STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
Herschel T. Vinyard Jr., *Secretary*

LAND AND RECREATION
Erma Slager, *Acting Deputy Secretary*

FLORIDA GEOLOGICAL SURVEY
Jonathan D. Arthur, *State Geologist and Director*

Bulletin No. 69 (Revised)

REGIONAL AND STATEWIDE TRENDS IN FLORIDA'S SPRING AND WELL GROUNDWATER QUALITY (1991-2003)

By

Rick Copeland, Neal A. Doran, Aaron J. White, and Sam B. Upchurch

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PREFACE

FLORIDA GEOLOGICAL SURVEY

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The Florida Geological Survey (FGS), is publishing as its Bulletin No. 69 (Revised), *Regional and Statewide Trends in Florida's Spring and Well Groundwater Quality (1991-2003) (Revised),* authored by Rick Copeland, Neal A. Doran, Aaron J. White, and Sam B. Upchurch.

After the publication of the original publication, several minor errors were discovered. Most errors were found in the statistical tables. This bulletin summarizes the results of a multi-year cooperative investigation on spring and groundwater quality between the Florida Department of Environmental Protection's FGS and the Bureau of Watershed Management, Division of Environmental Assessment and Restoration. The data presented will be useful to scientists, planners, and citizens in understanding the quality of Florida's groundwater resources.

Jonathan D. Arthur, Ph.D., P.G.
State Geologist and Director
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EXECUTIVE SUMMARY

Background

Over the past several decades, it has been observed that the flows in Florida's springs are declining and water quality is degrading. The primary chemical concern is considered to be increased nutrients, including soluble forms of nitrogen and phosphorus. The sources are predominantly from animal waste, human waste, and from the synthetic fertilizers used on lawns, golf courses, or for agricultural activities.

In recognition of these issues, the Secretary of the Florida Department of Environmental Protection (FDEP) directed the formation of the Florida Springs Task Force in 1999. The multi-agency task force consisted of 16 scientists, planners, and citizens who were concerned about the "environmental health" of Florida's springs. By 2000 the task force made a series of recommendations to protect and restore Florida's springs. They are outlined in detail in *Florida's Springs: Strategies for Protection and Restoration* (Florida Springs Task Force, 2000). Two of the recommendations were to:

(1) Implement springs monitoring programs to detect and document long-term trends in water quantity and quality

(2) Conduct research that will allow cause-and-effect relationships to be established between land use and water management activities.

The purpose of monitoring is to both support research efforts and to confirm the effectiveness of spring protection efforts. As a direct result of the first recommendation, the Florida Geological Survey (FGS) took the lead in implementing a spring monitoring program. By 2004 it published the latest *Springs of Florida* bulletin—a descriptive overview of Florida's springs.

The main purposes of this document are to: (1) determine trends in groundwater where sufficient data are available; (2) establish prototype methods for evaluating and reporting trends for future applications; and (3) enhance the efforts of determining cause-and-effect relationships between anthropogenic activities and the resulting spring-water quality and quantity on regional (water management district-wide) and statewide scales. The reason for the latter is that many other publications have addressed the causes of trends on an individual spring basis. If we attempted to develop an exhaustive list of possible causes of trends for each spring, it could take many years to accomplish. We decided to emphasize regional and statewide scales. An endeavor of this nature has never been attempted. If regional or statewide trends were found, the causes and possible solutions to those causes may become the highest priority water management issues.

In order to fully comprehend the implications of trends in springs, a thorough understanding of the behavior of groundwater in wells is also necessary. In 1983, the FDEP began a statewide groundwater quality monitoring network (Florida Statutes 403.063). Scott et al. (1991) stated that the purpose of the network was to detect or predict contamination of Florida's groundwater resources. Currently, several thousand wells are included in the network. However, a subset of the wells are conducive to trend analysis (the Temporal Variability

Network, or simply the TV Network). Since the FGS was asked to evaluate data for trends from springs, it followed to simultaneously do the same for groundwater from TV Network wells.

Approach

The FGS spring monitoring program commenced operations in 2001. For many of the springs, previous samples had never been collected, so long-term trend analyses were not possible. However, the FGS contacted each of the four northern water management districts (WMDs), the U.S. Geological Survey (USGS), and programs within the FDEP to request copies of their historical spring-water quality and quantity data. The entities each graciously delivered data to the FGS for analyses. It should be noted that the South Florida Water Management District (SFWMD) had insufficient data for trend analyses.

The FGS obtained sufficient data, meeting preset criteria, from 58 springs and 46 wells for the period January 1991 through December 2003. For reference, the study was divided into three time sequences. Sequence A represents the entire length of the study (1991-2003). Sequence B represents the January 1, 1991 – December 31, 1997 time frame, while Sequence C represents January 1, 1998 – December 31, 2003. The two shorter sequences were used to assist in identifying and evaluating shorter-term trends. As it turns out, Sequence B coincided with relatively normal rainfall, whereas Sequence C covered a time that Florida experienced an extended drought.

The analytes (constituents of interest) for this report can be broken down into five groups: (1) nutrients, (2) saline (or salt-water), (3) rock-matrix (or rock), (4) field, and (5) other. Of these, the three major groups are nutrients, saline, and rock-matrix. Nutrients are compounds that are essential for the growth of living organisms. Unfortunately, high concentrations in spring-water can adversely affect the biota in spring runs. Saline analytes are related to salts. The most significant sources of salt are from the ocean or deep groundwater in Florida's aquifers. High concentrations of saline compounds (e.g. sodium or chloride) can restrict the usage of water. Rock-matrix analytes have their sources in the aquifer material (e.g. limestones and dolostones). They occur naturally and, unless they occur in extremely high concentrations, are generally not harmful to our environment. The field and other analyte groups consist of miscellaneous constituents that are useful in explaining trends in other analytes.

Think of a trend as a direction of movement (Berube and Boyer, 1985). Although there are many secondary questions that pertain to trends, trend analysis can be broken down to one fundamental, primary question, "over time, are conditions changing (getting better or getting worse), or are they remaining the same?" One can think in terms of concentrations of water quality (measured by analytes) or water quantity (measured by flow or water levels). Subjective descriptions—such as better, worse, and remaining the same—are based on objective changes over time, or trends.

Throughout this report the term significant refers to statistical significance. Some of the trends reflect very important changes in water quality, whereas some only represent relatively minor changes in water quality that are not indicative of impending problems. If, during our analyses, a trend was discovered, it was based on statistical significance. That is, within a predefined probability, we do not expect the trend to occur randomly. Since not all of the audience of this report is familiar with the statistical procedures employed, we decided to simplify the procedures to the extent practical. For this reason, most analyses were restricted to linear trends, using nonparametric techniques. Data were checked for seasonality, and if found, were deseasonalized prior to trend analyses using a method recommended by the U.S Environmental Protection Agency (EPA, 1989). Trend analyses were conducted using the Mann-Kendall test, while the rates of change over time were determined using the Sen slope (Gilbert, 1987).

Results and Conclusions

The most important conclusion to be derived from this report is that Florida springs truly represent the "canary in the coal mine" with respect to assessing regional groundwater quality in Florida. As will be summarized, springs are apparently much better at indicating over-all change in a groundwater flow system than wells.

Monitoring wells only allow for the sampling of a discrete portion of the water in an aquifer. They limit detection to a particular depth interval and a relatively limited spatial extent. Karstic aquifers are especially limited in this respect as fractures and cavernous conduits may direct water flow around or below the location of a monitoring well. On the other hand, the quality of water discharging from a spring is an integral of the water quality of the total flow system within a springshed. This water is derived from deep and shallow flow systems and conduit and diffuse flow. Furthermore, the water quality, and flow, data are weighted according to the relative importance of the flow systems and chemical sources within the springshed. As a result, springs appear to be much better at detecting regional changes in a springshed water quality than do wells. This conclusion is supported by the fact that water-quality trends were much more obvious in spring data than in well data.

Springs

Of the analyte groups, rock-matrix and saline analytes had the greatest frequency of trends. Both analyte groups showed strong negative correlations with spring flow. For example, as spring flow decreased saline and rock-matrix analyte concentrations increased. The relationship was observed throughout the state. The greatest increases in the concentrations of rock-matrix and saline analytes occurred during a drought that occurred between late 1998 and mid 2002.

There are several probable explanations and all can be a result of the drought. First, during the drought there was less rainfall, and consequently there was less surface-water flow. In karst terrains, much surface-water flows directly to groundwater through sinking streams (swallets). Typically, this rapidly recharged groundwater is transmitted in well-developed subsurface conduits. Thus, there is very little contact time with the aquifer matrix before it discharges from springs, and it tends to have lower concentrations of rock-matrix analytes. During a drought, there is a decrease in the proportion of freshly recharged "surface water." This, at least partially explains the correlation between decreased spring discharge and increased concentrations of rock analytes.

A second probable explanation is related to the removal of older, saline-rich and usually more mineralized water from storage, often in the deeper portions of the Florida's aquifer systems. Beneath the state of Florida lies a "lens" of fresh water, which is replenished by rainfall. Freshly recharged water is flushed through Florida's karstic (sinkholes, caves, springs etc.) aquifers relatively quickly to springs. In contrast, the deeper water is older (Upchurch, 1992; and Katz, 2004). Because it has been in contact with the aquifer matrix for a relatively long period of time, the aquifer water has had a longer time to "pick up" dissolved matrix material constituents such as calcium and magnesium, especially in the Floridan aquifer system. With longer residence times, the older water tends to have higher concentrations of rock-matrix material.

A third explanation is similar to the second. Older, mineralized residual saltwater, was never fully flushed from the rock interstices in some portions of Florida (Johnson and Bush, 1986). With less rainfall during the drought, the water levels in the aquifers were lowered, and the size of the freshwater "lens" decreased. With decreasing freshwater potentials (e.g., water levels) the deeper and older connate water can find its way upward toward aquifer discharge points, such as springs. Thus, during the drought, increased concentrations in rock-matrix and saline analytes were observed, along with decreases in spring discharges. The trends were statewide in scale. The magnitude of scale was the most surprising and most significant finding of the study.

After the driest portion of the drought (2002), Florida's hydrologic conditions began to recover and the concentrations of both types of analytes began to decrease, as rainfall, recharge, and spring flow began to increase. The inverse relationship between spring-water discharge, and both rock-matrix and saline analyte concentrations, was also observed in a study by Katz (2004). In addition, Katz also found a positive correlation between concentrations of rock and saline analytes and spring-water age.

Nutrients in groundwater discharging from springs were one of the most important concerns of the Springs Task Force. Evaluation of trends in this report revealed that nutrient trends in springs had an uneven, or patchwork, distribution across the state. That is, both increasing and decreasing nutrient trends were common and were observed throughout Florida. This suggests that the trends were often related to local land-use and water-use activities. As such, most nutrient concentrations observed in springs are localized and should be analyzed in relation to the corresponding springshed.

Nitrogen and phosphorus comprised the most frequent nutrient exhibiting trends. Nitrogen in the form of nitrate (nitrate plus nitrite as N) had the greatest frequency of increasing (degrading) trends. However, some springs actually had decreasing nitrate trends. Phosphorus, as total phosphorus and orthophosphate, had both increasing and decreasing trends, depending on the springshed.

Note that decreasing nutrient trends are not necessarily good news. During the drought, an important observation was that some nitrate concentrations had positive correlations with spring flow. One possible explanation is that nitrogen can be stored in the soils of Florida's springsheds (Bruland et al., 2008). During the drought, soils may have stored the nitrogen originating from fertilizer applications and the nitrogen did not find its way to the groundwater regime. When rainfall conditions return to normal, the soils will release the nitrogen and concentrations in spring water will eventually increase. On a similar note, decreases in phosphorus in some areas may likewise not be a reflection of improved management. It is possible that the upward migration of older water, with different chemistry, reduced the phosphorus concentrations in many springs. If so, reduction of phosphorus could simply be a by-product of mixing with deeper, higher pH water—not an improvement in water quality. This mechanism is discussed by Hem (1985) and by Odum (1953). They indicated that the solubility of phosphorous can be controlled by pH. Dissolved phosphorous is generally more abundant in lower pH (more acidic) water. Conversely, higher pH (more basic) water contributes to the precipitation of phosphate and lowers the concentration of dissolved phosphorous in groundwater.

Wells

Within Florida's aquifers, the flow paths of spring-water can potentially be from both deep and shallow sources. Conversely, wells typically are drilled to a specific depth in an aquifer. Consequently, flow paths of well water are from a much narrower thickness of the aquifer, relative to spring water flow paths. Although there are exceptions, most of the 46 wells used in this study generally tap only the shallower portions of the aquifers. The wells tend to be less than 30 m (100 feet) deep. Because of the shallower depth, the older, deeper, and more mineralized deeper aquifer water had a lower probability of being observed in the shallow wells. Thus, rock-matrix and saline trends were not seen as frequently in wells as in springs. Nevertheless, decreasing trends in water levels within wells were common. In addition, pH—a field analyte—had a positive correlation with water levels; as water levels in wells decreased, so did pH.

A possible explanation for this positive correlation is as follows. Well intake zones for most wells in Florida are generally set at specified depths below the lowest predicted aquifer water levels. This is done in order to guarantee water to the well during drought conditions. During dry times the upper surface of the saturated zone is lowered downward toward the uppermost point of the intake zone. For the aquifers tapped by the 46 shallow wells used in this study, most recharge is from water, typically rainfall, penetrating the land surface and moving downward through the soil to the groundwater regime. Rainfall has a lower pH than most aquifer water. The pH is lowered further as rainwater picks up carbonic acid as it moves downward through Florida's soils (Freeze and Cherry, 1979; and Upchurch, 1992). Therefore, as the water table (or the potentiometric surface in confined aquifers) drops, generally the younger, freshly recharged water with lower pH has an increasing probability of entering well intake zones. As such, the lowering of the water table is a potential cause for decreasing trends in pH values across the state during the drought. A detailed description of this hypothesis, along with other related hypotheses, is discussed in the body of this report.

Another field analyte that displayed a trend was well water temperature. Between 1991 and 2003, its temperature typically increased; the reason is believed to be an increase in air temperature. Air temperature increased across Florida (Southeast Regional Climate Center, 2006). Since the wells used in this report tend to be shallow, it is believed that well water readily responded to air temperature changes. On the other hand, the sources of spring water are from shallow and deep portions of our aquifers. Deeper water tends not to respond to changes in air temperature. Thus, spring water displayed fewer temperature trends than did well water.

Concerns

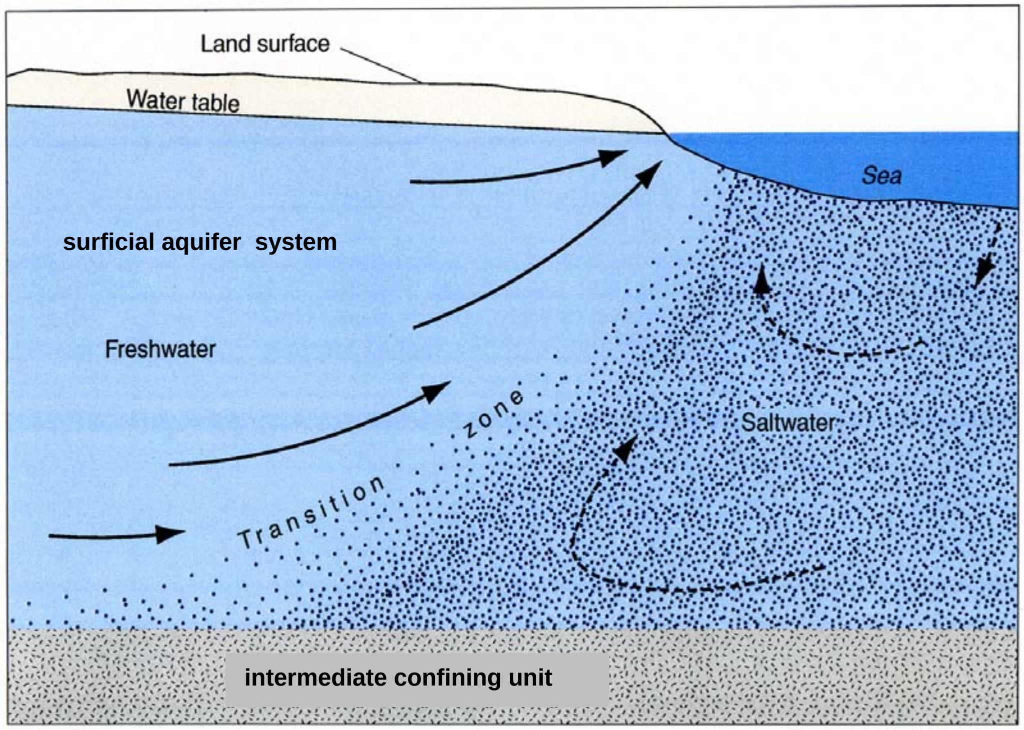
Rock-Matrix and Saline Indicators: Saltwater Encroachment

Saltwater encroachment is the displacement of fresh groundwater by the advance of saltwater due to its greater density (Neuendorf et al., 2005). It can occur during a drought when recharge declines and the freshwater "lens" shrinks in size. Over geologic time, it can occur with sea-level rise. It can also occur when excessive groundwater pumping causes the advancement of saltwater. Freeze and Cherry (1979) use the term saltwater intrusion as the migration of saltwater into freshwater aquifers under the influence of groundwater development (pumping). For this paper, we use the term intrusion to indicate a man-induced process and use the term encroachment to make no distinction between natural and man-made causes.

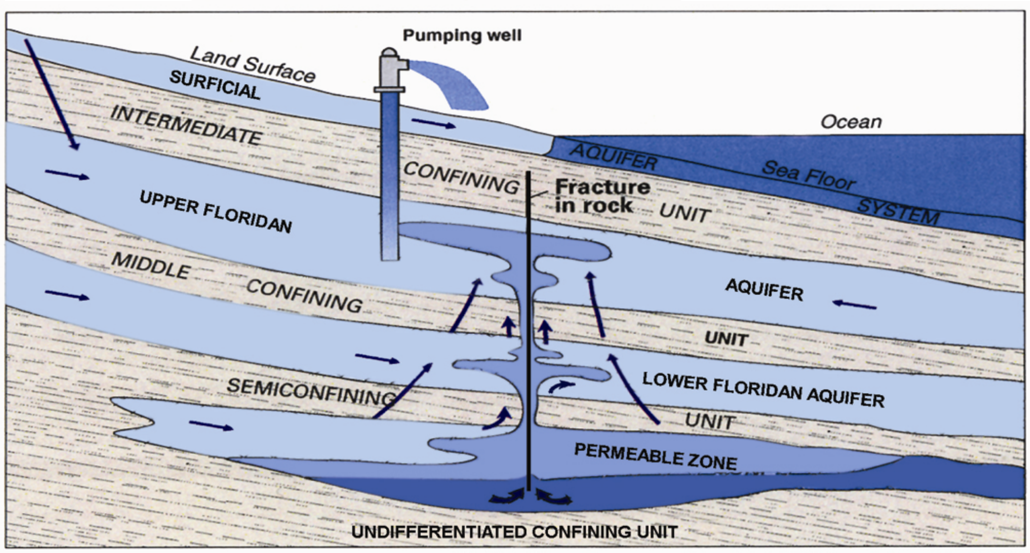
Figure 1 (top) displays the unconfined, surficial aquifer system. The saltwater/freshwater interface is represented by a transition zone. During a drought, the water table lowers, the transition zone migrates inland and the thickness of the freshwater zone ("lens") decreases in size.

In his work in northeastern Florida, Spechler (2001) mentioned several possible mechanisms that can drive encroachment and intrusion. During the drought, they included: (1) the movement of "un-flushed" pockets of relict seawater within the Floridan aquifer system, (2) the landward movement of the freshwater/saltwater interface, (3) regional upconing of saltwater below pumped wells, and (4) the upward leakage of saltwater from deeper, saline water–bearing zones through confining units. The latter can occur where the units are thin or are breached by joints, fractures, collapse features, or other structural anomalies. Examples are displayed in Figure 1 (bottom).

During the 1999-2002 drought, the flows in many springs decreased, and one spring (Hornsby Spring) stopped flowing altogether for a period of time. In addition to the decreased rainfall, there was an increased demand for groundwater (Verdi et al., 2006). The drought and the subsequent lowering of aquifer water levels resulted in decreasing spring flows throughout the state. The increased demand for groundwater during the drought exacerbated the problem in some of the springs. The increasing trends in rock-matrix analytes during the drought is an indication of a reduction in size of the fresh water "lens" underlying the state and an indication of saltwater encroachment. Because the concentrations of saline analytes increased almost everywhere in the state during the drought, it is an indication that encroachment occurred on a statewide scale.



Not to scale — Modified from Cooper (1964)



Not to scale — Modified from Spechler (2001)

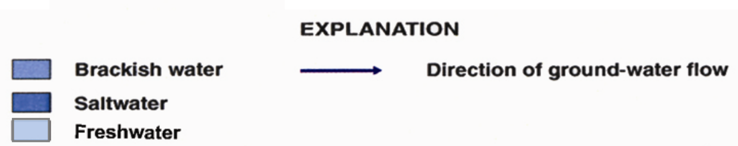


Figure 1. Schematics of freshwater/saltwater transition zone and possible mechanisms for saltwater/freshwater intrusion. Note Cooper (top) represents the saltwater/freshwater interface in the surficial aquifer system as a transition zone, whereas Spechler (bottom) depicts it as a sharp boundary.

The 1998-2002 drought was one of the worst historical droughts to affect Florida (Verdi et al, 2006). Except for south Florida, during the drought the deficit rainfall ranged from about 10 inches in southwest Florida to almost 40 inches in northwest Florida. In order to make up for the drought, groundwater pumping increased, largely for irrigation (Verdi et al., 2006). Because an increase in groundwater pumping occurred during one of worst droughts, it is likely that human-induced saline intrusion took place and contributed to the increase in saline and rock-matrix analyte trends. On a statewide scale, the extent and severity of the intrusion is difficult to quantify. However, within the northern portion of the SWFWMD, a water budget and a regional groundwater flow model indicated that the increase [0.3 cm/yr (+0.1 in/yr)] in groundwater withdrawals was less than 2.0% of the decline in recharge due to the decrease [18.3 cm/yr (7.2 in/yr)] in rainfall (Ron Basso, Southwest Florida Water Management District, personal communications). Nevertheless, intrusion should be a concern. If another drought of this magnitude occurs, depending on the amount of increased pumping, it could potentially have adverse effects on the long-term sustainability of Florida's groundwater resources.

Nutrients

The Florida Springs Task Force (2000) indicated that Florida's springs face serious threats due to rapid and continuing population growth. The state's increasing population has resulted in extensive land-use changes, increased demand for freshwater, and an increased use of fertilizers. As rainfall seeps through the soils, and moves the nutrients into Florida's underlying aquifers, it creates localized degradation in Florida's groundwater resources. A report regarding FDEP's Springs Initiative Program efforts (Florida Department of Environmental Protection, and Florida Department of Community Affairs, 2002) noted that nitrates have increased since the 1970s. It also noted that over the past 30 years many of Florida's springs experienced an increase in nuisance algae and invasive exotic aquatic plants. These plants tend to thrive on excess nutrients and decrease dissolved oxygen levels in spring runs.

Analyses for the 1991-2003 time frame indicated that trends in nutrient concentrations in Florida's spring-water increased in some springs, while they decreased in others. It is encouraging to note that there are some decreasing trends. The fact that nutrients (especially nitrate) tended to increase is an indication that some land-use management practices warrants reevaluation. But as noted previously, the relationship of these apparent decreasing trends may be related to diminishing spring flow.

Monitoring

The current study revealed an inverse relationship between rock and saline indicators and spring flow. The relationship was observed across the state (Figure 2). Note that changes in spring-water quality often lag behind changes in spring flow. For detail, the smaller charts depicted in Figure 2 have been enlarged and can be found in Appendix A.

Historically, the WMDs and the USGS have monitored spring-water quality and discharge. With the commencement of the Springs Initiative, FDEP joined in the monitoring efforts. Considerable efforts were made to eliminate inconsistencies in monitoring activities. Unfortunately, at the beginning of the study, the efforts were not always successful. Specifically, the WMDs, USGS, and FDEP did not always monitor the same analytes, use the same laboratory analytical methods, or collect flow data on the same date as chemical and biological data were collected. In addition, they often sampled at different frequencies. All these inconsistencies made statewide comparisons very difficult. The results of this investigation demonstrate that statewide monitoring must continue. For this reason, it is hoped that, in the future, the state can find ways to minimize monitoring inconsistencies.

Recommendations

One of the most surprising and most significant observations of this study was that rock-matrix and saline analytes were increasing almost everywhere in Florida's springs, especially during the drought of Sequence C (1998-2003). Saltwater encroachment is a *hugely significant* issue. Saltwater can restrict water use and negatively affect freshwater ecology, and can adversely affect the long-term term sustainability of Florida's water resources. The relationships among rainfall, recharge, groundwater withdrawals, groundwater quality and levels, plus spring-water flows warrant further research, as does the effects of global climate change.

The concentrations of at least one nutrient (nitrate) in numerous springs have been excessively increasing since the 1970s (Florida Department of Environmental Protection and Florida Department of Community Affairs, 2002). One of the most visible changes in spring-water quality has been the increase in nuisance algae and invasive exotic aquatic plants. What is the relationship between the increases in nutrients and the nuisance plants? Further research is needed. In addition, land-use management practice modifications are needed in order to reverse the increasing trends. It is beyond the scope of this study to elaborate on the management strategies. For a detailed discussion of many of the available strategies, an excellent reference is: *Protecting Florida's Springs - Land Use Planning Strategies and Best Management Practices* (Florida Department of Environmental Protection and Florida Department of Community Affairs, 2002).

Spring-water quality is sensitive to changes in spring flow and to aquifer water levels. Springs represent excellent natural sampling locations for monitoring saline encroachment. It is recommended that, to the extent practical, springs should be incorporated into a statewide saltwater encroachment monitoring network. The results of the spring monitoring could then potentially be used to supplement well monitoring networks that are often used for saltwater encroachment purposes.

Although the monitoring of springs and wells is critical for the sustainability of Florida's water resources, not all analytes of concern are sampled. Synthetic organic, other supplementary analytes (supplementals), as well as biological indicators, should be included on the monitoring lists. It should be understood that supplementals are expensive to collect and analyze, and for these reasons, they can only be sampled on a low frequency basis. It should also be noted that supplemental monitoring is often determined by site-specific issues. For example, pesticides may only be detected at certain times of the year or in certain locales, determined by land use conditions. Supplementals such as pesticides, synthetic organic compounds, and trace metals should occasionally be sampled.

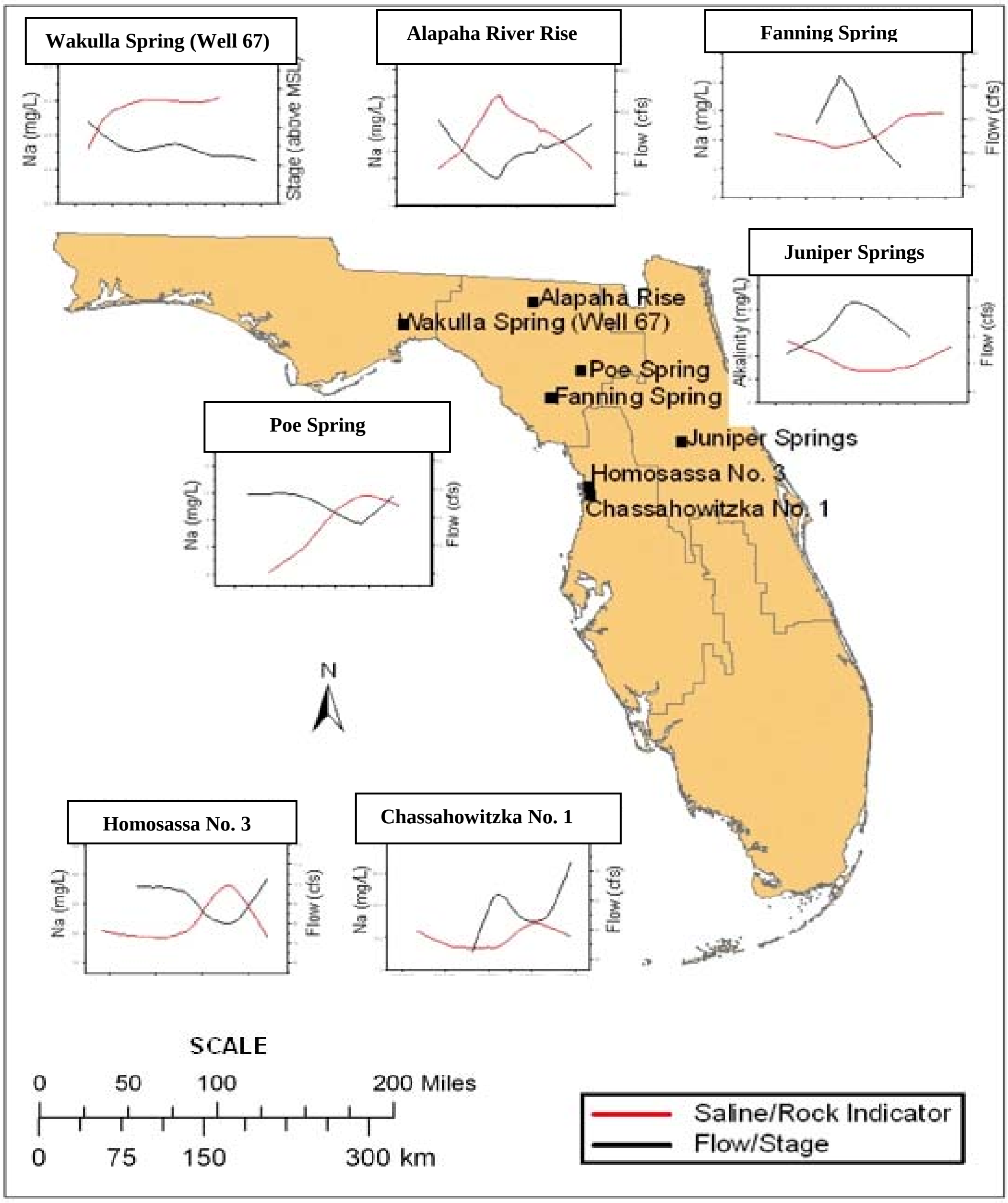


Figure 2. Inverse relationship of flow to rock and salinity indicator concentrations. Darker lines represent water levels (whether by stage or spring flow); lighter lines represent saline or rock-matrix indicators (sodium or alkalinity). Time axes vary. The graphs indicate reciprocity between decreases in water levels and increases of salinity, regardless of location in the state. Florida's spring-water chemistry shows a high sensitivity to changes in flow (See Appendix A for enlarged versions of inset charts).

It is critical that evaluations of spring water and groundwater be clearly disseminated to the public as efficiently as practical. One efficient method is the use of indices. Stock exchange indices have been used in the financial community for many years. Groundwater quantity indices are used by the Edwards Aquifer Authority in Texas. As an example, the authority use real-time water levels in the Bexar County Index well as an index (indicator) for the entire county. During dry times, as water levels fall, water restriction measures may be invoked by the authority. When water levels rise, the restrictions are lifted (Edwards Aquifer Authority, 2006). There are several potential indices that could be developed for use in Florida. If one or more indices were developed, they have the potential to become very useful in informing the public about the status of our springs. However, in order to be viable, buy-in by both the public and scientific communities are essential. Hopefully, indices will be adopted in the future.

It is essential that technical reports regarding the results of analyses be generated frequently and in a relatively short time frame. It is acknowledged that it takes a considerable amount of time for an initial report to be generated. However, after the initial report, the lag time between sample collection and report generation should reduce considerably. In addition, subsequent reports using similar interpretative methods could employ computer programs to create "boiler plate" reports as quickly as analytical data are received from a laboratory.

Standardized spring and well sampling throughout the state is a critical need. If standardization is achieved, analyses of trends in the future will be much easier to conduct. This in turn will make the resulting interpretations more comprehensive, and the dissemination of the interpretive results will be more meaningful to the public. Specific aspects of the standardization effort include: core and supplemental water-quality analytes and indicators, data reporting, sampling and laboratory quality assurance, data management, data analysis, and assessment reporting,

Recommendation Synopsis

Research

- Determine the relationships between increases in nutrients and nuisance plants/algae

- Determine the best land-use management practice needed in order to reverse increasing nutrient trends

- Improve our understanding of the relationships among: (1) rainfall, (2) recharge, (3) groundwater withdrawals, (4) groundwater quality and levels, and (5) spring-water quality and discharge

- Develop a "spring environmental health" report card.

Monitoring

- Recognize the importance of springs in saltwater encroachment monitoring and incorporate spring monitoring into that effort

● Add supplemental analytes to spring monitoring lists on a periodic basis

● Develop spring water-quality and quantity interpretative reports on a regular basis

● Adopt area-wide randomized spring sampling on a periodic basis in order to produce a synoptic report of all springs in Florida

● Continue to use the Florida Water Resource Monitoring Council to increase monitoring efficiency. Topics for discussion should include:

- core and supplemental water quality analytes and indicators
- possible development of a "spring environmental health" index
- possible implementation of the random sampling of springs
- sampling and laboratory quality assurance
- data management
- data analysis
- assessment reporting

REGIONAL AND STATEWIDE TRENDS IN FLORIDA'S SPRING AND WELL GROUNDWATER QUALITY (1991-2003)

by
Rick Copeland (PG #126), Neal A. Doran,
Aaron J. White, Sam B. Upchurch

INTRODUCTION

Florida is blessed with some of the most spectacular springs in the world. There are estimated to be over 700 springs in the state. People have been attracted to our springs since before Florida became a state. From a scientific perspective, some of Florida's springs have been sampled for over a century. The FGS published its first *Springs of Florida* bulletin (Ferguson et al., 1947), which documented the chemical and flow data of the major springs. The bulletin was revised in 1977 (Rosenau et al., 1977) and a new bulletin was generated in 2004 (Scott et al., 2004). In each revision, additional chemical data were presented. Unfortunately, as beautiful as the springs are, not all is well. As Florida's population continues to grow, water-use and land-use changes are reflected in our spring water. The quantity and quality of spring water are both changing, and at least some of the changes are directly related to human activities.

Since the 1940s Florida's population has grown from about two million to about 18 million in 2000. This means that Florida has increased its population by a rate of about 600 people per day for those 60 years. In fact, between the years 2000 and 2005, the net rate of increase has been over 700 people per day (U.S. Census Bureau, 2006). In the year 2000, Floridians withdrew 3.14 billion gallons of groundwater daily (Marella and Berndt, 2005). Marella and Berndt (2005) indicated that agriculture and public supply accounted for over 82 percent of t he groundwater use. Based on these data, each person used over 150 gallons per day of groundwater. It is not surprising that an extensive increase in water use has followed Florida's population growth. Neither is it surprising that there has been a noticeable decline in the discharge of many of Florida's springs and that the intensive land-use changes have been followed by a noted deteriorations in spring-water quality. Scott et al. (2004) mentioned that one of the most notable deteriorations has been the increase in nutrient concentrations in spring water. While nutrients such as nitrogen and phosphorous are required by aquatic organisms for growth and reproduction, when the concentrations are found to be higher than natural levels, problems can arise. Since the 1970s, concentrations of nitrate, a soluble form of nitrogen, have been found to be increasing in a number of Florida springs (Florida Springs Task Force, 2000).

Over the past several decades, flows in Florida's springs are declining and water quality is degrading. The primary chemicals of concern are nutrients, including soluble forms of nitrogen and phosphorus.

In order to improve and protect our springs, the Florida Springs Task Force (2000) made a series of recommendations to the Governor of Florida. One was that Florida should implement spring monitoring programs in order to detect and document long-term trends in water quality. In addition, it was recommended that the state should conduct research in order to determine the cause-and-effect relationship between land-use and water-management activities, and the resulting changes in spring-water quality and quantity.

As a result of the Florida Spring Task Force's first recommendation, the FGS was asked to evaluate historical spring data in order to detect and document trends in spring-water quality and quantity. This document reports the findings of analyses for trends in springs, using data from the Springs Initiative of FDEP, the WMDs, and the USGS spring sampling programs.

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FLORIDA'S SPRINGS

Scott et al. (2004) presented an excellent overview of Florida's springs. Although they did not specifically evaluate trends, the authors described hundreds of Florida's springs, including a description of their water quality. In doing so they described many aspects that control the water quality and quantity of groundwater. With this in mind, their work can be considered a precursor to the present trend analysis document. With the authors' permission, much of the following introduction from the sections labeled "Florida's Springs" to "Differences in Spring and Well Water Quality" are paraphrased from their work, "Springs of Florida."

Many terms relating to hydrogeology and springs may be unfamiliar to the reader. For this reason a glossary of terms is found in Appendix B1. In addition, Appendix B2 elaborates on the sources of the analytes discussed in this report, along with the probable causes for the trends observed.

Spring-water discharge comes primarily from the Floridan aquifer system, which is also the state's principle source of groundwater. The springs provide a "window" into the aquifer, allowing for a measure of the health of the aquifer. Chemical and biological constituents that enter the aquifer through recharge processes may negatively affect the water quality in aquifers, as well as the flora and fauna of springs and spring runs. The declines in water quality can be directly attributed to Florida's increased population and changing land-use patterns (Florida Springs Task Force, 2000).

Classification of Springs

Springs are most often classified on the amount of flow or discharge of water. The flow-based classification listed in Table 1 is taken from Meinzer (1927) (Table 1). One discharge measurement is all that is required to place a spring into one of eight magnitude categories. However, it should be understood that each spring exhibits a variable discharge, depending upon rainfall, recharge and groundwater withdrawals within their recharge areas. This can result in a spring being classified as a first magnitude spring at one point in time and a second magnitude at another. In the past, a spring assigned a magnitude when it was first described and continued with that magnitude designation even though the discharge may have changed considerably over time. To alleviate this confusion, the FGS (Copeland, 2003) adopted a system using the historical median of the flow measurements to classify a spring's magnitude. Using the new system along with the Meinzer system, a spring's magnitude is now based on the median value of all annual median discharge measurements for the period of record. Of the over 700 springs inventoried by the FGS, there are 33 first-magnitude springs, 191 second-magnitude, and 151 third-magnitude springs. Most are located in the northern portion of the state (Figure 3).

Table 1. Spring Magnitude.

	Discharge	
Magnitude	**Metric Units**	**English Units**
1	≥ 2.832 cms	≥ 100 cfs (≥ 64.6 mgd)
2	≥ 0.283 to 2.832 cms	≥ 10 to100 cfs (≥ 6.46 to 64.6 mgd)
3	≥ 0.028 to 0.283 cms	≥ 1 to 10 cfs (≥ 0.646 to 6.46 mgd)
4	≥ 0.0063 to 0.028 cms	≥ 100 gpm to 1 cfs (≥ 100 to 448gpm)
5	≥ 0.631 to 6.308 lps	≥ 10 to 100 gpm
6	≥ 0.063 to 0.631 lps	≥ 1 to 10 gpm
7	≥ 0.473 to 3.785 lpm	≥ 1 pint/min to 1 gpm
8	< 0.473 lpm	< 1 pint/min

cms = cubic meters per second
cfs = cubic feet per second
mgd = million gallons per day
gpm = gallons per minute
lps = liters per second
pint/min = pints per minute
lpm = liters per minute

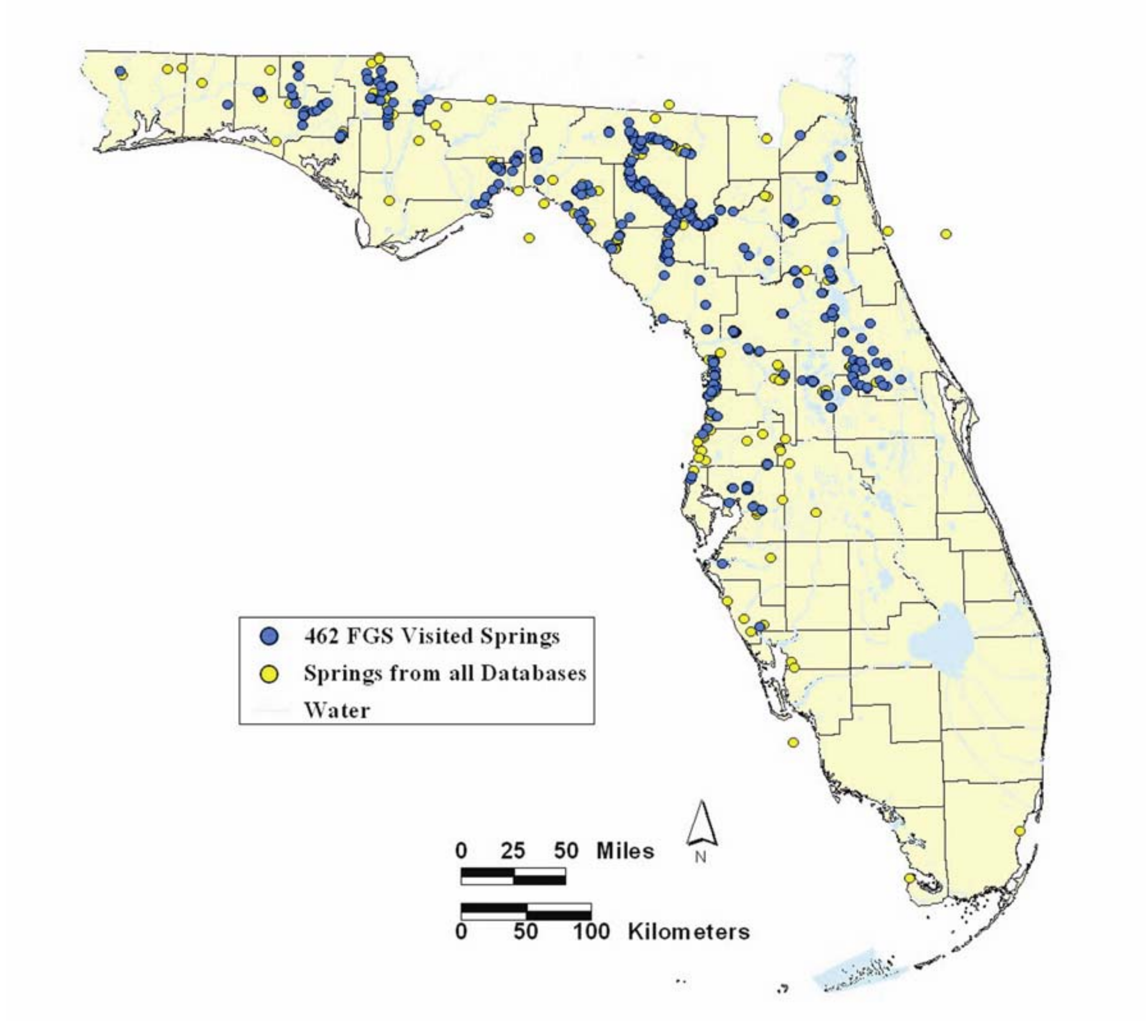


Figure 3. Locations of Florida's springs (From Scott et al., 2004).

A second spring classification system is also in use. The Florida Spring Classification System (Copeland, 2003) (Table 2) is based on an assumption that karst activities have influenced almost all springs in Florida. Under this system, all springs in Florida can be classified into one of four categories, based on the spring's point of discharge. Is the point of discharge a vent or is it a seep and is the point of discharge located onshore or offshore? Since all springs are either vents or seeps, the classification can be simplified into the following categories.

A spring vent is defined as an opening that concentrates groundwater discharge to the Earth's surface, including the bottom of the ocean. The opening is significantly larger than the average pore space of the surrounding aquifer matrix. A vent is occasionally considered to be a cave, and groundwater flow from this type of vent is typically turbulent. On the other hand, a spring seep is composed of one or more small openings in which water discharges diffusely (or "oozes") from the groundwater environment. The diffuse discharge originates from the intergranular pore spaces in the aquifer matrix. Flow from seeps is typically laminar.

Offshore Springs

Springs occur both onshore and offshore in Florida. Currently, little is known about the offshore, or submarine springs, with the exception of the Spring Creek Group—the largest spring group in Florida, averaging more than one billion gallons of water discharged per day (maximum flow estimated at more than two billion gallons of water per day [Rosenau et al., 1977; Lane, 2001]). Offshore or submarine springs (Figure 4) are known to exist off Florida's Atlantic and Gulf of Mexico coastlines. These springs are most common in the offshore portion of Florida from Crystal Beach Spring (Figure 4, Spring No. 7) to Bear Creek Spring (Figure 4, Spring No. 1). Offshore springs have also been identified off the northeastern and southwestern parts of the Florida and the western panhandle (Rosenau et al., 1977) (Figure 4). Water-quality data from some of these springs indicate that, at best, the water is brackish. There are anecdotal reports of "fresh water" flowing from Florida's offshore springs.

Table 2. Florida's Spring Classification System. (From Copeland, 2003)

SPRINGS		
	Onshore	**Offshore**
Vent	*Onshore Vent* Examples Karst spring Resurgence (River Rise) Estavelle (intermittent resurgence or exsurgence) Subaqueous riverine vent Subaqueous lacustrine vent Sand boil	*Offshore Vent* Examples Offshore karst spring Unnamed offshore vent Offshore estavelle vent
Seep	*Onshore Seep* Examples Subareal riverine seep Subaqueous lacustrine seep	*Offshore Seep* Examples Unnamed offshore seep Offshore estavelle seep

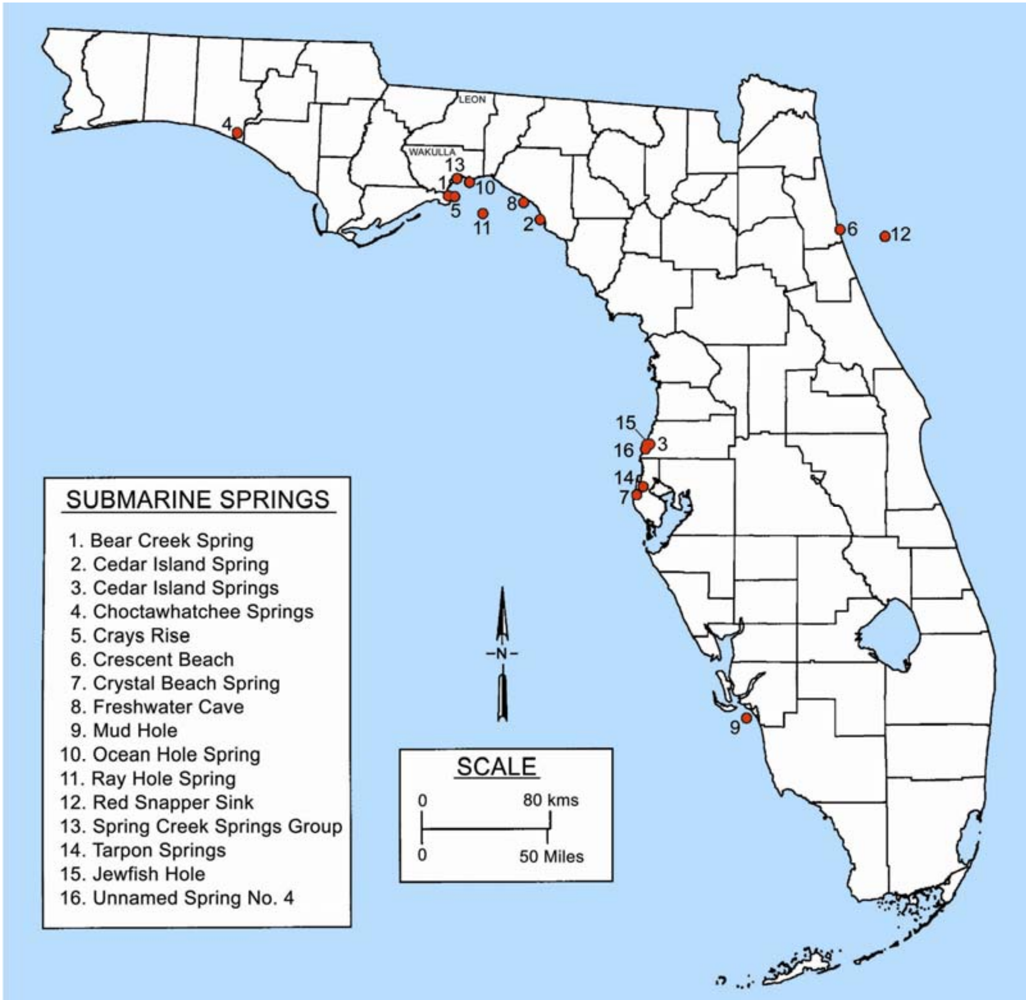


Figure 4. Offshore Springs (From Rosenau et al., 1977).

Spring Recharge Basins

In addition to the awareness of increasing trends in contaminants such as nitrate over the past several years (Figure 5), there has also been an increased awareness on the drainage basins that supply water to Florida's groundwater and springs. The amount of water and the nature and concentrations of chemical constituents that discharge from springs are functions of the geology, hydrology, weather conditions and land uses within the spring recharge basin. This type of basin, often referred to as a springshed, consists of those areas within groundwater and surfacewater basins that contribute to the discharge of the spring (Dehan, 2002; Copeland, 2003). The springshed consists of all areas where water can be shown to contribute to the groundwater flow system that discharges from the spring of interest. Karst systems frequently include sinking streams that transmit surface water directly to the aquifer; the recharge basin may include surface water drainage basins that bring water into the spring drainage from outside of the groundwater basin.

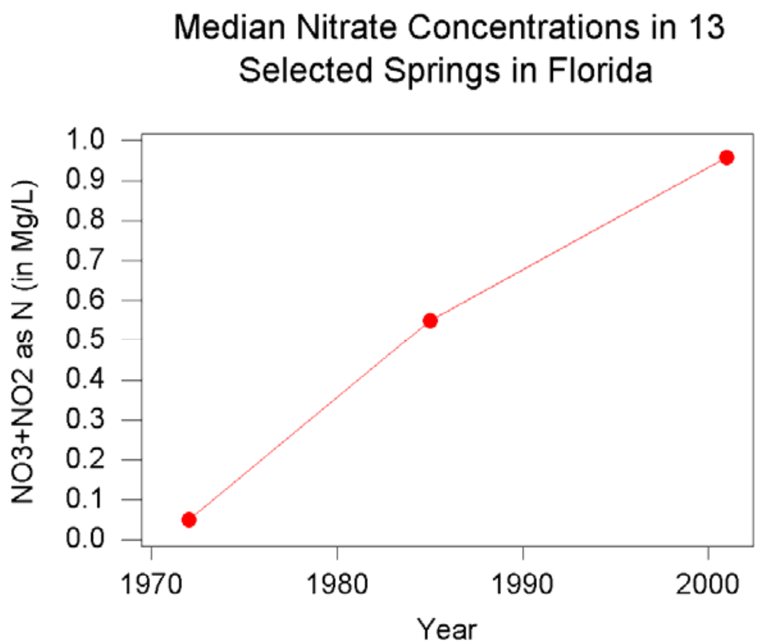


Figure 5. Median nitrate concentrations in 13 selected first-magnitude springs. Springs are Alexander, Chassahowitzka Main, Fanning, Ichetucknee, Jackson Blue, Madison Blue, Manatee, Rainbow, Silver, Silver Glen, Volusia Blue, Wakulla, and Wacissa #2 (From Scott et al., 2004).

OVERVIEW OF THE HYDROGEOLOGY OF FLORIDA'S GROUNDWATER

Florida enjoys a humid, subtropical climate throughout much of the state (Henry, 1998). Rainfall, in the region of the major springs (Figure 1), ranges from 127 cm (50 inches) to over 152 cm (60 inches) per year. As a result of the climate and the geologic framework of the state, Florida has an abundant supply of fresh groundwater. Scott (2001) estimated that more than 8.3 billion cubic meters [2.2 quadrillion (2.2 x 10^{12}) gallons] of freshwater are contained within Florida's aquifers. However, only a very small percentage of freshwater is available as a renewable resource for human consumption.

The Florida peninsula is the exposed portion of the broad Florida Platform. The Florida Platform, as measured at the 200 meter (more than 600 ft) below sea level contour, is more than 483 km (300 miles) wide. It extends more than 240 km (150 miles) westward under the Gulf of Mexico, and more than 113 km (70 miles) under the Atlantic Ocean. The present day Florida peninsula is less than one half of the total platform.

The Florida Platform is composed of a thick sequence of variably permeable carbonate sediments, limestone and dolostone, lying on older igneous, metamorphic and sedimentary rocks. The Cenozoic carbonate sediments may exceed 1,220 m (4,000 ft) thick. A sequence of sand, silt and clay with variable amounts of limestone and shell overlie the carbonate sequence (see Scott et al, 1991 and Scott, 1992b for discussion of the Cenozoic sediment sequence and the geologic structure of the platform). In portions of the west-central and north-central peninsula and in the central panhandle, the carbonate rocks, predominantly limestone, occur at or very near the surface. Away from these areas, the overlying sand, silt and clay sequences become thicker. As the rocks sediments compacted and were subjected to other geologic forces, fractures formed. These fractures allowed water to move more freely through the sediments and provided the template for the development of Florida's many cave systems.

There are three major aquifer systems in Florida, the Floridan, the intermediate and the surficial aquifer systems (Southeastern Geological Society, 1986; Scott et al., 1991). The Floridan aquifer system (FAS) occurs within a thick sequence of permeable carbonate sediments (see Miller, 1986 and Berndt et al., 1998 for discussion of the FAS). In some areas, it is overlain by the intermediate aquifer system (IAS) and the intermediate confining unit (ICU) which consists of carbonates, sand, silt and clay. The surficial aquifer system (SAS) overlies the IAS (or the FAS where the IAS is absent), and is composed of sand, shell and some carbonate. The vast majority of Florida's springs result from discharge from the Upper Floridan aquifer system (UFAS), a subdivision of the FAS as discussed by Miller (1986).

Typical natural recharge to the FAS originates as rainwater. As the acidic rainwater percolates downward to the FAS, it is made slightly more acidic by carbon dioxide from the atmosphere and organic acids in the soil. Once in the FAS, the groundwater dissolves portions of the limestone and enlarges naturally occurring fractures. The dissolution enhances the permeability of the sediments and forms cavities and caverns. Sinkholes are formed by the collapse of overlying sediments into the cavities. Occasionally, the collapse of the roof of a cave creates an opening to the land surface. See Lane (1986) for a description of sinkhole types common in Florida.

Recharge to the FAS occurs over approximately 55 percent of the state (Berndt et al., 1998). Recharge rates vary from less than 2.54 cm (one inch) per year to more than 25.4 cm (10 inches) per year. Water entering the upper portion of the FAS eventually discharges from a spring. The water has variable residence times. Katz et al. (2001) and Katz (2004) found that water flowing from larger springs had a mean groundwater residence time of more than 20 years and may reflect the mixing of older and younger waters.

Florida's springs occur primarily in the northern two-thirds of the peninsula and the central panhandle where carbonate rocks are at or near the land surface. Most of these springs produce water from the UFAS which consists of sediments that range in age from Late Eocene (approximately 36 - 38 million years old [my]) to mid-Oligocene (approximately 33 my). Miocene to Pleistocene sediments (24 my to 10,000 years) often are exposed in the springs.

The geomorphology of the state, coupled with the geologic framework, controls the distribution of springs. The springs occur in areas where karst features (for example, sinkholes and caves) are common, the potentiometric surface of the FAS is high enough and the surface elevations are low enough to allow groundwater to flow at the surface. Springs generally occur in lowlands near rivers and streams. There are a number of springs known to flow from vents within river channels and many more are thought to exist. Hornsby and Ceryak (1998) identified many newly recognized springs in the channels of the Suwannee and Santa Fe Rivers. Springs that have yet to be described have been found within the Apalachicola River between Gadsden and Jackson Counties (H. Means, Florida Geological Survey, personal communication, 2004).

Weather and climatic events affect the appearance of spring water. For example, during periods of higher than normal precipitation, such as hurricanes, some springs may reverse flow. When this occurs, stream water flows into the aquifers. During these times, spring water often has a dark appearance because of the presence of tannins from surfacewater sources. Once stream levels drop enough, the dark waters again reverse flow. When this occurs, discharge becomes much clearer. Dryer periods also affect the appearance of springs. For example, during 1998 - 2002, Florida experienced a major drought with a rainfall deficit in places totaling more than 127 cm (50 in) (Verdi et al., 2006). The resulting reduction in recharge from the drought, along with the normal withdrawals, caused a lowering of the potentiometric surface in the FAS. Many first magnitude springs experienced a significant flow reduction. Some springs ceased flowing completely. The appearance of the springs also changed as river and lake levels declined reducing the size of the spring-water body and exposing sediments along the banks.

QUALITY OF GROUNDWATER AND SPRING WATER

Natural Factors Affecting Groundwater and Spring-Water Quality

Most of the Florida land mass is a peninsula that is surrounded by saltwater. Relict saltwater also underlies the entire state. The reason for this is that the Florida Platform consists of carbonate rocks that were deposited in a shallow ocean. At the time of deposition, saltwater existed in their intergranular pore spaces. Gradually over geologic time, sea level was lowered relative to its position when the carbonate sediments were deposited. Through compaction and down warping of sediments on both sides of the Platform, a series of complex fracture patterns developed. The patterns are often reflected at land surface and have actually influenced the pathways of many of Florida's streams.

Over geologic time, as sea level lowered, the central portion of the Florida Platform was exposed to the atmosphere. As rainfall percolated downward it eventually replaced the upper portion of saltwater in the developing aquifers with a freshwater "lens." Today, the irregularly shaped "lens" is generally thickest in the central portion of the state, where it is over 610 m (2,000 ft) thick (Klein, 1975). It becomes narrow toward Florida's coastline. The base of the "lens" is typically a transitional rather than a sharp boundary. Groundwater in the deeper portion of the "lens", and along the coasts, is mixed with saltwater and has relatively high concentrations of saline indicators such as sodium (Na), chloride (Cl), and sulfate (SO_4).

Water discharging from Florida's aquifer systems and springs has its primary source from rainfall. Much of the rainfall reaching land surface flows overland to surfacewater bodies, evaporates, or is transpired by plants. However, a portion of the rainfall percolates downward through the sediments, or enters sinkholes, where it recharges the aquifers. During its travel downward from land surface to the water table, and during residence within Florida's aquifer systems, many factors affect the water chemistry.

A long residence time may allow sufficient time for chemical reactions between the water and the aquifer rock. As such, water chemistry reflects the composition of the aquifer rock. Typical residence times range from less than several days (in secondary produced caverns and sinkholes) to centuries (Hanshaw et al., 1965).

A second factor affecting groundwater chemistry is flow path, which is the length and depth of the path that the groundwater follows as it flows through an aquifer (Upchurch, 1992). In general, shallow, short flow paths (which are characteristic of the SAS) result in shorter residence times for chemical reactions to take place. Consequently, the total dissolved solid (TDS) content is less than in longer flow-path systems. If the flow path is long (on the order of tens of kilometers), such as commonly occurs in the FAS, reactions between rock and water become more probable and the TDS content of the water would be greater as a result of continued rock-water chemical reactions. Because of the residence time and the flow paths of the groundwater within an aquifer, the quality of spring water is typically reflective of the interactions of the major rock types in the aquifer and the groundwater itself.

A third factor which is of particular interest is intergranular porosity (pores through which water passes between the individual rock matrix grains). Even though Florida's aquifers have large, secondary cavernous pores spaces, most of the pores tend to be small (Upchurch, 1992). Fortunately, whenever the pores are very small, they act as filters for microbes, small organic substances, and clay minerals. In general, this results in naturally filtered groundwater that is very pure and desirable for both drinking water and recreation. Unfortunately, some pollutants are not always removed and our aquifers can become contaminated.

Differences in Spring- and Well-Water Quality

The processes controlling the water quality in wells is very similar to those controlling spring-water quality with at least one major difference. Wells are often drilled to production zones as close to land surface as is economical. This is the situation for the wells used in this study, which are for the most part monitoring wells. Monitoring wells tend be shallow (median depth ≈ 80 feet (24 m) (Appendix C). Most water in these shallow wells represents young, recently recharged water. On the other hand, because springs are major discharge points, spring-water can be considered to be an integrator of water from the entire springshed. Spring water is a mixture of young, shallow, freshly recharged water and older water from the deeper portions of the aquifer. For this reason, spring water tends to be older than the relatively shallow water found in the monitoring wells used in this study.

Indicators of Groundwater and Spring-Water Quality Problems

Spring water, while it resides in the aquifer, is considered to be groundwater. However, once spring water exits from the spring onto the earth's surface, it is considered to be surface water. Because of this change, the question arises whether regulators should apply groundwater or surfacewater quality standards to the water. Primary and secondary standards with maximum contaminant limits (MCLs) may exist for an analyte while the water is considered groundwater, but differ for surface water; or vice versa. Drinking water standards are protective of human health while surface water criteria are protective of aquatic biota. Although several analytes fall into this category, Nitrate (NO_3 + NO_2 as N), and hereafter abbreviated NO_3, is a good example. Based on drinking water criteria, nitrate has a groundwater threshold value of 10 mg/L (Florida Department of Environmental Protection, 1994). However, no numeric nitrate criteria exist for surface water, other than Class I surface water which is used for drinking water. The FDEP is currently developing criteria for spring water. Until legal numeric criteria are established for nitrates, it should be understood that any reference to threshold values in the following text simply infers potential water-quality problems.

One of the more disturbing aspects about Florida's groundwater quality has been the documented steady increase of nitrate over the past several decades (Jones et al., 1996; Champion and DeWitt, 2000; Means et al., 2003). An example is displayed in Figure 5 (From Scott et al., 2004). It shows that nitrate concentrations have a greater than 19-fold increase in nitrate concentrations in 13 selected first-magnitude springs (Alexander, Chassahowitzka Main, Fanning, Ichetucknee Main, Jackson Blue, Madison Blue, Manatee, Rainbow Group composite, Silver Main, Silver Glen, Volusia Blue, Wakulla, and Wacissa #2 Springs) between the 1970s and 2000.

The natural background nitrate concentrations in Florida groundwater are less than 0.05 mg/L (Upchurch, 1992). During the 2001-2002 time frame, the FGS sampled 125 spring vents. Of the 125 spring vents sampled, none had nitrate concentrations exceeding the 10 mg/L threshold for Class I surface and drinking water. Fifty-two of the spring vents sampled had nitrate concentrations exceeding 0.50 mg/L (42 percent) and 30 (24 percent) had concentrations greater than 1.00 mg/L. Thus, over 40 percent of the sampled springs had at least a ten-fold increase in nitrate concentrations above background and approximately one quarter of them had at least a 20-fold increase. The elevated nitrate concentrations may adversely affect the aquatic ecosystem in springs and spring runs. Further research is still needed and is currently being sponsored by the Springs Initiative Program. The FDEP is aware of the nitrate issues and has worked with other governmental agencies to develop a series of steps to reduce nitrate concentrations in groundwater and springs in the middle Suwannee River Basin where many of Florida's springs are located (Copeland et al., 2000). The FDEP Bureau of Watershed Management and the Florida Department of Community Affairs are active in coordinating the development of spring protection measures.

Another groundwater quality concern is the influence of saline water. Several springs have concentrations of chloride (Cl; a saline indicator) exceeding the 250 mg/L threshold for drinking water. Springs with this type of water tend to be located along Florida's coast and along the St. Johns River. The ultimate source of the saline indicators is from naturally occurring saline water within the FAS (Klein, 1975), or from sea water near Florida’s coasts. When the concentrations of saline indicators are increasing, it may be the result of: (1) natural circumstances such as drought, (2) the consequent upconing of groundwater within the FAS, or (3) lateral intrusion of salt water due to increased groundwater pumping.

Enterococcus and total coliform bacteria represent a third concern. It is generally believed that these bacteria originate in fecal matter from warm-blooded animals (Jelinkova and Rotta, 1978). Total coliform concentrations in several springs has exceeded the drinking water standard of four colonies per 100 ml (Florida Department of Environmental Protection, 1994). However, it has been determined that these bacteria can complete their normal life-cycle outside of warm-blooded animals, especially in environments found in parts of Florida (Fujioka and Byappanahalli, 2004), thus the concentrations of fecal coliform may not necessarily represent a direct link to warm-blooded animal pathogens. Further research is needed before definitive conclusions can be made regarding the source of fecal bacteria. Another concern is concentrations of enterococcus and fecal coliform bacteria with regards to swimming. The Florida Department of Health has set beach swimming standards and advisory thresholds for both organisms. To date, exceedances of the standards and thresholds in springs have not been a problem. Nevertheless, many residents swim in spring runs and these bacteria are a concern.

SPRING SELECTION PROCESS

Very little spring-water quality sampling, mostly by the USGS, occurred until the 1940s. In 1947, the FGS published its first edition of "Springs of Florida" (Ferguson et al., 1947) which documented the water quality in the major springs of Florida. The document was revised in 1977 and many previously undocumented springs were sampled (Rosenau et al., 1977). It should also be noted that during the 1970s, the three northern water management districts were formed. They were the NWFWMD, the SRWMD, and the (Saint Johns River Water Management District (SJRWMD). Within a few years, these WMDs, along with the USGS and the already established SWFWMD, occasionally collected spring-water quality samples. By the 1990s, the NWFWMD, SRWMD, SJRWMD, and SWFWMD had established periodic to regular sampling, often with the assistance of the USGS, of springs within their jurisdiction.

Partially due to the sampling efforts of the WMDs, in the 1990s it became apparent that the water quality in some of Florida's springs was deteriorating. For this reason, in 1999 the Secretary of the Florida Department of Environmental Protection directed the formation of a multi-agency Florida Springs Task Force to provide recommendations for the protection and restoration of Florida's springs. In late 2000 the Task Force made recommendations for the preservation and restoration of Florida's springs to the Secretary, and in 2001 the Florida Legislature passed the Florida Springs Initiative. The Initiative authorized funds for FDEP to begin investigating the status of Florida springs and develop strategies for protecting them. As a result of the Initiative, the four WMDs, FDEP, and the FGS have cooperated to monitor Florida's springs.

The Springs Initiative has been responsible for the collection of spring-water quality since 2001. Beginning with that year, much of the data used in this report were obtained from Springs Initiative-sponsored samples. Methods of evaluating the data used in this report can be used in the future to analyze the spring data currently being generated as a result of the Springs Initiative. In the meantime, data of spring-water quality collected as part of WMD spring sampling programs were used for this interpretative report.

The FGS requested spring data from each of the four northern WMDs in order to analyze spring-water quality and quantity for trends. The districts delivered available data to the FGS in 2002 and 2003. It was soon discovered the WMDs had only sporadically sampled their springs through the 1980s. However, beginning in the early 1990s each district had begun to sample springs in a semi-consistent manner. Even though data do exist for many springs, only 58 springs (Figure 6) were ultimately included in the analysis; one from the NWFWMD, 14 from the SRWMD, 15 from the SJRWMD, and 28 from the SWFWMD. Selection was determined based on the consistency of the data. As a working definition, we considered consistency to be the longest string of data in terms of time, along with the greatest number of analytes. We also wanted the largest number of springs to be included that met our concept of consistency. With these criteria in mind we determined that the time period from January 1991 through December 2003 represented the time in which the most consistent data existed for the greatest number of springs. We realize that there are several springs that have decades of data. We also realize that since commencement of the Springs Initiative, many springs now have data, but the time sequences are short. As a result, our data interpretations are valid only for the 1991-2003 time frame.

A discussion of analytes evaluated and frequencies of sampling will be discussed later. Figure 6 displays the location of the included springs in the analyses. A list of the names of springs, along with location information, can be found in Appendix D.

WELL SELECTION PROCESS

In 1983, the Florida Legislature passed the Water Quality Assurance Act (Florida Statutes, 1983, Chapter 403.063). As a result, FDEP, with the assistance of the five water management districts, plus several counties (Alachua, Broward, Collier, Lee, Miami-Dade, and Palm Beach) established extensive groundwater monitoring networks. The purpose was to document both ambient groundwater quality conditions (Background Network) and to detect changes in Florida’s groundwater quality resulting from the effects of various land uses and potential sources of contamination (Very Intense Study Area Network [Scott et al., 1991]). Both networks were in operation until 2000. A major subdivision of the Background Network was the Temporal Variability (TV) Network. The TV Network consists of a series of strategically-located Background Network wells scattered throughout the state. They are sampled on a monthly to quarterly frequency.

Beginning in 1996, FDEP began a major redesign of its water resource monitoring efforts. The purpose of the redesign was to characterize the environmental conditions of Florida’s water resources and to determine if those conditions are changing over time. The revised network (The Status Network) became operational in early 2000. A detailed description of the Status Network is presented by Copeland et al. (1999). Throughout the redesign process, the TV Network only had minor modifications. The stated purpose of the redesigned network is to evaluate temporal variability of Florida’s groundwater quality and to determine whether concentrations of the sampled analytes are increasing or decreasing over time. The TV Network consists of 46 wells (Figure 7); 25 wells monitor confined groundwater and 21 wells monitor unconfined groundwater. The wells tap each major aquifer system and are scattered throughout each of Florida’s five WMDs. As can be seen in Figure 7, some of the well locations represent

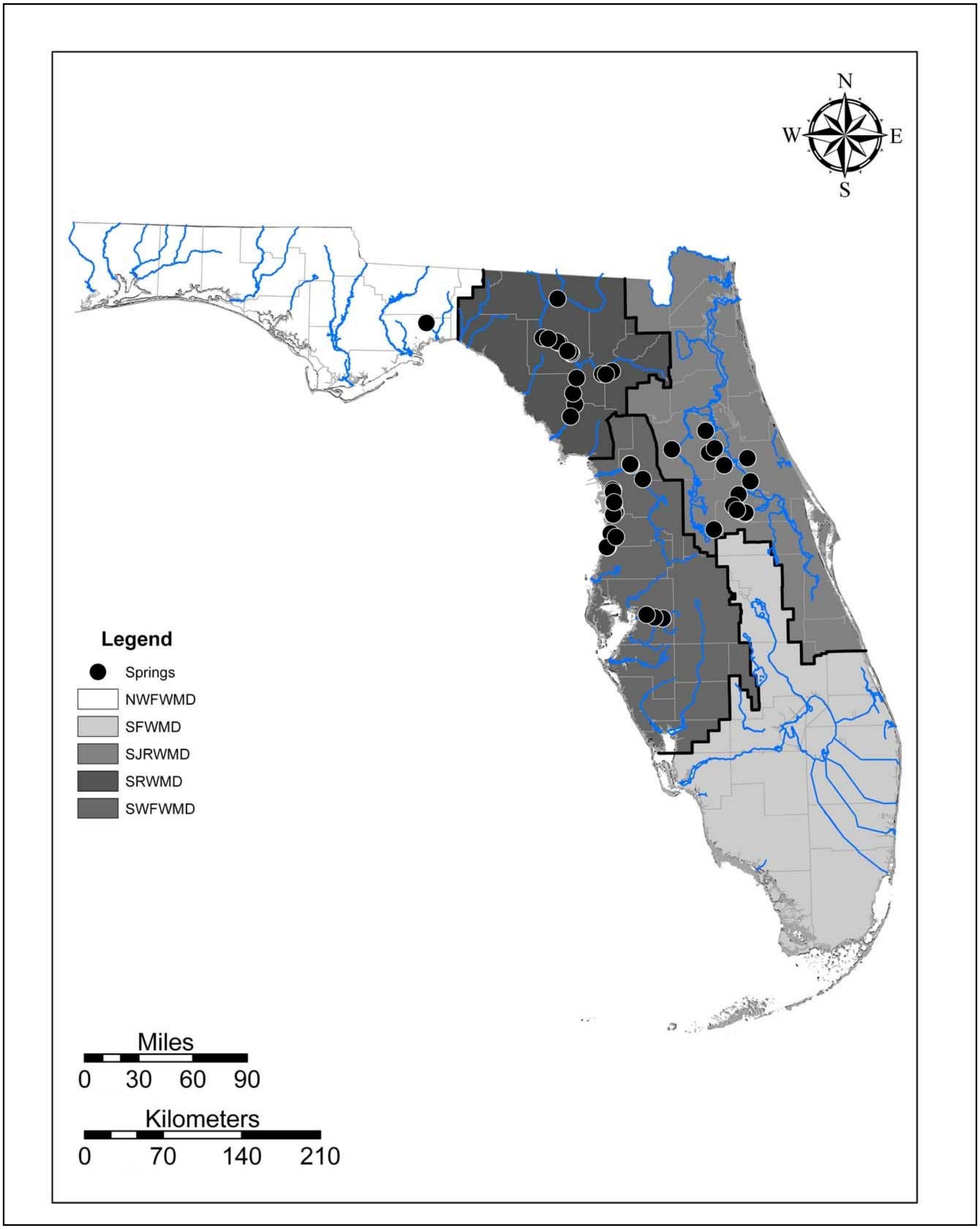


Figure 6. Location of springs analyzed in this report. (A list of the spring names can be found in Appendix C.)

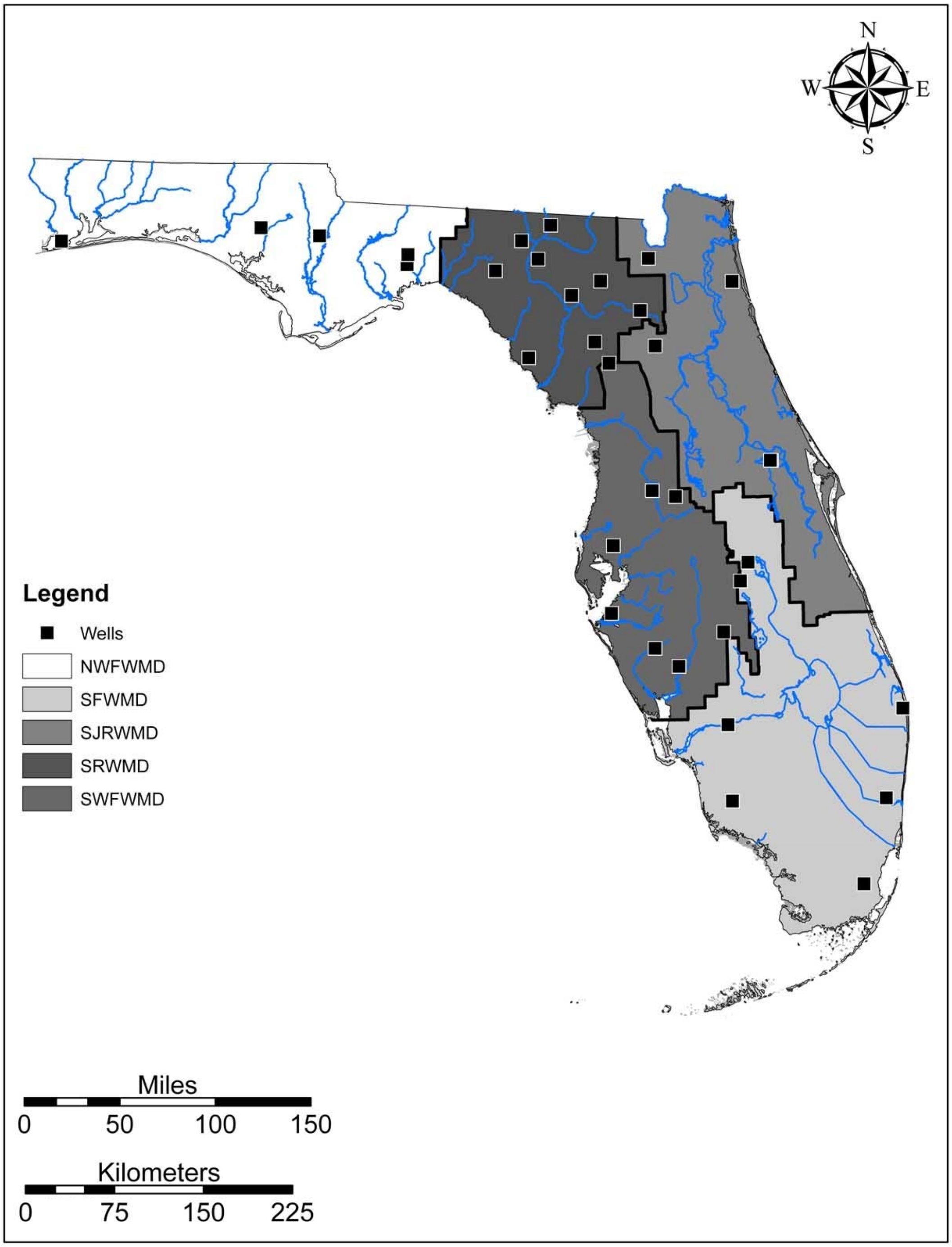


Figure 7. Location of Temporal Variability Network (TVN) wells. (A list of well identifiers can be found in Appendix D.)

clusters of wells. Wells that monitor confined ground water are sampled quarterly (thought to have less temporal variability), whereas wells that monitor unconfined groundwater are sampled monthly.

With respect to the WMDs, the NWFWMD has eight wells, the SRWMD has 10 wells, the SJRWMD has nine wells, the SWFWMD has 11 wells, and the SFWMD has eight wells in the TV Network that had significant data for analyses. A list of well names can be found in Appendix C, along with well construction data.

METHODS

This report uses a relatively simple methodology to determine the condition of spring and groundwater quality. Most analyses boil down to the single straightforward question, "*are conditions getting better, getting worse, or remaining the same*?" Though this report is based upon several statistical procedures, all address this single question.

With this simple objective in mind, additional elaboration is required to expand upon the connection with actual statistical tests and methods. First, since "better" and "worse" are subjective and qualitative questions, an approach that will quantify them is needed. Thus, a somewhat more objective and quantitative form of the above question becomes, "*for the 1991-2003 period of record, are the indicators decreasing, increasing, or remaining the same?*" This frames the question of quality in the terms of changing *quantities* between two end-points (i.e., the start and finish of a time period of interest); changes in quantities, such as flow and loading, can be objectively tested in a variety of ways.

In order to test quantities, the last remaining questions are: (1) which quantities and, (2) over what period of time? These further conditions must be defined. The first question is *which* quantities? For this report, as many indicators as possible were tested. This allowed the authors to ask questions of the largest possible scale; limiting the number of indicators only limits the possible number of observations and maximizing the number of observations allows the most comprehensive view of changes that might be of concern. Second, for the quantities examined an increase or decrease in concentration must be addressed over a *time frame*. Therefore, in order to maximize the effectiveness of the analysis, the longest possible time series was chosen for as many springs as possible. In summary, the choice was for the *longest possible time frame for data with the highest quality, for as many indicators possible, and for as many springs as possible*. Laboratory and collection methodologies have varied over the last several decades in the state of Florida. Variations include not only differences among WMDs, but even use of different laboratories by the same district, changes within laboratories, incomplete sampling intervals due to varying purposes and other reasons. Because of this, the earliest starting point for which data quality could be uniformly assumed to be high (in this case 1991) was chosen; this created the longest possible time series for analysis (1991-2003) for as many springs as possible.

Regarding the second question, for this report, we chose trend analysis to evaluate a given time series (between 1991 and 2003) for linear trends. Note that Urquhart and Kincaid (1999) mentioned that trends may deviate from strict linearity. Nevertheless, they mentioned that if a trend is present, a linear trend will be present, regardless of the type of mathematical structure of the trend, e.g. cyclic, episodic, or a stair-step look.

For this report, we were not only interested in detecting the presence of a trend we were also interested in a statistical method that was relatively insensitive to missing sampling points (e.g., gaps in data series), outliers, and, data that seldom had normal (Gaussian) distributions. Based upon these reasons, our choice for analysis was the non-parametric, Mann-Kendall (MK) test for trends. Discussions of the MK test and other statistical procedures used in the study, including the corresponding assumptions, are found in Appendix E.

Our last clarification involves interpretation of trends; not all increases are bad nor are all decreases good. For example, a decrease in nitrate is desirable and is considered to be good. On the other hand, a long-term decrease in flow is not desirable, since it may indicate an overuse of the resource. Thus, it can be considered to be bad. Another example, an increase or decrease in pH may not be considered to be good (if it is extreme), since this analyte is best defined by an optimal middle range; being far outside that range on either side is bad. The point is that change, in one direction or another, can be tested and the result has implications regarding the improvement or degradation of the system in question.

Definition of Trends

Natural systems in general undergo two main types of change: cyclic and linear (A and B, top of Figure 8). Cyclic change is common in nature. Two common examples of cyclic changes include diurnal and seasonal changes. Natural changes can also be linear, moving conditions from one state to another without returning to the original state. The focus of this report is to document linear trends in water quality and quantity. It is also assumed that trends in certain analytes are most likely anthropogenic, rather than natural in origin. In this case, three possible linear trend scenarios can be tested. In each case, a chemical component of a groundwater system (whether spring or well) can be plotted as a concentration against time (Figure 8, bottom). The first scenario (on the left) is that the system is increasing in concentration for a particular analyte (for which the symbol, "+", will be used in this report). One case could be phosphorus. Over a period of interest, change of concentration can be tested at a specific level of confidence (e.g., at a 95 percent confidence level, or an α level of 0.05). This means that by the end of the time period, the concentration was high enough to warrant the designation of being higher than expected by chance fluctuation alone. Such values are marked as being highly unlikely to have occurred unless notable changes to the system were introduced. In the opposite case (on the right), the concentration could have decreased significantly (represented by "-"). Such a trend suggests a substantial change to the physical environment and would therefore be recorded. The third scenario (middle chart) is that neither case was observed. As will be detailed below, this is not a positive statement affirming uniform conditions for the system in question; rather it is a general category for all conditions not classified within the former two situations. This is a default option and it is likely that a number of valid trends that could escape detection and be included in this scenario.

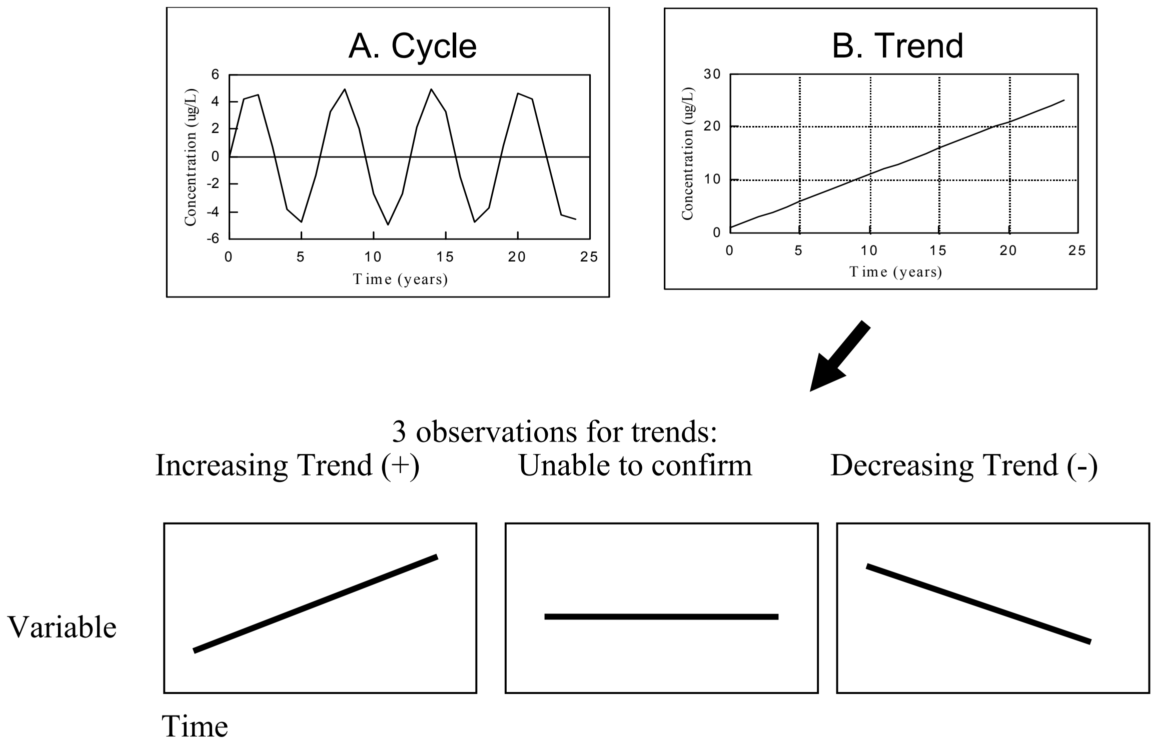


Figure 8. Illustration of three options for water-quality trends. Trends can either increase (+), decrease (-), or otherwise cannot be confirmed. Depending on the analyte, the interpretation is that the system is getting better, getting worse, or remaining the same. Taking the example of phosphorus, if the trend is increasing, the situation is getting worse. If the trend is decreasing, it is getting better. Finally, if neither, nothing can be confirmed. All analyses in this report are assigned to one of these three observations.

Problems with Trends

Trend analyses were largely straightforward and posed few problems. Visual analysis of time series plots showed that the majority of significant trends were based on a large amount of data that indeed demonstrated an obvious tendency. However, several exceptions arose and their handling is addressed in the following sections.

"Remaining the Same" – Possibility of Missed Trends

The last case scenario in the phrase "getting better, getting worse or *remaining the same*" leaves a question as to the identity of the last category. Note that the last observation—"…remaining the same"—cannot be addressed statistically. It is, therefore, considered the alternative case to the situation of an increasing or decreasing trend. Because of this "…remaining the same" amounts to a catch-all for *all remaining observations* (i.e., trends that neither increased nor decreased). Though simple in principle, a clarification should be stated. Within this last category remains interesting, important, and valuable information—cycles, interesting structure, nonlinear trends, or other phenomena. More problematic, it is likely the analyses conducted here "missed" a number of trends (due to the strict confidence limit).

However, it is important to state once again that the purpose for this study was neither to find *all* the trends possible, nor to find the largest *number* of trends; rather, the purpose was to identify all the trends that could be confidently, statistically labeled as such. Other studies employing greater power (i.e., ability to detect more trends) could, and probably should, be conducted. But since this is the first such statewide analysis of water-quality trends, the goal was to minimize the number of false trends—while maximizing the number of true trends—in order to get the best picture of where the clearest problems exist.

Outliers

Statisticians often encounter data that lies outside of an expected range of values. The reasons for this may include data transmission errors, failed laboratory analyses, contaminated samples, and sometimes accurate data recording unusual situations—causes are not always visible to analysts. This report was no exception. Technically, there are really only two ways of dealing with such data. One is to set arbitrary guidelines in advance and handle the data in accordance. This may include removing outliers that occur above or below a certain accepted range, e.g. - adjust the data. The other approach is to include all outliers in the dataset and analyze the data regardless. The rationale is that well-maintained data sometimes records outliers but, with sufficient data, the effects will be minimal. This report chose the latter option and included all data in all analyses—none were discarded. Their presence was accounted for and accommodated in several ways. The first was simply by the choice of analysis. Nonparametric statistics are relatively insensitive to the influence of extreme data points (outliers).

A large number of “bad” data points can still influence even a nonparametric analysis. Cross-checking results and examining raw data can assist with this judgment. In order to compare and check the influence of outlying data, every nonparametric statistical trend test [the Mann-Kendall (MK) will be discussed later] result was checked against a linear regression (parametric test) of the same data. Further, both analyses were conducted with different statistical packages: Minitab (Minitab, 2003) for MK and S-PLUS (S-PLUS, 2003) for cross checking regression analyses. Visual examination of each individual time series was conducted to corroborate the results of the statistical tests; suspicious data sets were re-analyzed. Inspections revealed that in the vast majority of cases, reported statistical trends were composed of time series that showed clear visual trends. Comparison of MK results to linear regressions (though parametric) showed surprising similarity. Not only did the non-parametric MK results closely match the parametric analyses, but both were surprisingly unaffected by outliers; thus providing strong confirmation that both the data was of high quality and that it gave robust signals.

Detection Levels

Though the data used in these analyses were the best available in terms of quality assurance, other factors had to be considered. The analysis of outliers demonstrated that consistency of data handling, laboratory reporting, and subsequent quality assurance was good. Yet an additional issue surfaced in the plotted time series: the effect of laboratory detection limits. For statistical purposes, if a sample’s concentration was below the laboratory’s method detection limit, it was considered to be the detection limit. For example, where improvements in laboratory methodologies over time lowered the minimum detection value for several analytes, trend analyses detected significant downward trends where no such trend existed. Indeed, a number of time series plots revealed that a number of trends—statistically significant by MK tests—were actually the artifact of such "stair step" patterns trending down over time (Figure 9).

All data series, therefore, were checked visually for such spurious results. Those data series found exhibiting such results were removed from consideration in the final analyses. These were assigned the designation "DL" (detection level) in result tables (e.g., "plus-minus" charts which will be discussed later); trends created by detection level artifacts were removed from further analysis.

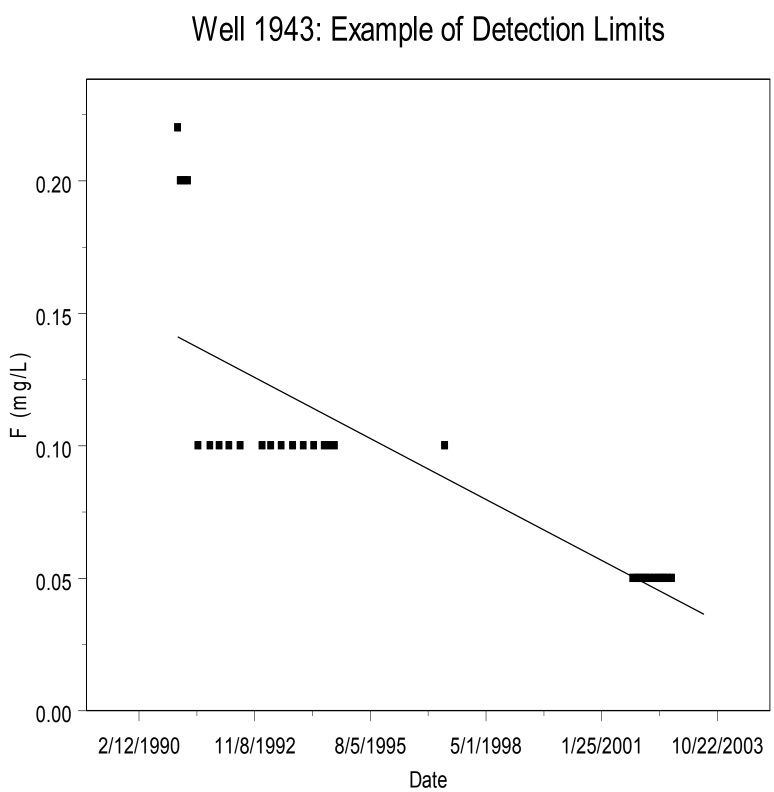


Figure 9. Example of a spurious trend. Detection limit changes can generate the appearance of false trends. All time series for all analytes were visually checked for aberrant results since visual inspection was was necessary to identify artifacts.

Sparse Data

The quantity and consistency of existing data varied widely depending on sampling agency, analyte, and location of springs or wells. Given the amount of data used for the time series studied herein, a distinction should be made concerning how the *quantity* of data affected its *quality*. First, all reported analyses had sufficient data for time series analysis. Sufficient data constituted a minimum of 10 points for the entire series. Many software packages would not generate statistical results without a minimum set of points—which was often 10 values. At the same time, there is a difference between what constitutes a sufficient amount of data and how that (sufficient) quantity is structured through time. The former issue concerns whether an analysis could be conducted while the latter has implications for the reliability of the interpretation. On one end of the spectrum, some locations only had 10 values, while at the other some had in excess of 100 values. As it turns out, considering both springs and wells, the median number of data for the 1991-2003, Sequence A, time frame was 38.

Long-term, consistent data collection is an ideal situation for analysis. However, most data sets were between the extremes of a lot or too little. Much of the data used here can be described by the term "sparse data" which we use to mean there are not very many data points in the time sequence but there were a minimum of ten. Often the spring data were collected for some other purpose than for time-series analysis having little structure at all. This results in "messy data." Messy or disorderly data includes missing values, outliers, transcription errors, or extreme and skewed results. Simply stated, a high proportion of time sequences have varying amounts of missing data. The missing data hinders reliable data interpretation. One example of "messy data" is nitrate concentrations at Wakulla Spring (Figure 10). An example is as follows. Suppose a large number of data points exist at the beginning of the time series, nothing in the middle, and one point at the opposite end of the series. Also, suppose a trend is detected. The problem with such a trend is that although it is statistically valid, it may be entirely dependent upon the single point at the one end of the series. If such a trend is labeled valid, then poor judgment was used. The best interpretation for a trend exists when there is an abundance of points sampled consistently for the longest period of time.

Time gaps in data series were the most common problem. In a number of cases data collected early in the time series were followed by one or more data collection gaps of varying temporal duration. Such trends are dependent upon the connection of two (occasionally more) clusters of data. Though the trends may be valid, they are not ideal; this example underscores the necessity for sampling agencies to implement consistent collection plans over the long term. Though the data can often be used, its utility can be challenged, or considered suspect. The reason is that the value of any individual data point is a function of the number and reliability of nearby data points to which it can be compared over the long term. Data that are sparse, inconsistently collected, or have large time gaps are substantially less valuable than a consistent,

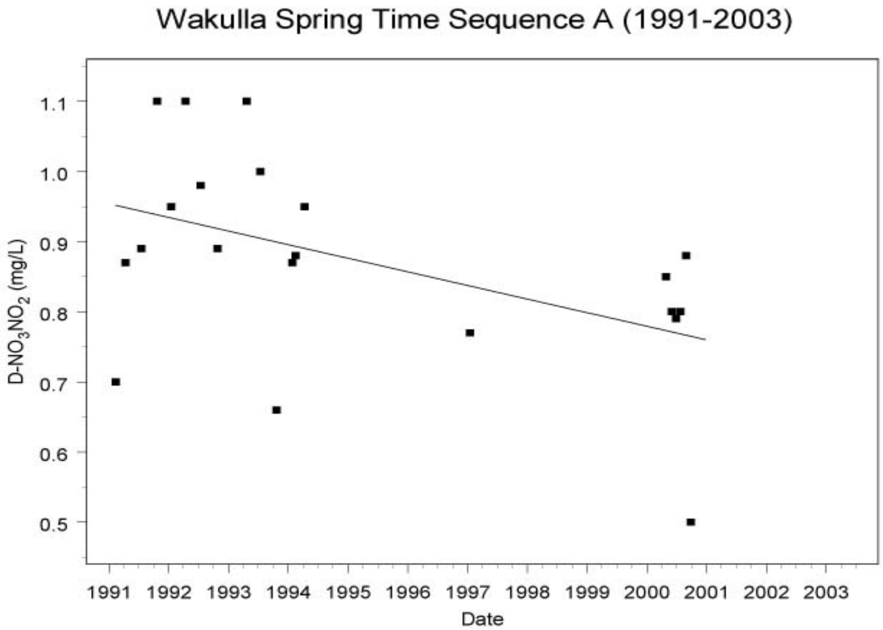


Figure 10. Example of sporadic, unsystematic, and incomplete sampling. Only seven points were collected in the final eight years of this Wakulla Spring study. Sparse, inconsistent sampling after 1994 meant the trend seen here was dependent on relatively few points collected in 2000. Though the trend is statistically valid, this is an excellent illustration of the need for consistent long-term data collection. Ironically, though budget issues are often responsible for gaps in sampling, note that missing data greatly reduces the value of points remaining. Note no data were obtained after 2001 even though Sequence A continued through 2003.

well-documented time series. Sparse data collection was a significant issue in several notable springs. For example the trend for nitrate at Wakulla Spring for Sequence A included a six-year "gap" (1994-2000) during which there was only one sample collected. Although the statistical conclusion that nitrate concentrations at Wakulla were decreasing is valid (to be discussed later), with the lack of data during the 1994-2000 time frame, some may doubt the interpretation of a decreasing trend.

Incomplete data sets existed for many analytes and indicators. Time series for some analytes (e.g., iron) only had a handful of points over the 13 years. For such very small sets, trend analysis was meaningless and these were excluded from analysis.

ANALYTES AND INDICATORS

A total of 48 chemical constituents and indicators, with a period of record 1991-2003, were analyzed for this study. A list of analytes and their corresponding STORET codes can be found in Appendix F. Data were obtained from several different sources. The state water management districts offered the most information, followed by FDEP and the USGS. Each agency used their respective sampling and analysis procedures under whatever guidelines that were being followed for that particular period of time. This complicated the statistical analyses. However, identification of useful data led to a field of 48 different analytes of water quality with a temporal span of 13 years. Table 3 lists, in alphabetical order by column, all of the analytes examined in this study.

Table 3. Analyte and Indicator List.

Analyte/Indicator		
Color	Depth to Groundwater	Total Chloride
Dissolved Alkalinity	Dissolved Phosphorus	Total Dissolved Solids
Dissolved Calcium	Dissolved Phosphate	Total Fluoride
Dissolved Chloride	Dissolved Sulfate	Total Kjeldahl Nitrogen
Dissolved Fluoride	Dissolved Strontium	Total Magnesium
Dissolved Iron	*Enterococci* Bacteria	Total Nitrate
Dissolved Potassium	Fecal Coliform	Total Nitrate Nitrite
Dissolved Magnesium	Mean Daily Flow	Total Organic Carbon
Dissolved Manganese	pH	Total Phosphorus
Dissolved Sodium	Residuals	Total Phosphate
Dissolved Ammonia	Specific Conductance, Field	Total Potassium
Dissolved Nitrate	Specific Conductivity, Lab	Total Strontium
Dissolved Nitrate, Nitrogen	Temperature	Total Sulfate
Dissolved Nitrate Nitrite	Total Alkalinity	Turbidity (Hatch Meter)
Dissolved Organic Carbon	Total Bicarbonate	Turbidity, Field Sampling
Dissolved Oxygen	Total Calcium	Water Level (feet relative to mean sea level)

Sample Collection and Laboratory Analyses

Because many different agencies and laboratories were used to collect and analyze groundwater samples, unwanted variability was potentially introduced that affected the trend analyses. At a minimum, potential variability was introduced by: (1) different sampling personnel, techniques and equipment, (2) sample transport from the field to the laboratory, (3) environmental and laboratory contamination, (4) concurrent use of several analytical laboratories, and (5) varying methods of reporting results.

For additional information on the analytes, including abbreviations and units for those 27 analytes that had detectable trends, see Table 4. Spring and well water samples were collected

Table 4. Analytes and Indicators Displaying Trends

Analyte	Abbreviation	Unit of Measure
Alkalinity	Alk	mg/L
Ammonia/Ammonium	NH_3 or NH_4	mg/L
Calcium	Ca	mg/L
Chloride	Cl	mg/L
Discharge or flow	–	cfs or cubic feet per second (ft^3/sec); one cfs = 0.028 cubic meters per second
Dissolved Oxygen	DO	mg/L
Fluoride	F	mg/L
Iron	Fe	µg/L and mg/L
Magnesium	Mg	mg/L
Nitrate as N	NO_3 or $NO_3 + NO_2$	mg/L
Nitrogen (total)	N	mg/L
Orthophosphate as P	PO_4	mg/L
pH	–	–
Potassium	K	mg/L
Sodium	Na	mg/L
Specific Conductance	SC	µS/cm at 25 ºC
Stage	–	feet above datum
Strontium	Sr	µg/L
Sulfate	SO_4	mg/L
Temperature (of water)	Temp	ºC
Total Dissolved Solids	TDS	mg/L
Total Kjeldahl Nitrogen	TKN	mg/L
Total Organic Carbon	TOC	mg/L
Total Phosphorus	P	mg/L
Total Suspended Solids	TSS	mg/L
Turbidity	Turb	NTU **(Current)*** JTU **(Historic)**
Water Level/Stage	WL(msl)	feet above mean level (1988)

*JTU and NTU are approximately equivalent, though not identical
msl = mean sea level (National Geodetic Vertical Datum, 1988)

by several agencies and a private company for the SRWMD. Regarding springs, the agencies include the SRWMD (plus its subcontractor), the SJRWMD, the SWFWMD, and the USGS. For wells, samples were collected by the NWFWMD, the SRWMD and its subcontractor, the

SJRWMD, the SWFWMD, the SFWMD, and the FDEP. In addition, multiple analytical laboratories were used to process the samples.

For the 1991-2003 time sequence, spring sampling and analyses faced all of the potential aforementioned problems. During the same time period, especially during the early days of the operation of the TV Network, well monitoring encountered many of the same problems that spring monitoring encountered. The TV Network is operated by the FDEP and by the mid 1990s, the FDEP reduced a considerable portion of unwanted variability by adopting a policy of using a standardized sampling protocol, a standardized method of sample transport, a single analytical laboratory, and a standard set of analytical methods and reporting protocols. It is hoped that one day, spring monitoring throughout Florida will also adopt similar protocols that will reduce variability.

In spite of the potential variability, not all is negative. For all water samples and data used in this report, each corresponding sampling agency and/or analytical laboratory has an individually-approved quality assurance/quality control (QA/QC) plan on file with FDEP. Regarding QA/QC, the contact for each WMD, FDEP, and the USGS are found in Appendix G.

It should be noted that by 2001, in an effort to achieve standardization, the FDEP adopted a recommended method for spring-water quality sampling. An overview of the protocols is found in Scott et al. (2004). The TV Network is managed by the Watershed Monitoring Section (WMS) of the FDEP. It recently produced an overview of its well water sampling protocols (Florida Department of Environmental Protection, 2003).

Analytes used in this study

Multiple agencies collected water-quality samples for this publication; however one agency may have sampled one analyte, while another agency sampled a similar analyte that was closely related to the first. This was quite common for the analytes nitrate, ammonia, phosphate, phosphorus, magnesium, sodium, potassium and chloride. Most often, the difference was between the collection of the dissolved (filtered sample) and total (unfiltered sample) form of the analyte. It would be preferable if sufficient data in both the dissolved and total forms of these analytes were available. Unfortunately, it was not always the case. It was decided to combine the total and dissolved forms because of the importance placed on nutrients in order to obtain a time series with a sufficient number of data values. We do not recommend this procedure in the future because it would be better to use one or both of the forms in conducting statistical analyses. In the recommendations section (discussed later) we recommend a more consistent set of analytes be used in the future. Nevertheless, for this study, we occasionally used a combined surrogate form of nitrate, ammonia, phosphate, phosphorus, magnesium, sodium, potassium and chloride. We did this solely for the purpose of obtaining a sufficient amount of data necessary for data analyses.

Grouping of Analytes

For convenience, and in an effort to better understand groundwater quality trends, the analytes (or indicators) were divided into several groups. They are: (1) Field, (2) Rock-matrix or Rock, (3) Saline or Saltwater, (4) Nutrient, and (5) Other analytes. However, because of occasional chemical complexities, many analytes are grouped into more than one category. Table 5 lists them by group. Note that analytes in the table only refer to those that displayed trends. A detailed description of each analyte is found in Appendix F.

Table 5. Analyte Groups

Field	Rock-Matrix (Rock)*	Saline or saltwater	Nutrient	Other
Discharge	Alk	Ca	Ca and Mg	TSS
DO	Ca	Cl	K	Turb
pH	F	K	N	TOC
SC	Fe	Na	NH_3 and NH_4	
Temp	K	SC	NO_3 or $NO_3 + NO_2$	
WL(msl) or Stage	Mg	SO_4	PO_4 and P	
	PO_4 and P	TDS	SO_4	
	SC	WL(msl) or Stage	TKN	
	SO_4		TOC	
	Sr			
	pH			

*Light gray indicates common rock and saline-related indicators while dark gray shows common nutrient analytes.

Descriptions of Analyte Groups

Each analyte represents a measure or variable that can be used to assist in judging the overall health of Florida's groundwater. Field analytes such as discharge, water level, and flow describe quantity, but they can also greatly affect quality. The rock analytes suggest upconing of water from deep within Florida's aquifers. The saline analytes suggest intrusion or upconing of water from the deep portions of our aquifers, and the nutrient analytes are those that stimulate biological growth or are present as a direct result of biological activity.

Field Analytes

Field analytes represent a grouping for convenience. Measurements of field analytes were conducted prior to collecting samples for laboratory analyses. The analytes in this group that were used for trend analyses include: discharge (or flow), dissolved oxygen (DO), pH, specific conductance (SC), water temperature (Temp), and water level [water level relative to mean sea level (msl) based on the North American Vertical Datum (NGVD) of 1988)].

Rock-Matrix Analytes

Rock-matrix analytes are those indicative of the rocks making up an aquifer. Because of natural rock weathering, water that has had a long residence time in an aquifer system has a greater probability of having a high concentration of dissolved rock matrix material. Rock indicators include: alkalinity (Alk), calcium (Ca), magnesium (Mg), plus to a lesser extent, fluoride (F), iron (Fe), pH, potassium (K), strontium (Sr), sulfate (SO_4), phosphorous (P), orthophosphate (PO4) and SC. Since phosphate and phosphorus are often found in the mineral fluorapatite, these two analytes are also included in the rock-matrix group.

Saline or Saltwater Analytes

Saline analytes are those associated with salts within either connate water or seawater. Connate waters are those waters trapped within the sediments at the time of their deposition. Since the original sediments were deposited in a marine environment, the pore spaces contain very old saltwater. Saline analytes are obviously also found in the seawater located along Florida's coasts. The major difference is the age of water. High concentrations of saline analytes are often an indication of horizontal saltwater encroachment. However, they can also be an indication of encroachment of highly mineralized water from the deeper portion of Florida's aquifers, below the fresh-water "lens". The encroachment can be caused by the depletion of the less dense fresh-water "lens" during a very dry period (e.g. a drought), or by the upconing of connate water during periods of heavy groundwater withdrawals. Pumping of groundwater increased during dry periods and this process exacerbated the apparent intrusion process. Saline analytes include: calcium, chloride, potassium, sodium (Na), specific conductance, sulfate, total dissolved solids (TDS), plus water level (MSL) and stage.

Nutrient Analytes

Nutrients represent naturally occurring compounds or elements that are essential for the growth of living organisms. However, if found in high concentrations, over-enrichment of nutrients (eutrophication) in a body of surface water can lead to an overgrowth of plant life (including algae) and possibly a loss of dissolved oxygen. For this report, nutrient analytes include: organic carbon, phosphate, phosphorus, a series of nitrogen related species, and to a lesser extent, Mg, Ca, K, and sulfur in the form of sulfate. The nitrogen related species include nitrogen, ammonia, total kjeldahl nitrogen, nitrate, and nitrite.

Other Analytes

Analytes in the "other" category do not fit in any of the other four categories. They represent a miscellaneous group. For trend analyses, the analytes included in this group are suspended solids, and turbidity.

DATA

The original data were from several sources. The data used for the trends analyses discussed in this document are in Appendix H.

Data Sources

The majority of the water-quality data from the springs were collected and analyzed by the water management districts. The data for wells were obtained from the FDEP Watershed Monitoring Section.

Data Verification

The analysis of the data was verified several times with processes including internal and external reviews in addition to repeat analyses by each author. The internal review consisted of audits performed by two of the authors (N. Doran and A. White). These audits included hand-eye verification of every analysis figure for accuracy. Repeat calculations were performed and compared with the first value made using new values calculated from the original data. When errors were found, the data were recalculated by at least two of the co-authors and then replaced.

The external verification was conducted through multiple meetings with WMD staff. During these meetings many of the actual samplers and initial compilers of the data were present. Two rounds of discussion took place; once before this document was compiled and again as it neared completion. These meetings lasted for several hours and many comments were made on procedures and verification policies. Each concern was subsequently addressed and is exhibited in the subsequent sections of this document.

Data Preparation

Preparing the data for analysis included addressing the problems of seasonality, missing values, duplicate data, censored data and detection limits. The data variation caused by seasonal cycles increases the difficulty of detecting long-term trends. This problem can be alleviated by removing the cycles before applying tests or by using tests unaffected by the cycles (Gilbert, 1987).

Missing values (i.e., samples that were never collected) cause their own special difficulties for analysis. For example, suppose 12 monthly water samples were scheduled to be collected from a selected well in a given year. Suppose that for a variety of reasons, only 10 were actually collected. Thus, the well had two missing values for each indicator sampled. Unless otherwise stated for the statistical analyses, missing values were treated as if they were never collected. For example, if only 10 samples were collected, then descriptive statistics were based on 10, instead of 12 samples.

Duplicate data resulted from two samples collected from the same spring or well consecutively. The two samples were then labeled as representing two different sampling events and sent to a laboratory for analyses for the same set of analytes. The purpose of duplicates is to evaluate the internal precision of a laboratory. For statistical analyses, it was decided that the primary sample, collected first in the time sequence, would be used. The second duplicate sample was only used for quality assurance evaluations.

The minimum detection level for analytes from analytical laboratories can cause environmental data to be censored. That is, the distributions are truncated at their lower ends near the laboratory detection level. As stated earlier, for statistical analyses, all data reported as "Below Detection Level (BDL)" were arbitrarily set at the detection level. In addition, it should be noted that for a given analyte, over the period of record, the laboratory detection levels changed, giving multiple detection limits.

Time Sequences

Data for analyses were segmented into three time sequences: Sequence A (1991-2003), Sequence B (1991-1997), and Sequence C (1998-2003). The first sequence spanned the entire sampling period, January 1, 1991 to December 31, 2003. The two smaller time sequences were used to assist in identifying and evaluating shorter-term trends (five to six years).

Within the time sequences, each analyte needed to have a minimum of 10 data points in order for any statistics to be performed. In addition to the minimum number of 10 data points, it was arbitrarily decided that for Sequence A at least three data points from Sequence B and at least three data points from Sequence C needed to be present. If Sequence A lacked this additional criterion, then no analyses were performed on the sequence. As an example, suppose a spring had 15 data points, 12 in Sequence C and three in Sequence B. An analysis for trend was conducted for Sequence A, and C, but not B. If a spring only has 14 data points, 12 in Segment C and two in Segment B, then no analyses was performed for Sequence A nor Sequence B. However, the statistical analysis was conducted for Sequence C. A question arises, are only three data points sufficient to represent the time Sequence B or C within Sequence A? It certainly is not desirable and is an example of "messy" data. This situation was considered to be sufficient for trend analyses because this study represented the first statewide analyses for trends. Fortunately, this was not a common situation and, hopefully in the future, available data will be less "messy."

Data Used for Analyses and Explanation of Appendices

All data presented in this report represent a collaborative effort among the five water management districts, the U.S. Geological Survey and the Florida Geological Survey for spring data, plus Alachua, Palm Beach, Broward, Miami-Dade, Lee, and Collier Counties for well data. This is significant since each sampling agency has its own agenda resulting in different reasons for the collection of a particular analyte.

Resultant data for both springs and wells can be found in Appendix H. The appendix contains the actual concentrations for the analytes measured. The state is broken down into three regions, Northwest, Central, and South Florida. Within each regional folder, the data are placed in their respective WMD. Missing data were noted with an asterisk. In the folder, the results of the MK analyses along with the corresponding n (number of data points) and the Sen Slope (SS) for each spring and well (to be discussed later) can also be found. The format is similar to that within the data folder. Finally, plus/minus charts (to be discussed later) are also included.

The data in the statistical analysis folder are temporal data. A numerical value of -9999 was included to maintain the order of the spread sheet. A value of -9999 can either mean that data are missing or it can mean that there are an insufficient number of samples to perform the statistical analyses (procedures to be discussed later).

The remaining data were placed in tables. The tables contain the following information: (1) the identification (ID) that names the spring (or well), (2) its location in latitude and longitude, (3) the time sequence, (4) the dates for which samples were obtained, (5) a p-value for significant increase, (6) a p-value for significant decrease, (6) the total number of samples within the sequence, (7) the calculated SSs, and (8) the trend results. With regards to the results, the tables indicate whether there was a significant increase (UP), decrease (DOWN), or no evidence of trend. Throughout this report an upward trend will be designated with either an up arrow (↑) or a plus sign (+). A downward trend will either be designated with a down arrow (↓) or a negative sign (-).

INFORMATION GOALS AND DATA ANALYSIS PROTOCOLS

Information Introduction

The purpose of data analyses was to document water-quality trends in Florida's springs and wells for the period 1991 - 2003. Prior to evaluation, a list of information goals was developed. The goals were then turned into specific questions for which statistical procedures could be used in an attempt to answer them. The questions are listed below and are followed by a discussion of the statistical procedures used in this report. A more detailed discussion of all statistical procedures used in this report can be found in Appendix E.1 and E2. Minitab Release 14 (Minitab, 2003) and S-PLUS 6.2 Professional Edition (S-PLUS, 2003) were used for all analyses. The six questions were:

1. What were the statistical distributions for each of the sampled analytes?
2. For Sequence A (the longest time sequence), for each analyte, and for each spring or well, was seasonality present?
3. For each sequence, for each analyte, and for each spring or well, were linear time series trends present?
4. If trends were present, what were their slopes?
5. For springs or wells with detectable trends, were they spatially related?
6. If evidence was found to indicate that the degrading trends were man-induced, what are plausible solutions and recommendations?

Overview of Statistical Analyses Procedures

Descriptive Statistics

Descriptive statistics were produced for each analyte at each spring and well (station) for the longest time sequence. The descriptions can be found in Appendix I. For each sampled station for Sequence A, the tables list the analyte (or indicator), the measurement unit, the number of samples collected, the number of samples with concentrations below the laboratory detection level (BDL), the minimum value, the first, second and third quartiles, and the maximum value. The first, second and third quartiles (Q1, Q2, and Q3) correspond to the 25th, 50th (median), and 75th percentile respectively. An example of the descriptive statistics is presented in Table 6. For a given analyte, the reported minimum concentration value in the table often reflected the minimum detection level reported by the analytical laboratory.

Table 6. Example of Descriptive Statistics Table
(Sequence A; January, 1991 – December, 2003)

Analyte	Meas. Unit	Num. Samp.	Num. BDLs	Min Value	Q1 Value	Median Value	Q3 Value	Max. Value
NO_3	mg/L	30	7	0.05	0.09	1.00	2.00	10.30
PO_4	mg/L	29	4	0.05	0.10	0.10	0.15	1.30

Kruskal-Wallis, Mann-Whitney, and Wilcoxon Rank Sum Tests

Seasonality can be thought of as periodic fluctuations or cycles. As an example, Figure 11 displays monthly water temperatures for an imaginary well during the 1992 calendar year. Not surprisingly the temperature is highest during the summer and lowest during the winter months, indicating that for temperature there exists a one year cycle.

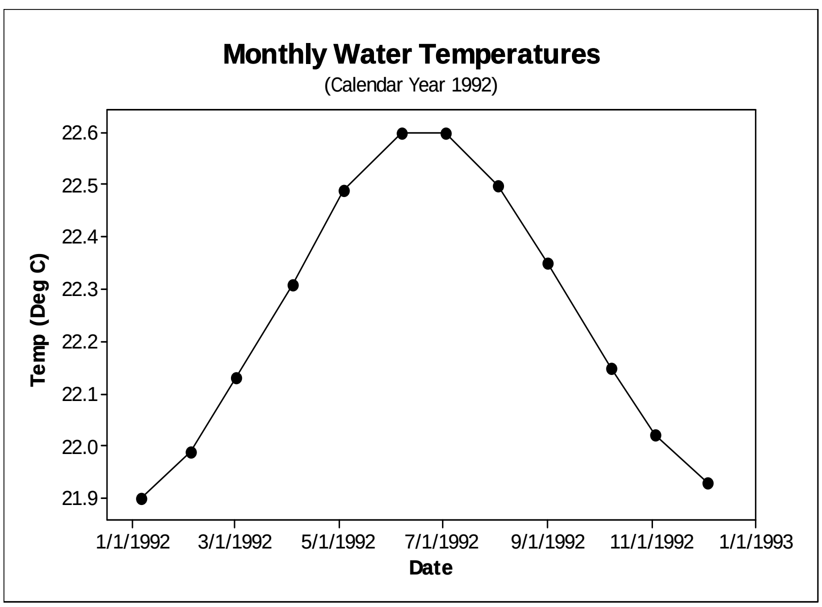


Figure 11. Monthly water temperatures plotted over the 1992 calendar year for an imaginary well.

Cycles are not restricted to calendar years. They can occur over virtually any length of time. Figure 12 displays an example of a cycle longer than one year. In the example, the concentration of an imaginary analyte has a six year cycle or season. Depending on the variable of interest, it may or may not have been influenced by cycles whose frequencies are longer than 13 years; Sequence A was 13 years in length (1991–2003). It is difficult to make that determination of the cycle's influence on the analyte. With this in mind, the authors were concerned with the influence of shorter term cycles on Sequence A. Since ground-water samples were collected on a quarterly and monthly basis while springs were sampled either on a quarterly or quasi-quarterly fashion, it was decided to determine if cycles in those frequencies were present in the data.

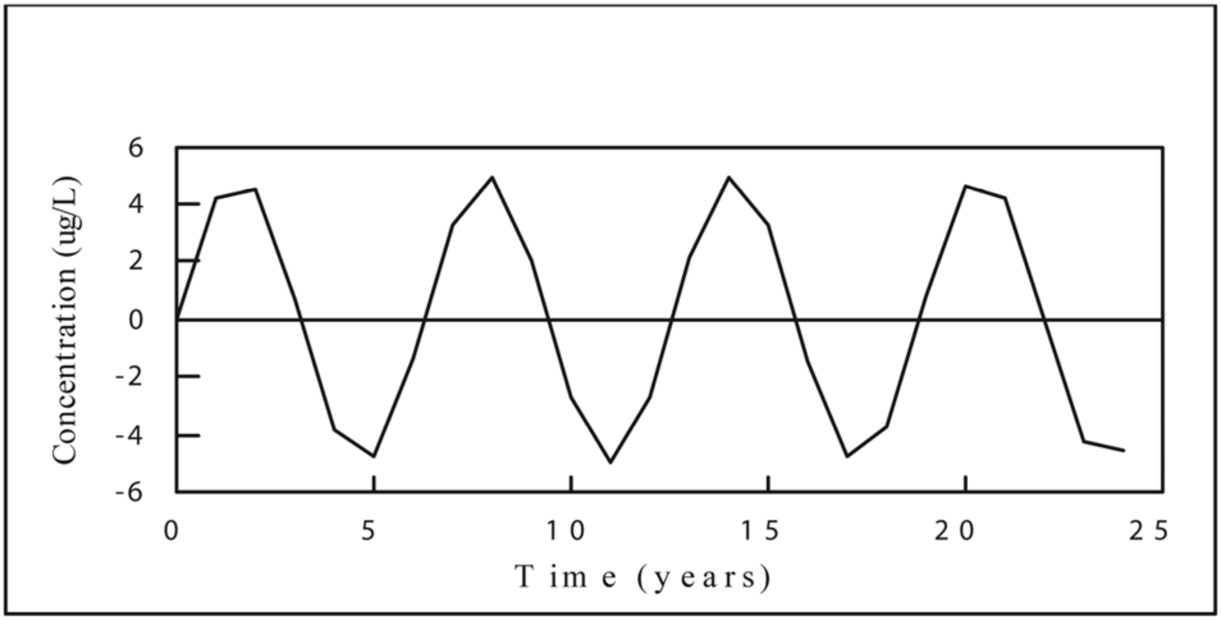


Figure 12. Example illustration of seasonality with a six-year cycle.

For each spring or well for Sequence A, the presence of seasonality for each sampled analyte was determined using a Kruskal-Wallis (KW) test (Hollander and Wolfe, 1973; Gilbert, 1987). Quarterly and monthly seasonality tests were conducted because stations were generally sampled quarterly and occasionally monthly. It should be noted that monthly seasonality tests could only be conducted if samples were collected on a monthly or quasi-monthly basis. For the most part, monthly samples were only collected for 24 of the 46 wells and only for field analytes. On the other hand, quarterly samples were obtained on the remaining wells and quasi-quarterly samples were collected on most of the springs. The quasi-quarterly sampling by the WMDs and the arbitrary seasonal breakdown was as follows: (1) December - February, (2) March - May, (3) June - August, and (4) September - November. It should be noted that as we conducted the analyses for trends, we found that, based on the four arbitrary seasons, most analytes did not display significant seasonality. We recognize that in the future, with the acquisition of additional data and with additional trend analyses, a better breakdown may be discovered. Nevertheless, for this analysis exercise, the KW test was used to compare the distribution of two or more populations (seasons) by indirectly comparing their median values during each season as defined by this study. If we had defined only two seasons, the KW test is equivalent to a Mann-Whitney (MW) test (Conover, 1999). Both tests are discussed in greater detail in Appendix E. It should also be noted that the results of the MW test are identical to another very similar test; the Wilcoxon rank sum test (WT) (Conover, 1999). The WT test was occasionally used during this study because some of the statistical software used included the WT test rather than the MW test. Conover (1999) discusses the WT test in detail. Results of the WT test are identical with those of the MW test.

Consider a situation in which one wants to determine if two populations have the same statistical distributions for a given season and samples are therefore obtained for each season. For the MW test, the null hypothesis is that the median of the two populations are the same while the alternate hypothesis is that they are not. The two samples are combined into a single ordered sample from smallest to highest. Each observation is then assigned a rank without regard to which sample it originally came from. The sum of the ranks assigned to those values from one of the populations is then generated. If the rank sum of the corresponding population is very small (or very large), there is an indication that the values from one population tends to be smaller (or larger) than the values from the other. If so, the distributions of the two populations are not equal. If the rank sums of the two populations are not equal, neither are their medians.

Returning to the KW test, it compares the distribution of more than two populations (e.g., seasons). For this report, each test was two-sided. The null hypothesis is that the median concentration of an analyte sampled in any season is equal to the median of the remaining seasons. The alternate hypothesis is that the median concentration for at least one season is not equal to the others. Under the latter scenario, it is assumed that seasonality does exist. For quarterly data, tests were conducted assuming that each quarter was a season. For monthly data sets, tests were conducted assuming that each month was a season. The level of significance was preset to $\alpha = 0.05$.

For example, 38 temperature samples were collected at Weeki Wachee Main Spring for time Sequence A. However, data were not available for the period 1991 through most of 1993. Data were available for the 1993-2001 time frame. All samples were sampled on a quarterly basis; nine in each of seasons (1), (2), and (4), plus ten in season (3). The KW test compared the median values for each of the four seasons and, based on the test, it was concluded that the median of at least one season did not equal the other medians. Thus, it was concluded that quarterly seasonality does exist for the spring with respect to temperature. Since monthly data were not available, no conclusion could be made regarding monthly seasonality. Results for these analyses are found in Appendix J.

Deseasonalized Data

If seasonal cycles were present in the data, the data were deseasonalized using a method presented by Intelligent Decision Technologies (1998). Although most measurements of central tendency used in this report pertain to the medians, means were used (Sen, 1968) in the deseasonalization transformation equation (Intelligent Decisions Technologies, 1998). The Sen method subtracts the mean of the corresponding season from each datum and then adds the overall average (mean) of the sequence back to the original datum. For example, suppose 10 years of quarterly data were collected at a site for chloride. Suppose the overall mean of the data for the 10 year period was 1.0 unit while the mean of the winter quarter was 0.2 mg/L. Now suppose a concentration for a particular winter quarter sample was 1.2 mg/L. In mg/L, the corresponding transformed, deseasonalized datum becomes:

x = (original) – [seasonal (winter) mean] + (overall mean) = (transformed x)
x = 1.2 mg/L – 0.2 mg/L + 1.0 mg/L = 2.0 mg/L.

Mann-Kendall Test

Gilbert (1987) stated that the Mann-Kendall (MK) test can be viewed as a nonparametric test for zero slope of the linear regression of time-ordered data versus time. Given that it is a nonparametric technique, it does not depend on an assumption of a particular underlying distribution. The test identifies correlations in data through temporally ranking the data and then determining the number of times the concentration goes up or down relative to the previous time step. It only uses the relative magnitudes of the data rather than their measured values.

Data reported as trace or below the minimum detection level (MDL) were used by assigning a common value that was smaller than, or equal to, the smallest measured value in the data set. For this report, below detection level (BDL), was assigned an arbitrary value equal to the detection level (DL).

Once the seasonality tests were completed (results found in Appendix J), each analyte was tested for a linear trend using the MK test ($\alpha = 0.05$) for each time sequence. A macro program was used for the analysis while working within Minitab [Appendix E.1)]. However, if data were insufficient ($n < 10$), the MK test was not conducted. For this exercise, we always used a one-sided test. The reason was that we had a preconceived idea as to whether or not a downward (or upward) trend was an indication that conditions were getting worse (or better). The results of the MK tests are found in Appendix K.

Seasonal Kendall Test

A common test used in the analyses of time series is the Seasonal Kendall (SK) test (Gilbert, 1987). It is an adoption of the MK test, and can be used if there is seasonality in the data. The SK test is the technique of choice. Unfortunately, it has a set of requirements that were not obtainable. Miller et al. (2004) mentioned that the test requires that the percentage of censored data (e.g. data reported as BDL) be no more than about five percent. In addition, Miller stated that there should only be one censoring level. This latter requirement was not obtainable because our data were obtained from agencies operating independently of each other. The agencies used multiple laboratories with multiple detection levels, which amounted to multiple censoring levels. Thus, the SK test was not used in this investigation. In the future, as better and more consistent data are obtained, the SK test is the recommended test.

Sen Slope

If a trend was found to exist for either non-seasonal or seasonal data, its corresponding slope was determined using a Sen Slope (SS) estimator (Sen, 1968; and Gilbert, 1987). The estimator measured the median difference between successive concentration observations over the time series. The SS was used only to measure the magnitude of the slope. It was not used as a hypothesis test. Results are found in Appendix K.

Sign Test

For each analyte exhibiting a trend, a map showing the location of the corresponding station was created. In addition to statistical evaluations, visual estimates were made as to whether clusters of corresponding upward or downward trends existed. Associations with depth, land use, and other relationships were evaluated. The last statistical procedure used was the sign test (Sullivan, 2004). The sign test is a relatively simple procedure to conduct. It was used to determine if a significant number of stations demonstrated upward or downward trends over a geographical region. Note that one spring in the SWFWMD was not used in the analyses. The reason will be discussed later.

As an example, suppose during Sequence A, 29 of the 57 springs displayed an upward trend for nitrate. Can it be concluded that there exists an upward statewide trend? What if 40 (or 45) of the springs demonstrated upward trends? If one thinks of the causes of trends in individual stations as being random processes, we could expect about half of the springs to have upward trends, while about half should have downward trends. On the other hand, if a large proportion of the springs had upward trends, we might be suspicious that one or more phenomena were affecting springs and causing the upward trends over a region. Finally, if an extremely large proportion of the springs demonstrated upward trends, we would become even more confident that the phenomena were affecting the upward concentrations over a region.

For the sign test, one assigns a (+) value if there is an upward trend and a (-) value if there is a downward trend. Sullivan (2004) stated that zeros add nothing to the test and therefore should be eliminated from further analysis. Thus, all springs demonstrating no trend were assigned a value of zero (0) and were eliminated from further analyses. The test simply compares the proportion of + values to the – values. For this exercise, α was preset to 0.05 for the level of significance for these evaluations.

Caveats and Assumptions

It should be noted that this study was not set up as a designed experiment. We took existing data and attempted to evaluate them. As a consequence, there were many less-than-perfect situations that we needed to address in order to conduct the statistical analyses related to this project. Whenever one takes existing data which were originally collected with a variety of goals in mind and attempts to evaluate them with a new set of objectives, problems should be expected. For example, R.A Fisher, a statistician sometimes referred to as the "*Father of Modern Statistics*" (Sullivan, 2004), once stated, *"To call in the statistician after the experiment is done may be no more than asking him to perform a postmortem examination: he may be able to say what the experiment died of."* This quote is appropriate for our study. We faced many unpleasant situations with regard to the data analyses.

One of the major sources of problems pertained to the assumptions of the statistical procedures (see Appendix E). Generally these tests assumptions are: (1) the measurements are mutually independent, (2) the observations are random, (3) the populations are continuous, and (4) the scales or measurements are at least ordinal. For the sign test, the assumptions are slightly different: (1) the stations are mutually independent, (2) the measurement scale is at least ordinal, and (3) if the probable outcome of a sign is (+) or (-), for one station, the same is true for all other stations. With the exception of the independence issue, the assumptions were valid. The issue of dependency will be addressed during the discussion of the results of the study.

RESULTS

The trend results of every spring and well for each analyte can be found in Appendix K. What follows is a set of examples from selected springs and wells. Our purpose is to give the reader a generalized idea about the behavior of analytes during the study period. Although some discussion regarding the causes of trends at an individual spring will be discussed, the emphasis of this report is on regional and statewide trends. A discussion regarding the possible sources of the analytes and the most probably causes of trends can be found in Upchurch (1992) and Appendix B2. The trend results are divided into both springs and wells by water management district. There were no springs analyzed in the SFWMD. Thus springs were geographically divided into the NWFWMD, SRWMD, SJRWMD, and SWFWMD. A note is needed regarding the relationship between time-series figures and Sequences. If sufficient data were available, time series analyses were generated for each Sequences A, B, and C. However, if data were missing for the front or back end of the Sequence, the corresponding figures still cover the entire sequence. As an example, the first series discussed is for magnesium in Wakulla Spring during Sequence A (1991-2003). Unfortunately, no data exists for the last two years of the sequence. Nevertheless, the figure displays the entire sequence. This is true for all time series discussed.

Springs

Northwest Florida Water Management District

In the NWFWMD, only Wakulla Spring (Figure 13) had sufficient data for analyses for this study. Wakulla was sampled through a piece of tubing placed into a major conduit of the spring. Thus, the samples are considered spring-water samples. However, for years, the FDEP has, for administrative purposes, considered the tubing to be a well (Well 67 in the Temporal Variability Network). Since FDEP considers the station to be a well and the fact that the tubing taps a spring vent, the station for this report was analyzed both as a spring and a well. Stage data were collected at the spring vent, and stage was used in lieu of water levels.

Rock and Saline Analytes, Nutrients, and Flow

Rock-matrix analytes included cations such as calcium and magnesium. Wakulla Spring shows an increase in dissolved magnesium over time Sequence A (1991-2003). Increases in magnesium and specific conductance (SC) are illustrated in Figure 14. The time series for magnesium at Wakulla, like many analytes, showed inconsistent sampling over the period of record. In this case the time period from 1994 to 2000 contained only one point. For the given data, the MK

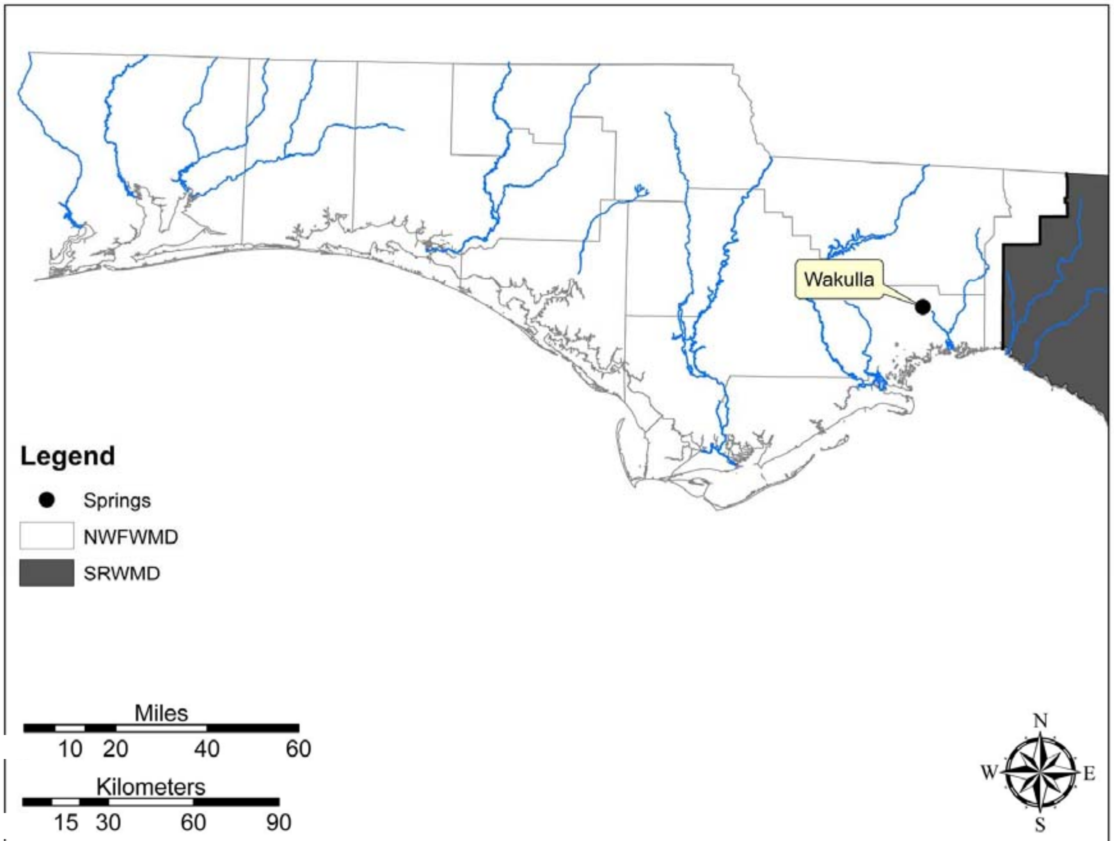
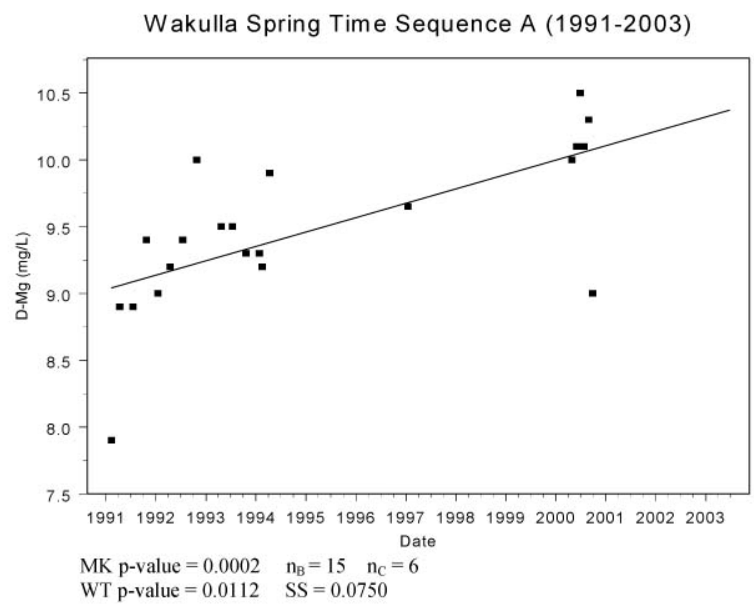


Figure 13. Location of Wakulla Spring within the NWFWMD.

test confirmed an increasing trend ($p < 0.05$). For almost every time-series figure, the median value of the second half of the sequence was compared to median of the first half, using the Wilcoxon rank sum test (WT). This enabled us to not only determine the slope of the trend, but to also better evaluate magnitude of change during the time series. There was a significant change over the period of record ($p < 0.05$). Whether by analysis of trends, or comparison of two halves of the time sequence, the latter half of the study revealed elevated values of dissolved magnesium. The missing data from the intervening years in the magnesium time series (Figure 14, top) appear to be accounted for in the time series for SC (Figure 14, bottom). Wakulla Spring showed a clear increase in SC over time. The probable causes for the increases in magnesium and SC, will be discussed later on a districtwide and statewide perspective.

