to this mineralized ground water. The median sodium and chloride concentrations of all springs in the sampling network are 4.97 and 8.6 mg/L, respectively.

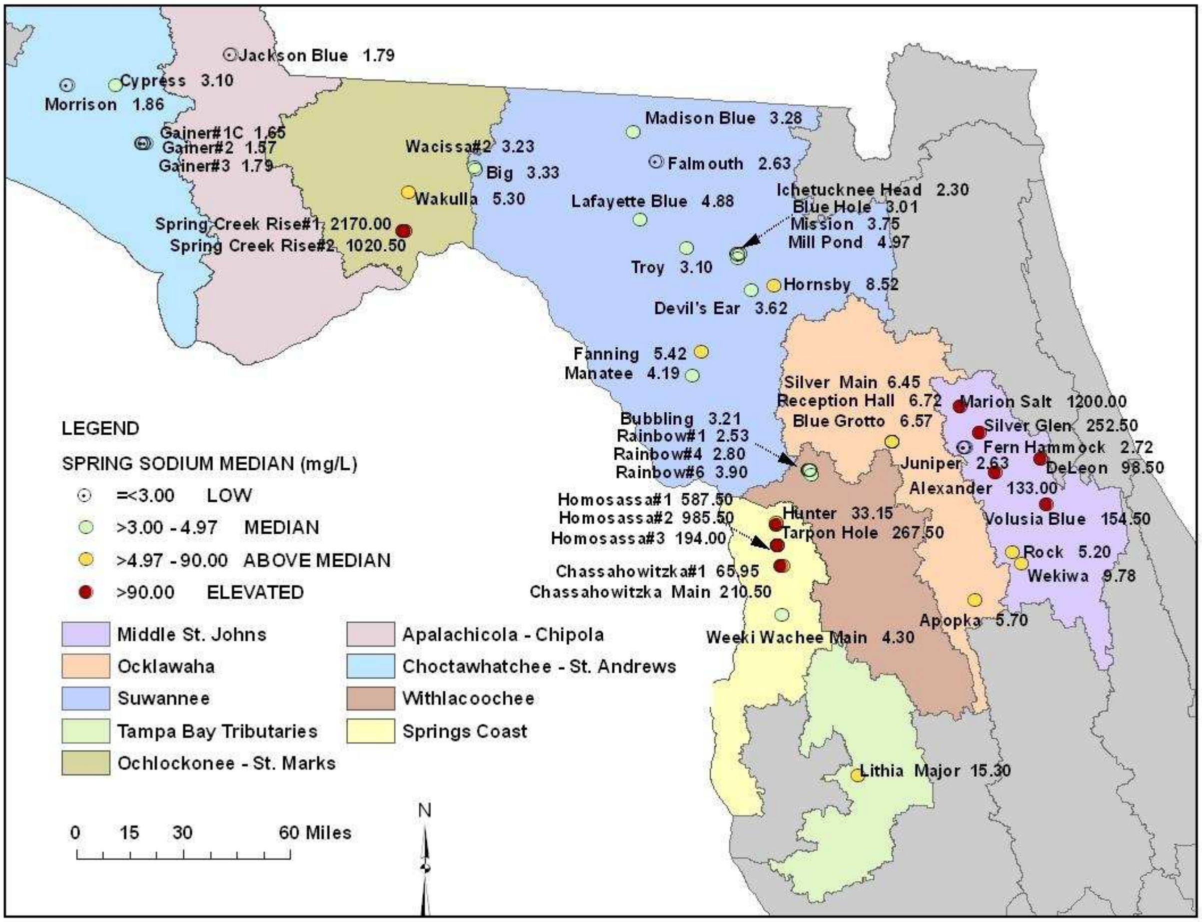
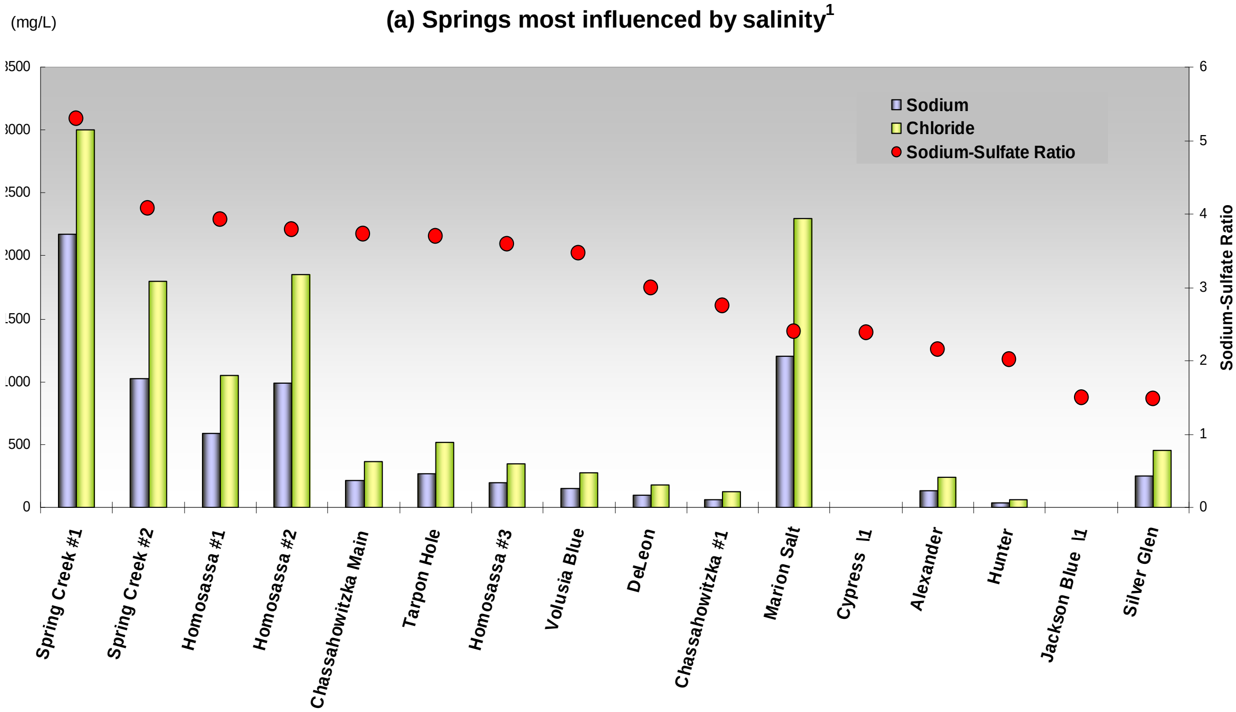


Figure 11: Median Sodium Concentrations in Spring Network (2001-2006)

In the more saline springs, sodium and chloride concentrations are both greater than 1,000 mg/L. Those with the highest sodium and chloride concentrations include Springs Creek Rise #1 and #2, Marion Salt, Homosassa #1, #2, #3, and Tarpon Hole. Silver Glen, Chassahowitzka Spring Main, Volusia Blue, and Alexander Springs are mineralized springs that also have elevated sodium. Once again, most of these springs are either in coastal areas or in the inland area of saline ground water in the Middle St. Johns River Basin.

The mineral content of springs with naturally higher salinity can have an influence on biological diversity within their receiving waters and is therefore important to consider when evaluating their ecological health. The sodium-chloride (Na-Cl) and sodium–sulfate (Na-SO_4) ratios were used to categorize the springs into low salinity and those influenced by high salinity sources (including coastal and inland mineralized ground water). These are shown in **Figure 12**. All of the springs in the Springs Coast Basin (with the exception of Weeki Wachee) are included in the high salinity-influenced group. Many of the springs in the area of mineralized ground water near the St. Johns River are also included in the high salinity-influenced group.

(a) Springs most influenced by salinity[1]



[1] **Note:** Jackson Blue and Cypress Springs have low chloride and sodium levels, are not tidally influenced, and not known to tap mineralized water yet their sodium-sulfate ratio is atypical compared to other freshwater springs.

(b) Springs less influenced by salinity

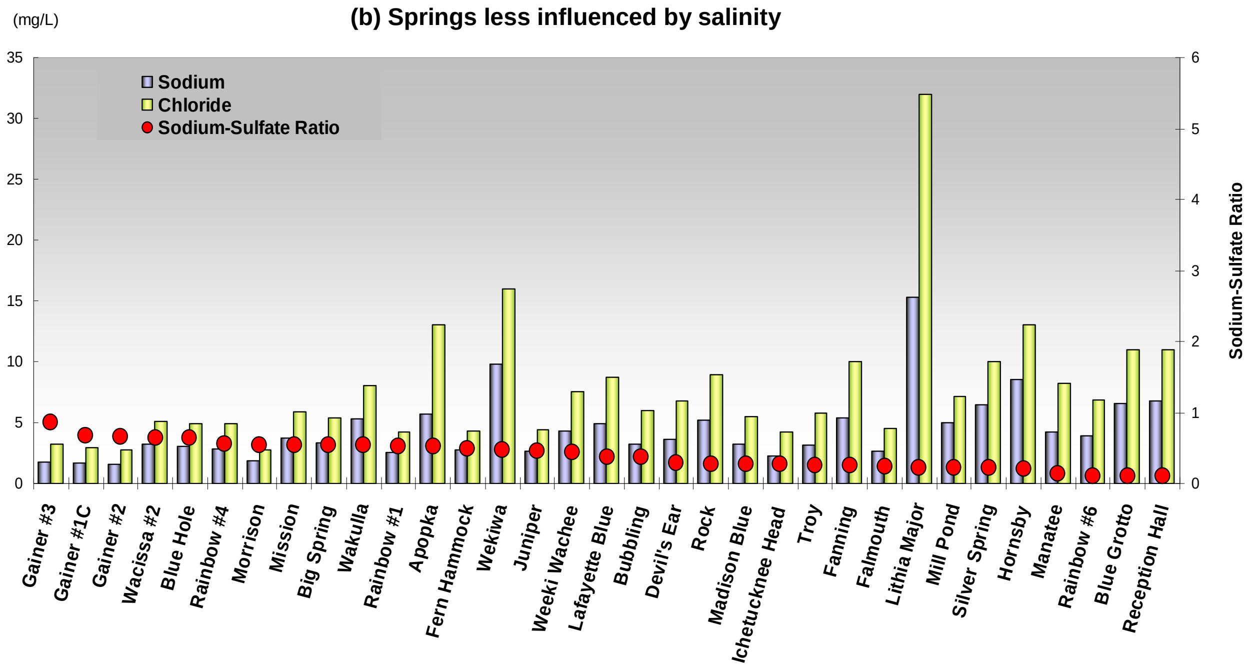


Figure 12: Salinity Influence on Select Springs as Indicated by Sodium-Sulfate Ratio

Cypress and Jackson Blue Spring have anomalously higher Na-SO_4 ratios than expected because neither is tidally influenced and not known to tap mineralized water. Both springs are located relatively close together in the northern panhandle region and may be expressing a distinctive ground water chemistry that could be naturally occurring or influenced in some way by anthropogenic sources. As expected, the specific conductance of the more saline springs is higher than what is typically found in freshwater.

Sodium, chloride, specific conductance and sulfate concentrations for the springs in the monitoring network are shown in **Tables 9** and **10**. The salinity-influenced springs that are also tidally influenced were found to have high variation in concentrations of sodium, chloride and other salinity indicators. Most of the tidally influenced springs with elevated sodium and chloride concentrations also had a higher sodium-sulfate ratio (**Figure 12**). The tidally influenced springs, based on these parameters, include Spring Creek #2 and the majority of the network springs in the Springs Coast Basin (Chassahowitzka Spring Main, Tarpon Hole, Homosassa #1, #2, and #3, Chassahowitzka #1, and Hunter Springs).

Springs with decreases in sodium (by 3 mg/L or more when comparing the 2000-2005 median and the 2006 concentration) include DeLeon, Volusia Blue, Silver Glen, and Alexander Springs. Springs that had notable decreases in chloride medians (by 2 mg/L or more) include DeLeon, Spring Creek #1, Volusia Blue, Silver Glen and Marion Salt. Decreases in salinity indicators were noted for several springs in the Middle St. Johns Basin. These could be due to the dilution created by aquifer recharge during wetter climatic periods.

Ground Water – Surface Water Interaction

Ground water residing in the aquifer for years to decades is often the primary source of spring water. However, some springs have greater contributions from water that was much more recently rainwater or surface water. Several indicator analytes can be used to evaluate the relative inputs of water that was more recently surface water or rain water.

Low dissolved oxygen (DO) is a normal characteristic of ground water and is understandably a typical characteristic of spring water, however there is a wide range in DO concentrations in springs across the state. Springs that have greater recent surface and rain water contributions and those that have more local recharge generally have DO concentrations that are higher than typical for ground water. Many springs that have continuously higher-than-typical DO concentrations are shallow, have shallow flow systems and receive a lot of recharge from local precipitation. High DO can also occur in springs in or adjacent to rivers. These springs may have DO concentrations that fluctuate based on precipitation and river stage. During normal conditions, the discharge from these springs closely resembles ground water in water quality. However, in response to river stage rises during wetter periods or after significant storm events, some of these springs can reverse flow and receive surface water and for a time afterward discharge water that is more like surface water in chemical composition than ground water. This can also occur for some tidal springs that on occasion can receive surface water during high tide.

Table 9: Sodium and Chloride in Spring Network (2001-2006)

BASIN & SPRING NAME	Total Sodium (mg/L) (929)						Total Chloride (mg/L) (940)					
	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	1.5	1.79	2.1	1.75	1.86	2	3.7	4.3	4.6	4.2	4.25	4.4
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	2.32	3.1	3.8	2.75	2.89	3.1	3.1	4	4.8	3.6	3.75	4
Gainer Spring #1C	1.4	1.645	2.2	1.79	1.825	1.89	2.5	2.9	3.2	2.9	2.9	3
Gainer Spring #2	1.2	1.57	2.3	1.54	1.67	1.71	2.3	2.7	2.9	2.6	2.7	2.7
Gainer Spring #3	1.5	1.785	2.4	1.96	1.975	2.01	2.9	3.25	3.6	3.2	3.4	3.5
Morrison Spring	1.7	1.855	1.9	1.88	1.88	1.9	2.5	2.75	3	2.7	2.8	2.8
Middle St. Johns Basin												
Alexander Springs	110	**133**	153	125	**130**	138	210	**240**	270	230	**240**	260
DeLeon Spring	67.7	**98.5**	158	67.7	**72.45**	98.5	130	**180**	250	130	**135**	180
Fern Hammock Springs	2.3	2.715	2.9	2.67	2.815	2.9	4	4.3	4.5	4.2	4.3	4.5
Juniper Springs	2.2	2.63	2.86	2.76	2.81	2.86	4	4.4	4.6	4.2	4.4	4.5
Marion Salt Springs	982	**1200**	1360	1050	**1220**	1360	1800	**2300**	2500	1900	**2200**	2500
Rock Springs	4.4	**5.2**	5.76	5.42	**5.585**	5.76	8.1	**8.9**	9.4	9.1	**9.3**	9.4
Silver Glen Springs	207	**252.5**	285	216	**247**	257	380	**450**	480	380	**420**	480
Volusia Blue Spring	97.2	**154.5**	228	121	**140**	211	160	**280**	420	230	**255**	390
Wekiwa Spring	8.4	**9.78**	10.5	9.6	**10.05**	10.3	14	**16**	17	16	**16**	17
Ochlockonee - St. Marks												
Spring Creek Rise #1	300	**2170**	6530	1100	**1100**	1100	520	**3000**	12000	1900	**1900**	1900
Spring Creek Rise #2	182	**1020.5**	5590	306	**2633**	4960	330	**1800**	9800	500	**5000**	9500
Wakulla Spring	4.4	**5.3**	7.35	5.33	**5.82**	7.35	7.6	8	11	8	**8.65**	11
Ocklawaha Basin												
Apopka Spring	4.94	**5.695**	6.04	5.57	**5.965**	6.03	12	**13**	15	13	**13**	14
Blue Grotto Spring	5.4	**6.565**	7.39	6.66	**7.205**	7.39	8.9	**11**	12	11	**11**	12
Reception Hall Spring	5.7	**6.72**	7.41	6.75	**7.27**	7.41	8.8	**11**	12	11	**11**	11
Silver Spring Main	5	**6.45**	7	6.41	**6.575**	6.72	9	**10**	11	9.6	**10**	10
Springs Coast Basin												
Chassahowitzka Spring #1	31.5	**65.95**	162	58	**124**	152	61	**125**	290	97	**235**	280
Chassahowitzka Spring Main	51	**210.5**	564	216	**458**	564	87	**365**	1000	380	**840**	1000
Homosassa Spring #1	391	**587.5**	855	544	**619.5**	772	680	**1050**	1600	980	**1100**	1400
Homosassa Spring #2	830	**985.5**	1140	903	**1045**	1090	1500	**1850**	2100	1600	**1850**	1900
Homosassa Spring #3	113	**194**	359	118	**258**	332	210	**350**	650	210	**465**	610
Hunter Spring	14.4	**33.15**	56.3	34.2	**45.1**	56.3	26	**61.5**	110	55	**80**	110
Tarpon Hole Spring	113	**267.5**	988	203	**416**	988	200	**515**	1800	330	**775**	1800
Weeki Wachee Main Spring	3.6	4.295	5.24	4.47	4.955	5.24	6.7	7.55	8	7.7	7.9	8
Suwannee River Basin												
Big Spring	2.9	3.33	5	3.44	3.445	3.9	5	5.4	6	5.2	5.4	5.6
Blue Hole Spring	2.67	3.005	3.54	2.97	3.17	3.54	4.3	4.9	5.5	4.8	4.9	5
Devil's Ear Spring	3.15	3.615	5.1	3.52	3.615	4.08	6.3	6.75	8.7	6.3	6.6	7.1
Falmouth Spring *	2.47	2.63	2.72	2.47	2.595	2.72	4.1	4.5	4.5	4.5	4.5	4.5
Fanning Springs	4.15	**5.42**	6.39	5.42	**5.65**	5.83	8.3	**10**	12	10	**10**	11
Hornsby Spring *	8.46	**8.52**	8.55	8.52	**8.535**	8.55	12	**13**	13	13	**13**	13
Ichetucknee Head Spring	2.1	2.3	2.76	2.4	2.62	2.76	3.6	4.2	4.5	4.2	4.45	4.5
Lafayette Blue Spring	4.2	4.88	6.8	4.96	**5.64**	5.68	7.9	**8.7**	12	8.6	**9.7**	10
Madison Blue Spring	2.77	3.275	4.4	3.04	3.38	3.67	4.7	5.5	6.7	5.3	5.4	5.9
Manatee Spring	3.69	4.19	4.85	4.28	4.39	4.85	7.2	8.25	9	8.2	**8.7**	9
Mill Pond Spring	4.3	4.97	6.08	4.81	**5.085**	5.58	6.8	7.2	8.1	6.8	7.05	7.2
Mission Spring	3.5	3.75	4.51	3.75	4.015	4.51	5.4	5.9	6.3	5.6	5.75	5.9
Troy Spring	2.68	3.1	3.9	3.1	3.37	3.5	5.3	5.8	7.3	5.5	5.9	6.1
Wacissa Spring #2	2.79	3.23	3.83	3.32	3.4	3.83	4.8	5.1	5.6	5	5.2	5.5
Tampa Bay Tributaries Basin												
Lithia Springs Major	12.6	**15.3**	18.3	14.3	**15.2**	16	26	**32**	35	29	**30.5**	32
Withlacoochee Basin												
Bubbling Spring	2.6	3.21	3.5	3.15	3.33	3.34	5.2	6	6.4	5.7	6	6.1
Rainbow Spring #1	2	2.525	2.78	2.67	2.725	2.78	3.6	4.2	4.8	4.6	4.7	4.8
Rainbow Spring #4	2.2	2.8	3.06	2.82	2.945	3.06	4.2	4.95	5.4	5.3	5.35	5.4
Rainbow Spring #6	2.89	3.9	4.22	4.09	4.215	4.22	4.8	6.9	7.3	6.9	7.2	7.3

Values in red are higher than the Springs Initiative network median of 4.97 mg/L for sodium and 8.6 mg/L for chloride.

Table 10: Specific Conductance and Sulfate in Spring Network (2001-2006)

BASIN & SPRING NAME	Specific Conductance (uS/cm) (94)						Total Sulfate(mg/L) (945)					
	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	238	249	270	247	254	263	0.92	1.2	1.4	0.99	1.15	1.2
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	208	215	232	215	217.5	232	1.2	1.3	1.4	1.3	1.3	1.3
Gainer Spring #1C	117	138	160	136	139.5	142	2.3	2.45	2.7	2.3	2.4	2.5
Gainer Spring #2	108	115	143	117	117.5	121	2.2	2.4	2.7	2.4	2.4	2.5
Gainer Spring #3	114	121.5	130	124	125.5	129	2	2.1	2.3	2.1	2.15	2.2
Morrison Spring	200	221.5	241	223	227	241	3.3	3.4	3.5	3.3	3.4	3.4
Middle St. Johns Basin												
Alexander Springs	928	1050	1160	990	1080	1140	56	**62**	68	62	**62**	64
DeLeon Spring	699	853	1180	699	765	853	24	**33**	41	24	**25.5**	33
Fern Hammock Springs	111	114	120	111	114	120	5	5.55	5.9	5	5.55	5.9
Juniper Springs	109	113.5	122	112	115.5	122	5.5	5.7	5.9	5.5	5.75	5.9
Marion Salt Springs	6300	**7800**	8120	6350	**7695**	8120	400	**500**	540	400	**475**	540
Rock Springs	246	254	276	248	262.5	276	18	**19**	19	18	**19**	19
Silver Glen Springs	1540	**1905**	2050	1540	**1925**	1970	150	**170**	180	150	**165**	170
Volusia Blue Spring	848	1240	1780	1030	1235	1600	29	**44.5**	67	37	**41**	58
Wekiwa Spring	327	339	362	331	347	362	20	**21**	22	21	**21.5**	22
Ochlockonee - St. Marks												
Spring Creek Rise #1	2100	**8980**	31900	6240	**6240**	6240	85	**410**	1600	270	**270**	270
Spring Creek Rise #2	1400	**5250**	34400	1800	**18100**	34400	59	**250**	1300	77	**688.5**	1300
Wakulla Spring	286	306	360	303	308.5	323	9	10	12	10	10.5	12
Ocklawaha Basin												
Apopka Spring	243	249.5	268	249	256.5	268	10	11	12	11	11	11
Blue Grotto Spring	440	461	518	491	504	518	59	**63.5**	82	68	**69**	70
Reception Hall Spring	460	502	534	493	509.5	521	57	**72.5**	82	67	**68.5**	72
Silver Spring Main	430	451	510	440	446.5	462	21	**30.5**	65	21	**24.5**	26
Springs Coast Basin												
Chassahowitzka Spring #1	504	782	1590	620	1150	1300	14	**24**	46	19	**38**	45
Chassahowitzka Spring Main	590	**1540**	3880	1540	**3155**	3820	18	**56.5**	150	59	**120**	150
Homosassa Spring #1	2560	**3760**	5200	3310	**3860**	4910	100	**150**	220	140	**155**	190
Homosassa Spring #2	4920	**6090**	7030	5340	**6050**	6700	210	**260**	300	230	**245**	280
Homosassa Spring #3	922	**1415**	12200	922	2170	12200	33	**54**	96	34	**68**	85
Hunter Spring	287	417	598	378	462	598	12	16.5	22	15	17.5	22
Tarpon Hole Spring	943	**2010**	6620	1430	**2765**	6620	30	**72.5**	250	49	**105.5**	250
Weeki Wachee Main Spring	293	317	341	327	332	341	8.8	10	11	10	10	10
Suwannee River Basin												
Big Spring	298	326	370	328	335.5	339	5.5	6.2	6.6	6.2	6.25	6.6
Blue Hole Spring	287	297.5	309	293	304	309	4.2	4.7	28	4.3	4.4	4.6
Devil's Ear Spring	356	371.5	388	372	383.5	388	12	13	15	12	12	13
Falmouth Spring *	396	400	400	396	398	400	11	11	11	11	11	11
Fanning Springs	440	475	498	483	488	490	19	**21**	23	22	**22**	23
Hornsby Spring *	434	436	490	434	435	436	40	**42**	83	40	**41**	42
Ichetucknee Head Spring	305	320	340	327	334	340	8.2	8.7	9.3	8.2	8.55	8.8
Lafayette Blue Spring	416	428.5	454	447	450	454	10	13	14	13	13	14
Madison Blue Spring	268	282	309	286	290	291	9.8	12	17	12	12	13
Manatee Spring	452	474.5	528	473	483	497	24	**32.5**	42	31	**33**	35
Mill Pond Spring	337	350	363	345	348	356	19	**23**	29	19	**21**	23
Mission Spring	283	304	311	304	307	309	5.3	6.9	8.7	5.3	5.7	5.9
Troy Spring	266	362	388	374	383.5	388	11	12	13	12	12	13
Wacissa Spring #2	230	267	300	258	280	285	3.9	5	5.3	5	5	5.3
Tampa Bay Tributaries Basin												
Lithia Springs Major	464	500.5	532	464	488.5	517	51	**70**	88	51	**66.5**	67
Withlacoochee Basin												
Bubbling Spring	314	332.5	357	323	332	348	7.6	8.6	10	7.6	7.8	8
Rainbow Spring #1	133	151	161	144	156	160	4.4	4.8	5.2	4.8	4.85	4.9
Rainbow Spring #4	237	250	267	244	258	264	4.5	5.05	5.3	5.1	5.1	5.1
Rainbow Spring #6	234	331	355	321	339.5	355	8.5	**37**	44	34	**36**	36

Values in red are higher than the Springs Initiative network median 16.5 mg/L for sulfate and surface water criteria of 1275 uS/cm for specific conductance.

The medians for DO in network springs are summarized in **Table 11** and are plotted relative to typical spring and surface water DO concentrations in **Figure 13**. Springs with the highest DO concentrations (greater than 5 mg/L) include Jackson Blue, Rainbow Spring #1, Juniper, Fern Hammock, Rainbow #6, Rainbow #4, and Hunter Springs. These springs are presumably under significant surface water influence and/or receive rapid recharge from local precipitation. Eight springs have DO concentrations less than 1 mg/L. These include Big, Lafayette Blue, Rock, Falmouth, Mission, Mill Pond, Volusia Blue, Troy, DeLeon, Wekiwa, and Hornsby Springs. These data suggest that ground water is usually the predominant source of water to them and their interaction with local sources of recharge is somewhat dampened, perhaps by a confining geologic unit.

One issue that becomes apparent upon review of the DO data is that for some springs, the maximum values are sometimes significantly greater than the median DO values. This type of variation could indicate that although the primary source water may be ground water, there could be times when significant surface water fluxes occur. Temporary anthropogenic effects on DO can even occur at springs frequented by recreational scuba divers in instances where the spring retains the diver's expended oxygen. This may explain why DO in Volusia Blue Spring, a spring frequented by divers, has been as high as 6.7 mg/L in comparison to its median, which is less than 1.0 mg/L.

Evaluating other indicators can help in understanding the sources of water and vulnerability to contamination in springs. **Figure 14** shows the total dissolved solids (TDS), calcium and sulfate medians for network springs relative to one another. Medians for TDS, calcium and sulfate are also presented in **Tables 10** through **12**. The springs at the top of the chart are significantly influenced by fresh surface water; in the center the predominant influence is ground water and those at the bottom are influenced by either modern seawater or deep saline ground water. The elevated TDS and sulfate concentrations that indicate saline water influence are notable for some of the coastal springs and those in the area of mineralized ground water near the St. Johns River, which is consistent with sodium and chloride concentrations. Some of the springs with low DO also have elevated concentrations of calcium and sulfate, suggesting a chemical signature consistent with the Upper Floridan aquifer, whereas others have higher DO concentrations and corresponding lower sulfate, calcium and TDS, more characteristic of fresh surface waters.

Median values for several other indicators of surface water influence are provided in this report. These include turbidity (**Table 12**); color and total organic carbon (**Table 13**); and pH and fecal coliform bacteria (**Table 14**). The concentration and variability of these ground water–surface water interaction indicators might be useful in identifying springs that are more readily or least likely to be influenced by surface water or direct recharge from rainfall. Median and maximum values for turbidity and total organic carbon were relatively low for all network springs with the exception of Spring Creek Rise #1 and #2. Spring Creek Rise #1 and #2 were among the few springs that had notable fluctuations in color and pH, which like DO, suggests a fluctuation between water sources. High levels of color and total organic carbon with corresponding low pH can indicate that tannic surface water such as a swamp or blackwater stream is an intermittent source of water to the spring.

There were significant fluctuations in fecal coliform counts for many of the network springs as shown in **Table 14** when comparing median to maximum coliform values. The median values for fecal coliform were below detection for most of the network springs. The maximum values for several springs were expressed as intermittent small spikes in fecal coliform counts that are not unusual for natural surface waters and not necessarily indicative of a contaminant source.

Table 11: Dissolved Oxygen and Calcium in Spring Network (2001-2006)

BASIN & SPRING NAME	Dissolved Oxygen (299)						Total Calcium (916)					
	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	0	**7.08**	9.38	6	**6.555**	6.75	41.4	46.1	19.2	44.2	47.9	48.8
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	3.87	4.615	5.25	3.87	4.365	4.78	30.8	36.3	38	36.2	37.35	38
Gainer Spring #1C	1.33	1.72	2.95	1.33	1.45	1.74	17.9	22.9	34.6	22.1	22.95	23.4
Gainer Spring #2	1.65	2.05	3.04	1.65	1.99	2.58	15.8	18.25	23.7	17.7	18.6	19.1
Gainer Spring #3	1.42	1.825	2.59	1.42	1.625	1.86	17.1	18.65	20.8	19.2	19.7	20.8
Morrison Spring	2.76	3.08	3.71	2.76	2.9	3.08	30.8	33.8	34.8	33.7	33.9	34.8
Middle St. Johns Basin												
Alexander Springs	0.92	1.13	1.56	1.12	1.205	1.39	39.2	46.3	148	44.1	45.8	48.5
DeLeon Spring	0.17	0.38	2.14	0.17	0.26	1.14	50.8	54.8	72.7	53.2	53.8	55.4
Fern Hammock Springs	5.44	**6.145**	6.61	5.44	**5.165**	6.61	12.4	13.15	22.5	13	13.5	22.5
Juniper Springs	5.86	**6.22**	7.67	5.86	**6.015**	6.21	10.9	13.6	14.5	13.7	14.1	14.5
Marion Salt Springs	2.23	2.56	3.92	2.23	2.345	2.55	160	**197**	219	182	**196**	219
Rock Springs	0.67	0.88	1.51	0.69	0.78	1.04	30.2	31.5	33.8	31.5	32.45	33.8
Silver Glen Springs	2.03	2.775	4.1	2.56	2.625	3.04	62.7	**72.95**	79.1	67.2	**73**	74.6
Volusia Blue Spring	0.27	0.55	6.7	0.3	0.43	0.63	56.1	**63.65**	76.4	63.6	**69.3**	76.4
Wekiwa Spring	0.18	0.35	0.58	0.18	0.26	0.3	39.6	43	61.5	42.7	43.05	43.6
Ochlockonee - St. Marks												
Spring Creek Rise #1	0.2	2.005	8.94	1.36	1.36	1.36	52.5	**118.25**	264	80.7	**80.7**	80.7
Spring Creek Rise #2	0.12	1.36	7.48	1.27	2.12	2.97	41.4	**78.6**	234	53.5	**141.75**	230
Wakulla Spring	1.17	1.92	4.78	1.17	1.485	1.92	38.1	44.3	46.7	42	45.65	46.7
Ocklawaha Basin												
Apopka Spring	2.01	2.105	2.79	2.01	2.09	2.11	29	31.5	32.4	31.3	32.4	32.4
Blue Grotto Spring	2.77	3.61	6.08	3.59	3.645	4.08	67.30	**75.5**	94.2	81.3	84.1	94.2
Reception Hall Spring	2.93	3.57	5.99	3.34	3.575	3.73	71.9	**80.75**	91.5	85.5	**86.05**	86.8
Silver Spring Main	1.18	1.67	2.45	1.18	1.37	1.67	73.1	**77.4**	81.2	78.3	**79.65**	81.2
Springs Coast Basin												
Chassahowitzka Spring #1	3.9	4.48	5.76	4.22	4.385	4.56	48.5	54.3	60.9	54.4	**56.85**	60.9
Chassahowitzka Spring Main	2.63	4.31	5.6	4.02	4.275	4.43	49.9	**59.2**	75.1	60.5	**72.3**	75.1
Homosassa Spring #1	3.1	3.805	4.74	3.48	3.56	3.76	54.6	**62.15**	340	58.3	**63.25**	74
Homosassa Spring #2	1.78	3.67	5.52	3.2	3.415	3.54	70.7	**80.3**	88.9	77.7	**80.3**	88.9
Homosassa Spring #3	3.28	4.1	5.4	3.59	3.95	4.14	36.8	43.8	53.4	40.1	48.65	53.4
Hunter Spring	4.03	**5.11**	6	4.73	4.935	5.15	28.6	30.8	35.2	31.1	33.8	35.2
Tarpon Hole Spring	1.78	2.425	2.98	2.33	2.335	2.44	43.5	52.85	88.7	49.9	**62.8**	88.7
Weeki Wachee Main Spring	1.11	1.56	2.13	1.11	1.4	1.71	48.2	52.2	59.1	52.4	**56.5**	59.1
Suwannee River Basin												
Big Spring	0.75	0.975	2.95	0.75	0.85	1.36	48.5	54.25	67.8	55.3	**57.1**	58.1
Blue Hole Spring	1.26	1.83	2.76	1.85	1.955	2.14	47.9	53.95	56.8	52.5	**55.5**	56.8
Devil's Ear Spring	2.37	3.42	5.21	3.55	3.725	5.21	62	**66.7**	70.3	67.5	**69.55**	70.3
Falmouth Spring	0.58	0.64	1.28	0.58	0.61	0.64	62.8	**63.1**	67.3	62.8	**65.05**	67.3
Fanning Springs	0.75	2.04	2.63	1.87	1.97	2.1	77.7	**85.8**	105	88	**89.6**	91.6
Hornsby Spring	0.29	0.3	0.47	0.29	0.295	0.3	72.6	**72.9**	74.3	72.6	**72.75**	72.9
Ichetucknee Head Spring	3.25	3.53	4.81	3.37	3.445	3.81	47.4	**57.6**	70.3	60.8	**61.6**	63.4
Lafayette Blue Spring	0.52	0.96	1.97	0.76	1	1.2	67.2	**72.75**	76.7	73.5	**75**	75.1
Madison Blue Spring	1.01	1.94	2.34	1.94	2.03	2.03	39.3	42.3	47.1	41.3	44.4	47.1
Manatee Spring	1.03	1.565	3.09	1.11	1.31	1.35	82.4	**89.05**	97.1	89.9	**93.5**	95.8
Mill Pond Spring	0.21	0.61	2.61	0.38	0.59	0.61	52.6	**56.8**	59.6	54.2	**57.1**	58.4
Mission Spring	0.35	0.63	1.48	0.59	0.655	0.77	47.1	50.8	55.9	50.3	53.6	55.9
Troy Spring	0.29	0.53	2.1	0.49	0.53	0.72	37.6	**64.5**	70.8	64.5	**68.2**	70.8
Wacissa Spring #2	2.17	2.71	5.55	2.48	2.775	2.97	35.8	41.7	46	42.7	44	46
Tampa Bay Tributaries Basin												
Lithia Springs Major	1.66	2.02	2.98	1.66	1.755	2.17	64.1	**71**	78.8	69.3	**71**	72.1
Withlacoochee Basin												
Bubbling Spring	3.94	4.45	7.38	3.94	4.305	4.36	49.6	**58.2**	66.5	58.2	**58.45**	59.1
Rainbow Spring #1	5.68	**6.58**	7.02	5.68	**6.36**	6.58	18.7	22.45	24.8	22.3	22.8	24
Rainbow Spring #4	4	**5.17**	6.01	4	4.76	5.05	38.1	42.55	67.4	41.9	44.15	67.4
Rainbow Spring #6	4.75	**5.74**	7.19	5.35	**5.685**	5.71	38.1	**54.4**	60.1	54.4	**57.25**	60.1

Values in red are higher than the Springs Initiative network median of 54.3 mg/L for calcium and surface water criteria of 5 mg/L for DO.

