Photo credit: Florida Geological Survey

Florida Springs Initiative

Program Summary and Recommendations

2007

DEPARTMENT OF ENVIRONMENTAL PROTECTION

FLORIDA

Florida Springs Initiative, Program Summary and Recommendations, 2007

Executive Summary

The Florida Springs Initiative (FSI) was created by the Florida Department of Environmental Protection (DEP) in 2001 to implement the recommendations of the 2000 Florida Springs Task Force Report. This document provides an overview of spring protection activities since FSI's inception and recommends future FSI actions that are based on the program's experiences to date. This adaptive management approach will tailor resources and staff to the challenges of protecting and restoring individual springs.

Much has been learned about springs and how to protect them over the past six years. FSI should now integrate intra- and interagency collaboration in restoration and protection actions and the refinement of research objectives.

In collaboration with public and private partners, the FSI will pursue the following strategies to promote effective spring protection and management:

(1) Identify and delineate the springsheds, primary ground water pathways and recharge areas, and major nutrient loading sources for Florida's priority springs.

(2) Understand the relationships between nutrients and the ecological conditions in spring ecosystems through baseline monitoring and focused research.

(3) Understand the relationship between the quantity and quality of spring flow, and spring ecosystem structure and condition, through baseline monitoring and focused research.

(4) Assess the effectiveness of existing best management practices (BMPs) in reducing ground water pollution.

(5) Apply the information obtained from monitoring and research to develop springshed management plans and/or other spring-protective measures in association with other programs, agencies, and stakeholders.

(6) Support physical restoration projects that will enhance and improve both spring ecology and public recreational experiences.

(7) Support educational outreach, such as the Learning in Florida's Environment (LIFE) Program, and community involvement, such as the spring working groups.

Florida Springs Initiative, Program Summary and Recommendations, 2007

I. Purpose of This Report

Since its establishment in 2001 by the Florida Department of Environmental Protection (DEP), the Florida Springs Initiative (FSI) has carried out numerous activities on many fronts to address the key recommendations of the 2000 Springs Task Force report. The intent of this report is to summarize statewide spring assessment and protection activities in general, review progress made under the FSI, and develop a strategy and recommended actions for the next five years.

II. Overview of Spring Issues

It is beyond debate that the springs of Florida are cherished natural resources. 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 flows greater than 100 cubic feet per second; see **Appendix A**). Thirty-nine of Florida's 67 counties have springs or include land areas that contribute water to springs (known as springsheds). Springs exist in four of the state's water management districts and four of DEP's regulatory districts. **Figure 1** shows the distribution of springs in Florida.

Florida's springs provide countless environmental, recreational, and cultural benefits. The spring caves provide unique habitat to specialized animals. The springs and their runs have abundant wildlife, provide critical base flow to rivers and estuaries, and provide unique opportunities for swimming, fishing, and other recreational uses. Historically, springs were the sites of Native American villages and towns for European settlers, and they are still gathering places for church congregations, school outings, family reunions, and entire communities. Some springs also provide economic benefit by being historic tourist destinations or by providing water for bottling plants. Over the years, people who live near springs and visit springs have seen their springs degrade, either by the loss of historical discharge or prolific algal growth and the decreased biological diversity that apparently stem from water quality and quantity problems. The condition of the banks, vents, and runs of many springs has also been physically degraded because of adjacent land management practices or overuse.

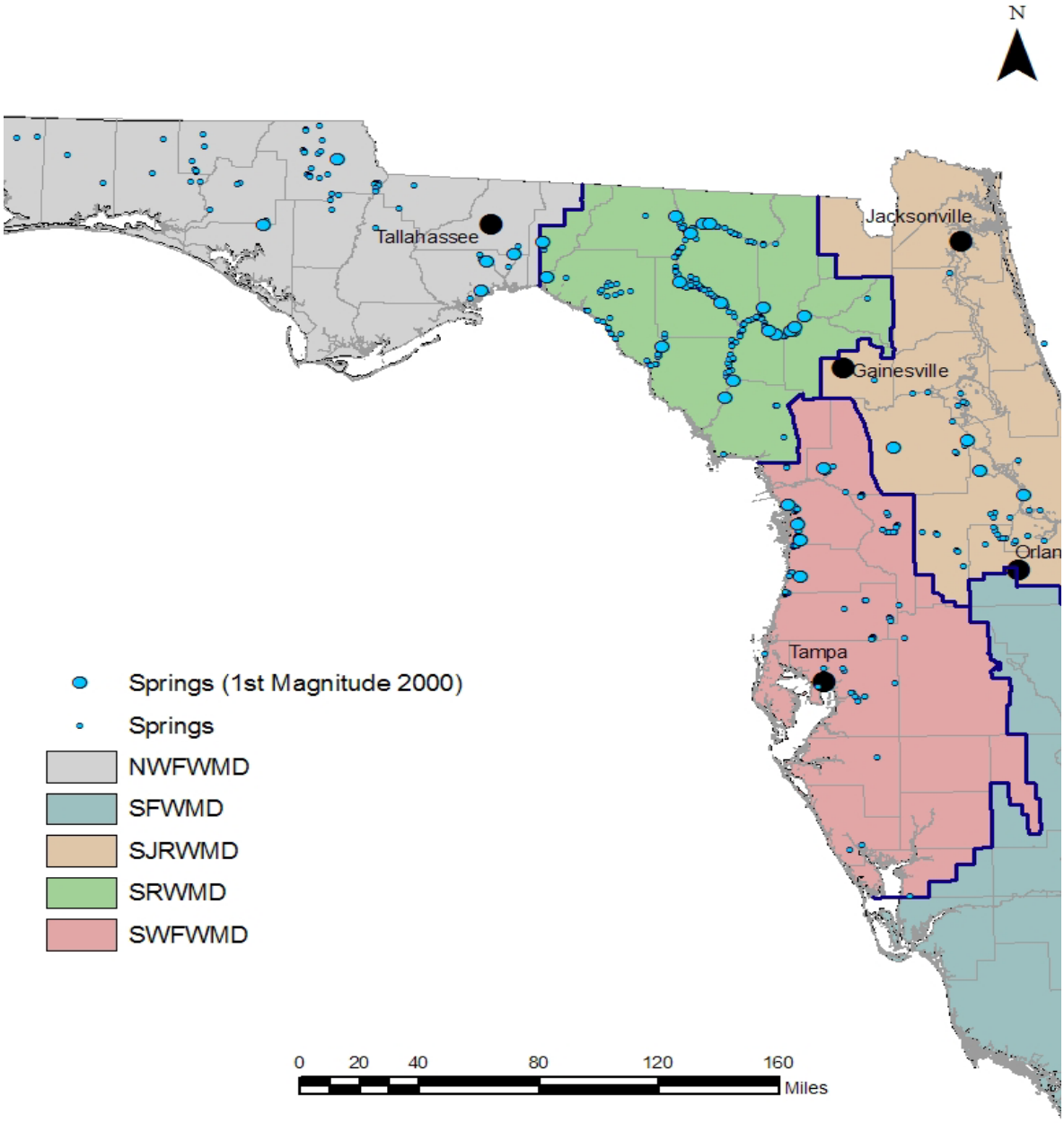

Figure 1. Distribution and size of springs in Florida in 2000

Note: NWFWMD – Northwest Florida Water Management District
SFWMD – South Florida Water Management District
SJRWMD – St. Johns River Water Management District
SRWMD – Suwannee River Water Management District
SWFWMD – Southwest Florida Water Management District

The source of the springs in the 39-county area is ground water. The majority of the springs, including all first-magnitude springs, discharge from the Floridan aquifer, the underground limestone reservoir that many thought could provide unlimited amounts of water. Yet, within the last 40 years, some springs have dried up or have been severely limited in flow. Variable spring flow is not a new phenomenon and is a normal response to changes in precipitation. However, it is clear that as ground water levels permanently decline, so do spring flows. During predevelopment times, countless offshore springs discharged into Florida's bays and estuaries, but many of these have stopped flowing as land has been drained, wetlands have been filled, and ground water consumption has surpassed ground water recharge.

White Springs in Hamilton County and Worthington Springs in Union County, both turn-of-the-century resort sites, are examples of springs that no longer flow. The change from historical flow is due to either blockage in underground conduits, changes in the aquifer levels linked to well withdrawals, or a combination of these factors. Kissingen Springs in Polk County is an example of a spring that dried up completely due to dewatering in a large phosphate-mining area. Blue Spring in Volusia County, which provides critical winter habitat to manatees, is currently exhibiting a reduction in flow.

Declining ground water levels can also be accompanied by subtle water quality changes in springs as they begin to exhibit more of the characteristics of the deeper, brackish zones of ground water. Decreasing spring flows are also often accompanied by an increase in the growth of algae that may be related to subtle water quality changes as well as reduced flow.

The current method for protecting flows in Florida's springs includes the review of consumptive use permits issued by the water management districts as well as the establishment of Minimum Flows and Levels (MFLs) for the specific springs or river systems that contain springs. MFLs are developed by the water management districts for certain waterbodies at the direction of the Florida Legislature. Their purpose is to protect water resources, including the ecological integrity of aquatic systems, from overwithdrawal for human use.

Ecological Imbalances Related to Nutrients

The degradation of water quality in the Floridan aquifer appears to be related to another change in many Florida springs. Spring openings (or vents) and their receiving waters are experiencing ecological imbalances, as evidenced by the profuse growth of algae and/or invasive aquatic vascular plants, such as hydrilla. This overgrowth chokes out native plants and makes spring runs inhospitable to certain fish, snails, crayfish, turtles, and other animals that depend on the spring habitat (**Figure 2**).

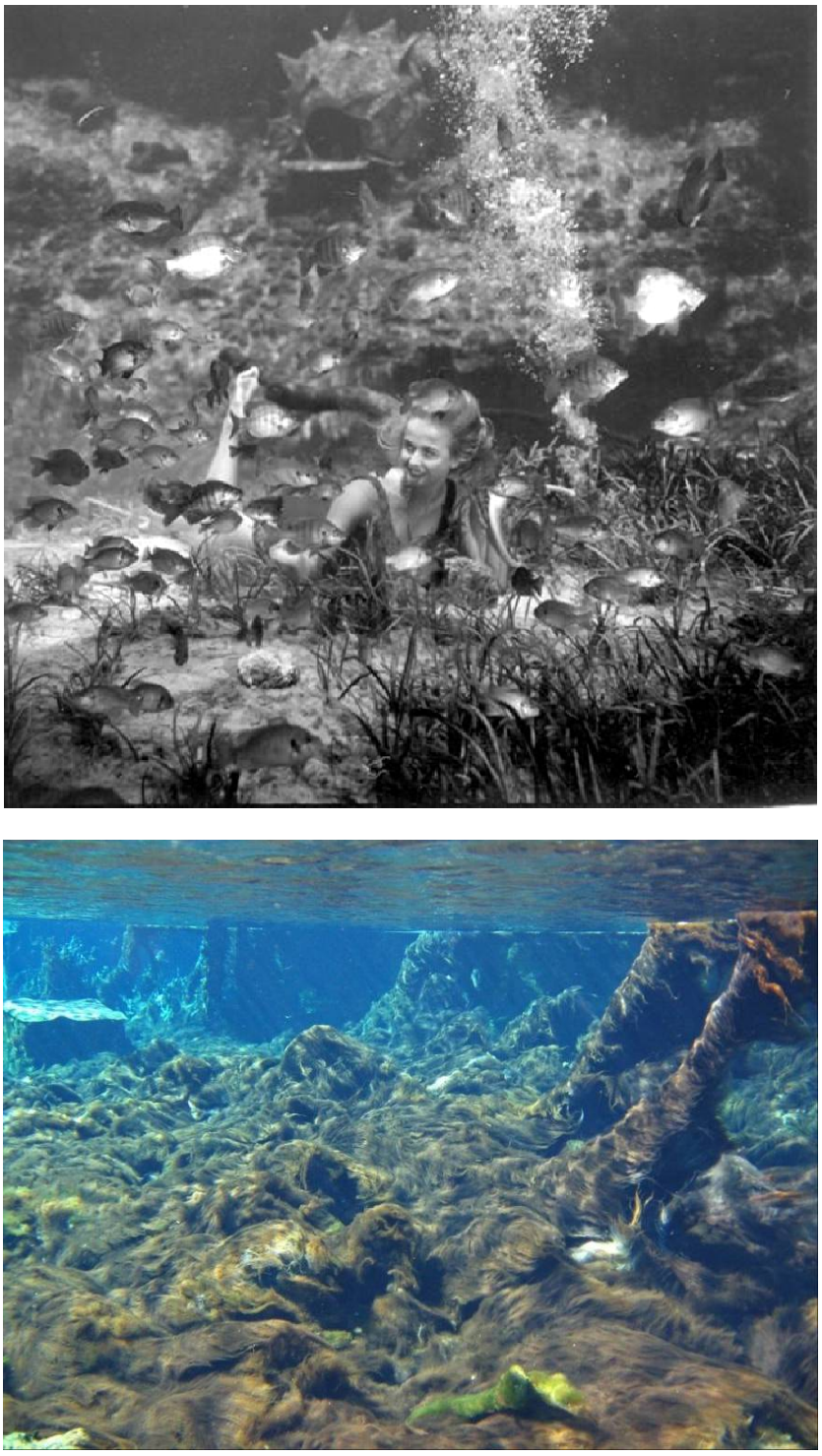

Figure 2. Change in biota and increase in algae at Weeki Wachee Spring, Hernando County, 1950s (top photo) and 2001 (bottom photo).
(credits: Florida Archives; Agnieszka Pinowska)

Biological studies now document excessive algal growth at many major springs. In some of the more extreme examples, such as Silver Springs and Weeki Wachee Springs, algal mat accumulations are several feet thick. Most scientists agree that elevated nutrient levels in the water are at least partly to blame. Nitrogen is considered the main chemical indicator of nutrient enrichment of springs, and nitrate levels have climbed steadily in many of the springs that have been sampled over the decades (**Figure 3**). The nitrate found in ground water and spring water has been found by isotope analysis to be from inorganic sources such as synthetic fertilizer, or organic sources such as human wastewater or animal manure, or a combination of the two.