Figure 15 (top) displays a trend for nitrate-nitrite concentrations in Wakulla Spring for the 1991-2003 time frame. The time series shows noticeable data gaps from 1995 to 2000 and again during 2001-2003. In the Wakulla Basin, Chelette et al. (2002) indicated that there are several significant sources of nutrients. These include effluent from a large spray field, fertilizer application, and numerous onsite waste disposal treatment sites (OSTDS) within the basin, and up-gradient of the spring. Fortunately, it appears, since 1991, the concentration of nitrate has significantly decreased. Nitrate in the form of dissolved nitrate-nitrite declined (Figure 15, top).



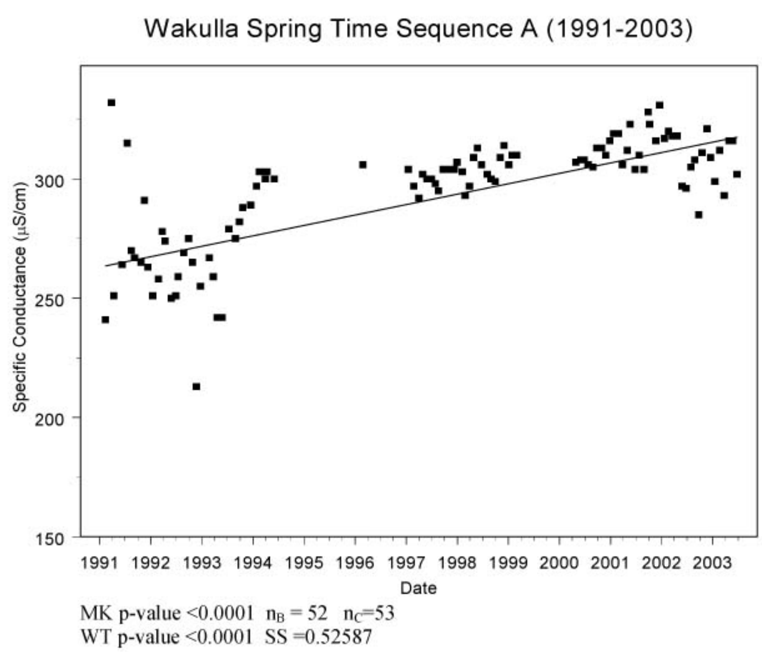
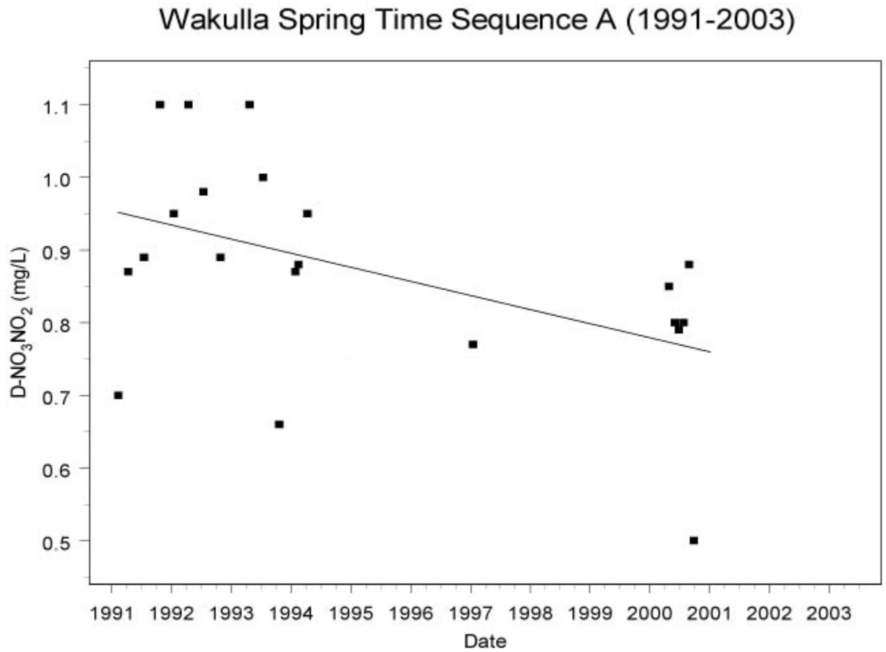
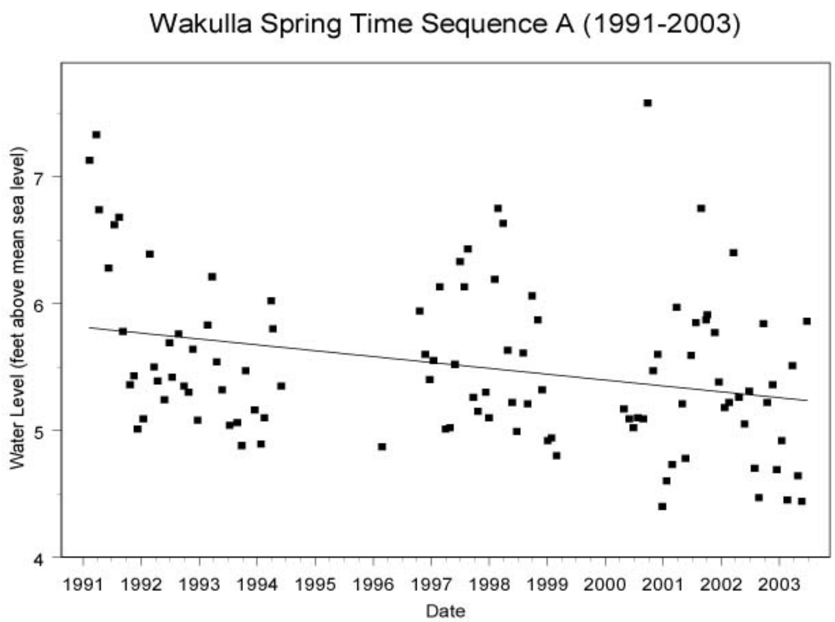


Figure 14. Increasing rock analytes at Wakulla Spring. Magnesium (top) and specific conductance (SC) (bottom) have upward trends ($p < 0.05$). Tests include MK for time series trends, (WT) on sequences B and C (first and second half of study), plus SS calculations on the rates of changes.



MK p-value = 0.024 n_B = 15 n_C = 6
WT p-value = 0.035   SS = -0.01



MK p-value =0.0005 n_B= 52 n_C=53
WT p-value =0.0412   SS =-0.0063

Figure 15. Decreasing nitrates and water levels at Wakulla Spring. Dissolved nitrate (top) and water levels (bottom) had significant trends. Tests (p = 0.05) included MK and WT. WT compare medians of the first and second halves of the study. (1.0 m = 3.3 ft)

MK and WT tests indicate that whether by trend analysis or comparison of the first and second half of the time sequences, concentrations of nitrogen decreased. Loper et al. (2005) suggested that the decreasing nitrate concentrations were due to lowered concentrations of effluent from a large spray field located within 16 km (10 mi) of the spring. Figure 15 (bottom) illustrates a significant drop in stage level.

Suwannee River Water Management District

Figure 16 displays the locations of the 15 springs located in the Suwannee River Water Management District (SRWMD) used in this report. The spring names and the abbreviations are found in Table 7.

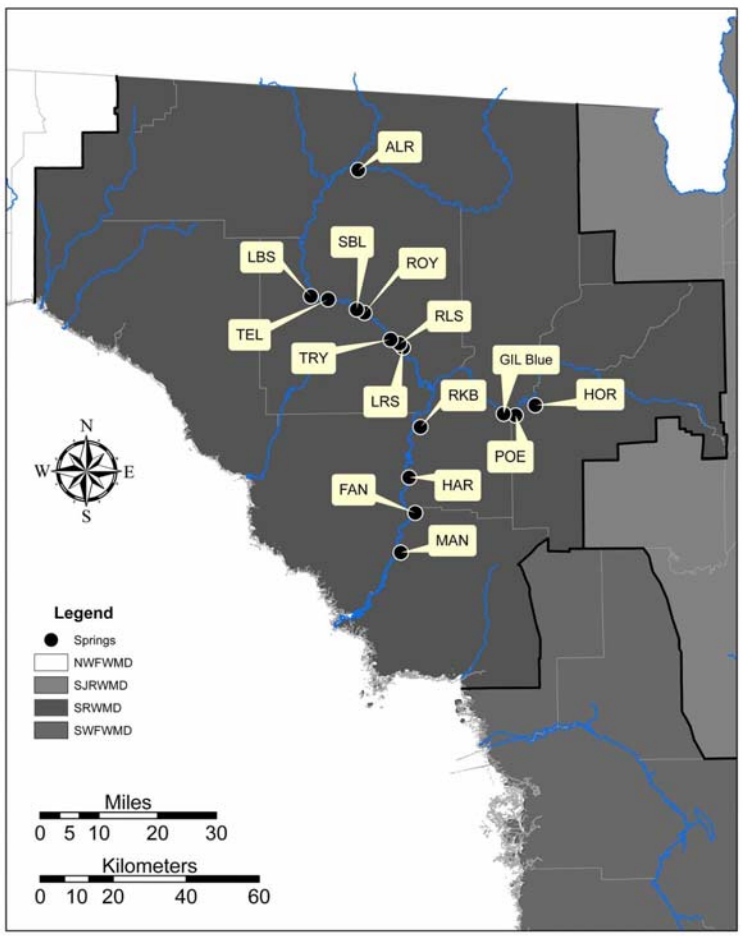


Figure 16. Location of springs within the SRWMD.

Table 7. Suwannee River Water Management District Spring Names and Abbreviations.

Spring	Abbreviation	Spring	Abbreviation
Alapaha Rise	ALR	Poe Spring	POE
Gilchrist Blue Spring	GIL Blue	Ruth/Little Sulfur Springs	RLS
Fanning Spring	FAN	Rock Bluff Spring	RKB
Hart Spring	HAR	Royal Spring	ROY
Hornsby Spring	HOR	Suwannee Blue Spring	SBL
Lafayette Blue Spring	LBS	Telford Spring	TEL
Little River Spring	LRS	Troy Spring	TRY
Manatee Spring	MAN		

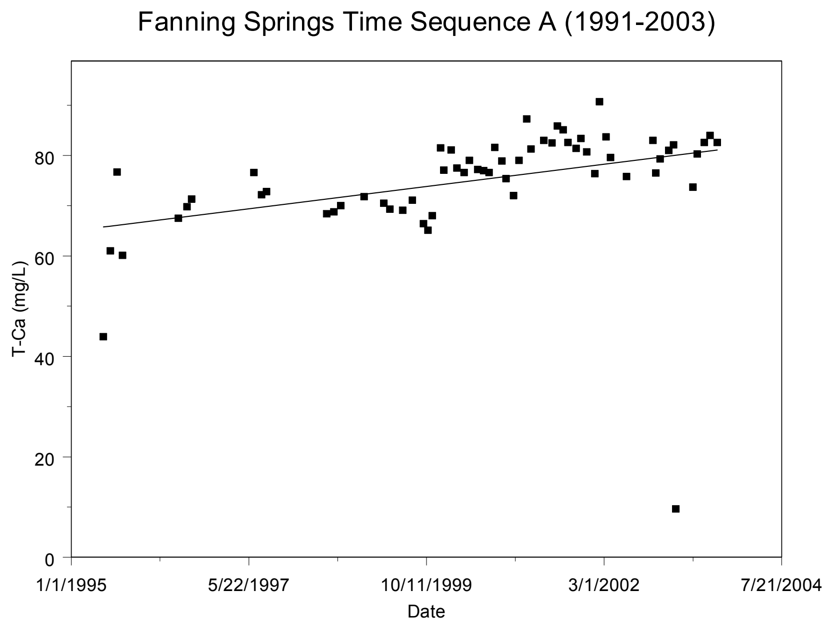
Many of the springs are located along the Suwannee River, along a section of the river which is roughly perpendicular to the coast, at least in its lower stretch. Numerous trends were noted along an approximate south to north, or lower to upper, river direction. (Specific results are found in Appendix K).

Rock-Matrix and Saline Analytes

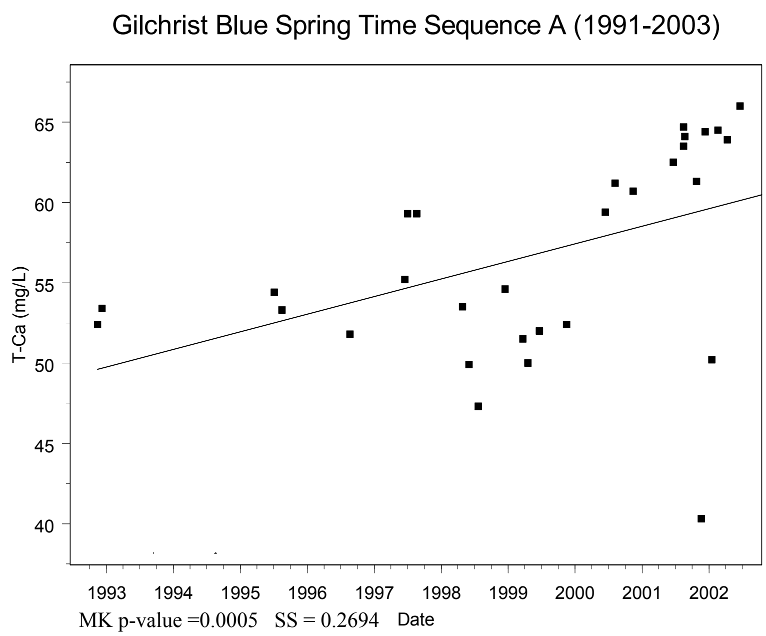
Calcium, magnesium, and sodium increased strongly in the SRWMD over Sequence A. Increases were particularly strong in the latter half of the study (Sequence C). Increasing trends were dominant for several analytes. Magnesium and sodium had significant increases in eight of 14 springs with no decreases. Calcium increased in nine springs. Examples of increases in the rock indicators are shown in Figures 17-20. Figures 17 and 18 illustrate trends in calcium for four springs over Sequence A while Figures 19 and 20 demonstrate patterns for magnesium for four springs over Sequence A or C, depending on the spring.

Note that for many of the time-series figures that compared two stations, the vertical scales do not coincide. By keeping the vertical scales constant, occasionally the variability of one graph became so small that you could not see it. In the end, we decided it was better to use inconsistent vertical and to emphasize variability over time.

Changes in calcium in springs for the lower Suwannee River are similar to changes in springs farther north. Fanning Spring (FAN) and Gilchrist Blue Spring (GIL Blue) illustrate two of the nine springs that exhibited an increase in calcium (Figure 17). In addition to calcium, FAN showed significant increases in other rock-matrix and saline indicators including alkalinity, chloride, potassium, magnesium, sodium, and specific conductance. The time series plot in Figure 17 shows a gradual increase in calcium from 60 mg/L in 1995 to approximately 80 mg/L in 2003; the gradual increase had a low variance around the best fit line. When data for sequences B and C were compared, Sequence C data had clearly higher medians (WT test p-value, <0.0001, illustrated by box plots in inset figure in bottom corner). Like FAN, for Sequence A, calcium concentrations in GIL Blue increased. The initial concentration was about 50 mg/L and ended with 65 mg/L; both springs increased in concentration by approximately 20 mg/L. GIL Blue also had many other analytes with upward trends that mirrored FAN: alkalinity, chloride, magnesium, sodium, and specific conductance. Springs farther north (Figure 18) had similar looking trends to those springs located farther south (Figure 17), although the overall trends in other analytes were different. Suwannee Blue Spring (SBL) and Troy Spring (TRY) together had increases in only

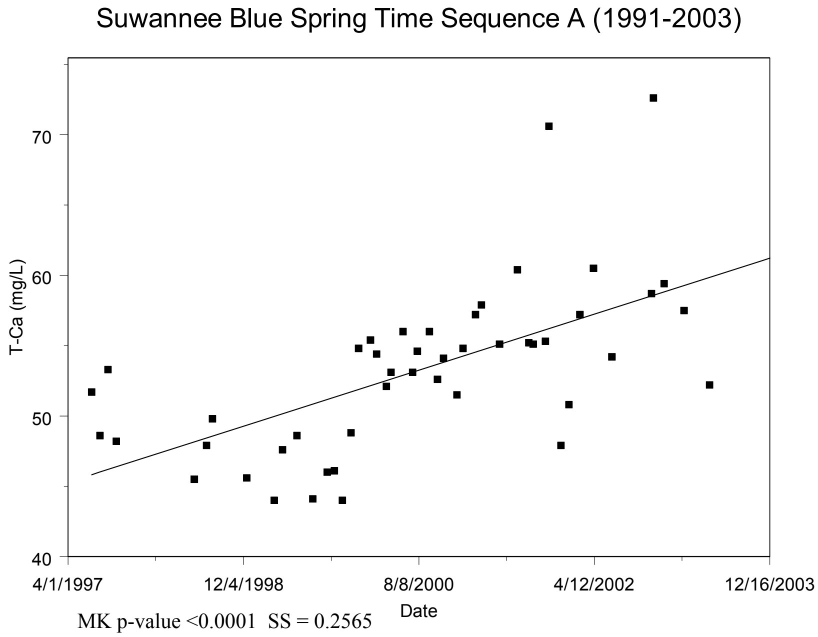


MK p-value =0.0005 n_A= 10 n_B = 40
WT p-value <0.0001 SS =0.2694

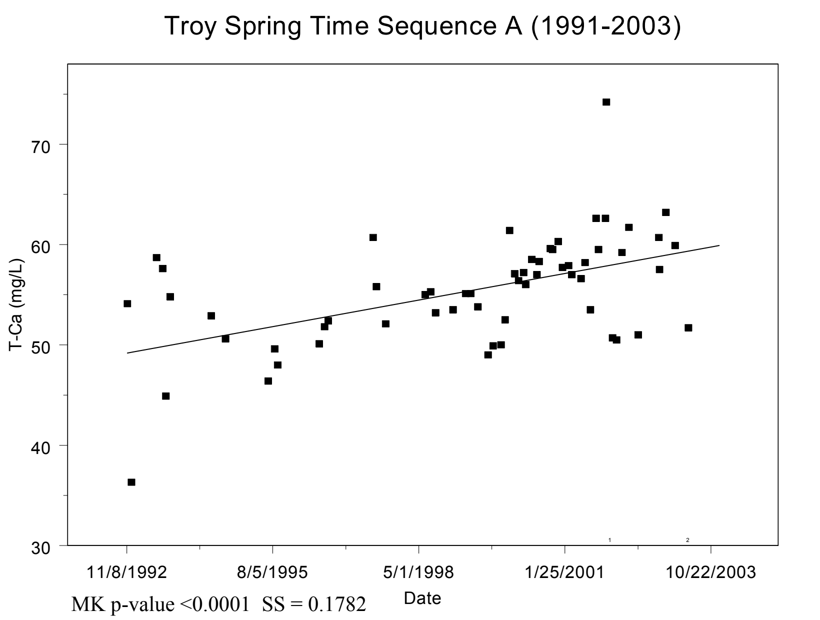


MK p-value =0.0005 SS = 0.2694
WT p-value =0.0563 n_A = 8 n_B = 33

Figure 17. Increasing rock analytes at Fanning and Gilchrist Blue Springs. Fanning (top) and Gilchrist Blue Springs (bottom) had significant increases in calcium. Tests ($p < 0.05$) included MK for for trend, WT on Sequences B and C, plus SS calculations on the rate of change. Beginning and ending sampling dates for the two springs are not the same.



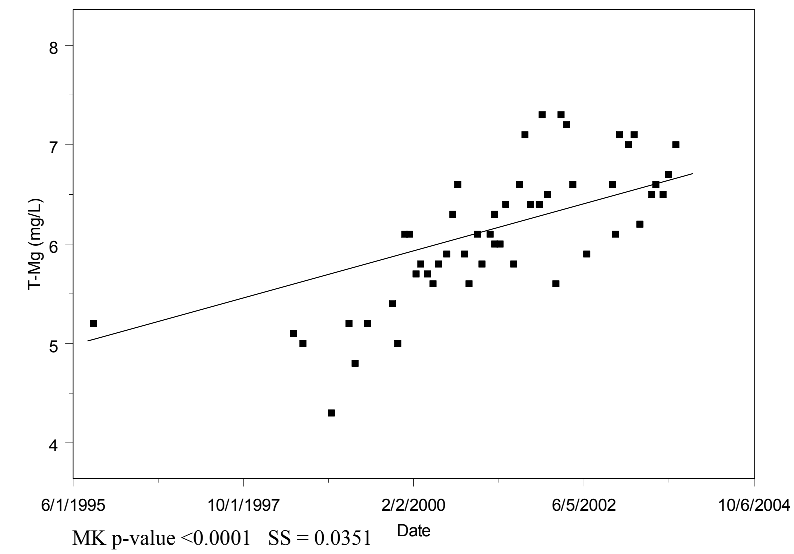
MK p-value <0.0001 SS = 0.2565
WT p-value <0.0001 $n_A = 23$ $n_B = 24$



MK p-value <0.0001 SS = 0.1782
WT p-value =0.0006 $n_A = 18$ $n_B = 42$

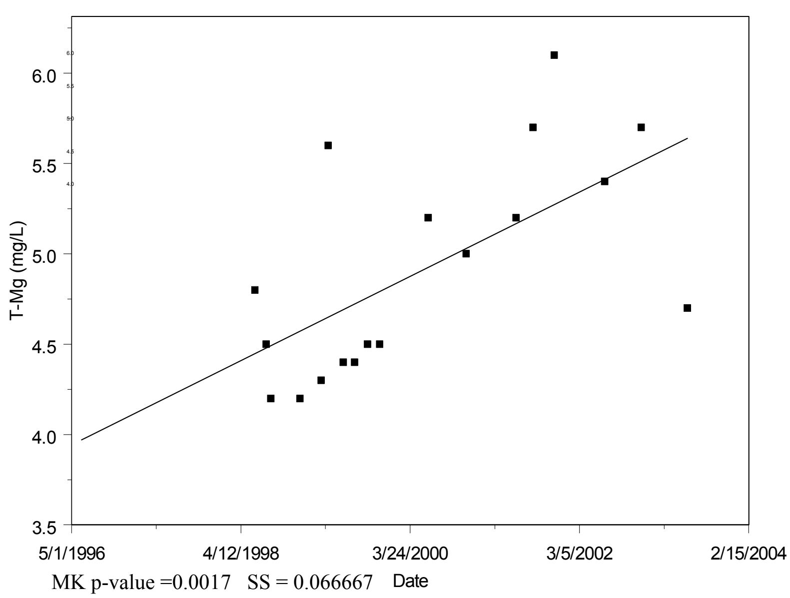
Figure 18. Increasing rock analytes at Suwannee Blue and Troy Springs. Suwannee Blue (top) and Troy Spring (bottom) had significant increases in calcium. Tests ($p < 0.05$) included MK for trend, WT on Sequences B and C, plus SS calculations on the rate of change. Beginning and ending sampling dates for the two springs are not the same.

Manatee Spring Time Sequence A (1991-2003)



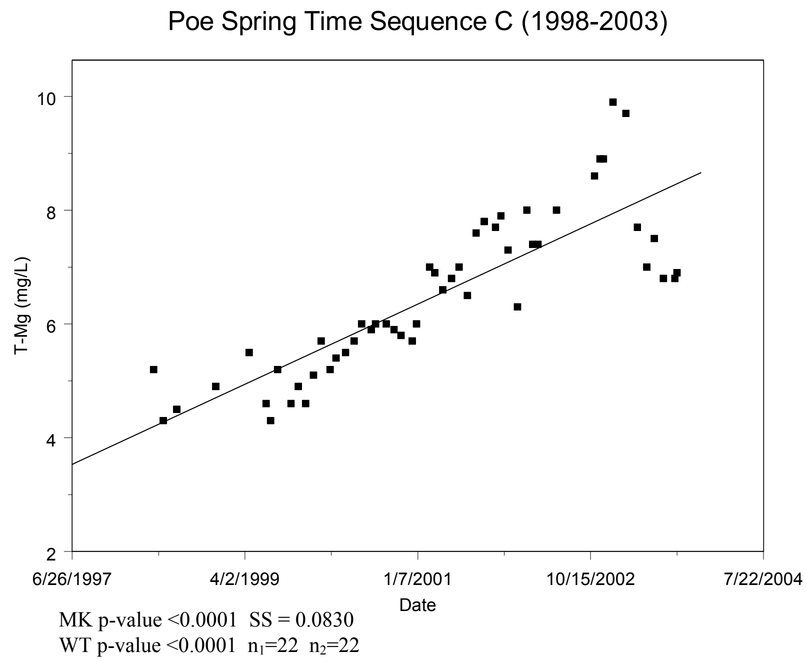
MK p-value <0.0001 SS = 0.0351
WT p-value <0.0001 $n_1 = 22$ $n_2 = 22$

Hart Springs Time Sequence C (1998-2003)



MK p-value =0.0017 SS = 0.066667
WT p-value =0.006 $n_1 = 9$ $n_2 = 9$

Figure 19. Increasing rock analytes at Manatee and Hart Springs. Manatee (top) and Hart Springs (bottom) had significant increases in magnesium. Tests ($p < 0.05$) included MK for trend, WT on the first (1) half and the second (2) half of both time series. Beginning and ending sampling date for springs are not the same.



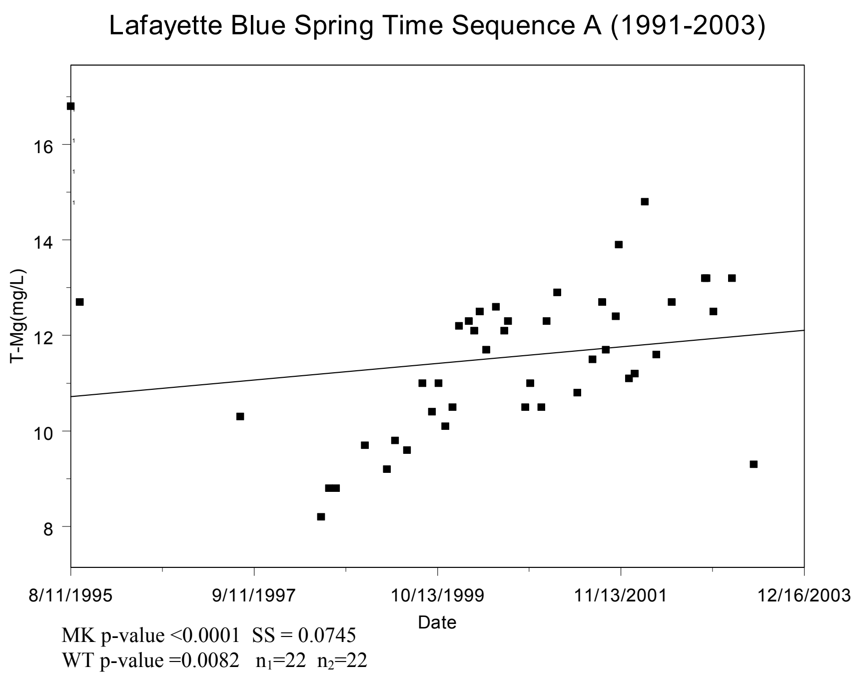


Figure 20. Increasing rock analytes at Poe and Lafayette Blue Springs. Poe (top) and Lafayette Blue Spring (bottom) had significant increases in magnesium. Tests ($p < 0.05$) included MK for trend, WT on the first and second half of both series, and SS calculation on rate of change. Beginning and ending sampling dates for the springs are not the same.

calcium, magnesium and sodium. Unlike FAN and GIL Blue, SBL and TRY exhibited no linked trends in alkalinity, chloride, potassium, or specific conductance.

Toward the south, Manatee (MAN) and Hart (HAR) (Figure 19) began the time series with approximately four mg/L of magnesium; by the conclusion of the series, they were at six to seven mg/L. Further north, Poe Spring (Poe) (Figure 20) began at about four mg/L in 1998 and rose to about 10 mg/L in late 2002. Lafayette Blue Springs (LBS) (Figure 20)(began at about eight mg/L in 1998 and rose to about 14 mg/L in 2001.

Flow

The SRWMD consistently collected flow or discharge data at specific spring vents during the same day that they collected water samples from their springs. However, the SRWMD did not begin collecting discharge data until the 1997-1998 time frame.

During Sequence C, for the SRWMD, flow rates decreased significantly in 12 of 16 springs. There was not an increase in flow rate in any of the springs during the same time sequence. In addition, the degree of decrease in flow was sometimes severe. Figures 21-24 illustrate the trends for eight springs starting at the lower end of the Suwannee River and moving inland and northward.

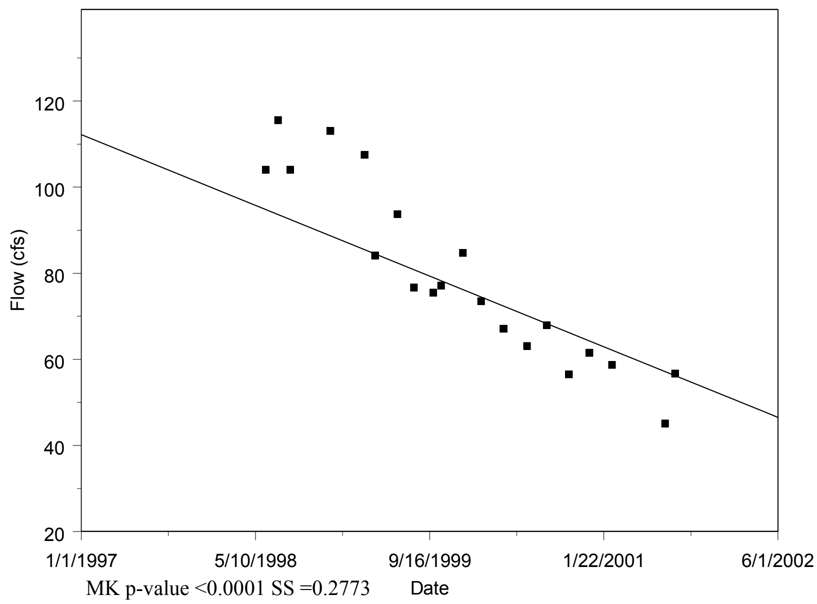
Springs at the lowest end of the Suwannee River included Fanning (FAN) and Hart (HAR) Springs (Figure 21). Both springs show substantial drops in flow levels. By the end of the period of record, flow was reduced to approximately half the levels seen at the beginning of the time series. FAN's highest recorded flows were near 120 cubic feet per second (cfs), but ended near 50 cfs. HAR's highest recorded flow was approximately 90 cfs and fell to near 40 cfs at the end fo the time series.

Upstream from these springs are Rock Bluff (RKB) on the Suwannee and Hornsby (HOR) Springs on the Santa Fe River (Figure 22). Both displayed even sharper declines in flow. Rock Bluff went from a high of 50 cfs to under 20; flow was reduced to zero cfs briefly in 2001. Hornsby showed an even stronger decline: over 200 cfs was measured in 1998 and the flow reduced to zero cfs during a period starting in early 2000. This was followed by a small recovery of flow rate in 2003.

Poe Spring, on the Santa Fe River, and Little River Sulfur Spring (LRS) on the middle Suwannee region had strong declines in flow rate (Figure 23 (Sequence A; but mostly C)). Poe Spring recorded discharges of 60 to 80 cfs near the beginning of the time series but declined to near 20 cfs by the end. LRS began the time series with a flow rate near 90 cfs and ended near 20. Decline in flow at LRS closely followed a regression line fit to the date (Figure 23, bottom).

Troy (TRY) and Telford (TEL) Springs both had downward trends in flow. Though flow at Troy was approximately three times higher than Telford (Figure 24; Sequence A, but mostly C)), there was a slight increase in flow in mid-1998 followed by a decrease for both springs in early 2000, and then another slight increase in flow occurred in late 2001. Overall, both springs seem to show that flow was reduced by at least half, with LRS indicating a reduction in flow by a third at the end of the time series.

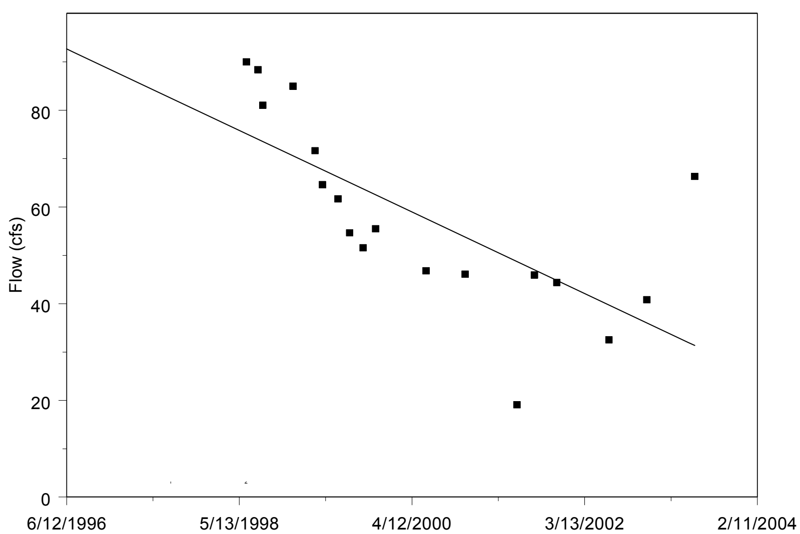
Fanning Springs Time Sequence C (1998-2003)



MK p-value <0.0001 SS =0.2773

WT p-value =0.0002 n_1 =11 n_2 = 11

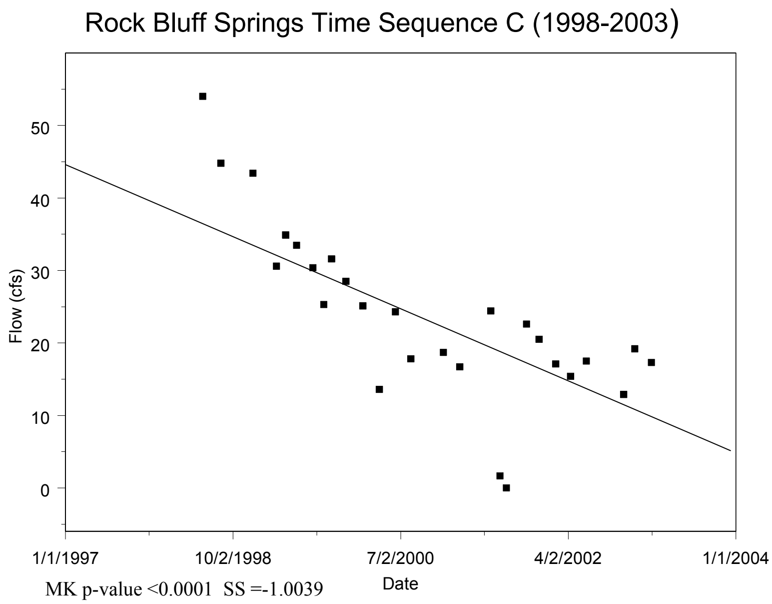
Hart Springs Time Sequence C (1998-2003)



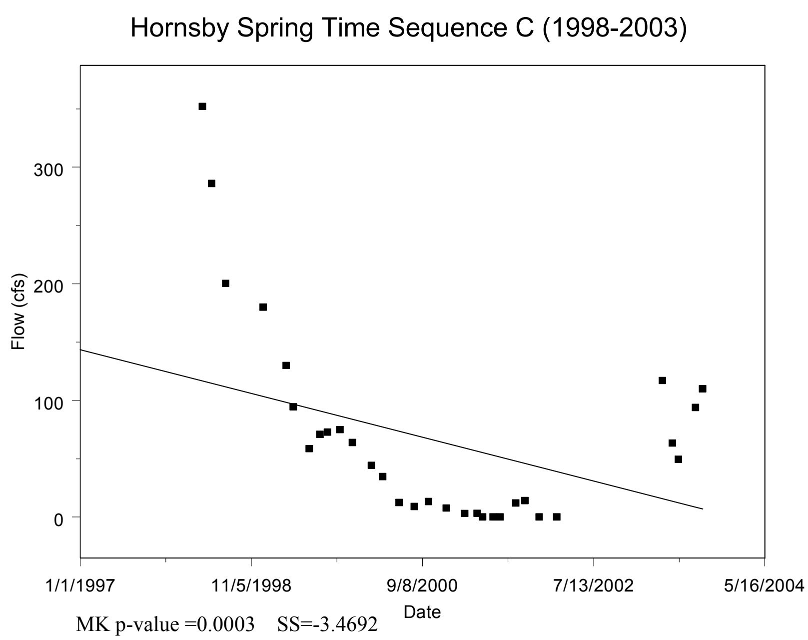
MK p-value <0.0001 SS =-3.2411

WT p-value =0.0012 n_1=9 n_2=9

Figure 21. Decreasing flow at Fanning and Hart Springs. Between 1998 and 2001 Fanning (top) and Hart Springs (bottom) had significant decreases in flow. Tests ($p < 0.05$) included MK for trend, WT, plus an SS calculation on rate of change. Over the period of record, flow at both springs was reduced significantly. Beginning and ending sampling dates are not the same. [One cfs equals 0.028 cubic meters per second (cms).]

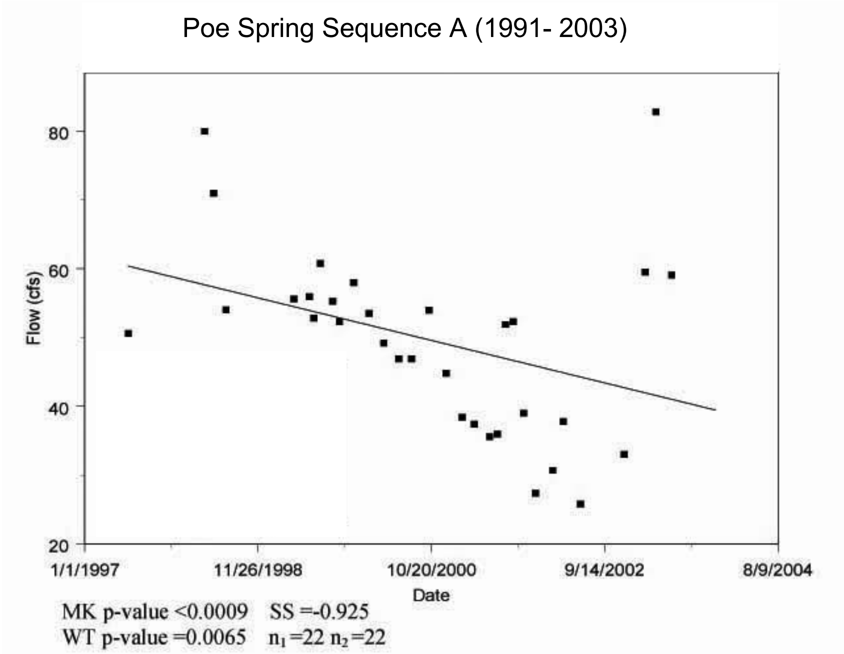


MK p-value <0.0001 SS =-1.0039
WT p-value =0.0001 n_1 =14 n_2 =14



MK p-value =0.0003 SS=-3.4692
WT p-value =0.0006 n_1= 17 n_2 = 17

Figure 22. Decreasing flow at Rock Bluff and Hornsby Springs. Rock Bluff (top) and Hornsby Springs (bottom) had significant decreases in flow. Tests ($p < 0.05$) included MK for trend, WT, plus an SS calculation. For both Rock Bluff and Hornsby, flow reduced dramatically. Hornsby Springs flow stopped for a period after late 2000. Beginning and ending sampling dates are not the same. (One cfs = 0.028 cms)



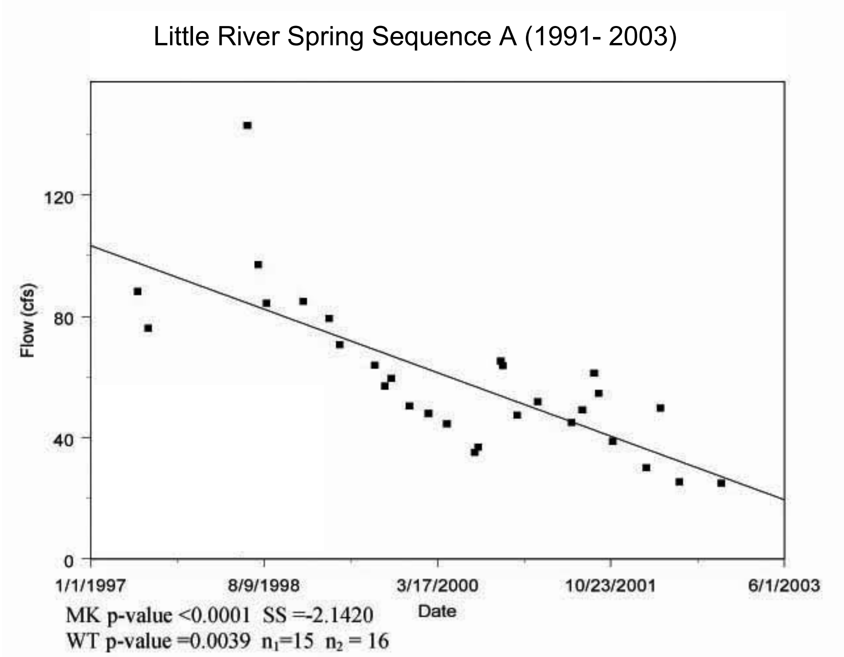
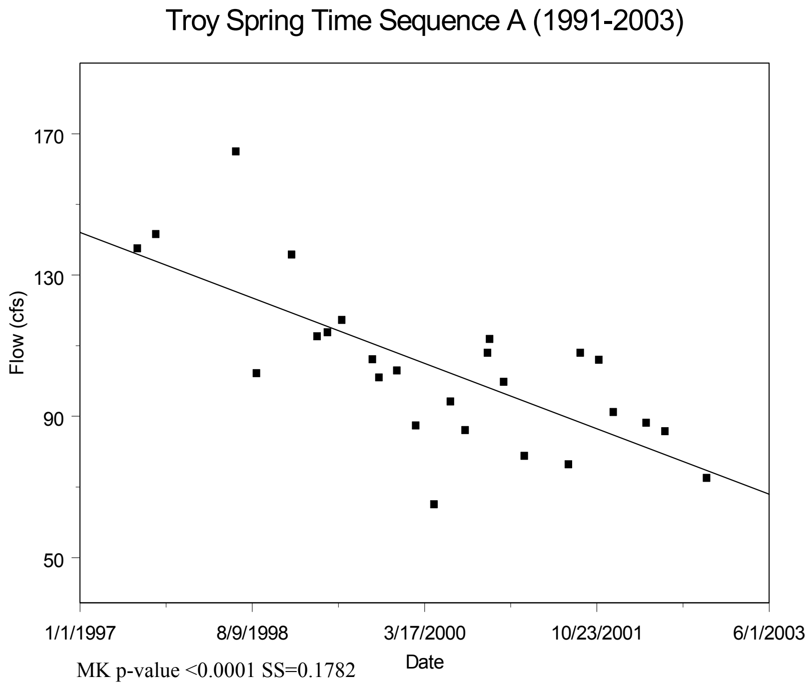
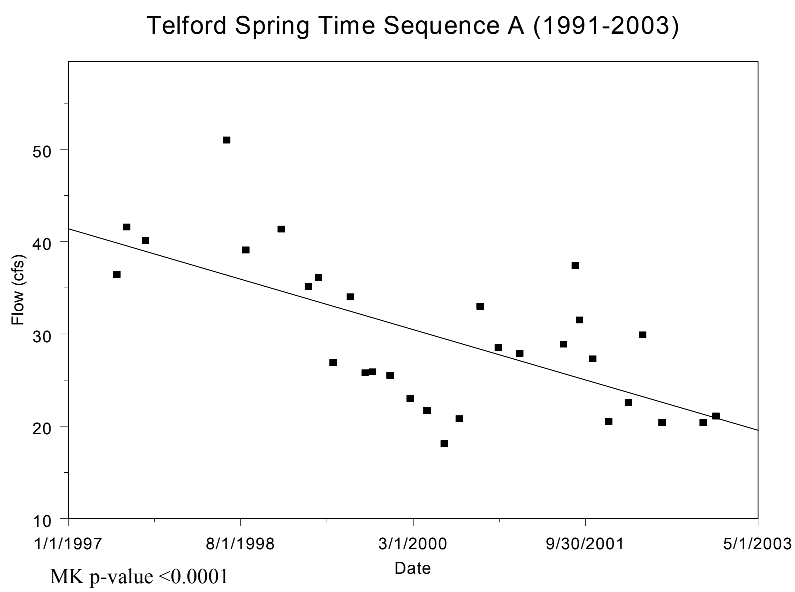


Figure 23. Decreasing flow at Poe and Little River Springs. Poe (top) and Little River Springs (bottom) had significant decreases in flow. Tests ($p < 0.05$) included MK for trend, WT, plus an SS calculation on rate of change. For both Poe and Little River flow reduced to about one third by the end of the series. Beginning and ending sampling dates are not the same. (One cfs = 0.028 cms)



MK p-value <0.0001 SS=0.1782
WT p-value =0.0221 $n_1 = 13$ $n_2 = 13$



MK p-value <0.0001
WT p-value =0.1547 SS =-0.6674
$n_1=15$ $n_2=15$

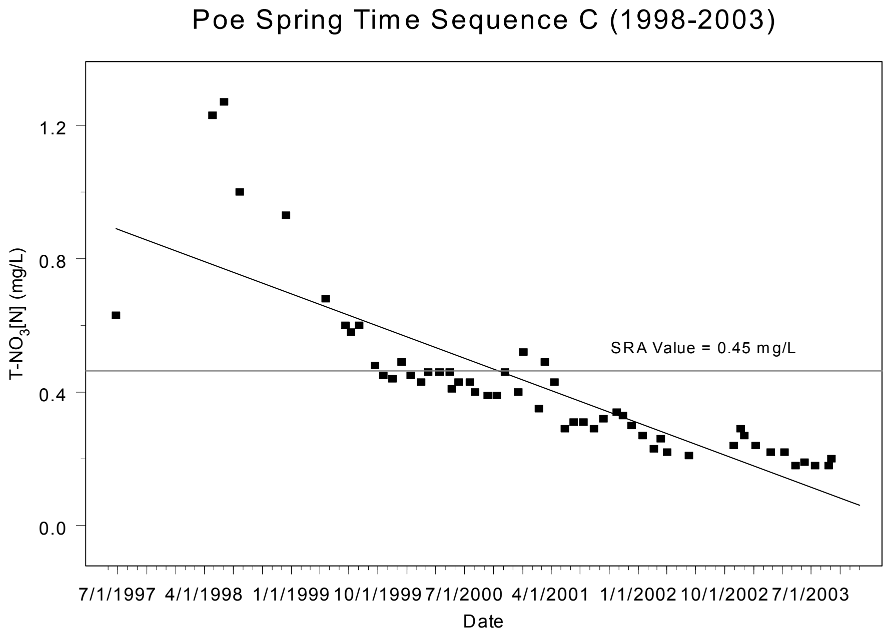
Figure 24. Decreasing flow at Troy and Telford Springs. Troy (top) and Telford Springs (bottom) had significant decreases in flow. Tests ($p < 0.05$) included MK for trend, WT, plus an SS calculation on rate of change. Over the period of record, flow at both Troy and Telford was reduced by half. Beginning and ending sampling dates are not the same. (One cfs = 0.028 cms)

Nutrient Analytes

For the study period, nutrients in the SRWMD had more complex patterns than the patterns of either the salinity indicators or flow. While some nutrient trends were very strong, others were not as clear. During Sequence A, o f the 15 springs in the SRWMD, TKN increased significantly in nine springs (with no decreasing trends). Nitrate appeared to decrease (downward trend in six springs, while it increased in three springs). At the same time, other nutrients—phosphorus and phosphate specifically—appeared to increase. For phosphorus, there were five springs with increasing trends and only one spring indicating a decrease; for phosphate there were four springs with increasing trends and only one spring with a decreasing trend.

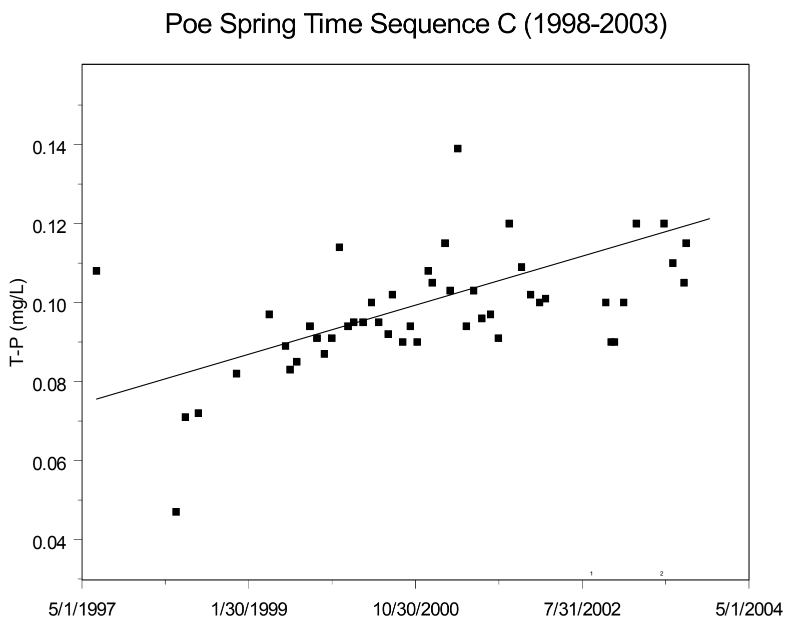
The FDEP has a maximum nitrate standard of 10 mg/L for groundwater and Class I surface water before considering the water impaired. Both water standards are directed toward maintaining drinking water quality (Florida Department of Environmental Protection, 1994). Currently, there is not a numeric standard that is directed toward changes and concentrations of biota in surface water. However, FDEP has established a non-legal threshold for nitrate and phosphorus for surface water (Florida Department of Environmental Protection, 2004). The thresholds were based on a statewide evaluation of chlorophyll concentrations in lakes. The groundwater-surface water relational assessment (SRA) limit is 0.45 mg/L for nitrate. Groundwater nitrate concentrations exceeding the 0.45 mg/L limit suggest that there is a potential for adverse affects on aquatic organisms in the spring runs. Technically, the threshold level applies only to surface water and there is a need to establish a groundwater to surface water interaction for the threshold to be relevant. Since springs represent an interaction between groundwater and surface water, we used the threshold level for comparative purposes. Figures 25 and 26 represent examples of changes in nutrients in springs of the SRWMD. Figure 25 is an example of a decreasing nitrate trend. Nitrate significantly decreased from 1998-2003 for Poe Spring. For comparative purposes the SRA was chosen as a fixed reference and is the gray line in Figure 25. Poe Spring exceeded the SRA recommendations prior to 1999, but then declined to levels below the SRA. Possible reasons for the decline in nitrate in the Suwannee Basin will be discussed later.

While nitrate often decreased in the SRWMD, TKN rose significantly. Phosphorus also exhibited some increasing concentrations. Total phosphorus at Poe Spring (Figure 26) almost doubled from 1999 to 2003. Phosphorus and phosphate both increased at several springs. An even greater number of upward trends, however, were seen for TKN. Figure 26 (bottom) shows an increase in TKN at Lafayette Blue Spring over the study period. The plot also illustrates some of the differences between nutrient and saline trends. While saline and rock-matrix analyte plots give evidence of clear increases, trend lines for nutrient plots were sometimes less well defined and potentially not as strong. Figure 26 shows a significant upward trend for total phosphorus (MK test, $p < 0.05$) though the p-value of 0.0443 does not indicate such a strong increasing trend; data for the first and second half of the time sequence were not significantly different (WT p-value = 0.3633). The potential causes of nutrient and other trends will be discussed later.

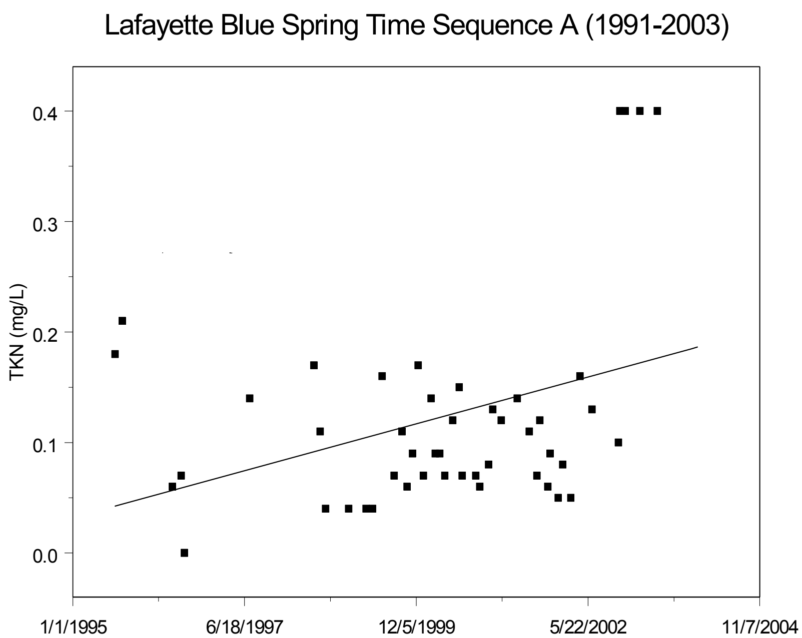


MK p-value <0.0001 SS =-0.0090
WT p-value <0.0001 n_1= 22 n_2 = 23

Figure 25. Decreasing nitrates at Poe Spring. The horizontal line represents The FDEP's SRA limit for total nitrate (0.45 mg/L). Levels exceeded recommended SRA limit prior to late 1999 but since then were significantly lower.



MK p-value <0.0001 SS = 0.0007
WT p-value = 0.0001 $n_1 = 22$ $n_2 = 23$



MK p-value = 0.0443 SS = 0.0012
WT p-value = 0.3633 $n_B = 6$ $n_C = 41$

Figure 26. Increasing nutrient analytes at Poe and Lafayette Blue Springs. Poe (top) and Lafayette Blue (bottom) illustrate two increasing nutrients in the SRWMD: one for phosphorus and the other for TKN. Poe shows a clear increase in phosphorus while TKN at Lafayette Blue illustrates one of the many increasing TKN trends in SRWMD springs. Beginning and ending sampling dates for these springs are not the same.

St. Johns River Water Management District

The springs located in the St. Johns River Water Management District (SJRWMD) and used in this report are found in Figure 27. Spring names and abbreviations are found in Table 8.

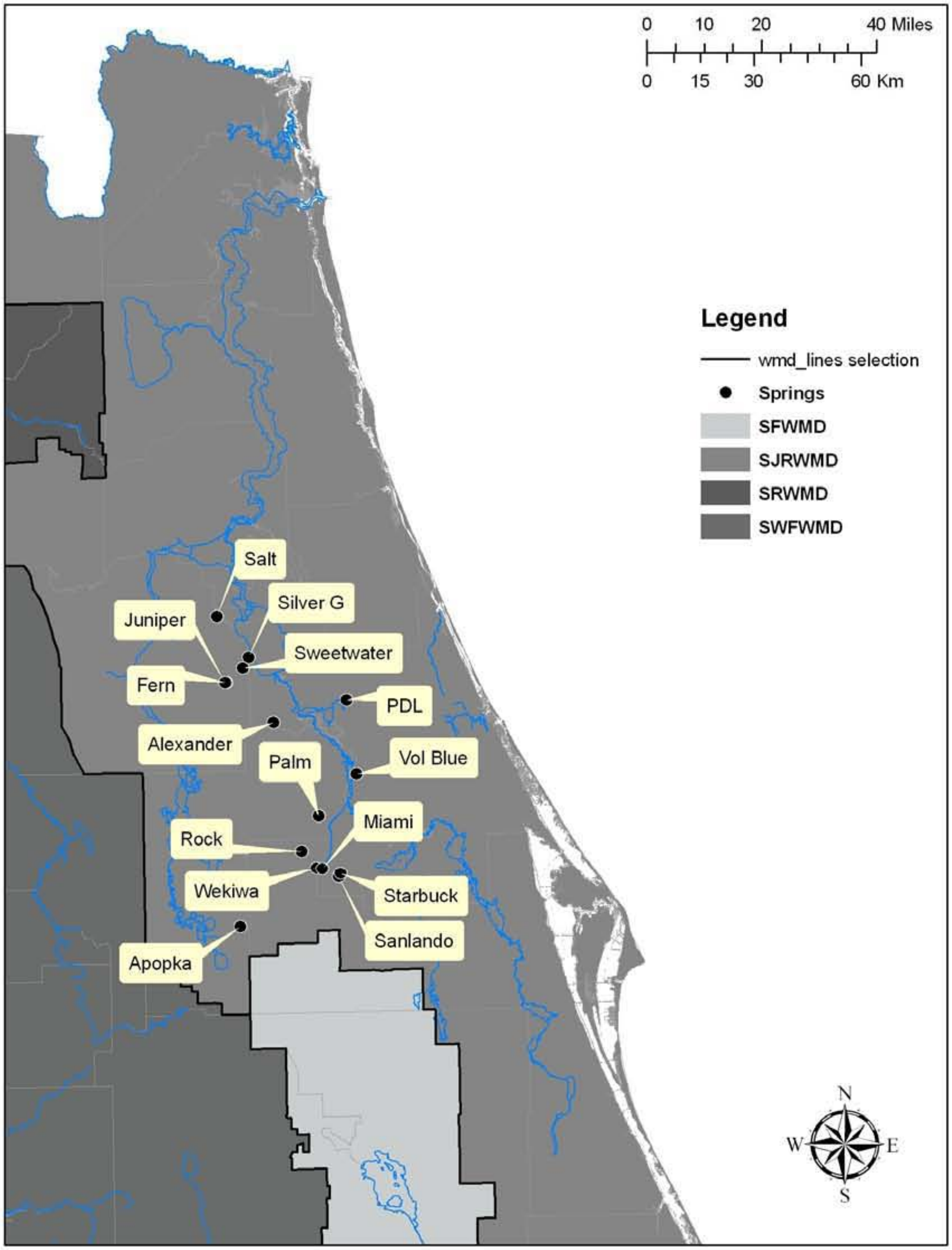


Figure 27. Location of Springs within the SJRWMD.

Table 8. St. Johns River Water Management District Spring Names and Abbreviations

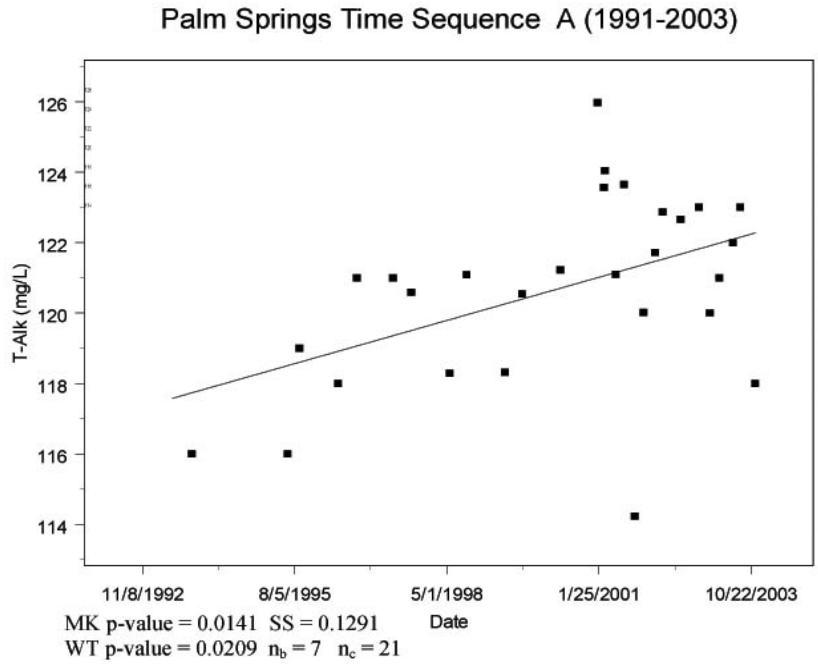
Spring	Abbreviation		Spring	Abbreviation
Alexander Spring	Alexander		Salt Springs	Salt
Apopka Spring	Apopka		Sanlando Springs	Sanlando
Fern Hammock Springs	Fern		Silver Glen Springs	Silver G
Juniper Springs	Juniper		Starbuck Spring	Starbuck
Miami Spring	Miami		Sweetwater Spring	Sweetwater
Palm Spring	Palm		Volusia Blue Spring	Vol Blue
Ponce De Leon Spring	PDL		Wekiwa Spring	Wekiwa
Rock Spring	Rock			

Calcium, strontium, fluoride, and pH increased in a significant number of springs over time Sequence A, while phosphate levels decreased. With respect to individual springs, Miami, Palm, Sanlando, and Wekiwa Springs had at least eight analytes with increasing trends over Sequence A, while Volusia Blue Spring (Vol Blue) and Sweetwater Spring decreased in at least eight analytes over the same time sequence. Alexander, Salt, and Silver Glen (Silver G) Springs each had six or fewer analytes showing any trend (positive or negative). Sequence B had no districtwide trends. During Sequence C fluoride and pH increased in a large number of springs while flow decreased at many locations.

Rock-Matrix and Saline Analytes

Increasing trends were associated with the following rock-matrix analytes: strontium, calcium, pH and fluoride increased over Sequence A. Nine springs had significant increases in calcium and pH while one spring had a decreasing trend for theses analytes. Both fluoride and strontium increased in 10 springs. Strontium decreased in one, whereas fluoride decreased in none. No trends were observed in Sequence B. Within Sequence C, upward trends were observed for fluoride and pH, while flow decreased. Thus, major changes for the SJRWMD, like other districts, occurred during 1998 to 2003 (Sequence C).

Figures 28-30 depict increases in two rock-matrix analytes for three springs in Seminole and Orange Counties. Not depicted are Starbuck, Rock, and Apopka, which showed the same pattern. Alkalinity and strontium suggest changing chemistries. Both analytes increased in Palm, Sanlando, and Wekiwa Springs. All plots show trends closely fitting an increasing best-fit line. Starting at about 116 mg/L for alkalinity, Palm Springs increases to about 126 mg/L. Sanlando Springs begins at about 130 mg/L and increases to approximately 150 mg/L. Strontium at Sanlando Springs began around 60 µg/L and ended over 90 with little variation in the upward trend. Wekiwa Spring started at a higher level (near 100 µg/L) and ended the time series at about 140 µg/L. Wekiwa Spring is also unique in showing an apparently quick increase in concentration between 1993 and 1995. Palm Springs differed from the other two springs in having strontium concentrations at the start of the study three to four times higher than the other two springs.



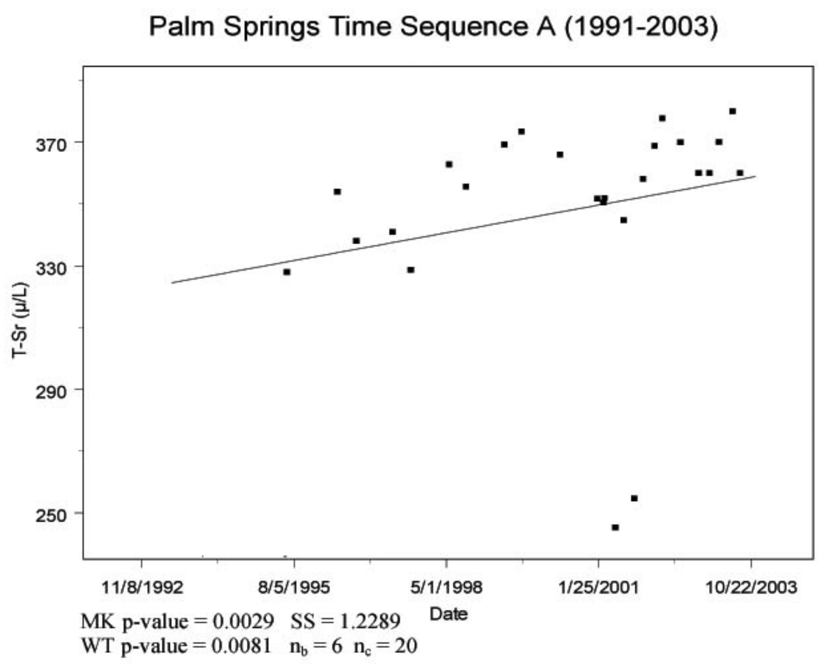


Figure 28. Increasing rock analytes at Palm Springs. Alkalinity (top) and strontium (bottom) increased significantly over Sequence A. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation. Beginning and ending dates for the springs were not the same.

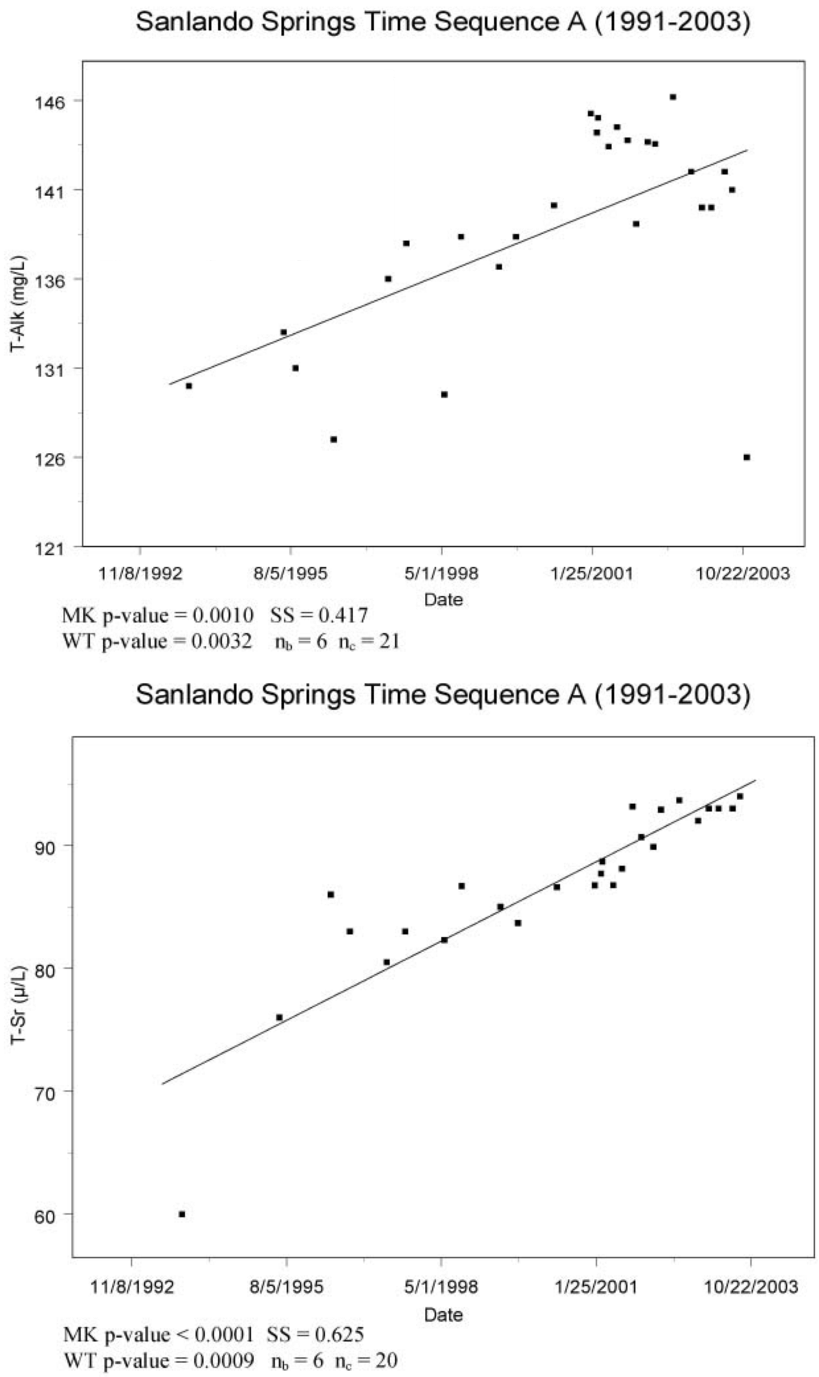
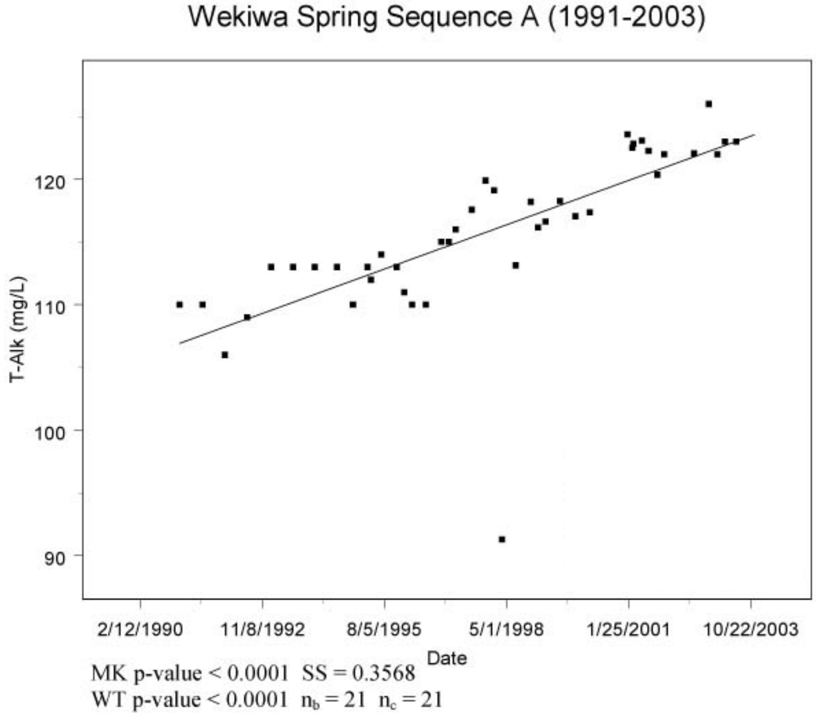


Figure 29. Increasing rock analytes at Sanlando Springs. Alkalinity (top) and strontium (bottom) increased significantly over Sequence A. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change. Beginning and ending sampling dates for these springs were not the same.



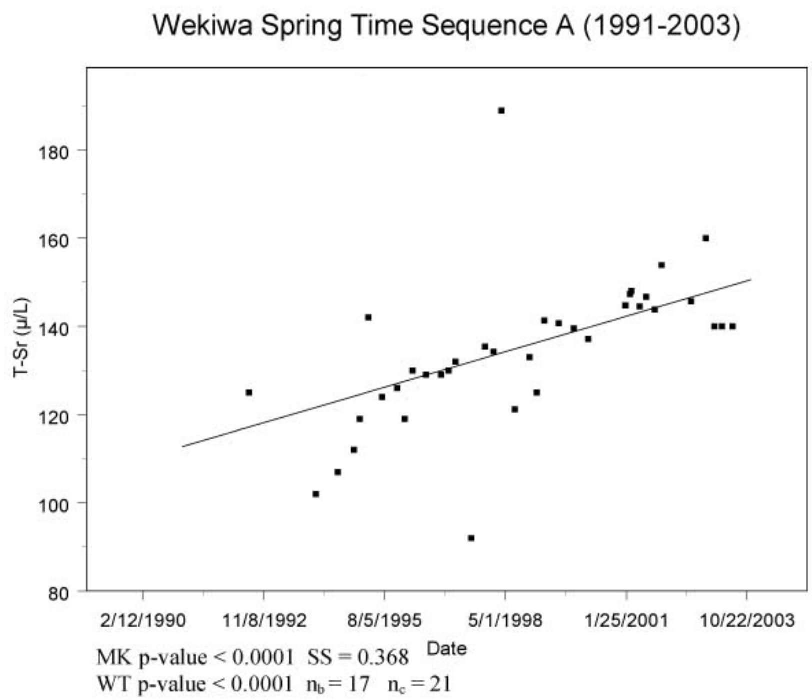


Figure 30. Increasing rock analytes at Wekiwa Spring. Alkalinity (top) and strontium (bottom) increased significantly over Sequence A. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation. Beginning dates for these springs were not the same.

Nutrient Analytes

For the study period, there were fewer nutrients trends in the SJRWMD than in other WMDs. For example, both phosphorus and TKN demonstrated few to no changes (no increases or decreases for phosphorus, no increases and two decreases for TKN). Nitrate showed no clear trend direction. For example, in the seven springs showing trends for nitrate, three increased and four decreased. With respect to nutrients, only phosphate showed consistent trends across the district. Eleven springs decreased in phosphate while no springs increased.

Figure 31 shows two phosphate trends, which also are considered to be Rock-matrix analytes. Phosphate levels for both Palm and Starbuck Springs fell by nearly half of the initial concentrations. Phosphate at Palm Springs (top figure) began the time series at approximately 0.15 mg/L and dropped to about 0.09 in 2002. Values from the end of the time series, 2002 to 2003, suggest a rise in concentrations. Starbuck levels began near 0.17 mg/L and fell to about 0.12 mg/L. Similar to Palm Springs, Starbuck appears to record a rise in concentrations near the end of the time series in 2003.

Southwest Florida Water Management District

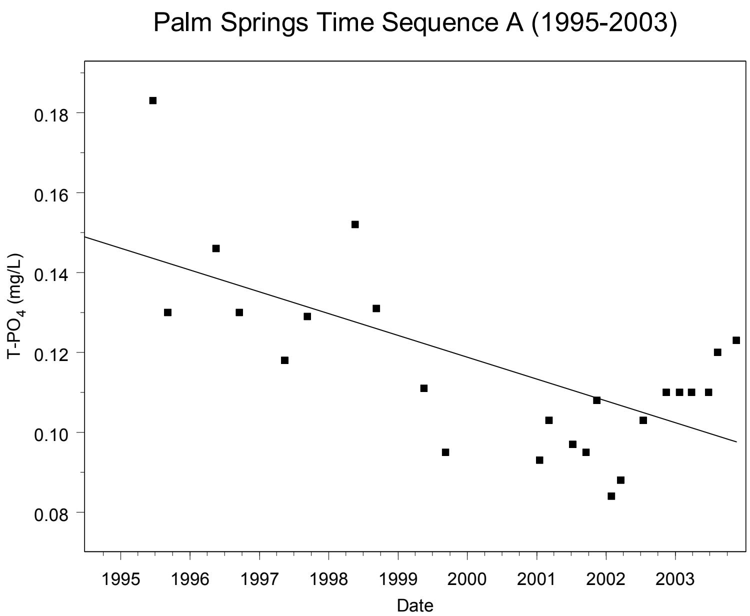
Figure 32 shows the locations of the springs in the SWFWMD. Table 9 displays the corresponding spring abbreviations.

Note that after our analyses, the SWFWMD notified the authors and told us that they now question the validity of using Boyette Spring data. They now believe it receives a significant portion of its water from a nearby sinkhole (< 1 kilometer away) and much of the receiving water is dairy waste (Morrison, 2000). Since the individual spring analyses were already completed, we decided to keep the spring in the analyses. However, because of the point-source dairy contamination, Boyette Spring data were removed from districtwide and statewide analyses. Also, the SWFWMD was the only WMD to analyze for bicarbonate, rather than alkalinity.

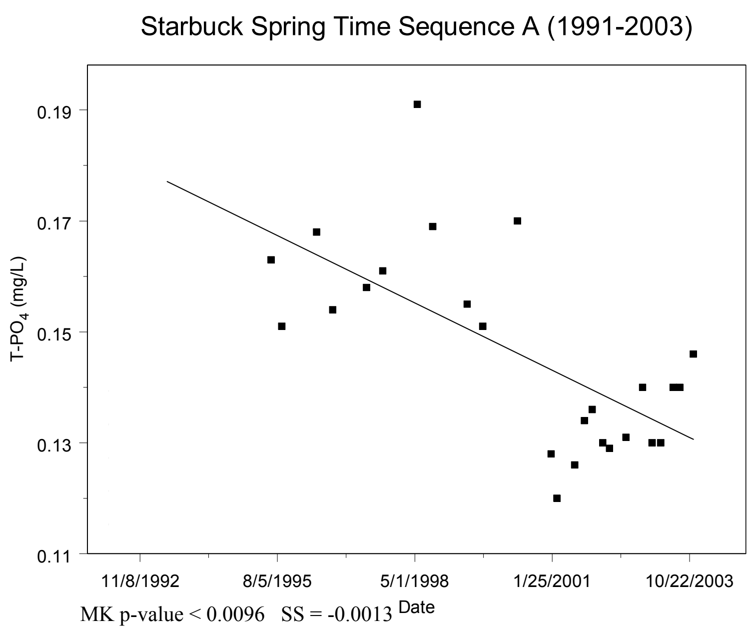
The SWFWMD springs had strong trends in rock-matrix, saline and nutrient indicators. Similar to the SRWMD, rock-matrix and saline indicators rose significantly. Unlike the SRWMD, nutrient indicators showed different types of trends. Differences in behavior of nutrients between the SRWMD and SWFWMD suggest regional differences exist between these two areas. Similarities in rock-matrix and saline trends between the SRWMD and SWFWMD suggest these trends extend beyond district boundaries. Some springs showed more changing chemistries than others. Betty Jay, Boyette, and Tarpon Hole Springs had many analytes with increasing trends. Buckhorn Main and Hidden River No. 2 Spring had a number of decreasing trends. Those showing no trends among the analytes studied during time Sequence B included Boat, Bobhill, Rainbow Swamp No. 3, and Wilson Head Springs.

Rock-Matrix and Saline Analytes

Strong increases in both rock-matrix and saline analytes were evident in springs in the SWFWMD during time Sequence A. Analytes with increasing trends include bicarbonate,



MK p-value < 0.0220   SS = -0.0013
WT p-value < 0.0081 $n_b = 6$ $n_c = 19$



MK p-value < 0.0096   SS = -0.0013
WT p-value < 0.0218 $n_b = 6$ $n_c = 20$

Figure 31. Decreasing phosphate concentrations at Palm and Starbuck Springs. Palm (top) and Starbuck Springs (bottom) illustrate the most sharply decreasing nutrient (phosphate) in the district. Both springs show substantial reductions since the beginning of the time series, with a potential increase at the end of the series. Note samples were not collected until 1995.

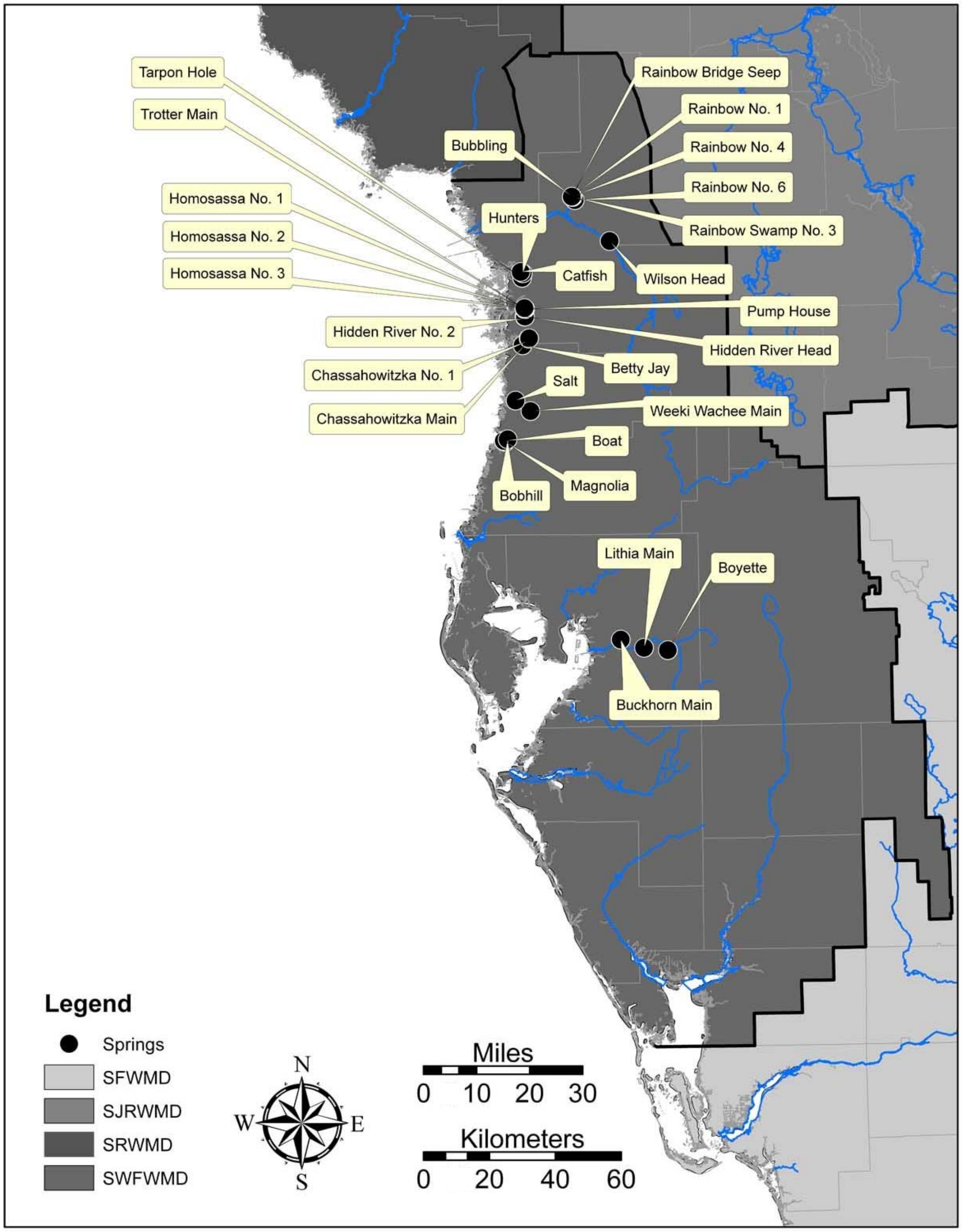


Figure 32. Location of springs within the SWFWMD.

Table 9. Southwest Florida Water Management District Spring Names and Abbreviations

Spring	Abbreviation		Spring	Abbreviation
Betty Jay Spring	Betty Jay		Hunters Spring	Hunters
Boat Spring	Boat		Lithia Main Spring	Lithia Main
Bobhill Spring	Bobhill		Magnolia Spring	Magnolia
Boyette Spring	Boyette		Pump House Spring	Pump House
Bubbling Spring	Bubbling		Rainbow No. 1 Spring	Rainbow No. 1
Buckhorn Main Spring	Buckhorn Main		Rainbow No. 4 Spring	Rainbow No. 4
Catfish Spring	Catfish		Rainbow No. 6 Spring	Rainbow No. 6
Chassahowitzka No. 1 Spring	Chassahowitzka No. 1		Rainbow Bridge Seep	Rainbow Bridge Seep
Chassahowitzka Main Spring	Chassahowitzka Main		Rainbow Swamp Spring No. 3	Rainbow Swamp No. 3
Hidden River Head Spring	Hidden River Head		Salt Spring	Salt
Hidden River No. 2 Spring	Hidden River No. 2		Tarpon Hole Spring	Tarpon Hole
Homosassa No. 1 Spring	Homosassa No. 1		Trotter Main Spring	Trotter Main
Homosassa No. 2 Spring	Homosassa No. 2		Weeki Wachee Main Spring	Weeki Wachee Main
Homosassa No. 3 Spring	Homosassa No. 3		Wilson Head Spring	Wilson Head

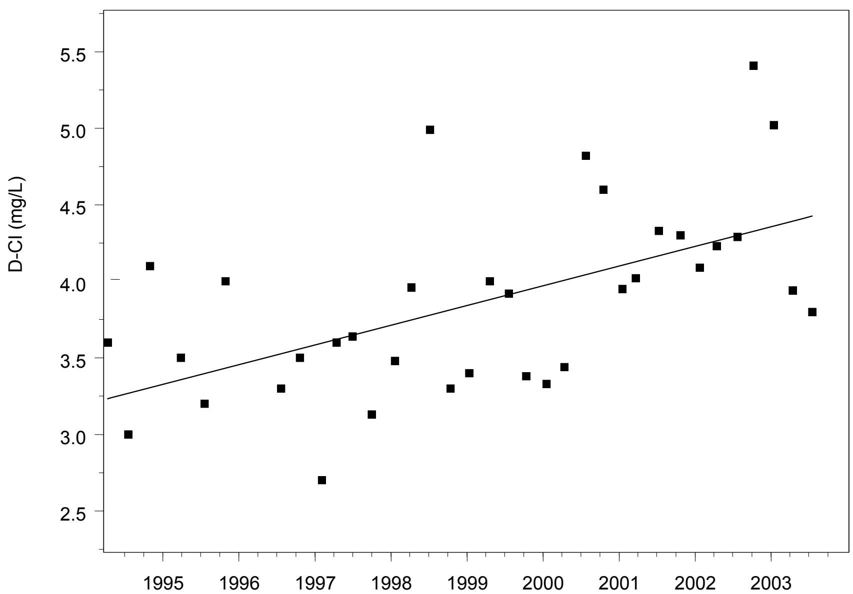
calcium, chloride, potassium, magnesium, sodium, conductivity, sulfate, strontium, and total dissolved solids. Of these, increases strongly attributable to rock chemistries were bicarbonate and strontium. Regarding salinity, rises in sodium, chloride, and total dissolved solids were observed. Analytes in common to both groups included calcium, potassium, magnesium, specific conductance, and sulfate (which showed strong increases). Similar to other districts, Sequence B had very few trends. The majority of the influence for these increases occurred during time Sequence C.

Chloride increased in 18 springs. Figures 33-35 depict the chloride trends from several springs in the northern SWFWMD along the Gulf Coast.

Springs occur from north to south along the Gulf Coast. Figure 33 includes two springs from southern Marion County, one of the northernmost counties in SWFWMD. These springs, Rainbow No. 6 and Bubbling Springs, increased in chloride concentrations, both springs show a steady increase during the years of Sequence A. Both springs began with 3.0-4.0 mg/L of chloride and ended the time series with approximately 5.0-6.0 mg/L.

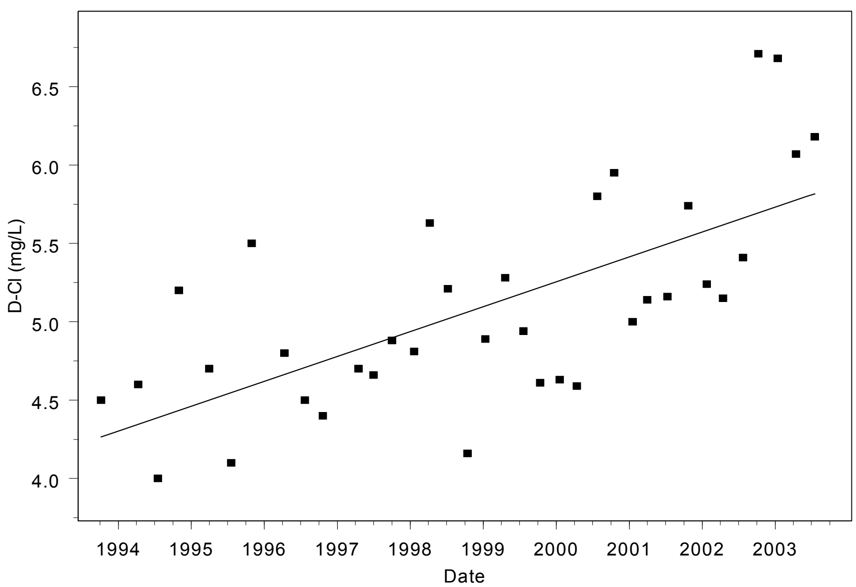
For a couple of springs just to the south in Citrus County, the increase in chloride was more dramatic (Figure 34). Hunters Spring (top) began the time series with approximately 50 mg/L of chloride. Values rose quickly at one point, more than doubling, and then declined. Trotter Main (bottom) showed a similar pattern, though with sharper changes. Trotter Main had values of approximately 50 mg/L near the start, as did Hunters, but then increased to nearly 250

Rainbow No. 6 Spring Time Sequence A (1991-2003)



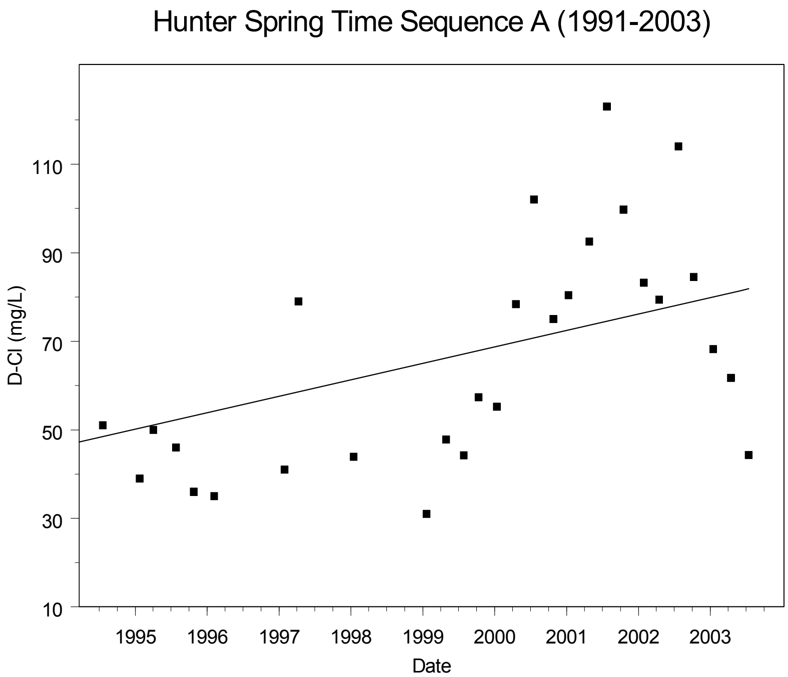
MK p-value = 0.0002 SS = 0.0321
WT p-value < 0.0001 $n_b = 16$ $n_c = 23$

Bubbling Spring Time Sequence A (1991-2003)

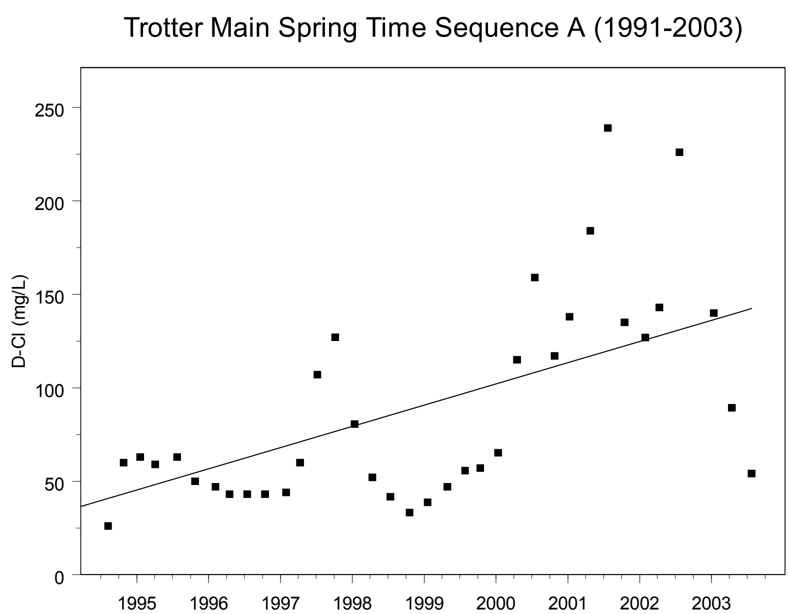


MK p-value = 0.0002 SS = 0.0417
WT p-value = 0.0014 $n_b = 13$ $n_c = 23$

Figure 33. Increasing saline analytes at Rainbow and Bubbling Springs. Rainbow No. 6 (top) and Bubbling Springs (bottom) had significant increases in chloride. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change. Beginning and ending dates for these springs are not the same.

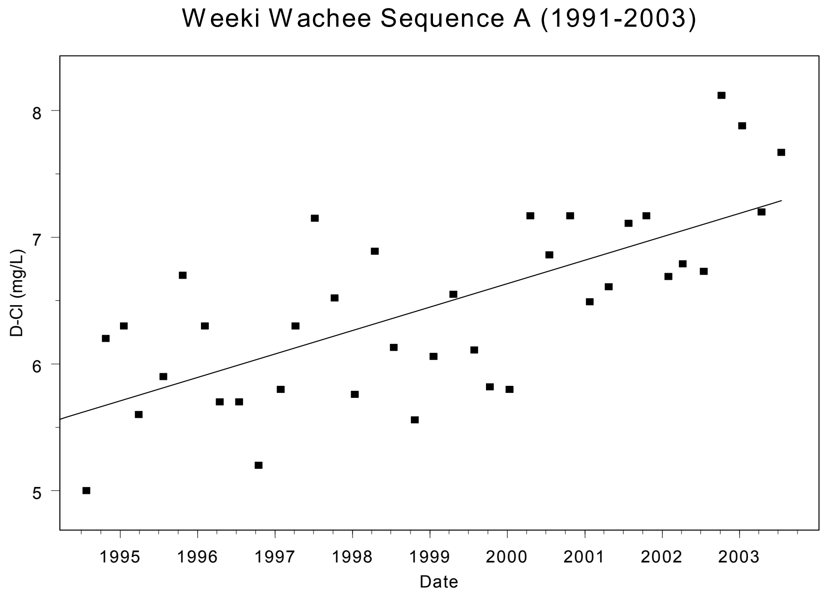


MK p-value = 0.0005   SS = 1.5802
WT p-value = 0.0033 n_b = 12 n_c = 20

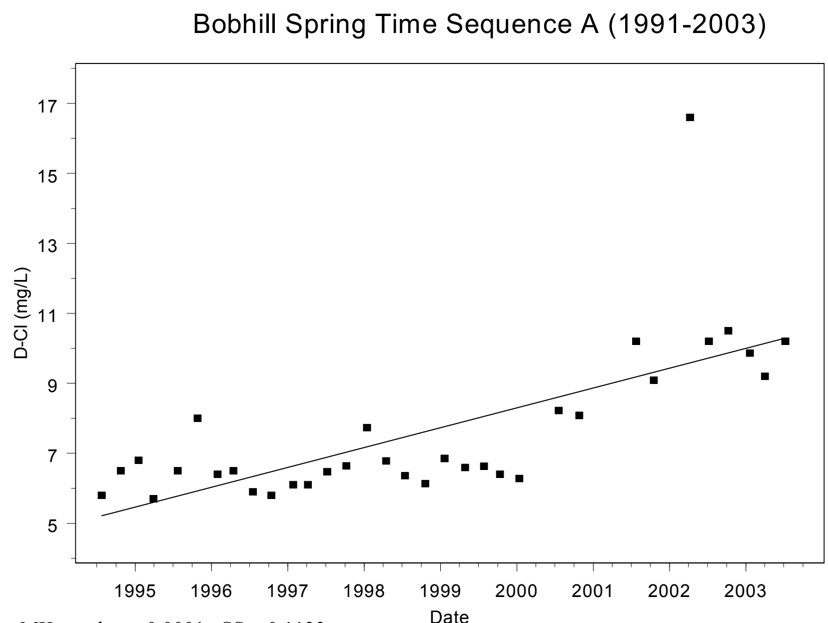


MK p-value < 0.0001   SS = 0.1133
WT p-value = 0.0009 n_b = 15 n_c = 23

Figure 34. Increasing saline analytes for Hunters and Trotter Main Springs. Hunter (top) and Trotter Main Springs (bottom) had significant increases in chloride. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change. Beginning and ending dates for these springs are not the same.



MK p-value < 0.0001 SS = 0.0457
WT p-value < 0.0032 n_b = 15 n_c = 23



MK p-value < 0.0001 SS = 0.1133
WT p-value < 0.0009 n_b = 14 n_c = 19

Figure 35. Increasing saline analytes for Weeki Wachee and Bobhill Springs. Weeki Wachee (top) and Bobhill Springs (bottom) had significant increases in chloride. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change.

mg/L at one point—a five-fold increase. Figure 35 depicts chloride concentrations at Weeki Wachee and Bobhill Springs. Weeki Wachee began the time series with only about 6.0 mg/L of chloride and ended with a concentration of about 8.0 mg/L. Bobhill Spring began about 5.0 mg/L and ended with about a 9.0 mg/L chloride concentration.

Flow

Flow data were available for only three gaging stations within the SWFWMD. While there were inadequate data to make statistical conclusions for the SWFWMD, data from the three` stations suggested possible declines similar to the SRWMD. Homosassa No. 1 flow levels declined for the years 1996-2003 (Figure 36). Longer-term trends are depicted in Figure 37, which further illustrates declines in flow. Since the 1960s, average yearly flow for Rainbow Springs has declined (dark gray line indicates a timeline for Sequence A). WT tests between the first and second half of the data series show a difference between the two data series. However, for data representing time Sequence A, results do not indicate a significant difference. This suggests that trends on the scale of this study (i.e., 13 years) may sometimes be missed in spite of being part of a larger change (e.g. 40 years of data).

Long-term flow in Weeki Wachee Springs flow data (Figure 37, bottom) has an equally interesting pattern. Although no regression is displayed, flow data going back to 1904 displays a rise until the 1960s, followed by a decline until the present. Gray lines illustrate the time line for Sequence A and that for post-1960. The range in flow during this time appears to be two-fold (100 to 250 cfs). Such a pattern may reveal that short-period trends may be part of longer-term cycles for groundwater; implications of this will be addressed later.

Nutrient Analytes

For Sequence A, nitrate increased strongly (19 springs with upward trends, only one down), while ammonia, phosphate, phosphorus, TKN, and total organic carbon showed little indication of trends. Since TKN, phosphorus, and total organic carbon decreased somewhat (though not significantly) it seems to indicate that nitrate-nitrogen alone showed the strongest increase for SWFWMD. All other analytes showed little change or even evidence of a slight decline. Also unlike patterns seen in the rock and saline indicators, nitrate increased during both sequences B and C. This is in contrast with the rock analytes which showed strongest activity during Sequence C.

Figure 38 and 39 illustrate nutrient trends and their variability for SWFWMD. Hunter and Magnolia Springs (Figure 38), illustrate clear increases in nitrate over Sequence A. Nitrate increases occurred regardless of initial concentrations at the beginning of the time series. For example, Hunter Spring (top) had a consistent increase from a low initial value (about 0.25 mg/L) to just under the SRA threshold of 0.45 mg/L. Hunter remained under the SRA value for the time period. Magnolia Spring showed a rate of increase similar to Hunter (SS = 0.0046 and 0.0042, respectively). However, Magnolia began the time series with a higher starting value (about 0.35 mg/L). The trend for Magnolia crossed over the SRA threshold (Figure 38, bottom, gray line marks SRA value). Similarly Weeki Wachee (Figure 39, top), began the time series with a value near 0.45 mg/L and increased to 0.8 mg/L by the end of the time sequence. All three springs had similar rates of change yet differed in their initial concentrations of nitrate.

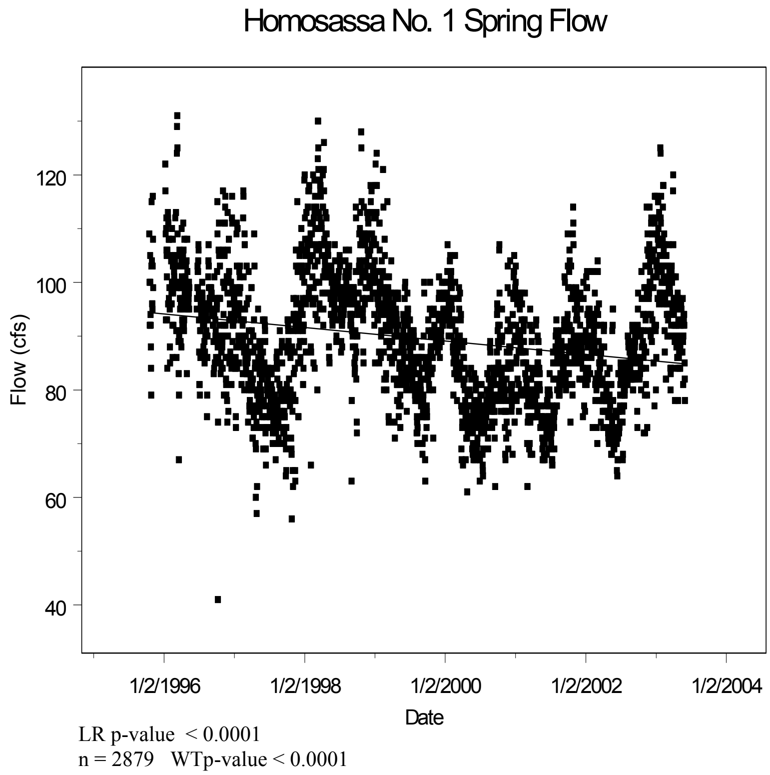


Figure 36. Decreasing flow at Homosassa No. 1 Spring. Flow rates declined significantly from 1996 to 2003. (One cfs = 0.028 cms)

Overall, TKN showed little activity (one trend up, four down for Sequence A). Figure 39 (bottom) shows a trend in TKN for Boyette Spring. It started with relatively low initial values and was followed with a rapid increase in 1998. Values went from near 0.5 mg/L to over 3.0 mg/L in short period of time.

Field Analytes

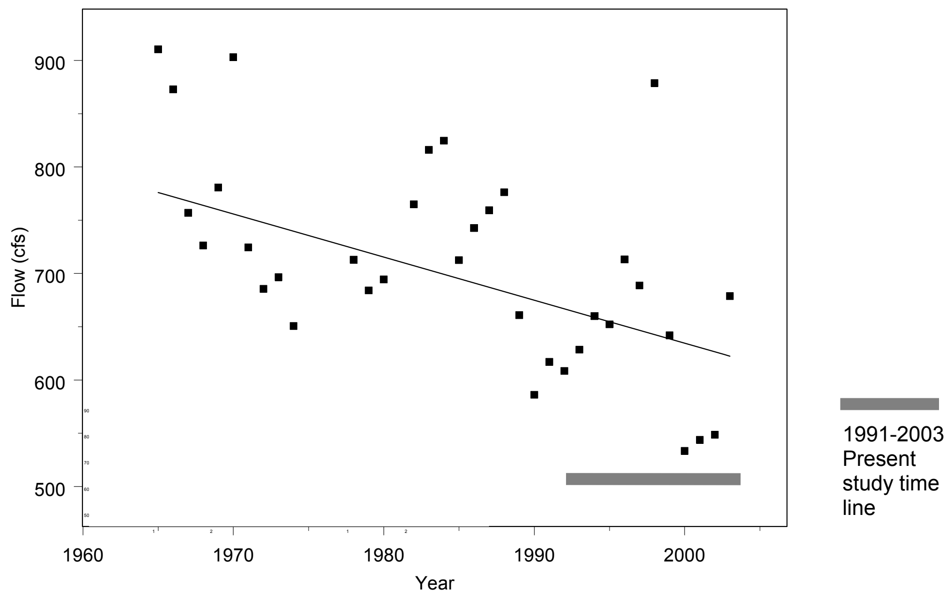
Only two Field analytes demonstrated decreasing trends over Sequence A, pH and temperature. The analyte pH decreased in 10 springs, while temperature decreased in eight. The trends for pH largely occurred in Sequence C.

Wells

The wells used for this study are a subdivision of FDEP's Background Network. The subdivision is referred to as the Temporal Variability (TV) Network. Although independent of springs, it was believed that evaluating trends in wells would shed insight as to the chemical behavior of Florida's groundwater. The TV Network subdivides wells into whether they are confined or unconfined. Because of the small number of confined and unconfined wells per WMD, for districtwide and statewide analyses, the wells were also combined into one pool (All).

Decreasing trends in water levels and pH were often observed. Because of the drought, the lowering of water levels was predictable. However, the decrease in pH was unexpected. Plausible reasons for the declines will be discussed later.

Rainbow Springs Average Flow (1965-2003)



Weeki Wachee Flow (1904-2003)

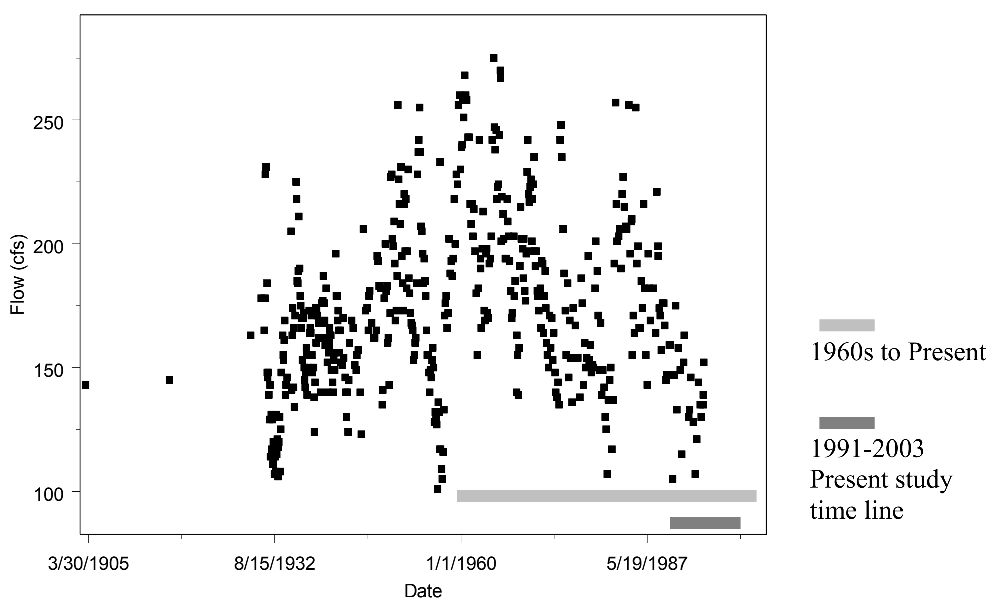
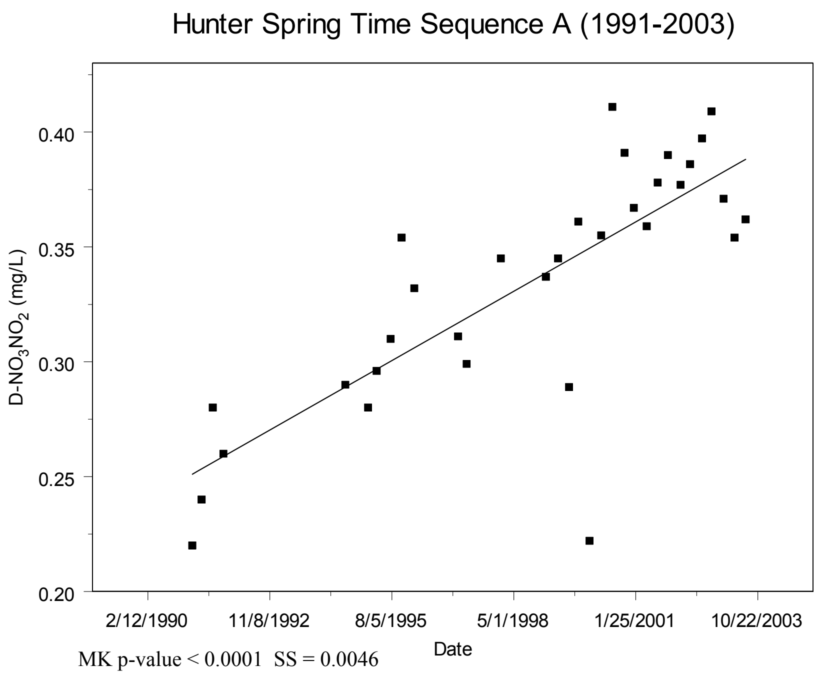
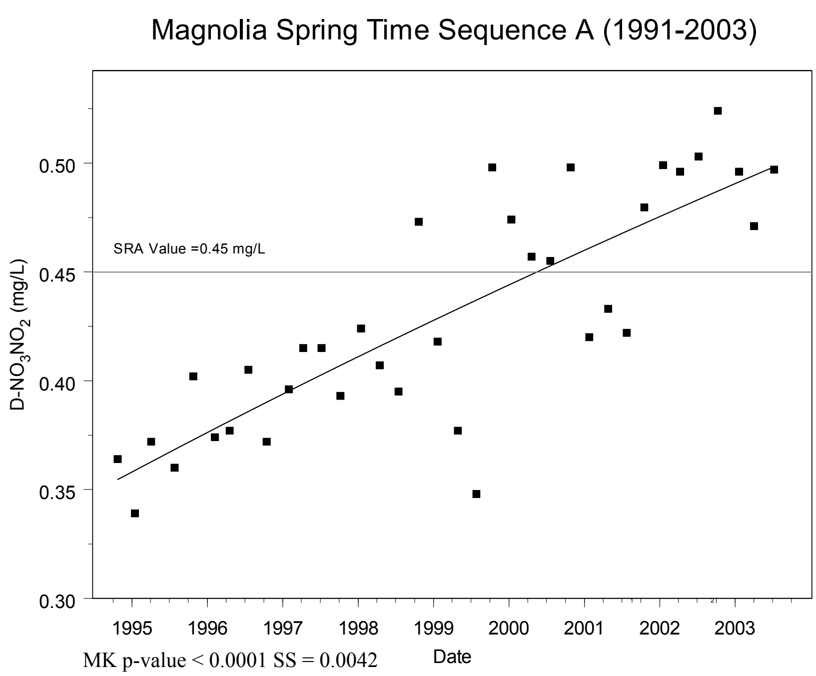


Figure 37. Long-term flow trends at two SWFWMD springs. Rainbow (top) and Weeki Wachee Springs (bottom) show historic changes. For Rainbow, points represent average flow per year. Although no regression line on the graph, Weeki Wachee data since 1904 (bottom) showed a rise until about 1960 followed by a subsequent fall. Dark gray lines represent time line for Sequence A. (One cfs = 0.028 cms)



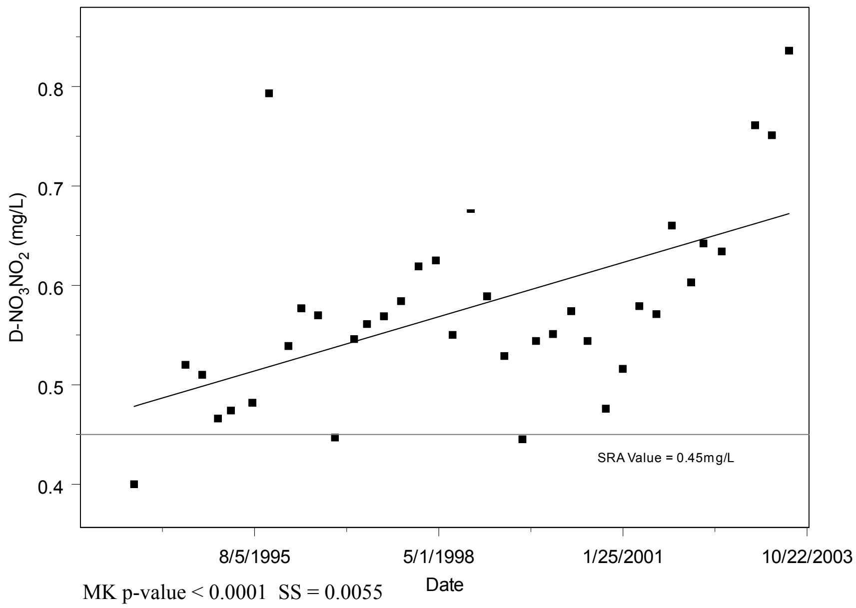
MK p-value < 0.0001 SS = 0.0046
WT p-value = 0.0001 n_b = 12 n_c = 20



MK p-value < 0.0001 SS = 0.0042
WT p-value = 0.0001 n_b = 13 n_c = 23

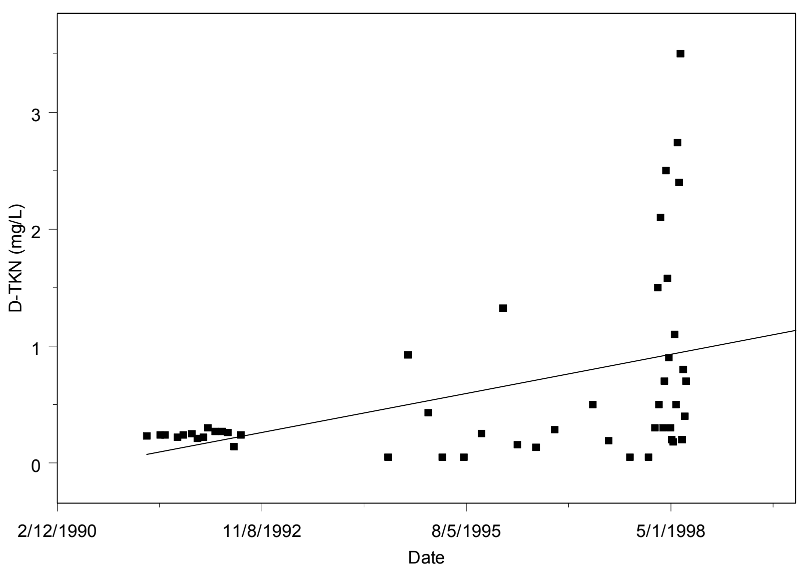
Figure 38. Increasing nitrates at Hunters and Magnolia Springs. Hunters (top) and Magnolia Springs (bottom) illustrate the most actively increasing nutrient trend in the district (nitrate). Hunters' increase remained below the the SRA (0.45 mg/L). Magnolia Spring's increase in nitrate began below the SRA and ends above it; thus it crosses a recommended limit. Beginning and ending dates for these springs were not the same.

Weeki Wachee Time Sequence A (1991-2003)



MK p-value < 0.0001 SS = 0.0055
WT p-value = 0.0111 n_1 = 15 n_2 = 23

Boyette Spring Time Sequence A (1991-2003)



MK p-value = 0.0005 SS = 0.0100
WT p-value = 0.0002 n_b = 27 n_c = 22

Figure 39. Increasing nutrient analytes at Weeki Wachee and Boyette Springs. Weeki Wachee (top) shows a clear increase in nitrate in Sequence A. Most of the time series for Sequence A included values above 0.45 mg/L. Boyette (bottom) illustrates an unusual trend in TKN. TKN values sometimes rose suddenly over a very short period of time in 1998. SWFWMD staff indicated the source of the TKN was probably from a nearby dairy waste lagoon. Beginning and ending dates for these springs were not the same.

Northwest Florida Water Management District

Northwest Florida wells (Figure 40) showed a lowering of water levels for Sequence A (six of eight wells were down, with no increasing trends). Temperature increased in five wells, while the analyte sodium and sulfate increased in four wells. No wells demonstrated downward trends for temperature, sodium, and sulfate. The analyte pH decreased in four wells.

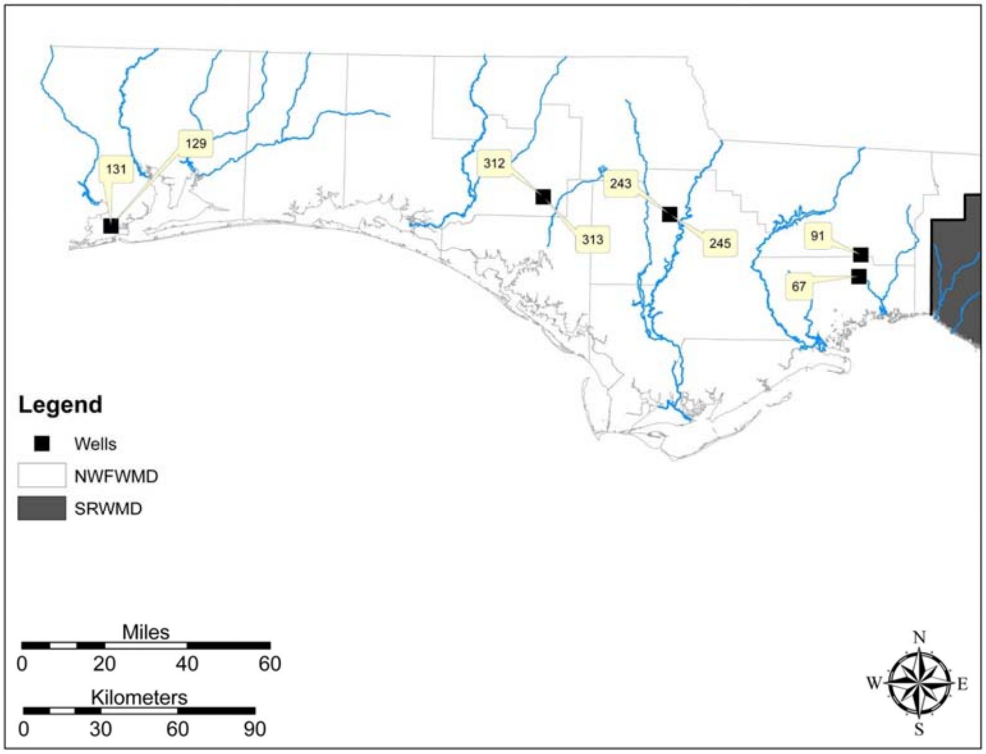


Figure 40. Location of wells within the NWFWMD.

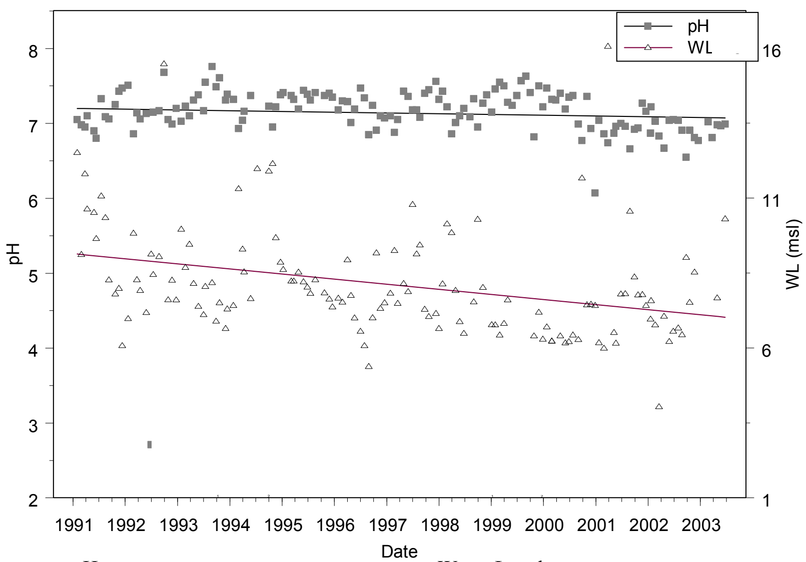
Changes in sequences B and C reflected those in Sequence A. For Sequence B water level fell (six of eight wells had decreasing levels, while none increased). Several wells also showed increases in sodium (increased in four wells, decreased in none) and conductivity (increased in five wells, decreased in none).

Unlike springs, where the main influences on the chemistries occurred during Sequence C, the only notable analyte in well data demonstrating a change was pH. The analyte decreased in six of eight wells studied (and increased in none).

Water Levels and pH

Figures 41and 42 illustrate several of these trends. The association of water level and pH suggest a relationship between the two analytes and will be discussed later. A drop in water levels occurred in both unconfined and confined wells. Confined aquifer Well 312 (Figure 42) showed a 5 m (15 ft) decline over the period of record.

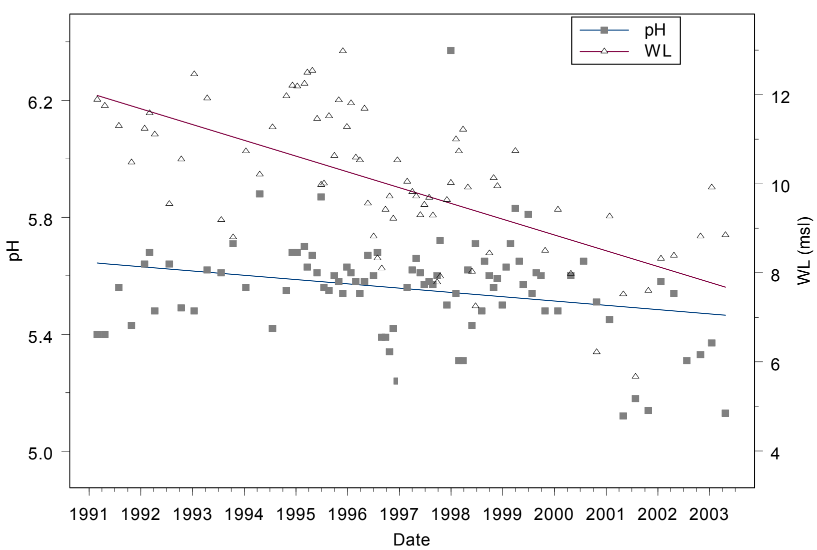
Well 91 Time Sequence A: pH and WL



pH
MK p-value = 0.0010 $n_b = 80$ $n_c = 66$
WT p-value = 0.0028 SS =-0.0016

Water Level
MK p-value < 0.0001 $n_b = 81$ $n_c = 54$
WT p-value < 0.0001 SS = -0.0161

Well 129 Time Sequence A: pH and WL

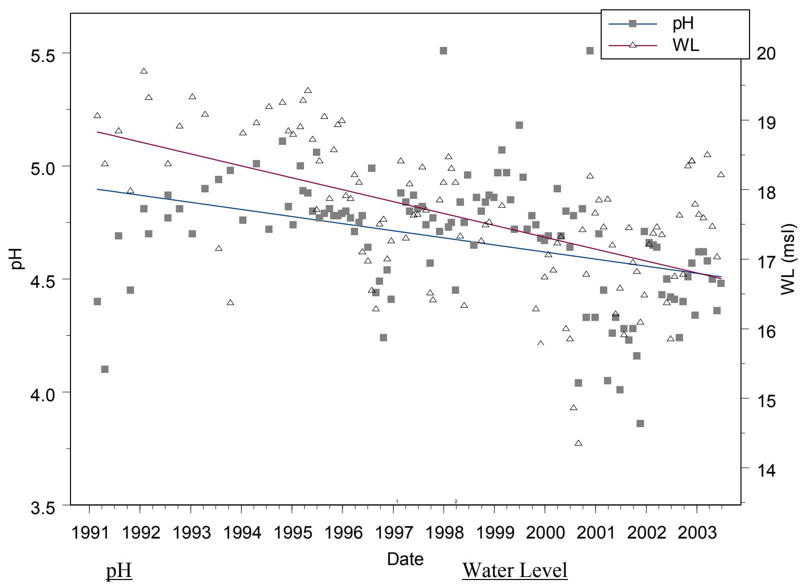


pH
MK p-value = 0.0158 $n_b = 53$ $n_c = 36$
WT p-value = 0.0001 SS = -0.0012

Water Level
MK p-value < 0.0001 $n_b = 53$ $n_c = 24$
WT p-value < 0.0001 SS = -0.0466

Figure 41. Decreasing pH and water levels in NWFWMD wells (#91 and #129). Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change.

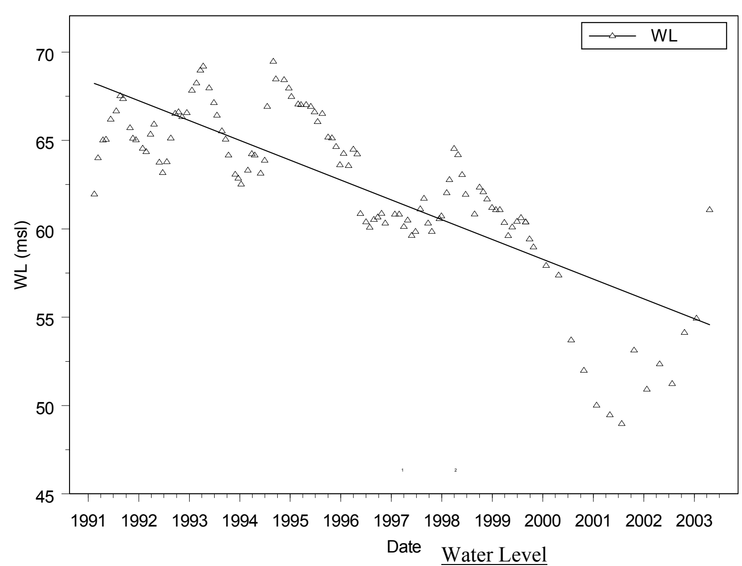
Well 131 Time Sequence A: pH and WL



pH
MK p-value < 0.0001 $n_b = 53$ $n_c = 66$
WT p-value = 0.0004 SS = -0.0030

Water Level
MK p-value < 0.0001 $n_b = 52$ $n_c = 55$
WT p-value < 0.0001 SS = -0.0187

Well 312 Time Sequence A: WL



Water Level
MK p-value < 0.0001 $n_b = 81$ $n_c = 35$
WT p-value < 0.0001 SS = -0.0893

Figure 42. Decreasing pH and water levels in NWFWMD wells (#131 and #312). Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change. Water level is in feet above mean seal level. (One m = 0.3048 ft)

Suwannee River Water Management District

The locations of the SRWMD TV wells are displayed in Figure 43. Decreasing water level trends were observed in the SRWMD. Temperature rose in Sequence C (seven increased and none decreased). Trends in Sequence A suggested the same pattern as in northwest Florida: declines in water level and pH.

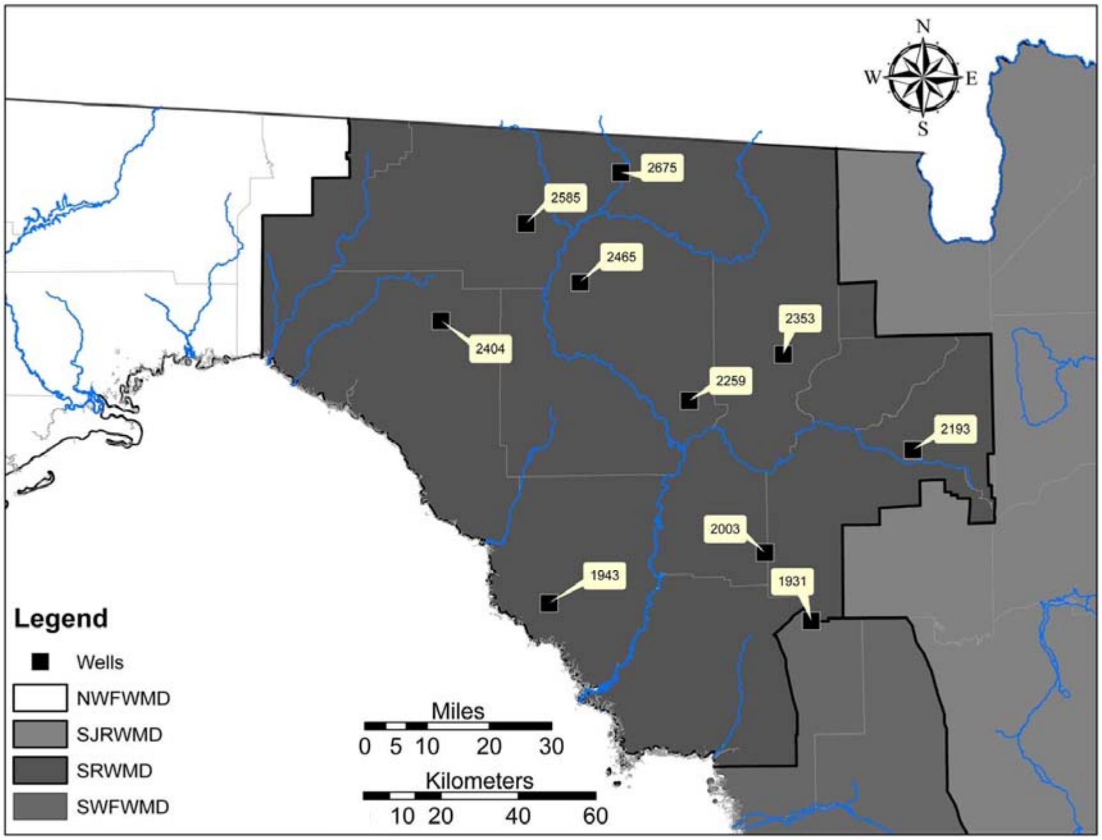
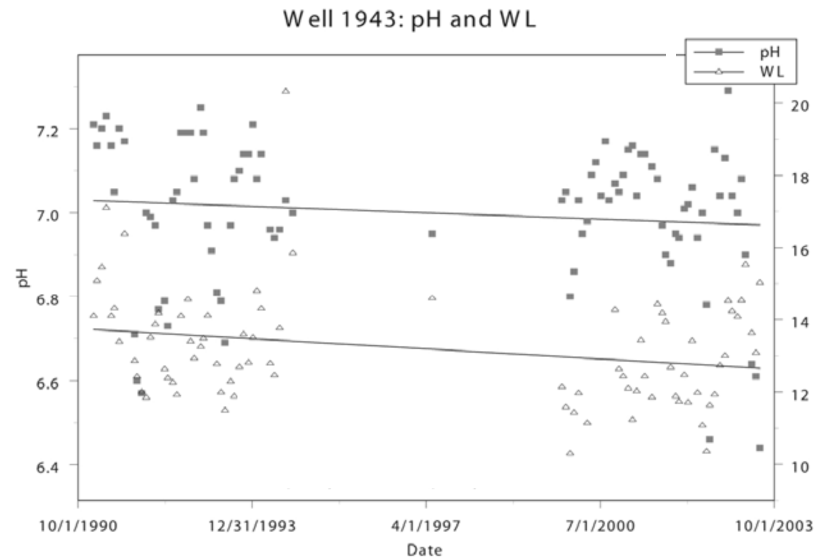


Figure 43. Location of wells within the SRWMD.

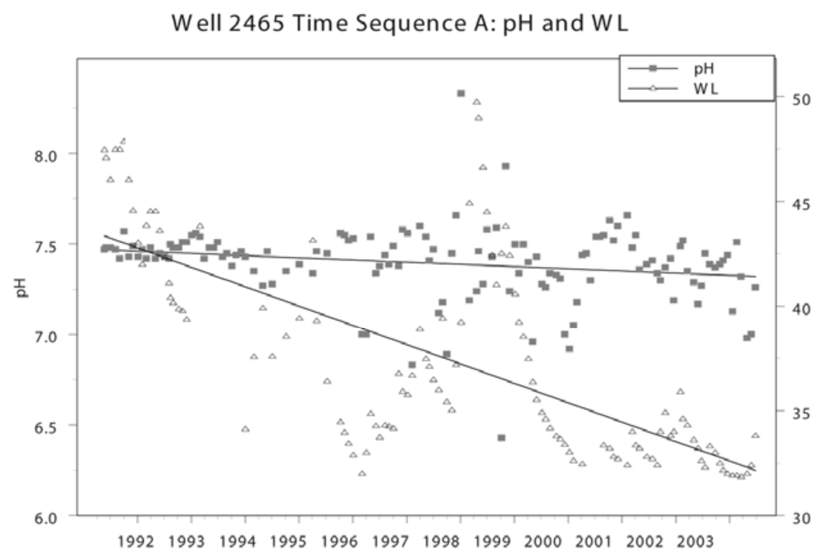
Water Levels and pH

Over the period of record, water level and pH trends looked similar to other districts. As two examples (Figure 44) of unconfined wells (Wells 1943 and 2465), a drop in water level appeared to be accompanied by a decrease in pH. Note that Well 2465 had rapidly declining water levels but a relatively slower change in pH. The water level decreased approximately 5 m (15 feet) by the end of the study. Confined groundwater showed similar patterns. Figure 45 shows water level and pH falling simultaneously for wells 2585 and 2675. In Well 2585, the water level drop is a minimum of 3 m (15 ft); some points in the early time series have substantially higher water level values [18 m (60 ft)] and suggest the difference was even greater. By far the most extreme water level difference was recorded was Well 2675. From a high point of 27 m (90 ft) msl in 1994, water levels fell to approximately 9 m (30 ft) by 2003. This is nearly 18 m (60 ft) difference is due to its location near the Alapaha River. Local karst features create differences in water levels in response to rainfall. Like other wells in the district, Well 2675 experienced a decline in pH.



pH
MK p-value = 0.0405 n_b = 44 n_c = 45
WT p-value = 0.3388 SS = -0.0011

Water Level
MK p-value = 0.0499 n_b = 43 n_c = 39
WT p-value = 0.0051 SS = -0.0114



pH
MK p-value = 0.0013 n_b = 68 n_c = 64
WT p-value = 0.0001 SS = -0.0009

Water Level
MK p-value < 0.0001 n_b = 56 n_c = 59
WT p-value < 0.0001 SS = -0.0944

Figure 44. Decreasing pH and water levels in SRWMD wells (#1943 and #2465). Both wells are unconfined. Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change. The beginning sampling dates for wells are not the same. (One m = 0.3048 ft.)