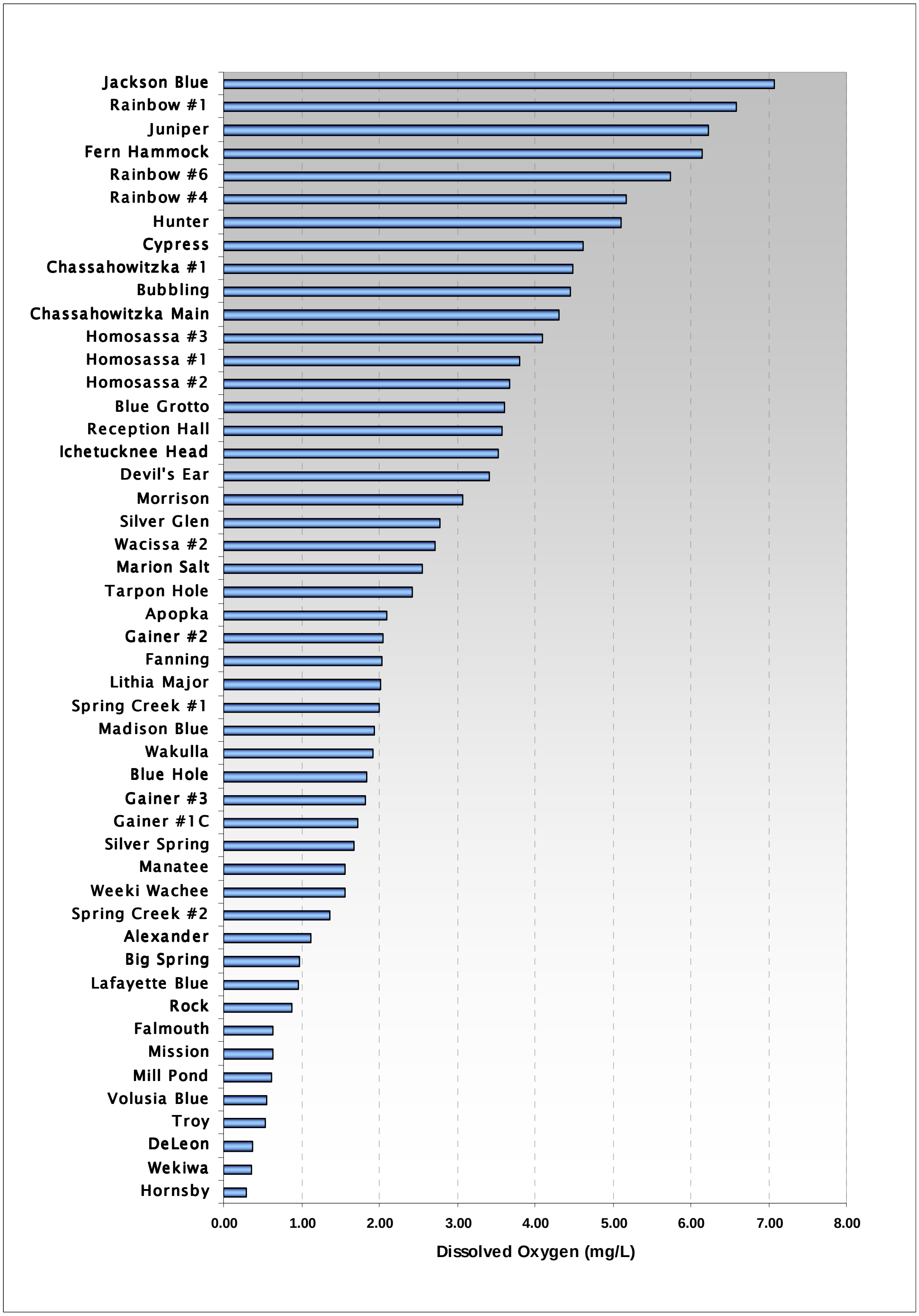


Figure 13: Plot of Median Dissolved Oxygen Concentrations in Network Springs

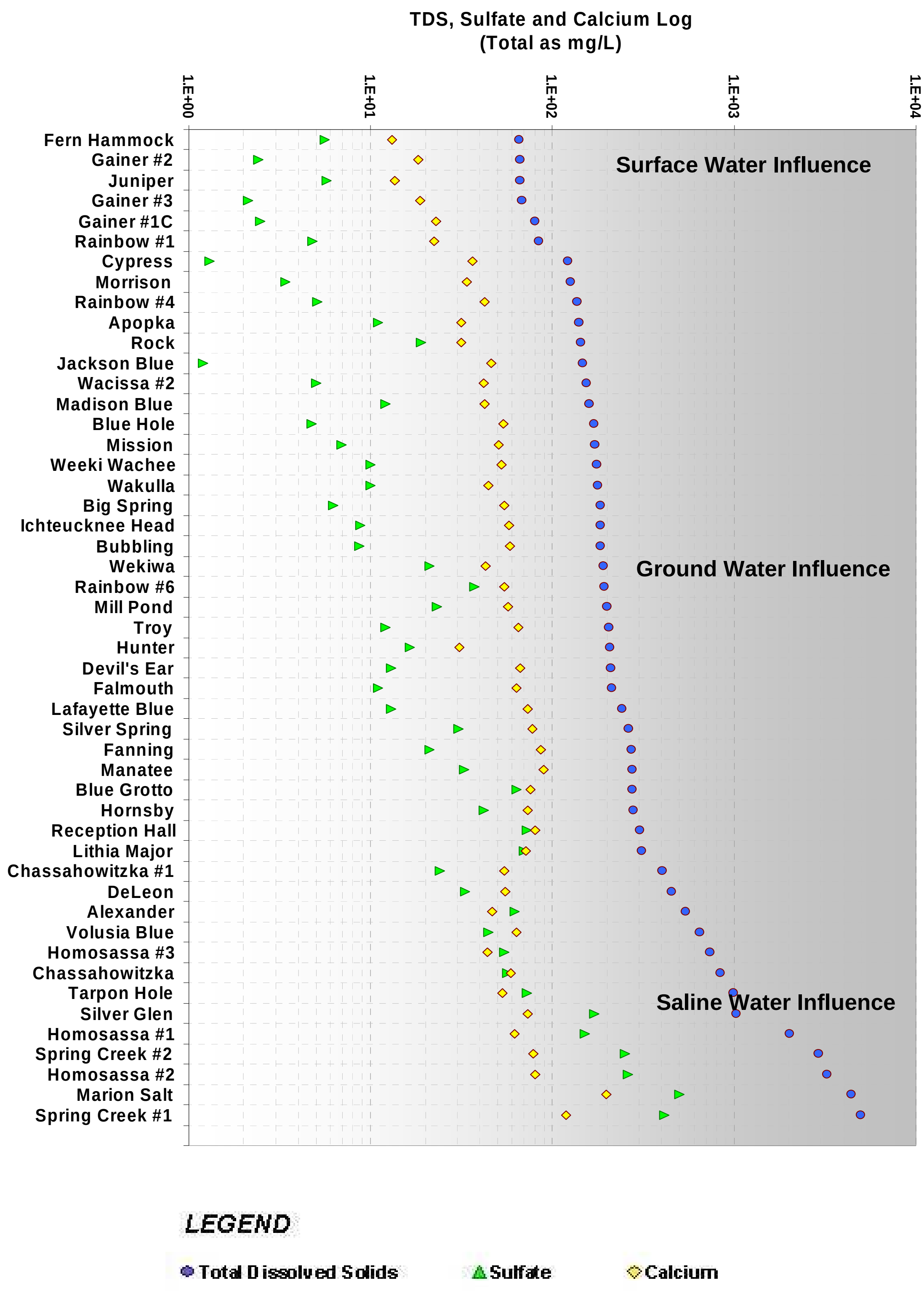


Figure 14: Plot of Median Total Dissolved Solids, Sulfate and Calcium Concentrations in Network Springs

Table 12: Total Dissolved Solids and Turbidity in Spring Network (2001-2006)

	Total Dissolved Solids (70300)						Turbidity (76)					
	2001-2006			2006			2001-2006			2006		
BASIN & SPRING NAME	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	125	145	173	125	136.5	147	0.025	0.1	1.7	0.1	0.175	1.7
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	102	120.5	143	102	113.5	130	0.025	0.1	0.75	0.05	0.125	0.15
Gainer Spring #1C	68	79	125	69	76	125	0.025	0.2	6.6	0.1	0.125	1.2
Gainer Spring #2	50	66	82	58	65.5	68	0.1	0.15	0.65	0.1	0.225	0.4
Gainer Spring #3	58	67.5	74	60	68.5	71	0.025	0.15	0.45	0.1	0.225	0.4
Morrison Spring	106	124	132	106	109	126	0.025	0.1	0.25	0.1	0.1	0.1
Middle St. Johns Basin												
Alexander Springs	498	**538**	601	529	**533**	541	0.025	0.1	4.1	0.05	0.1	0.35
DeLeon Spring	328	**446**	620	328	**367.5**	446	0.15	0.55	0.8	0.45	0.5	0.7
Fern Hammock Springs	55	65	78	61	67	78	0.15	0.2	0.6	0.2	0.225	0.6
Juniper Springs	53	66	76	58	65	75	0.05	0.15	0.4	0.1	0.125	0.2
Marion Salt Springs	3440	**4360**	4560	3570	**4085**	4560	0.2	0.35	0.7	0.25	0.325	0.7
Rock Springs	132	142.5	155	140	144	155	0.025	0.15	0.3	0.15	0.2	0.3
Silver Glen Springs	854	**1020**	1060	854	**1020**	1060	0.025	0.1	0.35	0.1	0.1	0.25
Volusia Blue Spring	396	**640**	898	531	**574.5**	816	0.05	0.25	19	0.1	0.35	19
Wekiwa Spring	175	188	201	186	193	201	0.1	0.15	0.75	0.1	0.125	0.2
Ochlockonee - St. Marks												
Spring Creek Rise #1	1120	**4895**	20000	3380	**3380**	3380	0.3	1	2	0.59	0.59	0.59
Spring Creek Rise #2	767	**2890**	16700	976	**8338**	15700	0.1	0.65	2.8	0.6	1.7	2.8
Wakulla Spring	160	175	187	160	169.5	178	0.025	0.15	1	0.15	0.2	0.25
Ocklawaha Basin												
Apopka Spring	122	138	159	122	135.5	144	0.10	0.225	0.6	0.1	0.175	0.25
Blue Grotto Spring	217	**273**	301	217	**287**	301	0.025	0.1	0.45	0.05	0.1	0.3
Reception Hall Spring	277	**301**	319	306	**307.5**	319	0.025	0.1	0.9	0.1	0.125	0.15
Silver Spring Main	199	**259**	302	229	**243.5**	257	0.025	0.1	0.5	0.1	0.245	0.5
Springs Coast Basin												
Chassahowitzka Spring #1	267	**396**	843	321	**553.5**	651	0.025	0.1	0.45	0.05	0.175	0.25
Chassahowitzka Spring Main	310	**825**	2100	825	**1615**	1950	0.1	0.25	1.3	0.15	0.25	0.3
Homosassa Spring #1	1310	**2000**	2940	1800	**2030**	2460	0.55	1.2	7.2	1	1.2	1.9
Homosassa Spring #2	2710	**3220**	4080	2970	**3220**	3620	0.5	1.9	3	1	1.55	3
Homosassa Spring #3	480	**727**	1260	511	**938**	1140	0.15	0.325	0.9	0.2	0.35	0.45
Hunter Spring	143	206	302	196	**230.5**	294	0.025	0.1	1.3	0.05	0.125	0.25
Tarpon Hole Spring	488	**983**	3250	744	**1450**	3250	0.25	0.5	6.8	0.5	0.725	1
Weeki Wachee Main Spring	150	174	190	170	182	186	0.025	0.1	0.4	0.1	0.1	0.1
Suwannee River Basin												
Big Spring	166	182	221	166	180	187	0.1	0.25	13	0.2	0.25	0.25
Blue Hole Spring	149	167.5	203	150	155.5	164	0.025	0.15	1.4	0.15	0.225	0.4
Devil's Ear Spring	196	208.5	228	197	**215.5**	228	0.025	0.1	0.3	0.1	0.125	0.3
Falmouth Spring	204	209	210	204	**206.5**	209	0.25	0.3	0.3	0.25	0.275	0.3
Fanning Springs	254	**268**	323	254	**257**	276	0.05	0.25	1	0.1	0.25	1
Hornsby Spring	247	**275**	313	247	**261**	275	0.1	0.15	0.2	0.1	0.15	0.2
Ichetucknee Head Spring	164	182	204	164	179	184	0.025	0.2	2.7	0.1	0.175	0.35
Lafayette Blue Spring	222	**238.5**	263	238	**239**	248	0.1	0.375	0.7	0.2	0.3	0.35
Madison Blue Spring	147	158	171	147	151	160	0.15	0.25	0.95	0.15	0.2	0.25
Manatee Spring	251	**272.5**	304	251	**271**	283	0.2	0.3	1	0.2	0.45	1
Mill Pond Spring	168	198	244	189	195.5	199	0.025	0.15	0.55	0.1	0.15	0.45
Mission Spring	151	170	178	151	166	178	0.025	0.1	0.45	0.1	0.125	0.25
Troy Spring	171	203	214	196	**213**	214	0.025	0.2	2.7	0.1	0.2	0.25
Wacissa Spring #2	136	153	195	136	150	157	0.05	0.25	1.1	0.25	0.45	1.1
Tampa Bay Tributaries Basin												
Lithia Springs Major	264	**306.5**	317	266	**282.5**	309	0.025	0.1	0.2	0.1	0.15	0.2
Withlacoochee Basin												
Bubbling Spring	155	183	200	155	171	180	0.025	0.1	0.25	0.05	0.175	0.25
Rainbow Spring #1	68	83	102	69	80.5	96	0.025	0.1	0.15	0.1	0.125	0.15
Rainbow Spring #4	127	135	146	127	136.5	146	0.025	0.1	1.6	0.05	0.2	0.25
Rainbow Spring #6	125	190	207	175	184.5	203	0.025	0.1	0.15	0.1	0.1	0.15

Values in red are higher than Total Dissolved Solids statewide median for Springs Initiative stations of 202.5 mg/L and Turbidity threshold of 29 mg/L based on surface water criteria for Class I Potable and Class III Fresh waters

Table 13: Color and Total Organic Carbon in Spring Network (2001-2006)

BASIN & SPRING NAME	Color (81)						Total Organic Carbon (680)					
	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	2.5	2.5	5	2.5	2.5	5	0.5	0.5	4.6	0.5	0.5	0.5
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	2.5	2.5	30	2.5	2.5	2.5	0.5	0.5	0.5	0.5	0.5	0.5
Gainer Spring #1C	2.5	2.5	5	2.5	3.75	5	0.5	0.5	1.3	0.5	0.5	0.5
Gainer Spring #2	2.5	2.5	5	2.5	5	5	0.5	0.5	5.1	0.5	0.5	0.5
Gainer Spring #3	2.5	2.5	5	2.5	3.75	5	0.5	0.5	2.6	0.5	0.5	0.5
Morrison Spring	2.5	2.5	2.5	2.5	2.5	2.5	0.5	0.5	0.5	0.5	0.5	0.5
Middle St. Johns Basin												
Alexander Springs	2.5	2.5	5	2.5	2.5	5	0.5	0.5	2.3	0.5	0.5	0.5
DeLeon Spring	2.5	2.5	10	2.5	5	5	0.5	**1.3**	2	0.5	**1.2**	1.4
Fern Hammock Springs	2.5	2.5	5	2.5	3.75	5	0.5	0.5	0.5	0.5	0.5	0.5
Juniper Springs	2.5	2.5	2.5	2.5	2.5	2.5	0.5	0.5	1.5	0.5	0.5	0.5
Marion Salt Springs	2.5	2.5	10	5	5	5	0.5	**1**	1.3	1	**1**	1
Rock Springs	2.5	2.5	5	2.5	5	5	0.5	0.5	1.2	0.5	0.5	0.5
Silver Glen Springs	2.5	2.5	5	2.5	3.75	5	0.5	0.5	1.3	0.5	0.5	0.5
Volusia Blue Spring	2.5	2.5	10	2.5	5	10	0.5	**1.7**	2.5	0.5	**1.55**	1.7
Wekiwa Spring	2.5	2.5	5	5	5	5	0.5	**1.2**	1.7	0.5	**1.2**	1.2
Ochlockonee - St. Marks												
Spring Creek Rise #1	2.5	**55**	200	60	**60**	60	1.6	**6.1**	16	6.3	**6.3**	6.3
Spring Creek Rise #2	2.5	**60**	200	20	**40**	60	1.7	**5.4**	16	3.8	**5.4**	7
Wakulla Spring	2.5	5	30	2.5	3.75	10	0.5	0.5	2.9	0.5	0.5	1.1
Ocklawaha Basin												
Apopka Spring	2.5	2.5	10	2.5	2.5	5	0.50	0.5	2.7	0.5	0.5	0.5
Blue Grotto Spring	2.5	2.5	5	2.5	2.5	2.5	0.50	0.5	1.2	0.5	0.5	0.5
Reception Hall Spring	2.5	2.5	2.5	2.5	2.5	2.5	0.5	0.5	0.5	0.5	0.5	0.5
Silver Spring Main	2.5	2.5	5	2.5	2.5	2.5	0.5	0.5	1.4	0.5	0.5	0.5
Springs Coast Basin												
Chassahowitzka Spring #1	2.5	2.5	5	2.5	5	5	0.5	0.5	1.6	0.5	0.5	0.5
Chassahowitzka Spring Main	2.5	2.5	5	2.5	3.75	5	0.5	0.5	1.3	0.5	0.5	0.5
Homosassa Spring #1	2.5	2.5	20	5	5	10	0.5	**1**	3.1	0.5	**0.8**	1.2
Homosassa Spring #2	2.5	2.5	15	5	7.5	15	0.5	**1.1**	3.3	1	**1.25**	2.5
Homosassa Spring #3	2.5	2.5	5	2.5	3.75	5	0.5	**1.05**	2.9	0.5	**0.75**	1.1
Hunter Spring	2.5	2.5	5	2.5	3.75	5	0.5	0.5	1.2	0.5	0.5	0.5
Tarpon Hole Spring	2.5	2.5	10	5	5	5	0.5	0.5	1.4	0.5	0.5	1
Weeki Wachee Main Spring	2.5	2.5	5	2.5	2.5	5	0.5	0.5	1.5	0.5	0.5	0.5
Suwannee River Basin												
Big Spring	2.5	2.5	30	2.5	5	5	0.5	0.5	3.2	0.5	0.5	1.1
Blue Hole Spring	2.5	2.5	5	2.5	2.5	2.5	0.5	0.5	1.3	0.5	0.5	0.5
Devil's Ear Spring	2.5	2.5	10	2.5	3.75	10	0.5	0.5	2.2	0.5	0.5	2.2
Falmouth Spring	2.5	5	5	5	5	5	0.5	**1.1**	1.8	0.5	**0.8**	1.1
Fanning Springs	2.5	2.5	5	5	5	5	0.5	0.5	1.5	0.5	0.5	0.5
Hornsby Spring	2.5	10	10	10	10	10	1	**1.5**	2	1.5	**1.75**	2
Ichetucknee Head Spring	2.5	2.5	2.5	2.5	2.5	2.5	0.5	0.5	1	0.5	0.5	0.5
Lafayette Blue Spring	2.5	5	40	5	5	5	0.5	**1.55**	5.2	1.2	**1.4**	1.5
Madison Blue Spring	2.5	2.5	5	2.5	5	5	0.5	0.5	3	0.5	0.5	0.5
Manatee Spring	2.5	2.5	5	2.5	5	5	0.5	0.5	1.6	0.5	0.5	1.1
Mill Pond Spring	2.5	2.5	5	2.5	2.5	5	0.5	0.5	1.2	0.5	0.5	0.5
Mission Spring	2.5	2.5	10	2.5	2.5	5	0.5	0.5	1.5	0.5	0.5	0.5
Troy Spring	2.5	5	60	5	5	5	0.5	0.5	7.8	0.5	0.5	0.5
Wacissa Spring #2	2.5	2.5	40	2.5	5	10	0.5	0.5	4.2	0.5	0.5	1.1
Tampa Bay Tributaries Basin												
Lithia Springs Major	2.5	2.5	5	2.5	5	5	0.5	0.5	2.7	0.5	0.5	0.5
Withlacoochee Basin												
Bubbling Spring	2.5	2.5	10	2.5	5	5	0.5	0.5	1.1	0.5	0.5	0.5
Rainbow Spring #1	2.5	2.5	10	2.5	5	5	0.5	0.5	0.5	0.5	0.5	0.5
Rainbow Spring #4	2.5	2.5	10	2.5	2.5	5	0.5	0.5	0.5	0.5	0.5	0.5
Rainbow Spring #6	2.5	2.5	5	2.5	2.5	5	0.5	0.5	1.1	0.5	0.5	0.5

Values in red are higher than the Color threshold of 20 Pt-co based on current official application of the Lake Condition Index and Total Organic Carbon statewide median for Springs Initiative stations of 0.5 mg/L

Table 14: pH and Fecal Coliform in Spring Network (2001-2006)

BASIN & SPRING NAME	pH (406)						Fecal Coliform (31616)					
	2001-2006			2006			2001-2006			2006		
	min	median	max	min	median	max	min	median	max	min	median	max
Apalachicola - Chipola Basin												
Jackson Blue Spring	7.17	7.525	8.06	7.3	7.4	7.6	0	0	6	0	0.5	2
Choctawhatatchee - St. Andrew Basin												
Cypress Spring	7.35	7.69	7.82	7.5	7.65	7.8	0	0	2	0	0	1
Gainer Spring #1C	7.58	8.02	8.57	7.7	8.05	8.2	0	0	20	0	0	1
Gainer Spring #2	7.58	8.19	8.78	7.8	8.05	8.2	0	0	18	0	0	1
Gainer Spring #3	7.68	8.15	8.78	7.9	8	8.2	0	0	12	0	0	1
Morrison Spring	7.4	7.6	7.9	7.6	7.8	7.9	0	0	1	0	0	1
Middle St. Johns Basin												
Alexander Springs	7.32	7.7	7.87	7.6	7.65	7.8	0	0	1	0	0	0
DeLeon Spring	7.14	7.32	7.56	7.2	7.35	7.5	0	0	0	0	0	0
Fern Hammock Springs	7.73	8	8.3	7.8	8	8.1	88	**175**	422	132	**293**	422
Juniper Springs	8	8.225	8.7	8.2	8.2	8.3	0	0	2	0	0	0
Marion Salt Springs	7	7.46	7.5	7.4	7.5	7.5	0	0	0	0	0	0
Rock Springs	7.13	7.585	7.8	7.5	7.5	7.8	0	0	4	0	0	0
Silver Glen Springs	7.43	7.735	7.92	7.7	7.75	7.8	0	0	1	0	0	0
Volusia Blue Spring	7.07	7.3	7.44	7.2	7.25	7.4	0	0	0	0	0	0
Wekiwa Spring	6.83	7.21	7.5	7.1	7.2	7.5	0	0	0	0	0	0
Ochlockonee - St. Marks												
Spring Creek Rise #1	6.83	7.23	7.91	7.2	7.2	7.2	0	0	8	0	0	0
Spring Creek Rise #2	6.84	7.22	7.75	7.1	7.35	7.6	0	2	8	1	1.5	2
Wakulla Spring	7.2	7.48	7.93	7.4	7.41	7.6	0	0	2	0	0.5	2
Ocklawaha Basin												
Apopka Spring	7.51	7.82	8	7.6	7.75	8	0	0	30	0	0	0
Blue Grotto Spring	7.02	7.32	7.43	7.2	7.2	7.3	0	0	100	0	1	7
Reception Hall Spring	7	7.3	7.4	7.2	7.2	7.3	0	0	10	0	1	4
Silver Spring Main	6.99	7.28	7.4	7.2	7.25	7.4	0	0	24	0	0	0
Springs Coast Basin												
Chassahowitzka Spring #1	7.28	7.5	8.08	7.3	7.4	7.5	0	0	22	0	0	4
Chassahowitzka Spring Main	7.29	7.48	7.75	7.4	7.4	7.4	0	0	70	0	0	0
Homosassa Spring #1	7.28	7.51	7.67	7.4	7.5	7.6	0	0	2	0	0	2
Homosassa Spring #2	7.1	7.445	7.62	7.4	7.4	7.6	0	0	2	0	0	2
Homosassa Spring #3	7.29	7.575	7.81	7.4	7.45	7.7	0	0	10	0	0	0
Hunter Spring	7.6	7.91	8.02	7.6	7.85	7.9	0	0	2	0	0	0
Tarpon Hole Spring	7.39	7.54	7.72	7.4	7.5	7.6	0	0	15	0	0	0
Weeki Wachee Main Spring	7.17	7.5	7.72	7.4	7.45	7.5	0	0	2	0	0	2
Suwannee River Basin												
Big Spring	7	7.36	7.6	7.3	7.4	7.6	0	0	3200	0	3	44
Blue Hole Spring	7.14	7.495	7.72	7.3	7.5	7.5	0	0	8	0	0	0
Devil's Ear Spring	7.1	7.31	7.5	7.1	7.35	7.5	0	0	2	0	0	2
Falmouth Spring	7.1	7.1	7.3	7.1	7.2	7.3	0	4	74	0	2	4
Fanning Springs	6.97	7.1	7.35	7	7.05	7.3	0	0	10	0	0	8
Hornsby Spring	7.15	7.2	7.2	7.2	7.2	7.2	0	3	12	0	0	0
Ichetucknee Head Spring	7.2	7.43	7.91	7.3	7.35	7.6	0	0	5	0	0	0
Lafayette Blue Spring	6.9	7.115	7.3	7.1	7.2	7.3	0	2	14	0	2	4
Madison Blue Spring	7.43	7.595	7.8	7.5	7.7	7.8	0	0	4	0	0	0
Manatee Spring	7	7.115	7.43	7	7.1	7.2	0	0	16	0	0	2
Mill Pond Spring	7.09	7.38	7.5	7.3	7.4	7.5	0	0	4	0	0	2
Mission Spring	7.17	7.4	7.91	7.3	7.4	7.6	0	0	0	0	0	0
Troy Spring	7.24	7.37	7.56	7.3	7.35	7.47	0	0	6	0	0	0
Wacissa Spring #2	6.97	7.5	7.73	7.4	7.6	7.7	0	0	88	0	3	10
Tampa Bay Tributaries Basin												
Lithia Springs Major	7.16	7.3	7.41	7.3	7.3	7.34	0	0	0	0	0	0
Withlacoochee Basin												
Bubbling Spring	7.1	7.38	7.96	7.2	7.3	7.5	0	0	4	0	0	0
Rainbow Spring #1	7.8	8.01	8.7	7.6	7.95	8	0	0	0	0	0	0
Rainbow Spring #4	7.35	7.59	8.18	7.4	7.45	7.6	0	0	2	0	0	2
Rainbow Spring #6	7.2	7.57	7.75	7.3	7.4	7.5	0	0	6	0	0	0

Values in red are higher than pH Range of acceptable values (6 to 8.5) based on surface water criteria for Class I Potable and Class III Fresh waters and Fecal Coliform of 4 col/100 mL - Class I Potable Water (Gainer Spring only); or 400 col/100 mL - Class III Fresh (all other springs)

Fern Hammock Springs and Big Spring both had samples that were over the Class III freshwater threshold of 400 colonies/100 mL for fecal coliform bacteria. The data for Big Spring indicate that increased precipitation and severe storm events may be related to episodic higher bacteria counts that occurred from 2003 to 2005. However, Fern Hammock Spring consistently has high fecal coliform counts. A chronic bacteria issue like this usually suggests that there is a persistent source of bacteria nearby. This finding of elevated fecal coliform in Fern Hammock Spring agrees with annual FDEP EcoSummaries for Juniper Creek, downstream from Fern Hammock, which have frequently reported the detection of elevated enterococci bacteria counts in Juniper Creek. These bacteria in both waters may be from the same or a similar source.

Discharge

Spring discharge is an important component of the Springs Initiative monitoring program. Discharge data are used to document current status relative to the past and help scientists understand the impacts of climatic fluctuations as well as human influences on changes in discharge over time. Regular (and in some instances continuous) discharge measurements coupled with water quality data also help us interpret discharge-related changes in water quality. Florida's water management districts are the regional agencies assigned with the responsibility of regulating water withdrawals and have either adopted or proposed minimum flows and levels for many of the springs. Springs with adopted and/or proposed minimum flows and levels and their status are shown in **Appendix D**.

Two types of discharge data are collected in support of the Springs Initiative program, automated measurement at fixed gaging stations and quarterly spring discharge monitoring near water quality monitoring stations.

Long-term discharge and stage data have been collected by the USGS for only a few springs. However, in recent years more springs have been included in real-time stage and discharge gaging stations established by the USGS and Florida's water management districts. Under the Springs Initiative, the USGS has expanded the number of springs monitored for discharge. **Table 15** provides a summary of mean monthly discharges measured at USGS stations associated with springs in Florida. Most of these are "real-time" sites, with up-to-the-minute data available online at the following link:
http://waterdata.usgs.gov/fl/nwis/current/?type=flow&group_key=NONE

In addition to fixed gaging stations, manual discharge measurements are collected within the same time frame and location as quarterly water quality sampling. This effort, begun in July, 2004, provides data for making loading estimates for nutrients and other analytes of interest. **Table 16** provides quarterly discharge data from locations at or near spring water quality monitoring stations for those springs that were selected to be included in the quarterly discharge monitoring stations.

The absence of discharge data for some springs listed in these tables, in part, reflects the lack of data prior to the Springs Initiative program which began in 2001. Until that time, there was no statewide program designed specifically to monitor baseline conditions at Florida's springs. Prior to this time, the discharge measurement work was conducted by the USGS and water management districts but it was not conducted for a large number of springs. Therefore, there is very little long-term (greater than 50 year) regular data collection for spring discharge and it is difficult to assess discharge trends over time. Fortunately, for a handful of Florida springs

Table 15: Mean Monthly Discharge at U. S. Geological Survey Spring Stations

Basin/Discharge Station	Mean Monthly Average Discharge by Year (in cubic feet per second)					
	2001	2002	2003	2004	2005	2006
Apalachicola - Chipola						
Jackson Blue Spring nr Marianna, FL	--	--	236.57	123.69	175.60	104.61
Middle St. Johns						
Silver Glen Springs nr Astor, FL	--	129.60	116.37	112.37	93.59	99.18
Volusia Blue Springs nr Orange City, FL	--	150.58	156.27	143.26	170.44	167.29
Wekiva River nr Sanford, FL[1]	242.21	321.34	412.23	329.81	341.90	270.97
Ochlockonee – St. Marks						
Wakulla River nr Crawfordville, FL[1]	--	--	--	427.55	631.85	605.29
Ocklawaha						
Silver River nr Ocala, FL[1]	444.94	501.08	686.92	537.21	--	--
Springs Coast						
Chassahowitzka River nr Homosassa, FL[1]	49.50	55.30	70.35	71.78	66.08	61.30
Crystal River @ Bagley Cove nr Crystal River, FL (Tidally-corrected)[1]	--	652.10	614.77	975.01	944.38	891.32
Homosassa Springs @ Homosassa Springs, FL	83.73	86.57	103.12	103.32	96.62	84.57
Weeki Wachee River nr Brooksville, FL[1]	131.13	141.33	206.61	209.30	193.78	155.37
Suwannee River						
Blue Hole Spring nr Hildreth, FL	--	74.73	--	--	191.47	156.10
Cedar Head Spring nr Hildreth, FL	--	3.15	--	--	12.10	10.15
Devil's Eye Spring nr Hildreth, FL	--	39.44	--	--	56.77	48.12
Fanning Springs nr Wilcox, FL	54.14	59.03	57.38	95.67	73.04	62.57
Ichetucknee Head Spring nr Hildreth, FL	--	22.07	--	--	70.50	69.56
Ichetucknee River @ U.S. 27nr Hildreth, FL[1]	--	198.51	--	--	--	--
Madison Blue Spring nr Blue Springs, FL	--	58.41	114.99	143.07	129.98	69.42
Manatee Spring nr Chiefland, FL	102.14	90.43	134.75	198.55	220.38	159.96
Mill Pond Spring nr Hildreth, FL	--	15.91	--	--	37.00	30.97
Mission Springs Complex nr Hildreth, FL	--	58.17	--	--	112.60	93.13
Troy Spring nr Branford, FL	--	77.85	136.38	85.46	132.97	146.52
Withlacoochee						
Rainbow River at Dunnellon, FL	543.65	548.41	625.08	648.28	693.28	619.12

Notes:

[1]- Includes aggregate spring discharge from multiple springs

-- - Indicates no discharge measured that year

Table 16: Quarterly Discharge at Spring Network Stations (2001-2006)

Basin/Spring Name	Discharge by Month/Year in Cubic Feet per Second									
	07/2004	**10/2004**	**01/2005**	**04/2005**	**07/2005**	**10/2005**	**01/2006**	**04/2006**	**07/2006**	**10/2006**
Apalachicola - Chipola										
Jackson Blue Spring	96.60	98.50	126.00	231.00	108.13	112.96	168.66	96.64	106.00	64.80
Choctawhatchee - St. Andrews										
Cypress Spring	93.20	*91.07*	108.42	80.00	70.20	66.86	99.26	97.32	92.30	83.40
Gainer Springs Group	180.00	162.00	179.00	160.09	120.65	190.57	158.86	30.09	150.00	160.00
Morrison Spring	46.90	49.20	--	--	--	--	--	46.38	67.20	85.90
Middle St. Johns										
Alexander Springs	90.86	166.03	137.53	93.76	104.37	--	93.55	200.84	80.20	126.00
DeLeon Spring	15.94	46.93	32.35	21.61	11.43	31.32	35.92	248.15	28.90	28.70
Fern Hammock Springs	--	--	--	--	--	--	--	--	--	12.10
Juniper Springs	6.46	20.99	13.41	6.72	5.40	--	3.33	5.37	24.10	12.80
Marion Salt Springs	72.24	91.04	110.29	67.35	55.83	67.32	75.88	103.09	86.50	77.80
Rock Springs	52.69	65.49	65.76	48.40	57.90	60.77	66.33	58.10	47.80	50.40
Silver Glen Springs	66.39	136.59	107.57	98.00	97.19	--	56.88	68.12	96.50	109.00
Volusia Blue Spring	--	--	208.42	150.87	--	123.37	188.82	159.12	159.00	144.00
Wekiwa Spring	50.82	92.92	85.27	--	76.98	64.47	68.05	82.14	60.30	63.00
Ochlockonee-St. Marks										
Spring Creek Rise #2	--	--	--	--	--	--	--	--	--	366.00
Wakulla Spring	386.00	403.00	346.00	*544.00*	--	598.00	250.29	*372.50*	--	496.00
Wakulla River (County Rd 365)	391.00	416.00	368.00	*620.50*	--	616.00	296.84	266.00	818.50	*657.50*
Ocklawaha										
Reception Hall Spring (SS)	--	--	--	--	--	--	--	--	--	304.00
Silver Spring Main	--	--	--	--	--	--	--	--	292.00	253.00
Springs Coast										
Chassahowitzka Spring #1	9.70	19.90	10.68	3.51	6.74	10.10	7.06	--	6.66	10.90
Chassahowitzka Main Spring	--	--	--	--	--	--	--	--	27.10	60.20
Homosassa Springs Group	--	--	93.00	--	--	--	--	--	81.40	79.30
Weeki Wachee Main Spring	--	--	--	166.67	--	220.26	--	--	146.00	158.00
Suwannee River										
Big Spring (Wacissa)	38.21	83.34	73.48		57.74	56.20	56.59	44.26	53.60	48.80
Blue Hole Spring (Ichetucknee)	--	--	--	--	--	--	--	--	133.00	118.00
Devil's Ear/Eye (Gilchrist)	--	--	--	--	--	--	--	--	168.00	108.00
Fanning Springs	157.00	--	118.00	--	--	90.18	--	86.23	93.80	87.30
Ichetucknee Head Spring	--	--	--	--	69.43	39.56	19.69	47.73	64.30	60.30
Lafayette Blue Spring	50.39	--	--	--	--	109.66	--	117.17	67.00	44.50
Madison Blue Spring	96.02	--	184.85	--	--	145.84		117.01	84.00	64.10
Manatee Spring	138.00	123.00	156.00	--	--	170.67	140.71	172.38	168.00	*135.50*
Mill Pond Spring (Ichetucknee)	--	--	--	--	22.71	30.11	19.69	21.51	23.00	27.80
Mission Spring (Ichetucknee)	--	--	--	--	--	--	--	--	75.40	77.60
Troy Spring	68.70	--	--	--	--	88.19		203.66	110.00	97.00
Tampa Bay Tributaries										
Lithia Springs Major	39.55	109.45	46.79	34.72	47.23	40.67	64.42	6.37	34.40	33.10
Withlacoochee										
Bubbling Spring (Rainbow)	26.32	81.92	53.92	31.07	21.21	47.51	18.56	80.66	18.30	12.00
Rainbow Spring #1	--	--	--	--	--	--	--	--	21.80	55.10
Rainbow Spring #4	--	--	--	--	--	--	--	--	131.00	100.00

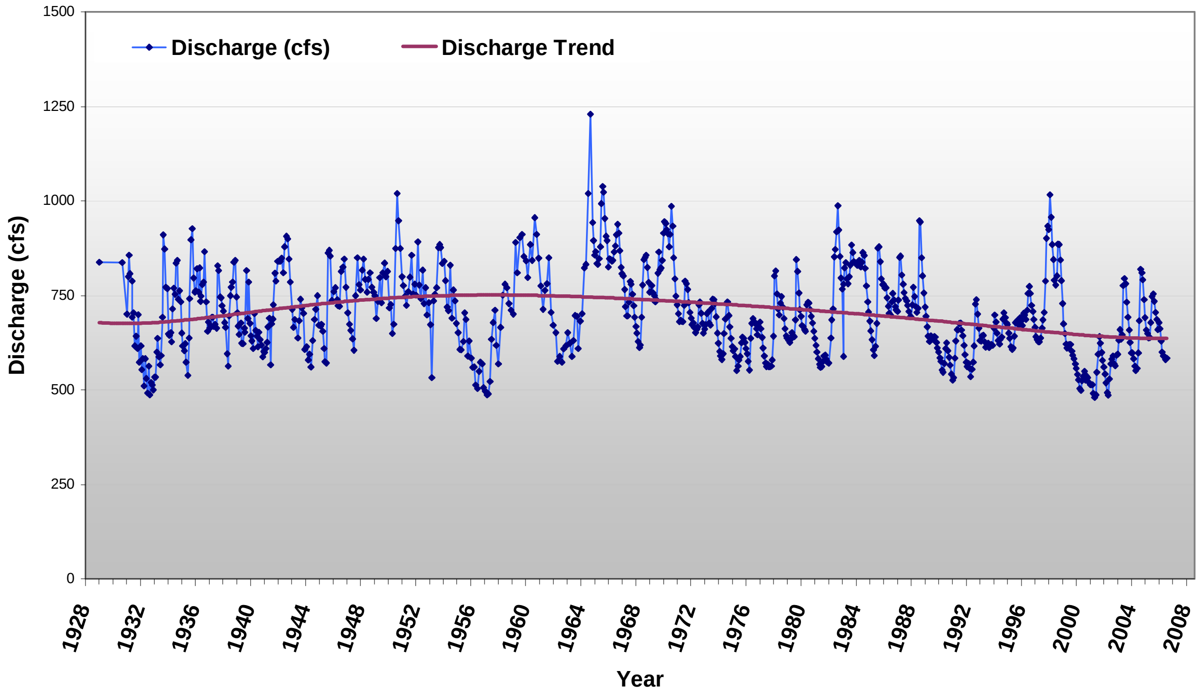
Notes: All discharge measurements prior to 7/2006 were made by the Florida Geological Survey except for those in the Apalachicola-Chipola, Choctawhatchee-St. Andrew, and Ochlockonee-St. Marks Basins, which were made by the Northwest Florida Water Management District. Discharge measurements for 7/2006 and 10/2006 were made by the U. S. Geological Survey.