Biological response to nutrients in spring water is a complicated issue that has been the subject of several recent and ongoing studies. An ongoing FSI objective is to establish a nutrient threshold or index that correlates the water column concentrations of nutrients with biological effects. This will remain a focus of DEP's attention in upcoming years.

Physical Impacts

Springs that are adjacent to highway rights of way, land developments, farms, or silviculture areas are often affected by erosion and siltation, as well as nutrient runoff. Most springs with heavy recreational use have been degraded by the people who visit them. Swimmers, boat traffic, and the trampling of aquatic plants on sandy stream banks cause sediment to fill spring basins, smothering spring vents and the surrounding vegetation. Unmanaged sites also often become dumping grounds for trash and litter.

As the state acquires and manages more land where springs occur, these problems diminish; however, spring sites that remain unmanaged often continue to degrade, either due to a lack of interest or lack of funding. Managers of state parks are continually challenged to maintain a viable balance between recreational use and the ecological health of rivers and spring runs. Most of the restoration projects funded under the FSI have focused on sediment removal, stabilization, and controlled access at the larger springs within state parks.

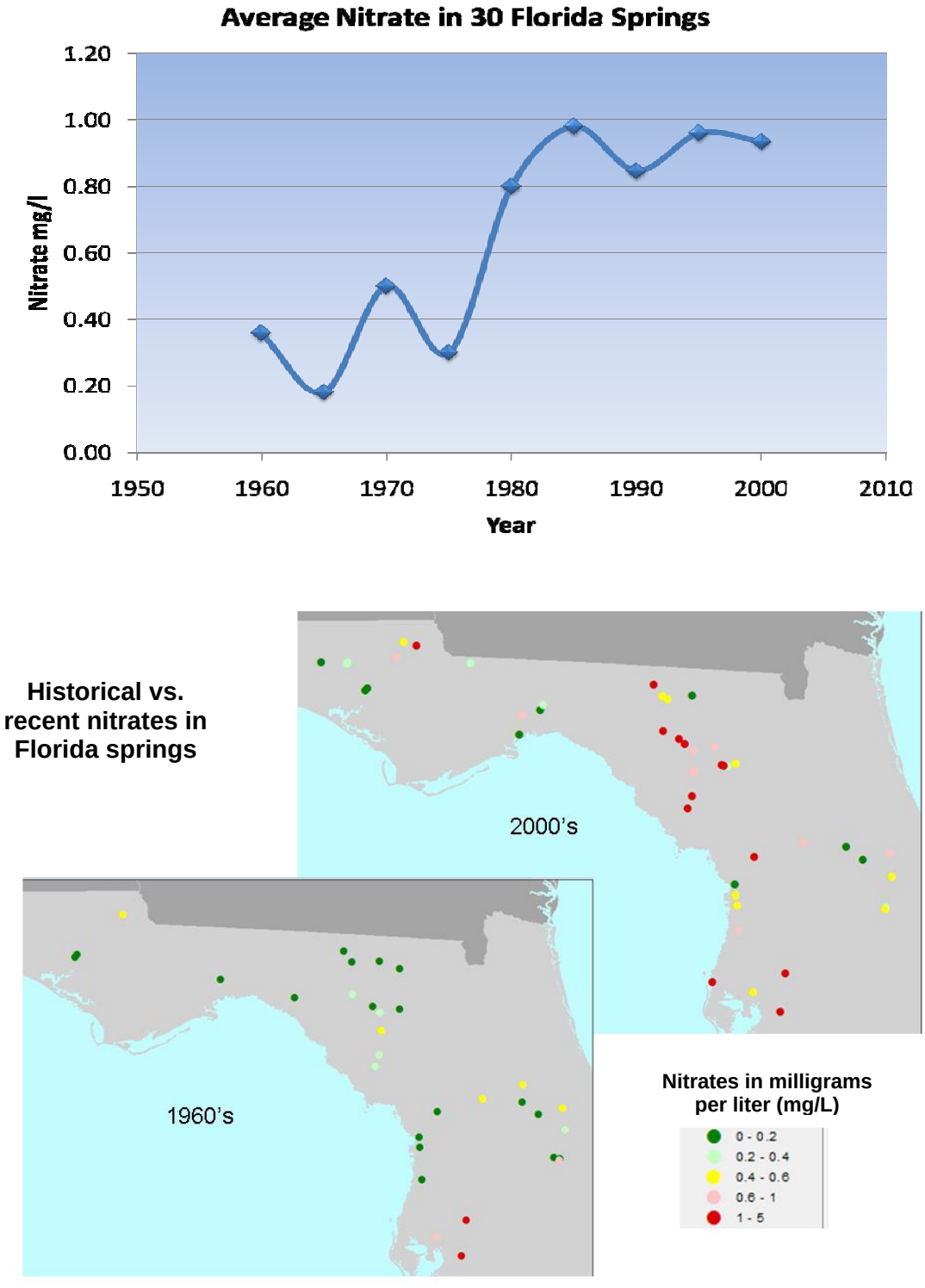

Figure 3. Evidence of increasing nitrate levels in Florida springs, 1960–2000
(*Source: Joe Hand, DEP Watershed Assessment Section*)

III. Summary of Spring-related Actions in Florida

A number of DEP programs and other agencies have played a role in spring research and restoration work.

Water Management Districts

All four water management districts that contain springs have taken actions to assess, protect, and/or restore springs in their jurisdictions (**Figure 1**); some of these actions have been supported by FSI funding.

St. Johns River Water Management District

The district maintains records for 89 springs within its jurisdiction and routinely monitors a number of them. Some of the more notable springs in the district include Silver Springs, Volusia Blue Spring, DeLeon Springs, and Wekiwa Spring. Several technical reports prepared by the district on springs and spring water quality date back to the early 1990s. The publication *Springs of the St. Johns River Water Management District* was produced in 2002, and an update of the document is available on line at the district's *Springs of the District* website. The SJRWMD has developed and adopted MFLs for 9 springs. MFLs for Messant, Miami, Palm, Rock, Sanlando, Seminole, Stabuck, and Wekiwa Springs were all adopted in 1992; Rock Spring and Wekiwa Spring are scheduled for re-evaluation in 2007. An MFL for Blue Spring was adopted in 2006.

The district has conducted or is currently working on several research projects that are being supported by the FSI; these include the recently completed 50-year retrospective study of ecological conditions in the Silver River and ongoing work to characterize water quality at the different springs and spring vents that are part of the Silver Springs complex.

Southwest Florida Water Management District

The district includes the Springs Coast region of the state. Notable springs in the district include Rainbow Springs, Homosassa Spring, Weeki Wachee Spring, and the Kings Bay Springs complex (in the Crystal River area). The district's quarterly water quality monitoring program includes most of the area's major springs. Since the mid-1990s, the district has assessed the condition of springs and factors contributing to water quality problems and prepared spring technical reports.

Spring protection and restoration have been addressed in several planning documents: the 2001 Comprehensive Watershed Management (CWM) plan for the Springs Coast; the 2001 CWM plan for the Withlacoochee Basin; and the 2004 Surface Water Improvement and Management (SWIM) plan for the Rainbow River. The CWM plans are vehicles for implementing a wide range of projects to protect and restore springs using district and state funding. Projects include land acquisition, stormwater management and planning, monitoring and assessment, and public education. Many of these activities are coordinated through the Coastal Rivers Basin Board.

Suwannee River Water Management District

The district's jurisdiction includes the majority of Florida's springs, most of which are in the Suwannee and Santa Fe River Basins. Some of the more recognizable springs include Ichetucknee

Springs, Manatee Springs, Fanning Springs, Troy Springs, and the Devils Springs complex. The district first conducted spring assessments in the late 1990s, although cooperative studies with the U.S. Geological Survey (USGS) occurred much earlier. Most of the larger springs are included in the district's Water Assessment Regional Network, which began in the late 1990s. The district helped establish the Suwannee River Partnership to address agricultural impacts to the river and associated springs. It has prepared MFL documents to address spring flows at Madison Blue Spring (adopted in 2005), in the lower and middle Suwannee Basin (adopted in 2006 and scheduled for adoption in 2007, respectively), and the lower Santa Fe Basin (scheduled for adoption in 2008). The district has also been very active in land acquisition, including springs and other significant karst features. Some of the acquired properties have been subsequently developed as state parks.

The FSI has provided funding to the district to support springshed delineation modeling, routine spring flow measurement, and restoration actions to remove sediment from spring vents.

Northwest Florida Water Management District

The district includes several springs in the St. Marks, Chipola, and Choctawhatchee River Basins. The most notable springs with issues include Wakulla Spring and Blue Spring in Jackson County (Jackson Blue). The district has conducted routine monitoring in Wakulla Springs for many years. As a follow-up to its SWIM plan for the St. Marks Basin, the district conducted a detailed nutrient assessment in 2001 that identified major nutrient inputs into Wakulla Springs.

The FSI has supported the district in several research and monitoring projects and one engineering design for restoration at Gainer Spring in Washington County.

U.S. Geological Survey

The USGS has the longest running inventory of springs, measurement of spring flows, and monitoring of spring water quality. The earliest USGS publication on springs, *Measurement of Springs of Florida* (Water Supply Paper 102), was produced in 1904. The USGS led or participated with the Florida Geological Survey (FGS) in two other inventories of springs in Florida, publishing the *Springs of Florida* reports in 1947 and 1977.

For several years, the USGS has provided hydrologic measurement services to the water management districts and currently obtains quarterly spring flow measurements and climate measurements for the FSI. The USGS is also a regional expert in water quality and isotope analysis to determine the age of water and the source of nitrogen in water, and has conducted water quality research for the FSI in several areas, most recently at Ichetucknee Springs.

Florida Department of Environmental Protection

Division of State Lands

The Division of State Lands has supported spring protection through the purchase of important river corridors, lands that contain springs, and buffers around springs. The division also manages contracts with local governments that maintain parks at springs on state-owned lands and a contract with a private concession that operates at Silver Springs, which is also owned by the state.

Division of Recreation and Parks

The Division of Recreation and Parks (the Florida Park Service) is charged with preserving and maintaining the condition of springs that are designated as state parks, as well as maximizing the recreational and educational experiences of park visitors. It currently manages 15 state parks that were established around major springs. At state parks, FSI funds have been used for restoration (such as debris and sediment removal and erosion control) and protection (such as relocating or upgrading septic tanks or connecting to municipal wastewater facilities, constructing boardwalks, and installing stormwater treatment swales), along with educational and outreach projects.