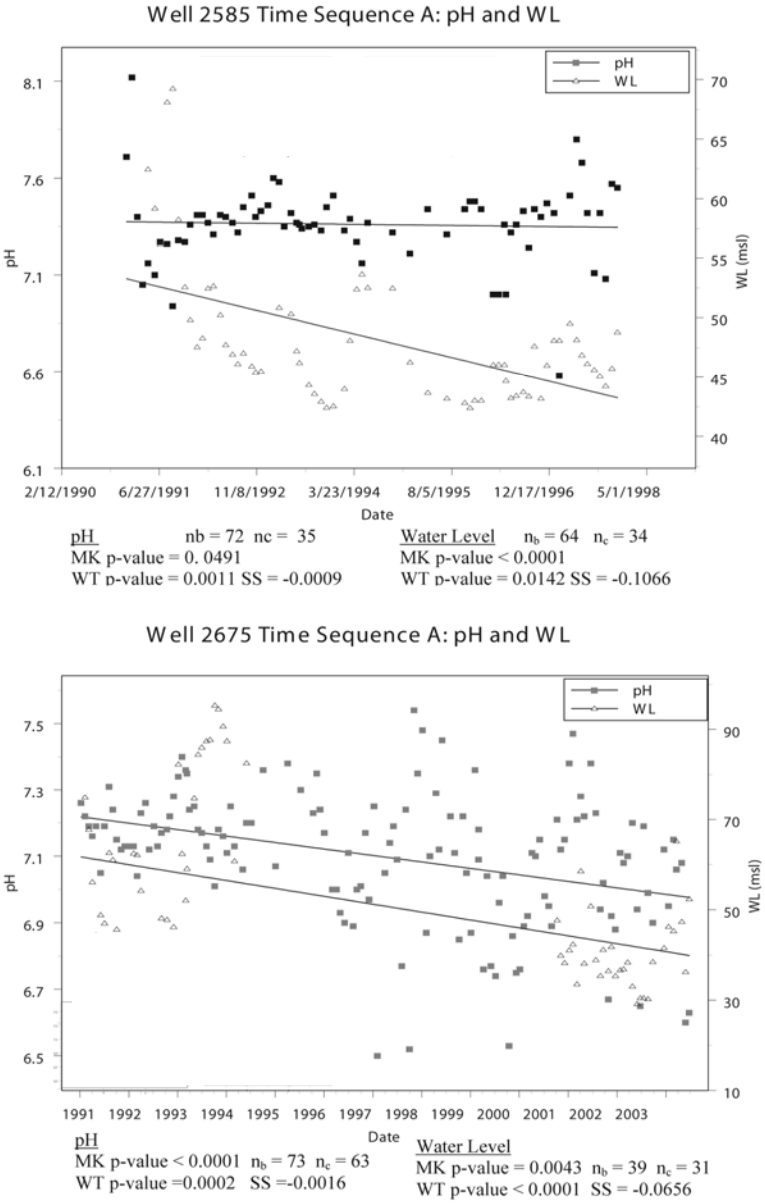


Figure 45. Decreasing pH and water levels in SRWMD wells (#2585 and #2675). Both wells are confined. Tests ($p < 0.05$) included MK for trend, WT on Sequences B and C, plus SS calculations. Note beginning sampling dates for wells are not the same. (One m = 0.3048 ft.)

St. Johns River Water Management District

Figure 46 displays the location of TV Network wells in the SJRWMD. The trends for the wells shown in Figure 46 in the SJRWMD were slightly different from both the NWFWMD and

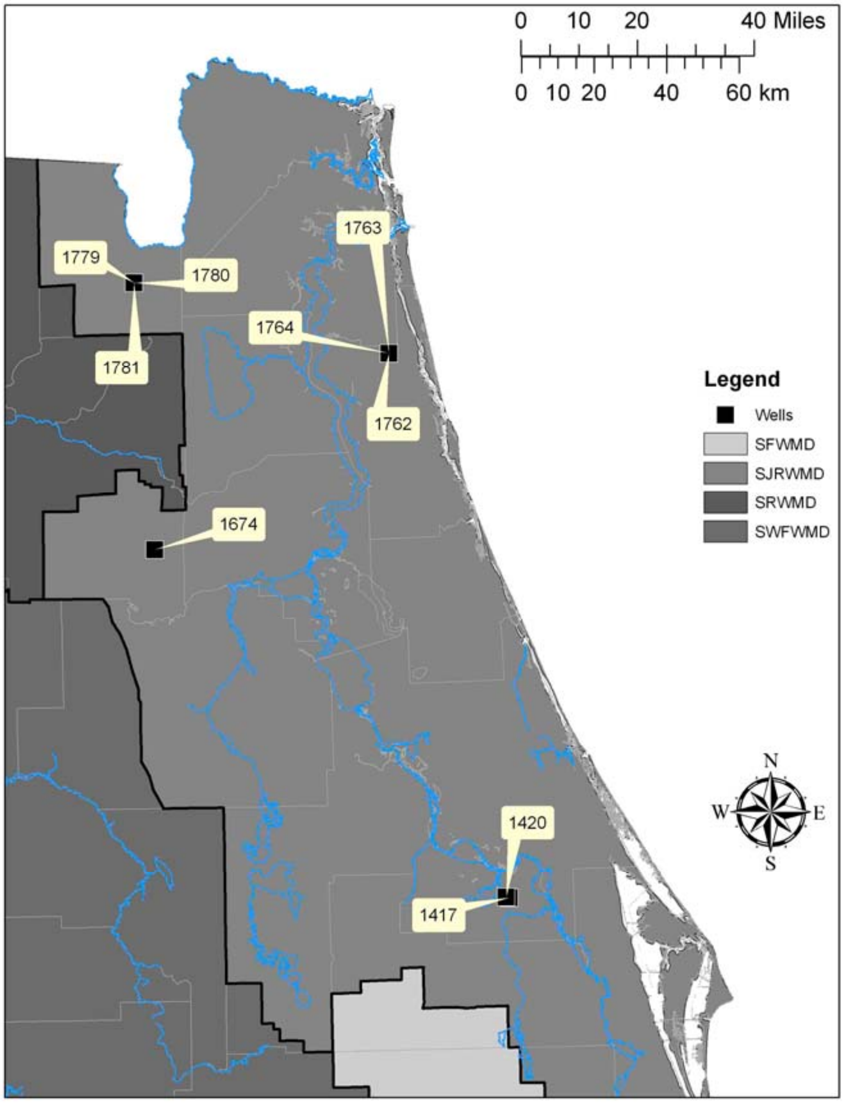
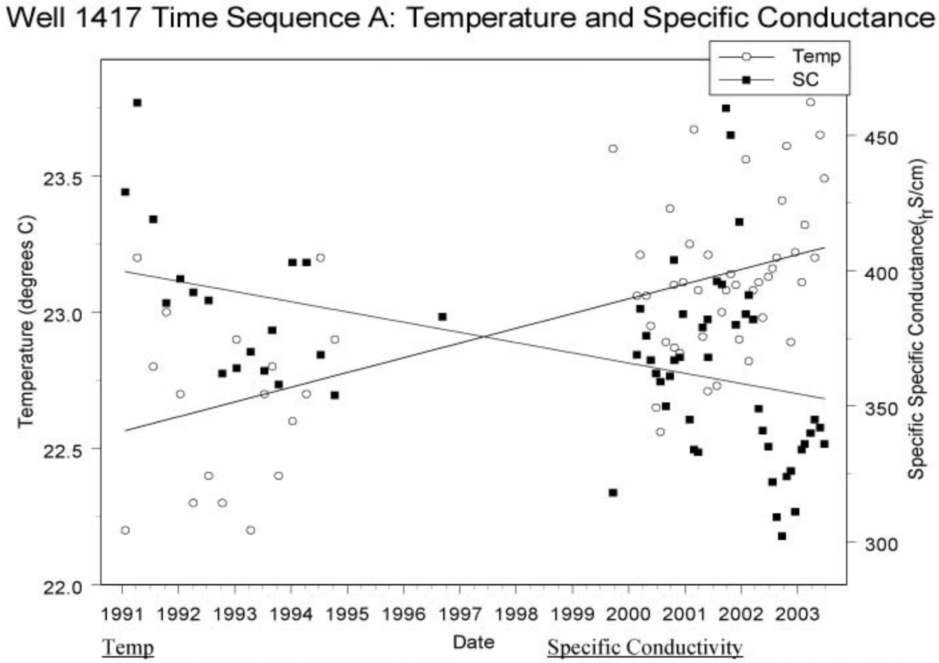


Figure 46. Location of wells within the SJRWMD.

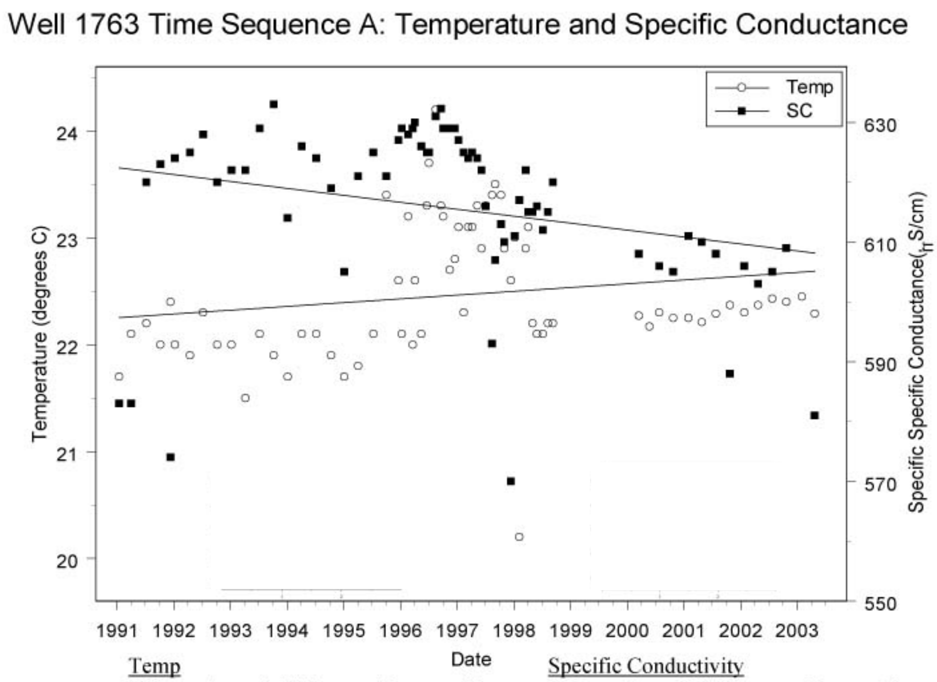
the SRWMD. There were fewer wells with decreasing water level in the SJRWMD. However, decreases in pH were similar to the other WMDs. The greatest proportion of decrease was in specific conductance. During Sequence A, zero increased while five decreased. During Sequence B one increased and four decreased, and during Sequence C, one increased while five decreased. Along with specific conductance, rock analytes such as calcium and alkalinity showed decreases for Sequence A. A number of wells showing an increase in temperature, both in Sequences A (six increased, one decreased) and Sequence C (four increased, two decreased). In Sequence C, increases in dissolved oxygen were notable. This occurred while pH was decreasing (none increased, four wells decreased). Water levels had an unclear direction (four wells increased and only one decreased). Unlike other districts, pH decreased in many wells while water level tended to increase during Sequence C.

Figure 47 shows both unconfined and confined groundwater (Wells 1417 and 1763, respectively) in the SRWMD. Figure 48 shows the relationship for a confined well (well 1762)



Temp
MK p-value < 0.0001 n_b = 18 n_c = 43
WT p-value = 0.0001 SS = 0.0122

Specific Conductivity
MK p-value < 0.0001 n_b = 18 n_c = 43
WT p-value = 0.0027 SS = -1.0000



Temp
MK p-value = 0.0044 n_b =46 n_c = 26
WT p-value = 0.6739 SS = 0.0059

Specific Conductivity
MK p-value = 0.0014 n_b = 46 n_c = 23
WT p-value < 0.0001 SS =-0.1111

Figure 47. Temperature and specific conductance in SJRWMD wells (#1417 and #1763). Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change.

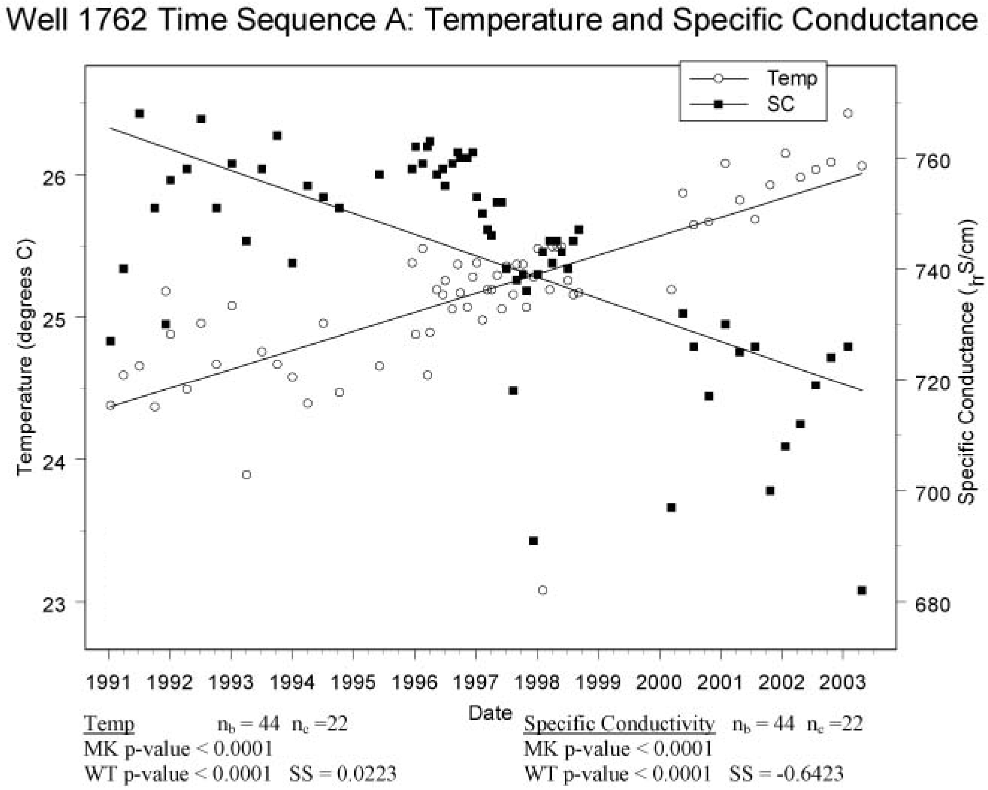


Figure 48. Temperature and specific conductance in SJRWMD well (#1762). Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change.

in the SJRWMD. All the wells start with different initial temperature and specific conductance. Well 1417 temperature starts around 22º C and ends over 23º C. Confined groundwater (Well 1763) starts near 22º C but ends slightly higher. Though the slope is significant, a WT test between segments B and C showed no significant differences (p-value 0.6739), indicating the amount of increase was less. At the same time, another confined well (Well 1762; Figure 48) had a clear temperature increase, starting near 24º C and ending near 26º C.

Well 1417 began with greater than 400 µS/cm specific conductance but ended with just above 300 (Figure 48, top). Slightly more attenuated downward trends are present in the confined water (wells 1763 and 1762). Well 1763 showed trends within the range of 630 to about 600—all within 30 µS/cm. Well 1762 had a drop in specific conductance that was also over a relatively modest range of 760 - 700 µS/cm (Figure 48).

Southwest Florida Water Management District

The SWFWMD wells (Figure 49) had the least amount of change among the WMDs. There were only a few cases worth noting. For Time Sequence A, six of 11 wells had temp-

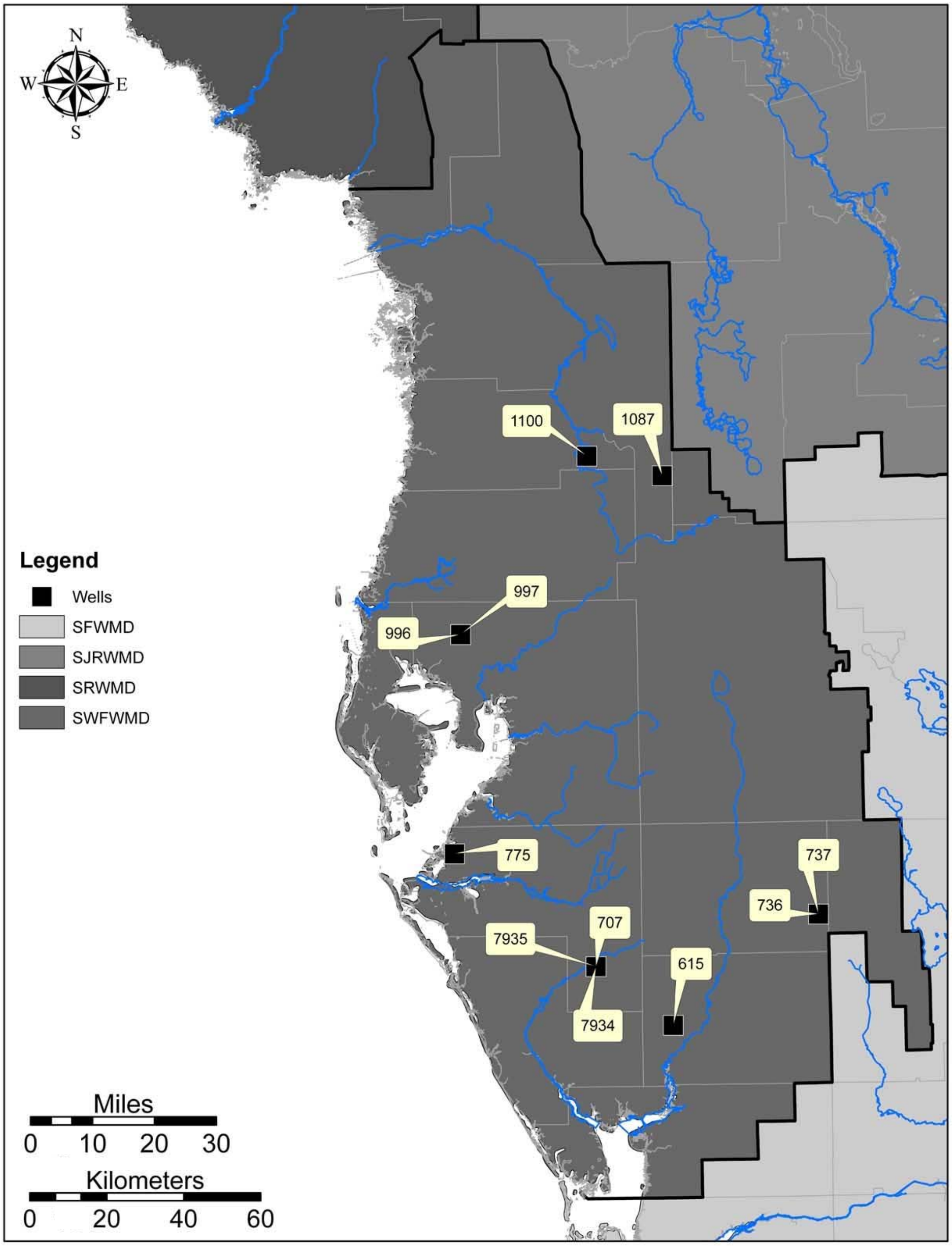


Figure 49. Location of wells within the SWFWMD.

perature trends. Five of the six increased. Sequence B had four increases with no decreases in temperature. In Sequence C, water levels increased in four wells, while none decreased in none; specific conductance decreased in five wells but only increased in one.

Like wells in the northern part of the state, water levels and pH often decreased significantly in a number of places in the SWFWMD. Figure 50 illustrates declining water levels and pH for two SWFWMD unconfined groundwater wells. Water level decreased at Well 996. At the same time, WT tests did not affirm differences between Sequence B and C water levels. The decreasing water level-trend was probably caused by the drought which occurred during Sequence C (low points are visible after the year 2000), but recovered after 2001. Thus, the overall reduction in water levels was relatively small, when viewed from Sequence A (insignificant difference in the WT test). In contrast, Well 1087 had a significant reduction in water level and in pH.

Well 707 (confined; Figure 51), along with wells 996 and 1087 (unconfined), demonstrated declining water levels that matched trends toward the three previously discussed WMDs. The pH levels in Sequences B and C in Well 707 indicated the lack of verifiable difference between the time sequences (WT test) although a MK test detected a significant downward slope for pH. On the other hand, significant declines in water levels were observed. As with the unconfined groundwater, confined Well 707 showed a reduction in water level during the drought in 2000. For Sequence A, the similarities in water-level changes in the SWFWMD and in the northern WMDs for springs and wells, suggested a statewide cause rather than only local influences.

South Florida Water Management District

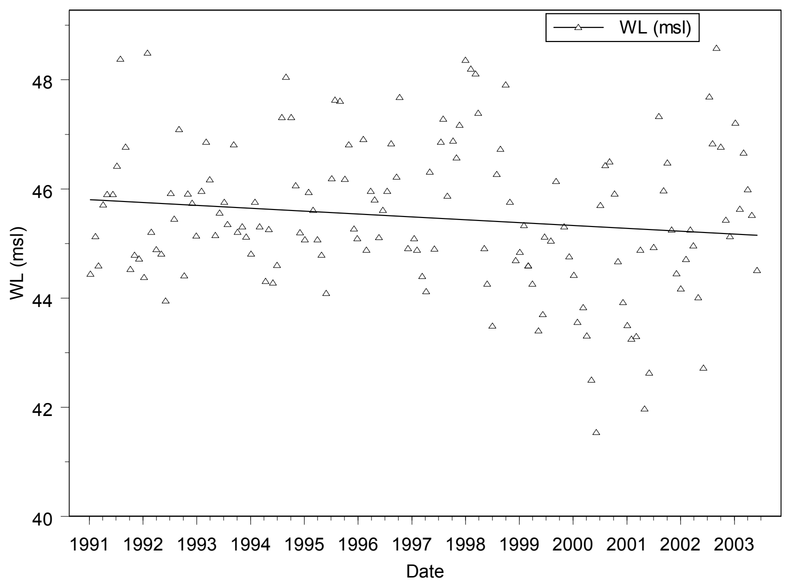
Figure 52 displays the location of the wells in the SFWMD. A small number of trends were present for a variety of analytes but nothing to suggested strong district-wide changes. The only possible exception was pH. For time Sequence C, of nine wells six registered trends—one increased and five decreased for pH. Examples of decreasing pH levels can be seen in two unconfined groundwater wells: 6490 and 3398 (Figure 53). The figure also demonstrates that water levels decreased in Well 6490. Relatively higher water levels at the start of the study may account for much of the change (Figure 53, top). The connection between pH and water level will be explored later. However, pH trends around the state were dominantly toward lower values. South Florida was no exception.

Districtwide Spring Trends

Maps depicting all of the trends for each analyte for each spring or well by water management district can be found in Appendix L.

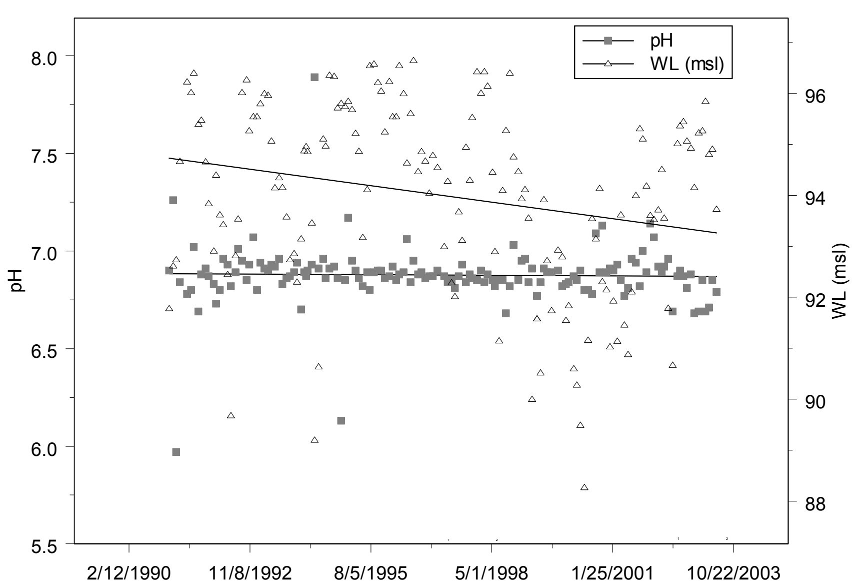
Evaluating individual trends is essential for this study. However, looking at trends from another scale can often be enlightening. For example, were there districtwide or statewide areal trends present? The sign test ($\alpha = 0.05$) was the major tool used for the analyses.

Well 996 Time Sequence A: WL



Water Level
MK p-value = 0.0434 $n_b = 86$ $n_c = 64$
WT p-value = 0.0616 SS = -0.0040

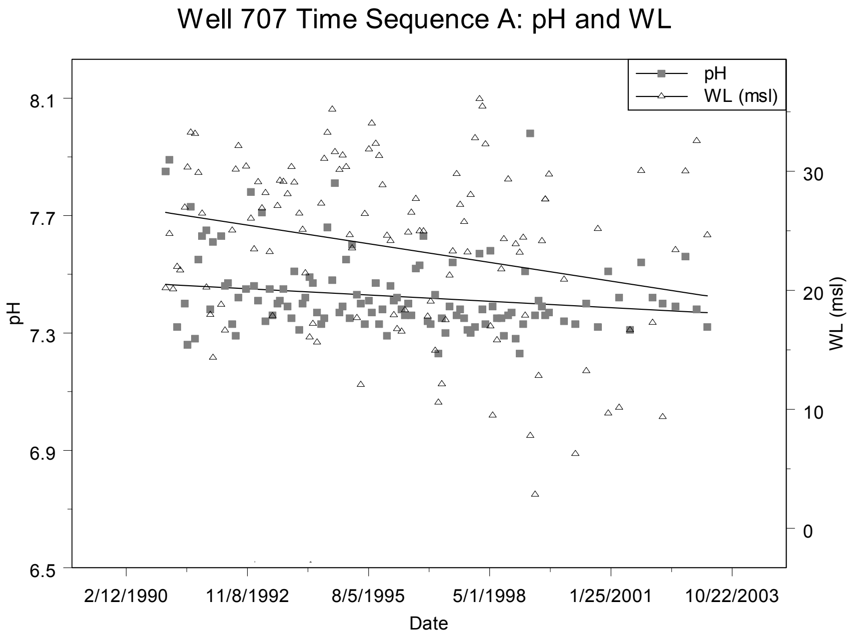
Well 1087 Time Sequence A: pH and WL



pH
MK p-value = 0.0442 $n_b = 84$ $n_c = 64$
WT p-value = 0.1617 SS = -0.0002

Water Level
MK p-value = 0.0023 $n_b = 84$ $n_c = 64$
WT p-value < 0.0001 SS = -0.0096

Figure 50. Decreasing pH and water levels in SWFWMD wells (#996 and #1087). Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change. (One ft = 0.305 m)



pH	Water Level
MK p-value = 0.0045 n_b = 82 n_c = 34	MK p-value = 0.0001 n_b = 82 n_c = 33
WT p-value = 0.1627 SS = -0.0008	WT p-value = 0.0223 SS = -0.0592

Figure 51. Decreasing pH and water levels in SWFWMD well (#707). Water levels and pH for Southwest confined groundwater (Well 707). Tests ($p < 0.05$) included MK for trend, WT on sequences B and C, plus an SS calculation on rate of change.

Wakulla Spring is the only spring in the NWFWMD to have sufficient data for trend analyses. If only one station is present, a districtwide analysis for trends, based on the sign test, is not possible (Gilbert, 1987). For these reasons, and because Wakulla Spring is located only about 24 km (15 miles) to the SRWMD border, we included Wakulla Spring with the SRWMD. In addition, the SFWMD had no spring with sufficient data for analyses. Thus, districtwide trends could only be conducted for the SRWMD (16 springs including Wakulla), the SJRWMD (14 springs), and the SWFWMD (27 springs).

Recall (p. 59) that the after the delivery of Boyette Spring water quality data, the SWFWMD declassified Boyette as a spring. Because of the point-source dairy contamination, Boyette Spring data were removed from both districtwide and statewide analyses. Also, recall (p. 35) that the statistical test used to evaluate the presence of areal trends was the sign test (Appendix E). As used in this study, the sign test compares the proportions of significantly increasing trends to significantly decreasing trends. If we were unable to confirm a trend, or if there were insufficient data, the corresponding sequences were not used for the sign tests. Note that for the sign test discussions that follow, the symbol "+" indicates an upward trend, "-" designates a downward trend, and a blank indicates no discernable trend.

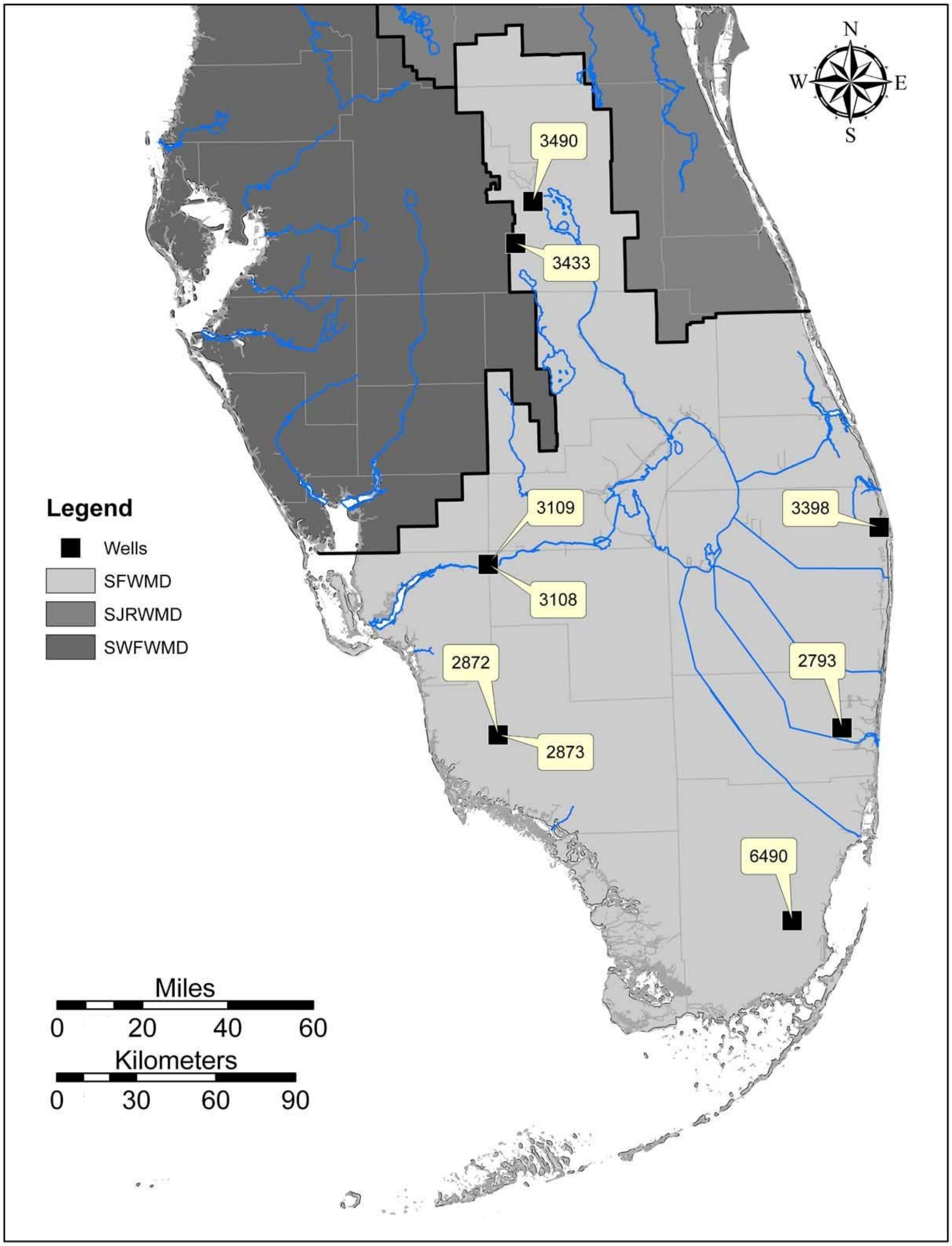
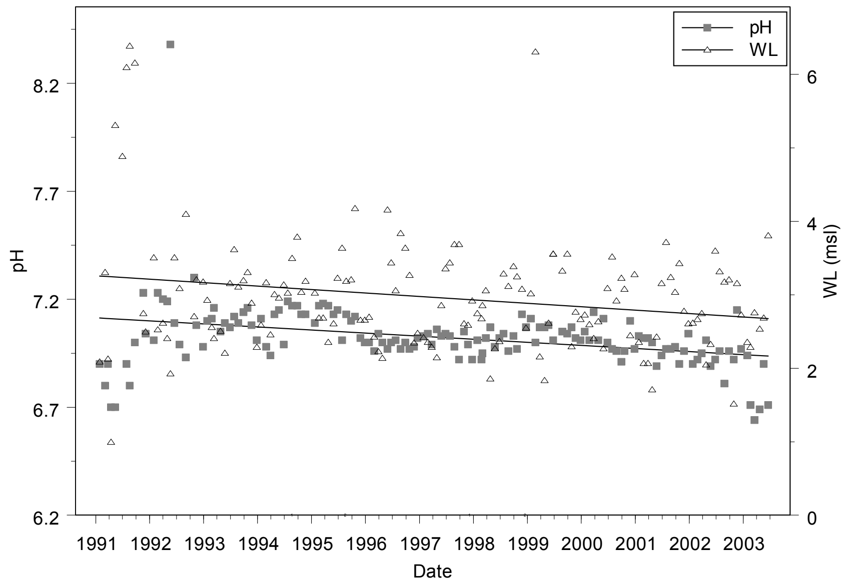


Figure 52. Location of wells within the SFWMD.

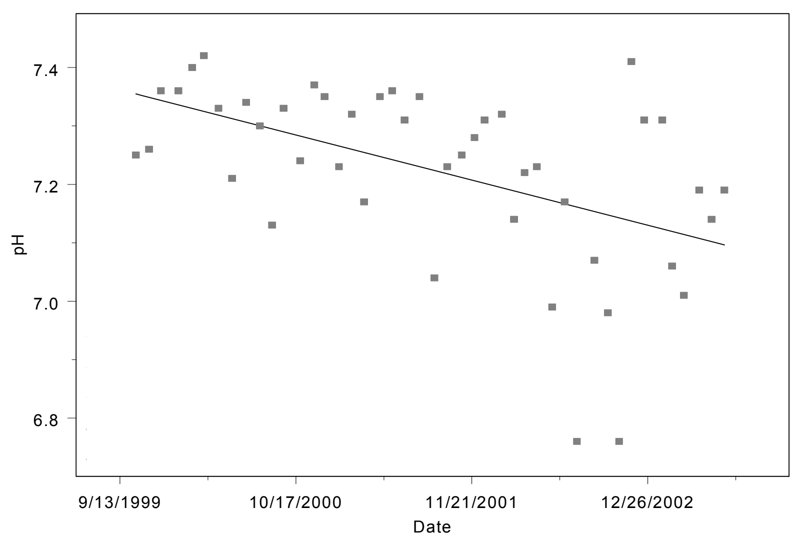
Well 6490 Time Sequence A: pH and WL



pH
MK p-value < 0.0001 $n_b = 80$ $n_c = 66$
WT p-value = 0.0002 SS = -0.0012

Water Level
MK p-value = 0.0488 $n_b = 81$ $n_c = 66$
WT p-value < 0.1353 SS = -0.0014

Well 3398 Time Sequence C: pH



pH
MK p-value = 0.0001 $n_1 = 23$ $n_2 = 23$
WT p-value = 0.0002 SS = -0.0050

Figure 53. Decreasing pH and water levels in SFWMD wells (#6490 and # 3398). SFWMD unconfined groundwater shows downward trends. Tests ($p < 0.05$) included MK for trend, WT, plus an SS calculation on rate of change.

Districtwide Spring Trends in Suwannee River Water Management District

The individual spring trends for Sequence A in the SRWMD (including Wakulla Spring) are displayed in Table 10. Significant trends were those with p-values less the 0.05. Flow had a significant decreasing trend while calcium, magnesium, sodium, specific conductance, total kjeldahl nitrogen (TKN), and temperature each had upward districtwide trends (Table 11). The two far right columns of Table 10 summarize the total number of pluses and minuses for the respective analyte. Table 11 summarizes the analytes displaying districtwide trends using the sign test, along with corresponding p-values.

For Sequence B (Table 12), there were no observable trends. Trends in Sequence C (Table 13) were similar to those in Sequence A. Table 14 summarizes Sequence C. Flow decreased, while calcium, magnesium, sodium, phosphorous and total kjeldahl nitrogen, had upward trends. Total organic carbon had a downward trend.

Districtwide Spring Trends in St. Johns River Water Management District

Spring trends for the SJRWMD are shown in Table 15. For Sequence A (Table 16) calcium, fluoride, pH, and strontium each had upward trends while orthophosphate (or simply phosphate) had a downward trend. As with the SRWMD, no districtwide trends were observed for Sequence B (Table 17) within the SJRWMD. However, for Sequence C (Tables 18 and 19), flow had a downward trend while pH and fluoride had upward trends.

Districtwide Spring Trends in Southwest Florida Water Management District

Individual spring trends for the SWFWMD are displayed in Table 20. For Sequence A (Table 21), bicarbonate (related to alkalinity), calcium, chloride, magnesium, nitrate, potassium, sodium, specific conductance, strontium, sulfate, and total dissolved solids, each had upward districtwide trends. The analytes pH and temperature had downward trends. Unfortunately, flow data were only available from three gaging stations within the SWFWMD. For this reason, there were insufficient data to make conclusions regarding districtwide flow trends.

During Sequence B (Table 22), fluoride and nitrate each had an upward trend whereas phosphorus had a downward trend (Table 23). As with Sequence A, there existed insufficient data to determine significant flow trends during Sequence B.

Sequence C was similar to Sequence A in terms of trends (Table 24). Bicarbonate, calcium, chloride, magnesium, nitrate, potassium, specific conductance, sodium, strontium, sulfate, and total dissolved solids showed upward trends while pH had a downward trend (Table 25). Again there were insufficient data to determine districtwide trends in flow. However, during Sequence C, three gaging stations did have sufficient data and all three of these sites demonstrated downward trends (Table 26).

Table 10. Spring Trends in the SRWMD (plus Wakulla Spring), Sequence A (1991-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	+	-
Alk			+							+		+		+			4	0
Ca	+		+		+	+		+	+		+	+		+		+	10	0
Cl		+	+				+		-			+		+			4	1
DO	-	+	-	-	-	-		-		+	-	-		-			2	9
F														+		+	2	0
Flw*	-		-	-	-	-	-	-	-		-	-				-	0	11
K					-	-										+	1	2
Mg	+		+	+	+			+	+		+			+		+	9	0
Na	+		+		+	+		+	+			+		+		+	9	0
NH_3		DL	+	DL	+	DL	DL	DL	DL		DL			DL		DL	2	0
NO_3**	-	+		-	-	-	+				-			-		-	3	6
P		+			+	+	+			-				+			5	1
PO_4			+		+	+			+							-	4	1
pH	-			+		+		+			+			+			5	1
SC-lb	+	+	+		-	-	+			+		+		+		+	8	2
SO_4	+					-						+		+		+	4	1
TKN		+	+	+		+	+		+		+	+		+			9	0
Temp		+	+		+			+	+	+	+						7	0
TOC									-	+						+	2	1
Trb			+			+				-						+	3	1

All analytes total unless otherwise stated
* Inferred from stage data.
**NO3 = NO3 + NO2 as N (total)
DL = Influenced by changing laboratory method detection level.

1. Wakulla Spring (NWFWMD)
2. Manatee Spring
3. Fanning Spring
4. Hart Spring
5. Rock Bluff Spring
6. Little River Spring
7. Ruth/Little Sulfur Springs
8. Troy Spring
9. Suwannee Blue Spring
10. Royal Spring
11. Telford Spring
12. Lafayette Blue Spring
13. Alapaha River Rise
14. Gilchrist Blue Spring
15. Poe Spring
16. Hornsby Spring

Table 11. SRWMD (plus Wakulla Spring) Districtwide Spring Trends, Sequence A.
(Based on sign tests results for Sequence A (see two far right columns in Table 10.)

Analyte	+	-	**Trend Direction**	**P-Value**
Ca	10	0	Up	0.001
Mg	9	0	Up	0.002
Na	9	0	Up	0.002
SC-lb	8	2	Up	0.008
TKN	9	0	UP	0.002
Temp	7	0	Up	0.008
Flow	0	11	Down	0.001

Table 12. Spring Trends in the SRWMD (plus Wakulla Spring) Sequence B (1991-1997).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	+	-
Alk					+					+						+	3	0
Ca	+																1	0
Cl								-									0	1
DO	-																0	1
F																	0	0
Flw*	-																0	1
K	-																0	1
Mg	+		-							+						+	3	1
Na	+									+						+	3	0
NH_3			+														1	0
NO_3**																	0	0
P						-		-			-						0	3
PO_4					-			-			-						0	3
pH					-												0	1
SC-lb					+					+	+					+	4	0
SO_4			-								+						1	1
TKN					DL			DL		DL	DL					-	0	1
Temp					+			+		+	+						4	0
TOC																	0	0
Trb			+		-			DL		DL	DL					-	1	2

All analytes total unless otherwise stated
* Inferred from stage data.
**NO3 = NO3 + NO2 as N (total)
SC-lb = Specific Conductance (laboratory) a
DL = Influenced by changing laboratory method detection level.

1. Wakulla Spring (NWFWMD)
2. Manatee Spring
3. Fanning Spring
4. Hart Spring
5. Rock Bluff Spring
6. Little River Spring
7. Ruth/Little Sulfur Springs
8. Troy Spring
9. Suwannee Blue Spring
10. Royal Spring
11. Telford Spring
12. Lafayette Blue Spring
13. Alapaha River Rise
14. Gilchrist Blue Spring
15. Poe Spring
16. Hornsby Spring

Note: No Sequence B districtwide trends were observed in the SRWMD.

Table13. Spring Trends in the SRWMD (plus Wakulla Spring), Sequence C (1998-2003).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	+	-
Alk		+												+	-	-	2	2
Ca		+	+		+		+	+	+		+	+		+	+	+	11	0
Cl		+				-	+		-			+	+	+	+		6	2
DO	-	+	-	-	-	-		-	+		-	-					2	8
F									+				+	+	+	+	5	0
Flw*	-		-	-	-	-	-	-	-		-	-			-	-	0	12
K		+	+			-	+					+	+		+	+	7	1
Mg		+	+	+	+	+	+	+	+		+	+		+	+	+	13	0
Na		+	+	+	+	+	+	+			+	+		+	+	+	12	0
NH_3		+D	+	+D	+	+D	+D	+D	+D		+D	+D		+D	+D	+D	2	0
NO_3**		+		-	-	-	+	-			-	-		-	-	-	2	9
P		+			+	+	+	+	+		+			+	+		9	0
PO_4		+	+		+	+		+	+						+	-	7	1
pH	-			+		+							-		+		3	2
SC-lb		+	+		-	-	+	-			-	+		+	+	+	7	4
SO_4		+	-	+		-					-	+		+	+	+	6	3
TKN		+	+	+	+D	+	+	+	+		+	+D		+	+	+D	10	0
Temp		+	+						+				+				4	0
TOC		-	-		-	-	-	-	-		-	-	+	-	-		1	11
Trb						+	+		+						+	+	5	0

All analytes total unless otherwise stated
* Inferred from stage data.
**NO3 = NO3 + NO2 as N (total)
D = DL = Influenced by changing laboratory method detection level.

1. Wakulla Spring (NWFWMD)
2. Manatee Spring
3. Fanning Spring
4. Hart Spring
5. Rock Bluff Spring
6. Little River Spring
7. Ruth/Little Sulfur Springs
8. Troy Spring
9. Suwannee Blue Spring
10. Royal Spring
11. Telford Spring
12. Lafayette Blue Spring
13. Alapaha River Rise
14. Gilchrist Blue Spring
15. Poe Spring
16. Hornsby Spring

Table 14. SRWMD (plus Wakulla Spring) Districtwide Trends based on sign tests, Sequence C.
(Based on sign tests results. See two far right columns in Table 13.)

Analyte	+	-	Trend Direction	P-Value
Flow	0	12	Down	<0.001
Ca	11	0	Up	<0.001
Mg	13	0	Up	<0.001
Na	12	0	Up	<0.001
P	9	0	Up	0.002
TKN	10	0	Up	0.001
TOC	1	11	Down	0.006

Table 15. Spring Trends in the SJRWMD, Sequence A (1991-2003).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+	-
Alk		+				+	+		+	+			+	-	+	7	1
Ca	+	+		+	+	+	+	+	+					-	+	9	1
Cl			-			+	+			+			+	-	+	5	2
F				+			+	+	+	+	+	+	+	+	+	10	0
Flw			+		+			-	-	-		+				3	3
K			-													0	1
Mg		+	-	+		+	+		+	+				-	+	7	2
Na		+	-		-		+			+			+	-	+	5	3
NO_3*		-	+			+		+			-			-	-	3	4
P																0	0
PO_4	-	-		-	-		-	-	-	-	-DL	-		-	-	0	11
pH	+			+	+	+	+	+		+		+	-	+		9	1
SCfld	-		-		-				-			-		-	+	1	6
SO_4		+	-	+	-	+	+	+	-		+	-	+	-	+	8	5
TKN			-								-					0	2
Temp											+				+	2	0
TDS			-			+				+			+	-	+	4	2
Sr	+	+		+	+		+		+	+	+		+	-	+	10	1

Analytes are total rather than dissolved except for Apopka Spring. SC-fld = Specific Conductance field
*NO3 = Depending on spring, nitrate could be in the form of: (1) D - NO3 + NO2 (as N), (2) D - NO3 (as N) or T - NO3 (as N) combined; (3) T - NO3 + NO2 (as N) combined, or (4) T - NO3 (as N)
DL = Influenced by changing laboratory method detection level.

1. Alexander Spring
2. Apopka Spring
3. Volusia Blue Spring
4. Fern Hammock Springs
5. Juniper Springs
6. Miami Spring
7. Palm Springs
8. Ponce de Leon Spring
9. Rock Springs
10. Sanlando Springs
11. Salt Springs
12. Silver Glen Springs
13. Starbuck Spring
14. Sweetwater Spring
15. Wekiwa Spring

Table 16. SJRWMD Districtwide Trends Based on Sign Tests, Sequence A.
(Based on sign tests results. See two far right columns in Table 15.)

Analyte	**+**	**-**	**Trend Direction**	**P-Value**
Ca	9	1	Up	0.011
F	10	0	Up	0.001
PO_4	0	11	Down	<0.001
pH	9	1	Up	0.011
Sr	10	1	Up	0.001

Table 17. Spring Trends in the SJRWMD, Sequence B (1991-1997).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+	-
Alk	-			-	-									-	+	1	4
Ca											+			-		1	1
Cl								+			+			-		2	1
F												+		+		2	0
Flw	+		+		+						+	+				5	0
K											+			+		2	0
Mg											+			-		1	1
Na											+			-	+	2	1
NO_3*												-				0	1
P		-			-				-					-	-	0	5
PO_4																0	0
pH								-			-	-			-	0	4
SCfld	-			-					-		+	-		-		1	5
SO_4											+				+	2	0
TKN											+			-		1	1
Temp												+				1	0
TDS					-			+	-		+	-		-		2	4
Sr									+		+			-		2	1

Analytes are total rather than dissolved except for Apopka Spring.
*NO3 = Depending on spring, nitrate could be in the form of: (1) D - NO3 + NO2 (as N), (2) D - NO3 (as N) or T - NO3 (as N) combined; (3) T - NO3 + NO2 (as N) combined, or (4) T - NO3 (as N)
DL = Influenced by changing laboratory method detection level.

1. Alexander Spring
2. Apopka Spring
3. Volusia Blue Spring
4. Fern Hammock Springs
5. Juniper Springs
6. Miami Spring
7. Palm Springs
8. Ponce de Leon Spring
9. Rock Springs
10. Sanlando Springs
11. Salt Springs
12. Silver Glen Springs
13. Starbuck Spring
14. Sweetwater Spring
15. Wekiwa Spring

Note: No Sequence B districtwide trends were observed in the SJRWMD.

Table 18. Spring Trends in the SJRWMD, Sequence C (1998-2003).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+	-
Alk		+		+	+		+								+	5	0
Ca				+				+						-	+	3	1
Cl				-	-	+	+	+		+		-	+	-	+	6	4
F				+	+	+	+	+		+					+	7	0
Flw	-	-	-	-	-				-		-			-		0	8
K								+								1	0
Mg				+										-		1	1
Na													+	-	+	2	1
NO_3*		-				+										1	1
P	-											-			-	0	3
PO_4																0	0
pH				+	+	+	+			+	+	+	+	+	+	10	0
SCfld								+				-				1	1
SO_4					-	+	+					-	+	-		3	3
TKN								-			-					0	2
Temp							+			+			+		+	4	0
TDS												-		-		0	2
Sr				+						+			+	-		3	1

Analytes are total rather than dissolved except for Apopka Spring.
*NO3 = Depending on spring, nitrate could be in the form of: (1) D - NO3 + NO2 (as N), (2) D - NO3 (as N) or - T - NO3 (as N) combined; (3) T - NO3 + NO2 (as N) combined, or (4) T - NO3 (as N)
DL = Influenced by changing laboratory method detection level.

1. Alexander Spring
2. Apopka Spring
3. Volusia Blue Spring
4. Fern Hammock Springs
5. Juniper Springs
6. Miami Spring
7. Palm Springs
8. Ponce de Leon Spring
9. Rock Springs
10. Sanlando Springs
11. Salt Springs
12. Silver Glen Springs
13. Starbuck Spring
14. Sweetwater Springs
15. Wekiwa Spring

Table 19. SJRWMD Districtwide Trends Based on Sign Tests, Sequence C.
(Based on sign tests results. See two far right columns in Table 13.)

Analyte	**+**	**-**	**Trend Direction**	**P-Value**
Flow	0	8	Down	0.008
pH	10	0	Up	0.001
F	7	0	Up	0.008

Table 20. Spring Trends in the SWFWMD, Sequence A (1991-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	1	2	3	4*	5	6	7	8	9	10	11	12	13	14
Bicarb*[1]	+		+	-	+	+		+	+	+	+	+	+	+
Ca			+	-	+					+	+	+		+
Cl			+	-	+	-	+	+		+	+	+	+	+
F	+								+			+		
K		+					+	+	+	+	+	+	+	+
Mg			+	-	+		+	+		+	+	+	+	+
Na			+	-	+	-	+	+		+	+	+		+
NH_3	-D				-D					-D			-D	-D
NO_3*[2]		+		-		+		+	+	+	+	+	+	+
P*[3]				-			-							
PO_4														
pH					-					-	-		-	-
SC-fld			+	-	+	-	+			+	+	+	+	+
SO_4			+			-	+	+		+	+	+	+	+
Sr	+		+	+	+		+	+				+	+	+
TDS			+	-	+		+	+				+		+
Temp			-					-	-		-			
TKN	-D			+				-D	-D	-D	-D			
T-N														
TOC		-	+		-	-D	-D	-D	-D	-D	-D			
Fe*[3]		-D						-D		-D	-D			-

Bicarb* = Only WMD to sample bicarbonate was SWFWMD. Other WMDs sampled alkalinity.
NO3* = D-NO3+NO2 as N.
Fe*[3] = Only WMD to sample D-Fe was SWFWMD
D = DL = Influenced by changing laboratory method detection level.
4* = Boyette Spring not used in determining presence of districtwide or statewide trends.

1. Betty Jay Spring
2. Boat Spring
3. Bobhill Spring
4. Boyette Spring
5. Bubbling Spring
6. Buckhorn Main Spring
7. Catfish Spring
8. Chassahowitzka Main Spring
9. Chassahowitzka No. 1. Spring
10. Hidden River Head Spring
11. Hidden River No. 2 Spring
12. Homosassa No. 1 Spring
13. Homosassa No. 2 Spring
14. Homosassa No. 3. Spring

Table 20. Spring Trends in the SWFWMD, Sequence A (continued).

Analyte	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Summary	
															+	-
Bicarb*[1]	+	+	+			+	+	+			+		+		19	0
Ca			+			+	+		-		+	+	+		12	1
Cl	+	+			+	+	+	+			+	+	+		18	1
F											+				4	0
K	+			+	+	+	+	+			+	+	+		18	0
Mg	+					+	+	+			+	+	+		16	0
Na	+				+	+	+	+			+	+	+		16	1
NH_3	-D				-D		-D						-D		0	0
NO_3*[2]	+		+	+	+		+		+	+	+	+	+		19	0
P*[3]	-				-								-		0	4
PO_4		+	-												1	1
pH	-					-	-		-		-				0	10
SC-fld	+					+	+	+			+	+	+		15	1
SO_4	+	-				+	+	+			+	+	+		15	1
Sr	+		+		+	+	+		+		+	+	+		17	0
TDS	+					+	+	+	+		+	+	+		14	0
Temp	-		-			-	-								0	8
TKN	-D		-				-					-D	-		0	3
3T-N						-									0	1
TOC	-D	-	-D		-D	-D	-D	-D	-D		-				1	4
Fe*[3]			-D	-D	-	-D	-D					-D			0	2

Bicarb*[1] = Only WMD to sample bicarbonate was SWFWMD. Other WMDs sampled alkalinity.
NO3*[2] = D-NO3+NO2 as N.
Fe*[3] = Only WMD to sample D-Fe was SWFWMD
D = DL = Influenced by changing laboratory method detection level.

15. Hunter Spring
16. Lithia Spring Major
17. Magnolia Spring
18. Pump House Spring
19. Rainbow No. 1 Spring
20. Rainbow No. 4 Spring
21. Rainbow No. 6 Spring
22. Rainbow Swamp Spring No. 3
23. Rainbow Bridge Seep Spring
24. Salt Spring
25. Tarpon Hole Spring
26. Trotter Main Spring
27. Weeki Wachee Main Spring
28. Wilson Head Spring

Table 21. SWFWMD Districtwide Trends Based on Sign Tests, Sequence A*.

Analyte	**+**	**-**	**Trend Direction**	**P-Value****
Bicarb	19	0	Up	<0.001
Ca	12	1	Up	0.002
Cl	18	1	UP	<0.001
K	18	0	Up	<0.001
Mg	16	0	Up	<0.001
Na	16	1	Up	<0.001
NO_3	19	0	Up	<0.001
pH	0	10	Down	0.002
SC	15	1	Up	< 0.001
$S0_4$	15	2	Up	0.001
Sr	17	0	Up	<0.001
TDS	14	0	Up	<0.001
Temp	0	8	Down	0.004

* After evaluation of individual springs, the SWFWMD declassified Boyette Spring as a spring. As a consequence, Boyette data were not used for evaluations of districtwide or statewide trends.
**Trends suspected of being influenced by changing laboratory detection levels are not included.

Table 22. Spring Trends in the SWFWMD, Sequence B (1991-1997).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bicarb*[1]						+		+						
Ca					-									
Cl	+					-					-			
F				+			+					+	+	+
K	+			+		-				-	-			
Mg	+				-	-			+					
Na	+					-				-	-			
NH_3														
NO_3*[2]				+		+						+	+	
P*[3]							-		-				-	-
PO_4				-										
pH				+										
SC-fld	+			+		-					-			
SO_4	+				-	-					+			
Sr														
TDS	+					-				-	-			
Temp														+
TKN														
T-N														
TOC						-	-D							
Fe*[3]				+		+								

Bicarb*[1] = Only WMD to sample bicarbonate was SWFWMD. Other WMDs sampled alkalinity.
NO3*[2] = D-NO3+NO2 as N.
Fe*[3] = Only WMD to sample D-Fe was SWFWMD
D = DL = Influenced by changing laboratory method detection level.
4* = Boyette Spring not used in determining presence of districtwide or statewide trends.

1. Betty Jay Spring
2. Boat Spring
3. Bobhill Spring
4. Boyette Spring
5. Bubbling Spring
6. Buckhorn Main Spring
7. Catfish Spring
8. Chassahowitzka Main Spring
9. Chassahowitzka No. 1. Spring
10. Hidden River Head Spring
11. Hidden River No. 2 Spring
12. Homosassa No. 1 Spring
13. Homosassa No. 2 Spring
14. Homosassa No. 3. Spring

Table 22. Spring Trends in the SWFWMD, Sequence B (continued).

	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Summary	
															+	-
Bicarb*[1]		+													3	0
Ca					-	-			-						0	4
Cl											+				2	2
F			+			+			+	+	+	+			10	0
K															1	3
Mg						-									2	3
Na											+		+		3	3
NH_3															0	0
NO_3*[2]			+	+								+	+		7	0
P*[3]					-	-					-	-			0	8
PO_4															0	1
pH									-			+	-		1	2
SC-fld							+				+				3	2
SO_4						-					+				3	3
Sr															0	0
TDS											+				2	3
Temp					-										1	1
TKN											+				1	0
T-N															0	0
TOC				-	-D	-D	-D		-D						0	2
Fe*[3]	+														2	0

Bicarb*[1] = Only WMD to sample bicarbonate was SWFWMD
NO3*[2] = NO3+NO2 as N.
Fe*[3] = Only WMD to sample D-Fe was SWFWMD
D = DL = Influenced by changing laboratory method detection level.

15. Hunter Spring
16. Lithia Spring Major
17. Magnolia Spring
18. Pump House Spring
19. Rainbow No. 1 Spring
20. Rainbow No. 4 Spring
21. Rainbow No. 6 Spring
22. Rainbow Swamp Spring No. 3
23. Rainbow Bridge Seep Spring
24. Salt Spring
25. Tarpon Hole Spring
26. Trotter Main Spring
27. Weeki Wachee Main Spring
28. Wilson Head Spring

Table 23. SWFWMD Districtwide Trends Based on Sign Tests, Sequence B.

Analyte	+	-	Trend Direction	P-Value*
F	10	0	Up	0.002
NO_3	7	0	UP	0.016
P	0	8	Down	0.004

* After evaluation of individual springs, staff at the SWFWMD declassified Boyette Spring as a spring. As a consequence, Boytte data were not used for evaluations of districtwide or statewide trends.

**Trends suspected of being influenced by changing laboratory detection levels are not included.

Table 24. Spring Trends in the SWFWMD, Sequence C (1998-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Bicarb*[1]	+		+		+	+		+	+	+	+	+	+	+
Ca					+			+		+	+			
Cl			+	-	+			+		+	+			
F				+	+								+	
Flw														
K			+		+			+		+	+			
Mg			+		+	+	+	+		+	+		+	
Na			+	-	+		+	+		+	+			
NH_3			-											
NO_3*[2]			+	-		-			+	+	+	+	+	+
P*[3]								-				+		
PO_4									-					
pH					-					-	-			
SC-fld			+	-	+				+	+	+			
SO_4				-	+			+	+	+	+			
Sr	+		+	+	+	+	+	+	+			+	+	+
TDS			+		+	+	+	+	+					
Temp				+							-			
TKN														
T-N			+	-	-	-								
TOC				+		-					-			-
Fe*[3]				-								+		

Bicarb*[1] = Only WMD to sample bicarbonate was SWFWMD
NO3*[2] = NO3+NO2 as N
Fe*[3] = Only WMD to sample D-Fe was SWFWMD
D = DL = Influenced by changing laboratory method detection level.
4* = Boyette Spring not used in determining presence of districtwide or statewide trends.

1. Betty Jay Spring
2. Boat Spring
3. Bobhill Spring
4. Boyette Spring
5. Bubbling Spring
6. Buckhorn Main Spring
7. Catfish Spring
8. Chassahowitzka Main Spring
9. Chassahowitzka No. 1. Spring
10. Hidden River Head Spring
11. Hidden River No. 2 Spring
12. Homosassa No. 1 Spring
13. Homosassa No. 2 Spring
14. Homosassa No. 3 Spring

Table 24. Spring Trends in the SWFWMD, Sequence C (continued).

	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Summary +	Summary -
Bicarb*[1]	+	+	+		+	+	+				+	+	+	+	21	0
Ca				+		+	+				+	+			9	0
Cl	+				+	+	+				+	+	+		12	0
F							+						+		4	0
Flw															0	0
K	+	+		+	+	+	+				+	+	+	+	15	0
Mg	+			+		+	+				+	+			14	0
Na	+				+	+	+				+	+	+	+	14	0
NH_3					-DL	-	-DL								0	2
NO_3*[2]	+	-	+	+			+				+	+	+	-	14	3
P*[3]	-				-								-	-	1	5
PO_4															0	1
pH	-					-	-								0	6
SC-fld	+			+		+	+				+	+	+		12	0
SO_4	+			+	+	+	+				+	+			12	0
Sr	+		+		+	+	+				+	+	+	+	19	0
TDS	+					+	+				+	+			10	0
Temp		-													0	2
TKN															0	0
T-N		-	+			-								-	2	6
TOC			-										+		1	4
Fe*[3]														+	2	0

Bicarb*[1] = Only WMD to sample Bicarbonate was SWFWMD
Fe*[3] = Only WMD to sample D-Fe
NO3*[2] = NO3+NO2 as N
D = DL = Influenced by changing laboratory method detection level.

15. Hunter Spring
16. Lithia Spring Major
17. Magnolia Spring
18. Pump House Spring
19. Rainbow No. 1 Spring
20. Rainbow No. 4 Spring
21. Rainbow No. 6 Spring
22. Rainbow Swamp Spring No. 3
23. Rainbow Bridge Seep Spring
24. Salt Spring
25. Tarpon Hole Spring
26. Trotter Main Spring
27. Weeki Wachee Main Spring
28. Wilson Head Spring

Table 25. SWFWMD Districtwide Trends Based on Sign Tests, Sequence C.

Analyte	+	-	Trend Direction	P-Value*
Bicarbonate	21	0	Up	<0.001
Ca	9	0	Up	0.002
Cl	12	0	Up	<0.001
K	15	0	Up	<0.001
Mg	14	0	Up	<0.001
Na	14	0	Up	<0.001
NO_3	14	3	Up	0.006
pH	0	6	Down	0.016
SC	12	0	UP	<0.001
SO_4	12	0	UP	<0.001
Sr	19	0	Up	<0.001
TDS	10	0	Up	0.002

* After evaluation of individual springs, staff at the SWFWMD declassified Boyette Spring as a spring. As a consequence, Boytte data were not used for evaluations of districtwide or statewide trends.

Table 26. Spring Flow from Three Stations in the SWFWMD.

Spring Location	Trend Direction	P-value
Homosassa Springs at Homosassa	Down	<0.0001
Chassahowitzka River near Chassahowitzka	Down	<0.0001
Chassahowitzka River Near Homosassa	Down	<0.0001

For a summary of districtwide trends see Table 27. The table displays the Sequence (A, B, and C) by WMD. It displays the analytes with upward and downward trends. In addition, it displays the corresponding p-values. If a p-value is less than α (significance level preset at 0.05), it is concluded that a districtwide trend exists. It should be noted that the lower the p-value, the lower the probability is that the null hypothesis (no trend) is true and, therefore, the stronger the argument for the existence of a trend. For example, a p-value of slightly less than 0.05 indicates that there was slightly less than one in 20 chance that a trend did not exist. If the p-value was 0.01, then there is only a one in 100 chance of the error occurring. In addition to the authors presetting α to be 0.05, they also, arbitrarily, set a p-value of 0.02 as being strong evidence for a trend. Thus, a p-value less than 0.05, but greater than or equal to 0.02, was considered to be evidence for a moderately strong trend. Based on this argument, the p-values in Table 27 represent strong evidence for trends.

Table 27. Statewide Spring Trend Summary by WMD and Time Sequence.
Light gray boxes indicate saline-related indicators, dark gray nutrient-related indicators.
(p-values are from sign tests by the corresponding water management district)

Sq	**SRWMD (including Wakulla Spring)**				**SJRWMD**				**SWFWMD**			
A	**Up**	p-val	**Dwn**	p-val	**Up**	p-val	**Dwn**	p-val	**Up**	p-val	**Dwn**	p-val
	Ca	0.001	Flow	0.001	Ca	0.011	PO_4	<0.001	Ca	0.002	Tmp	0.004
	Mg	0.002			F	0.001			Bcarb	<0.001	pH	0.011
	Na	0.002			pH	0.011			Mg	<0.001		
	TKN	0.002			Sr	0.001			Sr	<0.001		
	Tmp	0.008							K	<0.001		
									Na	<0.001		
									Cl	<0.001		
									SO_4	0.001		
									SC	< 0.001		
									TDS	<0.001		
									NO_3	<0.001		
B	-	-	-	-	-	-	-	-	F	0.002	P	0.004
									NO_3	0.008		
C	Ca	<0.001	Flow	0.002	pH	0.001	Flw	0.008	Ca	0.002	pH	0.016
	Mg	<0.001	TOC	0.003	F	0.008			Bicarb	<0.001		
	Na	<0.001							Mg	<0.001		
	P	0.002							Sr	<0.001		
	TKN	0.001							K	<0.001		
									Na	<0.001		
									Cl	<0.001		
									SO_4	<0.001		
									SC	<0.001		
									TDS	0.004		
									NO_3	0.006		

Bcarb = Bicarb; Dwn = Down; Flw = Flow; Tmp = Temp

Statewide Spring Trends

It should be pointed out that bicarbonate was sampled only by the SWFWMD. However, the other WMDs sampled alkalinity. The two species are considered to have sufficient similarities to be considered one analyte (bicarbonate/alkalinity species) for the sign test exercises. Tables 28-30 show analytes with statewide trends for each time sequence.

For Sequence A (Table 28), analytes showing upward statewide trends were alkalinity, calcium, chloride, fluoride, magnesium, nitrate, potassium, sodium, specific conductance, sulfate, strontium, and total dissolved solids. Flow was the only analyte with a downward trend. For Sequence B (Table 29), the sign tests revealed that nitrate and F had upward trends, while phosphorus showed a decreasing trend.

For Sequence C (Table 30), the sign tests indicated that alkalinity, calcium, chloride, fluoride, magnesium, nitrate, potassium, sodium, specific conductance, sulfate, strontium, and total dissolved solids, and total kjeldahl nitrogen each had upward trends, while flow and total organic carbon demonstrated downward trends. Except for flow, the analytes with statewide trends were the same in Sequence C as they were in Sequence A. No statewide trend determination for flow for Sequence B could be made because of insufficient data.

Table 28. Statewide Trends Based on Sign Tests for 57 Springs, Sequence A (1991-2003).

Analyte	+	-	Trend Direction	P-Value
Alk	29	1	Up	<0.001
Ca	31	2	Up	<0.001
Cl	27	4	Up	<0.001
F	16	0	Up	<0.001
Flow	3	14	Down	0.006
K	20	3	Up	0.001
Mg	32	2	Up	<0.001
Na	30	4	Up	<0.001
NO_3	25	11	Up	0.020
SC*	24	9	UP	0.014
SO_4	27	8	Up	0.001
Sr	27	1	Up	<0.001
TDS	18	2	Up	<0.001

*Specific conductivity - SWFWMD and SJRWMD measured specific conductivity (field); SRWMD measured specific conductivity (lab).

Table 29. Statewide Trends Based on Sign Tests for 57 Springs, Sequence B (1991-1997).

Analyte	+	-	Trend Direction	P-Value
NO_3	7	1	Up	0.034
P	0	16	Down	<0.001
F	12	0	Up	< 0.001

Table 30. Statewide Trends Based on Sign Tests for 57 Springs, Sequence C (1998-2003).

Analyte	+	-	Trend Direction	P-Value
Alk	27	2	Up	<0.001
Ca	23	1	Up	<0.001
Cl	24	6	Up	0.001
F	16	0	Up	<0.001
Flow	0	20	Down	<0.001
K	23	1	Up	<0.001
Mg	28	1	Up	<0.001
Na	28	1	Up	<0.001
SC*	20	5	Up	0.003
SO_4	21	6	Up	0.004
Sr	22	1	Up	<0.001
TDS	10	0	Up	0.002
TKN	10	2	Up	0.020
TOC	2	15	Down	0.002

* Specific conductance - SWFWMD and SJRWMD measured specific conductance (field); SRWMD measured specific conductivity (lab).

Constrained Version of Statewide Trends

A second, more constrained, criterion was also used in the sign test evaluation. For these analyses, in order for an analyte to be considered to have a statewide trend, not only did it need to show a significant statewide trend based on a sign test, *there also needed to be significance in at least two of the three WMDs*. Since several springs are located within a common springshed, the areal clustering of these latter springs can potentially be influenced by springs having highly correlated water chemistries. For Sequence A (Table 31), using the more constrained approach, calcium, magnesium, and sodium showed increasing statewide trends while no analyte had decreasing trends. There were insufficient flow data in the SWFWMD and, using the two-WMD criterion, no statewide trend determination could be made for flow. There were no statewide trends for analytes using the constrained two WMD criteria for Sequence B. However, for Sequence C, Table 32 indicates that flow decreased statewide, while calcium, magnesium, and sodium increased. Because of lack of available space in many of the following tables, abridged abbreviations are assigned to each WMD for both spring and well tables. They are as follows: NWFWMD (NW), SRWMD (SR), SJRWMD (SJ), SWFWMD (SW), and SFWMD (SF).

Table 31. Statewide Trends in at Least Two WMDs, Sequence A (1991-2003).
(Statewide trend and districtwide trend in at least two WMDs.)

Analyte	+	-	Sig in WMD	Trend Direction	P-Value
Ca	31	2	SR, SJ, SW	Up	<0.001
Mg	32	2	SR, SW	Up	<0.001
Na	30	4	SR, SW	Up	<0.001

SR = SRWMD, SJ = SJRWMD, SW = SWFWMD

Table 32. Statewide Trends in at Least Two WMDs, Sequence C (1998-2003).
(Statewide trend and districtwide trend in at least two WMDs.)

Analyte	+	-	Sig in WMD	Trend Direction	P-Value
Flow	0	19	SR, SJ	Down	<0.001
Ca	23	1	SR, SW	Up	<0.001
Mg	28	1	SR, SW	Up	<0.001
Na	28	1	SR, SW	Up	<0.001

SR = SRWMD, SJ = SJRWMD, SW = SWFWMD

Independence of Springs and Wells

According to Conover (1999), a sign test makes three assumptions. First, the measurement scale is at least ordinal within each pair. For this study, each pair may be determined to be a plus, a minus or a tie. Second, the pairs need to be internally consistent. That is, the probability of any one pair being plus (or minus) is the same for all pairs. Third, the pairs of data are considered to be mutually independent bivariate random variables. The three assumptions are discussed in detail in Appendix E. For the analyses in this report, the first two assumptions are readily achieved. However, the third assumption was not always met. Although sampling stations are often considered to be randomly located, and each analyte to be a random variable, it is not always correct to assume that the pairs of data are mutually independent. Some of the springs are located within a common springshed. Because of their proximity to one another, the analyte concentration in one spring may (but not necessarily) be highly correlated with other springs within the springshed. Likewise, some of the wells are in clusters; that is, the wells are located next to each other, but tap different aquifers. Like springs, because of their proximity to one another, the concentration in one well may be highly correlated (but not necessarily) with the other wells in the cluster. Note the farther a station is located from a second one, the less likely the two are highly correlated with each other.

One way to deal with the proximity problem would be to randomly select one spring from each springshed, or one well from each cluster. This effort will reduce the dependency issue. However, it will also reduce the number of springs and wells available for analyses. Because it was very difficult to find springs and wells with sufficient data for trend analyses, it was not desirable to eliminate sampling stations.

Because some of the wells are clusters, dependency due to the close proximity of wells to one another, can be, and probably is, a problem in the evaluation of well water-quality trends. Three clusters of two wells are found in the NWFWMD. Two clusters of three wells and one cluster of two wells are found in the SJRWMD. One cluster of three wells and two clusters of two wells are found in the SWFWMD. Finally, two clusters of two wells are in the SFWMD. For statewide trends, the best way to combat the problem is to: (1) emphasize analytes with strong trend signals (e.g. p-values < 0.02) and (2) emphasize which analytes demonstrate significant trends in, for example, at least three of the five WMDs.

Quantifying the effect of dependency can be difficult. However, the strength of the statewide (and districtwide) trend signals (p-values) can assist in evaluating the dependency issue for this project. Table 33 displays the statewide plus/minus chart for Sequence A for Alk/Bicarbonate, calcium, magnesium, strontium and fluoride for the 57 springs. The table reveals that for Alk/Bicarb, there were 29 "+" values and zero "-" values. For Sr, there were 27 "+" values and only one "-". For both analytes, the p-values of the sign test were <0.001. Notice in the cells in Table 33 that contains the values 29 for Alk/Bicarb and 27 for strontium, there is a 12* in parentheses and an 7** in parentheses respectively. The asterisk next to the 12 indicates that if there is no "-" value, one could have as few as 12 "+" values and still have a p-value less than 0.001. The double asterisk next to the 7 indicates that if there is no "-" value, one could have as few as seven "+" values and still have a p-value less than 0.05 (the level of significance). Since there were 29 and 27 "+" values for Alk/Bicarb and strontium respectively, it is highly unlikely that dependency is a major factor regarding whether or not there are statewide trends.

Table 33. Selected Statewide Analyte Results, Sequence A (1991-2003).

Analyte	+	<0.01	<0.05	-	Direction	P-Value
Alk/Bicarb	29	(12*)	(7**)	0	Up	<0.001
Ca	31	(18*)	(9**)	2	Up	<0.001
Mg	32	(18*)	(9**)	2	Up	<0.001
Sr	27	(16*)	(8**)	1	Up	<0.001
F	16	(12*)	(7**)	0	Up	0.007

* Min. # of + and still have a probability value (P-Val) <0.001 with a given number of - values
** Min. # of + and still have a probability value (P-Val) <0.050 with a given number of - values

Also in Table 33, note that for the rows corresponding to calcium and magnesium, there were 31 and 32 "+" values respectively and, for both analytes there were only two "-" values. The single and double asterisks indicate that if there were only two "-" values, one could have as few as 16 "+" values and still have a p-value of less than 0.001. One could also have as few as 9 "+" values and still have a p-value of less than the significance level of 0.05. Since, for each analyte, there were 31 and 32 "+" values respectively, it is highly unlikely that dependency is a significant issue when stating there are statewide trends for these analytes.

Table 27 indicates that the p-values are overwhelmingly, on a districtwide basis, less than 0.02. In addition, most analytes displaying statewide trends in Tables 28 - 30 have very low p-values (generally less than 0.02). Because of the high proportion of extremely strong trend signals (low p-values), the authors conclude that although dependency is an issue to be aware of, it is not a major issue with regard to districtwide and statewide trends for springs for this study.

Districtwide Well-Water Trends

The number of wells with sufficient data for trend analyses varied per WMD between eight and 11. In addition, wells within a district were labeled as withdrawing water from either: (1) unconfined groundwater or (2) confined groundwater. However a third categorized was used for statistical analyses. It was a combination of both categories (all wells combined). As with any statistical test, the smaller the sample size, the more difficult it is to find enough evidence to reject a null hypothesis. The combined (All) category had the effect of increasing the sample size of wells per WMD.

Several indications of changing groundwater quality were observed. The basis of the evidence is arbitrary and two criteria were used. They were:

A. Number of wells showing a trend in major the direction exceeds minor direction by greater than a two to one margin, and
B. Number of wells in major direction must exceed number minor direction by at least four.

For example, Table 34 reveals that the number of wells with decreasing trends in water levels [WL(msl)] is six and that the number with increasing trends is zero. Since the number of decreasing trends (dominant direction) exceeds the number with increasing trends (minor) direction by at least four, we made the interpretation that the NWFWMD had a decreasing districtwide trend in water levels for Sequence A. The criteria was used for unconfined, confined, and the combined categories. In another example, also for Sequence A in the NWFWMD in the combined category, dissolved oxygen had downward trends in four wells and one well demonstrated an upward trend. Even though there is a dominance of downward trends, the number of wells with downward trends did not exceed the number with upward trends by at least four. Thus, the authors did not consider the existence of a potential downward trend for dissolved oxygen for the NWFWMD.

Evidence of Districtwide Well Water-quality Trends – Northwest Florida Water Management District

Data from eight wells (six unconfined and two confined) in the NWFWMD were used. For unconfined groundwater for Sequence A, sodium, sulfate, and temperature showed potential evidence for upward trends, while pH and water levels (WL[msl]) demonstrated potential evidence for downward trends (Table 34). Using the criteria mentioned above, with only two wells tapping confined groundwater, potential evidence for districtwide trends did not exist. For the combined category (All), potential evidence for upward trends existed for temperature, while water levels demonstrated a potential downward trend. Table 35 displays the plus/minus (upward/downward) results for Sequence A for the NWFWMD. It also lists several potential reasons for the changes in water quality and quantity.

Table 36 displays the trend results for Sequence B. For unconfined groundwater, sodium and field specific conductance (SC-fld) had a potential increase. For the combined category, SC-fld increased while water levels decreased (Table 37). For Sequence C (Table 38), the only analyte demonstrating evidence for trends was pH. For unconfined groundwater, as well as the combined category, it demonstrated a potential downward trend (Table 39).

Table 34. Well Trends in the NWFWMD, Sequence A (1991-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW						Confined		Uncon		Con		Both (All)	
	Well Number						Well Number							
Analyte	**67*[1]**	**91**	**129**	**131**	**245**	**313**	**243**	**312**	+	-	+	-	+	-
Alk		+		+		-		+	2	1	1	0	3	1
Ca	+			+		+			3	0	0	0	3	0
Cl				+		+			2	0	0	0	2	0
DO	-		-	-		+		-	1	3	0	1	1	4
F				-DL		-DL		-DL	0	0	0	0	0	0
Fe									0	0	0	0	0	0
K				-					0	1	0	0	0	1
Mg	+	+		+					3	0	0	0	3	0
Na	+	+		+		+			4	0	0	0	4	0
NH_3									0	0	0	0	0	0
NO_3*[2]	-			-DL		+		-DL	1	1	0	0	1	1
PO_4		-							0	1	0	0	0	1
pH	-	-	-	-					0	4	0	0	0	4
SC-fld	+	+	-	+		-		+	3	2	1	0	4	2
SO_4	+	+		+		+			4	0	0	0	4	0
TDS									0	0	0	0	0	0
Temp		+	+	+		+		+	4	0	1	0	5	0
TOC									0	0	0	0	0	0
Trb-l		-		-					0	2	0	0	0	2
WL(msl)	-	-	-	-		-		-	0	5	0	1	0	6

Well 67*[1] - taps conduit of Wakulla Spring.
NO3*[12] = NO3 + NO2 as N (Dissolved).
DL = Trend influenced by changes in laboratory detection level; not due to environmental change.

Well Number	WMD Well ID
67	Wakulla Spring Well
91	Charles Donahue
129	Weller Ave MPZ
131	Weller Ave Shallow
243	Blountstown Floridan
245	Blountstown Surficial
312	USGS 422A NR Greenhead
313	USGS 422B NR Greenhead

Table 35. Potential NWFWMD Districtwide Trends, Sequence A. (Note small sample size.)

Analyte	**Confined or Unconfined**	**Direction**	**Comments**
Na	Unconfined	Up	Lowering WL may be cause of slight increase in saline analytes.
pH	Unconfined	Down	Lowering WL may be cause of decreased pH
SO4	Unconfined	Up	Lowering WL may be cause of slight increase in saline analytes.
Temp	Unconfined All	Up	Increase in air temperature
WL(msl)	Unconfined All	Down	Decrease in rainfall.

Table 36. Well Trends in the NWFWMD, Sequence B (1991-1997).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW						**Confined**		**Uncon**		**Con**		**Both (All)**	
	Well Number						Well Number							
Analyte	**67*[1]**	**91**	**129**	**131**	**245**	**313**	**243**	**312**	+	-	+	-	+	-
Alk						+			1	0	0	0	1	0
Ca	+					+			2	0	0	0	2	0
Cl						+			1	0	0	0	1	0
DO	-		-	-				-	0	3	0	1	0	4
F		-DL	-DL	-DL				-DL	0	0	0	0	0	0
Fe	-	-		+				-	1	2	0	1	1	3
K	-	-		-					0	3	0	0	0	3
Mg	+			+		+			3	0	0	0	3	0
Na	+	+		+		+			4	0	0	0	4	0
NH_3									0	0	0	0	0	0
NO_3*[2]									0	0	0	0	0	0
PO_4									0	0	0	0	0	0
pH		+							1	0	0	0	1	0
SC-fld	+	+		+		+		+	4	0	1	0	5	0
SO_4			-			+			1	1	0	0	1	1
TDS									0	0	0	0	0	0
Temp			+					+	1	0	1	0	2	0
TOC									0	0	0	0	0	0
Trb-l									0	0	0	0	0	0
WL(msl)	-	-	-	-		-		-	0	5	0	1	0	6

Well 67*[1] - taps conduit of Wakulla Spring.
NO3*[2] = NO3 + NO2 as N (Dissolved).
DL = Trend influenced by changes in laboratory detection level; not due to environmental change.

Well Number	WMD Well ID
67	Wakulla Spring Well
91	Charles Donahue
129	Weller Ave MPZ
131	Weller Ave Shallow
243	Blountstown Floridan
245	Blountstown Surficial
312	USGS 422A NR Greenhead
313	USGS 422B NR Greenhead

Table 37. Potential NWFWMD Districtwide Trends, Sequence B. (Note small sample size.)

Analyte	**Confined or Unconfined**	**Direction**	**Comments**
Na	Unconfined,	Up	Lowering WL may be cause of slight increase in saline analytes.
SC-fld	Unconfined All	Up	Lowering WL may be cause of slight increase in saline analytes.
WL	Unconfined All	Down	Decrease in rainfall.

Table 38. Well Trends in the NWFWMD, Sequence C (1998-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW						Confined			Uncon		Con		Both (All)	
	Well Number						Well Number								
Analyte	**67*[1]**	**91**	**129**	**131**	**245**	**313**	**243**	**312**		+	-	+	-	+	-
Alk						-				0	1	0	0	0	1
Ca					+	+				2	0	0	0	2	0
Cl						+				1	0	0	0	1	0
DO	-	-		-	+	+	-	-		2	3	0	2	2	5
F		+								1	0	0	0	1	0
Fe										0	0	0	0	0	0
K		-				+				1	1	0	0	1	1
Mg					+	+				2	0	0	0	2	0
Na						+				1	0	0	0	1	0
NH_3						-				0	1	0	0	0	1
NO_3*[2]						+				1	0	0	0	1	0
PO_4		-								0	1	0	0	0	1
pH	-	-	-	-			-	-		0	4	0	2	0	6
SC-fld				+	+	-		+		2	1	1	0	3	1
SO_4						+				1	0	0	0	1	0
TDS						+				1	0	0	0	1	0
Temp		-	+	+				+		2	1	1	0	3	1
TOC		-								0	1	0	0	0	1
Trb-l		-								0	1	0	0	0	1
WL(msl)	-		-		+	-	+	-		1	3	1	1	2	4

Well 67*[1] - taps conduit of Wakulla Spring.
NO3*[2] = NO3 + NO2 as N (Dissolved).
DL = Trend influenced by changes in laboratory detection level; not due to environmental change.

Well Number	WMD Well ID
67	Wakulla Spring Well
91	Charles Donahue
129	Weller Ave MPZ
131	Weller Ave Shallow
243	Blountstown Floridan
245	Blountstown Surficial
312	USGS 422A NR Greenhead
313	USGS 422B NR Greenhead

Table 39. Potential NWFMD Districtwide Trends, Sequence C. (Note small sample size.)

Analyte	Confined or Unconfined	Direction	Comments
pH	Unconfined All	Down	Possibly higher mixture of younger recharge water near well screen during low water level times.

Evidence of Districtwide Well Water-quality Trends – Suwannee River Water Management District

Sufficient data existed for nine wells (five unconfined and four confined) in the SRWMD (Table 40). Only pH and water levels for Sequence A for the combined category, and water levels for unconfined groundwater had potential trends. They were downward (Table 41). For Sequence B (Table 42), SC-fld, and pH demonstrated a potential downward trend for all wells (Table 43). For Sequence C (Table 44) temperature had a potential upward trend for combined groundwater (Table 45), whereas water levels potentially decreased. For unconfined groundwater, temperature potentially increased.

Table 40. Well Trends in the SRWMD, Sequence A (1991-2003).

(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW					Confined GW				Uncon		Con		Both (All)	
	Well Number					Well Number									
Analyte	**1931**	**1943**	**2259**	**2465**	**2003**	**2404**	**2585**	**2675**	**2193**	+	-	+	-	+	-
Alk			+		-	-	+			1	1	1	1	2	2
Ca				-	-	-				0	2	0	1	0	3
Cl	+	+		-	-			+		2	2	1	0	3	2
DO	+			+					-	2	0	0	1	2	1
F		-DL	-DL							0	0	0	0	0	0
Fe										0	0	0	0	0	0
K		-	-Dr	-DL	+	-Dr	-Dr			1	1	0	0	1	1
Mg					+					1	0	0	0	1	0
Na	+	+		-	-			+		2	2	1	0	3	2
NH_3	+									1	0	0	0	1	0
NO_3*[1]	+	-DL	-	-	-	-DL		+	-DL	1	3	1	0	2	3
PO_4		-								0	1	0	0	0	1
pH		-	-	-	+	-Dr*[2]	-	-	-	1	3	0	3	1	6
SC-fld					-					0	1	0	0	0	1
SO_4		-		+	-	-				1	2	0	1	1	3
TDS										0	0	0	0	0	0
Temp	+		-	+	+	-	-		-	3	1	0	3	3	4
TOC					+					1	0	0	0	1	0
Turb(lab)	-	-	-			-				0	3	0	1	0	4
WL(msl)	-	-		-	-		-	-	+	0	4	1	2	1	6

NO3*[1] = NO3 + NO2 as N (dissolved)
DL = Trend is influenced by changing laboratory detection level; not due to environmental change.
Dr*[2] = High pH during early portion of time segment, which could possibly be related to well grout.
Dr = Drilling fluids may be cause of high concentrations during early period of time segment.

Well Number	WMD Well ID	Well Number	WMD Well ID
1943	-111117007	2585	-011011002
2259	-061410003	2675	+021332004
2465	-021231001	2193	-072013001
2003	-101601002	1931	R18T11SEC3101
2404	-030833001		

Table 41. Potential SRWMD Districtwide Trends, Sequence A.

Analyte	Confined or Unconfined	Direction	Comments
pH	All	Down	High mixture of young, recharge water near well screen during drought.
WL (msl)	Unconfined All	Down	Less rainfall, less recharge, and more pumping of GW

Table 42. Well Trends in the SRWMD, Sequence B (1991-1997).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW					Confined GW				Uncon		Con		Both (All)	
	Well Number					Well Number									
Analyte	**1931**	**1943**	**2259**	**2465**	**2003**	**2404**	**2585**	**2675**	**2193**	+	-	+	-	+	-
Alk		+					+			1	0	1	0	2	0
Ca										1	0	0	0	1	0
Cl		+							+	1	0	1	0	2	0
DO			+			+			+	1	0	2	0	3	0
F		-DL	-		-DL					0	1	0	0	0	1
Fe			-	-				-		0	2	0	1	0	3
K			-Dr	-DL	-	-Dr	-Dr			0	1	0	0	0	1
Mg		+			-					1	1	0	0	1	1
Na		+					-	+		1	0	1	1	2	1
NH_3										0	0	0	0	0	0
NO_3*		-DL	-	-	-	-DL			-DL	0	3	0	0	0	3
PO_4										0	0	0	0	0	0
pH	-		-		-			-		0	3	0	1	0	4
SC-fld		+		-		-		-	-	1	1	0	3	1	4
SO_4					-	-			-	0	1	0	2	0	3
TDS										0	0	0	0	0	0
Temp	+		-			-		-		1	1	0	2	1	3
TOC										0	0	0	0	0	0
Turb(lab)										0	0	0	0	0	0
WL(msl)	+		-	-	+	+	-	-	+	2	2	2	2	4	4

NO3* = NO3 + NO2 as N (dissolved)
DL = Trend influenced by change in laboratory detection level; not due to environmental change.
Dr = Drilling fluids may be cause of high concentrations during early period of time segment.

Well Number	WMD Well ID
1943	-111117007
2259	-061410003
2465	-021231001
2003	-101601002
2404	-030833001
2585	-011011002
2675	+021332004
2193	-072013001
1931	R18T11SEC3101

Table 43. Potential SRWMD Districtwide Trends, Sequence B.

Analyte	Confined or Unconfined	Direction	Comments
pH	**All**	Down	Possibly higher mixture of younger recharge water near well screen during low later level times.
SC-fld	All	Down	Possibly higher mixture of younger, recharge water near well screen during low water level times.

Table 44. Well Trends in the SRWMD, Sequence C (1998-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW					Confined GW				Uncon		Con		Both (All)	
	Well Number					Well Number									
Analyte	**1931**	**1943**	**2259**	**2465**	**2003**	**2404**	**2585**	**2675**	**2193**	+	-	+	-	+	-
Alk		-		-	-					0	3	0	0	0	3
Ca		-		-	-				+	0	3	1	0	1	3
Cl		-			-					0	2	0	0	0	2
DO	+	+	+	+	-				-	4	1	0	1	4	2
F				+	+					2	0	0	0	2	0
Fe										0	0	0	0	0	0
K					+					1	0	0	0	1	0
Mg		-							+	0	1	1	0	1	1
Na		-			-				+	0	2	1	0	1	2
NH_3	+									1	0	0	0	1	0
NO_3*				+	-					1	1	0	0	1	1
PO_4	+									1	0	0	0	1	0
pH	-				+		+		-	1	1	1	1	2	2
SC(fld)	-	+	+	+	-			+	+	3	2	2	0	5	2
SO_4		+								1	0	0	0	1	0
TDS		-			-					0	2	0	0	0	2
Temp	+		+	+	+	+	+	+		4	0	3	0	7	0
TOC					+					1	0	0	0	1	0
Turb(lab	-				+					1	1	0	0	1	1
WL(msl)	-	+	-	-	-	-	-		-	1	4	0	3	1	7

NO3* = NO3 + NO2 as N (dissolved)

Well Number	WMD Well ID
1943	-111117007
2259	-061410003
2465	-021231001
2003	-101601002
2404	-030833001
2585	-011011002
2675	+021332004
2193	-072013001
1931	R18T11SEC3101

Table 45. Potential SRWMD Districtwide Trends, Sequence C.

Analyte	Confined or Unconfined	Direction	Comments
Temp	Uncon, All	Up	Air temperature in WMD increased. Water temperature may be related.
WL(msl)	All	Down	Less rainfall, less recharge, and more pumping of GW.

Evidence of Districtwide Well Water-quality Trends – St. Johns River Water Management District

There were sufficient data for nine wells (three unconfined and six confined) in the SJRWMD for districtwide trend analyses. Since there were only three wells tapping unconfined groundwater, evidence of districtwide trends for this category of well was not achievable.

For Sequence A (Table 46), for combined groundwater, calcium specific conductance (SC) displayed evidence for downward trends while temperature displayed evidence of an upward trend (Table 47). For Sequence B (Table 48), there was evidence for downward trends for pH. For Sequence C (Table 50), there is evidence that DO rose while pH and SC dropped (Table 51).

Table 46. Well Trends in the SJRWMD, Sequence A (1991-1998).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW			Confined GW						Uncon		Con		Both (All)	
	Well Number			Well Number											
Analyte	**1417**	**1764**	**1781**	**1420**	**1674**	**1762**	**1763**	**1779**	**1780**	+	-	+	-	+	-
Alk	-	-	-	+	-		+			0	3	2	1	2	4
Ca	-	-			-	-				0	2	0	2	0	4
Cl		-				-	-			0	1	0	2	0	3
DO	+				+					1	0	1	0	2	0
F	-DL	-DL	-DL				-DL			0	0	0	0	0	0
Fe							-			0	0	0	1	0	1
K	-Dr		-		-		-Dr			0	1	0	1	0	2
Mg	-	+		+		+				1	1	2	0	3	1
Na	-	-		+						0	2	1	0	1	2
NH_3	-	+			+					1	1	1	0	2	1
NO_3*	-DL	-DL		-		-DL	-DL			0	0	0	1	0	1
$P0_4$		-							-	0	1	0	0	1	2
pH		-	-DL	-			-		-	0	1	0	3	0	4
SC	-		-		-	-	-			0	2	0	3	0	5
SO_4	+	+		+	-		-			2	0	1	2	2	3
TDS										0	0	0	0	0	0
Temp	+	+			-	+	+	+	+	2	0	4	1	6	1
TOC	-Dr									0	0	0	0	0	0
Turb(lab)										0	0	0	0	0	0
WL(msl)			+			-				1	0	0	1	1	1

NO3* = NO3 + NO2 as N (dissolved).
DL = Reason for trend is due to a lowering of the laboratory detection level; not due to environmental change.
Dr = Drilling fluids may be cause of relatively high concentrations during early period of time segment.

Well Number	WMD Well ID
1417	S-0045
1420	S-0038
1674	R22T10SEC2001
1762	SJ0029
1763	SJ0030
1764	SJ0032
1779	BA0054
1780	BA0055
1781	BA0056

Table 47. Potential SJRWMD Districtwide Trends, Sequence A.

Analyte	Confined or Unconfined	Direction	Comments
Ca	All	Down	Generally as WL rose, Ca decreased; Ca low in recharge water.
pH	All	Down	pH is low in recharge water
SC	All	Down	Generally as WL rose, SC decreased; SC low in recharge water.
Temp	Confined All	Up	Air temperature increase.

Table 48. Well Trends in the SJRWMD, Sequence B (1991-1997).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	Unconfined GW			Confined GW						Uncon		Con		All (Both)	
	Well Number			Well Number											
Analyte	**1417**	**1764**	**1781**	**1420**	**1674**	**1762**	**1763**	**1779**	**1780**	+	-	+	-	+	-
Alk		-		+	-					0	1	1	1	1	2
Ca	-	-			-					0	2	0	1	0	3
Cl	-	-								0	2	0	0	0	2
DO					+	-				0	0	1	1	1	1
F	-DL	-DL					-DL			0	0	0	0	0	0
Fe		+				-				1	0	0	1	1	1
K	-Dr				-	-	-Dr			0	0	0	2	0	2
Mg	-	-								0	2	0	0	0	2
Na		-				-				0	1	0	1	0	2
NH_3										0	0	0	0	0	0
NO_3*	-DL									0	0	0	0	0	0
$P0_4$										0	0	0	0	0	0
pH		-			-	-	-			0	1	0	3	0	4
SC	-	-		+	-	-				0	2	1	2	1	4
SO_4		-		+			-			0	1	1	1	1	2
TDS										0	0	0	0	0	0
Temp					-	+	+			0	0	2	1	2	1
TOC										0	0	0	0	0	0
Turb(lab)										0	0	0	0	0	0
WL(msl)		+								1	0	0	0	1	0

NO3* = NO3 + NO2 as N (dissolved).
DL = Reason for trend is due to a lowering of the laboratory detection level; not due to environmental change.
Dr = Drilling fluids may be cause of relatively high concentrations during early period of time segment.

Well Number	WMD Well ID
1417	S-0045
1420	S-0038
1674	R22T10SEC2001
1762	SJ0029
1763	SJ0030
1764	SJ0032
1779	BA0054
1780	BA0055
1781	BA0056

Table 49. Potential SJRWMD Districtwide Trends, Sequence B.

Analyte	Confined or Unconfined	Direction	Comments
pH	**All**	**Down**	High mixture of young, recharge water near well screen during drought.

Table 50. Well Trends in the SJRWMD, Sequence C (1998-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW			**Confined GW**						**Uncon**		**Con**		**All (Both)**	
	Well Number			Well Number											
Analyte	**1417**	**1764**	**1781**	**1420**	**1674**	**1762**	**1763**	**1779**	**1780**	+	-	+	-	+	-
Alk	-		-							0	2	0	0	0	2
Ca			-							0	1	0	0	0	1
Cl										0	0	0	0	0	0
DO	+		+	+					+	2	0	2	0	4	0
F										0	0	0	0	0	0
Fe										0	0	0	0	0	0
K	-	+	-							1	2	0	0	1	2
Mg			-							0	1	0	0	0	1
Na		+								1	0	0	0	1	0
NH_3		+								1	0	0	0	1	0
NO_3*		-								0	1	0	0	0	1
$P0_4$			-							0	1	0	0	0	1
pH		-	-	-					-	0	2	0	2	0	4
SC	-	+	-		-	-	-			1	2	0	3	1	5
SO_4			-							0	1	0	0	0	1
TDS										0	0	0	0	0	0
Temp	+	+			-	+	+			2	0	2	1	4	1
TOC										0	0	0	0	0	0
Turb(lab)		+								1	0	0	0	1	0
WL(msl)	+		+	+	-				+	2	0	2	1	4	1

NO3* = NO3 + NO2 as N (dissolved).

Well Number	WMD Well ID
1417	S-0045
1420	S-0038
1674	R22T10SEC2001
1762	SJ0029
1763	SJ0030
1764	SJ0032
1779	BA0054
1780	BA0055
1781	BA0056

Table 51. Potential SJRWMD Districtwide Trends, Sequence C.

Analyte	Confined or Unconfined	Direction	Comments
DO	All	Up	Generally DO is high in recharge water.
pH	All	Down	High mixture of young, recharge water near well screen during drought.
SC	All	Down	Generally as WL rose, SC decreased; SC is low in recharge water.

Evidence of Districtwide Well Water-quality Trends – Southwest Florida Water Management District

There were sufficient data for 11 wells (five unconfined and six confined) in the SWFWMD for districtwide trend analyses (Table 52). For Sequence A, evidence exists for an upward trend in temperature combined groundwater. The same can be said for Sequence B (Table 53). In the combined category, for Sequence C (Table 56), evidence existed for a downward trend in field specific conductance and an upward trend in water levels.

Table 52. Well Trends in the SWFWMD, Sequence A (1991-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW					**Confined GW**											
	Well Number					Well Number						**Uncon**		**Con**		**All (Both)**	
Analyte	**736**	**996**	**7934**	**1087**	**1100**	**615**	**707**	**737**	**775**	**997**	**7935**	+	-	+	-	+	-
Alk				+			+			-		1	0	1	1	2	1
Ca				-				-		-		0	1	0	2	0	3
Cl		-								-		0	1	0	1	0	2
DO												0	0	0	0	0	0
F	-DL	-DL		-DL								0	0	0	0	0	0
Fe								+				0	0	1	0	1	0
K	+	-Dr					-	+		-Dr		1	0	1	1	2	1
Mg	-	-								-		0	2	0	1	0	3
Na		-		+						-		1	1	0	1	1	2
NH_3		-										0	1	0	0	0	1
NO_3*[1]	-DL			-			-	-DL		-DL		0	1	0	1	0	2
PO_4												0	0	0	0	0	0
pH		+		-			-	-				1	1	0	2	1	3
SC-fld		-						-	-			0	1	0	2	0	3
SO_4	-	-		-*[2]				-		+		0	2	1	1	1	3
TDS												0	0	0	0	0	0
Temp	+			+			+	+	-	+		2	0	3	1	5	1
TOC												0	0	0	0	0	0
Trb(lab)	-											0	1	0	0	0	1
WLmsl		-		-			-					0	2	0	1	0	3

NO3*[1] = NO3 + NO2 as N (dissolved).
*[2] The first two values of SO4 in Well 1087 are extremely high values, and are questionable. Trend is not present if both are eliminated.
DL = Reason for trend is due to a lowering of the laboratory detection level; not environmental change.
Dr = Drilling fluids may be cause of relatively high concentrations during early period of time segment.

Well Number	WMD Well ID
736	Crewsville SH
996	Claywell Elem SF
7934	Romp 23 Surf
1087	Withla. St. Forest G
1100	Rdge MNR Rmp99x SH-A
615	ROMP 17 SWNN
707	ROMP 23-1 DEEP
737	Crewsville UP Int
775	ROMP TR 8-1 Int
997	Claywell Elem FL
7935	ROMP 23 PZ2

Table 53. Potential SWFWMD Districtwide Trends, Sequence A.

Analyte	**Confined or Unconfined**	**Direction**	**Comments**
Temp	All	Up	Possibly related to higher air temperature.

Wells 7934, 7935, and 1100 were not sampled until 1999. Each had upward trends for WL. The upward trend shows up in Sequence C.

Table 54. Well Trends in the SWFWMD, Sequence B (1991-1997).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW					Confined GW						Uncon		Con		All (Both)	
	Well Number					Well Number											
Analyte	**736**	**996**	**7934**	**1087**	**1100**	**615**	**707**	**737**	**775**	**997**	**7935**	+	-	+	-	+	-
Alk							+			-		0	0	1	1	1	1
Ca								-				0	0	0	1	0	1
Cl		-										0	1	0	0	0	1
DO												0	0	0	0	0	0
F		-DL		-DL				-				0	0	0	1	0	1
Fe				+								1	0	0	0	1	0
K		-Dr						-Dr		-Dr		0	0	0	0	0	0
Mg		-					+	+		-		0	1	2	1	2	2
Na										-		0	0	0	1	0	1
NH_3												0	0	0	0	0	0
NO_3*[1]	-DL							-				0	0	0	1	0	1
PO_4												0	0	0	0	0	0
pH							-	-				0	0	0	2	0	2
SC-fld		-					+	-				0	1	1	1	1	2
SO_4		-		-*[2]			+	-				0	1	1	1	1	2
TDS												0	0	0	0	0	0
Temp	+			+			+			+		2	0	2	0	4	0
TOC												0	0	0	0	0	0
Trb(lab)												0	0	0	0	0	0
WLmsl		+					-			+		1	0	1	1	2	1

NO3*[1] = NO3 + NO2 as N (dissolved).
*[2] The first two values of SO4 in Segment B are extremely high values, and are questionable. Trend is not present if both outliers are not eliminated.
DL = Reason for trend is due to a lowering of the laboratory detection level; not environmental change.
Dr = Drilling fluids may be cause of relatively high concentrations during early period of time segment.

Well Number	WMD Well ID
736	Crewsville SH
996	Claywell Elem SF
7934	Romp 23 Surf
1087	Withla. St. Forest G
1100	Rdge MNR Rmp99x SH-A
615	ROMP 17 SWNN
707	ROMP 23-1 DEEP
737	Crewsville UP Int
775	ROMP TR 8-1 Int
997	Claywell Elem FL
7935	ROMP 23 PZ2

Table 55. Potential SWFWMD Districtwide Trends, Sequence B.

Analyte	Confined or Unconfined	Direction	Comments
Temp	All	Up	Possibly related to higher air temperature.

Table 56. Well Trends in the SWFWMD, Sequence C (1998-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW					**Confined GW**						**Uncon**		**Con**		**All (Both)**	
	Well Number					Well Number											
Analyte	**736**	**996**	**7934**	**1087**	**1100**	**615**	**707**	**737**	**775**	**997**	**7935**	+	-	+	-	+	-
Alk			+									1	0	0	0	1	0
Ca												0	0	0	0	0	0
Cl		+	-									1	1	0	0	1	1
DO				-	+		-					1	1	0	1	1	2
F												0	0	0	0	0	0
Fe												0	0	0	0	0	0
K		-	+									1	1	0	0	1	1
Mg		+	+									2	0	0	0	2	0
Na												0	0	0	0	0	0
NH_3	+		-									1	1	0	0	1	1
NO_3*		+										1	0	0	0	1	0
PO_4												0	0	0	0	0	0
pH		+	+			-						2	0	0	1	2	1
SC-fld				-	-		-		-	+	-	0	2	1	3	1	5
SO_4		+										1	0	0	0	1	0
TDS		+										1	0	0	0	1	0
Temp												0	0	0	0	0	0
TOC			-									0	1	0	0	0	1
Trb(lab)	-											0	1	0	0	0	1
WLmsl			+		+				+		+	2	0	2	0	4	0

NO3* = NO3 + NO2 as N (dissolved).

Well Number*[1]	WMD Well ID
736	Crewsville SH
996	Claywell Elem SF
7934	Romp 23 Surf
1087	Withla. St. Forest G
1100	Rdge MNR Rmp99x SH-A
615	ROMP 17 SWNN
707	ROMP 23-1 DEEP
737	Crewsville UP Int
775	ROMP TR 8-1 Int
997	Claywell Elem FL
7935	ROMP 23 PZ2

Table 57. Potential SWFWMD Districtwide Trends, Sequence C.

Analyte	**Confined or Unconfined**	**Direction**	**Comments**
SC-fld	All	Down	Slight decrease in SC-fld. Lower in recharge water.
WLmsl	All	Up	Not entirely understood.

Evidence of Districtwide Well Water-quality Trends – South Florida Water Management District

For Sequence A (Table 58), there were sufficient data for six unconfined and three confined wells and there was no evidence of trends. For Sequence B (Table 59), again there was no evidence of trends. However, for Sequence C (Table 60), the only evidence for a districtwide trend was for unconfined, and for all wells combined, suggesting a downward trend for pH (Table 61).

Table 58. Well Trends in the SFWMD, Sequence A (1991-2003).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW						**Confined GW**			**Uncon**		**Con**		**All (Both)**	
	Well Number						Well Number								
Analyte	**2793**	**2872**	**3109**	**3398**	**3490**	**6490**	**2873**	**3108**	**3433**	+	-	+	-	+	-
Alk						-				0	1	0	0	0	1
Ca	-									0	1	0	0	0	1
Cl	-	-				-				0	3	0	0	0	3
DO	+					-				1	1	0	0	1	1
F	-DL	-DL								0	0	0	0	0	0
Fe										0	0	0	0	0	0
K	-DL	-				+				1	1	0	0	1	1
Mg		-								0	1	0	0	0	1
Na		-				-				0	2	0	0	0	2
NH_3	+									1	0	0	0	1	0
NO_3*	-DL	-				+				1	1	0	0	1	1
PO_4										0	0	0	0	0	0
pH	+	-				-	-			1	2	0	1	1	3
SC-fld	-						+			0	1	1	0	1	1
SO_4	-					+				1	1	0	0	1	1
TDS										0	0	0	0	0	0
Temp	+	-				-				1	2	0	0	1	2
TOC										0	0	0	0	0	0
Trb(lab)		-				-				0	2	0	0	0	2
WLmsl	-	+				-	+			1	2	1	0	2	2

NO3* = NO3 + NO2 as N (dissolved).
DL = Reason for trend is due to a lowering of the laboratory detection level; not due to environmental change.

Well Number	WMD Well ID
2793	G-2364
2872	C-00972
2873	C-00973
3108	L-02200
3109	L-02202
3398	PBSS44
3433	POF-0008
3490	KISSPARK
6490	27-3

Note: No Sequence A districtwide trends were observed in the SFWMD.

Table 59. Well Trends in the SFWMD, Sequence B (1991-1997).
(+ = ↑ trend, blank = no evidence of trend, - = ↓ trend)

	Unconfined GW						Confined GW			Uncon		Con		All (Both)	
	Well Number						Well Number								
Analyte	**2793**	**2872**	**3109**	**3398**	**3490**	**6490**	**2873**	**3108**	**3433**	+	-	+	-	+	-
Alk	-									0	1	0	0	0	1
Ca	-									0	1	0	0	0	1
Cl	-	-				-				0	3	0	0	0	3
DO	+									1	0	0	0	1	0
F						-				0	1	0	0	0	1
Fe	-									0	1	0	0	0	1
K		-				+				1	1	0	0	1	1
Mg	-					+				1	1	0	0	1	1
Na	-	-								0	2	0	0	0	2
NH_3										0	0	0	0	0	0
NO_3*										0	0	0	0	0	0
PO_4										0	0	0	0	0	0
pH	+									1	0	0	0	1	0
SC-fld	-					-				0	2	0	0	0	2
SO_4	-	+				+				2	1	0	0	2	1
TDS										0	0	0	0	0	0
Temp	+	-				-				1	2	0	0	1	2
TOC										0	0	0	0	0	0
Trb(lab)										0	0	0	0	0	0
WLmsl		+					+			1	0	1	0	2	0

NO3* = NO3 + NO2 as N (dissolved).

Well Number	WMD Well ID
2793	G-2364
2872	C-00972
2873	C-00973
3108	L-02200
3109	L-02202
3398	PBSS44
3433	POF-0008
3490	KISSPARK
6490	27-3

Note: No Sequence B districtwide trends were observed in the SFWMD.

Table 60. Well Trends in the SFWMD, Sequence C (1998-2003).
(+ = ↑ trend, 0 = no evidence of trend, - = ↓ trend)

	Unconfined GW						**Confined GW**			**Uncon**		**Con**		**All (Both)**	
	Well Number						Well Number								
Analyte	**2793**	**2872**	**3109**	**3398**	**3490**	**6490**	**2873**	**3108**	**3433**	+	-	+	-	+	-
Alk	+		+							2	0	0	0	2	0
Ca										0	0	0	0	0	0
Cl	+	+								2	0	0	0	2	0
DO									-	0	0	0	1	0	1
F	-									0	1	0	0	0	1
Fe										0	0	0	0	0	0
K					-					0	1	0	0	0	1
Mg						-				0	1	0	0	0	1
Na	+									1	0	0	0	1	0
NH_3	+				+					2	0	0	0	2	0
NO_3*			-							0	1	0	0	0	1
PO_4			+							1	0	0	0	1	0
pH		-	-	-		-		-	+	0	4	1	1	1	5
SC-fld	+	-			-					1	2	0	0	1	2
SO_4										0	0	0	0	0	0
TDS										0	0	0	0	0	0
Temp	-	+			-					1	2	0	0	1	2
TOC			-							0	1	0	0	0	1
Trb(lab)		-	-							0	2	0	0	0	2
WLmsl	-	+	+	-	+					3	2	0	0	3	2

NO3* = NO3 + NO2 as N (dissolved).

Well Number*[1]	WMD Well ID
2793	G-2364
2872	C-00972
2873	C-00973
3108	L-02200
3109	L-02202
3398	PBSS44
3433	POF-0008
3490	KISSPARK
6490	27-3

Table 61. Potential SFWMD Districtwide Trends, Sequence C.

Analyte	**Confined or Unconfined**	**Direction**	**Comments**
pH	Uncon, All	Down	Generally pH fell during all time segments. Possibly related to slight decreases in water levels

Statewide Well Water-quality Trends

Table 62 shows analytes with statewide trends for each time sequence for unconfined, confined, and all (combined) groundwater resources.

Table 62. Statewide Groundwater Trends Based on Sign Tests: Sequences A, B, and C.

Sequence A (1991 - 2003)

Groundwater Resource		
Unconfined GW	**Confined GW**	**All**
WL(msl) ↓ p-val = 0.004		WL(msl) ↓ p-val= 0.002
Turb ↓ p-val = 0.002		Turb ↓ p-val= 0.001
		Ca ↓ p-val = 0.029
	pH ↓ p-val = 0.002	pH ↓ p-val = <0.001
Temp ↑ p-val = 0.018		Temp ↑ p-val = 0.018

Sequence B (1991 - 1997)

Groundwater Resource		
Unconfined GW	**Confined GW**	**All**
None	pH ↓ p-val = 0.016	pH ↓ p-val = 0.011

Sequence C (1998 - 2003)

Groundwater Resource		
Unconfined GW	**Confined GW**	**All**
pH ↓ p-val = 0.029	None	pH ↓ p-val = 0.048
		Temp ↑ p-val = 0.010

For Sequence A, Table 62 reveals that temperature had an upward trend statewide for unconfined and combined groundwater. For unconfined groundwater, turbidity and water levels had downward trends while pH trended downward in confined groundwater. For combined groundwater, calcium, turbidity, water levels and pH had downward trends, whereas temperature had an upward trend. By defining strong trends as those with p-values of less than 0.02, pH, water levels, turbidity had strong downward trends for combined groundwater, whereas temperature had a strong upward trend. During Sequence B, pH had downward trends in confined and in the combined groundwater resources. During Sequence C, temperature had an upward trend, while pH had a strong downward trend in both combined and unconfined groundwater resources.

Comparison of Strong Statewide Trends for Groundwater and Spring Water

Whereas well water (Table 62) displays strong trends in several field analytes, Table 63 indicates that rock and saline indicators show strong (p-value <0.02) statewide trends for springs. In Table 63, during Sequence A, flow had a significantly decreasing trend and the following rock-matrix and saline indicators had upward trends: alkalinity, calcium, chloride, fluoride, potassium, magnesium, sodium, specific conductance, strontium, sulfate, and total dissolved solids. Fluoride had an increasing trend while phosphorous had a decreasing trend during Sequence B. Trends during Sequence C were the same as those in Sequence A.

Table 63. Statewide Spring-water Quality Summary for Rock and Saline Indicators.
(Only indicators displaying strong significant trends (P-Value < 0.020)

Sequence A (1991 - 2003)		
Analyte	**Trend Direction**	**P-Value**
Flow	Down	0.006
Alk	Up	<0.001
Ca	Up	<0.001
Cl	Up	<0.001
F	Up	<0.001
K	Up	0.001
Mg	Up	<0.001
Na	Up	<0.001
SC	Up	0.004
Sr	Up	<0.001
SO_4	Up	<0.001
TDS	Up	<0.001
Sequence B (1991-1997)		
F	Up	<0.001
P	Down	<0.001
Sequence C (1998-2003)		
Flow	Down	<0.001
Alk	Up	<0.001
Ca	Up	<0.001
Cl	Up	0.001
F	Up	<0.001
K	Up	<0.001
Mg	Up	<0.001
Na	Up	<0.001
SC	Up	0.004
Sr	Up	<0.001
SO_4	Up	0.003
TDS	Up	0.033

Constrained Version of Statewide Trends for Groundwater

More constrained criteria were also used in the sign test evaluation for combined groundwater. For these analyses, in order for an analyte to be considered to have a statewide trend, not only did it need to show a statewide trend based on a sign test, it also needed to have evidence of a districtwide trend in at least three of the five WMDs. Regarding combined groundwater resources, Table 64 indicates that for Sequence A, calcium, pH, and water levels had downward trends, while temperature had a statewide increasing trend. All were strong trends. The analyte pH had a strong downward trend during Sequence B while temperature had a strong upward trend and pH had a strong downward trend during Sequence C.

Table 64. Statewide Trends for at Least Three WMDs: Sequences A, B, and C for Combined Groundwater Resources.

Statewide Sequence A (1991-2003) Trends in at Least three WMDs

Analyte	+	-	Evidence in WMD	Trend Direction	P-Value*
Ca	3	11	SR, SJ, SW	Down	0.018
pH	3	20	NW, SR, SJ, SW, SF	Down	<0.001
Temp	20	8	NW, SJ, SW	Up	0.018
WL(msl)	4	18	NW, SR, SW,	Down	0.002

Statewide Sequence B (1991-1997) Trends in at Least 3 WMDs

Analyte	+	-	Evidence in WMD	Trend Direction	P-Value*
pH	2	11	SR, SJ, SW	Down	0.003

Statewide Sequence C (1998-2003) Trends in at Least 3 WMDs

Analyte	+	-	Evidence in WMD	Trend Direction	P-Value*
pH	5	18	NW, SJ, SF	Down	0.006
Temp	15	4	NW, SR, SJ	Up	0.010

* In addition to a p-value <0.05, there must be significant trends in at least three of the five WMDs.

DISCUSSION

Recall that the definition of a constrained statewide trend was that at the $\alpha = 0.05$ level of significance for springs, analytes also had to have statistically significant trends using the sign test in two of the three WMD regions [(1) SRWMD plus Wakulla Spring, (2) SJRWMD, and (3) SWFWMD]. For wells, analytes had to have statistically significant statewide trends using the sign test and evidence of districtwide trends needed to exist in three of the five WMDs. Considering the constrained versions of statewide trends, Table 65 summarizes the results. For spring-water quality, calcium, magnesium, and sodium had increasing trends during Sequences A and C. In addition, strontium had an upward trend during Sequence A, while flow had a decreasing trend for Sequence C. For combined groundwater, during Sequence A, temperature increased while calcium, pH, turbidity, and water levels decreased significantly. For Sequence B, pH decreased while for Sequence C, pH decreased and temperature increased.

Spring-water quality is considered an integrator of what affects groundwater during its flow path from the recharge area to the spring discharge point. Regarding springs, there were no strong rock and saline trends during Sequence B. Because of the highly correlative relationship among the rock and saline indicators during Sequence A and C, it indicates that the time period of Sequence C (1998-2003) was the one in which most trends developed and is also when the drought occurred. The evidence derived from well-water quality is not nearly as strong. However, there is supporting evidence. Regarding well-water quality, no strong trends occurred during Sequence B. The indicator pH had strong decreasing trends in Sequence A and C and a significantly decreasing trend during Sequence B.

Table 65. Constrained Statewide Spring and Groundwater-quality Summary.

Sequence	Springs*	All GW** (Unconfined and Confined)
A (1991 - 2003)	Ca ↑	Ca ↓
	Mg ↑	pH ↓
	Na ↑	Temp ↑
	Sr ↑	WL(msl) ↓
B (1991 - 1997)	-	pH ↓
C (1998 - 2003)	Flow ↓	pH ↓
	Ca ↑	Temp ↑
	Mg ↑	
	Na ↑	

*Significant in at least two water management districts.
**Significant in at least three water management districts.

Major Cause of Statewide Trends: Drought and Consequential Saltwater Encroachment

From a districtwide or a statewide perspective, if regional trends did not exist, one would expect, for a given analyte, a similar number would increase as would decrease. However, the results of sign tests in this study, especially on the statewide scale, indicate that for springs the rock-matrix and the saline indicators were the two groups that had the vast majority of area-wide trends for Sequences A and C. In wells, the field indicators, such as temperature, water levels and pH, were the ones that displayed large, area-wide trends. Districtwide and statewide trends occurred mostly in Sequences A and C, but not very often in Sequence B (1991-1997). What are the causes of the rock, saline, and field indicator trends? Are the causes related? Is there one overall reason for the trends, or are there a variety of reasons?

The most severe portion of the drought occurred during the 1999-2000 time frame (Verdi et al., 2006). Could the reasons for the area-wide trends be related to the drought? If saline indicators trended upward during the study period, is it an indication that Florida experienced saltwater encroachment on a regional and/or statewide scale? We decided that for this paper, we would differentiate between the terms saltwater encroachment and saltwater intrusion. As modified from Neuendorf et al. (2005), saltwater encroachment is defined as the displacement of fresh groundwater by the advance of saltwater due to its greater density. Freeze and Cherry (1979) use the term intrusion as the migration of saltwater into freshwater aquifers under the influence of groundwater development. *For our purposes, intrusion indicates a man-induced process, while encroachment makes no such distinction between natural and man-made causes.*

Because the drought lasted for much of the 13-year time frame of the study, we addressed the drought-related questions by reviewing annual weather data for Sequences B and C. We believed that these data could shed light on the behavior of field indicators such as temperature, spring flow, and water level. Temperature was addressed first. Table 66 displays mean annual statewide temperatures and rainfall for Sequences B and C, based on data from the Southeastern Regional Climate Center (2006). Regarding air temperature (Table 66), there were 84 SERCC weather stations in Florida with sufficient data to calculate annual means for the 1991-2003 time period. For these stations, the mean temperature for Sequence B was 22.12 ° C (71.81º F) and the mean for Sequence C was 22.23 ° C (72.02 º F), a slight increase. Figure 54 depicts the year to year changes in mean temperature.

Table 66. Summarized Annual Weather Data in Florida (1991-2003).

Category	Sequence B (1991 - 1997)	Sequence C (1998 – 2003)	Difference (Seq. C - Seq. B)
Mean Air Temperature (84 Weather Stations)	22.12 ° C (71.81 º F)	22.23° C (72.02 º F)	+ 0.12 ° C (+ 0.21 º F)
Mean Rainfall (88 Weather Stations)	139.64cm/yr (54.98 in/yr)	127.76 cm/yr (50.30 in/yr)	+11.89 cm/yr (4.68 in/yr)

Regarding rainfall (Table 66), there were 88 stations with sufficient data to calculate annual means. For Sequence B, the mean was 139.64 cm/yr (54.98 in/yr). For Sequence C, the mean was 127.76 cm/yr (50.30 in/yr). Figure 54 indicates that beginning in 1999 and continuing through 2000, Florida experienced a very dry period. It began one year after the beginning of Sequence C. During Sequence C, there was a deficit of between 10 and 13 cm/yr (four and five in/yr) of rainfall annually relative to Sequence B. With reduced rainfall, there was less recharge to groundwater and, consequently, spring flow declined.

In searching for an explanation for the statewide trends, the drought and saltwater encroachment can explain virtually all of the rock-matrix and saline-indicator trends. Recall that Florida's fresh groundwater forms a "lens" of freshwater that, because of its lower density, overlies saline water. During periods of abundant rainfall, aquifer recharge exceeds discharge and the freshwater "lens" increases in size. However, during the state's periodic droughts, the rate of aquifer recharge is less than discharge and the "lens" shrinks in size. With less recharge, the potentiometric surfaces of aquifers are lowered and spring flow declines. As they decline, we believe that younger and fresher groundwater discharging from springs is eventually replaced by deeper and older water. The deeper water contains more minerals (transition zone water) because it has been in the aquifer system for a longer period of time. This idea is supported by Upchurch (1992) and Katz (2004). Figure 55 illustrates the relative position among sea water, transition water (including both "outer" and "inner") and freshwater within the Floridan aquifer system. Note the relationship between "outer" and "inner" transition water. The "outer" contains a greater proportion of saline indicators, while the "inner" water contains a greater percentage of rock-matrix analytes.

Figure 56 depicts a schematic of possible encroachment before and during a drought. During the drought, aquifer water levels decline, inferring that the fresh water" lens" decreases in size. Coastal springs, or springs that are tidally influenced, experience lateral encroachment of sea water. Inland springs can also be affected. Encroachment can occur because of the potential replacement of older and denser saline water at the base due to the lowering of the head in the Upper Floridan aquifer system. If the potentiometric surface of the UFAS become less than the aquifers lying below the UFAS, saline water can invade from below.

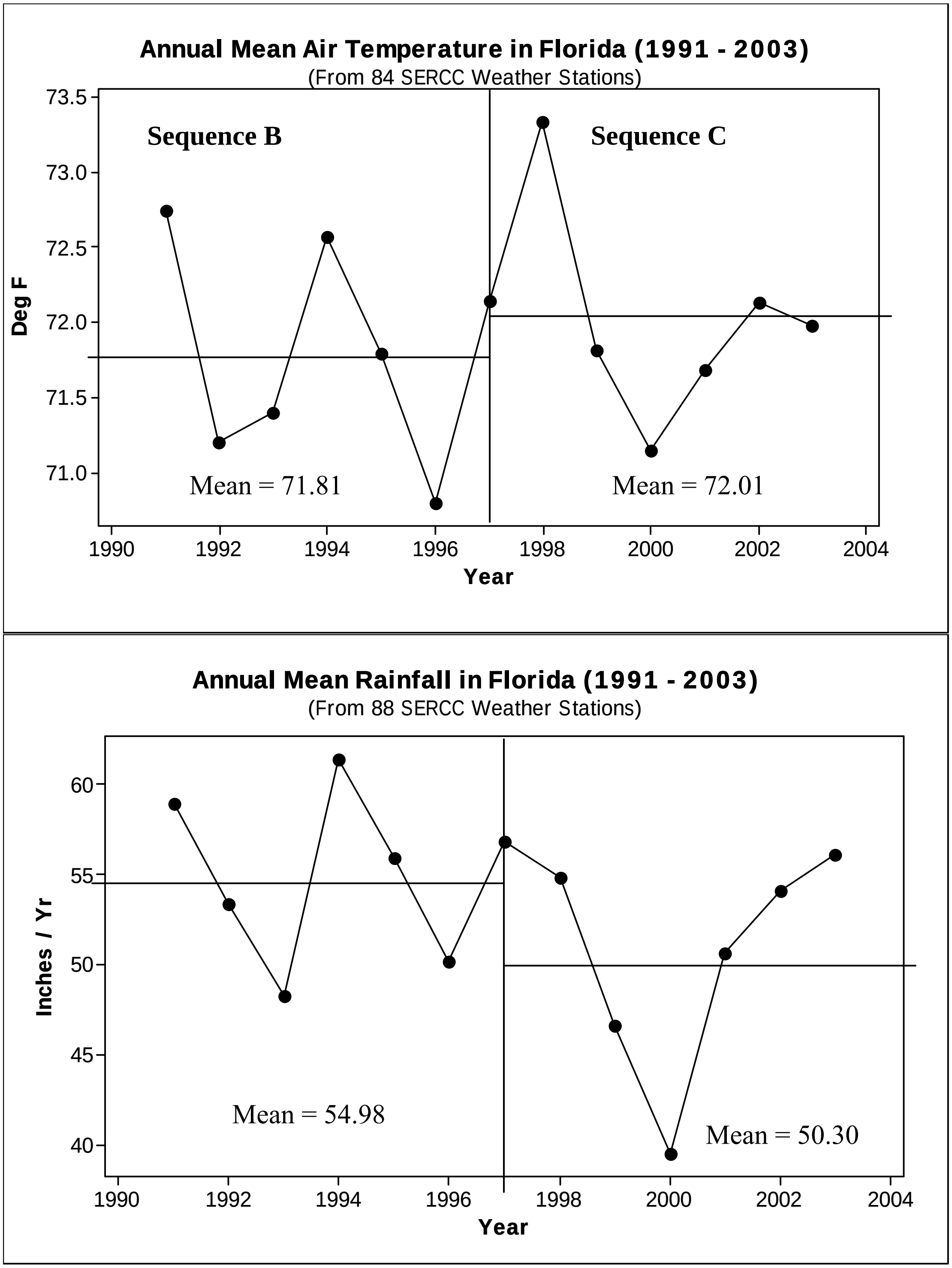


Figure 54. Weighted mean temperature and rainfall data in Florida (1991-2003). Horizontal lines in each time sequence, represent the corresponding mean values. (1.00 in = 2.54 cm; °C = (5/9)[°F – 32.00.)

It should be understood that the confining units below the UFAS generally retard the upward encroachment of deep, confined saline water. Nevertheless, because of the drought during Sequence C, on a statewide basis, we infer saline encroachment did occur and that the extent varied across the state depending on the severity of the drought.

During a drought, there is less surface water runoff. Thus, there is not as much young less-mineralized surface water recharging Florida's aquifers through swallets and sinks. Again, this is favorable for increasing trends in rock and saline indicators in spring discharge.

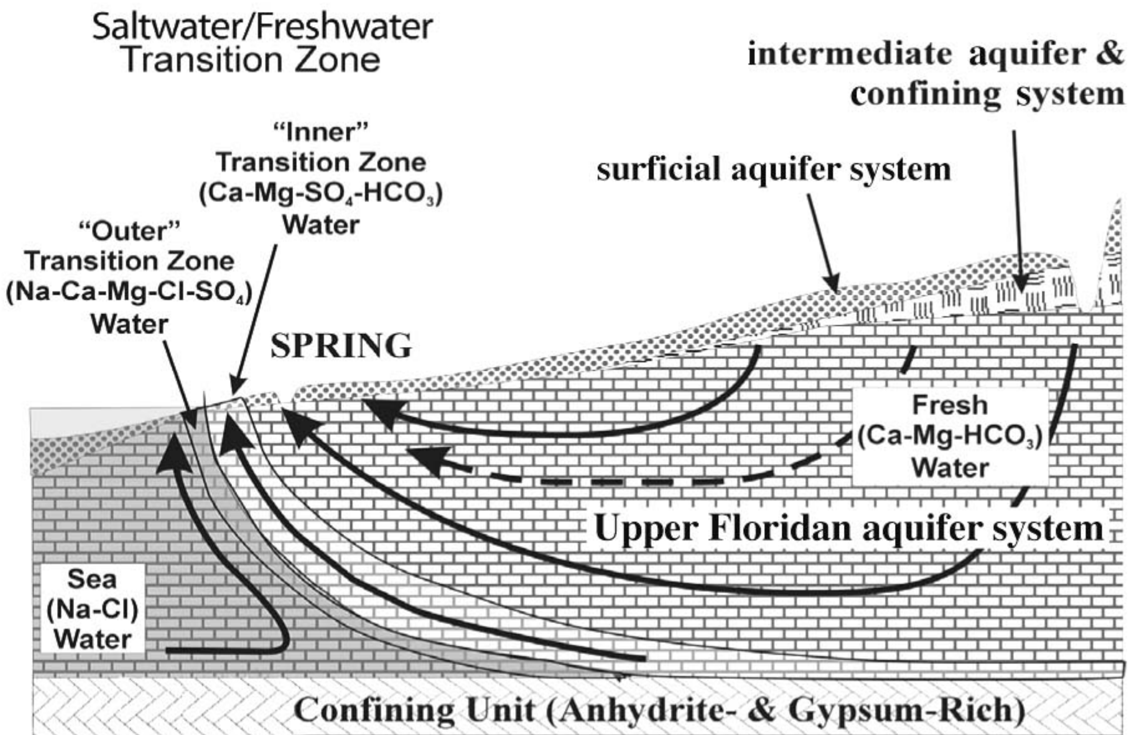


Figure 55. Relative position of rock-matrix and saline analytes in the Upper Floridan aquifer system.

Drought

Verdi et al. (2006) mentioned that a drought is a time of less-than-normal or expected rainfall. It can be thought of as a period of time when there is insufficient water to support the agricultural, urban or environmental needs of a society. They also stated that a hydrological drought is an extended period during which stream flow, lake, reservoir storage, and groundwater levels are below normal.

Referring to a drought, Jackson (1997) said, "In general, an extended period of dry weather or period of deficient rainfall that may extend over an indefinite number of days. There is not a quantitative standard to determine the degree of deficiency needed to constitute a drought. Qualitatively, a drought may be defined by its effect as a dry period of sufficient length and severity to cause at least partial crop failure or having impacted the ability to met normal water demand."

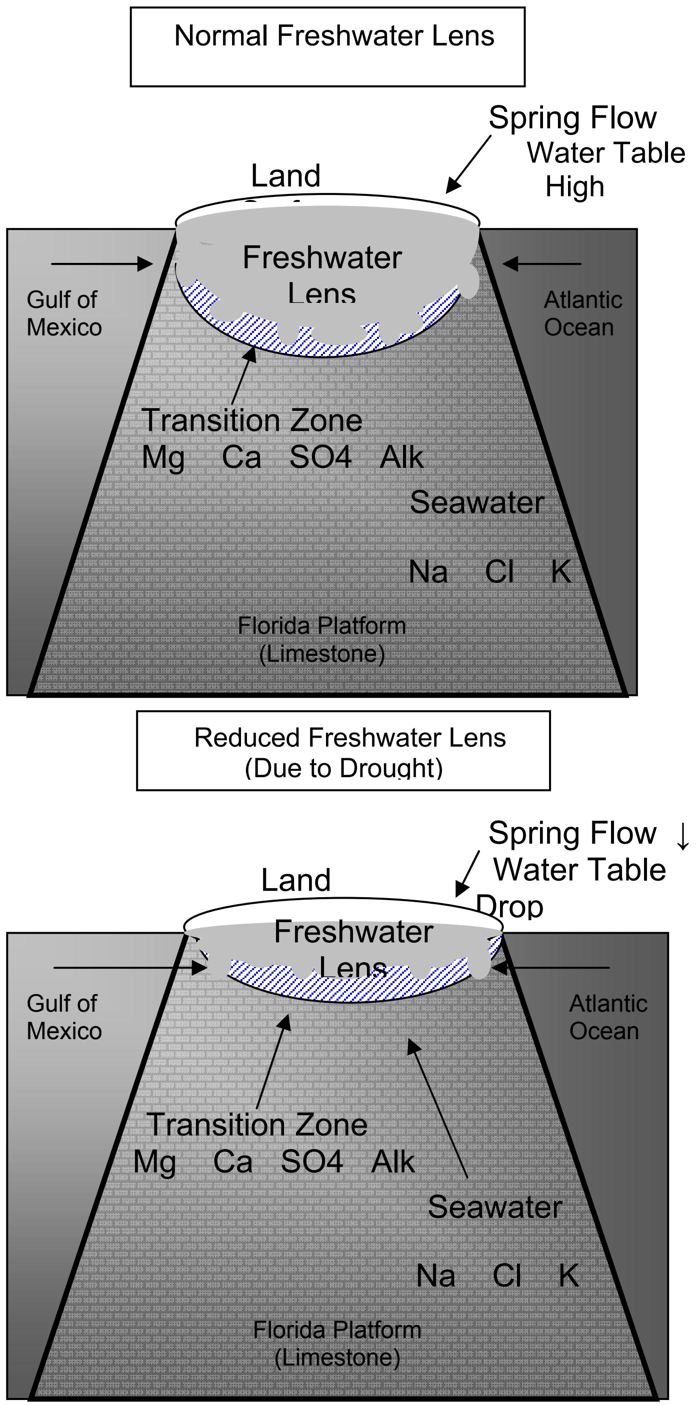


Figure 56. Fresh groundwater wedge before and during a drought. Top – Saline transition water (hatched) and saline water surround Florida. During normal times, freshwater "lens" is thicker and spring flow is greater. Bottom - Reduction in spring flow reflects freshwater "lens" decrease. Reduction draws in saline water, both laterally and potentially from below.