Springs in **BOLD** are "historical" first magnitude springs that historically had discharges of 100 cubic feet per second or greater.Values in *italics* reflect the mean of two or more discharge measurements, and dashes (--) reflect no data collected for that quarter.

(notably Volusia Blue, Silver and Rainbow), the USGS has collected frequent and continuous discharge measurements since the late 1920s and early 1930s, which provides some idea of how springs respond over a longer period of time. **Figure 14** shows long-term spring discharge trends for the Rainbow Group of the Withlacoochee Basin and Volusia Blue Spring of the Middle St. Johns Basin. The discharge trend for Silver River was presented as **Figure 3**.

The historical records of discharge from the Rainbow Springs Group and Volusia Blue Spring are most likely dictated by precipitation, similar to what was demonstrated for Silver Springs. Periods of low discharge seen in **Figure 14** would most likely be during periods of drought but discharge could also be influenced by ground water withdrawals.

(a) Rainbow River below Rainbow Springs Group



(b) Volusia Blue Spring Run

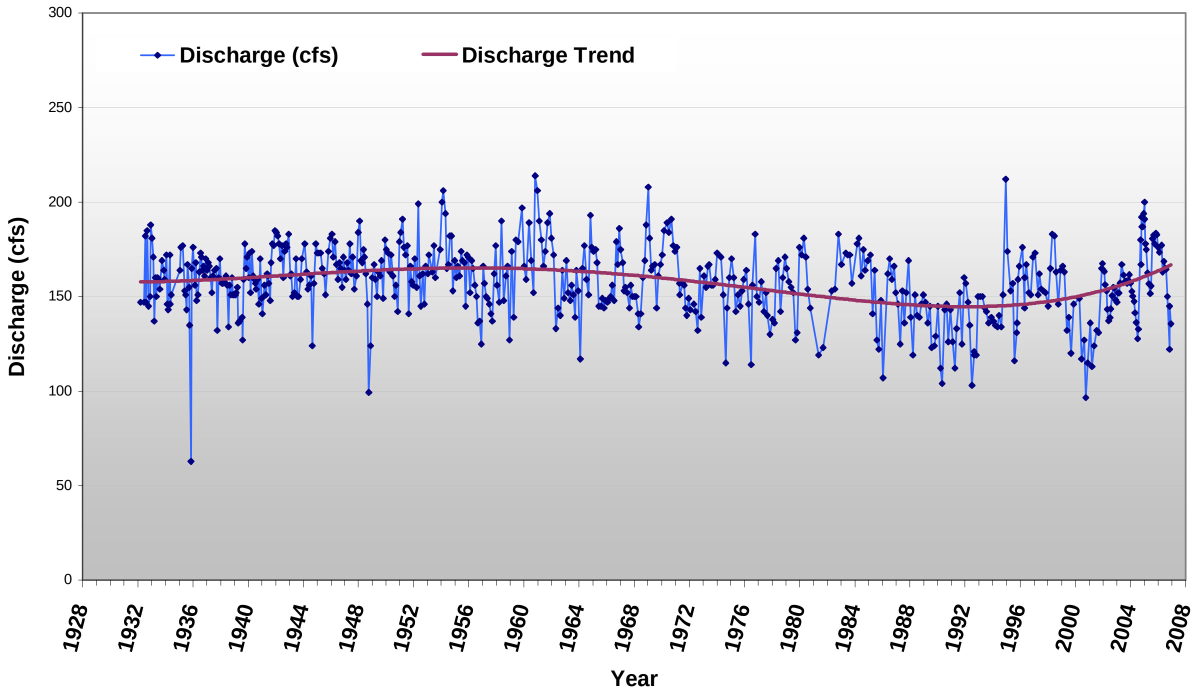


Figure 14: Historical Discharge Trends for Rainbow Springs Group and Volusia Blue Spring

SUMMARY OF MONITORING NETWORK FINDINGS

The purpose of this report is to provide a summary of the results of the water quality and measurement work conducted under this program to date and to document the status of this particular set of high priority springs. These springs, selected based on their historical, recreational and/or ecological significance, generally represent the range of natural conditions and responses to human influences confronting first and second magnitude springs statewide.

Nutrients

One of the most significant findings in this report is the large number of springs that have elevated nitrate (nitrate+nitrite) concentrations relative to background and relative to the proposed nitrogen threshold. A background nitrate+nitrate concentration of 0.02 mg/L was calculated from median concentrations for the springs with lowest nitrate concentrations in the state. This concentration was exceeded by all 49 network springs. Of the network springs, Alexander, Silver Glen and Juniper Springs, located in the Ocala National Forest, had the lowest nitrate+nitrite concentrations; however other springs not in the network have lower nitrate medians. The FDEP-proposed nitrate standard for clear waters, including springs, of 0.35 mg/L was exceeded by median nitrate+nitrite concentrations in 36 of the 49 springs in the network (approximately 73 percent). Over 40 percent of network springs had nitrate+nitrite medians greater than 1 mg/L. Network springs with the highest nitrate-nitrogen concentrations (in descending order) include Fanning, Apopka, Jackson Blue, Lithia Major, Troy, Lafayette Blue, Manatee, Devil's Ear, and Rock Springs. Sources of the nitrate in several of the more impacted springs are discussed in a following section of this report.

Phosphorus, as orthophosphate, was found to occur at significant concentrations in ground water discharged by most springs in the network. While anthropogenic sources of phosphorus do exist in these areas, elevated concentrations correspond with natural background phosphorus concentrations in the Upper Floridan aquifer. Phosphorus occurs at naturally high concentrations in some portions of the surficial aquifer and the Hawthorn Group, which lies atop the Tertiary limestones of the Upper Floridan aquifer throughout much of the state. This natural background condition makes it difficult to identify any potential anthropogenic inputs in areas where they could be a concern. Only the springs in the Choctawhatchee-St. Andrew Basin, where the Hawthorn Group material is absent, had low phosphorus concentrations.

Potassium is also an important nutrient that can be useful to help identify possible nutrient sources. Potassium concentrations and potassium–sodium ratios in springs were used to identify springs where potassium is most likely of an anthropogenic origin. Nearly as mobile as nitrate when in solution, potassium is a key component of inorganic fertilizers and was found at above background concentrations in several of the springs that also had elevated nitrate. The springs with the highest probability of significant anthropogenic potassium sources based on potassium-sodium ratios and corresponding elevated nitrate in descending order include Fanning, Troy, Morrison, Manatee, Rock and Apopka springs.

Salinity

Salinity indicators were used to identify the springs that are saline-influenced due to their setting near the coast or inland in an area that includes the St. Johns River of the Middle St. Johns River Basin. Saline-influenced springs were found to have naturally elevated concentrations of sodium, chloride, specific conductance, total dissolved solids, as well as potassium. The St. Johns River area and coastal waters in the Springs Coast Basin are two settings with significantly elevated concentrations of these analytes. Interpreting trends in salinity indicator concentrations can be difficult due to many factors such as tidal fluctuations, changes in aquifer recharge due to fluctuations in precipitation or ground water withdrawal. At this time, the available quarterly monitoring data for network springs is not sufficient to establish long term salinity trends with adequate confidence. Future work will use the salinity indicators in conjunction with discharge data to evaluate springs with declining trends.

Ground Water-Surface Water Interaction

Ground water–surface water indicators that include DO, total dissolved solids, sulfate and calcium were used to compare spring water to ground water and surface water. This approach helped to identify the predominant sources of water influencing the various springs and identify those springs that are more vulnerable to recent ground water recharge or surface water. The springs with the highest DO concentrations, which may indicate a significant surface water component or more direct infiltration of rainfall, in decreasing order include Jackson Blue, Rainbow #1, Juniper, Fern Hammock, Rainbow #6, Rainbow #4, Hunter, Cypress, Chassahowitzka #1, Bubbling and Homosassa #1 springs. Persistently elevated fecal coliform bacteria counts in one spring, Fern Hammock Spring, point to a nearby source of contamination. Calcium, total dissolved solids and sulfate concentrations in many of these springs that interact most with water from the surface also have chemical signatures closer to surface water than ground water from the Upper Floridan aquifer.

Discharge

Because of the lack of long-term discharge data for springs, significant trends are difficult to discern. The monitoring network data are helpful in determining short term changes and longer term changes when combined with data from other sources. Three springs with 50 to 75 year records–Silver, Rainbow and Volusia Blue – show a slow decline in discharge from the late 1950s and early 1960s to present. This trend is likely due to low rainfall but in some cases it could be worsened by ground water withdrawals.

RECOGNIZED SOURCES OF NITRATE IN SPRINGS

As discussed previously in this report, nitrogen enrichment, primarily by nitrate-nitrogen, has been linked with the overgrowth of algae and resultant ecological impacts to spring runs. The water discharged from spring vents is mainly from ground water, thus the discharge of nitrate into spring systems comes from ground water. This is not surprising since nitrate is the most widespread contaminant in the state impacting ground water quality (FDEP, 2008a).

The occurrence of nitrate in the springs of a particular area depends on the proximity and relative nitrogen contribution of sources and the vulnerability of the ground water to contamination. This section of the report provides an assessment of nitrate sources impacting 10 springs or spring groups that are impaired by nutrients and documents the major sources most likely impacting those springs. The springs that are assessed and their approximate contributing areas (springsheds) are shown in **Figure 15**.

Aquifer Vulnerability

One thing that all springs have in common is that they occur in areas of karst terrain. Karst areas exist where limestone is near enough to the land surface to be exposed to weathering and dissolution processes. Infiltrating precipitation and surface water can cause erosion and dissolution of the underlying limestone, create sinkholes and solution channels and enlarge underground caves and conduits within the aquifeIn karst areas, the soils are sandy and permeable and the thickness of overburden between the surface and the underlying aquifer may be minimal. These types of areas need the most protection from sources of nitrate such as septic tanks, wastewater disposal sites, animal waste, and areas where fertilizer is applied. In addition, soils in these areas are low in natural fertility and moisture-holding capacity and sometimes require excessive amounts of irrigation water and fertilizer for successful production of agricultural crops.

While the immediate area of a spring always lies within a vulnerable karst area, its springshed can extend for miles and include ground water recharge areas that are not so vulnerable. To evaluate the relative aquifer vulnerability within springsheds, a tool developed by the Florida Geological Survey (FGS) can be used. In 2004, the FGS developed a statewide GIS model for aquifer vulnerability known as the Florida Aquifer Vulnerability Assessment (FAVA; in Arthur et al, 2007). By utilizing information on depth to ground water, hydraulic head differences, thickness of confining units, soil permeability and other characteristics, this model predicts the vulnerability of the underlying aquifer systems to surface contamination. **Figure 16** shows the FAVA model results for aquifer vulnerability for the Upper Floridan aquifer in the spring areas.

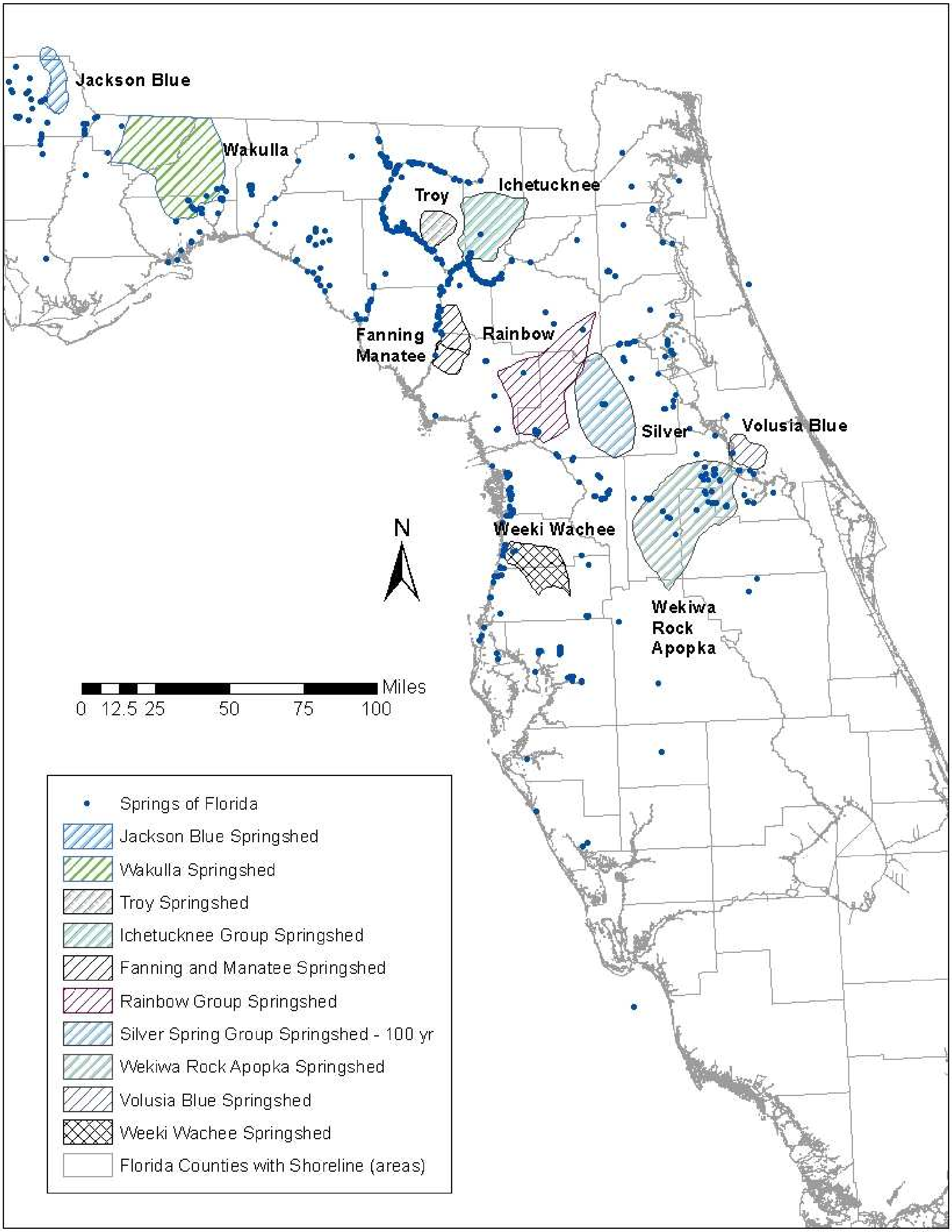


Figure 15: Selected Springs with Significant Nitrate Issues and their Springsheds

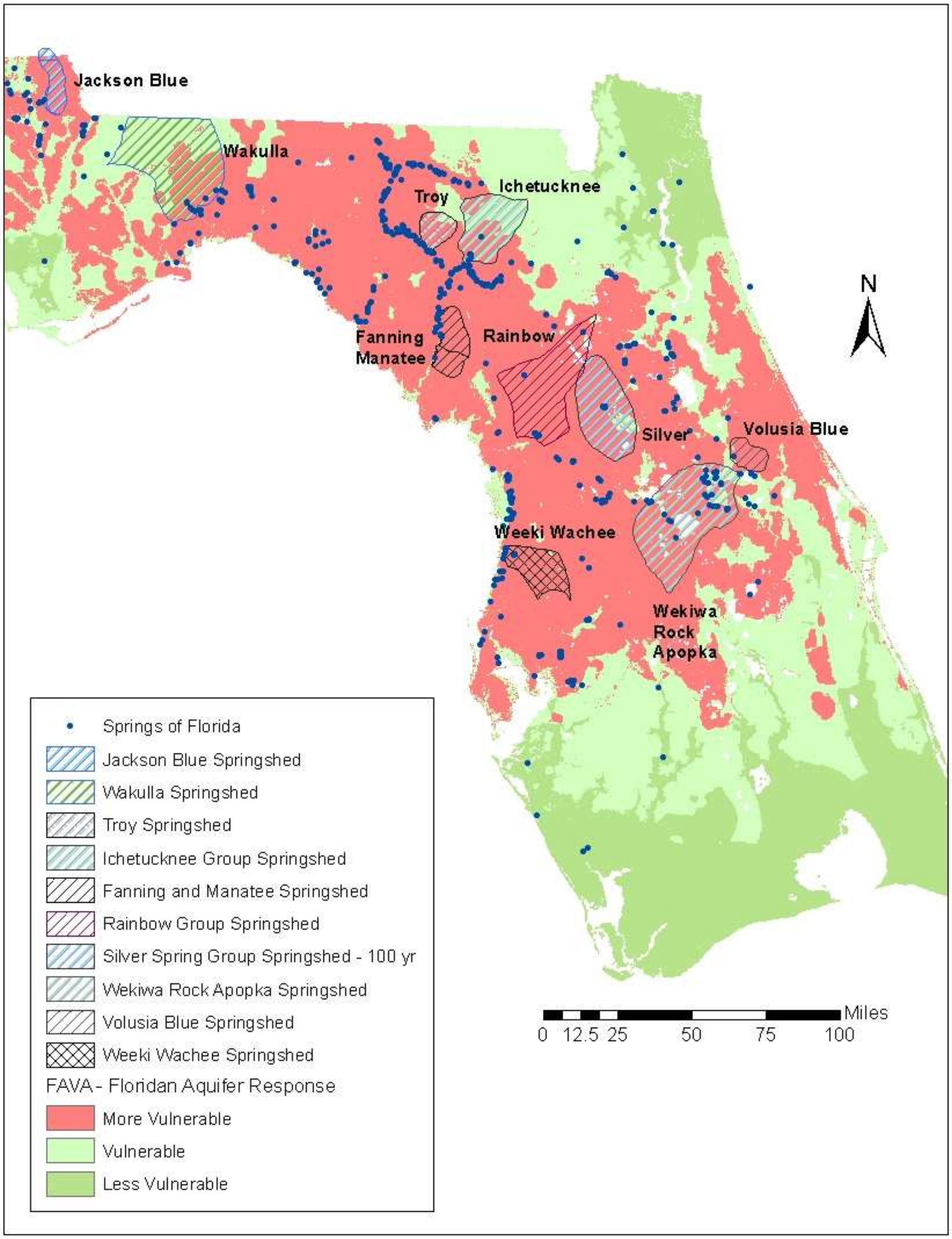


Figure 16: Aquifer Vulnerability in Spring Areas

Potential Sources of Nitrate

As discussed in a previous section of this report, the sources of nitrate are of mainly human origin. In general, inorganic fertilizer is the predominant source of nitrate influencing water quality overall (SJRWMD, 2007). However, for some springs, other sources may be just as significant depending on their prevalence and location in the springshed. **Table 17** provides a comparison of nitrogen loadings for the range of nitrate sources that are most likely to occur in spring areas. Estimated fertilizer inputs are from published agronomic rates provided by the University of Florida Institute of Food and Agricultural Sciences (IFAS). Potential input from other sources was calculated from actual research data or data from typical permitted facilities.

Inorganic fertilizer use is difficult to estimate because application amounts and frequencies vary. However it would not be unusual for a farmer or homeowner to apply more than an IFAS recommended rate for a variety of reasons necessary for successful crop production, thus the rates in **Table 17** should be considered estimates. Low soil fertility, excessive fertilizer leaching because of rain events or over irrigation, and multiple cropping of agricultural fields are all reasons why growers might fertilize in excess of the IFAS-recommended rates. Also, over-fertilization is not uncommon for some residential homeowners. The high potential for fertilizer leaching in the excessively-drained sandy soils typical of spring areas is a major reason that inorganic fertilizer is such a prevalent source of nitrate in the ground water and springs. The amount of nitrogen leaching to ground water from fertilizer applied to crops has been estimated at 20 to 35 percent under a Mid-Atlantic Coastal Plain scenario (Bohlke and Denver, 1995); however the amount under these soil conditions would likely be higher.

Animal waste is used as a fertilizer source in several of these springsheds and IFAS provides recommended application rates for chicken and cow manure. However, animal waste management is often a significant challenge for poultry operations, dairies and horse farms. Disposal demands of animal waste often exceed recommended application rates. For larger dairies, for example, accepted practices of spray irrigating liquid waste and land spreading solid waste per IFAS-recommendations are difficult to follow because of the large volumes of manure being managed. A typical dairy cow generates approximately 50,000 lb/year of raw manure (Van Horn et al, 1990). Under an ideal scenario it has been estimated that only 6.6 percent of the waste from beef and dairy operations would leach to ground water, but under less favorable conditions up to 60 percent could leach (Van Horn et al, 1991). An average 1,000 lb horse generates over 14,000 lb/year of manure, and when confined to a stall can produce 730 cu ft/yr of bedding material that must be managed (Davis and Swinker 2003). The poultry industry in North Florida produces about 4,000 lb of manure for every 1,000 chickens (Mitchell et al, 1990). Leaching of nitrogen from poultry waste could range from 0 to 30 percent (Jacob and Mather, 1997). A small percentage of leaching of nitrate from either type of operation, because of the volume, could amount to a significant load of nitrate to ground water.

Domestic wastewater discharge to ground water also can contribute significant loads of nitrate and can impact springs. This is particularly a concern when facilities discharging large volumes of secondarily-treated wastewater are located near springs or along preferred ground water flow pathways to springs. Nitrogen loading amounts from many of the larger facilities can be similar to or higher than those from inorganic fertilizers applied to agricultural sites, with the ultimate amount received by ground water depending on specific practices at the application sites. Also, wastewater loadings from residential septic tanks can be significant in aggregate in large,

Table 17: Potential Sources of Nitrate to Ground Water in Florida Spring Areas and Estimated Loadings

Nitrogen Source	Estimated Nitrogen Inputs per Year (lb/acre/year unless otherwise noted)	Comments
Agriculture and Turf Grass		
Row and field crops- field corn, inorganic fertilizer[1]	210	Irrigated; (Mylavarapu et al, 2009),
Vegetables, inorganic fertilizer[1]	60 – 200	Sweet corn, potatoes, tomatoes, at 200 /lb/ac/crop (Hochmuth and Hanlon, 2000)
Hay field/Silage, inorganic fertilizer[1]	320	Bahia grass, assume 4 cuttings; (Mylavarapu et al, 2009)
Fertilized pasture, inorganic fertilizer[1]	50–160	Bahia grass; (Mylavarapu et al, 2009)
Fertilized pasture, cow manure (wet and dry)	102-274	Recommended rates in WAM model document; (SWET, 2002)
Fertilized pasture, poultry litter	257-275	Recommended rates in WAM model document; (SWET, 2002)
Silviculture, inorganic fertilizer[1]	40-50* 150-200**	*Per application, recommended for newly planted sites, not used on an annual basis; (UF/IFIS, 2008); ** for pine straw production, max 1,000 lb/acre/20-yr period (Minogue et al, 2007)
Container nursery, control release fertilizer, inorganic[1]	17-472	Based on 2 to 3 lb control release fertilizer/ yd^3 of potting mix, ranging from pot sz #1 to pot sz #25 spacing (Yeager, 2009; Garber et al, 2002)
Citrus grove, inorganic fertilizer – historical	100- 300 oranges; 90-240 grapefruit	Documented application rates (Parsons and Boman;2006)
Inorganic fertilizer, bermudagrass-central Florida[1]	174-261	4-6 lb/1000 sq ft; (Sartain et al, 2009)
Inorganic fertilizer, St. Augustine grass-central Florida[1]	87-131	2-3 lb/1000 sq ft; (Sartain et al, 2009)
Domestic Wastewater		
High density residential septic system- conventional	129	Assumes 4 systems per acre, 57.7 mg/L and 184 gpd; (based on Hazen and Sawyer, 2009)
Medium density residential septic system- conventional	64.6	Assumes 2 systems per acre, 57.7 mg/L and 184 gpd; (Hazen and Sawyer, 2009)
Low density residential septic system- conventional	6.5	Assumes 1 system per 5 acres, 57.7 mg/L and 184 gpd; (Hazen and Sawyer, 2009)
High density residential septic system – performance-based	77.4	Assumes 4 systems per acre, 34.6 mg/L and 184 gpd; (based on Harden et al, 2009)
Medium density residential septic system – performance-based	38.7	Assumes 2 systems per acre, 34.6 mg/L and 184 gpd; (based on Harden et al, 2009)
Low density residential septic system – performance-based	3.9	Assumes 1 system per 5 acres,34.6 mg/L and 184 gpd; (based on Harden et al, 2009)
Secondary Treated Effluent	21,900-46,820 lb/yr	Loading based on concentration X discharge rate; typical values with concentration depending on individual plant requirements; typical secondary effluent concentration range 7.2 – 15.4 mg/L, for example discharge of 1 MGD was assumed
Advanced Waste Treatment (AWT) Effluent	9,120 lb/yr	Loading based on concentration X discharge rate; normal AWT requirement to treat to 3 mg/L , for example discharge of 1 MGD was assumed
Atmospheric deposition	32.8	2008 wet deposition average for 4 north and central Florida sites; (from USGS National Atmospheric Deposition Program web site)

Note: [1]Estimated loadings from fertilization are conservative, based on recommended agronomic rates and not actual field data.

subdivisions where residential lots are closely spaced. However, loadings are much lower in less densely developed areas. Recent septic tank research in Florida shows that the nitrogen loadings from performance-based residential septic tanks are approximately 40 percent lower than those from conventional septic systems but they do not typically meet the 10 mg/L treatment expectation (Harden et al, 2009 in draft).

Inputs of atmospheric deposition of nitrate can be significant, as seen in **Table 17.** Atmospheric deposition in precipitation varies significantly, with higher concentrations occurring in more urban areas. According to the USGS National Atmospheric Deposition Program data, in a less populated area of northwest Florida with little agriculture, the median TN concentration in atmospheric deposition (as wet deposition) over the past 10 years was only 0.12 mg/L. However in the Orlando area, where atmospheric deposition from urban sources such as vehicle emissions and industry exists, the median TN concentration from wet deposition was almost ten times higher (1.1 mg/L). Atmospheric deposition in agricultural areas may also be significant. The 10-year median TN concentration in precipitation at a Gadsden County site, which has row and field crop farming, was 0.69 mg/L. While these inputs by atmospheric deposition can be significant, several reports note that atmospheric deposition's actual load of nitrogen to ground water is expected to be low in comparison to other sources when they are present (Chelette et al, 2002; Katz et al, 2005; MACTEC, 2009; SJRWMD 2007). Atmospheric inputs of nitrogen, although significant, are spread across all areas, and are thus available at manageable concentrations which allow plant uptake or attenuation by soil. The nitrate concentrations in some background springs discussed earlier in the report may include inputs from atmospheric deposition or natural sources, since these springs are not generally near significant agricultural or wastewater-related sources of nitrogen. These springs generally have nitrate concentrations of less than 0.05 mg/L.

It is common for nitrate in a spring to be coming from a mixture of sources. As a further complication, a spring is often being impacted by a mixture of sources that include sources that are no longer present due to land use changes. The springs selected for this discussion (**Figure 15**) have been impacted by a range of sources. Some have springsheds that are dominated by agricultural land uses whereas others have a higher percentage of urban-residential land use.

By-Springshed Evaluation of Nitrate Sources

The major influence on the water quality of most springs is ground water that flows through regional and local subsurface systems. If there is adequate ground water quality data, there is usually a relationship between nitrate in ground water in a particular springshed and the nitrate concentration in the spring(s). Most of the available nitrate data for ground water is from targeted sampling of private wells by the FDOH, thus the springsheds with the largest number of wells sampled for nitrate are typically the ones with more widespread ground water quality issues. This targeted sampling is conducted under the FDEP Water Supply Restoration Program in areas where contaminant sources are known or suspected to exist. The analyses are run at the FDOH central laboratory and water quality and sample location data are maintained in a database by FDEP. In some of these springsheds there is also ground water data from Floridan aquifer system wells sampled under other programs. **Appendix E** provides maps of each of these spring areas showing the nitrate concentrations in wells with data. This summary information represents data collected over varying periods of record, depending on area. No attempt was made to distinguish between data sources, although the majority of the wells are private drinking water wells. It is assumed that the majority of these private wells withdraw water from the Upper Floridan aquifer, since it is the main potable water source in these areas.

The breakdown of land uses potentially contributing to nitrate issues in these springsheds and numbers of specific sources that may contribute nitrate to ground water and springs is shown in **Table 18**. Using the information in **Tables 17** and **18**, along with information from previous work in these springsheds, some assertions can be made about the sources of nitrate impacting these springs. This type of information may be useful in predicting the sources of nitrate in springsheds where less information is available.

Wakulla Spring

Wakulla Spring, impaired by nutrients, had a median nitrate concentration of 0.69 mg/L and the concentration has been declining slightly over the past several years. Its springshed is large, extending northward into southern Georgia and includes the city of Tallahassee and several smaller communities in Leon and Wakulla counties. Several studies have indicated that the Woodville Karst Plain, which extends from the southern outskirts of Tallahassee southward and makes up 40 percent of the springshed in Florida, is the major focus area for nitrate sources potentially impacting the spring because of the high vulnerability of the aquifer in this region (**Figure 16**).

Over 29 percent of the 302 wells in the springshed with nitrate data had concentrations higher than 1 mg/L, and 15 wells had nitrate concentrations higher than the ground water standard (10 mg/L). The highest nitrate concentration in a well was 32 mg/L. Wells with the highest nitrate concentrations (>10 mg/L) are in the southern (high vulnerability) area of the springshed. Studies (Chelette et al, 2002; Katz et al, 2009) have indicated that the (17.5 MGD) City of Tallahassee municipal wastewater sprayfield is a large source of nitrate in this area and that it is impacting the spring. Until recent years, agricultural fertilizers applied to the sprayfield site may have also added to the load of nitrogen coming from the site.

Nitrate isotopic signatures in recent spring water samples (∂15N at 8.8 to 9 ‰) indicate that the nitrate is mainly of an organic waste origin (Katz et al, 2009). Numerous residential septic tanks also exist in the vicinity and are particularly concentrated in Woodville, located several miles to the north of the spring, and in several large subdivisions within the springshed. Ground water traces and cave divers have documented that large underground conduits are able to transmit water rapidly from source areas (Hazlett-Kinkaid, 2007; FSU, 2009). A dye trace from the Tallahassee municipal wastewater sprayfield to Wakulla Springs showed that the ground water travel time was approximately 60 days (Hazlett-Kinkaid, 2007). The major historical source of nitrate in the spring is wastewater from the municipal sprayfield; however it is likely that septic tanks in the more vulnerable areas are also significant contributors. The City of Tallahassee wastewater treatment plant will soon be upgraded to provide advanced wastewater treatment (AWT), which should reduce the nitrate wastewater concentration by 75 percent.

Table 18: Nitrogen-related Land Use Characteristics for Selected Springsheds

Springshed	Total Acres	Row and Field Crops (percent)	Improved Pasture (percent)	Hayfield (percent)	Citrus (percent)	No. Dairies	No. Ornamental Nurseries	No. Poultry Farms	No. Cattle Feeding Operations	No. Horse Farms	High Density Residential (percent)	Medium Density Residential (percent)	Low Density Residential	No. Golf Courses	No. Domestic Wastewater Facilities, discharging to ground water
Jackson Blue	85,677	30.1	7.6	([1])	0	0	1	1	0	0	0	0.5	3.9	1	0
Wakulla	570,271	2.8	2.1	([1])	0	1	14	3	1	17	2.3	4.5	5.9	11	17
Troy	75,018	19	10.7	([1])	0	1	12	23	11	9	0	0.2	5.7	0	0
Fanning-Manatee	131,553	18.8	15.5	([1])	0	8	0	1	6	1	0.1	1.3	6.2	1	8
Ichetucknee Group	245,390	5.4	10.1	([1])	0	0	8	4	3	18	0.5	3	8.6	3	13
Silver Group	316,879	3.6	10.4	([2])	0.3	2	23	3	0	241	1	6.5	0.3	39	13
Rainbow Group	439,198	1.4	19.1	([2])	0	4	19	1	1	199	0	0.7	11.1	14	14
Wekiwa-Rock	564,141	3.6	6.7	([2])	4.6	0	288	12	2	213	1.9	8.7	6.4	36	85
Volusia Blue	66,793	0	2.2	([2])	0.2	0	5	2	0	6	1.8	28.7	14.6	15	21
Weeki Wachee	153,732	20.5	([1])	([2])	1.1	([4])	34	14	([3])	27	2	11.6	11.4	30	18

Notes:
Information on wastewater facilities is from the FDEP wastewater facilities database (WAFR). Other data were obtained from the following land use GIS coverages for these water management districts: NWFWMD, 2004: SJRWMD, 2004; SRWMD, 2006-2008; and SWFWMD, 2006.

[1] - combined with row and field crops
[2] - combined with improved pasture
[3] - combined with poultry farms as “feeding operations"
[4] - combined with horse farms and aquaculture as “specialty farms”

Troy Spring

Troy Spring, on the Suwannee River, had a median nitrate concentration of 2.2 mg/L and is included under the Suwannee River Nutrient TMDL. Its springshed extends northeastward from the spring vent and includes a rural, agricultural area of Suwannee County that has approximately 30 percent of its land use in field and row crops, hayfields and improved pasture. There are also 23 poultry farms and 11 cattle feeding operations in the springshed. Ground water throughout this entire springshed is highly vulnerable (**Figure 16**), which is typical of all springs in the Middle Suwannee Basin.

Over 50 percent of the 148 wells in this springshed with nitrate data had concentrations higher than 1 mg/L and more than 10 percent of the detected concentrations were higher than 10 mg/L. The highest nitrate concentration in a well was 26 mg/L. Wells with elevated nitrate concentrations are distributed throughout the springshed and wells with the highest concentrations are in the northwestern and central portions of the springshed. Private wells with the highest nitrate concentration are near poultry farms, field and row crop/hayfields, improved pastures, cattle feeding operations, and ornamental nurseries.

Troy Spring was sampled for nitrate isotopes in 1997, 1998, 2001 and 2005 and ∂15N values were 5.4, 5.4, 6.7 and 5.3 ‰, respectively (Katz et al, 1999; Albertin et al, 2007). The isotope results suggest that the nitrate is from mixed inorganic and organic sources, which is consistent with the land use pattern of mixed agricultural activities (Katz et al, 1999). According to Hornsby and Mattson (1998), in 1997 fertilizer accounted for 48.9 percent of the total nitrogen inputs in Suwannee County, followed by poultry litter (34.1 percent). This information indicates that nitrate in Troy Spring is from inorganic fertilizer applied to row and field crops, hay, and pastures as well as poultry manure.

Fanning and Manatee Springs

Fanning and Manatee Springs are the largest springs in their combined springshed, which includes the towns of Chiefland, Trenton and Fanning Springs. Fanning Spring, an historical first magnitude spring, had the highest median nitrate concentration of all network springs at 5.2 mg/L. The median nitrate concentration in Manatee Spring was 1.8 mg/L. Both springs are impaired by nutrients and included under the Suwannee River Nutrient TMDL. The Upper Floridan aquifer is highly vulnerable within the entire springshed (**Figure 16**). Of the 188 wells in the springshed with nitrate data, over 57 percent had nitrate concentrations higher than 1 mg/L and over 5 percent have nitrate concentrations higher than the 10 mg/L ground water standard. The highest nitrate concentration in a well was 62 mg/L.