Florida Geological Survey

The 100-year-old FGS is the state bureau with the longest history of assessing geological and ground water conditions in areas where springs occur. The FGS participated in the first two *Springs of Florida* inventories, documented in 1947 and 1977 publications, and in 2004 produced an updated inventory and report (Bulletin 66). Other recent publications include springshed and spring protection area posters. Over the past seven years, the FGS has been heavily involved in spring research, monitoring, and measurement activities and serves as the state's repository for springshed maps and cave/conduit maps. In a multiyear project funded by DEP's Source Water Assessment and Protection Program, the FGS developed the Florida Aquifer Vulnerability Assessment (FAVA) model, which has proven to be a very effective tool for land use planning in areas near springs. The FGS has also played a lead role in research activities in Wakulla Springs to define the springshed, conduct cave mapping and dye tracer studies, and model the complicated hydrology. FGS currently conducts quarterly water quality monitoring of a network of priority springs with funding from FSI.

Division of Water Resource Management

The Division of Water Resource Management (DWRM) currently serves as the base for coordinating activities funded through FSI. In addition, DWRM houses several programs instrumental to spring protection. The Office of Water Policy coordinates with the water management districts in the establishment of MFLs. The Groundwater Protection Section oversees contracts and grants with the USGS and other research on ground water movement and pollutants. The Total Maximum Daily Load (TMDL) Program, which is beginning to assess the loading of nutrients and other pollutants to springs, is also contained within DRWM. DWRM has participated in the Suwannee River Partnership since its inception.

Florida Department of Community Affairs

The Florida Department of Community Affairs (DCA) has been a key partner in spring protection. DCA works with local governments in areas near springs to implement protective ordinances. In 2002, DCA worked with DEP to create a Model Land Development Code to assist local governments with updating their local ordinances to provide protection to springs. In 2003, the agencies also worked together to create the award-winning publication *Protecting Florida's Springs—Land Use Planning Strategies and Best Management Practices.* DCA is actively working on updating the guidance manual for the model code, which is now referred to as the *Implementation Guidebook* for local governments.

Florida Department of Health

The Florida Department of Health (DOH) has been an important agency involved in spring protection activities through its septic tank program. DOH evaluates septic systems that will reduce nitrate inputs to ground water to assist local governments in areas near springs.

Department of Agriculture and Consumer Services

The Florida Department of Agriculture and Consumer Services (DACS) is the lead agency in the development and implementation of agricultural best management practices (BMPs) to manage irrigation water and reduce nutrient discharges to surface water and ground water. DACS has also been a key participant in the Suwannee River Partnership in cooperation with the Suwannee River Water Management District.

IV. Florida Springs Initiative

Springs Task Force and FSI

In 1999, Governor Jeb Bush gave DEP's Secretary the responsibility for forming a multiagency and citizens' Springs Task Force to develop a strategic plan for spring protection and restoration in the state. The task force's recommendations, presented in a November 2000 report entitled *Strategies for Protection and Restoration,* provided the foundation for the FSI. With support from Governor Bush and the Florida Legislature, the FSI was formed in 2001. The Legislature provided $17.4 million in funding to support the FSI from 2001 to 2006. Current funding of $2.4 million per year is part of DEP's continuing base budget. To date, these funds have gone to minimally staff the program and to implement the activities and projects outlined in this report.

Springs Task Force members, who remain in an advisory capacity, include federal and state agencies, the state's four northern water management districts, regional planning councils, local governments, universities, nongovernmental organizations, the business community, and private citizens. The input of these experts on spring issues has influenced the types of projects carried out under the FSI. The 2000 Springs Task Force Report identified strategies of outreach, information, management, regulation, and funding as tools to protect and restore spring systems. **Appendix B** lists the Springs Task Force member groups, and **Appendix C** lists more than 100 projects implemented through the FSI since 2001.

The DEP staff members assigned to the FSI are responsible for managing the legislative appropriation, overseeing the program that was established based on the guidance in the 2000 Springs Task Force report, and chairing the Florida Springs Task Force. The FSI consists primarily of a grants program to direct and support the following general areas of spring protection:

- *Research and monitoring;*
- *Landowner assistance in the form of planning, management, and restoration;*

- *Restoration/protection activities and educational outreach in state parks; and*
- *Environmental education and outreach.*

The approximate total expenditures to date for each category are as follows

Research and Monitoring	*$7.5 million*
Landowner Assistance	*$2.5 million*
Division of Recreation and Parks	*$1.3 million*
Environmental Education	*$0.7 million*

Research and Monitoring

Since 2001, the FSI has dedicated approximately $1.25 million per year to 44 research and monitoring projects. In some instances, cooperative agreements and in-kind contributions by other state and federal agencies have also allowed the FSI to leverage its research funding, thus increasing the return on Florida's investment. A total of 58 sampling locations have been established in springs at state parks and all first-magnitude springs for quarterly water quality monitoring and flow measurement (**Figure 4**). Approximately $1 million has been encumbered in state fiscal year (FY) 2007–08 for dye trace studies, swallet studies to locate and describe stream-to-sink travel pathways (swallets are the sinkholes into which streams disappear), springshed delineations, nutrient–algal relationships, the sampling of the 58 monitoring sites, and the identification of biological indicators for springs.

The Florida Springs Water Quality Monitoring Network (**Appendix D**), which comprises those 58 sites, is the first and only statewide network established to monitor both spring water quality and flow. This network will allow DEP to assess statewide trends and compare the conditions of springs in different geographic areas. The FGS carries out this monitoring, with the USGS providing flow measurements. In addition to water chemistry monitoring, DEP's Bureau of Laboratories' Biological Assessment Subsection performs routine biological assessments at springs on state-owned lands.

The combination of chemistry, flow, and biological data for springs is important when evaluating cause-and-effect relationships for adverse impacts. When this information is combined with previous data collected for special studies and routine monitoring by the water management districts, a significant wealth of spring data is available. However, the data have been and continue to be managed by different entities. As a result, there is currently no common library for these data. The task of combining spring data from all these providers into one common database is a priority. This consolidation of data is necessary to be able to analyze the data and to use that analysis to guide spring restoration and protection measures.

One particular need identified by the Springs Task Force was to delineate the contributing areas (or springsheds) for all first-magnitude springs. The FSI has helped organize and contributed funding toward the delineation of 20 of Florida's 33 first-magnitude springs (**Table 1**). Springshed delineation is the first step toward identifying the areas around springs that should receive the

highest priority for protection. A next step is to carry out or complete detailed land use mapping to identify areas of potential concern within those springsheds.

Another step in this assessment is to identify those areas of the state where the aquifer is most vulnerable to contamination. The Florida Aquifer Vulnerability Assessment (FAVA) model developed by the FGS is an ideal tool for this purpose. At present, the FAVA model has been used to characterize aquifer vulnerability in the area surrounding Wekiwa Spring in Orange and Seminole Counties. FAVA assessments on a county scale have been or are currently being conducted in Alachua, Wakulla, Leon, Citrus, and Marion Counties for the purpose of spring protection. Developing a systematic process for completing land use/vulnerability assessments for all priority springs is a recommendation discussed later in this report.

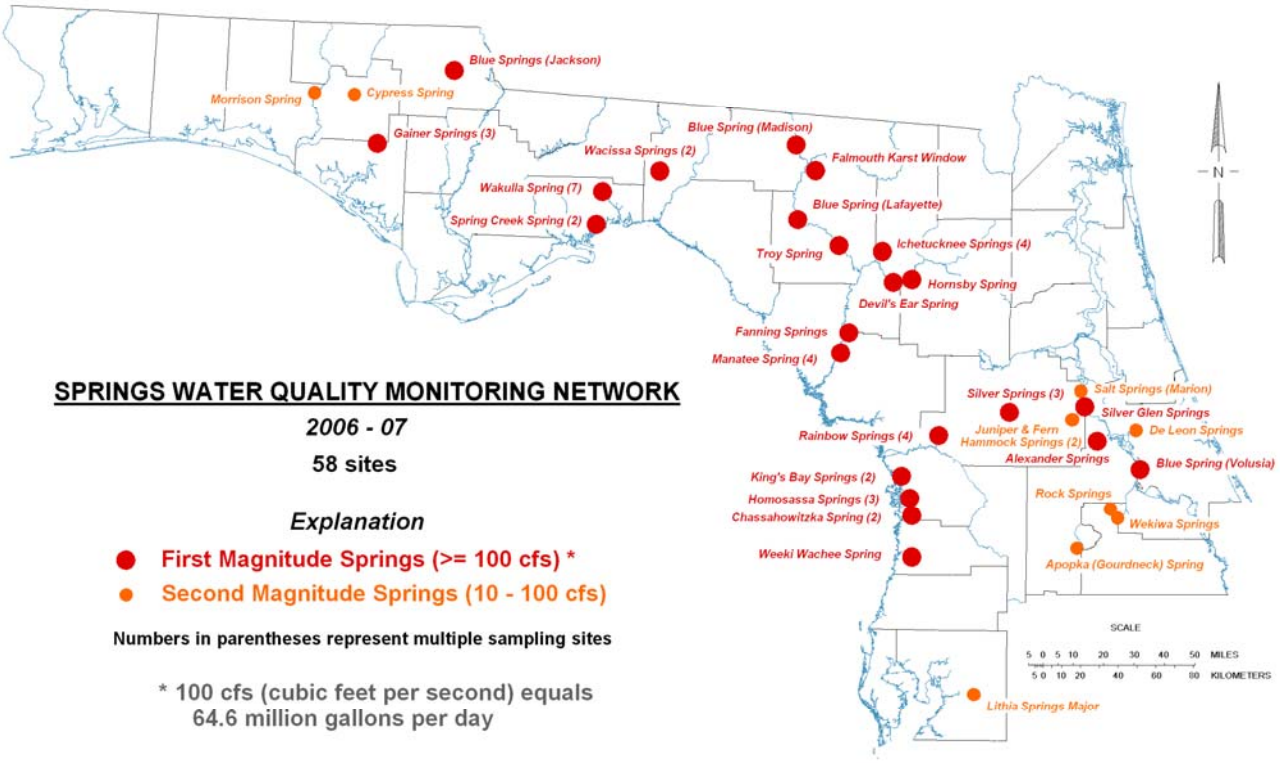

Figure 4. Florida Springs Water Quality Monitoring Network locations

Table 1. Florida's first-magnitude springs and springshed delineation status

Spring Name	Delineation Method	Delineation Source	Data Year
Delineated Springsheds			
Alexander Spring	POT- 10' contour intervals[2]	USGS	2005
Chassahowitzka Group	POT- 10' contour intervals	SWFWMD	1994
Fanning Spring	POT- 1' contour intervals[2]	SRWMD	2000
Gainer Group	POT- 10' contour intervals	NWFWMD	1998
Homosassa Group	POT- 10' contour intervals	SWFWMD	1994
Ichetucknee Group	POT- 10' contour intervals	USGS/SRWMD	2003
Jackson Blue Spring	POT- 10' contour intervals	NWFWMD	2004
Kings Bay Group	POT- 10' contour intervals	SWFWMD	1990
Madison Blue Spring	POT- 1' contour intervals	SRWMD	2003
Manatee Spring	POT- 1' contour intervals	SRWMD	2002
Rainbow Group	POT- 10' contour intervals	SWFWMD	1994
Santa Fe River Rise[1]	POT- 1' contour intervals	SRWMD	1995
Silver Glen Spring	POT- 10' contour intervals	USGS	2000
Silver Springs Group	POT- 10' contour intervals	USGS	2004
St. Marks River Rise[1]	POT- 10' contour intervals	USGS	1995
Troy Spring	POT- 1' contour intervals	SRWMD	2003
Volusia Blue Spring	POT- 10' contour intervals	SJRWMD	1995
Wacissa Group	POT- 10' contour intervals	USGS	1990
Wakulla Spring	POT- 10' contour intervals	DEP	2000
Weeki Wachee	POT- 10' contour intervals	SWFWMD	1994
Springsheds Not Yet Delineated			
Alapaha River Rise[1]			
Columbia Spring			
Devil's Ear Spring			
Falmouth Spring			
Holton Creek Rise[1]			
Hornsby Spring			
Lafayette Blue Spring			
Nutall River Rise[1]			
Santa Fe Spring			
Siphon Creek Rise[1]			
Spring Creek Group			
Steinhatchee River Rise[1]			
Treehouse Spring			

[1] River rises contain a mixture of ground water and resurging river water and are not considered "true springs" by some geologists. Therefore, the delineation of their springsheds may be a lower priority.