According to Henry (1998), the 30-year average (1961-1990) rainfall in Florida was just over 53 inches (135 cm) per year. For the 1999 and 2000 time frame, Florida had a deficit of over 30 inches (76 cm), relative to its 30-year mean. Also, since the average rainfall during Sequence C was only 50.30 inches/yr (127.8 cm/yr), Florida was in a drought. In fact, in 2001 the FDEP and the Florida Department of Community Affairs (2002) stated that, at that time, Florida was in the midst of an historical severe drought. The severity of the statewide drought varied depending on the local precipitation (Appendix M). Thus, the severity of the drought and the corresponding saltwater encroachment also varied across the state.

Rock-Matrix and Saline Indicator Evidence in Spring-water Quality

In Florida, recharge generally occurs first in the uppermost portion of aquifers and recharge water is younger than deeper water. Thus, during times of less recharge as spring flow is reduced, the proportion of older (transition) water increases. The older water is enriched in rock-matrix analytes. The fact that rock and saline indicators demonstrated strong increasing trends across the state (Tables 27-30), while flow had a strong decreasing trend is a compelling argument that Florida's freshwater "lens" decreased in size and saltwater encroachment did occur during Sequence C. Unfortunately, determining the locations where the actual encroachment took place cannot be determined with these sets of data. In the future, better monitoring should allow the state to make these determinations.

Rock-Matrix and Saline Indicator Evidence in Well-water Quality

Recall that the wells used for this report are TV wells and that they tend to be relatively shallow. Although the maximum depth of any of the wells used in this study is 1000 feet, 50 percent of the wells are between 57 and 161 feet (17 and 49 m) (Appendix C) and, as previously stated, the median depth of the wells is 80 feet (24 m). The wells generally tap the upper portion of the corresponding aquifer.

Figure 57 is a diagram of an unconfined well. Note the relative position of the well intake zone (well screen) to the water table. Under our hypothesis, groundwater just below the water table has the lowest pH. During wet periods (Figure 57, top), the distance from the intake zone to the water table (static water level) is at its maximum. During the drought (Figure 57, bottom), the water table was slowly lowered. As it dropped, a greater and greater proportion of groundwater with lower pH found its way into the well intake zone. As the drought continued, water levels, along with pH, decreased. There is no evidence that pH decreased throughout the groundwater column - only that the water table, with the most acidic water, moved downward closer and closer to the well intake zone during the drought.

Other explanations can explain the correlation between water level and pH. For example, D. Harrington (FDEP, personal communications) suggested that the lowering of the water table and subsequent oxidation in the uppermost portion of the saturation zone during a drought, could lead to a release of reduced sulfur compounds and a subsequent lowering of pH. P. Hansard (Colorado School of Mines, personal communications) supported Harrington's interpretation.

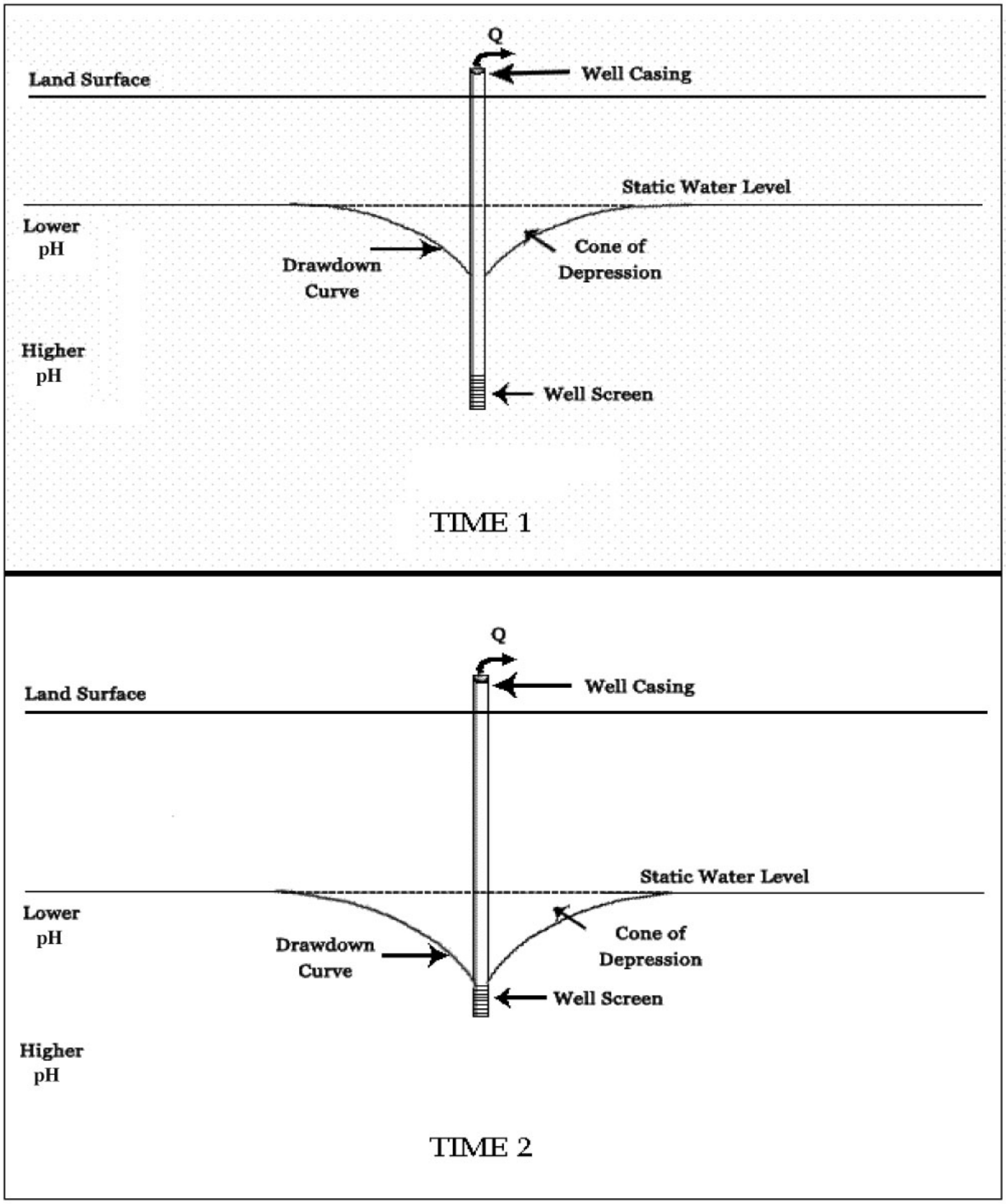


Figure 57. Water level and pH relationships for a well with a falling water table. Top (Time 1) – the upper portion of the water table generally consists of recently recharged, low pH metoric water. Botom (Time 2) - heavy pumping and drought conditions lower the water table, introducing progressively lower pH water to the well screen. As the water table is lowered, low pH water near the top of the water table moves closer and closer to the well screen.

As water levels decreased, dissolved oxygen could increase in the vicinity of the well. The increases in aerobic microbial respiration could increase carbon dioxide content, and consequently lower pH. He noted there did not need be a net change in pH in the entire groundwater column; simply that the zone of maximum respiration (e.g. the water table) got closer to the well screen during the drought. Although the specifics are not totally understood, the hypothesis that the lowering of pH is related to the lowering of water levels is testable. As Florida fully recovers from the drought, water levels and pH values should increase.

Table 62 indicates that for combined groundwater during Sequence A, decreasing trends occurred, not only for both water level and pH, but also for temperature, turbidity and calcium. Groundwater temperature increased statewide, while turbidity and calcium decreased. The most plausible explanation is that groundwater temperature increased as air temperature increased. Recall that most of the 46 wells were relatively shallow. An inspection of air temperature (Southeast Regional Climate Center, 2006) revealed that air temperature increased during Sequence A. An addition, spring water, which is an integrator of the entire springshed, both deep and shallow, had no temperature trends.

Regarding turbidity, no districtwide trends were observed and the only statewide trend occurred during Sequence A for combined (unconfined and confined) groundwater. Appendix B1 indicates that turbidity is a measure of light to pass through a water sample. It is caused by particulate material suspended in the water and colloidal material that hinders light penetration. The source of turbidity is often from surface water that contains high concentrations of humic substances and/or particulate matter, chemical reactions that result in the precipitation of colloidal material and certain forms of plankton growth. During the drought, less water originating from land surface can find its way into wells. Thus, the drought is a plausible explanation for the decreasing trends in turbidity.

The reason for the decreasing trend in calcium in wells is not fully understood. Calcite precipitation increases with increasing temperature. Thus, the increasing in temperature may be a cause for decreasing calcium concentrations. Paradoxically, increases in carbon dioxide near the well intake zone as water levels decreased (Figure 57) should cause calcite dissolution, and raise calcium concentrations. More research is needed in order to fully understand the positive correlation between water levels and calcium concentrations.

Regional to Sub-Regional Evidence of Saltwater Encroachment

In springs, rock-matrix and saline indicators demonstrated strong increasing trends across the state (Tables 27-32) while flow had a strong decreasing trend. Together they are compelling arguments that Florida's freshwater "lens" decreased in size and saltwater encroachment did occur during Sequence C. Annual mean temperature and precipitation data for each station, and for each WMD, are found in Appendix M. The data were used to calculate the weighted statewide means (weighted by the number of stations in each WMD) for rainfall used in the time series plots in Figure 58.

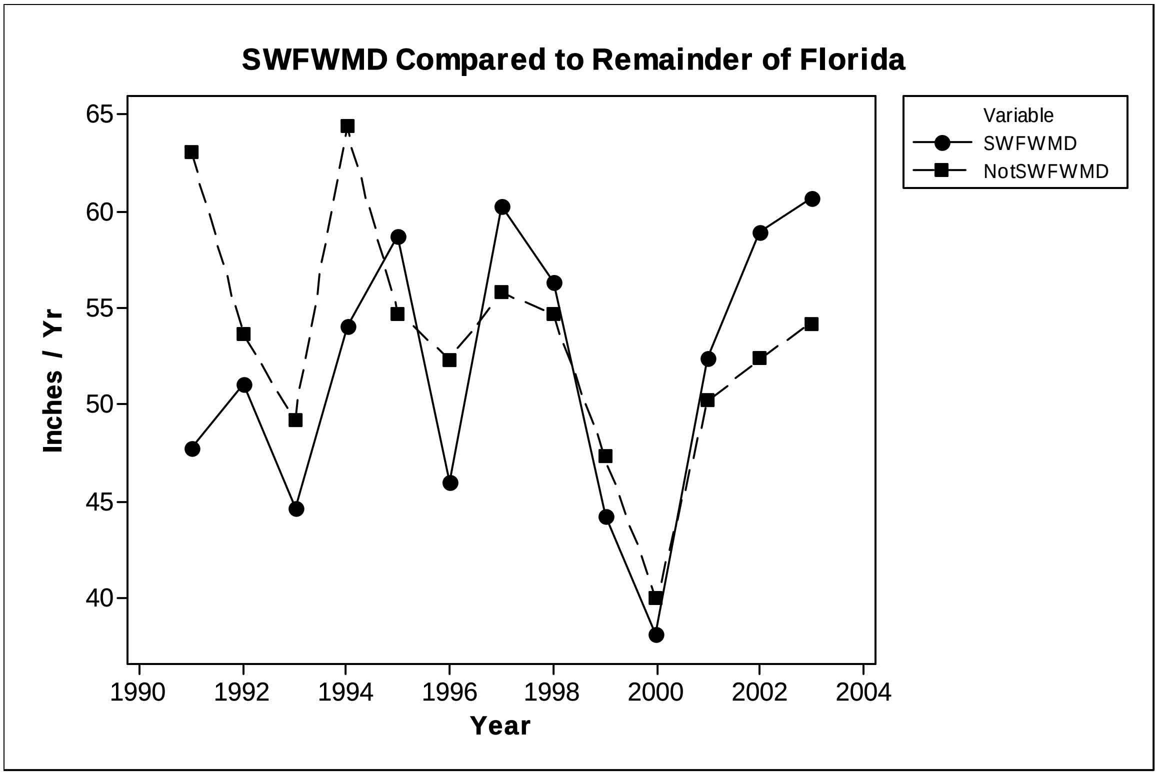


Figure 58. Weighted mean annual rainfall during Sequence A.

An inspection of rainfall data in Appendix M for each of the WMDs indicates that the rainfall deficit during Sequence C was less in the SWFWMD than the other regions of Florida. For this discussion, consider the SWFWMD (and surrounding area) to be a "donut hole" and the remaining WMD areas to be a "donut."

A comparison of the "donut hole" to the "donut" is found in Table 67. The table reveals that the weighted mean annual temperature in the SWFWMD "donut hole" for Sequence B was 22.59 ºC (72.66 ºF), whereas in Sequence C, it was only 22.56 °C (72.61 ºF), a decrease of (0.03 ºC (0.05 ºF). During Sequence B, the weighted mean annual rainfall in the "donut hole" was 131.55 cm/yr (51.79 in/yr) while the rainfall decreased to 131.50 cm/yr (51.77 in/yr) for Sequence C, a decrease of only 0.05 cm/yr (0.02 in/yr).

Table 67. Annual Weather Data, four WMDs Compared to SWFWMD (1991-2003).

WMD	Mean Annual	Sequence		Difference (Seq. C - Seq. B)
		Sequence B	Sequence C	
SW "Donut Hole"	Temp	22.59 °C (72.66 º F)	22.56 °C (72.61 º F)	- 0.03 °C (- 0.05 º F)
	Rain	131.55 cm/yr (51.79 in/yr)	131.50 cm/yr (51.79 in/yr	-0.05 cm/yr (- 0.02 in/yr)
NW, SR, SJ, SF "Donut"	Temp	22.01 °C (71.61 º F)	22.17 °C (71.90 º F)	+ 0.16 °C (+ 0.29 º F)
	Rain	142.60cm/yr (56.14 in/yr)	126.42 cm/yr (49.77 in/yr)	- 6.37 in/yr (- 16.18 cm/yr)

Consider the “donut.” It had different weather conditions, relative to the “donut hole.” For the “donut”, during Sequence B, the temperature averaged 22.01 °C (71.61 º F) and for Sequence C, the mean temperature was 22.17 ºC (71.90 ºF), an increase of 0.16 ºC (0.29 ºF). Regarding precipitation, during Sequence B, the “donut” averaged 142.60 cm/yr (56.14 in/yr) of rain, and during Sequence C, it averaged only 126.42 cm/yr (49.77 in/yr), a deficit of 16.18 cm/yr (6.37 in/yr).

Interestingly, during the worst of the drought (1999-2000) the SWFWMD “donut hole” region suffered severely (Verdi et al., 2006). As it turns out the SWFWMD region was also drier during Sequence B, relative to the rest of the state (Figure 58). Nevertheless, during the last two years of Sequence C, it recovered and actually had a more normal rainfall than the remainder of Florida (Figure 58).

Now consider each WMD. If one subtracts the mean rainfall during Sequence C from the mean of Sequence B at each rain station, then Table 68 indicates that the number of rain stations in the NWFWMD with an increase in rainfall was one, while the number with decreasing rainfall was eight. Using a sign test, the corresponding p-value was 0.020, and thus, there existed a downward trend in annual mean rainfall for the NWFWMD. The table also indicates that downward trends existed in the SRWMD, the SJRWMD, and the SFWMD. However, no trend was present in the SWFWMD “donut hole.” To reiterate, in terms of rainfall, for Sequence C, the SWFWMD suffered severely during the worst part of the drought (1999-2000) but only suffered mildly, relative to the rest of Florida, if one considers the entire 1998-2003 Sequence C time frame.

Table 68. Summarized rainfall, Sequence C minus Sequence B.

WMD	+	-	P-Val	Trend
NWFWMD	1	8	0.020	Down
SRWMD	0	11	<0.001	Down
SJRWMD	2	19	<0.001	Down
SWFWMD	12	10	0.416	No Trend
SFWMD	6	19	0.007	Down

Number of stations in which rainfall in Sequence C > than same station in Sequence B = +
Number of stations in which rainfall in Sequence C ≤ than same station in Sequence B = -
(Source: Southeast Regional Climate Center, 2006)

In spite of the relatively mild effect of decreased rainfall during the entire duration of Sequence C, there were many indications that the spring-water quality within the “donut hole” suffered severely. Table 27 displays the analytes with trends for each of the three time sequences for springs. Note the discussion that follows may be indicative that the severe effect denoted earlier may not have had time to reverse. On the other hand, it may indicate that saline encroachment (or even intrusion) was a problem during Sequence C.

Recall that during Sequences A and C, we consider increasing trends in saline and rock-matrix indicators, along with decreasing trends in spring flow and water levels, to be an indication of a decreasing volume of fresh water in Florida’s aquifers and an indication of saltwater encroachment. As spring flow decreased, spring discharge water was replaced with older, more mineralized water. The statewide changes in groundwater quality, along with statewide decreases in aquifer potentiometry, support this perspective.

For the following analysis consider Wakulla Spring to be part of the SRWMD. If one only considers saline (including flow) and rock-matrix indicators for Sequence A in the SRWMD (plus Wakulla), flow decreased while calcium, magnesium, and sodium increased. For the SJRWMD, calcium, fluoride, and strontium increased. However, for the SWFWMD, ten rock and saline analytes had increasing trends. They were calcium, bicarbonate, magnesium, strontium, potassium, sodium, chloride, sulfate, specific conductance, and total dissolved solids.

During Sequence C, strong trends were observed in seven saline indicators in the SWFWMD: strontium, potassium, sodium, chloride, sulfate, specific conductance, and total dissolved solids had upward trends. In addition, three rock indicators: calcium, bicarbonate, and magnesium had upward trends. Sufficient spring flow was only available at three stations in the SWFWMD (Homosassa Springs, Chassahowitzka River near Chassahowitzka, and Chassahowitzka River near Homosassa Springs). Flow was observed to decrease (see Homosassa and Chassahowitzka Springs in Table 26 and Appendix K). Data from only three springs are insufficient to estimate a regional trend. However, it is plausible, that if additional spring flow data were available, they would demonstrate that significant downward trends in spring flow in the SWFWMD did occur.

The increasing trends in saline and rock indicators indicate that salt-water encroachment occurred during Sequence C. Although data suggests that encroachment was most severe in the SWFWMD, because the concentrations of saline analytes increased almost everywhere in the state during the drought, it is an indication that encroachment occurred on a statewide scale.

The 1998-2002 drought was one of the worst historical droughts to affect Florida (Verdi et al, 2006). In order to make up for the drought, groundwater pumping increased (Verdi et al., 2006). Because an increase in groundwater pumping occurred during one of worst droughts, it is likely that human-induced saline intrusion took place. On a statewide scale, the extent and severity of the intrusion is difficult to quantify. However, within the northern portion of the SWFWMD, a water budget and a regional groundwater flow model indicated that the effect of groundwater withdrawals was less than 2.0% of the effect due to the loss of recharge because of decreased rainfall (Ron Basso, personal communications). Nevertheless, intrusion should be a concern. If another drought of this magnitude occurs, depending on the amount of increased pumping, it could potentially have adverse affects on the long-term sustainability of Florida’s groundwater resources.

Groundwater Withdrawals

The Florida Department of Environmental Protection (2008) stated that water use in Florida will increase as Florida’s population grows. The population in 1990 was officially 12,937,926. In 2000 it was 15,982,378 and by 2003 it was 16,713,149 (U.S. Census Bureau, 2006). Over those 14 years, it grew by 3,775,223, an increase of over 730 people per day.

According to Marella and Berndt (2005), Florida's groundwater withdrawals for all water use categories (agriculture, public supply, commercial/industrial, recreation, domestic, and power generation) in 2000 exceeded 3.1 billion gallons per day. Of those categories, agriculture and public supply accounted for over 82 percent. If divided evenly amongst the population, in 2000, over 190 gallons per day (gpd) of groundwater were used by each person of the state. Since Florida's population is growing by 730 people per day and each new person is using over 190 gpd, then the demand for groundwater increases by more than 135,000 gpd or by more 50 million gallons per year. Because of the lack of precipitation, in an effort to make up for the lack of rain, the pumping of groundwater typically increased during droughts. Thus during Sequence C the drought, the increased population and the increase in consumption of groundwater each had a negative impact on both the quantity and quality of Florida's groundwater resources.

Groundwater Summary

Groundwater quantity and quality data indicates that during Sequence C, Florida suffered from natural saltwater encroachment during the drought. The ability to quantify the extent and severity of the encroachment problem on a statewide basis is not possible at this time due to lack of sufficient data. The drought caused a decline in recharge which in turn lowered the potentiometric surfaces in Florida's aquifers followed by a decrease in spring flow. This was exacerbated by: (1) the increased pumping of groundwater during the drought and (2) the increased demand for groundwater because of the increased population. The consequence of the drought and the increased pumping of groundwater was saltwater encroachment. It is indicated by decreasing trends in spring flow and increasing trends in the concentration of rock and saline indicators.

A return of normal rainfall should greatly help in reversing the process. In the future, spring monitoring and trend analyses should identify any changes. In addition, water conservation practices, along with minimum flows and levels (MFLs) (Florida Statutes,1983, Chapter 373.042) being established by the WMDs should mitigate the effect of future droughts. Nevertheless, the monitoring of population growth, pumping of groundwater, per capita water use, as well as water quality and quantity, are also needed in order to properly manage our water resources.

Miscellaneous and Important Issues

Falling Well Water Levels – A Districtwide and Statewide Problem in Wells

Well-water level trends were consistent with what was seen in spring flow. The most common single trend seen among wells was a simultaneous decrease in water level and pH. Trends were seen in both confined and unconfined wells and both limestone and siliciclastic aquifers. This suggested the cause transcended local aquifer or rock-matrix characteristics. A physical linkage between water level and pH can be established, at least for the shallow wells used in this study, by referring again to Figure 57. Recall that wells penetrate the overlying rock to the point of an intake zone marked by a well screen. The drought or excessive groundwater withdrawal lowered the water table in relation to the intake zone. An explanation for the drop in pH, in conjunction with the fall of the water table, involves the water chemistry near the top of the water table. Since decreases in groundwater levels progressively allow greater volumes of lower pH water into the well screen, this creates the observation—over time—that pH is dropping. Therefore, the statewide lowering in well water levels corresponds to drops in pH. Thus, the chemical and physical trends in well water during the drought may simply reflect the increasing proximity of the upper portions of the water table to the well screen.

A second statewide trend observed in the shallow wells was an increase in water temperature. For Sequence A, increasing trends in temperature were observed on a statewide scale for unconfined groundwater but not for confined groundwater (Table 62). Increasing trends were evident in some districts (e.g., SRWMD) but not in others (e.g., SJRWMD and SWFWMD). There are several plausible explanations for the trends. The first involves the type of pumps used. Grundfos Redi-flo 2 pumps were the well pump most often used. These submersible pumps need well water to cool the pump motors. Samplers, particularly for large wells during sample collection, observed the warming of water. In comparison, peristaltic pumps were also used (e.g. for shallow wells less than 25 feet deep) and for springs. For these pumps, samplers did not observe altered water temperatures.

It is not likely that pump heating was the cause of increased districtwide and statewide temperature trends. The heating of water is not the same as the creation of an upward trend in a time series. In order for a trend to be observed, it would require not only that water be heated within the individual pump *but that the amount of heat added by the pump each year increased steadily over all parts of the state*.

Spring temperatures increased in some places but not in others. Peristaltic pumps, not submersible pumps, were used for shallow wells and springs. They do not require cooling. If well-water temperature rose as an artifact of the collection methodology then a separate explanation is needed to explain why temperature rose in springs, which were sampled with different equipment. Both shallow well and spring temperature increases were observed in the SRWMD. On the other hand, peristaltic pumps were also used in the SWFWMD, and, as it turned out, spring-water temperatures typically decreased while well-water temperature increased.

Another possibility is that the trends are statistical artifacts such as “aliasing.” Aliasing is a result of sampling over a time interval that is longer than the duration of cycles of the variable of interest. Figure 59 depicts cyclic variations of water levels. The cycle is approximately 7 days in length. If sampling occurs at intervals that are less than 7 days, a cyclic pattern will be detected, even if it is not the “true” 7-day cycle. By setting the sampling interval at the same period as the cyclicity, the cycles are not detected. In fact, with a 7-day cycle, the starting day of the week has a profound consequence on the apparent behavior of the data. Starting sampling on Day 1 (Monday) results in an apparent increase in water levels over time. Starting sampling on Day 3 (Wednesday) results indicate an apparent negative trend in water levels. Clearly, there is an important relationship between the period of sampling and the period of the cyclicity.

This issue is important for all analytes in trend analysis since it can involve any trends. The danger is that, in a time series short enough, one limb of the false cycle can appear as an upward or downward trending curve. The key problem with this explanation is that the results of the aliasing are cycles, not trends. As such, it is equally likely to sample in such a way that a false upward or downward trend is generated.

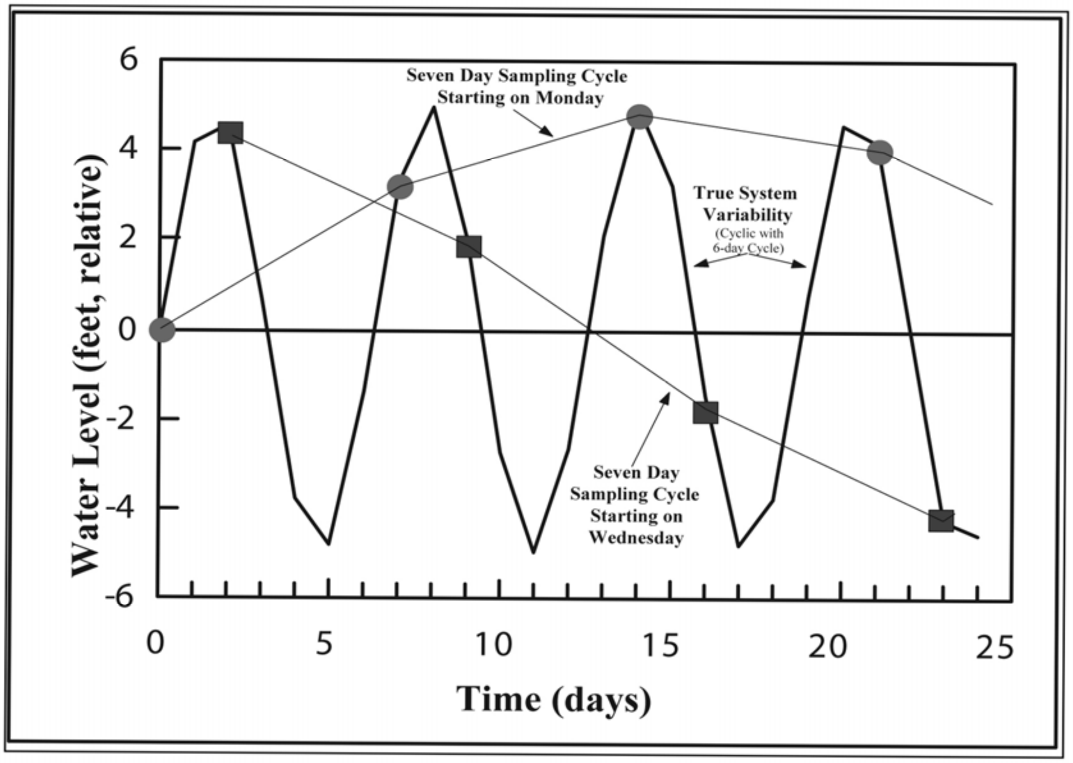


Figure 59. Example of aliasing.

Regarding water temperature, one should see an equal probability of up *and* down trends in water temperature. However, if both upward and downward tendencies are equally likely then it requires a second explanation to understand why trends so often tend in the same direction; or to say it another way, it is not that trends are going up but that *so many* are going up. The sign tests (Table 49) reveal that the majority of trends described here were predominately up. The simplest explanation for increased temperature is that a single cause is responsible for the widespread singular trends.

It appears that the most plausible explanation for increasing well water temperature is an increase in air temperature. Table 67 indicates that the mean air temperature across most of Florida was about 0.29 °F (0.16 ° C) higher during Sequence C (1998-2003) relative to Sequence B (1991-1997). For the shallow wells, it is possible that localized air temperature increases are responsible for increasing water temperature.

Nitrogen and Phosphorus Nutrients—Regional and Local Problem in Springs

Several nutrient trends in springs were analyzed for the four water management districts providing spring data. Nitrates (in various forms), phosphorus, phosphate (or ortho-phosphate), TKN and ammonia were the most common. These can be grouped as nitrogen and phosphorus and will be addressed separately for each water management district.

Nitrate concentrations have increased in northern Florida springs for over 30 years. The data analyzed for Wakulla Spring indicates a downward trend for the 1991 - 2003 time frame, yet the spring has a longer history of nitrate increases (Figure 60). From the 1970s to the early 1990s, nitrate concentrations in Wakulla Spring rose from approximately 0.2 mg/L to over 1.0 mg/L. Increases in nitrogen trends are typically due to specific land use inputs. The most common inputs are from fertilizer application, septic tanks, animal excrement, golf courses, and wastewater treatment facilities (Florida Spring Task Force, 2000).

Nutrient transport is a complex process. Nitrate and other nutrients wash into aquifers and undergo large-scale mixing with groundwater (Martin and Gordon, 1997). Analyte concentrations in springs following storms change as a function of epikarst (upper weathered karst) flushing. Nitrate concentrations increase as a result of this effect. Changes in concentration are often seasonal (Katz, 2000; Boyer et al., 1999).

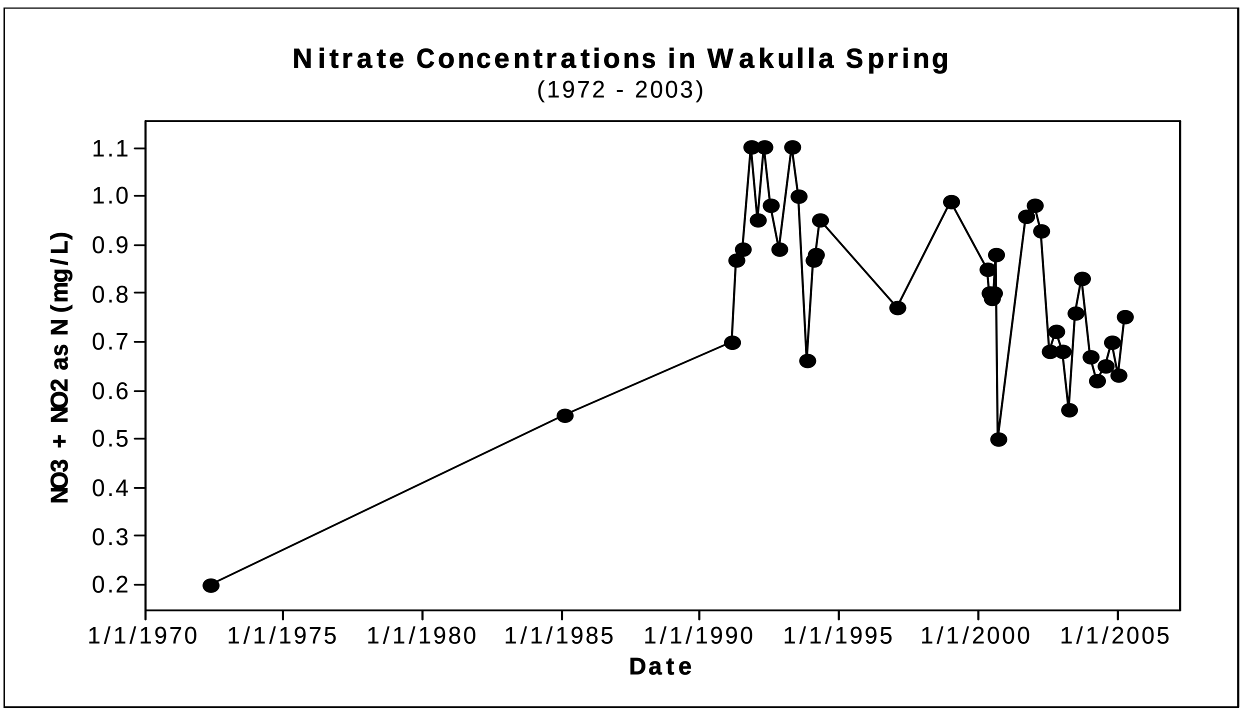


Figure 60. Nitrate Concentrations in Wakulla Spring between 1972 and 2005.

Nitrogen in the Northwest Florida Water Management District

One on-going study is taking place at a wastewater treatment facility (WWTF) spray field located approximately 10 miles from Wakulla Spring. Wastewater has been noted to change concentrations of a number of analytes including chloride, nitrogen, phosphorus, organic carbon, coliform bacteria, sodium, and potassium (Elder et al., 1985). Depending on the analyte and the percent of organic material present, soil and underlying rock matrices can absorb much of the material introduced. Spray-field monitoring wells have documented changes in both chloride and nitrate-nitrogen concentrations. Chloride has been noted to increase from 3 to 15 mg/L while nitrate-nitrogen climbed from 0.5 to 4 mg/L in nearby wells (Elder et al., 1985). The association of combined increases in nitrate and chloride has also been reported in other parts of the country (e.g. Ogallala Aquifer, Texas; Hudak, 2002). Wekiwa Springs in the SJRWMD appear to have a similar wastewater input problem. Septic tanks are sometimes referred to as on site waste disposal systems (OSWDS). Their leachate plus lawn fertilization seem to be the most likely source of the nitrogen (Toth and Fortich, 2002).

Studies of Leon and Wakulla Counties have documented six main nitrogen sources were identified: atmospheric deposition, wastewater treatment facilities, OSWDSs, commercial fertilizers, livestock and sinking streams (Chelette et al., 2002). Of these sources, there are both inorganic and organic sources of nitrogen, either of which could be introduced in dissolved or particulate form. Forms of nitrogen can be classified as either dissolved inorganic, particulate inorganic, dissolved organic, and particulate inorganic. The exact contribution of each of these forms is difficult to establish. Actual amounts of nitrogen contributed from these sources have been documented with varying accuracy. WWTF contributions are well established, whereas data from OSWDS are more difficult to acquire. Regardless of the exact contribution, the overall contribution of WWTF and OSWDS comprise the majority of nitrogen inputs into the environment. They deliver, respectively, 550 and 800-2,400 kg-N/ha-yr (Chelette et al., 2002). Though atmospheric deposition of nitrogen is substantial, it is dispersed over wider areas and comprises approximately 4-5 kg-N/ha-yr (total of wet and dry deposition combined).

Based on Chelette et al. (2002), much of the nitrogen fertilizers applied to the landscape is sequestered or returned to the atmosphere; only a fraction becomes part of groundwater. Nitrogen is a highly reactive element and its chemical pathways are difficult to establish. It can be sequestered in vegetation, lake-bottom sediments, the subsurface, or it can return to the atmosphere. In spite of the small proportion of nitrogen actually entering groundwater, total nitrate discharging from Wakulla Spring at least doubled over the last 25 years.

Agricultural sources have been documented through isotopes and water ages. Many springs have complex flow paths with older and younger flow paths converging within springs. Isotopic studies indicate a variety of water ages in northern Florida springs. Nitrate concentrations are negatively correlated to age of spring water and the nitrate originates from varying proportions of inorganic (fertilizers) and organic-N (animal wastes) sources (Katz et al., 1999b; Toth, 1999). Close correlation of nitrate trends in some Florida counties to county-wide fertilizer sales underscores this relationship (Chelette et al., 2002; Katz et al., 1999b).

Another factor in localization is underlying geology and soil. Even within agricultural areas nutrients may show up in groundwater in greater or less proportion based on underlying geology, soil conditions, and preferential flow paths within aquifers. One study in Florida illustrates this for nitrate in surface water and groundwater. In the northwestern portion of the state the Dothan soils are plenthitic (iron hardpan) with a shallow perched water table (Day, 1997). These conditions result in less nitrate percolating into the aquifer, although greater concentrations of nitrate may be concentrated in surface runoff. Other soils in the panhandle can provide a suitable environment for nitrate to persist and eventually find its way into groundwater. Bowman (1991) also indicated that soil types can affect nitrate input into groundwater. Our study shows that nitrate has been trending downward in Wakulla Spring significantly during the 1991-2003 period (Figure 60). The time series includes gaps. However, both MK trend results and WT tests of Sequence B and C data confirm a drop in the latter half of the series. These results suggest that a moderate improvement may have occurred. Loper et al. (2005) suggested that the improvements are due to decreased effluent concentrations at the spray field. At the same time, the highly elevated starting point of the time series in 1991 (1.0 mg/L), as compared to 0.2 mg/L in 1972, was the product of several decades of a strong rise (Figure 60).

Nitrogen in the Suwannee River Water Management District

The SRWMD was the only district to provide flow data on the days that nutrient samples were collected. This allowed an examination of flow-related loading for the analytes. Of the nutrient analytes examined for the SRWMD, the only one having a districtwide trend was TKN (nine increased and zero decreased). At the same time, other nutrient analytes suggest increases and decreases. Nitrate decreased in six springs (and increased in only three), while phosphorus increased in five and phosphate increased in four (with each only decreasing in one spring).

At least four explanations exist that can possibly explain the decrease in nitrate. First, since the latter half of the time series was a drier period, it is possible that less nitrate became available to groundwater as a result of decreased precipitation or a possible reduction in fertilizer applications during the dry period. Second, during the dry period, the soil may have stored nitrogen. Under both of these scenarios, when the current dry period ends, nitrate trends in springs will be expected to increase. Third, efforts by the local WMDs to conserve on the rates of fertilizer application were successful. Under this scenario, when the dry period ends, in all likelihood, nitrate concentrations in springs will continue to decline. Fourth, during the drier times, spring discharge is reduced. Reduced flow creates an appearance of lower nitrate concentration in the springs. For example, flow-adjusted trends and flow/concentration plots revealed a different behavior between nitrate-nitrogen and TKN over the period of record. Figures 61-64 compare and contrast flow-adjusted trends. Flow adjustments were derived in two ways. The figures include plots of: (1) the product of flow volumes and nutrient concentrations against time and log-log plots of nutrient concentration as a function of the flow.

The figures contrast different springs with a variety of trend directions. Troy Spring (Figure 61, top) demonstrates an inverse relationship over time for flow-adjusted nitrate, while the log-log plot (Figure 61, bottom) shows a positive relationship exists between nitrate concentrations (vertical axis) and flow (horizontal axis). Figure 62 (top) displays no apparent flow relationship over time for flow-adjusted trend for TKN for Troy Spring, while Figure 62 (bottom) reveals that TKN concentration (vertical axis) has an inverse relationship with flow (horizontal axis). Figure 63 (Hornsby Spring) shows a negative relationship over time for flow-adjusted nitrate (top), but demonstrates a positive relationship regarding the log concentration of nitrate versus the log of flow (bottom). In Figure 64 (top) there is a positive relationship over

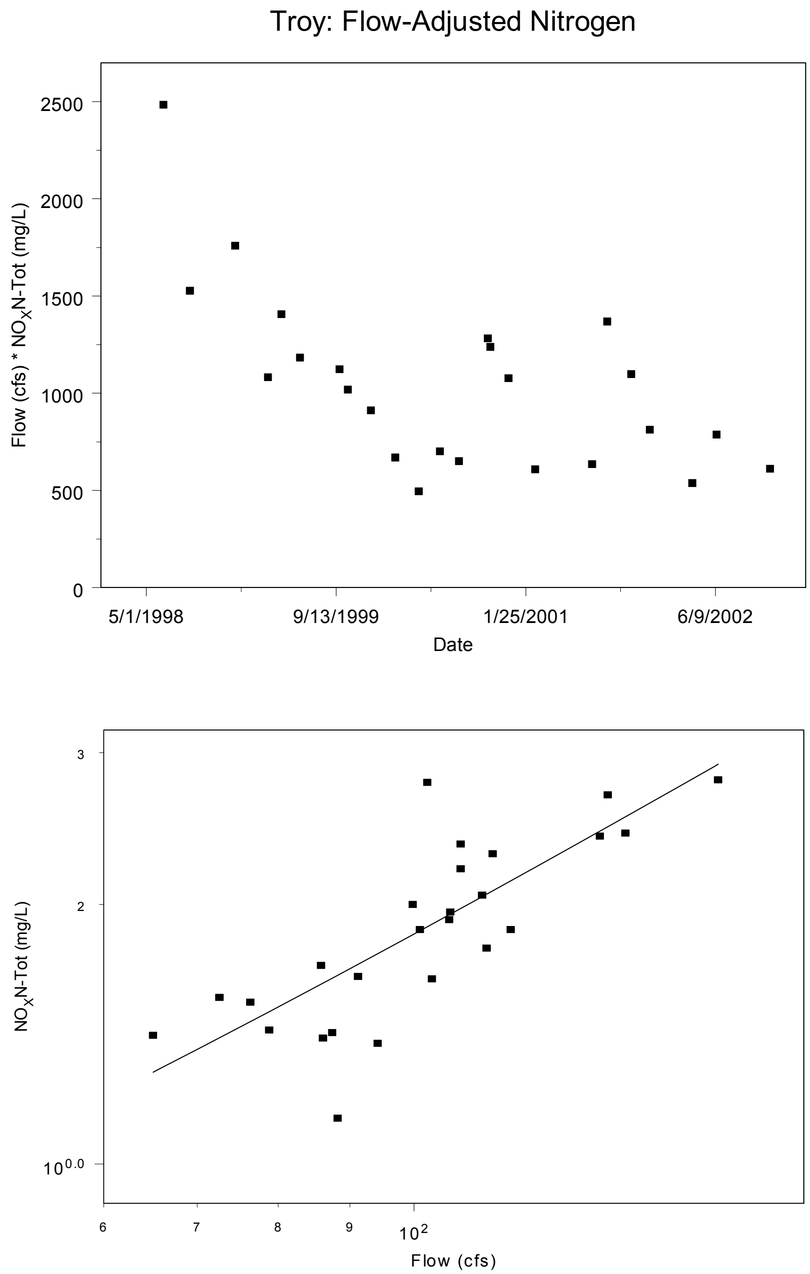
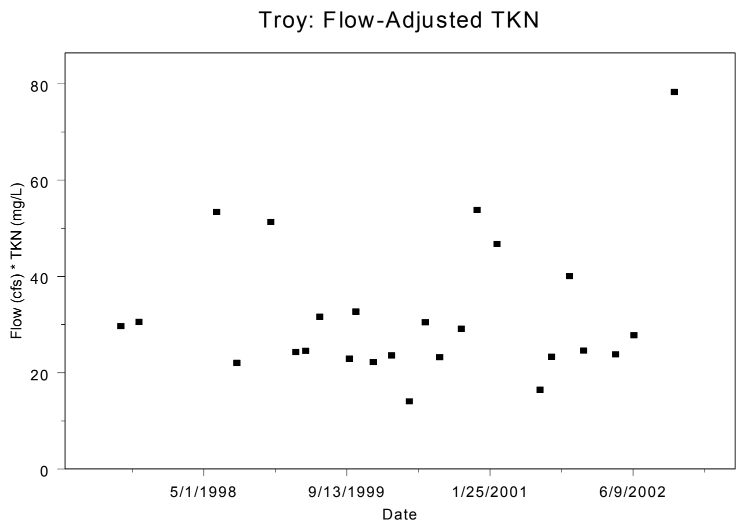


Figure 61. Flow adjustment for Nitrate in Troy Spring. Flow-adjusted nitrate (top) shows a clear decline over time, while the log of nitrate plotted against log of flow (bottom) shows a clear positive association.



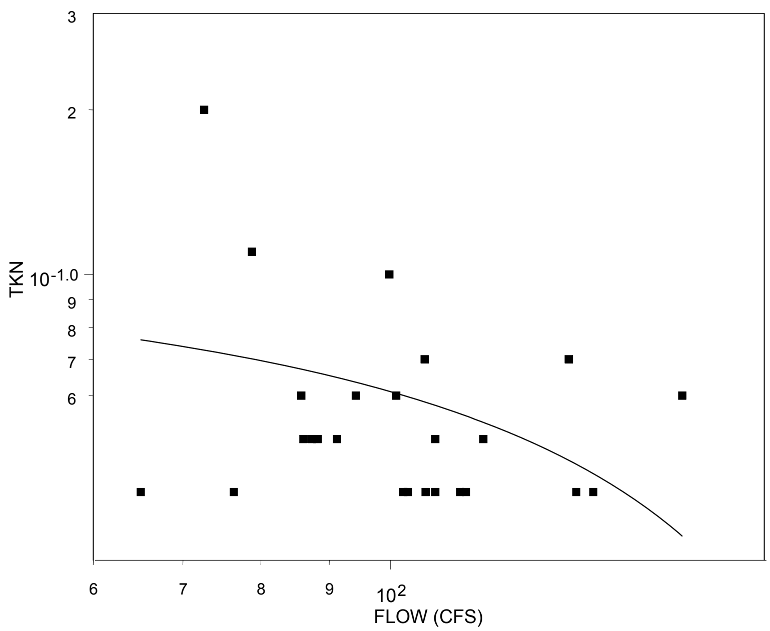
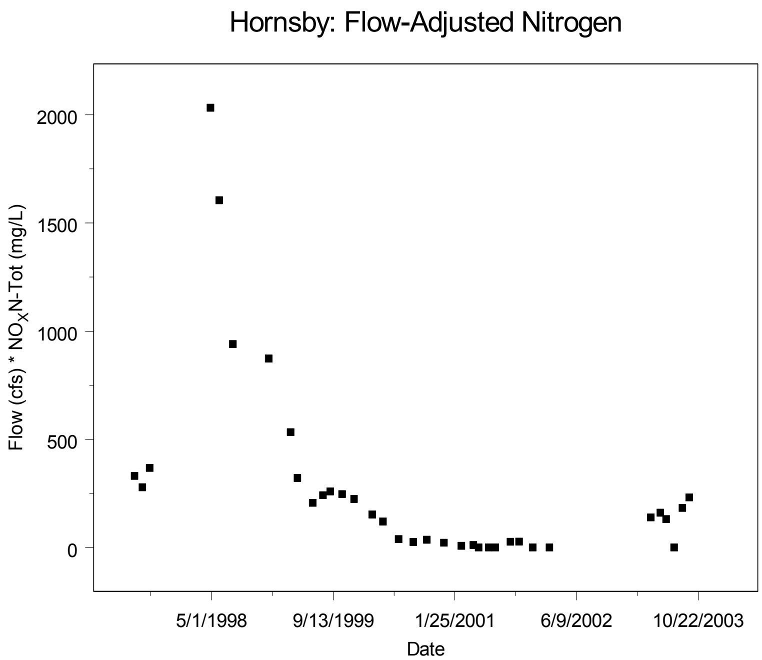


Figure 62. Flow adjustment for TKN in Troy Springs. Flow adjusted TKN shows little change over time while the log of flow versus the log of TKN (bottom) is slightly negative.



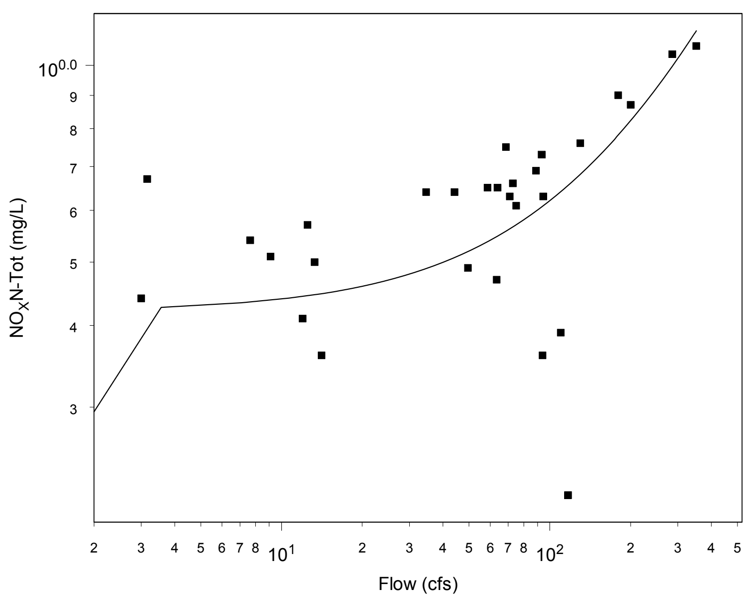


Figure 63. Flow adjustment for nitrate in Hornsby Spring. Flow adjusted nitrate-nitrite (top) over time shows a clear decline over time. The log of nitrate plotted against log of flow (bottom) shows a positive association.

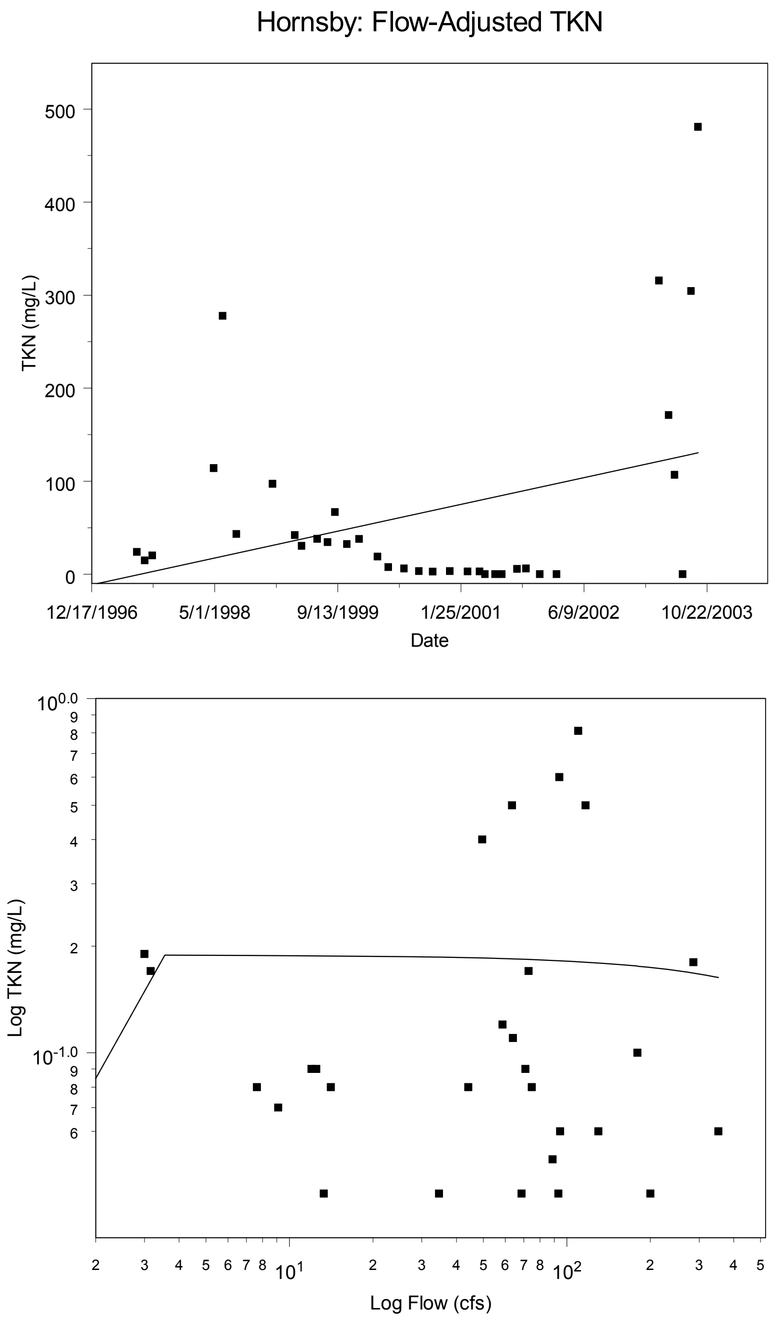


Figure 64. TKN versus time and log of TKN versus log of flow in Hornsby Spring. TKN shows a drop with a sudden rise at the end of the time series (top). However, there is very little relationship between the log of flow and the log of TKN (bottom).

time for TKN. However, there is a slightly negative relationship between the log of TKN compared to the log of flow (bottom). Hornsby Spring had the sharpest decrease in flow of all SRWMD springs and actually stopped flowing during portions of the study period.

Figures 61-64 suggest that reduced spring flow was responsible for apparent decreases in nitrate concentrations and increases in TKN concentrations. Because in all cases, whether nitrate concentration is increasing, decreasing, or showing no trend, nitrate concentrations closely follow flow amounts in the springs. This flow-dependent behavior is one plausible explanation of the decreasing nitrate trends in the Suwannee District; nitrate concentrations may have fallen in some springs simply as a function of reduced flow.

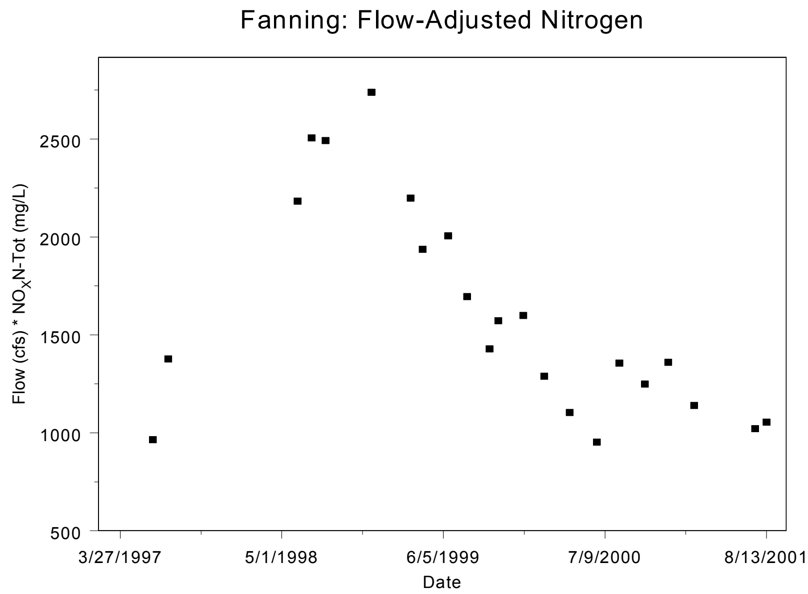
One clear observation revealed by flow adjustments is how the two forms of nitrogen differ for the SRWMD. TKN showed a clearly different pattern than nitrate-nitrogen. For Troy Spring (Figure 61, top) nitrate loading decreased over time. However, as a function of flow, nitrate concentrations correlated positively with flow (Figure 61, bottom). On the other hand, TKN slightly increased over time (Figure 62, top), but had an inverse relationship with flow (Figure 62, bottom). Hornsby Spring was similar to Troy Spring. Nitrate loading (Figure 63, top) decreased over time and it correlated positively correlated with flow (Figure 63, bottom). TKN concentrations increased over time (Figure 64, top), but TKN had an insignificant correlation with flow (Figurer 64, bottom). As with the other two springs, nitrate loading at Fanning Spring (Figure 65, top) decreased during the drought, and nitrate concentrations were correlated positively with flow (Figure 65, bottom). With regard to TKN, its loading increased over time (Figure 66, top), and TKN was inversely correlated with flow (Figure 66, bottom).

Table 69 summarizes nutrient relationships for several springs in the SRWMD. The table contains summary data for Troy, Hornsby, and Fanning Springs (already discussed), plus Little River, Telford, and Ruth/Little Sulfur (RLS) Springs. For each of these selected springs, the table contrasts the relationships among concentration, loading, time, and flow for both nitrate and TKN.

At the bottom of the table is a summary. Nitrate concentrations and nitrate loading generally decreased over time. Nitrate concentrations were positively related to flow. As flow decreased during the drought, nitrate concentrations generally decreased. Since nitrate concentrations are dependent on flow, as rainfall returns to normal, nitrate concentrations may begin to increase, because of the increased spring flow.

TKN behaved differently. TKN concentrations generally increased over time, while TKN loading generally decreased. TKN concentrations were inversely (negatively) related to flow. As flow decreased during the drought, TKN concentrations generally increased.

These results raised questions concerning the different sources and chemical behaviors of both forms of nitrogen. It is clear that nitrate closely followed the flow amounts—at least for these selected springs in the Suwannee District. However, TKN shows an almost inverse relationship with flow. Since TKN is a combination of both NH_3 and organic nitrogen, a possible explanation is that the sources of the organic nitrogen in TKN were from either highly organic water originating from swamps or from agriculture and/or waste water sources.



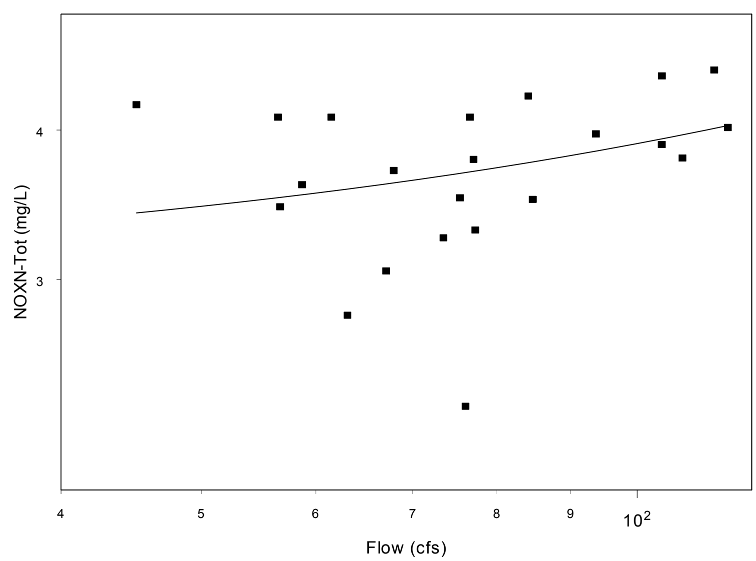


Figure 65. Flow adjustment for nitrate in Fanning Spring. Flow adjusted nitrate-nitrite shows a sharp rise followed by a decline over time (top). The log of nitrate-nitrite plotted against log of flow (bottom) shows a positive relationshiship.

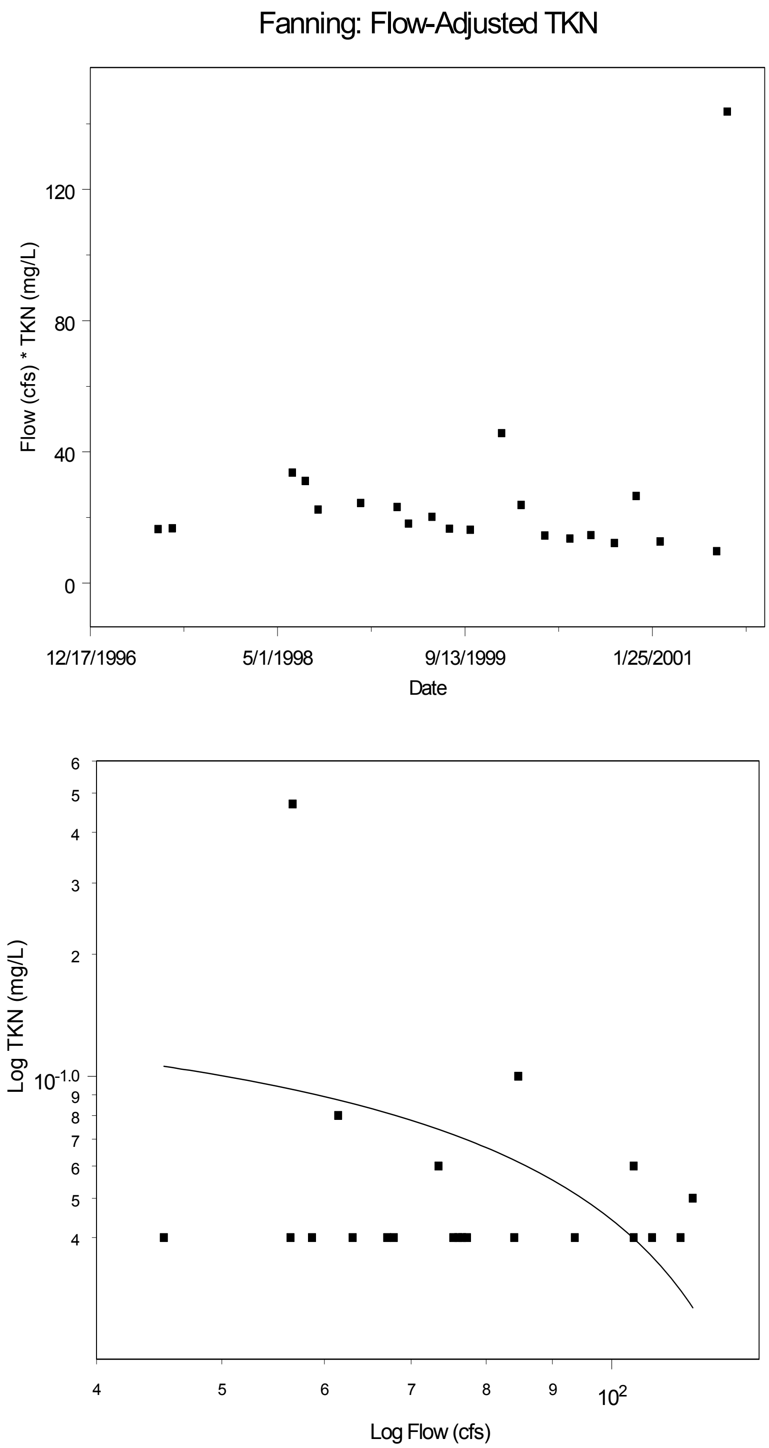


Figure 66. Flow-Adajustment for TKN in Fanning Spring. TKN shows nearly no flow-adjusted trend over time (top). Plotted against the log of flow versus the log of TKN shows an inverse negative re-ationship with flow (bottom).

Table 69. Relationships among Concentration and Loading of Nitrate and TKN versus Time and Flow in Selected Springs in the SRWMD

Spring	Reference	Nitrate or TKN	Loading or Concentration	Versus Time or Flow	Relationship + , 0, or -
Troy	Table 10	Nitrate	Concentration	Time	0
	Table 10	TKN	Concentration	Time	0
	Figure 62	Nitrate	Loading	Time	-
	Figure 62	TKN	Loading	Time	0
	Figure 62	Nitrate	Concentration	Flow	+
	Figure 62	TKN	Concentration	Flow	-
Hornsby	Table 10	Nitrate	Concentration	Time	-
	Table 10	TKN	Concentration	Time	0
	Figure 63	Nitrate	Loading	Time	-
	Figure 63	TKN	Loading	Time	+
	Figure 63	Nitrate	Concentration	Flow	+
	Figure 63	TKN	Concentration	Flow	0
Fanning	Table 10	Nitrate	Concentration	Time	+
	Table 10	TKN	Concentration	Time	+
	Figure 64	Nitrate	Loading	Time	0
	Figure 64	TKN	Loading	Time	0
	Figure 64	Nitrate	Concentration	Flow	+
	Figure 64	TKN	Concentration	Flow	-
Little River	Table 10	Nitrate	Concentration	Time	-
	Table 10	TKN	Concentration	Time	+
	Appendix M	Nitrate	Loading	Time	-
	Appendix M	TKN	Loading	Time	-
	Appendix M	Nitrate	Concentration	Flow	+
	Appendix M	TKN	Concentration	Flow	-
Telford	Table 10	Nitrate	Concentration	Time	-
	Table 10	TKN	Concentration	Time	+
	Appendix M	Nitrate	Loading	Time	-
	Appendix M	TKN	Loading	Time	-
	Appendix M	Nitrate	Concentration	Flow	+
	Appendix M	TKN	Concentration	Flow	-
Ruth/Little Sulfur	Table 10	Nitrate	Concentration	Time	+
	Table 10	TKN	Concentration	Time	+
	Appendix M	Nitrate	Loading	Time	-
	Appendix M	TKN	Loading	Time	-
	Appendix M	Nitrate	Concentration	Flow	+
	Appendix M	TKN	Concentration	Flow	-
Overall for springs above	**Reference**	**Nitrate or TKN**	**Loading or Concentration**	**Versus Time or Flow**	**Relationship + , 0, or -**
	Table 10	Nitrate	Concentration	Time	-
	Table 10	TKN	Concentration	Time	+
	Appendix M	Nitrate	Loading	Time	-
	Appendix M	TKN	Loading	Time	-
	Appendix M	Nitrate	Concentration	Flow	+
	Appendix M	TKN	Concentration	Flow	-

During 2003, a relatively wet year, large amounts of organic debris, originating from swamps or other sources, possibly entered the groundwater regime though swallets and were simply flushed through the springs. However, there is another possibility for increasing TKN trends. Since NH_3 showed little activity in the SRWMD, changes in organic nitrogen are possibly responsible for increased trends. Organic material found within the deeper and older Avon Park Formation is a possible source of organic nitrogen and, by extension, TKN. During the drought, deeper organic-rich groundwater, originating from the Avon Park Formation, may have found its way to the springs. The mechanism for transporting the older water to springs is analogous to that controlling the increases of rock and saline analyte concentrations during a drought. In either scenario, it appears that nitrogen from organic sources found their way into the SRWMD groundwater during the period of record while nitrate concentrations were controlled by spring flow.

Nitrogen in the St. Johns River and Southwest Florida Water Management Districts

There were no observed districtwide nutrient trends in the SJRWMD. However, nutrients were a large problem in the SWFWMD. Nineteen springs showed upward trends in nitrate and only one had a downward trend. In comparison, phosphorus and phosphate trends (to be discussed shortly) were suggestive of a slight improvement. Unlike the SRWMD, flow data were sparse for the SWFWMD and loading could not be determined. This disparity (dominant upward trends in SWFWMD for nitrate but relatively inactive [or improving] phosphorus trends) provided another good example of the “patchy” nature of nutrient trends in the state.

Much has been said about the SWFWMD’s nitrate problems (Champion and DeWitt, 2000; Champion and Starks, 2001; Jones and Upchurch, 1994; Jones et al., 1996; Jones et al., 1997). These earlier works provide explanations for what is seen in this study. The following springs had upward nitrate trends during the period of record: Boat, Buckhorn Main, Chassahowitzka No. 1, Chassahowitzka Main, Hidden River Head, Hidden River No. 2, Homosassa (Nos. 1, 2 and 3), Hunter, Magnolia, Pumphouse, Rainbow (No. 1 and 6), Rainbow Bridge Seep, Salt, Tarpon Hole, Trotter Main, and Weeki Wachee Main Springs.

Marion County

Marion County includes the Rainbow Springs Group; the fourth largest spring group system in Florida. Data were analyzed for Rainbow No. 1, Rainbow No. 4, Rainbow No. 6, Rainbow Swamp No. 3, and Rainbow Bridge Seep.

Rainbow Springs Group

Rainbow Springs Group, like many other springs in the SWFWMD, had nitrate concentrations well above that of the natural Floridan aquifer system value (<0.05 mg/L). The main source of nitrate in the group was primarily derived from inorganic sources of nitrate, in particular inorganic fertilizers applied to pastures near the springs. Thus the nitrates represent a local flow system (Champion and Starks, 2001; Jones, et al., 1996).

Citrus County

Citrus County has several spring groups: King's Bay, Homosassa, and Chassahowitzka Springs Groups. Springs included Chassahowitzka No. 1, Chassahowitzka Main, Hidden River Head, Hidden River No. 2, Homosassa Numbers 1-3, Hunter, Pumphouse, and Trotter Main Springs.

King's Bay Springs Group

The King's Bay Springs Group is the second largest system in Florida. Tarpon Hole and Hunter Springs are part of this group. Freshwater springs were located on the east side of the bay while springs with brackish water were found in the central and western portions. As of 2001, flow in the springs was only 75 percent of the historical average (Champion and Starks, 2001).

Water quality in the King's Bay Springs Group is tidally influenced. TDS and chloride concentrations change with tides. This suggests that, even at low tide, the springs are strongly influenced by the coastal transition zone. Most nitrate input was from inorganic sources, most likely inorganic fertilizers applied to golf courses and residential properties near the springs. Thus, the nitrates are indicative of a local flow system (Jones and Upchurch, 1994).

Homosassa Springs Group

The Homosassa Springs Group, in western Citrus County, had several springs with upward nitrate trends: Homosassa, Trotter Main, Pumphouse, and Hidden River Head. Like the King's Bay Group, the Homosassa Springs Group shows an influence from the coastal transition zone (Jones et al., 1997). Like the King's Bay Springs Group, Homosassa Springs Group nitrates were derived primarily from inorganic sources of nitrate—inorganic fertilizers applied to residential and golf course turf grass near the springs. Again, the nitrates represent a local flow system.

Chassahowitzka Springs Group

Like the King's Bay and Homosassa Groups, Chassahowitzka Springs Group varies between fresh and brackish and is tidally influenced. TDS and chloride concentrations varied greatly, showing a coastal transition zone influence even at low tide (Jones et al., 1997). Nitrate concentrations were generally below 0.6 mg/L but varied among individual springs in the group. Mixing of coastal transition zone waters and variations in Floridan aquifer system nitrate concentrations were sources of variations. Most nitrate was derived from inorganic sources, such as inorganic fertilizers applied to residential and golf course grass near the springs (Jones et al., 1997).

Hernando County

Hernando County included two spring groups: Weeki Wachee and Aripeka Springs Groups. Springs included Boat, Magnolia, Salt, and Weeki Wachee.

Weeki Wachee Springs Group

This group lies within western Hernando County, southwest of Brooksville and is located inland of the brackish water to the west. Weeki Wachee Main Spring had increasing nitrates. As with other SWFWMD springs, the sources of nitrate are probably inorganic fertilizers applied to golf and residential lawns in the vicinity of the springs (Jones, et al., 1997).

Boat Springs, Bobhill, and Magnolia Springs

These springs are located southwest of the Weeki Wachee Springs Group in Hernando County. Average discharge for these springs is relatively low (Rosenau, et al., 1977). As with other SWFWMD springs, TDS and chloride concentrations range from fresh to brackish with proximity to the coast. TDS and chloride concentration changes suggest the group is influenced by the coastal transition zone. The sources of nitrates are possibly inorganic fertilizers applied to residential and golf course lawns near the springs.

Hillsborough County

The only sampled springs in Hillsborough County were Lithia Spring and Buckhorn Springs. The only spring with increasing nitrate was Buckhorn Spring.

Lithia Spring and Buckhorn Spring

Unlike most of the other springs, Lithia and Buckhorn Springs exhibit little change in TDS or chloride. They are not affected by the higher salinities of the transition zone. The high amounts of nitrate in Lithia and Buckhorn Springs are derived from an inorganic source—inorganic fertilizers applied to citrus within the vicinity of the springs (Jones and Upchurch, 1994).

Summary of the Nitrate Problem in Spring Water

Originally, the land around these springs consisted of pine forest, hammock forests and scrub (Champion and Starks, 2001; and Wolfe, 1990). This natural setting was eventually replaced by agricultural development such as livestock pastures, row crops and citrus. Additionally, the last several decades have included urban and commercial development. These developments included many residential units and golf courses. Studies at the SWFWMD have concluded that during the last 25 years, nitrate from inorganic fertilizers has leached into the Upper Floridan aquifer and is now discharging from the springs. Population within SWFWMD has been projected to increase to 4.6 million by 2010 (Champion and Starks, 2001). With nitrate already leaching into the FAS, and development ongoing, the nitrate increases will continue for the foreseeable future.

Phosphorus in Spring Water by Water Management District

Phosphorus is strongly correlated with underlying phosphatic rock formations in Florida, predominately from the Hawthorn Group (Scott et al., 1991). The unusually high phosphorus contents of streams and lakes deriving water drained from phosphatic areas have long been studied (Odum, 1953).

Other potential sources of increased phosphorus in springs involve industry and wastewater. Naturally high phosphorus concentrations occur in surface waters in some parts of the state, but can be elevated in other areas by municipal wastewater and phosphate mining. Because the removal of phosphorus is not often addressed in wastewater treatment, it is an important source of contamination. Although some facilities may have the ability to treat for phosphorus, most onsite wastewater treatment and sewage treatment facilities do not prevent introduction of phosphorus into the environment.

Suwannee River Water Management District

Wakulla Spring is the only spring that was evaluated in the NWFWMD and for Wakulla Spring, phosphorus was not an issue. For the SRWMD, flow-adjusted trends for phosphorus and phosphate were examined. Figures 67-75 compare flow-adjusted trends among springs that show varying trends in phosphorus and phosphate. Overall, the response of phosphate is more similar to that of TKN than nitrate-nitrogen for the SRWMD. Figures 67 and 68 are examples of the relationship between flow and analyte concentrations in a spring (Troy) for phosphorus and phosphate. Time series of the flow-adjusted analytes show little evidence of temporal trends (Figures 67, top and 68, top). Log-log plots of concentration and flow (Figures 67, and 68, bottom) show only slight relationship between: (a) flow and phosphorus, or (b) flow and phosphate concentrations.

Ruth/Little Sulfur (RLS) Spring shows a slight decrease in the log of concentration versus the log of flow (Figures 69, top and 70, top) for both analytes. However, it has slightly decreasing phosphorus and phosphate flow-adjusted trends over the period of record (Figures 69, bottom and 70, bottom). Fanning Spring (Figures 71 and 72) shows a slightly different picture. Flow-adjusted concentrations for both phosphorus and phosphate decrease after 1998 [(Figures 71 (top) and 72 (top)]. However, phosphorus concentrations increase with flow (Figure 71 bottom), while phosphate concentrations decrease slightly over time (Figure 72, bottom). Little River Spring (Figure 73) has decreasing phosphorus and phosphate flow-adjusted trends over the period of record (Figures 73, top and 74 top). The log of phosphorous and the log of phosphate (Figure 73 bottom and 74, bottom) both decrease with the log of flow.

However, like TKN, both phosphorous and phosphate also showed negative relationships between the log of the concentration and the log of the flow. An explanation for these trends is suggested when these plots are compared to one of the few examples of a decreasing phosphate trend in the SRWMD. Hornsby Spring showed a strong decrease in flow-adjusted phosphate (Figure 75, top), with an increase at the end of the time series. The strong downward trend reflects the rapid reduction in flow within Hornsby Spring over the time series. A log-log plot of concentration against flow (Figure 75, bottom) shows a positive increase, unlike the other springs. When phosphate decreased, flow also decreased. The implications are that, like TKN, phosphorus-based nutrients increased at a rate faster than flow decreased. This is why trends

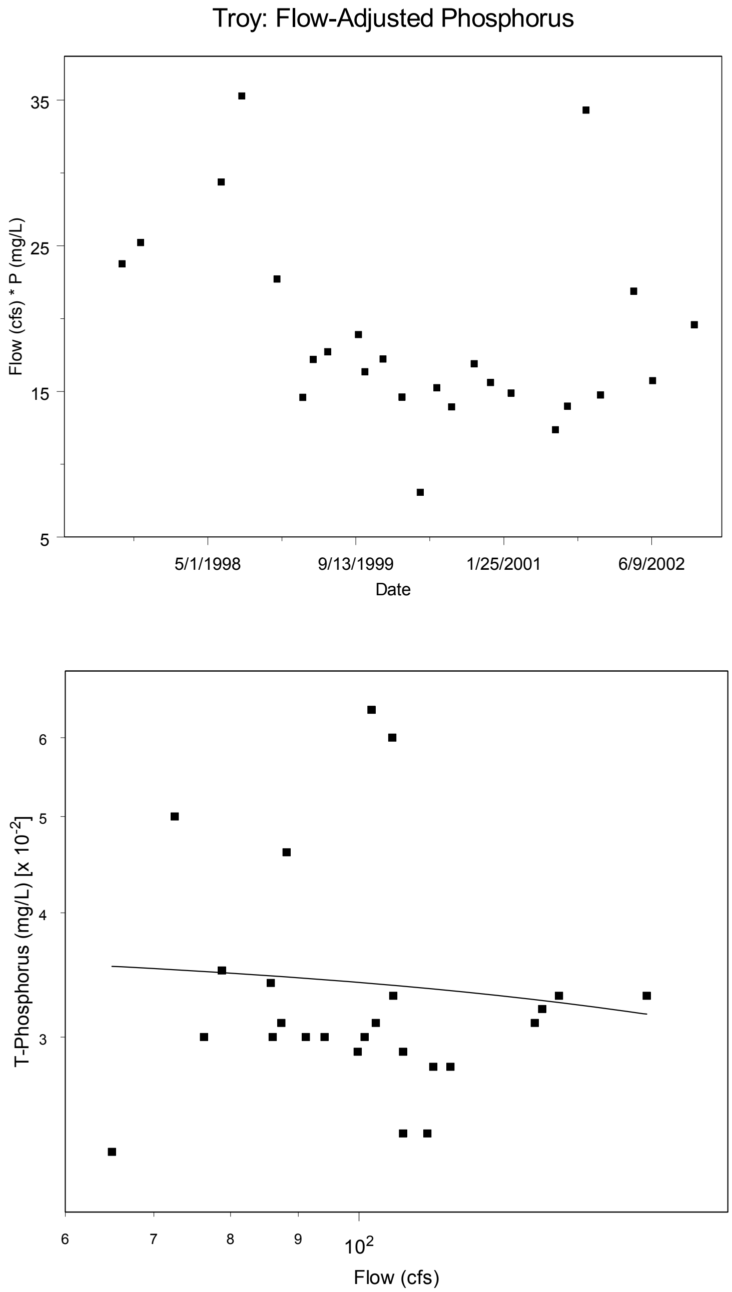


Figure 67. Flow adjustment for phosphorus in Troy Spring. phosphorus (top) show little declines over time while the log of phosphorus has a negative relationship to the log of flow. Phosphate (bottom) shows a slight negative trend over time while the log of phosphate has little to no relationship to the log of flow.

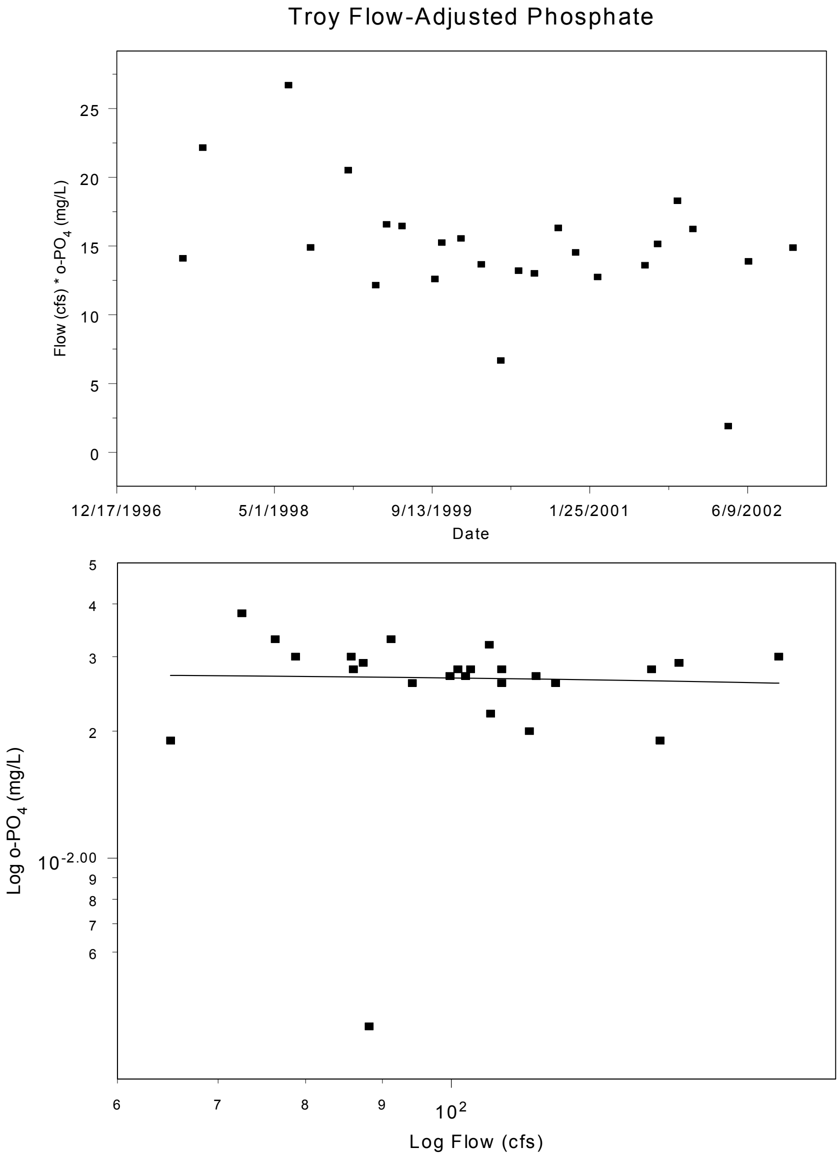


Figure 68. Flow-adjustment for phosphate in Troy Spring. Phosphate (top) shows a slight negative trend over time while the log of phosphate has little to no relationship to the log of flow (bottom).

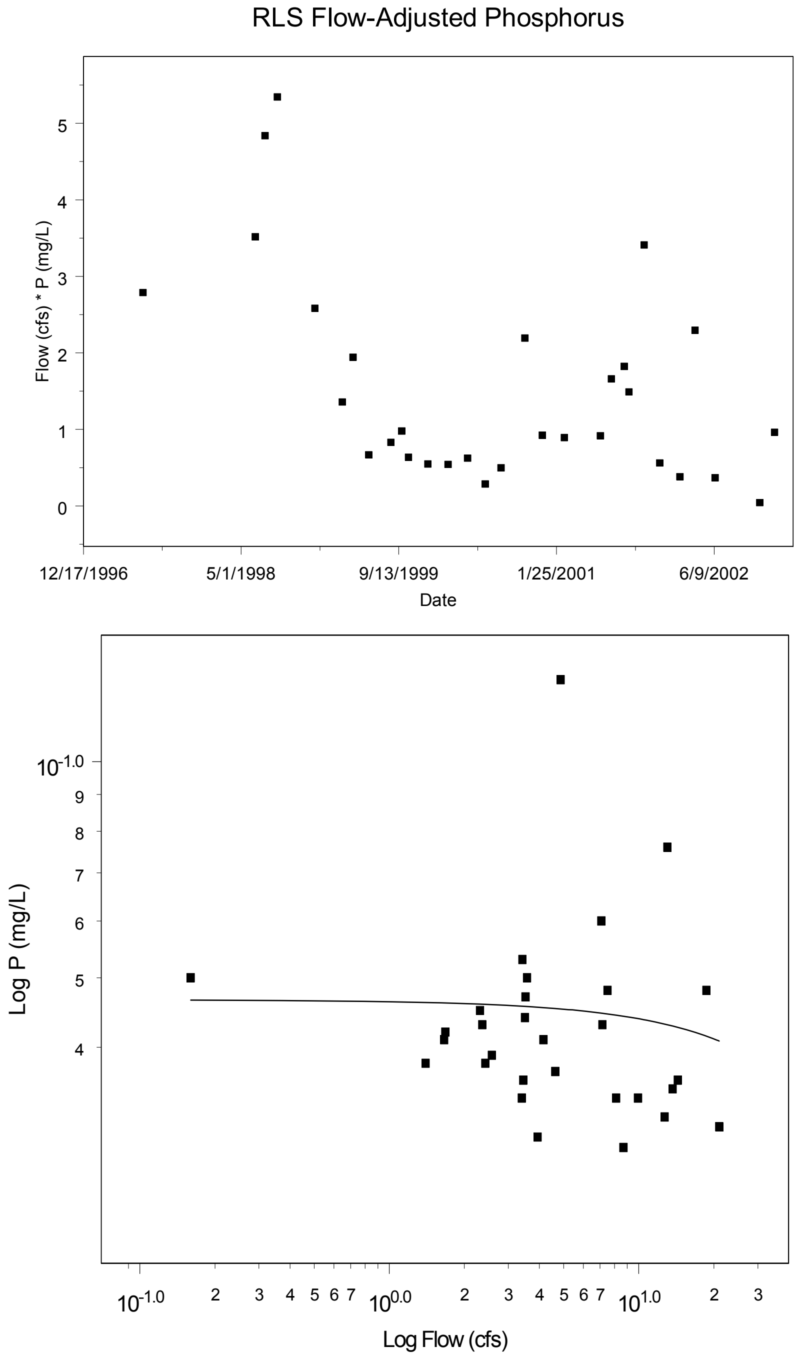
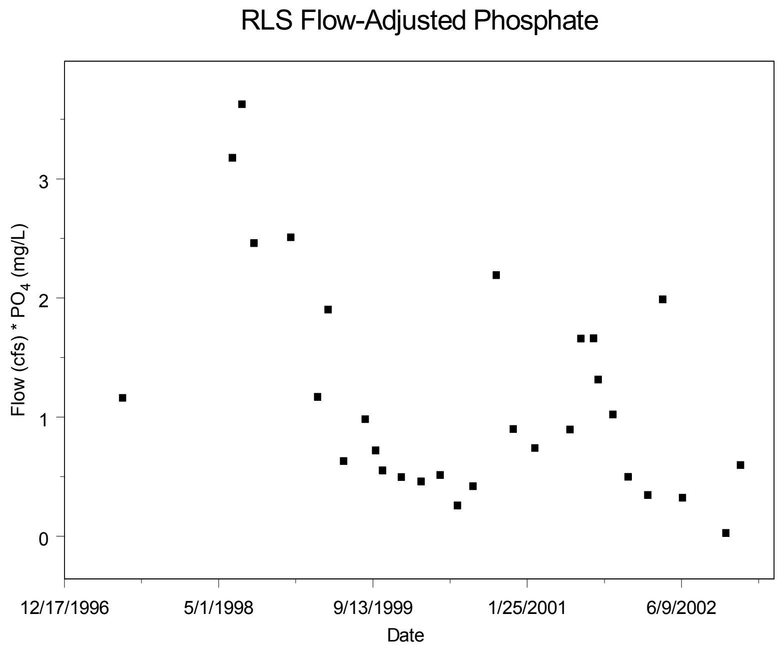


Figure 69. Flow adjustment for phosphorus in Ruth/Little Sulfur Springs. Phosphorus (top) shows slight decline over time. The log of phosphorus (bottom) has a slightly negative relationship to the log of flow (bottom).



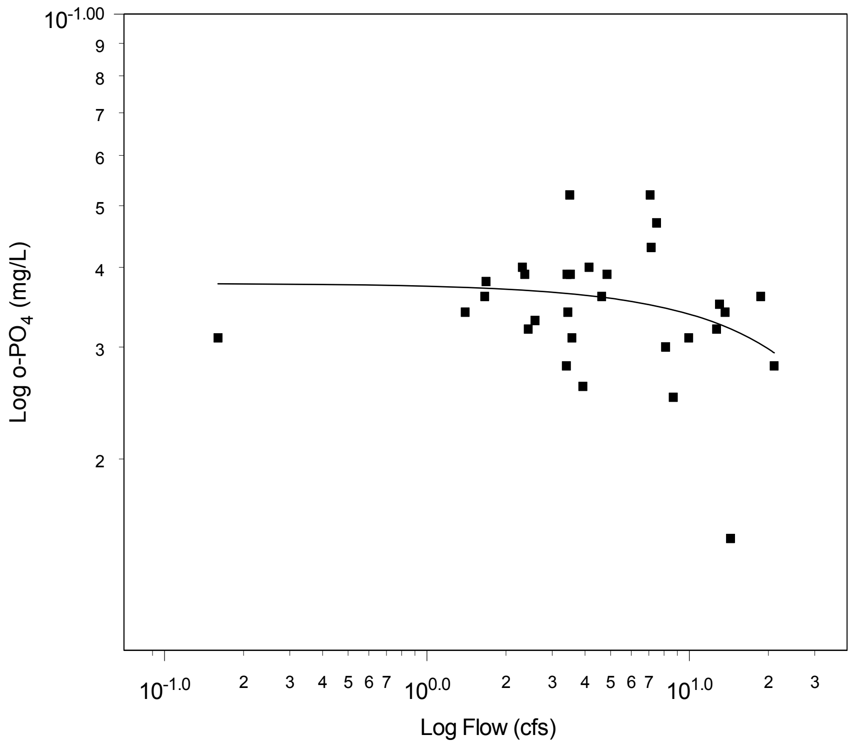
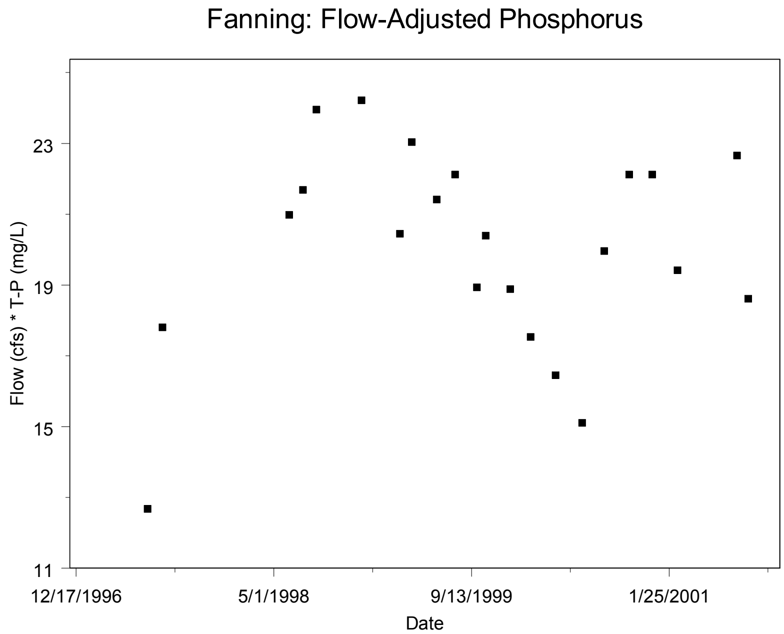


Figure 70. Flow adjustment for phosphate in Ruth/Little Sulfur Springs. Flow-adjusted phosphate declines over time (top). The log of phosphate has has possible negative relationship to the log of flow (bottom).



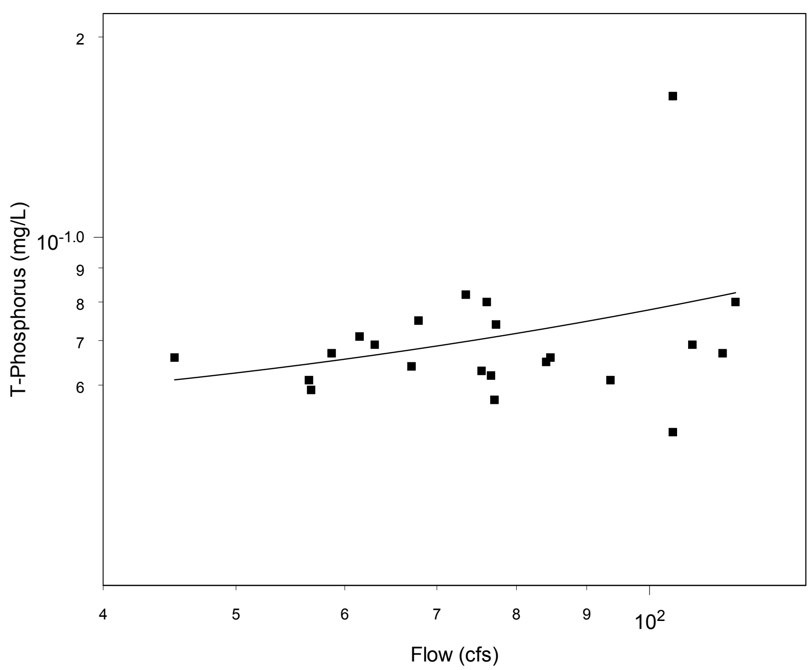


Figure 71. Flow-adjustment for phosphorus in Fanning Spring. Phosphorus declines after 1998 (top). The log of phosphorus has a positive relationship to the log of flow (bottom).

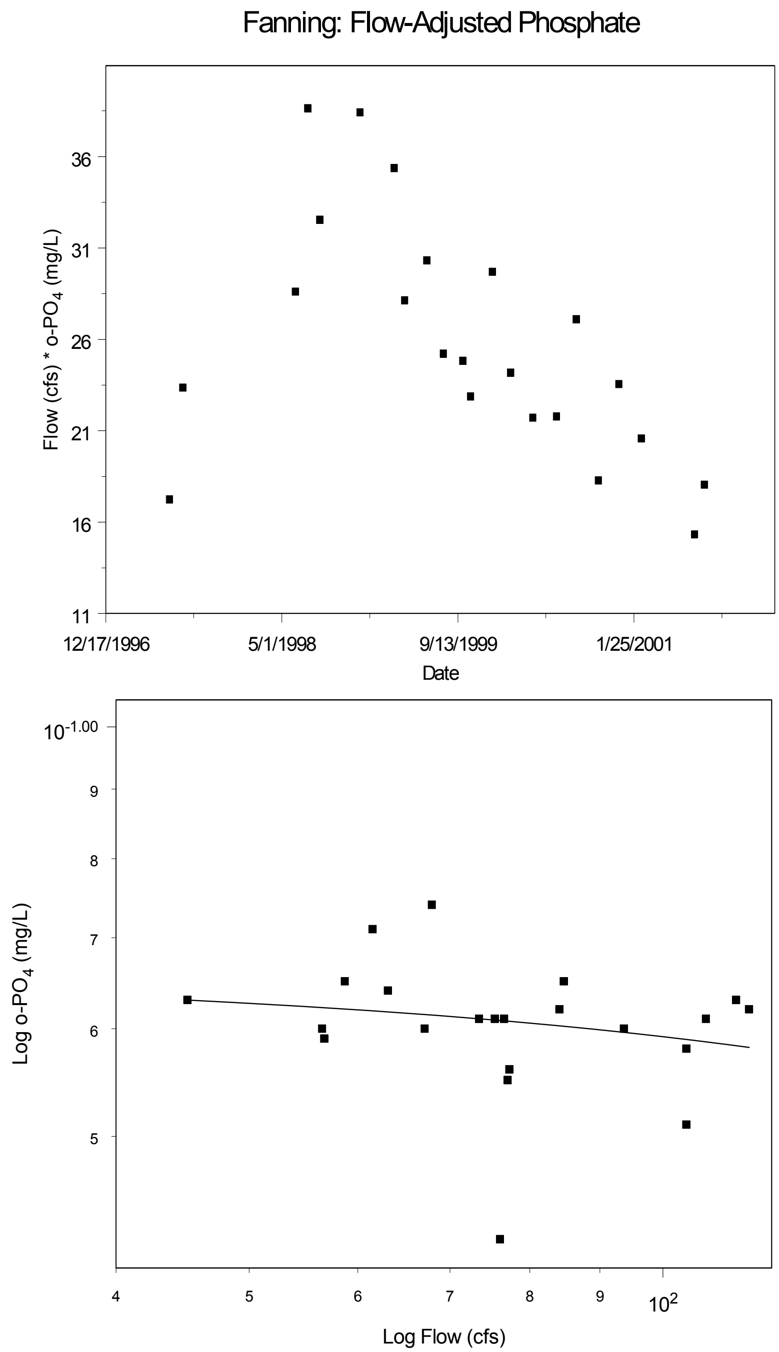
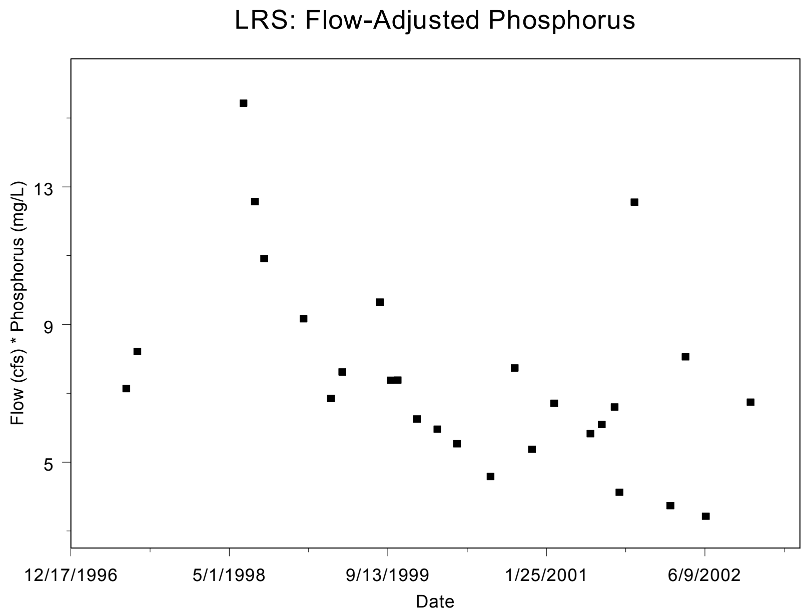


Figure 72. Flow adjustment for phosphate in Fanning Spring. The flow adjusted phosphate shows an increase through 1998 and then a decline (top). However, the log of phosphate shows a slight decline with the log of flow (bottom).



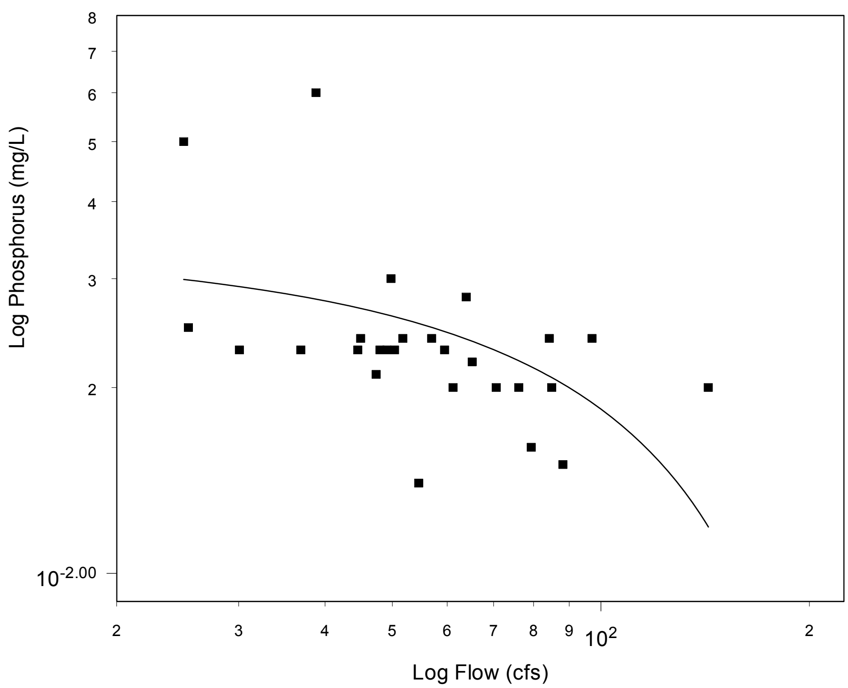


Figure 73. Flow adjustment for phosphorous in Little River Spring. Flow adjusted phosphorous declines over time (top). However, the log of phosphorus declines with a decline in the log of flow (bottom).

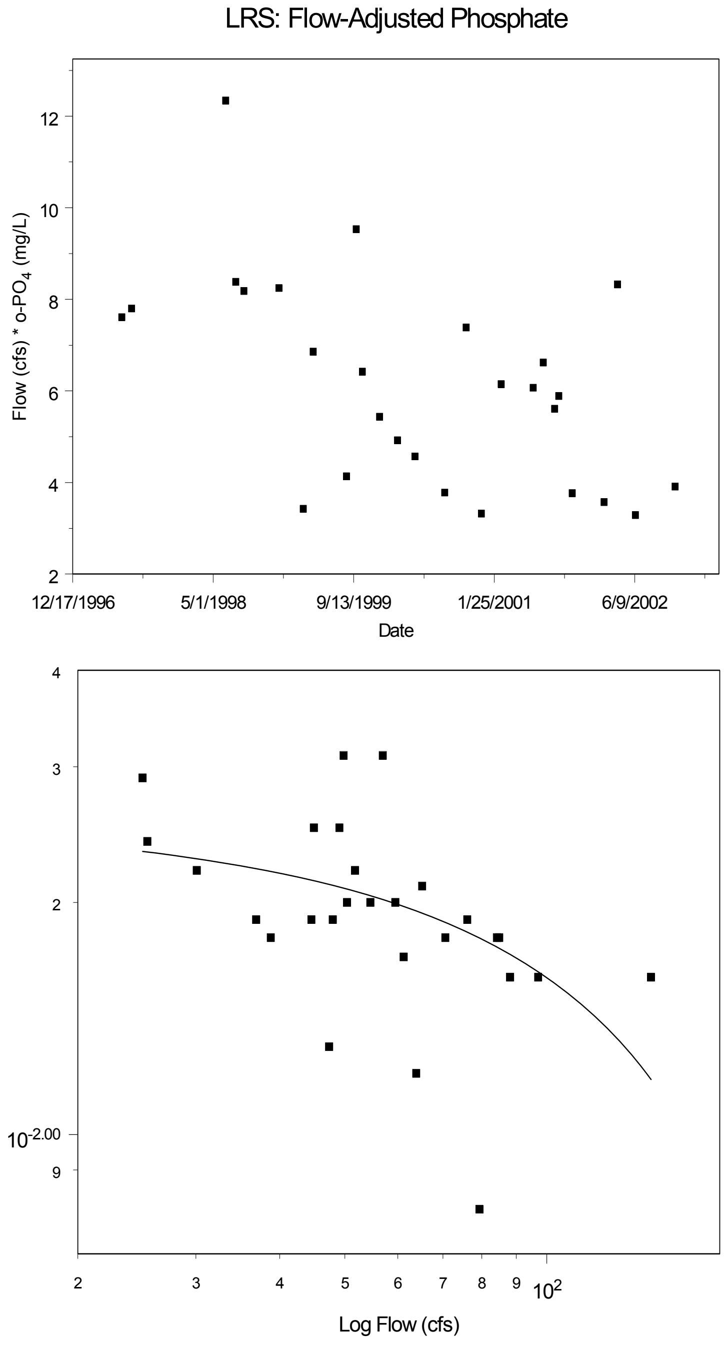
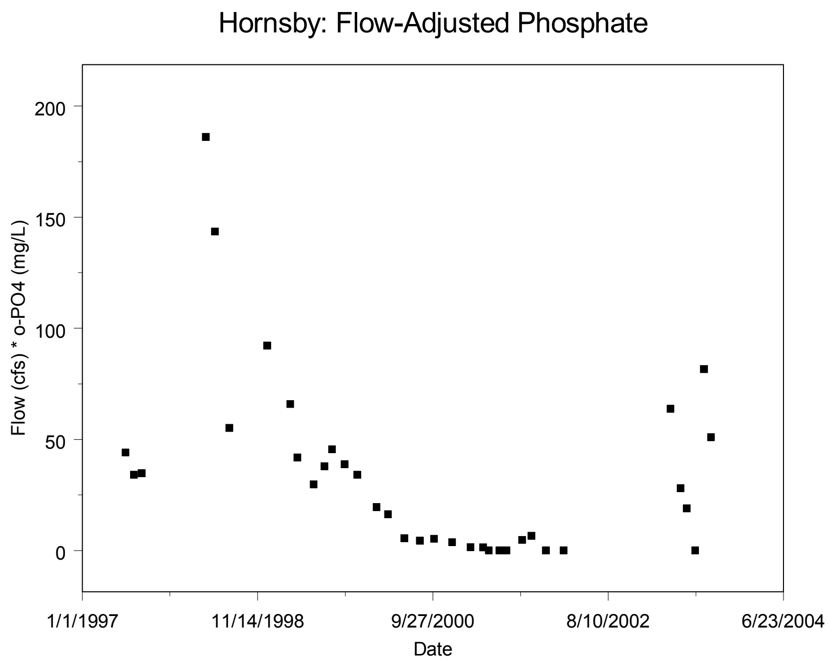


Figure 74. Flow adjustment for phosphate in Little River Spring. Phosphate (top) shows a decline over time while the log of phosphate has a negative relationship to the log of flow (bottom). Relationship of concentration to flow shows a stronger decline than at other springs.



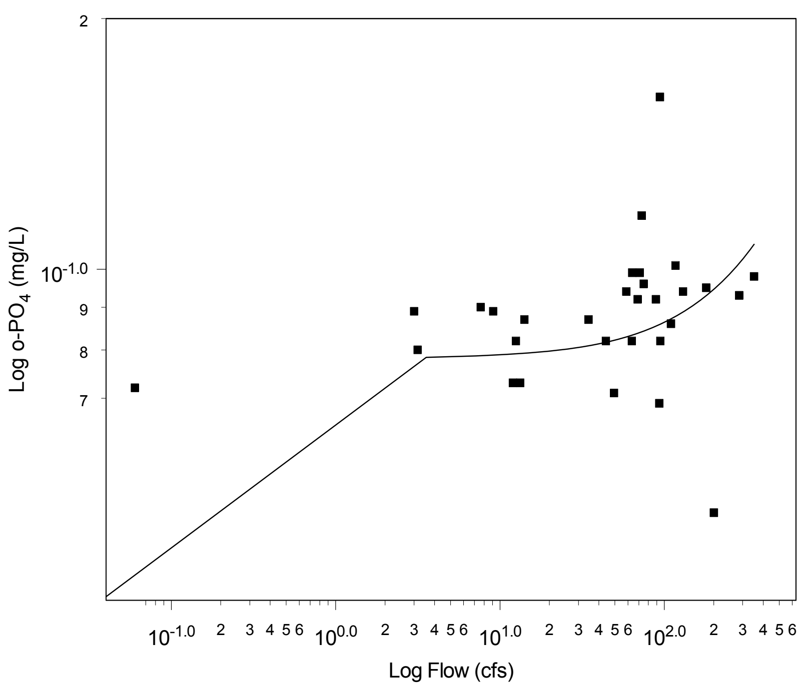


Figure 75. Flow adjustment for phosphate in Hornsby Spring. One of the few examples of a decreasing phosphate trend in the SRWMD. Flow-adjusted phosphate shows a pronounced decline over time with a large increase at the end (top). The log of phosphate as a function of the log of flow (bottom) shows an association. This pattern is the opposite of what is seen with the majority of the SRWMD springs where increasing phosphate trends correspond to a negative relationship with the log of flow.

with decreasing concentrations (like phosphate at Hornsby Spring) show positive relationships with flow: the concentrations were almost entirely dependent on flow, and the concentrations were decreasing.

A reduction in flow may have actually *masked* a number of otherwise upward trends in nutrient analyte concentrations. This would mean that the actual number of nutrient increases may be greater than this report is able to document and it is likely the trends recorded here *underestimate* the true number of increases.

A second explanation for reduction in phosphate has been noted in other states. Trend analyses in water quality of North Carolina noted a significant reduction in phosphate following the 1988 state-wide ban of phosphate use in detergents. Trend analyses show reductions from the time period of 1983 to 1995 (Childress et al., 1998). Similar reductions in phosphate detergent, or improvements in wastewater treatment, could also result in downward phosphorus trends in Florida.

The most plausible explanation we can postulate includes a hypothesis that explains the selective nutrients, plus rock and saline analyte trends. TKN and phosphorus-based nutrients increased at a rate faster than flow decreased. The phosphorus trends may simply be additional observations of the shrinking of Florida's freshwater "lens" and the uptake of older water inferred across the state. Several seemingly unrelated trends (e.g. salinity, pH, phosphorus) are simultaneously answered by this single explanation making it the preferred, but not necessarily the correct, option. More work is needed to fully understand this observation.

St. Johns River and Southwest Florida Water Management Districts

The SJRWMD had no increasing phosphate trends with 11 decreasing trends, while the SWFWMD had no increasing trends with five decreasing trends. Possibly related to this is the observation that the SJRWMD also witnessed nine springs showing significantly increasing pH values, with only one spring showing a decrease. Odum (1953) observed that surface waters in Florida, such as streams, often have high concentrations of phosphorus and low pH values. On the other hand, we observed that springs have high pH values, relative to surface waters, and often contain less phosphorus concentrations than streams. Odum (1953) suggested a controlling role for pH in the solubility of phosphorus in natural surface water conditions. Based on these observations, the decreasing trends observed for phosphate and phosphorus may actually reflect an increasingly larger volume of deeper water components comprising spring-water because of the drought. Such deeper water would be both higher in pH and lower in phosphorus. With the exception of the SRWMD, nearly every phosphorus-related trend in the state is downward. This explanation has the advantage of being consistent with the clearly observed statewide increase in rock and saline indicators. Thus, if older and deeper-sourced water is discharging at springs, then it would create both a strong increase in rock and salinity trends, which are clearly documented, *as well as* the decrease in phosphorus seen here.

Comparison of Coastal to Inland and Tidal to Non-Tidal Springs

Most trends observed in this study were for rock-matrix and saline analytes and most were caused by the drought. By closely examining the trends displayed in this report, it became obvious that the magnitude of change for springs located near the coast during the drought was greater than for inland springs. However, did coastal springs have proportionally more increasing trends than did inland springs? Did tidal springs have proportionally more increasing trends than did non-tidal springs?

An inspection of Figures 13, 16, 27, and 32 reveals that for some spring, it is easy to determine as to whether they are inland or not. Others are not so easy to identify. For example, in the SJRWMD, almost all springs in this report are located very near the St. Johns River, which parallels the coast (Figure 27). For this reason, SJRWMD springs were not used in this evaluation. Wakulla Spring in the NWFWMD (Figure 13) is located near the coast and was easily categorized as being a coastal spring. For the SRWMD, the Suwannee River flows roughly perpendicular to the coast (Figure 16). Based on this observation, the authors categorized the first seven springs, beginning at the mouth of the Suwannee River as being coastal. All other SRWMD springs were placed into the inland category. Staff at the SWFWMD categorized their springs for us. The spring categorizations for both WMDs are found in Table 70.

Table 70. Inland and Coastal Springs within the SRWMD and the SWFWMD

SRWMD (including Wakulla Spring)		SWFWMD	
Coastal Springs	**Inland Springs**	**Coastal Springs**	**Inland Springs**
MAN	ALR	Betty Jay	Bobhill
FAN	LBS	Boat	Boyette
HAR	TEL	Chassahowitzka No. 1	Bubbling
RKB	SBL	Chassahowitzka Main	Buckhorn
LRS	ROY	Hidden River Head	Catfish
RLS	GIL Blue	Hidden River No. 2	Lithia
TRY	POE	Homosassa No.1	Rainbow No. 1
Wakulla (NWFWMD)	HOR	Homosassa No.2	Rainbow No. 4
		Homosassa No.3	Rainbow No. 6
		Hunters	Rainbow Swamp No. 3
		Magnolia	Rainbow Bridge Seep
		Pump House	Weeki Wachee Main
		Salt	Wilson Head
		Tarpon Hole	
		Trotter Main	

Once the springs were categorized, a two-sample proportion test (Sullivan, 2004) was used to determine whether the proportion of springs with upward trends was the same for both coastal and inland springs. Data from Sequence C were used. Each test was conducted for each of the rock-matrix and the saline indicators at a significance level of 0.05. The null hypothesis was that the proportions of upward trends were the same for both coastal and inland springs, while the alternate hypothesis was that they were not the same.

The results are found in Table 71. The table lists the analyte in the first column. The second, third, and fourth columns contain the number of coastal springs trending upward, the number trending downward and the proportion of springs trending upward for coastal springs. Columns five, six, and seven lists the number of inland springs trending upward, the number trending downward and the proportion of springs trending upward for inland springs. Finally, the right-hand column (column 8) displays the p-values for each test.

All of the p-values are greater than 0.05. Based on this evaluation, there are insufficient data to conclude that the proportion of coastal springs were different from inland springs during Sequence C. For the springs showing trends for the rock-matrix and saline analytes, greater than 90% of the trends were increasing. This was true regardless of being associated with coastal or inland springs.

Table 71. Comparison of Coastal and Inland Springs for Upward Trends During Sequence C, excluding spring in the SJRWMD

Analyte	Coastal U	Coastal D	Prop C U	Inland U	Inland D	Prop I U	P-value
Alk	13	0	1.000	12	2	0.857	0.488
Ca	16	0	1.000	17	0	1.000	1.000
Mg	20	0	1.000	18	0	1.000	1.000
Cl	14	1	0.933	15	2	0.882	1.000
F	1	0	1.000	5	0	1.000	1.000
K	15	1	0.938	10	0	1.000	1.000
Na	19	0	1.000	18	1	1.000	1.000
P	9	2	0.812	5	3	0.625	0.603
PO4	8	0	1.000	3	1	0.750	0.333
SC	14	5	0.736	15	2	0.882	0.408
SO4	11	3	0.786	14	2	0.875	0.642

I = Inland, **C** = Coastal

The results of Table 71 represent a geographic comparison (coastal versus inland). Some individuals at the SWFWMD expressed a concern that not all coastal springs listed in Table 70 were tidally influenced. They requested a comparison of tidal versus non-tidal springs. The two right-hand columns in Table 70 represent coastal and inland springs in the SWFWMD. All of their coastal springs are tidally influenced, whereas their inland springs are not. Data from the springs listed in the two right-hand columns of Table 70 were used to produce Table 72.

The results in Table 72 list the analytes in the first column. The second, third, and fourth columns contain the number of tidal springs trending upward, the number trending downward and the proportion of springs trending upward for tidally-influenced springs. Columns five, six, and seven lists the number of non-tidal springs trending upward, the number trending downward and the proportion of springs trending upward for non-tidally influenced springs. Finally, the right-hand column (column 8) displays the p-values for each test.

Table 72. Comparison of Tidal and Non-Tidal Springs for Upward Trends During Sequence C in the SWFWMD

	Tidal U	Tidal D	Prop T U	Non-Tidal U	Non-Tidal D	Prop Non-Tidal U	P-Val
Bicarb	12	0	1.000	9	0	1.000	1.000
Ca	6	0	1.000	3	0	1.000	1.000
Mg	8	0	1.000	6	0	1.000	1.000
Cl	6	0	1.000	6	1	0.857	0.857
F	1	0	1.000	3	0	1.000	1.000
K	7	0	1.000	8	0	1.000	1.000
Na	6	0	1.000	8	0	1.000	1.000
P	1	2	0.333	0	3	0.000	1.000
SC	7	0	1.000	5	0	1.000	1.000
S04	8	0	1.000	4	0	1.000	1.000
Sr	10	0	1.000	9	0	1.000	1.000
TDS	4	0	1.000	6	0	1.000	1.000

Note that all of the p-values listed in Table 72 are greater than 0.05. Since many of the tidal springs in Table 72 are the same as the coastal springs listed in Table 70, it is not surprising that the results in Table 71 and Table 72 are similar. Note that the sample size is small. Note also that unlike the other analytes, phosphorous had decreasing trends. In spite of phosphorous, based on this evaluation, there is insufficient data to conclude that the proportion of upward trends for tidal springs were different from non-tidal springs. For the springs showing trends in the rock-matrix and saline analytes, greater than 90% of the trends were increasing. This was true regardless of being associated with tidal or non-tidal springs.

Global Factors Influencing Florida’s Groundwater

Reasons for the trends in Florida’s groundwater may range from small-area (large-scale) to large-area (small-scale). For those utilizing Florida’s resources, several large-area influences need to be discussed.

Global Long-Term Cycles: Atlantic Multidecadal Oscillation

The Atlantic Multidecadal Oscillation (AMO) is a term used to describe long-term changes in sea surface temperature (SST) of the North Atlantic Ocean. Cycles of cool and warm ocean temperatures are quasi-periodic lasting between 60-80 years (Kerr, 2000, 2005). The AMO is driven by ocean-scale changes in the Atlantic, most likely associated with thermohaline circulation. For Florida, these changes have been observed to be particularly strong (Sutton and Hodson, 2005). An AMO warm phase delivers more precipitation, while a cool phase may be marked by drought. For southern Florida, inflow into Lake Okeechobee can change by 40 percent between extremes (Figure 76, top). It should be noted that a similar observation between the AMO and surface water-flows in the SWFWMD have been observed (Southwest Florida Water Management District, 2004).

Figure 76 (top) displays changes in North Atlantic SST as a function of time. The period prior to 1920 had relatively low temperatures. Between 1920 and 1960 the SST increased. It decreased from 1960 to about 1970, and then subsequently it rose again. The effects of the

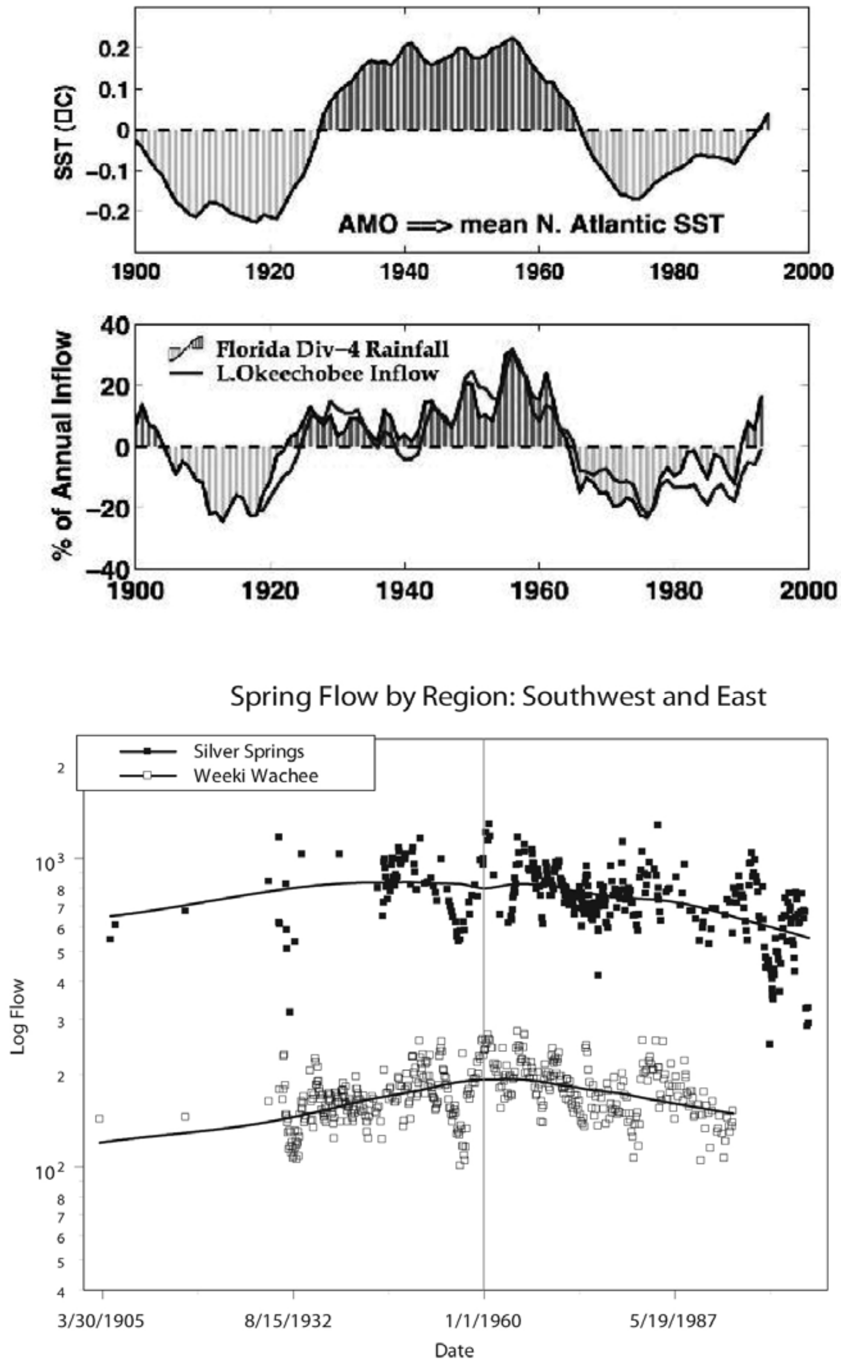


Figure 76. Atlantic Multidecadal Oscillation and Florida spring flow. The Atlantic Multidecadal Oscillation (AMO, top panels) compared to long-term changes in Florida's spring flow (bottom). Top shows North Atlantic sea surface temperature (SST, °C) since 1900. Top lower panel shows effects of the positive AMO on the rainfall and corresponding flow into Lake Okeechobee. Bottom chart is the log of flow against time for two large Florida springs: Silver Springs and Weeki Wachee Springs. The lines (smoothed spring flow) increase until 1960 (marked) and decline thereafter. Flow from the springs align with AMO patterns during past century. (National Oceanic and Atmospheric Administration [2006b]).

positive AMO were reflected in southern Florida rainfall and inflow into Lake Okeechobee. Figure 76 (bottom) shows spring flow for Silver and Weeki Wachee Springs, two major springs in Florida with long term flow data. It shows the log of flow over time. A semi-arbitrary line, drawn at 1960, marks a divide between a period of relative increases in spring flow and subsequent declines. The dividing line closely corresponds to AMO patterns, suggesting this is a strong influence for Florida springs.

AMO cycles are influenced by other oceanographic anomalies (McCabe et al., 2004). More than half of the spatial and temporal variance of the multidecadal drought frequency over the conterminous US is related to the Pacific Decadal Oscillation (PDO) and AMO together. These droughts also influenced Florida's groundwater. Kerr (2000, 2005) indicates that the recent drought impacts over the United States (1996, 1999-2002) were associated with North Atlantic warming (positive PDO) and northeastern and tropical Pacific cooling (negative PDO). It is believed that the positive AMO since 1995 (i.e., warm North Atlantic SST) may continue. Because of this, changes in the PDO have important implications for the state of Florida. In mid-1998, the PDO became negative until 2002 when both PDO and AMO became positive. A positive AMO and a negative PDO (e.g., 1998) can result in a drought similar to that suffered by Florida in the 1950s. However, a positive AMO and a positive PDO can also cause a drought (e.g., the drought Florida went through in the 1930s). Thus, if the PDO remains positive while the AMO continues to be positive, a decade-long, 1930s-type drought is a possibility (McCabe et al., 2004). The authors indicated this has important implications for water resource planners, particularly in the more arid southwestern portions of the US. At the same time, results of analyses in this report show a clear affect on Florida groundwater by the same climatically-driven process.

Global Short-Term Cycles: El Niño and La Niña

In addition to the longer-term global changes seen in the AMO and PDO the time period encompassed two additional significant events: back-to-back years of an extreme El Niño and an extreme La Niña. For background, El Niño is an oscillation of tropical Pacific ocean-atmospheric interactions. The usual effects of El Niño are increased rainfall and flooding or drought and wildfire—varying depending on location around the Pacific Basin. Under normal conditions, trade winds blow westward across the tropical Pacific, pushing back the warmer overlying surface water (Figure 77, middle panel). This creates a slightly higher sea surface in the western (compared to the eastern) Pacific. The temperature in the western Pacific can also be about 8°C warmer than the eastern. This allows cooler, nutrient-rich deeper water off the coast of South America to upwell. Rainfall is commonly less over the cooler eastern waters during this period. However, during El Niño, trade winds are reduced and there is a decrease in the depth of the thermocline in the western Pacific. Warmer water then moves east and caps the cooler, normally upwelling water, in the east. This creates a band of warm water across the Equatorial Pacific (Figure 77, bottom panel). As a result, more rainfall and flooding occur in places such as Peru. La Niña is something of a reverse of El Niño. It is characterized by atypically cold water temperatures in the Equatorial Pacific (compared to the warm water characterizing El Niño). A band of cold water is observed to stretch along the Equator during La Niña (Figure 77, top panel). El Niño and La Niña are the opposite ends of the El Niño-Southern Oscillation (ENSO) cycle. El Niño is sometimes the warm phase of ENSO while La Niña is the cold phase.

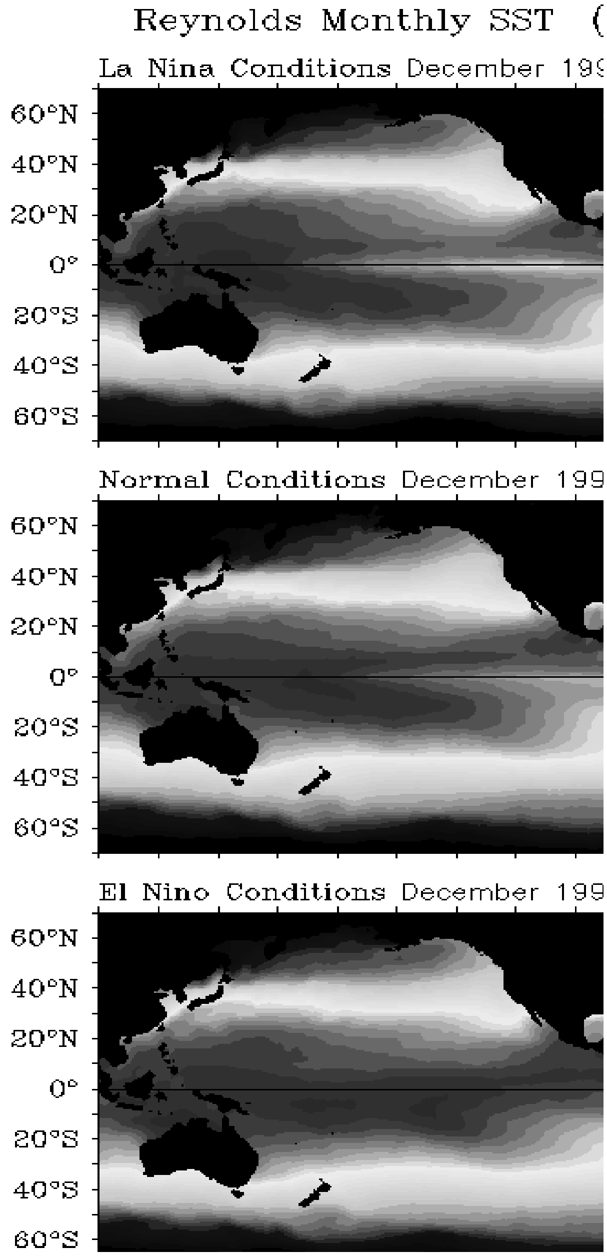


Figure 77. Sea surface temperature, La Niña, and El Niño. Sea surface temperatures for La Niña, normal, and El Nino conditions in the Equatorial Pacific (top, center, and bottom respectively). Note strong difference between 1997 (bottom) and 1998 (top). Cooler and warmer water are indicated by light and dark, respectively. The years 1997-1998 were the divide between Time Sequence B (1991-1997) and Time Sequence C (1998-2003) [From National Oceanic and Atmospheric Administration (2006a)].

Without respect to this knowledge, this study was broken into time sequences that reflected the timing of the events: Sequence B (1991-1997) ended with El Niño and Sequence C (1998-2003) began with La Niña. Analysis of hundreds of individual time series bridging these time sequences revealed that 1998 was a visible break-point in the data, analogous in geology to a stratigraphic "marker bed." This means that data from various springs and wells could sometimes be referred to common visible time series "excursions" around that approximate period of time. This raises the possibility that, although Florida was under the influence of a longer-term decline in water quantity (Figure 77), the consequence of these shorter-duration perturbations were more strongly felt.

Brief but substantial excursions in analyte values – whether upward or downward – probably contribute a greater influence on the overall trend lines than do more subtle, long-term influences. Thus, excursions in 1997-1998 and drought are likely the cause behind most of the trends in this report. Earlier years of the study included a weak La Niña (1994-1995). This was followed by a very strong El Niño, occurring in 1997. Immediately following this was a strong La Niña (cold) event in 1998. These extreme years were followed a severe statewide (and national) drought in 2000.

Acid Rain

One possible explanation for the decrease in well-water pH over the study period was acid rain. Acid rain is often the product of sulfur, carbon, or nitrogen oxides that result from industry, burning coal, or combustion of other materials. During the investigation, it was suggested that lower well-water pH values simply reflected increasing airborne chemical pollutants in Florida's precipitation. If this were true a time series of pH values in Florida rainfall should show a decreasing trend. Figure 78 reveals that this was not the case. The figure plots the mean monthly rainfall pH values for seven rainfall stations from around Florida (Appendix M). The rainfall means showed no significant trends over time, though standard deviation decreased slightly. The drought resulted in less rainfall. This should result in a reduction in the pH standard deviation, not an increase.

Implications of Future Low Rainfall and Increasing State Water Demands

The AMO cycle seen in Figure 76 is approximately a 60-year cycle with 30 years of increased rainfall followed by 30 years of decreased rainfall. Since little is known about these cycles, the accurate modeling of future rainfall changes is not currently possible. At the same time, with a state that is growing so rapidly in population as Florida, water demand increases are inevitable. Regardless of current lack of ability to understand larger-scale driving factors in water quantity, the influence on statewide water resources created by AMO/PDO and El Niño/La Niña may soon prove to be important.

For the sake of illustration, a simple scenario can be posited. If one can assume a cycle is 60-years long (something which cannot be predicted in advance) and one can assume that the increase began in 2004, this would mean a welcomed 30-year increase in rainfall. At the current rate of growth of more than 700 people per day, an increased volume of water would relieve state water needs and possibly reduce or reverse increasing concentrations of both rock and saline-indicators in spring water. However, once the cycle reached its high point, a decline in rainfall

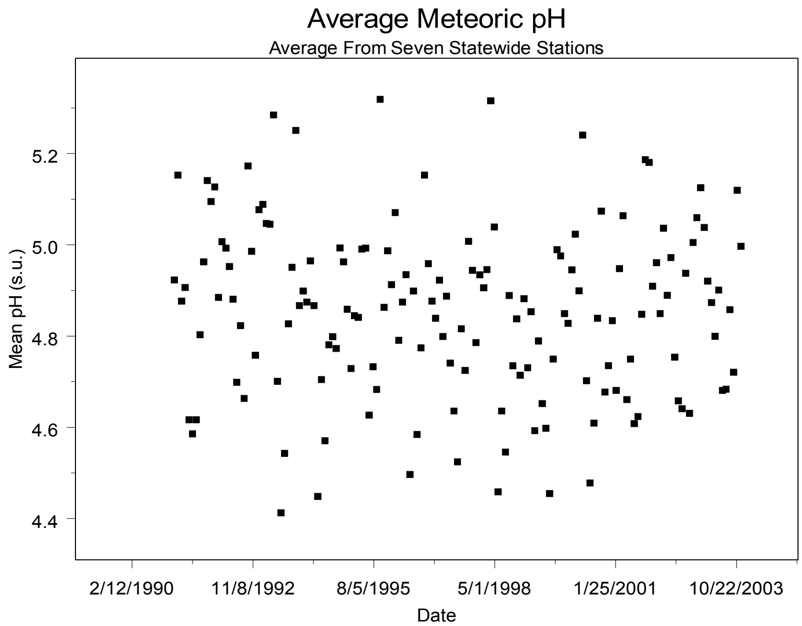


Figure 78. Average monthly pH from seven atmospheric rain stations (1991- 2003).

will follow for the next 30 years. The concern is that Florida would no longer have its current 18 million residents, but millions more. By 2010, it is estimated that the population will be over 19 million and, by 2030, it will be 29 million (Clouser, 2006; McGovern, 2004). Once rainfall declines begin, the amount of recharge will be less, and because of Florida's increased population, the demand for groundwater will increase. Florida's springs can be expected to have substantially lower amounts of flow, and, unless appropriate, long-term sustainability measures are incorporated into public policy, the quality of spring water will decline.

Implications Regarding Long-Term Sustainability

Alley et al. (1999) stated that groundwater sustainability is the development and use of groundwater in a manner that can be maintained for an indefinite time without causing unacceptable environmental, economic or social consequences. Scott (2001) estimated that more than two quadrillion gallons of potable groundwater exist within Florida's aquifer. They also believed that in order to determine the outlook for sustaining Florida's groundwater resources, four questions needed to be addressed:

- What is the level of infrastructure development and population growth that is supportable by the state's water resources?
- Should mineralized waters be considered as part of a sustainable water supply?
- How much impact on the environment is acceptable?
- How do we balance ecological sustainability with human needs and economic growth?

Scott (2001) also indicated that once the removal of water exceeds the recharge, "mining" of the groundwater occurs. At that point, Florida's groundwater is no longer sustainable.

With Florida's growing population, what are reasonable solutions? Scott and Schmidt (2000) mentioned that mineralized water can be converted to fresh water through reverse osmosis (RO) processes and surface water can be used to supplement groundwater supplies. However, they pointed out that both potential solutions present their own set of problems and they proposed a set of subsequent questions:

- Does the inclusion of these waters in the sustainable supply create a false sense of security?
- Should aquifer storage and recovery (ASR) water be a portion of the sustainable water supply?
- Should growth management and environmental stability rely on RO and ASR waters?
- Is it wise to allow growth management and environmental decisions to be based on expensive alternative water supplies or is that simply avoiding the "natural" limitations?