Agricultural land uses dominate this area, with more than 34 percent of the area in the combined uses of row and field crops, hay fields and improved pastures. Most of the springshed area is in Levy and Gilchrist Counties. Both counties are ranked among the highest in the state for silage corn production, with Levy consuming more than 3,700 and Gilchrist consuming more than 2,000 tons of nitrogen fertilizer per year (Obreza and Means, 2006). There are 8 dairies in the springshed and 6 of these are large, requiring industrial wastewater permits. There are 8 domestic wastewater treatment plants that discharge to ground water, with the 0.475 MGD City of Chiefland and the 0.2 MGD City of

Trenton plants the largest and the others much smaller. Less than 8 percent of the springshed is in residential land use and 6.2 percent of that residential land use is low density.

Nitrogen 15 values for both Fanning and Manatee Springs fall within the range indicative of mixed inorganic and organic sources of nitrogen, with ∂15N values of 7.1, 7.2 and 7.3‰ over a 10-year period and the ∂15N for Manatee Spring at 5.8‰ in 1997 (Katz et al, 1999 and Albertin et al, 2007). These isotope results are in agreement with the land use in the area dominated by heavy fertilizer use and numerous large dairy operations.

Ichetucknee Springs Group

Of the springs in the Ichetucknee Group, nitrate concentrations in Ichetucknee Head Spring (0.77 mg/L), Blue Hole (0.695 mg/L), and Mission Spring (0.58 mg/L) were the highest. Blue Hole and Mission were listed as impaired by nutrients. The springshed of the Ichetucknee Group includes an upland area where the Upper Floridan aquifer characterized as vulnerable and a karst plain area in which it is characterized as more vulnerable. The largest urban center, Lake City, is in the upland area. The upland area has a clay confining layer between the surface and the aquifer, whereas the more vulnerable karst plan (about 56 percent of the springshed, **Figure 16**) has no confining layer.

The land uses in this springshed include medium density residential and commercial development in the Lake City area and mainly rural agricultural lands in the remainder of the springshed. Medium- and low-density residential development makes up 11.6 percent of the springshed. Many residences within the Lake City service area are provided municipal wastewater treatment by the (3 MGD) city wastewater plant, which discharges secondarily-treated effluent to a sprayfield southwest of the city. The sprayfield is approximately 10 miles north of the Ichetucknee Head Spring (Katz and Griffin, 2007) and near the historical river channel known as the Ichetucknee Trace. Agricultural land uses in the springshed include row and field crops, improved pasture and hay, which combined make up about 15 percent of the springshed's land uses. Ground water data from the springshed indicate that over 22 percent of the wells with data in the springshed have nitrate concentrations greater than 1 mg/L. Two wells in the springshed had nitrate concentrations higher than the ground water standard.

Nitrogen isotope data from several of the springs in the Ichetucknee Group show that the springs in this group are not all influenced by the same sources of nitrogen. The ∂15N results for Ichetucknee Head Spring an Blue Hole Spring indicated that the nitrate was mainly from inorganic sources, the results from Mission Spring indicated that the nitrate may be from a combination of inorganic and organic sources, and the results for Devils Eye Spring, also nutrient-impaired, indicated that the nitrate was from an organic nitrogen source (Albertin et al, 2007; Katz and Griffin, 2007). The contribution of nitrate to Devils Eye Spring from a wastewater source was confirmed by a dye trace that linked a nearby septic tank drainfield on state park land to Devils Eye Spring. Another dye trace, conducted on a larger scale, linked Rose Sink (located about 4 miles south of the Lake City sprayfield) with several of the Ichetucknee Group springs (Butt and Murphy, 2003). The land uses in the watershed of Rose Creek includes agricultural and forest lands that are being converted to residential areas. Separate dye trace studies have confirmed the connection of Black and Dyal Sinks, located in Clayhole Creek, with Rose Sink and the springs. Stormwater in Clayhole Creek flows underground in Black, Clayhole and Dyal Sinks before it moves toward Ichetucknee Springs. Clayhole Creek was found to be connected to Rose Sink and the Ichtucknee Springs. However, no direct evidence has specifically linked the sprayfield to the springs. Multiple sources of nitrate are impacting these springs, with fertilizer from agricultural fields, pastures, and possibly residential lawns being the most significant in the springs with the greatest discharge.

Silver Springs Group

The Upper Floridan aquifer within most of the springshed of the nutrient-impaired Silver Springs Group is highly vulnerable to contamination (88 percent in **Figure 16**). Of the springs in the Silver Springs Group, Silver Main (AKA: Mammoth Spring) has the highest discharge and had a median nitrate concentration of 1.1 mg/L. Nitrate concentrations in these springs have steadily increased as the springshed transitioned from natural land to agricultural and urban development. According to the most recent land use figures (2004), approximately 8 percent of the springshed is in urban development. Over 66 percent of the 328 wells in the springshed with nitrate data had concentrations higher than 1 mg/L and 23 wells had nitrate concentrations higher than 10 mg/L. The highest nitrate concentration in a well was 31 mg/L. The more elevated nitrate concentrations in wells were found in the central and western areas of the springshed.

The largest city in the springshed (and in close proximity to the springs) is Ocala. Ocala's two municipal wastewater treatment plants (approximately 9 MGD total capacity) and wastewater and residuals application sites are in the 100-year capture zone of the spring group. The capture zone also includes the (0.998 MGD) Silver Springs Shores wastewater plant and application site, plus approximately 10 smaller wastewater facilities. Also, many of the residential areas in the 100-year capture zone are on individual septic tanks. According to the Marion County Planning Department (Kuphal, 2005), most of the domestic wastewater loading of nitrogen in Marion County, which includes the spring group's 10-year capture zone, may be from septic tanks. Much of land in the springshed is used for thoroughbred horse farms and exists as improved pasture. There are approximately 241 horse farms in the 100-year capture zone and improved pasture and/or hayfields make up 10 percent of the land use in the area. Other land uses that could contribute nitrate to ground water and the springs include 23 ornamental nurseries and 39 golf courses.

A USGS study of nitrate in ground water of the Silver Springs area (Phelps, 2004) found that for a network of wells in urban areas, the median nitrate concentration in ground water was 1.15 mg/L and for as similar network in agricultural areas, it was 1.7 mg/L. Nitrate isotope data in the ground water samples from those wells indicated that the source of nitrate in the agricultural areas appeared to be mainly inorganic fertilizers and in the urban areas the ∂15N values were in a range that suggested a mixture of inorganic and organic nitrogen sources. The ∂15N results for the springs were variable. Phelps (2004) found that the source of nitrate in Silver Main was inorganic on one occasion and mixed inorganic and organic on another occasion. In a later sampling, SJRWMD found that most of the springs sampled had values in the mixed source range (Toth and Knowles, 2007). Based on the land use and other data, the main sources of nitrate in the springs most likely include inorganic fertilizer applied to pastures and wastewater from septic tanks and municipal wastewater application sites. Because of the large number of horse farms in the springshed, horse manure could also be a contributing source.

Rainbow Springs Group

All of the network springs in the Rainbow Springs Group have median nitrate concentrations higher than 1 mg/L. The Upper Floridan aquifer is highly vulnerable to contamination in over 95 percent of their springshed (**Figure 16**). This area is mostly rural, with Williston and Dunnellon being the largest population centers. The City of Williston's 0.45 MGD municipal wastewater treatment plant, which discharges to a sprayfield, is the largest point source of domestic wastewater and most areas outside of Williston's service area are on individual septic tanks. The predominant agricultural land use that could be a nitrogen source in the springshed is improved pasture (19.1 percent, which also includes hayfields in the available landuse coverage). Many of these pastures are associated with the large number of horse farms in the springshed (approximately 199, **Table 18**).

Over 41 percent of the 222 wells in the springshed with nitrate data had concentrations higher than 1 mg/L and 2 of those had nitrate concentrations higher than the ground water standard. The highest nitrate concentration in a well was 23 mg/L. The distribution of elevated ground water wells are found throughout the entire springshed and the wells with the most elevated nitrate levels (>10 mg/L) are in the central portion of the springshed.

A SWFWMD assessment of nitrate sources in the Rainbow Springs area (Jones et al, 1996) identified fertilized pastures as the principal source of nitrate in the springs because primarily inorganic sources were identified in ∂15N analyses of ground water and spring water samples. Nitrogen loading calculations showed that pasture fertilization contributed the largest amount of nitrogen in the study area and the highest nitrate concentrations in ground water samples were found near pasture lands. About 10 years later, Albertin et al (2007) found ∂15N values were lower than 3‰ in spring water samples, which agreed with the SWFWMD finding that the nitrate source in the springs was inorganic fertilizer. The available information indicates that the main source of nitrate causing impairment of the springs is inorganic fertilizer applied to pastures.

Wekiwa and Rock Springs

The Upper Floridan aquifer is highly vulnerable to contamination in more than 76 percent of the combined springsheds of Wekiva and Rock Springs, also known as the Wekiva ground water basin (**Figure 16**). Apopka Spring and several other springs are also included in this group. Nitrate concentrations in these two springs increased significantly during the 1980s to their maximum concentrations in the mid-to-late 1990s and then declined somewhat to their current levels. The nitrate concentration in Wekiva declined from a high of over 2 mg/L to approximately 1 mg/L or lower. The 2006 median nitrate concentrations for Wekiva and Rock were 1.0 and 1.3 mg/L, respectively, and these two springs are part of the nutrient-impaired Wekiva River system. Over 6,600 wells (mainly private drinking water wells) in the springshed have been sampled by FDOH for nitrate since the late 1980s. Of these, over 44 percent had nitrate concentrations higher than 1 mg/L and over 15 percent exceeded 5 mg/L. Almost 400 wells in this springshed had nitrate concentrations higher than the 10 mg/L ground water standard.

The Wekiwa-Rock Springs springshed, which also includes other springs such as Apopka Spring, includes a mixture of urban and agricultural land uses. This area, just north of Orlando, experienced a significant population growth spurt in the mid-1980s and many agricultural lands were converted to more urban uses. Citrus growing, once a dominant land use in the springshed, was reduced dramatically in the mid –to-late 1980s due to winter freezes, the rising real estate values and the citrus canker eradication program, which took many acres of citrus out of production. Now, only 4.6 percent of the springshed is in citrus production. Nitrate contamination of ground water in areas of current or past citrus production is a well documented issue in the ridge citrus growing area, which includes this springshed.

Other sources of nitrate may now be replacing citrus as potential impacts to the springs. Residential land use is accompanied by wastewater treatment facilities. There are approximately 85 domestic wastewater plants in the springshed and 15 of them have design capacities of greater than 10 MGD. Wastewater from these facilities is applied to sprayfields and rapid infiltration basins, used for irrigation water on golf courses, and a very small portion is discharged to surface water. In areas not on municipal sewer, homes are on septic tanks. Residential land use is also accompanied by fertilizer use on lawns and turf areas such as golf courses. A recent study found that lawn fertilizer applications on residential homes result in nitrate concentrations of 1 to 2 mg/L in shallow ground water (MACTEC, 2009). There are approximately 36 golf courses in the springshed using fertilizer and there are also over 200 small horse farms that may also apply fertilizer. Fertilizer impacts from commercial plant nurseries may also be an issue in the springshed. There are approximately 288 ornamental nursery sites in the springshed and well data from several suggests that some nurseries may be significant sources of nitrate in the ground water.

Nitrogen isotope data suggest that different areas of the springshed are impacted by different sources. The ∂15N results for 15 well and spring samples collected in the late 1990s (Toth and Fortich, 2001) indicated that at about half of the sites were in the range of inorganic sources, four were definitely associated with organic sources, and the remainder could have been from a mixture of inorganic and organic sources. The ∂15N results for a 2009 sampling by FDEP and the USGS (Katz and Griffin, 2009; MACTEC, 2009) were also mixed, with the results for Rock Spring more indicative of an inorganic origin and results for Wekiwa Spring perhaps more indicative of organic sources or a mixture of organic and inorganic sources. The elevated concentration of boron in samples from Wekiwa Spring may be related to domestic wastewater (Hicks, 2009). The combination of information indicates that the sources of nitrate in Wekiwa and Rock Springs are multiple. Trends in nitrate concentrations in both springs indicate that past use of inorganic fertilizer for citrus was once a major source of nitrate in both springs that now may be dissipating. Existing nearby municipal wastewater disposal and application sites and residential septic tanks are sources of the nitrate in Wekiwa Spring and both springs may now be impacted by existing sources of inorganic fertilizer such as residential lawns, golf courses and ornamental nurseries.

Volusia Blue Spring

The Volusia Blue springshed is highly urbanized and includes parts of Deltona, Orange City, DeBary, Lake Helen and DeLand and ground water in this area is highly vulnerable (**Figure 16**). The median nitrate concentration in Volusia Blue Spring is 0.645 and there is low level ground water contamination by nitrate. Over 45 percent of its springshed is in residential land use and there are 21 domestic wastewater facilities discharging to ground water. Most of the residences in the springshed are on city sewer. There is very little agricultural land use in this springshed; however it does include 21 golf courses.

Over 13% of the 45 wells in the springshed with nitrate data (all private wells) had concentrations higher than 1 mg/L. The highest nitrate concentration in a well was 9.9 mg/L. The wells with elevated nitrate concentrations are mainly found in the northwestern portion of the springshed but there is a lack of data in many areas.

There is no nitrogen isotope data for Volusia Blue Spring or ground water in the springshed, but based on the land use characteristics, the likely sources of the nitrate causing impairment of the spring include a mixture of inorganic fertilizer from residences and golf courses and domestic wastewater.

Weeki Wachee Spring

The Weeki Wachee Springs group lies in western Hernando County in a springshed that includes residential development at its western end, nearest the springs, and rural agricultural lands in the eastern part of the springshed. The springshed includes portions of both Hernando and Pasco Counties. The median nitrate concentration in Weeki Wachee Main Spring is 0.765 mg/L and it has been listed as impaired due to excessive nutrients. Residential development makes up the largest portion of the Weeki Wachee springshed, about 25 percent and a combination of agricultural lands accounts for about 20 percent of the springshed. Domestic wastewater treatment is decentralized throughout the springshed, with the largest domestic wastewater facility being the 0.75 MGD facility at Hernando Airport. The largest communities, Spring Hill, Shady Hills, and Weeki Wachee do not have central wastewater treatment facilities.

Over 41 percent of the 153 wells in the springshed with nitrate data had concentrations higher than 1 mg/L and 8 wells had nitrate concentrations higher than 10 mg/L. The highest nitrate concentration in a well was 24 mg/L. The wells with elevated nitrate are mainly found in the western portion of the springshed and the highest nitrate levels (>10 mg/L) are found in clusters in the north central part of the springshed to the west and south of the city of Brooksville.

Twenty-four springs in the SWFWMD were sampled for nitrogen isotopes between 1991 and 1999 and over 80 percent of the ∂15N values were below 6.2‰, with most indicating that inorganic fertilizer was the more significant source of nitrate in the Springs Coast region (Champion and Starks, 2001). Based on the land uses near the springs, much of the fertilizer appears to come from nearby subdivisions and golf courses (Champion and Starks, 2001). There are 30 golf courses in the springshed and most are near the spring. The main sources of nitrate causing impairment of Weeki Wachee Spring most likely include inorganic fertilizer applied to nearby residential lawns and golf courses and wastewater from septic tanks.

RECOMMENDATIONS

One of the advantages of a multi-year monitoring program is that there are opportunities to review the plan and data and make adjustments when necessary. The following are proposed actions for future emphasis and recommendations for improving and enhancing the usefulness of this program and its reporting.

1. Update the springs monitoring plan so that it defines priorities and establishes a well designed network to address specific priorities.

Since the statewide spring monitoring program began, much has been learned about the condition of springs and the issues that are being faced. The current spring monitoring plan will be adapted to focus on these priority issues.

2. Include information on ecological effects associated with nutrient enrichment, in addition to water quality and flow.

Evaluating the occurrence, trends, and impacts of nutrients on spring ecosystems is a major area of interest and a focus for upcoming springs monitoring and research. The TMDL Program relies on this program to provide information and data for springs so that their water quality and ecological conditions can be evaluated and the nutrient-impaired springs can be identified and addressed. Future reports will include more detailed information on spring water quality data and document nutrient-related impacts on spring ecosystems.

3. Evaluate the existing monitoring network to potentially include other priority springs that may have issues, provide information from under-represented regions of the state, and integrate springs monitoring and restoration with other monitoring and restoration initiatives of FDEP.

The original emphasis of monitoring under this program was on higher magnitude springs and/or those associated with state parks. However, other springs with potential issues and those representing water quality conditions in other regions of the state should also be considered for monitoring under this program. Limited and sporadic nitrate data have been compiled for some of these non-network springs from multiple sources (**Appendix A**). Many of these springs that represent water quality from smaller springsheds may have a greater and more immediate response to localized contaminant sources and monitoring data from them may be helpful in evaluating the impacts of springshed-scale land use and restoration activities including agricultural best management practices. Under the available monitoring budget, expansion of the network may mean relying on other organizations or programs to collect data from some of the current monitoring stations.

4. Collaborate with other organizations that also conduct monitoring and discharge measurements to obtain more information on discharge, develop consistency in naming convention and locations of springs stations and coordinate data sharing and monitoring activities.

If funding is available, measurement of spring discharge should continue under the FDEP program. It is important to maintain discharge stations to observe long term trends that would not otherwise be detected. This report includes a comprehensive assessment of available discharge data collected as part of the Springs Initiative Network and the USGS. The discharge data will be available for future assessment the influences on changes in spring discharge. The network discharge stations are measured at the same time water quality samples are collected. These data will be used in the future to help characterize contaminant loading and ground water transport issues. Future reports will also include discharge information on springs that have established minimum flows and levels.

Efforts have been made to address inconsistencies in the spring naming convention between agencies and accuracy issues for spring sampling stations. Many of these issues have been resolved and an approach for identifying inconsistencies and making corrections has been proposed. The FDEP 2008 Springs Master List (**Appendix B**) contains the conventional names for known springs along with the best available information on station location. This list also contains some updates to the 2004 *Springs of Florida* report, submitted as Bulletin 66 by the FGS. This list is offered as a means of obtaining consistency in naming convention with FDEP programs and for other agencies as well. The FDEP Springs Master List is also available as a GIS layer which will be updated when necessary and used to review potential new stations that might be added to the network in the future.

Future reports will not be limited to the Springs Initiative-collected data, but will include information from other data sources as well. An obvious way to achieve the goal of increasing the pool of available spring water quality and discharge data is to work with other organizations in the state to develop a common platform for sharing consistent, high quality data. It is anticipated that a new FDEP water quality database is to be developed by the Bureau of Watershed Restoration and it may serve as a common data transfer and retrieval platform to exchange data between organizations that do monitoring. Three of the water management districts currently also perform routine spring monitoring and there are also occasional special projects that include spring data collection. One important action that is recommended for the upcoming year is to work more closely with other organizations to collaborate and share spring data and work on common strategies as we collect new data. This collaboration will benefit the assessment of trends in springs and help identify springs that are impaired by nutrients and need restoration plans.

REFERENCES

Albertin, A., J. O. Sickman, A. Pinowska, R. J. Stevenson, and M. Anderson, 2007. Stable Isotope Compositions of Macroalgae, Sediment and Nitrate in Florida Springs. Final Report, Task 1, October 31, 2007. Florida Department of Environmental Protection.

Arthur, J. D., H. A. R. Wood, A. E. Baker, J. R. Cichon, and G. L. Raines, 2007. Development and Implementation of a Bayesian-based Aquifer Vulnerability Assessment in Florida. Natural Resources Research, Vol. 16, No. 2, p. 93-107.

Bohlke, J. K., and J. M. Denver, 1995. Combined Use of Ground Water Dating, Chemical and Isotopic Analyses to Resolve the History and Fate of Nitrate Contamination in Two Agricultural Watersheds, Atlantic Coastal Plain, Maryland. Water Res. Research, Vo. 31, No. 9, pp 2319-2339.

Boniol, D., SJRWMD, 2/5/2008 personal communication to R. Hicks, FDEP, on cause of elevated chloride in Upper Floridan aquifer and springs along Middle St. Johns River.

Butt, P. L., and G. J. Murphy, 2003. Dyal and Black Sinks Dye Trace, Columbia County, Florida, May-September, 2003. Karst Environmental Svcs. for FDEP Springs Initiative.

Campion, K. M., and R. Starks, 2001. The Hydrology and Water Quality of the Springs in West-Central Florida. SWFWMD Water Quality Monitoring Program report, May 2001.

Chelette, A. R., T. R. Pratt and B. G. Katz, 2002. Nitrate Loading as an Indicator of Nonpoint Source Pollution in the Lower St. Marks-Wakulla Rivers Watershed. NWFWMD Water Resources Special Report 02-1.

Cowell, B.C., and C. L. Dawes, 2004. Growth and Nitrate-Nitrogen Uptake by the Cyanobacterium *Lyngbya wollei*. *J Aquat Plant Man* **42**: 69–71.

Davis, J. G., and A. M. Swinker, 2003. Horse Manure Management – Quick Facts. Colordado State University Cooperative Extension, AGF-212-03.

Florida Springs Task Force, 2000. Florida's Springs: Strategies for Protection and Restoration**;** Florida Department of Environmental Protection, 59 p.

Florida Department of Environmental Protection, 2008. EcoSummaries, Environmental Assessment Section. Available on the internet at http://www.dep.state.fl.us/labs/cgi-bin/reports/results.asp

FDEP, 2008a. Integrated Water Quality Assessment for Florida: 2008 305(b) Report and 303(d) List Update, October 2008.

FSU, 2009. Woodville Basin Tracer Study, FDEP Agreement No WM926., Florida State University Department of Oceanography.

Garber, M. P., J. M. Ruter, J. T. Midcap and K. Bondari, 2002. Survey of Container Nursery Irrigation Practices in Georgia. HortTechnology, October-December 2002, 12(4).

Gao, X., 2008. Nutrient TMDLS for the Wekiwa River (WBIDs 2956, 2956A, and 2956C) and Rock Springs Run (WBID 2967). FDEP Div. Water Res. Mgmt, Bur. Watershed Mgmt.

Hallas, J. F. and W. Magley, 2008. Nutrient and Dissolved Oxygen TMDL for the Suwannee River, Santa Fe River, Manatee Springs (3422R), Fanning Springs (3422S), Branford Spring (3422J), Ruth Spring (3422L), Troy Spring (3422T), Royal Spring (3422U), and Falmouth Spring (3422Z). FDEP Div. Water Res. Mgmt., Bur. Watershed Mgmt.

Hand, J., 2004. Typical Water Quality Values for Florida Lakes, Streams and Estuaries, FDEP Watershed Assessment Section. In draft.

Harden, H. and J. Chanton, 2009. Interim Findings of Wakulla County, Florida Performance-Based Septic System Study, in draft. Florida State University Oceanography Department.

Hazen and Sawyer, 2009. Florida Onsite Sewage Nitrogen Reduction Strategies Study, Task A2. Literature Review of Nitrogen Reduction Technologies for Onsite Sewage Treatment Systems for Florida Department of Health Contract CORCL.

Hazlett-Kinkaid, 2007. Tallahassee SE Spray Field Tracer Test- 2006-2007, Final Report on the Setup and Results, Woodville Karst Plain, North Florida.

Hicks, R., 2009. Findings of Reclaimed Water Sampling Event, Wekiva BMAP Area. FDEP September 3, 2009 internal memorandum to J. Gihring.

Hochmuth, G. J., and E, A. Hanlon, 2000. IFAS Standardized Fertilization Recommendations for Vegetable Crops. UF/IFAS CIR 1152.

Hornsby, D., and R. Mattson, 1998. Surfacewater Quality and Biological Monitoring Annual Report 1997. SRWMD Water Res. Rep. WR98-03.

Hornsby, D., R. A. Mattson, and T. Mirti, 2000. Surface water quality and biological monitoring. Annual Report. 1999. Suwannee River Water Management District Technical Report WR-00-04. iv, 148 pp.

Jacob, J. P., and Mather, F. B., 1997. Florida's Commercial Broiler Industry. Gainesville, UF/IFAS FS PS20.

Jennifer J. J., R. W. Litaker, and H. W. Paerl, 2008. Morphological and Genetic Evidence that the Cyanobacterium *Lyngbya wollei* (Farlow ex Gomont) Speziale and Dyck Encompasses at Least Two Species, Appl Environ Microbiol. 2008 June; 74(12): 3710–3717.

Jones, G. W., S. B. Upchurch, and K. M. Champion, 1996. Origin of Nitrate in Ground Water Discharging from Rainbow Springs, Marion County, Florida. SWFMD Ambient Ground-Water Monitoring Program Report, June 1996.

Katz, B. G., H. D. Hornsby, J. F. Bohlke, and M. F. Mokray, 1999. Sources and Chronology of Nitrate Contamination in Spring Waters, Suwannee River Basin, Florida. USGS WRI Report 99-4252.

Katz, B. G., 2004. Sources of nitrate contamination and age of water in large karstic springs of Florida. Environmental Geology 46:689-706.

Katz, B., R. Copeland, T. Greenhalgh, and R. Ceryak, 2005. Using Multiple Chemical Indicators to Assess Sources of Nitrate and Age of Ground Water in a Karstic Spring Basin, Environmental and Engineering Geoscience; November 2005; v. 11; no. 4; p. 333-346; DOI: 10.2113/11.4.333.

Katz, B. G., and D. W. Griffin, 2009. Using Geochemical and Microbiological Indicators to Refine the Assessment of Nitrate Sources in the Wekiwa Springs Basin. USGS Deliverable for FDEP Contract No. 929.

Katz, B. G., D. W. Griffin, J. H. Davis, 2009. Groundwater Quality Impacts from the Land Application of Treated Municipal Wastewater in a Large Karstic Spring Basin: Chemical and Microbiological Indicators, Science of the Total Environment 407 (2009) 2872-2886.

Katz, B., D. W. Griffin, P. B. McMahon, H. Harden, E. Wade, R. W. Hicks, and J. Chanton, 2009. Fate of Effluent-Borne Contaminants Beneath Septic Tank Drainfields Overlying a Karst Aquifer. USGS Special Pub. in draft.

Kendall, C., 1998. Tracing Nitrogen Sources and Cycling in Catchments in Isotope Tracers in Catchment Hydrology (1998), C. Kendall and J. J. McDonnell (Eds.). Elsevier Science B.V., Amsterdam, pp. 519-576.

Kuphal, T., 2005. Quantification of Domestic Wastewater Discharge and Associated Nitrate Loading in Marion County, Florida. Marion County Planning Department, August, 2005.

MACTEC, 2009. Draft Data Summary Report Sources of Nitrate in the Wekiva River Basin, Phase II. Prepared for SJRWMD and FDEP under SJRWMD Contract 25009.

Mattson, R.A., SJRWMD, 2009, personal communication.

Mattson, R. A., E. F. Lowe, C. L. Lippincott, J. Di, and L. Battoe, 2006. Wekiva River and Rock Springs Run Pollutant Load Reduction Goals. Report to the Florida Department of Environmental Protection. St. Johns River Water Management District.

Minogue, P. J., H. K. Ober, S. Rosenthal. Overview of Pine Straw Production in North Florida: Potential Revenues, Fertilization Practices, and Vegetation Management Recommendations. UF/IFAS FOR125.

Mitchell, C. C., J. O. Donald, and J. Martin, 1990. The Value and Use of Poultry Waste as a Fertilizer. Alabama Coop. Extension Serv. Circ. ANR-244. Auburn, AL.

Mylavarapu, R., D. Wright, G. Kidder, and C. G. Chambliss, 2009. UF/IFAS Standardized Fertilization Recommendations for Agronomic Crops. University of Florida IFAS Extension SL129.

Obreza, T., and G. Means, 2006. Characterizing Agriculture in Florida's Lower Suwannee River Basin Area, UF/IFAS SL 241.

Parsons, L. and B. Boman, 2006. Best Management Practices for Florida Citrus. HortTechnology, July-September 2006 16(3).

Phelps, GG., 2004. Chemistry of Ground Water in the Silver Springs Basin, Florida with an Emphasis on Nitrate. USGS Scientific Investigations Report 2004-5144.

Potapova, M. and D. F. Charles, 2005. Choice of Substrate in Algae-based Water Quality Assessment. J. North American Benthological Soc. 24(2): 415-427.

Rosenau, J. C., G. L. Faulkner, C. W. Hendry, and R.W. Hull, 1977. Springs of Florida, Florida Bureau of Geology and Florida Department of Environmental Regulation, Bull. 31 (revised). 461 p.

Sartain, J. B., L. T. Trenholm, E. F. Gilman, T. A. Obreza, and G. Toor, 2009. Frequently Asked Questions about Landscaping Fertilization for Florida-Friendly Landscaping Ordinances. University of Florida IFAS, ENH1115.

Scott, T. M., G. H. Means, R. P. Meegan, R. C. Means, S. B. Upchurch, R. E. Copeland, J. Jones, T. Roberts, and A. Willet, 2004. Springs of Florida. Florida Geological Svy. Bull. 66, 377 p.

SJRWMD, 2007. Sources, Transport and Transformations of Nitrate-N in the Florida Environment. SJRWMD Special Pub. SJ2007-SP10 pepared by the Univ. of Florida School of Forest Resources and Conservation.

Soil and Water Engineering Technology, 2002. Computer Modeling Services for the Suwannee River Watershed, FDACS #7148.

Spechler, R., and K. J. Halford, 2001. Hydrogeology, Water Quality and Simulated Effects of Ground-Water Withdrawals from the Floridan Aquifer System, Seminole County and Vicinity. USGS WRI 01-4182.

Stevenson, R. J., A. Pinowska, A. Abertin and J. O. Sickman, 2007. Ecological Condition of Alga and Nutrients in Florida Springs: The Synthesis Report. Department of Zoology, Michigan State Univ., FDEP Contract WM 858.

SWFWMD, 2002. Upper Peace River An Analysis of Minimum Flows and Levels, August, 25, 2002. DRAFT. SWFWMD Ecological Evaluation Section.

Toth, D.J., 1999. Water quality and isotope concentrations from selected springs in the St. Johns River Water Management District. Technical Publication SJ99-2. Palatka, Fla.: St. Johns River Water Management District.

Toth, D. J., and C. Fortich, 2002. Nitrate Concentrations in the Wekiva Ground Water Basin with Emphasis on Wekiwa Springs. SJRWMD Technical Pub. SJ2002-2.

Toth, D. J. , and L. Knowles, 2007. Silver Springs Characterization Phase III-Isotope, Anthropogenic, Pesticide, and Wastewater Chemical Characterization. Deliverable for Agreement S0277 with FDEP.

UF/IFIS Florida Forest Stewardship Bulletin, last updated July 3, 2008. http://www.sfrc.ufl.edu/Extension/florida_forestry_information/forest_management/fertilization.html

United States Census Bureau, 2005. Interim State Projections, Statistics on the internet at http://www.census.gov/population/projections/PressTab6.xls .

United States Geological Survey, 2009. The Water Cycle: Springs; Publication on the internet at http://ga.water.usgs.gov/edu/watercyclesprings.html .

Van Horn, H.H., R. A. Nordstedt, A. V. Bottcher, E. A. Hanlon, D. A. Graetz, and C. F. Chambliss, 1991. Dairy Manure Management: Strategies for Recycling Nutrients to Recover Fertilizer Value and Avoid Environmental Pollution. UF/IFAS Circular 1016.

Yeager, T. H., 2009. Current Fertilization Practices Used in Container Nurseries. UF/IFAS, unpublished manuscript.