[2] POT = Potentiometric surface maps that are created from measured water levels and look like topographic elevation maps with either 10- or 1-foot elevation contours; 1-foot contours are more detailed maps.

Research projects funded by the FSI have also included the assessment of ground water flow paths within springsheds and the identification of major conduits and cave systems. The FGS recently completed a study to identify and map swallets, where rivers and streams disappear underground. Swallets are important, as they provide a short circuit for surface water to recharge directly into the ground water system. For example, the entire flow of Munson Slough—a stream that receives urban stormwater from over 50 percent of the city of Tallahassee—disappears into a swallet. Dye trace studies funded by the FSI found that this particular swallet is connected to Wakulla Spring.

Dye trace studies have been very useful in assessing the connection of specific areas to springs. A second dye trace study in the Wakulla Spring springshed identified a flow pathway between the city of Tallahassee municipal wastewater sprayfield and the spring. Another dye trace study found a pathway between the Lake City sprayfield and the Ichetucknee Springs complex.

One very important area of research discussed earlier is exploring the relationship of nutrients in springs, especially nitrate and phosphorus, to the adverse biological conditions brought on by algal growth. The biological program at Michigan State University, in cooperation with the University of Florida, recently completed a multiyear (2002–06) study that included in-the-field and bench-scale experimentation to better quantify the cause-and-effect relationship between nutrients and algal growth. The results are anticipated to assist in the development of numeric thresholds for these chemical components of spring water.

The Silver Springs 50-year retrospective ecological assessment, recently completed by the SJRWMD, also provides pieces of evidence to better understand the algal growth responses to human-induced impacts. Silver Springs has the longest record of both chemical and biological data, and this repeat of H.T. Odom's 1957 ecological assessment provides a representative snapshot of alterations that have occurred, along with changes in the chemical quality of the spring water. These types of studies are necessary to provide enough information to help researchers determine the factors that cause algal growth. Without investing in ecological assessments of this kind, it is impossible to propose meaningful corrective and restorative actions.

Table 2 lists the research and monitoring studies funded by FSI, categorized by topic.

Table 2. FSI-funded research and monitoring projects

Category	Project
Statewide research and monitoring	Inventory and Assessment of Florida's First-magnitude Springs (FGS Open File Report 85)
	Springs of Florida Update (FGS Bulletin 66)
	Quarterly Monitoring and Analysis of First-magnitude Springs and Other Selected Springs
	Discharge Monitoring at Select First- and Second-magnitude Springs
Spring water quality, hydrology	Pesticide Monitoring and Analyses of Water and Sediment from Jackson Blue Spring
	Wastewater Constituent Analysis at Silver Springs
	Impacts of Land Use on the Water Quality of Fanning Springs
	High Springs Gap Springshed Water Level Monitoring
	O'Leno Hydrogeology and Nutrient Loading on the Santa Fe River
	Nutrient Budget for the Ichetucknee Springshed
	Water Quality Study of the Ichetucknee River
	Springs Assessment in the Suwannee River Water Management District— Water Quality and Discharge Monitoring
	Springs Assessment in the Northwest Florida Water Management District— Water Quality, Discharge Monitoring, and Spring Inventories
Spring geology	Springs Assessment in the Suwannee River Water Management District—Delineation and Characterization of Springsheds
	Springs Assessment in the Northwest Florida Water Management District—Delineation and Characterization of Springsheds
	Modeling Flow Contributions to Alexander, Volusia Blue, Silver Glen, and Silver Springs
	Age-Dating at Select First-magnitude Springs
	Dye Tracing Potential Surface Water Sources for Wakulla Springs
	Ground Water Flow Model Development for Wakulla Springs
	Wekiwa Basin Delineation Using Florida Aquifer Vulnerability Assessment (FAVA)
	Radiolocation of Highway Positions over Leon Sinks Cave System
	Manatee Springs Bathymetric Survey
	Levy Blue Springs Bathymetric Survey
	Reconnaissance for Tallahassee Sprayfield Dye Trace Study
	Ichetucknee Springs Dye Trace Study
	Tracing Reclaimed Water from Lake City Sprayfield into Ichetucknee Springshed
	Locating, Identifying, and Describing Stream-to-Sink Features
	Cannon Creek and Lime Sink Dye Trace Study
	Tallahassee Sprayfield Dye Trace Study
	Investigation of Offshore Spring Resources

Category	Project
Spring biology, ecology	Fish and Bivalve Survey at 16 Springs
	Baseline Inventories of Aquatic Snails at 14 Springs and Spring Runs
	Apple Snail Abundance and Recruitment at 6 First-magnitude Springs
	Effects of Nitrate on Reproductive Parameters of Eastern Mosquitofish
	Effects of Nitrate on Growth and Development of Southern Toads
	Survey of Frog Diversity at Select Springs
	Impacts of Nitrate on Apple Snails
	Biological Inventory of Spring Caves Associated with the Ocklawaha River, Holmes Creek, Choctawhatchee River, Econfina River, St. Johns River, Apalachicola River, Suwannee River, and Withlacoochee River
	Relationships Between Nutrients and Algal Growth
	Silver Springs 50-Year Retrospective
Economics, planning, other	Impacts of Land Use on the Water Quality of Fanning Springs
	Economic Survey of Four Spring Parks
	Silver Glen Spring Carrying Capacity Study

Landowner Assistance/State Parks

Since 2001, the FSI has spent an average of about $600,000 per year on landowner assistance, with 33 projects completed or under way. The term "landowner assistance" has been applied to a variety of planning, management, and restoration projects carried out by or in cooperation with local governments, DCA, DACS, and the state parks. These projects have included the following:

- *Local government building setbacks and buffers,*
- *Septic tank design and siting,*
- *Alternatives for wastewater treatment,*
- *Stormwater management,*
- *Residential and agricultural BMPs for nutrient management, and*
- *Restoration and protection at state and county parks.*

In the future, these diverse types of projects will be reorganized into two more descriptive categories of *Land Use Planning* and *Restoration and Protection*.

Land Use Planning: Model Land Development Code

The FSI provided a total of $630,000 and worked with DCA to establish the first voluntary Model Land Development Code Program in the state, with the goal of protecting fragile spring ecosystems through the comprehensive planning process. Four counties—Citrus, Levy, Marion, and Wakulla—were chosen to participate in the program because of their potential impact on water quality and spring resources. In 2006, Wakulla and Marion Counties submitted comprehensive plan amendments for spring protection for DCA approval that specifically addressed spring protection, marking unprecedented commitments by local governments to protect their springs. In addition, the Wakulla County Board of Commissioners voted unanimously to adopt the land use strategies and development standards recommended in the Model Land Development Code to protect Wakulla Spring and ground water resources, including the sources of area drinking water.

DCA is updating the model code this year and plans to incorporate that code into a new edition of the publication, *Protecting Florida's Springs,* in the near future. In addition, the model code will be part of a DCA website: *Protecting Florida's Springs: An Implementation Guidebook.* As a next step, DCA should promote the adoption of the model code in priority counties while the FSI continues to support spring protection measures at comprehensive planning hearings, local government workshops, and other planning venues.

Land Use Planning: Best Management Practices

BMPs are a set of recommended, voluntary, standardized actions to reduce nonpoint source pollution in surface and ground water. Agricultural BMPs to reduce nutrient input to ground water are the most commonly applied approach to address the impacts of agricultural practices in springsheds.

The FSI has supported agricultural BMPs and landowner assistance activities to implement those BMPs under the Suwannee River Partnership. The Suwannee River Partnership is an agricultural BMP program being implemented by dairy and poultry farmers in the Suwannee River and Santa Fe Basins to reduce nutrient loads to ground water, springs, and rivers. This partnership between farmers, the water management district, and state and federal agencies provides a model for other areas of the state where agricultural activities affect springs. Although there are no data yet to link the BMPs implemented under the Suwannee River Partnership to reduced nitrate concentrations in ground water or springs, this local stakeholder cooperation and action is critical and must continue to be encouraged.

The FSI has also supported the development of silviculture and golf course management BMPs to reduce nutrient inputs and provided funding for the distribution of BMP manuals and materials. As BMP implementation expands to include turfgrass and hay and row crops, it will be important to monitor changes in ground water and spring chemistry to assess and improve BMP effectiveness.

Along roadways and in urban and residential areas, other kinds of BMPs are implemented. The FSI has provided support for the implementation of stormwater BMPs for roadway and parking lot renovations at Edward Ball Wakulla Springs State Park and has provided educational materials in support of the Florida Friendly Yards Program implemented by county extension offices. Within DEP, the Stormwater Nonpoint Source Discharge Elimination System and Nonpoint Stormwater

Sections are responsible for regulating urban nonpoint discharges of stormwater under the National Pollutant Discharge Elimination System (NPDES) and providing federal funding for stormwater BMP construction projects, respectively. Continued close coordination with these two programs and with stormwater management activities by local governments and the water management districts will be important in upcoming years to ensure spring protection as development continues across the state.

Restoration and Protection: Parks and Private Lands

To date, most of the restoration work performed using FSI funding has been at state parks. Recent protection measures have included replacing septic tanks with better on-site treatment systems or connecting to sewer lines at several parks, including Ichetucknee Springs, Wakulla Springs, Wekiwa Springs, and DeLeon Springs. Sediment removal from the Homosassa Spring basin and run and the installation of boardwalks for erosion control at Lafayette Blue Spring are typical restoration projects. A somewhat larger project included the removal of abandoned automobiles and trash from Cherokee Sink, a recent addition to Wakulla Springs State Park.

Restoration activities can also include springs at county-operated parks or easements provided by private landowners, although these projects are infrequent. Some restoration activities have taken place on private lands because that work not only enhances those karst features, but also the public lands to which they are intimately connected. Examples include work at Indian Springs, Tucker Sink, and Butler Sink, all of which are linked hydrologically and geologically to Wakulla Springs, a state park. Restoration and construction projects are expensive, and with its existing budget, the FSI must work hard to find matching funding. Combining funding with the Florida Fish and Wildlife Conservation Commission (FWCC), water management districts, and local governments on some spring restoration activities will be explored where appropriate.

Restoration and Protection: Land Acquisition

The FSI has been instrumental in identifying lands for acquisition under the Florida Forever land acquisition program to provide spring protection. More than 7,000 acres have been acquired to protect springs and springsheds, including land purchases made by the water management districts. Florida Forever is a key program for protecting priority lands associated with threatened springs. In 2005, the state purchased more than 330 acres of land surrounding Silver Springs, a first-magnitude spring in Marion County. In 2007, the state acquired an additional 4,471-acre parcel that is close to Silver Springs. The state acquisition of lands in rapidly developing and vulnerable karst areas prevents their development and reduces potential impacts to ground water.

Education and Outreach

Since its inception, the FSI has spent about $400,000 annually on education and outreach, funding a total of 28 projects, many of which were also categorized as landowner assistance or parks projects. Significant accomplishments include the establishment and maintenance of five spring working groups, support of two Spring Ambassadors, construction and maintenance of a spring website, development of spring-related educational materials and videos, and support of spring education in school classrooms. In addition, staff from the FSI and FGS have invested countless hours in face-to-face meetings with local government officials and staff, and in presentations to planning councils, neighborhood and environmental groups, and schools. These grassroots educational and

outreach efforts are instrumental in creating a culture of change in the community and in effectively initiating local spring protection.

Spring working groups provide a neutral venue for interaction between members of the public, environmental organizations, local and state government officials and staff, and technical experts to share information about spring issues, identify threats to springs, and develop and implement solutions. These groups have proven effective in educating people about the issues and identifying strategies to address them. Existing spring working groups are focused around Wakulla Spring, Ichetucknee Springs, the Santa Fe River Springs, Silver Springs, and Jackson Blue Spring.

The value of these efforts has been noticed, and other organizations and agencies have recently shown interest in sponsoring spring working groups. A Rainbow Springs Working Group is currently being developed. Also, the FWCC is setting up new working groups at Volusia Blue and Fanning/Manatee Springs.

Spring Ambassadors are locally based individuals who are involved in their community on behalf of springs. Three Spring Ambassadors are currently working with their communities to support Fanning/Manatee, Ichetucknee, and Wakulla Springs. The FSI provides funds for two of these Spring Ambassadors (Fanning/ Manatee and Wakulla Springs), who are supervised by the respective state park.