These are very serious questions that the citizens of Florida will face in the very near future. Analyses from this report suggest that salt-water encroachment may already be occurring and as our population continues to grow, we are more susceptible than ever to droughts. We need to commence addressing these issues now. If the AMO theory is correct, we may be fortunate and have a 30-year "wet" period in store for us. If so, we may have additional time to address the sustainability issue. If it is incorrect, we need to address the issue now.

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APPENDIX A. RELATIONSHIPS AMONG SPRING FLOWS, ROCK, AND SALINITY INDICATOR CONCENTRATIONS FOR SELECTED SPRINGS

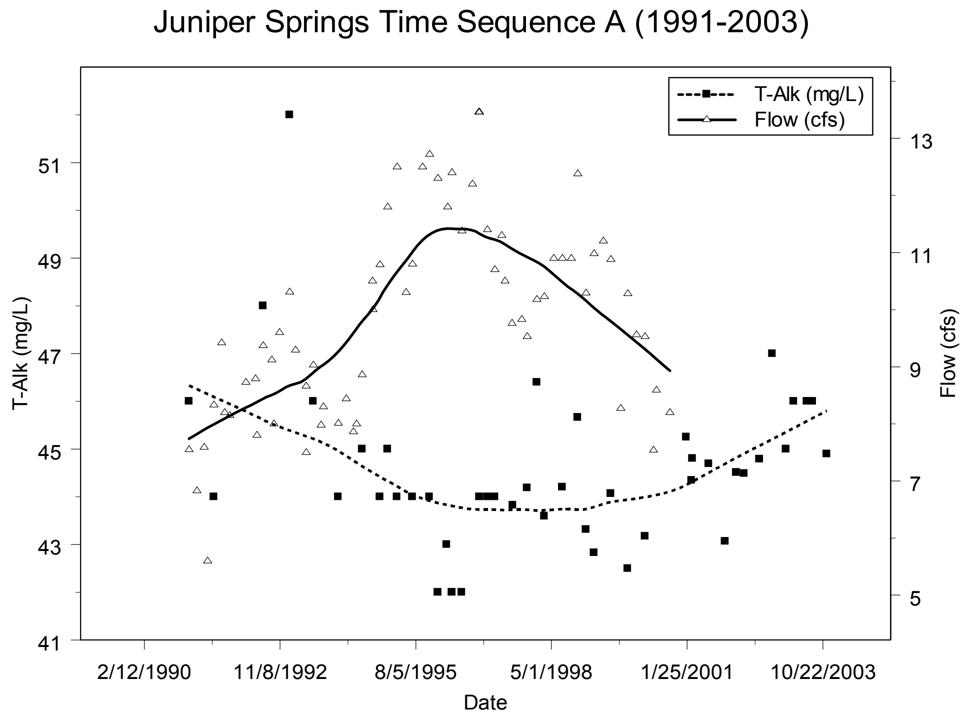

Figure A1. **Juniper Springs – Alkalinity versus flow.**

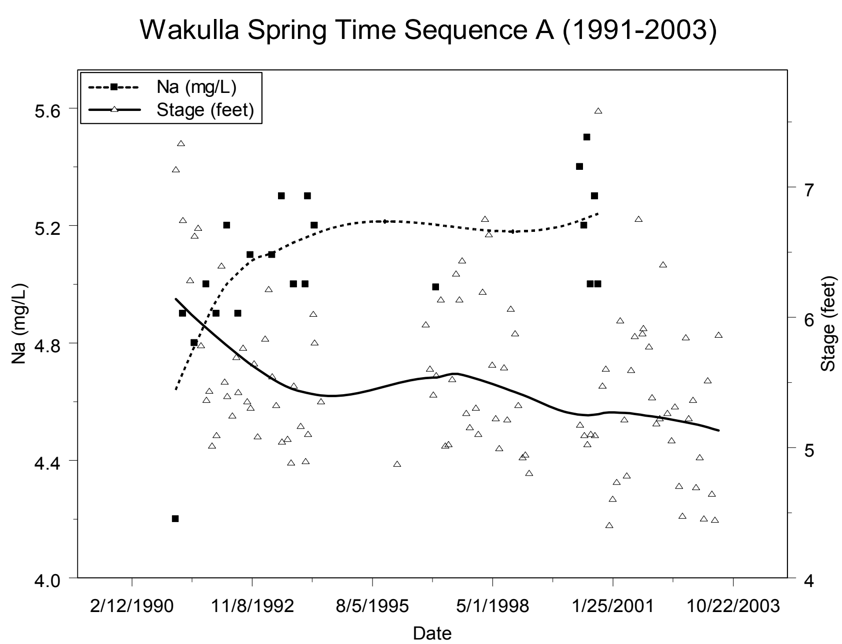

Figure A2. Wakulla Spring – Sodium versus stage.

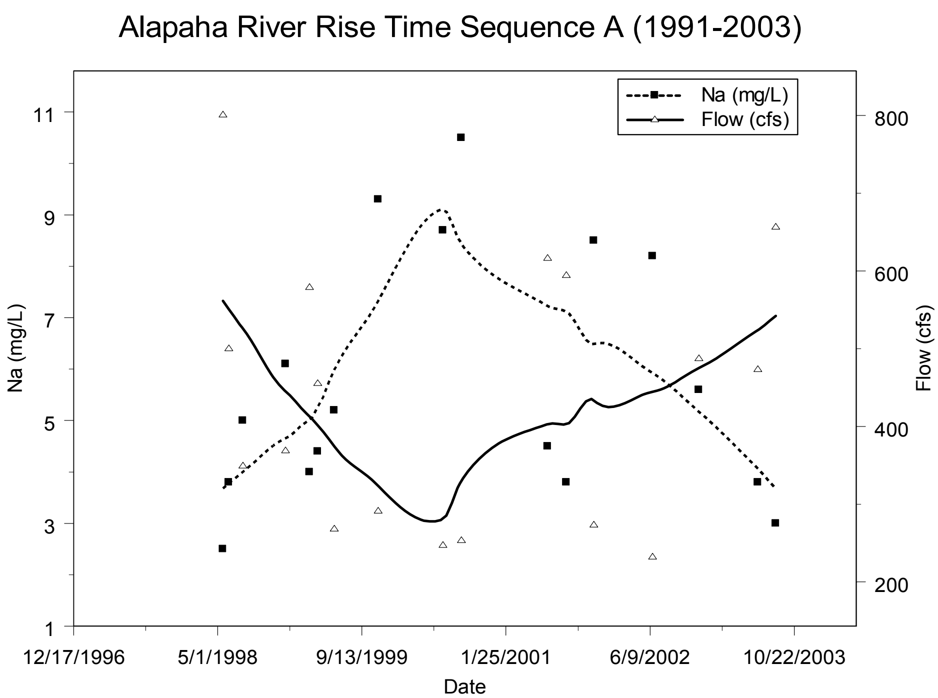

Figure A3. **Alapaha River Rise – Sodium versus flow.**

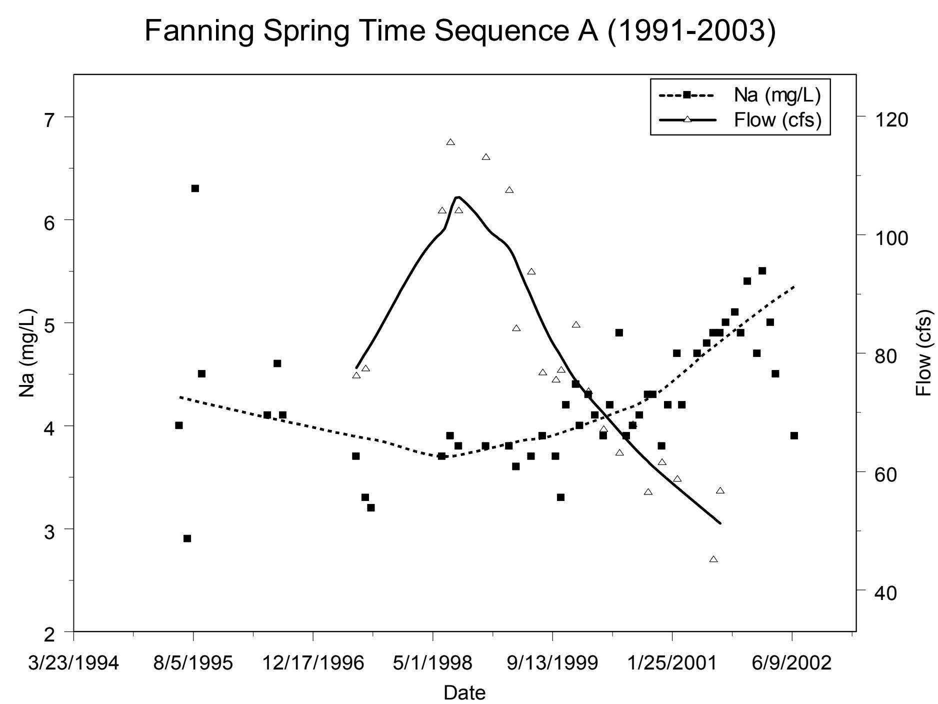

Figure A4. Fanning Spring – Sodium versus flow.

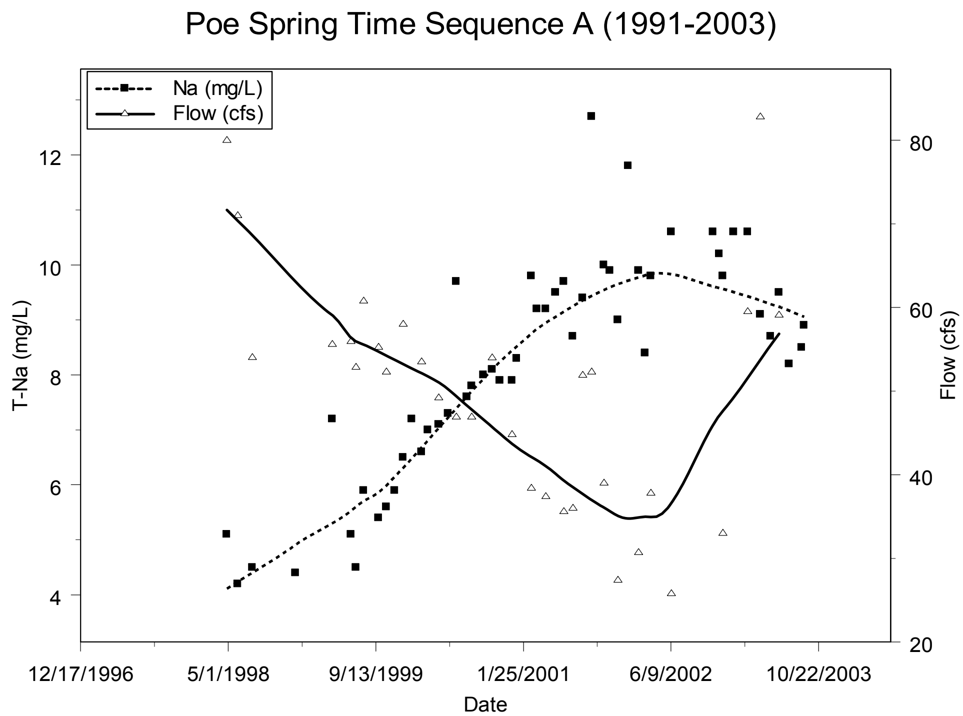

Figure A5. Poe Spring – Sodium versus flow.

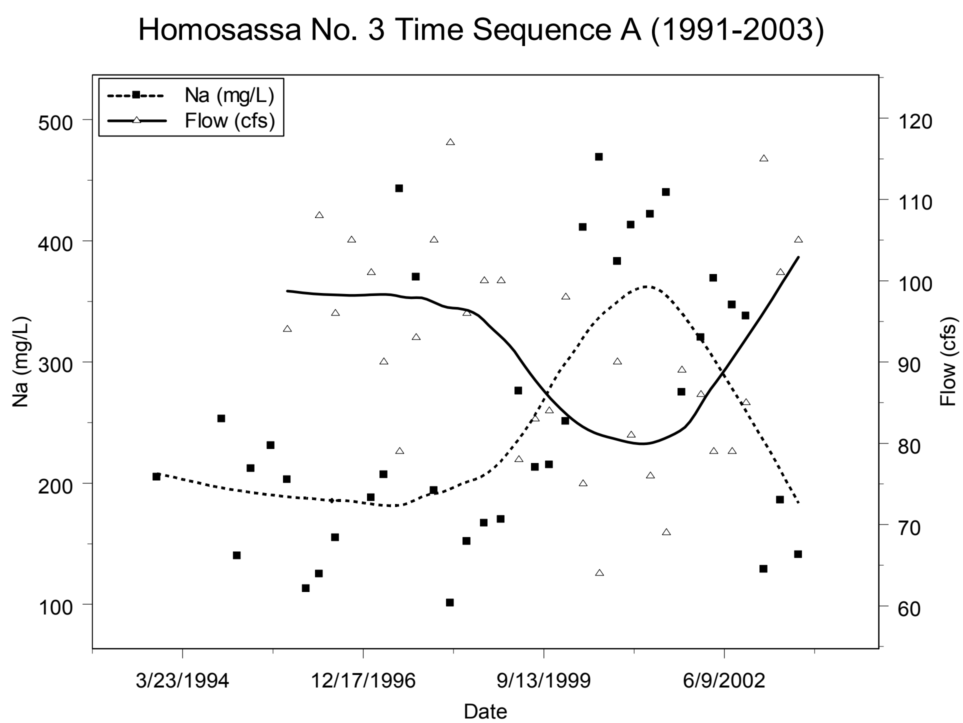

Figure A6. Homosassa No. 3 Spring – Sodium versus flow.

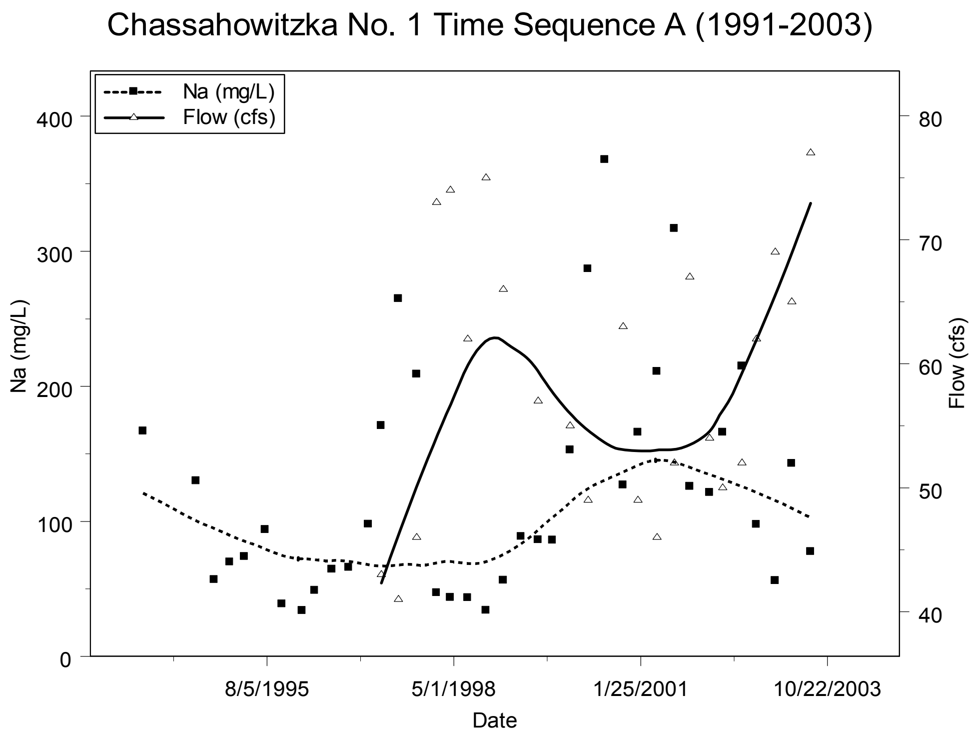

Figure A7. Chassahowitzka No. 1 Spring – Sodium versus flow.

APPENDIX B. GLOSSARY OF TERMS AND POSSIBLE CAUSES OF TRENDS

APPENDIX B1. GLOSSARY
(Modified from Poucher and Copeland, 2006)

alluvial sinkhole – An alluvial sinkhole is an ancient or relict sinkhole (paleosinkhole) that has been filled with soil and/or sediment. It may or may not have a surficial expression. See also *paleosinkhole* and *relict sinkhole* (SDII Global Corporation, 2002).

artesian – A modifier that describes a condition in which the potentiometric surface is above the elevation of the top of the aquifer (Modified from Field, 1999). It is synonymous with *confined*.

aquifer – A body of soil, sediment, or rock that is saturated with water and sufficiently permeable to allow production of water from wells (SDII Global Corporation, 2002).

blind valley – A stream valley that terminates abruptly at a sinkhole, swallow hole, or swallet (where the stream disappears underground) (SDII Global Corporation, 2002).

caliche – See *duricrust*.

cave – A natural underground opening or series of openings and passages large enough to be entered by an adult person (Modified from Monroe, 1970).

cavern – A cave or conduit system with larger than average size that has been created by the dissolution of limestone or other soluble rock (SDII Global Corporation, 2002).

cavernous porosity – A pore system having large, cavernous openings; the lower size limit, for field analysis, is practically set at approximately the smallest opening that an adult person may enter (Field, 1999).

"chimney" sink – A cover-collapse sinkhole that forms near a vertical shaft or "chimney", typically developing where bedrock is near land surface. These features are common in the Gainesville area of Florida (Modified from SDII Global Corporation, 2002).

collapse sinkhole – A type of sinkhole formed by collapse of the cover materials (soil, sediment, or rock) into an underground void created by the dissolution of limestone or dolostone. See *rock- collapse sinkhole* and *cover-collapse sinkhole* (SDII Global Corporation, 2002).

conduit; karst conduit – Large dissolutional voids, including enlarged fissures and tabular tunnels. In some usage, it is restricted to voids that are water-filled. Conduits may include all voids greater than 10 mm (one cm) in diameter, but another classification scheme places them between arbitrary limits of 100 mm to 10 m. Whichever value is accepted in a particular context, smaller voids are commonly termed subconduits (Field, 1999).

conduit flow; karst conduit flow – Undergroundwater flow within conduits. Conduit flow is generally turbulent, but can also be laminar (Field, 1999).

confined – See *artesian*.

cover – Materials consisting of soil, sediment, or rock that overlies the soluble rock (limestone, dolostone etc.) in a karst terrane. In Florida, the cover includes the sand and clay deposits that overlie the limestone (Modified from SDII Global Corporation, 2002).

cover-collapse sinkhole – A sinkhole formed by cover materials (sand, clay, etc.) raveling into a void in the underlying limestone (Modified from SDII Global Corporation, 2002).

cover-subsidence sinkhole – A collapse sinkhole that forms when the upper surface of the limestone is dissolved away, and the cover materials slowly subside to occupy the space once occupied by limestone. Voids may not be well developed in cover-subsidence sinkholes because of the continued downward movement of cover materials. See also *solution sinkhole* and *sag depressions* (SDII Global Corporation, 2002).

diffuse flow – Groundwater flow conditions that are generally slow-moving, may be laminar (Reynolds number much less than 1.0), has uniform discharge, and a slow response to storms (Modified from Field, 1999).

discharge – The rate of flow at a given instant in terms of volume per unit of time (Modified from Neudendorf et al., 2005). It is synonymous with flux.

doline – A bowl- or funnel-shaped hollow in limestone topography, ranging in diameter from few meters to a kilometer, and in depth up to several hundred meters (Modified from Monroe, 1970). A doline is synonymous with *sinkhole*.

dolostone – A sedimentary rock composed predominantly of the mineral dolomite ($Ca,Mg(CO_3)_2$). While soluble, dolostone is less likely to contain well-developed karst features than limestone (Modified from SDII Global Corporation, 2002).

duricrust – A deposit of precipitated minerals, mainly calcite, formed in the soil or near-surface layers in arid or semi-arid zones at the horizon where ascendant capillary water evaporates and salts held in solution are deposited. In Florida, seasonal rainfall and intense evaporation may form similar semi-concreted soils within the epikarst (Modified from Field, 1999).

epikarst – **1**. The zone of weathering that penetrates the upper surface of a limestone stratum. Weathering of limestone results in development of rubble, fine-grained, carbonate-rich silt, clay, and karren (including pinnacles and valleys in the limestone rock surface) (Modified from SDII Global Corporation, 2002). **2**. An intensely dissolved zone consisting of an intricate network of intersecting roofless, dissolution-widened fissures, cavities, and tubes dissolved into the uppermost part of the carbonate bedrock.

The dissolution features in the epikarst zone are organized to move infiltrating water laterally to down-gradient seeps and springs or to collector structures such as shafts that conduct the water farther into the subsurface (Huntoon, 1995).

estavelle – **1**. A spring that reverses flow because of relative changes in the elevation of groundwater potentials and stream stage (SDII Global Corporation, 2002). **2**. An intermittent spring resurgence or exsurgence, active only in wet seasons (Modified from Field, 1999). Generally, an estavelle is located near streams or rivers. When the water level of the stream is high (e.g. during flood stage), surface water directly recharges the aquifer.

exsurgence – A spring or seep in karstic terrane not clearly connected with swallets (or *ponors*) at a higher level (Field, 1999).

fissure – Any discontinuity within the rock mass that is either initially open or capable of being opened by dissolution to provide a route for water movement. Fissures in this sense, applied generally in karst, therefore include the primary sedimentary bedding planes as well as tectonic faults and joints. More specifically, the term has been used to describe voids with an average width dimension of 10 to 100 mm (Modified from Field, 1999).

fracture – Cracks formed in soils, sediment or rocks by natural stresses. In Florida, many fractures have been developed to relieve stress caused by Earth tides (SDII Global Corporation, 2002). It is synonymous with *joint*.

fracture trace – A confirmed pattern observed through remote sensing (areal photography or satellite imagery) that owes its origin to jointing or fracturing in the underlying soils, sediments, or bedrock. See *photolineament* (SDII Global Corporation, 2002).

grotto – A cave chamber or room preceded by a narrower passage (Modified from Field, 1999).

joint – See fracture.

karren – Features that develop on the upper surface of a limestone or other soluble rock as it is weathered These features are prevalent in the Quilin area in China and in western Ireland. In Ireland they are sometimes referred to as burren. In Florida, karren are usually buried under the cover materials and consists of pinnacles and depressions in the rock surface. The depressions may or may not be related to sinkhole activity (Modified from SDII Global Corporation, 2002).

karst – A term describing landforms that have been modified by dissolution of soluble rock (limestone or dolostone) (Modified from SDII Global Corporation, 2002).

karst terrane – A terrane, generally underlain by limestone or dolostone, in which the topography is chiefly formed by the dissolution of rocks, and which may be characterized by sinkholes, sinking streams, closed depressions, subterranean drainage, and caves (Copeland, 2003).

karst window – **1**. A depression opening that reveals portions of a subterranean flow, or the unroofed portion of a cave (a vertical window). **2**. An opening in natural limestone walls formed by the joining of subterranean karst grottos as a result of dissolution processes (a horizontal window). Both terms are modified from Field (1999). Note also that the Florida Springs Nomenclature Committee believes that flow through an exposed conduit in the aquifer is different from flow onto the Earth's surface. For this reason, the Florida Springs Nomenclature Committee does not consider a karst window to be a spring. It is an exception to the definition of a spring (See *spring*).

karstic aquifer – An aquifer containing soluble rocks with a permeability structure that includes abundant interconnected conduits dissolved from the host rock.

The interconnected conduits are organized and facilitate the circulation of fluid in the down-gradient direction wherein the permeability structure evolved as a consequence of dissolution by fluid (Modified from Huntoon, 1995).

laminar flow – Flow in which the head loss is proportional to the first power of velocity. Water flowing in a laminar manner will have streamlines that remain distinct and that flow direction at every point remains unchanged with time. Darcy's Law strictly applies under laminar flow conditions only (Modified from Field, 1999).

limestone – A sedimentary rock primarily composed of the mineral calcite ($CaCO_3$). Limestone is soluble and often develops karst features when weathered (Modified from SDII Global rp., 2002).

magnitude – See *Spring magnitude*.

nonartesian — A condition in which the upper surface of the zone of saturation forms a water table under atmospheric pressure. The term is synonymous with *unconfined* (Field, 1999).

offshore spring – The point of discharge of the spring is seaward of the mean low-tide level (Copeland, 2003).

onshore spring – The point of discharge of the spring is landward of the mean low-tide level (Copeland, 2003).

overflow stream – A stream valley that is down gradient of a swallow hole, swallet, or blind valley and that carries water only when the recharge capacity of the swallow hole is exceeded. In Florida, the term is sometimes used to identify an overflow, or paleo-overflow, stream valley (Modified from SDII Global Corporation, 2002).

paleokarst – This term describes either an ancient karst terrane or the presence of features associated with an ancient karst terrane. The term is used to describe old sinkholes and other karst features that are no longer actively forming. In west-central Florida, the term is used to refer to sinkholes that formed decades to millions of years ago and are no longer active (Modified from SDII Global Corporation, 2002).

paleosinkhole – An ancient sinkhole that is no longer active. See *relict sinkhole* and *alluvial sinkhole* (SDII Global Corporation, 2002).

photolineament – A natural linear feature on the land surface that has been identified from areal photographs or other images. Photolineaments are identified by alignments within or between lakes and wetlands, sinkholes, stream segments, soils, and vegetation patterns. Photolineaments are also known as photolinears**.** Note that photolinears may or may not represent geologic features, so the term is not synonymous with fracture trace. See *fracture trace* (Modified from SDII Global Corporation, 2002).

pipe – In karst terminology, it is a semi-circular conduit through which water and soil can pass. Pipes are often nearly vertical and they have steep (nearly vertical) sides (SDII Global Corporation, 2002).

polje – A large flat-bottom sinkhole complex formed by the coalescence of several smaller sinkholes. Poljes are flat-bottomed because of subsequent sedimentation, usually in a lake. Payne's Prairie in Alachua County is an example (Modified from SDII Global Corporation, 2002).

ponor – Hole in the bottom or side of a closed depression through which water passes to or from an underground channel (Field, 1999). It is synonymous with *swallow hole*.

raveling – Raveling is the process by which water transports soil particles downward into cavities in the underlying strata. Because sand is typically damp and the grains are angular, in Florida they do not easily ravel without moving water.

Because of their cohesiveness, clay-rich strata are more difficult to ravel than sandy soils (SDII Global Corporation, 2002).

relict sinkhole – A relict (or relic) sinkhole is an ancient sinkhole that is no longer active. It may be expressed as a sinkhole lake, depression in the land surface, or loose soils in the subsurface. See *paleosinkhole* and *alluvial sinkhole* (Modified from SDII Global Corporation, 2002).

resurgence – re-emergence of groundwater through a karst feature, a part or all of whose waters are derived from surface inflow into ponors at higher levels (Modified from Field, 1999).

river rise – see *resurgence* (Field, 1999).

rock-collapse sinkhole – A collapse sinkhole formed when the limestone, or other soluble rock, cavern ceiling fails and collapses into a void (Modified from SDII Global Corporation, 2002).

rubble – In the context of karst, rubble describes the gravel-like debris that forms as limestone is weathered (Modified from SDII Global Corporation, 2002).

sag depression – A sag depression is often the surficial manifestation of a solution or cover subsidence sinkhole. As the underlying bedrock is dissolved away, the cover materials slowly sag, creating a depression. Owing to the shallow water table, sags often become small, circular wetlands (SDII Global Corporation, 2002).

sand boil – A spring in which the vent has been filled in with sand. Spring discharge continuously suspends the sand particles that cover the spring. Thus the spring has a "boiling" appearance (Copeland, 2003).

seep – **1**. To move slowly through small openings of a porous material (Field, 1999). **2**. With regard to springs in Florida, a seep is also a noun that infers one or more small openings in which water discharges diffusely ("oozes") from the groundwater environment. Discharge is from intergranular pore spaces in the matrix and flow is typically laminar (Copeland, 2003).

seepage – The infiltration or percolation of water through rock or soil to or from the Earth's surface and is usually restricted to the very slow movement of groundwater (Field, 1999).

sink – See *sinkhole*.

sinkhole – A landform created by subsidence of soil, sediment, or rock as underlying strata are dissolved by groundwater. Sinkholes can form by collapse into subterranean voids created by dissolution of limestone or dolostone or by subsidence as these strata are slowly dissolved away (Modified from SDII Global Corporation, 2002).

siphon – **1**. In speleology, a cave passage in which the ceiling dips below a water surface (Monroe, 1970). **2**. A flooded cave passage. A gallery (conduit) in the form of a "U" with water moving only under pressure when the siphon is completely filled (Field, 1999). **3**. Site and origin of an intermittent spring; section of a flooded cave or sump flooded passage (Field, 1999).

soil piping – Laterally limited, vertical areas of loose soil often caused by downward vertical movement of the soil (raveling). See *pipe* (Modified from SDII Global Corporation, 2002).

solution sinkhole – Sinkhole formed by the slow subsidence of soil or sediment as the upper surface of the underlying, water-soluble sediment or rock is removed by dissolution. See *cover-subsidence sinkhole* (SDII Global Corporation, 2002).

source aquifer – The aquifer from which the water in a spring originates (Copeland, 2003).

spring – A point where underground water emerges onto the Earth's surface (including the ocean bottom). The image of a trickle of water springing from a hillside hardly matches that of a vast cave pouring forth a river, but both are called springs. Springs may be exsurgences or resurgences, depending upon the source of their water. They may also be part-time exsurgences and part-time resurgences. In some usages, "spring" is restricted to the water that outflows; in other usages, the word can refer to the water, the outlet, or the locality of the outflow (Field, 1999). Note that the Florida Springs Nomenclature Committee believes that flow through an exposed conduit in an aquifer is different from flow onto the earth's surface. For this reason, the Florida Springs Nomenclature Committee does not consider a karst window to be a spring. It is an exception to the definition of a spring.

spring boil – Variable discharge from a spring in which hydrostatic pressure is great enough to cause a turbulent discharge (Modified from Field, 1999).

spring complex – See s*pring group*. The Florida Springs Nomenclature Committee encourages the use of spring group and discourages the use of this term.

spring group – A collection of individual spring vents and seeps that lie within a discrete spring recharge basin (or springshed).

The individual vents and seeps of onshore spring groups almost always share a common spring run, or a tributary to the run. Spring group vents and seeps are often spread over an area of several square miles. It should be emphasized that the term spring group will be restricted to those vents and seeps that discharge a well-defined spring recharge basin. The spring vents or seeps within a springshed may be referred to as springs. As an example, the Rainbow Springs Group will include several spring vents that drain the Rainbow Springs Group basin, and discharge into the Rainbow River spring run. Note that a spring recharge basin is defined only by potentiometric data and not by chemical or other physical characteristics of the spring discharge. However, chemical and additional physical data can, and should, be used to better define individual spring vent basins within a spring group basin. This type of mapping was conducted for the Rainbow Springs Group in Marion County by Jones et al. (1996). All springsheds have not been mapped. Therefore, if a springshed is not mapped, then it is acceptable to use the term "springs" to refer to multiple vents discharging into a common spring run.

spring magnitude – A category based on the volume of flow from a spring per unit time.

spring pool – A small body of water, either artificially impounded or naturally occurring, that encompasses one or more spring vents. It contains spring discharge that flows into a spring run. It contains spring discharge that flows into a spring run (The Florida Springs Nomenclature Committee, 2003).

spring recharge basin – Those areas within groundwater and surfacewater basins that contribute to the discharge of the spring. The position of the divide is orthogonal to isopotential lines (Copeland, 2003). It is synonymous with *springshed*.

Note that the position of the recharge basin boundary is time dependent. That is, the boundary is representative of a "snapshot" in time, rather than permanent. Thus, the boundaries of springsheds are dynamic and vary as a result of a changing potentiometric surface. If a spring is found to drain one springshed during times of high potentiometry, and another basin during low times, then the spring should be connected with two spring basins in the spring database (Copeland, 2003).

Whenever practical, descriptive aspects of the recharge basin should be noted in the spring database. The following are examples. The relative recharge to groundwater within the basin should be noted. Those portions of the basin where confined and unconfined groundwater conditions exist should also be recorded. Finally, groundwater vulnerability within the springshed should be noted if possible. A potential tool to predict vulnerability is the Florida Aquifer Vulnerability Assessment (FAVA) model (Baker et al., 2002).

spring run – **1**. A body of flowing water that originates from a karst spring (Field, 1999). **2**. A stream (river, creek, etc.) whose primary (>50 percent) source of water is from a spring, springs, or spring group (The Florida Springs Nomenclature Committee 2003). For example, the Wakulla River, where the predominant source of water is from Wakulla Spring, is a spring run. However, farther downstream, where surface water tributaries, contribute 50 percent or greater of the flow, the Wakulla River is no longer considered a spring run. A detailed hydrogeologic (e.g., the collection of discharge and seepage data) study may be needed in order to identify boundaries of a spring run (The Florida Springs Nomenclature Committee, 2003).

spring seep – See *seep*.

spring vent – See *vent*.

springs – Multiple spring vents or seeps located in proximity to each other.

The usage of this term is discouraged, but for pragmatic reasons, it cannot be entirely dropped. For example, several vents may discharge into a common spring run and the collection of scientific data (e.g. water samples or discharge measurements) cannot be obtained from individual vents located in the run. However, it may be practical to obtain a composite water sample or composite flow measurement representing several vents. Under this situation, the term springs is acceptable. However, a list of each vent or seep represented by the composite sample should be recorded by the sampler, and ultimately placed into the spring database (Copeland, 2003).

steephead – A deeply cut valley, generally short, terminating at its upslope end in an amphitheater, at the foot of which a stream may emerge; e.g., ocean, lake, river, or stream (Field, 1999).

springshed – See *spring recharge basin*.

subaqueous spring – A spring that discharges below the surface of a water body (Field, 1999). The term implies a pre-existing receiving surfacewater body and is synonymous with *submerged* (Poucher and Copeland, 2006).

submerged – See *subaqueous*.

submarine spring – See *offshore spring*.

swallet – See *swallow hole*.

swallow hole – A place where water disappears underground in a limestone region. A swallow hole generally implies water loss in a closed depression or blind valley, whereas a swallet may refer to water loss into alluvium at a streambed, even though there is no depression (Field, 1999).

tidal spring – A spring whose discharge is controlled by tidal cycles. Near the coast, tidal springs may alternately discharge saline and fresh water. Inland, the pattern of fresh water discharge may simply reflect tidal changes in the potentiometric surface (SDII Global Corporation, 2002).

turbulent flow – The flow conditions in which inertial forces predominate over viscous forces and in which head loss is not linearly related to velocity. It is typical of flow in surface- water bodies and subsurface conduits in karst terranes, provided that the conduits have a minimum diameter of approximately 2-5 mm, although some research suggests that 5-15 mm may be more appropriate (Modified from Field, 1999).

trace – See *overflow stream* (SDII Global Corporation, 2002).

uvala – Large, complex sinkholes with irregular bottoms, formed by the coalescence of several smaller closed depressions. The bottom of an uvala is characterized by multiple sinkholes and an irregular bottom (Modified from SDII Global Corporation, 2002).

unconfined – See *nonartesian*.

vent – An opening that concentrates groundwater discharge at the Earth's surface, including the bottom of the ocean. The spring point of discharge is significantly larger than that of the average pore space in the surrounding rock and is often considered a cave or fissure. Flow from the opening is mostly turbulent (Copeland, 2003).

Appendix B2. Interpretation of the Origins of Temporal Trends in Florida's Groundwater

		Interpretation When There Is A Pattern of	
Analyte	**Origin in Groundwater**	**Increasing Trends**	**Decreasing Trends**
Alkalinity (Alk)	The primary natural source of alkalinity is dissolution of rock materials. In limestone aquifers, the reaction of recharging water with calcite in the limestone is: $H_2O + CO_2 + CaCO_3 \Leftrightarrow Ca^{+2} + 2HCO_3^-$. Where saline water encroachment is not a problem, HCO_3^- is the primary source of alkalinity and the dominant anion in Florida springs.	1. The proportion of conduit flow is decreasing and diffuse flow is increasing 2. Relative contribution of water held in storage in the aquifer is increasing because of longer residence times and more opportunity to react with the host aquifer 3. A connection with the surface that allowed rapid recharge may be less efficient 4. A new, more alkaline water source has been added to the flow system	1. Conduit flow is becoming more important than diffuse flow 2. Relative contribution of water held in storage in the aquifer is decreasing because of increased rapid recharge 3. A new, more acidic water source has been introduced
Ammonia/Ammonium (NH_3/NH_4)	Ammonia/ammonium is generally not detectable in natural groundwater. Small quantities may be present near decaying organics in a chemically reducing environment. Where these analytes are reported, the sources are typically fertilizer, animal wastes, or industrial effluent. Many fertilizers contain ammonium either as ammonium nitrate, urea, or some other ammonium compound. Animal wastes (human and other) also contain ammonium and urea [$(NH_2)_2CO$]. In animal wastes and some fertilizers, much of the ammonia degasses into the atmosphere rather than entering the groundwater system.	1. Increased use of or change in formulation of fertilizers 2. New sources of waste disposal in springshed 3. Changes in waste management in springshed (new septic tanks, landfills, feedlots, etc.) 4. Increase in drainage of wetlands or natural sources of chemically reduced nitrogen 5. Decrease in the reduction/oxidation potential of the groundwater that causes an increase in nitrate reduction	1. Decreased use of or change in formulation of fertilizers 2. Reduction in the sources of waste disposal in springshed 3. Changes in waste management in springshed (septic tanks, landfills, feedlots, etc.) 4. Decrease in drainage of wetlands or natural sources of chemically reduced nitrogen 5. Increase in the reduction/oxidation potential of the groundwater that causes an increase in nitrification (ammonia/ammonium oxidation)
Calcium (Ca)	The primary natural source of calcium in groundwater is dissolution of rock materials. In limestone aquifers, the reaction of recharging water with calcite in the limestone is: $H_2O + CO_2 + CaCO_3 \Leftrightarrow Ca^{+2} + 2HCO_3^-$. Deep groundwater flow systems in the Floridan aquifer may skim along the top of the gypsum/anhydrite-rich strata of the Middle Confining Unit of the Floridan. Here, calcium is derived from dissolution of gypsum ($CaSO_4.2H_2O$) and/or anhydrite ($CaSO_4$). Near the coasts and where saline water encroachment is a problem, the saline water is a source of Ca^{2+} as well.	1. The proportion of conduit flow is less and there is more diffuse flow 2. Relative contribution of water held in storage in the aquifer is increasing because of longer residence times and more opportunity to react with the host aquifer 3. A connection with the surface that allowed rapid recharge may be less efficient (a swallet has closed or become blocked) 4. A new, calcium-rich water source has been added to the flow system, either within the springshed or by encroachment of saline water	1. The proportion of conduit flow is increasing and there is less diffuse flow 2. Relative contribution of water held in storage in the aquifer is decreasing because of shorter residence times and less opportunity to react with the host aquifer 3. A connection with the surface that allowed rapid recharge may have developed or become more efficient (a swallet opened up)
Chloride (Cl)	Chloride is normally present in low concentrations in natural Florida groundwater systems. There are four important sources: (1) low concentrations in rainwater as a result of entrainment of marine aerosols, (2) mixing with seawater near Florida coasts, (3) dissolution of gypsum and/or anhydrite at the base of the upper Floridan aquifer, and (4) connate water trapped within the upper Floridan aquifer. The latter is an important issue within the St. Johns River corridor.	1. Saline water encroachment is occurring, either by lateral movement of sea water or connate water or by up-coning of water from below 2. A new source of chloride has been added to the springshed (landfill, industry, etc.)	1. Saline water intrusion is declining, probably because pumping stresses are reduced or aquifer potentials have risen 2. A source of chloride has been eliminated or reduced in the springshed (landfill, industry, etc.)
Discharge or flow	Spring discharge is an artifact of the recharge rate of sources water, hydraulic gradient, spring elevation relative to aquifer potentials, and spring vent geometry.	1. Increase in recharge rates (more rainfall and increases in elevation of the potentiometric surface) 2. Reduction of stage in the receiving water (allows for increased drainage of the aquifer) 3. Reduction in pumping stress on aquifer	1. Decrease in recharge rates (less rainfall and declines in elevation of the potentiometric surface) 2. Increase of stage in the receiving water (retards flow from the spring) 3. Increase in pumping stress on aquifer
Dissolved Oxygen (DO)	Dissolved oxygen content in spring water is a function of (1) oxygen content of the recharge water, (2) water temp. (the lower the temperature, the higher the oxygen solubility), (3) presence of	1. Increase in surfacewater component of spring flow, increase in conduit flow relative to diffuse flow 2. Decrease in ambient water temperature	1. Decrease in surfacewater component of spring flow, increase in importance of diffuse flow relative to conduit flow 2. Increase in ambient water temperature

Appendix B2. Interpretation of the Origins of Temporal Trends in Florida's Groundwater

		Interpretation When There Is A Pattern of	
Analyte	Origin in Groundwater	Increasing Trends	Decreasing Trends
	biota that consume oxygen in the soils and aquifer along the flow path, (4) presence of organic and mineral matter that can be oxidized along the flow path, (5) residence time of the water in the aquifer, and (6) spring vent dynamics and rate of flow.	3. Change in sample location relative to sources of water aeration	3. Change in sample location relative to sources of water aeration
Fluoride (F)	The primary source of fluoride in Florida spring water is dissolution of carbonate fluorapatite [$Ca_5(PO_4,CO_3)_3F$], the dominant phosphate mineral in the Miocene-Pliocene Hawthorn Group. Minor fluoride concentrations may be associated with saline water encroachment.	1. Increase in flow component derived from contact with the Hawthorn Group 2. Increase in waste sources, including human and animal wastes, especially landfills and septic tanks 3. Increased industrial activity in springshed	1. Decrease in flow component derived from contact with the Hawthorn Group 2. Waste management improvement, including human and animal wastes 3. Decreased industrial activity or better chemical management in springshed
Iron (Fe)	Iron is a widespread component in Florida rocks, including limestone, dolostone, and siliciclastic strata of the Hawthorn Group. When included within the rock mass, the iron is often present in a reduced form as pyrite [FeS_2]. Upon weathering and in a mildly reducing system, the iron remains reduced in the ferrous state (Fe^{2+}) and it can travel with the groundwater. In a chemically oxidizing system, the iron is oxidized to Fe^{3+} at which time it typically precipitates as ferric hydroxide ($Fe(OH)^3$). In springs, the moderately reducing water results in discharge of ferrous iron. Oxidation and precipitation often occur after the iron has entered the spring run.	1. Changes in water chemistry resulting in increased reduction/oxidation potential in water (dissolution of pyrite and freeing of ferric iron). This is often caused by injection of non-native water into the host aquifer. 2. Increase in sources in springshed, including waste disposal, disposal of waste iron in sinkholes, runoff from metallic sources 3. Increased use of iron-rich agricultural and horticultural plant and animal supplements 4. Changes in sample location, sample collection methods, or time of sampling that could change iron because of reduction/oxidation potentials or other physical conditions of sample.	1. Changes in water chemistry resulting in increased reduction/oxidation potential in water (precipitation of ferric hydroxide in water). 2. Decrease in sources in springshed, including waste disposal, disposal of waste iron in sinkholes, runoff from metallic sources 3. Decreased use of iron-rich agricultural and horticultural plant and animal supplements 4. Changes in sample location, sample collection methods, or time of sampling that could change iron availability and oxidation state
Magnesium (Mg)	In Florida, magnesium is found in dolomite [$CaMg(CO_3)_2$] and in several of the important clay minerals of the Hawthorn Group, such as palygorskite [$(Mg,Al)_5(Si,Al)_8O_{20}(OH)_2.8H_2O$] and montmorillonite [$(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2.nH_2O$]. Upon weathering, these and other magnesian clay minerals release magnesium to the groundwater. Saltwater encroachment is another source of magnesium in Florida groundwater. When the magnesium coexists with fluoride derived from weathering of carbonate fluorapatite, it can be assumed that the magnesium is from Hawthorn clays. If chloride is correlated to the magnesium, saline water is a probable source.	1. Up-coning or lateral migration of saline water 2. Increased proportion of flow that is diffuse in dolomitic rocks 3. Increased use of magnesium-rich soil supplements 4. Development of a quarry up-gradient that could increase the availability of highly soluble rock dust	1. Relaxation of up-coning or lateral migration of saline water, usually as a result of reductions in pumping stresses in aquifer or increased potentials 2. Reduced proportion of flow that is diffuse in origin in dolomitic rocks 3. Decreased use of magnesium-rich soil supplements
Nitrate plus Nitrite as N (NO_3 + NO_2 as N)	There are no significant natural sources of nitrate (NO_3) in groundwater in Florida. Small amounts may be derived from naturally occurring organics by nitrification, but most nitrate comes from anthropogenic activities, such as use of fertilizers, waste disposal, and industrial applications. In recent years, nitrate has increased in rainfall as a result of atmospheric emissions and airborne dust related to human activities.	1. Increase use of nitrate-based fertilizers (turf mangmt., row crops, golf courses and other sources have been identified as sources of nitrate increases in Fla. Springs) 2. Increase in the rate of nitrification of reduced forms of nitrogen (e.g. NO_2) by lowering of the water table, addition of nutrients that promote growth of nitrification microbes in soil 3. Increased surfacewater runoff to swallets, drainage wells, etc.	1. Decrease in use of nitrate-based fertilizers, especially of rapid-release. 2. Decrease in the rate of nitrification of reduced forms of nitrogen by raising of the water table, reduction of nutrients that promote growth of nitrification microbes in soil 3. Decrease of nitrate-rich surface water runoff to storm-water facilities, swallets, drainage wells, etc. (can result from better storm water management and use of pre-treatment in storm-water infiltration basins) 4. Increase recharge and aquifer flow dynamics result in dilution and dispersion of nitrate in aquifer system
Nitrogen (total) (N)	Total nitrogen is an analyte that reflects ammonium/ ammonia, nitrite, nitrate, and some organic nitrogen compounds. It is sometimes used as a surrogate analyte for some or all of	See above	See above

Appendix B2. Interpretation of the Origins of Temporal Trends in Florida's Groundwater

Analyte	Origin in Groundwater	Interpretation When There Is A Pattern of Increasing Trends	Interpretation When There Is A Pattern of Decreasing Trends
	these compounds.		
Orthophosphate as P (o-PO_4)	In Florida groundwater, orthophosphate is derived from several sources, including (1) weathering of phosphatic minerals in the Hawthorn Group, (2) use of fertilizers, (3) waste disposal, including solid and human wastes, and (4), to a minor extent, natural humic substances. Orthophosphate has a very limited solubility in alkaline environments, so carbonate aquifers typically have low concentrations. When springs have relatively high concentrations of orthophosphate, it is typically because the water has had a low residence time in the aquifer and there has not been sufficient time or reaction surface for buffering to occur. In other words, a conduit flow system may be indicated.	1. Increase in acidic, phosphate-rich flow supplied by surfacewater sources, especially storm-water disposal in sinkholes, swallets and siphons, to conduit flow systems 2. Increase in flow component derived from contact with the Hawthorn Group 3. Increase in phosphatic fertilizer use 4. Increase in animal waste use, including human and animal wastes 5. Increased industrial activity in springshed	1. Increase in low phosphate recharge through surfacewater sources, 2. Decrease of conduit flow component relative to the low-phosphate, diffuse flow component 3. Decrease in the flow component derived from contact with the Hawthorn Group 4. Decrease in, or better management of, phosphatic fertilizer use 5. Decrease in animal waste use or waste management improvement, including human and animal wastes 6. Decreased industrial activity or better phosphate management in springshed
pH	The analyte pH is a measure of the acid-base balance of water. The pH in limestone aquifers is buffered by the reaction shown under alkalinity (above), and the groundwater is typically near neutral (6.9-7.3). If pH values are low relative to the pH created by chemical equilibration with the minerals in limestone, the water has not had opportunity to equilibrate because of short residence time, insufficient reaction surface in the karst conduits, or a combination of the two. If the pH is relatively high, reactions other than equilibration with the calcite in the limestone a may be indicated. This includes reactions with the grouting materials in wells and with highly reactive, fine grained calcite. Because of the highly reactive calcite dust produced in limestone quarries, high pH groundwater may result. Some industrial wastes create relatively high pH values.	1. Reduction in the amount of more alkaline, diffuse flow relative to more acidic, conduit flow 2. Increased use of soil amendments to buffer acidic soils 3. Increase in highly soluble, carbonate dust related to the establishment of a quarry up-gradient 4. Change in sampling methods (this usually results in random noise, not a systematic change)	1. Increase in the amount of more alkaline, diffuse flow relative to more acidic, conduit flow in the water discharging from a spring 2. Decreased use of soil amendments to buffer acidic soils 3. Change in sampling methods (this usually results in random noise, not a systematic change)
Potassium (K)	In Florida, potassium occurs in some clay minerals, such as illite [$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)_4O_{10}[(OH)_2,(H_2O)]$], and feldspars, such as orthoclase [$KAlSi_3O_8$]. These mineral sources are minor compared to sources associated with saline water intrusion and anthropogenic sources, such as fertilizer and waste disposal.	1. Increased use of potassium-rich fertilizers 2. Saline water intrusion, either as a result of increase pumping stress or reduction in aquifer potentials during droughts	1. Decreased use of potassium-rich fertilizers 2. Decrease in saline water intrusion, either as a result of reduced pumping stress or an increase in aquifer potentials
Sodium (Na)	The sources of sodium in Florida groundwater include saline water (seawater and connate water), animal wastes, and industrial wastes. Rainfall contains small amounts of sodium as a result of marine aerosols and dust.	1. Saline water intrusion, either as a result of increase pumping stress or reduction in aquifer potentials during droughts 2. Increased waste disposal in springshed (landfill leachate, human waste, etc.)	1. Reduction in saline water intrusion, either as a result of decreased pumping stress or increased aquifer potentials during wet periods 2. Decreased waste disposal or better waste management in springshed
Specific Conductance (SC)	Specific conductance is a measure of the ability of water to conduct an electrical current. The higher the concentrations of dissolved salts in the water, the higher the specific conductance. Bicarbonate, chloride, and sulfate are the constituents that contribute most to the specific conductance of an aqueous solution.	1. Increase in the proportion of diffuse flow relative to conduit flow 2. Saline water encroachment	1. Decrease in the proportion of diffuse flow relative to conduit flow 2. Reduction in saline water encroachment
Strontium (Sr)	Strontium is included as a trace constituent in aragonite, a calcium carbonate polymorph that commonly occurs in marine	1. Saline-water encroachment 2. Increase in the proportion of water from diffuse flow	1. Reduction in up-coning of saline-water as a result of reductions in pumping stresses or increases in aquifer potentials

Appendix B2. Interpretation of the Origins of Temporal Trends in Florida's Groundwater

Analyte	Origin in Groundwater	Interpretation When There Is A Pattern of Increasing Trends	Interpretation When There Is A Pattern of Decreasing Trends
	shells, corals, and certain algae. Therefore, when newly deposited, the carbonate sediments that become limestone and/or dolostone contain small, but important, concentrations of strontium, primarily in aragonite. As the carbonate sediments are altered to limestone or dolostone, the strontium is released to groundwater. Therefore, strontium is, in part, a good indicator of the chemical maturity of limestone. The strontium in the aragonite is derived from seawater, so seawater and saline waters in general may serve as sources for strontium in groundwater. There are few other natural sources.	relative to conduit flow	2. Decrease in the proportion of water from diffuse flow relative to conduit flow
Sulfate (SO_4)	The sources of sulfate in Florida water include (1) dissolution of gypsum or anhydrite at the top of the Middle Confining Unit of the Floridan Aquifer System, (2) oxidation of pyrite in the aquifers and confining strata, (3) seawater and connate water, and (4) minor sulfate in marine aerosols in rainfall. Organic-rich sediments, such as peat, can serve as local sources of sulfate, as well.	1. Up-coning of saline water from the bottom of the upper Floridan aquifer or saline or connate water encroachment 2. Increased proportion of diffuse flow component relative to conduit flow 3. Increases in use of gypsum as a soil amendment for alkaline soils 4. Increase waste sources in springshed 5. Increase in industrial sources in springshed	1. Reduction in up-coning of saline water from the bottom of the upper Floridan aquifer or saline or connate water intrusion 2. Decreased proportion of diffuse flow component relative to conduit flow 3. Decreases in use of gypsum as a soil amendment for alkaline soils 4. Decrease waste sources in springshed 5. Decrease in industrial sources in springshed
Water Temperature (Temp)	In spring systems, the water temperature generally reflects mean annual air temperature in the springshed. Low or high temperatures typically reflect conduit flow systems where seasonal variations in temperature create temperature variations that are not ameliorated by diffusion or mixing in the aquifer.	1. Climate cycles resulting in increased annual mean temperatures 2. Changes in the proportion of conduit and diffuse flow 3. Decreased influx of seasonally cool water through swallets, siphons, drainage wells, storm-water basins	1. Climate cycles resulting in decreased annual mean temperatures 2. Changes in the proportion of conduit and diffuse flow 3. Increased influx of seasonally cool water through swallets, siphons, drainage wells, storm-water basins
Total Dissolved Solids (TDS)	Total dissolved solids is a measure of the total mass of constituents dissolved in groundwater.	1. Major causes of increased total dissolved solids relate to saline water encroachment 2. Introduction of new water sources to aquifer through waste disposal or construction	1. Major causes of decreased total dissolved solids relate to reductions in saline water encroachment
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl nitrogen TKN) refers to concentrations of organic nitrogen plus ammonia/ammonium in a water sample. The organic nitrogen concentration in the water can be obtained by subtracting ammonium/ammonia concentration from TKN concentration. The presence of TKN in groundwater indicates a nearby source of organic or ammonia/ammonium nitrogen, such as a swamp or wetland or organic wastes (animal, human). The Avon Park Formation, which is part of the upper Floridan aquifer, contains peat beds that locally contribute TKN to groundwater.	1. Influx of organic materials to aquifer via swallets, siphons, injection wells, drainage wells, sinkholes in storm-water basins, etc. 2. Increase of surfacewater component in aquifer relative to groundwater with long residence time and filtration	1. Reduction in influx of organic materials to aquifer via swallets, siphons, injection wells, drainage wells, sinkholes in storm-water basins, etc. 2. Decrease of surfacewater component in aquifer relative to groundwater with long residence time and filtration
Total Organic Carbon (TOC)	Total organic carbon (TOC) is an analyte that is similar to TKN (above). It's sources include organic-rich sediments and animal and plant wastes. Small amounts may be disseminated in sediments, such as clays and silts of the Hawthorn Group.	See above	See above
Total Phosphorous (T–P)	This includes orthophosphate as well as complex phosphates and other phosphorus, including organic phosphorus, compounds. Sources include naturally occurring org. sediments and wastes.	See Total Kjeldahl nitrogen and orthophosphate	See Total Kjeldahl nitrogen and orthophosphate
Total Suspended Solids (TSS)	This analyte constitutes the materials entrained in the water that can be recovered by filtering with an 0.45µ micropore filter.	1. Introduction of surface water 2. Increase in turbulent flow in conduits (often as a result of	1. Reduction of surface water influx 2. Decrease in turbulent flow in conduits

Appendix B2. Interpretation of the Origins of Temporal Trends in Florida's Groundwater

		Interpretation When There Is A Pattern of	
Analyte	**Origin in Groundwater**	**Increasing Trends**	**Decreasing Trends**
	The analyte, therefore, reflects particulate sediment discharging from the spring, colloidal precipitates forming in the spring, and microbenthic plants and animals living in the spring.	pumping) 3. Rapid introduction of aquifer or other geologic materials (sinkholes, construction, etc.)	3. Flushing of particulates (sediments) in conduits
Turbidity (Turb)	Turbidity is a measure of the ability of light to pass through a water sample. Turbidity is caused by particulate materials suspended in the water and some dissolved or colloidal materials that hinder light penetration. Sources of turbidity in springs include surfacewater that contains high concentrations of humic substances and/or particulate matter, chemical reactions that result on precipitation of colloidal materials, and certain forms of plankton growth.	See above	See above
Water Level/Stage (WL)	Water level, or stage, is a measure of the hydraulic potential, or elevation of an unconfined water level. In a spring, the stage is either controlled by water levels in the receiving water (the river or stream into which the spring discharges) or by the potentiometric surface of the source aquifer. Unlike rivers and streams, high stage may not reflect high discharge because of backwater effects associated with the receiving water. In fact, at highest stage, many springs (estavelles) flow backwaters from the receiving water into the aquifer.	1. Increase of aquifer potentials as a result of increased recharge 2. Increase in aquifer potentials as a result of reductions in aquifer stress (pumping) 3. Increase in stage of the receiving water (river, spring run)	1. Decrease of aquifer potentials as a result of reduced recharge 2. Decrease in aquifer potentials as a result of increases in aquifer stress (pumping) 3. Decrease in stage of the receiving water (river, spring run)

APPENDIX C - Well Construction and Location Data

						TD =	Total	Depth		
						Csg =	casing	Depth		
						LSElev =	Land	Surface	Elevation	
						MP =	Measuring	Point		
						Con/Un =	confined or	unconfined		
										Florida
										Geological
										Survey (FGS)
										W number
Well ID	**STATION_NAME**	**TD**	**Csg**	**LSElev**	**MP**	**Con/Un**	**County**	**LATITUDE N**	**LONGITUDE W**	**(If applicable)**
NW 67	Wakulla Spring Well					UN	Wakulla	301407	841809	
91	Donahue	80	56	25.69	26.33	UN	Leon	301840.901	841738.3	
129	Weller Ave MPZ	232	222	20	20.82	UN	Escambia	302228.2	872003	
131	Weller Ave Shallow	60	50	20	21.05	UN	Escambia	302228.401	872003	
243	Blontstown Floridan	303	202	82.3	84.75	CON	Calhoun	302700.03	850413.2	
245	Blontstown Surf	25	5	82.82	84.4	UN	Calhoun	302700.7	850412.2	
312	USGS 422a NR Greenhd	150	110	66.11	69.01	CON	Washington	303024.8	853503	
313	USGS 422b NR Greenhd	26	23	67.48	70.28	UN	Washington	303024.7	853503	
SR 1943	-111117007	36	6	17	18	UN	Dixie	293137	831430	
2003	-101601002	60	30	89	88.14	UN	Gilchrist	293829.9	823948.8	
2193	-72013001	65	48	157	158.22	CON	Bradford	295236.1	821549.7	
2259	-61401003	48	18	56	58.72	UN	Suwannee	295950.4	825143.9	
2353	-41734002	133	113	143	145	CON	Columbia	300612.5	823630	
2404	-30833001	68	48	90	91.97	CON	Taylor	301113.7	833139.6	
2465	-21231001	80	40	86	88.04	UN	Suwannee	301630.9	830912	
2585	-11011002	78	58	78	80.49	CON	Madison	302451.2	831750.6	
2675	21332004	103	63	121	123	CON	Hamilton	303153.1	830229.6	
SW 615	ROMP 17 SWNN	670	620	25	29	CON	Desoto	271028.2	815835.4	
707	ROMP 23-1 Deep	1000	904	63	66	CON	Manatee	271853.4	821039.3	
736	Crewsville SH-AGW	26	6	90	92	UN	Hardee	272544.6	813522.8	
737	Crewsville UP INT-AG	116	96	90	92	CON	Hardee	272544.6	813522.8	
775	ROMP TR 8-1 INT	160	100	15.2	19.29	CON	Manatee	273459.7	823246	
996	Claywell Elem. SF	17	10	51.34	53.30	UN	Hillsborough	280548.3	823122.4	
997	Claywell Elem. FL	60	40	52.44	53.98	CON	Hillsborough	280548.4	823122.5	W5989
7934	ROMP 23 Surf	21	20	60	6	UN	Manatee	271853.4	821039.2	
7935	ROMP 23 PZ2	250	175	60		CON	Manatee	271853.4	821039.2	
1087	Withla. St. Forest G	175	99	96.94	98.54	UN	Sumter	282742	815855.7	
1100	RdgeMnrRMP99XSh-A	57	36	75	76	UN	Hernando	283036.7	821054.8	
SJ 1417	S-0045	37	27	17.32	18.26	UN	Seminole	284318	810857	
1420	S-0038	165	55	19.14	21.48	CON	Seminole	284324	810928	
1762	SJ0029	603	350	64.77	68.29	CON	St. Johns	300507	812726	
1763	SJ0030	120	100	64.84	68.29	CON	St. Johns	300507	812726	
1764	SJ0032	60	40	64.73	65.64	UN	St. Johns	300508.8	812726.3	
1779	BA0054	700	370	125.75	128.88	CON	Baker	301618	821109	
1780	BA0055	100	80	125.72	128.77	CON	Baker	301618	821109	
1781	BA0056	60	40	125.17	128.71	UN	Baker	301618	821109	
AL 1674	R22T10Sec2001	95	56	102	103.19	CON	Alachua	293622.2	820815.6	
1931	R18T11Sec3101	75	58	100	85.51	UN	Alachua	292850.4	823230.2	
SF 2793	G-2364	80	80	0	5.92	UN	Broward	260826.3	801443.2	
2872	C-00972	44	25	11.18	15.28	UN	Collier	260844.9		
2873	C-00973	150	90	11.18	14.48	CON	Collier	260844.9	813236.7	
3108	L-02200	163	122	17.4	20	CON	Lee	264331.3	813406.1	
3109	L-02202	19	7	17.43	20.03	UN	Lee	264331.3	813406	
3398	PBS-S44	76.6	61.5	9	11.76	UN	Palm Beach	264901.7	800451.4	
3433	POF-0008	194	149	65	68.56	CON	Polk	274848.9	812619.5	
3490	KISSPARK	73.8	35	60	63	UN	Polk	275715	812208	
6490	27-3	19	19	10.3	11	UN	Dade	252924.4	802716.2	

APPENDIX D. SPRING LOCATIONS

Spring	County	Latitude/ Longitude	Spring	County	Latitude/ Longitude
NWFWMD			**SJRWMD**		
Wakulla Spring	Wakulla	30.234/ -83.086			
SRWMD			Alexander Spring	Lake	29.072/ -81.569
Alapaha Rise	Hamilton	30.427/ -83.086	Apopka Spring	Lake	28.559/ -81.675
Gilchrist Blue Spring	Gilchrist	29.820/ -82.678	Fern Hammock Springs	Marion	29.175/ -81.701
Fanning Spring	Levy	29.578/ -82.932	Juniper Springs	Marion	29.175/ -81.706
Hart Spring	Gilchrist	29.666/ -82.948	Miami Spring	Seminole	28.702 -81.436
Hornsby Spring	Alachua	29.840/ -82.588	Palm Spring	Seminole	28.835 -81.443
Lafayette Blue Spring	Lafayette	30.115/ -83.223	Ponce De Leon Spring	Volusia	29.125 -81.355
Little River Spring	Suwannee	29.986/ -82.963	Rock Spring	Orange	28.748 -81.495
Manatee Spring	Levy	29.480/ -82.974	Salt Springs	Marion	29.351 -81.733
Poe Spring	Alachua	29.815/ -82.644	Sanlando Springs	Seminole	28.681 -81.388
Ruth/Little Sulfur Springs	Suwannee	29.996/ -82.023	Silver Glen Springs	Marion	29.207 -82.047
Rock Bluff Spring	Gilchrist	29.789/ -82.915	Starbuck Spring	Seminole	28.689 -81.384
Royal Spring	Suwannee	30.073/ -83.071	Sweetwater Spring	Marion	29.210 -81.653
Suwannee Blue Spring	Suwannee	30.081/ -82.931	Volusia Blue Spring	Volusia	28.939 -81.332
Telford Spring	Suwannee	30.107/ -82.834	Wekiwa Spring	Orange	28.712 -81.460
Troy Spring	Lafayette	30.006/ -82.997			

APPENDIX D (continued)

SWFWMD					
Spring	**County**	**Latitude/ Longitude**	**Spring**	**County**	**Latitude/ Longitude**
Betty Jay Spring	Citrus	28.690 -82.592	Pump House Spring	Citrus	28.789 -82.584
Boat Spring	Hernando	28.430 -82.653	Rainbow No. 1 Spring	Marion	29.094 -82.433
Bubbling Spring	Marion	29.093 -82.430	Rainbow No. 4 Spring	Marion	29.094 - 8277.433
Buckhorn Main Spring	Hillsborough	27.884 -82.299	Rainbow No. 6 Spring	Marion	29.085 -82.424
Catfish Spring	Citrus	28.891 -82.595	Rainbow Swamp Spring No. 3	Marion	29.094 -82.433
Bobhill Spring	Hernando	28.435 -82.641	Rainbow Bridge Seep	Marion	29.094 -82.433
Boyette Spring	Hillsborough	27.854 -81.274	Salt Spring	Citrus	29.094 -82.615
Chassahowitzka No. 1 Spring	Citrus	28.709 -82.571	Tarpon Hole Spring	Citrus	28.891 -82.591
Chassahowitzka Main Spring	Citrus	28.709 -82.572	Trotter Main Spring	Citrus	28.874 -82.582
Homosassa No. 1 Spring	Citrus	28.792 -82.585	Weeki Wachee Main Spring	Hernando	28.789 -82.569
Homosassa No. 2 Spring	Citrus	28.792 -82.585	Wilson Head Spring	Sumter	28.510 -82.316
Homosassa No. 3 Spring	Citrus	28.792 -82.585			
Hidden River Head Spring	Citrus	28.769 -82.583			
Hidden River No. 2 Spring	Citrus	28.769 -82.584			
Hunters Spring	Citrus	28.887 -82.588			
Lithia Main Spring	Hillsborough	27.861 -82.228			
Magnolia Spring	Pasco	28.428 -82.649			

APPENDIX E. STATISTICS

APPENDIX E1. STATISTICAL METHODOLOGIES

(Xu-Feng Niu, Ph. D. [Department of Statistics, Florida State University], and R. Copeland)

Test for Seasonality

Kruskal-Wallis (K-W) test—The K-W test (Hollander and Wolfe, 1973) was designed for comparing multiple populations. For this report, there are considered to be either four (winter, spring, summer, and fall) or 12 monthly seasons. The null hypothesis is:

H_0: Measurements of the particular analyte collected in each season are from the same distribution.

The alternative hypothesis is

H_a: Measurements in the seasons are not from the same distribution.

The basic assumptions for this test are:

i) The measurements from different seasons are mutually independent, i.e., the four (or 12) groups of observations $\{Y_{it},\ t = 1, \cdots, n_i\}$ are mutually independent.

ii) For a given season i, the observations $\{Y_{it},\ t = 1, \cdots, n_i\}$ are a random (independent) sample from population i.

iii) The four populations are continuous with distribution functions $\{F_i(x), i = 1, \cdots, 4\}$, and the four (or 12) distribution functions are connected through the relationship $F_i(x) = F(x - \tau_i)$. The distributions have the same shape and are different only by a mean shift τ_i.

Under the null hypothesis, we have $F_i(x) \equiv F(x - \tau),\ \ for\ i = 1, 2, 3, 4$ or equivalently $\tau_1 = \tau_2 = \tau_3 = \tau_4 \equiv \tau$. The test procedure is

1) Combine the observations in the seasons and order them from the least to the largest

2) Let r_{it} be the rank of Y_{it} in the joint sample. Set $R_i = \sum_{t=1}^{n_i} r_{it}$ *and* $\overline{R}_i = R_i / n_i$, i.e., R_i is the rank sum of the observations in season i and $\overline{R}_i$ is the average rank for these same observations.

3) Let $N = \sum_{i=1}^{4} n_i$. The Kruskal-Wallis (K-W) statistic H is then defined as

$$H = \frac{12}{N(N+1)} \sum_{i=1}^{4} n_i \left(\overline{R}_i - \frac{N+1}{2} \right)^2 = \frac{12}{N(N+1)} \sum_{i=1}^{4} \frac{R_i^2}{n_i} - 3(N+1), \qquad \text{(A1)}$$

4) For testing the null hypothesis at the α level of significance, reject H_0 if $H \geq h_a$ where the critical value h_α can be found in Table A.12 of Hollander and Wolfe (1973).

5) Large-Sample Approximation. For comparing four populations ($k=4$), Table A.12 of Hollander and Wolfe (1973) provides critical values for$1 \leq n_i \leq 4$. When $n_i \geq 5,\ for\ i = 1, 2, 3, 4,$ the distribution of statistic H can be approximated by a chi-square distribution with 3 degrees of freedom under the null hypothesis. The test thus can be performed by rejecting H_0 if $H \geq \chi_{3,\alpha}$; otherwise do not reject H_0.

Mann-Whitney (M-W) test (or Wilcoxon Rank Sum test)—For testing seasonality of a water quality analyte, one can first perform the Kruskal-Wallis (K-W) test. If the null hypothesis $\{F_i(x) \equiv F(x-\tau),\ \ for\ i = 1, 2, 3, 4\}$ is not rejected, we may conclude that there is no seasonality in the data. If the null hypothesis is rejected, we need to figure out measurements in which two seasons have different distributions (different means).

For comparing any two populations, the Mann-Whitney (M-W) test can be employed. For example, suppose that we want to compare measurements of a water quality analyte from two different seasons, $\{Y_{it},\ \ t = 1, \cdots, n_i\}$ and $\{Y_{jt},\ \ t = 1, \cdots, n_j\}$. The null hypothesis in this comparison is $H_0\!:\ \ F_i(x) \equiv F_j(x)$ and the alternative hypothesis is $H_a\!:\ \ F_i(x) \equiv F_j(x-\Delta)$ or equivalently $Y_{it} = Y_{jt} + \Delta$ where $\Delta$is the location shift or the difference between the two season.

The Mann-Whitney (M-W) test procedure can be performed as follows:

1) Combine the observations in the two seasons and order them from the least to the largest
2) Let r_{it} be the rank of Y_{it} in the joint sample. Set $W_i = \sum_{t=1}^{n_i} r_{it}$, i.e., W_i is the rank sum of the observations in season i.
3) One-Sided Upper-Tail Test. To test H_0: $\Delta = 0$ versus H_a: $\Delta > 0$ at the significance level α, reject H_0 if $W_i \geq w_\alpha$ where the critical value w_α can be found in Table A.6 of Hollander and Wolfe (1999).
4) One-Sided Lower-Tail Test. To test H_0: $\Delta = 0$ versus H_a: $\Delta < 0$ at the significance level α, reject H_0 if $W_i \leq n_i(n_i + n_j + 1) - w_\alpha$.
5) Two-Sided Test. To test H_0: $\Delta = 0$ versus H_a: $\Delta \neq 0$ at the significance level α, reject H_0 if $W_i \geq w_{\alpha/2}$ or $W_i \leq n_i(n_i + n_j + 1) - w_{\alpha/2}$.
6) Large-Sample Approximation. When $n_i \geq 10$ *and* $n_j \geq 10$, define

$$W_i^* = \frac{W_i - [n_i(n_i + n_j + 1)]}{[n_i n_j (n_i + n_j + 1)]^{1/2}}. \qquad \text{(A2)}$$

The distribution of the statistic W_i^* can be approximated by the standard normal distribution N(0, 1). For the one-sided upper-tail test at the significance level α, reject H_0 if $W_i^* \geq z_\alpha$. For the one-sided lower-tail test at the significance level α, reject H_0 if $W_i^* \leq z_\alpha$. For the two-sided test, reject H_0 if $|W_i^*| \geq z_{\alpha/2}$.

Both M-W test and K-W test are nonparametric tests (also called distribution-free tests) that are applicable to different families of distributions such as normal, log-normal, and other continuous distributions. It should be pointed out that nonparametric tests still require independent observations. In other words, for a given season i, the observations $\{Y_{it},\ t = 1, \cdots, n_i\}$ need to be independent for the tests to be valid.

Test for Trends

Mann-Kendall (M-K) Test--For each analyte and each given season, the existence of linear upward or downward trends in the data will be determined by the Mann-Kendall

(M-K) test (Gilbert, 1987; Hollander and Wolfe, 1973) or the Seasonal-Kendall (S-K) test if seasonality is present. Regarding the M-K test, consider observations in the ith season $\{Y_{it},\ \ t=1,\cdots,n\}$. The M-K test can be performed in the following steps:

1) Calculate the differences

$$\{Y_{i2}-Y_{i1}, Y_{i3}-Y_{i1}, \cdots, Y_{in}-Y_{i1}, Y_{i3}-Y_{i2}, \cdots, Y_{in}-Y_{i2}, \cdots, Y_{in}-Y_{i,n-1}\}.$$

2) Let sign($Y_{is}-Y_{it}$) be the indicator function that takes the values 1, 0, and –1 according to the the sign of ($Y_{is}-Y_{it}$), i.e., sign($Y_{is}-Y_{it}$) = 1 if $Y_{is}-Y_{it} > 0$, sign($Y_{is}-Y_{it}$) = 0 if $Y_{is}-Y_{it} = 0$, and sign($Y_{is}-Y_{it}$) = -1 if $Y_{is}-Y_{it} < 0$. The Mann-Kendall (M-K) statistic is

$$K_i = \sum_{t=1}^{n-1} \sum_{s=t+1}^{n} sign(Y_{is}-Y_{it}). \qquad \text{(A3)}$$

3) Suppose that we want to test the null hypothesis of no trend in the data against the alternative hypothesis of an upward linear trend at the significance level α. We reject the null hypothesis if $K_i \geq k_\alpha$ where the critical value k_α can be found in Table A.21 of Hollander and Wolfe (1973). The one-sided lower-tail test and the two-sided test can be performed similarly.

3) Large sample approximation. When the sample size of the particular analyte for a given season is greater than 40 (n>40), normal approximation can be used for the trend testing. Specifically, we have (Gilbert, 1987, Chapter 16)

$$Var(K_i) = \frac{1}{18}\left[n(n-1)(2n+5) - \sum_{j=1}^{q} m_j(m_j-1)(2m_j+5) \right], \qquad \text{(A4)}$$

where q is the number of tied groups and m_j is the number of observations in the jth group. Define

$$Z_i = (K_i - 1)/[Var(K_i)]^{1/2}, \quad if\ K_i > 0;$$
$$Z_i = 0, \quad if\ K_i = 0;$$
and $$Z_i = (K_i + 1)/[Var(K_i)]^{1/2}, \quad if\ K_i < 0.$$

If the H_0 is true, the statistic Z_i has a standard normal distribution.

Sen Slope (S-S) Sen's nonparametric estimator of slope is based on the Mann-Kendall approach and is intended to identify the slope of data regardless of seasonal influences. The first step is to calculate the number of slope estimates (N) for the time series, where N = [(n)(n-1)/2], and n = the number of observations in the series. Each slope estimate is determined by:

$$Q = \frac{x_j - x_i}{j - i}, \qquad \text{(A5)}$$

where x_j and x_i are the values of data collected at times i and j, and j > i. In other words, the difference in the numerator of equation A5 reflects the change in condition of a sample collected at time j as compared to an earlier sample collected at time i. If the time intervals are equal, then the denominator of equation A5 becomes a constant and equation A5 results in the differences calculated for the Mann-Kendall test.

The median of the ranked series is determined as follows:

Sen=s estimator = median slope,

= $Q_{(N+1)/2}$ if N is odd,

= $2\ (Q_{N/2} + Q_{(N+2)/2})$ if N is even.

A two-sided test for confidence on the slope is determined using the table of the cumulative normal distribution. At an $\alpha = 0.10$, the $Z_{1-\alpha/2}$ is 1.64. This value from the table is compared to

$$C_\alpha = Z_{1-\alpha/2}\,[VAR(S)]^{0.5},$$

where

$$VAR(S) = \frac{1}{18}[n(n-1)(2n+5) - \Sigma_{p=1,q}\, t_p(t_p - 1)(2t_p + 5)]. \qquad \text{(A6)}$$

The value of n is the number of samples in the time series, *q* is the number of ties, and t_p is the number data in the p^{th} group (the number of multiple samples in group *p*).

For the example, n = 5 samples, *q*, the number of tied groups = 0, and t_p, the number of ties in the p^{th} group = 0.

Time Series Models and Estimation of Trends - Recall assumptions i, ii, and iii. If one of the three assumptions fails, results from the test methods may not be valid. The observations of a particular water quality analyte are collected in a time order and hence likely to be temporally correlated. Thus for trend analyses, one or more of the assumptions may not be valid. With this consideration in mind, the test methods described so far should only be used for initial data analysis. For a formal trend analysis, time series models should be considered.

Time series models are widely applied to data analyses in many fields of economical, biological, physical, and social sciences (Box and Jenkins, 1976; Brockwell and Davis, 1991; Pankratz, 1991; Tsay, 2002). Let $\{I_i(t),\ i=1,2,3,4\}$ be the four indicator variables for the four seasons, respectively. For example, $I_1(t)=1, \text{if } t$ is a spring quarter and $I_1(t)=0, \text{if } t$ is one of the other three quarters. Let $\{Y_t,\ \ t=1,\cdots,n\}$ be the quarterly measurements of a water quality analyte at a given sample well. We may consider the following regression and time series model for the observations:

$$Y_t = \sum_{i=1}^{4} \alpha_i I_i(t) + \sum_{i=1}^{4} \beta_i \, t \, I_i(t) + \xi_t, \qquad \text{(A7)}$$

where $\{\alpha_i, i=1,2,3,4\}$ are the intercepts for the four (or 12) seasons, $\{\beta_i, i=1,2,3,4\}$ are the slopes (linear trends) for the four seasons, and $\{\xi_t, t=1,\cdots,n\}$ are random noises that may follow an autoregressive and moving-average (ARMA) model. A special class of ARMA models is the autoregressive type of models that have the form:

$$\xi_t = \sum_{j=1}^{p} \phi_j \xi_{t-j} + \varepsilon_t, \qquad \text{(A8)}$$

where p is the order of the autoregression, $\{\phi_j, j=1,\cdots,p\}$ are unknown coefficients, and the ε_t's are assumed to be uncorrelated and with identical normal distribution N(0, σ^2).

The models in (A7) and (A8) can be fitted simultaneously by the SAS or the Splus statistical packages. The coefficients in the models can be estimated by the maximum likelihood methods. Different hypotheses on the coefficients can be tested by model comparison. For example, we test the null hypothesis

$$H_0\!: \quad \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 \equiv \alpha, \qquad \text{(A9)}$$

which is equivalent to comparing model (A?) with the model

$$Y_t = \alpha + \sum_{i=1}^{4} \beta_i \, t \, I_i(t) + \xi_t . \tag{A10}$$

Similarly, we may test different hypotheses on the slopes $\{\beta_i, i = 1, 2, 3, 4\}$.

Transformations - Notice that in model (A8), the random errors ε_t's are assumed to be uncorrelated, normally distributed, and with constant variance, which implies that the observations $\{Y_t, \ \ t = 1, \cdots, n\}$ are 1) normally distributed and 2) with constant variance σ^2. If one of the two assumptions is invalid, transformations should be performed on Y_t to improve normality or to stabilize the variance.

When $\{Y_t, \ \ t = 1, \cdots, n\}$ are positive numbers, the most popular transformation family is the Box-Cox power transformation family $\{Y_t^{\lambda}, \ \ -3 \le \lambda \le 3\}$ where $\lambda = 0$ corresponding to the logarithm transformation. In practice, an appropriate transformation for Y_t is usually chosen from the class $\{\lambda = -2, -1.5, -1, -0.5, 0, 0.5, 1.0, 1.5, 2\}$. The logarithm and the square-root transformations are the most popular transformations chosen in data analysis.

Missing data and censored data--Missing data will cause some problems in time series analysis. Here are two ad hoc ways to impute missing data in a time series:

1) Suppose that Y_t is missing, we may impute Y_t by $Y_t^* = \dfrac{Y_{t-1} + Y_{t+1}}{2}$.
2) Another way is to impute Y_t by the sample mean of the same season. For example, if the time *t* is a spring quarter, Y_t can be imputed by the sample mean of the spring quarter observations in the series. The same way can be applied to monthly data.

In water quality data analysis, censored data are usually caused by the minimum detection limit (MDL) of analytical laboratories. A popular way is to impute censored data by MDL/2 or to simply use MDL.

APPENDIX E2. MACRO CODES FOR MANN-KEDALL AND SEN SLOPE

Macro Codes for Mann-Kendall Analysis

```
macro

mk x

mcolumn x diffs y freqs wp S VarS Z p temp
mconstant i j k m nx nx1 ny y1 y2 xname lab1 lab2

mreset
notitle
brief 0
noecho
kkname xname x
kkset lab1 "        Ho: No trend in "
kkcat lab1 xname lab2
let nx = n(x)
if nx lt 10
  brief 2
  Note
  note   ***  Error  *** The number of observations in the data set must
  note                 be greater than or equal to 10 for the Normal
  note                 Approximation method to produce valid results.
  note
  note  *** Macro Exiting  ***
  note
  note
  goto 100
endif
let nx1 = nx-1
let m = 1
do i = 1:nx1
  let k = i + 1
  do j = k:nx
    let diffs(m) = x(j)-x(i)
    let m = m+1
  enddo
enddo
tally x ;
  store y wp.
sign diffs y
tally y;
  store y freqs.
let ny = n(y)
if ny = 1
  if y = -1
    let S = -1*freqs
  elseif y = 0
```

```
    let S = 0
  elseif y = 1
     let S = Freqs
  endif
elseif ny = 2
  let y1 = y(1)
  let y2 = y(2)
  if y1 = -1 and y2 = 1
    let S = freqs(2) - freqs(1)
  elseif y1 = -1 and y2 = 0
    let S = -1*freqs(1)
  elseif y1 = 0 and y2 = 1
    let S = freqs(2)
  endif
elseif ny = 3
  let S = freqs(3) - freqs(1)
endif

let VarS =((nx*nx1*(2*nx+5)) - sum(wp*(wp-1)*(2*wp+5)))/18
if S > 0
  let Z = (S-1)/sqrt(VarS)
elseif S = 0
  let Z = 0
elseif S < 0
  let Z = (S+1)/sqrt(varS)
endif

cdf Z p
let p = 1-p  ### p-value for upward trend.
title
mtitle "Mann-Kendall Trend Test using the Normal Approximation"
mtitle lab2
notitle
note
brief 2
print Z ;
   format('The calculated Z = ', f9.4).
print p;
   format('For Ha: Upperward trend, the p-value = ', f8.5).
cdf Z p  ### p-value for downward trend
print p;
   format('For Ha: Downward trend, the p-value = ', f8.5).
Note    The Normal approximation is valid only for data sets where n >= 10
copy nx temp
print temp;
  Format('   For the given data set, n = ', I5).
mlabel 100
endmacro
```

Macro Codes for Sen Slope

```
macro

sens X;
season sn.

mcolumn X slope medslope
mconstant i j k m nX nX1 xname ss ttl1 ttl2 ttl3 ttl4 sn

mreset
notitle
if season = 0
  let nX = n(X)
  let nX1 = n(X) - 1
  let k = 1

  do i = 1:nX1
    let m = i + 1
    do j = m:nX
      let slope(k) = (X(i)-X(j))/(i-j)
      let k = k + 1
    enddo
  enddo

  let medslope = median(slope)
  text medslope medslope;
    maxwidth 20.
  let ss = medslope(1)
  kkname xname x
  kkset ttl1 "Sen's Slope for "
  kkset ttl2 " = "
  kkcat ttl1 xname ttl3
  kkcat ttl3 ttl2 ttl4
  kkcat ttl4 ss ttl3
  let medslope(1) = ttl3
  mtitle "Sen's Slope"
  write medslope
else

endif
endmacro
```

APPENDIX F. ANALYTES

APPENDIX F1. ANALYTE DESCRIPTIONS

Field Analytes

Field analytes represent a grouping of convenience. Most were obtained prior to collecting samples for laboratory analyses. The analytes in this group that were used for trend analyses include discharge (or flow), dissolved oxygen, pH, specific conductance (SC), temperature (of water), and water level (msl).

Discharge—Discharge, or spring **flow**, is controlled by ground-water levels in the aquifers and generally changes slowly in response to fluctuations in potentiometry. Discharge is measured in cubic feet per second or gallons per day. For trend analyses, discharge is referred to as flow.

Dissolved Oxygen—Oxygen readily dissolves in water. It is often abbreviated to as DO. The source of oxygen can be atmospheric or biological. Typically springs, that discharge water from a deep aquifer source, have low dissolved oxygen concentrations. On the other hand, in shallow ground water the dissolved oxygen content is relatively high. This is due to a greater exposure to the atmosphere and an increase in biological activity.

pH—pH measures the acidity or alkalinity of water. It is defined as the negative log of the activity of the hydrogen ion in a solution. Values range between zero and 14. A low pH (below seven) represents acidic conditions, and a high pH above seven represents alkaline conditions. A pH of seven indicates the water is near neutral conditions. As raindrops form they incorporate dissolved carbon dioxide, forming weak carbonic acid. The resulting rain has a low pH. In Florida, as rainwater passes through soil layers it incorporates organic acids and the acidity increases.

When acidic water enters a limestone aquifer, the acids react with calcium carbonate in the limestone and dissolution occurs. Generally, most spring water falls within a pH range of seven to eight. Regarding spring water, during heavy rain events, spring water can drop in pH as tannic acids from nearby surface waters are flushed into the spring system. It should be noted that sampled river rises tend to have a lower pH than the clear-water spring systems, due to the surface-water component of the river rise water. The pH in well water generally falls within the six to eight range.

Specific Conductance—Specific conductance (SC) is a measure of the ability of a substance, in this case ground water, to conduct electricity at 25 ºC. The conductance is a function of the amount and type of ions in the water.

Instead of measuring SC in the field, some sampling agencies had their laboratory measure SC in the laboratory. For trend analyses, SC in the field (SC-field) was preferred. However, in order to generate sufficient data for time sequences A, B, and C, laboratory SC (SCL) was used if SC-field was unavailable. One sampling agency used the term field conductance [cond(field)] for SC-field. For trend analyses, the abbreviation SC is used. Note that it includes SC-field, and SCL.

Stage—The stage is the height of a water surface above an arbitrarily established datum plane. For this report, stage is converted water level above the National Geodetic Vertical Datum (NGVD) of 1927 (SFWMD, 2005), or approximately mean seal level (msl). It is often used in spring monitoring.

Temperature (of water)**—**Geologic material is characteristically a good insulator. Rocks and sediments tend to buffer changes in the temperature (Temp) of ground water. Thus, ground-water temperature does not vary much and tends to reflect the average annual air temperature in the vicinity of springs or wells. In Florida, ground-water temperatures generally range from 68°F to 75°F (20° C to 24° C), plus or minus several tenths of a degree. It plays a role in chemical and biological activity within the aquifer and can assist in determining residence time of the water in the aquifer.

Water Level—In a well, the variable water level is considered to be the distance from a measuring point located close to land surface downward to the ground-water surface. In data files, it is sometimes recorded as the depth to water and abbreviated (DtoH2O). Although it is convenient to measure water levels in this manner and store them in a data base, interpreting how water levels change over time can be somewhat confusing. For example, if potentiometric levels of an aquifer decrease over time due to a drought, potentiometric levels will drop. However, water levels as the reported in a data base will increase (the distance from land surface to the ground-water surface will increase). In order to avoid this confusion, for this report, all water level data were converted to its elevation, relative the NGVD datum of 1927, or approximately mean sea level. Thus, when levels in ground water decrease, water level data decrease. For this report, the converted water level data is used and is abbreviated WL(msl); water level relative to mean sea level.

Rock-Matrix Analytes

Because of natural rock weathering, water that has had a long residence time in an aquifer system has a greater probability of having high concentration of rock matrix material. Thus rock-matrix analytes are those indicative of the rocks making up an aquifer. For this report, rock indicators include alkalinity, calcium, magnesium, plus to a lesser extent, fluoride, iron, pH, potassium, strontium, sulfate, and specific conductance.

Alkalinity—In the presence of acids, alkalinity (Alk) results from of the dissociation of calcite (or aragonite) ($CaCO_3$) and dolomite (CaMg ($CaCO_3$)). The two minerals are the major mineral constituents in carbonate aquifers, such as the FAS and the Biscayne Aquifer. Upon dissolution carbonate (CO_3) and bicarbonate (HCO_3) are the two resulting predominant chemical species. In most natural systems, in the pH range of 6.4 to 10.3 at 25 ºC, bicarbonate is the major anion. As such, bicarbonate is the dominant constituent of alkalinity of the water. This is the situation regarding alkalinity in Florida. Depending on the laboratory, either total alkalinity or bicarbonate was measured. For the purpose of trend analyses, the two analytes are considered to be very similar to each other and the term alkalinity (Alk) will represent either constituent.

Calcium—Calcium (Ca) and magnesium (Mg) are the dominant cations in the carbonate aquifers in Florida and are the major minerals that constitute limestone and dolostones respectively. The Floridan aquifer system is composed of calcite and dolomite. Regarding calcium, it is released upon the weathering carbonate rocks. It is also released upon the weathering of gypsum and anhydrite. Gypsum is occasionally found in the intermediate aquifer system and Upchurch (1992) indicated that both are common at the base of the Floridan aquifer system in the Avon Park and Oldsmar Formations. Both dissolved calcium (D-Ca) and total Ca (T-Ca) were sampled. Occasionally a sampling agency alternated between the two species. For trend analyses, whenever possible, D-Ca was used and was the species of choice. However, both species were lumped together into a surrogate analyte (simply calcium) and were treated as if they were the same species.

Fluoride—Hem (1985) indicated that fluoride is a source of fluoride (F) is the mineral fluorapatite. This mineral is commonly found in the Hawthorn Group of the IAS (Copeland, 1981). Both dissolved fluoride (D-F) and total fluoride (T-Fe) were sampled. For trend analyses, whenever possible, D-F was used and was the species of choice.

Iron—Three common sources of iron (Fe) in Florida's ground water are the: (1) oxidization of the mineral pyrite, (2) oxidation of organic compounds, and (3) dissolution of iron oxide and silicate minerals (Upchurch, 1992). It is generally more prevalent in the SAS and the IAS than the FAS. Both dissolved fluoride (D-Fe) and total fluoride (T-Fe) were sampled. For trend analyses, whenever possible, D-Fe was used.

Magnesium—Due to chemical similarities, many of the factors that govern the distribution of calcium in Florida aquifer systems may also be applied to magnesium. The intermediate aquifer system's Hawthorn Group contains significant sources of magnesium, including magnesium-rich clays (Strom and Upchurch, 1983). The FAS also contains abundant dolomite which is the major source of Mg in Florida's aquifer systems.

Both dissolved magnesium (D-Mg) and total Mg (T-Mg) were sampled. Occasionally a sampling agency alternated between the two species. For trend analyses, whenever possible, D-Mg was used and was the species of choice. However, both species were lumped together into a surrogate analyte (magnesium) and were treated as if they were the same species.

Potassium—In Florida's ground water, potassium (K) is primarily derived from sea water (Upchurch, 1992). Therefore, coastal regions, where the fresh-water/saltwater transition zone is present, typically contain the highest K concentrations. Other sources are drilling fluids in newly installed wells, clay minerals, and in fertilizers. Both dissolved (D-K) and total (T-K) potassium were sampled. For trend analyses, whenever possible, D-K was used.

pH—As previously stated, when acidic water enters a limestone aquifer, the acids react with calcium carbonate in the limestone and dissolution occurs. In Florida, pH often has a direct inverse relationship with the concentrations of Ca, Mg, and Alk. For example, during heavy rain events, spring water and shallow ground water can drop in pH as acidic surface water recharges the aquifer systems.

Specific Conductance—Because it is a measure of electrical conductance at 25 º C, and because it a good indicator for the dissolution of limestones and dolostones, SC is a good rock-matrix indicator.

Strontium—Strontium (Sr) is relatively uncommon in Florida's aquifer systems. However, it occasionally substitutes for calcium (Upchurch, __) in the in the $CaCO_3$ matrix of carbonate aquifers. It is more prevalent in the older, deeper, and more saline portion of the FAS. The dissolved (D-Sr) and the total (T-Sr) species were sampled. Whenever possible, the dissolved form was used for trend analyses.

Sulfate—Sulfate (SO_4) is commonly found in aquifer waters in Florida and has several sources. The two most common sources are from seawater and the dissolution of gypsum and anhydrite (naturally occurring rock types within Florida's aquifer systems). Sulfate is often used as a soil amendment to acidify soils, and thus is associated with agricultural activities. Finally, disposal and industrial waste activities release sulfate to ground water.

Salt-Water or Saline Analytes

Saltwater analytes are those associated with salts with either connate or seawater. Connate waters are those waters trapped within the sediments at the time of their deposition. Since the original sediments were deposited in a marine environment, the pore spaces contain very old salt water. Saltwater analytes are obviously also found in the seawater located along Florida's coasts. The major difference is the age of water. High concentrations of saltwater analytes are often an indication of horizontal saltwater intrusion. However, it can also be an indication of intrusion of highly mineralized water from the deeper portion of the Florida's fresh water "lens." The intrusion can be caused by the depletion of the less dense freshwater "lens" during very dry period (e.g. a drought), or by the upconing of connate water during periods of heavy ground-water withdrawals. It should be noted that the pumping of ground water increased during dry periods and exacerbated the intrusion process. For this report, saline analytes include calcium, chloride, potassium, sodium, specific conductance, sulfate, total dissolved solids (TDS).

Calcium—In addition to it predominance as a rock-matrix indicator, calcium can also be considered an indicator of saltwater intrusion. As previously stated, calcium can be released into Florida's ground water from the weathering of gypsum and anhydrite found at the base of the Floridan aquifer system. If calcium concentrations are found to be increasing, in conjunction with sulfate, it can be an indication that the older and deeper water from the base of the fresh water "lens" is finding its way into the shallower portions of Florida's ground-water systems. If this occurs, there is the potential that increases in the concentration of other saltwater indicators will follow.

Chloride—Chloride (Cl) is the most abundant constituent in seawater. Ground water and spring water that are tidally influenced may have high chloride concentrations. Other sources for Cl in Florida are from rainfall via marine aerosols from the ocean, and as a by-product of waste. Chloride is chemically conservative and reacts very little with ground water.

Potassium—As stated previously, K is primarily derived from sea water. However, it can be introduced into ground water via fertilizers. Another source is from drilling fluids in newly installed wells, and from clay minerals.

Sodium—In Florida, sodium (Na) in ground water has several sources. The major source is the mixing of seawater with fresh water. Two other, but relatively minor sources are marine aerosols and the weathering of sodium-bearing minerals like feldspars and clays. Thus, to a very minor degree, sodium can also be considered a rock analyte. However, for this report is considered a saline analyte. Both dissolved sodium (D-Na) and total sodium (T-Na) were sampled. The species D-Na was preferred for trend analyses.

Specific Conductance—Because it is a measure of electrical conductance, and because it highly mineralized water has a concentration of SC, it is a good indicator of saline conditions.

Sulfate—Because of its source (gypsum and anhydrite), SO_4 is considered to be a rock indicator. However, as previously stated, sulfate can be released into Florida's ground water from the weathering of gypsum and anhydrite found at the base of the Floridan aquifer system, and because seawater is also an important source of sulfate in coastal areas, sulfate is an excellent saltwater indicator.

Total Dissolved Solids—As stated previously, TDS is primarily derived from the dissolution of carbonate rocks in Florida's aquifers. It is also originates from saline and connate marine water.

Nutrient Analytes

These analytes represent compounds or elements that are essential for the growth of living organisms. They occur naturally. However, if found in high concentrations, it can cause the over-enriching of a body of surface water (eutrophication), leading to an overgrowth of plant life (including algae) and possibly a loss of dissolved oxygen. For this report, nutrient analytes include phosphate, phosphorous, a series of nitrogen related species, and to a lesser extent, Mg, Ca, K, and sulfur in the form of sulfate. The nitrogen related species include nitrogen, ammonia, total kjeldahl nitrogen, nitrate, and nitrite.

Calcium—Since calcium is an essential nutrient and is a major ingredient in fertilizers, it is included in the nutrient analyte category.

Magnesium—As with calcium, magnesium is an essential nutrient and is a major ingredient in fertilizers. Thus, it is included in the nutrient analyte category.

Nitrogen—For this report, the monitored nitrogen species is total nitrogen. The amount of ammonia, nitrate, nitrite, and organic nitrogen, when summed, gives the total nitrogen (T-N) content of ground water. For ground water, the major sources are fertilizers and animal excrement.

Ammonia and ammonium—Taken from Upchurch (1992), nitrate is one member of a sequence of related nitrogen compounds that includes nitrogen gas (N_2), nitrite or nitrogen dioxide gas (NO_2) and other oxides, ammonia and ammonium (NH_3, NH_4), a number of other inorganic and organic compounds. The gaseous phases exist in the atmosphere and in soil atmospheres, but are not of importance in the saturated zones of aquifers. Ammonia gas also escapes into the atmosphere. Thus, ammonia is present in ground water in the form of ammonium (NH_4) because of the prevalent pH conditions and reduction-oxidation potentials. A source of the nitrogen can be from fertilizers and animal excrement.

Nitrate and Nitrite—Nitrate (NO_3) and nitrite (NO_2) are both found in Florida's ground and spring water. In terms of abundance, in oxidizing environments, nitrate dominates significantly over nitrite. For this reason, nitrate is not often measure by itself. Rather, it is measured as part of a nitrate species. The monitored species of nitrate are dissolved nitrate plus nitrite as N (D- NO_3 + NO_2), dissolved nitrate as N (D- NO_3), total nitrate plus nitrite as N (T-NO_3+NO_2), and total nitrate as N (T-NO_3). The concentrations of all of these analytes are considered to be measures of nitrate.

Nitrate contamination recently has become a problem in Florida's ground and spring water. Nitrate often originates from fertilizers, septic tanks and animal waste that enter the aquifer in the spring recharge area. Nitrate, being a nutrient, encourages algal and aquatic plant growth in spring water, which may lead to eutrophication of the spring run or associated water body. Nitrite, which is much less of a problem, can originate from sewage and other organic waste products.

Organic Carbon—Natural and non-naturally occurring organic carbon are present in varying concentrations in spring water in Florida. The primary source of naturally occurring organic carbon is humic substances (decaying plant material). Synthetic organic carbon represents a minor component. The species sampled was total organic carbon (TOC).

Phosphate—Phosphate as monitored is orthophosphate (PO_4) as P. It is an essential nutrient and occurs in ground water in Florida. Unfortunately, an excess of phosphate can cause run-away plant growth and the eutrophication of surface waters. The mineral fluorapatite found in the Hawthorn Group in the IAS is possibly the most important source of phosphate in ground water in Florida. However, other sources include organic and inorganic fertilizers, animal waste, human waste effluent and industrial waste. Both dissolved (D-PO_4) and total (T-PO_4) orthophosphate were sampled. The species D-PO_4 was preferred for trend analyses.

Phosphorous—Total phosphorous (T-P) is the species of phosphorous monitored in spring water by the water management districts of Florida. It includes the total of several oxidation states that range from P^{3-} to P^{5-}. Phosphorous can originate from the mineral fluorapatite. However, it is a component of sewage. It presence in can cause the eutrophication of surface water.

Potassium—Since K is a major ingredient in fertilizers, it is included in the nutrient analyte category.

Sulfate—Since SO_4 is an ingredient in fertilizers, it is included in the nutrient analyte category.

Total Kjeldahl Nitrogen—Total kjeldahl nitrogen (TKN) is a measure of the sum of the ammonia nitrogen and organic nitrogen in the ground water sample. The ammonia nitrogen, mainly occurring as ammonium (NH4), occurs in trace amounts in ground water. Organic nitrogen originates from biological sources including sewage and other waste. It is also found naturally in the Avon Park Formation toward the base of the FAS (Upchurch, 2000).

Other Analytes

Analytes in the “Other” category do not fit in the other four. They represent a miscellaneous group. For trend analyses, the analytes included in this group are organic carbon,
suspended solids, and turbidity.

Suspended Solids—These refers to the total amount of solid material suspended in the water column. As opposed to turbidity, total suspended solids (TSS) do not take into account the light scattering ability of the water. TSS are filtered out of a water sample.

Turbidity—Turbidity is a measure of the colloidal suspension of tiny particles and precipitates in spring water. High turbidity water impedes the penetration of light and can be harmful to aquatic life. Most Florida springs discharge water low in turbidity.

APPENDIX F2. ANALYTE LIST WITH STORET CODES

Analytes Abbreviated *	STORET ID Number	Analyte	Units	Description
Bicarb	29801	Bicarbonate	mg/L	ALKALINITY,WATR,DISS.,FIX END PT,LAB,AS CACO3,MG/L
Color	81	Color	PT-CO	COLOR,APPARENT(UNFILTERED SAMPLE) PLAT-COB UNITS
Cond(field)	94	Specific Conductance, Field	MICRO MHO	SPECIFIC CONDUCTANCE,FIELD (UMHOS/CM @ 25C)
D-Alk	4255	Dissolved Alkalinity	mg/L	BICARBONATE ALKALINITY(CAC03),DISSOLVED,WATER
D-Ca	915	Dissolved Calcium	mg/L	CALCIUM, DISSOLVED (MG/L AS CA)
D-Cl	941	Dissolved Chloride	mg/L	CHLORIDE, DISSOLVED IN WATER
D-F	950	Dissolved Fluoride	mg/L	FLUORIDE, DISSOLVED (MG/L AS F)
D-Fe	1046	Dissolved Iron	µg/L	IRON, DISSOLVED (UG/L AS FE)
D-K	935	Dissolved Potassium	mg/L	POTASSIUM, DISSOLVED (MG/L AS K)
D-Mg	925	Dissolved Magnesium	mg/L	MAGNESIUM, DISSOLVED (MG/L AS MG)
D-Mn	1056	Dissolved Manganese	µg/L	MANGANESE, DISSOLVED (UG/L AS MN)
D-Na	930	Dissolved Sodium	mg/L	SODIUM, DISSOLVED (MG/L AS NA)
D-NH3	608	Dissolved Ammonia	mg/L	NITROGEN, AMMONIA, DISSOLVED (MG/L AS N)
D-NO3	618	Dissolved Nitrate	mg/L	NITRATE NITROGEN, DISSOLVED (MG/L AS N)
D-NO3(N)	620	Dissolved Nitrate, Nitrogen	mg/L	NITRATE NITROGEN, TOTAL (MG/L AS N)
D-NO3NO2	631	Dissolved Nitrate Nitrite	mg/L	NITRITE PLUS NITRATE, DISS. 1 DET. (MG/L AS N)
DO	299	Dissolved Oxygen	mg/L	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE

*Light gray indicates common rock and saline-related indicators while dark gray shows common nutrient analytes.

Complete Analyte Descriptions continued				
Analytes Abbreviated	**STORET ID Number**	**Analyte**	**Units**	**Description**
DOC	681	Dissolved Organic Carbon	mg/L	CARBON, DISSOLVED ORGANIC (MG/L AS C)
D-P	666	Dissolved Phosphorus	mg/L	PHOSPHORUS, DISSOLVED (MG/L AS P)
D-PO4	671	Dissolved Phosphate	mg/L	PHOSPHORUS, DISSOLVED ORTHOPHOSPHATE (MG/L AS P)
D-SO4	946	Dissolved Sulfate	mg/L	SULFATE, DISSOLVED (MG/L AS SO4)
D-Sr	1080	Dissolved Strontium	µg/L	STRONTIUM, DISSOLVED (UG/L AS SR)
DtoH2O	72109	Depth to Ground Water	FR MPFT	DEPTH TO WATER LEVEL FROM A MEASURING POINT (FEET)
Entero	31649	Enterococci Bacteria	NO/100ML	ENTEROCOCCI- ME-MF
Fcol	31616	Fecal Coliforms	NO/100ML	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C
Flow (cfs)	60	Mean Daily Flow	cfs	FLOW, STREAM, MEAN DAILY CUBIC FEET PER SECOND (CFS)
pH	406	pH	SU	PH, FIELD, STANDARD UNITS
Resid	530	Residuals	mg/L	RESIDUE, TOTAL NONFILTRABLE (MG/L)
SCL	95	Specific Conductivity	MICRO MHO	SPECIFIC CONDUCTANCE (UMHOS/CM @ 25C)
T-Alk	411	Total Alkanity	mg/L	ALKALINITY, TOTAL (MG/L AS CACO3
T-Ca	916	Total Calcium	mg/L	CALCIUM, TOTAL (MG/L AS CA)
T-Cl	940	Total Chloride	mg/L	CHLORIDE,TOTAL IN WATER
TDS	70300	Total Dissolved Solids	mg/L	RESIDUE,TOTAL FILTRABLE (DRIED AT 180C),MG/L
Temp	10	Temperature	˚C	TEMPERATURE, WATER (DEGREES CENTIGRADE)
T-F	951	Total Fluoride	mg/L	FLUORIDE, TOTAL (MG/L AS F)
T-K	937	Total Potassium	mg/L	POTASSIUM, TOTAL MG/L AS K)

*Light gray indicates common rock and saline-related indicators while dark gray shows common nutrient analytes.

Complete Analyte Descriptions continued				
Analytes Abbreviated	**STORET ID Number**	**Analyte**	**Units**	**Description**
TKN	623	Total Kjeldahl Nitrogen	mg/L	NITROGEN, KJELDAHL, DISSOLVED (MG/L AS N)
T-Mg	927	Total Magnesium	mg/L	MAGNESIUM, TOTAL (MG/L AS MG)
T-Na	929	Total Sodium	mg/L	SODIUM, TOTAL (MG/L AS NA)
T-NO3	615	Total Nitrate	mg/L	NITRITE NITROGEN, TOTAL (MG/L AS N)
T-NO3NO2	630	Total Nitrate Nitrite	mg/L	NITRITE PLUS NITRATE, TOTAL 1 DET. (MG/L AS N)
TOC	680	Total Organic Carbon	mg/L	CARBON, TOTAL ORGANIC (MG/L AS C)
T-P	665	Total Phosphorus	mg/L	PHOSPHORUS, TOTAL (MG/L AS P)
T-PO4	650	Total Phosphate	mg/L	PHOSPHATE, TOTAL (MG/L AS PO4)
T-SO4	945	Total Sulfate	mg/L	SULFATE, TOTAL (MG/L AS SO4)
T-Sr	1082	Total Strontium	µg/L	STRONTIUM, TOTAL (UG/L AS SR)
Turb	76	Turbidity (Hatch Meter)	HACH FTU	TURBIDITY,HACH TURBIDIMETER (FORMAZIN TURB UNIT)
Turb(field)	82078	Field Sampling of Turbidity	NTU	TURBIDITY,FIELD NEPHELOMETRIC TURBIDITY UNITS,NTU
WL	82545	Water Level (from sea level)	ft	WATER LEVEL RELATIVE TO MEAN SEA LEVEL (FEET)

***LIGHT GRAY INDICATES COMMON ROCK AND SALINE-RELATED INDICATORS WHILE DARK GRAY SHOWS COMMON NUTRIENT ANALYTES.**

APPENDIX G. Data Quality Assurance (QA) Officer Contact Information

Spring Data			
Agency	**Contact**	**Telephone**	**Address**
NWFWMD	QA Officer	850-539-5999	81 Water Management Dr. Havana, FL 32333-4712
SRWMD	QA Officer	386-362-1001	9225 County Road 49 Live Oak, FL 32060
SJRWMD	QA Officer	386-329-4500	4049 Reid Street, P.O. Box 1429 Palatka, FL 32178-1429k
SWFWMD	QA Officer	813-985-7481	7601 US Highway 301 Tampa, FL 33637
USGS	Chief - National Stream Gaging Project	603-226-7847	NA
Well Data			
FDEP	QA Officer - Watershed Monitoring Section	850-245-8517	2600 Blairstone Road Tallahassee, FL 32399

APPENDIX H. DATA FROM SPRINGS AND WELLS

All data related to this study are available online at:
http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/B69Appendices/APPENDIX_H_(Spring_and_Well_Data)/

The entire data set is located within the folder entitled Data. The actual raw data from the WMDs and the DEP TV Network that was used for seasonality tests and the trend analysis are divided into three regions of the state, Northwest, Central, and South Florida. Within these regions Northwest contains the spring and well data from within the Northwest and Central WMD, Central contains the spring and well data from St. Johns and Southwest WMDs, and South contains the spring and well data from South Florida WMD.

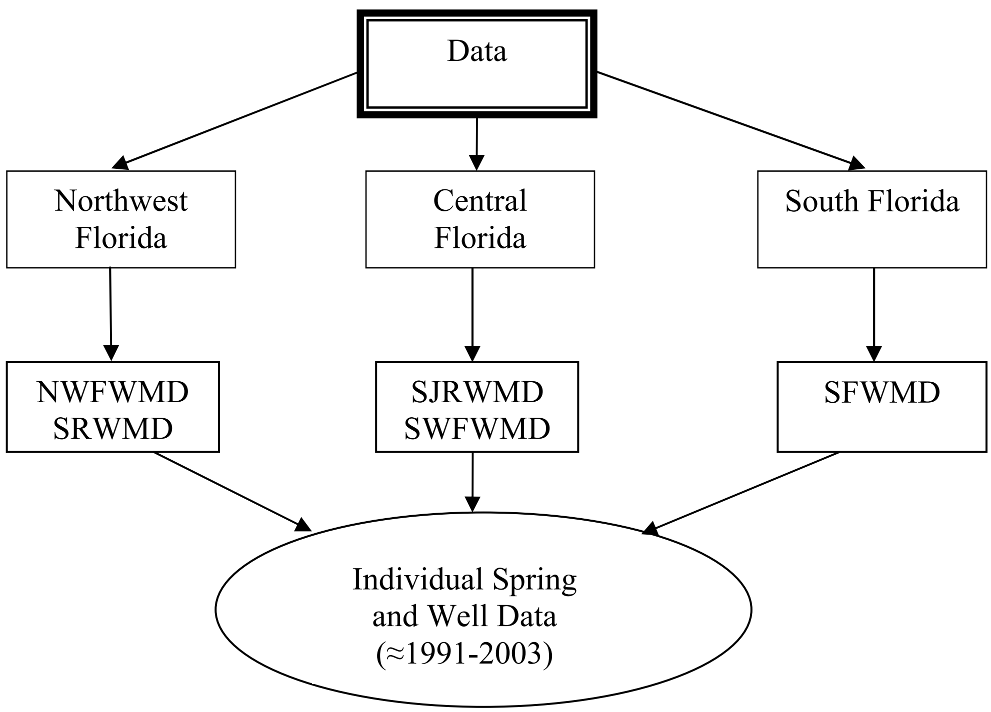

Figure H1. Flow diagram for water quality data in the online directory. Diagram explaining raw data from WMDs and DEP TV Network.

APPENDIX I—DESCRIPTIVE STATISTICS
Springs

Suwannee River Water Management District Springs

Descriptive Statistics for ALR from September, 1997 to August 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	14	0.7	0.9	1.2	1.4	1.4
NATOT	mg/l	14	2.5	4.1	5.1	8.4	10.5
MGTOT	mg/l	14	2.4	4.0	5.9	7.7	8.9
CATOT	mg/l	14	17.6	32.2	34.5	39.2	48.6
CLTOT	mg/l	15	1.0	6.3	7.1	8.5	9.0
FTOT	mg/l	14	0.1	0.1	0.1	0.2	0.2
SO4TOT	mg/l	14	8.5	16.1	26.5	31.0	33.0
TKN	mg/l	14	0.1	0.3	0.3	0.4	0.5
NOXNTOT	mg/l	15	0.0	0.1	0.2	0.4	0.7
PTOT	mg/l	15	0.1	0.1	0.1	0.1	0.2
OPO4DISS	mg/l	15	0.0	0.1	0.1	0.1	0.1
COLITOT	#/100ML	3	*	*	*	*	*
COLIFEC	#100ML	3	*	*	*	*	*
FLOWCFS	CFS	14	232.0	269.2	358.7	559.0	800.4
TOC	mg/l	14	4.0	8.9	10.5	16.3	24.7
DOC	mg/l	14	4.4	8.5	9.9	12.2	21.3
CONDL	uS/cm	15	126.0	224.0	283.0	305.5	317.0
PHF	s.u.	15	6.8	7.1	7.2	7.3	7.5
TEMP	Deg C	15	17.0	20.4	21.2	21.6	23.4

*Less than 10 samples
NA - No samples

TOT = Total, Diss = Dissolved

Descriptive Statistics for FAN from June, 1995 to July 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	50.0	0.4	1.8	2.0	2.3	2.8
NATOT	mg/l	50.0	2.9	3.8	4.2	4.7	6.3
MGTOT	mg/l	50.0	4.1	4.9	5.4	5.7	7.0
CATOT	mg/l	50.0	43.9	70.1	75.2	81.3	90.7
CLTOT	mg/l	50.0	4.3	8.0	8.5	9.0	12.7
FTOT	mg/l	50.0	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	50.0	14.0	18.3	19.3	20.0	24.5
TKN	mg/l	49.0	0.0	0.0	0.0	0.1	0.9
NOXNTOT	mg/l	50.0	2.4	3.5	3.8	4.1	4.6
PTOT	mg/l	50.0	0.0	0.1	0.1	0.1	0.2
OPO4DISS	mg/l	50.0	0.0	0.1	0.1	0.1	0.1
COLITOT	#/100ML	7.0	*	*	*	*	*
COLIFEC	#100ML	7.0	*	*	*	*	*
FLOWCFS	CFS	22.0	45.1	64.1	76.4	91.4	115.5
TOC	mg/l	49.0	0.0	1.0	3.9	8.5	35.6
DOC	mg/l	40.0	0.2	2.0	5.7	7.9	20.5
CONDL	uS/cm	50.0	429.0	446.0	456.0	461.8	467.0
PHF	s.u.	50.0	7.0	7.1	7.2	7.3	7.4
TEMP	Deg C	50.0	21.9	22.2	22.3	22.4	22.8

*Less than 10 samples
NA - No samples

Descriptive Statistics for GIL BLU from November, 1992 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	33.0	1.0	0.2	0.3	0.3	0.6
NATOT	mg/l	33.0	1.8	2.3	2.5	3.0	4.1
MGTOT	mg/l	32.0	4.1	5.1	5.9	6.5	7.1
CATOT	mg/l	33.0	40.3	52.4	58.6	62.8	66.0
CLTOT	mg/l	33.0	3.0	5.0	5.3	5.8	7.0
FTOT	mg/l	31.0	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	33.0	5.5	9.0	9.9	10.5	14.0
TKN	mg/l	33.0	0.0	0.0	0.0	0.1	0.1
NOXNTOT	mg/l	36.0	1.5	1.6	1.7	1.7	1.9
PTOT	mg/l	33.0	0.0	0.0	0.0	0.0	0.3
OPO4DISS	mg/l	33.0	0.0	0.0	0.0	0.0	0.0
COLITOT	#/100ML	8.0	*	*	*	*	*
COLIFEC	#100ML	8.0	*	*	*	*	*
FLOWCFS	CFS	21.0	23.8	31.5	36.4	45.1	86.6
TOC	mg/l	31.0	0.0	0.0	1.5	5.4	18.4
DOC	mg/l	24.0	0.2	0.6	1.1	5.0	11.3
CONDL	uS/cm	35.0	308.0	348.0	355.0	362.0	426.0
PHF	s.u.	36.0	6.8	7.3	7.4	7.5	7.6
TEMP	Deg C	36.0	21.2	22.3	22.5	22.6	23.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for HAR from June, 1992 to June, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	16.0	0.2	0.4	0.5	0.6	0.7
NATOT	mg/l	16.0	2.4	2.5	2.8	3.1	3.7
MGTOT	mg/l	16.0	4.2	4.4	4.7	5.3	6.1
CATOT	mg/l	16.0	60.2	71.0	77.6	79.9	92.7
CLTOT	mg/l	20.0	0.0	7.0	7.1	7.6	16.0
FTOT	mg/l	16.0	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	16.0	18.2	20.0	20.5	22.3	26.0
TKN	mg/l	19.0	0.0	0.0	0.0	0.0	0.1
NOXNTOT	mg/l	20.0	1.0	0.1	1.2	1.3	1.4
PTOT	mg/l	20.0	0.1	0.1	0.1	0.1	0.2
OPO4DISS	mg/l	20.0	0.1	0.1	0.1	0.1	0.1
COLITOT	#/100ML	5.0	*	*	*	*	*
COLIFEC	#100ML	5.0	*	*	*	*	*
FLOWCFS	CFS	16.0	19.1	46.1	55.1	74.0	90.0
TOC	mg/l	15.0	0.4	1.9	5.5	8.7	19.7
DOC	mg/l	16.0	0.4	1.8	4.3	8.6	16.7
CONDL	uS/cm	20.0	419.0	434.3	439.0	448.3	465.0
PHF	s.u.	20.0	6.9	7.1	7.2	7.2	7.4
TEMP	Deg C	20.0	21.9	22.1	22.1	22.2	22.4

*Less than 10 samples
NA - No samples

Descriptive Statistics for HOR from November, 1992to September, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	60	0.200	0.900	1.000	1.025	1.500
NATOT	mg/l	60	2.800	7.700	8.800	9.300	11.800
MGTOT	mg/l	60	4.500	7.750	9.250	10.750	15.400
CATOT	mg/l	60	43.400	59.350	64.150	70.825	98.300
CLTOT	mg/l	60	4.000	11.650	12.600	14.600	62.000
FTOT	mg/l	50	0.080	0.180	0.200	0.228	0.280
SO4TOT	mg/l	60	10.000	39.625	47.000	60.625	108.000
TKN	mg/l	60	0.020	0.058	0.080	0.123	0.770
NOXNTOT	mg/l	60	0.010	0.510	0.635	0.730	1.920
PTOT	mg/l	60	0.038	0.084	0.094	0.101	0.265
OPO4DISS	mg/l	59	0.004	0.079	0.087	0.116	0.116
COLITOT	#/100ML	6	*	*	*	*	*
COLIFEC	#100ML	6	*	*	*	*	*
FLOWCFS	CFS	29	0.000	7.640	44.200	88.900	352.000
TOC	mg/l	48	0.000	1.900	4.850	8.525	15.000
DOC	mg/l	39	0.800	2.950	5.500	7.300	11.700
CONDL	uS/cm	60	375.000	432.250	453.000	487.000	543.000
PHF	s.u.	60	6.840	7.175	7.290	7.353	8.110
TEMP	Deg C	60	19.800	22.175	22.500	22.700	27.400

*Less than 10 samples
NA - No samples

Descriptive Statistics for LBS from August, 1995 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	39	0.0	0.7	0.8	0.8	5.1
NATOT	mg/l	39	3.2	4.7	5.3	5.8	28.7
MGTOT	mg/l	39	8.2	10.5	11.5	12.4	16.8
CATOT	mg/l	39	48.8	59.6	64.9	67.1	81.7
CLTOT	mg/l	39	1.5	8.9	9.3	10.7	16.8
FTOT	mg/l	39	0.1	0.1	0.1	0.1	0.2
SO4TOT	mg/l	39	9.0	12.0	12.5	13.7	17.5
TKN	mg/l	42	0.0	0.1	0.1	0.1	0.2
NOXNTOT	mg/l	42	1.0	1.3	1.6	1.9	2.4
PTOT	mg/l	42	0.0	0.0	0.0	0.1	0.2
OPO4DISS	mg/l	42	0.0	0.0	0.0	0.0	0.1
COLITOT	#/100ML	9	*	*	*	*	*
COLIFEC	#100ML	9	*	*	*	*	*
FLOWCFS	CFS	25	20.4	34.9	49.3	74.6	160.1
TOC	mg/l	28	0.8	2.0	7.8	11.6	19.6
DOC	mg/l	36	1.0	2.5	6.6	10.6	12.6
CONDL	uS/cm	42	403.0	428.3	440.5	447.0	455.0
PHF	s.u.	42	6.8	7.2	7.3	7.3	7.5
TEMP	Deg C	42	0.3	21.3	21.5	21.6	22.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for LRS from August, 1994 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	48.0	0.1	0.5	0.5	0.7	0.9
NATOT	mg/l	48.0	1.3	2.3	2.5	2.8	4.2
MGTOT	mg/l	48.0	6.0	6.5	7.0	7.8	12.2
CATOT	mg/l	48.0	49.6	55.6	58.5	61.6	96.6
CLTOT	mg/l	48.0	0.0	5.3	5.8	6.0	9.0
FTOT	mg/l	47.0	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	48.0	14.0	17.5	19.2	22.0	27.0
TKN	mg/l	48.0	0.0	0.0	0.0	0.1	0.2
NOXNTOT	mg/l	51.0	0.9	1.1	1.2	1.3	1.7
PTOT	mg/l	48.0	0.0	0.0	0.0	0.0	0.1
OPO4DISS	mg/l	48.0	0.0	0.2	0.0	0.0	0.0
COLITOT	#/100ML	*	*	*	*	*	*
COLIFEC	#100ML	*	*	*	*	*	*
FLOWCFS	CFS	28.0	25.4	46.8	55.8	72.0	143.0
TOC	mg/l	46.0	0.0	1.2	2.7	7.0	19.9
DOC	mg/l	36.0	0.2	1.8	3.9	6.7	14.1
CONDL	uS/cm	49.0	348.0	368.0	373.0	376.0	398.0
PHF	s.u.	49.0	6.9	7.3	7.3	7.5	7.7
TEMP	Deg C	48.0	21.4	21.7	21.8	21.8	22.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for MAN from August, 1995 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	41.0	0.3	0.8	0.9	1.0	1.6
NATOT	mg/l	41.0	2.9	3.5	3.8	4.0	5.9
MGTOT	mg/l	41.0	4.3	5.6	5.9	6.4	7.9
CATOT	mg/l	41.0	60.5	76.6	83.0	85.7	96.9
CLTOT	mg/l	45.0	1.0	7.2	7.6	8.1	14.0
FTOT	mg/l	41.0	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	41.0	24.5	29.0	31.0	32.0	42.0
TKN	mg/l	43.0	0.0	0.0	0.1	0.1	17.8
NOXNTOT	mg/l	46.0	1.2	1.4	1.5	1.6	2.0
PTOT	mg/l	45.0	0.0	0.0	0.0	0.0	0.1
OPO4DISS	mg/l	45.0	0.0	0.2	0.0	0.0	0.0
COLITOT	#/100ML	11.0	9.0	30.0	60.0	100.5	4900.0
COLIFEC	#100ML	11.0	2.0	10.0	13.0	60.0	2000.0
FLOWCFS	CFS	19.0	83.9	139.9	170.5	180.3	203.0
TOC	mg/l	41.0	0.3	2.2	6.9	9.6	18.4
DOC	mg/l	37.0	0.4	2.1	5.8	8.8	15.3
CONDL	uS/cm	46.0	433.0	460.3	466.0	473.0	499.0
PHF	s.u.	46.0	6.8	7.2	7.3	7.3	7.7
TEMP	Deg C	46.0	20.0	22.1	22.2	22.3	22.5

*Less than 10 samples
NA - No samples

Descriptive Statistics for POE from April, 1998 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	41.0	0.1	0.6	0.7	0.9	1.2
NATOT	mg/l	41.0	4.2	6.5	7.9	9.5	12.7
MGTOT	mg/l	41.0	4.3	5.2	5.9	7.0	8.0
CATOT	mg/l	41.0	48.7	61.6	67.5	70.3	76.3
CLTOT	mg/l	42.0	6.0	9.6	12.8	13.7	16.4
FTOT	mg/l	41.0	0.0	0.1	0.2	0.2	0.2
SO4TOT	mg/l	41.0	10.0	12.8	19.5	29.0	37.0
TKN	mg/l	40.0	0.0	0.1	0.1	0.1	0.3
NOXNTOT	mg/l	45.0	0.2	0.3	0.4	0.5	1.3
PTOT	mg/l	42.0	0.0	0.1	0.1	0.1	0.2
OPO4DISS	mg/l	42.0	0.1	0.9	0.1	0.1	0.1
COLITOT	#/100ML	8.0	*	*	*	*	*
COLIFEC	#100ML	8.0	*	*	*	*	*
FLOWCFS	CFS	28.0	25.8	38.3	51.2	54.3	80.0
TOC	mg/l	39.0	1.0	3.1	7.3	10.2	33.3
DOC	mg/l	41.0	1.0	2.2	4.8	8.8	32.6
CONDL	uS/cm	45.0	385.0	405.0	423.0	434.0	445.0
PHF	s.u.	45.0	6.5	7.2	7.2	7.3	7.5
TEMP	Deg C	45.0	21.8	22.2	22.3	22.3	22.5

*Less than 10 samples
NA - No samples

Descriptive Statistics for RKB November, 1992 to June, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	55	0.000	0.300	0.300	0.500	1.000
NATOT	mg/l	55	1.400	1.850	2.000	2.200	4.000
MGTOT	mg/l	55	2.200	2.750	3.000	3.350	4.600
CATOT	mg/l	55	39.100	48.300	50.900	53.200	56.700
CLTOT	mg/l	55	1.000	4.000	4.500	5.000	10.800
FTOT	mg/l	7	0.020	0.060	0.070	0.090	0.140
SO4TOT	mg/l	55	9.000	11.000	12.000	12.400	25.500
TKN	mg/l	55	0.000	0.040	0.050	0.100	0.220
NOXNTOT	mg/l	55	0.310	0.810	0.910	1.020	1.140
PTOT	mg/l	55	0.044	0.060	0.062	0.069	0.163
OPO4DISS	mg/l	55	0.006	0.055	0.058	0.063	0.085
COLITOT	#/100ML	7	*	*	*	*	*
COLIFEC	#100ML	7	*	*	*	*	*
FLOWCFS	CFS	25	0.000	17.500	24.400	30.580	54.000
TOC	mg/l	46	0.000	1.425	4.100	5.600	11.700
DOC	mg/l	37	0.400	2.300	3.800	5.900	10.600
CONDL	uS/cm	55	240.000	293.000	298.000	304.500	315.000
PHF	s.u.	55	6.500	7.240	7.390	7.475	7.750
TEMP	Deg C	55	18.800	21.800	22.000	22.100	22.400

*Less than 10 samples
NA - No samples

Descriptive Statistics for ROY from November, 192 to June, 1999

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	27.0	0.1	0.5	0.5	0.6	1.0
NATOT	mg/l	27.0	2.0	2.4	2.6	2.9	4.0
MGTOT	mg/l	27.0	8.6	10.0	10.9	11.5	15.5
CATOT	mg/l	27.0	0.0	46.7	48.9	52.1	60.4
CLTOT	mg/l	27.0	0.4	4.9	5.0	5.8	8.0
FTOT	mg/l	20.0	0.1	0.1	0.1	0.2	0.2
SO4TOT	mg/l	27.0	6.6	8.6	9.0	9.9	10.7
TKN	mg/l	27.0	0.0	0.0	0.1	0.1	1.5
NOXNTOT	mg/l	27.0	0.2	1.3	1.6	1.8	2.2
PTOT	mg/l	27.0	0.0	0.0	0.0	0.0	0.1
OPO4DISS	mg/l	27.0	0.0	0.0	0.0	0.0	0.0
COLITOT	#/100ML	0.0	*	*	*	*	*
COLIFEC	#100ML	0.0	*	*	*	*	*
FLOWCFS	CFS	6.0	*	*	*	*	*
TOC	mg/l	19.0	0.0	1.1	1.5	1.9	13.5
DOC	mg/l	7.0	*	*	*	*	*
CONDL	uS/cm	27.0	345.0	360.0	367.0	371.0	487.0
PHF	s.u.	27.0	6.9	7.2	7.4	7.5	7.8
TEMP	Deg C	27.0	18.8	21.7	21.8	21.9	22.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for RLS from June, 1996 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	39	0.4	1.6	2.0	2.4	3.3
NATOT	mg/l	39	2.1	3.6	3.9	4.4	5.8
MGTOT	mg/l	39	4.5	6.0	6.8	7.2	9.8
CATOT	mg/l	38	46.6	61.4	64.9	68.3	79.5
CLTOT	mg/l	43	3.0	7.0	7.7	8.2	27.6
FTOT	mg/l	39	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	39	9.5	11.1	12.3	13.9	20.5
TKN	mg/l	42	0.0	0.1	0.2	0.2	0.3
NOXNTOT	mg/l	46	1.1	2.1	3.0	5.0	5.8
PTOT	mg/l	43	0.0	0.0	0.4	0.0	0.1
OPO4DISS	mg/l	43	0.0	0.0	0.0	0.0	0.1
COLITOT	#/100ML	11	3.0	15.0	30.0	85.0	290.0
COLIFEC	#100ML	11	2.0	2.5	10.0	19.0	160.0
FLOWCFS	CFS	30	1.4	2.8	4.4	9.6	21.0
TOC	mg/l	38	1.0	2.9	5.9	9.8	24.9
DOC	mg/l	39	1.0	2.9	7.0	8.6	46.2
CONDL	uS/cm	43	375.0	391.5	398.0	414.0	435.0
PHF	s.u.	43	6.8	7.1	7.2	7.3	7.5
TEMP	Deg C	43	20.4	21.5	21.6	21.8	22.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for SBL from June, 1997 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	43.0	0.0	0.4	0.6	0.9	2.1
NATOT	mg/l	43.0	1.8	2.6	2.8	3.0	4.0
MGTOT	mg/l	43.0	8.4	9.4	10.1	10.7	13.6
CATOT	mg/l	43.0	44.0	48.4	53.1	55.2	70.6
CLTOT	mg/l	43.0	4.5	5.3	5.9	7.0	15.0
FTOT	mg/l	43.0	0.0	0.1	0.1	0.2	0.2
SO4TOT	mg/l	43.0	7.0	8.3	9.5	11.5	17.3
TKN	mg/l	42.0	0.0	0.0	0.0	0.1	0.2
NOXNTOT	mg/l	48.0	1.8	2.3	3.1	5.3	9.7
PTOT	mg/l	43.0	0.0	0.0	0.0	0.0	0.4
OPO4DISS	mg/l	43.0	0.0	0.0	0.0	0.0	0.0
COLITOT	#/100ML	17.0	10.0	20.0	40.0	100.0	109.0
COLIFEC	#100ML	17.0	1.0	1.0	3.0	10.0	16.0
FLOWCFS	CFS	28.0	4.5	7.7	12.3	21.1	39.3
TOC	mg/l	42.0	0.3	1.4	4.1	6.6	14.9
DOC	mg/l	38.0	0.2	1.6	4.3	7.3	39.3
CONDL	uS/cm	45.0	306.0	358.0	365.0	374.0	402.0
PHF	s.u.	45.0	6.7	7.3	7.4	7.5	8.0
TEMP	Deg C	44.0	21.0	21.6	21.7	21.7	22.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for TEL from November, 1992 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	55.0	0.0	0.3	0.4	0.5	0.9
NATOT	mg/l	55.0	2.4	2.9	3.1	3.6	6.3
MGTOT	mg/l	55.0	7.0	16.0	16.6	18.0	28.7
CATOT	mg/l	55.0	38.0	54.2	57.4	60.9	119.0
CLTOT	mg/l	55.0	1.0	5.3	6.0	6.4	9.0
FTOT	mg/l	52.0	0.1	0.2	0.2	0.2	0.3
SO4TOT	mg/l	55.0	13.4	40.4	42.7	45.8	53.0
TKN	mg/l	54.0	0.0	0.0	0.1	0.1	0.4
NOXNTOT	mg/l	57.0	0.5	2.0	2.2	2.5	3.3
PTOT	mg/l	55.0	0.0	0.0	0.0	0.1	0.1
OPO4DISS	mg/l	55.0	0.0	0.0	0.0	0.0	0.1
COLITOT	#/100ML	7.0	*	*	*	*	*
COLIFEC	#100ML	7.0	*	*	*	*	*
FLOWCFS	CFS	31.0	18.1	24.3	28.9	36.9	51.0
TOC	mg/l	47.0	0.0	1.4	3.9	9.2	13.6
DOC	mg/l	37.0	0.4	2.0	6.3	8.1	12.1
CONDL	uS/cm	56.0	375.0	440.0	445.5	457.0	477.0
PHF	s.u.	56.0	6.8	7.1	7.2	7.3	7.4
TEMP	Deg C	55.0	15.0	21.1	21.3	21.5	21.9

*Less than 10 samples
NA - No samples

Descriptive Statistics for TRY from November, 1992 to December, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
KTOT	mg/l	56.0	0.1	0.6	0.7	0.8	1.2
NATOT	mg/l	56.0	1.7	2.4	2.7	0.8	1.2
MGTOT	mg/l	56.0	0.0	6.1	6.5	6.8	8.9
CATOT	mg/l	55.0	0.1	51.4	55.1	58.3	74.2
CLTOT	mg/l	56.0	2.0	5.1	5.7	6.0	12.2
FTOT	mg/l	49.0	0.0	0.1	0.1	0.1	0.2
SO4TOT	mg/l	56.0	8.5	10.4	11.0	12.0	14.9
TKN	mg/l	56.0	0.0	0.0	0.1	0.1	0.4
NOXNTOT	mg/l	59.0	0.9	1.5	1.7	2.0	2.8
PTOT	mg/l	56.0	0.0	0.0	0.0	0.0	0.1
OPO4DISS	mg/l	56.0	0.0	0.0	0.0	0.0	0.1
COLITOT	#/100ML	16.0	10.0	10.0	10.0	100.0	660.0
COLIFEC	#100ML	16.0	1.0	1.0	1.0	3.5	470.0
FLOWCFS	CFS	26.0	65.1	87.6	102.6	112.5	165.0
TOC	mg/l	48.0	0.0	1.4	3.0	7.3	14.9
DOC	mg/l	37.0	0.6	2.6	5.9	7.7	14.0
CONDL	uS/cm	57.0	219.0	350.0	356.0	363.0	379.0
PHF	s.u.	57.0	6.9	7.3	7.4	7.5	7.8
TEMP	Deg C	56.0	16.1	21.3	21.3	21.4	21.8