APPENDIX A: NITRATE MEDIANS FOR ALL SPRINGS WITH DATA (1998-2008)

≤0.2 mg/L	0.2-0.5 mg/L	0.5-1 mg/L	1-3 mg/L	>3 mg/L
ALEXANDER SPRING [BKG]	ALA930971 (ALACHUA)	ALLEN MILL POND SPRINGS	ALLEN SPRING	**APOPKA SPRING***
BEECHER SPRING [BKG]	ALAPAHA RIVER RISE	**BLUE HOLE SPRING (COLUMBIA) ****	ALLIGATOR HOLE SPRING	BALTZELL SPRING
BELTONS MILLPOND HEAD SPRING 3 [BKG]	AUCILLA SPRING	BLUEBIRD SPRINGS	ALLIGATOR SPRING (MARION) **	BETTY SPRING
BIG SPRING (BIG BLUE SPRING) (JEFFERSON)	BAIRD SPRING #1	BOBHILL SPRING -	ANDERSON SPRING	BOYETTE SPRING*
BLUE ALGAE BOIL SPRING [BKG]	BECKTON SPRING	BUGG SPRING (LAKE)	BATHTUB SPRING (SUWANNEE)	CONVICT SPRING
BLUE CREEK SPRING	BETEEJAY SPRING	CANAL 485A SPRING 2	BIG KING SPRING**	DOUBLE RUN SPRING (LAKE)
BLUEBERRY SPRING [BKG]	BLACK SPRING (JACKSON)	CEDAR HEAD SPRING	BLUE GROTTO (LEVY)*	**FANNING SPRINGS****
BOULDER SPRINGS	BLACK SPRINGS (CITRUS)	**CHASSAHOWITZKA SPRING #1 -**	**BLUE GROTTO SPRING (MARION) -**	HAYS SPRING (JACKSON)
BRADLEY SPRING	BLUE HOLE SPRING (JACKSON)	COFFEE SPRINGS	BONNET SPRING	HEALTH SPRING*
BRIGHT ANGEL SPRING	BLUE RUN SPRING	COL1012972 (COLUMBIA)	BOULWARE SPRINGS	**JACKSON BLUE SPRING-**
CAMP LE NO CHE SPRING [BKG]	BLUE SINK SPRING	COL428981 (COLUMBIA)	BRANFORD SPRING	LAF924971 (LAFAYETTE)
CAMP SEMINOLE SPRINGS	BOAT SPRING	CRAB SPRING	BRIDAL CHAMBER SPRING	LAKE BLUE SPRING-
CATFISH SPRINGS (MARION)	BRUNSON LANDING SPRING	DARBY SPRING	**BUBBLING SPRING****	MOORING COVE SPRINGS
CEDAR ISLAND SPRING (TAYLOR)	BUZZARD LOG SPRING	**DELEON SPRING (VOLUSIA) ***	BUCKHORN SPRING MAIN *	OWENS SPRING
CEDAR SPRING	CASSIDY SPRINGS	DOGWOOD SPRING	CANAL 485A SPRING 1B -	RUTH SPRING (LAFAYETTE)**
CLIFTON SPRINGS [BKG]	CATFISH SPRING (CITRUS)	DOUBLE SPRING (JACKSON)	CATFISH CONVENTION HALL SPRING*	SHANGRI-LA SPRINGS
COL522981 (COLUMBIA)	**CHASSAHOWITZKA SPRING MAIN**	ELLAVILLE SPRING	CATFISH HOTEL SPRING	SOCRUM SPRING
COLUMBIA SPRING	CITRUS BLUE SPRING	**FALMOUTH SPRING -**	CATFISH RECEPTION HALL	SUW718971 (SUWANNEE)*
COPPER SPRING[BKG]	CORDLE SPRING	GADSEN SPRING	CHRISTMAS TREE SPRING	SUW725971 (SUWANNEE)
CROAKER HOLE SPRING	**CYPRESS SPRING**	GEMINI SPRINGS #3	COL61982 (COLUMBIA)	SUWANNEE BLUE SPRING-
DIX625991 (DIXIE)	DEVILS EYE SPRINGS (SUWANNEE)	GEMINI SPRINGS **	CRYSTAL BEACH SPRING (PINELLAS)	TRAIL SPRING
DIX625992 (DIXIE)	DIX625994 (DIXIE)	GUM SPRING #3	CRYSTAL SPRINGS (PASCO)*	TROOP SPRING
DIX625993 (DIXIE)	FENNEY SPRING	HAM610981 (HAMILTON)	CRYSTAL SWAMP SPRING #1 (PASCO)	
DOBES HOLE SPRING	**GAINER SPRING #2**	HIDDEN RIVER HEAD SPRING -	CRYSTAL SWAMP SPRING #2 (PASCO)	
DROTY SPRING [BKG]	**GAINER SPRING #3**	HIDDEN RIVER SPRING #2 **	CRYSTAL SWAMP SPRING #3 (PASCO)	
EVA SPRING	GATOR SPRING (HERNANDO)	HOMOSASSA SPRING -	**DEVILS EAR SPRING (GILCHRIST)****	

≤0.2 mg/L	0.2-0.5 mg/L	0.5-1 mg/L	1-3 mg/L	>3 mg/L
FERN HAMMOCK SPRINGS	GIL729971 (GILCHRIST)	**HOMOSASSA SPRING #1 -**	DEVILS KITCHEN A SPRING	
FOLSOM SPRING	GRASSY HOLE SPRING	**HOMOSASSA SPRING #3 -**	DEVILS KITCHEN B SPRING	
FOREST SPRING	HALLS RIVER HEAD SPRING	**ICHETUCKNEE HEAD SPRING (SUWANNEE) -**	FIRST FISHERMANS PARADISE	
GAINER SPRING #1C	HAM54012 (HAMILTON)	JENKINS CREEK SPRING *	GARDEN OF EDEN SPRING	
GARNER SPRING	HOLMES BLUE SPRING	LAF929972 (LAFAYETTE)	GEYSER SPRING	
GIL99974 (GILCHRIST)	**HOMOSASSA SPRING #2**	LEVY BLUE SPRING	GILCHRIST BLUE SPRING**	
GINGER ALE SPRING	HORN SPRING	LILLY SPRING	GINNIE SPRING-	
GREEN ALGAE BOIL SPRING	**HORNSBY SPRING**	LIME RUN SPRING OR SINK (SUWANNEE)	GLEN SPRING	
GREEN COVE SPRINGS [BKG]	HORSEHEAD SPRING	LITTLE KING SPRING **	GREEN SINK	
GREEN SPRING	**HUNTER SPRING**	LITTLE SPRING (HERNANDO)	GUARANTO SPRING	
HAM522981 (HAMILTON)	IDIOTS DELIGHT SPRING	LOG SPRING (MARION)	GUM SPRING #1**	
HAM923973 (HAMILTON)	JEF64991 (JEFFERSON)	LOST RIVER SPRING	GUM SPRING #2 -	
HAMPTON SPRING (TAYLOR) [BKG]	JEFFERSON BLUE SPRING	MILL POND SPRING (JACKSON)	GUM SPRING MAIN**	
HOLTON CREEK RISE	LAF710981 (LAFAYETTE)	**MISSION SPRINGS -**	HAM1017971 (HAMILTON)	
IRON SPRING (LAFAYETTE)	LAF718971 (LAFAYETTE)	MYRTLES FISSURE SPRING	HAM610982 (HAMILTON)	
ISLAND SPRING	LIME SPRING (SUWANNEE)	OTTER SPRING	HAM610983 (HAMILTON)	
JABO SPRING	LOG SPRING (JEFFERSON)	PALM SPRINGS (SEMINOLE) -	HAM610984 (HAMILTON)	
JAMISON SPRINGS	LOUISE SPRINGS	PEGASUS SPRING	HAM612982 (HAMILTON)	
JEF312991 (JEFFERSON)	MAGNOLIA CIRCLE SPRING	PICKARD SPRING	HART SPRINGS-	
JEF63991	MAGNOLIA SPRING	POTTER CREEK SPRING	INDIAN CAVE SPRING	
JEF63992 (JEFFERSON)	MATTAIR SPRINGS	RAINBOW BRIDGE SEEP NORTH	INDIAN CREEK #3 SPRING	
JEF63993 (JEFFERSON)	**MILL POND SPRINGS (COLUMBIA)**	RAINBOW SPRING	JACOBS WELL SPRING	
JUG ISLAND SPRING	MINNOW SPRING	RUTH SPRING (CITRUS)	JULY SPRING	
JUNIPER SPRINGS	NATURAL BRIDGE SPRING	SALLY WARD SPRING	LADIES PARLOR SPRING	
LAF1024001 (LAFAYETTE)	NICHOLS SPRING	SAWDUST SPRING	LAF57981 (LAFAYETTE)	
LAF93971 (LAFAYETTE)	POE SPRING	**SILVER SPRING MAIN ****	LAF57982 (LAFAYETTE)	
LEV719991 (LEVY)	PONCE DE LEON SPRING (HOLMES)	SIPHON CREEK RISE	LAF919972 (LAFAYETTE)	
LEV97991 (LEVY)	PUMPHOUSE SPRINGS	SPRINGBOARD SPRING	LAF929971 (LAFAYETTE)	
LITTLE COPPER SPRING [BKG]	RHODES SPRINGS #1	SUW919971 (SUWANNEE)	**LAFAYETTE BLUE SPRING***	
LURAVILLE SPRING	RHODES SPRINGS #2	TANNER SPRING (HAMILTON)	LETTUCE LAKE SPRING	
MAGNESIA SPRING	RHODES SPRINGS #4	TROTTER MAIN SPRING -	**LITHIA SPRING MAJOR***	
MAINTENANCE SPRING	ROSSETER SPRING	TURTLE SPRING	LITTLE OTTER SPRING	
MANATEE MINERAL SPRING	SALT SPRING (HERNANDO)	**WAKULLA SPRING ***	LITTLE RIVER SPRING*	
MARION BLUE SPRING	SANDBAG SPRING	**WEEKI WACHEE SPRING -**	MAD610981 (MADISON)	

≤0.2 mg/L	0.2-0.5 mg/L	0.5-1 mg/L	1-3 mg/L	>3 mg/L
MARKEE SPRING [BKG]	SANLANDO SPRINGS	WILSON HEAD SPRING (MARION) *	MAD610982 (MADISON)	
MCCRABB SPRING [BKG]	SHADY BROOK HEAD SPRING #2		MAD612981 (MADISON)	
MIAMI SPRING	ST. MARKS RIVER SWALLET		MAD612982 (MADISON)	
MOCCASIN SPRINGS	STARBUCK SPRING		**MADISON BLUE SPRING****	
MORRISON SPRING	SULPHUR SPRING (HILLSBOROUGH)		**MANATEE SPRING****	
MOSQUITO SPRINGS	SUMTER BLUE SPRING		MASTODON BONE SPRING	
MUD SPRING (PUTNAM) [BKG]	SUNBEAM SPRING		MEARSON SPRING	
MUNROE SPRING	SUW923971 (SUWANNEE)		MORGAN SPRING	
NASHUA SPRING [BKG]	SUWANACOOCHEE SPRING		NATURAL WELLS (LEON)	
NEWPORT SPRING [BKG]	TAY924993 (TAYLOR)		NO NAME COVE SPRING	
NOVA SPRING	THOMAS SPRING (JEFFERSON)		ORANGE GROVE SINK	
NUTALL RISE	TREEHOUSE SPRING		ORANGE GROVE SPRING	
ORANGE SPRING (MARION) [BKG]	TWIN SPRING		OSCAR SPRING	
PALM SPRINGS (LAKE) [BKG]	**VOLUSIA BLUE SPRING**		PEACOCK SPRINGS	
PARKER ISLAND SPRING	VORTEX SPRING		PERRY SPRING	
RIVER SINK SPRING	**WACISSA SPRING #2**		POT HOLE SPRING	
ROCK SINK SPRING	WITHERINGTON SPRING		POT SPRING	
SALT SPRINGS (MARION)	WOODS CREEK RISE		RACCOON ISLAND SPRING	
SALT SPRINGS (PASCO) #2			**RAINBOW SPRING #1****	
SANDYS SPRING [BKG]			**RAINBOW SPRING #4****	
SANTA FE RIVER RISE (ALACHUA)			**RAINBOW SPRING #6****	
SANTA FE SPRING (COLUMBIA)			**RECEPTION HALL SPRING****	
SATSUMA SPRING [BKG]			ROCK BLUFF SPRINGS**	
SHARKS TOOTH SPRING			**ROCK SPRINGS (ORANGE) ***	
SILVER GLEN SPRINGS [BKG]			ROCKY VENT SPRING	
SNAIL SPRINGS [BKG]			ROYAL SPRING	
SPRING CREEK RISE #2			RUM ISLAND SPRING	
SPRING CREEK RISE MAIN			RUNNING SPRINGS #2	
SPRING WARRIOR SPRING			RUNNING SPRINGS#1	
ST. MARKS RIVER RISE (LEON)			SHIPWRECK SPRING	
STEINHATCHEE RIVER RISE			SUN SPRINGS	
STEINHATCHEE SPRING [BKG]			SUW919973 (SUWANNEE)	
SULFUR SPRING (ORANGE)			TELFORD SPRING-	
SUN EDEN SPRING [BKG]			TIMBER SPRING	
SUWANNEE SPRINGS[BKG]			**TROY SPRING-**	

≤0.2 mg/L	0.2-0.5 mg/L	0.5-1 mg/L	1-3 mg/L	>3 mg/L
SWEETWATER SPRINGS [BKG]			TURTLE MEADOWS SPRING	
TARPON HOLE SPRING			TURTLE NOOK SPRING	
SALT SPRINGS (PASCO) #2			**RAINBOW SPRING #1****	
SANDYS SPRING [BKG]			**RAINBOW SPRING #4****	
SANTA FE RIVER RISE (ALACHUA)			**RAINBOW SPRING #6****	
SANTA FE SPRING (COLUMBIA)			**RECEPTION HALL SPRING****	
SATSUMA SPRING [BKG]			ROCK BLUFF SPRINGS**	
SHARKS TOOTH SPRING			**ROCK SPRINGS (ORANGE) ***	
SILVER GLEN SPRINGS [BKG]			ROCKY VENT SPRING	
SNAIL SPRINGS [BKG]			ROYAL SPRING	
SPRING CREEK RISE #2			RUM ISLAND SPRING	
SPRING CREEK RISE MAIN			RUNNING SPRINGS #2	
SPRING WARRIOR SPRING			RUNNING SPRINGS#1	
ST. MARKS RIVER RISE (LEON)			SHIPWRECK SPRING	
STEINHATCHEE RIVER RISE			SUN SPRINGS	
STEINHATCHEE SPRING [BKG]			SUW919973 (SUWANNEE)	
SUN EDEN SPRING [BKG]			TELFORD SPRING-	
SUWANNEE SPRINGS[BKG]			TIMBER SPRING	
SWEETWATER SPRINGS [BKG]			**TROY SPRING-**	
TARPON HOLE SPRING			TURTLE MEADOWS SPRING	
TAY616991 (TAYLOR)			TURTLE NOOK SPRING	
TAY616992 (TAYLOR)			**WEKIWA SPRING (ORANGE) ***	
TAY622991 (TAYLOR)				
TAY625991 (TAYLOR)				
TAY625993 (TAYLOR)				
TAY625995 (TAYLOR)				
TAY69991 (TAYLOR)				
TAY69992 (TAYLOR)				
TAY730991 (TAYLOR)				
TAY76991 (TAYLOR)				
TAY76992 (TAYLOR)				
TAY924991 (TAYLOR)				
TOBACCO PATCH LANDING SPRING				
WACISSA SPRING #3				
WADESBORO SPRING				
WALDO SPRING [BKG]				
WALKER SPRING (JEFFERSON)				

≤0.2 mg/L	0.2-0.5 mg/L	0.5-1 mg/L	1-3 mg/L	>3 mg/L
WARM MINERAL SPRING				
WASHINGTON BLUE SPRING (CHOCTAWHATCHEE)				
WASHINGTON BLUE SPRINGS (ECONFINA)				
WEEKI PRESERVE SPRING				
WELAKA SPRING [BKG]				
WELLS LANDING SPRING				
WHITE SULPHUR SPRINGS (HAMILTON) [BKG]				
WILLIFORD SPRING				
WILSON SPRING (COLUMBIA)				
WW GAY SPRING				

Notes:
Data used in this summary from all springs with any available data, with some having very limited data. Sources include Springs Monitoring Network, water management districts, U. S. Geological Survey, and special projects. Springs included in Springs Initiative Monitoring Network are in **BOLD**. BKG signifies that the spring may be considered for use as representing background water quality for nitrate. ****** indicates elevated concentration with increasing trend; ***** indicates elevated concentration with decreasing trend; **-** indicates elevated concentration with no trend.

APPENDIX B: SPRINGS MASTER LIST (1998-2008)

The **FDEP 2008 SPRINGS MASTER LIST** consists of springs that were visited by the Florida Department of Environmental Protection, Water Management Districts and the United States Geological Survey and have available water quality or discharge data. It is provided as a reference tool to assist in consistency in the statewide naming system and locational accuracy. This information will be updated in future reports as necessary. This springs master list intentionally contains some springs that are known to no longer flow and includes associated waterbodies (such as karst windows, sinks and river rises) that are important for studying springs. There may be variations in the spring magnitudes reported in this document when compared to other publications. Spring magnitude is sometimes assigned based on historical information (groups of vents) rather than more recent conditions at a single spring vent. Spring magnitude in this document was assigned using available data from the best available recent flow conditions; however, for some springs the magnitude was only available in historic documents and/or reported for a group of vents. The spring magnitudes used in this report were primarily those published by Water Management Districts, Florida Geological Survey and the United States Geological Survey. The Information collected by the Florida Geological Survey about spring flow in 2002-2003 reflects hydrologic conditions significantly influenced by the severe drought Florida experienced (1998-2003). Springs that had stopped flowing during this time period were noted and future visits to obtain discharge data will need to be collected to analyze whether these springs will recover and if their magnitudes have changed over the long term.

The **FDEP SPRING MAGNITUDE CATEGORIES** for this report (shown below) was developed to differentiate between those springs that may flow once again in the future, depending on aquifer levels and recharge (Magnitude = 0), and those springs that have ceased flowing entirely and are not expected to recover regardless of changes in hydrogeologic and climatic conditions (Magnitude = None).

1st Magnitude - > 100 cubic feet per second (cfs)

2nd Magnitude - >10 - 100 cfs

3rd Magnitude - >1 - 10 cfs

4th Magnitude - >100 gal/min (gallons per minute) - 448 gal/min (1 cfs)

5th Magnitude - >10 to 100 gal/min

6th Magnitude - >1 to 10 gal/min

7th Magnitude - >1 pint to 1 gal/min

8th Magnitude - Equal to or less than 1 pint/min

0 Magnitude - No longer flowing but may recover

None - No longer flowing at any time

Unknown - No record of spring discharge available

(FDEP 2009 Magnitude Categories based on FGS Springs of Florida – Bulletin 66 (2004); and Rosenau et al. (1977), p. 4, as adapted from Meinzer (1927), p. 3)

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
A. WAYNE LEE SPRING	UNKNOWN	Sumter	28 51 34.91399	82 05 15.70999	Group 4
ABDONEY SPRING	2	Citrus	28 47 48.69199	82 35 10.05200	Group 5
ADAMS SPRING	UNKNOWN	Hamilton	30 25 54.77617	83 11 53.50664	Group 1
ALA930971 (ALACHUA)	2	Alachua	29 49 40.59403	82 38 27.00682	Group 1
ALA930972 (ALACHUA)	2	Alachua	29 50 40.78445	82 37 51.08022	Group 1
ALAPAHA RIVER RISE	1	Hamilton	30 26 20.28889	83 05 22.42420	Group 1
ALEXANDER SPRING	1	Lake	29 04 52.68291	81 34 33.18088	Group 2
ALLEN MILL POND SPRINGS	3	Lafayette	30 09 46.22781	83 14 35.05582	Group 1
ALLEN SPRING	2	Columbia	29 49 38.15700	82 38 45.68000	Group 1
ALLIGATOR HOLE SPRING	UNKNOWN	Marion	29 12 54.40000	82 03 3.300000	Group 1
ALLIGATOR SPRING (CITRUS)	UNKNOWN	Citrus	28 48 1.617369	82 35 16.71294	Group 5
ALLIGATOR SPRING (MARION)	3	Marion	28 57 36.81699	82 13 45.67599	Group 4
ANDERSON SPRING	2	Suwannee	30 21 12.27474	83 11 23.01402	Group 1
APOPKA SPRING	2	Lake	28 33 59.76522	81 40 50.40767	Group 1
ARIPEKA SPRING #1	3	Hernando	28 26 18.71084	82 39 31.62071	Group 5
ARIPEKA SPRING #2	3	Hernando	28 26 7.061749	82 39 32.15602	Group 5
AUCILLA SPRING	3	Jefferson	30 20 25.08000	83 59 25.89199	Group 1
BAIRD SPRING	3	Citrus	28 42 30.95218	82 34 39.35640	Group 5
BAIRD SPRING #1	3	Citrus	28 42 26.91486	82 34 41.51827	Group 5
BAIRD SPRING #2	3	Citrus	28 42 29.88287	82 34 42.80038	Group 5
BAIRD SPRING #3	3	Citrus	28 42 32.85551	82 34 46.71904	Group 5
BAIRD SPRING #4	3	Citrus	28 42 33.33298	82 34 48.98520	Group 5
BALTZELL SPRING	2	Jackson	30 49 50.15996	85 14 3.839999	Group 2
BAMBOO SPRING	UNKNOWN	Putnam	29 30 57.04920	81 52 0.177000	Group 1
BANANA SPRING	UNKNOWN	Citrus	28 48 3.635420	82 35 17.43986	Group 5
BAPTIZING SPRING	UNKNOWN	Suwannee	30 08 1.905399	83 08 2.962999	Group 1
BARREL SPRING (JACKSON)	4	Jackson	30 35 32.75884	85 10 14.44799	Group 2
BARREL SPRING (ORANGE)	3	Orange	28 42 41	81 28 18	Group 2
BATHTUB SPRING (SUWANNEE)	2	Suwannee	30 05 30.21454	83 05 54.01471	Group 1
BEAR CREEK RISE	UNKNOWN	Franklin	29 58 54.30176	84 27 47.41685	Group 1
BEAR SPRING (CITRUS)	0	Citrus	28 48 6.469849	82 35 14.12002	Group 5
BEAR SPRING (LAKE)	UNKNOWN	Lake	28 39 6.139329	81 43 0.778870	Group 1
BEAVER CREEK SPRING	2	Taylor	29 45 57.41093	83 20 6.178850	Group 1
BECKTON SPRING	2	Washington	30 38 55.12913	85 41 37.18691	Group 3
BECKY SPRINGS	UNKNOWN	Clay	30 05 7.080000	81 53 45.95999	Group 2
BEECHER SPRING	2	Putnam	29 26 55.16801	81 38 48.70600	Group 2
BELCHER SPRING	2	Citrus	28 47 48.28700	82 35 10.62800	Group 5
BELL SPRING (GILCHRIST)	3	Gilchrist	29 35 50.79904	82 56 28.21750	Group 1
BELL SPRINGS (COLUMBIA)	2	Columbia	30 19 45.81407	82 41 17.45412	Group 1
BELTONS MILLPOND HEAD SPRING 1	2	Sumter	28 45 26.55900	82 03 44.59600	Group 4
BELTONS MILLPOND HEAD SPRING 2	2	Sumter	28 45 27.49099	82 03 43.57200	Group 4
BELTONS MILLPOND HEAD SPRING 2A	2	Sumter	28 45 28.39299	82 03 48.28200	Group 4
BELTONS MILLPOND HEAD SPRING 2B	2	Sumter	28 45 29.19599	82 03 45.04899	Group 4
BELTONS MILLPOND HEAD SPRING 3	2	Sumter	28 45 29.67200	82 03 45.30500	Group 4
BELTONS MILLPOND HEAD SPRING 4	2	Sumter	28 45 30.36599	82 03 47.49800	Group 4
BETEEJAY LOWER SPRING	UNKNOWN	Hernando	28 41 31.95474	82 35 34.35756	Group 5
BETEEJAY SPRING	UNKNOWN	Hernando	28 41 25.39399	82 35 29.41099	Group 5
BETTY SPRING	3	Suwannee	29 54 53.19651	82 50 23.84184	Group 1
BIG HOLE SPRING	UNKNOWN	Sumter	28 45 33.04499	82 05 54.93999	Group 4
BIG KING SPRING	3	Levy	29 06 59.12338	82 38 32.13899	Group 1
BIG SPRING (BIG BLUE SPRING) (JEFFERSON)	2	Jefferson	30 19 39.84153	83 59 5.378890	Group 1
BIG SPRING (TAYLOR)	2	Taylor	29 58 27.36930	83 44 19.79620	Group 1
BLACK SPRING (JACKSON)	2	Jackson	30 41 55.40302	85 17 40.07576	Group 2
BLACK SPRINGS (CITRUS)	3	Citrus	28 52 38.27996	82 35 56.40000	Group 5
BLACKWATER SPRINGS	3	Lake	28 53 17.12547	81 29 50.83507	Group 2
BLIND SPRING	2	Hernando	28 39 28.32177	82 38 4.620950	Group 5
BLUE ALGAE BOIL SPRING	5	Lake	28 52 30.37651	81 26 26.32505	Group 2

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
BLUE CREEK SPRING	2	Taylor	29 50 41.01000	83 33 28.04299	Group 1
BLUE GROTTO (LEVY)	UNKNOWN	Levy	29 23 16.16999	82 29 10.78000	Group 1
BLUE GROTTO SPRING (MARION)	UNKNOWN	Marion	29 12 54.90590	82 02 59.59132	Group 1
BLUE HOLE SPRING (CITRUS)	UNKNOWN	Citrus	28 47 55.63427	82 35 22.33819	Group 5
BLUE HOLE SPRING (COLUMBIA)	1	Columbia	29 58 49.90703	82 45 30.37913	Group 1
BLUE HOLE SPRING (JACKSON)	2	Jackson	30 49 12.52347	85 14 41.62271	Group 2
BLUE RUN SPRING	UNKNOWN	Hernando	28 41 12.50199	82 36 5.165000	Group 5
BLUE SINK SPRING	2	Suwannee	30 20 8.485690	82 48 30.39404	Group 1
BLUE SPRING (OKALOOSA)	UNKNOWN	Okaloosa	30 37 46.69438	86 27 6.818399	Group 3
BLUE SPRING (SUWANNEE)	2	Hamilton	30 25 22.95072	83 00 55.52798	Group 1
BLUEBERRY SPRING	4	Lake	28 51 2.634480	81 26 41.48441	Group 2
BLUEBIRD SPRINGS	3	Citrus	28 47 20.38027	82 34 46.25806	Group 5
BLUFF SPRINGS	3	Bay	30 25 30.95550	85 32 54.19590	Group 3
BOAT SPRING	3	Hernando	28 26 11.57851	82 39 23.43617	Group 5
BOBHILL SPRING	3	Hernando	28 26 4.957999	82 38 27.97499	Group 5
BONNET SPRING	2	Suwannee	30 07 27.56312	83 08 17.45944	Group 1
BOULDER SPRINGS	5	Lake	28 52 17.96837	81 27 0.355459	Group 2
BOULWARE SPRINGS	4	Alachua	29 37 15.20673	82 18 25.90535	Group 1
BRADLEY SPRING	3	Taylor	29 42 0.169960	83 24 40.06998	Group 1
BRANFORD SPRING	2	Suwannee	29 57 17.52526	82 55 42.27174	Group 1
BRANTLEY SPRING	2	Suwannee	30 00 29.81797	82 59 11.46652	Group 1
BREAM FOUNTAIN SINK	UNKNOWN	Wakulla	30 10 33.5	84 24 56.5	Group 1
BRIDAL CHAMBER SPRING	UNKNOWN	Marion	29 12 53.20000	82 03 5.5	Group 1
BRIGHT ANGEL SPRING	UNKNOWN	Putnam	29 30 59.65919	81 51 43.52339	Group 1
BRUMBLEY SPRING	2	Jefferson	30 20 41.38685	83 58 51.63329	Group 1
BRUNSON LANDING SPRING	3	Washington	30 36 33.22386	85 45 30.88954	Group 3
BUBBLING SPRING	3	Marion	29 06 4.455680	82 26 5.451359	Group 4
BUCKHORN EAST SPRING	2	Hillsborough	27 53 20.67399	82 18 5.189999	Group 2
BUCKHORN SOUTH SPRING	2	Hillsborough	27 53 12.84600	82 18 18.75699	Group 2
BUCKHORN SPRING MAIN	2	Hillsborough	27 53 21.81079	82 18 9.796899	Group 2
BUCKHORN SPRINGS #395	UNKNOWN	Hillsborough	27 53 38.3	82 17 53.1	Group 2
BUCKHORN SPRINGS #396	UNKNOWN	Hillsborough	27 53 38.7	82 17 6.2	Group 2
BUCKHORN SPRINGS #397	UNKNOWN	Hillsborough	27 53 26.5	82 16 36.8	Group 2
BUCKHORN WEST SPRING	2	Hillsborough	27 53 21.14100	82 18 16.81900	Group 2
BUGG SPRING (LAKE)	2	Lake	28 45 7.152230	81 54 5.462210	Group 1
BUZZARD LOG SPRING	2	Jefferson	30 19 48.49867	83 59 12.80159	Group 1
CAMP GROUND SPRING (TAYLOR)	2	Taylor	30 04 4.265109	83 33 13.76329	Group 1
CAMP LE NO CHE SPRING	4	Lake	28 57 8.716000	81 32 31.88219	Group 2
CAMP SEMINOLE SPRINGS	4	Marion	29 30 21.79252	81 57 5.232059	Group 1
CAMPGROUND SPRING (GILCHRIST)	3	Gilchrist	29 53 57.44377	82 51 57.94091	Group 1
CANAL 485 SPRING 5	3	Sumter	28 46 7.5	82 07 1.241000	Group 4
CANAL 485A SPRING 1B	3	Sumter	28 46 10.60300	82 07 4.804000	Group 4
CANAL 485A SPRING 2	3	Sumter	28 46 12.93499	82 07 3.375	Group 4
CANAL SPRING	2	Hillsborough	28 02 5.227980	82 20 34.88254	Group 1
CARLTON SPRING	9	Taylor	30 03 29.76897	83 35 14.53200	Group 1
CASSIDY SPRINGS	2	Jefferson	30 19 57.79618	83 59 20.53168	Group 1
CATFISH CONVENTION HALL SPRING	UNKNOWN	Marion	29 12 55.58935	82 02 38.06163	Group 1
CATFISH HOTEL SPRING	UNKNOWN	Marion	29 12 55.40000	82 02 42.40000	Group 1
CATFISH RECEPTION HALL	UNKNOWN	Marion	29 12 53.79999	82 03 6.400000	Group 1
CATFISH SPRING (CITRUS)	2	Citrus	28 53 52.79992	82 35 56.40000	Group 5
CATFISH SPRINGS (MARION)	3	Marion	29 30 55	81 51 42	Group 1
CEDAR COVE SPRINGS	UNKNOWN	Citrus	28 54 6.840000	82 35 57.11999	Group 5
CEDAR HEAD SPRING	3	Columbia	29 58 59.87992	82 45 31.31999	Group 1
CEDAR ISLAND SPRING (PASCO)	UNKNOWN	Pasco	28 22 1.014060	82 41 59.36424	Group 5
CEDAR ISLAND SPRING (TAYLOR)	2	Taylor	29 48 58.72960	83 35 1.974440	Group 1
CEDAR SPRING	5	Lake	28 52 21	81 26 54	Group 2
CHARLES SPRING	2	Suwannee	30 10 2.509970	83 13 49.27000	Group 1
CHASSAHOWITZKA SPRING	UNKNOWN	Citrus	28 42 54.95108	82 34 34.35600	Group 5
CHASSAHOWITZKA SPRING #1	3	Citrus	28 42 58.24206	82 34 30.31906	Group 5
CHASSAHOWITZKA SPRING #2	2	Citrus	28 42 57.66401	82 34 31.62517	Group 5
CHASSAHOWITZKA SPRING MAIN	1	Citrus	28 42 55.86505	82 34 34.33253	Group 5
CHATTAHOOCHEE SPRING	4	Gadsden	30 41 50.67820	84 50 55.82004	Group 2
CHIMNEY SPRINGS (MARION)	UNKNOWN	Marion	29 14 40	81 38 34	Group 2

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
CHOCTAWHATCHEE SPRINGS (WALTON)	UNKNOWN	Walton	30 24 5.713776	86 03 35.78040	Group 3
CHRISTMAS TREE SPRING	UNKNOWN	Marion	29 12 58.29999	82 02 57.30000	Group 1
CHUMUCKLA SPRINGS	5	Santa Rosa	30 50 0	87 17 48	Group 4
CITRUS BLUE SPRING	2	Citrus	28 58 9.601569	82 18 52.34349	Group 4
CLAM SPRINGS	UNKNOWN	Gadsden	30 41 45.69064	84 51 28.71323	Group 2
CLEMMONS SPRING	3	Washington	30 38 29.09601	85 41 34.67252	Group 3
CLIFTON SPRINGS	3	Seminole	28 41 59.53977	81 14 17.22397	Group 2
COFFEE SPRINGS	3	Suwannee	29 57 34.04671	82 46 31.17827	Group 1
COL1012971 (COLUMBIA)	2	Columbia	29 51 24.88338	82 43 47.98160	Group 1
COL1012972 (COLUMBIA)	2	Columbia	29 51 23.37868	82 43 54.11730	Group 1
COL101971 (COLUMBIA)	3	Columbia	29 49 55.96126	82 40 9.711159	Group 1
COL101974 (COLUMBIA)	2	Columbia	29 50 2.393589	82 40 36.04461	Group 1
COL101975 (COLUMBIA)	4	Columbia	29 50 1.755999	82 40 41.55200	Group 1
COL1105041	3	Columbia	29 58 49.88199	82 45 28.86199	Group 1
COL428981 (COLUMBIA)	3	Columbia	29 51 12.72895	82 36 19.87571	Group 1
COL522981 (COLUMBIA)	3	Columbia	30 19 15.75972	82 45 21.29422	Group 1
COL522982 (COLUMBIA)	3	Columbia	30 19 17.26456	82 45 23.50213	Group 1
COL61982 (COLUMBIA)	4	Columbia	29 56 17.89600	82 31 49.32700	Group 1
COL917971 (COLUMBIA)	3	Columbia	29 55 29.37913	82 46 19.16566	Group 1
COL928971 (COLUMBIA)	3	Columbia	29 53 10.18589	82 45 5.507169	Group 1
COL930971 (COLUMBIA)	2	Columbia	29 49 52.19215	82 39 24.26237	Group 1
COLUMBIA SPRING	1	Columbia	29 51 14.79924	82 36 43.03174	Group 1
CONVICT SPRING	3	Lafayette	30 05 18.02483	83 05 45.48202	Group 1
COPPER SPRING	2	Dixie	29 36 50.45069	82 58 25.89046	Group 1
CORDLE SPRING	UNKNOWN	Walton	30 59 7.200000	86 12 47.52000	Group 3
COW SPRING	0	Suwannee	30 06 19.01994	83 06 49.70999	Group 1
CRAB SPRING	2	Citrus	28 43 1.916940	82 34 33.06892	Group 5
CRAYS RISE	2	Wakulla	29 59 22.19995	84 24 28.80000	Group 1
CRESCENT BEACH SUBMARINE SPRING	2	St. Johns	29 46 6	81 12 30	Group 5
CRESCENT DRIVE SPRING	UNKNOWN	Citrus	28 52 39	82 35 54.95999	Group 5
CROAKER HOLE SPRING	2	Putnam	29 26 18	81 41 21	Group 2
CRYSTAL BEACH SPRING (PINELLAS)	2	Pinellas	28 05 3.964060	82 47 5.109109	Group 5
CRYSTAL SPRINGS #5 (PASCO)	2	Pasco	28 10 58.23999	82 11 8.530000	Group 2
CRYSTAL SPRINGS #6 (PASCO)	2	Pasco	28 10 58.78000	82 11 7.763000	Group 2
CRYSTAL SPRINGS (PASCO)	2	Pasco	28 10 55.92310	82 11 6.530750	Group 2
CRYSTAL SWAMP SPRING #1 (PASCO)	2	Pasco	28 11 13	82 10 52	Group 2
CRYSTAL SWAMP SPRING #2 (PASCO)	2	Pasco	28 11 6	82 10 48	Group 2
CRYSTAL SWAMP SPRING #3 (PASCO)	2	Pasco	28 11 7	82 11 34	Group 2
CYPRESS SPRING	2	Washington	30 39 29.00	85 41 4.00	Group 3
D-1415 SEEP	UNKNOWN	Duval	30 16 26	81 50 6	Group 2
DALKEITH SPRINGS	3	Gulf	30 00 20.73024	85 08 59.69472	Group 2
DANIEL SPRINGS	3	Jackson	30 56 55.66901	85 18 27.75491	Group 2
DARBY SPRING	2	Alachua	29 51 9.417669	82 36 21.46651	Group 1
DEER SPRING	3	Gilchrist	29 50 28.19260	82 42 26.36682	Group 1
DELEON SPRING (VOLUSIA)	2	Volusia	29 08 3.408110	81 21 45.89416	Group 2
DEVILS EAR SPRING (GILCHRIST)	1	Gilchrist	29 50 7.256180	82 41 47.76176	Group 1
DEVILS EYE SPRING (GILCHRIST)	2	Gilchrist	29 50 6.574130	82 41 47.72224	Group 1
DEVILS EYE SPRINGS (SUWANNEE)	2	Suwannee	29 58 25.22532	82 45 36.03208	Group 1
DEVILS KITCHEN A SPRING	UNKNOWN	Marion	29 12 53.59999	82 03 4.800000	Group 1
DEVILS KITCHEN B SPRING	UNKNOWN	Marion	29 12 54	82 03 5.199999	Group 1
DIX625991 (DIXIE)	3	Dixie	29 43 36.80999	83 20 40.72600	Group 1
DIX625992 (DIXIE)	3	Taylor	29 43 8.560999	83 20 46.35600	Group 1
DIX625993 (DIXIE)	2	Dixie	29 40 37.17999	83 21 38.96299	Group 1
DIX625994 (DIXIE)	3	Dixie	29 40 35.61400	83 21 50.50699	Group 1
DIX95971 (DIXIE)	3	Dixie	29 42 15.83409	82 57 9.872500	Group 1
DOBES HOLE SPRING	UNKNOWN	Pasco	28 26 3.799999	82 10 10.90000	Group 4
DOGWOOD SPRING	2	Gilchrist	29 50 17.00300	82 42 6.456129	Group 1
DOUBLE RUN SPRING (LAKE)	3	Lake	28 40 46.5	81 44 31.69999	Group 1
DOUBLE SPRING (HILLSBOROUGH)	UNKNOWN	Hillsborough	28 02 10.43940	82 20 37.52772	Group 1
DOUBLE SPRING (JACKSON)	2	Jackson	30 42 13.67995	85 18 11.16000	Group 2
DRINKING SPRING	UNKNOWN	Washington	30 36 44.82669	85 49 23.58432	Group 3
DROTY SPRING	4	Lake	28 49 41.03508	81 30 37.29700	Group 2
EAST LAKE TOHOPEKALIGA UNNAMED SPRING NW	UNKNOWN	Osceola	28 20 1.320000	81 14 23.28000	Group 4
EAST LAKE TOHOPEKALIGA UNNAMED SPRING SW	UNKNOWN	Osceola	28 16 23.52000	81 17 26.52000	Group 4