The FSI has funded the publication of brochures on BMPs for lawns and landscapes, as well as on land use planning and development standards; the production of a state-of-the-art video documenting Florida's aquifers and springs; the 2004 publication of an update to the comprehensive 1977 FGS report that includes 463 springs; and the convening of statewide conferences on springs. Educational materials also include posters and kiosks that are erected at state parks. In addition, the FSI commissioned the creation and launch of the web production, *Florida's Springs: Protecting Nature's Gems*, which is on DEP's spring website (http://floridasprings.org/). The website has received about half a million visitors to date and is the definitive resource on the web for Florida's freshwater springs.

The FSI also funds the Learning in Florida's Environment (LIFE) educational program with spring-specific curricula for middle school students in the community near three state parks: Wakulla Spring, Ichetucknee Springs, and Florida Caverns State Park. The program seeks to establish a series of field-based, environmental science enrichment programs and has succeeded in drawing the interest of young people. The program serves as another vehicle to encourage students to incorporate environmental protection into their daily lives or even choose environmental science–related career paths.

Regulation (and Coordination with Regulatory Programs)

Several federal and state laws provide the basis for actions to protect Florida's springs and springsheds.[1] These laws fall into three broad categories: the protection of water quality, the protection of flow (discharge), and the protection of species and habitats. Regulatory programs and

[1] The laws that have been enacted include the 1972 federal Clean Water Act, the 1973 federal Endangered Species Act, the 1972 federal Marine Mammal Protection Act, the 1967 Florida Air and Water Pollution Control Act (Chapter 403, Florida Statutes [F.S.]), the 1972 Florida Water Resources Act (Chapter 373, F.S.), the 1999 Florida Watershed Restoration Act (Section 403.067, F.S.), and the 1978 Florida Manatee Sanctuary Act (Subsection 370.12[2], F.S.).

rules stemming from these laws provide mechanisms for spring protection. These include water quality standards, wastewater discharge permits, Environmental Resource Permits (DEP and the water management districts), TMDLs for pollutants in impaired waters, consumptive use permits, and MFLs. Most of the regulatory tools listed above pertain to water quality; however, consumptive use permits and MFLs address water quantity.

The TMDL Program was given authority by the Legislature in the 2000 Florida Watershed Restoration Act to identify surface waters that are impaired by pollution and develop and implement activities to restore them. Those TMDLs for river and stream systems that receive flow from springs address water quality in the contributing springs.

The intent of the MFL program for surface waterbodies and aquifers is to ensure that future water withdrawals will not be "significantly harmful to the water resources or ecology of the area" (Section 373.042[1], F.S.). Water management districts can also establish MFLs to specifically protect nonconsumptive uses, such as aesthetics and recreation. Although springs are listed as high-priority waterbodies for the establishment of MFLs (Section 373.042[2], F.S.), the question remains as to whether the MFLs are adequate to prevent harm to spring systems as a whole. More work is needed to establish metrics for the cultural, recreational, ecological, and aesthetic value of springs in order to incorporate them into MFL development.

Over the last few years, the Governor and Legislature have taken a number of significant steps to ensure spring and springshed protection, including the following:

- *In 2002, the Legislature amended Chapter 373, F.S., requiring the state's five water management districts to include all first-magnitude and significant second-magnitude springs on their priority lists for the development of MFLs.*
- *In September 2003, the Governor and Cabinet unanimously approved the amendment of Rule 18-21, Florida Administrative Code (F.A.C.), to include protective measures for sovereign springs and spring runs in the construction of sand beaches, planting of aquatic vegetation, management of swimming and boating activities, and installation of wastewater treatment sites within 300 feet of springs or spring runs.*
- *In 2004, the Legislature passed the Wekiva Parkway and Protection Act (Sections 369.314-369.324, F.S.), which laid the groundwork for developing protection strategies for the Wekiva River and its associated springs that address municipal wastewater and residuals application, based on vulnerability. In enacting this law, the Legislature recognized that Florida's springs are threatened by actual and potential flow reductions and declining water quality.*
- *Chapter 2005-106, Laws of Florida, amended Section 369.318, F.S., to allow DEP to make rules that set nitrogen reduction requirements for wastewater treatment, reuse water, and residuals discharges within the Wekiva Study Area. These are to be adopted in the affected local governments' comprehensive plans.*

Broad-Based Protection and Restoration Efforts: Two Case Studies

Efforts currently under way at two major springs, Wekiwa Spring in central Florida and Wakulla Spring near Tallahassee, highlight the importance of collaboration and the need to implement a broad range of activities to protect and restore springs, including research and monitoring, education and outreach, land use planning and management, and regulation. They also illustrate the importance of tailoring protection and restoration activities to the unique characteristics of each spring and springshed.

Wekiva River Springs

Wekiwa Spring and nearby Rock Spring in central Florida are the largest of over 20 named Floridan aquifer system springs that discharge to the Wekiva River Basin, a major tributary to the St. Johns River (**Figure 5**). Because of their ecological, aesthetic, and recreational value, the Wekiva River and its tributaries have been designated an Outstanding Florida Water (OFW), a National and Florida Wild and Scenic River, and a Florida Aquatic Preserve. While large portions of the Wekiva River Basin are preserved, urban and suburban development are beginning to dominate the springshed of Wekiwa Spring. Major concerns with stormwater runoff, increased nutrients, and overpumping from Floridan aquifer system wells came to a head with the decision to construct the Wekiva Parkway through undeveloped sections of the basin.

The 2004 Wekiva Parkway and Protection Act (Sections 369.314-369.324, F.S.) laid the groundwork for developing protection strategies for the Wekiva River and its associated springs by focusing activities in the Wekiva Study Area. The success of this initiative may serve as a model for the development of similar measures in other threatened areas across the state. The Wekiva River Basin Commission was created to ensure that the Wekiva River Basin Coordinating Committee's recommendations are implemented. The activities specifically designed to protect Wekiva Study Area and its resources, including the springs, are broad in scope. They include the following:

- ***Land acquisition.*** *The acquisition of sensitive lands in the springshed was initiated in 2004.*
- ***Developing Pollutant Load Reduction Goals (PLRGs) and TMDLs.*** *Developing standards for water quality, the SJRWMD developed PLRGs for the Wekiva River and Rock Springs Run that are being used by DEP to complete nutrient TMDLs for these waters.*
- ***Strategy for water quality protection.*** *DEP completed a strategic planning document in 2004 and adopted a rule in 2006 (Rule 62-600, F.A.C.) to establish wastewater treatment requirements to reduce nitrogen contributions to the spring-run river system.*

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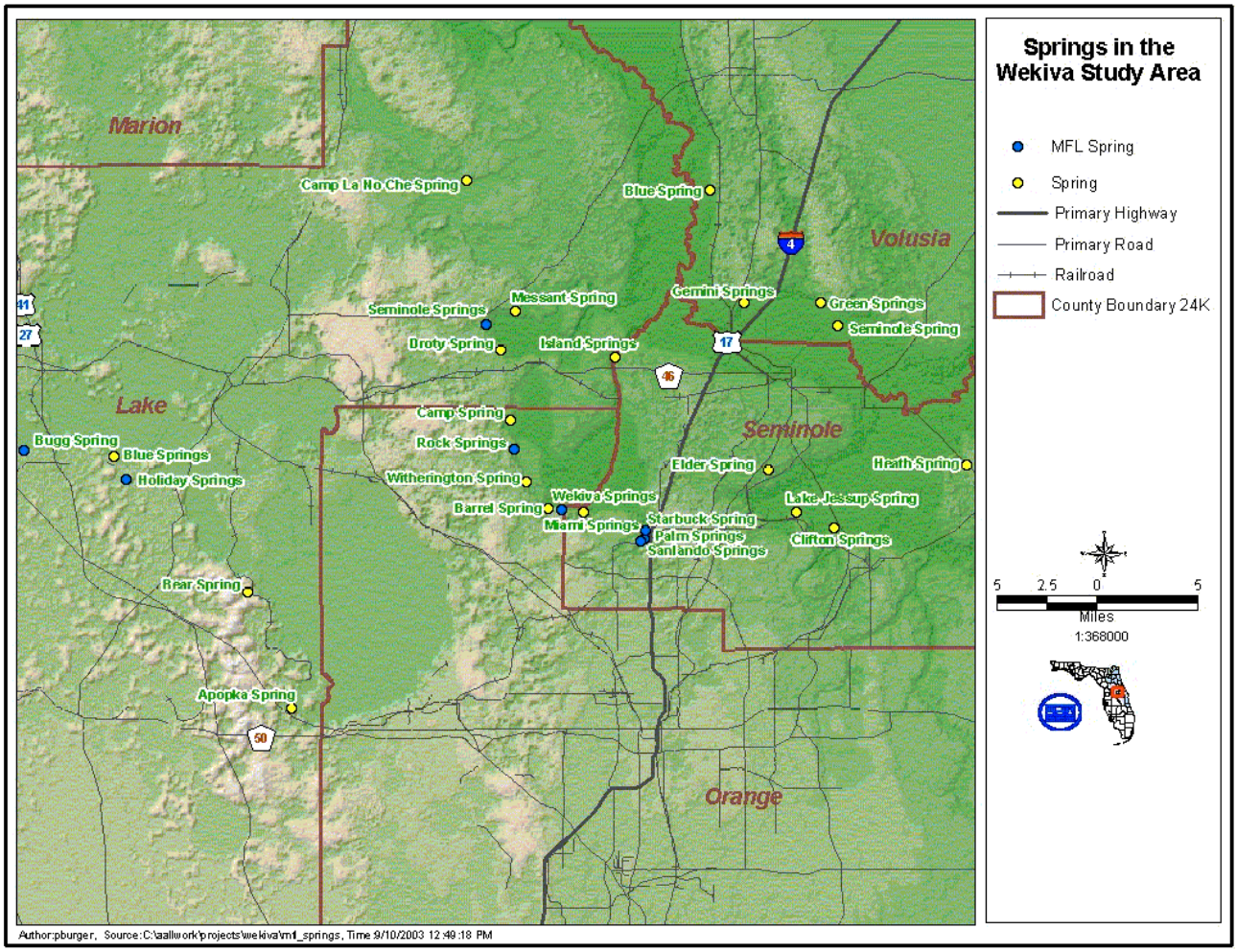

Figure 5. Springs in the Wekiva Study Area
(Source: A Strategy for Water Quality Protection: Wastewater Treatment in the Wekiva Study Area [DEP, 2004])

- ***Source assessment.*** *The assessment of on-site sewage treatment and disposal systems by DOH and the assessment of other sources of nutrients in the Wekiva River and springs by DEP and the water management district are ongoing.*
- ***MFL adoption.*** *The SJRWMD has already adopted MFLs for the Wekiva River and Rock Springs Run. Periodic water management district review of adopted MFLs for the springs is required.*
- ***Stormwater and wastewater planning in the Wekiva Protection Area.*** *Local governments are engaged in developing a master stormwater management plan for the area, expanding the reuse of reclaimed water, adopting a land use plan for each parkway interchange, amending local comprehensive plans to protect recharge areas, and developing alternative water sources.*

Wakulla Spring

Owned by the state and managed as a state park, Wakulla Spring is one of the world's largest first-magnitude springs (discharging an average of 252 million gallons per day) and the source of the Wakulla River. Because of its significant recreational, scenic, wildlife, economic, and historic value, the Wakulla River has been designated an OFW. The Edward Ball Wakulla Springs State Park has also been designated a National Natural Landmark and is on the National Register of Historic Places. The 600-square-mile springshed encompasses a portion of the Apalachicola National Forest and about 300 square miles of Leon County, including the city of Tallahassee. The springshed also extends into Georgia. Concerns include dramatic increases in nitrate levels in water from Wakulla Spring over the past 30 years (**Figure 6**).