*Less than 10 samples
NA - No samples

St. Johns River Water Management District Springs

Descriptive Statistics for Alexander for the Period April, 1956 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	76.0	22.0	23.0	23.4	24.0	26.0
SCl	uS/cm	32.0	815.0	1038.0	1134.5	1163.0	1430.0
SCf	uS/cm	47.0	813.0	1024.0	1096.0	1156.0	1650.0
pH	s.u.	50.0	6.9	7.5	7.8	7.8	8.2
T-Alk	mg/l	40.0	73.0	78.0	80.2	81.0	115.0
D-NO3	mg/l	2.0	*	*	*	*	*
T-NO3	mg/l	3.0	*	*	*	*	*
D-NO3NO2	mg/l	33.0	0.0	0.0	0.1	0.1	0.1
T-NO3NO2	mg/l	1.0	*	*	*	*	*
T-P	mg/l	3.0	*	*	*	*	*
D-P	mg/l	0.0	NA	NA	NA	NA	NA
TOC	mg/l	4.0	*	*	*	*	*
Ca	mg/l	27.0	32.0	42.0	45.0	48.0	50.0
T-Ca	mg/l	22.0	41.0	43.0	45.0	46.0	48.8
Mg	mg/l	27.0	14.0	17.8	20.0	21.0	24.9
T-Mg	mg/l	24.0	19.0	19.8	20.3	21.3	22.0
T-Na	mg/l	24.0	114.7	127.5	135.1	138.0	153.4
Na	mg/l	27.0	100.0	122.5	131.0	140.0	162.0
K	mg/l	26.0	2.0	3.5	3.9	4.3	7.5
T-K	mg/l	24.0	3.2	3.7	4.0	4.2	4.6
TKN	mg/l	46.0	169.0	228.6	244.8	262.5	333.0
T-SO4	mg/l	43.0	51.0	66.0	63.0	69.0	81.9
F	mg/l	21.0	0.1	0.1	0.1	0.1	0.5
T-F	mg/l	22.0	0.1	0.1	0.1	0.1	0.3
Si	mg/l	9.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	32.0	3.0	4.0	4.1	4.6	12.0
T-Fe	ug/l	3.0	*	*	*	*	*
D-Fe	ug/l	4.0	*	*	*	*	*
D-Sr	ug/l	23.0	365.0	665.5	741.0	752.0	949.0
T-Sr	ug/l	24.0	408.0	711.8	739.5	773.5	894.0
TDS	mg/l	39.0	502.0	551.0	578.0	610.0	698.0
T-PO4	mg/l	22.0	0.0	0.0	0.0	0.1	0.1

*Less than 10 samples
NA - No samples

D = Dissolved, T = total

Descriptive Statistics for Apopka for the Period May, 1972 to May, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	72.0	17.0	22.5	24.0	25.0	27.5
SCl	uS/cm	62.0	210.0	235.0	245.0	250.0	300.0
SCf	uS/cm	3.0	*	*	*	*	*
pH	s.u.	64.0	6.8	8.0	8.2	8.6	91.0
T-Alk	mg/l	62.0	53.0	71.0	72.6	76.8	109.0
D-NO3	mg/l	1.0	*	*	*	*	*
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	51.0	2.5	3.5	4.4	4.9	10.8
T-NO3NO2	mg/l	27.0	3.6	4.7	4.9	5.1	5.4
T-P	mg/l	60.0	0.0	0.0	0.1	0.1	1.7
D-P	mg/l	47.0	0.0	0.0	0.0	0.0	0.3
TOC	mg/l	45.0	0.9	3.1	4.5	7.9	18.5
Ca	mg/l	73.0	18.0	26.0	28.0	29.6	43.0
T-Ca	mg/l	1.0	*	*	*	*	*
Mg	mg/l	73.0	5.0	7.4	7.9	8.6	12.4
T-Mg	mg/l	1.0	*	*	*	*	*
T-Na	mg/l	1.0	*	*	*	*	*
Na	mg/l	73.0	1.5	0.5	6.0	7.0	40.0
K	mg/l	49.0	0.4	1.5	2.0	3.3	17.6
T-K	mg/l	1.0	*	*	*	*	*
TKN	mg/l	64.0	7.0	12.0	13.5	17.0	27.0
T-SO4	mg/l	63.0	2.0	8.0	9.6	11.0	17.0
F	mg/l	3.0	*	*	*	*	*
T-F	mg/l	1.0	*	*	*	*	*
Si	mg/l	4.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	53.0	2.0	4.8	5.0	8.0	40.0
T-Fe	ug/l	0.0	NA	NA	NA	NA	NA
D-Fe	ug/l	5.0	*	*	*	*	*
D-Sr	ug/l	32.0	20.0	58.8	60.2	66.9	100.0
T-Sr	ug/l	1.0	*	*	*	*	*
TDS	mg/l	60.0	108.0	132.8	145.0	137.5	233.0
T-PO4	mg/l	51.0	0.0	0.0	0.0	0.0	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for Fern from April, 1970 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	58.0	20.4	2.4	21.8	22.0	23.0
SCl	uS/cm	30.0	60.0	111.3	115.5	118.9	188.0
SCf	uS/cm	40.0	60.0	113.5	118.0	122.3	244.0
pH	s.u.	46.0	5.1	7.7	8.0	8.3	8.5
T-Alk	mg/l	36.0	37.0	43.6	44.0	45.1	83.0
D-NO3	mg/l	0.0	NA	NA	NA	NA	NA
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	33.0	0.0	0.1	0.1	0.1	0.1
T-NO3NO2	mg/l	0.0	NA	NA	NA	NA	NA
T-P	mg/l	0.0	NA	NA	NA	NA	NA
D-P	mg/l	0.0	NA	NA	NA	NA	NA
TOC	mg/l	1.0	*	*	*	*	*
Ca	mg/l	21.0	9.0	12.0	12.0	13.0	20.0
T-Ca	mg/l	26.0	11.0	12.0	12.1	13.0	15.9
Mg	mg/l	21.0	4.1	4.4	4.6	4.8	5.8
T-Mg	mg/l	26.0	4.0	4.4	4.6	4.8	6.5
T-Na	mg/l	26.0	2.0	2.2	2.9	3.0	4.0
Na	mg/l	20.0	1.6	2.0	2.4	3.0	3.0
K	mg/l	12.0	0.2	0.3	0.3	0.4	0.5
T-K	mg/l	1.0	*	*	*	*	*
TKN	mg/l	36.0	3.0	4.0	4.7	5.5	11.7
T-SO4	mg/l	38.0	3.0	5.1	6.2	7.0	20.0
F	mg/l	11.0	0.1	0.1	0.1	0.1	0.2
T-F	mg/l	24.0	0.1	0.1	0.1	0.1	0.1
Si	mg/l	3.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	34.0	3.9	4.0	4.0	4.1	13.0
T-Fe	ug/l	2.0	*	*	*	*	*
D-Fe	ug/l	1.0	*	*	*	*	*
D-Sr	ug/l	14.0	23.0	52.0	73.0	89.8	136.0
T-Sr	ug/l	25.0	53.0	74.0	81.0	86.8	210.8
TDS	mg/l	36.0	49.0	61.0	67.0	75.3	152.0
T-PO4	mg/l	21.0	0.0	0.0	0.0	0.0	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for Juniper from November, 1908 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	64.0	20.0	21.5	21.9	22.0	25.1
SCl	uS/cm	31.0	100.0	110.0	116.0	119.0	183.0
SCf	uS/cm	43.0	105.0	116.0	118.0	122.5	159.0
pH	s.u.	55.0	5.8	7.7	8.1	8.4	8.8
T-Alk	mg/l	45.0	21.0	43.2	44.0	45.0	63.0
D-NO3	mg/l	4.0	*	*	*	*	*
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	33.0	0.1	0.1	0.1	0.1	0.1
T-NO3NO2	mg/l	1.0	*	*	*	*	*
T-P	mg/l	1.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	2.0	*	*	*	*	*
Ca	mg/l	30.0	9.0	12.0	13.0	13.8	20.0
T-Ca	mg/l	27.0	8.0	12.0	12.0	13.0	14.3
Mg	mg/l	28.0	3.9	4.4	4.5	4.9	5.7
T-Mg	mg/l	27.0	3.8	4.1	4.4	4.6	5.1
T-Na	mg/l	27.0	2.0	2.6	3.0	3.0	4.0
Na	mg/l	28.0	1.6	2.7	3.0	0.3	9.0
K	mg/l	20.0	0.2	0.3	0.4	0.4	0.9
T-K	mg/l	1.0	*	*	*	*	*
TKN	mg/l	44.0	3.5	4.0	4.8	5.0	13.0
T-SO4	mg/l	44.0	4.0	6.0	6.1	8.0	42.0
F	mg/l	16.0	0.1	0.1	0.1	0.1	0.2
T-F	mg/l	26.0	0.1	0.1	0.1	0.1	0.1
Si	mg/l	11.0	5.0	8.5	8.8	9.2	10.0
Si(SIO3 as Si)	mg/l	35.0	3.9	4.0	4.8	5.0	13.0
T-Fe	ug/l	4.0	*	*	*	*	*
D-Fe	ug/l	1.0	*	*	*	*	*
D-Sr	ug/l	16.0	33.0	58.0	67.5	80.0	120.0
T-Sr	ug/l	26.0	45.0	69.8	78.2	81.0	107.0
TDS	mg/l	39.0	33.0	61.5	68.0	75.0	94.0
T-PO4	mg/l	22.0	0.0	0.0	0.0	0.0	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for Miami from October, 1960 to May, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	53.0	23.5	24.0	24.4	25.0	27.5
SCl	uS/cm	12.0	254.0	260.8	268.0	269.8	282.0
SCf	uS/cm	19.0	184.0	235.0	256.0	266.0	275.0
pH	s.u.	20.0	5.8	7.2	7.5	7.6	8.2
T-Alk	mg/l	14.0	81.0	108.2	109.9	111.2	113.8
D-NO3	mg/l	1.0	*	*	*	*	*
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	12.0	0.0	0.1	0.1	0.2	0.4
T-NO3NO2	mg/l	0.0	NA	NA	NA	NA	NA
T-P	mg/l	0.0	NA	NA	NA	NA	NA
D-P	mg/l	0.0	NA	NA	NA	NA	NA
TOC	mg/l	0.0	NA	NA	NA	NA	NA
Ca	mg/l	6.0	*	*	*	*	*
T-Ca	mg/l	12.0	28.0	32.8	33.6	35.5	37.1
Mg	mg/l	6.0	*	*	*	*	*
T-Mg	mg/l	12.0	8.5	8.6	8.9	9.4	9.8
T-Na	mg/l	12.0	5.0	5.7	6.0	6.1	7.0
Na	mg/l	6.0	*	*	*	*	*
K	mg/l	4.0	*	*	*	*	*
T-K	mg/l	7.0	*	*	*	*	*
TKN	mg/l	16.0	5.5	10.0	10.1	10.6	11.0
T-SO4	mg/l	17.0	3.0	8.0	9.1	9.7	17.0
F	mg/l	5.0	*	*	*	*	*
T-F	mg/l	12.0	0.2	0.2	0.2	0.2	0.2
Si	mg/l	4.0	8.0	8.4	8.7	8.9	8.9
Si(SIO3 as Si)	mg/l	12.0	4.0	4.0	4.2	4.3	8.0
T-Fe	ug/l	3.0	*	*	*	*	*
D-Fe	ug/l	1.0	*	*	*	*	*
D-Sr	ug/l	4.0	*	*	*	*	*
T-Sr	ug/l	12.0	160.0	176.4	180.9	187.2	218.0
TDS	mg/l	13.0	120.0	136.0	144.0	148.0	168.0
T-PO4	mg/l	11.0	0.1	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for Palm from April, 1956 to May, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	76.0	23.0	24.0	24.0	24.3	27.4
SCl	uS/cm	12.0	313.0	324.8	333.5	339.8	354.0
SCf	uS/cm	23.0	221.0	294.0	320.0	332.0	1790.0
pH	s.u.	22.0	5.9	7.1	7.3	7.6	8.4
T-Alk	mg/l	16.0	89.0	113.3	118.3	120.7	121.2
D-NO3	mg/l	2.0	*	*	*	*	*
T-NO3	mg/l	2.0	*	*	*	*	*
D-NO3NO2	mg/l	11.0	0.5	0.6	0.6	0.7	0.9
T-NO3NO2	mg/l	0.0	NA	NA	NA	NA	NA
T-P	mg/l	3.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	0.0	NA	NA	NA	NA	NA
Ca	mg/l	9.0	*	*	*	*	*
T-Ca	mg/l	11.0	34.0	38.0	40.0	41.4	43.4
Mg	mg/l	9.0	*	*	*	*	*
T-Mg	mg/l	11.0	10.9	11.2	11.6	12.2	13.1
T-Na	mg/l	11.0	8.0	8.8	9.0	9.3	11.7
Na	mg/l	9.0	*	*	*	*	*
K	mg/l	9.0	*	*	*	*	*
T-K	mg/l	9.0	*	*	*	*	*
TKN	mg/l	16.0	7.5	13.3	15.0	15.0	320.0
T-SO4	mg/l	19.0	12.0	20.0	22.7	23.8	320.0
F	mg/l	8.0	*	*	*	*	*
T-F	mg/l	12.0	0.2	0.2	0.2	0.2	0.2
Si	mg/l	8.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	11.0	4.0	4.2	4.4	4.5	8.0
T-Fe	ug/l	3.0	*	*	*	*	*
D-Fe	ug/l	2.0	*	*	*	*	*
D-Sr	ug/l	7.0	*	*	*	*	*
T-Sr	ug/l	11.0	302.0	333.4	354.0	364.4	373.5
TDS	mg/l	16.0	130.0	172.5	181.5	204.0	1130.0
T-PO4	mg/l	13.0	0.1	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples
SCl = specific conductance (lab)
SCf = specific conductance (field)

Descriptive Statistics for PDL from March, 1932 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	182.0	21.0	22.9	23.0	23.5	25.0
SCl	uS/cm	26.0	573.0	712.5	797.5	866.3	1062.0
SCf	uS/cm	147.0	256.0	550.0	593.0	700.0	1062.0
pH	s.u.	51.0	6.9	7.3	7.5	7.7	8.4
T-Alk	mg/l	49.0	99.0	107.0	106.8	119.7	126.0
D-NO3	mg/l	3.0	*	*	*	*	*
T-NO3	mg/l	2.0	*	*	*	*	*
D-NO3NO2	mg/l	33.0	0.6	0.8	0.9	1.0	1.3
T-NO3NO2	mg/l	0.0	NA	NA	NA	NA	NA
T-P	mg/l	2.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	1.0	*	*	*	*	*
Ca	mg/l	33.0	39.0	42.0	47.0	49.0	57.0
T-Ca	mg/l	23.0	44.0	48.0	51.0	52.0	54.0
Mg	mg/l	34.0	3.7	9.8	11.0	13.0	18.0
T-Mg	mg/l	25.0	11.1	12.4	13.3	15.0	19.0
T-Na	mg/l	25.0	60.4	74.0	81.8	94.3	135.0
Na	mg/l	34.0	21.0	57.3	65.0	80.8	135.0
K	mg/l	31.0	1.1	3.4	3.8	4.7	6.4
T-K	mg/l	24.0	1.7	4.0	4.3	4.7	5.7
TKN	mg/l	50.0	39.0	93.3	110.0	143.5	272.0
T-SO4	mg/l	51.0	10.0	19.5	24.0	30.5	43.0
F	mg/l	27.0	0.0	0.0	0.1	0.2	0.2
T-F	mg/l	23.0	0.1	0.1	0.1	0.1	0.1
Si	mg/l	17.0	5.6	6.4	6.7	7.0	8.0
Si(SIO3 as Si)	mg/l	34.0	3.0	3.0	3.3	3.8	10.0
T-Fe	ug/l	5.0	*	*	*	*	*
D-Fe	ug/l	25.0	0.0	10.0	50.0	50.0	56.0
D-Sr	ug/l	20.0	0.0	291.0	318.0	350.0	460.0
T-Sr	ug/l	24.0	142.0	327.9	356.6	386.5	484.0
TDS	mg/l	45.0	203.0	333.0	388.0	443.0	612.0
T-PO4	mg/l	20.0	0.0	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for Rock from February, 1931 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	151.0	21.5	23.5	23.8	24.0	28.5
SCl	uS/cm	31.0	224.0	248.0	255.0	260.5	300.0
SCf	uS/cm	73.0	210.0	230.0	248.0	256.0	356.0
pH	s.u.	70.0	6.4	7.3	7.5	7.7	8.2
T-Alk	mg/l	56.0	66.0	85.0	87.9	89.0	117.3
D-NO3	mg/l	8.0	*	*	*	*	*
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	32.0	1.2	1.5	1.5	1.6	1.8
T-NO3NO2	mg/l	1.0	*	*	*	*	*
T-P	mg/l	1.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	3.0	*	*	*	*	*
Ca	mg/l	43.0	24.0	28.0	29.0	30.0	35.0
T-Ca	mg/l	27.0	26.0	29.0	30.0	30.6	47.4
Mg	mg/l	44.0	7.1	8.1	8.5	9.0	11.6
T-Mg	mg/l	33.0	8.0	8.8	9.1	9.4	11.0
T-Na	mg/l	27.0	4.0	5.0	5.0	5.4	9.1
Na	mg/l	44.0	1.9	4.6	5.0	5.0	6.0
K	mg/l	42.0	0.3	0.7	1.0	1.2	2.5
T-K	mg/l	26.0	1.1	1.2	1.3	1.5	1.9
TKN	mg/l	64.0	5.0	7.5	8.0	9.0	24.0
T-SO4	mg/l	64.0	15.0	17.0	18.0	20.0	24.0
F	mg/l	38.0	0.0	0.2	0.2	0.3	0.3
T-F	mg/l	33.0	1.2	1.4	1.5	1.5	1.6
Si	mg/l	26.0	1.5	9.0	9.5	9.9	11.0
Si(SIO3 as Si)	mg/l	36.0	4.0	4.0	4.9	5.0	14.0
T-Fe	ug/l	3.0	*	*	*	*	*
D-Fe	ug/l	10.0	0.0	0.0	1.5	17.5	30.0
D-Sr	ug/l	28.0	35.0	127.8	169.0	192.3	350.0
T-Sr	ug/l	26.0	122.0	155.3	168.7	172.8	185.0
TDS	mg/l	55.0	118.0	134.5	143.0	148.0	289.0
T-PO4	mg/l	20.0	0.1	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for Salt from April, 1956 to May, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	66.0	22.8	23.5	23.7	24.0	29.6
SCl	uS/cm	32.0	4730.0	5486.0	5900.0	6580.0	7160.0
SCf	uS/cm	45.0	412.0	5190.0	5790.0	6360.0	7300.0
pH	s.u.	56.0	6.1	7.2	7.6	7.7	8.4
T-Alk	mg/l	48.0	55.0	64.0	65.0	66.1	78.6
D-NO3	mg/l	4.0	*	*	*	*	*
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	38.0	0.0	0.1	0.1	0.1	0.2
T-NO3NO2	mg/l	5.0	*	*	*	*	*
T-P	mg/l	6.0	*	*	*	*	*
D-P	mg/l	4.0	*	*	*	*	*
TOC	mg/l	1.0	*	*	*	*	*
Ca	mg/l	31.0	98.0	137.0	160.0	171.5	200.0
T-Ca	mg/l	26.0	121.6	144.8	155.3	166.8	193.0
Mg	mg/l	31.0	70.0	87.2	98.0	109.5	144.0
T-Mg	mg/l	25.0	71.1	87.6	99.9	107.0	122.9
T-Na	mg/l	26.0	627.0	818.0	923.5	1010.0	1141.0
Na	mg/l	32.0	480.0	826.0	939.0	1060.8	1350.0
K	mg/l	31.0	18.0	24.1	30.2	34.6	59.2
T-K	mg/l	24.0	20.1	26.4	29.0	32.1	35.9
TKN	mg/l	49.0	1120.0	1550.0	1750.0	1916.8	2480.0
T-SO4	mg/l	49.0	277.0	358.0	403.2	432.0	526.0
F	mg/l	20.0	0.0	0.1	0.1	0.1	240.0
T-F	mg/l	27.0	0.1	0.1	0.1	0.1	0.1
Si	mg/l	16.0	3.2	10.0	10.5	11.3	12.0
Si(SIO3 as Si)	mg/l	31.0	4.0	5.0	5.0	5.2	14.0
T-Fe	ug/l	11.0	18.0	52.8	61.0	66.7	82.0
D-Fe	ug/l	5.0	*	*	*	*	*
D-Sr	ug/l	26.0	2187.0	2829.3	3246.0	3588.0	6000.0
T-Sr	ug/l	26.0	2630.0	3067.5	3371.0	3553.5	4303.0
TDS	mg/l	42.0	2560.0	3132.5	3425.0	3810.0	4600.0
T-PO4	mg/l	16.0	0.0	0.0	0.0	0.0	0.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Sanlando from April, 1956 to May, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	74.0	23.0	24.0	24.0	24.5	28.5
SCl	uS/cm	12.0	303.0	337.8	346.0	358.3	378.0
SCf	uS/cm	20.0	211.0	285.0	302.5	335.3	363.0
pH	s.u.	22.0	5.6	6.9	7.1	7.4	8.1
T-Alk	mg/l	16.0	85.0	108.8	130.5	137.0	140.1
D-NO3	mg/l	2.0	*	*	*	*	*
T-NO3	mg/l	3.0	*	*	*	*	*
D-NO3NO2	mg/l	12.0	*	*	*	*	*
T-NO3NO2	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	4.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	1.0	*	*	*	*	*
Ca	mg/l	NA	NA	NA	NA	NA	NA
T-Ca	mg/l	11.0	37.0	40.0	41.0	43.7	45.3
Mg	mg/l	9.0	*	*	*	*	*
T-Mg	mg/l	11.0	10.9	11.1	11.7	12.2	12.8
T-Na	mg/l	11.0	9.0	9.4	10.3	11.0	12.5
Na	mg/l	9.0	*	*	*	*	*
K	mg/l	9.0	*	*	*	*	*
T-K	mg/l	11.0	*	*	*	*	*
TKN	mg/l	19.0	8.5	13.0	17.0	17.3	19.1
T-SO4	mg/l	20.0	0.0	10.8	12.0	13.2	19.0
F	mg/l	8.0	*	*	*	*	*
T-F	mg/l	12.0	0.2	0.2	0.2	0.2	0.2
Si	mg/l	8.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	11.0	4.0	4.0	4.1	4.2	7.0
T-Fe	ug/l	2.0	50.0	53.3	56.5	59.8	63.0
D-Fe	ug/l	3.0	*	*	*	*	*
D-Sr	ug/l	7.0	*	*	*	*	*
T-Sr	ug/l	12.0	60.0	81.4	83.0	85.5	86.7
TDS	mg/l	15.0	146.0	176.0	188.0	197.5	206.0
T-PO4	mg/l	14.0	0.1	0.2	0.2	0.2	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for Silver Glen from April, 1972 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	59.0	20.5	23.0	23.1	23.5	26.0
SCl	uS/cm	25.0	1652.0	1950.0	1987.0	2050.0	2271.0
SCf	uS/cm	40.0	1910.0	1960.0	2000.0	2080.0	2400.0
pH	s.u.	47.0	6.2	7.5	7.7	7.9	8.5
T-Alk	mg/l	35.0	62.0	66.0	67.3	68.5	80.0
D-NO3	mg/l	0.0	NA	NA	NA	NA	NA
T-NO3	mg/l	1.0	*	*	*	*	*
D-NO3NO2	mg/l	30.0	0.0	0.0	0.0	0.0	0.1
T-NO3NO2	mg/l	1.0	*	*	*	*	*
T-P	mg/l	3.0	*	*	*	*	*
D-P	mg/l	0.0	NA	NA	NA	NA	NA
TOC	mg/l	4.0	*	*	*	*	*
Ca	mg/l	20.0	55.0	67.8	72.5	75.0	83.0
T-Ca	mg/l	25.0	67.5	70.0	71.5	74.5	77.6
Mg	mg/l	20.0	23.0	33.8	36.6	38.0	52.0
T-Mg	mg/l	25.0	30.3	34.0	35.2	36.4	38.0
T-Na	mg/l	25.0	227.3	247.5	253.0	261.0	287.0
Na	mg/l	20.0	230.0	249.3	270.0	283.5	412.0
K	mg/l	19.0	8.2	8.8	9.3	9.8	21.6
T-K	mg/l	25.0	8.1	8.5	8.7	9.1	12.3
TKN	mg/l	37.0	394.0	452.9	471.0	494.0	707.0
T-SO4	mg/l	36.0	160.0	177.8	184.3	191.8	214.0
F	mg/l	14.0	0.0	0.1	0.1	0.1	0.5
T-F	mg/l	23.0	0.1	0.1	0.1	0.1	0.1
Si	mg/l	6.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	28.0	4.0	4.0	4.3	4.8	10.0
T-Fe	ug/l	2.0	*	*	*	*	*
D-Fe	ug/l	4.0	*	*	*	*	
D-Sr	ug/l	19.0	1066.0	1380.0	1480.0	1570.0	1660.0
T-Sr	ug/l	25.0	1310.0	1470.0	1501.0	1552.0	1710.0
TDS	mg/l	32.0	1000.0	1060.0	1105.0	1140.0	1220.0
T-PO4	mg/l	24.0	0.0	0.0	0.0	0.0	0.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Starbuck from July, 1944 to May, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	71.0	23.0	24.0	24.0	24.1	26.5
SCl	uS/cm	12.0	333.0	349.0	356.5	359.0	380.0
SCf	uS/cm	17.0	257.0	298.0	331.0	350.0	376.0
pH	s.u.	21.0	6.4	7.2	7.3	7.4	8.0
T-Alk	mg/l	16.0	98.0	116.0	119.5	122.8	125.0
D-NO3	mg/l	1.0	*	*	*	*	*
T-NO3	mg/l	2.0	*	*	*	*	*
D-NO3NO2	mg/l	12.0	0.3	0.3	0.4	0.5	0.7
T-NO3NO2	mg/l	1.0	*	*	*	*	*
T-P	mg/l	3.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	0.0	NA	NA	NA	NA	NA
Ca	mg/l	7.0	*	*	*	*	*
T-Ca	mg/l	11.0	35.0	39.2	40.4	42.7	43.9
Mg	mg/l	7.0	*	*	*	*	*
T-Mg	mg/l	11.0	10.7	11.0	11.6	12.2	12.6
T-Na	mg/l	11.0	11.0	12.0	12.0	12.5	13.0
Na	mg/l	7.0	*	*	*	*	*
K	mg/l	7.0	*	*	*	*	*
T-K	mg/l	11.0	1.2	1.3	1.4	1.5	1.9
TKN	mg/l	18.0	12.0	18.2	19.6	20.5	21.0
T-SO4	mg/l	19.0	12.0	20.3	23.0	24.0	28.0
F	mg/l	6.0	*	*	*	*	*
T-F	mg/l	12.0	0.2	0.2	0.2	0.2	0.2
Si	mg/l	6.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	11.0	4.0	4.2	4.4	4.6	8.0
T-Fe	ug/l	1.0	*	*	*	*	*
D-Fe	ug/l	2.0	*	*	*	*	*
D-Sr	ug/l	6.0	*	*	*	*	*
T-Sr	ug/l	11.0	233.0	293.0	305.3	308.9	335.5
TDS	mg/l	15.0	148.0	179.0	192.0	203.0	213.0
T-PO4	mg/l	13.0	0.1	0.2	0.2	0.2	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for Sweetwater from November, 1980 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	51.0	22.0	23.0	23.2	23.3	24.5
SCl	uS/cm	27.0	3306.0	3700.0	3820.0	4002.0	4322.0
SCf	uS/cm	29.0	3520.0	3860.0	4050.0	4220.0	4350.0
pH	s.u.	45.0	6.3	7.3	7.6	7.7	8.1
T-Alk	mg/l	33.0	64.0	71.0	72.0	73.1	110.0
D-NO3	mg/l	0.0	NA	NA	NA	NA	NA
T-NO3	mg/l	0.0	NA	NA	NA	NA	NA
D-NO3NO2	mg/l	32.0	0.0	0.0	0.0	0.4	0.1
T-NO3NO2	mg/l	1.0	*	*	*	*	*
T-P	mg/l	1.0	*	*	*	*	*
D-P	mg/l	1.0	*	*	*	*	*
TOC	mg/l	1.0	*	*	*	*	*
Ca	mg/l	18.0	97.0	105.0	110.0	117.5	133.0
T-Ca	mg/l	27.0	99.0	101.5	104.0	106.9	116.0
Mg	mg/l	17.0	49.6	62.0	64.6	69.5	91.2
T-Mg	mg/l	25.0	54.5	58.3	60.2	62.1	67.1
T-Na	mg/l	25.0	504.0	530.0	558.0	570.0	622.0
Na	mg/l	18.0	524.0	586.0	617.0	630.5	705.0
K	mg/l	18.0	17.2	18.5	18.9	20.2	24.8
T-K	mg/l	26.0	12.9	17.4	18.0	18.6	22.9
TKN	mg/l	36.0	846.0	1030.8	1064.7	1120.0	2160.0
T-SO4	mg/l	37.0	224.0	252.0	262.0	277.0	296.0
F	mg/l	13.0	0.1	0.1	0.1	0.1	0.1
T-F	mg/l	24.0	0.1	0.1	0.1	0.1	0.1
Si	mg/l	4.0	*	*	*	*	*
Si(SIO3 as Si)	mg/l	32.0	4.0	4.0	4.0	4.4	13.0
T-Fe	ug/l	4.0	*	*	*	*	*
D-Fe	ug/l	4.0	*	*	*	*	*
D-Sr	ug/l	17.0	1150.0	2160.0	2250.0	2480.0	4730.0
T-Sr	ug/l	27.0	1714.0	2181.0	2252.0	2337.5	4940.0
TDS	mg/l	33.0	2000.0	2070.0	2155.0	2260.0	2510.0
T-PO4	mg/l	21.0	0.0	0.0	0.0	0.0	0.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Vol Blue Spring for the Period

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	311.0	21.5	23.0	23.0	23.5	26.0
SCl	uS/cm	18.0	268.0	278.0	725.0	2081.3	23.2
SCf	uS/cm	299.0	220.0	1400.0	1676.2	1985.0	2610.0
pH	s.u.	57.0	6.5	7.3	7.4	7.6	8.2
T-Alk	mg/l	43.0	94.0	106.0	119.0	125.0	158.0
D-NO3	mg/l	2.0	*	*	*	*	*
T-NO3	mg/l	15.0	0.0	0.1	0.1	0.2	0.7
D-NO3NO2	mg/l	25.0	0.0	0.8	0.4	0.5	14.5
T-NO3NO2	mg/l	7.0	*	*	*	*	*
T-P	mg/l	31.0	0.0	0.1	0.1	0.1	0.1
D-P	mg/l	6.0	*	*	*	*	*
TOC	mg/l	15.0	0.0	3.0	5.0	6.1	72.0
Ca	mg/l	52.0	30.0	55.8	60.0	63.0	87.0
T-Ca	mg/l	10.0	36.6	39.4	41.0	64.3	68.0
Mg	mg/l	52.0	4.9	20.0	24.0	28.0	38.7
T-Mg	mg/l	10.0	5.9	6.3	116.8	29.4	34.7
T-Na	mg/l	10.0	6.0	6.1	110.1	228.5	310.0
Na	mg/l	52.0	4.3	139.8	190.0	240.0	324.0
K	mg/l	48.0	0.6	6.3	7.4	87.0	11.7
T-K	mg/l	5.0	7.8	7.8	9.0	10.0	10.2
TKN	mg/l	98.0	7.0	320.0	393.5	478.3	1000.0
T-SO4	mg/l	58.0	4.4	37.0	52.0	63.0	94.0
F	mg/l	44.0	0.0	0.1	0.1	0.1	0.4
T-F	mg/l	6.0	*	*	*	*	*
Si	mg/l	37.0	7.4	8.3	8.4	8.6	11.0
Si(SIO3 as Si)	mg/l	14.0	4.0	4.0	5.1	5.3	13.0
T-Fe	ug/l	12.0	10.0	10.0	40.0	70.0	670.0
D-Fe	ug/l	22.0	0.0	10.0	10.0	27.5	100.0
D-Sr	ug/l	42.0	66.0	800.0	864.0	1000.0	1580.0
T-Sr	ug/l	10.0	65.1	67.8	478.0	968.8	1166.0
TDS	mg/l	54.0	120.0	588.0	814.0	924.0	1200.0
T-PO4	mg/l	31.0	0.0	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for Wekiwa from April, 1956 to March, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	142.0	22.0	23.5	23.6	24.0	25.0
SCl	uS/cm	35.0	252.0	306.0	316.0	326.5	398.0
SCf	uS/cm	74.0	192.0	250.0	276.5	310.5	341.0
pH	s.u.	67.0	6.5	7.2	7.3	7.5	8.2
T-Alk	mg/l	56.0	72.0	98.0	110.0	113.4	128.0
D-NO3	mg/l	5.0	*	*	*	*	*
T-NO3	mg/l	3.0	*	*	*	*	*
D-NO3NO2	mg/l	33.0	0.6	1.5	1.6	1.7	2.0
T-NO3NO2	mg/l	2.0	*	*	*	*	*
T-P	mg/l	4.0	*	*	*	*	*
D-P	mg/l	2.0	*	*	*	*	*
TOC	mg/l	6.0	*	*	*	*	*
Ca	mg/l	42.0	19.0	30.3	33.0	36.8	40.0
T-Ca	mg/l	27.0	25.6	34.5	37.0	38.3	40.4
Mg	mg/l	43.0	8.1	9.1	9.8	10.4	12.3
T-Mg	mg/l	27.0	7.7	10.2	10.6	11.0	11.8
T-Na	mg/l	27.0	4.7	8.0	8.6	9.0	10.1
Na	mg/l	42.0	3.0	5.9	6.8	8.0	10.0
K	mg/l	41.0	0.4	1.0	1.3	1.4	3.1
T-K	mg/l	27.0	1.3	1.5	1.5	1.7	2.0
TKN	mg/l	63.0	7.0	10.0	13.0	14.0	27.0
T-SO4	mg/l	63.0	6.0	13.0	17.0	19.0	21.0
F	mg/l	35.0	0.1	0.1	0.2	0.3	0.4
T-F	mg/l	24.0	0.1	0.1	0.2	0.2	0.2
Si	mg/l	24.0	6.4	9.0	9.4	10.0	11.0
Si(SIO3 as Si)	mg/l	36.0	4.0	4.0	4.7	5.0	14.0
T-Fe	ug/l	7.0	*	*	*	*	*
D-Fe	ug/l	16.0	*	*	*	*	*
D-Sr	ug/l	28.0	49.0	104.8	127.0	143.8	310.0
T-Sr	ug/l	26.0	92.0	121.9	129.5	136.7	188.9
TDS	mg/l	55.0	101.0	148.5	166.0	177.0	203.0
T-PO4	mg/l	26.0	0.1	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Southwest Florida Water Management District

Descriptive Stats. for Betty Jay from January, 1995 to July, 2000

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	35	21.4	22.8	23.2	23.0	26.6
SCf	uS/cm	35	415.0	443.0	636.0	973.0	1921.0
pH	s.u.	35	6.9	7.3	7.4	7.4	7.6
Bicarb	mg/l	35	157.0	165.0	167.0	171.0	190.0
D-NO3	mg/l	35	0.2	0.2	0.3	0.3	0.4
T-NO3	mg/l	34	0.2	0.2	0.3	0.3	0.4
T-P	mg/l	35	0.0	0.0	0.0	0.0	0.1
D-NO3NO2	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	19	0.0	0.0	0.2	0.7	3.0
D-PO4	mg/l	35	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	35	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	22	0.3	0.4	0.5	0.6	0.8
TOC	mg/l	35	0.3	0.7	1.6	7.0	27.0
Ca	mg/l	35	54.0	57.0	60.7	63.4	77.9
Mg	mg/l	35	10.0	11.8	15.6	21.6	40.1
Na	mg/l	35	14.0	17.0	47.0	101.0	248.0
K	mg/l	35	0.4	0.7	2.0	3.8	9.7
D-SO4	mg/l	35	8.3	11.0	23.0	33.1	70.4
F	mg/l	30	0.1	0.1	0.2	0.2	0.2
Cl	mg/l	34	24.0	31.4	81.3	183.5	468.0
D-Fe	ug/l	35	25.0	30.0	30.0	59.0	111.0
D-Sr	ug/l	29	50.0	50.0	210.0	310.0	820.0
TDS	mg/l	35	230.0	264.0	345.0	539.0	1002.0

*Less than 10 samples
NA - No samples

D = Dissolved
T = Total
SCf = specific conductance (field)

Descriptive Statistics for Boat Sprig. from July, 1994 to Jan., 2002

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	21	22.3	22.9	23.5	24.4	25.3
SCf	uS/cm	21	378.0	597.0	854.0	1110.0	1304.0
pH	s.u.	20	7.2	7.5	7.6	7.6	7.9
Bicarb	mg/l	21	101.0	116.0	118.0	121.5	128.0
D-NO3	mg/l	20	0.3	0.3	0.4	0.4	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	21	0.0	0.0	0.0	0.0	0.2
D-NO3NO2	mg/l21	21	0.3	0.3	0.4	0.4	0.5
T-P	mg/l	21	0.0	0.0	0.0	0.0	0.1
D-PO4	mg/l	21	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	21	0.0	0.0	0.0	0.0	0.2
T-N	mg/l	7	*	*	*	*	*
TOC	mg/l	21	0.3	0.4	0.5	0.7	0.9
Ca	mg/l	21	43.0	47.0	50.4	52.8	58.1
Mg	mg/l	21	5.4	8.4	14.4	21.6	39.0
Na	mg/l	21	21.0	47.1	99.1	160.5	304.0
K	mg/l	21	0.9	1.8	3.8	6.0	12.5
D-SO4	mg/l	21	12.0	19.1	31.7	45.7	77.2
F	mg/l	20	0.0	0.1	0.1	0.1	0.1
Cl	mg/l	21	37.0	80.8	179.0	297.0	550.0
D-Fe	ug/l	20	25.0	30.0	30.0	30.0	72.0
D-Sr	ug/l	15	50.0	50.0	50.0	350.0	530.0
TDS	mg/l	21	209.0	285.5	450.0	657.0	1139.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Bobhill from July, 1994 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	33	22.0	24.0	24.4	25.0	26.7
SCf	uS/cm	33	256.0	263.0	275.0	290.5	383.0
pH	s.u.	32	7.1	7.4	7.6	7.7	7.8
Bicarb	mg/l	33	81.0	111.0	114.0	123.5	213.0
D-NO3	mg/l	32	0.2	0.5	0.6	0.7	0.9
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	21	0.0	0.0	0.1	0.3	0.5
D-NO3NO2	mg/l	33	0.2	0.5	0.6	0.7	0.9
T-P	mg/l	33	0.0	0.0	0.0	0.0	0.1
D-PO4	mg/l	32	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	32	0.0	0.0	0.0	0.0	0.3
T-N	mg/l	18	.05	0.7	0.8	0.9	1.2
TOC	mg/l	33	0.3	0.6	0.9	4.5	4.8
Ca	mg/l	33	42.0	45.5	47.9	50.4	74.1
Mg	mg/l	33	2.7	3.2	3.4	3.5	3.8
Na	mg/l	33	3.3	3.7	3.9	4.8	7.2
K	mg/l	33	0.1	0.3	0.4	0.5	1.1
D-SO4	mg/l	33	6.3	7.9	8.6	9.3	10.9
F	mg/l	32	0.0	0.0	0.1	0.1	1.2
Cl	mg/l	32	5.7	6.3	6.6	8.7	16.6
D-Fe	ug/l	32	25.0	30.0	42.0	70.3	12200.0
D-Sr	ug/l	26	50.0	50.0	210.0	282.0	450.0
TDS	mg/l	33	123.0	150.0	161.0	174.0	259.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Boyette Spring. from April, 1991 to July, 2002

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	69	18.8	23.5	24.0	24.3	25.0
SCf	uS/cm	68	5.02	538.3	550.0	600.0	629.0
pH	s.u.	69	6.1	6.5	6.6	6.6	6.8
Bicarb	mg/l	59	119.0	125.0	130.0	137.0	153.0
D-NO3	mg/l	67	4.1	11.0	12.3	14.0	18.6
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	20	0.0	0.2	0.3	0.8	3.5
D-NO3NO2	mg/l	69	4.1	11.0	12.3	14.0	18.6
T-P	mg/l	67	0.1	0.1	0.1	0.2	0.9
D-PO4	mg/l	68	0.1	0.1	0.1	0.1	0.2
T-NH3	mg/l	67	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	40	6.9	10.1	13.0	14.0	18.0
TOC	mg/l	60	0.3	1.6	1.8	2.0	5.2
Ca	mg/l	59	43.2	47.1	49.1	52.0	64.5
Mg	mg/l	59	17.4	18.3	19.3	20.9	23.0
Na	mg/l	59	12.4	16.1	16.5	18.3	25.0
K	mg/l	59	18.0	22.1	23.0	25.0	27.3
D-SO4	mg/l	59	39.8	47.0	50.1	52.0	62.0
F	mg/l	54	0.1	0.2	0.3	0.3	0.5
Cl	mg/l	59	18.9	23.0	27.8	32.0	42.6
D-Fe	ug/l	58	20.0	30.0	30.0	30.0	60.0
D-Sr	ug/l	33	50.0	50.0	50.0	210.0	300.0
TDS	mg/l	59	279.0	306.0	329.0	362.0	456.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Bubbling Spring. from Oct., 1993 to July, 2002

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	36	22.2	22.8	23.0	23.2	25.6
SCf	uS/cm	36	306.0	312.3	318.8	328.0	354.0
pH	s.u.	35	7.3	7.5	7.5	7.6	8.0
Bicarb	mg/l	34	135.0	140.8	144.0	152.8	173.0
D-NO3	mg/l	34	1.0	1.1	1.2	1.2	1.7
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	18	0.0	0.0	0.0	0.1	1.3
D-NO3NO2	mg/l	34	1.0	1.1	1.2	1.2	1.7
T-P	mg/l	35	0.0	0.0	0.0	00.0	0.3
D-PO4	mg/l	35	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	33	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	21	1.0	1.2	1.2	1.5	2.2
TOC	mg/l	36	0.1	0.3	0.3	0.5	1.8
Ca	mg/l	36	48.0	53.6	56.0	58.4	62.9
Mg	mg/l	36	4.8	5.6	6.0	6.2	6.7
Na	mg/l	35	2.5	2.8	2.9	3.2	4.2
K	mg/l	35	0.0	0.0	0.1	0.2	0.5
D-SO4	mg/l	35	6.2	6.7	7.2	7.9	10.0
F	mg/l	30	0.0	0.1	0.1	0.1	0.2
Cl	mg/l	36	4.0	4.6	5.0	5.5	6.7
D-Fe	ug/l	36	25.0	30.0	30.0	30.0	51.0
D-Sr	ug/l	28	50.0	50.0	210.0	210.0	422.0
TDS	mg/l	36	162.0	174.3	178.5	186.0	245.0
D-SiO2	mg/l	5	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for Buckhorn Spring. from July, 1994 to Jan., 2002

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	44	21.2	24.1	24.5	24.9	29.7
SCf	uS/cm	44	436.2	469.5	478.5	508.3	1241.0
pH	s.u.	44	7.2	7.4	7.5	7.5	7.6
Bicarb	mg/l	40	100.0	114.2	117.0	120.8	131.0
D-NO3	mg/l	42	0.8	1.3	2.0	2.2	3.7
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	27	0.0	0.0	0.2	.03	1.4
D-NO3NO2	mg/l	43	0.8	1.4	2.0	2.2	3.7
T-P	mg/l	43	0.0	0.0	0.0	0.0	1.1
D-PO4	mg/l	44	0.0	0.0	0.0	0.0	0.4
T-NH3	mg/l	43	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	21	1.8	1.9	2.2	2.7	2.8
TOC	mg/l	40	0.2	0.3	0.5	0.6	3.2
Ca	mg/l	40	44.0	60.0	61.6	65.4	82.0
Mg	mg/l	40	10.0	11.5	11.8	12.4	27.0
Na	mg/l	40	12.9	14.6	15.6	17.1	132.0
K	mg/l	40	0.3	0.6	0.7	1.0	4.6
D-SO4	mg/l	40	58.9	62.7	65.3	68.0	137.0
F	mg/l	34	0.1	0.2	0.2	0.2	0.6
Cl	mg/l	40	24.0	28.6	31.0	34.6	225.0
D-Fe	ug/l	40	20.0	25.0	30.0	30.0	50.0
D-Sr	ug/l	29	50.0	375.0	780.0	945.0	1200.0
TDS	mg/l	40	257.0	276.3	284.5	300.5	685.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Catfish from April, 1991 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	27	21.6	23.4	23.8	24.0	27.1
SCf	uS/cm	27	280.0	299.0	321.0	371.0	928.0
pH	s.u.	27	7.7	7.9	8.0	8.0	8.3
Bicarb	mg/l	26	64.0	77.0	79.0	84.3	98.0
D-NO3	mg/l	26	0.2	0.2	0.2	0.2	0.3
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	21	0.0	0.1	0.1	0.2	0.3
D-NO3NO2	mg/l	27	0.2	0.2	0.2	0.2	0.3
T-P	mg/l	27	0.0	0.0	0.0	0.0	0.1
D-PO4	mg/l	27	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	26	0.0	0.0	0.0	0.0	0.3
T-N	mg/l	9	*	*	*	*	*
TOC	mg/l	26	0.1	0.3	0.5	0.5	2.0
Ca	mg/l	26	27.0	29.0	30.6	32.0	36.0
Mg	mg/l	26	6.6	7.4	7.8	8.8	18.0
Na	mg/l	26	16.0	17.3	21.0	28.5	113.0
K	mg/l	26	0.5	0.6	0.7	0.9	4.0
D-SO4	mg/l	25	14.6	17.0	18.0	19.6	39.0
F	mg/l	23	0.0	0.1	0.1	0.1	1.2
Cl	mg/l	26	26.0	32.0	36.5	50.7	208.0
D-Fe	ug/l	25	20.0	29.5	30.0	30.0	294.0
D-Sr	ug/l	17	50.0	50.0	50.0	210.0	700.0
TDS	mg/l	26	145.0	167.5	177.5	194.3	488.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Chassahowitzka No. 1; Oct., 1993 to July, 2003
(Discharge data from March, 1997 to Dec., 2003)

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	38	20.4	23.2	23.4	23.5	24.8
SCf	uS/cm	38	497.0	658.8	893.5	1396.5	2510.0
pH	s.u.	38	6.7	7.5	7.6	7.6	8.1
Bicarb	mg/l	36	139.0	143.0	146.0	151.8	162.0
D-NO3	mg/l	37	0.1	0.4	0.5	0.5	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	21	0.0	0.1	0.1	0.2	0.6
D-NO3NO2	mg/l	38	0.1	0.5	0.5	0.5	0.5
T-P	mg/l	38	0.0	0.0	0.0	0.0	0.3
D-PO4	mg/l	38	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	37	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	22	0.3	0.5	0.6	0.6	0.9
TOC	mg/l	38	0.0	0.0	0.0	0.5	2.2
Ca	mg/l	37	48.8	51.0	54.6	60.4	73.6
Mg	mg/l	38	11.3	15.2	19.2	28.4	53.5
Na	mg/l	38	34.0	56.9	95.9	166.3	368.0
K	mg/l	38	1.2	2.3	3.2	6.6	13.4
D-SO4	mg/l	38	12.8	20.6	31.5	48.0	98.5
F	mg/l	36	0.1	0.1	0.1	0.2	0.6
Cl	mg/l	38	60.0	108.3	175.5	310.0	653.0
D-Fe	ug/l	38	25.0	25.0	30.0	30.0	63.0
D-Sr	ug/l	28	50.0	50.0	210.0	257.5	437.0
TDS	mg/l	38	259.0	361.3	475.0	720.8	1320.0
Discharge	CFS	70	34.0	48.8	56.0	65.3	80.0

*Less than 10 samples
NA - No samples

Descript. Stats. for Chassahowitzka Main; Oct., 1993 to July, 2003
(Discharge from March, 1997 to Dec., 2003)

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	38	22.6	23.3	23.5	23.8	24.4
SCf	uS/cm	38	588.0	1132.0	2325.0	3395.0	6390.0
pH	s.u.	38	7.2	7.4	7.5	7.6	7.8
Bicarb	mg/l	37	132.0	140.0	143.0	149.5	191.0
D-NO3	mg/l	37	0.0	0.4	0.4	0.5	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	21	0.0	0.1	0.1	0.2	1.8
D-NO3NO2	mg/l	38	0.0	0.4	0.4	0.5	0.5
T-P	mg/l	38	0.0	0.0	0.0	0.1	1.1
D-PO4	mg/l	38	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	37	0.0	0.0	0.0	0.0	1.2
T-N	mg/l	21	0.3	0.5	0.5	0.6	2.4
TOC	mg/l	38	0.2	0.3	0.5	0.5	4.1
Ca	mg/l	38	49.1	53.2	63.8	73.8	101.0
Mg	mg/l	38	12.7	21.9	45.5	68.8	130.0
Na	mg/l	38	47.7	119.3	313.5	498.3	1030.0
K	mg/l	38	2.2	4.6	12.0	20.6	38.7
D-SO4	mg/l	38	15.8	36.8	86.7	145.3	261.0
F	mg/l	33	0.1	0.1	0.1	0.2	0.2
Cl	mg/l	38	82.3	213.8	590.1	929.8	1870.0
D-Fe	ug/l	38	25.0	30.0	30.0	40.5	60.0
D-Sr	ug/l	29	50.0	50.0	380.0	685.0	1400.0
TDS	mg/l	38	293.0	539.0	1209.0	1865.0	3560.0
Discharge	CFS	70	34.0	48.8	56.0	65.3	80.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Hidden River No. 2; July, 1994 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	38	22.8	23.2	23.4	23.6	24.8
SCf	uS/cm	38	1466.0	2048.0	2615.0	3611.0	6500.0
pH	s.u.	37	7.4	7.6	7.6	7.8	7.9
Bicarb	mg/l	38	111.0	117.8	121.0	127.0	143.0
D-NO3	mg/l	37	0.4	0.6	0.6	0.7	0.8
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	20	0.0	0.0	0.1	0.2	1.8
D-NO3NO2	mg/l	38	0.4	0.6	0.6	0.7	0.8
T-P	mg/l	38	0.0	0.0	0.0	0.0	0.1
D-PO4	mg/l	38	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	38	0.0	0.0	0.0	0.0	0.2
T-N	mg/l	23	0.5	0.6	0.7	0.8	1.
TOC	mg/l	38	0.2	0.3	0.4	0.5	1.6
Ca	mg/l	38	43.0	52.9	63.5	80.2	97.6
Mg	mg/l	38	30.0	40.58	50.5	71.8	114.0
Na	mg/l	38	193.0	281.0	391.5	535.3	915.0
K	mg/l	38	7.7	11.0	13.0	19.5	35.4
D-SO4	mg/l	38	54.0	80.3	101.2	136.8	231.0
F	mg/l	33	0.0	0.1	0.1	0.1	0.5
Cl	mg/l	38	319.0	50.30	694.0	1002.5	1680.0
D-Fe	ug/l	38	25.0	28.8	30.0	30.0	104.0
D-Sr	ug/l	NA	NA	NA	NA	NA	NA
TDS	mg/l	38	580.0	52.8	1239.5	1661.0	2616.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Hidden River Head Spring.; July, 1994 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	37	22.1	23.2	23.4	23.6	25.0
SCf	uS/cm	37	1024.0	1369.0	1960.0	2630.0	3900.0
pH	s.u.	36	7.5	7.6	7.7	7.7	8.0
Bicarb	mg/l	36	108.0	117.0	119.5	127.8	141.0
D-NO3	mg/l	35	0.5	0.6	0.6	0.7	0.8
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	20	0.0	0.0	0.1	0.2	1.1
D-NO3NO2	mg/l	37	0.5	0.6	0.6	0.7	1.7
T-P	mg/l	37	0.0	0.0	0.0	0.0	0.1
D-PO4	mg/l	37	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	36	0.0	0.0	0.0	0.0	0.2
T-N	mg/l	22	0.5	0.7	0.8	0.8	1.1
TOC	mg/l	37	0.2	0.3	0.4	0.5	1.7
Ca	mg/l	37	37.1	47.0	57.7	70.1	96.1
Mg	mg/l	37	21.0	26.4	35.2	54.9	75.3
Na	mg/l	37	127.0	174.5	254.0	377.5	551.0
K	mg/l	37	1.8	6.7	8.6	14.0	19.0
D-SO4	mg/l	37	37.0	50.5	74.0	106.5	155.0
F	mg/l	32	0.0	0.1	0.1	0.1	0.2
Cl	mg/l	37	221.0	321.5	475.0	703.0	1070.0
D-Fe	ug/l	37	25.0	25.0	30.0	30.0	70.0
D-Sr	ug/l	NA	NA	NA	NA	NA	NA
TDS	mg/l	37	338.0	616.5	836.0	1273.5	2113.0

NA - No samples
*Less than 10 samples

Descriptive Stats. for Homosassa 1 from November, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	37	20.8	23.3	23.4	23.6	24.3
SCf	uS/cm	37	2620	3470	3980	4890	7140
pH	s.u.	37	6.8	7.6	7.6	7.7	7.8
Bicarb	mg/l	36	105	106.8	109	112.8	128
D-NO3	mg/l	36	0.2	0.4	0.4	0.5	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	37	0.0	0.0	0.0	0.0	0.3
D-NO3NO2	mg/l	NA	NA	NA	NA	NA	NA
TKN	mg/l	20	0.0	0.1	0.1	0.2	0.3
D-PO4	mg/l	37	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	36	0.0	0.0	0.0	0.0	0.0
T-N	mg/l	16	0.4	0.5	0.5	0.6	0.7
TOC	mg/l	37	0.3	0.5	0.5	0.8	2.1
Ca	mg/l	37	51	58	65.4	75.7	123
Mg	mg/l	37	49	66.8	78.9	103	141
Na	mg/l	37	377	512	601	798	1100
K	mg/l	37	14	19	23.9	30.2	48.5
D-SO4	mg/l	37	104	129	169	215	282
F	mg/l	37	0.0	0.1	0.1	0.2	0.6
Cl	mg/l	37	692	930	1145	1400	2074
D-Fe	ug/l	37	25	50	60	100	223
D-Sr	ug/l	29	50	50	450	950	2270
TDS	mg/l	37	1359	1799	2090	2698	4066

*Less than 10 samples
NA - No samples

Descriptive Stats. for Homosassa 2 from November, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	35	20.4	23.2	23.4	23.7	24.3
SCf	uS/cm	35	4850	5568.5	5900	6290	8690
pH	s.u.	35	6.5	7.6	7.6	7.6	7.8
Bicarb	mg/l	34	89	109	111	115	130
D-NO3	mg/l	34	0.2	0.4	0.4	0.5	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	35	0.0	0.0	0.0	0.0	1.7
D-NO3NO2	mg/l	35	0.2	0.4	0.4	0.5	0.5
TKN	mg/l	20	0.0	0.1	0.1	0.3	0.5
D-PO4	mg/l	35	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	35	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	20	0.5	0.5	0.6	0.6	1.0
TOC	mg/l	35	0.3	0.5	0.7	1.0	2.3
Ca	mg/l	35	69	76.8	80.1	88.4	141
Mg	mg/l	35	95	109	114	129	172
Na	mg/l	35	767	889.5	942	1007	1440
K	mg/l	35	24	33.2	35	39.1	60.7
D-SO4	mg/l	35	193	223.5	243	269	382
F	mg/l	30	0.0	0.1	0.1	0.2	0.5
Cl	mg/l	35	1418	1610	1680	1834	2583
D-Fe	ug/l	35	25	60	108	132.5	250
D-Sr	ug/l	27	50	275.5	1010	1330	2630
TDS	mg/l	35	2282	3021	3180	3548	5934

*Less than 10 samples
NA - No samples

Descriptive Stats. for Homosassa 3 from November, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	37	21.1	23.3	23.4	23.7	24.2
SCf	uS/cm	37	868	1300	1604	2330	3000
pH	s.u.	37	7.2	7.6	7.7	7.8	7.8
Bicarb	mg/l	36	82	103	105	109.5	124
D-NO3	mg/l	36	0.3	0.5	0.5	0.5	0.6
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	37	0.0	0.0	0.0	0.0	0.1
D-NO3NO2	mg/l	37	0.3	0.4	0.5	0.5	0.6
TKN	mg/l	20	0.0	0.1	0.1	0.1	0.8
D-PO4	mg/l	37	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	36	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	22	0.5	0.5	0.6	0.6	1.5
TOC	mg/l	37	0.2	0.4	0.5	1	3.1
Ca	mg/l	37	38	42.3	46	50.2	68.1
Mg	mg/l	37	17	25.8	31.7	44.1	70.3
Na	mg/l	36	101	168.25	214	352.5	469
K	mg/l	37	3.6	6.7	8.1	13	18.6
D-SO4	mg/l	37	30.8	45.7	63	93.8	121
F	mg/l	32	0.0	0.1	0.1	0.1	1.36
Cl	mg/l	37	181	289	397	579	831
D-Fe	ug/l	37	17.4	25	30	30	60
D-Sr	ug/l	29	50	50	250	400	600
TDS	mg/l	37	444	655	841	1214	1618

*Less than 10 samples
NA - No samples

Descriptive Stats. for Hunters from February, 1991 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	32	22.3	23.5	23.8	24.0	25.4
SCf	uS/cm	32	270	337.3	373	466.5	634
pH	s.u.	32	7.8	8.0	8	8.1	8.3
Bicarb	mg/l	32	65.6	79	80.4	83.2	91.9
D-NO3	mg/l	31	0.2	0.3	0.4	0.4	0.4
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	32	0.0	0.0	0.0	0.0	0.1
D-NO3NO2	mg/l	32	0.2	0.3	0.3	0.4	0.4
TKN	mg/l	17	0.0	0.1	0.1	0.1	1.7
D-PO4	mg/l	32	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	31	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	19	0.3	0.4	0.4	0.5	0.9
TOC	mg/l	32	0.1	0.3	0.4	0.5	1.1
Ca	mg/l	32	28	29.8	31	32.5	37.5
Mg	mg/l	32	5.8	7.0	8.1	9.4	11.8
Na	mg/l	32	16.5	25	31.5	45.3	68.9
K	mg/l	32	0.4	0.8	1.2	1.7	2.7
D-SO4	mg/l	32	10	13.7	14.7	17.6	21
F	mg/l	27	0.1	0.1	0.1	0.1	0.1
Cl	mg/l	32	28	44.1	57.2	80	123
D-Fe	ug/l	31	20	25	30	30	43.1
D-Sr	ug/l	21	50	210	210	250	590
TDS	mg/l	32	136	176.3	205	252	345

*Less than 10 samples
NA - No samples

Descriptive Stats. for Lithia Main from April, 1991 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	44	23.8	24.9	25	25.4	29.1
SCf	uS/cm	44	400	455.3	485	505	545
pH	s.u.	44	7.0	7.4	7.5	7.5	7.6
Bicarb	mg/l	40	106	110	113	119	126
D-NO3	mg/l	43	1.7	2.8	3.0	3.3	4.4
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	43	0.0	0.1	0.1	0.1	0.8
D-NO3NO2	mg/l	43	1.7	2.8	3.0	3.3	4.4
TKN	mg/l	26	0.0	0.1	0.1	0.1	0.9
D-PO4	mg/l	44	0.0	0.0	0.1	0.1	0.1
T-NH3	mg/l	42	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	22	2.2	2.9	3.0	3.4	5.2
TOC	mg/l	40	0.2	0.5	0.5	0.7	1.9
Ca	mg/l	40	58	65.1	67.1	70.5	81.2
Mg	mg/l	40	8.5	9.5	10.8	11.4	12.8
Na	mg/l	40	12	13	14	15.3	17
K	mg/l	40	0.3	0.7	0.7	0.8	1.1
D-SO4	mg/l	40	51.5	64.5	74	82.3	91
F	mg/l	34	0.2	0.2	0.3	0.3	0.5
Cl	mg/l	40	21	27.0	29.1	31.1	36.1
D-Fe	ug/l	39	0.0	25.0	30.0	30.0	0.5
D-Sr	ug/l	29	50	700	1190	1430	1840
TDS	mg/l	40	207	280.8	297.5	308.3	337

*Less than 10 samples
NA - No samples

Descriptive Stats. for Magnolia from October, 1994 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	36	23.1	23.6	24	24.4	25.7
SCf	uS/cm	36	318	380.5	425.5	495.3	632
pH	s.u.	35	7.5	7.7	7.7	8.1	8.1
Bicarb	mg/l	35	96	104	106	108.5	122
D-NO3	mg/l	35	0.3	0.4	0.4	0.5	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	36	0.0	0.0	0.0	0.0	0.1
D-NO3NO2	mg/l	36	0.3	0.4	0.4	0.5	0.5
TKN	mg/l	19	0.0	0.1	0.1	0.1	1.6
D-PO4	mg/l	35	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	35	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	22	0.3	0.5	0.5	0.6	0.7
TOC	mg/l	36	0.2	0.3	0.3	0.5	1.7
Ca	mg/l	36	40	42	44.3	47.1	53.8
Mg	mg/l	36	4.9	5.8	6.5	7.8	9.7
Na	mg/l	36	14	23.3	30	39.9	61.2
K	mg/l	36	0.3	0.9	1.1	1.5	2.5
D-SO4	mg/l	36	11.8	13.8	15.7	18.0	23.0
F	mg/l	31	0.0	0.1	0.1	0.1	0.1
Cl	mg/l	36	24.2	41.4	55.6	70.6	112.0
D-Fe	ug/l	36	25.0	25.0	30.0	30.0	90.0
D-Sr	ug/l	29	50.0	50.0	250.0	330.0	770.0
TDS	mg/l	36	164.0	202.3	237.5	266.0	334.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Pump House from October, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	26	19.9	21.7	22.9	23.6	24.5
SCf	uS/cm	26	361.0	456.5	663.4	660.3	2930.0
pH	s.u.	26	7.5	7.6	7.7	7.7	7.8
Bicarb	mg/l	25	111	116	118	12	134
D-NO3	mg/l	25	0.3	0.4	0.4	0.5	0.5
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	26	0.0	0.0	0.0	0.0	0.1
D-NO3NO2	mg/l	26	0.3	0.4	0.4	0.4	0.5
TKN	mg/l	20	0.0	0.1	0.1	0.2	0.4
D-PO4	mg/l	26	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	26	0.0	0.0	0.0	0.0	0.2
T-N	mg/l	10	0.5	0.5	0.5	0.6	1.3
TOC	mg/l	26	0.3	0.5	0.9	1.2	3.9
Ca	mg/l	26	39.0	41.1	44.5	47	51.6
Mg	mg/l	26	8.7	9.9	11.0	13.6	19.2
Na	mg/l	26	26.9	33.4	44.5	60.9	116.7
K	mg/l	26	0.8	1.2	1.3	2.0	4.0
D-SO4	mg/l	26	9.6	12.0	14.9	20.5	32.5
F	mg/l	18	0.1	0.1	0.1	0.1	0.2
Cl	mg/l	26	49.4	58.3	82.5	115.8	206.1
D-Fe	ug/l	26	25.0	30.0	30.0	30.0	66.0
D-Sr	ug/l	15	50.0	50.0	50.0	145.0	300.0
TDS	mg/l	26	213.0	251.0	279.0	340.5	506.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Rainbow 1 from October, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	37	22.8	23.4	23.5	23.8	25.0
SCf	uS/cm	37	127.0	147.0	152.0	159.0	196.0
pH	s.u.	34	7.7	8.0	8.1	8.2	8.7
Bicarb	mg/l	36	49.0	57.2	61.0	64.1	82.0
D-NO3	mg/l	34	0.5	0.9	1.1	1.2	1.9
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	35	0.0	0.0	0.0	0.0	0.2
D-NO3NO2	mg/l	34	0.5	0.9	1.1	1.2	1.9
TKN	mg/l	19	0.0	0.1	0.1	0.1	0.5
D-PO4	mg/l	36	0.0	0.0	0.0	0.0	0.1
T-NH3	mg/l	33	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	21	0.9	1.1	1.3	1.5	2.2
TOC	mg/l	37	0.0	0.3	0.3	0.5	1.6
Ca	mg/l	37	17.5	21.0	23.5	25.3	31.0
Mg	mg/l	37	3.0	3.4	3.6	3.8	4.6
Na	mg/l	37	1.9	2.2	2.4	2.5	2.7
K	mg/l	37	0.0	0.1	0.1	0.1	0.4
D-SO4	mg/l	37	3.8	4.4	4.6	4.8	7.5
F	mg/l	31	0.0	0.1	0.1	0.1	0.9
Cl	mg/l	37	2.7	3.4	3.8	4.1	5.4
D-Fe	ug/l	37	25.0	25.0	30.0	30.0	71.0
D-Sr	ug/l	28	50.0	50.0	210.0	210.0	309.0
TDS	mg/l	37	73.0	87.0	92.0	100.0	112.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Rainbow NO 4 from October, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	39	22.7	23.2	23.4	23.7	24.3
SCf	uS/cm	39	228.0	233.0	237.0	247.5	272.0
pH	s.u.	36	7.4	7.7	7.8	7.8	8.2
Bicarb	mg/l	38	93.0	101.3	104.0	107.8	129.0
D-NO3	mg/l	34	0.6	1.3	1.3	1.4	2.4
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	34	0.0	0.0	0.0	0.0	6.0
D-NO3NO2	mg/l	35	0.6	1.3	1.3	1.4	2.4
TKN	mg/l	21	0.0	0.1	0.1	0.3	0.9
D-PO4	mg/l	36	0.0	0.0	0.0	0.0	5.9
T-NH3	mg/l	34	0.0	0.0	0.0	0.0	0.0
T-N	mg/l	19	1.3	1.3	1.6	1.7	2.8
TOC	mg/l	38	0.1	0.3	0.5	0.5	1.4
Ca	mg/l	39	35.0	38.35	41.6	42.2	46.9
Mg	mg/l	39	3.5	4.5	4.9	5.0	5.4
Na	mg/l	39	2.0	2.5	2.6	2.8	3.0
K	mg/l	39	0.0	0.1	0.1	0.1	0.4
D-SO4	mg/l	39	3.7	4.3	4.5	5.0	7.2
F	mg/l	32	0.0	0.1	0.1	0.1	0.4
Cl	mg/l	39	3.2	4.0	4.2	4.8	6.0
D-Fe	ug/l	39	25.0	30.0	30.0	30.0	42.5
D-Sr	ug/l	21	50.0	50.0	210.0	220.0	530.0
TDS	mg/l	39	121.0	130.5	134.0	142.5	159.0

*Less than 10 samples
NA - No samples

Descriptive Stats. for Rainbow 6 from October, 1993 to July, 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	39	22.8	23.5	23.6	23.9	24.8
SCf	uS/cm	39	279.0	314.5	321.0	335.0	352.0
pH	s.u.	36	7.4	7.6	7.7	7.7	7.9
Bicarb	mg/l	38	96.0	109.0	113.5	121.5	132.0
D-NO3	mg/l	36	0.7	0.8	0.9	0.9	2.0
T-NO3	mg/l	NA	NA	NA	NA	NA	NA
T-P	mg/l	37	0.0	0.0	0.0	0.0	0.2
D-NO3NO2	mg/l	37	0.7	0.8	0.9	0.9	2.0
TKN	mg/l	21	0.0	0.1	0.1	0.2	1.2
D-PO4	mg/l	38	0.0	0.0	0.0	0.0	0.0
T-NH3	mg/l	36	0.0	0.0	0.0	0.0	0.1
T-N	mg/l	20	0.8	1.0	1.0	1.1	1.3
TOC	mg/l	39	0.1	0.3	0.3	0.5	1.3
Ca	mg/l	39	46.9	50.8	52.6	57.1	61.7
Mg	mg/l	39	5.2	6.1	6.3	6.8	7.2
Na	mg/l	39	3.0	3.5	3.6	3.9	4.2
K	mg/l	39	0.0	0.2	0.2	0.3	0.6
D-SO4	mg/l	39	27.0	35.0	36.2	38.2	44.9
F	mg/l	33	0.1	0.1	0.1	0.1	0.2
Cl	mg/l	39	4.6	5.5	6.0	6.4	7.7
D-Fe	ug/l	39	25.0	30.0	30.0	30.0	0.2
D-Sr	ug/l	29	50.0	50.0	220.0	490.0	706.0
TDS	mg/l	39	161.0	184.0	192.0	202.0	260.0

*Less than 10 samples
NA - No samples

Descriptive Statistics for Rainbow Bridge Seep Dates October 1994- January 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	26	22.4	23.175	23.4	23.5	24.4
Cond(field)	uS/cm	26	122	123	125	126.25	131
pH	s.u.	25	7.9	8.18	8.27	8.365	8.73
Bicarb	mg/l	25	40	48	49.2	51	75
D-TKN	mg/l	18	0.012	0.05	0.05	0.3495	0.91
T-NH3	mg/l	22	0.006	0.01	0.01	0.0165	0.32
D-NO3NO2	mg/l	23	0.442	0.47	0.521	0.594	0.814
T-P	mg/l	24	0.01	0.0263	0.031	0.0553	2.81
D-PO4	mg/l	25	0.013	0.023	0.027	0.035	0.066
TOC	mg/l	26	0.3	0.3	0.5	0.5	1.7
D-Ca	mg/l	26	15	17.475	18	19	21.1
D-Mg	mg/l	26	2.77	2.96	3.095	3.3	3.6
D-Na	mg/l	26	1.7	1.9975	2.03	2.1	2.41
D-K	mg/l	26	0.05	0.05	0.085	0.1	0.335
D-Cl	mg/l	26	2.4	2.875	3.1	3.385	3.65
D-SO4	mg/l	26	3.4	3.923	4.105	4.303	7.68
D-F	mg/l	24	-99.9	0.0525	0.061	0.0775	0.17
TDS	mg/l	26	60	72	78.5	86.23	111
T-N	mg/l	7	0.54	0.66	0.75	0.8	0.83
D-NO3	mg/l	22	0.44	0.469	0.509	0.5813	0.814
D-Fe	µg/l	26	22	30	30	30	80
D-Sr	µg/l	16	50	50	50	170	262

*Less than 10 samples
NA - No samples

Descriptive Statistics for Rainbow Swamp Spring No. 3 from February 1994- July 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Bicarb	Deg C	16	74	96.25	98.5	105	111
Cond(field)	uS/cm	16	137	239.75	246.5	256.75	294
D-Ca	s.u.	16	39	41	42.95	45.825	47.4
D-Cl	mg/l	16	3.6	4.393	4.515	4.975	6.12
D-F	mg/l	14	-99.9	0.0575	0.07	0.09	0.1
D-Fe	mg/l	16	25	26.25	30	30	67
D-K	mg/l	15	0.05	0.05	0.15	0.2	0.46
D-Mg	mg/l	16	3	3.4475	3.615	3.9425	4.11
D-Na	mg/l	16	2	2.5925	2.7	2.77	3.02
D-NO3	mg/l	16	1.1	1.221	1.31	1.3925	1.96
D-NO3NO2	mg/l	16	1.1	1.219	1.31	1.3925	1.96
D-PO4	mg/l	16	0.025	0.03025	0.034	0.04075	0.05
D-SO4	mg/l	16	9.7	11	11.6	12.375	13.5
D-Sr	mg/l	8	50	50	210	240	361
pH	mg/l	16	7.14	7.6925	7.79	7.8275	7.9
TDS	mg/l	16	130	136	142.5	148	159
Temp	mg/l	16	22.8	23.14	23.4	23.5	23.94
TKN	mg/l	9	0.005	0.031	0.08	0.231	0.885
T-N	mg/l	7	1.1	1.32	1.516	1.6	1.76
T-NH3	mg/l	15	0.006	0.01	0.01	0.01	0.068
TOC	µg/l	16	0.3	0.3	0.5	0.5	0.68
T-P	µg/l	15	0.027	0.032	0.035	0.05	0.107

*Less than 10 samples
NA - No samples

Descriptive Statistics for Salt Spring Dates: October 1994- January 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	24	23.4	23.6	23.85	24	26
Cond(field)	uS/cm	24	2570	4562	5975	9165	12270
pH	s.u.	24	7.12	7.5225	7.555	7.6175	7.65
Bicarb	mg/l	23	117	123	125	127	136
D-TKN	mg/l	19	0.04	0.05	0.204	0.36	2.786
T-NH3	mg/l	24	0.01	0.01	0.0265	0.04	0.1
D-NO3NO2	mg/l	24	0.347	0.41625	0.443	0.48575	0.548
T-P	mg/l	24	0.01	0.01	0.014	0.02675	0.187
D-PO4	mg/l	24	0.01	0.01	0.01	0.013	0.031
TOC	mg/l	24	0.3	0.5	0.53	0.6175	1.66
D-Ca	mg/l	24	65	75	98.65	109.25	176
D-Mg	mg/l	24	49	90.9	128	180	236
D-Na	mg/l	24	344	696	1029	1609	2385
D-K	mg/l	24	14	25.73	38.15	57.9	79
D-Cl	mg/l	24	608	1237	1623	2874	3920
D-SO4	mg/l	24	95	185.6	271.5	394	560
D-F	mg/l	22	0.002	0.1085	0.135	0.1718	0.48
TDS	mg/l	24	1300	2493	3301	4964	6891
T-N	mg/l	8	0.56	0.5765	0.605	0.8025	0.99
D-NO3	mg/l	24	-99.99	0.413	0.44	0.486	0.548
D-Fe	µg/l	24	30	43.25	61	83.75	113
D-Sr	µg/l	16	50	133	1075	1365	2030

*Less than 10 samples
NA - No samples

Descriptive Statistics for Tarpon Hole Spring Dates: February 1994- July 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	42	22.9	23.475	23.695	23.9	25.4
Cond(field)	uS/cm	42	980	1430	1801	2509	6490
pH	s.u.	42	7.36	7.5375	7.64	7.71	7.91
Bicarb	mg/l	41	90.2	109.94	114.8	123	145
T-N	mg/l	22	0.18	0.21	0.2348	0.36	0.5
D-TKN	mg/l	23	0.006	0.05	0.05	0.18	0.965
T-NH3	mg/l	39	0.006	0.01	0.01	0.01	0.06
D-NO3	mg/l	40	0.019	0.15	0.1655	0.18243	0.216
D-NO3NO2	mg/l	41	0.019	0.15	0.169	0.184	0.22
T-P	mg/l	40	0.015	0.02625	0.034	0.04075	0.066
D-PO4	mg/l	41	0.013	0.0225	0.027	0.03	0.05
TOC	mg/l	41	0.24	0.34	0.5	0.545	11
D-Ca	mg/l	41	8.95	48	51.2	58.15	110
D-Mg	mg/l	41	6.61	25.7	32	46.85	132
D-Na	mg/l	41	114	190	243	391.1	1060
D-K	mg/l	41	2.01	6.47	9.1	14.56	38.2
D-Cl	mg/l	41	205	322	458	688.7	2160
D-SO4	mg/l	41	31.1	51	71.2	100.35	267
D-F	mg/l	35	0.002	0.086	0.1	0.114	0.197
D-Fe	mg/l	39	19.8	25	30	36	86.5
D-Sr	µg/l	29	50	50	300	450	1180
TDS	µg/l	41	11	711	888	1372	3568

*Less than 10 samples
NA - No samples

Descriptive Statistics for Trotter Main Spring Dates: November 1994- July 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	38	21.1	22.95	23.5	23.8	25.2
Cond(field)	uS/cm	38	329	406.3	458	694.3	1131
pH	s.u.	38	7.38	7.65	7.73	7.76	7.87
Bicarb	mg/l	37	96	107	111	114.5	126
T-N	mg/l	22	0.43	0.525	0.5862	0.645	0.87
D-TKN	mg/l	22	0.005	0.05	0.05	0.259	2.742
T-NH3	mg/l	37	0.006	0.01	0.01	0.013	0.07
D-NO3	mg/l	36	0.401	0.457	0.4805	0.53825	0.576
D-NO3NO2	mg/l	38	0.01	0.4525	0.4795	0.5428	0.576
T-P	mg/l	38	0.01	0.01775	0.0205	0.024	0.073
D-PO4	mg/l	38	0.01	0.01575	0.0195	0.024	0.06
TOC	mg/l	37	0.3	0.3	0.5	0.6	3.11
D-Ca	mg/l	38	36	38.95	41.55	43.6	57.4
D-Mg	mg/l	38	7.85	9.18	10.9	14.54	58.4
D-Na	mg/l	38	19.7	28	36.35	71	134
D-K	mg/l	38	0.5	1	1.285	2.638	4.76
D-Cl	mg/l	38	26	47	63	129	239
D-SO4	mg/l	38	8.24	11	13	22.93	43
D-F	mg/l	29	0.07	0.09	0.1	0.12	0.154
D-Fe	µg/l	38	25	25	30	30	118
D-Sr	µg/l	29	50	50	210	230	416
TDS	mg/l	38	182	225.5	252	372.5	594

*Less than 10 samples
NA - No samples

Descriptive Statistics for Weeki Wachee Main Spring Dates: October 1993- July 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	38	20.2	23.7	23.9	24.125	24.9
Cond(field)	uS/cm	38	296	303	309.5	320.25	326
pH	s.u.	37	7.23	7.495	7.6	7.68	7.93
Bicarb	mg/l	37	130	135	137	143.5	155
TKN	mg/l	22	0.005	0.05	0.118	0.372	2.197
T-NH3	mg/l	37	0.006	0.01	0.01	0.013	0.09
D-NO3NO2	mg/l	38	0.4	0.519	0.5695	0.6273	0.836
T-P	mg/l	38	0.01	0.01	0.01	0.0203	0.447
D-PO4	mg/l	38	0.01	0.01	0.01	0.012	0.055
TOC	mg/l	38	0.19	0.3	0.5	0.625	1.6
D-Ca	mg/l	38	48.8	50.075	52.3	54.36	59.7
D-Mg	mg/l	38	4.99	5.6075	5.945	6.205	6.74
D-Na	mg/l	38	3.5	3.8	3.905	4.2475	4.56
D-K	mg/l	38	0.05	0.2	0.28	0.315	0.6
D-Cl	mg/l	38	5	5.8	6.395	6.945	8.12
D-SO4	mg/l	38	7.1	8.4	8.96	9.238	11.3
D-F	mg/l	33	0.002	0.09	0.1	0.1125	0.26
TDS	mg/l	37	163	171.5	183	190.5	270
T-N	mg/l	22	0.46	0.6075	0.65	0.7333	1.1
D-NO3	mg/l	37	0.4	0.518	0.569	0.622	0.836
D-Fe	µg/l	38	25	30	30	30	60
D-Sr	µg/l	29	50	50	210	220	431

*Less than 10 samples
NA - No samples

Descriptive Statistics for Wilson Head Spring Dates: April 1993- July 2003

Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
Temp	Deg C	18	21.5	22.853	23.15	23.5	24.22
Cond(field)	uS/cm	18	336	374.75	378	381	393
pH	s.u.	18	7.07	7.2725	7.365	7.46	7.71
Bicarb	mg/l	18	160	163	168	180	187
D-TKN	mg/l	4	0.005	0.00675	0.012	0.012	0.012
T-NH3	mg/l	17	0.006	0.008	0.01	0.0195	0.038
D-NO3NO2	mg/l	18	0.61	0.6888	0.819	0.9733	1.3
T-P	mg/l	18	0.034	0.04025	0.043	0.04775	0.083
D-PO4	mg/l	17	0.034	0.036	0.039	0.0435	0.06
TOC	mg/l	18	0.244	0.3	0.3	0.443	1.91
D-Ca	mg/l	18	69.3	71.55	75.15	76.613	83.2
D-Mg	mg/l	18	1.6	2.035	2.13	2.1875	2.29
D-Na	mg/l	18	2.87	3.13	3.17	3.2425	3.36
D-K	mg/l	18	0.08	0.36	0.41	0.46	0.66
D-Cl	mg/l	18	5.83	6.16	6.34	6.6225	7.12
D-SO4	mg/l	18	11.9	12.075	12.45	12.808	13.7
D-F	mg/l	13	0.012	0.05	0.051	0.065	0.12
TDS	mg/l	18	207	216	220.5	226.5	251
T-N	mg/l	17	0.602	0.787	0.9	1.035	1.4
D-NO3	mg/l	17	0.61	0.715	0.84	0.9805	1.3
D-Fe	µg/l	18	25	25	25	30	46.1

*Less than 10 samples
NA - No samples

Wells

Northwest Florida Water Management District

Descriptive Statistics for 67

Dates: November, 1987 to June, 2003

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	124	13.0	20.3	21.5	22.7	24.5
1046	D-Fe	microg/l	21	3.0	5.0	6.0	10.0	202.0
1056	D-Mn	microg/l	9	*	*	*	*	*
29801	Bicarb	mg/l	19	103.0	126.0	130.0	131.0	153.0
299	DO	mg/l	106	0.0	2.4	3.3	4..4	7.7
31616	Fcol	#/100 ml	6	*	*	*	*	*
31649	Entero	#/100 ml	6	*	*	*	*	*
406	pH	ph units	125	5.9	7.5	1.0	1.8	60.0
4255	D-Alk	mg/l	2	*	*	*	*	*
530	Resid	mg/l	6	*	*	*	*	*
608	D-NH3	mg/l	8	*	*	*	*	*
618	D-NO3	mg/l	6	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	27	0.5	0.8	0.9	1.0	1.2
666	D-P	mg/l	8	*	*	*	*	*
671	D-PO4	mg/l	14	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	16	0.1	1.0	2.2	7.8	35.6
70300	TDS	mg/l	14	130.0	160.3	164.5	170.3	182.0
72109	DtoH2O	Ft	13	0.0	0.0	0.0	0.0	0.0
76	Turb	Turb units	9	*	*	*	*	*
81	Color	Pt-Co	6	*	*	*	*	*
82078	Turb(field)	Turb units	10	0.0	0.0	0.0	0.2	0.4
915	D-Ca	mg/l	27	37.0	40.0	40.8	42.0	43.0
925	D-Mg	mg/l	27	7.9	9.1	9.4	10.0	11.0
930	D-Na	mg/l	27	4.0	4.9	5.0	5.2	6.0
935	D-K	mg/l	27	0.1	0.5	0.5	0.8	1.0
94	Cond(field)	micromhos/cm	124	177.0	273.5	301.0	310.0	395.0
941	D-Cl	mg/l	27	6.8	7.4	7.7	7.9	8.5
946	D-SO4	mg/l	27	8.5	10.0	11.0	11.0	12.0
950	D-F	mg/l	27	0.1	0.1	0.2	0.2	0.3

*Less than 10 samples
NA - No samples

D = Dissolved
Q1 = 1st Quartile
Q3 = 3rd Quartile

Descriptive Statistics for 91 **Dates: August, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	170	18.5	20.5	21.0	21.4	22.5
1046	D-Fe	microg/l	28	3.0	8.8	16.1	30.7	130.0
1056	D-Mn	microg/l	13	1.0	1.2	2.5	5.1	16.0
29801	Bicarb	mg/l	28	110.0	121.8	138.0	146.5	160.0
299	DO	mg/l	148	0.0	2.0	3.6	5.8	8.3
31616	Fcol	#/100 ml	13	1.0	1.0	2.0	4.0	30.0
31649	Entero	#/100 ml	12	1.0	1.0	2.5	11.0	92.0
406	pH	ph units	169	2.7	7.0	7.2	7.4	7.8
4255	D-Alk	mg/l	4	120.0	123.9	140.6	156.9	160.0
530	Resid	mg/l	12	4.0	4.0	4.0	4.0	5.0
608	D-NH3	mg/l	18	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	8	0.1	0.1	0.6	1.1	1.2
620	D-NO3(N)	mg/l	3	0.1	0.1	0.2	1.8	3.4
631	D-NO3NO2	mg/l	40	0.0	0.0	0.1	0.3	1.1
666	D-P	mg/l	14	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	24	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	23	1.0	1.1	2.0	4.2	16.2
70300	TDS	mg/l	24	16.0	140.0	153.0	170.3	189.0
72109	DtoH2O	Ft	44	-18.8	16.9	18.9	20.0	22.3
76	Turb	Turb units	15	0.2	0.2	0.3	0.7	1.0
81	Color	Pt-Co	12	5.0	5.0	12.5	15.0	15.0
82078	Turb(field)	Turb units	10	0.0	0.0	0.0	0.4	2.2
915	D-Ca	mg/l	40	40.9	46.3	49.6	55.4	62.0
925	D-Mg	mg/l	40	1.4	2.2	3.0	4.3	5.5
930	D-Na	mg/l	40	1.7	2.7	3.0	3.2	4.4
935	D-K	mg/l	40	0.0	0.3	0.4	0.5	1.0
94	Cond(field)	micromhos/cm	170	180.0	249.8	274.5	298.0	401.0
941	D-Cl	mg/l	42	3.0	4.7	5.1	5.5	6.9
946	D-SO4	mg/l	41	2.1	3.6	4.3	5.0	6.4
950	D-F	mg/l	40	0.0	0.1	0.1	0.1	0.5

*Less than 10 samples
NA - No samples

Descriptive Statistics for 129 **Dates: April, 1986 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	101	20.0	22.0	22.3	22.5	27.4
1046	D-Fe	microg/l	28	1200.0	1300.0	1300.0	1400.0	1700.0
1056	D-Mn	microg/l	10	17.0	18.8	21.5	22.3	24.9
29801	Bicarb	mg/l	20	16.0	17.0	18.0	18.3	20.4
299	DO	mg/l	66	0.0	0.2	0.3	0.5	2.4
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	2	*	*	*	*	*
406	pH	ph units	101	4.9	5.5	5.6	5.6	6.4
4255	D-Alk	mg/l	2	*	*	*	*	*
530	Resid	mg/l	2	*	*	*	*	*
608	D-NH3	mg/l	7	*	*	*	*	*
618	D-NO3	mg/l	8	*	*	*	*	*
620	D-NO3(N)	mg/l	4	*	*	*	*	*
631	D-NO3NO2	mg/l	31	0.0	0.0	0.0	0.0	0.2
666	D-P	mg/l	5	*	*	*	*	*
671	D-PO4	mg/l	12	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	12	2.3	3.0	5.6	7.9	12.2
70300	TDS	mg/l	14	33.0	55.5	61.0	64.8	110.0
72109	DtoH2O	Ft	16	-15.5	17.5	18.5	19.6	22.5
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	3	*	*	*	*	*
82078	Turb(field)	Turb units	3	*	*	*	*	*
915	D-Ca	mg/l	30	2.6	2.7	2.9	3.2	5.0
925	D-Mg	mg/l	30	1.3	1.4	1.5	1.5	2.2
930	D-Na	mg/l	30	3.4	6.1	6.3	6.4	6.7
935	D-K	mg/l	30	1.4	2.0	2.1	2.3	2.5
94	Cond(field)	micromhos/cm	101	52.0	70.0	71.0	72.0	760.0
941	D-Cl	mg/l	73	6.4	8.7	8.9	9.0	9.8
946	D-SO4	mg/l	73	0.2	0.2	0.2	1.0	5.0
950	D-F	mg/l	30	0.0	0.1	0.1	0.1	0.2

*Less than 10 samples NA No sampless

Descriptive Statistics for 131 **Dates: April, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	131	18.9	21.3	21.5	21.8	23.1
1046	D-Fe	microg/l	27	57.6	474.0	500.0	520.0	573.0
1056	D-Mn	microg/l	10	1.9	2.9	3.0	8.3	11.2
29801	Bicarb	mg/l	23	0.9	1.0	1.0	1.0	3.3
299	DO	mg/l	97	0.0	0.2	0.3	0.4	3.1
31616	Fcol	#/100 ml	8	*	*	*	*	*
31649	Entero	#/100 ml	6	*	*	*	*	*
406	pH	ph units	131	3.4	4.5	4.7	4.8	5.5
4255	D-Alk	mg/l	2	*	*	*	*	*
530	Resid	mg/l	6	*	*	*	*	*
608	D-NH3	mg/l	11	0.0	0.0	0.1	0.1	0.1
618	D-NO3	mg/l	8	*	*	*	*	*
620	D-NO3(N)	mg/l	4	*	*	*	*	*
631	D-NO3NO2	mg/l	34	0.0	0.0	0.0	0.0	0.2
666	D-P	mg/l	9	*	*	*	*	*
671	D-PO4	mg/l	16	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	16	1.0	1.4	2.2	5.6	12.0
70300	TDS	mg/l	18	12.0	24.5	27.0	30.0	56.0
72109	DtoH2O	Ft	44	-8.1	8.5	8.8	9.4	11.7
76	Turb	Turb units	10	0.1	0.1	0.1	2.0	12.0
81	Color	Pt-Co	7	*	*	*	*	*
82078	Turb(field)	Turb units	10	0.0	0.0	0.0	0.1	0.2
915	D-Ca	mg/l	33	0.1	0.4	0.5	0.7	2.2
925	D-Mg	mg/l	33	0.3	0.6	0.7	0.8	0.9
930	D-Na	mg/l	33	2.2	3.2	3.4	3.5	4.2
935	D-K	mg/l	33	0.1	0.2	0.2	0.3	4.2
94	Cond(field)	micromhos/cm	131	22.1	39.0	41.0	48.0	810.0
941	D-Cl	mg/l	36	4.9	5.3	5.9	6.1	8.9
946	D-SO4	mg/l	36	1.7	2.4	2.8	3.2	5.4
950	D-F	mg/l	33	0.0	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 243 **Dates: June, 1986 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	19	20.9	22.2	22.3	22.4	1418.0
1046	D-Fe	microg/l	3	*	*	*	*	*
1056	D-Mn	microg/l	1	*	*	*	*	*
29801	Bicarb	mg/l	6	*	*	*	*	*
299	DO	mg/l	18	0.0	0.1	0.1	0.1	2.3
31616	Fcol	#/100 ml	5	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	19	7.5	7.8	7.9	8.0	8.1
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	5	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	1	*	*	*	*	*
631	D-NO3NO2	mg/l	6	*	*	*	*	*
666	D-P	mg/l	7	*	*	*	*	*
671	D-PO4	mg/l	5	*	*	*	*	*
680	TOC	mg/l	7	*	*	*	*	*
70300	TDS	mg/l	5	*	*	*	*	*
72109	DtoH2O	Ft	1	*	*	*	*	*
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	3	*	*	*	*	*
915	D-Ca	mg/l	7	*	*	*	*	*
925	D-Mg	mg/l	7	*	*	*	*	*
930	D-Na	mg/l	7	*	*	*	*	*
935	D-K	mg/l	7	*	*	*	*	*
94	Cond(field)	micromhos/cm	19	212.0	241.0	243.0	244.5	431.0
941	D-Cl	mg/l	6	*	*	*	*	*
946	D-SO4	mg/l	6	*	*	*	*	*
950	D-F	mg/l	6	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 245 **Dates: June, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	50	0.0	18.6	20.1	21.4	23.9
1046	D-Fe	microg/l	3	*	*	*	*	*
1056	D-Mn	microg/l	1	*	*	*	*	*
29801	Bicarb	mg/l	16	0.5	0.8	1.0	2.0	3.4
299	DO	mg/l	49	0.3	3.9	4.6	5.1	7.4
31616	Fcol	#/100 ml	15	0.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	14	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	50	3.4	4.7	4.8	4.9	6.9
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	14	4.0	4.0	4.0	4.0	5.0
608	D-NH3	mg/l	15	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	1	*	*	*	*	*
631	D-NO3NO2	mg/l	16	0.0	0.4	0.4	0.4	0.5
666	D-P	mg/l	17	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	15	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	17	1.0	1.0	1.0	1.0	12.9
70300	TDS	mg/l	15	15.0	15.0	15.0	18.5	130.0
72109	DtoH2O	Ft	43	4.8	7.0	8.7	11.7	20.6
76	Turb	Turb units	16	0.1	0.1	0.1	0.2	1100.0
81	Color	Pt-Co	15	5.0	5.0	5.0	5.0	1500.0
82078	Turb(field)	Turb units	10	0.0	0.0	0.0	0.2	0.3
915	D-Ca	mg/l	17	0.1	0.3	0.4	0.9	1.5
925	D-Mg	mg/l	17	0.0	0.4	0.4	0.4	0.5
930	D-Na	mg/l	17	0.1	1.5	1.6	1.7	1.8
935	D-K	mg/l	17	0.1	0.1	0.2	0.2	0.4
94	Cond(field)	micromhos/cm	50	16.0	18.3	21.0	22.0	42.0
941	D-Cl	mg/l	16	0.2	2.3	2.4	2.5	12.0
946	D-SO4	mg/l	16	0.2	0.4	0.4	0.7	1.7
950	D-F	mg/l	16	0.0	0.0	0.0	0.1	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for 312 Dates: November, 1986 to April, 2003

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	141	18.4	20.6	20.8	21.0	23.4
1046	D-Fe	microg/l	25	70.0	280.0	302.0	331.0	454.0
1056	D-Mn	microg/l	11	8.7	11.6	12.0	18.7	34.0
29801	Bicarb	mg/l	19	75.0	90.0	92.0	96.0	100.0
299	DO	mg/l	88	0.0	0.2	0.3	0.4	1.4
31616	Fcol	#/100 ml	6	*	*	*	*	*
31649	Entero	#/100 ml	5	*	*	*	*	*
406	pH	ph units	141	1.0	1.0	1.0	1.8	18.0
4255	D-Alk	mg/l	2	*	*	*	*	*
530	Resid	mg/l	5	*	*	*	*	*
608	D-NH3	mg/l	10	0.0	0.0		0.0	0.1
618	D-NO3	mg/l	8	*	*		*	*
620	D-NO3(N)	mg/l	3	*	*	*	*	*
631	D-NO3NO2	mg/l	31	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	7	*	*	*	*	*
671	D-PO4	mg/l	15	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	14	1.0	1.3	2.4	3.8	18.5
70300	TDS	mg/l	16	20.0	90.0	96.0	106.0	160.0
72109	DtoH2O	Ft	16	-4.1	12.5	16.6	18.9	21.1
76	Turb	Turb units	8	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	3	*	*	*	*	*
915	D-Ca	mg/l	30	26.3	29.9	31.0	32.0	34.5
925	D-Mg	mg/l	30	2.9	3.2	3.3	3.5	4.0
930	D-Na	mg/l	30	1.0	1.5	1.5	1.6	2.5
935	D-K	mg/l	30	0.1	0.2	0.2	0.5	1.0
94	Cond(field)	micromhos/cm	141	139.0	170.0	178.0	186.0	410.0
941	D-Cl	mg/l	33	1.6	2.3	2.5	2.6	5.0
946	D-SO4	mg/l	33	0.7	0.8	0.9	1.2	8.1
950	D-F	mg/l	29	0.0	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 313 **Dates: November, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	130	18.0	19.7	20.5	21.3	23.1
1046	D-Fe	microg/l	18	1600.0	2608.8	4750.0	7250.0	10300.0
1056	D-Mn	microg/l	9	12.0	18.5	21.3	28.0	55.0
29801	Bicarb	mg/l	26	4.0	7.6	9.1	13.0	29.7
299	DO	mg/l	97	0.0	0.2	0.3	0.5	3.9
31616	Fcol	#/100 ml	16	0.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	15	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	130	4.7	5.6	5.7	5.9	6.5
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	15	4.0	4.0	4.0	4.0	4.0
608	D-NH3	mg/l	20	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	7	*	*	*	*	*
620	D-NO3(N)	mg/l	3	*	*	*	*	*
631	D-NO3NO2	mg/l	34	0.0	0.0	0.1	0.1	0.4
666	D-P	mg/l	17	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	23	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	22	1.0	1.1	1.3	1.9	14.6
70300	TDS	mg/l	25	12.0	22.0	28.0	35.0	96.0
72109	DtoH2O	Ft	43	-4.5	8.2	11.2	12.7	14.4
76	Turb	Turb units	17	0.6	1.4	2.3	4.8	310.0
81	Color	Pt-Co	15	5.0	5.0	5.0	5.0	10.0
82078	Turb(field)	Turb units	10	0.0	0.0	0.0	0.3	1.0
915	D-Ca	mg/l	33	2.2	3.0	3.6	4.2	7.0
925	D-Mg	mg/l	33	0.2	0.2	0.3	0.3	0.8
930	D-Na	mg/l	33	0.9	1.4	1.5	1.8	3.1
935	D-K	mg/l	33	0.1	0.2	0.2	0.3	0.5
94	Cond(field)	micromhos/cm	130	30.0	48.0	56.0	67.5	305.0
941	D-Cl	mg/l	36	2.0	3.0	3.4	3.8	7.1
946	D-SO4	mg/l	36	1.4	2.2	2.7	3.4	4.9
950	D-F	mg/l	33	0.0	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Suwannee River Water Management District
Descriptive Statistics for 1943 **Dates: March, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	108	18.5	20.9	22.5	23.8	25.4
1046	D-Fe	microg/l	26	0.0	3.0	3.5	10.0	50.0
1056	D-Mn	microg/l	12	0.0	1.0	1.0	10.0	10.0
29801	Bicarb	mg/l	28	178.0	215.8	224.5	238.3	254.0
299	DO	mg/l	45	2.6	4.4	5.6	6.5	7.9
31616	Fcol	#/100 ml	13	0.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	12	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	106	6.4	6.9	7.0	7.1	7.3
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	12	4.0	4.0	4.0	4.0	4.0
608	D-NH3	mg/l	12	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	5	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	32	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	14	0.0	0.0	0.0	0.0	0.1
671	D-PO4	mg/l	22	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	24	1.0	1.0	1.0	1.2	5.8
70300	TDS	mg/l	20	210.0	254.8	268.5	282.0	350.0
72109	DtoH2O	Ft	87	1.3	4.5	5.8	6.6	14.3
76	Turb	Turb units	17	0.1	0.1	0.2	0.3	2.7
81	Color	Pt-Co	12	5.0	5.0	5.0	5.0	5.0
82078	Turb(field)	Turb units	12	0.1	0.2	0.4	0.6	2.0
915	D-Ca	mg/l	38	71.5	89.0	92.0	95.9	102.0
925	D-Mg	mg/l	38	0.9	1.2	1.2	1.3	1.5
930	D-Na	mg/l	38	6.1	7.4	8.5	9.6	11.1
935	D-K	mg/l	38	0.0	0.1	0.1	0.7	2.6
94	Cond(field)	micromhos/cm	108	345.0	436.3	460.0	482.3	536.0
941	D-Cl	mg/l	38	8.8	11.3	14.5	15.0	19.0
946	D-SO4	mg/l	37	6.3	9.3	10.0	11.0	15.0
950	D-F	mg/l	37	0.1	0.1	0.1	0.2	1.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2003 **Dates: October, 1987 to June, 2003**

Code	**Analyte**	**Measured units**	**Num. Samples**	**Min. Value**	**Q1 Value**	**Median Value**	**Q3 Value**	**Max. Value**
10	Temp	Deg C	106	20.4	23.1	23.4	23.8	24.7
1046	D-Fe	microg/l	25	0.0	3.0	6.0	10.0	50.0
1056	D-Mn	microg/l	10	0.0	1.0	1.0	8.0	10.0
29801	Bicarb	mg/l	28	80.0	166.0	180.0	182.0	190.0
299	DO	mg/l	45	0.4	1.0	2.3	5.9	7.3
31616	Fcol	#/100 ml	13	0.0	1.0	1.0	30.0	2000.0
31649	Entero	#/100 ml	12	1.0	1.0	1.0	50.5	60.0
406	pH	ph units	104	6.5	7.0	7.2	7.3	7.6
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	12	4.0	4.0	4.0	6.3	47.0
608	D-NH3	mg/l	15	0.0	0.0	0.0	0.1	0.3
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	32	0.1	1.8	2.8	3.2	3.9
666	D-P	mg/l	15	0.1	0.1	0.1	0.1	0.2
671	D-PO4	mg/l	21	0.0	0.1	0.1	0.1	0.2
680	TOC	mg/l	23	1.0	1.0	1.2	2.0	41.0
70300	TDS	mg/l	19	95.0	162.5	193.0	205.5	228.0
72109	DtoH2O	Ft	84	39.9	45.2	47.1	51.6	54.0
76	Turb	Turb units	18	0.4	0.9	2.8	5.5	150.0
81	Color	Pt-Co	13	5.0	5.0	5.0	5.0	10.0
82078	Turb(field)	Turb units	12	0.4	2.0	5.3	16.3	33.5
915	D-Ca	mg/l	37	28.8	65.0	74.0	76.9	80.1
925	D-Mg	mg/l	37	0.6	0.9	1.0	1.1	1.3
930	D-Na	mg/l	37	0.5	2.5	3.0	3.0	3.5
935	D-K	mg/l	37	0.1	0.1	0.4	1.0	4.5
94	Cond(field)	micromhos/cm	106	166.0	330.3	351.5	371.0	415.0
941	D-Cl	mg/l	37	1.2	2.9	3.3	4.0	13.0
946	D-SO4	mg/l	36	0.7	2.5	3.1	4.3	6.3
950	D-F	mg/l	36	0.1	0.1	0.1	0.2	0.5

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2193 **Dates: June, 1989 to August, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	122	21.1	21.8	21.9	22.1	23.1
1046	D-Fe	microg/l	24	1.3	1200.0	1200.0	1200.0	1300.0
1056	D-Mn	microg/l	8	*	*	*	*	*
29801	Bicarb	mg/l	17	160.0	163.0	167.0	170.0	170.0
299	DO	mg/l	57	0.1	0.2	0.4	0.5	1.9
31616	Fcol	#/100 ml	0	NA	NA	NA	NA	NA
31649	Entero	#/100 ml	0	NA	NA	NA	NA	NA
406	pH	ph units	121	6.2	6.9	7.0	7.1	639.0
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	0	NA	NA	NA	NA	NA
608	D-NH3	mg/l	5	*	*	*	*	*
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	1	*	*	*	*	*
631	D-NO3NO2	mg/l	21	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	3	*	*	*	*	*
671	D-PO4	mg/l	8	*	*	*	*	*
680	TOC	mg/l	9	*	*	*	*	*
70300	TDS	mg/l	8	*	*	*	*	*
72109	DtoH2O	Ft	55	19.2	28.4	29.5	32.4	139.9
76	Turb	Turb units	4	*	*	*	*	*
81	Color	Pt-Co	1	*	*	*	*	*
82078	Turb(field)	Turb units	0	NA	NA	NA	NA	NA
915	D-Ca	mg/l	24	31.0	34.0	36.0	37.0	37.4
925	D-Mg	mg/l	24	15.0	18.0	18.0	19.0	19.2
930	D-Na	mg/l	24	4.0	4.3	4.5	4.5	4.7
935	D-K	mg/l	24	1.0	1.1	1.2	1.3	1.6
94	Cond(field)	micromhos/cm	122	29.0	325.0	334.0	335.0	365.0
941	D-Cl	mg/l	25	1.2	7.0	7.3	7.7	8.5
946	D-SO4	mg/l	25	0.2	0.2	0.2	4.3	17.0
950	D-F	mg/l	23	0.2	0.2	0.2	0.2	0.4

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2259 **Dates: March, 1986 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	129	21.1	22.2	22.5	22.8	32.1
1046	D-Fe	microg/l	126	0.0	3.0	5.0	10.0	50.0
1056	D-Mn	microg/l	8	*	*	*	*	*
29801	Bicarb	mg/l	23	165.0	170.0	177.0	180.0	185.0
299	DO	mg/l	60	2.9	3.5	3.7	4.2	45.8
31616	Fcol	#/100 ml	6	*	*	*	*	*
31649	Entero	#/100 ml	5	*	*	*	*	*
406	pH	ph units	127	6.1	7.1	7.2	7.2	7.7
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	5	*	*	*	*	*
608	D-NH3	mg/l	12	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	30	0.4	0.5	0.6	0.7	0.8
666	D-P	mg/l	8	0.0	0.0	0.0	0.0	0.1
671	D-PO4	mg/l	13	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	14	1.0	1.0	1.4	2.9	0.1
70300	TDS	mg/l	12	170.0	180.0	190.0	193.0	206.0
72109	DtoH2O	Ft	66	22.1	26.4	30.3	32.0	36.3
76	Turb	Turb units	10	0.1	0.2	0.5	1.0	21.0
81	Color	Pt-Co	6	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	31	42.0	65.0	68.0	70.3	74.9
925	D-Mg	mg/l	31	3.0	3.3	3.4	3.6	4.2
930	D-Na	mg/l	31	1.7	1.8	1.9	2.0	2.6
935	D-K	mg/l	31	0.3	0.4	0.5	0.9	2.3
94	Cond(field)	micromhos/cm	129	0.4	340.0	352.0	361.0	465.0
941	D-Cl	mg/l	35	1.0	3.3	3.5	3.7	5.0
946	D-SO4	mg/l	34	3.2	8.5	8.8	9.3	13.0
950	D-F	mg/l	30	0.1	0.1	0.1	0.2	0.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2353 **Dates: August, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	34	21.5	21.9	22.0	22.0	23.0
1046	D-Fe	microg/l	9	*	*	*	*	*
1056	D-Mn	microg/l	7	*	*	*	*	*
29801	Bicarb	mg/l	6	*	*	*	*	*
299	DO	mg/l	17	6.8	7.0	7.9	8.4	97.8
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	3	*	*	*	*	*
406	pH	ph units	33	7.0	7.5	7.6	7.7	7.9
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	3	*	*	*	*	*
608	D-NH3	mg/l	6	*	*	*	*	*
618	D-NO3	mg/l	3	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	7	*	*	*	*	*
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	9	*	*	*	*	*
680	TOC	mg/l	11	1.0	1.0	1.0	2.3	6.2
70300	TDS	mg/l	10	10.0	102.5	130.0	139.3	152.0
72109	DtoH2O	Ft	26	102.8	105.4	106.6	108.7	110.2
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	12	30.0	35.0	37.1	37.8	38.0
925	D-Mg	mg/l	12	1.2	4.3	4.4	4.5	4.6
930	D-Na	mg/l	12	2.0	3.6	3.9	4.0	4.3
935	D-K	mg/l	12	0.5	0.5	0.6	1.0	1.0
94	Cond(field)	micromhos/cm	34	0.2	226.4	235.0	236.0	252.0
941	D-Cl	mg/l	12	5.2	6.6	6.8	7.4	10.0
946	D-SO4	mg/l	11	1.9	2.1	2.2	5.0	5.0
950	D-F	mg/l	11	0.1	0.2	0.2	0.2	0.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2404 **Dates: August, 1986 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	127	18.9	19.6	19.8	19.9	24.0
1046	D-Fe	microg/l	26	2.7	2800.0	2985.0	3145.0	3600.0
1056	D-Mn	microg/l	13	0.1	119.0	123.0	124.0	134.0
29801	Bicarb	mg/l	19	209.0	211.0	220.0	220.0	222.0
299	DO	mg/l	57	0.0	0.1	0.2	0.5	2.4
31616	Fcol	#/100 ml	5	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	125	6.2	6.9	7.0	7.1	8.3
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	8	*	*	*	*	*
618	D-NO3	mg/l	6	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	26	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	15	0.3	0.4	0.4	0.5	0.5
680	TOC	mg/l	17	6.0	7.9	8.1	10.0	23.0
70300	TDS	mg/l	13	210.0	222.0	224.0	239.0	260.0
72109	DtoH2O	Ft	69	5.2	6.7	8.2	9.6	86.6
76	Turb	Turb units	10	0.1	0.3	0.8	1.6	2.2
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	30	47.0	53.5	57.5	60.2	63.7
925	D-Mg	mg/l	30	18.0	19.0	20.0	20.1	21.0
930	D-Na	mg/l	31	2.9	3.2	3.2	3.3	3.6
935	D-K	mg/l	31	0.4	0.4	0.5	0.8	2.2
94	Cond(field)	micromhos/cm	127	1.2	377.5	396.0	404.5	453.0
941	D-Cl	mg/l	33	1.0	5.3	5.6	5.9	7.3
946	D-SO4	mg/l	32	0.2	0.2	0.2	3.6	8.0
950	D-F	mg/l	30	0.2	0.3	0.3	0.3	0.6

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2465 **Dates: September, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	158	21.5	22.3	22.5	22.6	23.3
1046	D-Fe	microg/l	29	0.0	3.0	5.0	10.0	295.0
1056	D-Mn	microg/l	14	0.0	1.0	1.5	10.0	10.0
29801	Bicarb	mg/l	29	142.0	150.0	152.0	157.0	168.0
299	DO	mg/l	87	3.9	6.0	6.5	7.0	9.0
31616	Fcol	#/100 ml	13	0.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	12	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	156	6.4	7.3	7.4	7.5	8.3
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	12	4.0	4.0	4.0	4.0	5.0
608	D-NH3	mg/l	17	0.0	0.0	0.0	0.0	0.1
618	D-NO3	mg/l	6	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	36	1.9	2.7	3.6	4.1	6.9
666	D-P	mg/l	15	0.0	0.0	0.0	0.0	0.1
671	D-PO4	mg/l	24	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	25	1.0	1.0	1.0	2.9	21.0
70300	TDS	mg/l	21	108.0	160.0	170.0	178.0	204.0
72109	DtoH2O	Ft	90	33.4	47.5	53.7	55.9	57.4
76	Turb	Turb units	20	0.1	0.1	0.1	1.0	6.2
81	Color	Pt-Co	13	5.0	5.0	5.0	5.0	5.0
82078	Turb(field)	Turb units	14	0.0	0.1	0.3	0.4	0.7
915	D-Ca	mg/l	41	1.0	40.0	41.0	42.0	46.0
925	D-Mg	mg/l	41	2.8	17.0	17.2	18.0	19.0
930	D-Na	mg/l	41	1.9	2.1	2.1	2.2	5.1
935	D-K	mg/l	41	0.1	0.2	0.2	0.5	2.0
94	Cond(field)	micromhos/cm	158	0.3	323.0	340.0	347.0	412.0
941	D-Cl	mg/l	43	3.5	4.4	4.9	5.4	21.0
946	D-SO4	mg/l	42	5.1	6.1	6.5	6.8	12.0
950	D-F	mg/l	40	0.1	0.2	0.3	0.3	0.8

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2585 **Dates: October, 1987 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	127	19.7	21.3	21.6	21.9	25.3
1046	D-Fe	microg/l	20	0.0	124.0	234.0	427.5	1800.0
1056	D-Mn	microg/l	8	*	*	*	*	*
29801	Bicarb	mg/l	16	60.0	119.0	138.0	140.0	152.0
299	DO	mg/l	59	0.0	0.1	0.2	0.3	0.9
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	3	*	*	*	*	*
406	pH	ph units	126	6.6	7.2	7.4	7.5	9.0
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	3	*	*	*	*	*
608	D-NH3	mg/l	7	*	*	*	*	*
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	2	*	*	*	*	*
631	D-NO3NO2	mg/l	21	0.0	0.2	0.3	0.5	1.5
666	D-P	mg/l	5	*	*	*	*	*
671	D-PO4	mg/l	11	0.1	0.1	0.1	0.1	0.2
680	TOC	mg/l	13	1.0	1.7	2.7	4.0	21.0
70300	TDS	mg/l	10	130.0	150.5	159.0	160.0	178.0
72109	DtoH2O	Ft	65	11.3	31.9	35.7	38.9	52.2
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	4	*	*	*	*	*
915	D-Ca	mg/l	23	29.0	36.0	38.3	41.0	51.0
925	D-Mg	mg/l	24	3.9	9.5	11.0	12.0	13.2
930	D-Na	mg/l	23	2.3	2.5	2.7	2.9	4.4
935	D-K	mg/l	23	0.3	0.3	0.5	0.9	2.6
94	Cond(field)	micromhos/cm	127	0.3	259.5	283.0	295.0	422.0
941	D-Cl	mg/l	26	1.8	4.3	4.7	5.5	7.1
946	D-SO4	mg/l	25	3.1	5.8	7.5	8.9	12.0
950	D-F	mg/l	23	0.1	0.1	0.2	0.2	0.4

*Less than 10 samples NA - no samples

Descriptive Statistics for 2675 **Dates: September, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	157	18.2	19.9	20.1	20.5	21.9
1046	D-Fe	microg/l	24	1.0	9.8	20.0	38.5	620.0
1056	D-Mn	microg/l	8	*	*	*	*	*
29801	Bicarb	mg/l	26	110.0	157.3	166.0	178.8	205.0
299	DO	mg/l	89	0.2	0.6	1.0	1.5	4.9
31616	Fcol	#/100 ml	10	0.0	1.0	1.0	1.0	3.0
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	154	6.5	7.0	7.1	7.2	7.5
4255	D-Alk	mg/l	6	*	*	*	*	*
530	Resid	mg/l	9	*	*	*	*	*
608	D-NH3	mg/l	14	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	NA	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	30	0.0	0.1	0.1	0.3	2.1
666	D-P	mg/l	12	0.1	0.1	0.1	0.1	0.1
671	D-PO4	mg/l	17	0.1	0.1	0.1	0.1	0.2
680	TOC	mg/l	19	1.0	2.9	4.6	6.0	20.0
70300	TDS	mg/l	16	180.0	192.3	205.5	224.0	277.0
72109	DtoH2O	Ft	88	32.9	64.3	81.9	88.4	91.9
76	Turb	Turb units	12	0.1	0.3	0.5	0.8	2.7
81	Color	Pt-Co	10	5.0	5.0	10.0	15.0	20.0
82078	Turb(field)	Turb units	15	0.3	0.6	0.8	1.6	3.4
915	D-Ca	mg/l	33	21.0	60.0	65.0	68.7	85.5
925	D-Mg	mg/l	32	1.5	1.8	2.0	2.3	6.0
930	D-Na	mg/l	33	2.7	3.7	4.0	4.7	6.2
935	D-K	mg/l	33	0.6	1.1	1.3	1.5	2.9
94	Cond(field)	micromhos/cm	157	0.4	313.0	345.0	365.0	436.0
941	D-Cl	mg/l	35	4.2	6.7	7.7	8.7	17.0
946	D-SO4	mg/l	34	3.8	5.2	6.5	8.1	19.0
950	D-F	mg/l	32	0.1	0.1	0.1	0.2	1.4

*Less than 10 samples
NA - No samples

St. Johns Water Management District
Descriptive Statistics for 1417 **Dates: September, 1987 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	66	22.2	22.8	23.1	23.2	23.8
1046	D-Fe	microg/l	25	2760.0	3700.0	4100.0	5100.0	6500.0
1056	D-Mn	microg/l	9	*	*	*	*	*
29801	Bicarb	mg/l	27	135.0	139.0	150.0	159.0	180.0
299	DO	mg/l	49	0.0	0.2	0.3	0.4	1.4
31616	Fcol	#/100 ml	10	0.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	67	5.7	7.1	7.2	7.3	7.5
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	9	*	*	*	*	*
608	D-NH3	mg/l	13	0.2	0.2	0.2	0.3	0.8
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	NA	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	34	0.0	0.0	0.0	0.0	0.4
666	D-P	mg/l	12	0.2	0.2	0.2	0.2	0.3
671	D-PO4	mg/l	18	0.0	0.2	0.2	0.2	0.3
680	TOC	mg/l	19	3.9	4.6	5.1	19.0	42.6
70300	TDS	mg/l	16	174.0	191.8	198.0	222.0	261.0
72109	DtoH2O	Ft	63	4.3	11.6	13.5	15.2	18.3
76	Turb	Turb units	13	13.0	15.0	16.0	27.0	120.0
81	Color	Pt-Co	10	80.0	85.0	100.0	100.0	250.0
82078	Turb(field)	Turb units	15	0.6	0.8	1.1	2.1	13.5
915	D-Ca	mg/l	34	53.0	57.5	62.0	68.8	80.4
925	D-Mg	mg/l	34	0.8	0.9	1.0	1.1	1.4
930	D-Na	mg/l	34	7.6	8.0	8.8	9.1	10.0
935	D-K	mg/l	34	0.6	0.7	0.7	1.0	1.1
94	Cond(field)	micromhos/cm	67	0.4	341.5	368.0	390.5	560.0
941	D-Cl	mg/l	34	11.0	14.0	15.0	16.0	21.0
946	D-SO4	mg/l	34	1.0	3.3	4.6	5.6	15.0
950	D-F	mg/l	34	0.1	0.1	0.1	0.1	0.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1420 Dates: September, 1987 to June, 2003

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	41	21.6	22.4	22.6	22.9	25.4
1046	D-Fe	microg/l	24	3.0	5.8	10.0	30.0	42.0
1056	D-Mn	microg/l	9	*	*	*	*	*
29801	Bicarb	mg/l	20	115.0	120.0	120.0	121.0	126.0
299	DO	mg/l	21	0.0	0.1	0.1	0.2	1.4
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	3	*	*	*	*	*
406	pH	ph units	42	6.3	7.5	7.6	7.6	7.8
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	3	*	*	*	*	*
608	D-NH3	mg/l	7	*	*	*	*	*
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	27	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	11	0.1	0.1	0.1	0.1	0.2
680	TOC	mg/l	13	1.6	2.4	3.0	6.2	18.0
70300	TDS	mg/l	10	1960.0	2228.5	2285.0	2447.5	2572.0
72109	DtoH2O	Ft	38	1.0	3.1	4.0	5.1	8.0
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	4	*	*	*	*	*
915	D-Ca	mg/l	27	79.4	82.0	86.0	88.2	92.0
925	D-Mg	mg/l	27	62.0	70.0	71.6	73.7	77.5
930	D-Na	mg/l	27	550.0	650.0	650.0	675.0	703.0
935	D-K	mg/l	27	20.9	21.9	23.0	24.0	240.0
94	Cond(field)	micromhos/cm	42	3670.0	4131.8	4180.0	4238.3	4460.0
941	D-Cl	mg/l	27	1060.0	1170.0	1200.0	1200.0	1400.0
946	D-SO4	mg/l	27	5.6	179.5	180.0	180.0	194.0
950	D-F	mg/l	27	0.1	0.1	0.2	0.4	0.4

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1762 **Dates: July, 1987 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	79	22.8	24.9	25.2	25.4	26.2
1046	D-Fe	microg/l	32	3.0	5.0	10.0	30.0	77.0
1056	D-Mn	microg/l	15	1.0	30.0	30.0	30.0	30.0
29801	Bicarb	mg/l	21	129.0	130.0	132.0	133.0	140.0
299	DO	mg/l	49	0.0	0.1	0.1	0.2	1.7
31616	Fcol	#/100 ml	5	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	79	7.2	7.4	7.4	7.5	7.6
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	6	*	*	*	*	*
618	D-NO3	mg/l	12	0.0	0.0	0.0	0.1	0.9
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	36	0.0	0.0	0.0	0.0	0.9
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	19	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	20	1.0	1.7	3.9	6.0	18.5
70300	TDS	mg/l	17	482.0	500.0	532.0	545.0	596.0
72109	DtoH2O	Ft	76	26.4	28.6	30.2	31.3	36.3
76	Turb	Turb units	8	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	36	65.0	73.8	76.1	78.0	83.0
925	D-Mg	mg/l	36	34.0	37.0	39.0	40.0	44.3
930	D-Na	mg/l	36	13.0	16.0	17.0	17.4	19.0
935	D-K	mg/l	36	2.7	3.0	3.2	3.4	5.0
94	Cond(field)	micromhos/cm	79	682.0	736.5	747.0	757.5	768.0
941	D-Cl	mg/l	36	14.0	20.0	20.5	24.0	40.0
946	D-SO4	mg/l	36	190.0	220.0	220.0	230.0	240.0
950	D-F	mg/l	36	0.5	1.0	1.0	1.0	1.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1763 **Dates: July, 1987 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	82	20.2	22.1	22.3	22.9	24.2
1046	D-Fe	microg/l	31	30.0	48.0	60.0	66.5	105.0
1056	D-Mn	microg/l	14	30.0	45.3	51.0	56.3	68.0
29801	Bicarb	mg/l	23	287.0	299.0	300.0	301.0	315.0
299	DO	mg/l	56	0.0	0.1	0.2	0.5	2.3
31616	Fcol	#/100 ml	5	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	82	6.2	6.9	7.0	7.0	8.4
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	8	*	*	*	*	*
618	D-NO3	mg/l	12	0.0	0.0	0.0	0.0	3.1
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	38	0.0	0.0	0.0	0.0	3.1
666	D-P	mg/l	5	*	*	*	*	*
671	D-PO4	mg/l	19	0.2	0.4	0.4	0.4	0.5
680	TOC	mg/l	20	6.1	7.2	8.7	11.4	38.0
70300	TDS	mg/l	17	297.0	377.0	381.0	384.0	411.0
72109	DtoH2O	Ft	79	23.2	24.0	24.5	25.3	28.3
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	38	74.8	110.0	110.5	117.4	120.0
925	D-Mg	mg/l	38	1.7	3.0	3.1	3.2	3.5
930	D-Na	mg/l	38	9.5	13.0	13.0	13.5	15.0
935	D-K	mg/l	38	0.8	0.9	1.0	1.1	1.2
94	Cond(field)	micromhos/cm	82	6.1	608.3	620.0	625.8	633.0
941	D-Cl	mg/l	38	17.0	20.0	21.0	23.0	49.0
946	D-SO4	mg/l	38	0.2	0.2	0.6	1.0	9.0
950	D-F	mg/l	38	0.1	0.1	0.1	0.1	0.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1764 **Dates: July, 1987 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	106	19.7	22.2	22.4	22.6	24.5
1046	D-Fe	microg/l	30	30.0	295.8	362.0	467.5	560.0
1056	D-Mn	microg/l	14	20.0	30.0	30.0	30.0	38.0
29801	Bicarb	mg/l	29	11.0	14.0	26.0	36.0	52.0
299	DO	mg/l	78	0.0	0.2	0.3	0.4	1.8
31616	Fcol	#/100 ml	12	1.0	1.0	1.0	1.0	35.0
31649	Entero	#/100 ml	11	1.0	1.0	1.0	1.0	2.0
406	pH	ph units	106	4.7	5.1	5.3	5.5	6.3
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	11	4.0	4.0	4.0	4.0	4.0
608	D-NH3	mg/l	15	0.7	0.8	0.9	1.0	1.1
618	D-NO3	mg/l	12	0.0	0.0	0.0	0.0	1.6
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	44	0.0	0.0	0.0	0.0	1.6
666	D-P	mg/l	12	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	26	0.0	0.0	0.0	0.1	0.2
680	TOC	mg/l	27	10.0	11.5	12.6	15.3	49.2
70300	TDS	mg/l	24	91.0	102.0	146.5	166.3	331.0
72109	DtoH2O	Ft	103	15.2	16.2	16.8	17.6	20.5
76	Turb	Turb units	14	0.9	1.6	2.5	4.7	20.0
81	Color	Pt-Co	12	5.0	12.5	17.5	30.0	5.0
82078	Turb(field)	Turb units	15	0.1	0.4	0.7	1.0	2.2
915	D-Ca	mg/l	44	5.8	8.1	14.5	30.1	65.1
925	D-Mg	mg/l	44	1.5	2.3	2.8	3.8	7.9
930	D-Na	mg/l	44	10.1	12.0	12.6	13.1	17.7
935	D-K	mg/l	44	1.0	1.2	1.3	1.5	2.4
94	Cond(field)	micromhos/cm	106	122.0	137.3	156.0	178.0	443.0
941	D-Cl	mg/l	44	13.0	14.0	18.0	19.3	31.0
946	D-SO4	mg/l	44	8.0	15.3	19.5	28.0	93.0
950	D-F	mg/l	41	0.0	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1779 **Dates: September, 1989 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	27	21.8	22.3	22.5	22.7	24.8
1046	D-Fe	microg/l	8	*	*	*	*	*
1056	D-Mn	microg/l	6	*	*	*	*	*
29801	Bicarb	mg/l	7	*	*	*	*	*
299	DO	mg/l	21	0.0	0.1	0.3	0.4	1.8
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	27	7.4	7.6	7.6	7.7	8.0
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	6	*	*	*	*	*
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	12	0.0	0.0	0.0	0.0	1.6
666	D-P	mg/l	7	*	*	*	*	*
671	D-PO4	mg/l	10	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	10	1.0	1.0	1.2	7.2	21.0
70300	TDS	mg/l	9	*	*	*	*	*
72109	DtoH2O	Ft	24	72.3	76.9	79.7	80.0	81.8
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	12	32.0	33.9	34.9	35.1	39.6
925	D-Mg	mg/l	12	13.6	14.4	15.2	15.9	17.2
930	D-Na	mg/l	12	7.8	8.0	8.3	8.4	9.1
935	D-K	mg/l	12	1.2	1.3	1.7	2.9	6.3
94	Cond(field)	micromhos/cm	27	31.9	317.0	320.0	324.0	329.0
941	D-Cl	mg/l	12	5.0	6.0	6.3	8.5	12.0
946	D-SO4	mg/l	12	1.0	1.0	1.9	2.0	2.3
950	D-F	mg/l	12	0.3	0.4	0.5	0.5	0.5

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1780 **Dates: September, 1989 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	27	20.5	21.1	21.3	21.4	22.7
1046	D-Fe	microg/l	8	*	*	*	*	*
1056	D-Mn	microg/l	6	*	*	*	*	*
29801	Bicarb	mg/l	7	*	*	*	*	*
299	DO	mg/l	22	0.0	0.1	0.3	0.8	2.4
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	27	7.1	7.4	7.5	7.6	9.8
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	6	*	*	*	*	*
618	D-NO3	mg/l	4	*	*	*	*	*
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	12	0.0	0.0	0.0	0.0	0.7
666	D-P	mg/l	7	*	*	*	*	*
671	D-PO4	mg/l	10	0.0	0.3	0.3	0.4	0.4
680	TOC	mg/l	10	1.0	1.0	1.1	6.5	12.2
70300	TDS	mg/l	9	*	*	*	*	*
72109	DtoH2O	Ft	24	6.4	9.1	12.0	12.9	14.7
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	12	8.9	28.7	0.8	1.0	1.0
925	D-Mg	mg/l	12	1.3	13.0	13.9	14.7	16.5
930	D-Na	mg/l	12	7.6	7.7	7.9	8.2	10.2
935	D-K	mg/l	12	1.4	1.6	1.9	2.3	4.7
94	Cond(field)	micromhos/cm	27	138.0	287.0	291.0	294.0	301.0
941	D-Cl	mg/l	12	9.2	9.8	11.0	12.3	13.0
946	D-SO4	mg/l	12	1.0	1.8	2.7	3.0	5.0
950	D-F	mg/l	12	0.1	0.2	0.2	0.2	0.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1781 **Dates: September, 1989 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	51	20.4	21.1	21.3	21.4	23.5
1046	D-Fe	microg/l	8	*	*	*	*	*
1056	D-Mn	microg/l	6	*	*	*	*	*
29801	Bicarb	mg/l	14	29.0	32.0	33.5	34.8	85.0
299	DO	mg/l	46	0.2	0.7	0.8	1.0	8.4
31616	Fcol	#/100 ml	11	1.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	11	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	51	5.3	5.8	6.0	6.3	10.9
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	11	4.0	4.0	4.0	4.0	4.0
608	D-NH3	mg/l	13	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	4	0.0	0.0	0.1	0.1	0.1
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	19	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	14	0.0	0.0	0.0	0.1	0.1
671	D-PO4	mg/l	17	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	17	0.0	1.0	1.0	1.3	13.1
70300	TDS	mg/l	16	75.0	77.8	90.5	109.5	197.0
72109	DtoH2O	Ft	48	6.0	8.7	11.5	12.7	14.7
76	Turb	Turb units	14	0.1	0.1	0.1	0.6	2.1
81	Color	Pt-Co	12	5.0	5.0	5.0	5.0	5.0
82078	Turb(field)	Turb units	15	0.0	0.3	0.4	0.6	1.6
915	D-Ca	mg/l	19	9.0	10.0	11.8	27.4	56.3
925	D-Mg	mg/l	19	0.5	1.1	1.1	1.3	2.1
930	D-Na	mg/l	19	7.2	7.5	7.6	11.7	23.1
935	D-K	mg/l	19	1.3	1.3	1.4	4.7	8.0
94	Cond(field)	micromhos/cm	51	0.1	104.0	110.0	146.0	551.0
941	D-Cl	mg/l	18	9.6	10.0	10.5	11.0	22.0
946	D-SO4	mg/l	19	1.6	1.7	1.9	2.2	6.0
950	D-F	mg/l	19	0.0	0.1	0.1	0.2	0.3

*Less than 10 samples
NA - No samples

Alachua County

Descriptive Statistics for 1674 **Dates: May, 1987 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	137	18.2	22.8	22.9	22.9	23.1
1046	D-Fe	microg/l	20	3.0	8.0	10.0	18.3	100.0
1056	D-Mn	microg/l	5	*	*	*	*	*
29801	Bicarb	mg/l	20	27.0	32.0	33.0	34.0	42.0
299	DO	mg/l	108	2.3	2.9	3.3	3.6	7.0
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	138	5.3	6.0	6.1	6.3	7.5
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	6	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	1	*	*	*	*	*
631	D-NO3NO2	mg/l	24	0.4	0.4	0.4	0.5	0.8
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	7	*	*	*	*	*
680	TOC	mg/l	13	1.0	1.0	1.0	1.2	6.3
70300	TDS	mg/l	14	56.0	88.3	99.5	110.0	150.0
72109	DtoH2O	Ft	146	2.9	7.3	9.1	10.5	14.6
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	52	0.2	0.4	0.5	0.7	5.3
915	D-Ca	mg/l	24	9.4	9.9	10.0	11.3	13.0
925	D-Mg	mg/l	24	2.8	3.3	3.3	3.4	4.0
930	D-Na	mg/l	25	2.6	3.1	3.1	3.2	3.5
935	D-K	mg/l	24	0.5	0.6	0.6	0.9	1.0
94	Cond(field)	micromhos/cm	137	69.0	89.0	95.0	99.0	830.0
941	D-Cl	mg/l	23	1.0	5.1	5.4	5.6	6.0
946	D-SO4	mg/l	23	0.5	0.6	0.6	0.6	11.0
950	D-F	mg/l	24	0.8	0.9	1.0	1.0	1.9

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1931 **Dates: May, 1987 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	169	16.2	22.1	22.4	22.7	26.9
1046	D-Fe	microg/l	4	*	*	*	*	*
1056	D-Mn	microg/l	4	*	*	*	*	*
29801	Bicarb	mg/l	14	57.0	72.0	73.0	75.0	79.2
299	DO	mg/l	140	6.4	7.4	7.9	8.1	9.3
31616	Fcol	#/100 ml	11	1.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	11	1.0	1.0	1.0	1.0	2.0
406	pH	ph units	168	7.1	7.7	7.8	7.9	8.1
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	11	4.0	4.0	4.0	4.0	4.0
608	D-NH3	mg/l	19	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	1	*	*	*	*	*
631	D-NO3NO2	mg/l	20	0.1	0.2	0.4	0.5	0.8
666	D-P	mg/l	14	0.0	0.0	0.0	0.0	0.1
671	D-PO4	mg/l	13	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	18	1.0	1.0	1.0	1.2	6.5
70300	TDS	mg/l	20	60.0	82.5	87.0	94.5	130.0
72109	DtoH2O	Ft	170	28.6	38.1	39.5	42.1	46.9
76	Turb	Turb units	14	0.1	0.3	0.4	0.9	1.5
81	Color	Pt-Co	11	5.0	5.0	5.0	10.0	15.0
82078	Turb(field)	Turb units	66	0.1	0.5	0.9	1.2	41.0
915	D-Ca	mg/l	15	28.6	29.5	30.0	30.9	34.0
925	D-Mg	mg/l	15	0.4	0.4	0.4	0.4	0.5
930	D-Na	mg/l	16	1.1	1.5	1.6	1.6	1.8
935	D-K	mg/l	15	0.1	0.1	0.1	0.1	0.2
94	Cond(field)	micromhos/cm	170	105.0	158.0	161.0	162.0	239.0
941	D-Cl	mg/l	20	2.5	2.8	2.9	3.0	3.3
946	D-SO4	mg/l	20	1.2	1.2	1.3	1.3	2.3
950	D-F	mg/l	15	0.1	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples