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
EATON CREEK SPRINGS	UNKNOWN	Marion	29 20 18	81 53 2	Group 1
ECONFINA UNNAMED SPRING	NONE	Bay	30 25 53.46072	85 32 50.76532	Group 3
EGLIN BLUE SPRING	UNKNOWN	Okaloosa	30 38 45.81445	86 27 6.634979	Group 4
ELDER SPRING	3	Seminole	28 44 27.78490	81 17 28.75768	Group 2
ELLAVILLE SPRING	2	Suwannee	30 23 4.077999	83 10 21.01832	Group 1
ENTERPRISE SPRINGS	UNKNOWN	Volusia	28 51 40.64000	81 14 56.43000	Group 2
ESPIRITU SANTO SPRING	4	Pinellas	27 59 26.07046	82 41 12.35867	Group 1
EUCHEE SPRING	3	Walton	30 44 13.63769	86 11 36.57512	Group 3
EUREKA SPRING	2	Hillsborough	28 00 21.44066	82 20 45.15040	Group 1
EUREKA SPRING #1	0	Hillsborough	28 00 23.07344	82 20 39.33276	Group 1
EUREKA SPRING #2	0	Hillsborough	28 00 24.07341	82 20 36.33288	Group 1
EUREKA SPRING #3	0	Hillsborough	28 00 24.07345	82 20 32.33256	Group 1
EUREKA SPRING #4	0	Hillsborough	28 00 24.07341	82 20 37.33296	Group 1
EUREKA UNNAMED SPRING	2	Hillsborough	28 00 26.72675	82 20 38.59777	Group 1
EVA SPRING	3	Taylor	29 40 39.76997	83 23 57.31001	Group 1
EWING SPRING	NONE	Taylor	30 04 26.76468	83 39 56.54159	Group 1
FALMOUTH SPRING	1	Suwannee	30 21 40.18722	83 08 5.970300	Group 1
FANNING SPRINGS	2	Levy	29 35 15.32190	82 56 7.095590	Group 1
FANNING SPRINGS #1	UNKNOWN	Levy	29 35 16.18800	82 56 9.599999	Group 1
FANNING SPRINGS #2	UNKNOWN	Dixie	29 35 22.55999	82 56 13.38000	Group 1
FARA SPRING	2	Madison	30 16 34.43991	83 14 8.947900	Group 1
FENHOLLOWAY SPRING	9	Taylor	30 04 23.40126	83 40 0.323760	Group 1
FENNEY SPRING	2	Sumter	28 47 41.99128	82 02 17.21057	Group 4
FERN HAMMOCK SPRINGS	2	Marion	29 11 0.863840	81 42 29.50127	Group 2
FIRST FISHERMANS PARADISE	1	Marion	29 12 56.09999	82 02 50.40000	Group 1
FISH HOOK SPRING #1	UNKNOWN	Marion	29 30 34.12380	81 54 5.450399	Group 1
FISH HOOK SPRING #2	UNKNOWN	Marion	29 30 32.54700	81 54 8.294400	Group 1
FLETCHER SPRINGS	2	Lafayette	29 50 48	82 53 34	Group 1
FOLSOM SPRING	3	Taylor	30 06 49.85995	83 34 41.32998	Group 1
FOREST SPRING	4	Putnam	29 27 31.67992	81 39 30.59999	Group 2
GADSEN SPRING	2	Jackson	30 42 12.08682	85 17 18.42258	Group 2
GAINER SPRING #1	2	Bay	30 25 40.70280	85 32 49.73711	Group 3
GAINER SPRING #1C	2	Bay	30 25 39.62275	85 32 45.82853	Group 3
GAINER SPRING #2	2	Bay	30 25 38.61220	85 32 53.95200	Group 3
GAINER SPRING #3	2	Bay	30 25 44.30301	85 32 55.63251	Group 3
GALLOWAY SPRING	UNKNOWN	Washington	30 35 50.85632	85 50 31.25684	Group 3
GARDEN OF EDEN SPRING	UNKNOWN	Marion	29 12 58.09999	82 02 54.80000	Group 1
GARNER SPRING	2	Jefferson	30 19 49.11654	83 58 59.21860	Group 1
GATOR SPRING (HERNANDO)	4	Hernando	28 26 2.754559	82 39 5.613409	Group 5
GATOR SPRING (JACKSON)	UNKNOWN	Jackson	30 46 40.32731	85 10 1.735970	Group 2
GEMINI SPRINGS	UNKNOWN	Volusia	28 51 45.97999	81 18 46.06000	Group 2
GEMINI SPRINGS #1	UNKNOWN	Volusia	28 51 43.91999	81 18 38.88000	Group 2
GEMINI SPRINGS #2	UNKNOWN	Volusia	28 51 43.91999	81 18 38.88000	Group 2
GEMINI SPRINGS #3	UNKNOWN	Volusia	28 51 45.97815	81 18 41.05552	Group 2
GEYSER SPRING	1	Marion	29 12 55.40000	82 03 0.300000	Group 1
GIL1012971 (GILCHRIST)	2	Gilchrist	29 51 21.24492	82 43 55.88223	Group 1
GIL1012972 (GILCHRIST)	3	Gilchrist	29 51 21.77981	82 43 57.75408	Group 1
GIL1012974 (GILCHRIST)	2	Gilchrist	29 51 52.12699	82 44 24.25899	Group 1
GIL101971 (GILCHRIST)	3	Gilchrist	29 49 56.42900	82 40 42.24899	Group 1
GIL107971 (GILCHRIST)	2	Gilchrist	29 53 27.61499	82 52 26.99800	Group 1
GIL107972 (GILCHRIST)	2	Gilchrist	29 53 56.39000	82 51 58.51899	Group 1
GIL729971 (GILCHRIST)	2	Gilchrist	29 53 21.67300	82 52 29.88399	Group 1
GIL729972 (GILCHRIST)	4	Gilchrist	29 54 45.94500	82 50 12.43200	Group 1
GIL729973 (GILCHRIST)	4	Gilchrist	29 54 48.25300	82 50 12.08100	Group 1
GIL84971 (GILCHRIST)	2	Gilchrist	29 49 47.50374	82 53 29.18496	Group 1
GIL917972 (GILCHRIST)	3	Gilchrist	29 51 36.97899	82 52 46.32400	Group 1
GIL917973 (GILCHRIST)	4	Gilchrist	29 51 31.85399	82 52 51.06900	Group 1
GIL928971 (GILCHRIST)	3	Gilchrist	29 52 32.15182	82 45 6.810659	Group 1
GIL928972 (GILCHRIST)	4	Gilchrist	29 52 49.64600	82 45 11.91000	Group 1
GIL99971 (GILCHRIST)	4	Gilchrist	29 55 16.79100	82 49 26.77099	Group 1
GIL99972 (GILCHRIST)	3	Gilchrist	29 55 51.30745	82 48 8.696920	Group 1
GIL99974 (GILCHRIST)	3	Gilchrist	29 55 6.956000	82 46 18.26100	Group 1
GILCHRIST BLUE SPRING	2	Gilchrist	29 49 47.64094	82 40 58.26535	Group 1
GINGER ALE SPRING	5	Seminole	28 41 33.56890	81 23 27.89735	Group 2

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
GINNIE SPRING	2	Gilchrist	29 50 10.82130	82 42 0.437039	Group 1
GLEN JULIA SPRINGS	4	Gadsden	30 39 5.692319	84 42 26.69903	Group 2
GLEN SPRING	4	Alachua	29 40 30.04207	82 20 52.43622	Group 1
GOLD HEAD BRANCH	UNKNOWN	Clay	29 50 30.11995	81 57 14.40000	Group 2
GRASSY HOLE SPRING	2	Columbia	29 58 4	82 45 35	Group 1
GREEN ALGAE BOIL SPRING	5	Lake	28 52 32.87693	81 26 24.73410	Group 2
GREEN COVE SPRINGS	3	Clay	29 59 36.24157	81 40 40.47754	Group 2
GREEN SINK	N/A	Hillsborough	27 52 2.924999	82 17 0.844000	Group 2
GREEN SPRING	3	Volusia	28 51 46.03924	81 14 50.92382	Group 2
GROTTO SPRINGS	3	Calhoun	30 35 57.88413	85 09 51.27853	Group 2
GUARANTO SPRING	2	Dixie	29 46 47.26883	82 56 23.84944	Group 1
GUM SPRING #1	2	Sumter	28 57 33.48499	82 13 50.82499	Group 4
GUM SPRING #2	2	Sumter	28 57 13.83699	82 14 12.69200	Group 4
GUM SPRING #3	2	Sumter	28 57 13.20799	82 14 14.50399	Group 4
GUM SPRING #4	2	Sumter	28 57 10.79999	82 14 26.5	Group 4
GUM SPRING MAIN	2	Sumter	28 57 31.39798	82 13 53.49317	Group 4
HALLS RIVER HEAD SPRING	UNKNOWN	Citrus	28 49 36.50900	82 34 49.17599	Group 5
HALLS RIVER SPRING #1	UNKNOWN	Citrus	28 49 20.88000	82 35 38.20499	Group 5
HALLS RIVER SPRING #2	UNKNOWN	Citrus	28 49 35.68180	82 34 59.62633	Group 5
HAM1017971 (HAMILTON)	3	Hamilton	30 25 33.79700	83 01 20.88800	Group 1
HAM1017972 (HAMILTON)	4	Hamilton	30 25 40.47299	83 01 40.49499	Group 1
HAM1017973 (HAMILTON)	4	Hamilton	30 25 23.64299	83 00 38.31499	Group 1
HAM1017974 (HAMILTON)	2	Hamilton	30 25 3.781919	82 57 57.46288	Group 1
HAM1019971 (HAMILTON)	4	Suwannee	30 23 24.61700	82 55 36.59600	Group 1
HAM1019972 (HAMILTON)	4	Hamilton	30 24 1.292000	82 56 36.33799	Group 1
HAM1023971 (HAMILTON)	2	Hamilton	30 23 10.11599	82 54 22.86899	Group 1
HAM522981 (HAMILTON)	3	Hamilton	30 20 35.32299	82 50 29.10499	Group 1
HAM54012 (HAMILTON)	3	Madison	30 33 8.884000	83 15 36.94299	Group 1
HAM610981 (HAMILTON)	2	Hamilton	30 24 56.42700	83 11 57.74100	Group 1
HAM610982 (HAMILTON)	2	Madison	30 25 2.762259	83 12 26.66790	Group 1
HAM610983 (HAMILTON)	2	Hamilton	30 25 13.47192	83 12 51.37945	Group 1
HAM610984 (HAMILTON)	2	Hamilton	30 26 25.51546	83 13 10.50028	Group 1
HAM612982 (HAMILTON)	3	Madison	30 28 29.08714	83 14 36.17819	Group 1
HAM923972 (HAMILTON)	4	Hamilton	30 25 8.223999	83 08 42.52500	Group 1
HAM923973 (HAMILTON)	3	Hamilton	30 25 8.139970	83 08 56.64997	Group 1
HAMILTON SPRING (CALHOUN)	3	Calhoun	30 31 9.308459	85 09 47.51557	Group 2
HAMPTON SPRING (TAYLOR)	4	Taylor	30 04 53.35975	83 39 46.24549	Group 1
HARDEN SPRING	UNKNOWN	Seminole	28 49 16.99758	81 25 0.730489	Group 2
HART SPRINGS	2	Gilchrist	29 40 32.66691	82 57 6.160750	Group 1
HAYS SPRING (JACKSON)	2	Jackson	30 53 42.33124	85 13 28.14546	Group 2
HEALTH SPRING	3	Pinellas	28 06 23.08536	82 46 20.08888	Group 5
HEATH SPRING	UNKNOWN	Seminole	28 44 42.69725	81 07 41.34605	Group 2
HEIDI HOLE SPRING	UNKNOWN	Jackson	30 46 50.56900	85 09 48.34100	Group 2
HEILBRONN SPRING	9	Bradford	30 01 25.86248	82 09 22.38911	Group 1
HELENE SPRING	3	Lake	28 52 23.79999	81 27 10	Group 2
HENRY GREEN SPRING	UNKNOWN	Sumter	28 52 9.457999	82 05 40.93200	Group 4
HIDDEN RIVER HEAD SPRING	3	Citrus	28 46 7.357000	82 34 59.68900	Group 5
HIDDEN RIVER SPRING #2	UNKNOWN	Citrus	28 46 7.010000	82 35 3.633999	Group 5
HIDDEN RIVER SPRING #6	UNKNOWN	Citrus	28 46 3.942660	82 35 6.357480	Group 5
HIDDEN SPRING (JACKSON)	UNKNOWN	Jackson	30 42 20.19995	85 18 26.08999	Group 2
HIDDEN SPRING (SUWANNEE)	3	Suwannee	30 06 9.373859	83 06 50.39761	Group 1
HIGHTOWER SPRING	3	Washington	30 36 18.18864	85 45 55.50811	Group 3
HILL SPRINGS	UNKNOWN	Jackson	30 39 51.62946	84 55 34.62005	Group 2
HOLE IN THE ROCK SPRING	UNKNOWN	Jackson	30 47 0.196219	85 09 22.11250	Group 2
HOLIDAY SPRING	3	Lake	28 44 25.44860	81 49 4.688540	Group 1
HOLLY SPRING	N/A	Gilchrist	29 55 3.837503	82 49 26.44824	Group 1
HOLMES BLUE SPRING	2	Holmes	30 51 6.034500	85 53 9.047509	Group 3
HOLTON CREEK RISE	1	Hamilton	30 26 15.78461	83 03 26.48951	Group 1
HOLTON CREEK RISE	1	Hamilton	30 26 16.51192	83 03 27.41133	Group 1
HOMOSASSA SPRING	2	Citrus	28 47 58.93832	82 35 19.35920	Group 5
HOMOSASSA SPRING #1	UNKNOWN	Citrus	28 47 56.66733	82 35 18.69090	Group 5
HOMOSASSA SPRING #2	UNKNOWN	Citrus	28 47 56.64695	82 35 18.78832	Group 5
HOMOSASSA SPRING #3	UNKNOWN	Citrus	28 47 56.63299	82 35 18.67376	Group 5
HOMOSASSA UNNAMED SPRING #1	UNKNOWN	Citrus	28 47 53.86829	82 35 23.74112	Group 5

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
HOMOSASSA UNNAMED SPRING #2	0	Citrus	28 47 52.92319	82 35 22.74140	Group 5
HORN SPRING	2	Leon	30 19 8.888840	84 07 43.44718	Group 1
HORNSBY SPRING	0	Alachua	29 51 1.279399	82 35 35.52436	Group 1
HORSEHEAD SPRING	2	Jefferson	30 20 41.50060	83 59 40.35473	Group 1
HORSESHOE SPRING	3	Pasco	28 23 51.18316	82 41 23.82767	Group 5
HOSPITAL SPRING	UNKNOWN	Hernando	28 31 54.98266	82 37 37.36164	Group 5
HOUSE SPRING	0	Citrus	28 53 50.27996	82 35 27.59999	Group 5
HUNTER SPRING	UNKNOWN	Citrus	28 53 39.94721	82 35 32.93339	Group 5
ICHETUCKNEE HEAD SPRING (SUWANNEE)	2	Suwannee	29 59 3.097499	82 45 42.72664	Group 1
IDIOTS DELIGHT SPRING	3	Citrus	28 53 16.62661	82 35 22.03278	Group 5
INDIAN CAVE SPRING	UNKNOWN	Marion	29 12 56.09999	82 02 52.80000	Group 1
INDIAN CREEK #1 SPRING	UNKNOWN	Marion	29 05 35.90600	82 25 6.349000	Group 4
INDIAN CREEK #2 SPRING	UNKNOWN	Marion	29 05 35.59200	82 25 15.83719	Group 4
INDIAN CREEK #3 SPRING	UNKNOWN	Marion	29 05 34.63847	82 25 15.20820	Group 4
INDIAN CREEK #4 SPRING	UNKNOWN	Marion	29 05 34.81608	82 25 16.22650	Group 4
INDIAN SPRING (WAKULLA)	4	Wakulla	30 15 2.878629	84 19 19.50193	Group 1
INDIAN SPRINGS (GADSDEN)	UNKNOWN	Gadsden	30 31 24.69792	84 47 27.69683	Group 1
INDIAN WASHTUB	2	JACKSON	30 47 17.01799	85 08 42.45700	Group 2
INDIGO SPRINGS	UNKNOWN	Putnam	29 40 3	81 45 43	Group 2
IRON SPRING (LAFAYETTE)	3	Lafayette	29 49 40.80468	83 18 27.49460	Group 1
IRON SPRINGS (DIXIE)	3	Dixie	29 40 25.04800	82 57 27.33400	Group 1
ISABELLA SPRING	2	Pasco	28 24 0	82 39 0	Group 5
ISLAND SPRING	3	Seminole	28 49 24.40000	81 25 1.800000	Group 2
JABO SPRING	2	Taylor	29 52 57.31038	83 37 22.50797	Group 1
JACK PAUL SPRINGS	2	Washington	30 36 46.29343	85 44 1.461409	Group 3
JACKSON BLUE SPRING	1	Jackson	30 47 25.85359	85 08 24.31805	Group 2
JACKSON BLUE SPRING APALACHICOLA	1	Jackson	30 36 59.28347	84 55 19.37320	Group 2
JACKSON SPRING	3	Holmes	30 42 42.03409	85 55 41.01653	Group 3
JACOBS WELL SPRING	UNKNOWN	Marion	29 12 54.20000	82 03 6.800000	Group 1
JAMISON SPRINGS	3	Columbia	29 55 32.97299	82 46 12.44200	Group 1
JEF312991 (JEFFERSON)	3	Jefferson	30 20 41.82199	83 59 45.06400	Group 1
JEF63991	2	Jefferson	30 19 29.81300	83 59 9.109000	Group 1
JEF63992 (JEFFERSON)	2	Jefferson	30 19 23.50699	83 59 12.08499	Group 1
JEF63993 (JEFFERSON)	2	Jefferson	30 18 8.215199	83 58 46.62691	Group 1
JEF64991 (JEFFERSON)	2	Jefferson	30 20 38.87900	83 58 49.49199	Group 1
JEFFERSON BLUE SPRING	2	Jefferson	30 19 50	83 59 20	Group 1
JENKINS CREEK SPRING	2	Hernando	28 31 19.98443	82 38 3.362243	Group 5
JENKINS CREEK SPRING #5	UNKNOWN	Hernando	28 31 20.98444	82 38 3.362243	Group 5
JOHNSON SPRING	3	Gilchrist	29 49 53.39302	82 40 46.95758	Group 1
JONATHAN SPRING	3	Columbia	29 50 1.642200	82 40 31.49835	Group 1
JUG ISLAND SPRING	2	Taylor	29 50 47.65399	83 36 33.06999	Group 1
JULY SPRING	1	Columbia	29 50 10.22827	82 41 47.02639	Group 1
JUNIPER SPRINGS	3	Marion	29 11 1.341710	81 42 44.68090	Group 2
JURASSIC SPRING	UNKNOWN	Citrus	28 53 42.27223	82 35 23.71117	Group 5
KING SPRING (CITRUS)	UNKNOWN	Citrus	28 52 54.19170	82 35 42.17575	Group 5
KING SPRING (JACKSON)	UNKNOWN	Jackson	30 38 11.52064	84 55 10.24881	Group 2
KINGS BAY SPRING #1	UNKNOWN	Citrus	28 53 17.33734	82 35 23.06302	Group 5
KINI SPRING	1	Wakulla	30 16 43.72463	84 20 33.64004	Group 1
KISSENGEN SPRING	NONE	Polk	27 50 33.09899	81 48 40.29480	Group 3
LADIES PARLOR SPRING	UNKNOWN	Marion	29 12 52.70000	82 03 5.199999	Group 1
LAF1024001 (LAFAYETTE)	3	Lafayette	30 00 27.06199	82 58 56.10400	Group 1
LAF57981 (LAFAYETTE)	3	Lafayette	30 05 25.68699	83 06 31.58100	Group 1
LAF57982 (LAFAYETTE)	3	Lafayette	30 03 40.23209	83 03 26.53030	Group 1
LAF710981 (LAFAYETTE)	4	Lafayette	30 02 42.35899	83 02 1.910000	Group 1
LAF718971 (LAFAYETTE)	2	Lafayette	29 57 34.11421	82 57 11.94293	Group 1
LAF718972 (LAFAYETTE)	2	Lafayette	30 00 41.85805	83 00 15.33938	Group 1
LAF721001 (LAFAYETTE)	UNKNOWN	Lafayette	30 6 51.5	83 13 35.9	Group 1
LAF721002 (LAFAYETTE)	UNKNOWN	Lafayette	30 6 24.5	83 6 24.5	Group 1
LAF919971 (LAFAYETTE)	4	Lafayette	30 06 11.57699	83 08 51.52800	Group 1
LAF919972 (LAFAYETTE)	3	Lafayette	30 05 31.72951	83 06 48.07464	Group 1
LAF922975 (LAFAYETTE)	3	Madison	30 15 40.19907	83 14 47.69735	Group 1
LAF922976 (LAFAYETTE)	3	Madison	30 15 38.05693	83 14 58.86251	Group 1
LAF922977 (LAFAYETTE)	4	Lafayette	30 15 34.87300	83 15 5.402000	Group 1

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
LAF924971 (LAFAYETTE)	2	Lafayette	30 06 7.960390	83 09 57.99048	Group 1
LAF924972 (LAFAYETTE)	4	Lafayette	30 06 17.29499	83 12 14.09499	Group 1
LAF929971 (LAFAYETTE)	3	Lafayette	30 12 40.60735	83 14 43.44262	Group 1
LAF929972 (LAFAYETTE)	3	Lafayette	30 11 24.34132	83 15 1.506960	Group 1
LAF929973 (LAFAYETTE)	2	Lafayette	30 10 48.03586	83 14 51.87034	Group 1
LAF93971 (LAFAYETTE)	3	Lafayette	29 57 40.87699	82 57 16.51300	Group 1
LAFAYETTE BLUE SPRING	1	Lafayette	30 07 33.00333	83 13 34.08019	Group 1
LAKE BLUE SPRING	3	Lake	28 44 55.14114	81 49 40.11390	Group 1
LAKE JESSUP SPRING	3	Seminole	28 42 36.79920	81 16 4.764680	Group 2
LAKE LOWERY EAST SPRING	3	Clay	29 51 40.12380	81 58 48.40561	Group 2
LAKE LOWERY NORTH SPRING	3	Clay	29 52 17.71783	81 59 17.63199	Group 2
LAKE LOWRY WEST SPRING	3	Clay	29 51 57.68345	81 59 44.23545	Group 2
LAMARS LANDING SPRING	UNKNOWN	Jackson	30 46 49.24599	85 09 55.68400	Group 2
LANCASTER SPRING	3	Levy	29 11 26.52114	82 59 17.41960	Group 1
LAST SPRING	UNKNOWN	Hillsborough	28 02 2.788660	82 20 33.30365	Group 1
LETTUCE CREEK SPRING	UNKNOWN	Citrus	28 43 8.950439	82 34 36.35615	Group 5
LETTUCE LAKE SPRING	3	Hillsborough	28 01 5.526590	82 21 0.256000	Group 1
LEV719991 (LEVY)	2	Levy	29 27 3.699540	82 41 43.31525	Group 1
LEV97991 (LEVY)	3	Levy	29 11 30.40299	82 59 19.41299	Group 1
LEVY BLUE SPRING	3	Levy	29 27 2.686319	82 41 56.27890	Group 1
LILLY SPRING	2	Gilchrist	29 49 46.98133	82 39 40.36496	Group 1
LIME RUN SPRING OR SINK (SUWANNEE)	1	Suwannee	30 23 22.19	83 09 50.83	Group 1
LIME SPRING (SUWANNEE)	2	Hamilton	30 23 28.38763	83 10 7.319929	Group 1
LITHIA SPRING MAJOR	2	Hillsborough	27 51 58.60184	82 13 53.29394	Group 2
LITHIA SPRING MINOR	2	Hillsborough	27 51 55.14299	82 13 51.58299	Group 2
LITTLE BLUE SPRING (GILCHRIST)	UNKNOWN	Gilchrist	29 49 49.14569	82 41 1.782639	Group 1
LITTLE BLUE SPRING (JEFFERSON)	2	Jefferson	30 19 51.03000	83 59 20.53162	Group 1
LITTLE CHASSAHOWITZKA SPRING	1	Citrus	28 42 55.95105	82 34 31.35612	Group 5
LITTLE COPPER SPRING	3	Dixie	29 38 1.362910	82 58 0.646569	Group 1
LITTLE DEVIL SPRING	3	Gilchrist	29 50 4.428100	82 41 49.31750	Group 1
LITTLE FANNING SPRING	2	Levy	29 35 11.02801	82 56 7.694230	Group 1
LITTLE HIDDEN SPRING	3	Citrus	28 53 8.813439	82 35 38.62216	Group 5
LITTLE KING SPRING	3	Levy	29 06 39.04787	82 38 52.13514	Group 1
LITTLE LAGOON SPRING	UNKNOWN	Jackson	30 37 14.50375	85 10 2.874900	Group 2
LITTLE OTTER SPRING	2	Gilchrist	29 38 11.10198	82 57 30.33849	Group 1
LITTLE RIVER SPRING	2	Suwannee	29 59 48.71054	82 57 58.74329	Group 1
LITTLE SALT SPRING	3	Sarasota	27 04 31.20167	82 13 59.33027	Group 3
LITTLE SPRING (CITRUS)	2	Citrus	28 54 1.190479	82 35 43.33308	Group 5
LITTLE SPRING (HERNANDO)	2	Hernando	28 30 48.47083	82 34 51.69967	Group 5
LIVINGSTON SPRING	UNKNOWN	Madison	30 28 34.21996	83 24 39.80891	Group 1
LOG SPRING (JEFFERSON)	2	Jefferson	30 20 25.92060	83 59 34.81299	Group 1
LOG SPRING (MARION)	2	Marion	29 12 58.59999	82 02 53.30000	Group 1
LOST RIVER SPRING	UNKNOWN	Marion	29 12 58.59999	82 02 53.5	Group 1
LOST SPRINGS (CITRUS)	UNKNOWN	Citrus	28 56 14.91622	82 40 48.37332	Group 5
LOUISE SPRINGS	4	Hamilton	30 20 47.36599	82 49 54.19499	Group 1
LOWERY PARK SPRING	UNKNOWN	Hillsborough	28 00 54.06875	82 27 52.34039	Group 2
LUMBERCAMP SPRINGS	3	Gilchrist	29 42 23.69994	82 56 17.00002	Group 1
LURAVILLE SPRING	3	Suwannee	30 07 10.40094	83 10 1.649139	Group 1
MAD610981 (MADISON)	3	Madison	30 24 53.86241	83 12 5.322200	Group 1
MAD610982 (MADISON)	2	Madison	30 24 54.23900	83 12 7.045000	Group 1
MAD612981 (MADISON)	2	Madison	30 27 2.957999	83 13 23.83400	Group 1
MAD612982 (MADISON)	2	Madison	30 28 20.95100	83 14 35.67200	Group 1
MAD922971 (MADISON)	4	Madison	30 18 24.17300	83 12 53.61499	Group 1
MAD922972 (MADISON)	4	Madison	30 18 12.33399	83 13 20.78899	Group 1
MAD922973 (MADISON)	4	Madison	30 18 8.538000	83 13 29.33799	Group 1
MAD922974 (MADISON)	4	Madison	30 18 8.267999	83 13 29.81400	Group 1
MAD922975 (MADISON)	4	Madison	30 17 36.63299	83 13 57.20600	Group 1
MAD922976 (MADISON)	4	Madison	30 16 56.91899	83 13 57.54599	Group 1
MADISON BLUE SPRING	1	Madison	30 28 49.56870	83 14 39.70762	Group 1
MAGGIE SPRINGS	UNKNOWN	Jefferson	30 20 24.28435	83 58 57.68033	Group 1
MAGNESIA SPRING	4	Alachua	29 35 0.263510	82 08 58.53592	Group 1
MAGNOLIA CIRCLE SPRING	UNKNOWN	Citrus	28 53 38.42999	82 35 58.91000	Group 5
MAGNOLIA SPRING	4	Hernando	28 26 1.933480	82 39 8.956299	Group 5

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
MAINTENANCE SPRING	4	Sumter	28 45 24.39399	82 04 5.363999	Group 4
MANATEE MINERAL SPRING	UNKNOWN	Manatee	27 29 51.40801	82 32 57.03590	Group 2
MANATEE SANCTUARY SPRING	UNKNOWN	Citrus	28 53 26.86285	82 35 33.37428	Group 5
MANATEE SPRING	1	Levy	29 29 22.20199	82 58 36.73699	Group 1
MARION BLUE SPRING	2	Marion	29 30 51	81 51 25	Group 1
MARKEE SPRING	4	Lake	28 52 14.15240	81 27 9.831280	Group 2
MASTODON BONE SPRING	UNKNOWN	Marion	29 12 56.59999	82 03 1.5	Group 1
MATTAIR SPRINGS	3	Suwannee	30 22 41.05200	82 53 28.02899	Group 1
MAUND SPRING	3	Jackson	30 44 46.71532	85 12 55.79978	Group 2
MCBRIDE SLOUGH SPRING	3	Wakulla	30 14 23.93959	84 16 10.43449	Group 1
MCCLAIN SPRING	3	Citrus	28 47 46.57000	82 35 13.89699	Group 5
MCCRABB SPRING	3	Dixie	29 41 7.758529	82 57 36.73482	Group 1
MEARSON SPRING	2	Lafayette	30 02 28.83594	83 01 30.10126	Group 1
MESSANT SPRING	2	Lake	28 51 21	81 29 56	Group 2
MESSER SPRING	UNKNOWN	Hillsborough	27 53 41.08844	82 17 49.32960	Group 2
MIAMI SPRING	3	Seminole	28 42 36.59590	81 26 34.91134	Group 2
MILL POND SPRING (JACKSON)	2	Jackson	30 42 13.31995	85 18 27	Group 2
MILL POND SPRINGS (COLUMBIA)	2	Columbia	29 57 59.98197	82 45 35.91104	Group 1
MILLERS CREEK SPRING	3	Citrus	28 54 3.959960	82 36 13.68000	Group 5
MILLERS FERRY SPRING	UNKNOWN	Washington	30 34 27.77538	85 50 25.72831	Group 3
MINNOW SPRING	2	Jefferson	30 19 53.52347	83 59 11.73418	Group 1
MISSION SPRINGS	2	Columbia	29 58 34.37300	82 45 28.35699	Group 1
MOCCASIN SPRINGS	4	Lake	28 51 8.205480	81 26 34.45814	Group 2
MOORING COVE SPRINGS	4	Lake	28 45 0.421310	81 50 1.227769	Group 1
MORGAN SPRING	2	Hamilton	30 25 12.79995	83 12 26.5	Group 1
MORMAN BRANCH SPRING	3	Marion	29 11 32.83309	81 39 27.86598	Group 2
MORRISON SPRING	2	Walton	30 39 28.38082	85 54 14.17758	Group 3
MOSQUITO SPRINGS	3	Lake	29 02 11.32972	81 26 4.990630	Group 2
MUD HOLE SUBMARINE SPRING	UNKNOWN	Lee	26 15 51.31547	82 01 2.335079	Group 2
MUD SPRING (HERNANDO)	2	Hernando	28 32 46.97600	82 37 29.35400	Group 5
MUD SPRING (PUTNAM)	3	Putnam	29 27 39.59996	81 39 41.40000	Group 2
MUNROE SPRING	UNKNOWN	Leon	30 19 59.72840	84 10 41.62004	Group 1
MYRTLES FISSURE SPRING	2	Gilchrist	29 51 28.58899	82 44 2.467999	Group 1
MYSTIC SPRINGS	5	Escambia	30 51 29.23726	87 18 49.31999	Group 4
NAKED SPRING	UNKNOWN	Gilchrist	29 49 47.70630	82 40 52.58592	Group 1
NASHUA SPRING	4	Putnam	29 30 32.75995	81 40 37.19999	Group 2
NATURAL BRIDGE SPRING	1	Leon	30 17 6.664700	84 08 49.64182	Group 1
NATURAL WELLS (LEON)	NONE	Leon	30 17 54.10999	84 14 14.88000	Group 1
NEWPORT SPRING	3	Wakulla	30 12 45.70141	84 10 42.56281	Group 1
NICHOLS SPRING	UNKNOWN	Sumter	28 50 22.95000	82 12 9.319999	Group 4
NO NAME COVE SPRING	1	Marion	29 12 56.20000	82 02 46.69999	Group 1
NORTHSIDE SPRING #1	UNKNOWN	Wakulla	30 14 15.10638	84 16 52.31978	Group 1
NORTHSIDE SPRING #2	UNKNOWN	Wakulla	30 14 15.30333	84 16 52.48624	Group 1
NOVA SPRING	3	Seminole	28 49 3.020000	81 25 6.650000	Group 2
NUTALL RISE	1	Taylor	30 09 1.724470	83 57 47.82391	Group 1
OASIS SPRING	3	Gilchrist	29 55 31.70699	82 46 49.46499	Group 1
OLD PLANK ROAD SPRING	UNKNOWN	Leon	30 20 9.4992	84 8 54.7008	Group 1
ORANGE GROVE SINK	N/A	Suwannee	30 07 20.92080	83 07 55.14960	Group 1
ORANGE GROVE SPRING	2	Suwannee	30 07 38.13488	83 07 50.74802	Group 1
ORANGE SPRING (MARION)	3	Marion	29 30 38.34216	81 56 38.65955	Group 1
OSCAR SPRING	UNKNOWN	Marion	29 12 55.90000	82 03 2.800000	Group 1
OTTER SPRING	2	Gilchrist	29 38 41.28798	82 56 33.90968	Group 1
OWENS SPRING	2	Lafayette	30 02 45.39289	83 02 28.06918	Group 1
PALM SPRINGS (LAKE)	4	Lake	28 50 37.57890	81 27 0.342470	Group 2
PALM SPRINGS (SEMINOLE)	3	Seminole	28 41 28.03000	81 23 34.22999	Group 2
PALMA CEIA SPRING	8	Hillsborough	27 55 18.73560	82 29 17.93493	Group 1
PANACEA MINERAL SPRING	3	Wakulla	30 02 4.736759	84 23 22.63632	Group 1
PANACEA MINERAL SPRING #1	3	Wakulla	30 02 4.852279	84 23 23.63902	Group 1
PANACEA MINERAL SPRING #2	3	Wakulla	30 02 4.979219	84 23 24.29397	Group 1
PANACEA MINERAL SPRING #3	3	Wakulla	30 02 6.129959	84 23 26.28934	Group 1
PARKER ISLAND SPRING	UNKNOWN	Citrus	28 53 1.369999	82 35 43.25	Group 5
PEACOCK SPRINGS	2	Suwannee	30 07 23.61518	83 07 59.35274	Group 1
PEGASUS SPRING	3	Seminole	28 41 47.00000	81 23 24	Group 2

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
PERRY SPRING	2	Lafayette	30 05 47.06556	83 11 17.70103	Group 1
PETTIS SPRING	NONE	Madison	30 27 25.18560	83 42 43.59540	Group 1
PHILLIPPI SPRING	NONE	Pinellas	28 01 6.78000	82 41 26.15220	Group 1
PICKARD SPRING	2	Gilchrist	29 49 49.92287	82 39 43.51370	Group 1
PINEHURST SPRING	NONE	Sarasota	27 14 26.17926	82 30 29.34972	Group 3
PINEY WOOD SPRING	4	Washington	30 39 30.78499	85 41 26.30076	Group 3
PITT SPRING	3	Bay	30 25 58.67917	85 32 47.14061	Group 3
POE SPRING	2	Alachua	29 49 32.57676	82 38 56.30232	Group 1
POE WOODS SPRING	UNKNOWN	Alachua	29 49 20.9279	82 38 53.4119	Group 1
PONCE DE LEON SPRING (HOLMES)	2	Holmes	30 43 16.32589	85 55 50.46574	Group 3
POT HOLE SPRING	2	Dixie	29 48 38.45339	82 56 9.081239	Group 1
POT SPRING	2	Hamilton	30 28 14.88900	83 14 3.836800	Group 1
POTTER CREEK SPRING	2	Citrus	28 43 53.76118	82 35 47.56253	Group 5
POTTSBURG CREEK SPRING	3	Duval	30 17 23.99995	81 34 15.23999	Group 2
PUMP SPRING	UNKNOWN	Suwannee	30 08 19.63928	83 08 6.974739	Group 1
PUMPHOUSE SPRINGS	3	Citrus	28 47 47.38365	82 35 17.85627	Group 5
PURITY SPRING	NONE	Hillsborough	28 01 19.06777	82 27 39.34044	Group 2
RACCOON ISLAND SPRING	UNKNOWN	Marion	29 12 56.70000	82 02 39	Group 1
RACCOON SPRING	UNKNOWN	Jackson	30 42 24.56995	85 18 14.87002	Group 2
RAINBOW BRIDGE SEEP NORTH	4	Marion	29 06 6.936909	82 26 15.79804	Group 4
RAINBOW BRIDGE SEEP SOUTH	4	Marion	29 06 8.087999	82 26 16.18099	Group 4
RAINBOW CAVE SPRING	UNKNOWN	Marion	29 05 24.88474	82 25 35.23601	Group 4
RAINBOW EAST SEEP	3	Marion	29 06 9.728209	82 26 14.29706	Group 4
RAINBOW SEEP #1	UNKNOWN	Marion	29 06 9.753260	82 26 15.04143	Group 4
RAINBOW SPRING	1	Marion	29 06 9.867000	82 26 14.98899	Group 4
RAINBOW SPRING #1	UNKNOWN	Marion	29 06 8.913279	82 26 14.87918	Group 4
RAINBOW SPRING #2	UNKNOWN	Marion	29 06 8.345050	82 26 14.18437	Group 4
RAINBOW SPRING #3	UNKNOWN	Marion	29 06 7.545169	82 26 13.97961	Group 4
RAINBOW SPRING #4	UNKNOWN	Marion	29 06 6.866930	82 26 13.77318	Group 4
RAINBOW SPRING #5	UNKNOWN	Marion	29 05 54.60687	82 26 10.93715	Group 4
RAINBOW SPRING #6	UNKNOWN	Marion	29 05 34.11041	82 25 42.83152	Group 4
RAINBOW SPRING #7	UNKNOWN	Marion	29 05 32.12585	82 25 36.36965	Group 4
RAINBOW SPRING #8	UNKNOWN	Marion	29 05 4.625999	82 25 44.07499	Group 4
RAINBOW SPRING NORTH	UNKNOWN	Marion	29 06 9.705460	82 26 16.36306	Group 4
RAINBOW UNNAMED SWAMP SPRING	8	Marion	29 05 36.49985	82 25 44.31486	Group 4
RECEPTION HALL SPRING	UNKNOWN	Marion	29 12 52.60665	82 03 5.050980	Group 1
RHODES SPRINGS #1	2	Leon	30 17 1.789939	84 09 18.55663	Group 1
RHODES SPRINGS #2	2	Leon	30 17 11.25901	84 09 35.83871	Group 1
RHODES SPRINGS #3	2	Leon	30 16 51.53736	84 08 50.38638	Group 1
RHODES SPRINGS #4	2	Leon	30 17 0.714190	84 09 26.17790	Group 1
RITA MARIE SPRINGS	UNKNOWN	Hernando	28 41 24.53772	82 35 20.10944	Group 5
RIVER SINK SPRING	1	Wakulla	30 16 36.72480	84 20 27.63959	Group 1
RIVERDALE SPRING	UNKNOWN	Hernando	28 29 6	82 12 6.999839	Group 4
RIVERSITES SPRINGS	UNKNOWN	Marion	29 26 29	81 55 25	Group 1
ROARING SPRING	2	Columbia	29 58 34.37277	82 45 28.35705	Group 1
ROCK BLUFF SPRINGS	2	Gilchrist	29 47 56.70244	82 55 7.105729	Group 1
ROCK SINK SPRING	2	Dixie	29 43 40.44799	82 56 57.40000	Group 1
ROCK SPRINGS (ORANGE)	2	Orange	28 45 23.20357	81 30 6.245029	Group 2
ROCKY CREEK SPRING	UNKNOWN	Jackson	30 40 31.24113	85 07 55.38263	Group 2
ROCKY VENT SPRING	UNKNOWN	Marion	29 12 55.5	82 02 38.30000	Group 1
ROOKS SPRINGS	3	Jackson	30 41 16.43657	85 14 3.795939	Group 2
ROSE CREEK SINK	N/A	Columbia	30 04 9.000119	82 41 48.00011	Group 1
ROSSETER SPRING	2	Hamilton	30 32 40.78377	83 15 0.204660	Group 1
ROYAL SPRING	2	Suwannee	30 05 1.363339	83 04 29.20753	Group 1
RUM ISLAND SPRING	2	Columbia	29 50 0.672610	82 40 47.39167	Group 1
RUNNING SPRINGS #1	2	Suwannee	30 06 16.07075	83 06 57.32302	Group 1
RUNNING SPRINGS #2	2	Suwannee	30 06 14	83 06 56	Group 1
RUTH SPRING (CITRUS)	2	Citrus	28 43 56.87501	82 35 42.21258	Group 5
RUTH SPRING (LAFAYETTE)	3	Lafayette	29 59 44.78153	82 58 36.50271	Group 1
RYLES SPRING	2	Hernando	28 41 13.79554	82 36 50.82443	Group 5
SALLY SPRING	3	Calhoun	30 34 13.08406	85 10 24.31085	Group 2
SALLY WARD SPRING	2	Wakulla	30 14 29.08981	84 18 38.87953	Group 1
SALT CREEK HEAD SPRING (CITRUS)	UNKNOWN	Citrus	28 43 23.94948	82 35 5.356679	Group 5
SALT SPRING (HERNANDO)	2	Hernando	28 32 46.74907	82 37 8.275120	Group 5