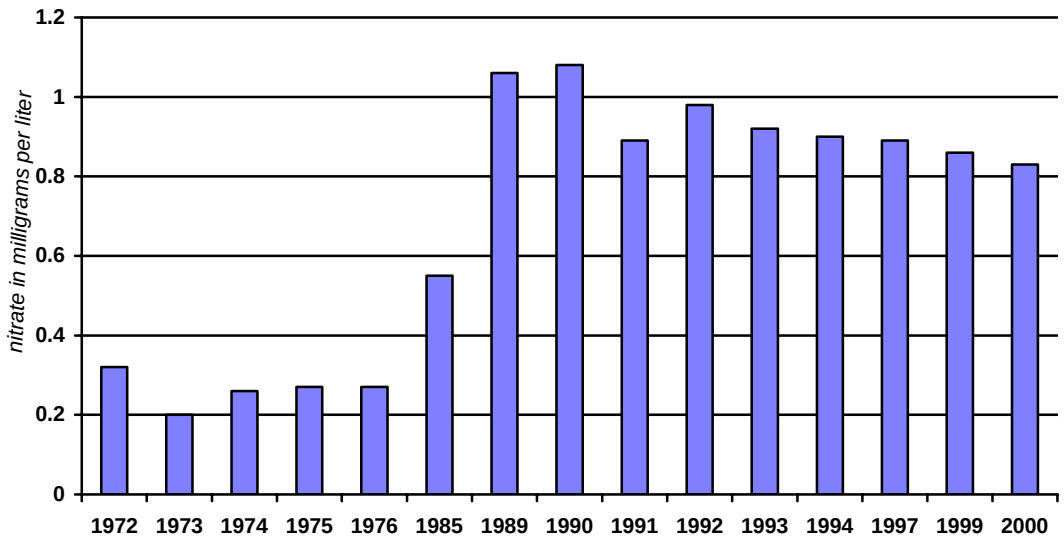

Figure 6. Nitrate trend in Wakulla Springs, 1972–2000

The Wakulla Springs Basin Working Group, formed in 1992, has been responsible for encouraging collaboration and communication between stakeholders. Working group activities involve information sharing by scientists, agency staff, and divers in order to prioritize research needs. The group's activities also include a wide variety of educational and outreach efforts such as field trips, a website, documentary film, brochure, and workshops on specific issues affecting the spring.

In addition to stakeholder collaboration, research and monitoring have been conducted to address the spring's problems, as follows:

- *A USGS study of potential impacts to the springs from the City of Tallahasssee (COT) Southeast Sprayfield,*
- *FGS dye trace studies to determine hydrologic connections in the springshed, and the creation of ground water flow and nitrate transport models, and*

- *Ongoing monitoring of spring water quality, flow, and velocity by the FGS and USGS.*

A USGS study to assess the impacts of the sprayfield on Wakulla Springs and a dye trace study have identified wastewater and fertilizer applications at the COT sprayfield as the major sources of nitrate affecting the spring. The study also identified contributions from local septic tanks as an increasing source of nutrients. The COT is taking corrective action in response to the study findings. A nutrient reduction plan has been implemented for the on-site farming operation at the sprayfield, and the COT plans to substantially reduce nitrogen discharges at the site through wastewater treatment plant modifications. Cave divers have verified the connection of underground conduits between Wakulla Spring and other karst features such as prominent sinkholes in the region.

Restoration efforts by Wakulla Springs State Park, funded by the FSI, have included cleaning out sinkholes and implementing BMPs and stormwater management on the park property. Florida Forever funding was also used to acquire land to protect water flowing to the spring (in particular, the acquisition of a 7,500-acre buffer around the spring). Other activities include land use planning and management, the connection of state park restroom facilities to a central sewer system, and the connection of park residences to performance-based, nutrient-reducing septic systems.

In October 2006, Wakulla County was the first in the state to adopt the Model Land Development Code. The code contains new measures designed to protect ground water quality by requiring setbacks from sinkholes and springs for new development, the use of advanced wastewater treatment (AWT) technologies for on-site septic systems in new developments, and replacements whenever existing systems fail.

V. Florida Springs Initiative Focus for the Future

The program's resources should be focused on where they are needed most and where they can be best applied to achieve the greatest, most efficient results. The FSI will prioritize resources for three main areas, as follows:

- *Funding the highest-priority research needs,*
- *Maintaining a robust baseline monitoring network to document statewide conditions, and*
- *Restoring priority springs, including the identification of nutrient loading sources and the design and implementation of a restoration plan.*

The FSI will continue to maximize the opportunities for outreach and stakeholder involvement in spring protection and will maintain current funding amounts and support for education, outreach, and regulatory coordination efforts. It will also consider the severity of impact, potential for corrective action, opportunity for collaboration, and ability to leverage other funds with FSI grants to restore priority springs.

In addition, the 2006 Legislature approved a *Protect Florida Springs* license plate that will generate funds separate from the amount appropriated each year for the FSI and will be administered by the Wildlife Foundation of Florida, Inc. DEP serves on a granting advisory committee that makes recommendations for funding community-based spring research and outreach that can supplement the work done under the FSI.

Research and Monitoring

Successful activities that should be continued in FY2007–08:

- *Continue, and modify as appropriate, water quality monitoring, flow measurement, and biological data collection activities.*
- *Increase the focus on data management activities to bring the FSI quarterly datasets up to date and make them readily available.*
- *Increase interagency efforts to compile all spring data under a common structure for use in data analysis.*
- *Complete research projects and spring source mapping studies that are multiyear contracts with the water management districts and universities.*
- *Complete the University of Florida's literature review of the effects of nutrients on springs. The review and data synthesis promise to provide new insight into this very complicated issue and direct research efforts.*

Activities to focus on in upcoming years are as follows:

- *Continue springshed delineation, detailed land use mapping, and aquifer vulnerability mapping for the remaining priority springs (including all remaining first-magnitude springs). Identify "hot spots" within the priority springsheds, based on (1) the primary pathways and travel times of ground water to springs and recharge areas and (2) the loadings of nitrate to ground water in springsheds. This information will serve to focus recommended corrective actions and related restoration plans.*
- *Identify and fund research projects that will help to develop a deeper understanding of the causes of ecological imbalances in spring systems. The TMDL and MFL Programs will benefit by having a more substantial basis for establishing targets to better restore or protect springs. Once the 2007–08 literature review and data analysis project has been completed, a long-range plan and budget for additional ecological research will be developed.*
- *Investigate the subtleties of spring water quantity–water quality dynamics further by expanding the monitoring network for simultaneous water quality and flow measurements to calculate loadings. This type of data is currently lacking.*
- *Support studies to assess the effectiveness of BMPs as they relate to spring water quality, in cooperation with other agencies as appropriate, and propose changes or alternative strategies to improve BMPs as needed.*

Planning Assistance and Restoration/Protection

Successful activities that should be continued in FY2007–08:

- *Collaborate with DCA on the successful Model Land Development Code project, promoting its adoption in priority counties.*
- *Promote specific spring protection measures at regional comprehensive planning workshops.*
- *Identify and promote the state acquisition of strategic lands within springsheds to improve/protect water quality and/or flow in spring systems.*
- *Fund spring restoration and protection projects on lands in state parks, land management by local governments, and landowner assistance in public-private partnerships.*

Activities to focus on in upcoming years:

- *Work with local governments, interested citizens, the water management districts, and other state governmental agencies to ensure that all priority springs have strategic springshed restoration and protection plans that include actions to address identified "hot spots" as well as springshed issues as a whole. The plans should include recommended corrective actions and should be implemented as funding becomes available.*
- *Partner with DCA, the water management districts, and regional planning councils to provide spring resource planning workshops for local governments.*
- *Collaborate with DCA to update the publication,* Protecting Florida's Springs, *with the latest technical information and incorporate the Model Land Development Code.*
- *Assess the effectiveness of existing and proposed agricultural nutrient management BMPs (e.g., turfgrass, row crops, dairy, and poultry) as protective of springs and propose changes or alternative strategies where ground water and springs are most vulnerable. This assessment will be coordinated with DEP, DACS, and the water management districts.*

Regulation (and Coordination with Regulatory Programs)

Activities that should be implemented in FY2007–08 and beyond:

- *Coordinate with the TMDL Program. TMDLs will be proposed, reassessed, or adopted in the upcoming years for Wekiwa and Rock Springs, the Wakulla River, the lower and middle Suwannee River, the Santa Fe River, the Ichetucknee River, and several springs in the Springs Coast region. The FSI will work with other sections in the Bureau of Watershed Restoration on stakeholder participation,*

communication, and the development of Basin Management Action Plans (BMAPs), including restoration projects in these systems.

- *Provide technical support to and coordinate with the Bureau of Water Facilities Regulation, regulatory districts, and local stakeholders on wastewater permitting decisions that potentially affect springs. These include domestic wastewater permits, residuals application site permits, and dairy and confined animal feeding operation permits, as well as other wastewater facilities that may have adverse impacts on springs.*
- *Provide training for regulatory districts on existing and potential spring issues (ecology, impacts, and relevant rules) and provide assistance in creating permit language protective of springs.*
- *Collaborate on springshed delineations and the establishment of MFLs with the water management districts and DEP's Office of Water Policy. For those MFLs that involve springs, the water management districts typically produce models that include a delineation of the springsheds for affected springs. This information needs to be made available for other purposes.*
- *Work with the Office of Water Policy and the water management districts to provide additional protection for selected springs based on long-term median flows (this may require legislation).*
- *Assist DOH in designing and implementing septic tank regulations that provide additional protection for springs and reduce nitrate loadings in springsheds.*

Education and Outreach

Successful activities that must be continued in FY2007–08:

- *Convene Springs Task Force meetings to maintain communication on current spring activities and issues, and to maximize multiagency cooperation and spring-related restoration efforts.*
- *Coordinate a Springs Conference in 2008 to share information with stakeholders on completed projects and the current state of knowledge. If the budget does not allow for a conference this fiscal year, work on preparation for one in FY2008–09.*
- *Fund five spring working groups and two Spring Ambassadors, and partner with other agencies and organizations to support additional working groups.*
- *Maintain websites on Florida springs and on Florida-friendly landscaping.*
- *Support ongoing LIFE Programs in the areas of Ichetucknee and Wakulla Springs State Parks and expand the program to Florida Caverns State Park in Marianna.*
- *Continue to support spring education in state parks by funding the development of educational venues and materials.*

Activities to focus on in upcoming years:

- *Expand DEP's LIFE Program by introducing curricula focused on springs, ground water, and spring protection to classrooms in schools located near state parks that have springs. The LIFE Program seeks to establish a series of field-based, environmental science enrichment programs; it has succeeded in drawing the interest of young people and serves as another vehicle to encourage them to take environmental science–related career paths.*
- *Expand web-based educational opportunities through the Office of Environmental Education and the Office of Communications and support new and creative educational concepts.*
- *Facilitate more springshed tours and public awareness projects for the public, key stakeholders, agency management, and local government officials.*
- *Support additional Spring Ambassadors and spring working groups where needed.*

Appendices

Appendix A. Classifications of Spring Magnitude and First-Magnitude Springs of Florida, by County

Table A-1. Classifications of spring magnitude

Magnitude	Average Flow (Discharge)
1	64.6 mgd or more
2	6.46 to 64.6 mgd
3	0.646 to 6.46 mgd
4	100 gpm to 448 gpm
5	10 to 100 gpm
6	1 to 10 gpm
7	1 pint to 1 gpm
8	Less than 1 pint/minute

Notes: mgd = million gallons per day; gpm = gallons per minute.
Source: Modified from *Springs of Florida,* FGS Bulletin No. 66, 2004.