Southwest Florida Water Management District
Descriptive Statistics for 615 **Dates: January, 2000 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	16	26.7	27.3	27.5	27.6	28.0
1046	D-Fe	microg/l	2	*	*	*	*	*
1056	D-Mn	microg/l	1	*	*	*	*	*
29801	Bicarb	mg/l	6	*	*	*	*	*
299	DO	mg/l	15					
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	16					
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	6	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	6	*	*	*	*	*
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	5	*	*	*	*	*
680	TOC	mg/l	5	*	*	*	*	*
70300	TDS	mg/l	4	*	*	*	*	*
72109	DtoH2O	Ft	0	NA	NA	NA	NA	NA
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	9	*	*	*	*	*
915	D-Ca	mg/l	6	*	*	*	*	*
925	D-Mg	mg/l	6	*	*	*	*	*
930	D-Na	mg/l	6	*	*	*	*	*
935	D-K	mg/l	6	*	*	*	*	*
94	Cond(field)	micromhos/cm	16	1101.0	1132.8	1140.0	1144.0	1161.0
941	D-Cl	mg/l	6	*	*	*	*	*
946	D-SO4	mg/l	6	*	*	*	*	*
950	D-F	mg/l	6	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 707 **Dates: October, 1985 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	135	25.6	29.0	29.9	30.1	31.5
1046	D-Fe	microg/l	27	3.0	22.5	39.0	68.0	260.0
1056	D-Mn	microg/l	11	1.0	1.0	1.9	10.0	25.0
29801	Bicarb	mg/l	22	130.0	136.0	138.5	140.0	142.0
299	DO	mg/l	29	0.0	0.1	0.1	0.1	1.0
31616	Fcol	#/100 ml	5	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	137	6.7	7.4	7.4	7.5	8.0
4255	D-Alk	mg/l	9	*	*	*	*	*
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	10	0.3	0.3	0.3	0.3	0.3
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	34	0.0	0.0	0.0	0.0	0.3
666	D-P	mg/l	8	*	*	*	*	*
671	D-PO4	mg/l	13	0.0	0.0	0.0	0.1	0.2
680	TOC	mg/l	13	1.0	1.0	1.5	1.8	28.0
70300	TDS	mg/l	12	746.0	764.3	778.5	801.3	845.0
72109	DtoH2O	Ft	136	29.9	36.8	41.4	48.2	63.2
76	Turb	Turb units	9	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	12	0.1	0.3	0.6	1.3	10.8
915	D-Ca	mg/l	31	94.0	107.0	110.0	110.5	145.0
925	D-Mg	mg/l	31	50.0	58.7	61.0	63.2	66.0
930	D-Na	mg/l	31	11.0	11.9	12.0	12.2	16.1
935	D-K	mg/l	31	2.3	3.4	3.6	3.8	4.9
94	Cond(field)	micromhos/cm	138	818.0	1018.0	1034.0	1047.0	1095.0
941	D-Cl	mg/l	34	2.0	15.0	16.0	16.0	21.0
946	D-SO4	mg/l	34	150.0	400.0	420.0	430.0	470.0
950	D-F	mg/l	31	0.9	1.0	1.0	1.1	1.6

*Less than 10 samples
NA - No samples

Descriptive Statistics for 736 **Dates: December, 1987 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	171	22.0	24.0	25.0	26.0	27.9
1046	D-Fe	microg/l	28	1570.0	2300.0	2950.0	3480.0	5490.0
1056	D-Mn	microg/l	12	3.9	4.0	6.5	10.0	20.0
29801	Bicarb	mg/l	30	29.0	48.8	75.5	104.5	155.0
299	DO	mg/l	70	0.0	0.2	0.2	0.3	3.4
31616	Fcol	#/100 ml	13	1.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	13	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	170	5.2	5.8	5.9	6.1	9.4
4255	D-Alk	mg/l	10	34.0	56.3	57.5	69.8	132.0
530	Resid	mg/l	14	4.0	4.0	4.0	4.0	245.4
608	D-NH3	mg/l	15	0.1	0.1	0.1	0.1	0.2
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	40	0.0	0.0	0.0	0.1	0.4
666	D-P	mg/l	16	0.1	0.1	0.2	0.2	0.2
671	D-PO4	mg/l	23	0.1	0.1	0.2	0.2	0.2
680	TOC	mg/l	22	4.1	5.6	7.3	8.4	19.5
70300	TDS	mg/l	21	73.0	103.0	135.0	152.0	204.0
72109	DtoH2O	Ft	170	3.5	5.6	6.7	8.0	10.4
76	Turb	Turb units	123	0.3	0.7	1.0	1.5	43.0
81	Color	Pt-Co	14	5.0	5.0	5.0	10.0	15.0
82078	Turb(field)	Turb units	42	0.6	0.7	1.2	1.8	7.2
915	D-Ca	mg/l	41	4.4	19.7	30.0	44.0	64.0
925	D-Mg	mg/l	41	1.0	2.5	3.2	3.7	5.0
930	D-Na	mg/l	41	3.4	4.0	4.4	5.6	8.0
935	D-K	mg/l	41	0.5	0.8	1.0	1.2	2.5
94	Cond(field)	micromhos/cm	171	28.0	163.7	209.0	269.5	900.0
941	D-Cl	mg/l	40	4.8	7.3	8.5	13.3	17.0
946	D-SO4	mg/l	40	1.1	7.6	15.0	20.0	29.3
950	D-F	mg/l	40	0.1	0.1	0.1	0.2	1.6

*Less than 10 samples
NA - No samples

Descriptive Statistics for 737 **Dates: December, 1987 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	143	22.0	24.0	24.6	25.0	26.5
1046	D-Fe	microg/l	28	479.0	762.5	815.0	900.0	1000.0
1056	D-Mn	microg/l	11	14.0	29.0	32.0	48.5	100.0
29801	Bicarb	mg/l	23	1.0	4.5	5.0	5.6	6.9
299	DO	mg/l	43	0.0	0.1	0.1	0.2	2.4
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	142	4.6	5.2	5.2	5.3	5.7
4255	D-Alk	mg/l	9	*	*	*	*	*
530	Resid	mg/l	5	*	*	*	*	*
608	D-NH3	mg/l	9	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	34	0.0	0.0	0.0	0.0	0.6
666	D-P	mg/l	7	*	*	*	*	*
671	D-PO4	mg/l	13	0.1	0.1	0.1	0.2	0.2
680	TOC	mg/l	13	1.0	1.0	1.4	1.6	3.0
70300	TDS	mg/l	12	23.0	29.0	37.0	42.0	65.0
72109	DtoH2O	Ft	142	3.8	5.4	6.4	7.7	9.1
76	Turb	Turb units	8	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	17	0.4	0.7	0.8	1.0	18.3
915	D-Ca	mg/l	32	0.6	0.9	0.9	1.4	4.0
925	D-Mg	mg/l	32	0.5	0.5	0.5	0.6	3.0
930	D-Na	mg/l	32	3.6	4.1	4.1	4.2	7.9
935	D-K	mg/l	32	1.0	1.3	1.3	1.5	1.7
94	Cond(field)	micromhos/cm	142	30.6	39.7	40.0	41.0	131.0
941	D-Cl	mg/l	34	5.0	6.0	6.4	6.6	7.3
946	D-SO4	mg/l	34	0.2	0.4	0.5	0.9	5.4
950	D-F	mg/l	32	0.0	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 775				**Dates: September, 1985 to April, 2003**				
Code	**Analyte**	**Measured units**	**Num. Samples**	**Min. Value**	**Q1 Value**	**Median Value**	**Q3 Value**	**Max. Value**
10	Temp	Deg C	18	23.8	24.2	24.8	25.1	27.0
1046	D-Fe	microg/l	3	*	*	*	*	*
1056	D-Mn	microg/l	1	*	*	*	*	*
29801	Bicarb	mg/l	6	*	*	*	*	*
299	DO	mg/l	14	0.1	0.3	0.4	3.8	6.0
31616	Fcol	#/100 ml	3	*	*	*	*	*
31649	Entero	#/100 ml	3	*	*	*	*	*
406	pH	ph units	17	6.9	7.1	7.1	7.2	7.4
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	3	*	*	*	*	*
608	D-NH3	mg/l	5	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	6	*	*	*	*	*
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	4	*	*	*	*	*
680	TOC	mg/l	5	*	*	*	*	*
70300	TDS	mg/l	4	*	*	*	*	*
72109	DtoH2O	Ft	16	0.0	4.0	5.2	7.1	9.1
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	8	*	*	*	*	*
915	D-Ca	mg/l	6	*	*	*	*	*
925	D-Mg	mg/l	6	*	*	*	*	*
930	D-Na	mg/l	6	*	*	*	*	*
935	D-K	mg/l	6	*	*	*	*	*
94	Cond(field)	micromhos/cm	18	852.0	871.8	878.0	884.0	3150.0
941	D-Cl	mg/l	6	*	*	*	*	*
946	D-SO4	mg/l	6	*	*	*	*	*
950	D-F	mg/l	6	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 996 **Dates: February, 1989 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	174	20.6	23.1	24.7	26.0	29.2
1046	D-Fe	microg/l	27	126.0	230.0	290.0	351.0	590.0
1056	D-Mn	microg/l	12	1.0	2.0	3.0	10.0	10.0
29801	Bicarb	mg/l	27	1.0	1.8	2.8	4.3	11.0
299	DO	mg/l	77	0.0	0.2	0.4	0.6	5.5
31616	Fcol	#/100 ml	10	1.0	1.0	1.0	1.0	2.0
31649	Entero	#/100 ml	10	1.0	1.0	1.0	1.0	4.0
406	pH	ph units	174	4.1	4.9	5.0	5.2	7.4
4255	D-Alk	mg/l	11	4.2	5.5	6.1	10.0	15.0
530	Resid	mg/l	11	4.0	4.0	4.0	4.0	6.0
608	D-NH3	mg/l	18	0.0	0.1	0.1	0.1	0.3
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	41	0.0	0.0	0.1	0.1	5.7
666	D-P	mg/l	13	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	22	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	22	1.9	2.4	2.9	4.6	6.4
70300	TDS	mg/l	19	27.0	46.0	51.0	61.0	96.0
72109	DtoH2O	Ft	174	4.7	7.1	8.0	8.5	11.8
76	Turb	Turb units	15	0.7	1.1	1.7	3.3	19.0
81	Color	Pt-Co	12	5.0	8.8	15.0	22.5	100.0
82078	Turb(field)	Turb units	38	0.3	2.7	4.5	7.4	27.0
915	D-Ca	mg/l	38	1.7	2.5	3.0	3.6	12.7
925	D-Mg	mg/l	38	1.5	1.8	2.4	2.9	3.5
930	D-Na	mg/l	38	3.1	3.9	4.3	5.0	5.4
935	D-K	mg/l	38	0.0	0.6	1.0	1.4	2.0
94	Cond(field)	micromhos/cm	173	51.8	66.0	74.0	82.0	792.0
941	D-Cl	mg/l	41	3.3	4.2	5.0	5.8	6.9
946	D-SO4	mg/l	41	12.0	14.0	16.0	18.0	25.0
950	D-F	mg/l	38	0.1	0.1	0.1	0.1	0.5

*Less than 10 samples
NA - No samples

Descriptive Statistics for 997 **Dates: February, 1989 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	144	23.3	24.0	24.8	25.1	26.0
1046	D-Fe	microg/l	28	0.3	699.0	750.0	771.3	890.0
1056	D-Mn	microg/l	11	3.0	10.0	13.0	14.5	21.0
29801	Bicarb	mg/l	20	168.0	179.3	180.0	187.0	222.0
299	DO	mg/l	46	0.0	0.1	0.1	0.2	4.7
31616	Fcol	#/100 ml	3	*	*	*	*	*
31649	Entero	#/100 ml	3	*	*	*	*	*
406	pH	ph units	141	6.2	7.2	7.2	7.3	8.6
4255	D-Alk	mg/l	10	110.0	179.3	183.0	190.0	200.0
530	Resid	mg/l	3	*	*	*	*	*
608	D-NH3	mg/l	10	0.0	0.1	0.1	0.1	0.1
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	34	0.0	0.0	0.0	0.0	0.1
666	D-P	mg/l	5	*	*	*	*	*
671	D-PO4	mg/l	14	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	14	0.3	1.0	1.5	2.0	4.6
70300	TDS	mg/l	11	204.0	218.5	222.0	227.0	232.0
72109	DtoH2O	Ft	141	5.8	8.2	8.9	9.4	11.1
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	13	0.2	0.2	0.5	1.0	1.1
915	D-Ca	mg/l	31	56.0	67.0	70.0	73.5	79.0
925	D-Mg	mg/l	31	0.1	2.5	2.8	2.9	7.7
930	D-Na	mg/l	31	5.6	6.1	6.3	6.5	16.5
935	D-K	mg/l	31	0.4	0.5	0.7	0.9	1.6
94	Cond(field)	micromhos/cm	142	24.7	372.5	381.0	384.0	405.0
941	D-Cl	mg/l	34	9.1	11.0	11.0	12.0	13.0
946	D-SO4	mg/l	34	1.8	2.7	3.2	5.0	7.6
950	D-F	mg/l	30	0.1	0.1	0.1	0.2	0.8

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1087 **Dates: September, 1985 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	172	18.5	22.5	23.0	23.6	25.5
1046	D-Fe	microg/l	26	1300.0	1700.0	1780.0	1800.0	2000.0
1056	D-Mn	microg/l	11	10.0	21.0	22.0	23.5	40.0
29801	Bicarb	mg/l	26	295.0	300.0	300.0	301.0	314.0
299	DO	mg/l	75	0.0	0.1	0.1	0.2	2.2
31616	Fcol	#/100 ml	10	0.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	171	6.0	6.8	6.9	6.9	7.9
4255	D-Alk	mg/l	9	*	*	*	*	*
530	Resid	mg/l	9	*	*	*	*	*
608	D-NH3	mg/l	14	0.2	0.2	0.2	0.3	0.3
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	38	0.0	0.0	0.0	0.0	0.3
666	D-P	mg/l	11	0.1	0.2	0.2	0.2	0.2
671	D-PO4	mg/l	18	0.1	0.2	0.2	0.2	0.2
680	TOC	mg/l	18	2.5	5.1	5.4	6.0	31.2
70300	TDS	mg/l	17	294.0	327.0	330.0	335.0	340.0
72109	DtoH2O	Ft	171	1.9	3.3	4.5	6.0	10.3
76	Turb	Turb units	12	15.0	16.0	16.5	19.8	35.0
81	Color	Pt-Co	9	*	*	*	*	*
82078	Turb(field)	Turb units	36	0.2	0.3	0.4	0.8	7.3
915	D-Ca	mg/l	35	100.0	116.0	120.0	120.0	220.0
925	D-Mg	mg/l	35	2.3	2.4	2.4	2.5	4.0
930	D-Na	mg/l	35	5.9	7.2	7.3	7.5	7.8
935	D-K	mg/l	35	0.4	0.4	0.4	0.6	1.0
94	Cond(field)	micromhos/cm	172	436.8	587.8	591.0	597.0	663.0
941	D-Cl	mg/l	38	10.0	12.0	12.0	12.6	14.0
946	D-SO4	mg/l	38	0.2	0.2	0.2	0.2	6.4
950	D-F	mg/l	35	0.1	0.1	0.1	0.1	0.4

*Less than 10 samples
NA - No samples

Descriptive Statistics for 1100 **Dates: July, 1988 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	66	22.4	24.0	24.8	25.7	29.0
1046	D-Fe	microg/l	6	*	*	*	*	*
1056	D-Mn	microg/l	6	*	*	*	*	*
29801	Bicarb	mg/l	11	56.0	58.0	62.0	65.5	110.0
299	DO	mg/l	46	0.9	3.3	3.8	4.3	6.2
31616	Fcol	#/100 ml	9	*	*	*	*	*
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	65	7.0	7.7	7.8	7.9	8.1
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	10	4.0	4.0	4.0	4.0	11.1
608	D-NH3	mg/l	11	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	17	0.0	0.0	0.1	0.1	0.2
666	D-P	mg/l	11	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	16	0.0	0.0	0.0	0.0	0.1
680	TOC	mg/l	17	1.0	1.0	1.0	1.2	2.8
70300	TDS	mg/l	16	80.0	93.0	100.0	141.0	512.0
72109	DtoH2O	Ft	65	33.9	37.6	41.0	43.0	46.3
76	Turb	Turb units	11	0.2	0.3	0.8	1.6	78.0
81	Color	Pt-Co	9	*	*	*	*	*
82078	Turb(field)	Turb units	35	0.1	1.1	2.8	5.0	352.0
915	D-Ca	mg/l	17	25.1	27.1	28.1	40.0	57.0
925	D-Mg	mg/l	17	1.1	1.1	1.1	1.4	2.1
930	D-Na	mg/l	17	2.9	3.0	3.2	3.7	4.7
935	D-K	mg/l	17	0.2	0.5	0.8	0.8	1.0
94	Cond(field)	micromhos/cm	66	147.0	191.0	200.0	219.0	321.0
941	D-Cl	mg/l	17	1.6	1.9	2.4	5.0	7.0
946	D-SO4	mg/l	17	15.0	16.0	17.0	31.0	41.0
950	D-F	mg/l	17	0.1	0.1	0.1	0.1	0.3

*Less than 10 samples
NA - No samples

Descriptive Statistics for 7934 **Dates: November, 1999 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	44	22.6	23.8	25.5	26.7	28.3
1046	D-Fe	microg/l	0	NA	NA	NA	NA	NA
1056	D-Mn	microg/l	0	NA	NA	NA	NA	NA
29801	Bicarb	mg/l	11	0.7	1.0	1.2	1.7	1.7
299	DO	mg/l	42	0.0	0.1	0.1	0.2	1.4
31616	Fcol	#/100 ml	12	1.0	1.0	1.0	1.0	104.0
31649	Entero	#/100 ml	12	1.0	1.0	1.0	1.0	4.0
406	pH	ph units	44	4.3	4.5	4.6	4.7	4.9
4255	D-Alk	mg/l	12	4.0	4.0	4.0	4.0	4.0
530	Resid	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
608	D-NH3	mg/l	12	0.2	0.2	0.3	0.3	0.3
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	12	0.0	0.0	0.0	0.0	0.0
666	D-P	mg/l	12	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	11	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	11	9.3	10.0	11.0	11.5	13.0
70300	TDS	mg/l	12	26.0	41.8	45.5	54.0	57.0
72109	DtoH2O	Ft	44	4.4	7.0	7.7	9.3	11.3
76	Turb	Turb units	12	1.2	1.3	1.4	1.9	3.8
81	Color	Pt-Co	12	20.0	30.0	40.0	50.0	60.0
82078	Turb(field)	Turb units	35	0.7	1.1	1.5	2.3	52.8
915	D-Ca	mg/l	12	2.7	3.1	3.1	3.5	4.4
925	D-Mg	mg/l	12	1.3	1.5	1.7	1.7	2.2
930	D-Na	mg/l	12	3.0	3.2	3.5	3.6	3.8
935	D-K	mg/l	12	0.7	0.7	0.8	1.0	1.2
94	Cond(field)	micromhos/cm	44	46.0	65.5	70.0	75.0	102.0
941	D-Cl	mg/l	11	5.1	5.5	5.7	6.3	7.2
946	D-SO4	mg/l	11	7.5	9.4	11.0	12.0	18.0
950	D-F	mg/l	10	0.0	0.0	0.0	0.0	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for 7935 **Dates: January, 2000 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	14	24.7	25.0	25.4	25.8	26.7
1046	D-Fe	microg/l	0	NA	NA	NA	NA	NA
1056	D-Mn	microg/l	0	NA	NA	NA	NA	NA
29801	Bicarb	mg/l	4	*	*	*	*	*
299	DO	mg/l	13	0.0	0.1	0.1	0.1	0.3
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	14	7.3	7.3	7.4	7.4	8.3
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	4	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	4	*	*	*	*	*
666	D-P	mg/l	4	*	*	*	*	*
671	D-PO4	mg/l	4	*	*	*	*	*
680	TOC	mg/l	4	*	*	*	*	*
70300	TDS	mg/l	4	*	*	*	*	*
72109	DtoH2O	Ft	14	0.0	0.0	0.0	0.0	0.0
76	Turb	Turb units	4	*	*	*	*	*
81	Color	Pt-Co	4	*	*	*	*	*
82078	Turb(field)	Turb units	10	0.3	0.6	0.8	1.3	17.3
915	D-Ca	mg/l	4	*	*	*	*	*
925	D-Mg	mg/l	4	*	*	*	*	*
930	D-Na	mg/l	4	*	*	*	*	*
935	D-K	mg/l	4	*	*	*	*	*
94	Cond(field)	micromhos/cm	4	*	*	*	*	*
941	D-Cl	mg/l	4	*	*	*	*	*
946	D-SO4	mg/l	4	*	*	*	*	*
950	D-F	mg/l	4	*	*	*	*	*

*Less than 10 samples
NA - No samples

South Florida Water Management District Wells
Descriptive Statistics for 2793 **Dates: June, 1986 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	163	24.2	25.5	26.0	26.6	28.5
1046	D-Fe	microg/l	22	303.0	1500.0	1700.0	1975.0	3100.0
1056	D-Mn	microg/l	7	*	*	*	*	*
29801	Bicarb	mg/l	25	204.0	240.0	250.0	265.0	275.0
299	DO	mg/l	110	0.2	0.3	0.4	0.4	0.8
31616	Fcol	#/100 ml	9	*	*	*	*	*
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	154	6.3	6.8	6.9	6.9	7.1
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	9	*	*	*	*	*
608	D-NH3	mg/l	19	0.7	0.9	1.0	1.1	1.2
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	9	*	*	*	*	*
631	D-NO3NO2	mg/l	30	0.0	0.0	0.0	0.0	0.2
666	D-P	mg/l	12	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	16	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	19	8.7	11.0	12.0	16.3	31.0
70300	TDS	mg/l	20	375.0	398.0	469.5	481.3	514.0
72109	DtoH2O	Ft	136	1.0	2.0	2.2	2.6	3.9
76	Turb	Turb units	13	3.1	3.7	4.0	4.3	12.0
81	Color	Pt-Co	10	80.0	85.0	100.0	100.0	120.0
82078	Turb(field)	Turb units	16	0.0	0.0	0.1	0.3	0.6
915	D-Ca	mg/l	27	93.0	112.0	120.0	120.0	134.0
925	D-Mg	mg/l	32	2.0	2.6	2.7	2.9	3.4
930	D-Na	mg/l	27	14.4	17.0	18.0	19.7	26.5
935	D-K	mg/l	27	0.6	0.8	1.0	1.3	3.1
94	Cond(field)	micromhos/cm	157	7.2	580.0	640.0	685.0	756.0
941	D-Cl	mg/l	30	25.0	31.0	34.5	35.0	51.0
946	D-SO4	mg/l	30	30.0	35.0	42.5	56.8	63.0
950	D-F	mg/l	27	0.2	0.2	0.2	0.2	0.4

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2872 **Dates: June, 1985 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	118	21.0	24.3	24.6	25.0	27.6
1046	D-Fe	microg/l	28	3.0	127.5	195.0	262.5	400.0
1056	D-Mn	microg/l	0	*	*	*	*	*
29801	Bicarb	mg/l	0	*	*	*	*	*
299	DO	mg/l	0	*	*	*	*	*
31616	Fcol	#/100 ml	0	*	*	*	*	*
31649	Entero	#/100 ml	0	*	*	*	*	*
406	pH	ph units	0	*	*	*	*	*
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	0	*	*	*	*	*
608	D-NH3	mg/l	30	0.0	0.1	0.1	262.5	400.0
618	D-NO3	mg/l	11	0.0	0.0	0.0	0.0	0.4
620	D-NO3(N)	mg/l	0	*	*	*	*	*
631	D-NO3NO2	mg/l	0	*	*	*	*	*
666	D-P	mg/l	0	*	*	*	*	*
671	D-PO4	mg/l	26	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	20	2.5	3.0	3.2	3.7	27.0
70300	TDS	mg/l	0	*	*	*	*	*
72109	DtoH2O	Ft	0	*	*	*	*	*
76	Turb	Turb units	0	*	*	*	*	*
81	Color	Pt-Co	0	*	*	*	*	*
82078	Turb(field)	Turb units	0	*	*	*	*	*
915	D-Ca	mg/l	0	*	*	*	*	*
925	D-Mg	mg/l	40	2.4	2.9	3.1	3.3	4.0
930	D-Na	mg/l	0	*	*	*	*	*
935	D-K	mg/l	0	*	*	*	*	*
94	Cond(field)	micromhos/cm	118	410.0	571.0	592.0	608.8	923.0
941	D-Cl	mg/l	0	*	*	*	*	*
946	D-SO4	mg/l	0	*	*	*	*	*
950	D-F	mg/l	0	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 2873 **Dates: October, 1991 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	61	23.5	24.7	24.9	25.7	28.3
1046	D-Fe	microg/l	4	*	*	*	*	*
1056	D-Mn	microg/l	2	*	*	*	*	*
29801	Bicarb	mg/l	8	*	*	*	*	*
299	DO	mg/l	13	0.0	0.2	0.3	0.4	1.7
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	3	*	*	*	*	*
406	pH	ph units	61	6.4	7.2	7.3	7.4	7.7
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	7	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	8	*	*	*	*	*
666	D-P	mg/l	8	*	*	*	*	*
671	D-PO4	mg/l	6	*	*	*	*	*
680	TOC	mg/l	6	*	*	*	*	*
70300	TDS	mg/l	4	*	*	*	*	*
72109	DtoH2O	Ft	61	4.2	7.4	8.5	9.4	10.9
76	Turb	Turb units	8	*	*	*	*	*
81	Color	Pt-Co	5	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	8	*	*	*	*	*
925	D-Mg	mg/l	8	*	*	*	*	*
930	D-Na	mg/l	8	*	*	*	*	*
935	D-K	mg/l	8	*	*	*	*	*
94	Cond(field)	micromhos/cm	61	0.0	0.0	0.0	0.7	8.2
941	D-Cl	mg/l	8	*	*	*	*	*
946	D-SO4	mg/l	8	*	*	*	*	*
950	D-F	mg/l	8	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 3108 **Dates: June, 1985 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	25	24.6	25.6	25.7	26.1	27.6
1046	D-Fe	microg/l	7	*	*	*	*	*
1056	D-Mn	microg/l	3	*	*	*	*	*
29801	Bicarb	mg/l	5	*	*	*	*	*
299	DO	mg/l	10	0.0	0.1	0.2	0.5	6.0
31616	Fcol	#/100 ml	4	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	10	6.9	7.2	7.3	7.3	7.4
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	4	*	*	*	*	*
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	5	*	*	*	*	*
631	D-NO3NO2	mg/l	5	*	*	*	*	*
666	D-P	mg/l	6	*	*	*	*	*
671	D-PO4	mg/l	10	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	8	*	*	*	*	*
70300	TDS	mg/l	9	*	*	*	*	*
72109	DtoH2O	Ft	23	6.5	8.2	9.8	11.3	16.3
76	Turb	Turb units	6	*	*	*	*	*
81	Color	Pt-Co	8	*	*	*	*	*
82078	Turb(field)	Turb units	8	*	*	*	*	*
915	D-Ca	mg/l	6	*	*	*	*	*
925	D-Mg	mg/l	11	74.2	76.9	80.4	83.3	85.5
930	D-Na	mg/l	6	*	*	*	*	*
935	D-K	mg/l	6	*	*	*	*	*
94	Cond(field)	micromhos/cm	25	2950.0	3117.0	3220.0	3320.0	3972.0
941	D-Cl	mg/l	6	*	*	*	*	*
946	D-SO4	mg/l	6	*	*	*	*	*
950	D-F	mg/l	6	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 3109 **Dates: April, 1985 to June, 2003**

Code	**Analyte**	**Measured units**	**Num. Samples**	**Min. Value**	**Q1 Value**	**Median Value**	**Q3 Value**	**Max. Value**
10	Temp	Deg C	51	23.4	24.5	25.2	26.3	28.8
1046	D-Fe	microg/l	6	*	*	*	*	*
1056	D-Mn	microg/l	3	*	*	*	*	*
29801	Bicarb	mg/l	13	266.0	287.0	290.0	298.0	305.0
299	DO	mg/l	47	0.1	0.1	0.2	0.4	1.8
31616	Fcol	#/100 ml	12	1.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	12	1.0	1.0	1.0	1.0	1.0
406	pH	ph units	47	6.3	6.6	6.7	6.8	6.9
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	12	4.0	4.8	6.0	9.8	14.0
608	D-NH3	mg/l	14	0.2	0.3	0.5	0.5	0.6
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	4	*	*	*	*	*
631	D-NO3NO2	mg/l	14	0.0	0.0	0.0	0.0	0.0
666	D-P	mg/l	14	0.0	0.0	0.1	0.1	0.1
671	D-PO4	mg/l	17	0.0	0.0	0.0	0.1	0.1
680	TOC	mg/l	15	21.0	23.0	24.0	26.0	100.0
70300	TDS	mg/l	16	397.0	418.8	432.0	460.0	508.0
72109	DtoH2O	Ft	47	3.4	5.7	6.5	7.3	9.4
76	Turb	Turb units	14	2.3	4.0	4.9	7.6	40.0
81	Color	Pt-Co	13	75.0	120.0	150.0	200.0	300.0
82078	Turb(field)	Turb units	15	0.0	0.0	1.7	3.2	4.2
915	D-Ca	mg/l	14	99.1	108.0	110.0	111.0	120.0
925	D-Mg	mg/l	14	10.0	10.8	10.9	11.1	12.0
930	D-Na	mg/l	18	15.6	17.7	18.7	20.0	21.9
935	D-K	mg/l	14	1.4	1.5	1.6	1.6	1.7
94	Cond(field)	micromhos/cm	51	0.0	626.0	651.0	698.0	856.0
941	D-Cl	mg/l	14	21.0	35.8	42.0	43.8	48.0
946	D-SO4	mg/l	14	0.2	2.1	3.0	4.8	5.5
950	D-F	mg/l	14	0.2	0.2	0.2	0.2	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 3398 **Dates: January, 1997 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	46	24.7	25.3	25.6	26.0	26.2
1046	D-Fe	microg/l	1	*	*	*	*	*
1056	D-Mn	microg/l	1	*	*	*	*	*
29801	Bicarb	mg/l	0	NA	NA	NA	NA	NA
299	DO	mg/l	46	0.1	0.2	0.3	0.4	3.5
31616	Fcol	#/100 ml	9	*	*	*	*	*
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	46	6.8	7.2	7.3	7.3	7.5
4255	D-Alk	mg/l	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA	NO DATA
530	Resid	mg/l	9	*	*	*	*	*
608	D-NH3	mg/l	10	0.2	0.2	0.2	0.3	0.3
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	10	0.0	0.0	0.0	0.0	0.0
666	D-P	mg/l	10	0.3	0.3	0.3	0.3	0.3
671	D-PO4	mg/l	10	0.3	0.3	0.3	0.3	0.3
680	TOC	mg/l	10	9.4	9.9	10.0	10.8	11.0
70300	TDS	mg/l	9	*	*	*	*	*
72109	DtoH2O	Ft	46	6.6	8.0	8.3	8.4	9.1
76	Turb	Turb units	10	0.2	0.2	0.3	0.3	11.0
81	Color	Pt-Co	9	*	*	*	*	*
82078	Turb(field)	Turb units	15	0.0	0.0	0.2	0.4	18.7
915	D-Ca	mg/l	10	62.5	66.9	67.2	68.1	72.5
925	D-Mg	mg/l	10	3.4	3.5	3.6	3.8	3.9
930	D-Na	mg/l	10	21.5	22.5	23.0	23.2	25.2
935	D-K	mg/l	10	2.3	2.8	2.9	3.1	3.5
94	Cond(field)	micromhos/cm	46	292.0	453.0	462.0	472.8	519.0
941	D-Cl	mg/l	10	34.0	34.3	35.0	37.8	38.0
946	D-SO4	mg/l	10	5.0	5.6	6.2	7.3	11.0
950	D-F	mg/l	10	0.1	0.2	0.2	0.2	0.2

*Less than 10 samples
NA - No samples

Descriptive Statistics for 3433 **Dates: July, 1985 to April, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	38	23.2	24.4	24.5	24.7	25.3
1046	D-Fe	microg/l	12	3.0	42.5	50.0	50.0	70.0
1056	D-Mn	microg/l	7	*	*	*	*	*
29801	Bicarb	mg/l	7	*	*	*	*	*
299	DO	mg/l	18	0.0	0.1	0.1	0.2	4.2
31616	Fcol	#/100 ml	5	*	*	*	*	*
31649	Entero	#/100 ml	4	*	*	*	*	*
406	pH	ph units	29	6.8	7.9	8.2	8.2	8.4
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	4	*	*	*	*	*
608	D-NH3	mg/l	16	0.1	0.1	0.2	0.2	0.2
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	8	*	*	*	*	*
631	D-NO3NO2	mg/l	7	*	*	*	*	*
666	D-P	mg/l	7	*	*	*	*	*
671	D-PO4	mg/l	15	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	9	*	*	*	*	*
70300	TDS	mg/l	13	79.0	90.0	97.0	103.0	137.9
72109	DtoH2O	Ft	17	-12.7	0.0	0.0	0.0	0.0
76	Turb	Turb units	7	*	*	*	*	*
81	Color	Pt-Co	6	*	*	*	*	*
82078	Turb(field)	Turb units	5	*	*	*	*	*
915	D-Ca	mg/l	7	*	*	*	*	*
925	D-Mg	mg/l	16	6.5	6.7	6.8	6.9	9.0
930	D-Na	mg/l	7	*	*	*	*	*
935	D-K	mg/l	7	*	*	*	*	*
94	Cond(field)	micromhos/cm	38	140.0	165.0	168.0	169.0	176.0
941	D-Cl	mg/l	7	*	*	*	*	*
946	D-SO4	mg/l	7	*	*	*	*	*
950	D-F	mg/l	7	*	*	*	*	*

*Less than 10 samples
NA - No samples

Descriptive Statistics for 3490 **Dates: March, 1999 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	45	22.6	22.8	22.9	23.0	23.3
1046	D-Fe	microg/l	1	*	*	*	*	*
1056	D-Mn	microg/l	0	NA	NA	NA	NA	NA
29801	Bicarb	mg/l	13	1.0	2.0	2.0	2.0	3.1
299	DO	mg/l	45	0.0	0.2	0.3	0.4	3.4
31616	Fcol	#/100 ml	12	1.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	12	1.0	1.0	1.0	2.3	10.0
406	pH	ph units	45	4.0	4.7	4.8	4.8	4.9
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	12	4.0	4.0	4.0	4.0	5.0
608	D-NH3	mg/l	13	0.0	0.0	0.0	0.0	0.1
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	0	NA	NA	NA	NA	NA
631	D-NO3NO2	mg/l	13	0.0	0.0	0.0	0.0	0.0
666	D-P	mg/l	13	0.0	0.0	0.0	0.0	0.0
671	D-PO4	mg/l	13	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	13	1.0	1.5	2.1	3.9	6.9
70300	TDS	mg/l	12	28.0	36.8	39.0	42.8	60.0
72109	DtoH2O	Ft	45	4.4	6.0	7.6	9.5	11.5
76	Turb	Turb units	13	0.1	0.1	0.1	0.1	19.0
81	Color	Pt-Co	13	5.0	5.0	5.0	15.0	75.0
82078	Turb(field)	Turb units	14	0.0	0.0	0.0	0.0	0.2
915	D-Ca	mg/l	13	0.1	0.1	0.1	0.1	0.3
925	D-Mg	mg/l	13	0.9	0.9	1.0	1.0	1.1
930	D-Na	mg/l	13	8.5	8.7	8.9	9.0	10.0
935	D-K	mg/l	13	0.2	0.2	0.2	0.3	0.4
94	Cond(field)	micromhos/cm	45	57.0	62.0	66.0	67.0	670.0
941	D-Cl	mg/l	13	14.0	15.0	15.0	15.0	17.0
946	D-SO4	mg/l	13	0.2	0.2	0.2	0.2	0.4
950	D-F	mg/l	13	0.1	0.1	0.1	0.1	0.1

*Less than 10 samples
NA - No samples

Descriptive Statistics for 6490 **Dates: December, 1985 to June, 2003**

Code	Analyte	Measured units	Num. Samples	Min. Value	Q1 Value	Median Value	Q3 Value	Max. Value
10	Temp	Deg C	154	22.5	25.3	25.6	25.9	26.9
1046	D-Fe	microg/l	19	3.0	5.0	8.0	12.5	50.0
1056	D-Mn	microg/l	2	*	*	*	*	*
29801	Bicarb	mg/l	26	210.0	216.3	220.0	222.3	234.0
299	DO	mg/l	138	0.0	0.3	0.4	0.7	1.9
31616	Fcol	#/100 ml	10	1.0	1.0	1.0	1.0	1.0
31649	Entero	#/100 ml	9	*	*	*	*	*
406	pH	ph units	154	6.6	7.0	7.0	7.1	8.4
4255	D-Alk	mg/l	0	NA	NA	NA	NA	NA
530	Resid	mg/l	9	*	*	*	*	*
608	D-NH3	mg/l	13	0.0	0.0	0.0	0.0	0.0
618	D-NO3	mg/l	0	NA	NA	NA	NA	NA
620	D-NO3(N)	mg/l	1	*	*	*	*	*
631	D-NO3NO2	mg/l	29	0.9	1.4	2.3	3.2	4.6
666	D-P	mg/l	12	0.0	0.0	0.0	0.0	0.1
671	D-PO4	mg/l	11	0.0	0.0	0.0	0.0	0.0
680	TOC	mg/l	13	1.0	1.8	2.0	2.1	58.0
70300	TDS	mg/l	13	312.0	313.0	323.5	332.8	351.0
72109	DtoH2O	Ft	156	2.8	7.0	7.5	7.9	9.3
76	Turb	Turb units	13	0.1	0.1	0.1	2.0	42.0
81	Color	Pt-Co	11	5.0	5.0	5.0	5.0	15.0
82078	Turb(field)	Turb units	16	0.0	0.0	0.1	0.3	0.5
915	D-Ca	mg/l	28	70.0	89.3	92.0	94.1	110.0
925	D-Mg	mg/l	28	2.9	4.0	4.6	5.1	6.1
930	D-Na	mg/l	28	14.0	17.9	22.5	26.0	31.0
935	D-K	mg/l	28	2.5	3.6	4.8	6.0	7.3
94	Cond(field)	micromhos/cm	154	461.0	557.5	575.0	589.0	684.0
941	D-Cl	mg/l	29	24.0	26.0	35.0	42.0	49.0
946	D-SO4	mg/l	29	18.0	21.0	26.0	29.0	37.0
950	D-F	mg/l	28	0.1	0.1	0.1	0.1	0.2

*Less than 10 samples
NA - No samples

APPENDIX J—SEASONALITY RESULTS

Spring Data followed by Well Data

Spring Data

Seasonality Results: Suwannee River Water Management District							
Name	**KTOT**	**NATOT**	**MGTOT**	**CATOT**	**CLTOT**	**FTOT**	**SO4TOT**
Alapaha River Rise	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Gilchrist Blue Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Fanning Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Hart Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Hornsby Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Lafayette Blue Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Little River Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Manatee Spring	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Poe Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Rock Bluff Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Ruth/Little Sulfur Springs	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Royal Spring	>.05	>.05	>.05	<.05	>.05	>.05	>.05
Suwannee Blue Spring	<.05	<.05	>.05	>.05	<.05	>.05	<.05
Telford Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Troy Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

TOT = Total

Seasonality Results: SRWMD cont.							
Name	**TKN**	**NOXNTOT**	**PTOT**	**OPO4DISS**	**COLITOT**	**COLI-FEC**	**FLOW CFS**
Alapaha River Rise	>.05	>.05	>.05	<.05	NA	NA	>.05
Gilchrist Blue Spring	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Fanning Spring	>.05	>.05	>.05	<.05	>.05	>.05	>.05
Hart Spring	>.05	>.05	>.05	>.05	NA	NA	>.05
Hornsby Spring	>.05	>.05	>.05	>.05	NA	NA	>.05
Lafayette Blue Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Little River Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Manatee Spring	>.05	<.05	>.05	>.05	<.05	<.05	<.05
Poe Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Rock Bluff Spring	>.05	>.05	>.05	<.05	>.05	>.05	>.05
Ruth/Little Sulfur Springs	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Royal Spring	>.05	>.05	>.05	>.05	NA	NA	NA
Suwannee Blue Spring	>.05	<.05	>.05	>.05	>.05	>.05	>.05
Telford Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Troy Spring	<.05	<.05	>.05	<.05	>.05	<.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05
NA Results not available due to lack of data

TOT = Total
FEC = Fecal

Seasonality Results: SRWMD cont.						
Name	**TOC**	**DOC**	**CONDL**	**PHF**	**TEMP**	**STAGEMSL**
Alapaha River Rise	>.05	>.05	>.05	>.05	<.05	NA
Gilchrist Blue Spring	>.05	>.05	>.05	>.05	>.05	NA
Fanning Spring	<.05	>.05	<.05	>.05	>.05	NA
Hart Spring	>.05	>.05	>.05	>.05	>.05	NA
Hornsby Spring	>.05	>.05	>.05	<.05	<.05	NA
Lafayette Blue Spring	>.05	>.05	<.05	>.05	>.05	NA
Little River Spring	>.05	>.05	>.05	>.05	>.05	NA
Manatee Spring	>.05	>.05	>.05	>.05	<.05	NA
Poe Spring	>.05	>.05	>.05	>.05	<.05	
Rock Bluff Spring	<.05	>.05	>.05	>.05	>.05	NA
Ruth/Little Sulfur Springs	>.05	>.05	>.05	<.05	>.05	NA
Royal Spring	>.05	NA	>.05	>.05	>.05	NA
Suwannee Blue Spring	>.05	>.05	<.05	<.05	>.05	NA
Telford Spring	>.05	>.05	>.05	<.05	>.05	
Troy Spring	>.05	>.05	>.05	>.05	>.05	NA

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

MSL = Mean Sea Level

Seasonality Results: SRWMD cont.				
Name	**DO**	**TURB**	**ALKTOT**	**NH3NTOT**
Alapaha River Rise	<.05	NA	NA	>.05
Gilchrist Blue Spring	>.05	>.05	>.05	>.05
Fanning Spring	<.05	>.05	>.05	>.05
Hart Spring	>.05	NA	NA	>.05
Hornsby Spring	>.05	>.05	>.05	>.05
Lafayette Blue Spring	>.05	>.05	<.05	<.05
Little River Spring	>.05	>.05	>.05	>.05
Manatee Spring	NA	NA	NA	NA
Poe Spring	NA	NA	NA	NA
Rock Bluff Spring	>.05	>.05	>.05	>.05
Ruth/Little Sulfur Springs	>.05	NA	NA	>.05
Royal Spring	>.05	>.05	>.05	>.05
Suwannee Blue Spring	NA	NA	NA	NA

Seasonality Results: SRWMD cont.				
Name	**TOTDEPM**	**TIME**	**CONDF**	**DtoH20**
Alapaha River Rise	NA	NA	NA	*
Gilchrist Blue Spring	NA	NA	NA	*
Fanning Spring	NA	NA	NA	*
Hart Spring	NA	NA	*	*
Hornsby Spring	NA	*	NA	*
Lafayette Blue Spring	NA	NA	NA	*
Little River Spring	NA	*	NA	*
Manatee Spring	NA	NA	NA	*
Poe Spring	NA	NA	NA	NA
Rock Bluff Spring	NA	NA	NA	>.05
Ruth/Little Sulfur Springs	NA	NA	NA	*
Royal Spring	*	*	*	*
Suwannee Blue Spring	NA	*	NA	*

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

TOT = Total

Seasonality Results: St. Johns Water Management District						
Name	**Temp**	**SCl**	**SCf**	**pH**	**D-NO3**	**T-NO3**
Alexander Spring	<.05	>.05	>.05	>.05	NA	NA
Apopka Spring	<.05	>.05	NA	>.05	NA	NA
Volusia Blue Spring	<.05	<.05	>.05	>.05	NA	>.05
Fern Hammock Springs	<.05	>.05	>.05	>.05	NA	NA
Juniper Springs	<.05	>.05	>.05	<.05	NA	NA
Miami Spring	NA	NA	NA	NA	NA	NA
Palm Spring	>.05	NA	NA	NA	NA	NA
Ponce De Leon Spring	>.05	>.05	<.05	>.05	NA	NA
Rock Spring	<.05	>.05	>.05	>.05	>.05	NA
Salt Springs	>.05	>.05	>.05	>.05	NA	NA
Sanlando Springs	>.05	NA	NA	NA	NA	NA
Silver Glen Springs	<0.05	>.05	>.05	>.05	NA	NA
Starbuck Spring	>.05	NA	NA	NA	NA	NA
Sweetwater Spring	<0.05	>.05	>.05	>.05	NA	NA
Wekiwa Spring	<0.05	>.05	>.05	>.05	>.05	NA

Seasonality Results: SJWMD Cont.						
Name	**D-NO3NO2**	**T-NO3NO2**	**T-P**	**D-P**	**TKN**	**TOC**
Alexander Spring	>.05	NA	NA	NA	>.05	NA
Apopka Spring	>.05	<.05	<.05	<.05	>.05	<.05
Volusia Blue Spring	>.05	NA	<.05	NA	>.05	>.05
Fern Hammock Springs	>.05	NA	NA	NA	>.05	NA
Juniper Springs	>.05	NA	NA	NA	>.05	NA
Miami Spring	NA	NA	NA	NA	NA	NA
Palm Spring	NA	NA	NA	NA	NA	NA
Ponce De Leon Spring	>.05	NA	NA	NA	<.05	NA
Rock Spring	>.05	NA	NA	NA	>.05	NA
Salt Springs	>.05	NA	NA	NA	>.05	NA
Sanlando Springs	NA	NA	NA	NA	NA	NA
Silver Glen Springs	>.05	NA	NA	NA	>.05	NA
Starbuck Spring	NA	NA	NA	NA	NA	NA
Sweetwater Spring	>.05	NA	NA	NA	>.05	NA
Wekiwa Spring	>.05	NA	NA	NA	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05
NA Results not available due to lack of data

D = Dissolved
T = Total

Seasonality Results: SJWMD Cont.

Name	T-SO4	F	T-F	Si	Si(SIO3 as Si)	D-Fe	T-Fe
Alexander Spring	>.05	>.05	>.05	>.05	>.05	NA	NA
Apopka Spring	<.05	NA	NA	NA	>.05	NA	NA
Volusia Blue Spring	>.05	<.05	NA	>.05	>.05	NA	NA
Fern Hammock Springs	>.05	>.05	>.05	NA	>.05	NA	NA
Juniper Springs	>.05	<.05	>.05	>.05	>.05	NA	NA
Miami Spring	NA	NA	NA	NA	NA	NA	NA
Palm Spring	NA	NA	NA	NA	NA	NA	NA
Ponce De Leon Spring	<.05	>.05	>.05	>.05	>.05	<.05	NA
Rock Spring	>.05	>.05	>.05	>.05	>.05	>.05	NA
Salt Springs	<.05	NA	>.05	>.05	>.05	NA	>.05
Sanlando Springs	NA	NA	NA	NA	NA	NA	NA
Silver Glen Springs	>.05	NA	>.05	NA	>.05	NA	NA
Starbuck Spring	NA	NA	NA	NA	NA	NA	NA
Sweetwater Spring	>.05	NA	>.05	>.05	>.05	NA	NA

Seasonality Results: SJWMD Cont.

Name	**D-Sr**	**T-Sr**	**TDS**	**T-PO4**	**T-Alk**	**T-Na**	**Na**
Alexander Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Apopka Spring	>.05	NA	<.05	>.05	<.05	NA	<.05
Volusia Blue Spring	>.05	>.05	>.05	>.05	<.05	>.05	<.05
Fern Hammock Springs	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Juniper Springs	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Miami Spring	NA	NA	NA	NA	NA	NA	NA
Palm Spring	NA	NA	NA	NA	NA	NA	NA
Ponce De Leon Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Rock Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Salt Springs	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Sanlando Springs	NA	NA	NA	NA	NA	NA	NA
Silver Glen Springs	NA	>.05	>.05	>.05	>.05	>.05	NA
Starbuck Spring	NA	NA	NA	NA	NA	NA	NA
Sweetwater Spring	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Wekiwa Spring	>.05	<0.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

D = Dissolved T = Total

Seasonality Results: SJWMD Cont.						
Name	**Ca**	**T-Ca**	**Mg**	**T-Mg**	**K**	**T-K**
Alexander Spring	>.05	>.05	>.05	>.05	>.05	>.05
Apopka Spring	>.05	NA	<.05	NA	<.05	NA
Volusia Blue Spring	<.05	>.05	>.05	>.05	>.05	NA
Fern Hammock Springs	>.05	>.05	>.05	>.05	>.05	NA
Juniper Springs	>.05	>.05	>.05	>.05	>.05	NA
Miami Spring	NA	NA	NA	NA	NA	NA
Palm Spring	NA	NA	NA	NA	NA	NA
Ponce De Leon Spring	>.05	>.05	>.05	>.05	>.05	>.05
Rock Spring	>.05	>.05	>.05	>.05	>.05	>.05
Salt Springs	>.05	>.05	>.05	>.05	>.05	>.05
Sanlando Springs	NA	NA	NA	NA	NA	NA
Silver Glen Springs	NA	>.05	NA	>.05	NA	>.05
Starbuck Spring	NA	NA	NA	NA	NA	NA
Sweetwater Spring	>.05	>.05	>.05	>.05	>.05	>.05
Wekiwa Spring	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

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NA Results not available due to lack of data

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Seasonality Results: Southwest Florida Water Management District							
Name	**Temp**	**Cond(field)**	**pH**	**Bicarb**	**T-N**	**D-TKN**	**T- NH3**
Bobhill	<.05	>.05	<.05	>.05	>.05	>.05	>.05
Boyette	<.05	>.05	>.05	<.05	>.05	>.05	>.05
Chassahowitzka 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Chassahowitzka M	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Hidden River No2	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Hidden River H	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Homosassa No 1	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Homosassa No 2	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Homosassa No 3	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Hunters	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Lithia Main	<.05	<.05	>.05	>.05	>.05	>.05	>.05
Magnolia	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Pump House	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow No 1	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow No 4	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow No 6	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow Swamp No 3	<.05	>.05	>.05	>.05	NA	>.05	>.05
Rainbow Bridge Seep	<.05	>.05	>.05	<.05	NA	>.05	>.05
Salt	<.05	<.05	>.05	>.05	>.05	>.05	<.05
Betty Jay	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Boyette	<.05	>.05	>.05	>.05	NA	>.05	>.05
Buckhorn	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Catfish	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Tarpon Hole	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Trotter Main	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Weeki Wachee Main	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Wilson Head	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Boat	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Bubbling	<.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

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NA Results not available due to lack of data

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Seasonality Results: SWFWMD cont.								
Name	**D-NO3**	**D-NO3NO2**	**T-P**	**D-PO4**	**TOC**	**D-Ca**	**D-Mg**	**D-Na**
Bobhill	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Boyette	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Chassahowitzka 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Chassahowitzka M	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Hidden River No2	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Hidden River H	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Homosassa No 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Homosassa No 2	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Homosassa No 3	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Hunters	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Lithia Main	>.05	>.05	>.05	>.05	>.05	>.05	>.05	<.05
Magnolia	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Pump House	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow No 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow No 4	>.05	>.05	>.05	<.05	>.05	>.05	>.05	>.05
Rainbow No 6	>.05	>.05	>.05	<.05	>.05	>.05	>.05	>.05
Rainbow Swamp No 3	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Rainbow Bridge Seep	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Salt	>.05	>.05	>.05	>.05	>.05	<.05	<.05	<.05
Betty Jay	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Boyette	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Buckhorn	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Catfish	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Tarpon Hole	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Trotter Main	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Weeki Wachee Main	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Wilson Head	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Boat	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05
Bubbling	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

D = Dissolved

T = Total

Seasonality Results: SWFWMD cont.								
Name	**D-K**	**D-Cl**	**D-SO4**	**D-F**	**D-Fe**	**D-Sr**	**TDS**	**D-SiO2**
Bobhill	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Boyette	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Chassahowitzka 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Chassahowitzka M	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Hidden River No2	>.05	>.05	>.05	>.05	>.05	NA	>.05	NA
Hidden River H	>.05	>.05	>.05	>.05	>.05	NA	>.05	NA
Homosassa No 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Homosassa No 2	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Homosassa No 3	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Hunters	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Lithia Main	>.05	<.05	<.05	>.05	>.05	>.05	<.05	NA
Magnolia	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Pump House	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Rainbow No 1	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Rainbow No 4	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Rainbow No 6	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Rainbow Swamp No 3	>.05	>.05	>.05	>.05	>.05	>.05	NA	NA
Rainbow Bridge Seep	>.05	>.05	>.05	>.05	<.05	>.05	>.05	NA
Salt	<.05	<.05	<.05	>.05	<.05	>.05	<.05	NA
Betty Jay	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Boyette	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Buckhorn	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Catfish	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Tarpon Hole	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Trotter Main	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Weeki Wachee Main	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Wilson Head	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Boat	>.05	>.05	>.05	>.05	>.05	>.05	>.05	NA
Bubbling	>.05	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

D = Dissolved

Well Data

Seasonality Results: Wells, Northwest Florida Water Management District						
Well ID	**Name**	**Temp**	**Fe, Diss**	**Alk**	**DO**	**Col, Fec**
67	WAKULLA SPRING WELL	<0.05	>.05	>.05	>.05	NA
91	CHARLES DONAHUE	<0.05	>.05	<0.05	>.05	>.05
131	WELLER AVE SHALLOW	<.05	>.05	>.05	>.05	NA
129	WELLER AVE MPZ	>.05	>.05	>.05	>.05	NA
313	USGS 422B NR GREENHD	<0.05	>.05	>.05	>.05	>.05
312	USGS 422A NR GREENHD	<0.05	>.05	>.05	>.05	>.05
245	BLOUNTSTOWN SURFICIA	<0.05	NA	>.05	>.05	>.05
243	BLOUNTSTOWN FLORIDAN	<0.05	NA	>.05	>.05	>.05

Seasonality Results: Wells, NWFWMD cont.							
Well ID	**Entero**	**pH, Field**	**TSS**	**Amm, Dis**	**Nitrate + Nitrite**	**P, Diss**	**Ortho-P, Diss**
67	NA	>.05	NA	>.05	>.05	>.05	>.05
91	>.05	>.05	>.05	>.05	<.05	>.05	>.05
131	NA	>.05	NA	>.05	>.05	>.05	>.05
129	NA	>.05	NA	>.05	>.05	NA	>.05
313	NA	>.05	NA	>.05	>.05	>.05	>.05
312	>.05	>.05	>.05	>.05	>.05	>.05	>.05
245	NA	>.05	>.05	>.05	>.05	>.05	>.05
243	NA	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, NWFWMD cont.							
Well ID	**TOC**	**TDS**	**Depth to Water**	**Turbidity**	**Color**	**Turb (field)**	**Ca, Diss**
67	>.05	>.05	NA	>.05	NA	<0.05	>.05
91	>.05	<.05	>.05	>.05	>.05	<0.05	<0.05
131	>.05	>.05	>.05	>.05	>.05	>.05	>.05
129	>.05	>.05	<.05	NA	NA	NA	>.05
313	>.05	>.05	>.05	>.05	>.05	>.05	>.05
312	>.05	>.05	>.05	>.05	>.05	NA	>.05
245	>.05	>.05	>.05	>.05	>.05	>.05	<.05
243	>.05	>.05	>.05	>.05	NA	NA	>.05

Seasonality Results: Wells, NWFWMD cont.							
Well ID	**Mg, Diss**	**Na, Diss**	**K, Diss**	**Specific Cond**	**Cl, Diss**	**SO4, Diss**	**F, Diss**
67	>.05	>.05	>.05	>.05	>.05	>.05	>.05
91	>.05	<0.05	>.05	<0.05	>.05	>.05	>.05
131	>.05	>.05	>.05	>.05	>.05	>.05	>.05
129	>.05	>.05	>.05	>.05	>.05	>.05	>.05
313	>.05	>.05	>.05	>.05	>.05	>.05	>.05
312	>.05	>.05	>.05	>.05	>.05	>.05	>.05
245	>.05	>.05	>.05	>.05	>.05	<.05	>.05
243	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, Suwannee River Water Management District							
Well ID	Name	W Temp	Fe, Diss	Alkalinity	DO	Col, Fec	Entero
2404	-30833001	<0.05	>.05	>.05	>.05	>.05	NA
2353	-41734002	>.05	>.05	>.05	>.05	>.05	NA
2259	-61401003	>.05	>.05	>.05	>.05	>.05	NA
2193	-72013001	<0.05	<0.05	>.05	>.05	NA	NA
2003	-101601002	<0.05	>.05	<0.05	>.05	>.05	<0.05
1943	-111117007	<0.05	>.05	>.05	>.05	>.05	NA
2675	21332004	<0.05	>.05	>.05	<0.05	>.05	>.05
2585	-11011002	<0.05	>.05	<0.05	>.05	NA	NA
2465	-21231001	<0.05	>.05	<0.05	>.05	>.05	NA

Seasonality Results: Wells, SRWMD cont.							
Well ID	pH, Field	TSS	Amm, Dis	Nitrate + Nitrite	P, Diss	Ortho-P, Diss	TOC
2404	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2353	>.05	NA	>.05	>.05	>.05	>.05	>.05
2259	>.05	NA	>.05	>.05	>.05	>.05	>.05
2193	>.05	NA	>.05	>.05	NA	>.05	>.05
2003	>.05	>.05	<0.05	>.05	>.05	>.05	>.05
1943	>.05	NA	>.05	>.05	>.05	>.05	>.05
2675	>.05	NA	>.05	>.05	>.05	>.05	>.05
2585	>.05	NA	>.05	>.05	>.05	>.05	>.05
2465	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, SRWMD cont.							
Well ID	**TDS**	**Depth to Water**	**Turbidity**	**Color**	**Turb(field)**	**Ca, Diss**	**Mg, Diss**
2404	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2353	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2259	>.05	>.05	>.05	NA	>.05	>.05	>.05
2193	>.05	>.05	NA	NA	NA	>.05	>.05
2003	>.05	>.05	>.05	>.05	>.05	<.05	>.05
1943	>.05	>.05	>.05	NA	>.05	>.05	>.05
2675	>.05	<.05	>.05	>.05	<.05	>.05	>.05
2585	>.05	>.05	>.05	NA	NA	>.05	>.05
2465	>.05	>.05	>.05	NA	>.05	>.05	>.05

Seasonality Results: Wells, SRWMD cont.						
Well ID	**Na, Diss**	**K, Diss**	**Specific Cond**	**Cl, Diss**	**SO4, Diss**	**F, Diss**
2404	>.05	>.05	>.05	>.05	>.05	>.05
2353	>.05	>.05	>.05	>.05	>.05	>.05
2259	>.05	>.05	>.05	>.05	>.05	>.05
2193	>.05	>.05	>.05	>.05	>.05	>.05
2003	>.05	>.05	>.05	>.05	>.05	>.05
1943	>.05	>.05	>.05	>.05	>.05	>.05
2675	>.05	>.05	>.05	>.05	>.05	>.05
2585	>.05	>.05	<.05	>.05	>.05	>.05
2465	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, St. Johns Water Management District							
Well ID	Name	W Temp	Fe, Diss	Alk	DO	Col, Fec	Entero
1420	S-0038	<.05	>.05	>.05	>.05	NA	NA
1417	S-0045	>.05	>.05	>.05	>.05	>.05	NA
1781	BA0056	<0.05	>.05	>.05	>.05	NA	NA
1780	BA0055	>.05	>.05	>.05	>.05	NA	NA
1779	BA0054	>.05	>.05	>.05	>.05	NA	NA
1764	SJ0032	<0.05	>.05	>.05	>.05	>.05	>.05
1763	SJ0030	>.05	<0.05	>.05	>.05	>.05	NA
1762	SJ0029	<0.05	>.05	>.05	>.05	>.05	NA
Alachua County							
1931	R18T11SEC3101	<0.05	NA	NA	>.05	NA	NA
1674	R22T10SEC2001	<.05	>.05	>.05	>.05	NA	>.05

Seasonality Results: Wells, SJWMD								
Well ID	pH, Field	TSS	Amm, Dis	Nitrate + Nitrite	P, Diss	Ortho-P, Diss	TOC	TDS
1420	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
1417	>.05	>.05	>.05	>.05	>.05	<0.05	>.05	>.05
1781	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
1780	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
1779	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
1764	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
1763	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
1762	>.05	NA	>.05	>.05	>.05	>.05	>.05	>.05
Alachua County								
1931	>.05	NA	NA	NA	NA	NA	NA	NA
1674	<0.05	NA	>.05	>.05	>.05	>.05	<.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, SJWMD							
Well ID	**Depth to Water**	**Turb**	**Color**	**Turb(field)**	**Ca, Diss**	**Mg, Diss**	**Na, Diss**
1420	>.05	>.05	>.05	NA	>.05	>.05	>.05
1417	>.05	>.05	>.05	>.05	>.05	>.05	>.05
1781	>.05	>.05	NA	>.05	>.05	>.05	>.05
1780	>.05	>.05	NA	>.05	>.05	>.05	>.05
1779	>.05	>.05	NA	>.05	>.05	>.05	>.05
1764	<.05	>.05	>.05	>.05	>.05	>.05	>.05
1763	>.05	>.05	>.05	>.05	>.05	>.05	>.05
1762	<.05	>.05	>.05	>.05	>.05	>.05	>.05
Alachua County							
1931	>.05	NA	NA	>.05	NA	NA	NA
1674	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Seasonality Results: Wells, SJWMD					
Well ID	**K, Diss**	**Specific Cond**	**Cl, Diss**	**SO4, Diss**	**F, Diss**
1420	>.05	>.05	>.05	<.05	>.05
1417	>.05	>.05	>.05	>.05	>.05
1781	>.05	>.05	>.05	>.05	>.05
1780	>.05	>.05	>.05	>.05	>.05
1779	>.05	>.05	>.05	>.05	>.05
1764	>.05	>.05	>.05	>.05	>.05
1763	>.05	>.05	>.05	>.05	>.05
1762	>.05	>.05	>.05	>.05	>.05
Alachua County					
1931	NA	>.05	NA	NA	NA
1674	>.05	>.05	<.05	>.05	<.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, Southwest Florida Water Management District						
Well ID	**Name**	**W Temp**	**Fe, Diss**	**Alkalinity**	**DO**	**Col, Fec**
7935	ROMP 23 PZ2	>.05	NA	>.05	>.05	NA
7934	ROMP 23 SURFICIAL	<0.05	NA	>.05	>.05	>.05
775	ROMP TR 8-1 INT	<0.05	NA	>.05	>.05	NA
997	CLAYWELL ELEM. FL	<0.05	>.05	>.05	>.05	NA
996	CLAYWELL ELEM. SF	<0.05	>.05	>.05	<0.05	>.05
737	CREWSVILLE UP INT-AG	<0.05	>.05	>.05	>.05	NA
736	CREWSVILLE SH-AGW	<0.05	>.05	<0.05	>.05	NA
707	ROMP 23-1 DEEP	<0.05	>.05	>.05	>.05	>.05
615	ROMP 17 SWNN	NA	NA	>.05	>.05	NA
1100	RDGE MNR RMP99X SH-A	>.05	>.05	>.05	>.05	>.05
1087	WITHLA. ST. FOREST G	<.05	>.05	>.05	>.05	>.05

Seasonality Results: Wells, SWFWMD cont.							
Well ID	**Entero**	**pH, Field**	**TSS**	**Amm, Dis**	**Nitrate Nitrite**	**P, Diss**	**Ortho-P, Diss**
7935	>.05	>.05	>.05	>.05	NA	>.05	>.05
7934	>.05	>.05	NA	>.05	>.05	>.05	>.05
775	NA	>.05	NA	NA	>.05	>.05	NA
997	NA	>.05	NA	NA	>.05	NA	>.05
996	>.05	>.05	>.05	>.05	>.05	>.05	>.05
737	NA	>.05	>.05	>.05	>.05	>.05	>.05
736	NA	<0.05	>.05	>.05	>.05	>.05	>.05
707	>.05	>.05	NA	>.05	>.05	>.05	>.05
615	NA	>.05	NA	>.05	>.05	>.05	>.05
1100	NA	<0.05	>.05	NA	>.05	>.05	>.05
1087	NA	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, SWFWMD cont.

Well ID	TOC	TDS	Depth to Water	Turbidity	Color	Turb(field)	Ca, Diss
7935	>.05	>.05	>.05	>.05	>.05	>.05	>.05
7934	>.05	>.05	>.05	>.05	>.05	>.05	>.05
775	>.05	>.05	>.05	>.05	NA	>.05	>.05
997	>.05	>.05	<.05	NA	NA	>.05	>.05
996	>.05	>.05	<.05	>.05	>.05	>.05	>.05
737	>.05	>.05	<.05	>.05	>.05	>.05	>.05
736	>.05	>.05	<.05	>.05	>.05	>.05	<.05
707	>.05	>.05	<.05	>.05	NA	>.05	<.05
615	>.05	>.05	>.05	>.05	>.05	>.05	>.05
1100	>.05	>.05	<.05	<.05	NA	>.05	>.05
1087	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Seasonality Results: Wells, SWFWMD cont.

Well ID	Mg, Diss	Na, Diss	K, Diss	Specific Cond	Cl, Diss	SO4, Diss	F, Diss
7935	>.05	>.05	>.05	>.05	>.05	>.05	>.05
7934	>.05	>.05	>.05	>.05	>.05	>.05	>.05
775	>.05	>.05	>.05	>.05	>.05	>.05	>.05
997	>.05	>.05	>.05	>.05	>.05	<0.05	>.05
996	>.05	>.05	>.05	>.05	>.05	>.05	>.05
737	>.05	<0.05	>.05	>.05	>.05	>.05	>.05
736	>.05	<0.05	<0.05	<0.05	<0.05	<0.05	>.05
707	>.05	>.05	>.05	>.05	>.05	>.05	>.05
615	>.05	>.05	>.05	>.05	>.05	>.05	>.05
1100	>.05	>.05	>.05	>.05	>.05	>.05	>.05
1087	>.05	>.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05
NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, South Florida Water Management District							
Well ID	**Name**	**W Temp**	**Fe, Diss**	**Alk**	**DO**	**Col, Fec**	**Entero**
6490	27-3	<0.05	>.05	>.05	<0.05	NA	NA
3490	KISSPARK	<0.05	NA	>.05	>.05	NA	<0.05
3433	POF-0008	<0.05	>.05	NA	>.05	NA	NA
3398	PBS-S44	<0.05	NA	>.05	>.05	NA	NA
3109	L-02202	<0.05	NA	>.05	>.05	NA	NA
3108	L-02200	<0.05	NA	>.05	>.05	NA	>.05
2873	C-00973	<0.05	NA	>.05	>.05	NA	NA
2872	C-00972	>.05	>.05	>.05	>.05	NA	>.05
2793	G-2364	<0.05	>.05	>.05	>.05	NA	>.05

Seasonality Results: Wells, SFWMD							
Well ID	**pH, Field**	**TSS**	**Amm, Dis**	**Nitrate + Nitrite**	**P, Diss**	**Ortho-P, Diss**	**TOC**
6490	>.05	NA	>.05	>.05	>.05	>.05	>.05
3490	>.05	>.05	>.05	<0.05	>.05	>.05	>.05
3433	>.05	NA	>.05	NA	NA	>.05	>.05
3398	>.05	NA	>.05	>.05	>.05	>.05	>.05
3109	<0.05	>.05	>.05	>.05	>.05	>.05	>.05
3108	>.05	NA	>.05	>.05	>.05	>.05	>.05
2873	>.05	NA	>.05	>.05	>.05	>.05	>.05
2872	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2793	>.05	NA	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05
NA Results not available due to lack of data

Diss = Dissolved

Seasonality Results: Wells, SFWMD						
Well ID	**TDS**	**Depth to Water**	**Turbidity**	**Color**	**Turb(field)**	**Ca, Diss**
6490	>.05	<.05	>.05	>.05	>.05	>.05
3490	>.05	>.05	>.05	>.05	>.05	>.05
3433	>.05	>.05	NA	NA	NA	NA
3398	>.05	<.05	>.05	>.05	>.05	>.05
3109	>.05	<.05	>.05	>.05	>.05	>.05
3108	>.05	<.05	>.05	NA	>.05	>.05
2873	>.05	<.05	>.05	NA	>.05	>.05
2872	>.05	<.05	>.05	>.05	>.05	>.05
2793	>.05	<.05	>.05	>.05	>.05	>.05

Seasonality Results: Wells, SFWMD							
Well ID	**Mg, Diss**	**Na, Diss**	**K, Diss**	**Specific Cond**	**Cl, Diss**	**SO4, Diss**	**F, Diss**
6490	<.05	>.05	<0.05	<0.05	>.05	<0.05	>.05
3490	>.05	>.05	>.05	>.05	>.05	<.05	NA
3433	>.05	NA	NA	>.05	NA	NA	NA
3398	>.05	>.05	>.05	<.05	>.05	>.05	>.05
3109	>.05	>.05	>.05	>.05	>.05	>.05	>.05
3108	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2873	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2872	>.05	>.05	>.05	>.05	>.05	>.05	>.05
2793	>.05	<.05	>.05	>.05	>.05	>.05	>.05

Failure to reject null (>0.05) also includes some data where analyses were inconclusive; data highlighted in yellow were the only tests conclusively rejecting null

<0.05 Significant at less than .05

NA Results not available due to lack of data

Diss = Dissolved

APPENDIX K. Mann-Kendall and Sen slope results.

Mann-Kendall and Sen slope results are available online at:
http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/B/B69Appendices/APPENDIX%20K%20(MK%20&%20SS)%20Results/

The files in Appendix K are arranged under general area of the state, and then by water management district within each area. The Excel spreadsheets use the following column labling convention:

Location = Location of sampling site

Sequence = Time Sequence (A, B, or C)

Dates = Beginning and ending dates of sequence.

Lat = Latitude

Long = Longitude

Type = Sampling type (Well or Spring)

Ha_up = Probability of null hypothesis (evidence for upward trend)

Ha_down = Probability of null hypothesis (evidence for downward trend)

Sen_slope = Sen slope

n = Number of observations in sequence

Up/DOW = Discusses evidence of an upward or downward trend

APPENDIX L—DISTRICT-WIDE MAPS

Abbreviations

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

Figures

Appendix L1—NWFWMD Springs

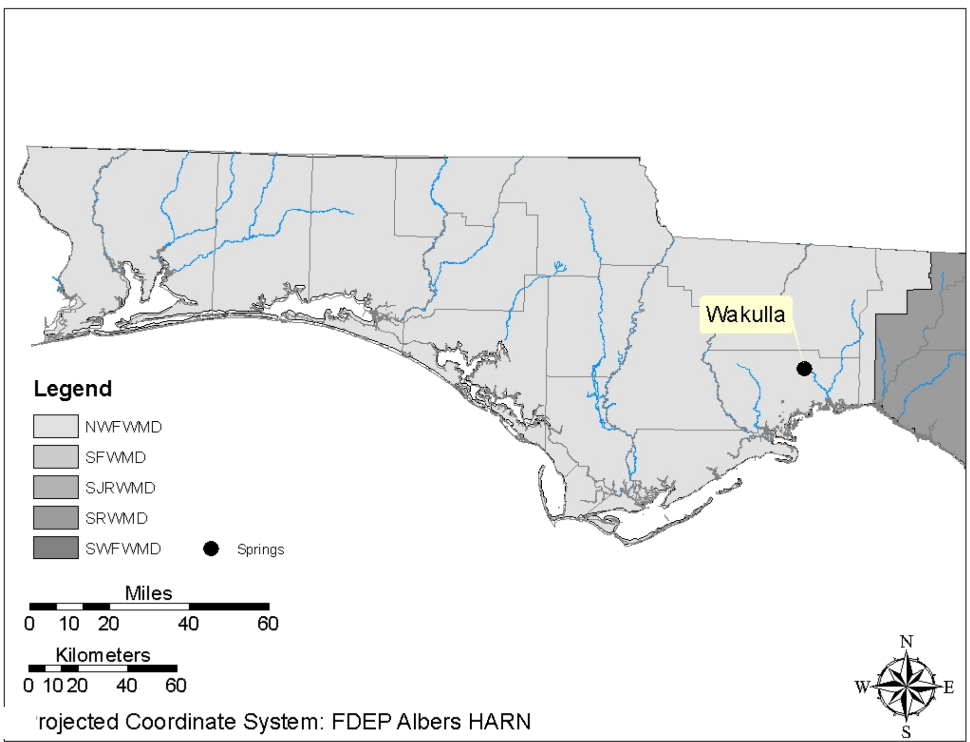

Figure L1. NWFWMD Spring

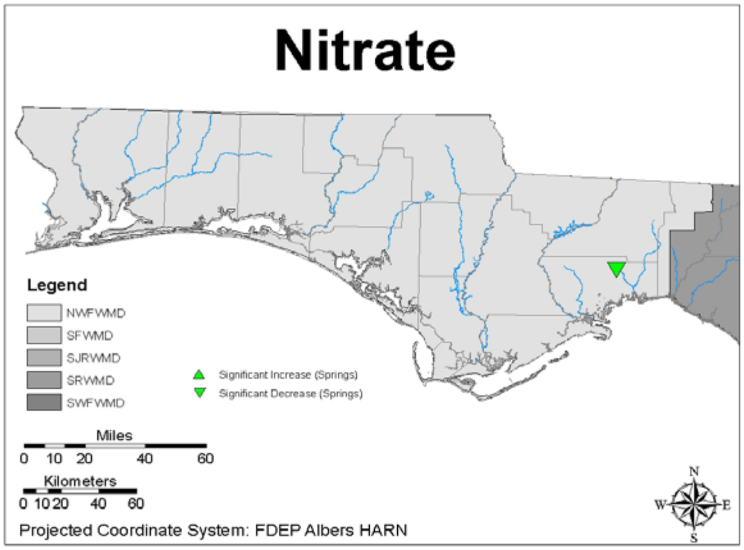

Figure L2. Nitrate trend in NWFWMD spring

Appendix L 2—Northwest Florida Water Management District Wells

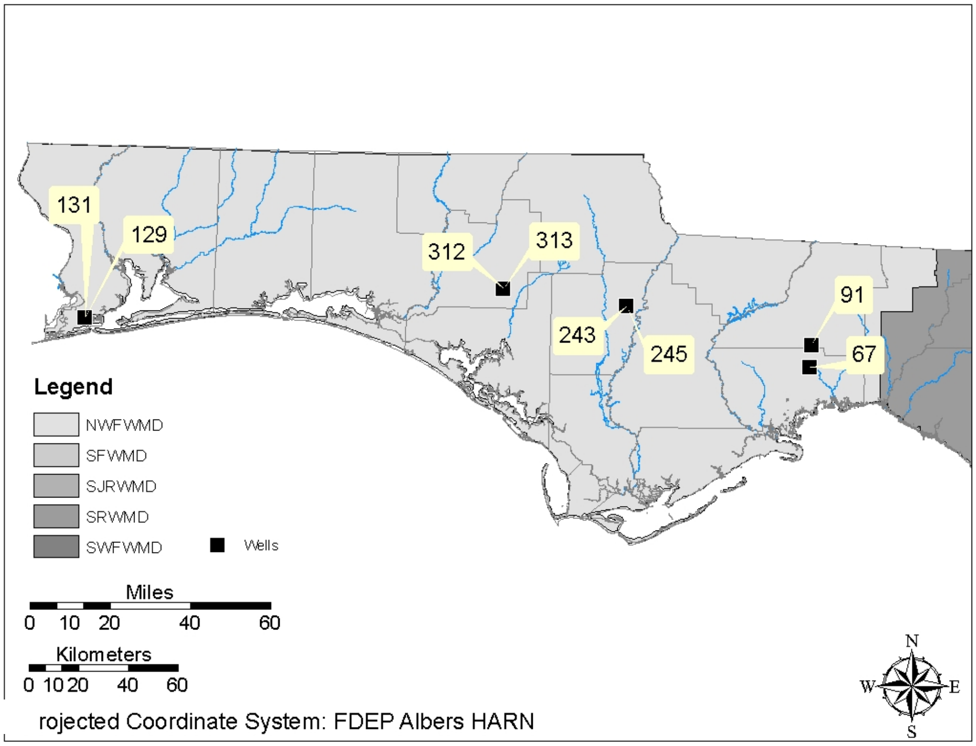

Figure L3. NWFWMD Wells

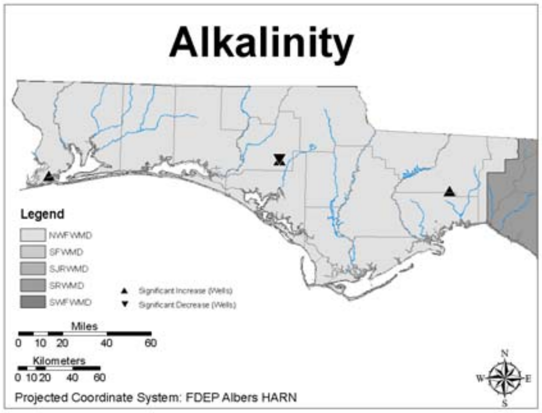

Figure L4. Alkalinity trends in NWFWMD wells

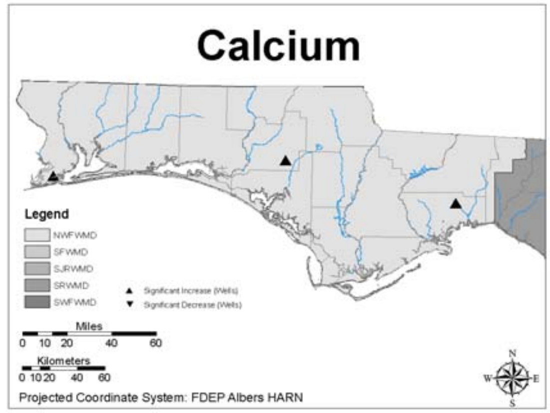

Figure L5. Calcium trends in NWFWMD wells.

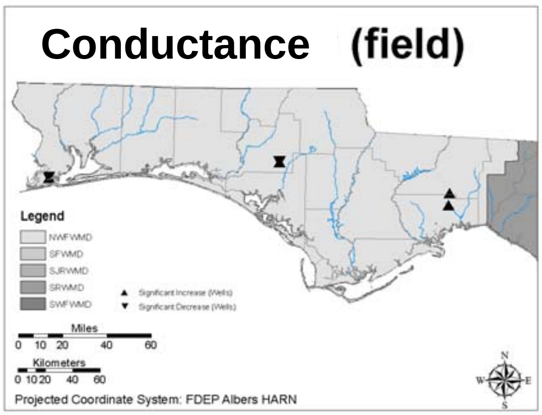

Figure L6. Conductance (field) trends in NWFWMD wells.

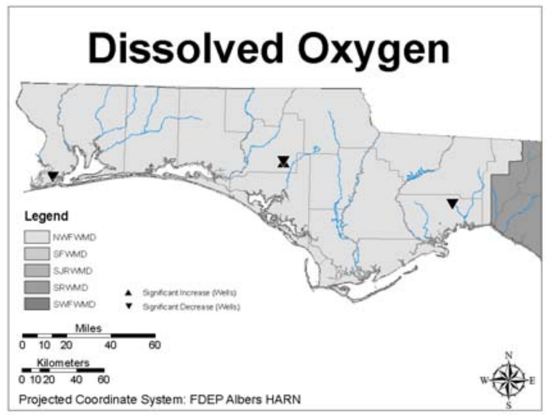

Figure L7. Dissolved oxygen trends in NWFWMD wells.

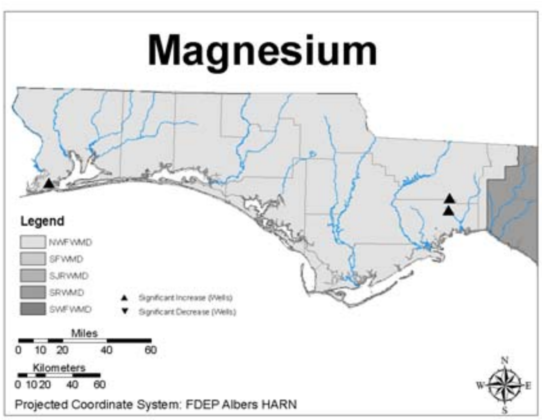

Figure L8. Magnesium trends in NWFWMD wells.

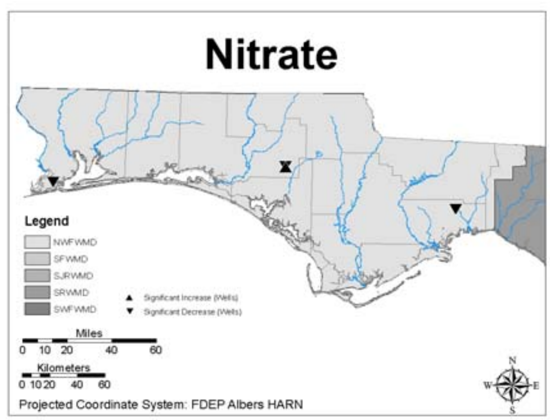

Figure L9. Nitrate trends in NWFWMD wells.

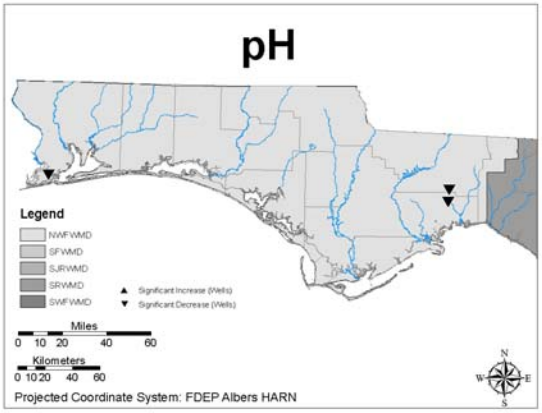

Figure L10. pH trends in NWFWMD wells.

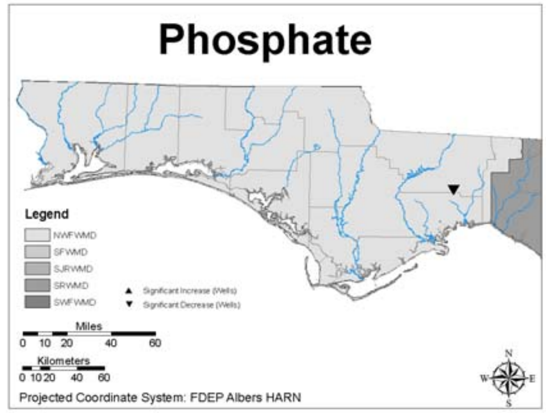

Figure L11. Phosphate trends in NWFWMD wells.

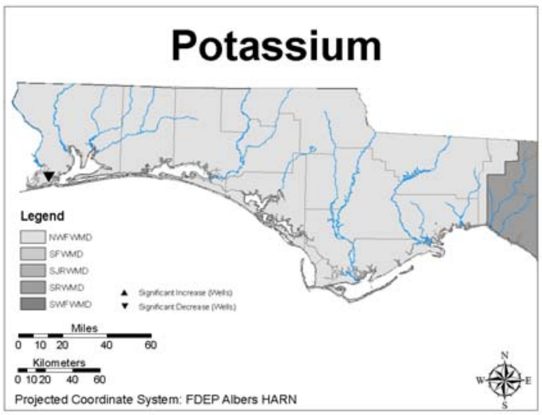

Figure L12. Potassium in NWFWMD wells.

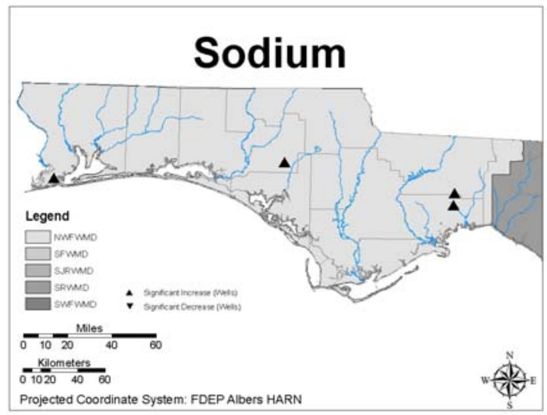

Figure L13. Sodium trends in NWFWMD wells.

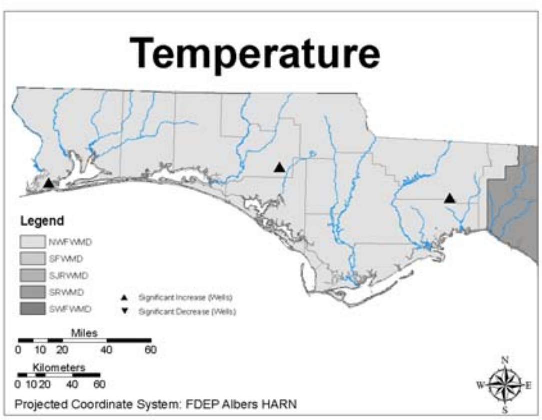

Figure L14 Temperature trends in NWFWMD wells.

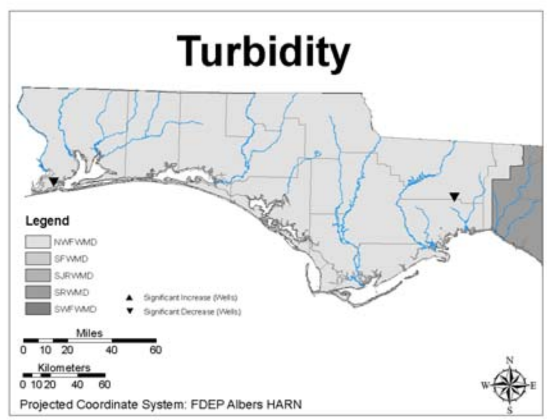

Figure L15 Turbidity trends in NWFWMD wells.

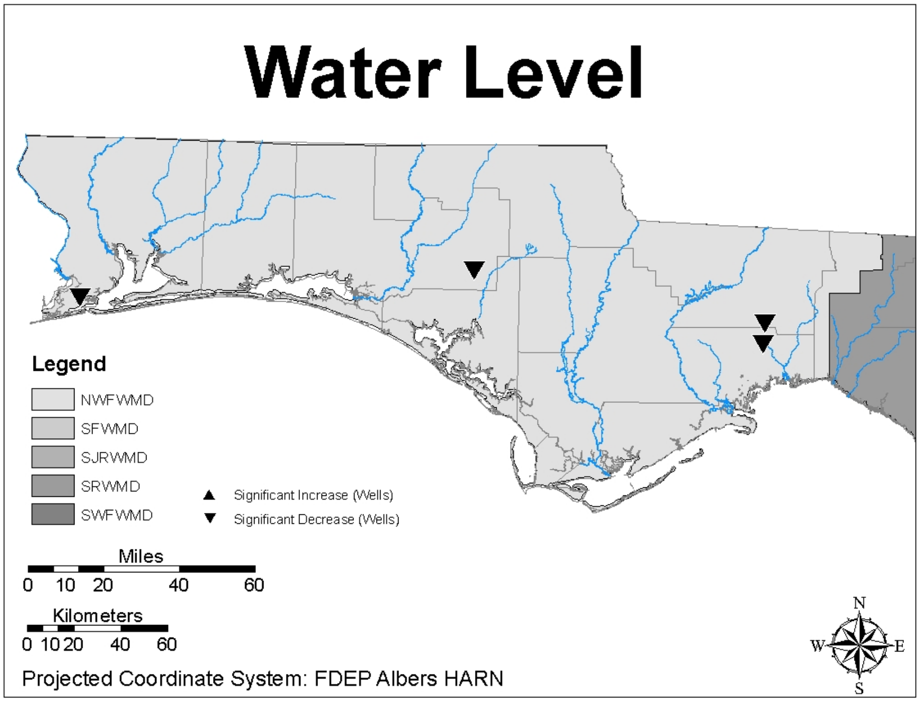

Figure L16. Water level trends in NWFWMD wells.

Appendix L 3—Suwannee River Water Management District Springs

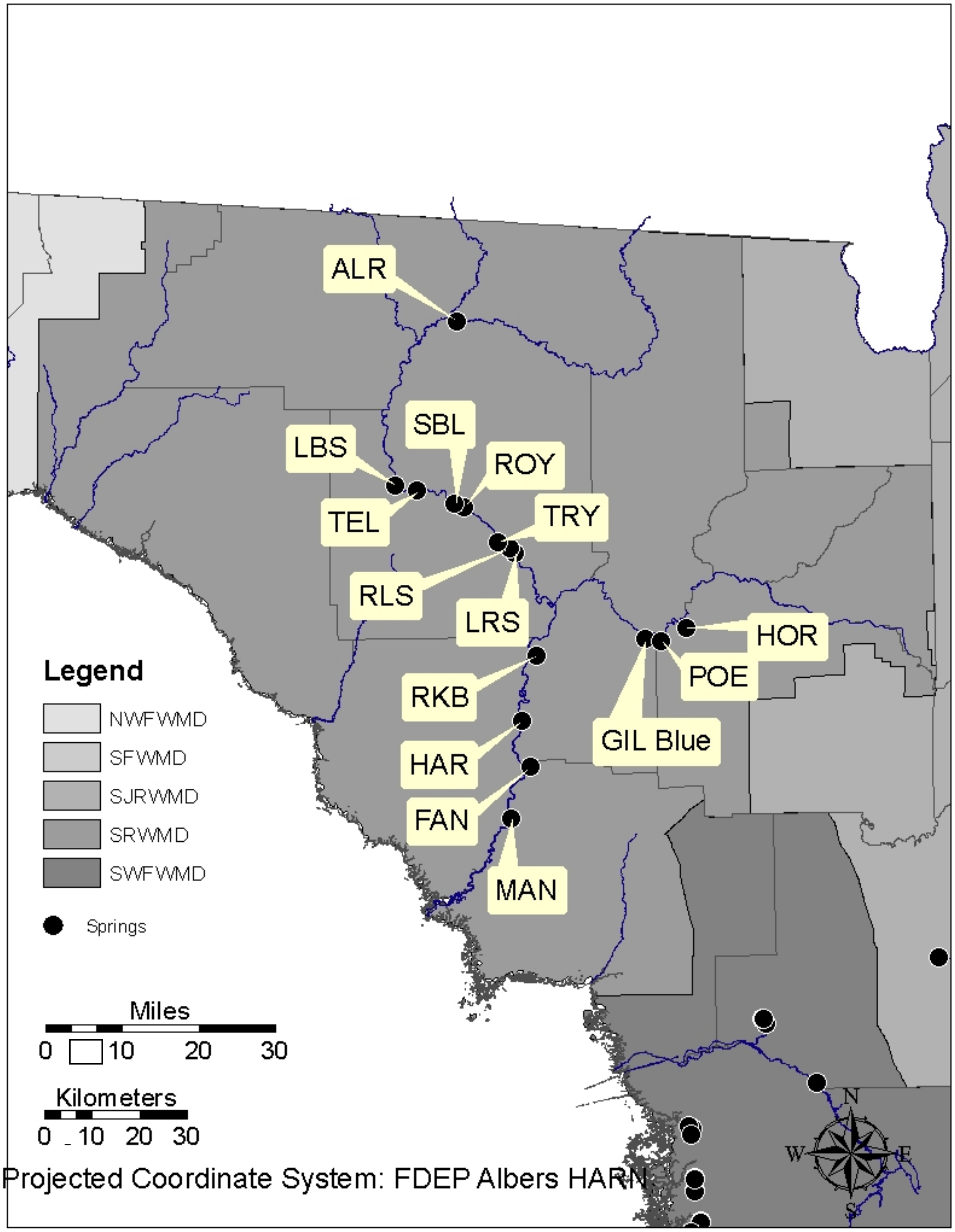

Figure L17. SRWMD springs.

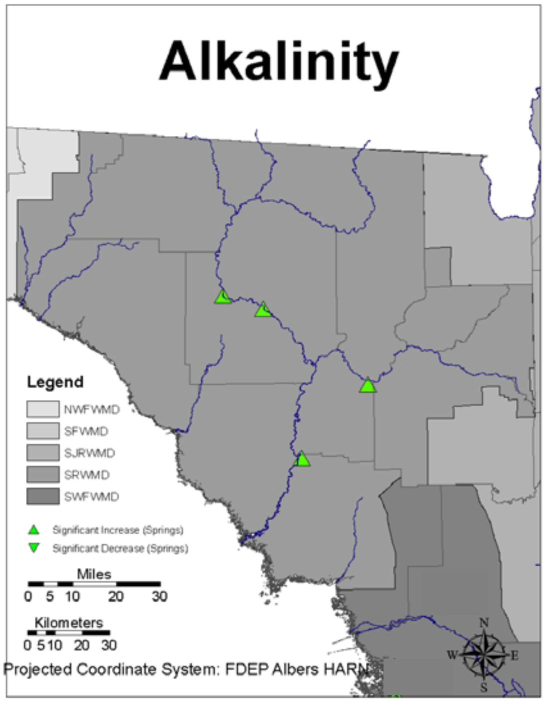

Figure L18. Alkalinity trends in SRWMD springs.

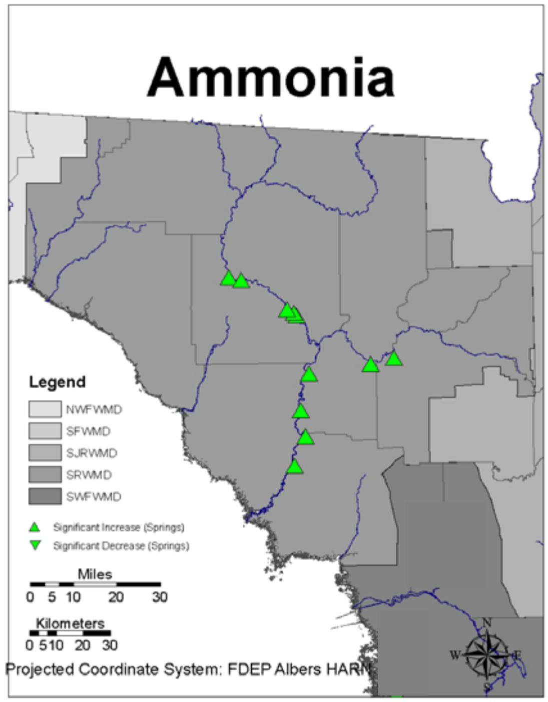

Figure L19 Ammonia trends in SRWMD springs.

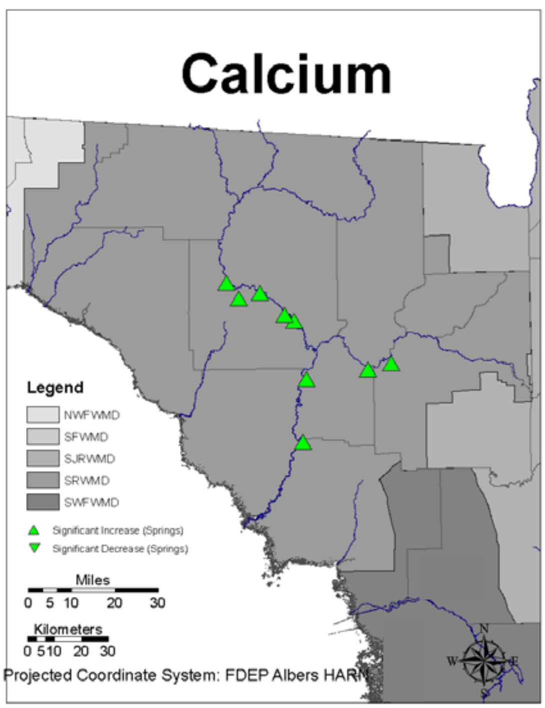

Figure L20 Calcium trends in SRWMD springs.

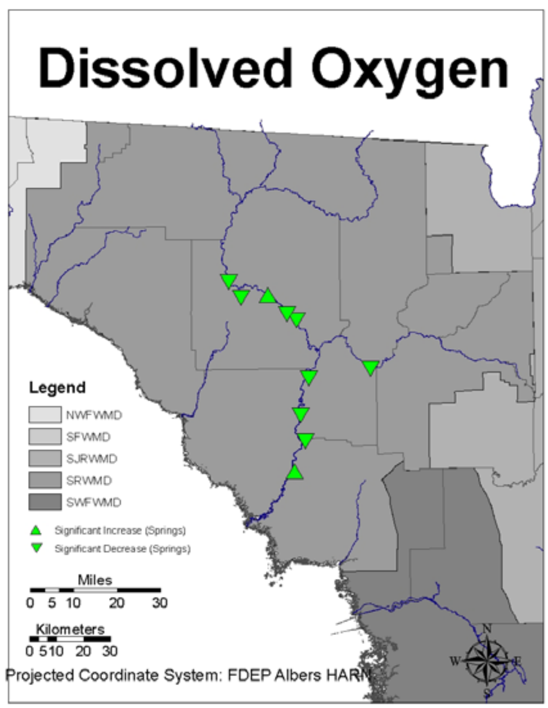

Figure L21. Dissolved oxygen trends in SRWMD springs.

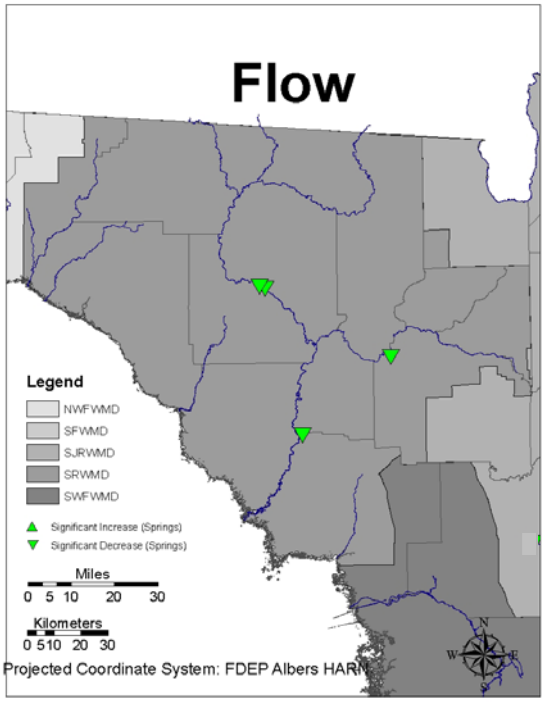

Figure L22. Flow trends in SRWMD springs.

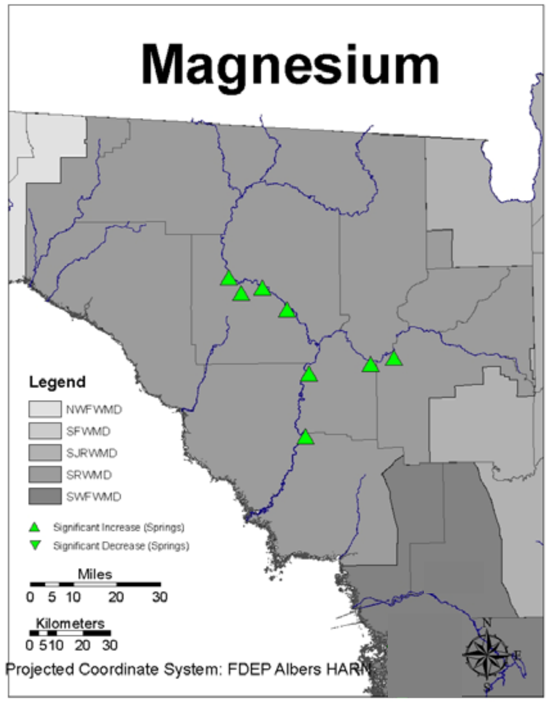

Figure L23. Magnesium trends in NWFWMD springs.

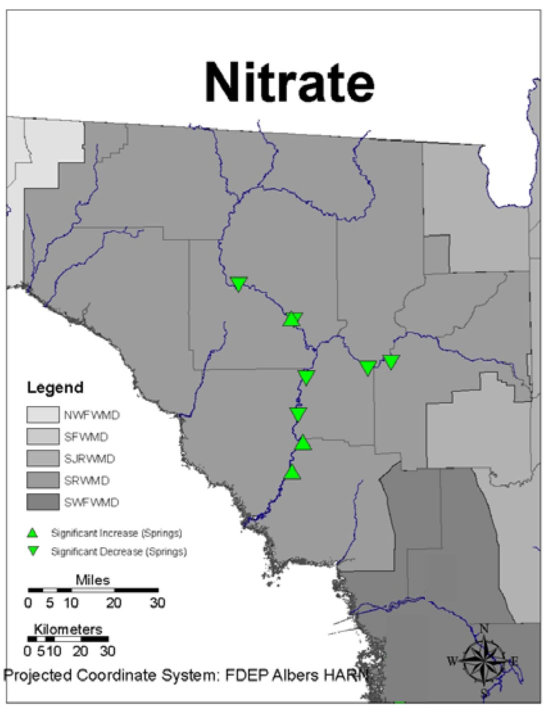

Figure L24. Nitrate trends in SRWMD springs.

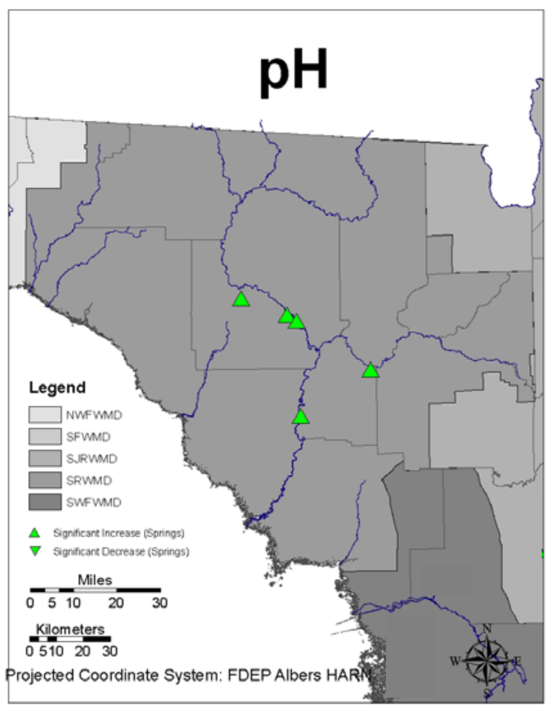

Figure L25. pH trends in SRWMD springs.

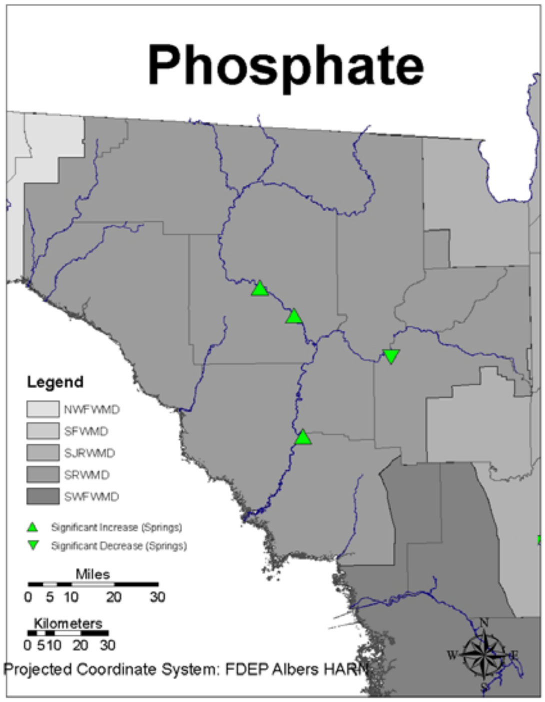

Figure L26. Phosphate trends in SRWMD springs.

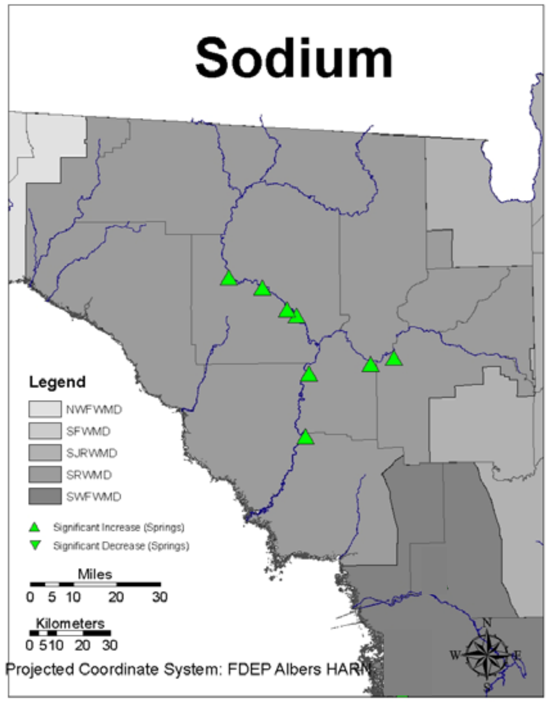

Figure L27. Sodium trends in SRWMD springs.

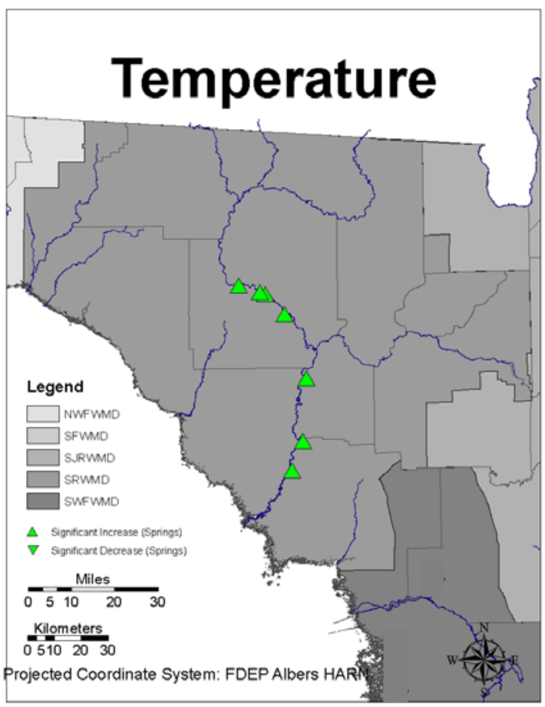

Figure L28. Temperature trends in SRWMD Springs.

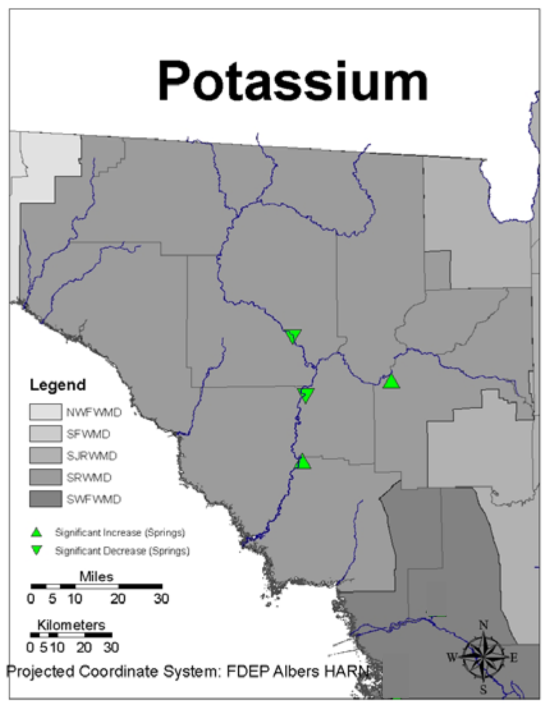

Figure L29. Potassium trends in SRWMD springs.

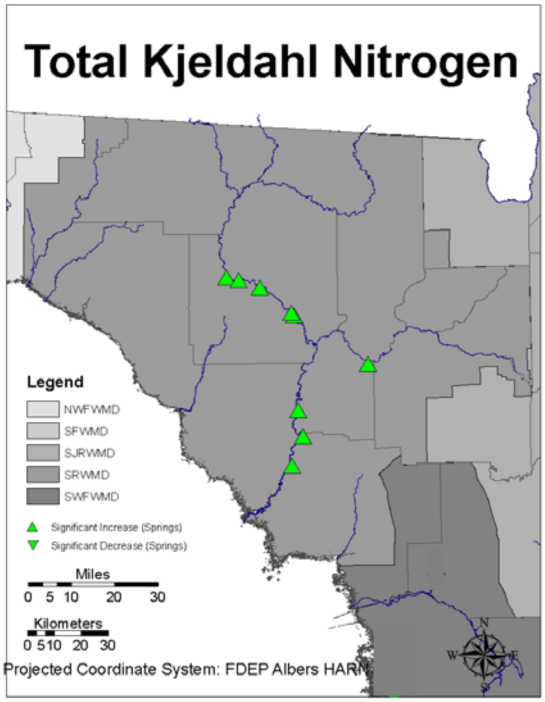

Figure L30. Total kjeldahl nitrogen trends in SRWMD springs.

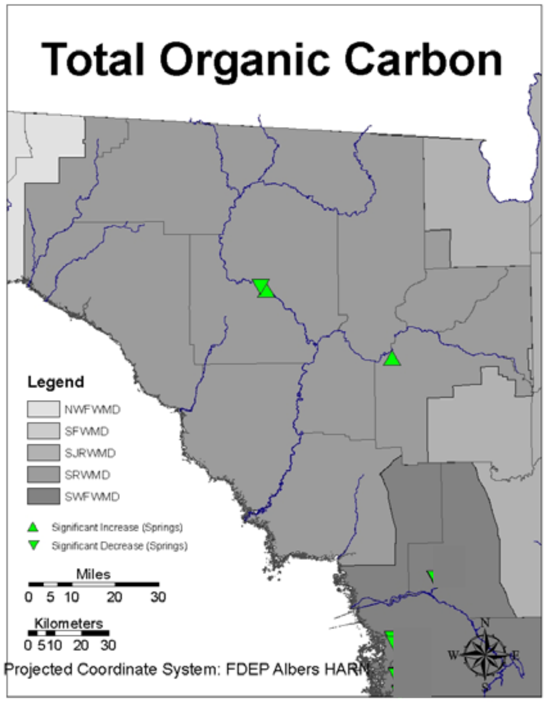

Figure L31. Total organic carbon trends in SRWMD springs.

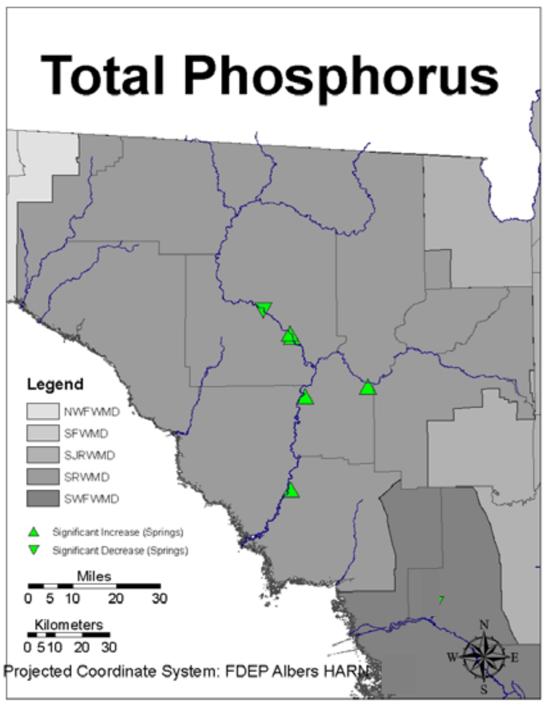

Figure L32. Total phosphorus trends in SRWMD springs.

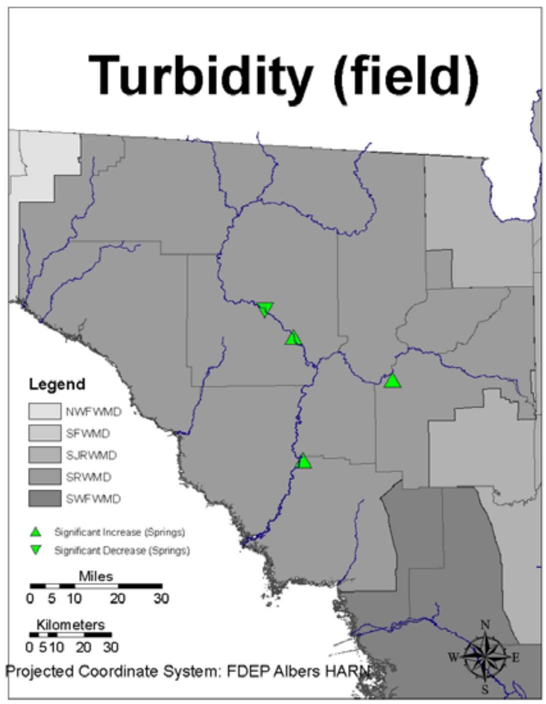

Figure L33. Turbidity trends in SRWMD springs.

Appendix L4—Suwannee River Water Management District Wells

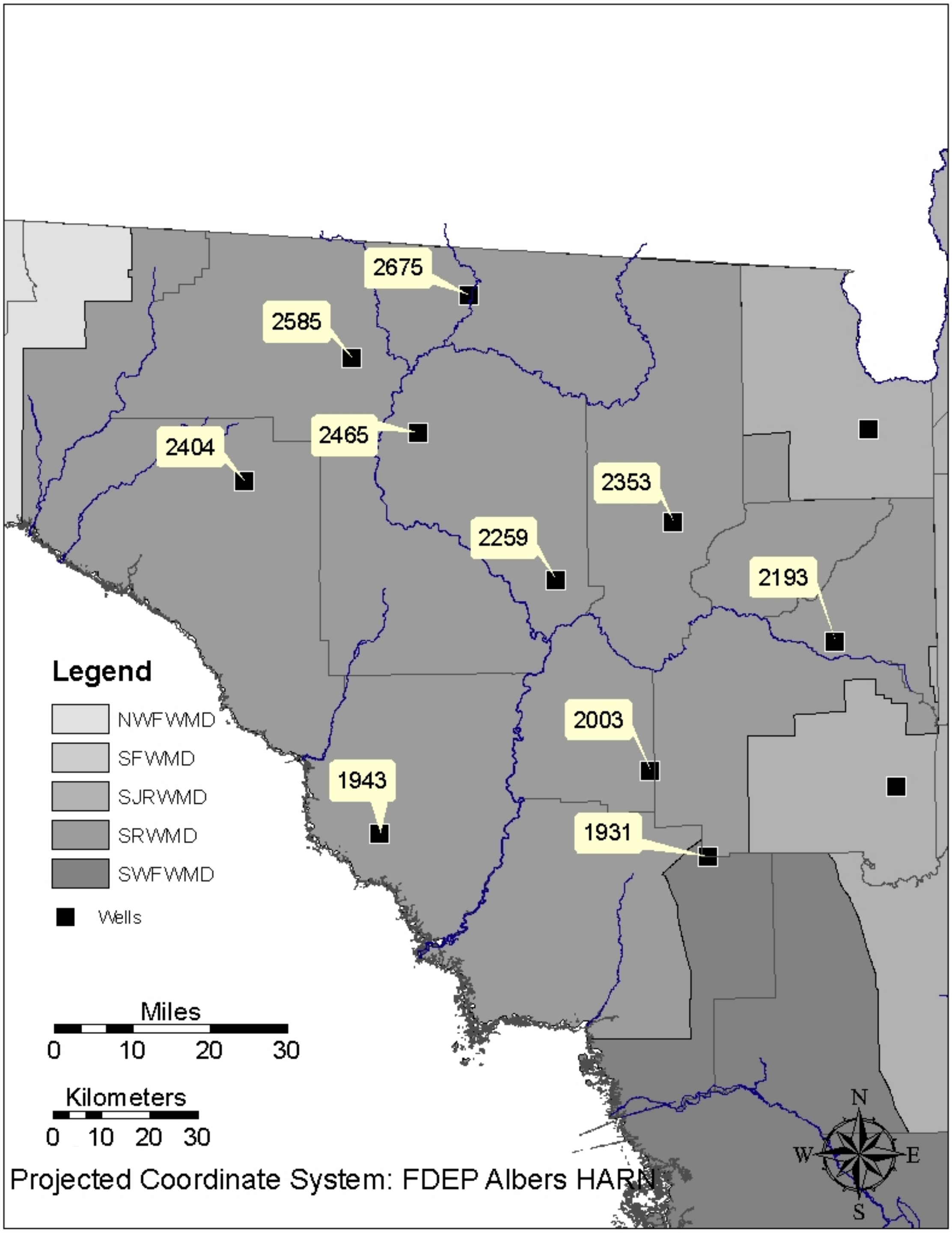

Figure34. SRWMD wells.

Figure L35. Alkalinity trends in SRWMD wells.

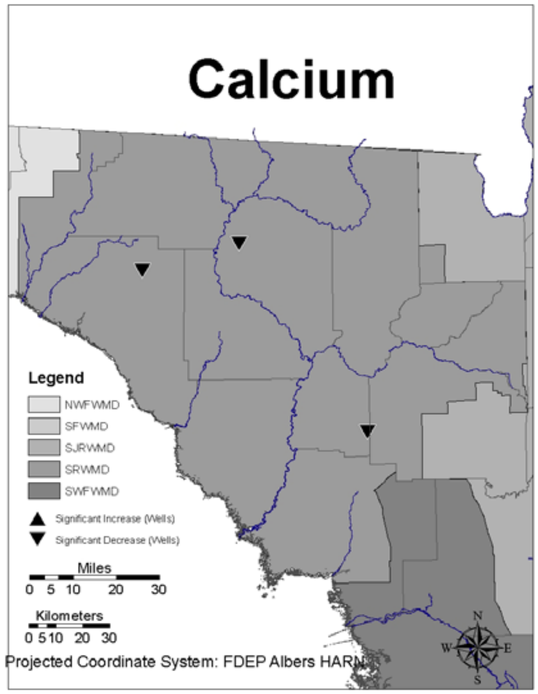

Figure L36. Calcium trends in SRWMD wells.

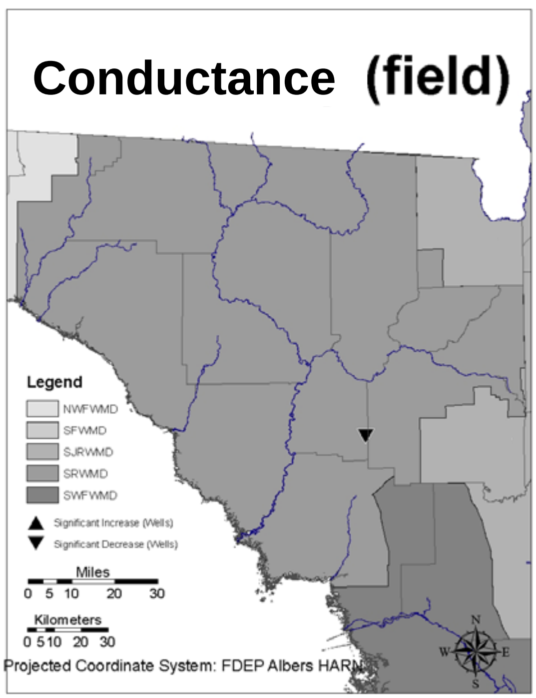

Figure L37. Conductance (field) trends in SRWMD SRWMD wells.

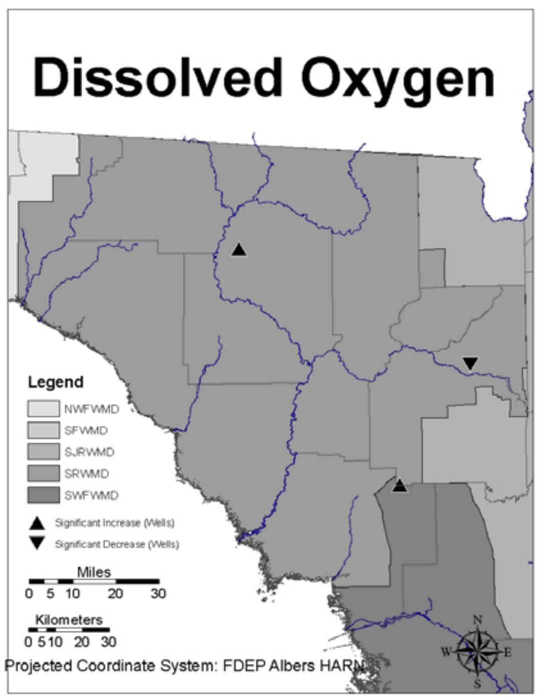

Figure L38. Dissolved oxygen trends in SRWMD wells.

Figure L39. Magnesium trends in SRWMD wells.

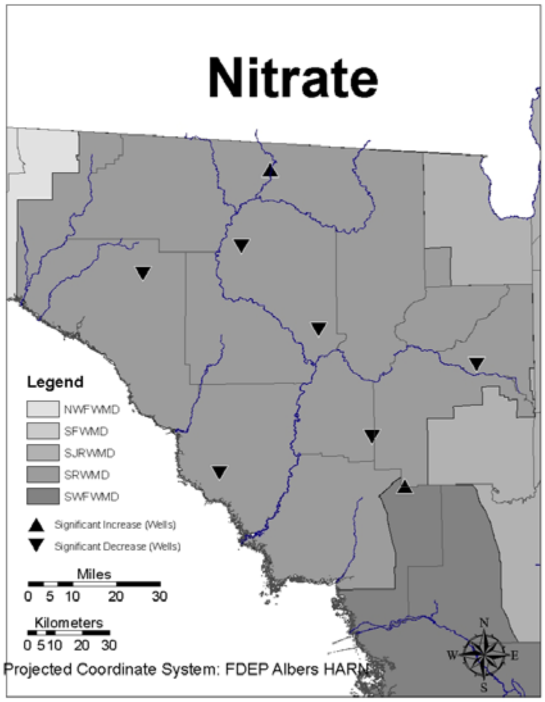

Figure L40. Nitrate trends in SRWMD wells.

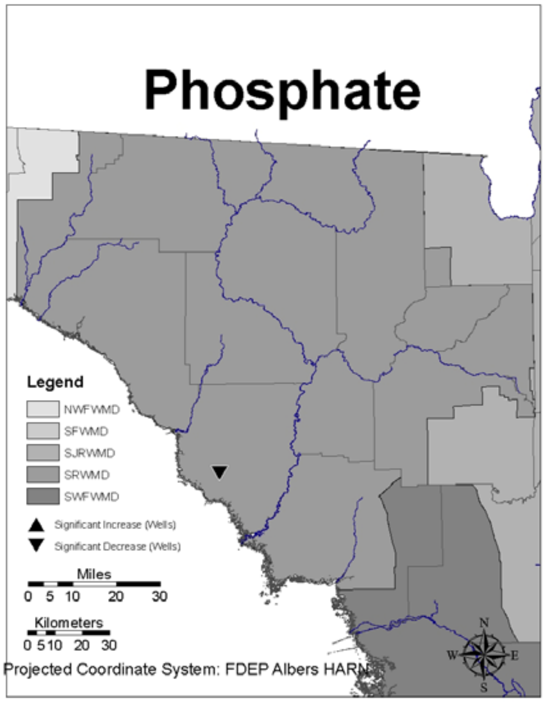

Figure L41 Phosphate trends in SRWMD wells.

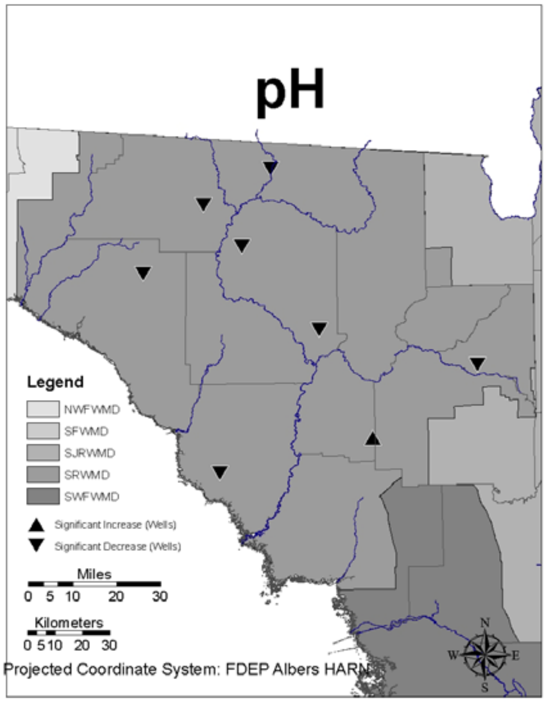

Figure L42. pH trends in SRWMD wells.

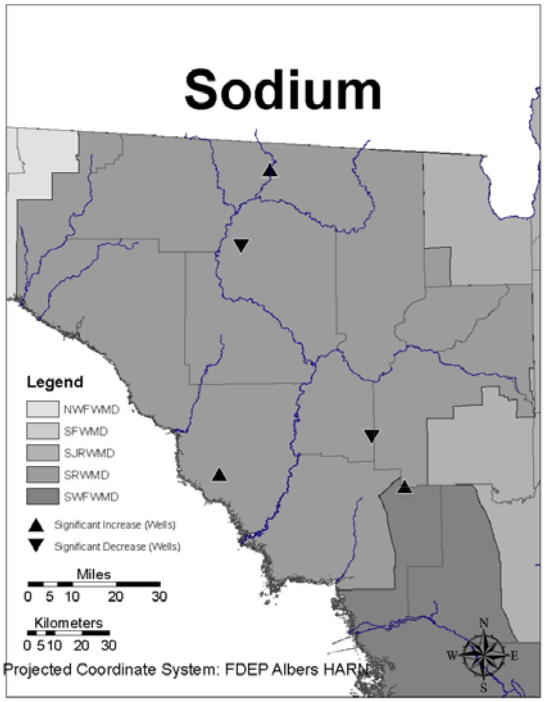

Figure L43. Sodium trends in SRWMD wells.

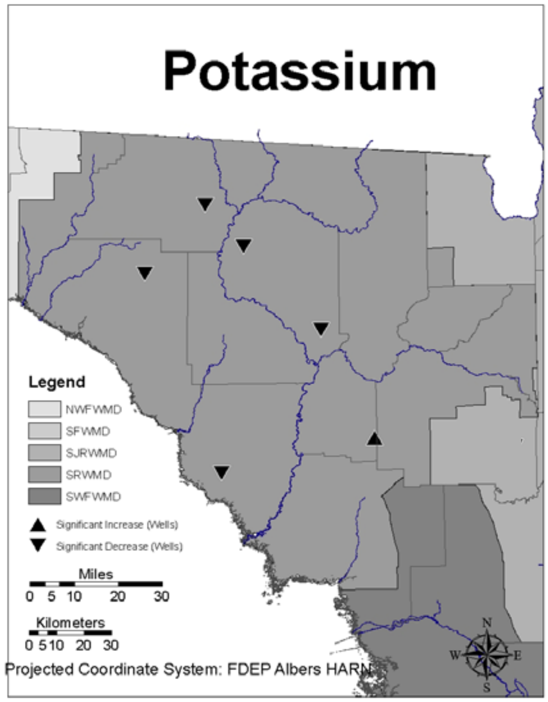

Figure L44. Potassium trends in SRWMD wells.

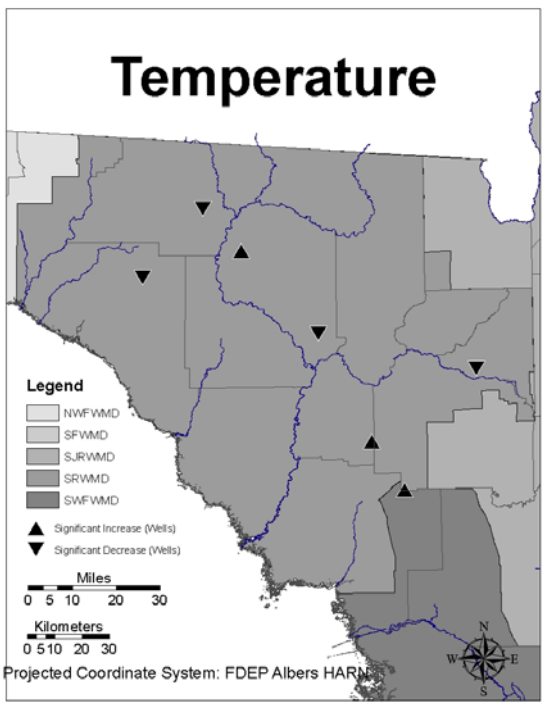

Figure L45. Temperature trends in SRWMD wells.

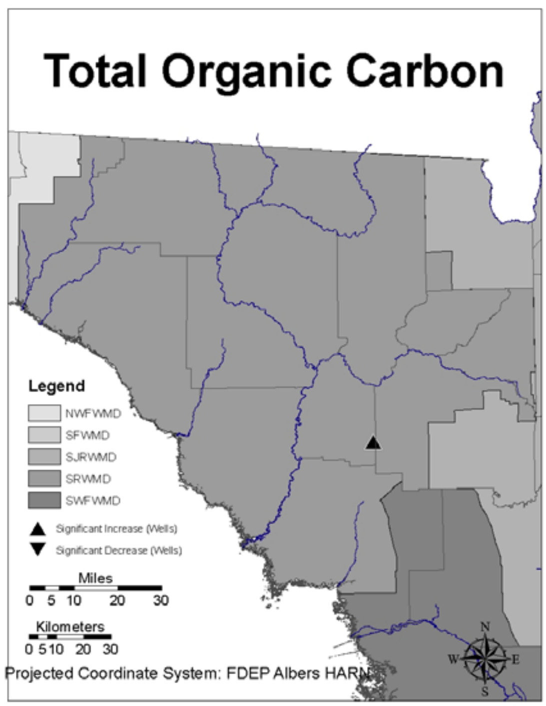

Figure L46. Total organic carbon trends in SRWMD wells.

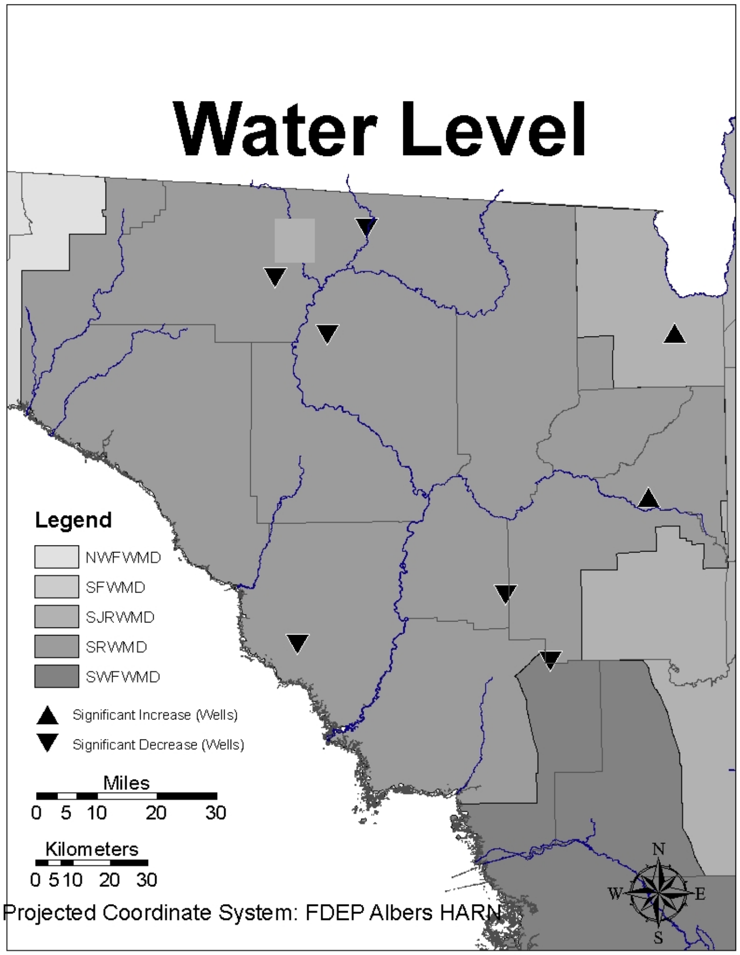

Figure L47. Water level trends in SRWMD wells.

Appendix L 5—St. Johns Water Management District Springs

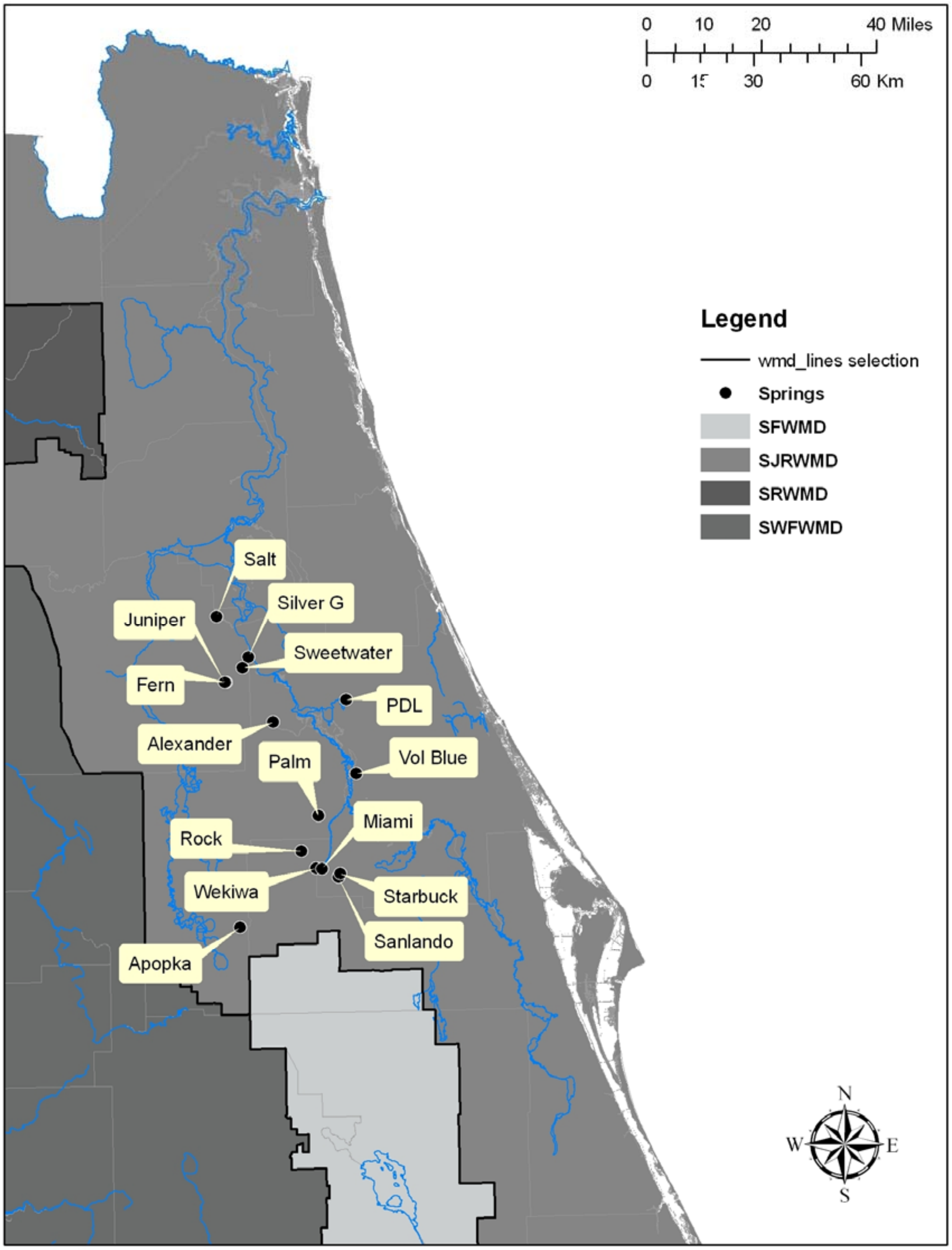

Figure L48. SJRWMD springs.