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
SALT SPRINGS (MARION)	2	Marion	29 21 2.357279	81 43 58.05198	Group 2
SALT SPRINGS (PASCO)	2	Pasco	28 17 33	82 43 6	Group 5
SALT SPRINGS (PASCO) #2	2	Pasco	28 17 35.51400	82 43 4.423999	Group 5
SANDBAG SPRING	2	Jackson	30 47 19.39445	85 13 18.90706	Group 2
SANDYS SPRING	5	Lake	28 44 42.10472	81 48 35.94628	Group 1
SANLANDO SPRINGS	2	Seminole	28 41 19.32374	81 23 43.06663	Group 2
SANTA FE RIVER RISE (ALACHUA)	1	Alachua	29 52 26.01811	82 35 29.89038	Group 1
SANTA FE SPRING (COLUMBIA)	1	Columbia	29 56 5.295730	82 31 49.51350	Group 1
SATSUMA SPRING	3	Putnam	29 30 45.35995	81 40 31.79995	Group 2
SAWDUST SPRING	3	Columbia	29 50 24.05018	82 42 12.63676	Group 1
SECOND FISHERMANS PARADISE	UNKNOWN	Marion	29 12 56.40000	82 02 43.19999	Group 1
SEMINOLE SPRING (LAKE)	2	Lake	28 50 44	81 31 22	Group 2
SEMINOLE SPRINGS (VOLUSIA)	5	Volusia	28 50 43.78862	81 14 2.654089	Group 2
SEVEN SISTERS SPRING (HAMILTON)	3	Hamilton	30 25 2.999929	83 09 19.19001	Group 1
SEVEN SPRINGS (PASCO)	NONE	Pasco	28 12 52.04015	82 39 56.35727	Group 5
SHADY BROOK HEAD SPRING #2	3	Sumter	28 47 8.957999	82 02 44.13300	Group 4
SHADY BROOK HEAD SPRING #3	UNKNOWN	Sumter	28 46 46.95699	82 02 36.30099	Group 4
SHADY BROOK HEAD SPRING #4	UNKNOWN	Sumter	28 45 15.96000	82 04 59.30400	Group 4
SHANDS BRIDGE SPRING	3	St. Johns	29 59 16	81 37 28	Group 2
SHANGRI-LA SPRINGS	3	Jackson	30 47 24.59713	85 08 34.38618	Group 2
SHARKS TOOTH SPRING	4	Lake	28 52 23.72635	81 26 24.09780	Group 2
SHELL CRACKER	3	Washington	30 39 4.375439	85 41 14.65876	Group 3
SHEPHERD SPRING	3	Wakulla	30 07 31.07993	84 17 7.800000	Group 1
SHINGLE SPRING	2	Suwannee	29 56 3.816460	82 55 13.62360	Group 1
SHIPWRECK SPRING	UNKNOWN	Marion	29 12 55.59999	82 02 38.40000	Group 1
SHIRLEY SPRING	3	Suwannee	30 12 39.62994	83 14 41.34998	Group 1
SILVER GLEN SPRINGS	1	Marion	29 14 45.03814	81 38 36.50110	Group 2
SILVER GLEN SPRINGS NATURAL WELL	2	Marion	29 14 44.52	81 38 37.07	Group 2
SILVER SPRING #8	1	Marion	29 12 57.73619	82 02 44.98739	Group 1
SILVER SPRING #9	1	Marion	29 12 56.16346	82 02 43.83229	Group 1
SILVER SPRING MAIN	1	Marion	29 12 58.34214	82 03 9.472390	Group 1
SIMS SPRING (MARION)	4	Marion	29 30 29	81 53 24	Group 1
SINAI SPRING	UNKNOWN	Jackson	30 39 52.54999	84 54 37.65689	Group 2
SINGING SPRING	UNKNOWN	Columbia	29 58 33.83903	82 45 28.44467	Group 1
SIPHON CREEK RISE	1	Gilchrist	29 51 22.28795	82 43 58.98265	Group 1
SIX MILE CREEK SPRING	NONE	Hillsborough	28 01 5.071403	82 20 17.33172	Group 1
SKIPPER SPRING	UNKNOWN	Washington	30 34 32.92917	85 50 37.58481	Group 3
SNAIL SPRINGS	5	Lake	28 49 25.84383	81 29 11.31755	Group 2
SOCRUM SPRING	UNKNOWN	Polk	28 09 7.055532	82 00 39.29454	Group 2
SPRING CREEK RISE #10	UNKNOWN	Wakulla	30 4 28.3799	84 19 39.7559	Group 1
SPRING CREEK RISE #2	UNKNOWN	Wakulla	30 04 54.42469	84 19 47.62675	Group 1
SPRING CREEK RISE #3	UNKNOWN	Wakulla	30 4 54.3719	84 19 45.84	Group 1
SPRING CREEK RISE MAIN	UNKNOWN	Wakulla	30 04 48.63741	84 19 47.30992	Group 1
SPRING WARRIOR SPRING	2	Taylor	29 56 6.066280	83 36 35.15659	Group 1
SPRINGBOARD SPRING	2	Jackson	30 42 26.63996	85 18 23.76000	Group 2
ST. MARKS RIVER RISE (LEON)	1	Leon	30 16 33.77095	84 08 56.15862	Group 1
ST. MARKS RIVER SWALLET	N/A	Leon	30 17 3.292000	84 09 2.604999	Group 1
STARBUCK SPRING	2	Seminole	28 41 49.24784	81 23 28.21542	Group 2
STEINHATCHEE RIVER RISE	1	Dixie	29 46 11.68369	83 19 30.12578	Group 1
STEINHATCHEE SPRING	4	Lafayette	29 50 28.54567	83 18 29.04943	Group 1
STEVENSON SPRING	2	Suwannee	30 25 1.519970	83 09 10.61999	Group 1
SULFUR SPRING (ORANGE)	4	Orange	28 46 12.65159	81 30 33.06001	Group 2
SULPHUR SPRING (HILLSBOROUGH)	2	Hillsborough	28 01 16.08143	82 27 5.885679	Group 2
SULPHUR SPRING (ORANGE)	2	Orange	28 46 12.65999	81 30 33.06000	Group 2
SUMTER BLUE SPRING	UNKNOWN	Sumter	28 47 8.800007	82 02 41.39988	Group 4
SUN EDEN SPRING	4	Lake	28 44 39.97697	81 49 11.59727	Group 1
SUN SPRINGS	2	Gilchrist	29 42 17.05265	82 56 0.697960	Group 1
SUNBEAM SPRING	2	Columbia	29 55 41.13994	82 46 11.32999	Group 1
SU-NO-WA SPRING	6	Nassau	30 26 17.16518	81 52 59.30781	Group 4
SUW1017971 (SUWANNEE)	3	Hamilton	30 25 42.43583	83 01 46.56536	Group 1
SUW1019971 (SUWANNEE)	4	Suwannee	30 22 58.03200	82 54 54.58600	Group 1
SUW1023971 (SUWANNEE)	4	Suwannee	30 23 47.29200	82 56 13.92700	Group 1
SUW106971 (SUWANNEE)	4	Suwannee	30 01 57.65500	83 00 48.62300	Group 1

Appendix B continued

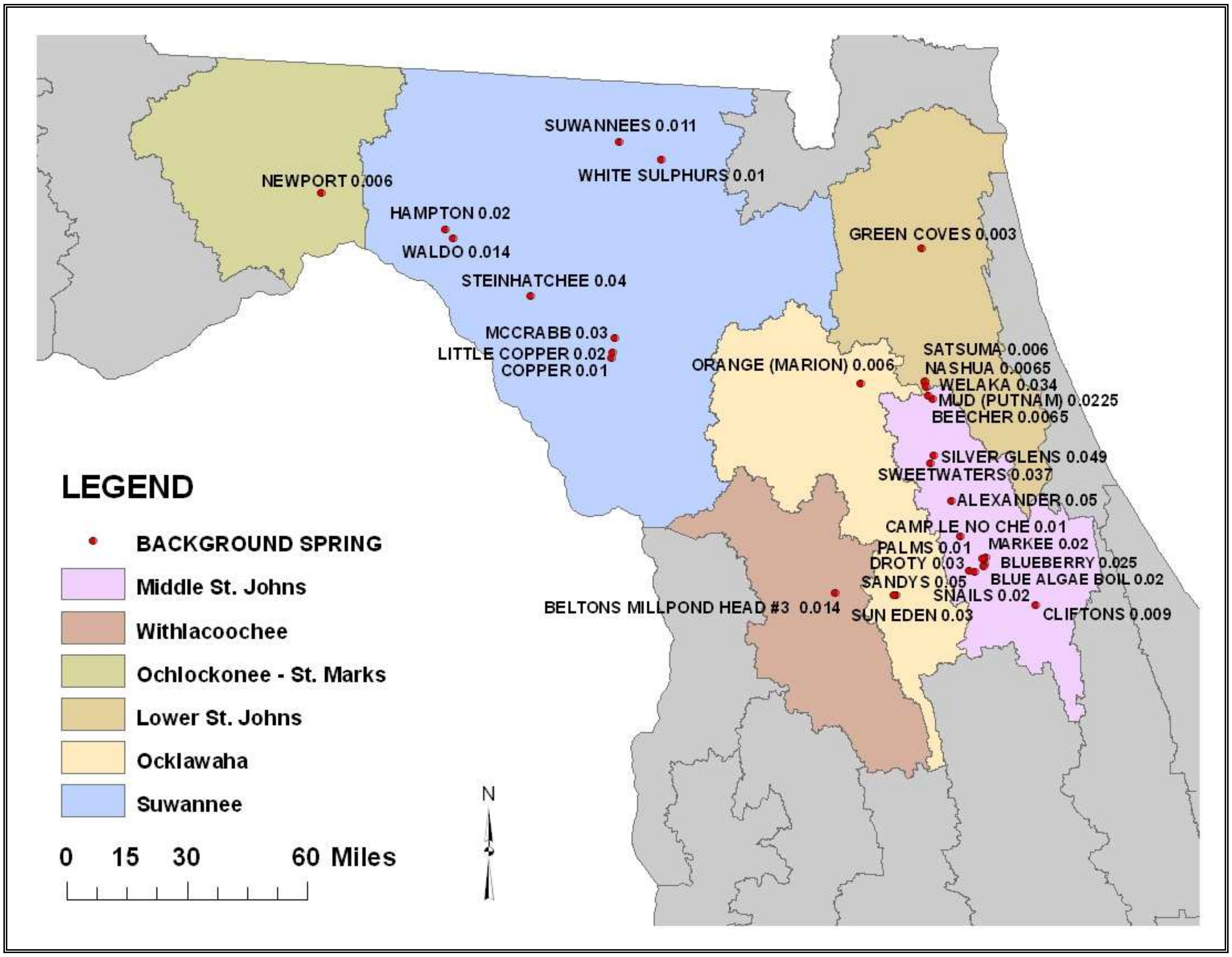
SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
SUW107971 (SUWANNEE)	2	Suwannee	29 53 48.15500	82 52 22.18400	Group 1
SUW718971 (SUWANNEE)	3	Suwannee	30 03 50.56465	83 03 43.18801	Group 1
SUW725971 (SUWANNEE)	3	Lafayette	30 03 43.25575	83 03 26.30310	Group 1
SUW917971 (SUWANNEE)	3	Suwannee	29 55 56.60827	82 48 2.703239	Group 1
SUW917972 (SUWANNEE)	4	Gilchrist	29 54 46.34100	82 50 42.54200	Group 1
SUW919971 (SUWANNEE)	3	Suwannee	30 05 1.090139	83 05 13.40472	Group 1
SUW919972 (SUWANNEE)	4	Suwannee	30 05 27.20699	83 05 50.46100	Group 1
SUW919973 (SUWANNEE)	3	Suwannee	30 06 9.239000	83 06 51.34499	Group 1
SUW919974 (SUWANNEE)	4	Suwannee	30 06 19.32299	83 07 16.74499	Group 1
SUW922971 (SUWANNEE)	3	Suwannee	30 17 8.689959	83 13 51.70001	Group 1
SUW922972 (SUWANNEE)	4	Suwannee	30 18 46.40200	83 12 35.10699	Group 1
SUW922973 (SUWANNEE)	3	Suwannee	30 18 47.58699	83 12 35.30799	Group 1
SUW922974 (SUWANNEE)	4	Suwannee	30 18 48.18499	83 12 35.47600	Group 1
SUW923971 (SUWANNEE)	4	Suwannee	30 23 31.01099	83 10 1.037999	Group 1
SUW923972 (SUWANNEE)	4	Hamilton	30 24 15.91499	83 09 27.75800	Group 1
SUW925971 (SUWANNEE)	2	Suwannee	30 25 39.80400	83 03 3.807000	Group 1
SUW925972 (SUWANNEE)	2	Suwannee	30 25 39.84799	83 03 33.49199	Group 1
SUW925973 (SUWANNEE)	3	Suwannee	30 25 27.18800	83 04 8.437000	Group 1
SUW925974 (SUWANNEE)	3	Suwannee	30 26 12.07600	83 04 43.78899	Group 1
SUW925975 (SUWANNEE)	4	Suwannee	30 26 13.45000	83 05 13.01300	Group 1
SUWANACOOCHEE SPRING	2	Madison	30 23 12.01740	83 10 18.35921	Group 1
SUWANNEE BLUE SPRING	2	Suwannee	30 04 53.29804	83 04 8.476819	Group 1
SUWANNEE SPRINGS	2	Suwannee	30 23 40.11979	82 56 4.335470	Group 1
SWEETWATER SPRINGS	2	Marion	29 13 7.600939	81 39 35.52839	Group 2
SYLVAN SPRINGS	2	Bay	30 25 54.33621	85 32 53.60106	Group 3
SYLVAN SPRINGS #2	3	Bay	30 25 53.79534	85 32 50.32999	Group 3
TANNER SPRING (HAMILTON)	2	Hamilton	30 27 52.46996	83 13 3.839990	Group 1
TANNER SPRINGS (JACKSON)	UNKNOWN	Jackson	30 49 29.83666	85 19 30.68039	Group 2
TARPON HOLE #2 SPRING	UNKNOWN	Citrus	28 52 53.92300	82 35 37.35600	Group 5
TARPON HOLE SPRING	UNKNOWN	Citrus	28 52 54.63844	82 35 41.33285	Group 5
TARPON SPRINGS	0	Pinellas	28 08 47.04936	82 45 32.36508	Group 5
TAY616991 (TAYLOR)	2	Taylor	29 55 9.462999	83 40 56.14599	Group 1
TAY616992 (TAYLOR)	2	Taylor	29 54 45.11268	83 39 2.941740	Group 1
TAY622991 (TAYLOR)	2	Taylor	29 52 24.79993	83 37 32.59999	Group 1
TAY625991 (TAYLOR)	3	Taylor	29 44 38.53499	83 20 42.25300	Group 1
TAY625992 (TAYLOR)	UNKNOWN	Taylor	29 45 41	83 20 6	Group 1
TAY625993 (TAYLOR)	2	Dixie	29 43 53.12400	83 20 47.92500	Group 1
TAY625995 (TAYLOR)	4	Dixie	29 44 2.454000	83 20 49.70200	Group 1
TAY69991 (TAYLOR)	3	Taylor	29 58 11.67113	83 44 43.47149	Group 1
TAY69992 (TAYLOR)	3	Taylor	29 58 14.67700	83 44 47.73300	Group 1
TAY730991 (TAYLOR)	2	Taylor	30 09 12.67499	83 51 20.62800	Group 1
TAY76991 (TAYLOR)	3	Taylor	29 40 34.90996	83 23 7.270009	Group 1
TAY76992 (TAYLOR)	2	Dixie	29 45 41	83 20 6	Group 1
TAY77041 (TAYLOR)	4	Taylor	29 58 19.10200	83 44 45.86999	Group 1
TAY77042 (TAYLOR)	4	Taylor	29 58 16.23399	83 44 43.42500	Group 1
TAY77043 (TAYLOR)	2	Taylor	29 58 20.56699	83 44 40.47199	Group 1
TAY77044 (TAYLOR)	4	Taylor	29 58 19.35399	83 44 41.60199	Group 1
TAY924991 (TAYLOR)	3	Taylor	30 06 28.64659	83 37 38.61797	Group 1
TAY924993 (TAYLOR)	3	Taylor	30 06 29.97431	83 37 41.43925	Group 1
TELFORD SPRING	2	Suwannee	30 06 25.37823	83 09 56.66104	Group 1
THOMAS SPRING (JEFFERSON)	2	Jefferson	30 20 22.96831	83 59 32.36658	Group 1
THOMAS SPRING (SUWANNEE)	2	Lafayette	30 08 13.79745	83 13 50.49731	Group 1
THREE SISTERS SPRINGS	2	Citrus	28 53 19.41119	82 35 21.08767	Group 5
THREE SISTERS SPRINGS #2	2	Citrus	28 53 17.19500	82 35 23.10900	Group 5
THUNDERING SPRINGS	6	Holmes	30 55 14.73953	85 53 27.13902	Group 3
TIMBER SPRING	UNKNOWN	Marion	29 12 56.29999	82 02 29.80000	Group 1
TOBACCO PATCH LANDING SPRING	3	Marion	29 25 42.72739	81 55 26.08666	Group 1
TRAIL SPRING	3	Gilchrist	29 53 54.08929	82 52 0.166149	Group 1
TRAM SPRINGS	UNKNOWN	Orange	28 46 4	81 28 14	Group 2
TREEHOUSE SPRING	1	Alachua	29 51 17.58981	82 36 10.35690	Group 1
TRICKLE SPRING	UNKNOWN	Lake	28 52 17.20000	81 27 6	Group 2
TROOP SPRING	3	Gilchrist	29 54 41.07900	82 50 32.44999	Group 1
TROTTER #1 SPRING	3	Citrus	28 47 46.88900	82 35 10.83299	Group 5
TROTTER LOWER SPRING	UNKNOWN	Citrus	28 47 47.93881	82 35 10.35887	Group 5

Appendix B continued

SPRING NAME	MAGNITUDE	COUNTY	LATITUDE	LONGITUDE	BASIN GROUP
TROTTER MAIN SPRING	3	Citrus	28 47 47.31958	82 35 11.02786	Group 5
TROTTER UPPER SPRING	UNKNOWN	Citrus	28 47 47.93881	82 35 9.358800	Group 5
TROY SPRING	1	Lafayette	30 00 21.69384	82 59 51.00913	Group 1
TURTLE MEADOWS SPRING	UNKNOWN	Marion	29 12 57.20000	82 02 45.19999	Group 1
TURTLE NOOK SPRING	UNKNOWN	Marion	29 12 57	82 02 42	Group 1
TURTLE SPRING	2	Lafayette	29 50 50.61469	82 53 25.02992	Group 1
TWIN CAVES SPRING	3	Jackson	30 47 12.88261	85 08 41.77590	Group 2
TWIN SPRING	2	Gilchrist	29 50 25.63335	82 42 21.10921	Group 1
UNNAMED SPRING (CITRUS) 2853010823543	UNKNOWN	Citrus	28 53 1.371589	82 35 43.25219	Group 5
UNNAMED SPRING (DIXIE) 2941100825735	UNKNOWN	Dixie	29 41 10.52029	82 57 35.41763	Group 1
UNNAMED SPRING (DIXIE) 2949090825600	UNKNOWN	Dixie	29 49 9.979999	82 56 0.349999	Group 1
UNNAMED SPRING (GILCHRIST) 2953480824601	UNKNOWN	Gilchrist	29 53 48.59191	82 46 1.673470	Group 1
UNNAMED SPRING (LAFAYETTE) 2953400831438	UNKNOWN	Lafayette	29 53 40.41315	83 14 38.92344	Group 1
UNNAMED SPRING (ORANGE) 2840500813321	UNKNOWN	Orange	28 40 50.29344	81 33 21.42539	Group 1
UNNAMED SPRING (TAYLOR) 2952240833733	2	Taylor	29 52 24.89994	83 37 33.80001	Group 1
UNNAMED SPRING (TAYLOR) 3006250833735	UNKNOWN	Taylor	30 06 25.85866	83 37 35.92492	Group 1
UNNAMED SPRING (WASHINGTON) 3034400855021	UNKNOWN	Washington	30 34 40.58345	85 50 21.17558	Group 3
UNNAMED SPRING (WASHINGTON) 30344100855016	UNKNOWN	Washington	30 34 41.56355	85 50 16.77052	Group 3
UNNAMED SPRING (WASHINGTON) 30400700853920	UNKNOWN	Washington	30 40 7.627150	85 39 20.89911	Group 3
UNNAMED SPRING (WASHINGTON) 3040090853919	UNKNOWN	Washington	30 40 9.909589	85 39 19.72147	Group 3
UNNAMED SPRING NEAR ARIPEKA FL	UNKNOWN	Pasco	28 23 53.00800	82 40 26.36291	Group 5
VOLUSIA BLUE SPRING	1	Volusia	28 56 50.94154	81 20 22.51824	Group 2
VORTEX SPRING	2	Holmes	30 46 13.98784	85 56 54.50546	Group 3
WACISSA SPRING #1	UNKNOWN	Jefferson	30 20 22.12573	83 59 30.39676	Group 1
WACISSA SPRING #2	UNKNOWN	Jefferson	30 20 23.58924	83 59 29.33542	Group 1
WACISSA SPRING #3	3	Jefferson	30 20 26.13378	83 59 26.67958	Group 1
WACISSA SPRING #4	UNKNOWN	Jefferson	30 20 25.49767	83 59 25.92293	Group 1
WADDELL MILL POND SPRING	3	Jackson	30 52 38.28438	85 20 41.64000	Group 2
WADESBORO SPRING	4	Clay	30 09 26.99992	81 43 21.35999	Group 2
WAKULLA NO NAME SPRING	3	Wakulla	30 12 53.33224	84 15 59.41858	Group 1
WAKULLA SPRING	1	Wakulla	30 14 6.643819	84 18 9.214449	Group 1
WALDO SPRING	3	Taylor	30 02 57.04281	83 37 47.73504	Group 1
WALKER SPRING (JEFFERSON)	3	Jefferson	30 16 50.75199	83 51 13.72699	Group 1
WALKER SPRING (SUWANNEE)	UNKNOWN	Suwannee	30 08 0.648199	83 07 47.22877	Group 1
WALSINGHAM SPRING	3	Washington	30 28 32.69891	85 31 42.73823	Group 3
WARM MINERAL SPRING	3	Sarasota	27 03 35.64500	82 15 35.83389	Group 3
WASHINGTON BLUE SPRING (CHOCTAWHATCHEE)	2	Washington	30 30 47.73214	85 50 49.86765	Group 3
WASHINGTON BLUE SPRINGS (ECONFINA)	2	Washington	30 27 10.16100	85 31 49.32756	Group 3
WATERFALL SPRINGS	2	Marion	29 06 5.255279	82 26 8.390400	Group 4
WATERMELON SPRING (GILCHRIST)	UNKNOWN	Gilchrist	29 49 30.9	82 49 30.8999	Group 1
WEBBVILLE SPRINGS	3	Jackson	30 50 21.21000	85 20 4.329099	Group 2
WEEKI PRESERVE SPRING	UNKNOWN	Hernando	28 29 52.07000	82 38 22.71999	Group 5
WEEKI WACHEE SPRING	1	Hernando	28 31 1.885910	82 34 23.39827	Group 5
WEKIVA SPRINGS (LEVY)	2	Levy	29 16 49.49424	82 39 21.89728	Group 1
WEKIWA SPRING (ORANGE)	2	Orange	28 42 42.79146	81 27 37.51506	Group 2
WELAKA SPRING	3	Putnam	29 29 40.39415	81 40 23.69773	Group 2
WELLS LANDING SPRING	3	Marion	29 25 15.65587	81 55 10.85120	Group 1
WHITE CAVE SPRING	UNKNOWN	Jackson	30 37 51.86034	84 55 21.86471	Group 2
WHITE SPRINGS (LIBERTY)	3	Liberty	30 25 0.706224	84 55 7.695839	Group 1
WHITE SULPHUR SPRINGS (HAMILTON)	0	Hamilton	30 19 47.82400	82 45 39.04299	Group 1
WHITEWATER SPRINGS	3	Putnam	29 38 1.319959	81 38 34.43999	Group 2
WILLIFORD SPRING	2	Washington	30 26 22.38643	85 32 51.29220	Group 3
WILSON HEAD SPRING (MARION)	3	Marion	28 58 47.14367	82 19 17.27813	Group 4
WILSON SPRING (COLUMBIA)	2	Columbia	29 54 0.181660	82 45 30.77006	Group 1
WITHERINGTON SPRING	3	Orange	28 42 53.72999	81 29 23.67000	Group 2
WOLF HEAD SPRING	UNKNOWN	Lake	28 38 41.86741	81 42 23.74372	Group 1
WOODBINE SPRING	UNKNOWN	Santa Rosa	30 22 16.06800	87 06 42.01199	Group 4
WOODS CREEK RISE	2	Taylor	30 07 26.70199	83 37 27.25699	Group 1
WORTHINGTON SPRING	4	Union	29 55 35.78551	82 25 33.30310	Group 1
WW GAY SPRING	5	Clay	30 09 14.09723	81 43 42.76177	Group 2
WW GAY SPRING #1	5	Clay	30 09 14.46663	81 43 41.50566	Group 2
WW GAY SPRING #2	5	Clay	30 09 14.09723	81 43 42.76177	Group 2
YALAHA SPRINGS	UNKNOWN	Lake	28 44 54.96000	81 48 20.16000	Group 1
ZOLFO SPRINGS	NONE	Hardee	27 30 13.13712	81 48 23.29668	Group 3

APPENDIX C: INFORMATION ON BACKGROUND SPRINGS

Background Springs- Locations



Summary information: Nitrate Concentrations in Potential Background Springs

SPRING NAME	MAGNITUDE	WBID	MEDIAN	COMBINED DATABASE NITRATE + NITRITE			BASIN
				TOTAL # SAMPLES	# SAMPLES >0.60 mg/L	# SAMPLES >0.35 mg/L	
ALEXANDER SPRING	1	2918Z	0.05	169	1	1	MIDDLE ST. JOHNS
BEECHER SPRING	2	2895A	0.0065	6	0	0	MIDDLE ST. JOHNS
BELTONS MILLPOND HEAD SPRING 3	2	1359	0.014	5	0	0	WITHLACOOCHEE
BLUE ALGAE BOIL SPRING	5	2948	0.02	4	0	0	MIDDLE ST. JOHNS
BLUEBERRY SPRING	4	2929A	0.025	4	0	0	MIDDLE ST. JOHNS
CAMP LE NO CHE SPRING	4	2929	0.01	5	0	0	MIDDLE ST. JOHNS
CLIFTON SPRINGS	3	2981E	0.009	11	0	0	MIDDLE ST. JOHNS
COPPER SPRING	2	3422A	0.01	6	0	0	SUWANNEE
DROTY SPRING	4	2955	0.03	6	0	1	MIDDLE ST. JOHNS
GREEN COVE SPRING	2	2213Q	0.003	26	0	0	LOWER ST. JOHNS
HAMPTON SPRING (TAYLOR)	4	3518Z	0.02	5	0	0	SUWANNEE
LITTLE COPPER SPRING	3	3422A	0.02	6	0	0	SUWANNEE
MARKEE SPRING	4	2948	0.02	5	0	0	MIDDLE ST. JOHNS
MCCRABB SPRING	3	3422	0.03	4	0	0	SUWANNEE
MUD SPRING (PUTNAM)	3	2213O	0.0225	12	0	0	MIDDLE ST. JOHNS
NASHUA SPRING	4	2213N	0.0065	4	0	0	LOWER ST. JOHNS
NEWPORT SPRING	3	793X	0.006	10	0	0	OCHLOCKONEE - ST. MARKS
ORANGE SPRING (MARION)	3	2747	0.006	26	0	0	OCKLAWAHA
PALM SPRINGS (LAKE)	4	2929A	0.01	5	0	0	MIDDLE ST. JOHNS
SANDYS SPRING	5	2838G1	0.05	5	0	0	OCKLAWAHA
SATSUMA SPRING	3	2213N	0.006	5	0	0	LOWER ST. JOHNS
SILVER GLEN SPRING	1	2893A3	0.049	203	40	42	MIDDLE ST. JOHNS
SNAIL SPRING	5	2955	0.02	8	0	0	MIDDLE ST. JOHNS
STEINHATCHEE SPRING	4	3573Z	0.04	32	0	0	SUWANNEE
SUN EDEN SPRING	4	2838D	0.03	8	0	0	OCKLAWAHA
SUWANNEE SPRING	2	3341Y	0.011	41	0	0	SUWANNEE
SWEETWATER SPRINGS	2	2905B	0.037	62	0	0	MIDDLE ST. JOHNS
WALDO SPRING	3	3473B	0.014	6	0	0	SUWANNEE
WELAKA SPRING	3	2213N	0.034	6	0	0	LOWER ST. JOHNS
WHITE SULPHUR SPRINGS (HAMILTON)	0	3341Z	0.01	11	0	0	SUWANNEE

APPENDIX D: STATUS OF SPRING MINIMUM FLOWS AND LEVEL IMPLEMENTATION

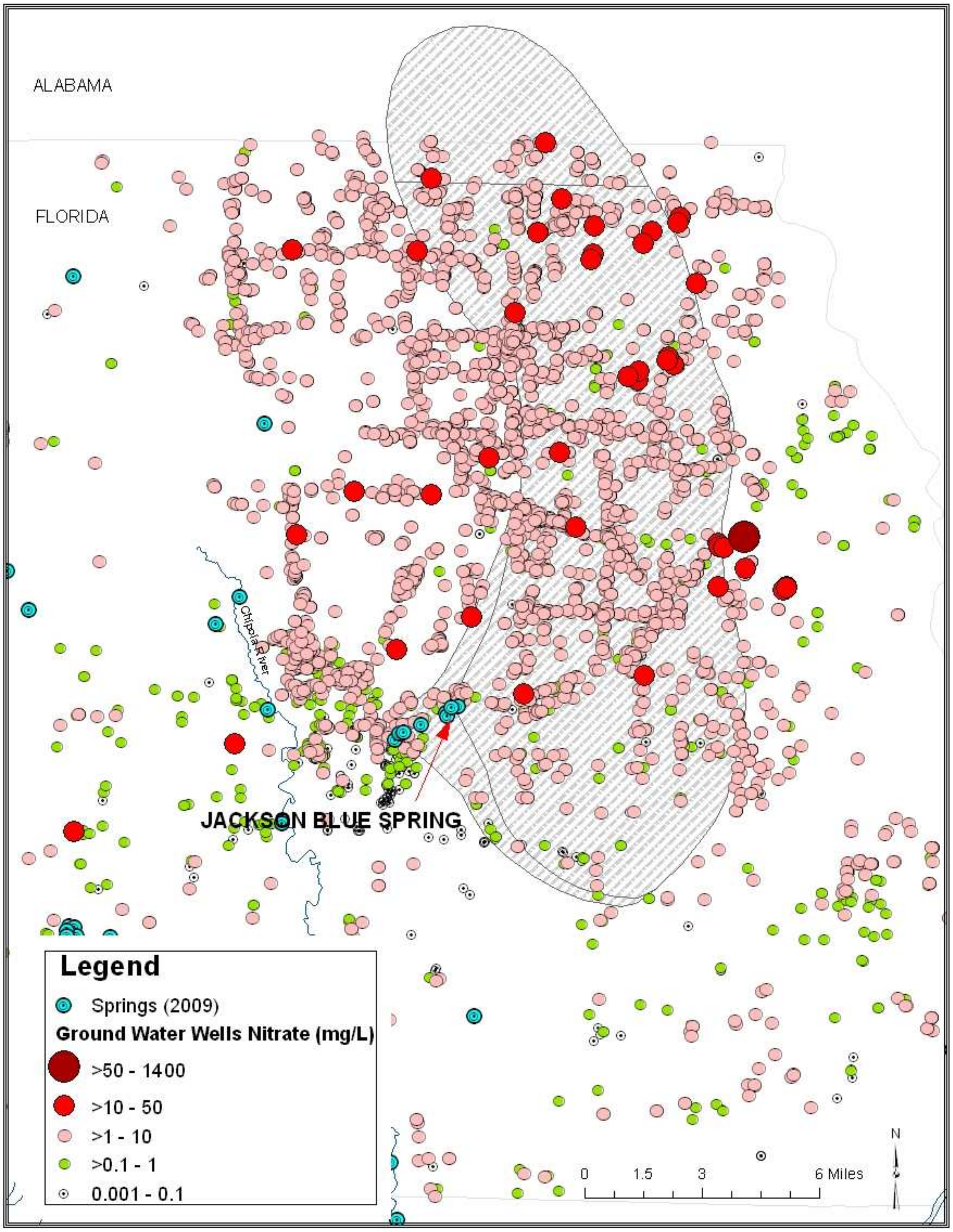
WMD	SPRING NAME	COUNTY	ADOPTED	PROPOSED
SR	Alapaha River Rise	Hamilton		2013
SJR	Alexander Spring	Lake		2013
SR	Allen Mill Pond Springs	Lafayette		2011
SR	Anderson Spring	Suwannee		2013
SR	Bell Spring (Gilchrist)	Gilchrist		2011
SR	Big Spring (Taylor)	Taylor		2015
SWF	Blind Spring	Hernando		2009
SR	Blue Hole Spring (Columbia)	Columbia		2010
SR	Bonnet Spring	Suwannee		2011
SR	Branford Spring	Suwannee		2011
SWF	Bubbling Spring	Marion		2009
SWF	Buckhorn Spring Main	Hillsborough		2008
SR	Charles Spring	Suwannee		2011
SWF	Chassahowitzka Spring #1	Citrus		2009
SWF	Chassahowitzka Spring Main	Citrus		2009
SR	COL101974 (Columbia)	Columbia		2010
SR	Columbia Spring	Columbia		2010
SWF	Crab Spring	Citrus		2009
SWF	Crystal Springs (Pasco)	Pasco	2007	
SJR	DeLeon Spring (Volusia)	Volusia		2011
SR	Devils Ear Spring (Gilchrist)	Gilchrist		2010
SR	Falmouth Spring	Suwannee		2013
SR	Fanning Springs	Levy	2006	
SJR	Gemini Springs	Volusia		2011
SJR	Green Spring	Volusia		2010
SR	Guaranto Spring	Dixie		2011
SWF	Gum Spring Main	Sumter		2010
SR	Hart Springs	Gilchrist		2011
SWF	Hidden River Head Spring	Citrus		2010
SR	Holton Creek Rise	Hamilton		2013
SWF	Homosassa Spring	Citrus		2009
SR	Hornsby Spring	Alachua		2010
SR	Ichetucknee Head Spring (Suwannee)	Suwannee		2010
NWF	Jackson Blue Spring	Jackson		2012
SWF	Jenkins Creek Spring	Hernando	2008	
SR	July Spring	Columbia		2010
SWF	Kings Bay Spring #1	Citrus		2010
SR	Lafayette Blue Spring	Lafayette		2011
SR	Lime Run Spring Or Sink (Suwannee)	Suwannee		2013
SR	Lime Spring (Suwannee)	Suwannee		2013
SWF	Lithia Spring Major	Hillsborough		2008