Table A-2: First-magnitude springs of Florida, by county

Spring	Water Management District	Discharge Range (cubic feet per second [cfs])	Nitrate+Nitrite Concentration (milligrams per liter [mg/L]) and Date Sampled	Mapped Cave System	Current Water Quality/ Discharge Monitoring	Basin Working Group	Springshed Delineation Map	Upland Owner
Alachua County								
Hornsby Spring	SRWMD	0 – 250	0.30 (sampled 10-9-01)	yes	yes, began quarterly sampling in summer 2006	yes	no	private
Bay County								
Gainer Group	NWFWMD	150 – 556	0.20 (Vent #1C, 9-1-05)	no	yes, quarterly	no	yes	private/state
Citrus County								
Chassahowitzka Group	SWFWMD	31.8 – 197	0.56 (Main, 8-2-05)	no	yes, quarterly	no	yes	state
Homosassa Group	SWFWMD	80 – 165	0.54 (Vent #3, 8-2-05)	yes	yes, quarterly	no	yes	state
Kings Bay Group	SWFWMD	975	0.39 (Hunter Spring, 8-4-05)	yes	yes, quarterly	no	yes	private/state
Columbia County								
Columbia Spring	SRWMD	39.5 – **305.97	0.089 (10-8-01)	no	no	yes	no	private
Ichetucknee Group	SRWMD	186 – 197.2	0.80 (Headspring, 7-14-05)	no	yes, quarterly	yes	yes	state
Santa Fe River Rise	SRWMD	**75 –	0.058 (10-9-01)	no	no	yes	no	state
Treehouse Spring	SRWMD	39.9 – 405.96	0.091 (10-8-01)	no	no	yes	no	private
Santa Fe Spring	SRWMD	47.9 – 149.99	0.023 (10-8-01)	no	no	yes	no	private
Dixie County								
Steinhatchee River Rise	SRWMD	350	0.056 (10-30-01)	no	no	no	no	state
Gilchrist County								
Devil's Ear Spring	SRWMD	**120 – 206.59	2.0 (7-14-05)	yes	yes, quarterly	yes	no	private
Siphon Creek Rise	SRWMD	120	0.7 (10-11-01)	no	no	yes	no	state

Spring	Water Management District	Discharge Range (cubic feet per second [cfs])	Nitrate+Nitrite Concentration (milligrams per liter [mg/L]) and Date Sampled	Mapped Cave System	Current Water Quality/ Discharge Monitoring	Basin Working Group	Springshed Delineation Map	Upland Owner
Hamilton County								
Alapaha River Rise	SRWMD	508 – 699	0.4 (10-10-01)	no	no	no	no	state
Holton Creek Rise	SRWMD	0 – 482	0.004 (10-10-01)	no	no	no	no	state
Weeki Wachee Main Spring	SWFWMD	101 – 275	0.76 (8-3-05)	no	yes, quarterly	no	yes	state
Jackson County								
Jackson Blue Spring	NWFWMD	56 – 265	3.4 (8-24-05)	yes	yes, quarterly	no	yes	state
Jefferson County								
Wacissa Group	SRWMD	64.5 – 605	0.19 (Big Blue Spring, 7-5-05)	no	yes, quarterly	no	yes	private/state
Lafayette County								
Lafayette Blue Spring	SRWMD	**45.9 – **162	2.6 (1-13-05)	no	yes, quarterly	no	no	state
Troy Spring	SRWMD	106 – 205	2.1 (7-14-04)	yes	yes, quarterly	no	yes	state
Lake County								
Alexander Spring	SJRWMD	74.5 – 162	0.053 (7-21-05)	no	yes, quarterly	no	no	federal
Leon County								
St. Marks River Rise	NWFWMD	*336 – *742	0.038 (8-16-05)	no	not currently sampled; was sampled quarterly from fall 2001 to summer 2005	no	no	private
Levy County								
Fanning Springs	SRWMD	51.5 – 139	6.3 (1-10-05)	no	yes, quarterly	no	yes	state
Manatee Spring	SRWMD	110 – 238	1.9 (7-7-05)	yes	yes, quarterly	no	yes	state
Madison County								
Madison Blue Spring	SRWMD	71.4 – 141	2.0 (1-13-05)	yes	yes, quarterly	no	yes	state
Marion County								
Rainbow Springs Group	SWFWMD	487 – 1,230	1.5 (Bubbling Spring, 8-9-05)	no	yes, quarterly	no	yes	state

Spring	Water Management District	Discharge Range (cubic feet per second [cfs])	Nitrate+Nitrite Concentration (milligrams per liter [mg/L]) and Date Sampled	Mapped Cave System	Current Water Quality/ Discharge Monitoring	Basin Working Group	Springshed Delineation Map	Upland Owner
Silver Glen Springs	SJRWMD	90 – 129	0.051 (7-27-05)	yes	yes, quarterly	no	no	federal
Silver Springs Group	SJRWMD	***517 – ***1,290	1.1 (Main Spring, 7-28-05)	yes	yes, quarterly	yes	yes	state
Suwannee County								
Falmouth Spring	SRWMD	1.59 – 365	0.39 (10-31-01)	yes	yes, began quarterly sampling in summer 2006	no	no	state
Taylor County								
Aucilla River, Nutall Rise	SRWMD	360	0.029 (10-1-01)	no	no	no	no	private
Volusia County								
Volusia Blue Spring	SJRWMD	63 – 214	0.61 (7-20-05)	yes	yes, quarterly	no	yes	state
Wakulla County								
Spring Creek Group	NWFWMD	307 – 2,000	0.11 (Spring Creek Rise #1, 8-22-05)	no	yes, quarterly	no	yes	private
Wakulla Spring	NWFWMD	*129 - *1,910	0.51 (8-12-05)	yes	yes, quarterly	yes	yes	state

Notes: Data are from the FGS unless otherwise noted. Nitrate values are selected from the most recently released FGS spring quarterly sampling data (winter 2005) where possible. All other nitrate values are from *Springs of Florida* (FGS Bulletin 66, 2004).

NWFWMD – Northwest Florida Water Management District
SJRWMD – St. Johns River Water Management District
SRWMD – Suwannee River Water Management District
SWFWMD – Southwest Florida Water Management District

* Data from NWFWMD.
** Data from SRWMD.
*** Data from SJRWMD.

Appendix B. Florida Springs Task Force Participants

DEP Division of Recreation and Parks
Florida Fish and Wildlife Conservation Commission
Florida Department of Community Affairs
Regional Planning Council
County Government
Northwest Florida Water Management District
Suwannee River Water Management District
St. Johns River Water Management District
Southwest Florida Water Management District
U.S. Geological Survey
University
Consultant – Technical
Water Bottling
Consultant – Education and Outreach
Agriculture
Environmental Groups
Task Force Chairman: Springs Coordinator

Appendix C. Projects Implemented through the FSI, 2001–present

Research and Monitoring

Year(s)	Activity
2001–02	Inventory and Assessment of Florida's First-magnitude Springs (FGS Open File Report 85)
2001–02	Pesticide Monitoring and Analyses of Water and Sediment from Jackson Blue Spring
2001–02	Wastewater Constituent Analysis at Silver Springs
2001–02	Fish and Bivalve Survey at 16 Springs
2001–02	Baseline Inventories of Aquatic Snails at 14 Springs and Spring Runs
2001–02	Apple Snail Abundance and Recruitment at 6 First-magnitude Springs
2001–03	Age-Dating at Select First-magnitude Springs
2001–04	Springs of Florida Update (FGS Bulletin 66)
2001–05	Springs Assessment in the Suwannee River Water Management District—Delineation and Characterization of Springsheds; Water Quality and Discharge Monitoring
2001–06	Quarterly Monitoring and Analysis of First-magnitude Springs and Other Selected Springs
2001–06	Discharge Monitoring at Select First- and Second-magnitude Springs
2001–06	Biological Monitoring at Select First- and Second-magnitude Springs
2001–06	Springs Assessment in the Northwest Florida Water Management District—Delineation and Characterization of Springsheds; Water Quality and Discharge Monitoring; Spring Inventories
2002–03	Effects of Nitrate on Reproductive Parameters of Eastern Mosquitofish; Effects of Nitrate on Growth and Development of Southern Toads; Survey of Frog Diversity at Select Springs
2002–03	Manatee Spring Conduits Monitoring
2002–03	Modeling Flow Contributions to Alexander, Volusia Blue, Silver Glen, and Silver Springs
2002–03	Impacts of Nitrate on Apple Snails
2002–03	High Springs Gap Springshed Water Level Monitoring
2002–03	Biological Inventory of Spring Caves Associated with the Ocklawaha River, Holmes Creek, Choctawhatchee River, Econfina River, St. Johns River, Apalachicola River, Suwannee River, and Withlacoochee River
2002–03	Impacts of Land Use on the Water Quality of Fanning Springs
2002–03	Economic Survey of Four Spring Parks
2002–03	Silver Glen Spring Carrying Capacity Study
2002–06	O'Leno Hydrogeology and Nutrient Loading on the Santa Fe River
2002–06	Relationships Between Nutrients and Algal Growth
2003–05	Silver Springs 50-Year Retrospective
2003–06	Dye Tracing Potential Surface Water Sources for Wakulla Springs; Ground Water Flow Model Development for Wakulla Springs
2004–05	Wekiwa Basin Delineation Using Florida Aquifer Vulnerability Assessment (FAVA)
2004–05	Radiolocation of Highway Positions over Leon Sinks Cave System
2004–05	Manatee Springs Bathymetric Survey
2004–05	Levy Blue Springs Bathymetric Survey
2004–05	Ichetucknee Springs Dye Trace Study
2004–05	Reconnaissance for Tallahassee Sprayfield Dye Trace Study
2004–06	Tracing Reclaimed Water from Lake City Sprayfield into Ichetucknee Springshed
2004–06	Locating, Identifying, and Describing Stream-to-Sink Features
2004–06	Cannon Creek and Lime Sink Dye Trace Study
2004–06	Investigation of Offshore Spring Resources
2005–06	Tallahassee Sprayfield Dye Trace Study
2005–06	Nutrient Budget for the Ichetucknee Springshed
2005–06	Water Quality Study of the Ichetucknee River

Landowner Assistance

Year(s)	Activity
2002	Land Use Management Tool
2002	Removal of Sediments from Alexander Spring
2002	Construction of Monitoring Well along St. Marks River
2002–03	Head Spring Restorations
2002–03	Nutrient Reduction BMPs
2002–03	Homeowner Brochure
2002–03	Three Public Workshops for Gainer, Jackson Blue, St. Mark, and Wakulla Springs and Spring Creek
2002–06	Springs BMPs/Land Use BMPs (also known as Model Land Development Code Program)
2002–06	*Water's Journey* Video Production
2002–06	Spring-specific Brochures and Updated Reprints of Ichetucknee, Wakulla, and Wekiwa Springs
2003	Ownership Mapping for 8 Privately Owned First-magnitude Springs
2003	*Portals to the Past* Spring Brochures
2004	Poe Springs Restoration
2004	Gainer Springs Restoration
2004–06	Golf Course BMPs
2004–06	Springshed Basin Road Signs
2004–06	Springs Curriculum Development
2004–06	Florida Springs Website Maintenance

Division of Recreation and Parks

Year(s)	Activity
2002	Restoration of Fanning Spring
2002	Ichetucknee Springs Restoration
2002	Fencing Around Ichetucknee and Rose Sinks
2002	Access Ramps and Boardwalks to Cherokee Spring at Wakulla Springs
2002	Video on Volusia Blue Spring
2002	Identify Invertebrate Communities by Habitat Type and Correlate with Velocity/Spring Flow at Volusia Blue Spring
2002–06	Water Quality Baseline Sampling in Half Mile Creek at Silver Springs and in Witherington, Barrel, and Sulphur Springs at Wekiwa Springs
2002	Baseline Water Quality Well Sampling for Nitrates at DeLeon Spring
2002	Exotic Fish, Exotic Plant, and Algae Removal and Erosion Control at Wekiwa Springs
2002	Septic Tank Drainfield and Boat Ramp at Manatee Springs
2002	Sewer Improvements at Rainbow Spring
2002	Sewer Hookup to Park Ranger Residence and Shop and Wakulla Springs
2002	Wakulla Springs Recharge Area Landowner Assistance Program Surveys
2002	Environmental Education at Camp Kulaqua
2002–03	Troy Spring Erosion Control
2002–06	Ambassador for Manatee Springs
2002–06	Ambassador at Wakulla Springs
2004	Sponsorship of Wakulla Springs Scientific Conference
2004	Removal of Septic Tank; Residence Sewer Hookup at Blue Hole in Florida Caverns
2004	Waterless Urinals at Rainbow Springs
2004	Wekiwa Springs Sewer System Upgrade/Connection
2004	Rose Sink Restoration at Ichetucknee Springs
2004	Indian Spring Restoration at Wakulla Springs
2004	Peacock Spring Boardwalk for Erosion Control at Ichetucknee Springs
2004–06	Wakulla Springs Educational Trail System
2004–06	Renovation of Rainbow Springs Education Center
2004–06	Educational Signage/Kiosks

Education and Outreach

Year(s)	Activity
2002	Spring Recharge Area Brochures
2002	Two Public Service Announcements
2002–03	2003 Springs Conference
2002–06	Springs Website Establishment Updates
2003	Florida Geological Survey Poster
2003	State Fair Exhibit
2003	Florida-friendly Landscape Website Establishment
2002–06	Working Group Coordinator for Ichetucknee Springs
2002–06	Working Group Coordinator for Wakulla Springs
2002–06	Working Group Coordination at Silver Springs
2003–06	Working Group Coordination at Santa Fe Springs
2005–06	LIFE Program on Springs at Two Sites

Appendix D. Florida Springs Water Quality Monitoring Network

The Florida Springs Water Quality Monitoring Network (FSWQMN) is a long-term monitoring effort designed to measure trends over time in spring water quality and discharges. The results can also assist in determining impairment in surface waters and aid in the development and establishment of TMDLs to restore and protect water quality.