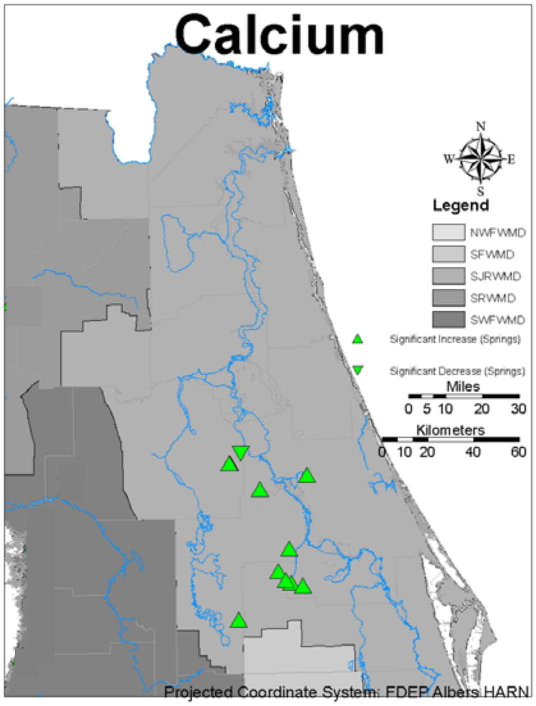

Figure L49. Calcium trends in SJRWMD Springs.

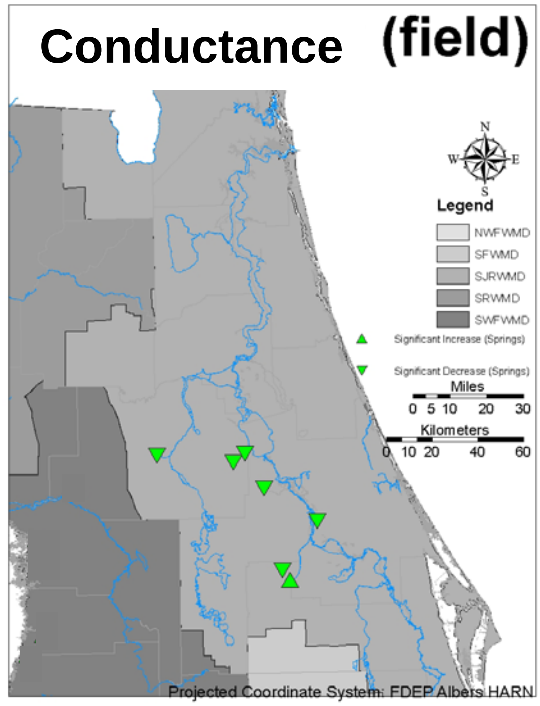

Figure L50. Conductance (field) trends in SJRWMD springs.

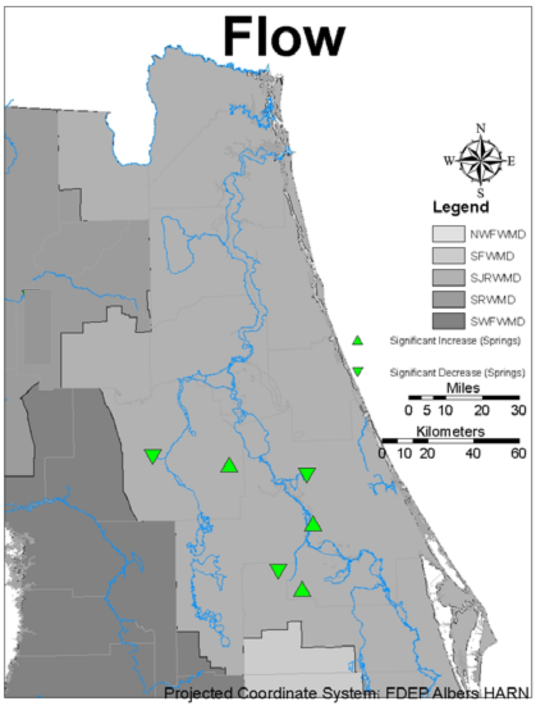

Figure L51. Flow trends in SJRWMD springs.

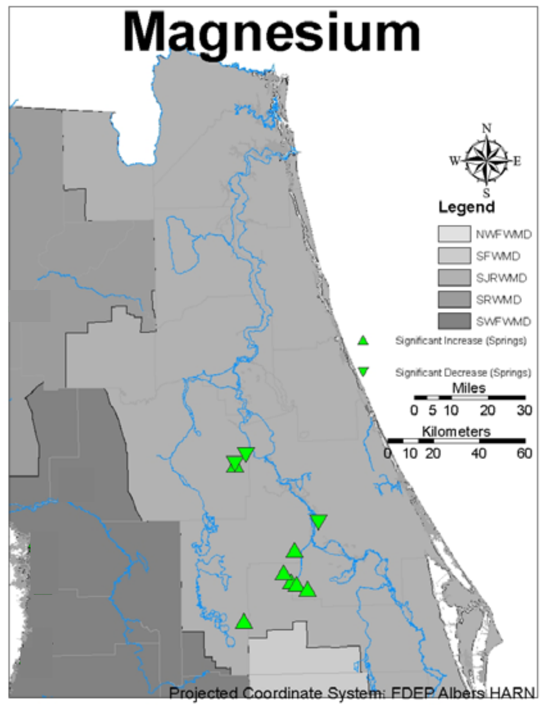

Figure L52. Magnesium trends in SJRWMD springs.

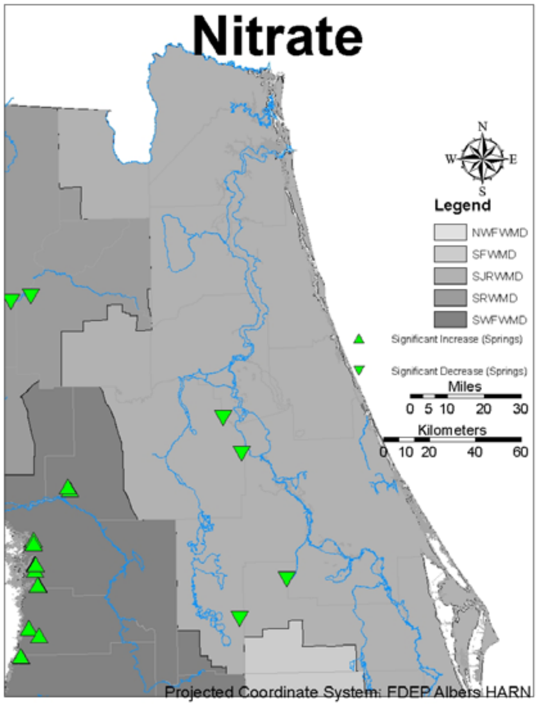

Figure L53. Nitrate trends in SJRWMD springs.

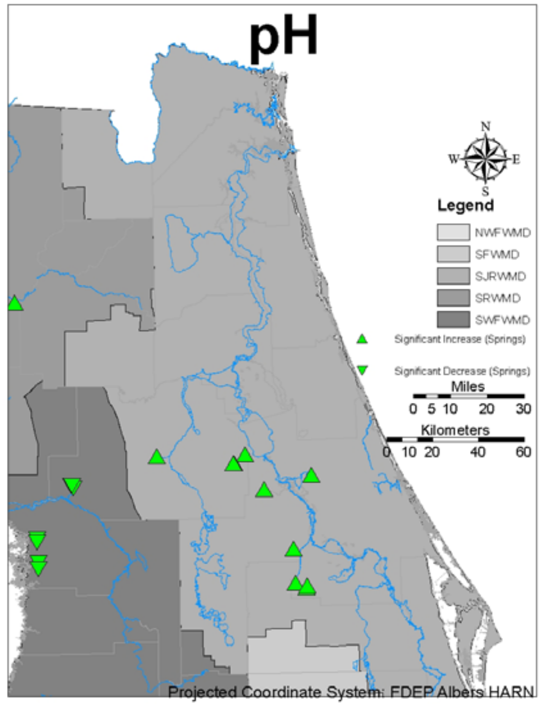

Figure L54. pH trends in SJRWMD springs.

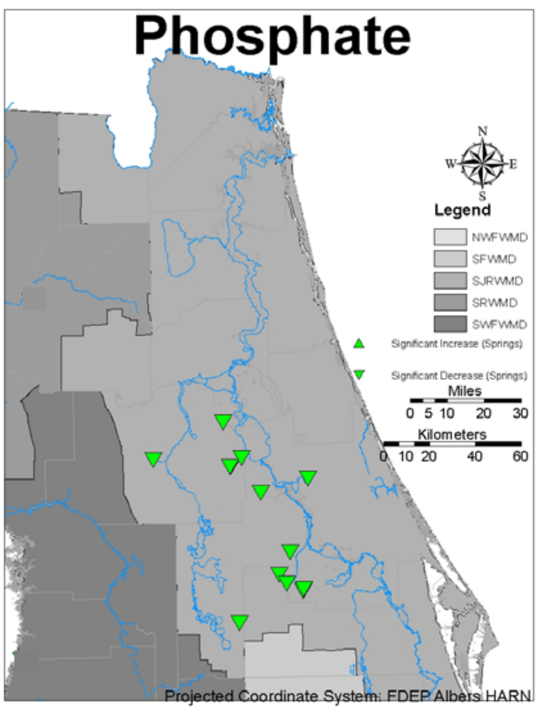

Figure L55. Phosphate trends in SJRWMD springs.

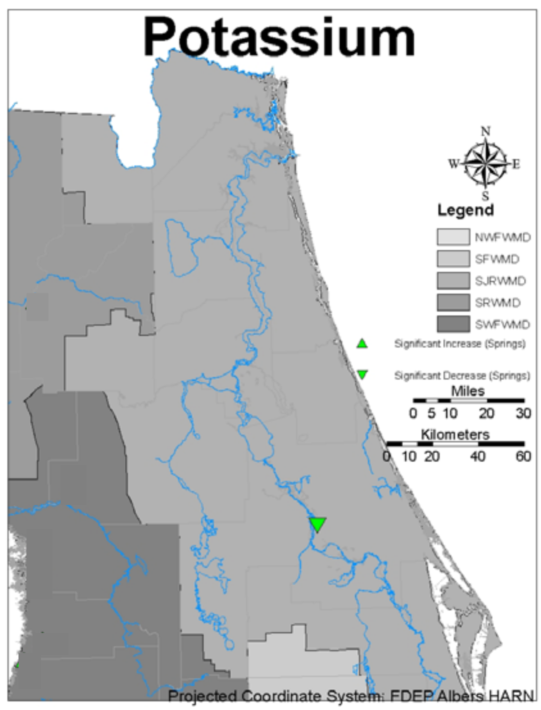

Figure L56 Potassium trends in SJRWMD springs.

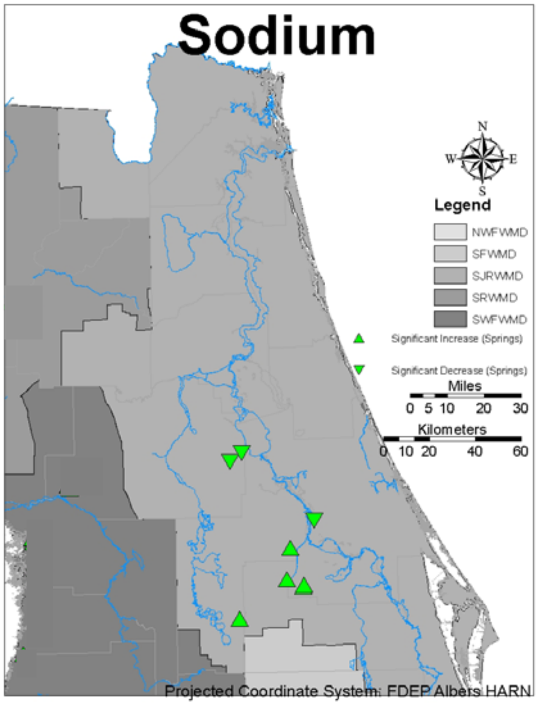

Figure L57. Sodium trends in SJRWMD springs.

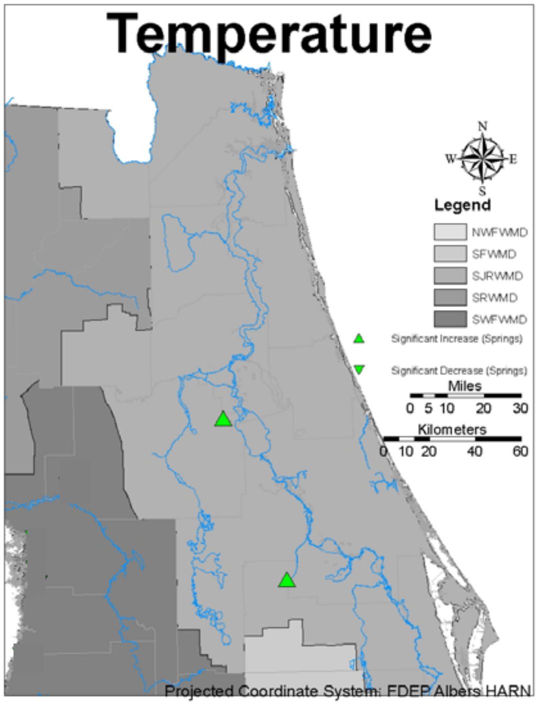

Figure L58. Temperature trends in SJRWMD springs.

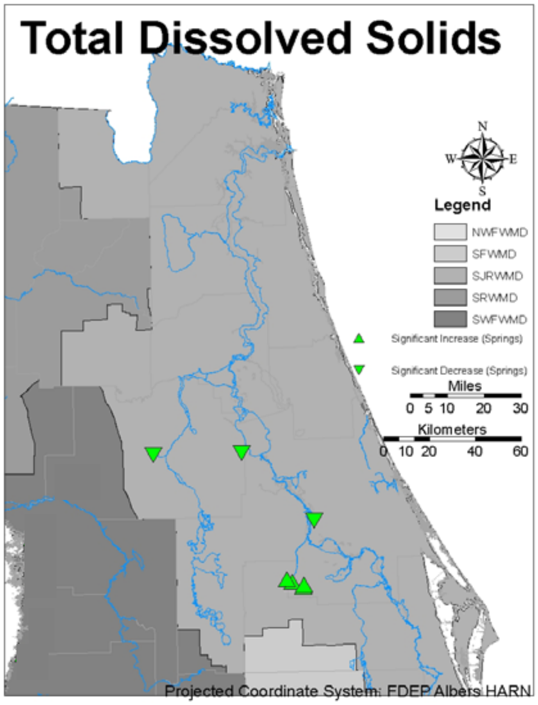

Figure L59. Total dissolved solid trends in SJRWMD springs.

Appendix L6—St. Johns Water Management District Wells

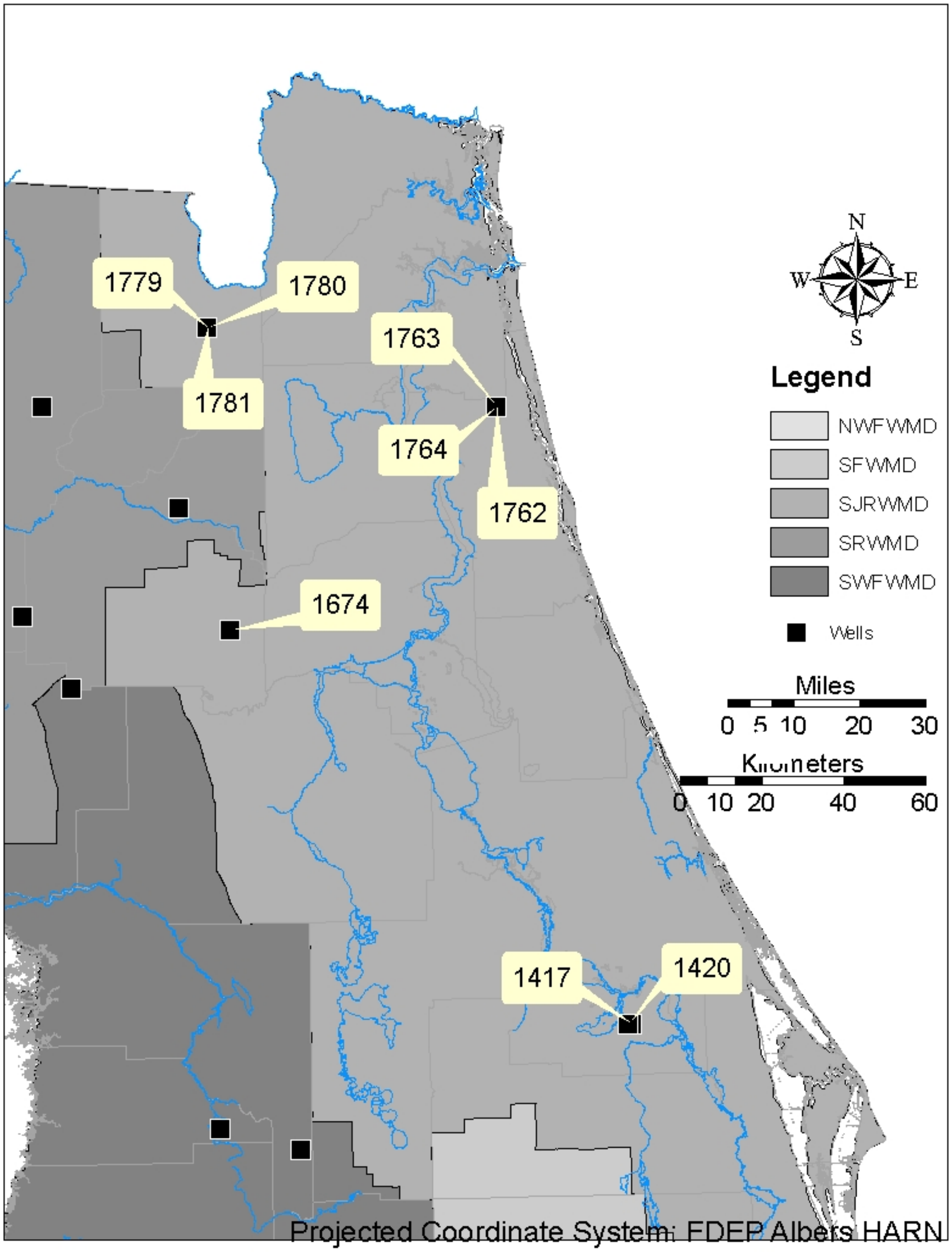

Figure 60. SJRWMD wells.

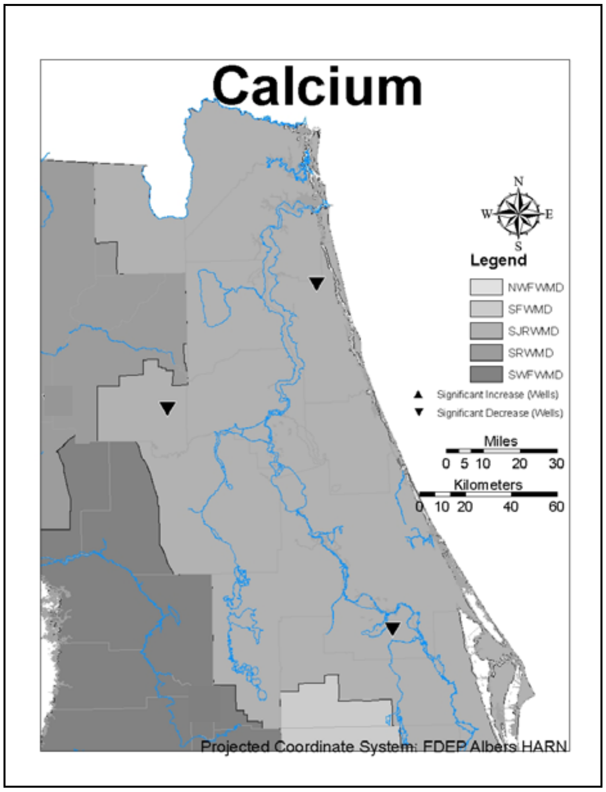

Figure L61. Alkalinity trends in SJRWMD wells.

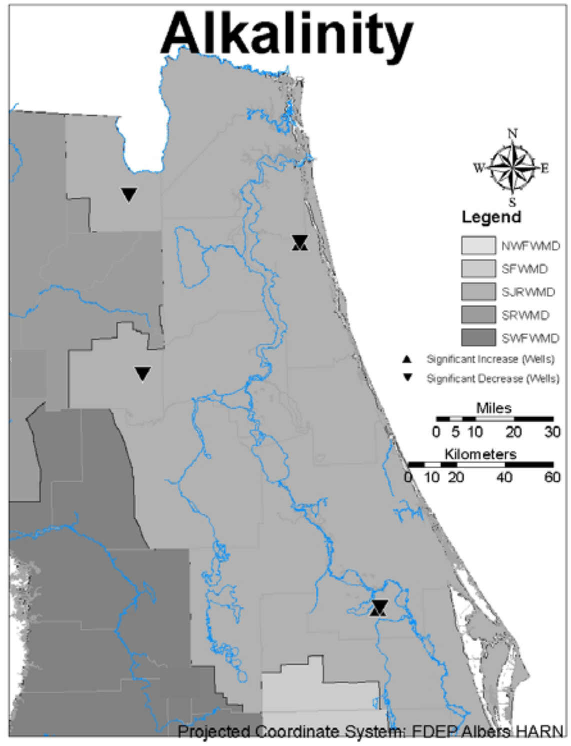

Figure L62. Calcium trends in SJRWMD wells.

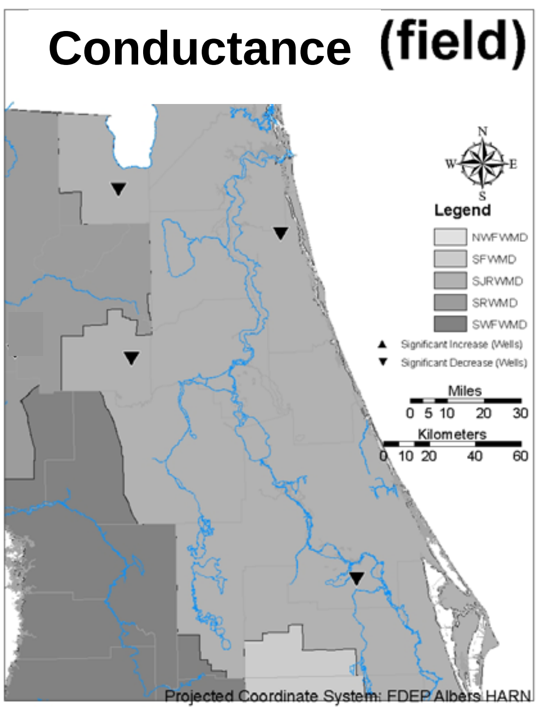

Figure L63. Conductance (field) trends in SJRWMD wells.

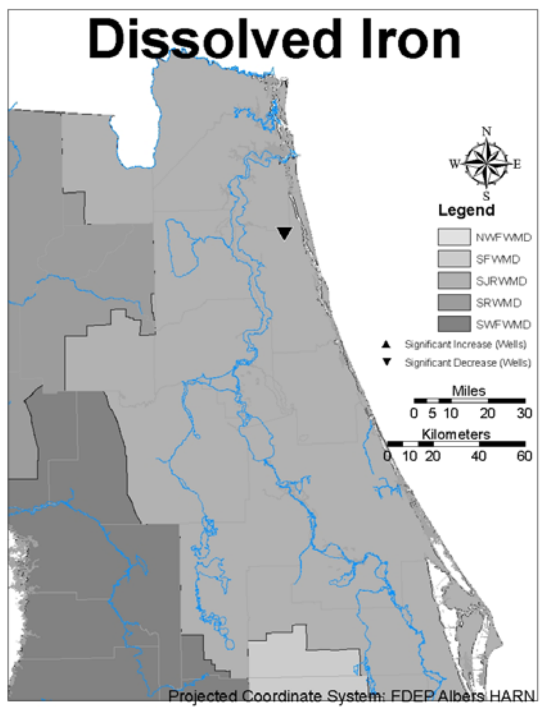

Figure L64. Dissolved iron trends in SJRWMD wells.

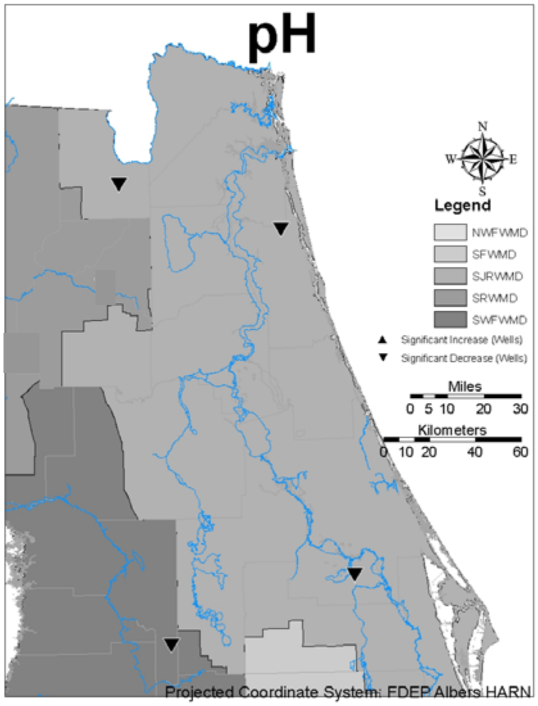

Figure L65. pH trends in SJRWMD wells.

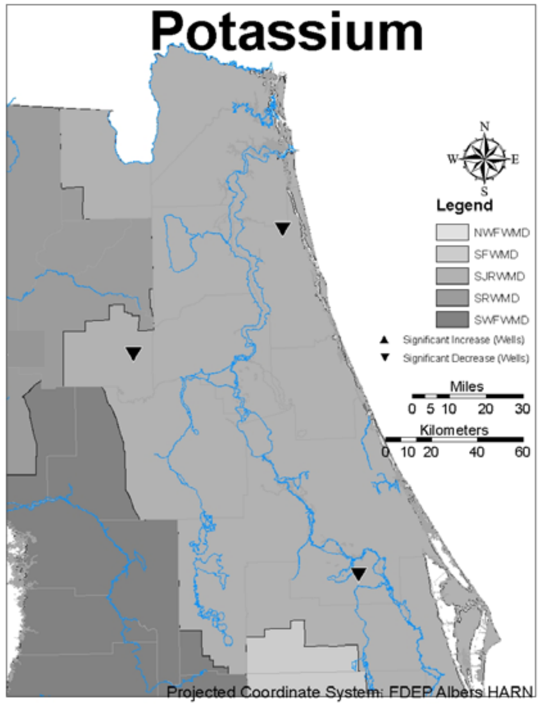

Figure L66. Potassium trends in SJRWMD wells.

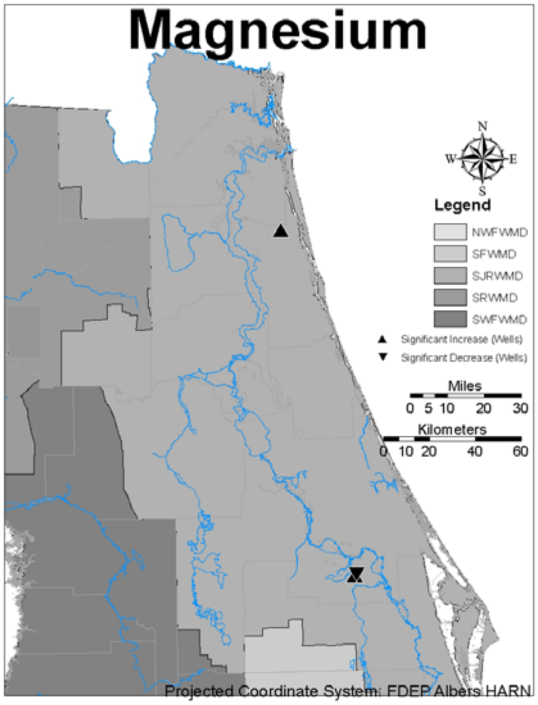

Figure L67. Magnesium trends in SJRWMD wells.

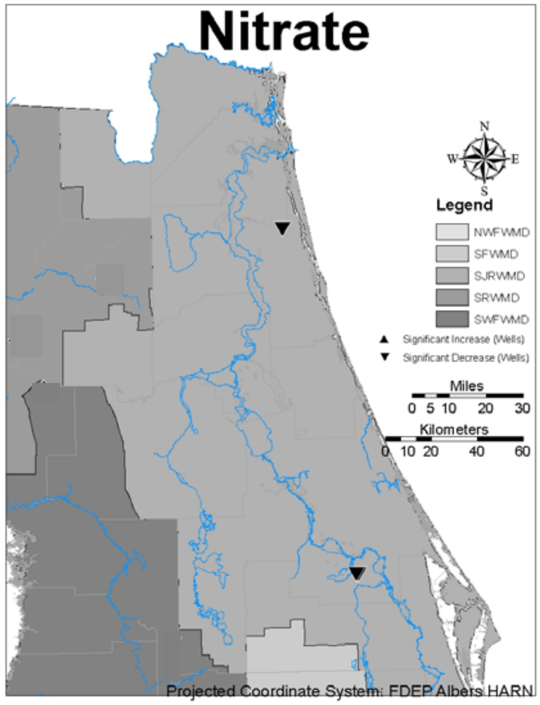

Figure L68. Nitrate trends in SJRWMD wells.

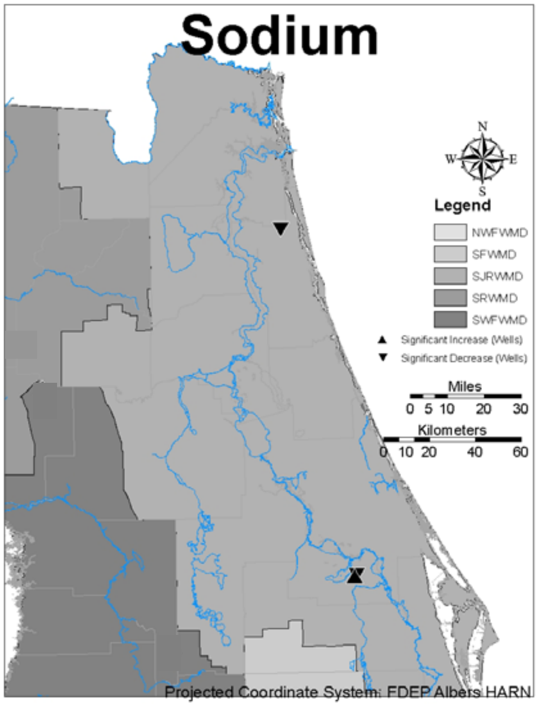

Figure L69. Sodium trends in SJRWMD wells.

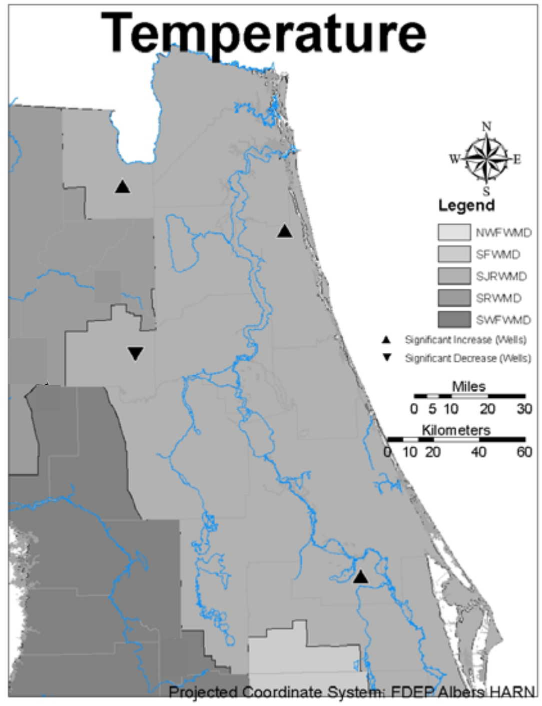

Figure L70. Temperature trends in SJRWMD wells.

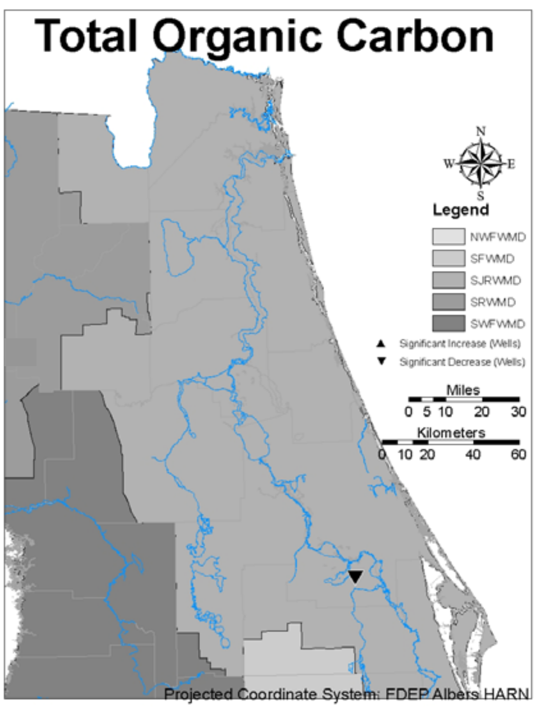

Figure L71. Total organic carbon trends in SJRWMD wells.

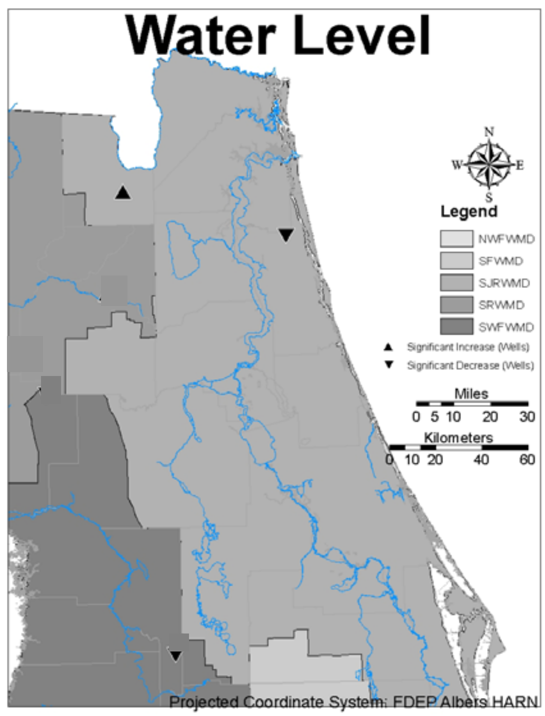

Figure L5. Water level trends in SJRWMD wells.

Appendix L 7—Southwest Florida Water Management District Springs

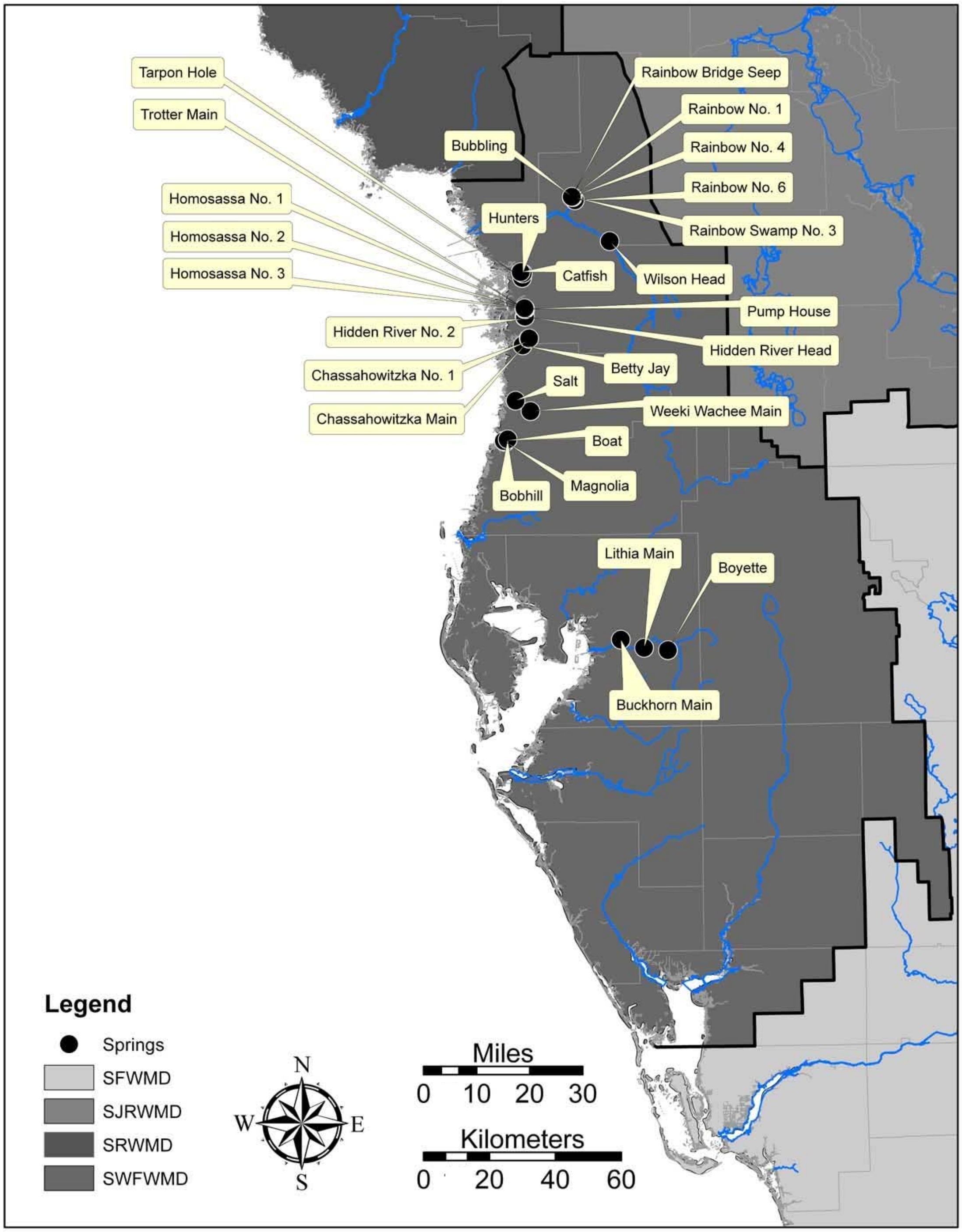

Figure 73. SWFWMD springs.

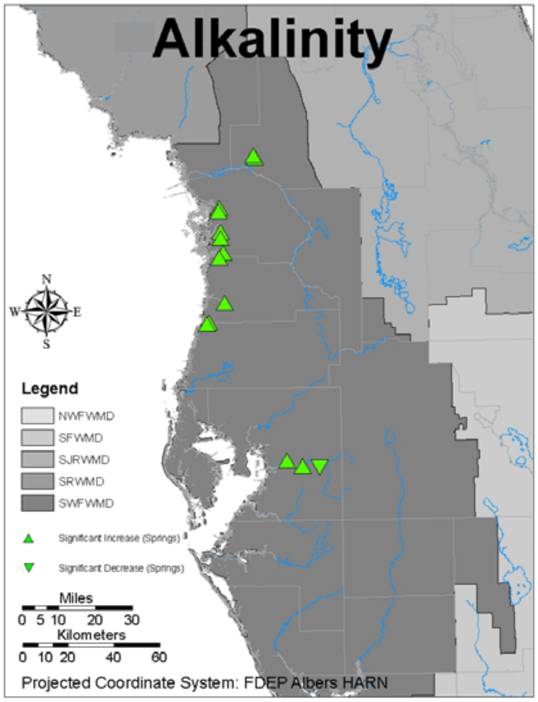

Figure L74. Alkalinity trends in SWFWMD springs.

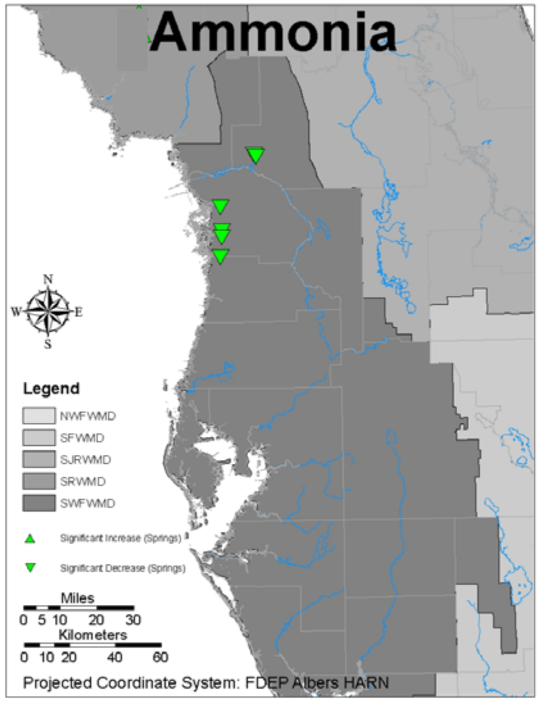

Figure L75. Ammonia trends in SWFWMD springs.

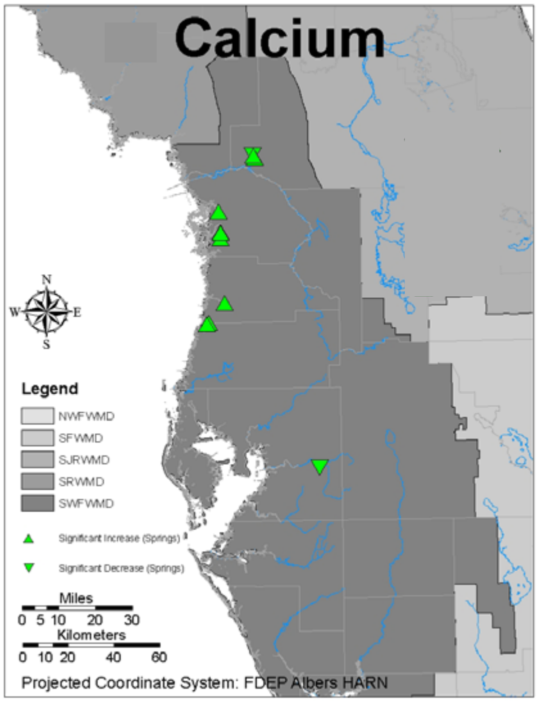

Figure L76. Calcium trends in SWFWMD springs.

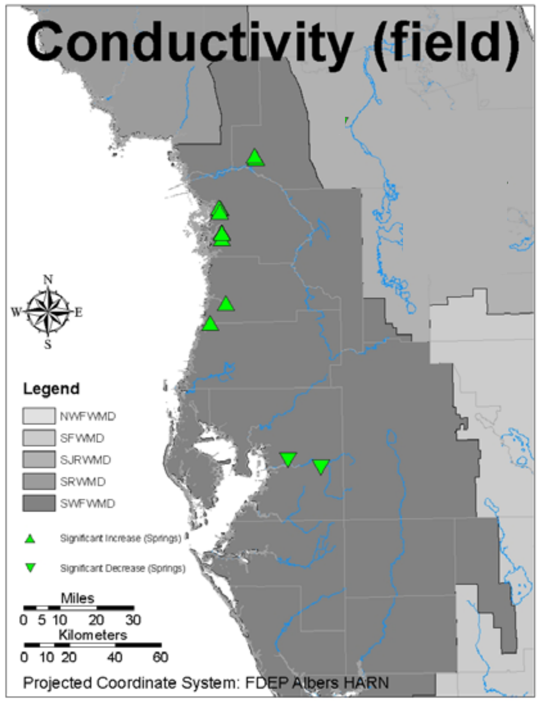

Figure L77. Conductivity (field) trends in SWFWMD Wells.

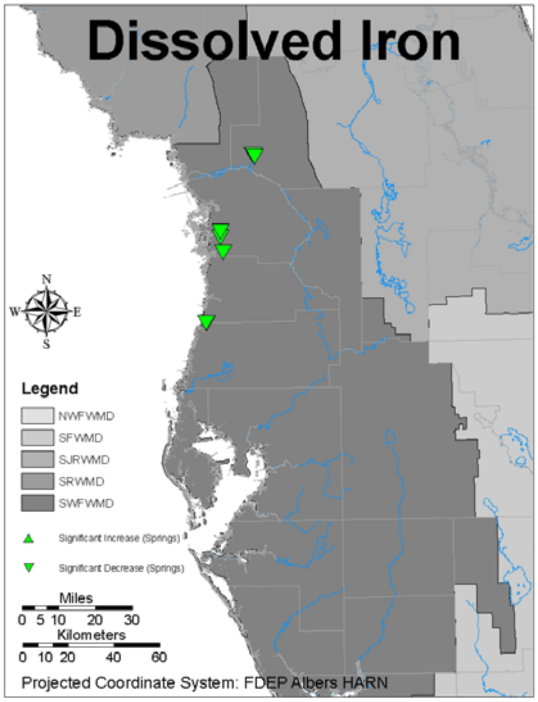

Figure L78. Dissolved iron trends in SWFWMD springs.

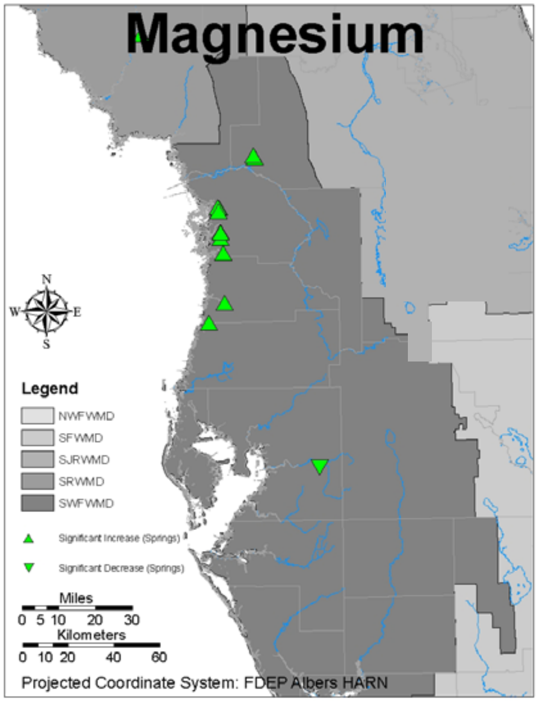

Figure L9. Magnesium trends in SWFWMD springs.

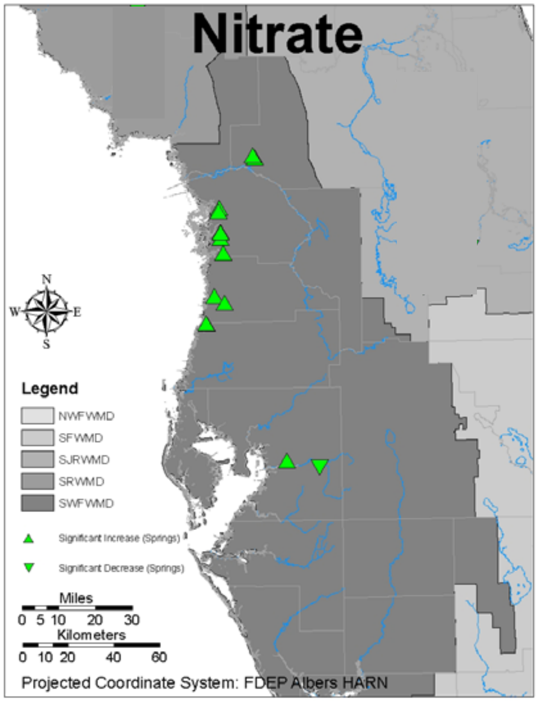

Figure L80. Nitrate trends in SWFWMD springs.

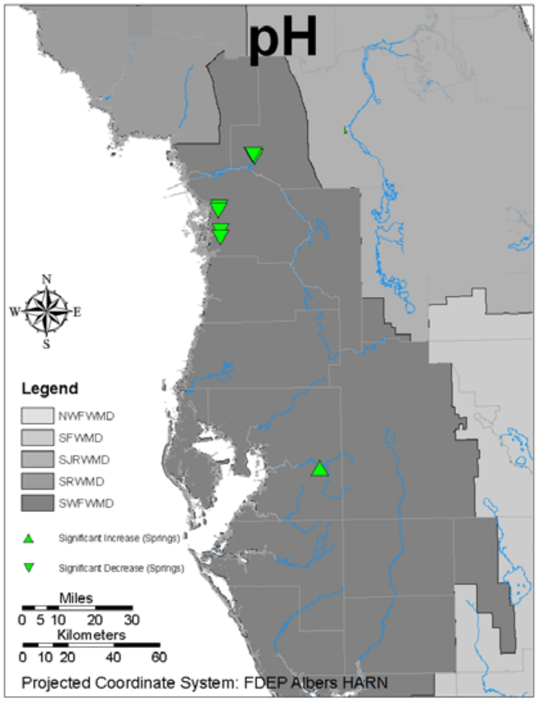

Figure L81. pH trends in SWFWMD springs.

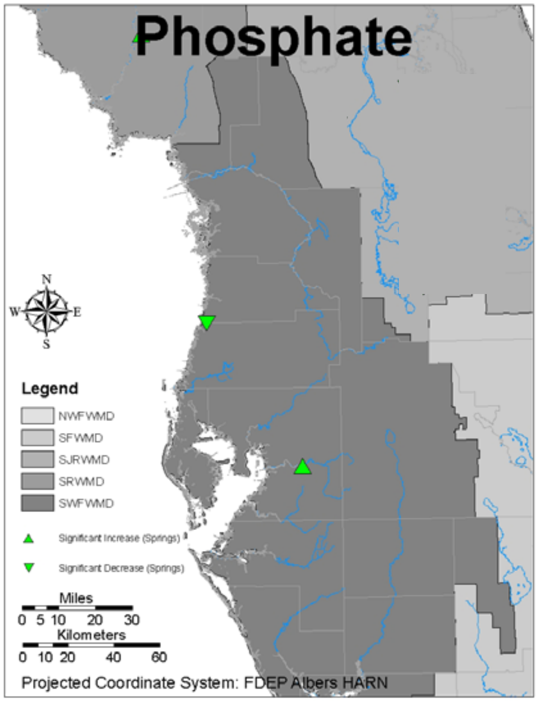

Figure L82. Phosphate trends in SWFWMD. springs.

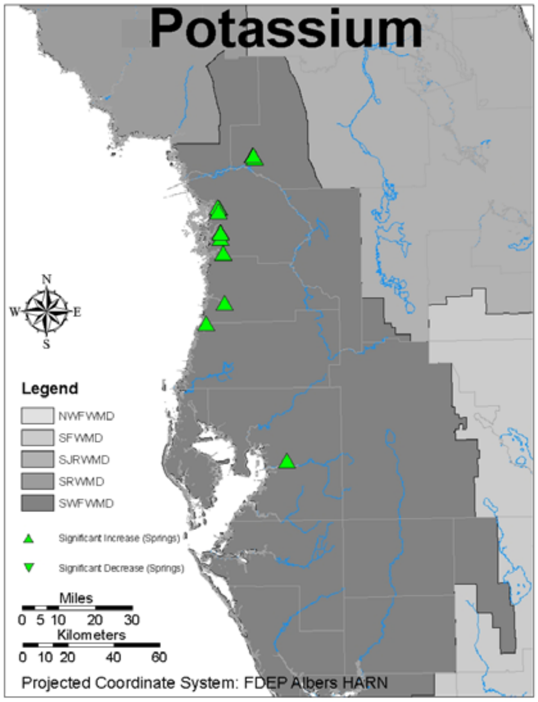

Figure L83. Potassium trends in SWFWMD springs.

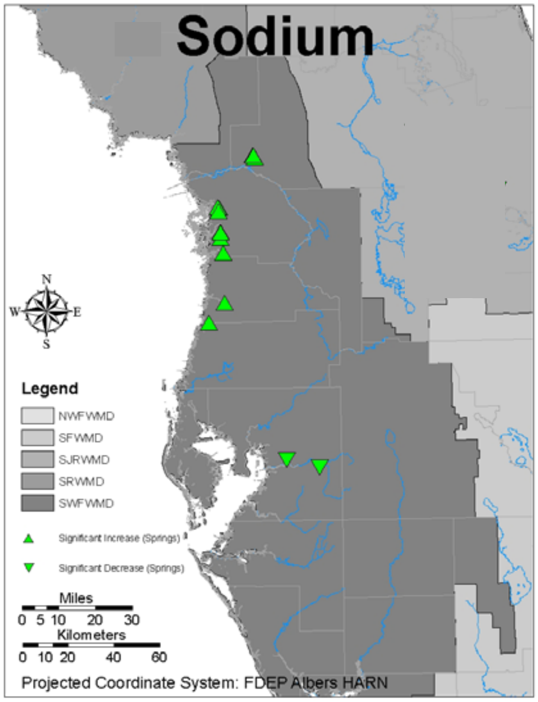

Figure L84. Sodium trends in SWFWMD springs.

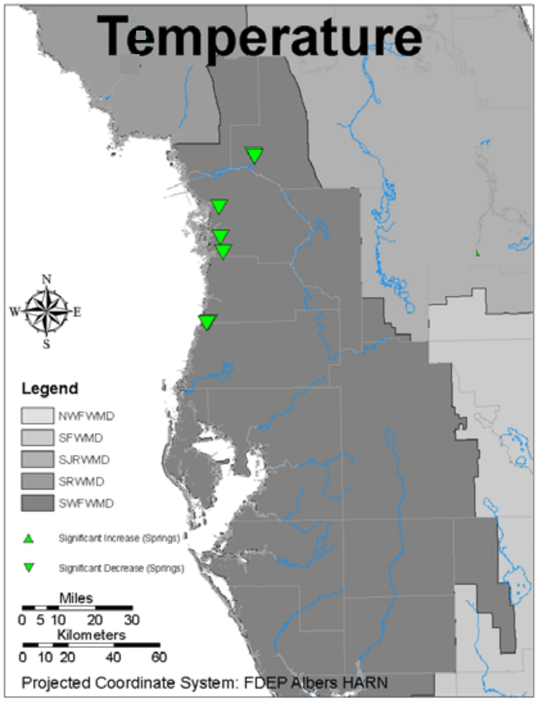

Figure L85. Temperature trends in SWFWMD springs.

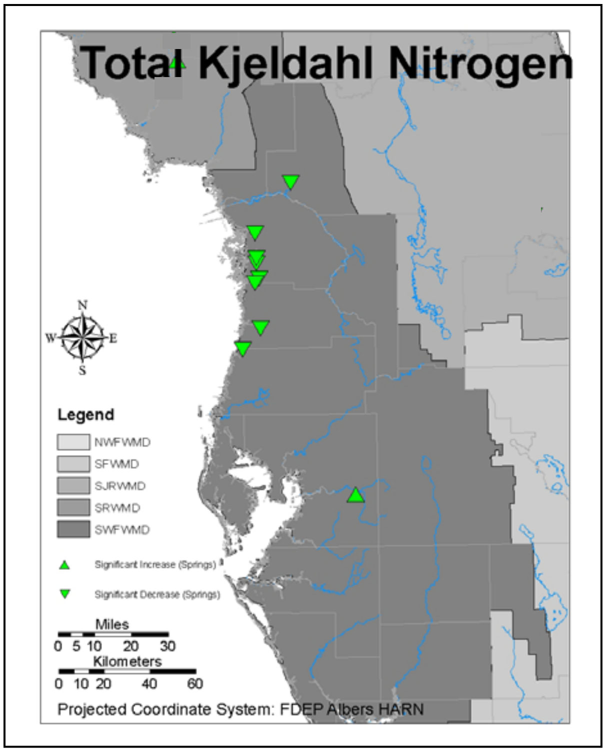

Figure L86. Total dissolved solid trends in SWFWMD springs.

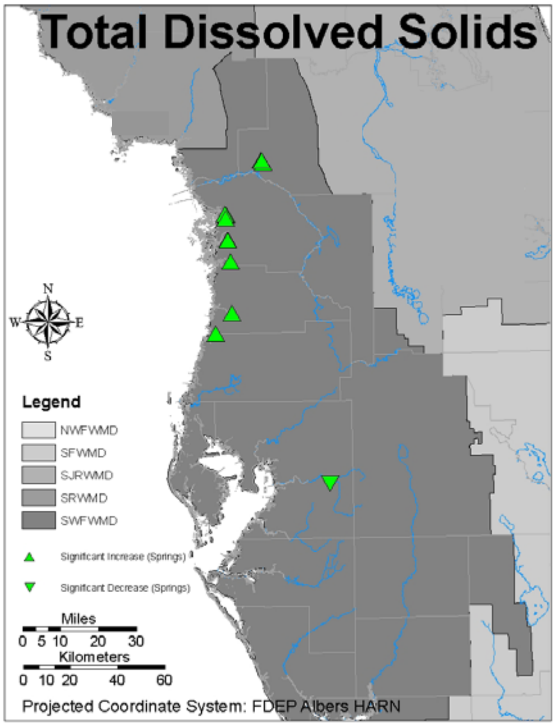

Figure L87. Total kjeldahl nitrogen trends in SWFWMD springs.

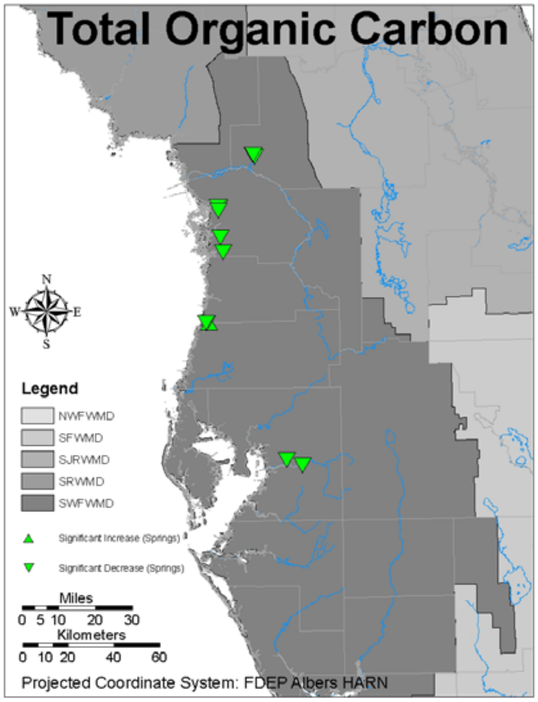

Figure L88. Total organic carbon trends in SWFWMD springs.

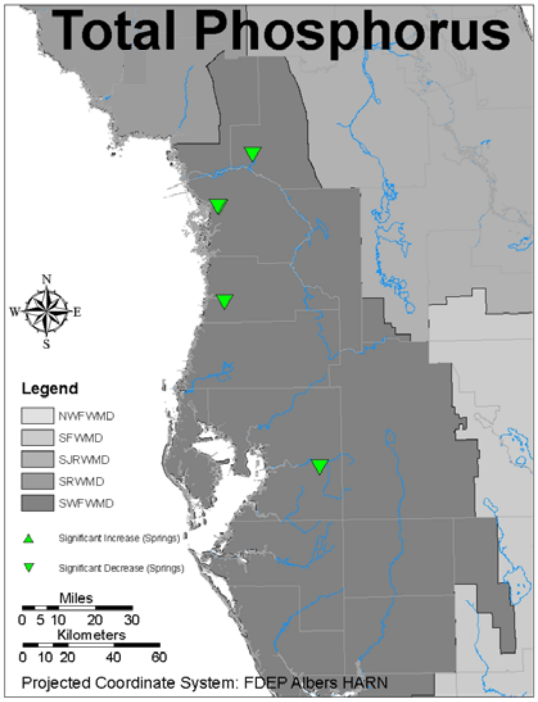

Figure L89. Total phosphorous trends in SWFWMD springs.

Appendix L 8—Southwest Florida Water Management District Wells

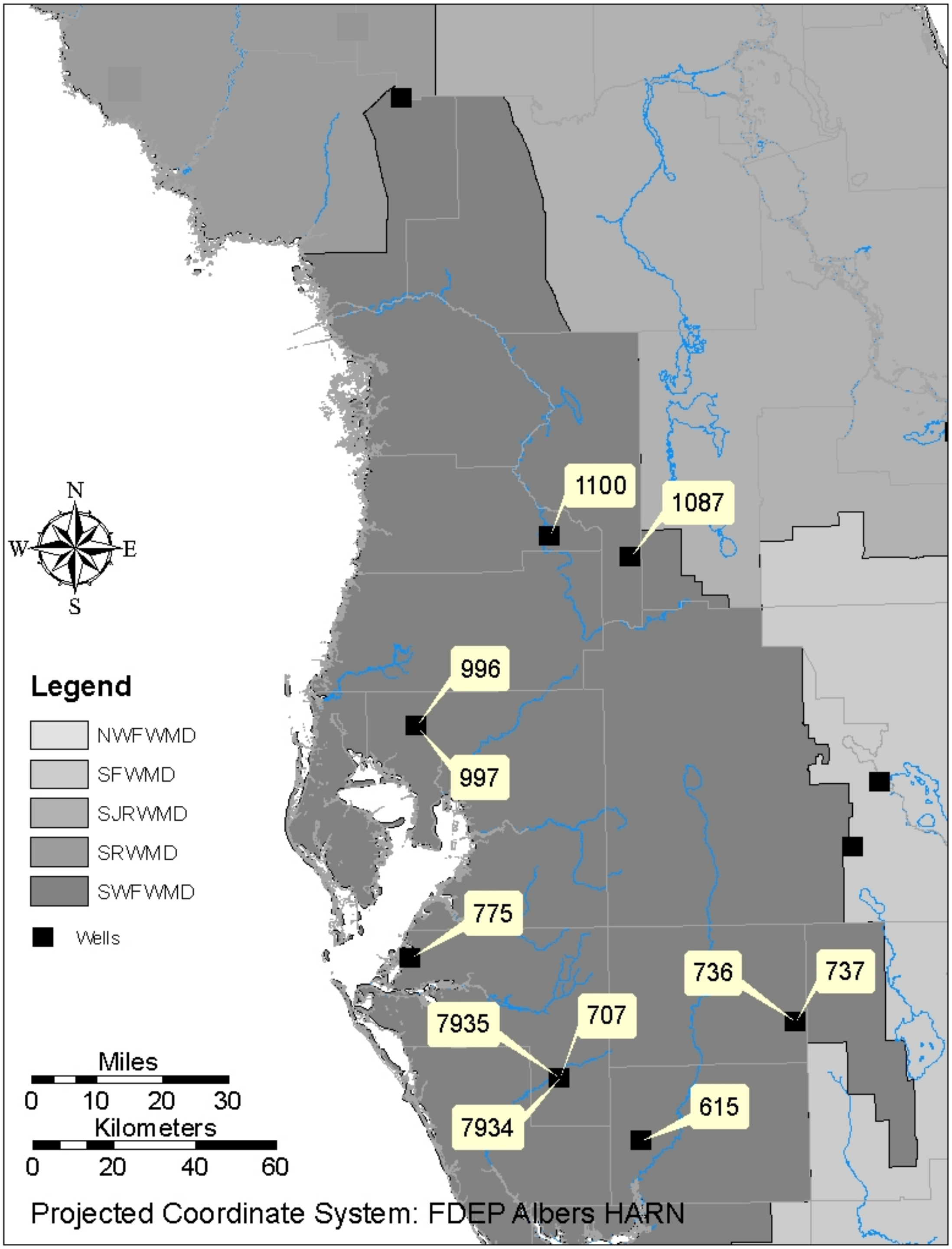

Figure 90. SWFWMD wells.

L31

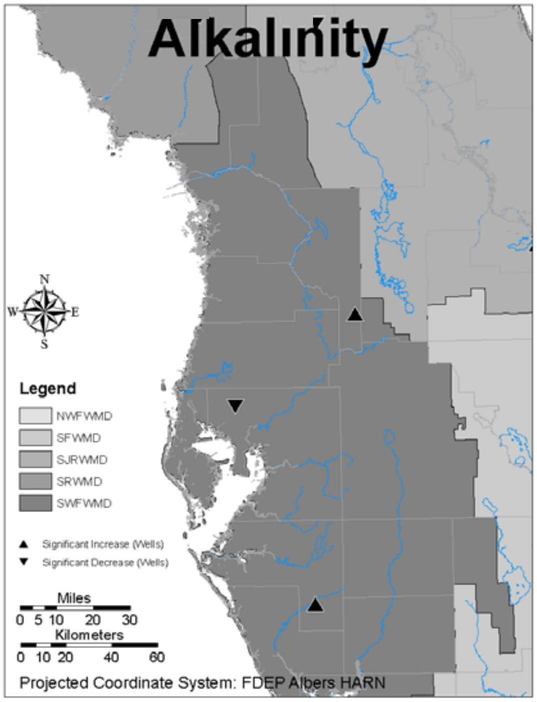

Figure L91. Alkalinity trends in SWFWMD wells.

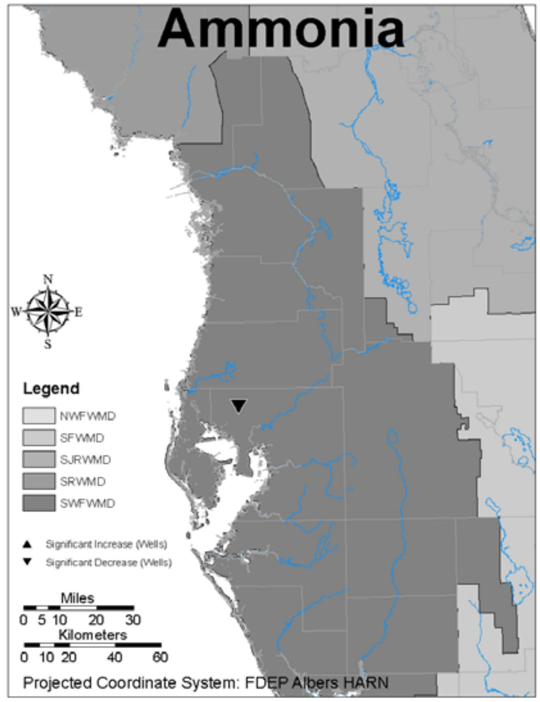

Figure L92. Ammonia trends in SWFWMD wells.

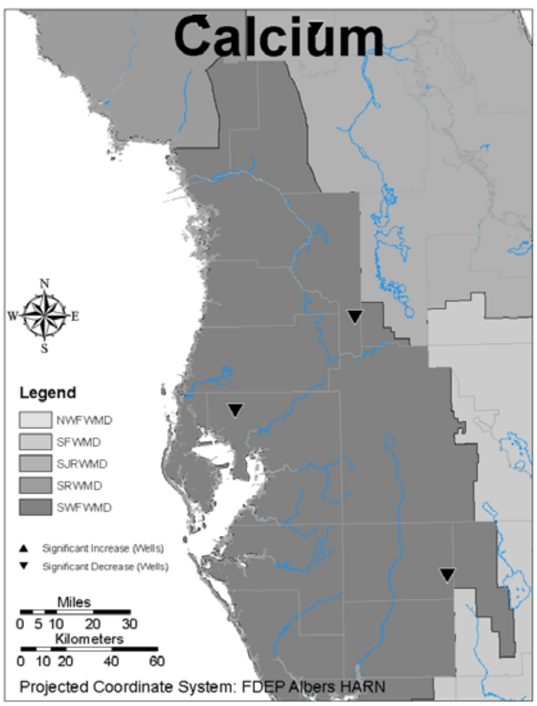

Figure L93. Calcium trends in SWFWMD wells.

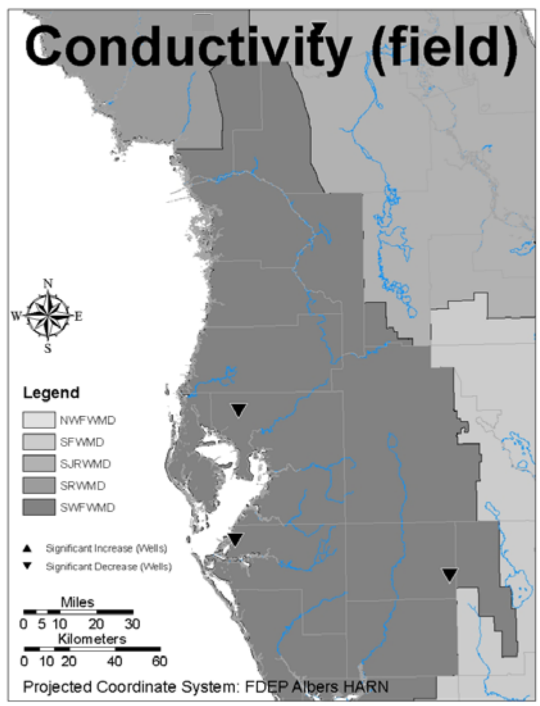

Figure L94. Conductivity (field) trends in SWFWMD wells.

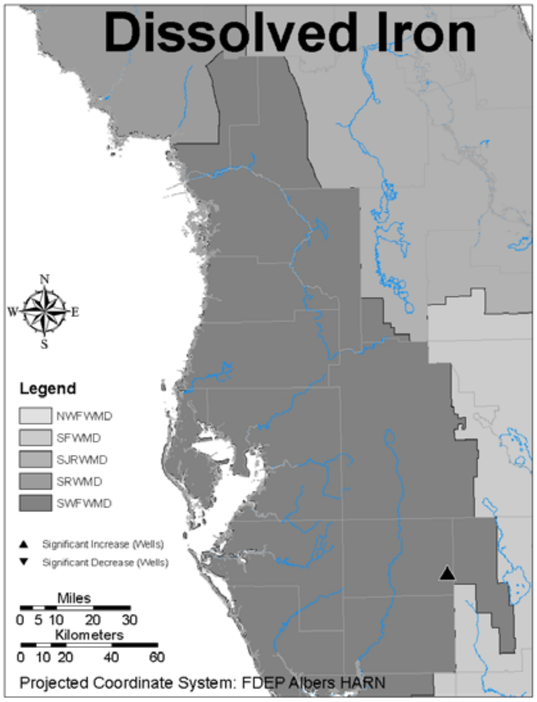

Figure L95. Dissolved iron trends in SWFWMD wells.

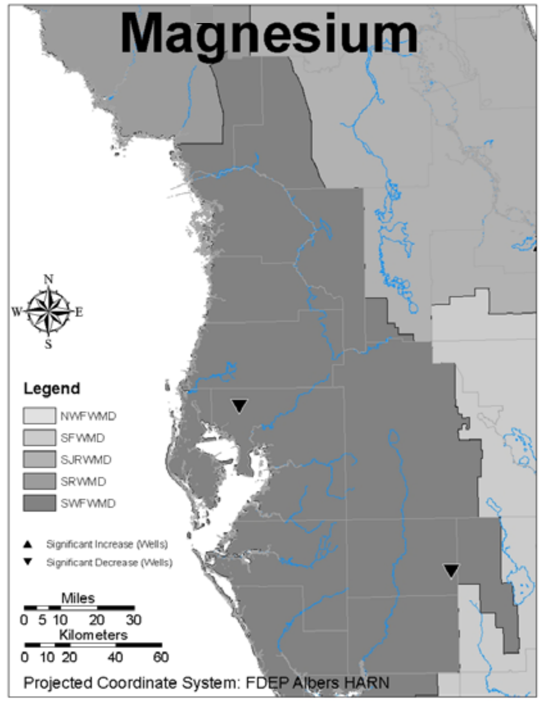

Figure L96. Magnesium trends in SWFWMD wells.

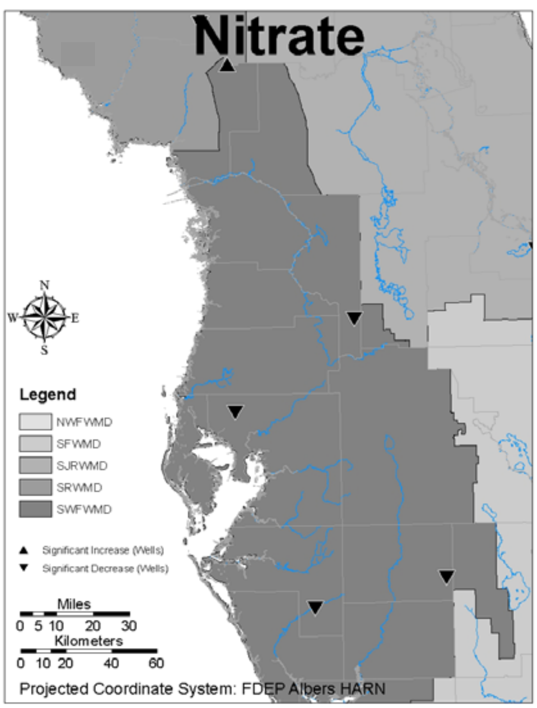

Figure L97. Nitrate trends in SWFWMD wells.

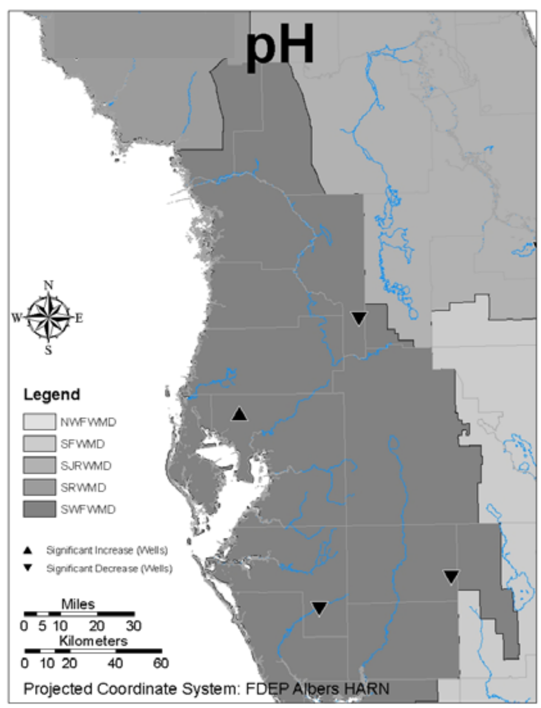

Figure L98. pH trends in SWFWMD wells.

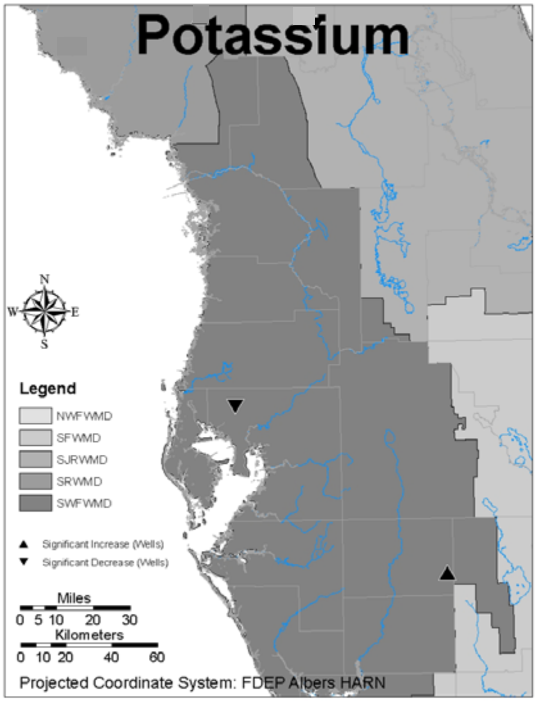

Figure L99. Potassium trends in SWFWMD wells.

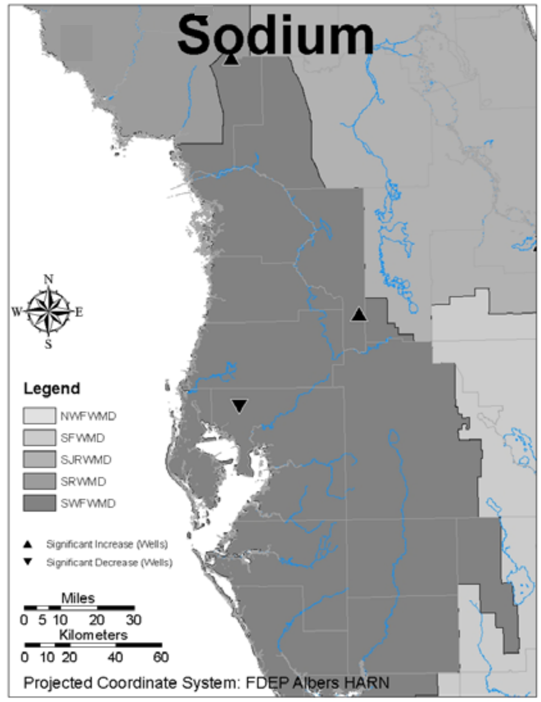

Figure L100. Sodium rends in SWFWMD wells.

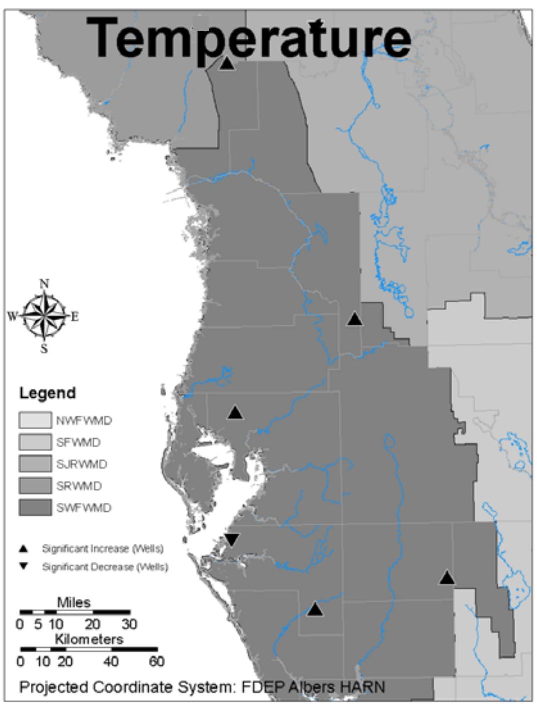

Figure L101. Temperature trends in SFWMD wells.

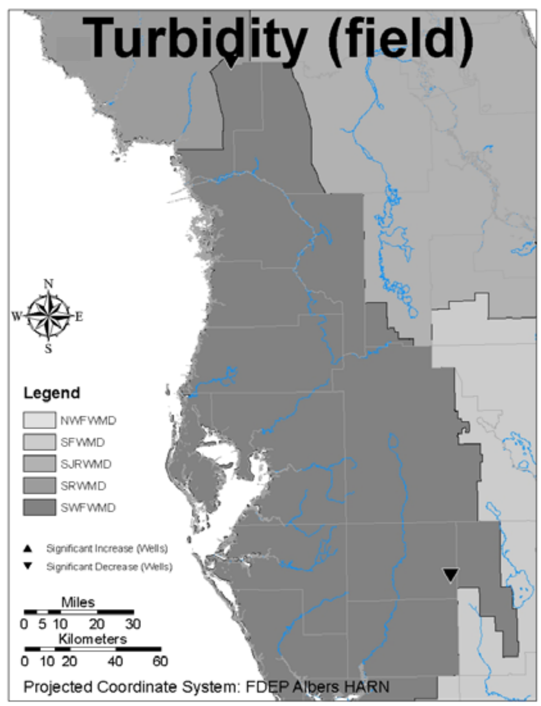

Figure L102. Turbidity (field) trends in SWFWMD wells.

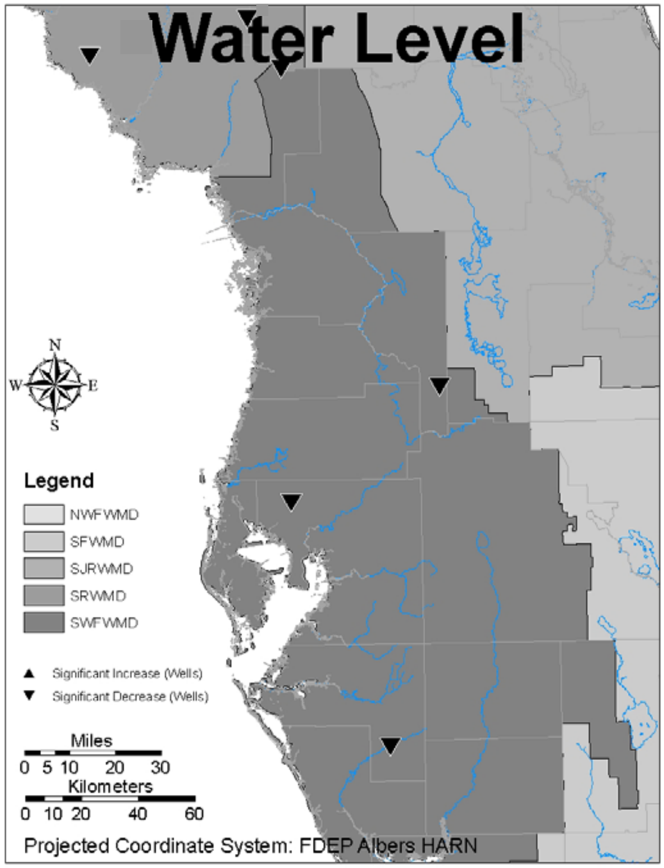

Figure 103. Water level in trends in SWFWMD wells.

Appendix L 9—South Florida Water Management District Wells

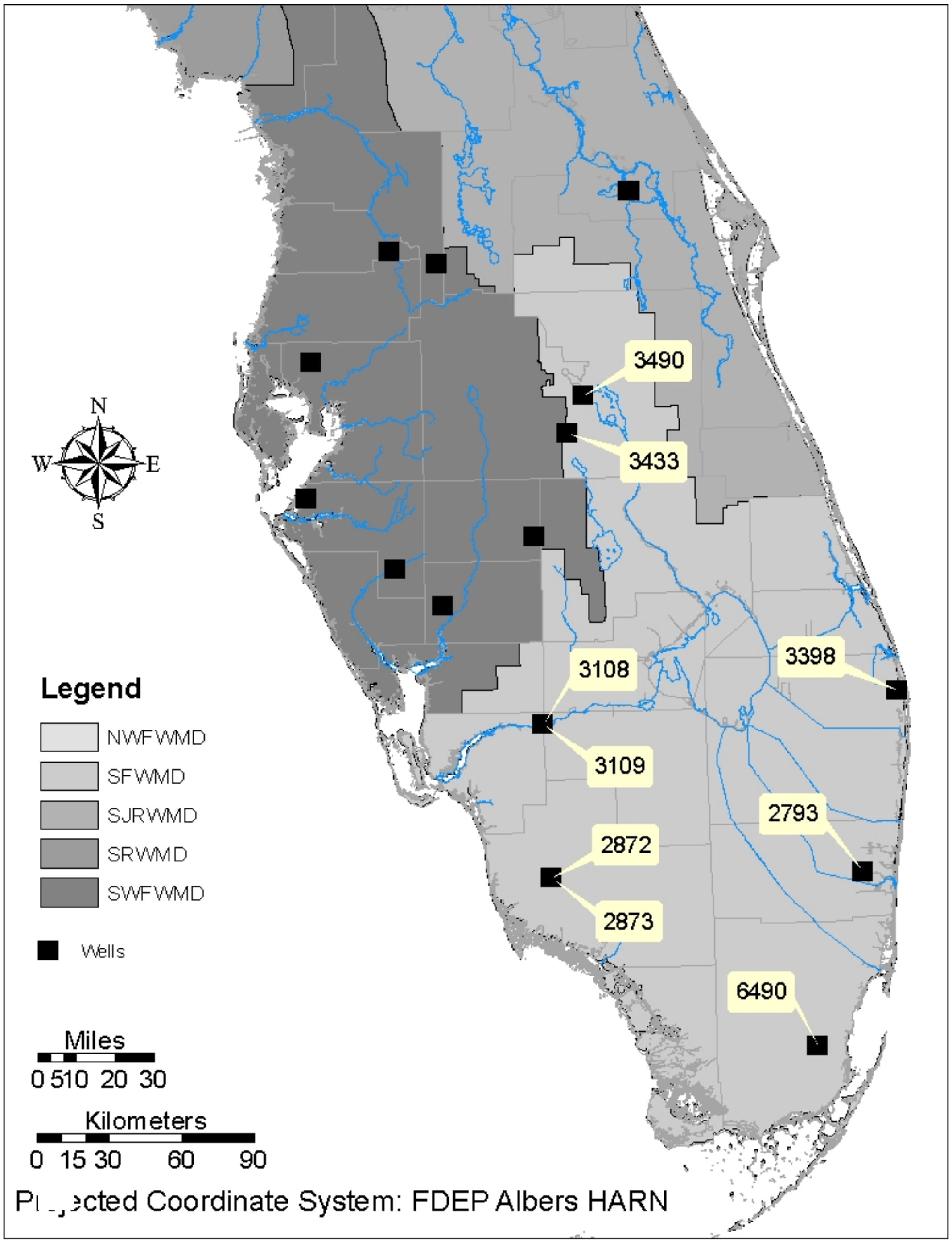

Figure 104. SFWMD wells.

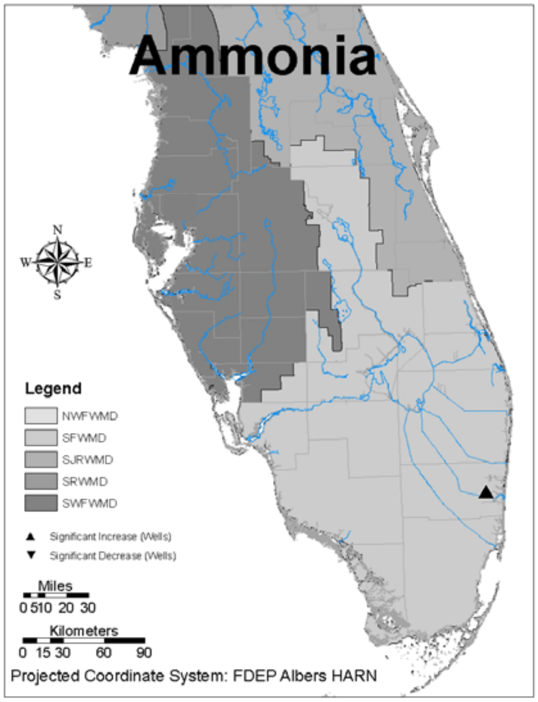

Figure L105. Ammonia trends in SFWMD wells.

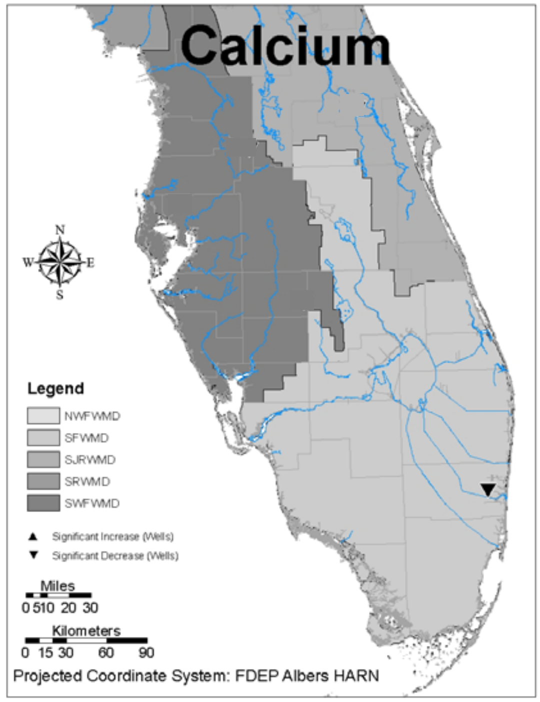

Figure L106. Calcium trends in SFWMD wells.

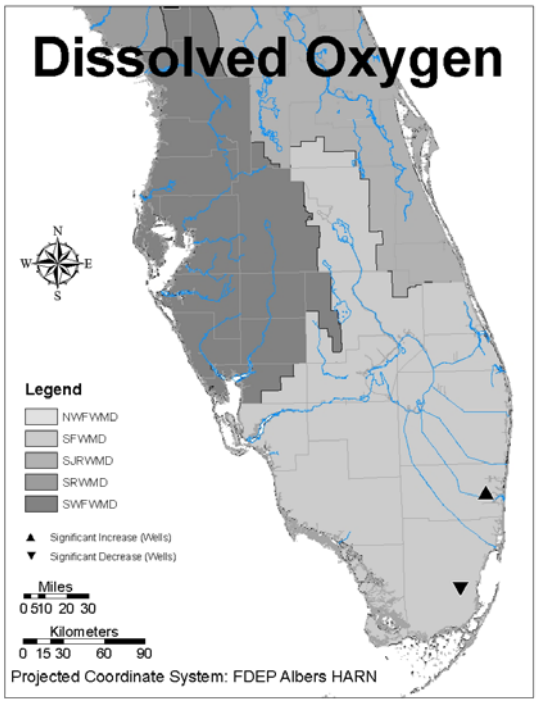

Figure L107. Dissolved oxygen trends in SFWMD wells.

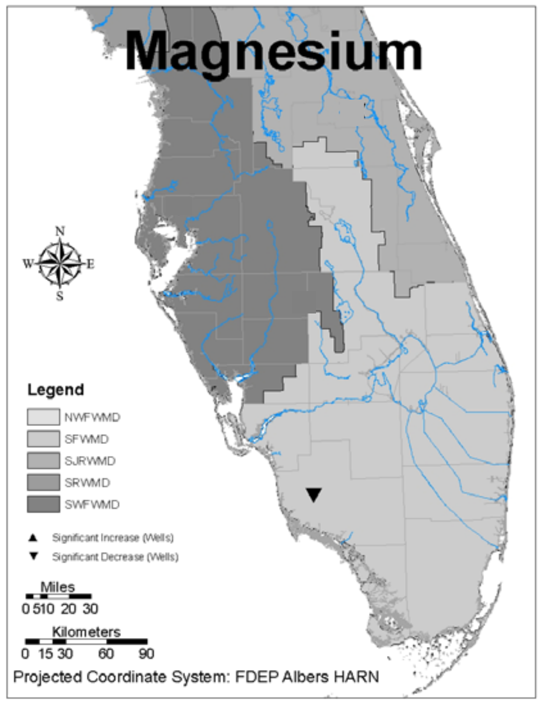

Figure 108. Magnesium trends in SFWMD wells.

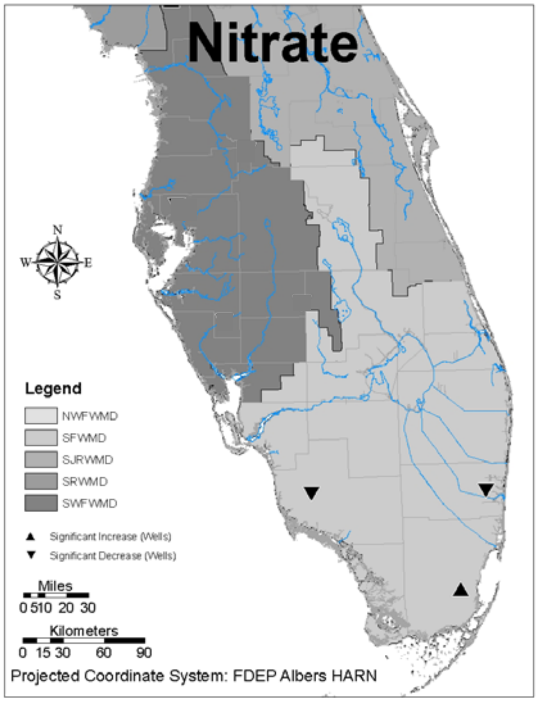

Figure L109. Nitrate trends in SFWMD wells.

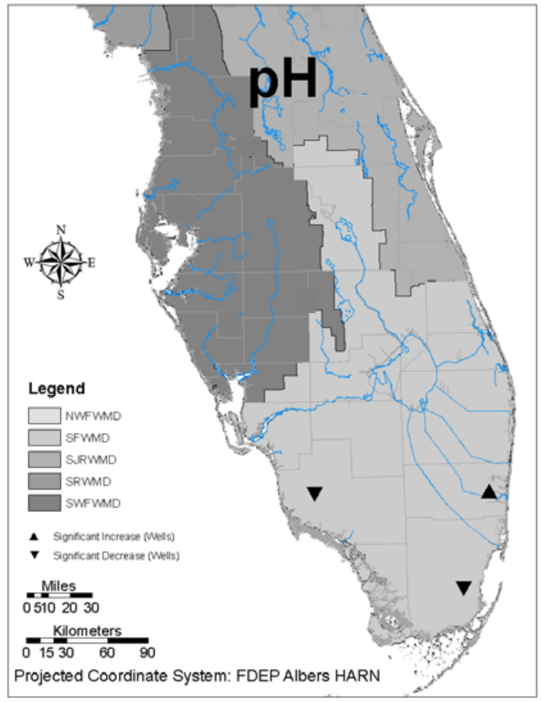

Figure L110. pH trends in SFWMD wells.

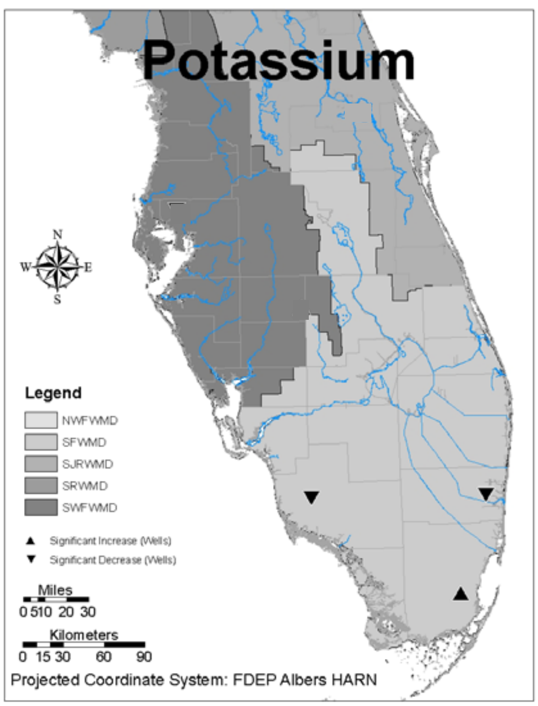

Figure L111. Potassium trends in SFWMD wells.

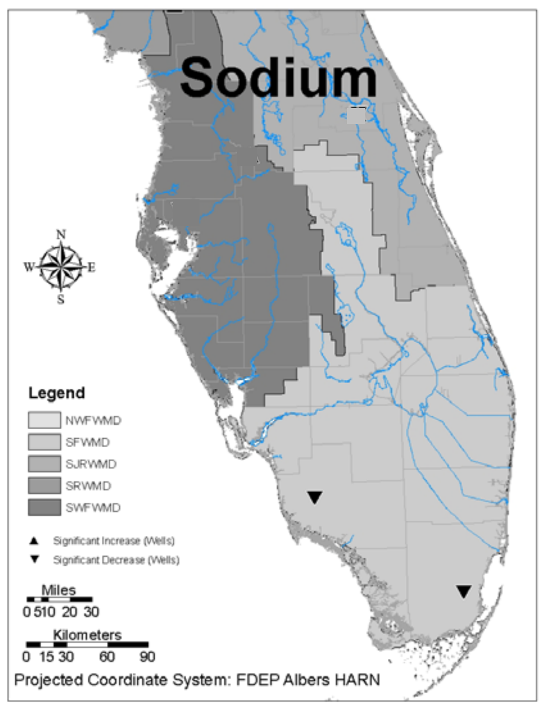

Figure L112. Sodium trends in SFWMD wells.

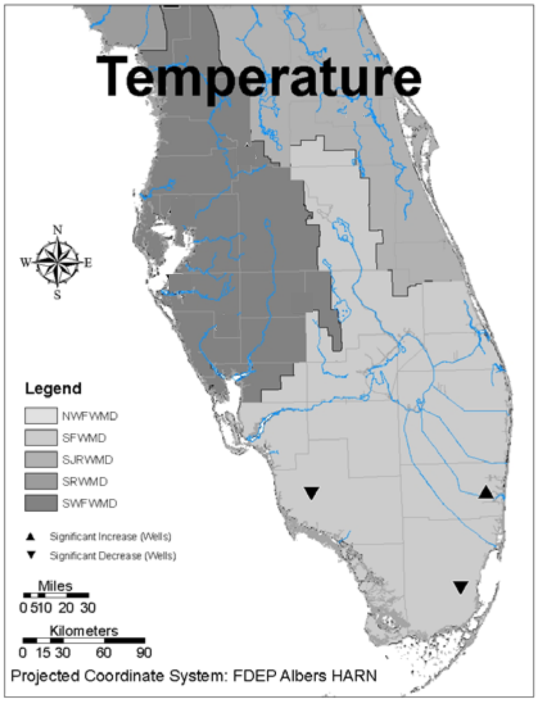

Figure L113. Temperature trends in SFWMD wells.

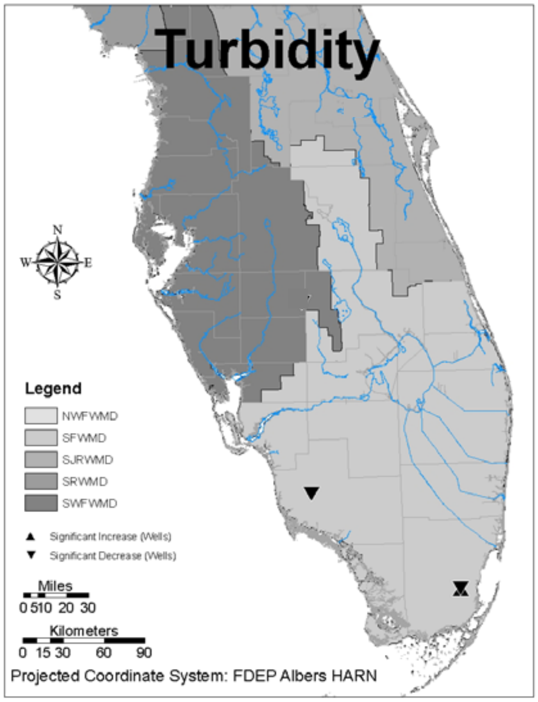

Figure L114. Turbidity trends in SFWMD wells.

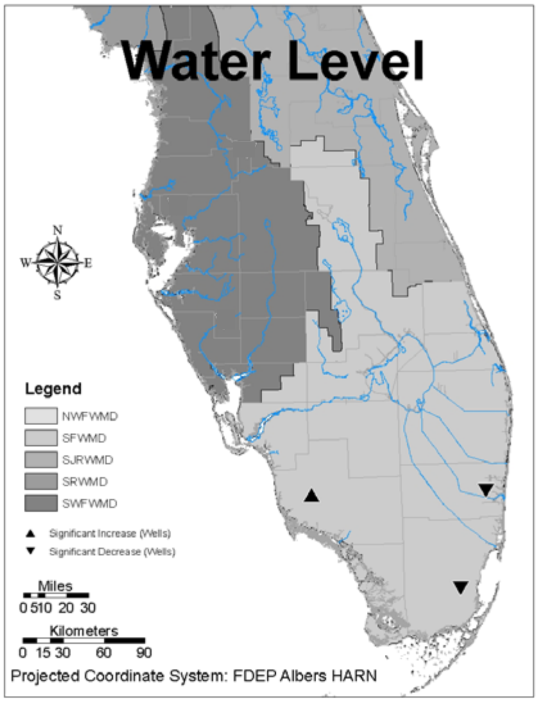

Figure L115. Water level trends in SFWMD wells.

APPENDIX M—RAINFALL AND TEMPERATURE DATA

Annual Rainfall (preciptation) and Termperature Data Per Water Management District (1991-2003)

Data from Southeastern Regional Climate Center (SERCC), Charleston, SC

http://www.dnr.sc.gov/climate/sercc/climateinfo/historical/historical_fl.html

NWFWMD Annual Precipitation Data (in/yr)

Year	Milton	Pensacola	Niceville	DeFuniak Sp	Panama City	Chipley	Wewahitchka	Tallahassee	Apalachicola	Mean
1991	76.5	71.9	48.7	41.6	77.6	72.7	75.8	72.3	88.2	71.3
1992	74.8	76.6	*	80.8	62.3	68.2	77.7	62.8	53.2	63.6
1993	56.6	61.3	57.7	47.2	53.5	50.1	54.5	51.9	51.3	54.2
1994	79.0	75.8	100.9	80.4	72.8	67.2	82.3	85.4	77.2	80.9
1995	81.0	55.1	83.8	69.0	62.2	55.9	53.4	52.4	53.1	62.4
1996	65.4	66.8	84.0	71.0	71.1	56.8	63.5	56.7	79.1	65.3
1997	64.9	80.5	75.5	73.3	61.4	68.0	56.3	64.3	57.9	66.8
1998	66.6	68.6	93.9	81.3	75.1	67.6	77.6	58.8	54.9	67.7
1999	53.1	47.1	50.4	59.3	53.5	44.2	55.9	50.1	42.6	48.4
2000	40.5	42.4	61.1	48.3	41.2	20.0	40.9	44.5	47.9	40.1
2001	55.1	47.5	56.6	55.2	50.4	53.7	55.9	63.5	53.9	52.6
2002	68.6	63.8	73.4	64.9	40.7	73.9	55.9	56.1	67.5	57.5
2003	75.9	63.9	76.2	84.5	78.7	62.7	74.1	65.3	72.1	66.7

NWFWMD Annual Temperature Data (° F)

Year	Milton	Pensacola	Crestview	DeFuniak Sp	Panama City	Chipley	Wewahitchka	Apalachicola	Tallahassee	Mean
1991	67.4	70.1	68.1	69.9	68.2	67.0	68.6	69.8	68.9	68.7
1992	66.4	68.1	67.0	65.8	66.5	65.5	66.9	67.6	67.2	66.7
1993	66.1	67.9	66.7	66.3	66.2	65.6	65.3	68.4	67.7	66.7
1994	66.9	68.6	67.7	66.9	67.4	66.1	67.4	69.5	68.0	67.6
1995	66.9	65.7	67.8	66.6	67.0	66.5	67.3	69.2	67.9	67.1
1996	65.6	67.3	66.9	64.9	65.7	65.3	66.4	67.7	66.5	66.2
1997	68.0	67.5	65.2	66.7	65.8	65.0	69.9	68.8	67.7	67.4
1998	70.5	69.8	*	68.7	65.5	68.3	70.0	72.1	69.8	69.3
1999	67.9	68.9	68.2	67.6	66.4	68.8	67.3	70.3	68.3	68.2
2000	64.8	68.4	52.7	67.5	66.6	55.6	67.2	69.4	67.9	65.9
2001	67.1	68.0	65.5	66.8	67.3	66.4	67.8	69.0	67.7	67.5
2002	67.3	68.2	66.1	67.1	70.4	66.7	68.0	68.4	68.3	68.0
2003	68.4	67.7	65.5	66.4	70.8	67.6	67.0	68.5	67.2	67.9

SRWMD Annual Precipitation Data (in/yr)

Year	Monticello	Madison	Perry	Steinhatchee	Cross City	Mayo	Live Oak	Jasper	Usher	High Sp	Lake City	Mean
1991	73.9	71.7	72.4	83.9	73.1	64.7	74.6	74.7	62.3	60.0	65.2	70.6
1992	54.0	54.7	53.8	53.0	57.4	49.8	52.2	57.5	57.7	60.1	47.9	54.4
1993	47.1	42.1	50.4	52.7	49.0	43.2	52.0	40.9	55.9	51.0	44.9	48.1
1994	92.8	37.8	72.4	73.6	67.0	66.5	65.9	53.2	58.2	54.4	52.8	63.2
1995	56.5	45.8	52.5	49.0	47.4	45.6	33.2	43.0	63.5	53.5	55.1	49.5
1996	64.7	53.7	67.1	69.5	67.6	67.8	54.7	56.0	70.3	59.3	49.5	61.8
1997	66.2	45.8	58.1	67.4	58.9	58.0	62.3	50.3	66.7	56.0	50.8	58.2
1998	61.5	57.4	63.0	56.9	65.9	69.2	71.3	60.7	63.7	54.1	60.0	62.2
1999	35.6	51.2	47.3	47.4	51.7	37.9	39.0	37.7	47.1	55.2	42.4	44.8
2000	51.2	41.0	35.2	39.1	48.6	42.7	41.1	44.2	41.9	46.2	34.0	42.3
2001	50.2	39.4	41.4	*	45.0	40.4	42.5	42.5	56.3	45.2	42.3	44.5
2002	35.6	40.3	62.1	*	43.5	55.0	45.1	51.0	62.5	58.0	53.3	50.6
2003	59.6	61.0	73.5	*	47.0	59.3	60.3	49.2	58.5	56.5	63.4	58.8

APPENDIX M. Rainfall and temperature data.

SRWMD Annual Termperature Data (°F)

Year	Madison	Perry	Steinhatchee	Cross City	Mayo	Live Oak	Jasper	Usher	High Sp	Lake City	Mean
1991	70.0	69.3	70.4	69.1	69.4	70.5	68.5	71.1	69.9	69.2	69.5
1992	68.1	68.2	67.5	62.9	67.7	68.8	65.8	69.6	66.0	68.0	67.1
1993	69.1	68.0	67.7	67.0	67.8	69.4	64.8	69.1	68.5	68.0	67.7
1994	65.5	69.5	69.3	67.4	69.1	70.7	66.8	70.1	69.6	69.0	68.5
1995	66.5	68.6	69.7	67.5	68.3	69.9	66.1	69.3	67.8	68.6	68.0
1996	66.1	67.4	67.2	66.7	67.5	69.5	65.5	68.3	66.7	67.7	67.1
1997	66.7	68.7	66.8	67.0	69.0	69.7	67.4	69.9	68.4	68.9	68.3
1998	69.6	70.3	67.6	69.7	71.2	72.7	69.3	71.9	70.4	70.7	70.1
1999	67.8	68.9	66.6	67.8	68.6	69.7	67.6	70.2	69.7	69.5	68.6
2000	67.1	67.7	64.7	67.9	67.3	69.4	66.4	68.3	68.7	66.3	67.4
2001	67.6	68.4	63.4	65.9	68.1	68.5	67.1	69.0	69.4	69.1	67.7
2002	66.9	68.7	*	69.9	68.5	69.3	67.1	69.4	68.9	69.2	68.6
2003	67.2	70.8	*	51.8	67.6	69.1	67.2	68.7	68.1	68.4	66.5

SJWMD Annual Precipitation Data (in/yr)

Year	Jaxville	Glen St Mary	Ferndale	Jax Beach	St.Augustine	Federal	Hastings	Palatka	Crescent	Gainesvill	Ocala	Lisbon	Clermont	Deland
1991	79.6	73.0	58.9	64.6	51.2	73.1	61.7	0.0	44.7	51.0	48.9	65.1	43.2	71.6
1992	63.2	61.8	63.2	47.5	51.4	54.5	59.1	0.0	36.6	54.3	45.1	55.9	51.8	54.3
1993	50.1	53.4	50.3	53.7	41.1	51.4	48.6	0.0	38.9	43.7	40.8	44.3	36.5	49.1
1994	67.3	53.0	53.4	63.1	63.2	61.7	69.2	0.0	56.9	48.9	55.8	66.9	65.5	68.7
1995	50.3	48.8	73.2	82.8	45.9	45.6	55.8	0.0	37.0	51.2	58.1	52.1	52.2	48.6
1996	60.6	53.3	53.2	45.0	54.2	36.1	57.1	0.0	39.0	54.7	53.0	57.9	51.6	57.1
1997	57.3	51.0	59.7	59.6	55.7	39.1	66.3	0.0	51.4	58.2	49.0	56.1	63.1	62.4
1998	56.7	60.3	48.9	42.0	47.0	32.9	57.1	15.2	48.2	45.6	53.4	37.2	34.5	47.5
1999	42.3	40.7	32.8	33.9	40.0	0.0	46.7	40.9	43.3	37.8	45.6	54.1	42.7	55.5
2000	39.8	38.6	41.6	45.8	43.6	37.0	44.4	49.3	44.5	34.3	28.6	29.3	28.9	42.4
2001	49.1	47.6	36.9	44.6	57.2	54.1	54.7	52.9	54.2	42.1	46.2	47.3	43.1	76.7
2002	54.7	62.6	55.6	52.6	52.9	48.5	52.3	57.4	43.1	52.3	57.2	57.2	85.1	62.7
2003	44.5	58.2	42.5	42.1	53.5	45.8	58.8	51.7	35.4	46.6	52.4	49.8	59.0	52.3

SJWMD Annual Precipitation Data (in/yr) continued

Year	Daytona B	Orlando	Sanford	Titusville	Melbourne	Ft Drum	Vero B	Vero B Airpt	Mean
1991	67.2	60.9	69.3	73.2	58.6	40.6	72.9	66.7	58.9
1992	46.4	53.0	59.9	58.8	49.4	23.8	60.1	54.9	50.2
1993	35.7	44.5	34.5	40.2	39.3	27.5	58.2	56.9	42.7
1994	66.6	67.9	71.1	78.3	69.9	49.3	77.1	65.8	60.9
1995	54.4	43.1	59.3	50.0	70.1	61.2	51.8	44.2	51.6
1996	60.5	56.7	62.8	64.3	49.5	15.5	61.7	59.0	50.1
1997	54.7	64.5	53.7	59.4	64.6	28.2	59.3	62.2	53.4
1998	40.5	43.8	48.8	43.3	55.2	61.2	62.9	64.8	47.6
1999	46.4	54.8	47.0	57.5	61.5	48.7	47.3	56.1	44.3
2000	40.2	30.4	32.8	32.7	43.2	18.9	42.5	47.3	38.0
2001	57.7	54.6	52.7	58.8	64.9	47.3	30.6	48.7	51.0
2002	59.9	66.4	66.2	53.9	55.4	56.6	15.2	55.9	55.6
2003	57.3	52.7	54.9	51.3	44.0	59.6	50.8	45.4	50.4

APPENDIX M. Rainfall and temperature data.

SJWMD Annual Temperature Data (° F)

Year	Jaxville	Glen St Mary	Ferndale	Jax Beach	St.Augustine	Federal	Hastings	Crescent	Gainesville	Ocala	Lisbon	Clermont	Deland	Daytona B
1991	70.4	68.4	69.2	70.6	71.2	70.8	70.2	71.2	69.8	71.8	72.6	73.5	70.9	72.5
1992	68.7	66.3	68.0	68.6	69.8	69.3	68.6	68.3	67.9	70.1	69.7	71.8	69.6	70.7
1993	68.2	66.1	67.9	69.0	69.6	69.0	68.6	68.0	68.0	70.2	69.8	70.9	69.7	70.3
1994	69.5	67.5	69.1	69.3	70.3	70.4	70.1	73.7	69.5	72.0	71.4	72.5	71.3	71.8
1995	68.3	66.8	67.7	69.0	69.3	70.2	69.1	72.0	69.0	71.1	70.1	71.8	71.3	70.7
1996	67.5	64.2	67.4	68.2	68.5	69.5	67.7	71.0	68.3	70.2	69.0	69.4	70.1	69.7
1997	68.4	66.7	68.6	69.4	69.7	73.5	68.4	73.2	69.6	71.6	69.7	71.7	71.6	71.1
1998	70.3	68.8	70.5	71.2	71.4	76.2	71.4	73.2	71.1	72.9	70.7	73.0	72.6	72.7
1999	68.6	67.2	69.0	69.8	70.4	9999.0	69.7	71.8	69.4	71.7	70.4	71.7	71.1	71.5
2000	67.4	66.0	67.9	68.7	69.6	72.5	68.6	71.2	68.2	70.5	69.6	71.1	70.2	70.3
2001	68.3	66.7	69.3	69.5	70.7	70.7	69.7	71.4	69.1	72.4	70.2	72.4	70.4	71.1
2002	68.9	67.8	68.4	70.8	70.9	71.1	70.6	72.0	69.1	71.0	70.9	72.3	70.9	71.5
2003	67.9	67.7	67.3	69.5	70.3	70.7	68.4	71.3	68.7	70.2	71.0	70.8	71.2	71.1

SJWMD Annual Temperature Data (○F) continued

Orlando	Sanford	Titusville	Melbourne	Ft Drum	Vero Beach	Vero B Airpt	Mean
74.0	72.2	72.7	73.4	73.7	73.4	74.8	71.8
72.7	70.7	70.9	72.1	67.8	72.2	73.4	69.9
72.3	70.4	70.9	72.0	67.6	72.3	73.0	69.7
73.6	72.7	72.4	73.7	72.9	74.0	74.6	71.5
72.7	71.9	72.8	72.4	71.6	72.2	74.4	70.7
72.1	70.9	71.2	71.6	69.6	71.7	72.9	69.6
72.8	72.3	71.8	73.0	71.9	72.6	74.6	71.0
73.8	73.3	73.4	74.2	77.1	72.7	74.1	72.6
72.8	72.0	71.8	73.0	72.5	72.1	72.6	70.9
72.3	72.5	71.4	72.2	68.1	70.8	72.3	70.1
72.5	72.2	73.3	72.4	71.9	70.8	72.4	70.8
72.8	73.2	73.5	72.7	72.5	62.6	73.2	70.8
72.7	72.9	72.7	72.4	72.5	73.3	73.2	70.7

SWFWMD Annual Precipitation Data (in/yr)

Year	Inverness	Bushnell	Brooksville	WeekiWachee	St. Leo	Hillsborough	Tarpon Sp	Tampa	St Pete	Plant City	Bartow	Winter Havn	Mt Lake	Parrish
1991	58.0	31.1	51.4	46.0	51.9	46.6	57.2	43.2	48.5	51.3	55.9	49.0	49.1	43.8
1992	62.8	32.5	44.4	34.3	51.2	51.7	58.3	35.0	44.1	58.7	50.5	44.3	45.1	63.9
1993	49.2	23.9	41.2	23.8	47.6	41.1	49.2	37.5	39.9	44.3	47.3	49.4	43.0	54.9
1994	49.2	56.0	59.4	47.2	55.9	56.9	42.6	47.2	42.0	63.9	60.0	62.7	58.0	64.5
1995	51.5	55.0	71.0	32.1	50.4	54.6	61.5	54.1	64.9	51.1	60.3	57.9	55.3	65.4
1996	45.7	38.4	43.3	56.6	50.6	54.1	52.0	49.4	41.4	50.2	46.1	50.2	53.1	40.4
1997	58.2	44.6	48.0	44.4	68.5	67.8	66.6	67.7	72.8	58.1	60.2	39.7	50.8	63.7
1998	42.2	50.0	47.5	50.7	56.1	55.8	54.2	55.4	54.6	62.4	62.3	66.0	38.0	57.1
1999	35.7	34.2	49.4	35.6	43.8	43.8	46.5	34.3	46.5	46.7	42.3	33.3	39.1	41.7
2000	38.2	33.0	40.6	38.1	39.3	33.8	46.9	29.9	46.8	42.4	35.9	47.3	29.5	30.1
2001	52.1	53.9	52.3	48.3	46.2	53.0	48.8	39.8	54.9	57.6	49.6	58.9	56.7	61.5
2002	63.3	62.4	63.2	59.9	69.7	62.2	59.1	62.1	62.3	62.2	65.4	77.1	59.1	51.3
2003	61.0	54.3	67.3	67.4	71.3	48.8	36.7	52.0	62.2	62.3	63.8	51.5	55.9	85.8

APPENDIX M. Rainfall and temperature data.

SWFWMD Annual Precipitation Data (in/yr) continued

Year	Ft Green	Bradenton	Wauchula	Avon Park	DeSotoCity	Arcadia	Myakka	PuntaGorda	Mean
1991	53.1	39.7	53.1	50.8	53.4	36.6	32.9	48.3	47.8
1992	57.7	65.4	54.2	46.6	50.7	59.9	58.7	53.8	51.1
1993	54.0	49.3	54.1	47.0	56.3	28.6	56.6	44.9	44.7
1994	65.9	54.0	40.1	58.7	53.7	46.2	56.8	48.7	54.1
1995	57.9	62.2	53.2	60.7	51.5	56.9	82.3	81.1	58.7
1996	42.4	50.8	43.9	40.7	35.0	31.4	45.5	50.2	46.0
1997	67.5	78.3	57.1	65.2	59.9	59.3	70.5	57.5	60.3
1998	64.8	54.8	66.1	59.4	59.1	52.7	76.5	52.1	56.3
1999	45.1	49.6	40.3	52.7	57.9	43.2	59.9	51.4	44.2
2000	45.9	44.0	29.6	26.1	32.9	45.0	45.2	38.7	38.1
2001	55.1	55.4	49.5	63.0	41.0	48.9	59.0	48.4	52.4
2002	71.7	0.0	53.3	57.6	69.2	60.1	51.4	53.1	58.9
2003	78.1	52.3	50.9	66.2	52.1	56.1	75.8	62.9	60.7

SWFWMD Annual Temperature Data (° F)

Year	Inverness	Bushnell	Brooksville	WeekiWachee	St. Leo	Tarpon Sp	Tampa	St Pete	Plant City	Bartow	Winter Havn	Mt Lake	Parrish	Ft Green
1991	70.9	68.0	72.0	74.2	72.9	74.3	74.3	75.0	73.7	74.4	75.6	74.1	72.8	72.8
1992	69.6	70.0	71.4	69.7	71.0	73.8	72.4	73.3	72.3	72.9	75.3	72.4	72.1	72.1
1993	69.5	70.6	71.7	70.0	72.1	73.2	72.5	73.2	72.2	72.8	73.4	71.9	71.2	71.2
1994	70.5	71.4	72.6	72.3	73.7	74.7	74.1	74.5	73.8	75.2	74.5	74.0	72.2	72.2
1995	69.2	71.5	71.7	70.9	72.9	73.9	73.0	72.8	72.7	73.6	73.8	72.7	71.0	71.0
1996	69.0	70.0	70.8	69.0	71.7	73.0	72.4	72.5	71.7	71.6	72.9	71.4	71.1	71.1
1997	69.9	70.7	70.8	71.6	73.2	74.5	73.8	74.1	73.0	74.1	75.2	72.7	73.2	73.2
1998	71.1	72.6	71.8	72.2	74.4	74.2	74.5	74.9	73.2	74.9	75.2	73.4	74.4	74.4
1999	70.5	70.5	72.6	67.9	73.0	72.8	73.6	73.9	71.7	73.8	71.5	72.3	72.6	72.6
2000	69.3	69.2	70.0	69.1	72.8	72.9	73.2	73.6	71.1	73.0	73.9	71.3	72.6	72.6
2001	69.9	70.8	69.2	70.9	72.9	72.9	73.4	73.6	72.4	73.8	73.9	72.2	72.9	72.9
2002	69.1	70.5	70.9	72.5	73.4	73.1	73.7	74.0	72.7	74.2	74.3	73.4	70.7	70.7
2003	69.2	70.6	71.2	71.1	72.9	72.9	73.1	73.4	72.4	73.8	73.9	75.1	73.0	73.0

SWFWMD Annual Temperature Data (○F) continued

Year	Bradenton	Wauchula	Avon Park	Arcadia	Myakka	PuntaGorda	Mean
1991	74.5	74.1	73.2	74.7	74.1	75.2	73.5
1992	73.1	72.7	71.4	72.7	73.6	73.9	72.3
1993	72.9	72.7	70.8	73.1	73.7	74.1	72.1
1994	74.4	73.5	73.3	74.9	74.4	75.3	73.6
1995	73.3	75.6	71.9	71.8	73.8	74.0	72.6
1996	71.8	70.7	71.2	71.2	73.3	73.2	71.5
1997	73.4	72.2	72.6	73.2	74.9	74.8	73.1
1998	74.1	73.0	73.6	73.9	75.6	75.5	73.9
1999	72.8	71.7	72.4	74.4	74.4	74.1	72.5
2000	72.0	70.9	71.7	71.7	72.5	73.9	71.9
2001	73.2	71.4	72.4	72.2	72.5	74.1	72.4
2002	NA	71.4	73.8	72.3	73.0	74.8	72.5
2003	77.3	71.8	73.1	72.4	72.7	74.7	72.9

APPENDIX M. Rainfall and temperature data.

SFWMD Annual Precipitation Data (in/yr)

Year	Tavenier	Flamingo	Royal Palm	PerrineAve	MiamiBeach	MiaBWSCM	Hialeah	Ft.Lauderdale	Tamiami	OasisRS	Everglades	Naples	Ft.Myers	Immakolee
1991	37.7	52.1	55.8	68.5	30.8	71.4	80.2	72.5	63.4	64.2	56.9	66.8	67.5	60.7
1992	34.8	45.3	47.8	52.3	42.0	57.8	71.0	56.4	39.5	57.2	56.3	47.9	55.5	47.2
1993	51.5	35.6	43.8	69.8	46.0	62.8	65.8	69.5	57.5	59.0	56.6	58.1	54.6	54.4
1994	52.7	47.4	43.9	83.6	56.7	79.6	89.0	87.3	67.4	73.9	41.2	55.5	52.7	60.3
1995	42.6	56.9	46.1	78.7	57.0	79.3	83.0	82.4	44.4	62.6	62.0	52.2	61.7	54.0
1996	48.8	44.1	41.0	65.8	44.8	57.7	66.3	67.0	40.7	67.2	34.5	34.2	*	34.1
1997	19.0	61.5	58.0	73.1	71.0	70.6	75.6	79.5	63.6	67.4	50.1	52.5	*	54.2
1998	24.0	38.0	61.4	61.0	46.9	70.2	72.4	70.0	58.7	54.2	62.1	58.2	57.2	48.5
1999	46.1	50.1	64.8	69.8	46.6	64.1	93.2	73.3	71.6	86.7	29.8	51.9	49.0	2.5
2000	46.1	31.7	49.9	56.6	52.9	61.1	54.2	60.2	46.3	56.6	26.4	38.8	48.8	*
2001	54.6	38.7	59.9	81.1	52.4	72.0	83.0	68.2	53.8	68.0	58.9	54.5	49.4	*
2002	51.1	38.1	52.8	62.2	*	63.3	68.0	67.0	36.5	55.5	53.4	64.9	52.1	*
2003	49.6	35.9	55.0	72.2	65.3	72.1	74.4	62.7	17.9	45.0	63.5	74.6	70.6	42.6

SFWMD Annual Precipitation Data (in/yr) continued

Year	DevilsGard	LaBelle	MooreHaven	BelleGlade	WPBeach	Stuart	Ft.Pierce	OkeeHRCN	DeSotoCity	Kissimme	Mean
1991	60.6	41.4	52.7	57.6	79.4	76.2	65.0	55.9	53.4	52.2	59.9
1992	55.5	43.2	51.0	57.8	61.1	72.9	52.3	51.2	50.7	54.1	52.5
1993	58.8	22.0	38.5	52.5	58.6	83.4	71.5	43.7	56.3	37.8	54.2
1994	56.8	11.4	58.1	77.0	85.9	99.9	80.2	60.7	53.7	73.0	61.7
1995	64.4	34.8	55.5	57.9	69.0	67.6	75.7	54.5	51.5	46.7	57.2
1996	51.7	10.9	38.6	51.1	46.8	49.9	56.2	*	35.0	55.8	44.4
1997	46.6	21.8	48.3	54.6	62.1	13.7	61.2	42.5	59.9	63.5	52.4
1998	65.4	37.4	51.5	50.1	67.1	68.7	58.9	44.4	59.1	43.3	52.7
1999	50.7	16.2	46.5	49.9	62.7	60.6	60.2	49.5	57.9	51.4	51.0
2000	35.7	19.8	32.7	44.1	41.7	11.9	41.0	25.3	32.9	38.2	40.6
2001	61.7	8.8	43.8	53.5	67.3	40.8	57.5	53.2	41.0	44.0	51.3
2002	60.1	15.6	51.5	12.2	60.2	5.9	46.3	33.5	69.2	69.9	47.8
2003	49.0	34.1	45.6	30.2	65.8	23.6	51.2	41.3	52.1	56.6	50.5

SFWMD Annual Temperature Data (° F)

Year	Tavenier	Flamingo	Royal Palm	PerrineAve	MiamiBeach	MiaBWSCM	Hialeah	Ft.Lauderdale	Tamiami	OasisRS	Everglades	Naples	Ft.Myers	Immakolee
1991	78.4	76.3	72.7	75.1	77.4	77.8	77.5	76.8	76.6	77.5	75.5	76.1	76.4	74.9
1992	77.7	74.3	72.3	73.9	76.2	76.9	76.4	75.8	75.2	75.8	72.8	73.6	75.0	73.7
1993	77.7	75.9	76.0	74.4	76.7	77.3	76.6	75.9	77.2	76.5	75.3	74.1	75.0	73.5
1994	78.4	76.8	78.5	75.3	77.7	78.1	77.9	76.9	78.3	77.4	73.9	76.0	76.6	75.1
1995	75.6	75.3	76.4	74.3	77.3	77.1	76.9	76.0	77.2	76.0	75.6	74.7	76.6	73.6
1996	75.6	74.3	77.1	74.3	76.8	76.5	76.3	75.5	76.9	75.3	76.9	74.1	*	74.2
1997	77.9	76.5	78.3	75.3	77.7	77.4	79.2	76.8	78.2	77.2	75.7	75.7	*	74.2
1998	78.6	76.8	76.0	75.3	76.5	77.8	80.2	77.4	78.1	77.9	81.2	76.1	77.7	75.6
1999	78.5	75.8	74.8	73.9	77.4	76.7	78.8	76.2	76.8	76.2	67.9	74.6	74.2	65.6
2000	77.5	77.2	74.6	73.8	77.3	76.7	79.1	76.1	75.4	75.7	73.8	75.8	73.9	*
2001	77.6	78.6	74.9	74.1	76.1	76.8	76.9	76.3	75.9	76.0	71.0	78.3	74.4	*
2002	78.2	79.8	75.7	74.9	*	77.6	77.6	76.7	79.3	77.2	76.4	76.1	75.0	*
2003	77.8	81.3	75.5	74.8	77.0	77.3	77.0	76.1	66.3	76.9	71.8	76.0	74.9	77.7

APPENDIX M. Rainfall and temperature data.

SFWMD Annual Temperature Data (° F) continued

Year	DevilsGard	LaBelle	MooreHaven	BelleGlade	WPBeach	Stuart	Ft.Pierce	OkeeHRCN	Archibold	Kissimme	Mean
1991	74.3	70.1	74.9	73.9	76.7	76.1	74.5	76.5	73.7	73.4	75.5
1992	72.4	78.4	73.1	72.6	75.2	75.2	72.2	74.6	70.9	71.9	74.4
1993	73.8	78.4	72.9	73.1	75.5	75.3	71.7	74.7	71.7	72.0	75.0
1994	74.4	74.3	74.1	75.0	76.1	76.5	74.2	76.6	73.0	73.6	76.0
1995	71.7	80.4	72.4	73.9	75.3	75.0	72.4	75.4	72.2	73.8	75.1
1996	69.1	71.5	72.5	73.1	74.8	75.3	72.8	*	71.2	72.0	74.4
1997	73.0	75.0	74.3	74.8	75.9	70.9	73.7	75.7	72.8	73.2	75.6
1998	75.5	68.2	74.9	74.4	76.5	76.6	73.9	73.5	72.8	74.9	76.1
1999	73.4	*	73.8	73.3	75.4	78.7	73.9	74.0	71.6	74.2	74.6
2000	75.1	*	73.3	73.2	75.1	*	73.5	72.6	71.1	72.0	74.9
2001	73.4	*	73.2	73.9	75.5	*	73.4	73.0	72.1	71.8	74.9
2002	74.8	73.5	74.2	71.0	76.0	81.4	73.7	73.5	72.5	72.1	75.8
2003	74.4	76.0	74.2	77.0	76.0	*	73.6	73.8	72.2	72.0	75.4

APPENDIX M. Rainfall and temperature data.

Mean Annual Temperature Data

Florida Water Management Districts Mean Temperature Data / WMD means per time sequence

Year	NWFWMD	SRWMD	SJRWMD	SWFWMD	SFWMD		Mean A	Mean B	Mean C
1991	68.7	69.5	71.8	73.5	75.5		72.7	72.7	73.3
1992	66.8	67.3	69.9	72.2	74.4		71.2	71.2	71.8
1993	67.0	67.7	69.8	72.2	75.0		71.4	71.4	71.2
1994	67.5	68.5	71.4	73.6	76.0		72.6	72.6	71.7
1995	67.1	68.1	70.6	72.6	75.1		71.8	71.8	72.1
1996	66.1	67.1	69.5	71.5	74.4		70.8	70.8	72.0
1997	67.0	68.4	70.9	73.0	75.6		72.1	72.1	*
1998	69.2	70.5	72.6	73.8	76.1		73.3	*	*
1999	68.0	68.7	70.9	72.4	74.6		71.8	*	*
2000	65.6	67.5	70.0	71.8	74.9		71.2	*	*
2001	67.1	68.0	70.8	72.3	74.9		71.7	*	*
2002	67.7	68.6	70.7	72.7	75.8		72.1	*	*
2003	67.5	68.4	70.7	72.6	75.4		72.0	*	*

Temperature per Sequence	Mean
A	71.9
B	71.8
C	72.0

WMD	Number of Stations	Weight
NWFWMD	9	0.107
SRWMD	9	0.107
SJRWMD	21	0.25
SWFWMD	20	0.238
SFWMD	25	0.298

Mean Annual Rainfall Data

Florida Water Management Districts Mean rainfall (precipitation) Data (in/yr) / *WMD means per time sequence*

Year	NWFWMD	SRWMD	SJRWMD	SWFWMD	SFWMD		Mean A	Mean B	Mean C
1991	71.3	70.6	58.9	47.8	59.9		59.0	59.0	54.8
1992	63.6	54.4	50.2	51.1	52.5		53.4	53.4	46.6
1993	54.2	48.1	42.7	44.7	54.2		48.3	48.3	39.5
1994	80.9	63.2	60.9	54.1	61.7		61.4	61.4	50.7
1995	62.4	49.5	51.6	58.7	57.2		55.9	55.9	54.1
1996	65.3	61.8	50.1	46.0	44.4		50.2	50.2	56.1
1997	66.8	58.2	53.4	60.3	52.5		56.9	56.9	
1998	67.7	62.2	47.6	56.3	52.7		54.8		
1999	48.4	44.8	44.3	44.2	51.0		46.6		
2000	40.1	42.3	38.0	38.1	40.6		39.5		
2001	52.6	44.5	51.0	52.4	51.3		50.7		
2002	57.5	50.6	55.6	58.9	47.8		54.1		
2003	66.7	58.8	50.4	60.7	50.5		56.1		

Rainfall per Sequence	Mean
A	52.8
B	55.0
C	50.3

WMD	Number of Stations	Weight
NWFWMD	9	0.101
SRWMD	11	0.124
SJRWMD	22	0.247
SWFWMD	25	0.281
SFWMD	22	0.247
Total	89	

APPENDIX N. ATMOSPHERIC DEPOSITION STATION INFORMATION

(Data available from http://nadp.sws.uiuc.edu/sites/sitemap.asp?state=fl)

Site ID	Site Name	Latitude	Longitude	County	Elevation (m)
FL03	Bradford Forest 2	9.9747 N	82.1981 W	Bradford	44
FL05	Chassahowitzka National Wildlife Refuge	28.7494 N	82.7494 W	Citrus	3
FL11	Everglades National Park-Research Center	25.39 N	80.68 W	Dade	2
FL14	Quincy	30.5481 N	84.6008 W	Gadsden	60
FL23	Sumatra 3	0.1111 N	84.9919 W	Liberty	14
FL32	Orlando 2	8.5923 N	81.1903 W	Orange	21
FL41	Verna Well Field 2	7.38 N	82.2839 W	Sarasota	25
FL99	Kennedy Space Center	28.5428 N	80.6444 W	Brevard	2