WMD	SPRING NAME	COUNTY	ADOPTED	PROPOSED
SR	Little River Spring	Suwannee		2011
SWF	Little Spring (Hernando)	Hernando	2008	
SR	Madison Blue Spring	Madison	2005	
SR	Manatee Spring	Levy	2006	
SJR	Messant Spring	Lake	1992	
SJR	Miami Spring	Seminole	1992	
NWF	Morrison Spring	Walton		2015
SWF	Mud Spring (Hernando)	Hernando	2008	
SR	Nutall Rise	Taylor		2015
SJR	Palm Springs (Seminole)	Seminole	1992	
SR	Peacock Springs	Suwannee		2011
SR	Poe Spring	Alachua		2010
SR	Pot Hole Spring	Dixie		2011
SR	Pot Spring	Hamilton		2013
SWF	Potter Creek Spring	Citrus		2009
SWF	Rainbow Spring	Marion		2009
SR	Rock Sink Spring	Dixie		2011
SJR	Rock Springs (Orange)	Orange	1992	
SR	Royal Spring	Suwannee		2011
SR	Rum Island Spring	Columbia		2010
SWF	Ruth Spring (Citrus)	Citrus		2009
SR	Ruth Spring (Lafayette)	Lafayette		2011
SWF	Ryles Spring	Hernando		2010
SWF	Salt Spring (Hernando)	Hernando	2008	
SJR	Sanlando Springs	Seminole	1992	
SR	Santa Fe Spring (Columbia)	Columbia		2010
SJR	Seminole Spring (Lake)	Lake	1992	
SJR	Silver Glen Springs	Marion		2013
SJR	Silver Spring Main	Marion		2011
SR	Siphon Creek Rise	Gilchrist		2010
SJR	Starbuck Spring	Seminole	1992	
SR	Steinhatchee River Rise	Taylor		2015
SR	Stevenson Spring (SUW923973)	Suwannee		2013
SWF	Sulphur Spring (Hillsborough)	Hillsborough	2007	
SR	SUW1017972 (alias Blue Spring)	Suwannee		2013
SR	Suwanacoochee	Madison		2013
SR	Suwannee Spring	Suwannee		2013
SR	TAY76992 (Taylor)	Taylor		2015
SR	Treehouse Spring	Alachua		2010
SR	Troy Spring	Lafayette		2011
SJR	Volusia Blue Spring	Volusia	2006	
SR	Wacissa Group	Jefferson		2015
NWF	Wakulla Spring	Wakulla		2012
SWF	Waterfall Springs	Marion		2009
SWF	Weeki Wachee Spring	Hernando	2008	
SJR	Wekiva River and Springs	Orange	1992	
SJR	Wekiva River and Springs	Orange		2013
SR	White Sulphur Springs (Hamilton)	Hamilton		2013

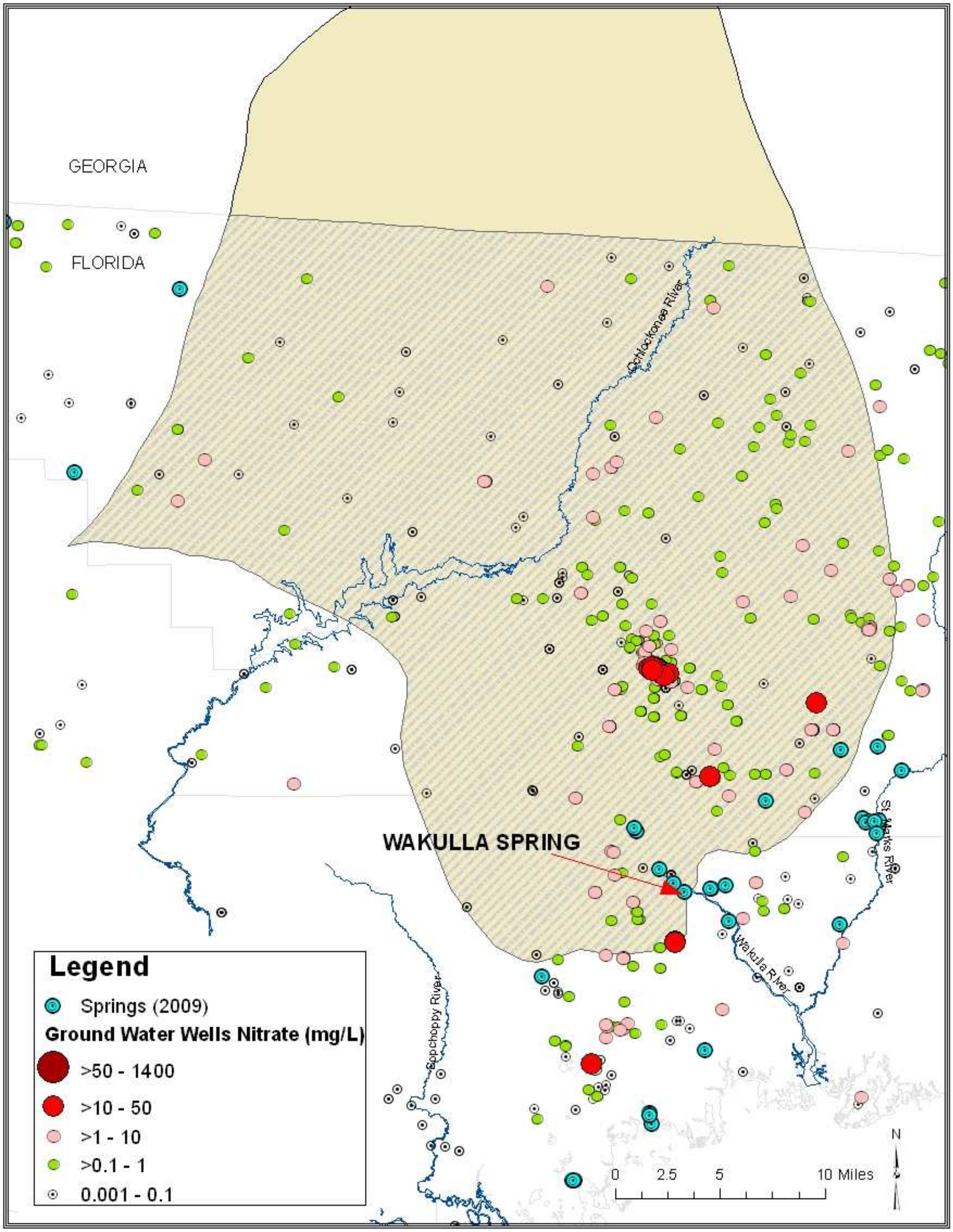
Note: This table is based on information provided by the water management districts as of 11/09 and subject to change.

APPENDIX E: MAPS SHOWING GROUND WATER NITRATE CONCENTRATIONS NEAR SELECTED SPRINGS

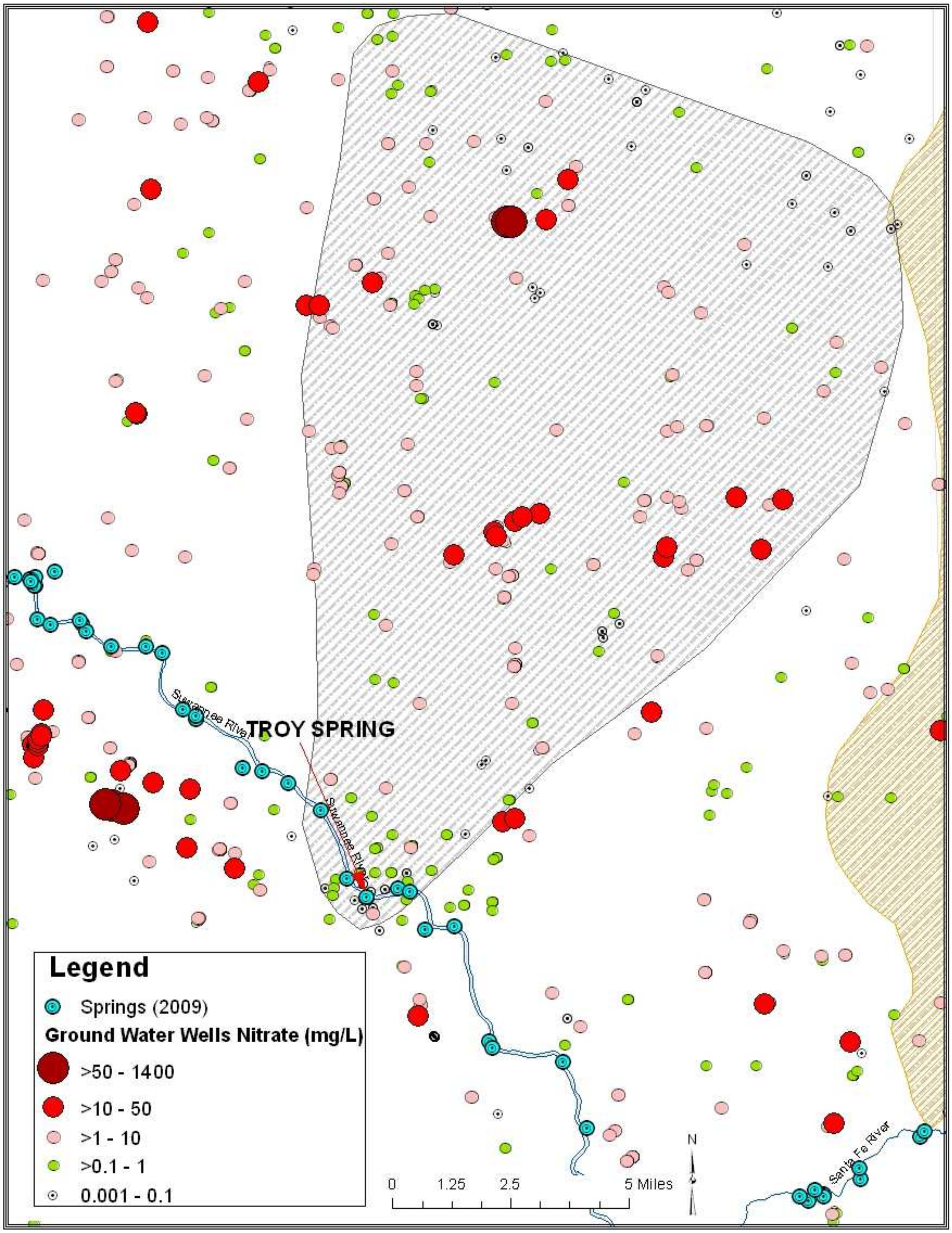
Nitrate Concentrations in Ground Water of Springshed, Jackson Blue Spring



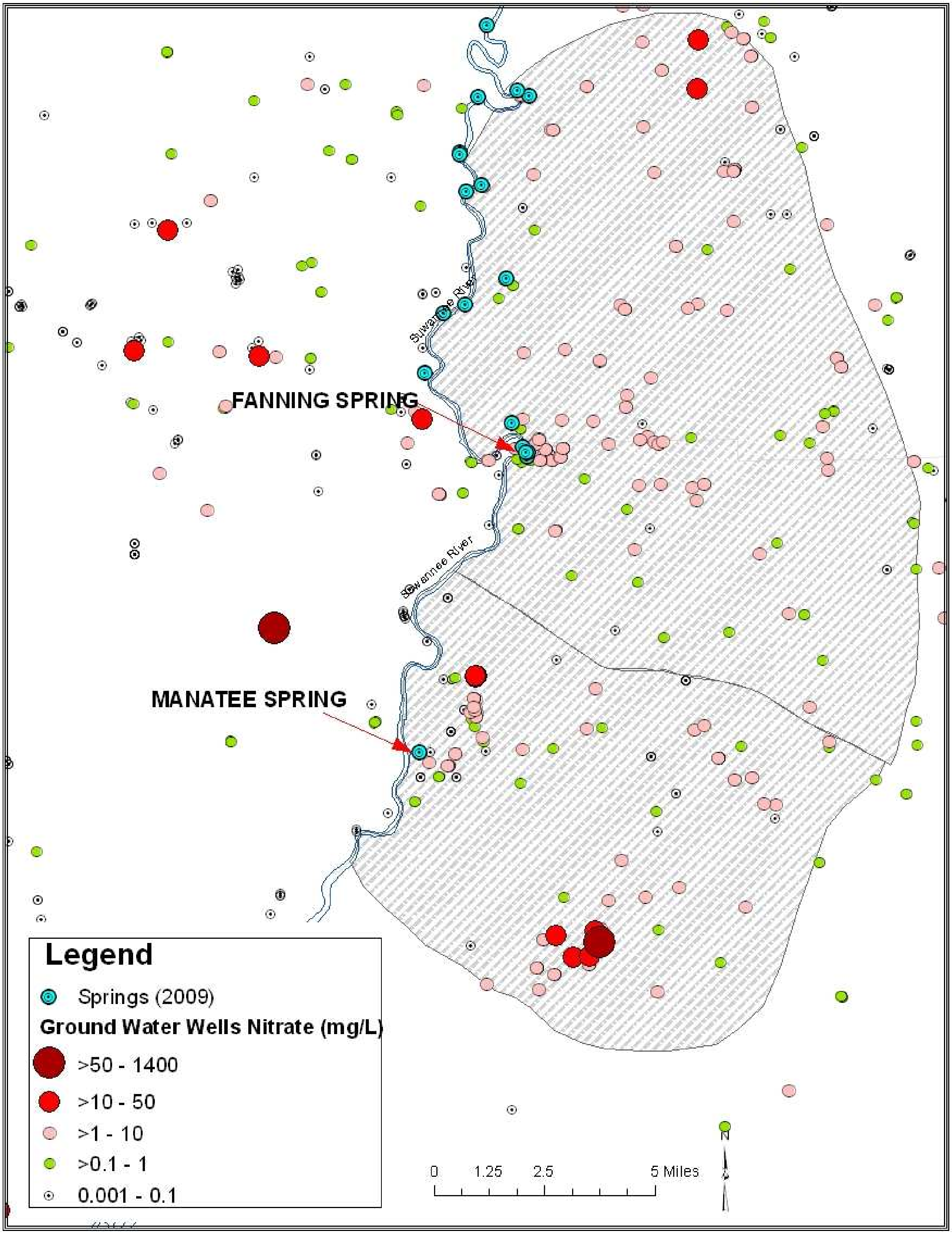
Nitrate Concentrations in Ground Water of Springshed, Wakulla Spring



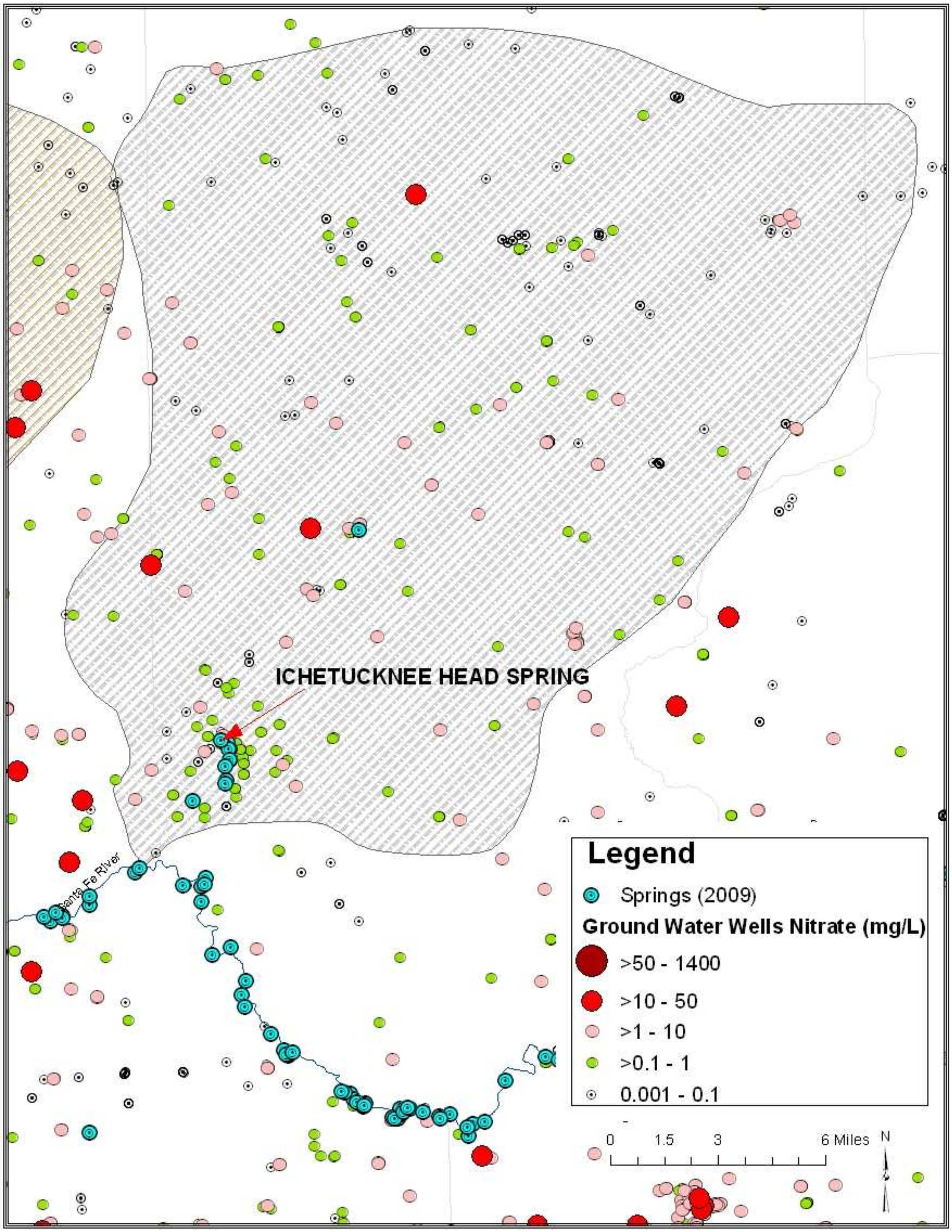
Nitrate Concentrations in Ground Water of Springshed, Troy Spring



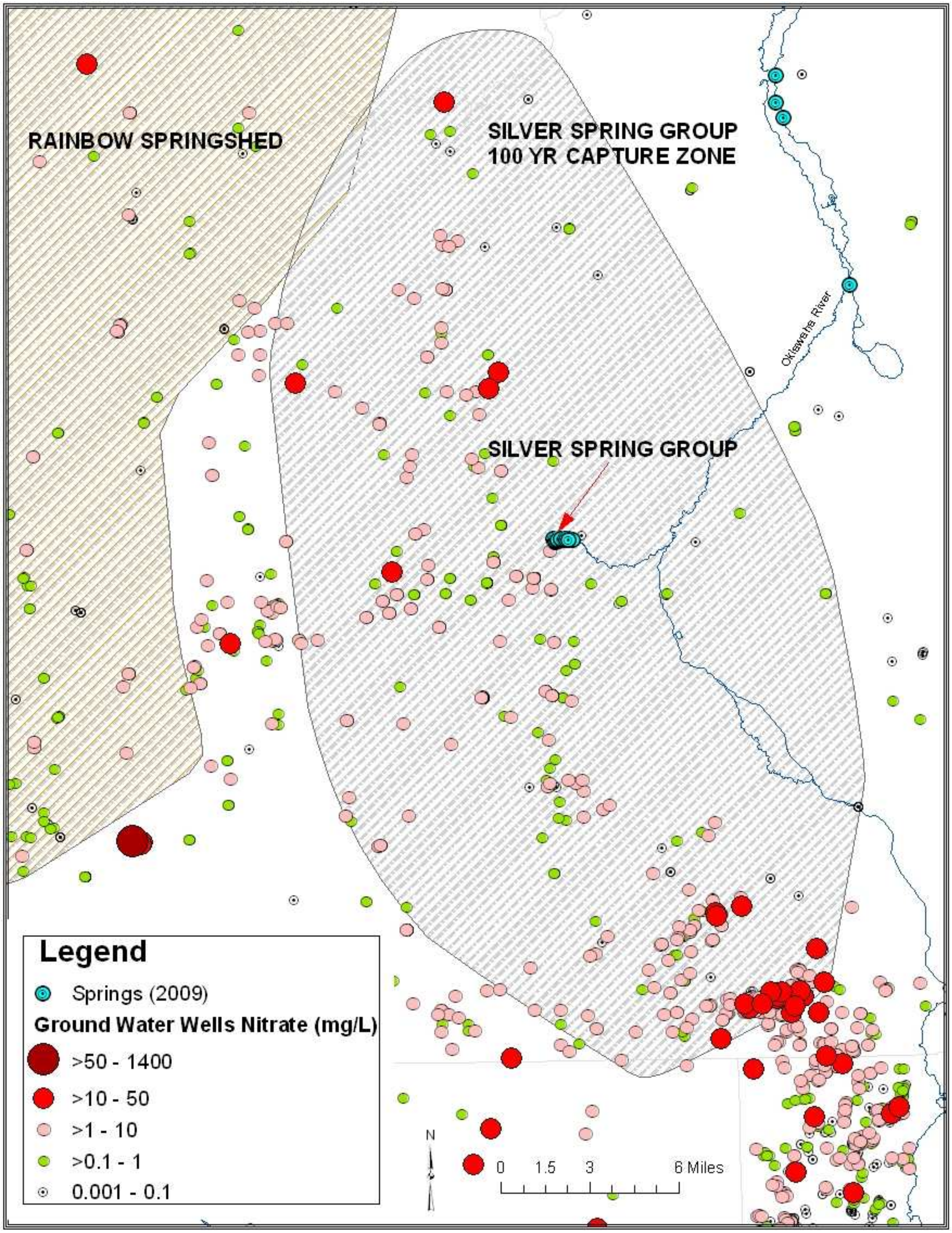
Nitrate Concentrations in Ground Water of Springshed, Fanning and Manatee Springs



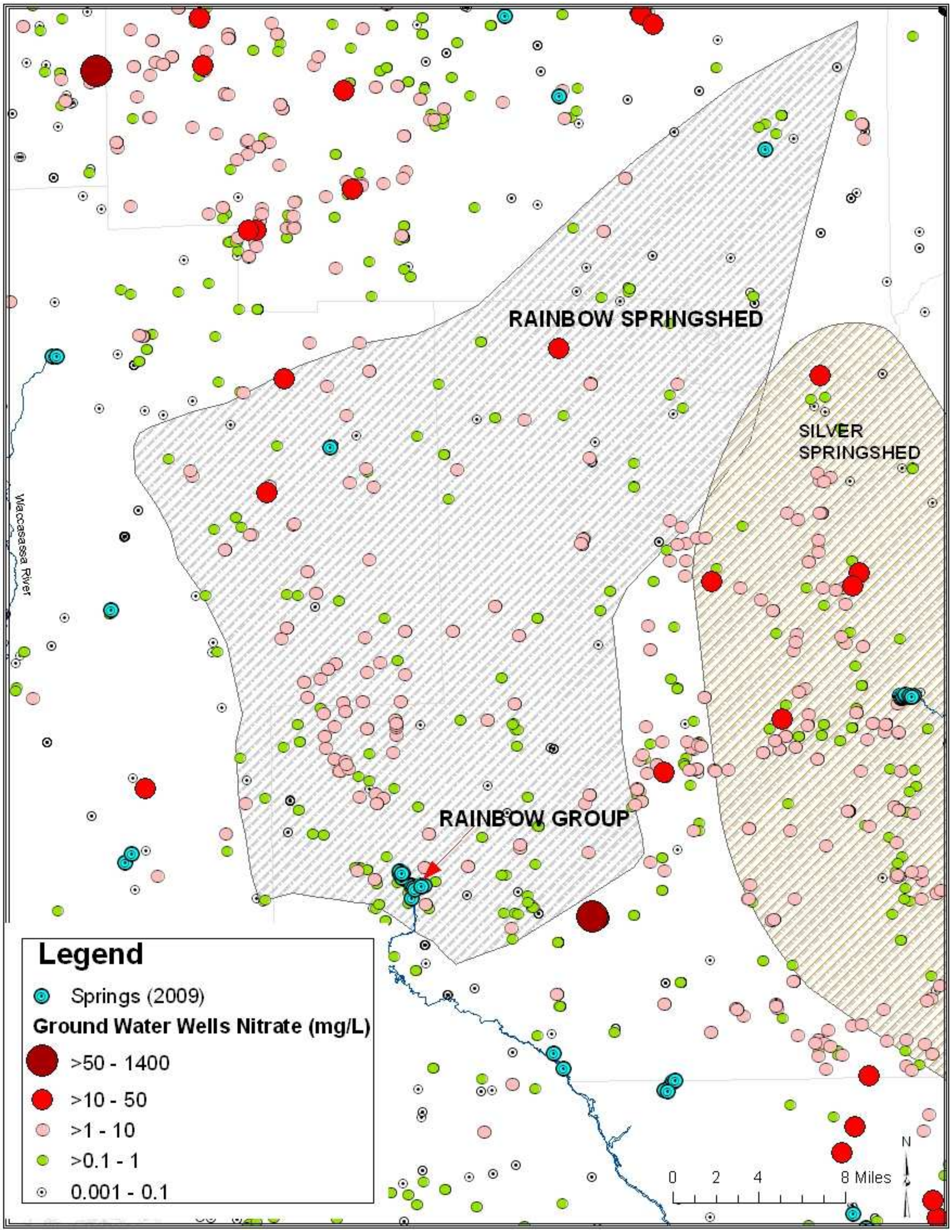
Nitrate Concentrations in Ground Water of Springshed, Ichetucknee Springs Group



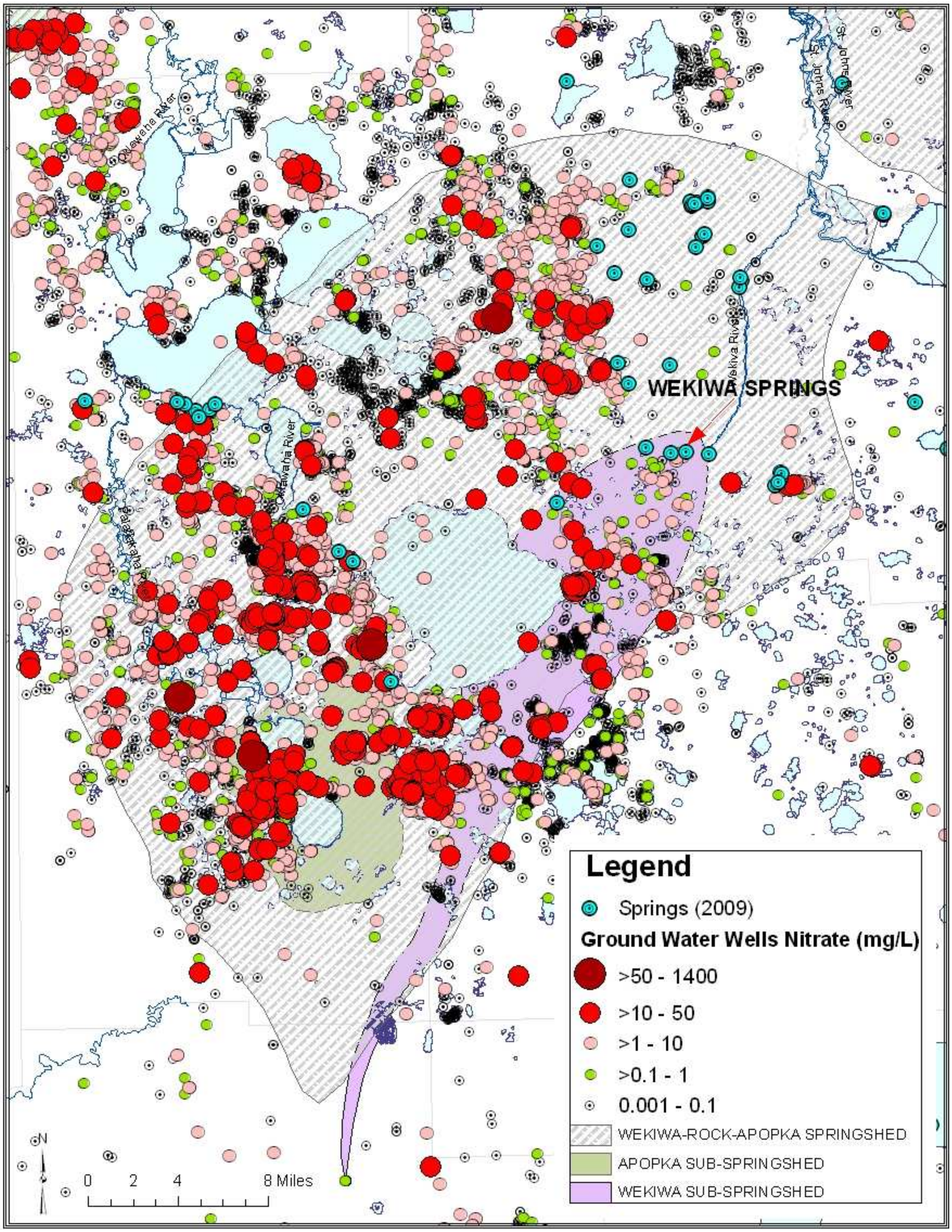
Nitrate Concentrations in Ground Water of Springshed, Silver Springs Group



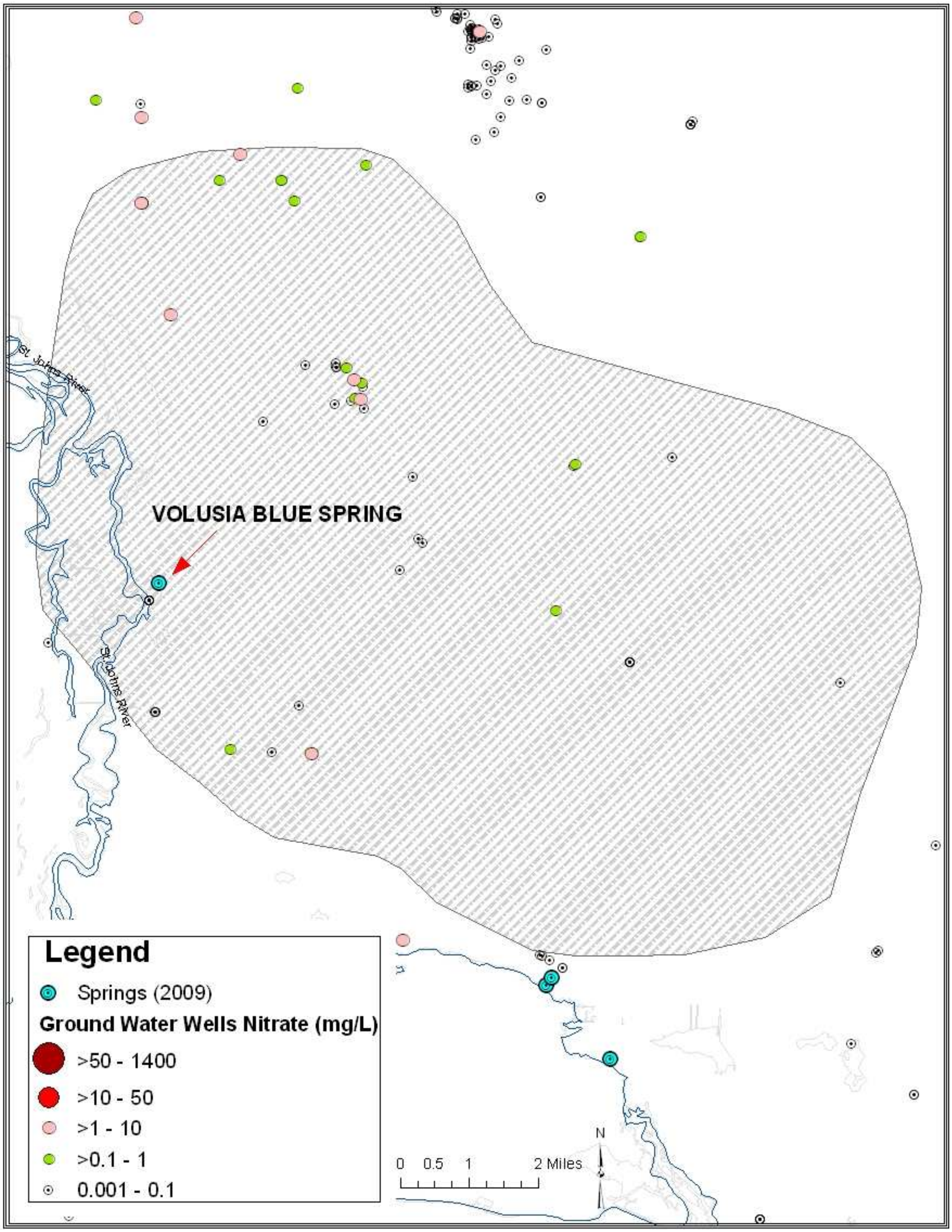
Nitrate Concentrations in Ground Water of Springshed, Rainbow Springs Group



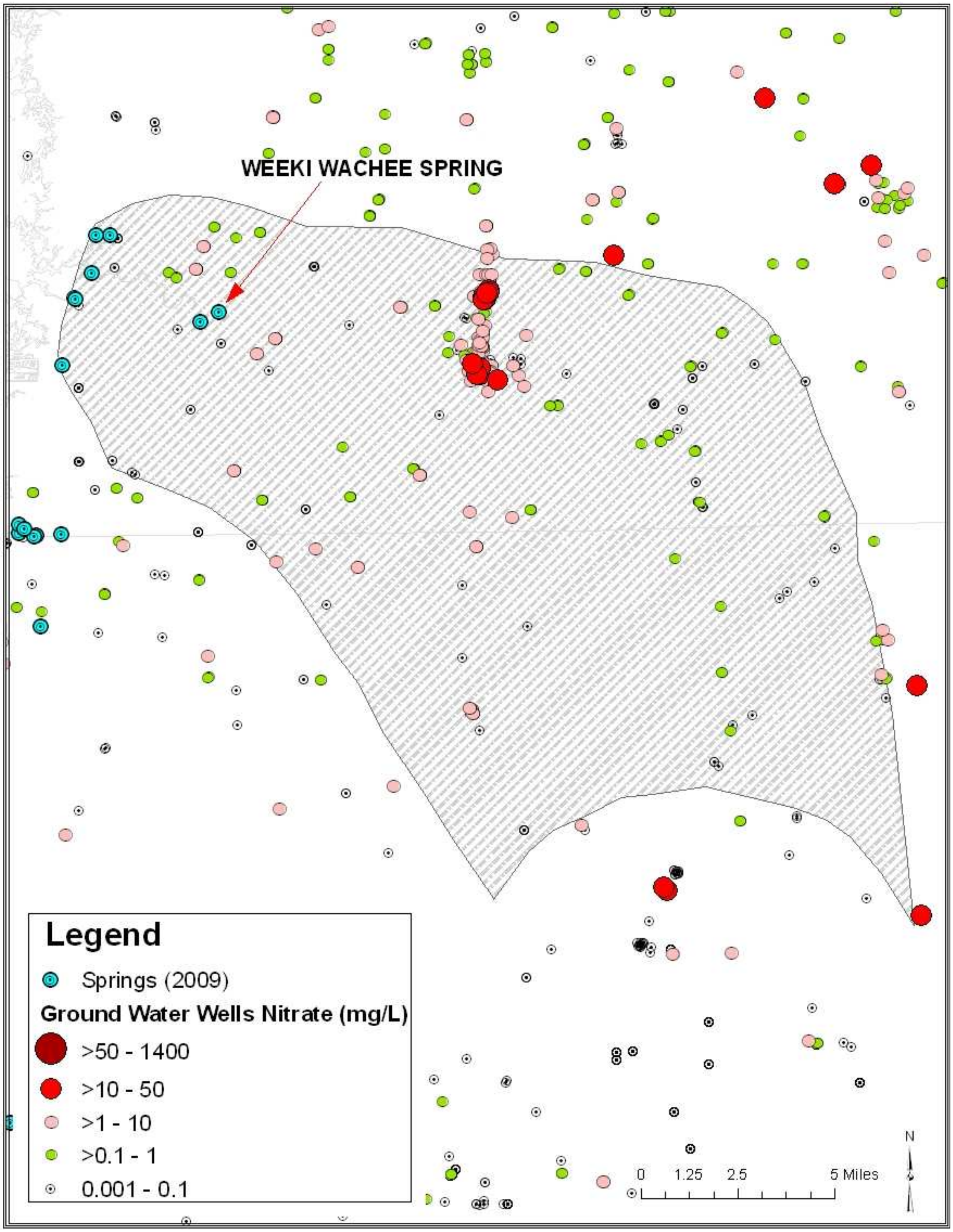
Nitrate Concentrations in Ground Water of Springshed, Wekiwa Springs Group



Nitrate Concentrations in Ground Water of Springshed, Volusia Blue Spring



Nitrate Concentrations in Ground Water of Springshed, Weeki Wachee Springs



Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
2600 Blair Stone Road, Mail Station 3575
Tallahassee, Florida 32399-2400
http://www.dep.state.fl.us/water/