The sampling stations are located within first- and second-magnitude springs, in a karst region stretching from the Florida Panhandle to central Florida (**Figure D-1**). They are spatially distributed so that researchers can make some inferences about the other springs in the immediate area.

This fixed-station network consists of a total of 58 separate freshwater and coastal sampling locations within spring vents and conduits (**Table D-1**). One river rise (where a river resurfaces after going under a landbridge) is no longer sampled.

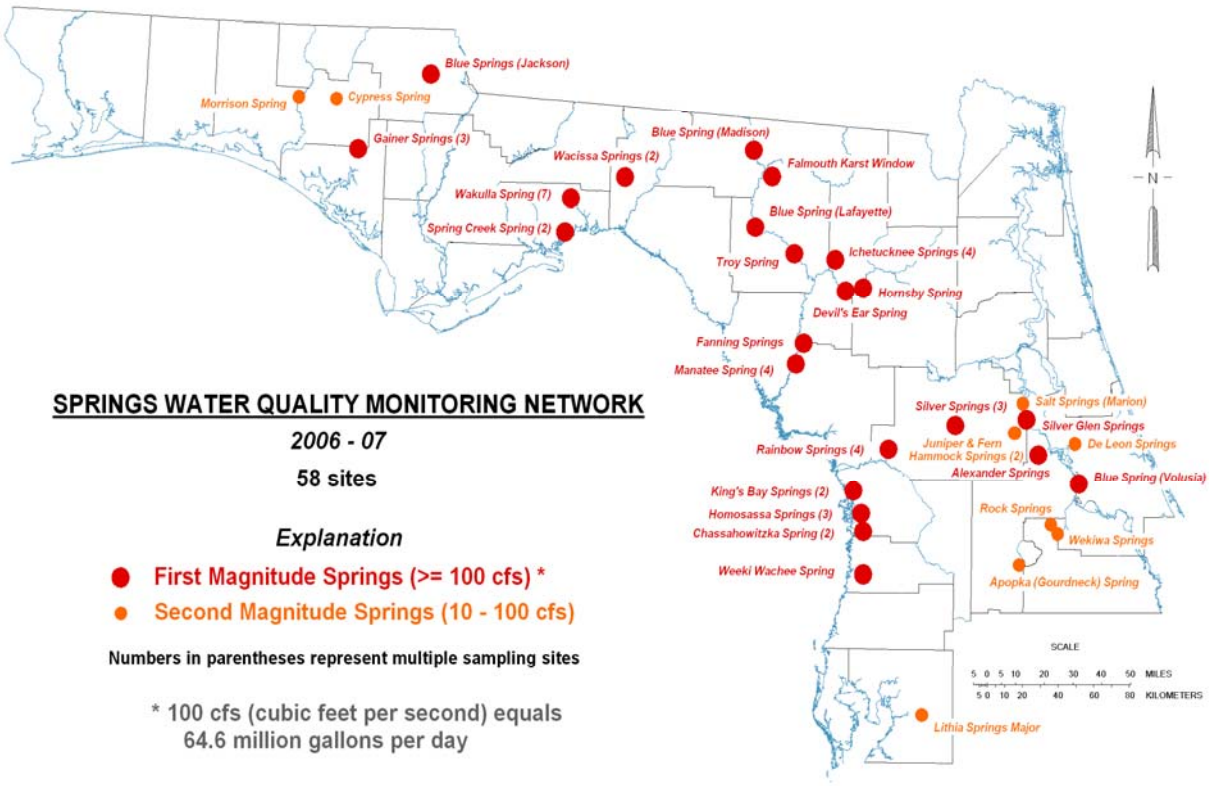

Figure D-1: Florida Springs Water Quality Monitoring Network

Table D-1: First- and second-magnitude spring water quality monitoring sites

	Spring Name	Type	County
1	Alexander Springs	Spring Vent	Lake
2	Apopka (Gourdneck) Spring	Spring Vent	Lake
3	Cypress Spring	Spring Vent	Washington
4	DeLeon Spring	Spring Vent	Volusia
5	Devil's Ear Spring	Spring Vent	Gilchrist
6	Falmouth Spring	Spring Vent	Suwannee
7	Fanning Springs	Spring Vent	Levy
8	Fern Hammock Springs	Spring Vent	Marion
9	Hornsby Spring	Spring Vent	Alachua
10	Jackson Blue Spring	Spring Vent	Jackson
11	Juniper Springs	Spring Vent	Marion
12	Lafayette Blue Spring	Spring Vent	Lafayette
13	Lithia Springs Major	Spring Vent	Hillsborough
14	Madison Blue Spring	Spring Vent	Madison
15	Morrison Spring	Spring Vent	Walton
16	Rock Springs	Spring Vent	Orange
17	Salt Springs	Spring Vent	Marion
18	Silver Glen Springs	Spring Vent	Marion
19	St. Marks River Rise[1]	River Rise	Leon
20	Troy Spring	Spring Vent	Lafayette
21	Volusia Blue Spring	Spring Vent	Volusia
22	Weeki Wachee Spring	Spring Vent	Hernando
23	Wekiwa Spring	Spring Vent	Orange
Chassahowitzka Springs Group			
24	Chassahowitzka Main Spring	Spring Vent	Citrus
25	Chassahowitzka Spring No. 1	Spring Vent	Citrus
Gainer Springs Group			
26	Gainer Spring No. 1C	Spring Vent	Bay
27	Gainer Spring No. 2	Spring Vent	Bay
28	Gainer Spring No. 3	Spring Vent	Bay
Homosassa Springs Group			
29	Homosassa Spring No. 1	Spring Vent	Citrus
30	Homosassa Spring No. 2	Spring Vent	Citrus
31	Homosassa Spring No. 3	Spring Vent	Citrus
Ichetucknee Springs Group			
32	Ichetucknee Head Spring	Spring Vent	Suwannee
33	Blue Hole Spring	Spring Vent	Columbia
34	Mission Spring	Spring Vent	Columbia
35	Mill Pond Spring	Spring Vent	Columbia
Kings Bay Springs Group			
36	Hunter Spring	Spring Vent	Citrus
37	Tarpon Hole Spring	Spring Vent	Citrus
Manatee Spring			
38	Manatee Spring	Spring Vent	Levy
39	Manatee– Blue Water Tunnel	Spring Conduit	Levy
40	Manatee– Sewer Tunnel	Spring Conduit	Levy
41	Manatee–Main Tunnel	Spring Conduit	Levy
Rainbow Springs Group			
42	Bubbling Spring	Spring Vent	Marion
43	Rainbow Spring No. 1	Spring Vent	Marion
44	Rainbow Spring No. 4	Spring Vent	Marion
45	Rainbow Spring No. 6	Spring Vent	Marion

	Spring Name	Type	County
Silver Springs Group			
46	Main Spring	Spring Vent	Marion
47	Reception Hall Spring	Spring Vent	Marion
48	Blue Grotto Spring	Spring Vent	Marion
Spring Creek Springs Group			
49	Spring Creek Rise No. 1	Spring Vent	Wakulla
50	Spring Creek Rise No. 2	Spring Vent	Wakulla
Wacissa Springs Group			
51	Big Spring	Spring Vent	Jefferson
52	Spring No. 2	Spring Vent	Jefferson
Wakulla Spring			
53	Wakulla Spring	Spring Vent	Wakulla
54	Wakulla B-Tunnel	Spring Conduit	Wakulla
55	Wakulla C-Tunnel	Spring Conduit	Wakulla
56	Wakulla A/D-Tunnel	Spring Conduit	Wakulla
57	Wakulla D-Tunnel	Spring Conduit	Wakulla
58	Wakulla A/K-Tunnel	Spring Conduit	Wakulla
59	Wakulla K-Tunnel	Spring Conduit	Wakulla

[1] Water quality at St. Marks was monitored quarterly from fall 2001 to summer 2005. Currently, it is not being monitored by the FSI.

The analysis of specific water quality parameters will be used in some instances to estimate the proportion of source waters (recent surface water versus primary ground water) contributing to total spring flow. More involved analyses will be used to relate discharge volume to water quality (i.e., loading calculations). A spring ground water quality index has been proposed to rank and compare water quality between individual spring vents and between spring systems.

Spring samples that are collected from the spring vent are considered surface water samples for regulatory purposes. Surface water quality standards are applied when analyzing these results, based on the designated use of spring-run waters at each location. Subaquatic conduits are accessed through tubes installed in wells that extend from the land surface into specific caves. Ground water quality standards are applied to results from these sites.

Disparities between ground water and surface water quality standards are problematic when analyzing results from spring vents and conduits, particularly for nutrient concentrations. Additionally, differences in water chemistry and biology between spring runs and other Florida rivers and streams are prompting a re-evaluation of the tools used in performing spring assessments.

Sampling frequency is quarterly (January, April, July, and October). FGS field staff currently perform the sampling.

The continuous gaging of many spring runs and some conduit sites is performed through agreements with the USGS **(Table D-2).** The USGS collects additional discharge measurements whenever the FGS collects a water quality sample. Some conduit sites also include equipment for measuring flow. In addition, DEP's Bureau of Laboratories performs quarterly to biannual biological assessments in selected spring runs, assessing riparian zone health, describing habitat, and carrying out biological sampling and limited water quality sampling. This information allows researchers to evaluate the impact of a spring's discharge on surface water.

Table D-2: USGS first- and second-magnitude spring gaging sites in Florida

Spring Name	County
Blue Spring	Jackson
Blue Springs	**Volusia**
Chassahowitzka Springs Group	Citrus
Fanning Spring	**Levy**
Homosassa Springs Group	Citrus
Ichetucknee System	**Columbia**
Ichetucknee River at U.S. 27	
Ichetucknee Head Spring	
Blue Hole Spring	
Cedar Head Spring	
Devil's Eye Spring	
Mission Springs Group	
Mill Pond Spring	
Ichetucknee River above Dampier's Landing	
Coffee Spring	
King's Bay Springs Group	**Citrus**
Little Fanning Spring	Levy
Manatee Spring	**Levy**
Rainbow Springs Group	Marion
Silver Glen Spring	**Marion**
Silver Springs	Marion
Troy Spring	**Lafayette**
Wakulla Springs	Wakulla
Weeki Wachee Main Spring	**Hernando**

Core and Supplemental Water Quality Indicators

Table D-3 lists the core chemical and field analytes collected at each monitoring station. In addition to these core analytes, an extended list of supplemental analytes was collected during the fall and spring quarters from fall 2002 to spring 2005.

Quality Assurance

DEP's Central Laboratory analyzes all water quality samples collected. DOH certifies the lab under the National Environmental Laboratory Program (NELAP). Field audits of sampling personnel are periodically carried out to verify adherence to DEP's Standard Operating Procedures. FSI staff carry out these field audits in coordination with DEP's Bureau of Laboratories, Environmental Assessment Section. Formalized procedures for computerized and manual data review are also applied to FSI project data.

Table D-3. Core and supplemental analytes for the Florida Springs Water Quality Monitoring Network

Core Indicators	Supplemental Indicators[2]
Calcium	Aluminum
Magnesium	Arsenic
Sodium	Barium
Potassium	Boron
Chloride	Cadmium
Sulfate	Cobalt
Fluoride	Chromium
Alkalinity as CaCO3	Copper
Nitrate + Nitrite	Iron
Ammonia	Manganese
Kjeldahl Nitrogen	Nickel
Total Phosphorus	Lead
Ortho-phosphate	Selenium
Specific Conductance	Tin
Organic Carbon	Strontium
Dissolved Solids	Zinc
Suspended Solids	
Turbidity	
Color	
Total Coliform	
Fecal Coliform	
Enterococci	
Water Temperature	
pH	
Specific Conductance	
Dissolved Oxygen	
Secchi Depth[1]	
Estimated Sample Depth[1]	
Stage[1]	
Discharge[1]	

[1] Measurement collected where possible.
[2] Supplemental indicators were collected during the fall and spring quarters from fall 2002 to spring 2005.

Data Management

Water quality samples are tracked from the field to the laboratory via DEP's Automated DAta Management (ADAM) software. Analytical results are provided electronically via the DEP Laboratory Information Management System (LIMS) to staff in DEP's Watershed Monitoring Section (WMS), 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, water quality checks, and extreme value checks. FSI and WMS staff then manually check each data file, using results from the computerized reviews to identify any obvious random or systematic errors. After data review for a project is completed, the data are considered "release quality," ready to be made available to DEP staff and the general public.